NOISE AND SHADOW-FLICKER STUDY

IMPOFU EAST WIND FARM

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Client:	Red Cap Impofu East (Pty) Ltd
Contact Person:	Lance Blaine
Address:	Unit B2, Mainstream Centre
	Main Road,
	7806, Hout Bay
3E Reference:	PR110633
3E Contact Person:	Lien Van Breusegem
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info@3E.eu
www.3E.eu

3E Renewable Energy Services
The Landing, Unit 401, 4Th Floor
20 Lower Burg Street
Cape Town, 8001

T +27 (0) 21 300 9923
F +27 (0) 21 300 9922

Nedbank, Southern Peninsula 12320900
Account number: 1020820934
Swift: NEDSZAJJ

Registration Number:
2011/112374/07
VAT 4280260649

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1 INTRODUCTION

Red Cap Impofu East (Pty) Ltd (Red Cap) is proposing to develop the Impofu East Wind Farm near Oyster Bay in the Eastern Cape. 3E was commissioned to undertake a specialist study to determine the potential noise and shadow flicker impact on the surrounding environment as a component of the Environmental Impact Assessment (EIA) process that is being undertaken by Aurecon South Africa (Pty) Ltd (Aurecon).

This report describes the potential impact that such a wind farm may have on the surrounding environment, highlighting the methods used in the assessment, the findings, and recommendations.

It provides an overview of the proposed project and the surrounding environment within which it is located (section 2), the applicable legislation and regulations (section 3), and the methodology used for this assessment, including the assumptions and limitations (section 4). Section 5 assesses and addresses the potential noise impact of the development, while the shadow flicker impact is described in section 6. Section 7 concludes the assessment report.

Cumulative impacts have been considered in Sections 5 and 6 by investigating different scenarios. These scenarios are described in section 4.

For both noise (during construction and operation) and shadow flicker, an evaluation of the predicted impacts of the project on the environment has been performed according to the Aurecon impact assessment methodology provided (see the Impofu East Wind Farm Scoping Report for a full description of the methodology).

The requirements of Appendix 6: Specialist Reports, in terms of the 2014 EIA Regulations, as amended, under the remit of the National Environmental Management Act (NEMA) (Act no. 107 of 1998), as amended, can be found in ANNEX G. The details of the expertise of the specialist, Lien Van Breusegem who prepared this report as well as her declaration of independence can be found in ANNEX F.

2 PROJECT SITE DESCRIPTION

2.1 PROJECT SITE

Red Cap proposes to develop three adjoining wind farms with a total of up to 95 wind turbines on a consolidated site of approximately 11 838 hectares (ha) near Oyster Bay as illustrated below in Figure 1. The three wind farms are referred to as Impofu East Wind Farm, Impofu West Wind Farm and Impofu North Wind Farm and are being assessed separately.

The project under investigation in the current report is the proposed Impofu East Wind Farm.

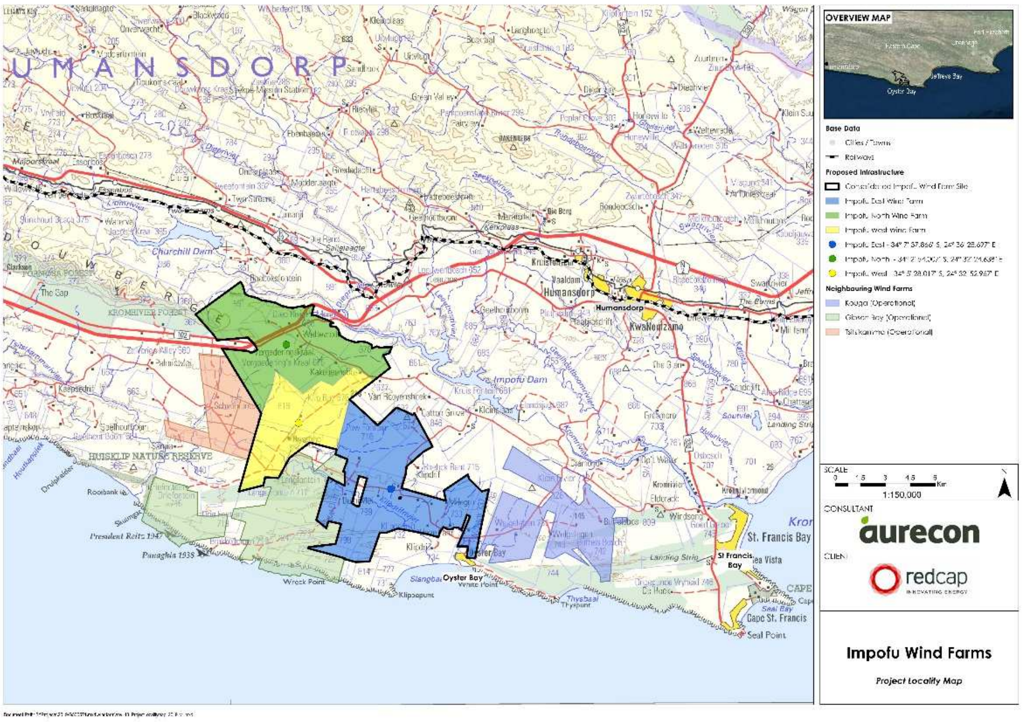


Figure 1: Consolidated Impofu Wind Farms Sites

As illustrated below in Figure 2, 33 wind turbine positions have been proposed for the Impofu East Wind Farm.

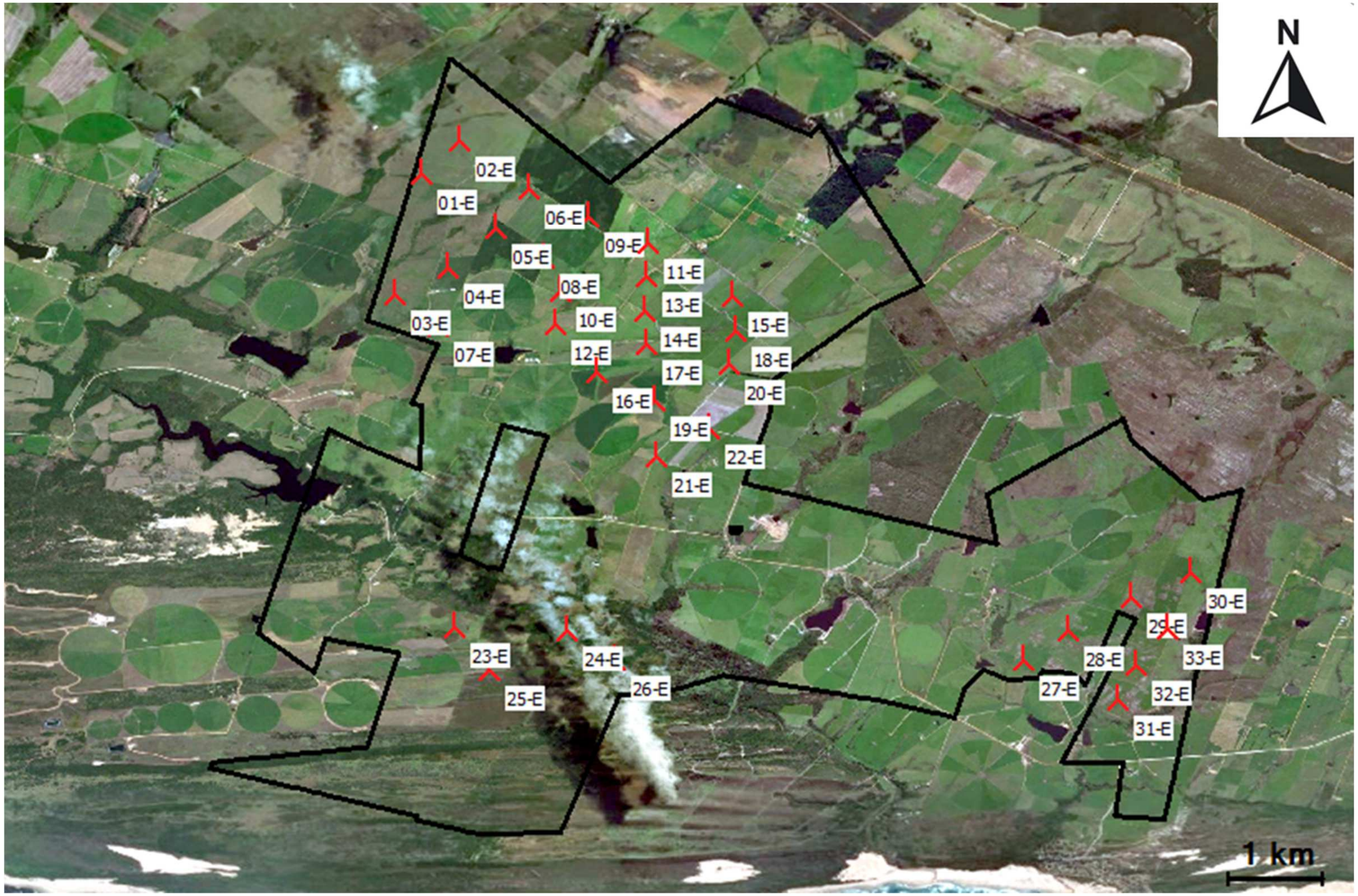


Figure 2: Overview of wind turbine locations of the Impofu East Wind Farm under study

2.2 NEIGHBOURING WIND FARMS

There are three existing neighbouring wind farms in the vicinity of the Impofu Wind Farm project, as listed below:

- Kouga Wind Farm (KWF): 32 N90HS-2.5MW wind turbines with 80m hub height;
- Gibson Bay Wind Farm: 37 N117-3MW wind turbines with 91m hub height; and
- Tsitsikamma Community Wind Farm (TCWF): 31 V112-3.075MW wind turbines with 94m hub height.

There is also a planned wind farm, Oyster Bay Wind Farm, which should begin construction in 2019. This project will consist of 43 V117-3.6MW wind turbines with 91.5m hub height.

An overview of all wind turbine positions (existing, under study and planned) can be found in the Figure 3 below.

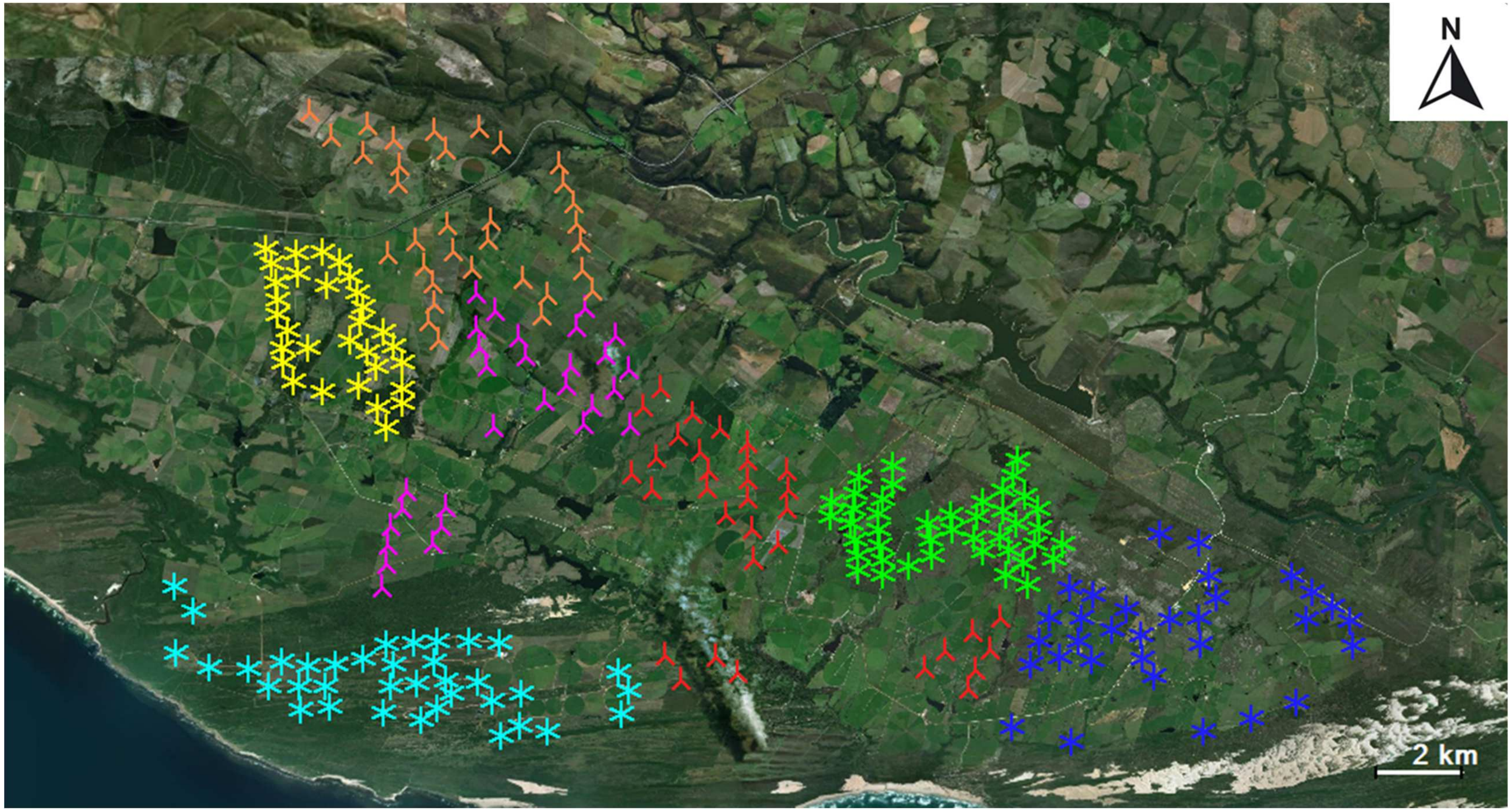


Figure 3: Overview of existing, under study and planned wind turbine locations (Red: Impofu East Wind Farm under study, orange: Impofu North Wind Farm under separate study, magenta: Impofu West Wind Farm under separate study, blue: existing KWF, light blue: existing Gibson Bay Wind Farm, yellow: existing TCWF, green: planned Oyster Bay Wind Farm)

2.3 ENVIRONMENTAL COMPONENTS

As the environmental components will have an impact on the propagation of the noise and the occurrence of shadow flicker, the environment and its impact on noise and shadow flicker is described briefly in the following section.

2.3.1 Topography

The proposed Impofu East Wind Farm will be situated in a rural area with an undulating character. The rural surroundings will lead to more ground absorption and less noise propagation. A Ground absorption factor (please refer to Section 4 for further details on the determination of the Ground absorption factor) consistent for rural areas has been taken into account in this assessment. The undulating character of the surroundings can affect the shadow flicker impact as a topographic area with higher elevation will act as an obstacle between the turbine and receptor, making shadow flicker impossible.

2.3.2 Roads

The roads located in the Impofu East site consist mainly of small dirt roads leading to the various farms in the area. There are no major roads within the Impofu East project site.

2.3.3 Land use

The land use is mainly agricultural, as it is used mostly for dairy farming. The presence of farms and their associated operation may contribute to background ambient noise levels during the day time. Over and above this, the area directly surrounding the proposed Impofu Wind Farms already has three operating wind farms with their operating noise also contributing to the background ambient noise levels.

2.3.4 Residential areas

The coastal village of Oyster Bay is located 2 km South-East of the project site. This settlement has been investigated as a potential sensitive receptor. Other settlements are St Francis Bay and Cape St Francis, located respectively 14km and 17km to the east of the project site and Humansdorp, located 18km to the north east. Given the large distance to these settlements, no noise and shadow flicker related impacts are expected.

2.3.5 Ground conditions and vegetation

Outside of the transformed areas, vegetation is well established and consists mainly of grasses and some trees. There is sufficient vegetation to assume relative soft ground conditions (in terms of noise propagation) for the EIA study. Additionally, some forested zones can be found. These will act as an obstacle between the turbines and the sensitive receptors reducing possible shadow flicker related impact.

2.3.6 Existing Background Ambient Sound Levels

Based on available information, most of the study area can be defined as having a rural character in terms of the background sound levels. The areas surrounding and already affected by the existing operational Kouga Wind Farm (KWF), Gibson Bay Wind Farm, and Tsitsikamma Community Wind Farm (TCWF) can, due to the presence of the wind farms, be considered as industrial (energy production) rather than rural. However, they will, given the rural surroundings, be considered against the same noise levels valid for rural areas.

For the current project, no ambient background noise measurements were performed. As the area is a large homogeneous rural farm area the noise levels will be representative for this type of area. This is confirmed by the site measurements presented in the specialist noise assessments done for the surrounding wind farms

(Kouga, Gibson, Tsitsikamma and Oyster Bay wind farms) (Sentech. 2010. Kouga Wind Energy Project, Specialist Study on Noise Impacts; M2 Environmental Connections CC, 2011. Noise Impact Assessment for Environmental Impact Assessment: Establishment of the Oyster Bay Wind Energy Facility on various farms near the town of Oyster Bay, Eastern Cape; M2 Environmental Connections CC, 2011. Noise Impact Assessment for Environmental Impact Assessment: Establishment of the Tsitsikamma Wind Energy Facility on various farms near the town of Humansdorp, Eastern Cape). Furthermore, the noise generated from the operational surrounding wind farms can be accurately modelled.

A background noise level of 45dB(A) is considered in the study. This is considered a valid approach taking into account that:

- If ambient noise levels are lower than the noise limit of 45dB(A) as set for rural areas, this limit needs to be considered.
- If the ambient noise levels are at or higher than 45dB(A) (ie the limit is already met or exceeded), the increase in noise levels caused by the wind farm needs to be considered and should not increase more than 3dB(A) when introducing the turbine noise.

In this report, the above is considered using the following two step approach:

- Firstly, the turbine noise is calculated, in order to verify whether or not the 45dB(A) limit is exceeded;
- Secondly the calculated turbine noise is combined with the 45dB(A) background ambient noise to calculate the increase in noise levels.

2.4 POTENTIAL SENSITIVE RECEPTORS

All houses and places of work located close to the turbine locations have been identified as sensitive receptors. Buildings within a distance of 3km of the proposed turbine locations of the combined three Impofu Wind Farms were investigated, as it is assumed that this is the maximum distance where potential shadow flicker and noise nuisance impacts can be experienced by the sensitive receptors. To determine the actual impact detailed calculations have been performed for the identified sensitive receptors.

The potential sensitive receptors were defined by Red Cap and 3E based on site visits and photographs taken by Red Cap during the site visits in 2017. 3E then undertook a detailed assessment of the identified receptors based on the photographs and high resolution 2017 aerial images, using 3E's experience in the identification of potential sensitive receptors. The locations of these receptors are shown in the figure below. The coordinates and function of each sensitive receptor are listed in ANNEX A.

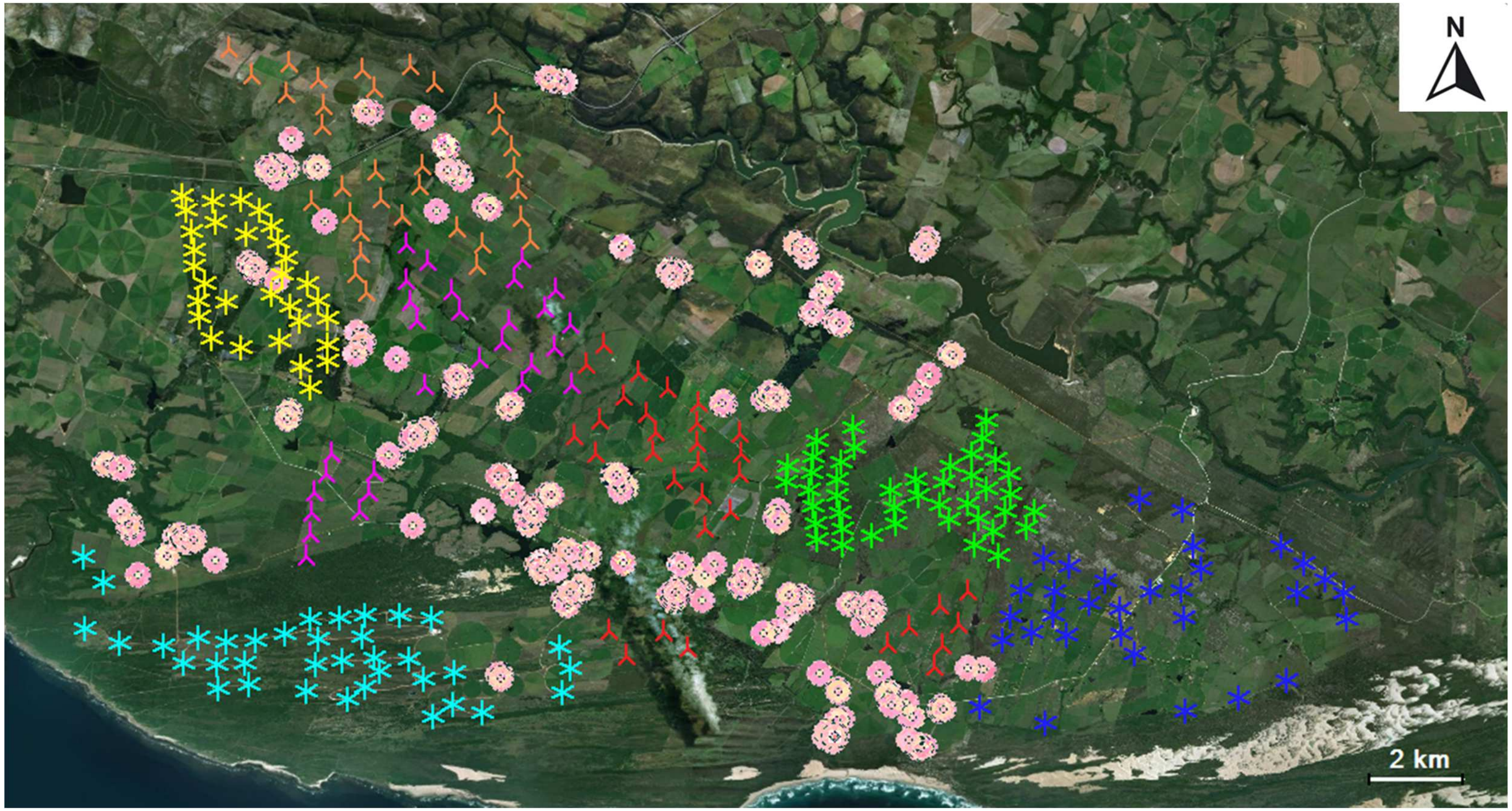


Figure 4: Potential Sensitive Receptors (pink symbols)- Identified for all three of the Impofu Wind Farms (Red, Orange and Magenta)

3 LEGAL FRAMEWORK, POLICIES AND GUIDELINES

This section describes the legislation, policies and guidelines with regard to noise impact. With regard to shadow flicker the World Bank Group's Environmental, Health, And Safety Guidelines for Wind Energy are described, as there is currently no South African legislation and policies governing shadow flicker.

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

The environmental rights 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 which the reasonable person can be expected to tolerate in particular circumstances. The subjectivity of this approach can be problematic which has led to the development of noise standards (see Section 3.7).

"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.

3.2 THE ENVIRONMENT CONSERVATION ACT

The Environment Conservation Act (Act 73 of 1989) ("ECA") allows the Minister of Environmental Affairs and Tourism ("now the Ministry of Environmental Affairs") to make regulations regarding the control of noise, vibration and shock.

3.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT

The National Environmental Management Act (Act 107 of 1998) ("NEMA") defines "pollution" to include any change in the environment caused by noise, amongst other factors, emitted from an activity where that change has an adverse effect on human health or wellbeing. A duty therefore arises under section 28 of NEMA ("duty of care and remediation of environmental damage") to take reasonable measures while establishing and operating the proposed wind farm to prevent significant noise pollution occurring. NEMA sets out measures which may be regarded as reasonable, including:

- to investigate, assess and evaluate the impact on the environment,
- 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,
- to cease, modify or control any act, activity or process causing the pollution or degradation,
- to contain or prevent the movement of the pollution or degradation,
- to eliminate any source of the pollution or degradation, and
- to remedy the effects of the pollution or degradation.

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

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

- The Minister to prescribe essential national noise standards -
  - For the control of noise, either in general or by specified machinery or activities or in specified places or areas; or
  - For determining:
    - A definition of noise; and
    - The maximum levels of noise;
- When controlling noise, the provincial and local spheres of government are bound by any prescribed national standards.

An atmospheric emission license issued in terms of Section 22 may contain conditions in respect of noise. However, it is not anticipated that an atmospheric emissions license would be required as impacts are anticipated to be below thresholds requiring the need for a license.

3.5 DRAFT MODEL AIR QUALITY MANAGEMENT BY LAW FOR ADOPTION AND ADAPTATION BY MUNICIPALITIES

Draft model air quality management by-laws for adoption and adaptation by municipalities was published by the Department of Environmental Affairs in the Government Gazette of 15 July 2009 as General Notice (for comments) 964 of 2009.

Section 18 specifically focuses on Noise Pollution Management, with sub-section 1 stating:

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

The draft regulations differ from the current provincial Noise Control Regulations, because 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 (For more details on the rating levels please refer to section 4.2 on the methodology of the noise assessment).

3.6 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 noise control regulations was devolved to provincial and local authorities. Provincial Noise Control Regulations have been published for the Eastern Cape Province under GN181/PG824/20011210.

3.7 NOISE STANDARDS

Four South African Bureau of Standards (SABS) scientific standards are considered relevant to potential noise impact from a wind farm. They are:

- SANS 10103:2004. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication'.
- SANS 0210:2004. 'Calculating and predicting road traffic noise'.

- SANS 10328:2008. ‘Methods for environmental noise impact assessments’.
- SANS 0357:2004. ‘The calculation of sound propagation by the Concave method’.

The relevant standards use the equivalent continuous rating level (for more details, see section 4.2) as a basis for determining what is acceptable. The levels may consider single event noise, 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.

3.8 INTERNATIONAL GUIDELINES

From the number of existing international guidelines and standards, the three described below were selected as the most relevant as they are used by different countries in the subject of environmental noise management. The last two documents are especially relevant as they focus on the noises associated with wind farms.

3.8.1 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, in the United Kingdom, in April 1999. It is based on the document entitled “Community Noise” that was prepared for the WHO 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 (going from 30dB(A) during the night inside bedrooms, to 55dB(A) outside during the daytime). The issue of noise control and health protection was briefly addressed. The document uses the LAeq and LA,max noise descriptors to define noise levels.

3.8.2 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 (ETSU) project. The aim of the project was to provide information and advice to developers and planners on noise from wind turbines. The report represents the consensus view of a number of experts (experienced in assessing and controlling the environmental impact of noise from wind farms). Their findings can be summarised as follows:

- Absolute noise limits applied at all wind speeds are not suited to wind farms; limits set relative to the background noise are more appropriate;
- $LA_{90,10mins}$ is a much more accurate descriptor when monitoring ambient and turbine noise levels;
- The effects of other wind turbines in a given area should be added to the effect of any proposed wind farm, to calculate the cumulative effect;
- Noise from a wind farm should be restricted to no more than 5 dB(A) above the current ambient noise level at a potential sensitive receptor;
- Wind farms should be limited to within the range of 35dB(A) to 40dB(A) (day-time) in a low noise environment. A fixed limit of 43 dB(A) should be implemented during all night time noise environments. This should increase to 45 dB(A) (day and night) if the potential receptor has financial investments in the wind farm; and

- A penalty system should be implemented for wind turbine/s that operates with a tonal characteristic.

3.8.3 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 10 m height, and
- 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 potential sensitive receptors;
    - Prediction methods to be used (ISO 9613-2);
    - Cumulative impact assessment requirements;
    - It also defines specific model input parameters;
    - Methods on how the results must be presented;
    - Assessment of Compliance (defining magnitude of noise levels).

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

3.9 WORLD BANK GROUP'S ENVIRONMENTAL, HEALTH, AND SAFETY GUIDELINES FOR WIND ENERGY

Shadow flicker occurs when the sun passes behind the wind turbine and casts a shadow. As the rotor blades rotate, shadows pass over the same point causing an effect called shadow flicker.

Shadow flicker may become a problem when potentially sensitive receptors are located nearby, or have a specific orientation to the wind farm.

If it is not possible to locate the wind turbines such that neighbouring receptors experience no shadow flicker effects, it is recommended that the predicted duration of shadow flicker effects experienced at a sensitive receptor not exceed 30 hours per year and 30 minutes per day on the worst affected day, based on a worst-case scenario.

Prevention and control measures to avoid significant shadow flicker impacts include the following:

- Site wind turbines appropriately to avoid shadow flicker being experienced or to meet limits placed on the duration of shadow flicker occurrence, as set out in the paragraph above.
- Wind turbines can be programmed to shut down at times when shadow flicker limits are exceeded.

4 METHODOLOGY

4.1 GENERAL

Noise and shadow flicker calculations have been executed in order to assess the potential impact of the proposed Impofu East Wind Farm on the affected people (sensitive receptors) living within 3km of the proposed wind turbine locations for all three Impofu Wind Farms (see Figure 3).

During the screening phase of the project all potential turbine locations were positioned such that the minimum distance between the turbine locations and any dwellings is at least 500m. These buffers were identified as no-go areas for the location of the wind turbines (this is also illustrated in Figure 5 and Figure 6 below). Even though there is no legislation or guidelines in South Africa enforcing this distance, it is generally accepted that a minimum distance of 500m will limit the impact of the wind farm on the local community as this setback distance is:

- used in legislation in several foreign countries such as Ireland, Australia, and, …
- often specified in the Environmental Authorisation (EA) for other approved wind farms in South Africa

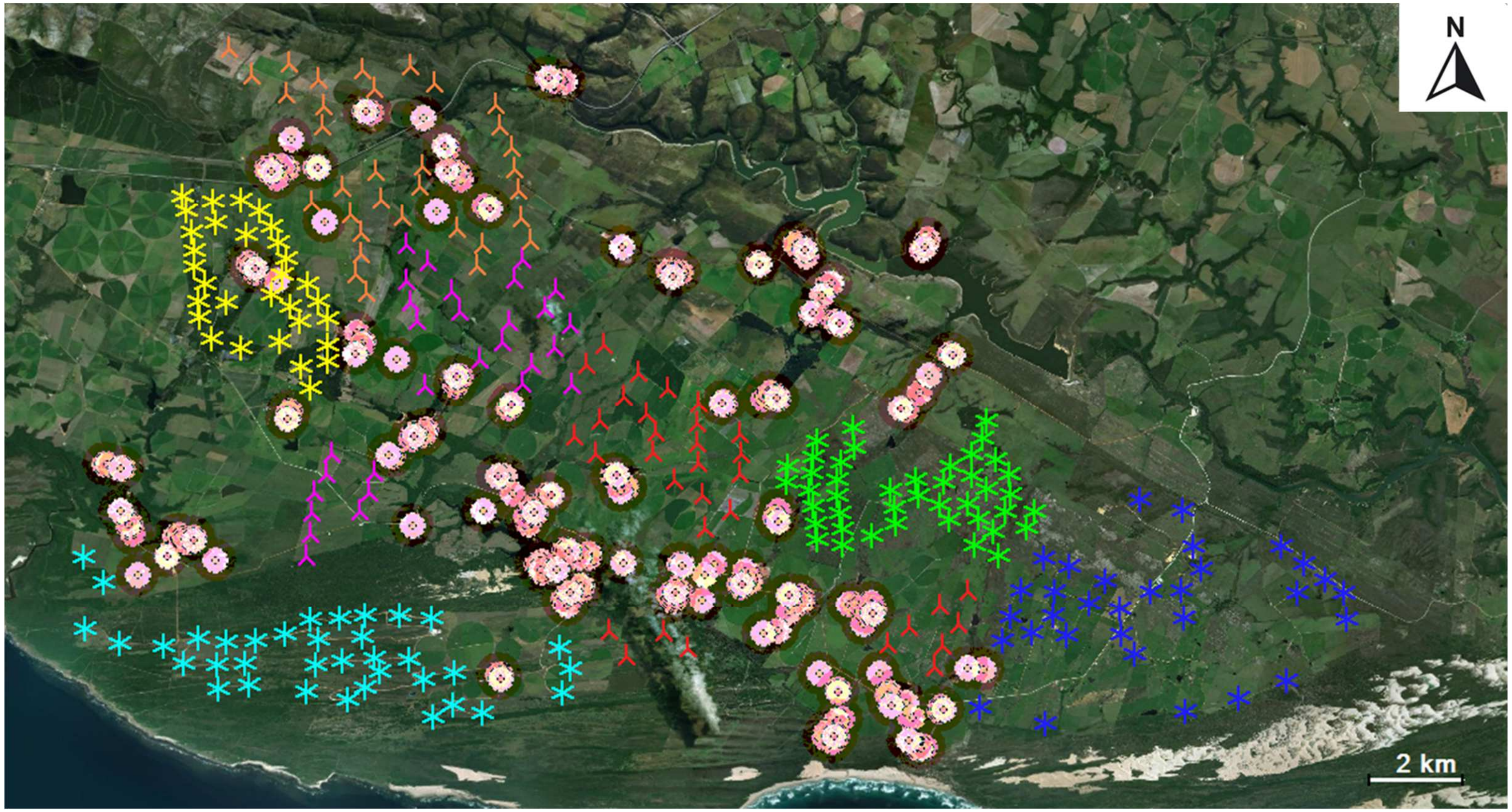


Figure 5: No-go areas (500m) around sensitive receptors

Figure 6: No-go areas around sensitive receptors- Detail Impofu East

For both noise and shadow flicker, the following scenarios where modelled:

- Baseline: The three existing neighbouring wind farms (Kouga Wind Farm (KWF), Gibson Bay Wind Farm and Tsitsikamma Community Wind Farm (TCWF)) will be considered in the baseline of the surrounding area;
- Impact Assessment: The Impofu East Wind Farm under study assessed with consideration of the baseline;
- Cumulative Impact Scenario 1: Impofu North, East and West Wind Farms considered as a consolidated site, in addition to the baseline.;
- Cumulative Impact Scenario 2: Impofu North, East and West Wind Farms considered with the planned Oyster Bay Wind Farm, in addition to the baseline.

The Jeffrey's Bay, Banna Ba Pifhu and Ubuntu Wind Farms have been excluded from the modelling and assessments as they are located at more than 10km from the wind farms under investigation. At such a distance they will not impact the area where the Impofu wind farms will be located.

4.2 NOISE

As described in SANS 10328:2008, and since there are potential noise-sensitive receptors within 2,000 m from a wind turbine location a Noise Impact Assessment is required.

Noise level limits in South Africa are set according to SANS 10103:2008, whereby noise from turbines ($L_{R,dn}$) in noise sensitive areas, such as rural areas, may not exceed 45dB(A). If noise levels exceed the continuous rating level in rural areas (i.e 45 dBA), it is probable that the noise is annoying or otherwise intrusive to sensitive receptors. Table 1 below sets out the typical sound level ratings according to SANS 10103:2008.

Table 1: SANS 10103: Typical zone Sound level ratings

Type of district	Equivalent continuous rating level ($L_{Req,T}$) for noise dB(A)					
	Outdoors			Indoors, with open windows		
	Day-night $L_{R,dn}$ 1)	Day-time $L_{Req,d}$ 2)	Night-time $L_{Req,n}$ 2)	Day-night $L_{R,dn}$ 1)	Day-time $L_{Req,d}$ 2)	Night-time $L_{Req,n}$ 2)
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

As 45 dB(A) is representative of a rural setting, modelling of the noise contour maps was developed for the various scenarios to determine the 45dB(A) contour for the existing and proposed wind turbines (the results of which are presented in Section 5).

Further, the level of exceedance can be related to the probable response of a community to the noise levels as indicated in Table 2 below. In estimating the response of a community to a particular noise SANS 10103 considers the diversity in response from individuals within a community to specific noise level range.

Table 2: Categories of group response to different noise level ranges (Source: SANS 10103 (2008))

Excess ($\Delta L_{Req,T}$) 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

Based on the above table the following categories for estimating a community's response to an increase in noise levels can be defined. If Δ is the increase in noise level, the following categories (as indicated in Table 2) are relevant:

- Δ ≤ 3 dB(A): An increase of 3 dB(A) 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 dB(A) in the general ambient noise level would not be noticeable.
- 3 < Δ ≤ 5 dB(A): An increase of between 3 dB(A) and 5 dB(A) will elicit 'little' community response with 'sporadic complaints'. In other words, people will just be able to notice a change in the sound character in the area.
- 5 < Δ ≤ 15 dB(A): An increase of between 5 dB(A) and 15 dB(A) will elicit a 'medium' community response with 'widespread complaints'. In addition, an increase of 10 dB(A) is subjectively perceived as a doubling in the loudness of a noise.
- For an increase of more than 15 dB(A) the community reaction will be 'strong' with 'threats of community action'.

In order to assess the potential increase of noise levels at sensitive receptors, a worst-case scenario was used by assuming that all sensitive receptors within the study area are experiencing sound levels at the rural threshold of 45dB(A).

The level of noise emitted by a wind turbine varies with the wind speed. Ambient noise also varies with wind speed. According to international norms such as the ISO 9613-2 standard, it is assumed that the noise of the wind turbine is most disturbing at a wind speed of 8m/s, because the ambient noise is still low enough that the difference between wind turbine generator (WTG) and ambient noise levels is high.

The noise calculations for this study are therefore performed at 8m/s, which is the speed at which the wind turbine noise will be most disturbing (highest turbine noise vs lower ambient noise due to the wind) for the chosen turbine type. As the wind speed increases above 8m/s the noise from the wind will increase more than the noise from the turbine so the worst-case scenario with regard to the noise from the turbine is at 8m/s wind speed.

Based on the data used (see Section 4.5), the noise contours were calculated using WindPRO 3.1. The calculations were performed for a Generic turbine type with a 90m hub height and noise levels of 105.5dB(A) at 8m/s and according to the ISO 9613-2 standard.

The following assumptions were made in the noise calculations:

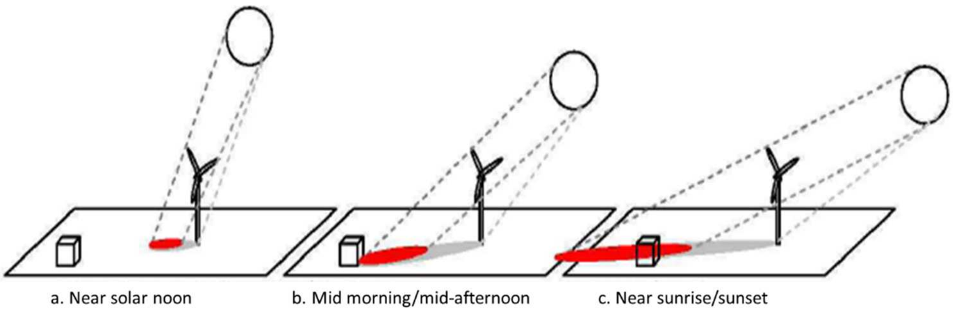
- A degree of ground attenuation consistent with rural areas was taken into account due to soil absorption. Ground attenuation is described in the ISO - standard 9613-2 by a parameter G which is a value between 0 and 1. A ground attenuation of 0 means that there will be no ground attenuation and that all noise will be reflected on the surface. This is the case in urban areas with hardened ground. A ground attenuation of 1 means that all noise will be absorbed by the ground surface. This will be the case for fully natural areas. In this calculation, based on the experience of 3E a sound absorption coefficient was used of 0.8 which is typical for an agricultural environment.
- Obstacles, background noise, and parameters for wind direction were not taken into account as this ensures that the study is looking at worst case noise impact.
- Air absorption was defined, considering a temperature of 10°C and 70% relative atmospheric humidity, as defined in the ISO - standard 9613-2.
- The noise calculations were performed for a height of 2m above ground level, which is assumed to be the height at which people receive the noise emission.

Considering the above-mentioned aspects this study investigates a worst-case scenario.

4.3 SHADOW FLICKER

In South Africa there is no national or local definition of maximum shadow-flicker thresholds from wind turbines. However, many countries (e.g. Germany, Australia, Austria and Brazil, amongst others) have defined shadow-flicker thresholds and the most common similarity between all of these is a limit of 30 hours per year. This limit is also used in the World Banks Environmental, Health, and Safety Guidelines for Wind Energy. As there is no South African shadow-flicker threshold, the generally accepted limit of 30h/yr is used in the current study.

Shadow-flicker occurs when the rotation of wind turbine blades causes alternating periods of shadow and light to a receptor. Shadow-flickering will only occur when the position of the turbine is between the sun and the sensitive receptor, and only when the turbine is operating and the sun is shining, as is shown in the figure below. The figure also shows that the distance the shadow impact will reach depends on the position of the sun. Shadow flicker is expected to reach the furthest around sunrise and sunset, even though the impact will be more limited as the light is more diffuse.



WindPRO is used to perform the calculation of average shadow hours per year. These are calculated for a "real-case" approach. In this approach the following assumptions are used:

- The sun is not always shining. It is only necessary to calculate shadow flicker when the sun is shining. Therefore, a Sunshine Index for the area is used which gives monthly figures of the expected amount of sunshine rated to the maximum possible amount of sunshine. These values give the expected amount of sunshine per month. A value of 0.61 means that 61% of the possible sunshine hours (sunrise to sunset) the sun will actually be shining. A higher Sunshine Index will result in more expected shadow flicker hours. The Sunshine Index for the Impofu East Wind Farm site is given in the table below.

Table 3: Sunshine Index (Sun hours/Possible sun hours)[1]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.61	0.62	0.61	0.68	0.67	0.71	0.71	0.71	0.63	0.60	0.60	0.63

- The wind turbines will not be turning all the time. When there is not enough wind the turbines will not be turning and will thus not cause any shadow flicker. To account for this the operational profile of the wind turbines is used which is estimated using the Wind Atlas of South Africa (WASA) data from 2010 to 2012. This means that the operational hours are considered.
- Due to the variations in wind direction, the rotor blades will not always be perpendicular to the receptor view line. As above, the operational profile of the wind turbines is used. In this case, the yaw direction is considered.
- Some obstacles on site were considered. Eight forested areas were introduced as obstacles that will block the shadow flicker if they are located between the turbine and the receptor.

With regard to the definition of the shadow flicker sensitive receptors the following assumptions were made:

- All receptors are modelled in "greenhouse mode", which assumes at least one window is always orientated to the sun enabling shadow-flicker for sensitive receptors; and
- 1.5m by 1.5m window sizes at 1m height for receptors was assumed.

4.4 TURBINE SPECIFICATIONS

3E has completed a noise and a shadow-flicker study for the given turbine layout (dated January 2019) using a standard turbine with worst case dimensions, i.e. a turbine with 90m hub height for the noise study (low hub heights are a worst case for noise studies) and 120m hub height for the shadow flicker study (high hub heights are considered a worst case for shadow flicker studies). Furthermore, a 75m blade length was considered for each turbine.

These worst-case hub heights and blade lengths were provided in the Terms of Reference provided by Aurecon and a representative turbine type was selected by 3E from a list of reputable manufactures.

For the noise study, 3E has selected a representative noise level of 105.5dB(A) at 8m/s based on a review of the available turbine types that meet the above criteria.

[1] The climate and temperature data for Port Elizabeth from Climatemps was used.

4.5 DATA USED

The data used in this study are summarised below:

- Wind turbine positions as defined by Red Cap and described in Section 2;
- 348 noise and shadow flicker sensitive receptors (for all three Impofu Wind Farms), as identified by Red Cap and checked and assessed in detail by 3E;
- Orographic map of the site. The orographic map was created at the start of the project (10/2017) using the latest available SRTM (Shuttle Radar Topography Mission) data from NASA (National Aeronautics and Space Administration);
- Roughness map of the site was manually created based on aerial pictures and site visit pictures provided by Red Cap;
- Wind data for the area. Wind data from 2010 to 2012 were long term extrapolated using WASA (Wind Atlas for South Africa) data;
- Noise curve data for the considered wind turbine types, as available from turbine manufacturers in October 2017;
- Sunshine Index for the region. The climate and temperature data for Port Elizabeth from Climatemps was used. The percentage of sunny daylight hours was used to define the sunshine Index.

4.6 IMPACT ASSESSMENT METHODOLOGY

The Impact Assessment Methodology is a quantitative methodology, generated through a spreadsheet provided by Aurecon, and backed up by professional judgement in the application of the criteria.

For each predicted impact, the criteria considered are the intensity (size or degree scale) and probability. The intensity includes the type of impact (being either a positive or negative impact);

the duration (temporal scale); and the extent (spatial scale).

To summarise consequence is calculated as follows:

- Consequence = type x (intensity + duration + extent).

To calculate the significance of an impact, the probability of that impact occurring is applied to the consequence:

- Significance = consequence x probability

In the assessment of the impact, the following aspects should also be considered:

- the confidence with which the assessment was undertaken,
- the reversibility of the impact, and;
- the resource (ir)replaceability.

For each predicted impact, the impact assessment is considered firstly in the case of no mitigation being applied and then with the most effective and feasible mitigation measure(s) in place.

Depending on the numerical result, the impact would fall into a significance category as either negligible, minor, moderate or major, and the type of impact would be either positive or negative (for further details on the methodology please refer to the Impofu East Wind Farm Scoping Report).

5 NOISE ASSESSMENT

5.1 CONSTRUCTION NOISE

5.1.1 Sources of Construction Noise

The construction noise will be mainly caused by the construction equipment and traffic. These two aspects are described in further detail below:

Construction equipment

The construction of a wind farm normally takes up to 2 years and involves activities such as:

1. The construction of gravel roads;
2. The excavation for and construction of concrete turbine foundations;
3. The construction of substations/ switching stations, and operation and maintenance buildings;
4. The trenching for underground cables connecting the turbines up to the substations; and
5. Temporary batching plants etc.

The construction equipment likely to be required to complete the above tasks will typically include: excavator/graders, bulldozers, dump trucks, vibratory roller, bucket loader, rock breakers, drill rig, flatbed trucks, pile drivers, concrete trucks, cranes, fork lifts and various 4WD (four wheel drive) and service vehicles.

Traffic

A significant source of noise during the construction phase is the additional traffic to and from

the site, as well as traffic on the site. This will include trucks transporting equipment, aggregate and cement as well as various components used to construct and install the wind turbine.

Construction traffic is expected to be generated throughout the entire construction period, however, the volume and type of traffic generated will be dependent upon the construction activities being conducted, which will vary during the construction period.

5.1.2 Evaluation of construction noise

Construction noise at the various turbine locations will have a local impact. Typical levels of construction equipment, as well as the expected noise impact at different distances is provided in Table 4.

Table 4: Typical Sound power levels (in dB(A)) of construction equipment[2]

Construction Equipment	Maximum sound power level	500m	750m	1000m	2000m
Auger Drill Rig	119.7	54.7	51.2	48.7	42.6
Backhoe	114.7	49.7	46.2	43.7	37.6
Chain Saw	119.7	54.7	51.2	48.7	42.6
Compactor (ground)	114.7	49.7	46.2	43.7	37.6
Compressor (Air)	114.7	49.7	46.2	43.7	37.6

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

Construction Equipment	Maximum sound power level	500m	750m	1000m	2000m
Concrete batch Plant	117.7	52.7	49.2	46.7	40.6
Concrete Mixer Truck	119.7	54.7	51.2	48.7	42.6
Concrete pump truck	116.7	51.7	48.2	45.7	39.6
Concrete saw	124.7	59.7	56.2	53.7	47.6
Crane	119.7	54.7	51.2	48.7	42.6
Dozer	119.7	54.7	51.2	48.7	42.6
Drill Rig Truck	118.7	53.7	50.2	47.7	41.6
Drum Mixer	114.7	49.7	46.2	43.7	37.6
Dump Truck	118.7	53.7	50.2	47.7	41.6
Excavator	119.7	54.7	51.2	48.7	42.6
Flat Bed Truck	118.7	53.7	50.2	47.7	41.6
Front End Loader	114.7	49.7	46.2	43.7	37.6
Generator	116.7	51.7	48.2	45.7	39.6
Generator (<25KVA)	104.7	39.7	36.2	33.7	27.6
Grader	119.7	54.7	51.2	48.7	42.6
Impact Pile driver	129.7	64.7	61.2	58.7	52.6
Jackhammer	119.7	54.7	51.2	48.7	42.6
Man Lift	119.7	54.7	51.2	48.7	42.6
Mounted Impact Hammer	124.7	59.7	56.2	53.7	47.6
Paver	119.7	54.7	51.2	48.7	42.6
Pickup Truck	89.7	24.7	21.2	18.7	12.6
Pumps	111.7	46.7	43.2	40.7	34.6
Rivit Buster/Chipping Gun	119.7	54.7	51.2	48.7	42.6
Rock Drill	119.7	54.7	51.2	48.7	42.6
Roller	119.7	54.7	51.2	48.7	42.6
Sand Blasting (single Nozzle)	119.7	54.7	51.2	48.7	42.6
Scraper	119.7	54.7	51.2	48.7	42.6
Sheers (on Backhoe)	119.7	54.7	51.2	48.7	42.6
Slurry Plant	112.7	47.7	44.2	41.7	35.6
Slurry Trenching Machine	116.7	51.7	48.2	45.7	39.6
Soil Mix Drill Rig	114.7	49.7	46.2	43.7	37.6
Tractor	118.7	53.7	50.2	47.7	41.6
Vacuum Excavator	119.7	54.7	51.2	48.7	42.6
Vacuum street sweeper	114.7	49.7	46.2	43.7	37.6
Ventilation Fan	119.7	54.7	51.2	48.7	42.6
Vibrating Hopper	119.7	54.7	51.2	48.7	42.6
Vibratory concrete Mixer	114.7	49.7	46.2	43.7	37.6
Vibratory Pile Driver	129.7	64.7	61.2	58.7	52.6
Warning Horn	119.7	54.7	51.2	48.7	42.6
Welder/Torch	107.7	42.7	39.2	36.7	30.6

The impact of the construction noise can be estimated by combining the different sources by adding them logarithmically. As it is unknown where the different activities may take place and how they will be combined, a scenario with noise levels of 115dB(A) at the wind turbines locations was assumed and modelled, calculating how this may impact on potential noise sensitive receptors as well as mapping this modelled construction activity over distance.

Table 5: Sound pressure levels of construction noise over distance

Distance from noise source	Sound Pressure level dB(A)
500	47
1000	40
1500	35
2000	32

It is likely that the construction noise will have little impact on the surrounding community as it will mostly occur during the day when the ambient noise is louder and there are unstable atmospheric conditions. The construction noise will be transient in nature and in all likelihood not constant for extended periods as the construction team will move from site to site.

The following measures should be implemented to reduce noise impact during the construction phase:

- Selection of mechanical equipment with lower sound power levels to minimise impact.
- Construction workers and personnel to wear hearing protection when required;
- Vehicles and machines to be properly serviced and well maintained;
- Vehicles must adhere to speed limits;
- Establishment of a proactive warning system to inform affected community members of the planned construction activities with an estimation of the commencement date and duration of each activity; and
- Establishment of a grievance procedure whereby noise complaints by affected community members are recorded and responded to.

5.1.3 Conclusion

The impact is expected to be minor negative considering the above provided information, as well as the fact that construction activities:

- have a local nature, as they are limited to the turbine position;
- have a short time duration. Only during construction will there be any impact;
- will take place during daytime hours when ambient noise levels are highest. However, there will be instances where working hours will extend into the night (i.e. laying foundations for the wind turbines). Additionally, during installation works will take place when wind speeds are at their lowest, whether it is during day or night. Before these activities are due to commence the community will be notified of the activities and the duration of said activity.
- Do not have constant noise levels. Not all equipment will be operating at the same time, traffic will have an impact only when passing by.

Considering all aspects as described above the impact assessment was executed. The results are presented in the table provided below:

Project phase	Construction			
Impact	Construction Noise Impact			
Description of impact	Impact of construction noise on neighbouring communities			
Mitigatability	Low	Mitigation does not exist; or mitigation will slightly reduce the significance of impacts		
Potential mitigation	use well maintained equipment with lowest noise levels, speed limit for vehicles, spread works across the site			
Assessment	Without mitigation		With mitigation	
Nature	Negative		Negative	
Duration	Brief	Impact will not last longer than 1 year	Brief	Impact will not last longer than 1 year
Extent	Limited	Limited to the site and its immediate surroundings	Limited	Limited to the site and its immediate surroundings
Intensity	Very low	Natural and/ or social functions and/ or processes are slightly altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Certain / definite	There are sound scientific reasons to expect that the impact will definitely occur	Almost certain / Highly probable	It is most likely that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	High	The affected environmental will be able to recover from the impact	High	The affected environmental will be able to recover from the impact
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	Minor - negative		Minor - negative	
Comment on significance	The impact of construction noise will be minor, as it will be temporary and reversible.			
Cumulative impacts	If all three wind farms are constructed at once, the cumulative impact will not be significantly different to the impact from one wind farm as constructing more wind farms will not cause more concentrated or greater noise sources but will rather spread the noise over a larger area. Thus the significance for Cumulative Scenario 1 and 2 would be Minor-Negative			

5.2 OPERATIONAL NOISE

5.2.1 Sources of Operational Noise

Noise produced by wind turbines has a double origin:

- Mechanical noise produced by the movement of parts in the nacelle of the turbine (gearbox and generator and control equipment for yaw, blade pitch); and
- Aerodynamic noise produced due to the movement of the turbine blades. This noise depends on the tip speed and the shape of the blades.

The level of noise emitted by a wind turbine varies with the wind speed. Ambient noise also varies with wind speed. According to international norms such as the ISO 9613-2 standard, it is assumed that the noise emitted from the wind turbine is most noticeable at a wind speed of 8m/s, because the ambient noise is still low enough that the difference between the wind turbine noise levels and ambient noise levels is high.

The noise curve used in the noise calculations is provided in the table below.

Table 6: Noise curve (dB(A)) used in the noise calculations

Wind Speed [m/s]	5	6	7	8	9	10
Noise emission [dB(A)]	103.3	104.9	105.4	105.5	105.5	105.5

5.2.2 Baseline Sound Levels

The baseline noise calculations undertaken have resulted in a baseline noise contour map as illustrated in Figure 7 below (further detailed images can be found in ANNEX D). The noise map displays the 45 dB(A) contour, which represents the connecting points of the same noise level. Figure 7 demonstrates how noise from the turbines dissipates fairly quickly over distance, it is anticipated that noise levels reach the 45dB(A) contour within 200m – 800m from the existing noise turbines.

Only the sensitive receptors located within the 45 dB(A) contour, where noise levels of more than 45dB(A) are expected are shown, and would thus most likely experience nuisance. As can be seen in Figure 7 the only receptors that are currently experiencing noise exceedances within the baseline are those located within the TCWF. As these sensitive receptors are already living within an existing wind farm location it can no longer be considered as being of a rural nature with regards to noise.

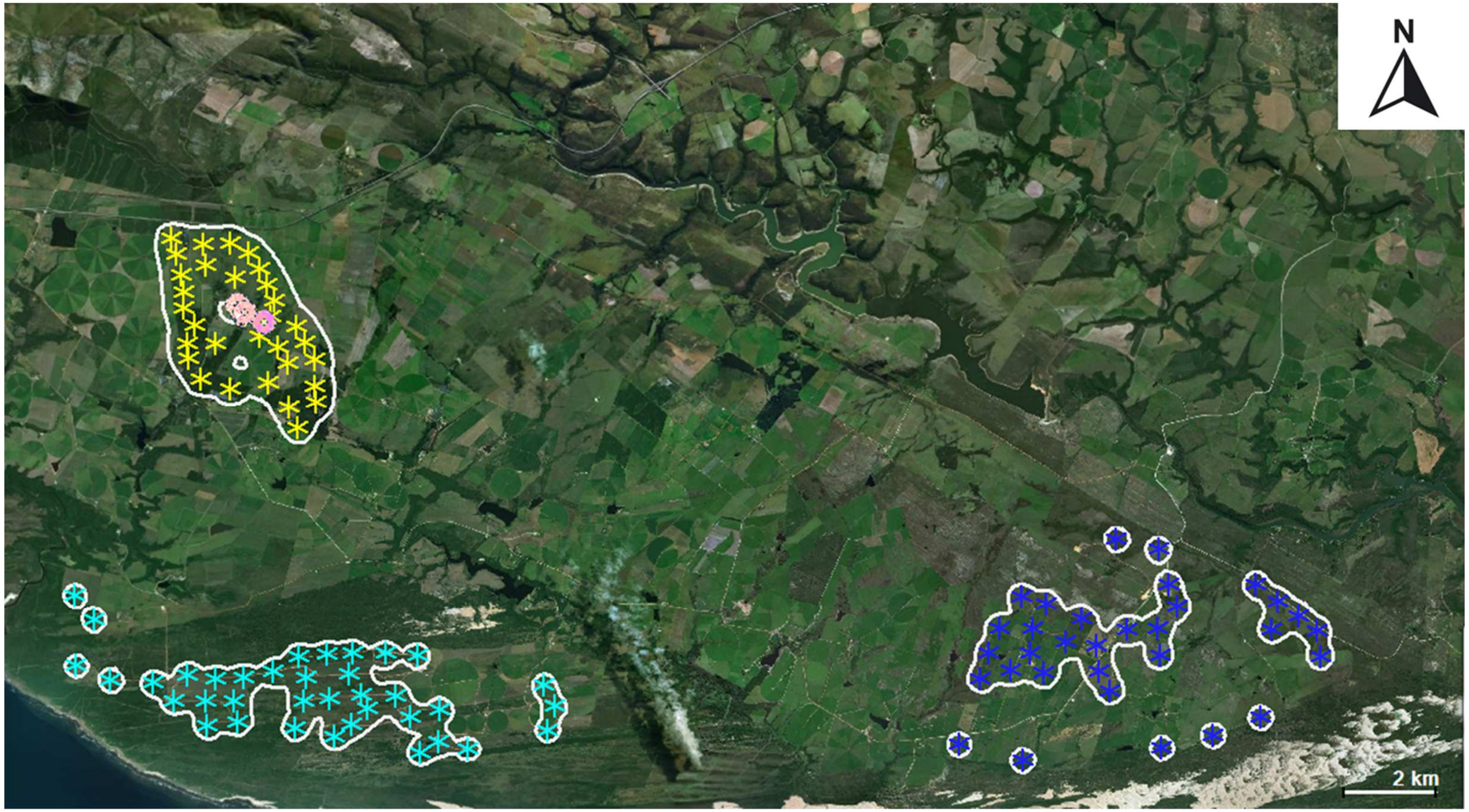


Figure 7: Noise contour map (45dB(A)) - Baseline scenario (White line: 45dB(A) contour lines, pink circles receptor with exceedance of 45dB(A) limit, blue: existing KWF, light blue: existing Gibson Bay Wind Farm, yellow: existing TCWF)

Table 7 below sets out the exceedances of noise levels at the sensitive receptors. Only one receptor within the TCWF falls below the 45dB(A) threshold (receptor 153a, with a noise level of 44.9dB(A). A further three are at the rural threshold, with nine receptors within the TCWF experiencing exceedances of between 45.1 – 50.4 dB(A). These noise levels are representative of a wind farm environment.

Table 7: Main Results- Sound Power Level for each Sensitive Receptor at the TCWF

Noise Sensitive Receptor	Sound Power Level dB(A)
153- SS and offices	50.4
153a	44.9
153b	45.0
153c	45.1
153d	45.0
153e	45.2
153f	45.3
153g	45.4
153h	45.4
153i	45.4
153j	45.3
153k	45.0
153l	45.0

5.2.3 Impact Assessment

For the impact assessment, the calculations were run for all receptors. The noise contour map including the proposed Impofu East Wind Farm is illustrated within Figure **8**. Further detailed images can be found in ANNEX D. As demonstrated in Figure **8**, no sensitive receptors were identified within the 45dB(A) contour of the Impofu East Wind Farm.

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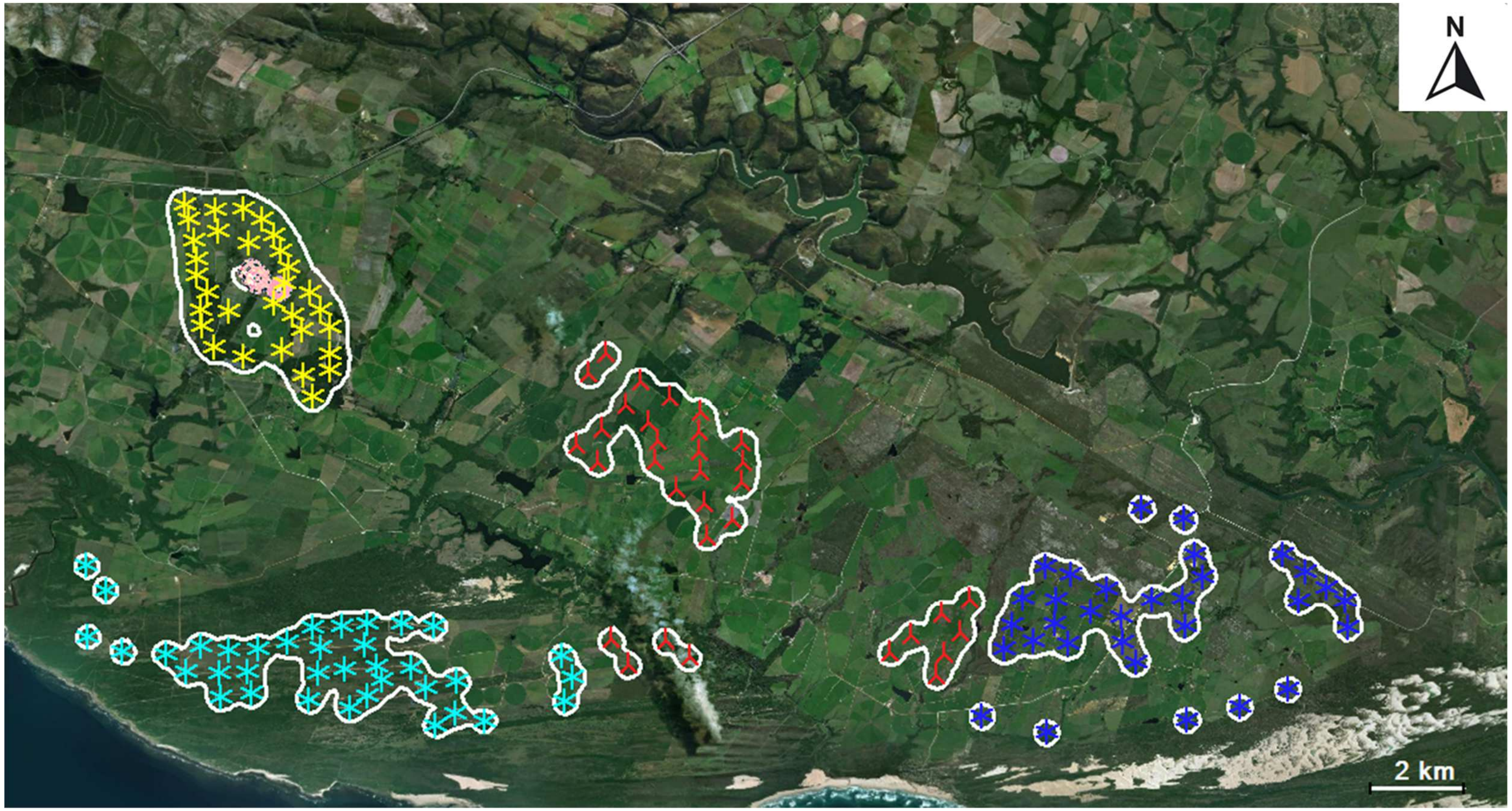


Figure 8: Noise contour map (45dB(A)) – Impact Assessment scenario (White line: 45dB(A) contour lines, pink circles receptor with exceedance of 45dB(A) limit, Red: Impofu East Wind Farm under study, blue: existing KWF, light blue: existing Gibson Bay Wind Farm, yellow: existing TCWF)

As a next step the results of the calculated turbines noise were combined with a background noise level of 45dB(A). These calculations were performed for all receptors except those located within the TCWF. These receptors are already experiencing exeedances in the baseline due to turbine noise i.e. they are already above 45dB(A). For these receptors the additional noise levels resulting from the Impofu East Wind Farm can be considered to be the calculated baseline turbine noise (already higher than 45dB(A)) combined with the additional noise generated from Impofu North Wind Farm.

Table 8 below sets out the exceedances that may be experienced at sensitive receptors due to the proposed Impofu East Wind Farm, while the expected noise increases for all sensitive receptors considering the ambient background noise is set out in ANNEX C.

All of the receptors with exceedance of the 45 dB(A) limit are located within the TCWF. All 13 receptors located within this wind farm would now experience exceedances of between 45.1dB(A) – 50.7dB(A). The additional noise level on these receptors caused by the Impofu East Wind Farm under investigation is limited to a maximum of 0.5dB(A), which is an inaudible difference.

For all sensitive receptors the increase in noise levels due to the presence of the Impofu East turbines is anticipated to never be higher than an increase of 3dB(A) for all receptors. Considering the guidelines in the SANS 10103 the turbines will not cause any response from the surrounding community.

Table 8: Main Results- Sound Power Level for each Noise Sensitive Receptor at the TCWF

Noise Sensitive Receptor	Sound Power Level dB(A)
153 – SS and offices	50.7
153a	45.1
153b	45.1
153c	45.2
153d	45.2
153e	45.4
153f	45.5
153g	45.5
153h	45.5
153i	45.5
153j	45.5
153k	45.2
153l	45.2

Based on the outcomes of the noise assessment, the anticipated noise impact from the proposed Impofu East Wind Farm can be rated as negligible. This is summerized in the impact assessment table below, that was filled out considering all information as described above.

Project phase	Operation			
Impact	Operational noise impact			
Description of impact	Impact of operational noise on neighbouring communities			
Mitigatability	Low	Mitigation does not exist; or mitigation will slightly reduce the significance of impacts		
Potential mitigation				
Assessment	Without mitigation		With mitigation	
Nature	Negative		Negative	
Duration	On-going	Impact will last between 15 and 20 years	On-going	Impact will last between 15 and 20 years
Extent	Limited	Limited to the site and its immediate surroundings	Limited	Limited to the site and its immediate surroundings
Intensity	Negligible	Natural and/ or social functions and/ or processes are negligibly altered	Negligible	Natural and/ or social functions and/ or processes are negligibly altered
Probability	Highly unlikely /	Expected never to happen	Highly unlikely /	Expected never to happen
Confidence	High	Substantive supportive data exists	High	Substantive supportive data exists
Reversibility	High	The affected environmental will be able to recover from the impact	High	The affected environmental will be able to recover from the impact
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	Negligible - negative		Negligible - negative	
Comment on significance	Noise levels of 45dB(A) are met for all receptors, except for the receptors already impacted by Tsitsikamma community wind Farm (TCWF). The TCWF receptors levels are already above the 45dB(A) level and the predicted increase from the Impofu Wind Farm will be less than 0.5dB(A) which is well below the 3dB(A) noticeable increase limit.			
Cumulative impacts	No cumulative effect expected, noise levels are met even in the cumulative scenario			

5.2.4 Cumulative Impact Assessment

As set out in Section 4.1, two scenarios were assessed as part of the cumulative impact assessment, namely:

- **Cumulative Impact Scenario 1**: Impofu North, East and West Wind Farms considered as a consolidated site, in addition to the baseline (KWF, Gibson Bay Wind Farm and TCWF).
- **Cumulative Impact Scenario 2**: Impofu North, East and West Wind Farms considered with the planned Oyster Bay Wind Farm, in addition to the baseline (KWF, Gibson Bay Wind Farm and TCWF).

The noise contour maps for Scenario 1 and 2 are illustrated in Figure 9 and Figure 10 below, respectively. Further detailed images can be found in ANNEX D. As observed on these figures, no additional sensitive receptors, besides those already identified within the TCWF, are located within the 45dB(A) noise contour. Therefore, the impact is considered to be the same as for Impofu East, negligible negative significance.

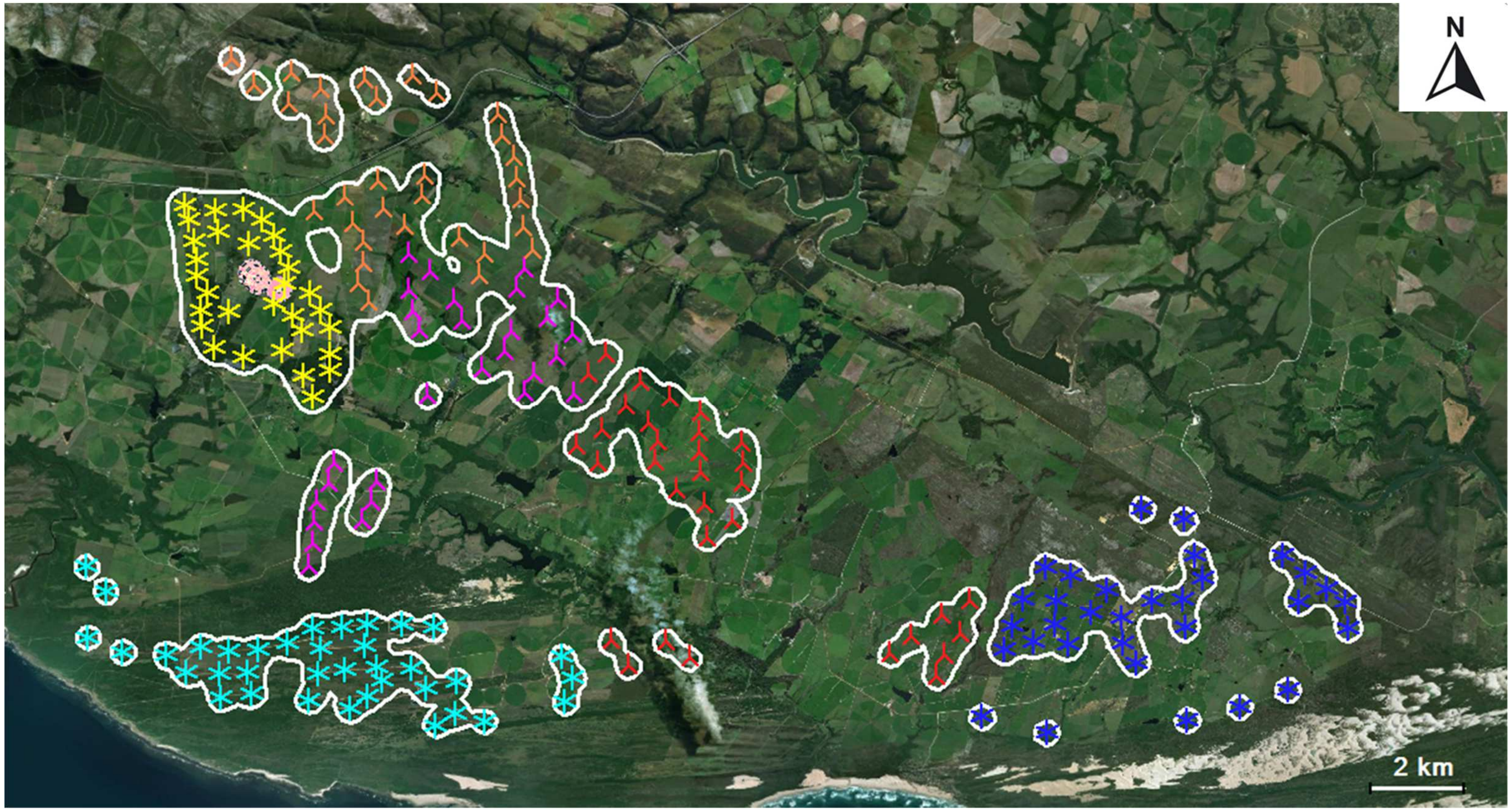


Figure 9: Noise contour map (45dB(A)) – Cumulative Impact Scenario 1 (White line: 45dB(A) contour lines, pink circles receptor with exceedance of 45dB(A) limit, Red: Impofu East Wind Farm under study, orange: Impofu North Wind Farm under separate study, magenta: Impofu West Wind Farm under separate study, blue: existing KWF, light blue: existing Gibson Bay Wind Farm, yellow: existing TCWF)

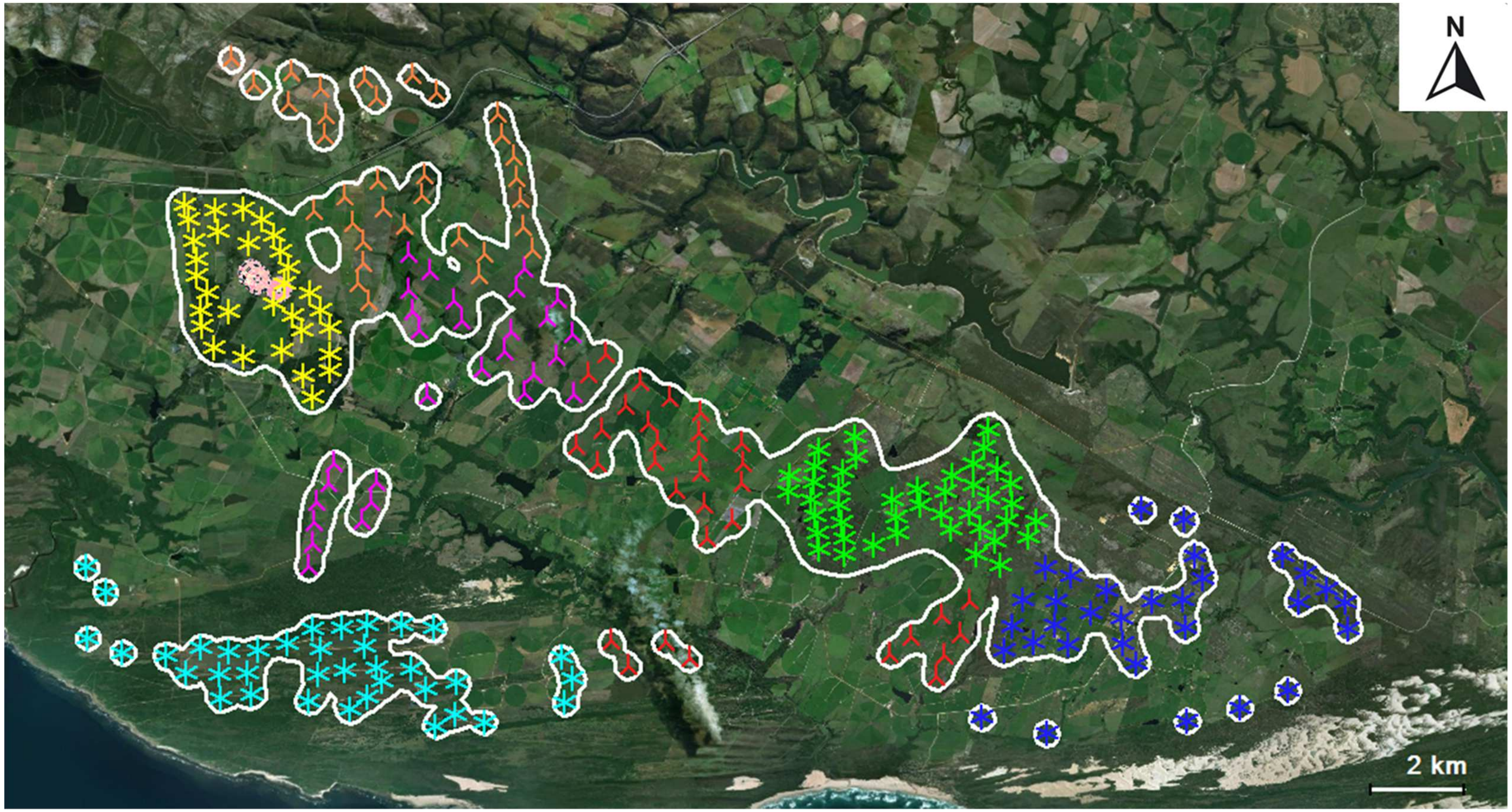


Figure 10: Noise contour map (45dB(A)) – Cumulative Impact Scenario 2 (White line: 45dB(A) contour lines, pink circles receptor with exceedance of 45dB(A) limit, Red: Impofu East Wind Farm under study, orange: Impofu North Wind Farm under separate study, magenta: Impofu West Wind Farm under separate study, blue: existing KWF, light blue: existing Gibson Bay Wind Farm, yellow: existing TCWF, green: planned Oyster Bay Wind Farm)

As set out in the table below, the 13 sensitive receptors within the TCWF would experience further noise increases for both Scenario 1 and 2. As can also be seen, the results for Scenario 1 and 2 are mostly similar. Where further noise levels are anticipated, these are still imperceptible, with increases still below 3dB(A).

Table 9: Main Results- Sound Power Level (dB(A)) for each Noise Receptor at the TCWF for the Cumulative Assessment Scenario 1 and 2

Noise Sensitive Area	Cumulative Impact Scenario 1 dB(A)	Cumulative Impact Scenario 2 dB(A)
153- SS and offices	50.8	50.8
153a	45.3	45.3
153b	45.4	45.4
153c	45.5	45.5
153d	45.4	45.4
153e	45.6	45.6
153f	45.8	45.8
153g	45.8	45.8
153h	45.8	45.8
153i	45.8	45.8
153j	45.7	45.8
153k	45.4	45.4
153l	45.4	45.4

5.3 DECOMMISSIONING NOISE

The lifetime of a wind farm is often linked to the duration of the Power Purchase Agreement (PPA) with Eskom. The wind turbines are maintained for the duration of the PPA to ensure maximum production, this is usually over a 20-year period.

Once the PPA has ended the wind farm can either be decommissioned, maintained further or upgraded with newer technology, depending on the fact if a new PPA is in place or not.

Decommissioning of a wind farm will also cause noise impact. This impact will be comparable to the noise impact during the construction phase. Therefor the assessment of the impact of decommissioning noise is not repeated but should be considered in line with the assessment in section 5.1.

If the turbines are upgraded, it should at that point be verified if the turbine noise will remain identical. If this is not the case a new assessment should then be made.

5.4 NO GO ALTERNATIVE

In the no go alternative, where the Impofu east Wind Farm will not be developed the noise levels will remain at their current level. These current noise levels will be those of the baseline scenario and can be consulted under section 5.2.2. This impact is considered to be of neutral significance.

6 SHADOW-FLICKER ASSESSMENT

Shadow flicker impact will be limited to the operational phase of the wind farm, as only when the blades are rotating can shadow flicker take place. The following section therefore focuses on the operational phase only and the construction and decommissioning phase are not described further.

6.1 EVALUATION OF SHADOW FLICKER

Shadow-flicker occurs when the rotation of wind turbine blades causes alternating periods of shadow and light to a sensitive receptor.

The expected yearly shadow-flickering impact was calculated for each of the scenarios. The shadow calculations resulted in a shadow map, one for each scenario. The shadow maps display the line of 30h/yr, which represent all connecting points where 30h/yr shadow flicker impact is expected. All areas within this line will experience 30h/yr or more shadow flicker. As described in section 4.3, 30h/yr is the typical limit considered as an acceptable impact for shadow flicker.

6.2 BASELINE SHADOW FLICKER

Shadow-flicker occurs when the rotation of wind turbine blades causes alternating periods of shadow and light to a sensitive receptor. The shadow flicker results of the calculations undertaken for the baseline scenario are represented in Figure 11 (further detailed images can be found in ANNEX E). As illustrated in the figure, sensitive receptors already experiencing exceedances are located within the existing TCWF.

Figure 11: Shadow contour map (30h)- Baseline scenario (White line: 30h/yr contour lines, black circles: receptors with exceedance of limit, blue: existing KWF, light blue: existing Gibson Bay Wind Farm, yellow: existing TCWF)

Table 10, sets out the sensitive receptors which are anticipated to experience exceedances in shadow flicker. The table demonstrates the number of anticipated shadow-flicker hours. The majority of the sensitive receptors within the baseline do not experience exceedances for shadow flicker. Currently, 18 sensitive receptors (highlighted in yellow) are experiencing exceedance for shadow flicker, they include receptors 39, 40, 40a, 40b,- 40d and 153-153l. The highest exceedances are experienced at receptors 153-153l. All of these receptors are located within the TCWF.

Table 10: Main Results- Average shadow flicker hours per year for each Sensitive Receptor

Receptor	Hours	Receptor	Hours	Receptor	Hours
6	17:47	40a	34:36	142a – working areas	00:00
7	00:00	40b	35:59	147	01:17
8	00:00	40d	46:13	148	00:00
13	00:00	42	00:00	148a	00:00
13a	00:00	42a	00:00	148b	00:00
13b	00:00	42b	00:00	148c	00:00
13c	00:00	42c	00:00	153 – SS and offices	183:52
13d	00:00	42d	00:00	153a	74:45
14	00:00	42e	00:00	153b	62:36
14a – workshop	00:00	50	00:00	153c	59:05
15	00:00	50a	00:00	153d	47:46
16	00:00	50b	00:00	153e	48:21
17	00:00	50c	00:00	153f	52:40
18	00:00	50d	00:00	153g	52:06
34	00:00	50e	00:00	153h	53:09
34a	00:00	50f	00:00	153i	53:19
34b	00:00	50g	00:00	153j	53:27
34c	00:00	81	00:00	153k	45:05
34d	00:00	84	00:00	153l	44:52
39	42:14	94	10:18		
40	37:44	142	00:00		

6.3 IMPACT ASSESSMENT

The Shadow Flicker map including the Impofu East Wind Farm is shown in Figure 12, below. Further detailed images can be found in ANNEX E. As illustrated a number of sensitive receptors are anticipated to experience exceedances from the proposed development. They are located on the south east and northern sections of the Impofu East Wind Farm. These receptors are mainly dwellings.

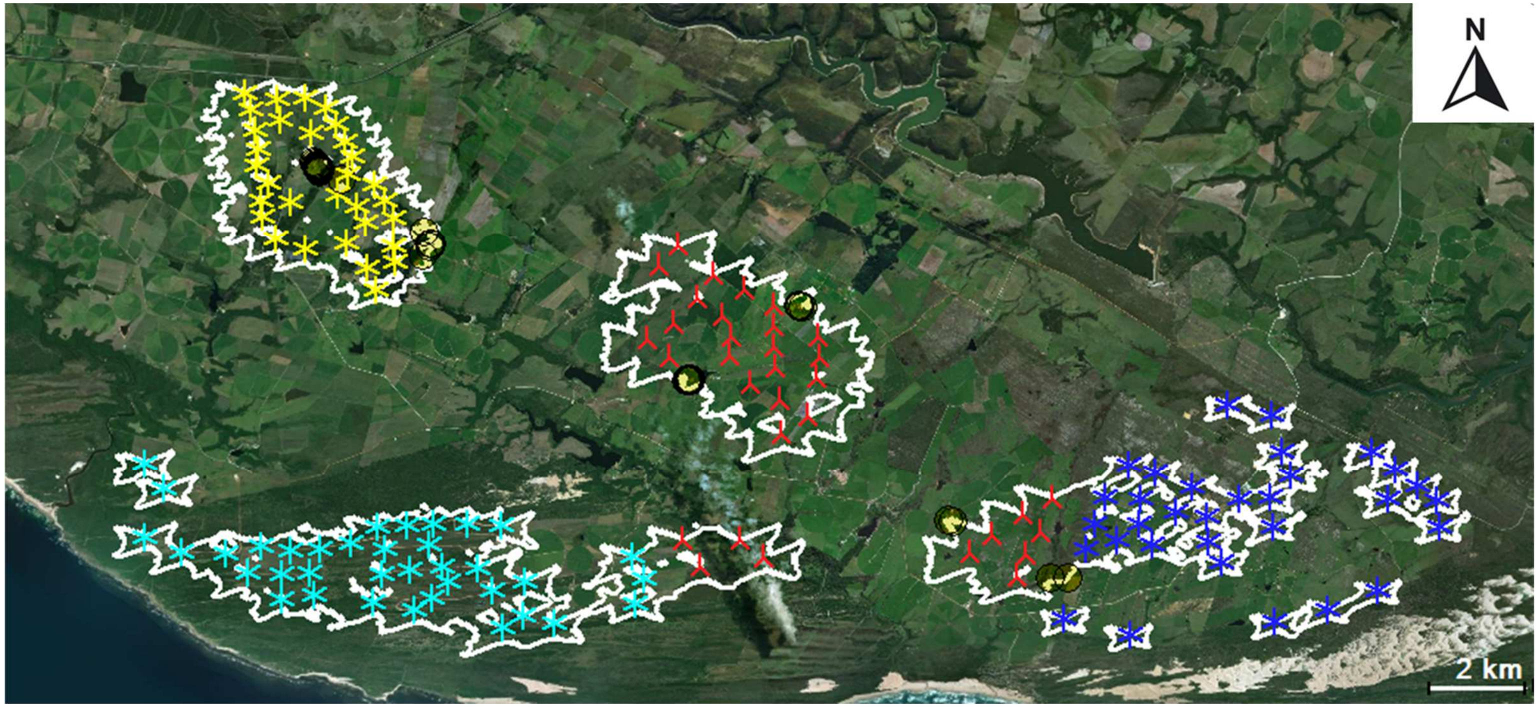


Figure 12: Shadow contour map (30h)- Impact Assessment scenario (White line: 30h/yr contour lines, black circles: receptors with exceedance of limit, Red: Impofu East Wind Farm under study, blue: existing KWF, light blue: existing Gibson Bay Wind Farm, yellow: existing TCWF)

Table 11, highlights in yellow the number of additional receptors who would experience exceedances in shadow flicker. It is anticipated that 17 receptors would be affected by the proposed development. The shadow receptors with exceedance located on the Impofu East site are marked in bold. In order to minimize the impact on dwellings, the developer ensured that no turbines would be located closer than 500m to any dwellings during the preliminary design. Additionally, Shadow Flicker impacts are relatively easy to mitigate and are thus not seen as a major issue. Once the turbines have been constructed a measurement of the actual shadow flicker will be performed and if exceedance of the limit is measured mitigation measures (such as the installation of blinds in the affected windows or the planting of trees and evergreen vegetation between the turbines and the affected window) will be undertaken.

Table 11 Main Results- Average shadow flicker hours per year for each Sensitive Receptor

Receptor	Hours	Receptor	Hours	Receptor	Hours
6	17:48	40a	34:36	142a – working areas	00:00
7	00:00	40b	35:59	147	30:04
8	00:00	40d	46:18	148	17:51
13	00:00	42	00:00	148a	16:05
13a	00:00	42a	00:00	148b	15:24
13b	00:00	42b	00:00	148c	15:36
13c	00:00	42c	00:00	153 – SS and offices	185:08
13d	00:00	42d	00:00	153a	74:49
14	00:00	42e	00:00	153b	62:36
14a – workshop	00:00	**50**	**36:40**	153c	59:05
15	00:00	**50a**	**40:10**	153d	47:46
16	00:00	**50b**	**54:30**	153e	48:21
17	00:00	**50c**	**47:33**	153f	52:40
18	00:00	**50d**	**44:23**	153g	52:09
34	**47:05**	**50e**	**42:40**	153h	53:09
34a	**45:10**	**50f**	**39:45**	153i	53:19
34b	**38:36**	**50g**	**36:14**	153j	53:27
34c	**50:33**	**81**	**30:45**	153k	45:05
34d	**53:22**	**84**	**36:04**	153l	44:52
39	42:14	**94**	**43:14**		
40	37:44	142	00:00		

It can be concluded that given the assumed modelling, it is likely that for some receptors the actual shadow flicker impact will be less or non-existing. Furthermore, it must be noted that all the additional receptors that could experience exceedances in shadow flicker caused by the proposed wind farm are located on the wind farm land itself. Therefore, the shadow flicker impact is considered minor. Furthermore, the possible mitigation measures can be easily implemented reducing the negative impact of shadow flicker from the Impofu East Wind Farm to negligible.

Considering all aspects as described above the impact assessment was executed. The results are presented in the table provided below:

Project phase	**Operation**			
Impact	**Shadow Flicker**			
Description of impact	**Shadow flicker impacts on identified sensitive receptors.**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**Undertaking actual shadow flicker measurements after commissioning of the turbines. Should exceedances be recorded the following mitigation measures can be implemented: installation of blinds, planting of trees and evergreen vegetation**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	On-going	Impact will last between 15 and 20 years	On-going	Impact will last between 15 and 20 years
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	Negligible	Natural and/ or social functions and/ or processes are negligibly altered	Negligible	Natural and/ or social functions and/ or processes are negligibly altered
Probability	Certain / definite	There are sound scientific reasons to expect that the impact will definitely occur	Probable	The impact has occurred here or elsewhere and could therefore occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	High	The affected environmental will be able to recover from the impact	High	The affected environmental will be able to recover from the impact
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance	Shadow flicker impact is expected for 17 of the receptors but all of these are within the Impofu East Wind Farm site. With mitigation measures of blinds and evergeen vegetation the impact can be mitigated if			
Cumulative impacts	Cumulative effect will occur but can be mitigated as well.			

6.4 CUMULATIVE IMPACT ASSESSMENT

The shadow flicker contour maps for cumulative scenario 1 and 2 are presented in Figure 13 and Figure 14 below. Further detailed images can be found in ANNEX E. In Figure 13, all sensitive receptors that are anticipated to experience exceedances are located within the consolidated Impofu Wind Farm sites. With the addition of the proposed Oyster Bay Wind Farm, as set out in Figure 14, a further four additional receptors are anticipated to experience exceedances for shadow-flicker.

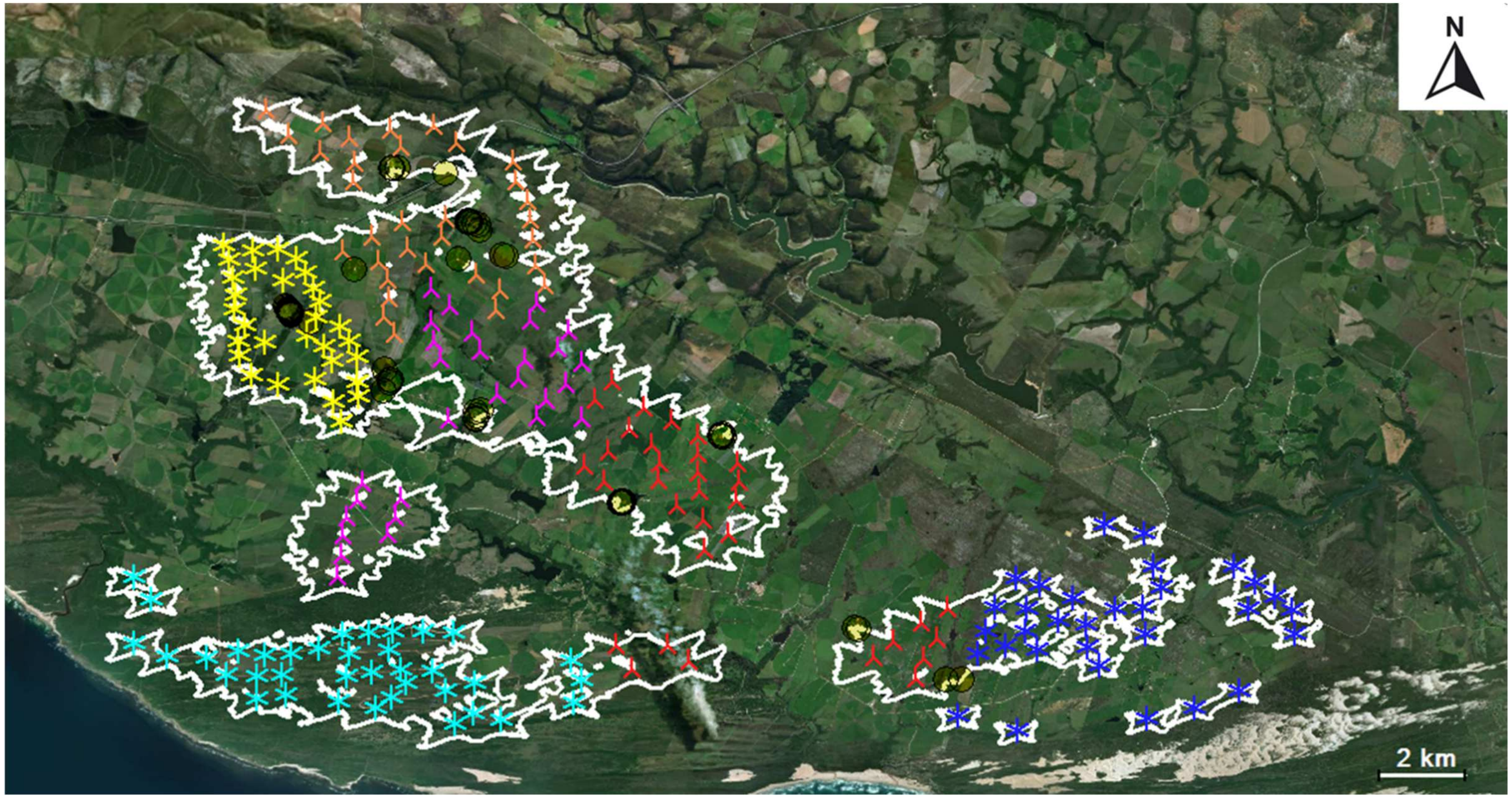


Figure 13: Shadow contour map (30h)- Cumulative Impact Scenario 1 (White line: 30h/yr contour lines, black circles: receptors with exceedance of limit, Red: Impofu East Wind Farm under study, orange: Impofu North Wind Farm under separate study, magenta: Impofu West Wind Farm under separate study, blue: existing KWF, light blue: existing Gibson Bay Wind Farm, yellow: existing TCWF)

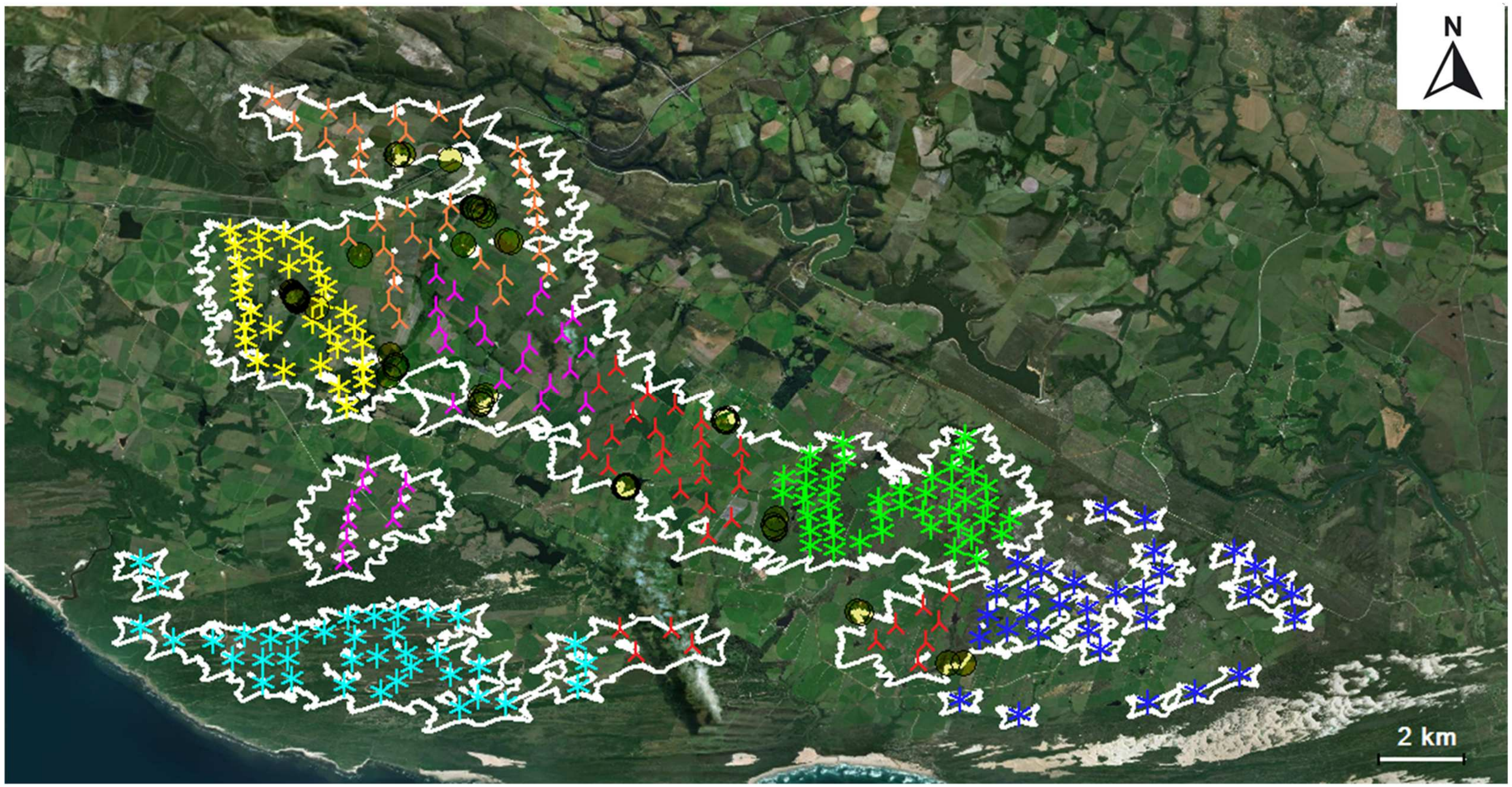


Figure 14: Shadow contour map (30h)- Cumulative Impact Scenario 2 (White line: 30h/yr contour lines, black circles: receptors with exceedance of limit, Red: Impofu East Wind Farm under study, orange: Impofu North Wind Farm under separate study, magenta: Impofu West Wind Farm under separate study, blue: existing KWF, light blue: existing Gibson Bay Wind Farm, yellow: existing TCWF, green: planned Oyster Bay Wind Farm)

As indicated in Table 12, calculations show that there is an exceedance for 61 receptors; however, this value can be seen as a worst-case value, as the greenhouse mode is used to model receptors, and a standard window size (1.5m x 1.5m) was considered for all receptors. For 22 additional receptors (6-8, 13-18, 42-442e, 142-142a) there is an exceedance in cumulative impact scenario 1. For 4 receptors (148-148c) the exceedance of the limit is caused by the Oyster Bay Wind Farm (cumulative scenario 2).

Even though there are a large number of sensitive receptors who could experience exceedances, all of these are due to the impact of the three proposed Impofu Wind Farms as these receptors are located on the Impofu Wind Farms consolidated site itself. However, with the implementation of the proposed mitigation measures it is anticipated that the cumulative impact is considered minor negative for both scenarios.

Table 12: Main Results- Average shadow flicker hours per year for each Sensitive Receptor

Receptor	Scenario 1	Scenario 2	Receptor	Scenario 1	Scenario 2	Receptor	Scenario 1	Scenario 2
6	86:22	86:22	40a	49:14	49:14	142a – working areas	45:18	45:18
7	47:22	47:22	40b	51:45	51:45	147	30:15	30:15
8	30:38	30:38	40d	67:38	67:38	148	17:56	80:59
13	56:41	56:41	42	45:34	45:34	148a	16:09	50:41
13a	57:06	57:06	42a	77:36	77:36	148b	15:28	52:48
13b	55:21	55:21	42b	94:44	94:44	148c	15:40	54:45
13c	58:20	58:20	42c	32:33	32:33	153 – SS and offices	194:00	194:00
13d	60:55	60:55	42d	36:05	36:05	153a	79:37	79:37
14	64:18	64:18	42e	32:38	32:38	153b	67:35	67:35
14a – workshop	68:46	68:46	50	36:40	36:40	153c	64:26	64:26
15	61:39	61:39	50a	40:10	40:10	153d	52:55	52:55
16	43:08	43:08	50b	54:31	54:31	153e	54:07	54:07
17	69:53	69:53	50c	47:33	47:33	153f	60:07	60:07
18	87:28	87:28	50d	44:23	44:23	153g	58:50	58:50
34	47:15	47:35	50e	42:40	42:40	153h	60:15	60:15
34a	45:17	45:41	50f	39:45	39:45	153i	60:49	60:49
34b	38:44	39:09	50g	36:14	36:14	153j	60:54	60:54
34c	50:41	51:01	81	30:55	30:55	153k	50:01	50:01
34d	53:31	53:49	84	36:16	36:16	153l	49:15	49:15

39	60:44	60:44	94	43:23	43:23
40	54:28	54:28	142	38:44	38:44

6.5 NO GO ALTERNATIVE

In the no go alternative, where the Impofu East Wind Farm will not be developed the shadow flicker impact will remain the same as in the current baseline scenario. Only the existing shadow flicker impact will take place. The existing shadow flicker impact can be consulted under section 6.2. This impact is considered to be of neutral significance.

7 CONCLUSION

This report has investigated the Noise and Shadow flicker impact of the Impofu East Wind Farm.

During the screening phase the potential impact to the vicinity of identified sensitive receptors was minimised by ensuring that no turbines would be located closer than 500m to any dwellings or work places.

In this report, as a first step the construction noise impact was investigated. This negative impact is expected to be minor considering the local nature, short time duration and the intermittent nature of the construction activities.

For Operational noise, no sensitive receptors were identified within the 45dB(A) contour of the Impofu East Wind Farm. It was determined that the receptors in the middle of the existing TCWF are already experiencing exceedances in the baseline (i.e. higher than 45dB(A)). The additional noise level on these receptors caused by the Impofu East Wind Farm under investigation is limited to a maximum of 0.5dB(A), which is an inaudible difference which will not cause any response from a community. It can therefore be concluded that there is no discernible impact from the planned Impofu East Wind Farm on these receptors. It should be noted that the identified sensitive receptors experiencing exceedances are located in the middle of an existing wind farm which means they are in effect no longer in a rural noise area, and rather in a new “renewable energy noise landscape”.

Furthermore, at each sensitive receptor that was assessed there is never an increase of more than 3dB(A) due to the increased noise from the Impofu turbines even if one assumes that the noise at the sensitive receptors is the maximum standard ambient rural noise level of 45dB(A). An increase of less than 3dB(A) is an increase that according to the guidelines in the SANS 10103 will not cause any negative response from the community as it is not perceived by people as a nuisance.

Thus, the noise impact from the proposed Impofu East Wind Farm can be rated as being of negligible negative significance.

Shadow flicker calculations indicated that the most impacted sensitive receptors are those close to or within the operational Tsitsikamma Community Wind Farm (18 receptors with number 39 to 40d and the receptors starting with number 153). The impact from the Impofu East Wind Farm on these receptors is very limited compared to the impact already being experienced from the existing TCWF. Furthermore, any mitigation that the TCWF may be undertaking due to the impact of their turbines on these receptors will similarly reduce the impact from the proposed Impofu East Wind Farm. For 17 receptors (34-34d, 50-50g, 81, 84, 94, 147) the main impact will be caused by the Impofu East Wind Farm but it must be noted that all of these receptors are located within the Impofu East Wind Farm project boundary. For 22 additional receptors (6-8, 13-18, 42-442e, 142-142a) there is an exceedance in the cumulative impact scenario 1 but again all of these receptors are located within the combined Impofu Wind Farms site. For those 39 receptors (receptors with exceedance in impact assessment scenario and cumulative impact scenario 1) it will be the proponent’s responsibility to mitigate any nuisance caused. For 4 receptors (148-148c) the exceedance of the limit is caused by the Oyster Bay Wind Farm (cumulative impact scenario 2).

Shadow Flicker impacts are relatively easy to mitigate and are thus not seen as a major issue. Once the turbines have been constructed, it is recommended that a measurement of the actual shadow flicker will be performed at the identified sensitive receptors for the Impofu East Wind Farm and if exceedance of the limit is measured, it is recommended that mitigation measures (such as the installation of blinds in the affected windows or the planting of trees and evergreen vegetation between the turbines and the affected window) is undertaken.

It can be concluded that, given all the additional receptors that could experience exceedances in shadow flicker caused by the proposed wind farm are located on the wind farm land, and considering the possible mitigation measures, the impact of shadow flicker in the impact assessment is considered negligible.

The following mitigation measures is to be implemented during the different phases of the project, to minimise the noise and shadow flicker impacts.

During the construction/decommissioning Phase:

- Select mechanical equipment with lower sound power levels to minimise impact.
- Construction workers and personnel to wear hearing protection when required;
- Vehicles and machines to be properly serviced and well maintained;
- Vehicles must adhere to speed limits;
- Establishment of a proactive warning system of planned construction activities with estimation of commencement date and duration of each activity; and
- Establishment of a grievance procedure whereby noise complaints by neighbours are recorded and responded to.

During operational Phase:

- Measurement of the actual shadow flicker impact at the identified sensitive receptors;
- If exceedances have been determined, install blinds in the affected windows; and/or plant trees and evergreen vegetation (ideally indigenous such as Coastal Silver oaks (*Brachylaena discolour*)) between the turbines and the affected windows.

Considering the results of the calculations and taking into account the proposed mitigation measures presented in this assessment, there is no objection to grant the project environmental authorisation.

ANNEX A POTENTIAL SENSITIVE RECEPTORS FOR THE IMPOFU EAST WIND FARM

The table below provides for each sensitive receptor the function and coordinates (in Geo DMS- WGS84).

Name	Function	Longitude	Latitude
1- house	residence	24°30'19.27"	-34°03'07.68"
1a - workshop	workshop/storage	24°30'22.34"	-34°03'08.85"
1b	workshop/storage	24°30'21.96"	-34°03'04.93"
1c	residence	24°30'22.64"	-34°03'08.28"
2	residence	24°30'26.44"	-34°03'13.49"
3	residence	24°30'19.05"	-34°03'05.52"
4	residence	24°30'34.71"	-34°03'06.37"
4a	residence	24°30'31.54"	-34°03'05.50"
4b	residence	24°30'32.17"	-34°03'05.69"
4c	residence	24°30'32.85"	-34°03'05.80"
4d	residence	24°30'33.38"	-34°03'05.99"
4e	residence	24°30'33.99"	-34°03'06.16"
4g	residence	24°30'35.88"	-34°03'06.64"
5	abattoir	24°30'59.20"	-34°03'06.41"
5a	residence	24°30'39.06"	-34°02'47.15"
5b-house	residence	24°31'00.89"	-34°03'06.33"
6	dairy	24°31'05.48"	-34°03'44.82"
7	workshop/storage	24°31'41.07"	-34°02'28.68"
8	residence	24°32'30.01"	-34°02'33.70"
9	residence	24°32'47.77"	-34°02'54.09"
9a- working area	workshop/storage	24°32'50.33"	-34°02'55.42"
13	residence	24°32'50.41"	-34°03'11.19"
13a	residence	24°32'49.36"	-34°03'10.71"
13b	residence	24°32'49.86"	-34°03'10.87"
13c	residence	24°32'51.05"	-34°03'11.32"
13d	residence	24°32'51.59"	-34°03'11.55"
14	residence	24°32'58.71"	-34°03'13.19"
14a - workshop	workshop/storage	24°32'55.66"	-34°03'12.74"
15	residence	24°32'59.98"	-34°03'17.26"
16	dairy	24°32'39.99"	-34°03'39.16"
17	residence	24°33'20.06"	-34°03'36.76"
18	residence	24°33'24.00"	-34°03'38.45"
19	residence	24°35'13.97"	-34°04'07.66"
20	workshop/storage	24°36'01.98"	-34°04'26.07"
20a - house	residence	24°36'02.67"	-34°04'25.79"
20b - working area	workshop/storage	24°35'58.87"	-34°04'26.43"
20c - workshop	workshop/storage	24°35'57.66"	-34°04'24.94"

Name	Function	Longitude	Latitude
20d - house	residence	24°35'53.84"	-34°04'24.07"
20e - staff house	residence	24°35'53.14"	-34°04'25.19"
20f - staff houses	residence	24°35'54.38"	-34°04'25.36"
20g	residence	24°35'54.47"	-34°04'25.55"
20h	residence	24°35'54.72"	-34°04'25.44"
20i	residence	24°35'56.48"	-34°04'27.82"
20j	residence	24°35'56.65"	-34°04'28.60"
22	residence	24°37'07.79"	-34°04'20.91"
25	residence	24°37'09.32"	-34°04'21.74"
26	water works entrance	24°37'39.81"	-34°04'08.71"
26a	residence	24°37'39.09"	-34°04'07.86"
28	water works buildings	24°37'47.67"	-34°04'12.35"
28a - work area	workshop/storage	24°37'47.98"	-34°04'16.72"
29	residence	24°38'08.01"	-34°04'35.89"
29a - house	residence	24°38'08.70"	-34°04'36.36"
29b	residence	24°38'05.58"	-34°04'37.26"
30	workshop/storage	24°38'01.29"	-34°04'44.40"
31	workshop/storage	24°37'52.53"	-34°04'55.93"
31a - working area	dairy	24°37'51.36"	-34°04'57.30"
31b - working area	residence	24°37'55.02"	-34°04'56.22"
32	residence	24°38'15.64"	-34°05'04.70"
32a	residence	24°38'14.89"	-34°05'04.33"
32b	residence	24°38'11.16"	-34°05'02.77"
34	workshop/storage	24°36'35.19"	-34°05'58.84"
34a	workshop/storage	24°36'36.36"	-34°05'57.28"
34b	dairy	24°36'37.46"	-34°05'58.91"
34c	workshop/storage	24°36'35.13"	-34°05'57.44"
34d	workshop/storage	24°36'34.53"	-34°05'57.57"
35	residence	24°37'09.12"	-34°05'56.17"
36	workshop/storage	24°37'12.77"	-34°05'53.81"
37	residence	24°37'21.03"	-34°05'55.26"
37a	residence	24°37'22.43"	-34°05'56.14"
37b	residence	24°37'19.56"	-34°05'54.34"
37c	residence	24°37'18.12"	-34°05'53.47"
37d	residence	24°37'15.41"	-34°05'51.50"
37e	residence	24°37'22.24"	-34°05'55.22"
37f	residence	24°37'20.68"	-34°05'54.17"
37g	residence	24°37'19.76"	-34°05'53.59"
37h	residence	24°37'18.20"	-34°05'52.73"
38	residence	24°37'16.21"	-34°05'52.40"

Name	Function	Longitude	Latitude
39	residence	24°31'29.01"	-34°05'17.67"
40	residence	24°31'34.50"	-34°05'11.59"
40a	residence	24°31'34.68"	-34°05'09.85"
40b	residence	24°31'36.28"	-34°05'09.51"
40d	residence	24°31'30.59"	-34°05'02.26"
41	dairy	24°32'03.10"	-34°05'22.02"
42	workshop/storage	24°32'53.55"	-34°05'38.48"
42a	residence	24°32'56.91"	-34°05'34.91"
42b	workshop/storage	24°32'52.70"	-34°05'35.27"
42c	residence	24°32'52.11"	-34°05'40.64"
42d	residence	24°32'51.84"	-34°05'40.27"
42e	residence	24°32'51.83"	-34°05'41.21"
43	residence	24°33'38.70"	-34°05'55.46"
43a	residence	24°33'35.67"	-34°05'58.05"
44	dairy	24°31'54.77"	-34°06'28.63"
44a - staff house	residence	24°31'57.25"	-34°06'29.53"
44b - staff house	residence	24°31'57.99"	-34°06'29.83"
45	residence	24°32'14.52"	-34°06'18.15"
45a	residence	24°32'14.73"	-34°06'17.58"
45b	residence	24°32'15.41"	-34°06'17.52"
45c	residence	24°32'14.84"	-34°06'17.01"
45d	residence	24°32'15.37"	-34°06'16.92"
45e	residence	24°32'15.33"	-34°06'16.40"
45f	residence	24°32'15.28"	-34°06'15.97"
45g	residence	24°32'15.93"	-34°06'16.16"
45h	residence	24°32'15.69"	-34°06'15.53"
45i	residence	24°32'15.91"	-34°06'14.86"
45j	residence	24°32'16.00"	-34°06'14.50"
45k	residence	24°32'16.32"	-34°06'14.11"
45l	residence	24°32'16.68"	-34°06'13.71"
46	residence	24°32'24.81"	-34°06'13.38"
46a	workshop/storage	24°32'26.12"	-34°06'11.76"
46b	workshop/storage	24°32'25.32"	-34°06'12.02"
46c	workshop/storage	24°32'23.51"	-34°06'13.46"
46d	residence	24°32'24.27"	-34°06'14.41"
46e	residence	24°32'23.71"	-34°06'14.81"
47	residence	24°33'31.48"	-34°06'45.39"
48	residence	24°33'25.63"	-34°06'45.51"
49	residence	24°33'37.87"	-34°06'57.92"
50	residence	24°35'02.39"	-34°06'46.00"
50a	residence	24°35'03.51"	-34°06'46.08"

Name	Function	Longitude	Latitude
50b	residence	24°35'05.46"	-34°06'45.99"
50c	residence	24°35'05.76"	-34°06'46.90"
50d	residence	24°35'04.86"	-34°06'46.89"
50e	residence	24°35'03.97"	-34°06'46.75"
50f	residence	24°35'02.90"	-34°06'46.76"
50g	residence	24°35'01.75"	-34°06'46.74"
51	residence	24°35'08.54"	-34°06'57.84"
52	dairy	24°35'13.29"	-34°06'54.70"
52a	workshop/storage	24°35'12.88"	-34°06'56.01"
54	dairy	24°35'56.29"	-34°07'49.98"
54a	workshop/storage	24°35'58.18"	-34°07'50.01"
54b	workshop/storage	24°35'58.19"	-34°07'50.58"
55	residence	24°35'53.66"	-34°08'06.57"
56	workshop/storage	24°35'52.04"	-34°08'09.35"
57	residence	24°35'50.11"	-34°08'15.72"
57a	residence	24°35'49.45"	-34°08'14.75"
57b	residence	24°35'50.79"	-34°08'14.41"
57c	residence	24°35'51.32"	-34°08'13.31"
57d	residence	24°35'51.82"	-34°08'12.06"
57e	residence	24°35'52.20"	-34°08'11.27"
58	residence	24°35'46.66"	-34°08'10.54"
59	residence	24°35'56.12"	-34°08'09.28"
60	residence	24°36'17.26"	-34°07'57.34"
60a	residence	24°36'16.68"	-34°07'57.85"
61	workshop/storage	24°36'13.92"	-34°08'15.00"
65	residence	24°36'24.52"	-34°07'50.32"
66	residence	24°36'45.74"	-34°08'04.80"
67	residence	24°36'50.86"	-34°07'55.16"
67a	workshop/storage	24°36'50.11"	-34°07'55.37"
67b	workshop/storage	24°36'51.23"	-34°07'55.08"
68	workshop/storage	24°36'47.36"	-34°08'06.22"
68b	workshop/storage	24°36'47.99"	-34°08'04.50"
69	dairy	24°36'50.83"	-34°08'01.98"
70	residence	24°36'54.78"	-34°08'02.38"
70a	residence	24°36'53.77"	-34°08'02.34"
70b	residence	24°36'52.77"	-34°08'02.31"
70c	residence	24°36'52.11"	-34°08'02.37"
71	workshop/storage	24°37'05.48"	-34°08'39.10"
72	residence	24°37'16.94"	-34°08'37.63"
73	residence	24°37'26.14"	-34°08'24.53"
74	workshop/storage	24°37'26.91"	-34°08'13.03"

Name	Function	Longitude	Latitude
75	dairy	24°37'29.51"	-34°08'13.96"
76	residence	24°37'35.17"	-34°08'17.58"
76a	residence	24°37'35.20"	-34°08'17.96"
76b	residence	24°37'36.79"	-34°08'18.30"
76c	residence	24°37'36.97"	-34°08'17.59"
76d	residence	24°37'36.66"	-34°08'16.06"
76e	residence	24°37'36.19"	-34°08'15.45"
76f	residence	24°37'36.57"	-34°08'14.21"
76g	residence	24°37'37.81"	-34°08'17.76"
76h	residence	24°37'37.72"	-34°08'16.56"
76j	residence	24°37'37.83"	-34°08'14.94"
78	residence	24°38'16.93"	-34°08'19.92"
79	residence	24°38'22.02"	-34°08'20.69"
80	residence	24°38'28.19"	-34°08'21.93"
80a	residence	24°38'27.44"	-34°08'21.80"
80b	residence	24°38'26.67"	-34°08'21.60"
80c	residence	24°38'25.96"	-34°08'21.51"
80d	residence	24°38'25.01"	-34°08'21.33"
81	workshop/storage	24°38'33.08"	-34°08'25.86"
82	dairy	24°38'36.49"	-34°08'19.74"
83	residence	24°38'37.59"	-34°08'23.07"
83a	residence	24°38'37.75"	-34°08'23.87"
84	residence	24°38'37.22"	-34°08'27.27"
85	residence	24°38'29.54"	-34°08'34.84"
86	residence	24°37'50.63"	-34°09'08.03"
88	residence	24°38'06.50"	-34°09'19.56"
89	dairy	24°38'48.82"	-34°09'22.46"
90	residence	24°38'41.62"	-34°09'08.83"
90a - house or working area	residence	24°38'06.79"	-34°09'21.07"
90b - working area	dairy	24°38'47.57"	-34°09'24.10"
90c - working area	worshop/storage	24°38'49.49"	-34°09'30.63"
90d - house	residence	24°38'51.41"	-34°09'31.63"
90e - staff house	residence	24°39'06.85"	-34°09'40.01"
90f -staff house	residence	24°39'08.63"	-34°09'40.47"
91	dairy	24°38'49.58"	-34°09'30.56"
92	residence	24°39'03.03"	-34°09'30.17"
93	residence	24°39'32.27"	-34°09'35.03"
93a - house	residence	24°39'31.18"	-34°09'35.85"
93b - working area	residence	24°39'34.55"	-34°09'35.43"
93c - house/ working area	residence	24°39'32.39"	-34°09'33.59"
94	workshop/storage	24°39'55.30"	-34°09'06.56"

Name	Function	Longitude	Latitude
96	workshop/storage	24°39'08.71"	-34°09'40.47"
97	workshop/storage	24°39'12.10"	-34°10'01.65"
98	residence	24°39'14.40"	-34°10'01.53"
99	residence	24°39'17.56"	-34°10'00.95"
100	residence	24°39'05.41"	-34°09'55.77"
100a	residence	24°39'04.67"	-34°09'56.07"
100b	residence	24°39'06.56"	-34°09'55.55"
101	residence	24°38'09.13"	-34°09'39.93"
102	workshop/storage	24°38'04.45"	-34°09'40.59"
103	residence	24°38'04.86"	-34°09'51.66"
104	residence	24°38'02.46"	-34°09'51.60"
105	residence	24°37'55.86"	-34°09'48.63"
106	residence	24°37'57.37"	-34°09'52.42"
106a - cabins/ lodges	residence	24°37'54.78"	-34°09'52.58"
106b	residence	24°37'55.29"	-34°09'52.44"
106c	residence	24°37'55.78"	-34°09'52.33"
106d	residence	24°37'56.27"	-34°09'52.24"
107	residence	24°38'00.73"	-34°09'55.29"
108	residence	24°34'21.29"	-34°08'16.54"
108a - workshop	dairy	24°34'19.44"	-34°08'14.74"
108b - houses	residence	24°34'18.49"	-34°08'11.80"
109	dairy	24°29'08.29"	-34°07'24.24"
110	residence	24°29'06.37"	-34°07'25.05"
110a	residence	24°29'05.18"	-34°07'25.18"
111	workshop/storage	24°29'09.81"	-34°07'23.25"
112	workshop/storage	24°29'01.01"	-34°07'23.39"
112a	workshop/storage	24°28'58.22"	-34°07'20.78"
113	residence	24°29'09.89"	-34°07'24.76"
114	residence	24°29'03.70"	-34°07'25.24"
114a	residence	24°29'02.54"	-34°07'25.29"
115	residence	24°28'54.70"	-34°07'21.91"
117	workshop/storage	24°28'47.39"	-34°07'34.01"
118	workshop/storage	24°28'47.08"	-34°07'35.48"
118a	residence	24°28'22.01"	-34°07'47.96"
120	residence	24°28'18.63"	-34°07'19.15"
121	workshop/storage	24°28'14.86"	-34°07'14.18"
121a	residence	24°28'16.22"	-34°07'11.88"
121b	residence	24°28'14.98"	-34°07'12.24"
122	residence	24°28'08.79"	-34°07'03.27"
123	residence	24°27'59.26"	-34°06'30.29"
123a - workshop	workshop/storage	24°27'57.09"	-34°06'29.95"

Name	Function	Longitude	Latitude
124	residence	24°28'10.41"	-34°06'33.16"
124a	residence	24°28'12.40"	-34°06'33.22"
124b	residence	24°28'11.76"	-34°06'33.27"
124c	residence	24°28'11.11"	-34°06'33.15"
124d	residence	24°28'09.14"	-34°06'33.07"
128	residence	24°39'20.04"	-34°05'54.05"
129	residence	24°39'08.85"	-34°06'05.31"
129b	workshop/storage	24°39'04.88"	-34°06'04.37"
130	residence	24°35'08.66"	-34°07'47.76"
140	residence	24°29'27.41"	-34°07'38.71"
142	residence	24°31'47.10"	-34°02'29.35"
142a- working areas	workshop/storage	24°31'42.19"	-34°02'28.85"
147	workshop/storage	24°40'08.92"	-34°09'07.66"
148	residence	24°37'20.23"	-34°07'13.60"
148a	dairy	24°37'17.83"	-34°07'19.06"
148b	residence	24°37'19.20"	-34°07'20.99"
148c	residence	24°37'18.99"	-34°07'21.58"
149	residence	24°39'46.93"	-34°05'27.23"
149a	residence	24°39'25.65"	-34°04'13.95"
149b	residence	24°39'27.20"	-34°04'12.81"
149c	residence	24°39'28.08"	-34°04'12.16"
149d	residence	24°39'28.54"	-34°04'10.29"
149e	residence	24°39'30.17"	-34°04'07.26"
149f - house	residence	24°39'48.80"	-34°05'28.09"
149g - house	residence	24°39'28.69"	-34°05'41.37"
150	residence	24°34'29.17"	-34°02'11.60"
151a	residence	24°34'15.17"	-34°02'08.01"
151b	residence	24°34'15.70"	-34°02'08.30"
151c	residence	24°34'16.49"	-34°02'08.84"
151d	workshop/storage	24°34'20.29"	-34°02'09.88"
152a	residence	24°30'50.73"	-34°00'28.90"
152b	residence	24°30'48.55"	-34°00'29.46"
152c	residence	24°30'46.18"	-34°00'29.19"
152d	residence	24°30'43.74"	-34°00'28.62"
152e	residence	24°30'41.22"	-34°00'27.96"
152f	residence	24°30'38.57"	-34°00'27.19"
152g	residence	24°30'35.81"	-34°00'26.19"
152h	residence	24°30'31.14"	-34°00'25.50"
152i	residence	24°30'25.79"	-34°00'24.29"
152j	workshop/storage	24°30'18.22"	-34°00'21.27"
152k	residence	24°30'16.37"	-34°00'20.86"

Name	Function	Longitude	Latitude
152l	workshop/storage	24°30'15.87"	-34°00'19.99"
152m	workshop/storage	24°30'11.06"	-34°00'20.64"
152n	residence	24°31'02.21"	-34°00'22.67"
152o	residence	24°31'00.40"	-34°00'22.27"
152p	residence	24°30'58.75"	-34°00'22.17"
152q	residence	24°30'57.17"	-34°00'21.80"
152r	residence	24°30'55.55"	-34°00'21.50"
152s	residence	24°30'58.55"	-34°00'23.40"
152t	residence	24°30'56.89"	-34°00'23.12"
152u	residence	24°30'55.27"	-34°00'22.92"
153- SS and offices	TCWF substation & operation-maintenance building	24°30'23.93"	-34°04'24.59"
153a	residence	24°30'01.42"	-34°04'12.33"
153b	residence	24°30'02.68"	-34°04'13.27"
153c	residence	24°30'03.88"	-34°04'13.56"
153d	residence	24°30'03.71"	-34°04'14.39"
153e	residence	24°30'05.63"	-34°04'16.04"
153f	residence	24°30'06.54"	-34°04'17.69"
153g	residence	24°30'06.85"	-34°04'16.40"
153h	residence	24°30'06.86"	-34°04'17.05"
153i	residence	24°30'06.54"	-34°04'18.46"
153j	residence	24°30'06.28"	-34°04'19.08"
153k	residence	24°30'03.70"	-34°04'15.05"
153l	residence	24°30'03.63"	-34°04'15.74"
154	residence	24°30'31.88"	-34°06'00.72"
154a - dairy & workshops	dairy	24°30'33.25"	-34°05'55.96"
154b - house	residence	24°30'30.18"	-34°06'01.46"
155	workshop/storage	24°30'32.09"	-34°05'57.07"
156	residence	24°32'12.86"	-34°07'18.57"
157	residence	24°33'12.88"	-34°07'09.49"
159	residence	24°33'50.19"	-34°07'17.28"
159a - workshop	workshop/storage	24°33'50.74"	-34°07'19.13"
159b - workshop	workshop/storage	24°33'49.01"	-34°07'13.75"
160a	residence	24°33'52.89"	-34°07'09.57"
160b	residence	24°33'53.41"	-34°07'08.47"
160c	residence	24°33'53.95"	-34°07'07.56"
160d	residence	24°33'53.49"	-34°07'10.76"
160e	residence	24°33'54.55"	-34°07'08.93"
160f	residence	24°33'55.11"	-34°07'09.95"
160g	residence	24°33'54.62"	-34°07'11.80"
160h	residence	24°33'55.59"	-34°07'11.06"

Name	Function	Longitude	Latitude
160i	residence	24°33'56.06"	-34°07'12.19"
161a	residence	24°34'33.81"	-34°08'03.19"
161b	residence	24°34'32.88"	-34°08'02.87"
161c	residence	24°34'33.20"	-34°08'06.91"
161d - dairy	dairy	24°34'10.55"	-34°06'59.22"
161e - staff house	residence	24°34'23.02"	-34°08'07.34"
161f -staff house	residence	24°34'23.63"	-34°08'07.39"
161g	workshop/storage	24°34'06.76"	-34°06'59.33"
161h - house	residence	24°34'31.11"	-34°08'06.80"
162a	residence	24°34'40.31"	-34°07'43.43"
162b	residence	24°34'39.97"	-34°07'40.84"
162c	residence	24°34'32.70"	-34°07'43.04"
162d - staff house	residence	24°34'23.85"	-34°07'38.83"
162e- staff house	residence	24°34'22.80"	-34°07'38.37"
162f -staff house	residence	24°34'21.85"	-34°07'37.82"
162g -staff house	residence	24°34'20.55"	-34°07'37.48"
163	residence	24°34'00.69"	-34°07'52.50"
163a - house	residence	24°34'12.89"	-34°07'51.61"
163b - Brakeduine lodge / house	residence	24°33'59.79"	-34°07'50.76"
163c - Brakkeduine cottages	residence	24°33'56.00"	-34°07'47.54"
163d - brakeduine cottages	residence	24°34'00.46"	-34°07'45.06"
164	residence	24°33'57.07"	-34°07'46.99"
165a	residence	24°33'22.10"	-34°09'04.09"
165b	residence	24°33'22.88"	-34°09'03.67"
165c	residence	24°33'24.16"	-34°09'03.33"
165d - dairy	dairy	24°33'23.79"	-34°09'06.07"

ANNEX B DETAILED RESULTS NOISE AND SHADOW FLICKER CALCULATIONS

	Noise Results (in dB(A))				Shadow Flicker Results (in h/yr)			
Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
1- house	40.0	40.1	41.6	41.6	2:09	02:09	05:35	05:35
1a - workshop	39.9	40.1	41.7	41.7	5:19	05:23	09:31	09:31
1b	39.1	39.3	41.1	41.1	0:51	00:55	04:58	04:58
1c	39.8	39.9	41.6	41.6	4:33	04:35	08:46	08:46
2	40.5	40.7	42.3	42.3	2:53	03:07	10:32	10:32
3	39.5	39.6	41.3	41.3	0:46	00:52	04:11	04:11
4	38.2	38.3	41.2	41.2	1:10	01:13	11:03	11:03
4a	38.4	38.5	41.1	41.1	3:00	03:03	11:08	11:08
4b	38.3	38.4	41.1	41.1	2:42	02:43	11:04	11:04
4c	38.3	38.4	41.1	41.1	1:52	01:57	10:41	10:41
4d	38.3	38.4	41.1	41.2	1:32	01:40	10:40	10:40
4e	38.3	38.4	41.2	41.2	1:20	01:22	10:42	10:42
4g	38.1	38.3	41.2	41.3	1:03	01:04	12:27	12:27
5	35.9	36	42.1	42.1	1:00	01:00	08:36	08:36
5a	35.0	35.1	41	41	0:00	00:00	17:08	17:08
5b-house	35.8	35.9	42.1	42.2	0:53	00:53	08:18	08:18
6	39.5	39.6	44.7	44.7	17:47	17:48	86:22	86:22

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
7	30.0	30.5	42.2	42.3	0:00	00:00	47:22	47:22
8	28.1	29.1	40.1	40.2	0:00	00:00	30:38	30:38
9	28.2	29.3	40.8	40.8	0:00	00:00	23:54	23:54
9a- working area	28.2	29.3	40.7	40.7	0:00	00:00	25:16	25:16
13	28.8	29.8	42	42	0:00	00:00	56:41	56:41
13a	28.8	29.9	42.1	42.2	0:00	00:00	57:06	57:06
13b	28.8	29.8	42.1	42.1	0:00	00:00	55:21	55:21
13c	28.7	29.8	41.9	41.9	0:00	00:00	58:20	58:20
13d	28.7	29.8	41.8	41.8	0:00	00:00	60:55	60:55
14	28.4	29.6	41.1	41.1	0:00	00:00	64:18	64:18
14a - workshop	28.6	29.7	41.3	41.3	0:00	00:00	68:46	68:46
15	28.5	29.7	41.1	41.1	0:00	00:00	61:39	61:39
16	30.4	31.2	43.5	43.5	0:00	00:00	43:08	43:08
17	28.1	29.8	42.4	42.4	0:00	00:00	69:53	69:53
18	27.9	29.7	42.7	42.7	0:00	00:00	87:28	87:28
19	24.2	30.5	35.6	36	0:00	00:00	06:30	06:30
20	23.3	31.3	33.8	34.6	0:00	00:00	00:00	00:00

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
20a - house	23.3	31.2	33.7	34.6	0:00	00:00	00:00	00:00
20b - working area	23.4	31.4	33.9	34.7	0:00	00:00	00:00	00:00
20c - workshop	23.4	31.3	33.9	34.7	0:00	00:00	00:00	00:00
20d - house	23.5	31.3	34.1	34.8	0:00	00:00	01:44	01:44
20e - staff house	23.5	31.4	34.2	34.9	0:00	00:00	02:27	02:27
20f - staff houses	23.5	31.4	34.1	34.9	0:00	00:00	02:59	02:59
20g	23.5	31.4	34.1	34.9	0:00	00:00	03:12	03:12
20h	23.5	31.4	34.1	34.8	0:00	00:00	02:04	02:04
20i	23.5	31.6	34.1	34.9	0:00	00:00	04:04	04:04
20j	23.5	31.6	34.2	34.9	0:00	00:00	03:16	03:16
22	22.3	29	30.9	32.9	0:00	00:00	00:00	00:00
25	22.3	29	30.9	32.9	0:00	00:00	00:00	00:00
26	21.9	27.7	29.6	32	0:00	00:00	00:00	00:00
26a	21.9	27.7	29.6	32	0:00	00:00	00:00	00:00
28	21.9	27.6	29.4	32.1	0:00	00:00	00:00	00:00
28a - working area	22.0	27.8	29.6	32.3	0:00	00:00	00:00	00:00

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
29	22.3	28.1	29.5	33.1	0:00	00:00	00:00	00:00
29a - house	22.3	28.1	29.5	33.1	0:00	00:00	00:00	00:00
29b	22.3	28.2	29.6	33.2	0:00	00:00	00:00	00:00
30	22.4	28.6	30	33.6	0:00	00:00	00:00	00:00
31	22.7	29.4	30.6	34.3	0:00	00:00	00:00	00:00
31a - working area	22.7	29.5	30.7	34.4	0:00	00:00	00:00	00:00
31b - working area	22.7	29.3	30.5	34.3	0:00	00:00	00:00	00:00
32	22.9	29	30.1	34.8	0:00	00:00	00:00	00:00
32a	22.9	29	30.1	34.8	0:00	00:00	00:00	00:00
32b	22.8	29	30.2	34.7	0:00	00:00	00:00	00:00
34	24.0	42.5	42.7	43.2	0:00	47:05	47:15	47:35
34a	23.9	42.1	42.2	42.8	0:00	45:10	45:17	45:41
34b	23.9	42.1	42.3	42.9	0:00	38:36	38:44	39:09
34c	23.9	42.4	42.5	43.1	0:00	50:33	50:41	51:01
34d	23.9	42.5	42.6	43.2	0:00	53:22	53:31	53:49
35	23.7	37.5	37.8	40.4	0:00	09:14	09:15	09:34
36	23.7	36.7	37	40	0:00	07:51	07:51	08:18

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
37	23.7	35.9	36.2	40.1	0:00	05:30	05:31	06:44
37a	23.7	35.8	36.1	40.2	0:00	06:28	06:29	07:48
37b	23.7	35.9	36.3	40	0:00	05:32	05:32	06:38
37c	23.7	36	36.4	39.9	0:00	05:54	05:55	06:51
37d	23.6	36.1	36.4	39.6	0:00	07:20	07:20	08:07
37e	23.7	35.7	36.1	40.1	0:00	05:37	05:37	07:03
37f	23.7	35.8	36.1	40	0:00	05:15	05:16	06:33
37g	23.7	35.8	36.2	39.9	0:00	05:32	05:33	06:48
37h	23.7	35.9	36.3	39.8	0:00	06:04	06:04	07:06
38	23.7	36.1	36.5	39.7	0:00	06:42	06:42	07:28
39	42.0	42.3	43.3	43.3	42:14	42:14	60:44	60:44
40	40.8	41	42.6	42.6	37:44	37:44	54:28	54:28
40a	40.8	41	42.6	42.7	34:36	34:36	49:14	49:14
40b	40.5	40.7	42.5	42.5	35:59	35:59	51:45	51:45
40d	41.8	42	43.6	43.6	46:13	46:18	67:38	67:38
41	35.6	35.9	40.7	40.7	5:47	05:47	09:13	09:13
42	30.6	32.6	41	41.1	0:00	00:00	45:34	45:34
42a	30.4	32.6	41.6	41.7	0:00	00:00	77:36	77:36

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
42b	30.7	32.6	41.3	41.4	0:00	00:00	94:44	94:44
42c	30.7	32.6	40.8	40.9	0:00	00:00	32:33	32:33
42d	30.7	32.6	40.9	41	0:00	00:00	36:05	36:05
42e	30.7	32.6	40.8	40.9	0:00	00:00	32:38	32:38
43	28.3	34.2	41.6	41.7	0:00	15:37	24:35	24:35
43a	28.4	34	40.6	40.7	0:00	20:27	29:16	29:16
44	32.4	33.2	41.4	41.4	0:00	00:00	15:37	15:37
44a - staff house	32.3	33.1	41	41.1	0:00	00:00	15:59	15:59
44b - staff house	32.2	33	40.9	41	0:00	00:00	15:09	15:09
45	31.9	32.9	38.1	38.2	0:47	00:47	06:11	06:11
45a	31.9	32.9	38.1	38.2	0:44	00:44	05:53	05:53
45b	31.8	32.9	38.1	38.2	0:42	00:42	05:47	05:47
45c	31.9	32.9	38.1	38.2	0:45	00:45	05:38	05:38
45d	31.8	32.9	38.1	38.2	0:44	00:44	05:40	05:40
45e	31.9	32.9	38.1	38.2	0:44	00:44	05:42	05:42
45f	31.9	32.9	38.1	38.2	0:43	00:43	05:53	05:53
45g	31.8	32.9	38.1	38.2	0:44	00:44	05:43	05:43

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
45h	31.9	32.9	38.1	38.2	0:43	00:43	06:03	06:03
45i	31.9	32.9	38.1	38.2	0:45	00:45	06:42	06:42
45j	31.9	32.9	38.1	38.2	0:42	00:43	06:50	06:50
45k	31.9	32.9	38.1	38.2	0:43	00:43	06:53	06:53
45l	31.9	32.9	38.1	38.2	0:42	00:42	07:12	07:12
46	31.5	32.7	37.9	38	0:00	00:00	06:34	06:34
46a	31.4	32.7	38	38.1	0:00	00:00	06:26	06:26
46b	31.5	32.7	38	38.1	0:00	00:00	06:38	06:38
46c	31.5	32.7	37.9	38	0:00	00:00	06:45	06:45
46d	31.5	32.7	37.9	38	0:00	00:00	06:36	06:36
46e	31.5	32.7	37.8	38	0:00	00:00	06:40	06:40
47	29	33.3	35.8	36.1	0:00	11:21	11:21	11:21
48	29.1	33	35.6	36	0:00	07:12	07:12	07:12
49	29.1	33.3	35.3	35.7	0:00	03:22	03:22	03:22
50	26.3	40.6	40.9	41.2	0:00	36:40	36:40	36:40
50a	26.3	40.5	40.9	41.1	0:00	40:10	40:10	40:10
50b	26.2	40.5	40.8	41.1	0:00	54:30	54:31	54:31
50c	26.3	40.3	40.7	40.9	0:00	47:33	47:33	47:33

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
50d	26.3	40.3	40.7	41	0:00	44:23	44:23	44:23
50e	26.3	40.4	40.7	41	0:00	42:40	42:40	42:40
50f	26.3	40.4	40.8	41	0:00	39:45	39:45	39:45
50g	26.4	40.5	40.8	41.1	0:00	36:14	36:14	36:14
51	26.4	38.6	39	39.4	0:00	26:10	26:11	26:11
52	26.2	39.3	39.7	40.1	0:00	28:11	28:12	28:12
52a	26.3	39.1	39.5	39.9	0:00	28:12	28:12	28:12
54	26.4	36.9	37.2	38.2	0:00	00:00	00:00	00:00
54a	26.4	37	37.3	38.3	0:00	00:00	00:00	00:00
54b	26.4	37	37.2	38.3	0:00	00:00	00:00	00:00
55	26.9	36.7	37	37.9	0:00	00:00	00:00	00:00
56	27.1	37.1	37.3	38.1	0:00	00:25	00:25	00:25
57	27.3	38.4	38.5	39.1	0:00	10:50	10:50	10:50
57a	27.4	38.2	38.3	38.9	0:00	09:37	09:37	09:37
57b	27.3	38	38.2	38.8	0:00	09:18	09:18	09:18
57c	27.2	37.8	37.9	38.6	0:00	07:22	07:22	07:22
57d	27.2	37.5	37.7	38.4	0:00	05:06	05:06	05:06
57e	27.1	37.4	37.6	38.3	0:00	03:42	03:42	03:42

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
58	27.4	37.4	37.6	38.3	0:00	00:00	00:00	00:00
59	26.9	36.9	37.1	38	0:00	02:39	02:39	02:39
60	26.0	36.5	36.7	38.1	0:00	00:00	00:00	00:00
60a	26.0	36.4	36.7	38.1	0:00	00:00	00:00	00:00
61	26.3	36.3	36.5	37.7	0:00	01:59	01:59	01:59
65	25.7	37.5	37.7	39.1	0:00	00:00	00:00	05:00
66	25.6	34.7	35	37.7	0:00	00:00	00:00	05:45
67	25.4	35.3	35.6	38.6	0:00	00:00	00:00	13:11
67a	25.4	35.3	35.6	38.6	0:00	00:00	00:00	13:04
67b	25.4	35.3	35.6	38.6	0:00	00:00	00:00	13:16
68	25.6	34.5	34.8	37.6	0:00	00:00	00:00	08:25
68b	25.5	34.6	34.9	37.8	0:00	00:00	00:00	07:56
69	25.5	34.6	34.9	38	0:00	00:00	00:00	07:24
70	25.5	34.4	34.7	38.1	0:00	00:00	00:00	12:07
70a	25.5	34.5	34.8	38	0:00	00:00	00:00	10:54
70b	25.5	34.5	34.8	38	0:00	00:00	00:00	09:12
70c	25.5	34.5	34.8	38	0:00	00:00	00:00	08:39
71	25.6	32.6	32.9	35.8	0:00	02:35	02:35	02:35

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
72	25.7	32.3	32.6	36.1	0:00	02:17	02:18	02:18
73	25.8	32.5	32.8	37.2	0:00	02:05	02:05	02:05
74	25.7	32.7	33.1	38.4	0:00	00:50	00:50	00:50
75	25.8	32.7	33	38.4	0:00	00:16	00:16	00:16
76	25.9	32.6	32.9	38.3	0:00	02:31	02:32	02:32
76a	25.9	32.6	32.9	38.2	0:00	02:49	02:50	02:50
76b	25.9	32.6	32.9	38.3	0:00	02:42	02:43	02:43
76c	25.9	32.6	32.9	38.3	0:00	02:03	02:03	02:03
76d	25.9	32.6	32.9	38.5	0:00	01:07	01:07	01:07
76e	25.9	32.6	33	38.6	0:00	01:05	01:06	01:06
76f	25.9	32.6	33	38.7	0:00	01:03	01:03	01:03
76g	26.0	32.6	32.9	38.4	0:00	01:59	02:00	02:00
76h	25.9	32.6	32.9	38.5	0:00	01:13	01:13	01:13
76j	25.9	32.6	33	38.7	0:00	01:09	01:09	01:09
78	27.3	34.8	35	39.6	0:00	14:39	14:45	14:45
79	27.6	35.4	35.6	39.8	0:00	16:44	16:49	16:49
80	28	36.3	36.4	40	0:00	17:20	17:26	17:26
80a	27.9	36.2	36.3	40	0:00	17:25	17:31	17:31

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
80b	27.9	36.1	36.2	39.9	0:00	17:14	17:20	17:20
80c	27.8	36	36.1	39.9	0:00	17:24	17:30	17:30
80d	27.8	35.8	36	39.9	0:00	17:19	17:24	17:24
81	28.3	37.6	37.7	40.3	0:00	30:45	30:55	30:55
82	28.4	37.2	37.3	40.5	0:00	07:47	07:49	07:49
83	28.5	37.9	37.9	40.6	0:00	09:48	09:50	09:50
83a	28.5	38	38.1	40.7	0:00	14:27	14:31	14:31
84	28.5	38.6	38.6	40.8	0:00	36:04	36:16	36:16
85	28.1	38.4	38.4	40.3	0:00	20:18	20:22	20:22
86	26.3	32.3	32.6	35.2	0:00	08:55	08:55	08:55
88	26.8	32.8	33	35.2	0:00	03:35	03:35	03:35
89	29.2	36.3	36.4	37.6	0:13	16:55	16:55	16:55
90	28.8	38.4	38.5	39.4	0:03	23:28	23:28	23:28
90a - house or working area	26.7	32.7	33	35.1	0:00	03:41	03:41	03:41
90b - working area	29.1	35.9	36	37.2	0:12	20:31	20:31	20:31
90c - working area	29.1	35.1	35.2	36.5	0:15	00:15	00:15	00:15
90d - house	29.3	35.1	35.2	36.5	0:20	00:20	00:20	00:20

	Noise Results (in dB(A))				Shadow Flicker Results (in h/yr)			
Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
90e - staff house	30.5	35.1	35.2	36.3	1:17	01:17	01:17	01:17
90f -staff house	30.7	35.1	35.2	36.4	1:32	01:32	01:32	01:32
91	29.1	35.1	35.2	36.5	0:16	00:16	00:16	00:16
92	30.4	36.3	36.4	37.4	2:44	02:44	02:44	02:44
93	34.6	37.8	37.8	38.6	5:16	05:16	05:16	05:16
93a - house	34.3	37.6	37.6	38.4	5:02	05:02	05:02	05:02
93b - working area	35.1	38	38	38.7	6:05	06:05	06:06	06:06
93c - house/ working area	34.7	38	38.1	38.8	5:18	05:18	05:18	05:18
94	37.1	41.3	41.3	41.9	10:18	43:14	43:23	43:23
96	30.7	35.1	35.2	36.4	1:33	01:33	01:33	01:33
97	29.8	32.8	32.9	34.3	3:01	03:01	03:01	03:01
98	30.0	32.9	33.1	34.4	1:22	01:22	01:22	01:22
99	30.3	33.1	33.3	34.6	0:00	00:00	00:00	00:00
100	29.6	33.1	33.2	34.6	1:33	01:37	01:37	01:37
100a	29.5	33	33.1	34.6	1:32	01:33	01:33	01:33
100b	29.7	33.1	33.3	34.7	1:38	01:38	01:38	01:38

	Noise Results (in dB(A))				Shadow Flicker Results (in h/yr)			
Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
101	26.5	31.5	31.8	33.9	0:00	03:38	03:38	03:38
102	26.3	31.3	31.6	33.7	0:00	02:54	02:54	02:54
103	26.1	30.6	30.9	33	0:00	00:00	00:00	00:00
104	26.0	30.5	30.9	33	0:00	00:00	00:00	00:00
105	25.9	30.5	30.8	33	0:00	00:00	00:00	00:00
106	25.9	30.3	30.7	32.8	0:00	00:00	00:00	00:00
106a - cabins/ lodges	25.8	30.2	30.6	32.8	0:00	00:00	00:00	00:00
106b	25.8	30.3	30.6	32.8	0:00	00:00	00:00	00:00
106c	25.8	30.3	30.6	32.8	0:00	00:00	00:00	00:00
106d	25.8	30.3	30.6	32.8	0:00	00:00	00:00	00:00
107	25.9	30.3	30.6	32.7	0:00	00:00	00:00	00:00
108	34.4	37	37.4	37.7	0:00	00:47	00:47	00:47
108a - workshop	34.1	36.7	37	37.3	0:00	00:45	00:45	00:45
108b - houses	33.5	36.2	36.6	36.9	0:00	00:44	00:44	00:44
109	33.2	33.4	34.7	34.8	0:40	00:55	02:21	02:21
110	33.2	33.4	34.7	34.8	0:50	01:03	01:03	01:03
110a	33.2	33.4	34.6	34.7	1:00	01:16	01:16	01:16

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
111	33.1	33.3	34.7	34.8	0:32	00:48	03:31	03:31
112	33.1	33.3	34.5	34.6	1:00	01:10	01:10	01:10
112a	33.0	33.2	34.4	34.4	0:22	00:25	00:25	00:25
113	33.2	33.4	34.7	34.8	0:31	00:43	03:26	03:26
114	33.2	33.4	34.6	34.7	1:16	01:35	01:35	01:35
114a	33.2	33.4	34.6	34.7	1:39	02:13	02:13	02:13
115	33.1	33.3	34.4	34.4	0:30	00:36	00:36	00:36
117	34.0	34.2	35	35	3:52	04:15	04:15	04:15
118	34.1	34.3	35.1	35.1	3:23	03:36	03:36	03:36
118a	37.0	37.2	37.4	37.5	14:06	14:38	14:40	14:40
120	34.2	34.4	35	35.1	10:56	11:07	11:07	11:07
121	33.9	34.1	34.7	34.8	0:00	00:00	00:00	00:00
121a	33.6	33.8	34.4	34.5	0:00	00:00	00:00	00:00
121b	33.7	33.9	34.5	34.6	0:00	00:00	00:00	00:00
122	33.0	33.2	33.9	34	0:00	00:00	00:00	00:00
123	30.8	31.2	32.2	32.3	0:00	00:00	00:00	00:00
123a - workshop	30.8	31.1	32.1	32.3	0:00	00:00	00:00	00:00
124	31.1	31.4	32.5	32.6	0:00	00:00	00:00	00:00

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
124a	31.1	31.5	32.5	32.7	0:00	00:00	00:00	00:00
124b	31.1	31.5	32.5	32.6	0:00	00:00	00:00	00:00
124c	31.1	31.5	32.5	32.6	0:00	00:00	00:00	00:00
124d	31.1	31.4	32.5	32.6	0:00	00:00	00:00	00:00
128	25.1	29	29.7	39	0:00	00:00	00:00	09:46
129	25.3	29.5	30.2	40.4	0:00	00:00	00:00	12:26
129b	25.2	29.5	30.2	40.4	0:00	00:00	00:00	12:32
130	28.3	35.3	35.7	36.5	0:00	03:25	03:25	03:25
140	34.5	34.6	35.9	36	0:00	00:03	07:36	07:36
142	29.8	30.3	42.1	42.1	0:00	00:00	38:44	38:44
142a- working areas	30.0	30.5	42.2	42.2	0:00	00:00	45:18	45:18
147	38.7	40.8	40.8	41.4	1:17	30:04	30:15	30:15
148	25.0	36.8	37	45	0:00	17:51	17:56	80:59
148a	25.0	36.7	36.9	44	0:00	16:05	16:09	50:41
148b	25.1	36.4	36.6	43.9	0:00	15:24	15:28	52:48
148c	25.1	36.4	36.6	43.9	0:00	15:36	15:40	54:45
149	24.5	27.9	28.7	36.3	0:00	00:00	00:00	00:00
149a	21.9	26	27.4	31.4	0:00	00:00	00:00	00:00

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
149b	21.9	25.9	27.3	31.4	0:00	00:00	00:00	00:00
149c	21.9	25.9	27.3	31.3	0:00	00:00	00:00	00:00
149d	21.8	25.8	27.2	31.2	0:00	00:00	00:00	00:00
149e	21.7	25.7	27.2	31.1	0:00	00:00	00:00	00:00
149f - house	24.6	27.9	28.7	36.4	0:00	00:00	00:00	00:00
149g - house	24.8	28.5	29.3	37.7	0:00	00:00	00:00	00:00
150	23.4	26	34	34.2	0:00	00:00	06:23	06:23
151a	23.6	26.1	34.9	35.1	0:00	00:00	01:57	01:57
151b	23.6	26.1	34.9	35	0:00	00:00	04:17	04:17
151c	23.6	26.1	34.8	35	0:00	00:00	07:54	07:54
151d	23.5	26	34.6	34.8	0:00	00:00	13:10	13:10
152a	24.0	25.2	30.6	30.8	0:00	00:00	00:00	00:00
152b	24.0	25.3	30.7	30.8	0:00	00:00	00:00	00:00
152c	24.0	25.3	30.6	30.8	0:00	00:00	00:00	00:00
152d	24.0	25.2	30.6	30.7	0:00	00:00	00:00	00:00
152e	24.0	25.2	30.5	30.7	0:00	00:00	00:00	00:00
152f	24.0	25.2	30.5	30.6	0:00	00:00	00:00	00:00
152g	23.9	25.2	30.4	30.5	0:00	00:00	00:00	00:00

	Noise Results (in dB(A))				Shadow Flicker Results (in h/yr)			
Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
152h	23.9	25.2	30.3	30.5	0:00	00:00	00:00	00:00
152i	23.9	25.1	30.2	30.3	0:00	00:00	00:00	00:00
152j	23.8	25	29.9	30.1	0:00	00:00	00:00	00:00
152k	23.8	25	29.8	30	0:00	00:00	00:00	00:00
152l	23.7	25	29.8	30	0:00	00:00	00:00	00:00
152m	23.8	25	29.8	30	0:00	00:00	00:00	00:00
152n	23.6	24.9	30.2	30.3	0:00	00:00	00:00	00:00
152o	23.6	24.9	30.1	30.3	0:00	00:00	00:00	00:00
152p	23.6	24.9	30.1	30.3	0:00	00:00	00:00	00:00
152q	23.6	24.9	30.1	30.3	0:00	00:00	00:00	00:00
152r	23.6	24.9	30.1	30.3	0:00	00:00	00:00	00:00
152s	23.6	25	30.2	30.4	0:00	00:00	00:00	00:00
152t	23.6	25	30.2	30.4	0:00	00:00	00:00	00:00
152u	23.6	25	30.2	30.4	0:00	00:00	00:00	00:00
153- SS and offices	50.4	50.7	50.8	50.8	183:52	185:08	194:00	194:00
153a	44.9	45.1	45.3	45.3	74:45	74:49	79:37	79:37
153b	45.0	45.1	45.4	45.4	62:36	62:36	67:35	67:35
153c	45.1	45.2	45.5	45.5	59:05	59:05	64:26	64:26

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
153d	45.0	45.2	45.4	45.4	47:46	47:46	52:55	52:55
153e	45.2	45.4	45.6	45.6	48:21	48:21	54:07	54:07
153f	45.3	45.5	45.8	45.8	52:40	52:40	60:07	60:07
153g	45.4	45.5	45.8	45.8	52:06	52:09	58:50	58:50
153h	45.4	45.5	45.8	45.8	53:09	53:09	60:15	60:15
153i	45.4	45.5	45.8	45.8	53:19	53:19	60:49	60:49
153j	45.3	45.5	45.7	45.8	53:27	53:27	60:54	60:54
153k	45.0	45.2	45.4	45.4	45:05	45:05	50:01	50:01
153l	45.0	45.2	45.4	45.4	44:52	44:52	49:15	49:15
154	38.6	38.8	40.3	40.3	0:00	00:00	00:00	00:00
154a - dairy & workshops	39.9	40.1	41.1	41.2	0:00	00:00	00:00	00:00
154b - house	38.3	38.5	40	40.1	0:00	00:00	00:00	00:00
155	39.5	39.7	40.8	40.8	0:00	00:00	00:00	00:00
156	32.9	33.6	37.6	37.7	0:00	00:00	16:37	16:37
157	30.3	32.6	34.9	35.2	0:00	00:00	00:38	00:38
159	29.4	33.3	34.8	35.2	0:00	00:00	00:00	00:00
159a - workshop	29.5	33.3	34.7	35.2	0:00	00:00	00:00	00:00

Sensitive Receptor	Noise Results (in dB(A)) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Shadow Flicker Results (in h/yr) Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
159b - workshop	29.3	33.3	34.9	35.3	0:00	00:00	00:00	00:00
160a	29.0	33.6	35.1	35.5	0:00	00:00	00:00	00:00
160b	28.9	33.6	35.2	35.6	0:00	00:00	00:00	00:00
160c	28.9	33.7	35.2	35.7	0:00	00:00	00:00	00:00
160d	29.0	33.6	35.1	35.5	0:00	00:00	00:00	00:00
160e	28.9	33.7	35.2	35.6	0:00	00:00	00:00	00:00
160f	28.9	33.6	35.1	35.6	0:00	00:00	00:00	00:00
160g	29.0	33.6	35	35.5	0:00	00:00	00:00	00:00
160h	29.0	33.6	35.1	35.5	0:00	00:00	00:00	00:00
160i	29.0	33.6	35.1	35.5	0:00	00:00	00:00	00:00
161a	31.4	35.6	36.1	36.5	0:00	00:00	00:00	00:00
161b	31.4	35.5	36	36.5	0:00	00:00	00:00	00:00
161c	32.0	36.1	36.5	36.9	0:00	01:05	01:05	01:05
161d - dairy	28.1	35.2	36.4	36.8	0:00	01:16	01:16	01:16
161e - staff house	32.5	35.7	36.2	36.6	0:00	01:48	01:49	01:49
161f -staff house	32.5	35.8	36.2	36.6	0:00	02:01	02:02	02:02
161g	28.2	34.9	36.2	36.6	0:00	00:53	00:53	00:53

	Noise Results (in dB(A))				Shadow Flicker Results (in h/yr)			
Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
161h - house	32.1	36	36.4	36.8	0:00	01:40	01:41	01:41
162a	29.2	34.5	35.1	35.8	0:00	00:00	00:00	00:00
162b	29.1	34.4	35.1	35.8	0:00	00:00	00:00	00:00
162c	29.5	34.3	35	35.6	0:00	00:00	00:00	00:00
162d - staff house	29.5	34	34.8	35.4	0:00	00:00	00:00	00:00
162e- staff house	29.5	33.9	34.8	35.4	0:00	00:00	00:00	00:00
162f -staff house	29.5	33.9	34.8	35.4	0:00	00:00	00:00	00:00
162g -staff house	29.5	33.9	34.8	35.4	0:00	00:00	00:00	00:00
163	31.3	33.9	34.8	35.2	0:00	00:00	00:00	00:00
163a - house	30.9	34.1	34.9	35.4	0:00	00:00	00:00	00:00
163b - Brakkeduine lodge / house	31.1	33.8	34.7	35.2	0:00	00:00	00:00	00:00
163c - Brakkeduine cottages	31.0	33.6	34.6	35.1	0:00	00:00	00:00	00:00
163d - Brakkeduine cottages	30.7	33.6	34.6	35.1	0:00	00:00	00:00	00:00

	Noise Results (in dB(A))				Shadow Flicker Results (in h/yr)			
Sensitive Receptor	Baseline	Impact Assessment - Impopfu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
164	30.9	33.6	34.6	35.1	0:00	00:00	00:00	00:00
165a	38.1	38.5	38.7	38.8	15:27	15:36	15:39	15:39
165b	38.0	38.4	38.5	38.7	14:42	14:51	14:54	14:54
165c	37.8	38.2	38.4	38.6	14:51	15:33	15:36	15:36
165d - dairy	38.1	38.5	38.6	38.8	17:25	17:35	17:37	17:37

ANNEX C DETAILED RESULTS INCREASE AMBIENT NOISE

Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
1- house	1.2	1.2	1.6	1.6
1a - workshop	1.2	1.2	1.7	1.7
1b	1.0	1.0	1.5	1.5
1c	1.1	1.2	1.6	1.6
2	1.3	1.4	1.9	1.9
3	1.1	1.1	1.5	1.5
4	0.8	0.8	1.5	1.5
4a	0.9	0.9	1.5	1.5
4b	0.8	0.9	1.5	1.5
4c	0.8	0.9	1.5	1.5
4d	0.8	0.9	1.5	1.5
4e	0.8	0.9	1.5	1.5
4g	0.8	0.8	1.5	1.5
5	0.5	0.5	1.8	1.8
5a	0.4	0.4	1.5	1.5
5b-house	0.5	0.5	1.8	1.8
6	1.1	1.1	2.9	2.9
7	0.1	0.2	1.8	1.9
8	0.1	0.1	1.2	1.2
9	0.1	0.1	1.4	1.4
9a- working area	0.1	0.1	1.4	1.4
13	0.1	0.1	1.8	1.8
13a	0.1	0.1	1.8	1.8
13b	0.1	0.1	1.8	1.8

Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
13c	0.1	0.1	1.7	1.7
13d	0.1	0.1	1.7	1.7
14	0.1	0.1	1.5	1.5
14a - workshop	0.1	0.1	1.5	1.5
15	0.1	0.1	1.5	1.5
16	0.1	0.2	2.3	2.3
17	0.1	0.1	1.9	1.9
18	0.1	0.1	2.0	2.0
19	0.0	0.2	0.5	0.5
20	0.0	0.2	0.3	0.4
20a - house	0.0	0.2	0.3	0.4
20b - working area	0.0	0.2	0.3	0.4
20c - workshop	0.0	0.2	0.3	0.4
20d - house	0.0	0.2	0.3	0.4
20e - staff house	0.0	0.2	0.3	0.4
20f - staff houses	0.0	0.2	0.3	0.4
20g	0.0	0.2	0.3	0.4
20h	0.0	0.2	0.3	0.4
20i	0.0	0.2	0.3	0.4
20j	0.0	0.2	0.3	0.4
22	0.0	0.1	0.2	0.3
25	0.0	0.1	0.2	0.3
26	0.0	0.1	0.1	0.2
26a	0.0	0.1	0.1	0.2
28	0.0	0.1	0.1	0.2

Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
28a - working area	0.0	0.1	0.1	0.2
29	0.0	0.1	0.1	0.3
29a - house	0.0	0.1	0.1	0.3
29b	0.0	0.1	0.1	0.3
30	0.0	0.1	0.1	0.3
31	0.0	0.1	0.2	0.4
31a - working area	0.0	0.1	0.2	0.4
31b - working area	0.0	0.1	0.2	0.4
32	0.0	0.1	0.1	0.4
32a	0.0	0.1	0.1	0.4
32b	0.0	0.1	0.1	0.4
34	0.0	1.9	2.0	2.2
34a	0.0	1.8	1.8	2.0
34b	0.0	1.8	1.9	2.1
34c	0.0	1.9	1.9	2.2
34d	0.0	1.9	2.0	2.2
35	0.0	0.7	0.8	1.3
36	0.0	0.6	0.6	1.2
37	0.0	0.5	0.5	1.2
37a	0.0	0.5	0.5	1.2
37b	0.0	0.5	0.5	1.2
37c	0.0	0.5	0.6	1.2
37d	0.0	0.5	0.6	1.1
37e	0.0	0.5	0.5	1.2
37f	0.0	0.5	0.5	1.2

Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
37g	0.0	0.5	0.5	1.2
37h	0.0	0.5	0.5	1.1
38	0.0	0.5	0.6	1.1
39	1.8	1.9	2.2	2.2
40	1.4	1.5	2.0	2.0
40a	1.4	1.5	2.0	2.0
40b	1.3	1.4	1.9	1.9
40d	1.7	1.8	2.4	2.4
41	0.5	0.5	1.4	1.4
42	0.2	0.2	1.5	1.5
42a	0.1	0.2	1.6	1.7
42b	0.2	0.2	1.5	1.6
42c	0.2	0.2	1.4	1.4
42d	0.2	0.2	1.4	1.5
42e	0.2	0.2	1.4	1.4
43	0.1	0.3	1.6	1.7
43a	0.1	0.3	1.3	1.4
44	0.2	0.3	1.6	1.6
44a - staff house	0.2	0.3	1.5	1.5
44b - staff house	0.2	0.3	1.4	1.5
45	0.2	0.3	0.8	0.8
45a	0.2	0.3	0.8	0.8
45b	0.2	0.3	0.8	0.8
45c	0.2	0.3	0.8	0.8
45d	0.2	0.3	0.8	0.8

Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
45e	0.2	0.3	0.8	0.8
45f	0.2	0.3	0.8	0.8
45g	0.2	0.3	0.8	0.8
45h	0.2	0.3	0.8	0.8
45i	0.2	0.3	0.8	0.8
45j	0.2	0.3	0.8	0.8
45k	0.2	0.3	0.8	0.8
45l	0.2	0.3	0.8	0.8
46	0.2	0.2	0.8	0.8
46a	0.2	0.2	0.8	0.8
46b	0.2	0.2	0.8	0.8
46c	0.2	0.2	0.8	0.8
46d	0.2	0.2	0.8	0.8
46e	0.2	0.2	0.8	0.8
47	0.1	0.3	0.5	0.5
48	0.1	0.3	0.5	0.5
49	0.1	0.3	0.4	0.5
50	0.1	1.3	1.4	1.5
50a	0.1	1.3	1.4	1.5
50b	0.1	1.3	1.4	1.5
50c	0.1	1.3	1.4	1.4
50d	0.1	1.3	1.4	1.5
50e	0.1	1.3	1.4	1.5
50f	0.1	1.3	1.4	1.5
50g	0.1	1.3	1.4	1.5

Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
51	0.1	0.9	1.0	1.1
52	0.1	1.0	1.1	1.2
52a	0.1	1.0	1.1	1.2
54	0.1	0.6	0.7	0.8
54a	0.1	0.6	0.7	0.8
54b	0.1	0.6	0.7	0.8
55	0.1	0.6	0.6	0.8
56	0.1	0.7	0.7	0.8
57	0.1	0.9	0.9	1.0
57a	0.1	0.8	0.8	1.0
57b	0.1	0.8	0.8	0.9
57c	0.1	0.8	0.8	0.9
57d	0.1	0.7	0.7	0.9
57e	0.1	0.7	0.7	0.8
58	0.1	0.7	0.7	0.8
59	0.1	0.6	0.7	0.8
60	0.1	0.6	0.6	0.8
60a	0.1	0.6	0.6	0.8
61	0.1	0.5	0.6	0.7
65	0.1	0.7	0.7	1.0
66	0.0	0.4	0.4	0.7
67	0.0	0.4	0.5	0.9
67a	0.0	0.4	0.5	0.9
67b	0.0	0.4	0.5	0.9
68	0.0	0.4	0.4	0.7

Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
68b	0.0	0.4	0.4	0.8
69	0.0	0.4	0.4	0.8
70	0.0	0.4	0.4	0.8
70a	0.0	0.4	0.4	0.8
70b	0.0	0.4	0.4	0.8
70c	0.0	0.4	0.4	0.8
71	0.0	0.2	0.3	0.5
72	0.1	0.2	0.2	0.5
73	0.1	0.2	0.3	0.7
74	0.1	0.2	0.3	0.9
75	0.1	0.2	0.3	0.9
76	0.1	0.2	0.3	0.8
76a	0.1	0.2	0.3	0.8
76b	0.1	0.2	0.3	0.8
76c	0.1	0.2	0.3	0.8
76d	0.1	0.2	0.3	0.9
76e	0.1	0.2	0.3	0.9
76f	0.1	0.2	0.3	0.9
76g	0.1	0.2	0.3	0.9
76h	0.1	0.2	0.3	0.9
76j	0.1	0.2	0.3	0.9
78	0.1	0.4	0.4	1.1
79	0.1	0.5	0.5	1.1
80	0.1	0.5	0.6	1.2
80a	0.1	0.5	0.5	1.2

Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
80b	0.1	0.5	0.5	1.2
80c	0.1	0.5	0.5	1.2
80d	0.1	0.5	0.5	1.2
81	0.1	0.7	0.7	1.3
82	0.1	0.7	0.7	1.3
83	0.1	0.8	0.8	1.3
83a	0.1	0.8	0.8	1.4
84	0.1	0.9	0.9	1.4
85	0.1	0.9	0.9	1.3
86	0.1	0.2	0.2	0.4
88	0.1	0.3	0.3	0.4
89	0.1	0.5	0.6	0.7
90	0.1	0.9	0.9	1.1
90a - house or working area	0.1	0.2	0.3	0.4
90b - working area	0.1	0.5	0.5	0.7
90c - working area	0.1	0.4	0.4	0.6
90d - house	0.1	0.4	0.4	0.6
90e - staff house	0.2	0.4	0.4	0.5
90f -staff house	0.2	0.4	0.4	0.6
91	0.1	0.4	0.4	0.6
92	0.1	0.5	0.6	0.7
93	0.4	0.8	0.8	0.9
93a - house	0.4	0.7	0.7	0.9
93b - working area	0.4	0.8	0.8	0.9
93c - house/ working area	0.4	0.8	0.8	0.9

Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
94	0.7	1.5	1.5	1.7
96	0.2	0.4	0.4	0.6
97	0.1	0.3	0.3	0.4
98	0.1	0.3	0.3	0.4
99	0.1	0.3	0.3	0.4
100	0.1	0.3	0.3	0.4
100a	0.1	0.3	0.3	0.4
100b	0.1	0.3	0.3	0.4
101	0.1	0.2	0.2	0.3
102	0.1	0.2	0.2	0.3
103	0.1	0.2	0.2	0.3
104	0.1	0.2	0.2	0.3
105	0.1	0.2	0.2	0.3
106	0.1	0.1	0.2	0.3
106a - cabins/ lodges	0.1	0.1	0.2	0.3
106b	0.1	0.1	0.2	0.3
106c	0.1	0.1	0.2	0.3
106d	0.1	0.1	0.2	0.3
107	0.1	0.1	0.2	0.2
108	0.4	0.6	0.7	0.7
108a - workshop	0.3	0.6	0.6	0.7
108b - houses	0.3	0.5	0.6	0.6
109	0.3	0.3	0.4	0.4
110	0.3	0.3	0.4	0.4
110a	0.3	0.3	0.4	0.4

Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
111	0.3	0.3	0.4	0.4
112	0.3	0.3	0.4	0.4
112a	0.3	0.3	0.4	0.4
113	0.3	0.3	0.4	0.4
114	0.3	0.3	0.4	0.4
114a	0.3	0.3	0.4	0.4
115	0.3	0.3	0.4	0.4
117	0.3	0.3	0.4	0.4
118	0.3	0.4	0.4	0.4
118a	0.6	0.7	0.7	0.7
120	0.3	0.4	0.4	0.4
121	0.3	0.3	0.4	0.4
121a	0.3	0.3	0.4	0.4
121b	0.3	0.3	0.4	0.4
122	0.3	0.3	0.3	0.3
123	0.2	0.2	0.2	0.2
123a - workshop	0.2	0.2	0.2	0.2
124	0.2	0.2	0.2	0.2
124a	0.2	0.2	0.2	0.2
124b	0.2	0.2	0.2	0.2
124c	0.2	0.2	0.2	0.2
124d	0.2	0.2	0.2	0.2
128	0.0	0.1	0.1	1.0
129	0.0	0.1	0.1	1.3
129b	0.0	0.1	0.1	1.3

Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
130	0.1	0.4	0.5	0.6
140	0.4	0.4	0.5	0.5
142	0.1	0.1	1.8	1.8
142a- working areas	0.1	0.2	1.8	1.8
147	0.9	1.4	1.4	1.6
148	0.0	0.6	0.6	3.0
148a	0.0	0.6	0.6	2.5
148b	0.0	0.6	0.6	2.5
148c	0.0	0.6	0.6	2.5
149	0.0	0.1	0.1	0.5
149a	0.0	0.1	0.1	0.2
149b	0.0	0.1	0.1	0.2
149c	0.0	0.1	0.1	0.2
149d	0.0	0.1	0.1	0.2
149e	0.0	0.1	0.1	0.2
149f - house	0.0	0.1	0.1	0.6
149g - house	0.0	0.1	0.1	0.7
150	0.0	0.1	0.3	0.3
151a	0.0	0.1	0.4	0.4
151b	0.0	0.1	0.4	0.4
151c	0.0	0.1	0.4	0.4
151d	0.0	0.1	0.4	0.4
152a	0.0	0.0	0.2	0.2
152b	0.0	0.0	0.2	0.2
152c	0.0	0.0	0.2	0.2

Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
152d	0.0	0.0	0.2	0.2
152e	0.0	0.0	0.2	0.2
152f	0.0	0.0	0.2	0.2
152g	0.0	0.0	0.1	0.2
152h	0.0	0.0	0.1	0.2
152i	0.0	0.0	0.1	0.1
152j	0.0	0.0	0.1	0.1
152k	0.0	0.0	0.1	0.1
152l	0.0	0.0	0.1	0.1
152m	0.0	0.0	0.1	0.1
152n	0.0	0.0	0.1	0.1
152o	0.0	0.0	0.1	0.1
152p	0.0	0.0	0.1	0.1
152q	0.0	0.0	0.1	0.1
152r	0.0	0.0	0.1	0.1
152s	0.0	0.0	0.1	0.1
152t	0.0	0.0	0.1	0.1
152u	0.0	0.0	0.1	0.1
154	0.9	0.9	1.3	1.3
154a - dairy & workshops	1.2	1.2	1.5	1.5
154b - house	0.8	0.9	1.2	1.2
155	1.1	1.1	1.4	1.4
156	0.3	0.3	0.7	0.7
157	0.1	0.2	0.4	0.4
159	0.1	0.3	0.4	0.4

Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
159a - workshop	0.1	0.3	0.4	0.4
159b - workshop	0.1	0.3	0.4	0.4
160a	0.1	0.3	0.4	0.5
160b	0.1	0.3	0.4	0.5
160c	0.1	0.3	0.4	0.5
160d	0.1	0.3	0.4	0.5
160e	0.1	0.3	0.4	0.5
160f	0.1	0.3	0.4	0.5
160g	0.1	0.3	0.4	0.5
160h	0.1	0.3	0.4	0.5
160i	0.1	0.3	0.4	0.5
161a	0.2	0.5	0.5	0.6
161b	0.2	0.5	0.5	0.6
161c	0.2	0.5	0.6	0.6
161d - dairy	0.1	0.4	0.6	0.6
161e - staff house	0.2	0.5	0.5	0.6
161f -staff house	0.2	0.5	0.5	0.6
161g	0.1	0.4	0.5	0.6
161h - house	0.2	0.5	0.6	0.6
162a	0.1	0.4	0.4	0.5
162b	0.1	0.4	0.4	0.5
162c	0.1	0.4	0.4	0.5
162d - staff house	0.1	0.3	0.4	0.5
162e- staff house	0.1	0.3	0.4	0.5
162f -staff house	0.1	0.3	0.4	0.5

Sensitive Receptor	Baseline	Impact Assessment - Impofu East	Cumulative Impact Scenario 1	Cumulative Impact Scenario 2
162g -staff house	0.1	0.3	0.4	0.5
163	0.2	0.3	0.4	0.4
163a - house	0.2	0.3	0.4	0.5
163b - Brakkeduine lodge / house	0.2	0.3	0.4	0.4
163c - Brakkeduine cottages	0.2	0.3	0.4	0.4
163d - Brakkeduine cottages	0.2	0.3	0.4	0.4
164	0.2	0.3	0.4	0.4
165a	0.8	0.9	0.9	0.9
165b	0.8	0.9	0.9	0.9
165c	0.8	0.8	0.9	0.9
165d - dairy	0.8	0.9	0.9	0.9

ANNEX D DETAILED FIGURES NOISE CONTOURS

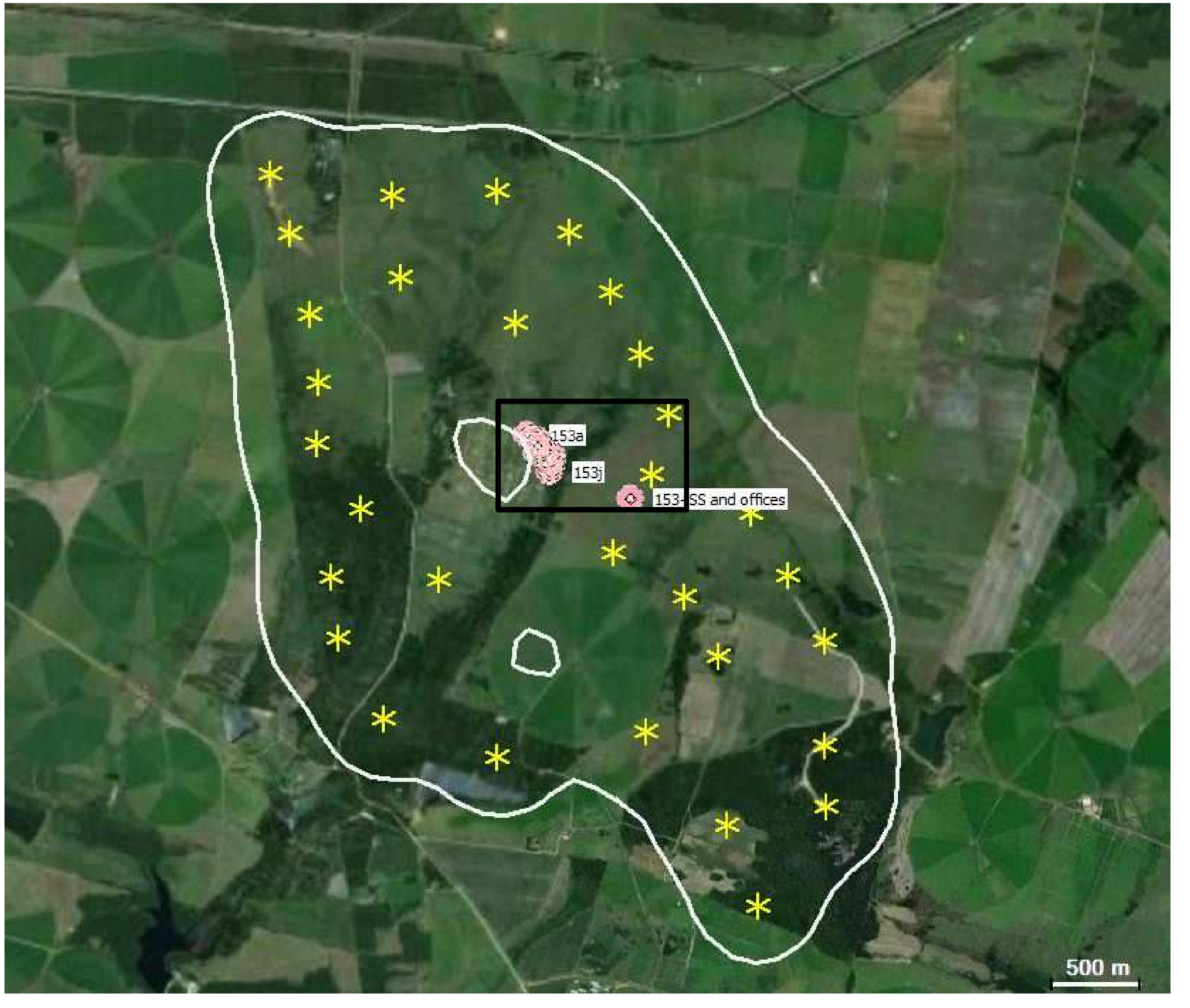
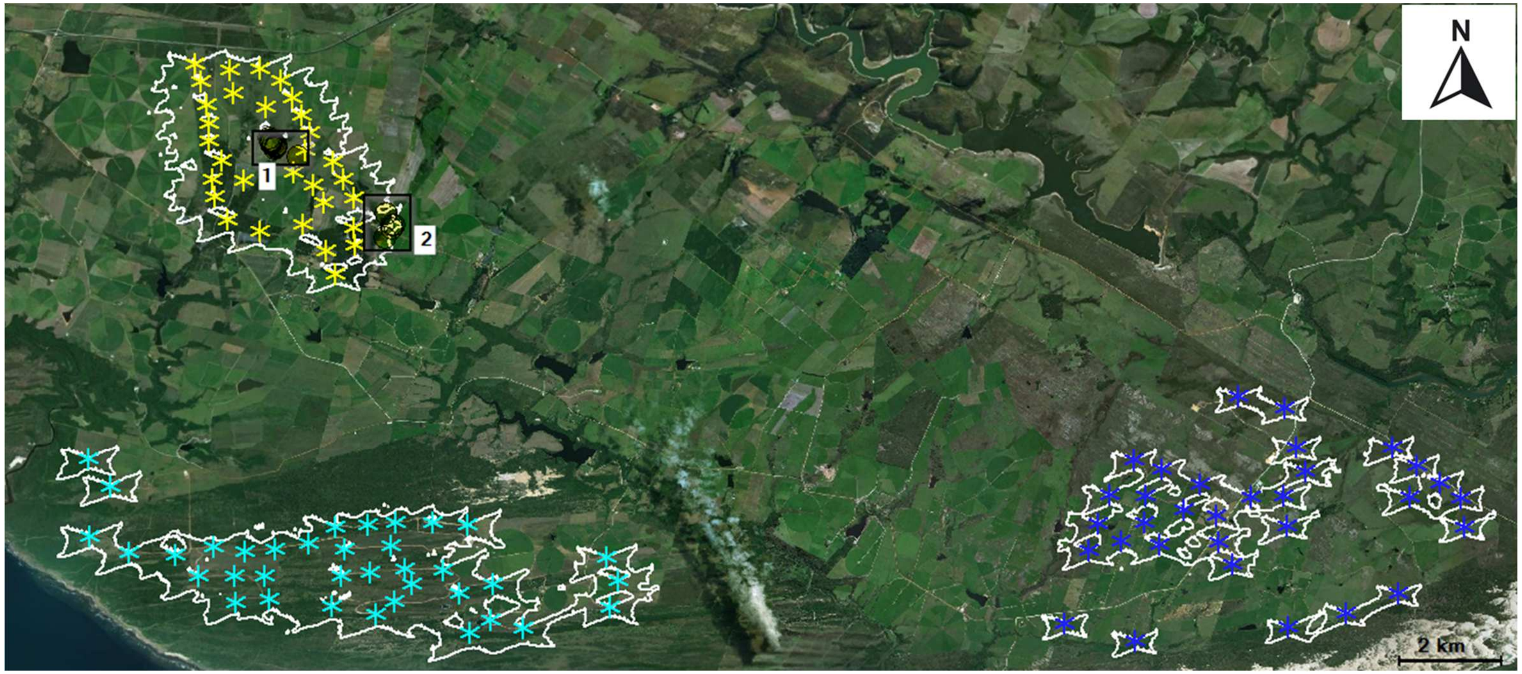


Figure 15: Noise contour map (45dB(A)) - Receptors with exceedance- Detail Tsitsikamma Community Wind Farm

Figure 16: Detailed location of noise receptors with exceedance

ANNEX E DETAILED FIGURES SHADOW CONTOURS

Baseline scenario

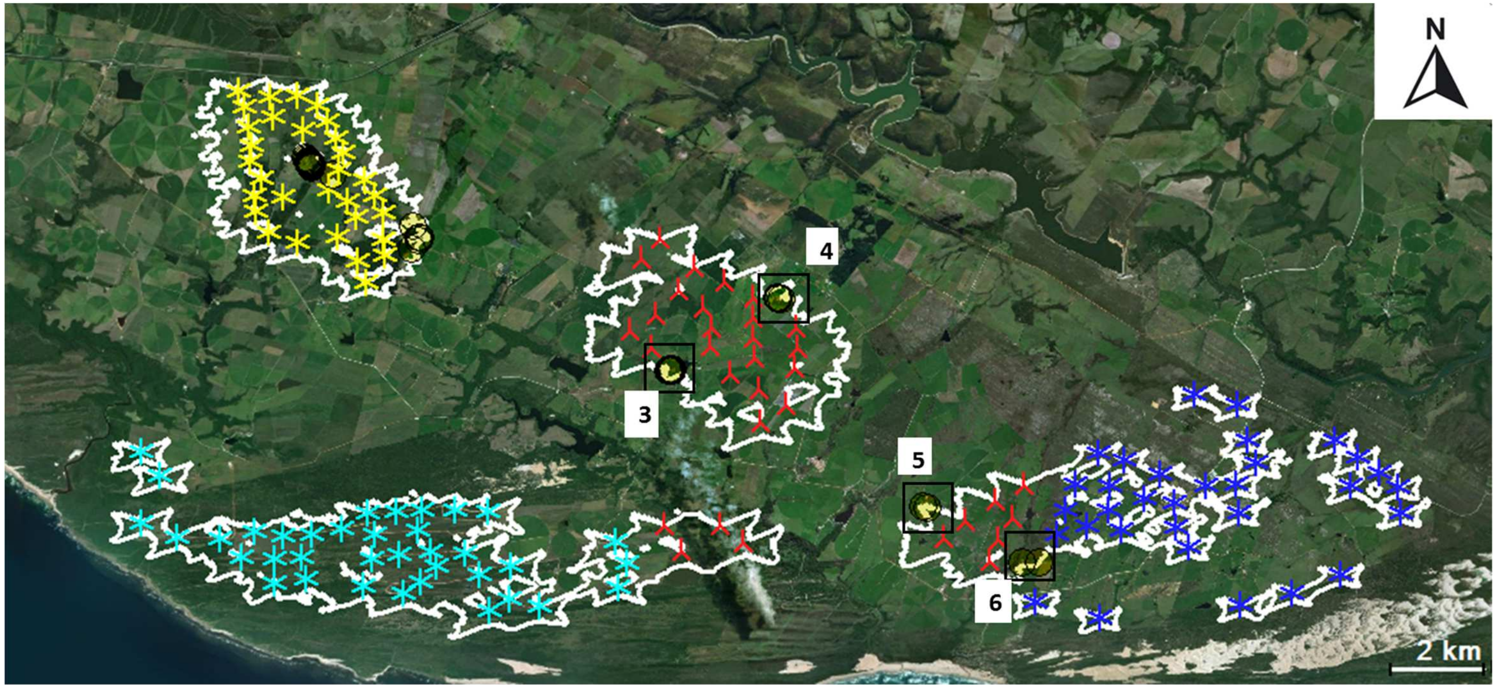


Zone 1


153a
153b
153c
153k
153e
153g
153f
153j
153- SS and offices
100 m

Zone 2

Impact Assessment scenario



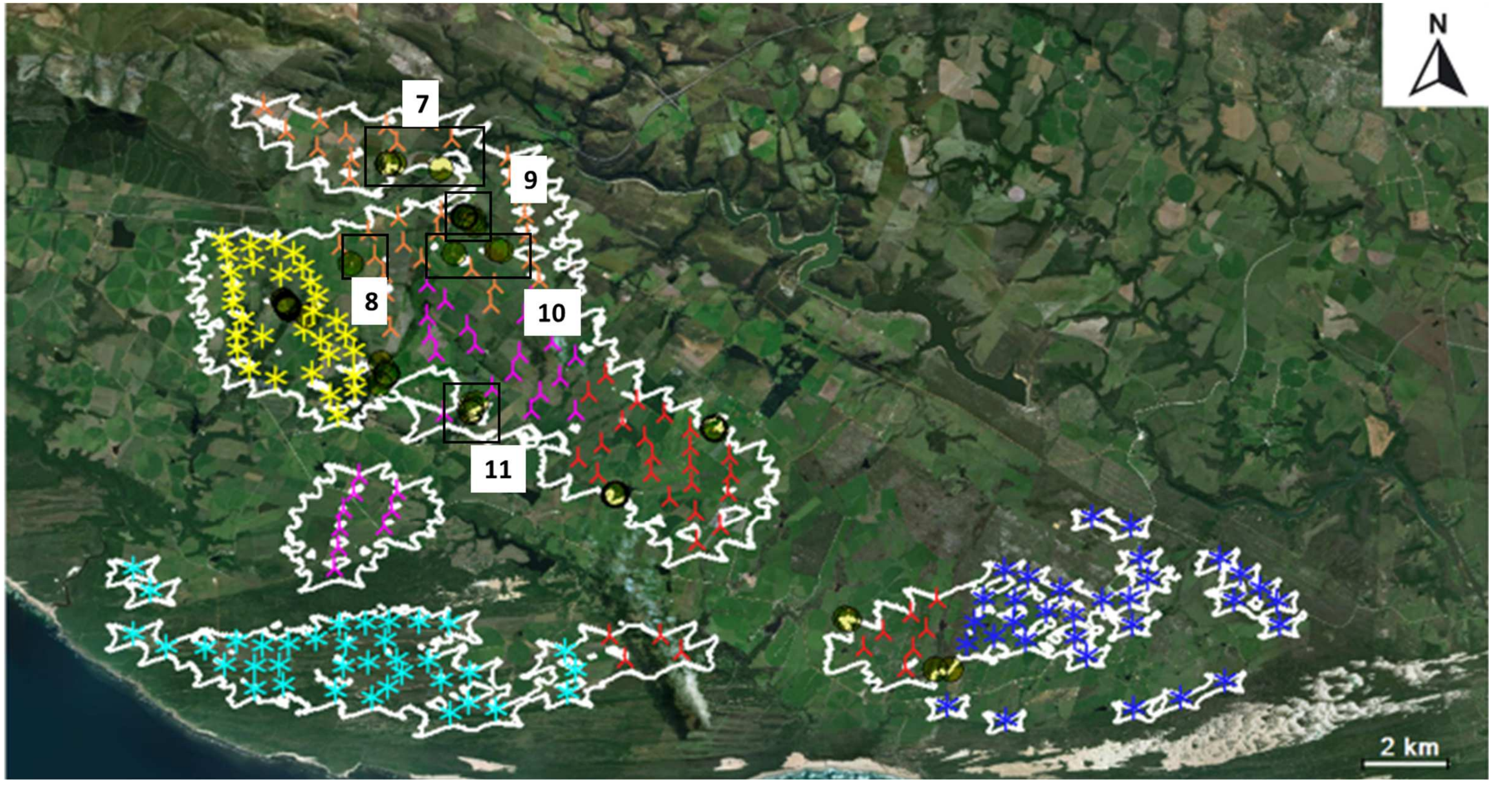
Zone 3

Zone 4

Zone 5

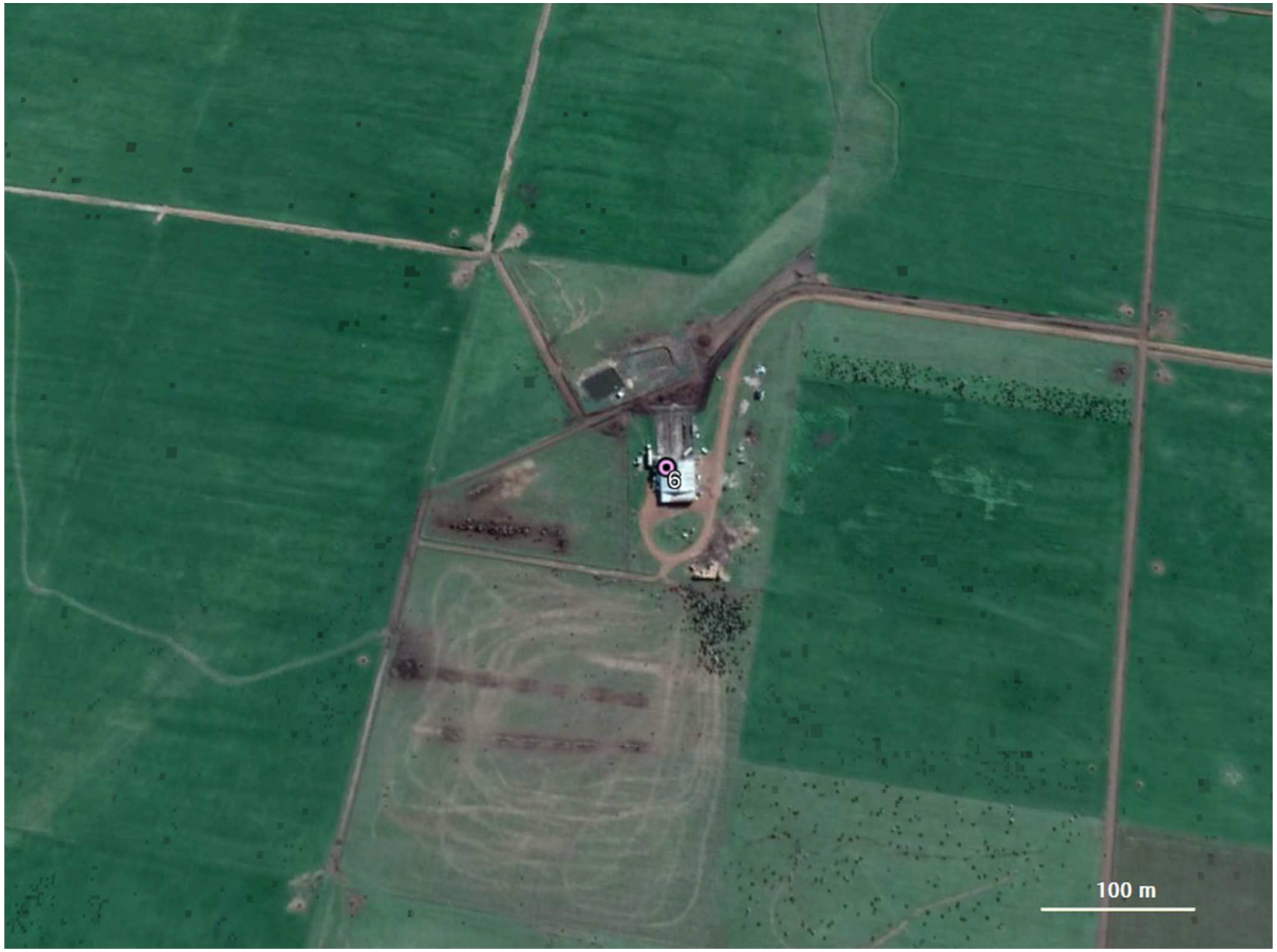
Zone 6

Cumulative: Scenario 1 scenario



Zone 7

Zone 8

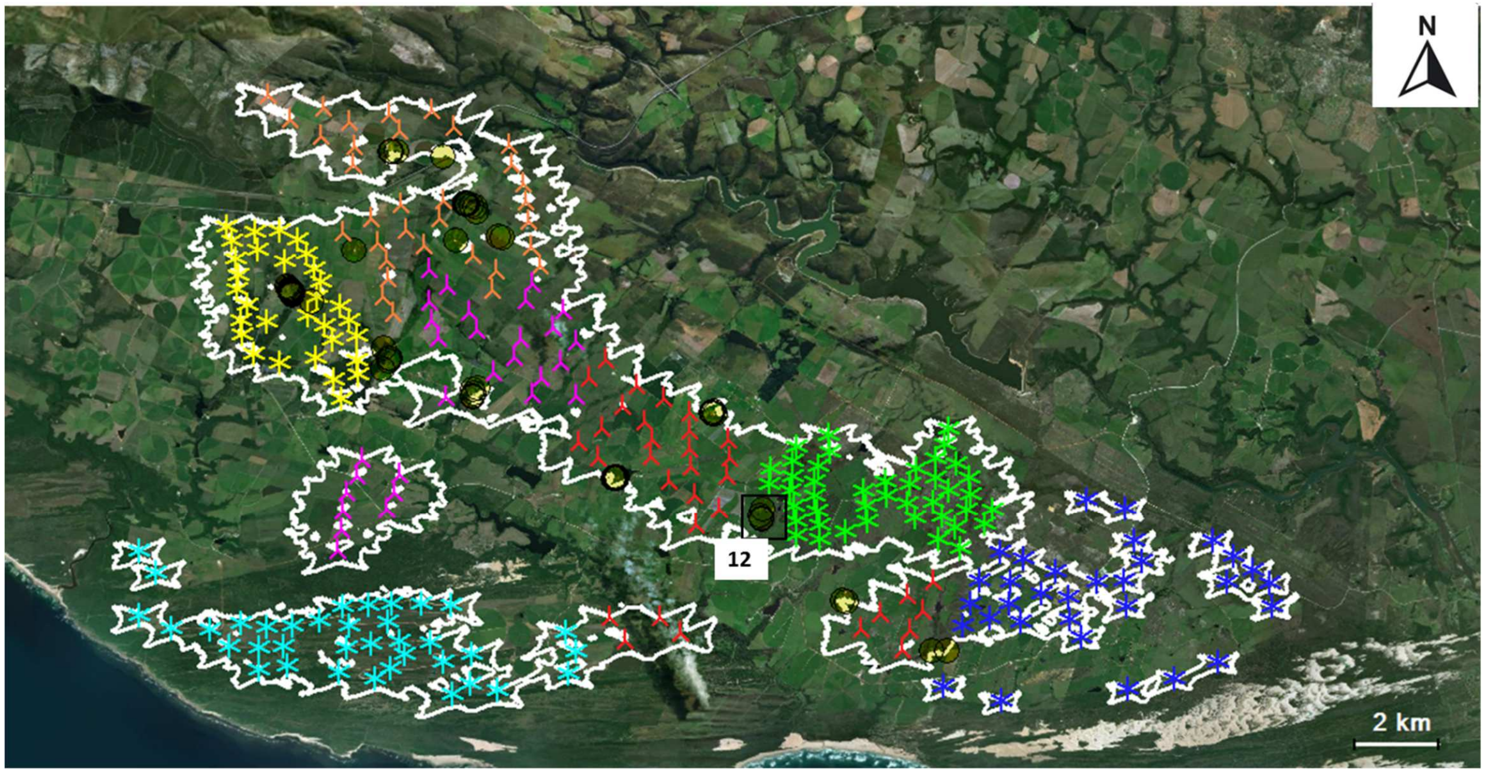


Zone 9

Zone 10

Zone 11

Cumulative: Scenario 2 scenario



Zone 12

ANNEX F SPECIALIST CV AND SPECIALIST DECLARATION

PERSONAL INFORMATION

Lien Van Breusegem

Kalkkaai 6 Quai à la Chaux, 1000 BE-Brussels

+32 2 229 15 24

+32 474 89 38 23

Lien.vanbreusegem@3E.eu

www.3E.eu

Gender F | Date of birth 29/11/1987| Nationality Belgian

WORK EXPERIENCE

08/2009 – present

Senior Consultant

3E NV– Brussels

Feasibility studies: evaluation of potential sites in terms of constraints and resources and optimisation of wind park lay-out

- Environmental Impact studies: Noise, Shadow flicker, Photomontages
- Drafting of necessary permitting documents
- Guidance during permitting application process
- Coordination and project management of the entire project development process from feasibility phase to assistance during permitting phase.
- Equator principles review, drafting of Equator Principles Action Plan

Business or sector: Consulting and Expert Services in Renewable Energy

KEY PROJECTS

Client Storm

2009-present

3E performs a wide range of tasks for Storm, for more then 120MW so far, most common tasks as listed below:

- Long term yield assessment
- Site suitability
- SCADA data analysis
- Component and take over inspections
- End of warranty inspections
- Drafting of Permitting applications
- Photomontages
- Shadow study
- Consumption and production profile comparison

My role Account Manager

Client Katoen Natie

2012-2016

Project guidance during development phase of wind farms on six sites. After feasibility phase four sites were withheld and wind park layout was defined (number of turbine, turbine dimensions).

For each site the permitting files, including technical plans and environmental impact assessment studies were drafted and handed in. Assistance during the permitting phase was provided.

My role Project Manager, Environmental Expert

Client IVC Group

2010-2015

Project guidance during development phase of a 7MW wind farm in Avelgem. After feasibility phase, the wind park layout was defined (number of turbine, turbine dimensions). The permitting files, including technical plans and environmental impact assessment studies were drafted and handed in. Assistance during the permitting phase was provided.

My role Project Manager

Client Edison Energy

2010-2011

Project guidance during development phase of a 7MW wind farm in Waasmunster. After feasibility phase, the wind park layout was defined (number of turbine, turbine dimensions). The permitting files, including technical plans and environmental impact assessment studies were drafted and handed in.

My role Project Manager, Environmental Expert

Client Grepobel

2011

Project guidance during development phase of a 7MW wind farm in Lommel. The wind park layout was defined (number of turbine, turbine dimensions). The permitting files, including technical plans and environmental impact assessment studies were drafted and handed in.

My role Project Manager, Environmental Expert

Client Xant

2012-2014

Project guidance during development phase of a prototype of a small wind turbine in Harelbeke. After feasibility phase, the wind park layout was defined (number of turbine, turbine dimensions). The permitting files, including technical plans and environmental impact assessment studies were drafted and handed in. Assistance during the permitting and construction phase, as well as operational phase is provided.

My role Project Manager, Environmental Expert

Client Gruissan

2016

Micrositing and long term yield assessment study for offshore site in the Golfe de Lion.

As a first step various sources of wind resource data were investigated, in order to identify the most reliable source. The site was modelled and the wind resource on site was calculated in order to assist in the definition of the most suitable layout. The energy production was then calculated for the final selected layout.

My role Technical expert: Wind Analyst

Client Parkwind

2016

Long term yield assessment study for 2 offshore sites in the Borssele concession.

Public information on the wind resource was used. This data was cleaned and long term extrapolated. Next a model calibration was performed. Operational data of a nearby existing offshore wind farm was used to validate and calibrate the model. The wind resource on site was then calculated for both sites and two potential turbine types.

My role Project Manager, Technical expert: Wind Analyst

Client Neoen

2015-2016

Long term yield assessment study, using WaSP and site suitability study for a 10 to 16.5MW wind project in La Valléé aux Grillons, France.

Using the on-site mast the wind data was cleaned and long term extrapolated. The terrain on site was modelled and the wind resource on site was calculated for 6 potential turbine types.

For the selected turbine type a site suitability study was performed verifying if the wind turbine is able to withstand the wind climate on site.

My role Technical expert: Wind Analyst

Client Energeco

2014

Long term yield assessment study, using WaSP and review of the noise study for a 10MW Wind project in Coulours, France.

Using the on-site mast, the wind data was cleaned and long term extrapolated. The terrain on site was modelled and the wind resource on site was calculated.

Additionally, a review of the noise study was performed. This review verified the model of the site and turbines, the measurement campaign and resulting noise levels.

My role Technical Expert: Wind analyst and Environmental Expert

Client Windvision

2016

Long-term Yield assessment, using CFD for two wind farms in Tunesia.

As no mast data was available at the time of the study reanalysis data was used. The wind flow model was validated and the wind resource calculated using the CFD software Meteodyn, resulting in the long term yield assessment of the turbines on site.

My role Technical Expert: Wind Analyst

Client Ecodelta

2016

Long-term Yield assessment, using CFD for a 6.4MW wind farm in Maria, Corsica.

Two mast were present on site. The mast data was cleaned and extrapolated to the long term. The wind flow model was validated and the wind resource calculated using the CFD software Meteodyn, resulting in the long term yield assessment of the turbines on site.

My role Technical Expert: Wind Analyst

Client Quadran

2016

Feasibility constraint mapping of the car stops along the highway in Wallonia.

As a first step a high level screening of aeronautical constraints was performed.

Next, for the remaining sites a detailed screening of remaining aspects (Nature, distance to houses, high tension lines, …) was performed.

As a last step the number of turbines and turbine dimensions were defined for each sites.

My role Technical Expert: GIS Expert

Client Quadran

2015

Equator principles review for a 12MW wind farm in Sabadell-Nueil Aubiers, France.

An evaluation of the social and environmental impacts of the project are evaluated, according to the equator principles and the standard of the IFC and all non-conformities are listed.

My role Environmental Expert

Client Innowind

2016

Equator principles review and drafting of equator principles action plan for a 34.5MW wind farm in Wesley, South Africa.

An evaluation of the social and environmental impacts of the project are evaluated, according to the equator principles and the standard of the IFC and all non-conformities are listed. Based on the non-conformities a equator principles action Plan, including delays was drafted.

My role Environmental Expert

EDUCATION & TRAINING

2009 – 2010

Environmental coordinator Level A

College-University Brussels (Hogeschool universiteit Brussel), Belgium

2005 – 2009

Master's degree in Environmental and Prevention Manager,

College-University Brussels (Hogeschool universiteit Brussel), Belgium

PERSONAL SKILLS

Mother tongue: Dutch

Other languages

1 Elementary proficiency

2 Limited working proficiency

3 Pro. working proficiency

4 Full Pro. proficiency

5 Native/bilingual proficiency

Understanding		Speaking		Writing
Listening	Reading	Spoken interaction	Spoken production	

English	4	4	4	4	4
French	3	3	3	3	3

Organisational / managerial / communication skills	Project management
Job-related skills	Wind Data Assessment (Metmast and LiDAR), Yield assessment (Windpro, WaSP CFD), Constraint Mapping (GIS), Site suitability, Small wind Technologies, offshore, Equator principles, Environmental Impact Studies (Noise, Shadow, Photomontages), Project guidance, permitting procedure.
Computer skills	Word, Excel, power point, Windpro, WaSP, WaSp Engineering, Meteodyn, Urbawind, ArcGIS, QGIS, Surfer, Global Mapper, …
Other skills	
Driving licence	Category B

ADDITIONAL INFORMATION

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	
NEAS Reference Number:	
Date Received:	

Application for integrated environmental authorisation and waste management licence in terms of the-

(1) National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014; and

(2) National Environmental Management Act: Waste Act, 2008 (Act No. 59 of 2008) and Government Notice 921, 2013

PROJECT TITLE

Specialist:	3E		
Contact person:	Lien Van Breusegem		
Postal address:	Lower Burg Street 20, The Landing, Office n°401		
Postal code:	8001	Cell:	
Telephone:	021 300 1921	Fax:	
E-mail:	Lien.vanbreusegem@3e.eu		
Professional affiliation(s) (if any)			

Project Consultant:	**Aurecon South Africa (Pty) Ltd**		
Contact person:	**Ms Mieke Barry**		
Postal address:	**PO Box 494, Cape Town**		
Postal code:	**8000**	Cell:	-
Telephone:	**021 526 6025**	Fax:	-
E-mail:	**Mieke.barry@aurecongroup.com**		

4.2 The specialist appointed in terms of the Regulations_

I, Lien Van Breusegem declare that -- General declaration:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist: Lien Van Breusegem

Name of company (if applicable): 3E

Date: 02/05/2018

ANNEX G REQUIREMENTS APPENDIX 6 OF NEMA

NEMA requirements for Specialist Reports		
Appendix 6	**Specialist Report content as required by the NEMA 2014 EIA Regulations, as amended**	**Section**
1 (1)(a)	(i) the specialist who prepared the report; and	Annex E
	(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Annex E
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section 1
(cA)	an indication of the quality and age of the base data used for the specialist report;	Section 4.5
(cB)	a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 5, section 6
(d)	the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 2.3.2
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process, inclusive of equipment and modelling used;	Section 4
(f)	details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 2.3
(g)	an identification of any areas to be avoided, including buffers;	Section 2.4
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 2.3 and section 2.4
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 2.3.2, section 4
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity, or activities;	Section 5.1.3, section 5.2.9, section 6.7, Section 7
(k)	any mitigation measures for inclusion in the EMPr;	Section 7
(l)	any conditions for inclusion in the environmental authorisation;	Section 7
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 7
(n)	a reasoned opinion-	Section 7
	(i) whether the proposed activity or portions thereof should be authorised; and	
	(iA) regarding the acceptability of the proposed activity or activities; and	
	(ii) if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	N/A
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
(q)	any other information requested by the competent authority.	N/A
2	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

QUALITY INFORMATION

Author:

Lien Van Breusegem

Verified by:

Naïma Vande Walle

28/03/2019

Approved by:

Naïma Vande Walle

28/03/2019

Template V. 12.13