Prepared for

Blue Wind Energy Facility

Bat Monitoring

Pre-construction phase - 2013/ 2014

Report - July 2013 to March 2014

March 2014

LOOKING DEEP INTO NATURE

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EXECUTIVE SUMMARY

The results collected to date of the 4 seasons bat community pre-construction monitoring programme for the Blue Wind Energy Facility are presented in this report.

Active detection (within the wind energy facility and a control area), passive detection at ground level (within the wind energy facility area and a control area) and at rotor height (in the wind energy facility site), and bat roost searches and inspection were implemented during the **pre-construction monitoring surveys conducted between July 2013 and March 2014, both inclusive, covering the 4 seasons** (winter to autumn). All these activities were conducted with the objective to characterize and map the bat activity for the study area, and assess the impact of the proposed wind energy facility.

These methodologies confirmed the **occurrence of 4 bat species** and the potential occurrence of 2 additional bat species in the study area. Only one of the confirmed species is considered to be of conservation concern and classified as “Near Threatened” by the South Africa Red List, the Natal long-fingered bat (*Miniopterus natalensis*). Bat activity in the study area was overall very low, even when comparing with other locations in South Africa. Considering the seasonal activity patterns, bats were more active during spring and decreasing the level of activity until the autumn. Only one survey was conducted during autumn season to date but considering the low activity registered on site during the program completed up to date, it is not expected a significant increase in bat activity in the coming months.. Among the environmental variables, wind speed and temperature were considered to have an influence on bat activity. Three active bat roosts were identified in the broader surroundings of the study area, with observation of individuals in one of them. The remaining two locations were confirmed as bat roosts only through the observation of bat droppings on site. No other suitable locations for roosting were identified within the wind energy facility site.

The analysis of bat activity and environmental features in the study area led to the **classification of the study area as having a low sensitivity for bats**. Therefore **no no-go areas were identified** and no constraints to the current wind turbine layout are foreseen.

Considering the **potential impacts of collision fatalities of bat species occurring in the area**, it was important to analyse their risk of collision with wind turbines. This analysis has shown that one bat species with confirmed occurrence on the site has a high risk of collision with the wind turbines and another 2 bat species have medium to high potential collision risk. These species are common and widespread but may be affected by the operational phase of this project. Therefore **mitigation measures are proposed to reduce the probability and significance of such impacts on local bat communities**.

Technical team

The technical team responsible for the monitoring surveys and report compilation is presented in following table.

Technician	Qualifications	Role on project
David Anger	Level 1 Nature Guide	Field observer
Eugene Fuhri	FGASA (Field Guide Association of South Africa) Level 3 Specialist Skills in Dangerous Animals and Birding	Field observer
Robyn Kadis	Nature Conservation student	Field observer
Francisco Cervantes	Master in Environmental Management Environmental and Marine Biology Majors Degree in Biology	Field observer
Joana Marques	Masters in Ecology and Environmental management Degree in Environmental Biology	Report compilation
Ricardo Ramalho	PhD in Environmental studies BSc Honours Degree in Biological Sciences Registered Professional Natural Scientist Zoological Sciences (400028/14)	Technical coordination
Jo-Anne Thomas	Masters of Science degree in Natural Science BSc Honours Degree in Natural Science Registered Professional Natural Scientist (Pr.Sci.Nat)	Coordination Report review

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This report provides information regarding the pre-construction bat community monitoring of Blue Wind Energy Facility. It does not include the data from the complete proposed monitoring programme, complete data processing and analyses. When submitting this report to 3rd parties it must be clearly mentioned that it is a report that includes solely the content described below.

PREFACE: BATS AND WIND TURBINES

Wind power has grown exponentially in the last decade and it is one of the main alternative energy sources to fossil fuels (Gsänger & Pitteloud 2013). Its development in South Africa has just started and by the end of 2012 only 10 MW were installed in the country (Gsänger & Pitteloud 2013).

This energy source is not free from environmental impacts. The installation of wind energy facilities around the world has revealed issues regarding wildlife conservation (Eichhorn & Drechsler 2010), specially related to bird (Barrios & Rodríguez 2004; Drewitt & Langston 2008) and bat communities (Barclay, Baerwald & Gruver 2007; Arnett *et al.* 2011). Beyond the birds and bats, habitat loss affects all existing biodiversity (Kikuchi 2008).

The impact on natural populations is not only due to direct mortality caused by collisions and barotrauma[1], the latter affecting bats only (Baerwald *et al.* 2008). Impact on natural populations may also be caused by the disturbance effect, barrier effects and habitat loss (Drewitt & Langston 2006). These impacts, especially mortality, have become a source of major concern among a number of stakeholder groups (Erickson *et al.* 2002). Results obtained during several international monitoring studies indicated that wind farms were responsible for the decrease in population of some species' (Carrete *et al.* 2009), although many other studies revealed that these impacts were not important when compared to those originating from other man-made infrastructures (Drewitt & Langston 2008). Nevertheless, the potential for wind farms to affect bat populations should not be underestimated (Madders & Whitfield 2006).

Extensive research has been conducted internationally regarding bats and wind farms (Horn, Arnett & Kunz 2008; Baerwald & Barclay 2009; Arnett *et al.* 2011). However, not much research has been conducted on these matters in South Africa until recently. Research about seasonal and daily movement patterns of bat species and what the potential impacts of the development of multiple wind energy facilities and thousands of turbines across the country might be has been lacking and has begun only recently.

Also, information regarding bat distribution, seasonal and daily movements and migration is very limited for South African bat communities. Therefore, the need to evaluate the potential effects and interactions between bats and wind energy facilities is more relevant in South Africa, since the countries' experience in wind energy generation has been extremely limited to date and wind energy developments are currently under expansion. Until recently, only eight wind turbines had been constructed, 3 at a demonstration facility at Klipheuwel in the Western Cape, in 2002 and 2003, 4 at a site near Darling, and 1 at Coega near Port Elizabeth. To date only a 1 year preliminary study assessing bird and bird fatalities has been completed in South Africa and the results published, reporting bat and bird fatalities produced by wind energy facilities (Doty & Martin 2013). This study was undertaken at a pilot turbine installed in the Coega Industrial Development Zone, Port Elizabeth, Eastern Cape, where a total of 18 bat fatalities were recorded over a 12 month period. Another short pilot study (over a 2 month period, covering solely

[1] Barotrauma is used in the present report referring to bat deaths due to tissue damage to air- containing structures caused by rapid or excessive pressure change close to the rotating wind turbine blades surface. Death is usually caused by pulmonary barotrauma where lungs are damaged due to expansion of air in the lungs that is not accommodated by exhalation (Baerwald *et al.* 2008).

a bat migration period) was conducted in the experimental Darling wind energy facility where only one bat fatality was recorded (Aronson, Thomas & Jordaan 2013). The potential impacts of wind turbines on South African bat communities is still largely unknown, due to a lack of research on bats in the country and a poor level of knowledge on bat abundance, locations of roost sites, and both foraging and migratory behaviour. Therefore, data collection and further investigations are needed. Pre- and post-construction monitoring at wind energy facilities can go some way to filling these gaps and promoting the sustainability of wind energy developments in South Africa.

The Guidelines for Surveying Bats in Wind Farm Developments (Sowler & Stoffberg 2012) were developed in collaboration with the Endangered Wildlife Trust (EWT). These guidelines provide technical guidance for consultants to carry out impact assessments and monitoring programmes for proposed wind energy facilities, in order to ensure that pre-construction monitoring surveys produce the required level of detail for authorities reviewing environmental authorisation applications. These guidelines outline basic standards of best practice and highlight specific considerations relating to the pre-construction monitoring of proposed wind energy facility sites in relation to bats.

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1. INTRODUCTION

This is the report of the bat community pre-construction monitoring programme, including the results from the 4 seasons monitoring period conducted from July 2013 to March 2014, both inclusive, for the Blue Wind Energy Facility site being developed by Diamond Wind (Pty) Ltd. The information included in this report will be completed upon the conclusion of the 12-month pre-construction monitoring programme, in June 2014 and the total information will be presented in an updated report. The main objective of this report is to provide a detailed characterisation of the bat communities and to provide a general year-round evaluation during the pre-construction phase. The purpose of the bat monitoring was to characterise bat communities within the study area, and allow the establishment of a baseline scenario for the pre-construction phase, and contribute towards determining potential impacts of the construction and operation of the wind energy facility on bat communities.

1.1. Scope of work and Objectives

The main objective of the Blue Wind Energy Facility (WEF) pre-construction monitoring programme was to characterise the bat community in the area, and assess the potential impacts of the WEF on the bat community.

The specific objectives of the pre-construction bat monitoring programme are:

a) Establish the pre-impact baseline reference and characterization of the bat communities occurring at the development area (e.g. species occurrence, activity and distribution);

b) Identify the potential changes in the bat community present within Blue wind energy facility site and the eventual exclusion effect caused by the projects' presence and/or operation (avoidance of the wind facility area during the operational phase of the project);

c) Assess the use of roosts in the wind energy facility development footprint and its immediate vicinity;

d) Identify potential impacts from the wind energy facility on the bat community and propose measures to avoid or, if unavoidable, mitigate, compensate and monitor, identified potential impacts.

In order to achieve the objectives of the pre-construction bat monitoring programme, an experimental protocol was established, covering the wind energy facility site, its immediate surroundings and a control area, and hence comply with the main requirements of the "South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments" (Sowler & Stoffberg 2012) and the major indications from the draft Environmental Impact Assessment (EIA) report of the Blue Wind Energy Facility (Savannah Environmental 2012).

To accomplish the above mentioned objectives, the monitoring work of the community of bats included the following tasks:

- Sampling of ultrasound in the wind energy facility site and in a control area. This task will provide data that will achieve Objectives a) and b);
- Inventory, search, inspection and monitoring of roosts in the area surrounding the wind energy facility. This task will provide data that will achieve Objective c) and Objective b).

The implementation of the continuation of a similar monitoring programme during operation phase of the development should include the implementation of bat carcass searches around the turbines and determination of the searcher detection efficiency and carcass removal (by scavengers or decomposition) which will provide data to quantify bat fatalities associated with the wind energy facility and determine the species affected.

All the above methodologies will enable Objective d) to be achieved.

The results of this study will contribute to the establishment of the baseline situation in order to better assess the potential impacts for the relevant local bat communities and allow the accomplishment of all the objectives stated above. The implementation of similar monitoring protocols and sampling locations during the subsequent phases of the project (for a minimum of three years after the facility becomes operational) will be very important once by referring to the baseline scenario established and implementing a Before-After Control-Impact analysis as proposed by international references (Atienza *et al.* 2011; Strickland *et al.* 2011; USFWS 2012) it will be possible to validate the potential impacts identified, to determine if other impacts are occurring and adequately adjust any mitigation measures proposed at this stage (or propose new and more appropriate ones if necessary).

1.2. Terms of reference

The following assessment was conducted according to the specialist terms of reference:

- Conduct a review of international literature and experience relating to operational wind farms - including other facilities around the world;
- Describe the affected environment and determine the bat species present in the future impact site;
- Identify species of special concern and assess potential effects of the development on the bat community;
- Assess how the bat community will be affected by the proposed development, listing, describing and evaluating potential impacts;
- Map sensitive areas in and around the proposed wind energy facility site;
- Provide recommendations for relevant mitigation measures which will allow the reduction of negative effects and maximization of the benefits associated with any identified positive impacts;
- Propose a suitable monitoring programme for the evaluation of the impacts expected during the operational phase of the development, if considered necessary.

1.3. Legal framework

It is considered best practise for bat monitoring to be undertaken on wind energy facility sites, following the requirements outlined by the "**Best practice guidelines for pre-construction surveying bats at proposed wind energy development sites in southern Africa**" (Sowler & Stoffberg 2012). At the time the present monitoring programme was proposed and implemented Best practice guidelines were the 2012 version. However, the experimental design implemented already considers some aspects discussed in a South African Bat Assessment Advisory Panel (SABAAP) workshop, that later were included in the 3rd edition of the "**Best practice guidelines for pre-construction surveying bats at proposed wind energy development sites in southern Africa**" (Sowler & Stoffberg 2014) released in February 2014. Examples of this compliance are the a minimum of 8 manual surveys conducted spread over the year (the monitoring programme actually considers 12 active surveys) high number of passive detectors used and continuous monitoring at some of the static sampling points, namely at rotor height. Nevertheless, the recommendations proposed by the guidelines must be adapted to the projects specificities and as it is stated in that document "each assessment should consider the scale and the likely impacts and take a proportionate approach".

There are no permit requirements dealing specifically with bats in South Africa. Legislation dealing with mammals applies to bats and includes the following:

National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004):

The National Environmental Management: Biodiversity Act (Act 10 of 2004) (NEMBA) provides for listing threatened or protected ecosystems, in one of four categories: critically endangered (CR), endangered (EN), vulnerable (VU) or protected. The Act calls for the management and conservation of all biological diversity within South Africa.

NEM:BA also deals with endangered, threatened and otherwise controlled species, under the ToPS Regulations (Threatened or Protected Species Regulations). The Act provides for listing of species as threatened or protected, under one of the following categories:

- Critically Endangered: any indigenous species facing an extremely high risk of extinction in the wild in the immediate future.
- Endangered: any indigenous species facing a high risk of extinction in the wild in the near future, although it is not a critically endangered species.
- Vulnerable: any indigenous species facing an extremely high risk of extinction in the wild in the medium-term future; although it is not a critically endangered species or an endangered species.
- Protected species: any species which is of such high conservation value or national importance that it requires national protection. Species listed in this category include, among others, species listed in terms of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

A ToPS permit is required for any activities involving any ToPS-listed species. A number of bat species are listed as critically endangered, endangered, vulnerable and protected in terms of Regulations published under this Act.

Nature and Environmental Conservation Ordinance No. 19 of 1974; Schedule 5:

Although the primary purpose of this Act is to provide for the amendment of various laws on nature conservation, it also deals with a number of other issues. This Act lists protected wild animals, including all bats except Fruit Bats of the family PTEROPODIDAE. A permit is required for any activities which involve endangered or protected flora and fauna.

IUCN Red List of Threatened Species

The International Union for the Conservation of Nature (IUCN) Red List of Threatened Species ranks plants and animals according to threat levels and risk of extinction, thus providing an indication of biodiversity loss. This has become a key tool used by scientists and conservationists to determine which species are most urgently in need of conservation attention. In South Africa, a number of bats are listed on the IUCN Red List.

1.4. Proposed wind energy facility and study area

The proposed Blue Wind Energy Facility includes up to 54 wind turbines distributed across an area of approximately 3300 ha. The wind turbine dimensions were not yet known by the elaboration of the present study, so rotor dimensions considered were from 28 to 183m above ground in order to enclose all hypotheses. The project is divided into three stages, for a phased construction process; nonetheless this study evaluates the three phases as one.

The project also includes foundations to support turbines, an on-site substation, underground (where practical) cabling between turbines to this substation, an overhead power line, internal access roads and a workshop area (Appendix I - Figure 14). The site is located in the Northern Cape Province, approximately 6km north-east of Kleinsee. The site is within the Nama Khoi Local Municipality and within a De Beers mining area. The site implementation is proposed on the following farms: Dikgat 195, Kleinsee 193, Dreyers pan 192 and Predikant Vlei 190 (Appendix I - Figure 14). The road 355 and Buffles River pass south of the study area.

The site falls within the Succulent Karoo biome (Mucina & Rutherford, 2006). The site is within Namaqua Strandveld, however due to the proximity with the coastal area to the west of the site Namaqua Duneveld vegetation is dominant. The Buffels River south of the site and the Saltpans located west within the Namaqua Dunevels are part of the Azonal Vegetation Biome and the Namaqualand Riviere and Namaqualand Salt pans vegetation type respecitively (Mucina & Rutherford, 2006; Appendix I - Figure 15).

The natural habitats have been severely degraded in the area close to the mining site being in process of recovery. The remaining area of the site remains natural with vast extensions of shrubs. The proposed Blue project falls within the more natural area, only marginally occupying the degraded vegetation area (Photograph 1). The sampling locations were therefore located in areas of scrubland as this is the dominant type of vegetation present. The Control area was chosen north of the proposed site with the same type of vegetation and topography.

In the margins of Buffels River, located at a minimum distance of 1.5 km from a proposed turbine, some small caves may be found, representing a location with high potential for bat roosts (Photograph 1).

Considering the vegetation present and the presence of rocky formations south of the site, bat species associated with scrubland and/or rocky formations are expected to be present, such as: *Eptesucus hottentotus* (Long-tailed serotine), *Neoromicia capensis* (Cape serotine) and *Tadarida aegyptiaca* (Egyptian free-tailed bat).

According to Mucina & Rutherford (2006) the climate in the region where the project is proposed is characterised mainly by the strong maritime influence with a mild climate. The mean annual precipitation is between 100 and 200 mm, while the mean annual temperatures range between 16 and 18ºC.

The closest National Park to the proposed wind energy facility site is the Richtersveld National Park and is located at approximately 30 km to the north and the Namaqua National Park, 50km south, so no major concerns are foreseen in this respect.

At least another three wind energy development are planned to be implemented in the area. They will be implemented at a maximum distance of 100 km (Kangnas/Springbok WEF), 60km (Koignaas WEF) and a minimum distance of 20km (Kannikwa Vlakte WEF) (CSIR 2012).

(A)  **(B)** 

(C) 

Photograph 1 – Photographs indicating the general landscape of the Blue wind energy facility site: A – Natural vegetation of Namaqualand Strandveld – shrubs; B – Degraded Strandveld vegetation in recovery process and Namaque Duneveld vegetation to the west of the proposed site; C – Rocky escarpments south of the study area, in the surroundings of the Buffels river, near Kleinsee.

1.5. Summary of the Bat Impact Assessment

During the Environmental Impact Assessment no Bat Impact Assessment Report was conducted, only a Faunal Impact Assessment Report was compiled (Todd 2012). This assessment was made by means of a desktop study complemented with a site visit in May 2013.

This assessment pointed that the site is likely to be poor in bat species diversity, due to the arid vegetation and climate. However fourteen species were pointed as possibly occurring, including two species of conservation concern, the Cape horseshoe bat (*Rhinolophus capensis*) and Angolan wing-gland bat (*Cistugo seabrai*). Were also identified along the Buffels River some suitable roosting locations, suitable for most of the species likely to occur at the site; as well as foraging areas along the drainage lines.

Regarding the potential impacts over bat populations, it was identified the risk of bats colliding with turbines while foraging, migrating or moving between areas. The most likely areas for this impact would be near Grootmis and along the coastal bluff. Mitigation measures suggested included the implementation of a Bat monitoring programme according to the South African Good Practice Guidelines for Surveying Bats in wind Farm Developments (Sowler & Stoffberg 2012), as soon as possible; and the adjustment of turbine placement considering the findings and recommendations from the monitoring studies.

2. Monitoring Programme Description

2.1. Desktop preparatory work

Prior to the commencement of field surveys, a desktop survey was conducted to compile the best information possible to provide a better evaluation of all the conditions present on the study area. Therefore, the available data sources (Table 1) were consulted to assess which species could occur in the different habitat occurring at the Blue Wind Energy Facility. In order to evaluate and interpret the obtained results, literature references and bat specialists were consulted, concerning any available information regarding possible migration routes, patterns of bat activity throughout the year in the study area, the presence of known roosts surrounding the study area that may be important for bats occurring on site, local or regional echolocation variation in the sound parameters, or other types of information that could be relevant for the contextualisation of the importance of the study area for bats occurring in South Africa, particularly, in Northern Cape.

Potential roosting sites and potential important areas for bats were identified, in a preliminary stage, by means of a desktop survey taking into consideration the 1:50 000 maps of South Africa, aerial imagery and any other relevant information overlaid in a Geographic Information System (GIS).

These locations were then verified during the first visit to the site, to fine tune and adjust the methodological protocol to the site characteristics and any other particular conditions found at the area. Whenever considered necessary, the methodology and techniques were adjusted for a better assessment of the bat communities present at the site.

Table 2 includes, but is not limited to, the list of data sources and reports consulted and taken into consideration, for the compilation of this report, in varying levels of detail. Other references were consulted for particular issues (these are detailed in section 6).

Table 1 – Main data sources consulted. The international references and guidelines used to support the methodological approach and result analysis are presented.

Type	Name	Reference	Detail of information
Data sources	Bats of Southern and Central Africa	(Monadjem *et al.* 2010)	National level
	African Chiroptera Report 2012	(ACR 2012)	National level
	Caves and Caving in the Cape	http://www.darklife.co.za/Caves/	Regional level
	Bat fatality at a wind energy facility in the Western cape, South Africa	(Aronson, Thomas & Jordaan 2013; Doty & Martin 2013)	Regional level
	The Vegetation of South Africa, Lesotho and Swaziland	(Mucina & Rutherford 2006)	National level
	Global List of Threatened Species	(IUCN 2013)	International level
	Renewable Energy Application Mapping – Report version I	(CSIR 2013)	National level
Other interna tional	Wind energy development and Natura 2000	(European Commission 2011)	International level Methodological approach and

Type	Name	Reference	Detail of information
			analysis
	Directrices para la evaluación del impacto de los parques eólicos en aves y murciélagos	(Atienza *et al.* 2011)	International level Methodological approach and analysis
	Comprehensive Guide to Studying Wind Energy/Wildlife Interaction	(Strickland *et al.* 2011)	International level Methodological approach and analysis
	U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines	(USFWS 2012)	International level Methodological approach and analysis
	South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments	(Sowler & Stoffberg 2012)	Methodological approach
	Bat surveys: Good practice guidelines, 2nd edition	(Hundt 2012)	Methodological approach
	Guidelines for consideration of bats in wind farm projects	(Rodrigues *et al.* 2008)	International level Methodological approach and analysis
	Good Practice Wind Project	www.project-gpwind.eu/	International level Methodological approach and analysis

Species occurrence

The probability of occurrence of bat species in the study area was evaluated according with several criteria, as described below. To evaluate species occurrence were used distribution maps published in South African publications (Monadjem *et al.* 2010; ACR 2012). In this evaluation, species which are known not to occur in the study area were not considered. The probability of occurrence of bat species in the Blue study area (within 50 km buffer from the wind energy facility) was characterised as:

- **High probability** – the species has been historically confirmed on, or near the site within the last 20 years; and the habitat present on site is suitable for the species preferences.
- **Moderate probability** – the species is within the higher probability modelled distribution of potential occurrence according to Monadjem et al. (2010); and the species has been historically confirmed in the area within the past 20-50 years; and/or the habitat is adequate for the species requirements.
- **Low probability** – the species is within the lower probability modelled distribution of potential occurrence according to Monadjem et al. (2010); and the species has been historically confirmed in the study area more than 50 years ago; and/or the habitat present in the site is adequate for the species preferences.

The use of these two sources of information may cause some differences in the evaluation on the probability of a species occurrence, since ACR (2012) presents a compilation of records of the species and Monadjem et al. (2010) presents a modelled distribution of the species based on several factors, such as previous records and habitat conditions. Regardless, both sets of information were considered and evaluated according with the type of biotopes present at the Blue Wind Energy Facility study area. Species which are known not to occur in the study area were not considered and the likelihood of occurrence was adjusted according to this specialist expertise and knowledge.

2.2. Field Surveys

Surveys undertaken during the pre-construction bat monitoring programme included the use of several field techniques, adjusted to the specific characteristics of the study area. The pre-construction bat monitoring programme, proposed to be implemented during 12 months, from July 2013 to June 2014, both inclusive, included the following: active surveys, through fixed sampling points, established along transects; passive surveys at ground level and rotor height; and searches and inspections of any structure thought to be used as roosting location by bats.

2.2.1. Sampling Period

The pre-construction bat monitoring programme will be implemented over a one-year period (12 consecutive months), as recommended by the South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments (Sowler & Stoffberg 2012).

The surveys presented in this report covers a 4 season period conducted between July 2013 and March 2014, both inclusive, including 9 surveys (Table 2), covering the spring, summer, autumn and winter seasons.

Passive detection was conducted permanently (refer to section 2.2.4.2) and active detection surveys were conducted three times in every season (once per month). It is considered that the sampling periods were adequate for the study area, complying with the requirements of the South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments (Sowler & Stoffberg 2012).

Table 2 – Schedule of bird monitoring fieldwork at the Blue Wind Energy Facility site. AD – Active detection; PD – Passive detection; RO – Roost searches.

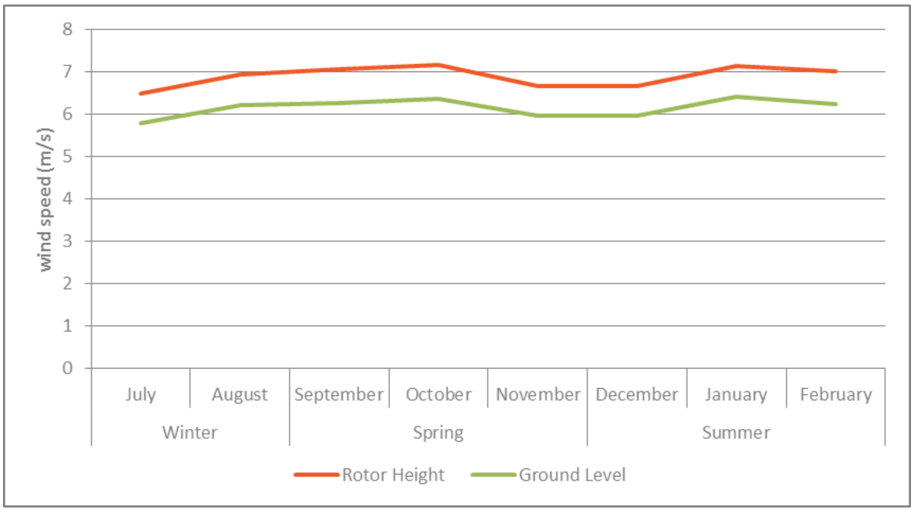
Year	Month	Season	Survey	Methods
2013	July (22th to 28th)	Winter	July	AD; PD
	August (4th to 8th)		August	AD; PD
	September (3th to 6th)	Spring	September	AD; PD
	October (14th to 20th)		October	AD; PD; RO
	November (12th to 18th)		November	AD; PD
	December (16th to 20th)	Summer	December	AD; PD; RO
2014	January (20st to 24rd)		January	AD; PD
	February (12th to 21th)		February	AD; PD; RO
	March (1st to 5th March)	Autumn	March	AD; PD

Year	Month	Season	Survey	Methods
	April	Autumn	May	To be conducted
	May	Autumn	June	To be conducted
	June	Winter	July	To be conducted

2.2.2. Weather conditions

Active surveys were conducted generally under mild weather conditions. Throughout the year, maximum temperatures were recorded in summer (maximum of approximately 31ºC), while minimum temperature where recorded in winter (minimum of approximately 9ºC). Wind speed conditions were acceptable, with general low average wind speeds of approximately 2-3 m/s. Some peaks of higher wind speed were recorded in spring and summer (maximum wind speed of approximately 8 m/s). No precipitation was recorded during the days when active surveys were conducted.

According to the data from the weather mast available at the wind energy facility area, the prevalent meteorological conditions most relevant to the study (average wind speed, average air temperature and average air humidity) were evaluated (Figure 1). The surveys occurred under mild weather conditions during most of the year with temperatures between 15ºC and 22ºC and humidity between 60 and 90% (Figure 1b). Average monthly wind speed was generally above 5 m/s, with wind of 6.5 – 7 m/s at 60 m height (Figure 1a).



(a)

(b)

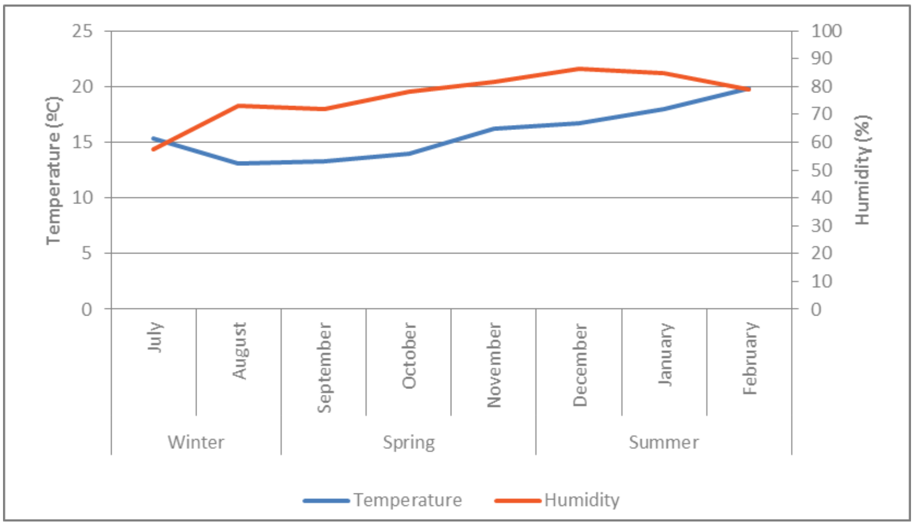


Figure 1 - Average weather conditions verified during the surveys conducted at Blue Wind Energy Facility (data from anemometer masts installed in the site – (a) wind at 60m altitude; wind at 30m; (b) temperature and humidity: average per month.

2.2.3. Evaluated Parameters

To characterise the bat community present in the study area, the following parameters where evaluated for the Blue WEF and control areas:

- Species Richness;
- Activity Index;
- Location and use of roosts within and around the site;
- Type of utilisation of the study area by bats.

2.2.4. Data collection techniques and methods

Bats are usually divided into two main groups: echolocating and non-echolocating bats, the former usually uses highly evolved ultrasound echolocation to navigate, forage and communicate (Schnitzler & Kalko 2001) and the latter uses vision for orientation, to navigate and search for food sources (Monadjem *et al.* 2010). Non-echolocating bats are commonly known as fruit bats (feeds mainly on fruits); whereas echolocating bats are known as insectivorous bats (insects are their main food resource). The different flight and echolocation inter-specific characteristics are directly related to differences in species' foraging habitats (Schnitzler & Kalko 2001).

Tracking the conservation status of bat populations through the abundance and distribution of echolocation calls has the potential to offer a more efficient alternative to trapping or visual sampling methods for bat survey and monitoring programmes (Walters *et al.* 2012). The detection, recording and analysis of ultrasounds is very useful in the detection and identification of different bat species, since these mammals are nocturnal and, in the majority of species, emit ultrasound calls to guide them, and to detect prey, as well as to communicate. Details pertaining to the collection techniques are provided below.

2.2.4.1. Active detection

The active detection of ultrasounds was conducted with a portable ultrasound detector along vehicle transects. Along each transect 5 minutes sampling points were established after an initial inspection and evaluation of the different habitats present in the area by an expert. The established transects and sampling points were intended to be representatives of the biotopes present at the study area, which is mainly comprised by areas of scrubland within Namaqua Strandveld (Figure 2). Two transects (one of about 10km each was established in the wind energy facility and another, with 7 km, in a similar control area) were established across the main biotopes present in the area (Figure 2). In the wind energy facility transect, 37 sampling points were established and in the control area 18 sampling points were conducted. Each point was characterised according to: minimum distance to the future turbines, slope, dominant orientation, existing biotope, average wind speed, dominant wind speed, average air temperature, minimum distance to a water source and minimum distance to known roosts.

The active detection surveys were conducted once per month. Each sampling point was characterised in terms of lunar phase, cloudiness, temperature, precipitation and wind speed and direction at the time it was conducted. At each 5 minute sampling point, all bat passes[2] heard and observed were recorded, as well as the entire bat passes detected between sampling points. The output from the bat detector was recorded for later analysis. The bat's time of usage of the area, during the 5 minutes sampling point was also determined, meaning that all the passes were timed. The surveys started 30 minutes before the sunset, ensuring that bat species that emerge early in the evening were included in the surveys (Sowler & Stoffberg 2012). At each survey the order by which the sampling points established along transects was conducted was altered so that each sampling point would not be conducted at the same time of the night. The manual surveys were not performed in adverse weather conditions (rain, very strong wind, fog, thunderstorms).[3]

2.2.4.2. Passive detection

Passive detection was performed by means of a Wildlife Acoustics® SM2BAT+ automatic ultrasound detector with a SMX-US ultrasonic omni-directional microphone (http://www.wildlifeacoustics.com) installed at ground level, at the most representative biotopes of the study area. The detectors were configured with a sampling ratio of 384 kHz, so that the maximum detected frequency would be 192 kHz. In order to use this maximum frequency, the detectors were configured with mono-channel, using only the left channel for recording. No compression or gain (+0,0dB) was used since compression of files may lead to lose of information on frequencies above 70 kHz and the third stage of gain has no effect on ultrasonic recording on 384 kHz recording sample ratio. Therefore files were saved with *.WAV format. As advanced settings the static detectors were configure with:

- Digital high-pass filter (HPF) Left - fs/64 (filters frequencies below 6kHz);
- Trigger win 0.5s;
- Div ratio 16.

[2] Contacts with bats detected by visual observation or ultrasonic detection of calls

[3] The equipment is also extremely sensitive to high levels of humidity as well as to electromagnetic changes.

- Low-pass filter (LPF) – Off;
- Trigger Level +10dB SNR;

The equipment was scheduled to automatically record bat calls every day over the monitoring period, starting 30 min before sunset and ending 30 after sunrise.

Seven detectors were used on the study area and were installed in six different locations. From these seven detectors, six (5 in the WEF and 1 in a Control area) were at ground level installed in aluminium portable telescope poles and one was at rotor height. The detector at rotor height was placed in the weather mast within the wind energy facility, and in the same location was placed one of the detectors at ground level biotopes (Figure 2). Each monitoring point was characterised according to: minimum distance to the proposed wind turbine locations, slope, dominant orientation, biotope, minimum distance to a water source and minimum distance to known roosts. The equipment automatically recorded the temperature at each recording event.

The detectors placed at the weather mast (one at rotor height and one at ground level) were running continuously, being supplied energy from the weather mast, aiming to monitor 100% of the nights on the monitoring programme. The remaining detectors were running for a minimum of 3 nights per month in six surveys and 5 nights in the remaining 6 months. The passive detection sampling effort was approximately 93.7%, which is more than required by the *South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments* (Sowler & Stoffberg 2012) where a minimum of 15-25% of annual coverage is recommended. This amount of effort is already in agreement with the new requirements of the third version of the *South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments* (Sowler & Stoffberg 2014), which recommend sampling 75% of the year. The passive detection locations were chosen during the first visit, in order to sample the most representative biotopes at the wind energy facility site and at the control area. This approach allowed registering bat activity in different weather conditions (including air temperature).

2.2.4.3. Non echolocating bats

Bats are usually divided into two different groups, mostly by their diet: fruit-eating bats and insectivorous bats. The South African fruit bats feed on the fruits, flowers and nectar of a wide range of indigenous trees as well on domestic or commercial fruit trees (Monadjem *et al.* 2010). To determine the occurrence of fruit-eating bat species on the study area, searches were directed to potential roosting sites suitable to these species during daytime. There is the possibility that two fruit-eating bat species occur at the site: the Egyptian rousette (*Rousettus aegyptiacus*) and the African straw-colored fruit bat (*Eidolon helvum*). However their probability of occurrence is very low. Nonetheless favourable foraging habitats were also searched for in the area (areas with favourable food supply). As a complimentary methodology, visual and acoustic (attempts to ear vocalizations) searches were conducted at night.

2.2.4.4. Roost searches, inspection and monitoring

The Faunal Impact Assessment Report (Todd 2012) indicated the probability of occurrence of bats roosting in caves, mine audits or in rock crevices, since these are present in the broader area of the proposed site. Some suitable crevices were identified along the Buffels River near Grootmis. Also old mining buildings and old buildings around Kleinsee may also provide potential roosts.

All structures considered to have potential for bat species roosting (e.g. caves, mines, abandoned buildings, bridges, etc.) were identified in the study area and its surroundings by means of a GIS based desktop study and during the fieldwork visits to the area. The potential roosting locations identified were then inspected in the subsequent surveys in order to record evidence of bats presence and occupation (such as live bats roosting, guano[4] accumulation, bat corpses or insect remains). Additional information was also recorded: season, the individual's activity rate, presence of progeny, degree of human disturbance and type of roost. During the fieldwork, the location of each roost prospected was recorded with a handheld GPS (Garmin® ETREX 10 and ETREX 20), as well as photographed.

When a roost was considered to have potential to be occupied by bats (through interviews to the local inhabitants, observation of traces of occupation), an active survey was conducted outside of the potential roost. The surveys were conducted using the same equipment as described in section 2.2.4.1, and lasted for one hour, starting half an hour before sunset, and finishing half an hour after sunset.

2.2.4.5. Vegetation units cartography

In order to properly assess the relationship between bat activity and the area conditions, a mapping of vegetation and biotopes present was specifically produced by the BioInsight team based on topographic maps, satellite images and visits to the wind energy facility site. The cartography included a 5000 m buffer surrounding the wind turbines that comprise the wind energy facility site.

Cartography was performed by means of Google Earth Imagery in Geographic Information System software at a 1:15 000 scale, and validated by the field observers, while travelling by car through the whole the wind energy facility area.

[4] Name given to bat droppings.

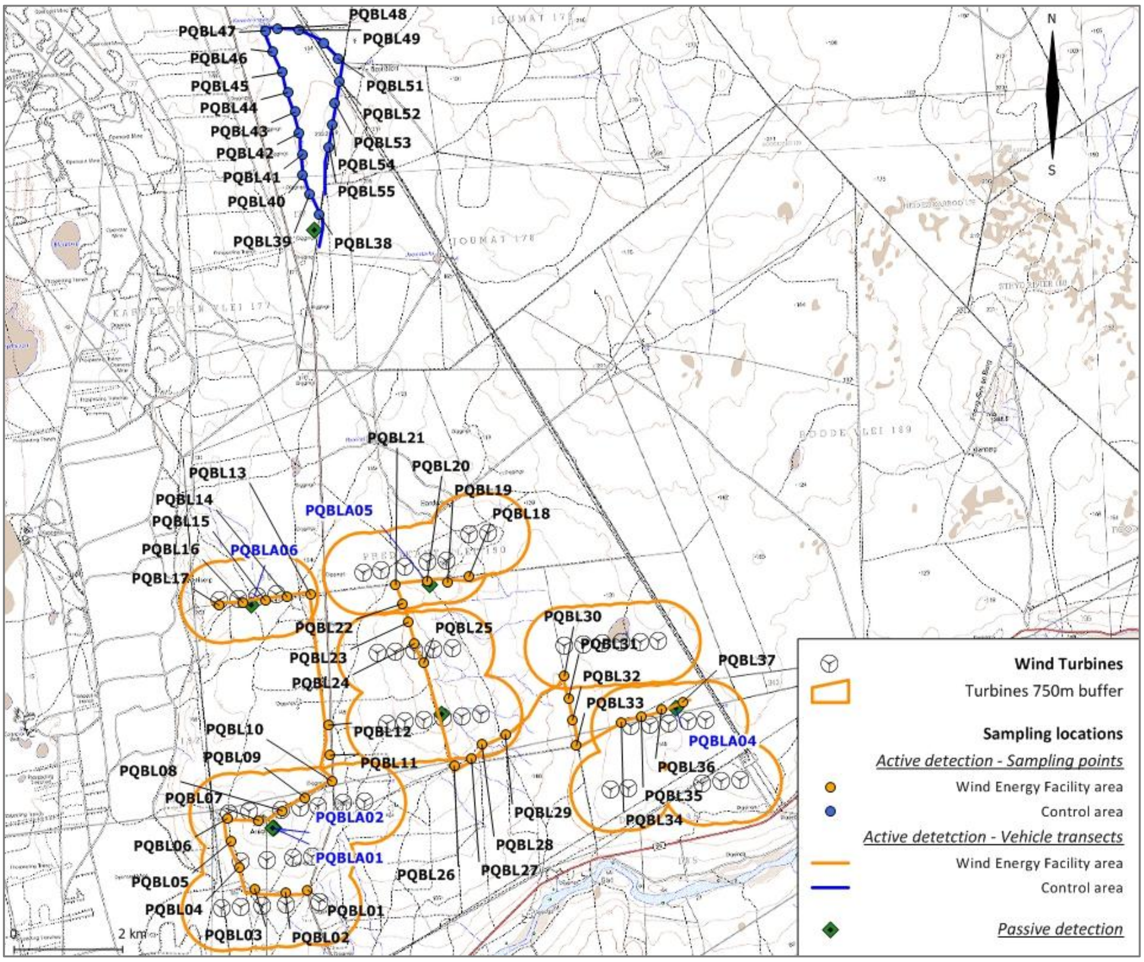


Figure 2 – Bat sampling location at the Blue Wind Energy Facility.

2.2.5. Data analysis and criteria

2.2.5.1. Ultra-sounds analysis

Acoustic monitoring, as indicated, produces a large amount of data recorded by the SM2BAT as *.WAV format. Using Wildlife Acoustics Kaleidoscope® Software, an acoustic scrubbing was conducted for filtering non-biological noise such as rain, wind, birds and insect sounds, false triggers or anthropogenic noise. This step was intended to eliminate periods of rain or wind, with long periods of noise with low frequencies, within the audible frequencies. It is however necessary to mention that the software is not perfect and that biological noise is highly variable.

Identification of bat species through analysis of echolocation calls is a very time consuming task[5], as specialized technicians have to go through each call, extract the necessary acoustic parameters with specific software and then identify the species using a reference echolocation call library for South Africa. Considering the amount of data produced, it was necessary to conduct a sub-sampling methodology of the overall calls. This sub-sampling methodology was intended to estimate the proportion of bats passes that belong to a certain species, among the total bat calls recorded. Since the sampling surveys were conducted throughout time and in several different locations, a simple random sampling would not be accurate enough. Therefore the adequate method applied was a stratified random sampling (Cochran 1977), using the sampling location and survey as factors.

Since sampling the total number of recordings was made with the purpose of analysing the species composition of the population in the study area, sub-sampling results were only used when analysing the species present at the site. In all remaining analysis, the total amount of data collected by the detectors where used (both from active and passive surveys).

The total size of the sample was then calculated according to the following equation (Cochran 1977):

$$n = P(1 - P)\left(\frac{z_{1-\alpha/2}}{e}\right)^2$$

, where: n = number of elements of the sample; P = estimated proportion of the interest characteristic (bat species); $z_{1-\alpha/2}$ = critical value associated to the degree of confidence; e = maximum error of estimation.

The number of elements of the sample of each of the considered factors was obtained through proportional affectation, using the equation (Cochran 1977):

$$n_i = N_i\left(\frac{n}{N}\right)$$

, where: n_i = number of elements of the sample in the factor; N_i = number of elements in the factor; n = number of elements of the sample; N = number of elements of the population.

With the number of elements to analyse in each of the factors (location and survey), resulting from this process of stratified random sampling, the recordings for analysis were randomly selected through a random algorithm. The randomly selected recordings were then processed by a specialized technician, considering the several parameters that allow the identification of bat species. One of the characteristics of echolocation pulses that have to be considered for the identification of bat species is the shape of echolocation pulses - frequency modulation (FM), quasi-constant frequency (QCF) and constant frequency (CF) (Altringham 1996; Russo & Jones 2002). However most bats use a combination of both FM/QCF (Altringham 1996), where the initial part of the pulse uses frequency modulation and the end of the pulse uses an almost constant pulse frequency. Further characteristics of the pulses are used for the species identification, such as the frequency of maximum energy (FMaxE), pulse duration, initial and final frequencies, bandwidth, interval between pulses, shape of the pulse, among others (Fenton & Bell 1981).

[5] It is estimated that on specialized technician can identify, on average, 30 echolocation recordings during a working day (8 hours)

The analysis of the recorded calls was performed using *Audacity 2.0.0 – Cross-Platform Digital Audio Editor*, from Dominic Mazzoni. Through the analysis of pulse characteristics, the identification of detected species was possible. The reference values used were the ones presented in several published and unpublished sources of South Africa (Gauteng & Northern Regions Bat Interest Group; Taylor *et al.* 2005; Hauge 2010; Monadjem *et al.* 2010; Kopsinis *et al.* 2010; ACR 2012; Pierce 2012). This acoustic echolocation parameters reference table was reviewed and adjusted in order to use the most accurate reference parameters as possible, considering the limitations of the current knowledge on South African bats echolocation.

To effectively use echolocation as a means of surveying bats, it is important that we can reliably identify the species detected. Even with their similar sensory aims, many bat species have evolved a species-specific echolocation call structure (Simmons, Fenton & O' Farrell 1979; O' Farrell, Miller & Gannon 1999) providing the potential to use their echolocation calls to identify bats to species level (O' Farrell 1997; O' Farrell, Miller & Gannon 1999; Sattler *et al.* 2007). However, these call structures are extremely flexible and may depend on various factors including habitat structure, foraging strategy, age, gender, morphology, and the presence of other conspecifics (Thomas, Bell & Fenton 1987; Obrist 1995; Murray, Britzke & Robbins 2001). As different species face similar sensory challenges, call convergence has led to overlap in frequencies and call shapes used, making it difficult to distinguishing between some calls (Preatoni *et al.* 2005).

In spite of the kind of problems faced through bioacoustics, on some recordings the identification was only possible to the level of genus, family or to some phonic groups with very similar acoustic identification parameters. If the species was identified through recording analysis and its occurrence in the study area was considered plausible, then it was classified as *Confirmed* in the study area. If a species could not be confirmed through recordings analysis, due to uncertainty with the call parameters obtained, and could only be identified as a group of species, its occurrence in the study area was considered as *Possible* (e.g. if the parameters obtained in a recording are coincident with call parameters from different species and none of them was confirmed in other recordings, then all these species are considered possible, if the habitat is suitable). When the pulses recorded were too weak, and no diagnostic parameters could be obtained, the identification was only up to the level where the specialists felt to have a high degree of confidence they were not making any inaccurate identification (family, gender, family group or species group).

Through call analysis it was also possible to identify the occurrence of different bat behaviours according to different types of pulses, such as echolocation pulses (searching phase and feeding buzz6) or social calls.

2.2.5.2. Spatial-temporal analysis

The results obtained from the nine surveys undertaken to date (between July 2013 and March 2014) were analysed separately and compared. The selection of bat pulses was made through the automatic scrubbing

[6] Feeding buzz: when a bat identifies a potential prey it starts to approach the insect prey. In this process it will increase the rate of its echolocation pulses and each pulse will become shorter until it is difficult to distinguish between different pulses. This method of increasing its echolocation resolution while homing in on its prey is referred to as a feeding buzz.

performed by the Kaleidoscope® Software, as described in the previous sub-chapter (2.2.5.1). For each sampling point (at the wind energy facility site and the control areas) the species and groups of species identified were listed, as well as their conservation status and distinctive behaviour.

Space and time use of the site was also studied. The number of bat passes and time use of each sampling point allowed the determination of the following parameters for active and passive detection:

- Average number of bat passes[7]/hour (Active and Passive detection);
- Average time of use (seconds)/hour (Active detection);
- Frequency of occurrence of each species/group of species identified (number of contacts of a specie or group of species / total number of records identified).

The calculation of the activity index (Miller 2001) is performed by counting the number of periods of time where a certain species was recorded. This method could be applied in areas of high species diversity, where files contain calls from more than one species. Considering that in the Blue Wind Energy Facility the analysis of the ultra-sounds revealed that this was not the case, a simpler approach was considered, **by calculating the number of bat passes per hour, as the activity index, for each of the sampling points**.

Notice however that the activity index does not provide an absolute number of individuals, indicating solely a relative index of abundance (Hayes 2000). An analysis of the activity index for each hour of the recording period was also performed in order to evaluate the variation of activity through time, indicating periods of higher bat activity.

These parameters were also analysed in terms of environmental factors, such as environmental conditions (temperature and wind speed), biotope, and illuminated lunar fraction. The same parameters were analysed in terms of space, according to the point locations (wind energy facility site and control area).

The occupation rate, species present and conservation status were determined to each roost prospected.

[7] For the calculation of the above parameters it was necessary to define a "bat pass". There is a standard widely used definition of bat pass: *two call notes from one bat not separated by more than 1 second* (White & Ghert 2001; Gannon, Sherwin & Haymond 2003). However, this is not very consensual since the duration and frequency of call notes vary according with the species present. In South Africa, and considering the species present, the current possible definition of bat pass is that of **a sequence of ≥1 echolocation calls where the duration of each pulse is ≥2 ms** (Weller & Baldwin 2012). Single call fragments do not apply, only complete pulses were considered for the analysis. Where there is a gap between pulses of >500ms in one file, this then represents a new bat pass.

3. Results & Discussion

The results presented in this report present all the data collected to date during the pre-construction bat monitoring programme for the Blue wind energy facility. Taking this into account, the baseline reference of the bat communities during the pre-construction phase of the Wind Energy Facility is established in this chapter. The discussion is based on the analysis of data collected and specialized bibliographic information available.

3.1. Desktop review

3.1.1. Species with potential occurrence at the site

According to Monadjem *et al*. (2010), a total of 67 species of bats may occur in South Africa. Through the analysis of species probability of occurrence at the study area, it was concluded that 14 bat species may occur in the vicinity of site, which corresponds to 21% of the overall species in the country (Table 3).

From the 14 bat species considered to have potential occurrence in the area, only 5 species is considered to have a low probability of occurrence and 4 other are considered to have a moderate probability of occurrence in the study area. The remaining 5 species are considered to have a low probability of occurrence on the site.

From the total list of 14 species with potential occurrence in the area, 5 are of conservation concern in South Africa, namely: *Miniopterus natalensis* (Natal long-fingered bat), *Rhinolophus capensis* (Cape horseshoe bat), *Rhinolophus clivosus* (Geoffory's horseshoe bat) and *Rhinolophus darlingi* (Darling's horseshoe bat), considered as "Near threatened"; *Cistugo seabrae* considered "Vulnerable" (Friedmann & Daly 2004). From these 5 species only *Miniopterus natalensis* has a high potential of occurrence within the study area. The remaining 4 species have a moderate probability of occurrence.

Regarding the 14 species considered to have a probability of occurrence at the site, only 3 species are perceived as having a potential high risk of collision with wind turbines, though only one has a high probability of occurrence, *Tadarida aegyptica*, which is a common and widespread species considered of Least Concern in South Africa (Table 3).

Table 3 – List of species with possible occurrence at the Blue Wind Energy Facility study area. IUCN (2013) and South Africa Red List (Friedmann & Daly 2004): NT – Near Threatened; LC – Least Concerned; NE – Not Evaluated; Flight height: LH – Low Height (generally below 2 meters); MH – Medium Height (generally between 2 and 10 meters); HH – High Height (generally above 10 meters). * Species included per reference of the Impact Assessment Study (Todd 2012), however during the field surveys no suitable habitat was found for these species.

Family	Scientific name	Common name	IUCN	South Africa Red List	Roosts	Habitat preferences	Foraging habits Flight type	Foraging habits Flight Height	Collision risk (Sowler & Stoffberg 2014)	Probability of occurrence
NYCTERIDAE	*Nycteris thebaica*	Egyptian silt-faced bat	LC	LC	Caves, culverts and trunks of large trees.	Savannah and Karoo biomes	Clutter forager	LH	Low	High
MINIOPTERIDAE	*Miniopterus natalensis*	Natal long-fingered bat	LC	NT	Caves	Savannahs and grasslands	Clutter-edge forager	MH, HH	Medium - High	High
VESPERTILIONIDAE	*Cistugo seabrae*	Angolan wing-gland bat	NT	VU	n.a.	Desert and semi-desert	Clutter-edge forager	MH	Low	Moderate
	Eptesicus hottentotus	Long-tailed serotine	LC	LC	Caves and rock crevices	Woodland and rocky regions	Clutter-edge forager	MH, HH	Medium	High
	Laephotis namibensis	Namibian long-eared-bat	LC	LC	Narrow crevices in rock faces	Arid habitat and fynbos desert near water	Clutter-edge	MH, LH	Low	Low
	Neoromicia capensis	Cape serotine	LC	LC	Under the bark of trees, foliage and buildings	Semi-arid areas to montage grassland, forests and savannah	Clutter-edge forager	MH	Medium - High	High
RHINOLOPHIDAE	*Rhinolophus capensis*	Cape horseshoe bat	LC	NT	Caves and mines	Fynbos and succulent Karoo biomes	Clutter forager	LH	Low	Moderate
	Rhinolophus clivosus	Geoffroy's horseshoe bat	LC	NT	Caves and mines	Savannah, woodland and riparian forest.	Clutter forager	LH	Low	Moderate
	Rhinolophus darlingi	Darling's horseshoe bat	LC	NT	Caves, mines adits, culverts and cavities in piles of boulders	Savannah and woodland	Clutter forager	LH	Low	Low

Family	Scientific name	Common name	IUCN	South Africa Red List	Roosts	Habitat preferences	Foraging habits Flight type	Foraging habits Flight Height	Collision risk (Sowler & Stoffberg 2014)	Probability of occurrence
MOLOSSIDAE	*Sauromys petrophilus*	Robert's flat-headed bat	LC	LC	Narrow cracks and under slabs of exfoliating rock	Rocky habitats, dry woodland, mountain fynbos or arid scrub	Open-air forager	HH	High	Moderate
MOLOSSIDAE	*Tadarida aegyptiaca*	Egyptian free-tailed bat	LC	LC	Caves, rock crevices, under exfoliating rocks, hollow trees, behind the bark of dead trees and buildings	Semi-arid scrubs, savannah, grassland and agricultural land	Open-air forager	HH	High	High
EMBALLONURIDAE	*Taphozous mauritianus*	Mauritian tomb bat	LC	LC	Rock faces, tree trunks, walls	Savannah woodland.	Open-air forager	HH	High	Low
PTEROPODIDAE	*Eidolon helvum*	African straw-coloured fruit bat	NT	NE	Trees	Forest	Clutter forager	MH, HH	Medium - High	Low*
	Rousettus aegyptiacus	Egyptian rousette	LC	LC	Caves	Forest	Clutter forager	MH, HH	Medium - High	Low*

3.1.2. Known migration routes

Bat migration and dispersion behaviours and distances covered by South African bat species are not very well documented yet. There is a lack of information in South Africa regarding the distribution and abundance of bats as the migratory habits and migration routes of bats through the country are not yet clearly understood. Much research is needed in this subject. However, there is some evidence that some species undergo long-distance migration and seasonal movements within South Africa. For example, Natal Long-fingered Bat *(Miniopterus natalensis*) is known to migrate up to 260 km (Van Der Merwe 1975) between summer maternity caves and those used during mating and hibernation periods during the winter months. Temminck´s Myotis (*Myotis tricolor*) may undertake similar seasonal migrations (Monadjem *et al.* 2010); however details of this species are not well known. The frugivorous bat, Egyptian rousette (*Rousettus aegyptiacus*) is a gregarious cave-dweller, also thought to move distances of between 50 km to 500 km along the KwaZulu-Natal coast (Monadjem *et al.* 2010).

A lack of information is available regarding South African bat species' home ranges and daily dispersion movements (mainly to forage). Non-migrating bats will require movement around its essential homing area: e.g. to forage, drink, and search for mates or search for new roosting locations. Some bat species will have daily roosts and night roosts (that they use for shorter periods while foraging in an area) (Monadjem *et al.* 2010). Daily dispersion will depend on several factors including the species, the habitat, weather conditions and food availability. Nevertheless, based on the available information for South Africa and/or international references regarding similar species elsewhere in the world, most bats species will cover, in general, less than 5 km from their roosting location per night. Nevertheless, some species have been recorded travelling longer distances, e.g. *Rousettus aegyptiacus* was radio tracked up to 24 km flying from a roosting cave to a feeding area (Jacobson et al. 1986 in Monadjem *et al.* 2010).

3.1.3. Known roosting locations

The nearest known bat roosting structure in relation to the proposed Blue Wind Energy Facility is Steenkampskraal Mine which is located approximately 230 km south from the study area (Figure 3), in the Western Cape. There are indications that at least two bat species occur in this mine, the *Miniopterus natalensis* and the *Rhinolophus capensis*, though in relatively low numbers (less than 20 individuals). This roost is considered to be a winter roost for these species, therefore some individuals may incur into migrations to reach or leave the Steenkampskraal Mine (Odendaal & Jacobs 2011; Wood 2012). Nonetheless the direction of the migration is unknown.

Other less important structures were found during a pre-construction monitoring programme on a site located 120 km from the Blue site (Bio3 2013) with some potential to supply bat roosts, however only in one of them bats were found: two individuals of Rhinolophus sp. or Hipposideros sp..

Considering the absence of further known roosting locations in the surrounding area of the wind energy facility site, and the distance that the known roosting locations were found, it is not expected that the bat community present at Blue wind energy facility site is in any way connected or related to these known roosting locations.

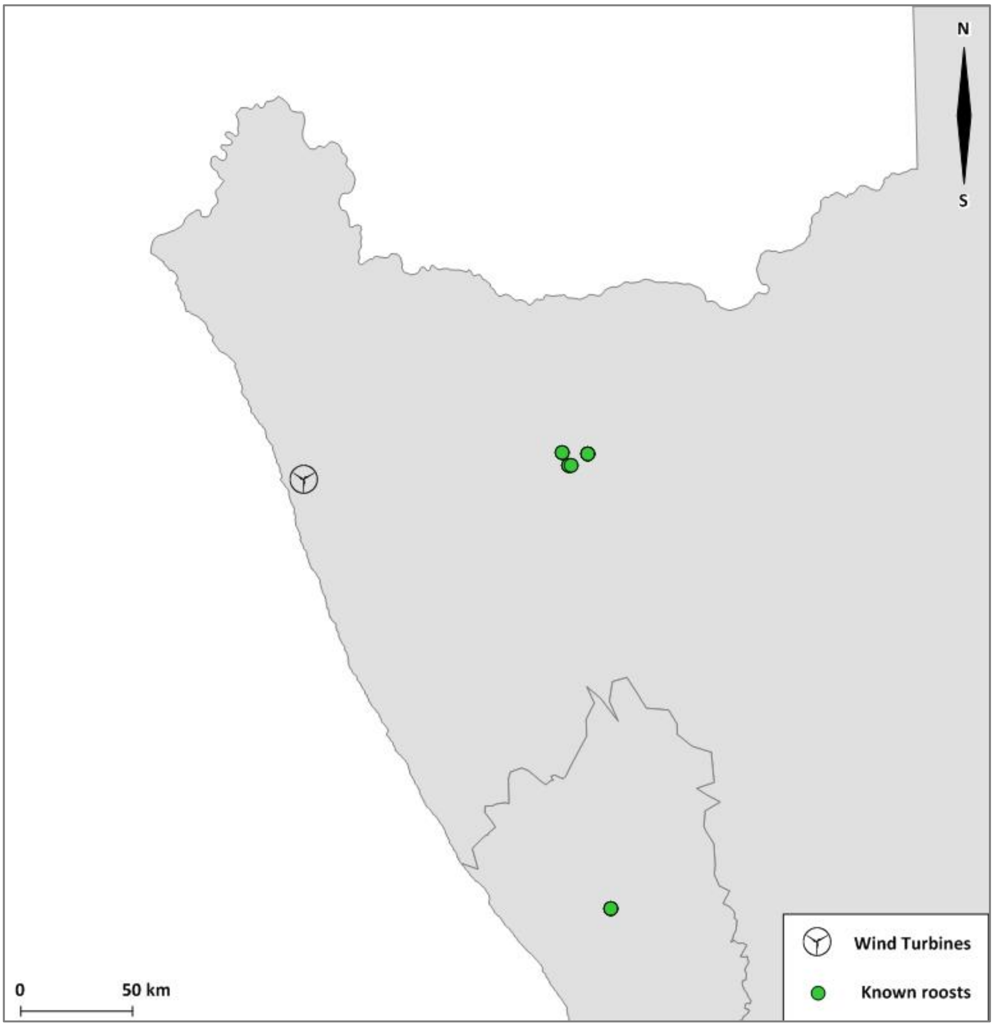


Figure 3 – Roosting locations known surrounding the Blue Wind Energy Facility study area (within a 250 km radius from the WEF).

3.2. Field Surveys

3.2.1. Echolocation bat species

During bat monitoring surveys conducted at the Blue Wind Energy Facility site between July 2013 and March 2014, both inclusive, a total of 4080 recordings (141 from active and 3939 from passive detection) were collected. For the identification of bat species occurring at the area and bat communities' characterization, a sub-sampling of the recordings from **passive** detection was conducted. Consequently, all recordings from active detection were analysed along with a total of 588 recordings from passive detection (with 95 % of confidence and an approximate error of 3.5% in the estimates). The results from the recordings analysis allowed the identification of the species or family of the individuals in 78% of the recordings analysed. The remaining records had weak pulses or very low volume and in those cases the identification of the individuals to the family level was not possible, being classified as Unidentified.

The results of all the methodologies implemented during the pre-construction bat monitoring programme at the Blue Wind Energy Facility site resulted in the identification of 4 echolocating bat species in the study area (Table 4). Only one of these species are classified as "Near Threatened", according to the South African Red List, i.e.: *Miniopterus natalensis*.

Table 4 – List of confirmed species at the Blue Wind Energy Facility site, between September 2012 and August 2013, through all methodologies implemented.

Common name	Scientific name	Conservation status		Risk of collision (Sowler & Stoffberg, 2012)	Method of Detection	
		Global (IUCN, 2012)	National (Friedmann & Daly, 2004)		Active surveys	Passive surveys
Long-tailed serotine	*Eptesicus hottentotus*	LC	LC	Medium	-	X
Natal long-fingered bat	*Miniopterus natalensis*	LC	NT	Medium-High	X	X
Cape serotine	*Neoromicia capensis*	LC	LC	Medium-High	X	X
Egyptian free-tailed bat	*Tadarida aegyptiaca*	LC	LC	High	X	X

Two additional species were considered as *Possible* species as the echolocation identification was not conclusive regarding these species. In some cases recordings of *Sauromys petrophilus* or *Eptesicus hottentotus* were obtained, but the positive identification of *Sauromys petrophilus* was not possible. On one other case, a recording of a Rhinolophus sp./Hipposideros sp. was obtained and with the assistance of Dr. Sandie Sowler was pointed that could possibly be a *Hipposideros caffer*. However considering the known distribution of this species and its habitat preferences, some reservations remain regarding this species, and further surveys are recommended before confirming its presence in the study area. Both species are considered Least Concern regarding their conservation status (Friedmann & Daly 2004).

In spite of the conservation status of the species confirmed in the study area, it is important to analyse their presence in the study area bearing in mind the potential risk caused by the project for any of these species. Therefore, it is of note that 1 of the species with confirmed presence in the study area present a potential high risk of collision with wind turbines, the *Tadarida aegyptiaca.* This is due to its flight type and foraging behaviour, since this species forage in open areas and may fly at high altitudes, potentially coincident with the rotor swept area (Appendix III). There are records of mortality of species from *Tadarida* sp. on wind farms in South Africa and elsewhere in the world (Arnett *et al.* 2008; EUROBATS 2013; Doty & Martin 2013).

All of the remaining confirmed species are considered to have a medium/medium-high potential collision risk with wind turbines, i.e.: *Eptesicus hottentotus*, *Miniopterus natalensis* and *Neoromicia capensis*. These species are clutter-edge foragers (Monadjem *et al.* 2010) and have specific morphologic and acoustic adaptations to allow the required manoeuvrability refined acoustic echolocation in order to hunt for its insect preys while avoiding colliding with the background vegetation (e.g. short and broad wings that facilitate slow, manoeuvrable flight) (Schnitzler & Kalko 2001). This means that this species will forage primarily around vegetation (clutter) associated with either forested areas or tall bushes and it is not expected to fly higher than 2 to 10 m above or far from the vegetation clutters. Therefore their absolute flight height (distance from the individuals to the ground) will depend mainly on the height of the vegetation, and on its foraging areas. There are records of mortality with wind turbines of species within the same genus in Europe (Appendix III) and of *Neoromicia capensis* in South Africa (Aronson, Thomas & Jordaan 2013; Doty & Martin 2013).

It is possible to assume that the species that are expected to be mostly affected by the wind energy facility could potentially be the open air foragers as most of these species, as well as presenting behaviours that pose higher risks, were amongst the more abundant species in the area (e.g. *Tadarida aegyptiaca*). Clutter edge foragers may be affected by the wind energy facility and collisions are likely to occur as well, because some of these species are within the genus that has records of mortality in other parts of the world. Nevertheless, it is considered that if mortality due to collision with wind turbines occurs with these medium and medium-high risk species it should be at a lesser extent and it will depend mainly on the habitats where turbines will be sited (higher if turbines are sited closer to high vegetation areas and lower if turbines are to be sited in open areas).

Nevertheless, bats also have to move from their foraging areas to the roosting areas and even the clutter and clutter-edge foragers may fly over open areas to accomplish this. Therefore, these movements will pose a potential higher collision risk with wind turbines.

At least one of the confirmed species in the study area is a migrant species, known to migrate from winter to summer roosts, with distances up to 150 km, i.e.: *Miniopterus natalensis* (Table 5). It is of note that for the remaining species, little information is available, regarding migratory movements, therefore making it very difficult to assess possible migration patterns. Considering that bats migrate for main two reasons, reproduction and hibernation, and that the reproduction migration is known to be when most fatalities are known to occur (Kunz *et al.* 2007; Arnett *et al.* 2008), it is important to refer to the breeding season of the species present in the study area. For most of the species, breeding season occurs between March and April or in August, typically during the autumn and early winter season, while births occur between October and December, during spring.

Table 5 – Migration, breeding and birth patterns of the species confirmed in the study area. Status according to the South Africa Red List: LC – Least concern; NT – Near Threatened (Friedmann & Daly, 2004); n.a. – information not available.

Scientific name	Common name	South Africa Red List	Migrant	Breeding season	Birth season
Tadarida aegyptiaca	Egyptian free-tailed bat	LC	n.a.	August	November-December
Neoromicia capensis	Cape serotine	LC	n.a.	March-April	October-November
Miniopterus natalensis	Natal long-fingered bat	NT	Females migrate to maternity roosts seasonally between roosts up to 150km	March-April	October-December
Eptesicus hottentotus	Long-tailed serotine	LC	n.a.	n.a.	n.a.

3.2.2. Non-echolocation species

In section 3.1.1 it was assessed that two fruit-eating bat species; the Egyptian rousette (*Rousettus aegyptiacus*) and the African straw-coloured fruit bat (*Eidolon elvum*) were possible but with low likelihood of occurrence in the study area. During the field surveys no suitable foraging sites for these species were observed being considered that the proposed Blue wind energy facility site do not have any potential for these species occurrence. Accordingly, despite the implementation of the detection technique referred in section 2.2.4.3 no individuals or evidences of bats belonging to this group were detected during the surveys conducted between July 2013 and March 2014.

3.2.3. Spatial-temporal activity

Most of the species that can occur in the study area are insectivorous and their annual cycle is related to the abundance of food resources. Since the insect population increases with the increase of temperature and precipitation (favourable conditions for its proliferation), it is expected that the bat activity follows a similar pattern. In the Northern Cape, the weather is very dry, with low levels of rainfall, and generally high temperatures throughout the year. Considering this environmental conditions bat activity is expected to present low values throughout the year. However as bat's activity levels are also influenced by other factors, such as weather, biotope or distance to water sources, and these factors are site-specific. More detailed analysis considering the site's conditions will be presented below.

3.2.3.1. Seasonal activity (passive detection)

Bat activity, was inferred from the total number of bat records[8] obtained from passive detection. Since the volume of information is much higher and longer continuous periods of time were monitored, compared with the active detection results, the activity estimated in the study area by passive detection tends to be more representative of reality, in relation to the results from active detection.

The pattern of bat activity observed shows that the higher bat activity was in spring season, decreasing towards summer, where a small second peak of activity is regarded in late summer (Figure 4). Two conclusions are apparent when observing Figure 4: overall bat activity is extremely low, usually below 1 pass per hour; bat activity was generally higher at the control area located north of the wind energy facility, possibly indicating that other areas in the surroundings of the site are more suitable for bats. This level of activity is in line with other locations in the Northern Cape (e.g. near Springbok – average 1 pass/hour) but is quite lower than other locations in the Western Cape (e.g. near Gouda – average 5 passes/hour).

Evaluating the activity at different heights, bat activity was higher at ground level in most of the surveys conducted. In January the mast detector installed at ground level suffered a malfunction, and that was only detected during February survey, leading to the loss of the data of that month for the PQBLA02 location. During September (spring season) bat activity was similar both at height and ground level, which can indicate a punctual utilization of higher altitude areas, possibly to commute or even migrate. As one migrant bat species is present in the study area (*Miniopterus natalensis*) is possible that these movements are attributed to its passage through, or arrival/departure from, the study site.

[8] The sub-sampling methodology conducted to analyse recordings collected from passive detectors was not used to determine the overall bat activity.

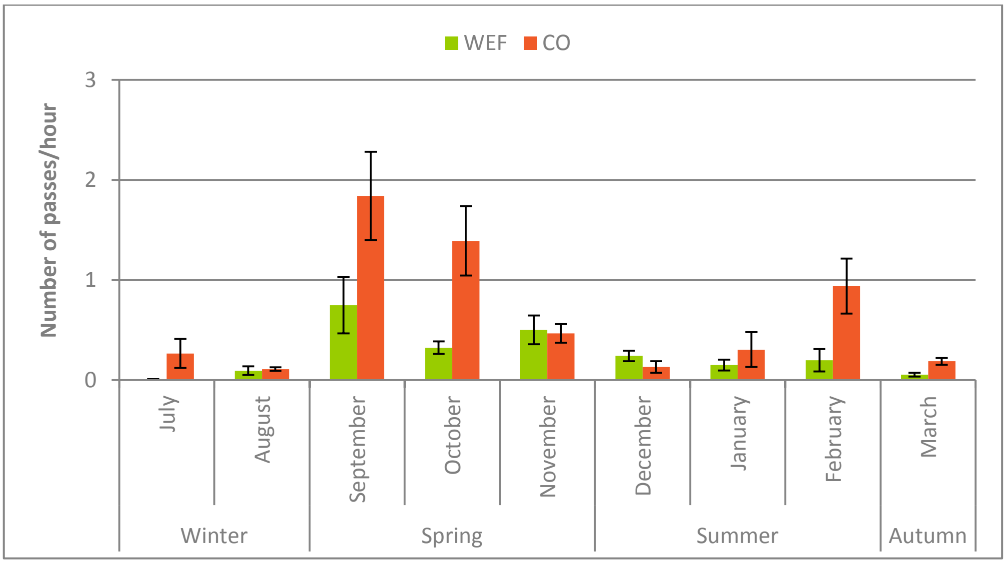


Figure 4 – Average number of bat passes/hour in the Blue Wind Energy Facility and Control area between July 2013 and March 2014 (Passive detection). Vertical bars represent standard error. Data from detectors at ground level.

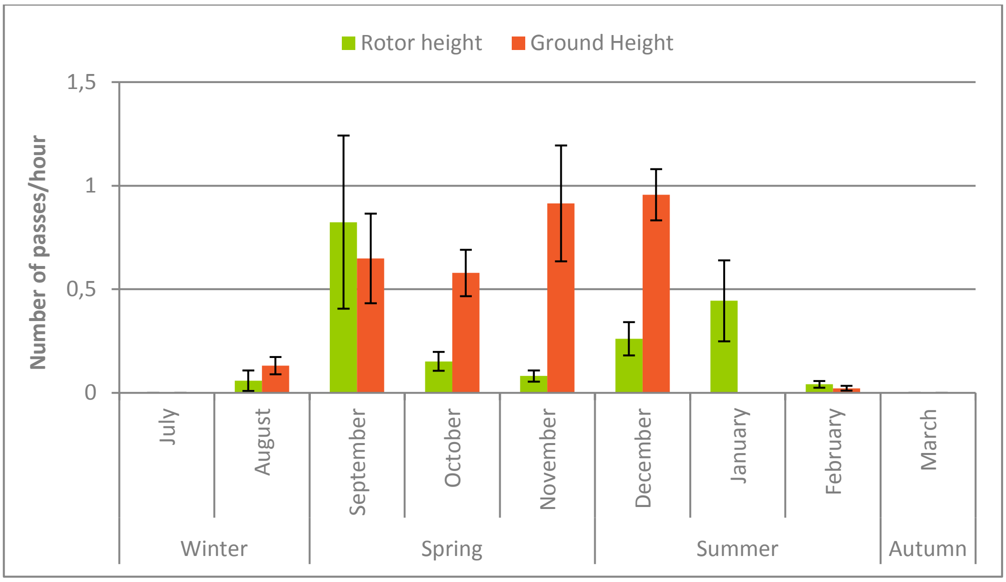


Figure 5 - Average number of bat passes/hour at rotor height and ground level between July 2013 and March 2014 (Passive detection). Vertical bars represent standard error.

Concerning the species occurrence at the study area, four species were confirmed in the study area through passive detection as referred previously. The most common and active species in the study area was the *Tadarida aegyptiaca*, being recorded in all surveys sampled. Other frequently recorded species in the study area was the *Neoromicia capensis*, being detected from September onwards in all surveys conducted (Figure 6). Regarding the other two confirmed species, the *Miniopterus fraterculus* was identified between August and November and the December and *Eptesicus hottentotus* was recorded in October, January and February. These species, only detected in short periods of time, could be using the area as a passage route between roosting locations as these months are associated with the breeding and birth seasons (see Table 5).

As for *Tadarida aegyptiaca* which was the most frequent species, was detected predominantly in spring survey, with special emphasis to the September survey. As referred previously, the spring season is determinant for most bat species as the births season, and for *Tadarida aegyptiaca* this is no exception, as births take place between November and December.

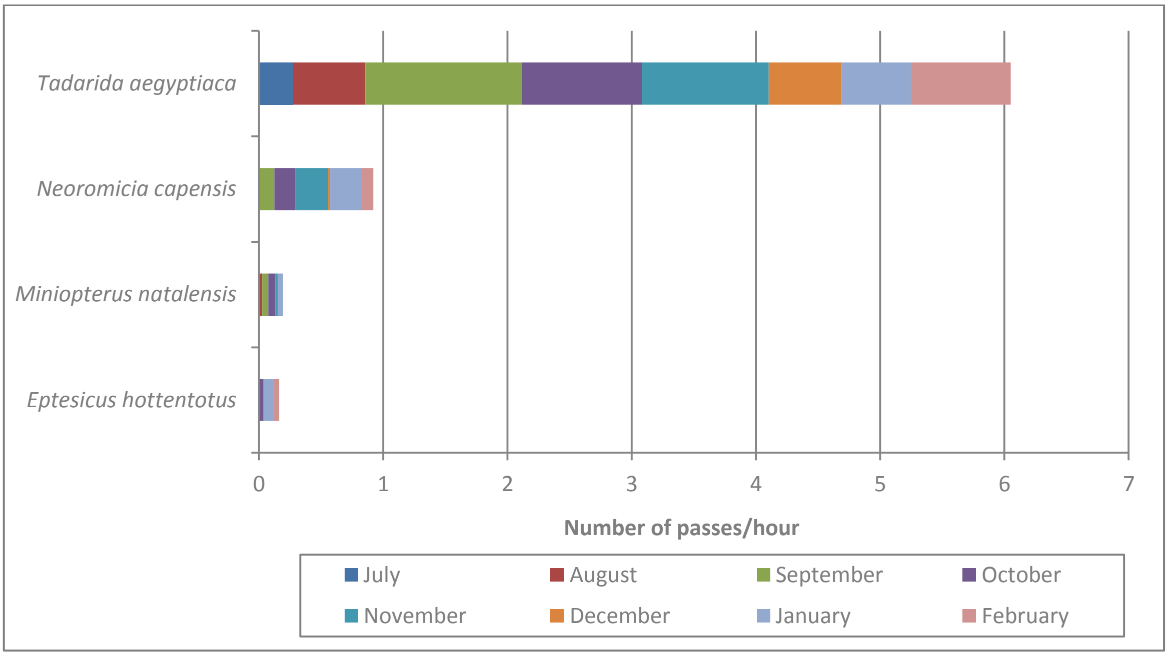


Figure 6 – Average number of passes/hour in each month of the confirmed bat species through passive detection, between July 2013 and February 2014[9].

The bats emit pulses to navigate, to avoid collision with objects and to locate prey. At first the pulses are spaced to verify the presence of prey and once a potential prey is detected the interval of emission of pulses decreases and, as the bat gets closer to the prey, the time between pulses decreases, originating the "buzz". Those buzzes are identified as feeding buzzes, corresponding to the moment when the bat is closest to its prey. During a feeding buzz the pulse frequency gets closer to the audible (Ahlen 1990; Tupinier 1996; Briggs & King 1998). While an individual is navigating or looking for prey it is also foraging, although no feeding buzzes are produced. So the feeding buzzes are the confirmation that the bat is using the area to forage, but the possibility that bats are foraging in the area in the absence of feeding buzz should always be considered. A large number of passes can also indicate that the area is used as a foraging site. A total of 12 feeding buzz events were detected within the analysed recordings from all surveys conducted between July 2013 and March 2014. Most of the feeding buzz pulses were attributed to *Tadarida aegyptiaca*, mostly in November and January, and in the area of the PQBLA02,

[9] The echolocation call analysis of the March survey will be presented in the final report.

in the south-western group of turbines. Since feeding buzzes are indicators of feeding activity it is logical to assume that bats use the study area for foraging and hunting activities. Feeding buzzes are events that are also less likely to be recorded, in relation to navigation pulses, therefore this information do not indicate abundance of foraging but the presence of foraging behaviour.

On the other hand, social calls are pulses emitted at lower frequencies and generally for shorter durations. The reason why social calls are emitted is not yet fully understood. However it is known that, for some species, the male individuals use these calls to attract females, at roost entrance, or to repel rival males (Kunz & Fenton 2003). This type of call is also considered to be used by several species to draw hunting territories and avoid conflict among individuals, especially when prey densities are very low, since the number of social calls rise when the insect densities diminish, and its use is being described by some authors as a measure for feeding success (Kunz & Fenton 2003) Social calls may also be used to promote group cohesion, especially at roost exits, as a way to defend from predators, and in breeding colonies (Kunz & Fenton 2003). In the study area, 27 social calls were identified within the recordings analysed and collected through active and passive detection. These were recorded mostly in December (summer season) and at the Control areas, around PQBLA07. Social calls were also detected in January and in October within the wind energy facility site. This time of the year is coincident with the birth season (November – December), indicating the possibility that the broader study area is used for reproduction purposes. Nonetheless the capture of social calls, as feeding buzzes is considered to be a rare event.

3.2.3.2. Influence of Environmental variables (passive detection)

Since bat activity depends on environmental conditions, such as temperature and wind speed, as well as on biotope and distance to water, it is important to analyse possible relations between bat activity and each one of these factors. The environmental variables considered in this analysis (air temperature and wind speed) were collected at the anemometer masts installed within the Blue Wind Energy Facility. For this reason, since no environmental variables were similarly collected for the control areas, only information regarding bat activity at the wind energy facility will be presented for the assessment of the weather variables influence on bat activity.

An influence of wind speed variable over bat activity is quite evident, especially considering the bat activity recorded at ground level (Figure 7). An average bat activity of 3 passes/hour is observed without wind at ground level, however an abrupt decrease is observed at 1m/s of wind, decreasing bat activity to 0.75 passes/hour. Regarding activity at Rotor height bat activity is constantly low, not being apparently affected by wind speed. The slight increase recorded at 13m/s may be due to the occurrence of static interference in the detector resulting in some false positive results, as it is very unlikely that bats are active with such wind speeds.

Considering that wind speed presented a negative influence over bat activity at ground level in the wind energy facility area, an analysis of the velocity of the wind within which most species are active is shown in Figure 8. The analysis of the cumulative activity of the groups of species with high, medium and low height of flight (as defined in Table 3) shows that about 50% of all bat activity occurs up to 3.5 m/s; 80% of the medium flight height bat species are active up to 5.5 m/s wind speed and that 80% of high flight species (species that are more likely to occur at blade swept area) occurs up to 7 m/s wind speed.

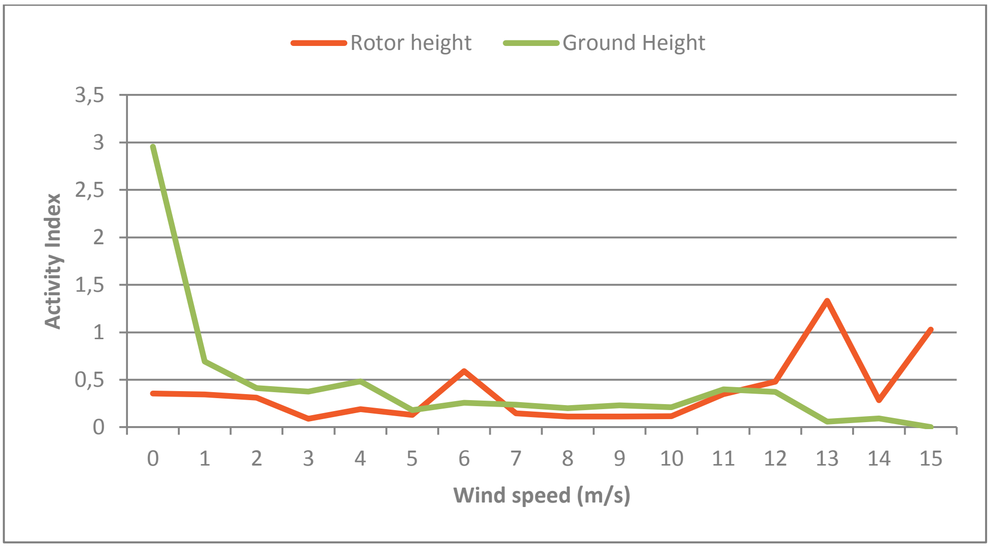


Figure 7 - Average activity index (average number of bat passes/hour) at different wind speed (m/s) in the wind energy facility site between July 2013 and March 2014.

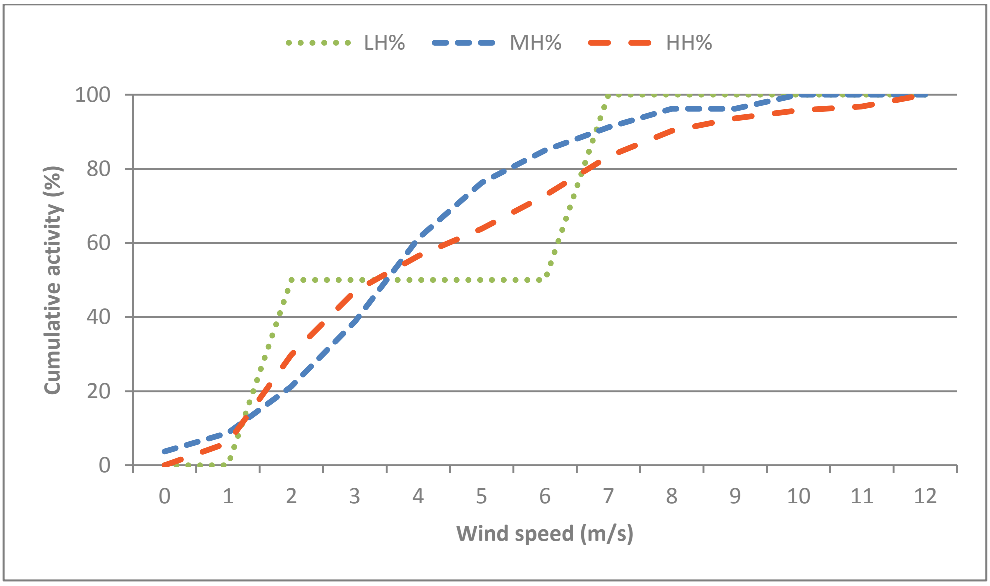


Figure 8 - Cumulative bat activity (%) of species with high altitude flight (HH), medium flight altitude (MH), and low height of flight (LH) and wind speed (m/s) in the wind energy facility site between July 2013 and March 2014.

As stated above, temperature may influence bat activity. Observing the relationship between bat activity and hourly air temperature (Figure 9) a peak of activity is observed at 24ºC and at 27-28ºC, indicating that an increase of air temperature up to these temperatures results in an increase of bat activity. Below or above these temperatures bat activity seems to decrease.

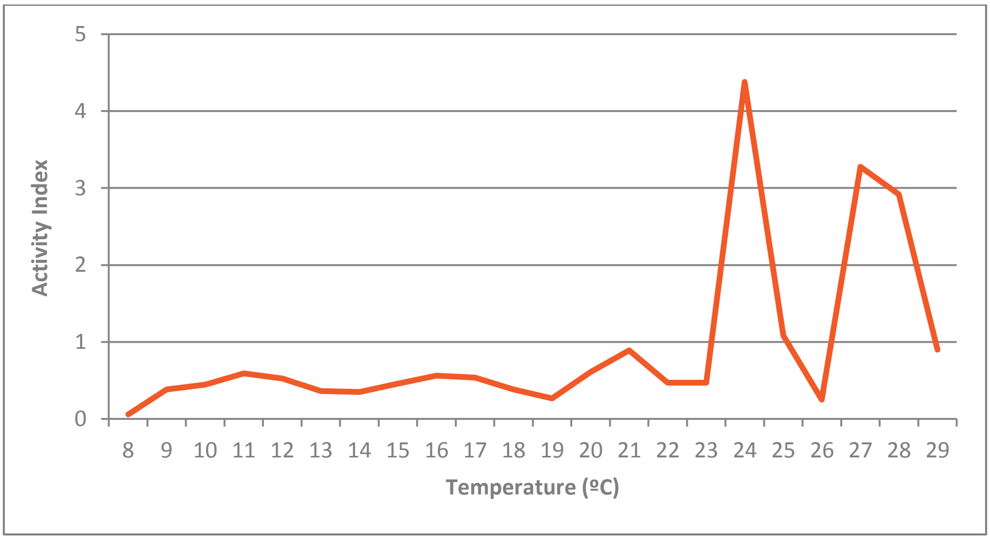


Figure 9 - Average activity index (average number of bat passes/hour) at different air temperatures (ºC) in the wind energy facility site between July 2013 and March 2014. Analysis considering the total data collected through all passive detectors at the wind energy facility.

3.2.3.3. Habitat use (active detection)

Figure 10 spatially depicts the average number of passes obtained in each point sampled during monitoring programme. The highest average number of passes was recorded at the Control area (Figure 10), which is located closer to some rocky outcrops which can provide roosting locations for bats, and may justify the highest levels of activity recorded in the control area, instead of the wind energy facility site. Considering the very homogenous characteristics of the vegetation present it cannot be ascertained why there were some sampling points in the central east area of turbines were the activity was slightly higher. All sampling points are located within similar strandveld vegetation, with no important features in the vicinities, with the exception of PQBL33 which is located near a sheep corral. Usually animal flocks attract insects, supplying a food source for bats, and therefore explaining why there was a higher activity surrounding this area. None of these sampling points with a slightly higher activity were located at less than 500m from a wind turbine. In the remaining area of the wind energy facility the activity was extremely low.

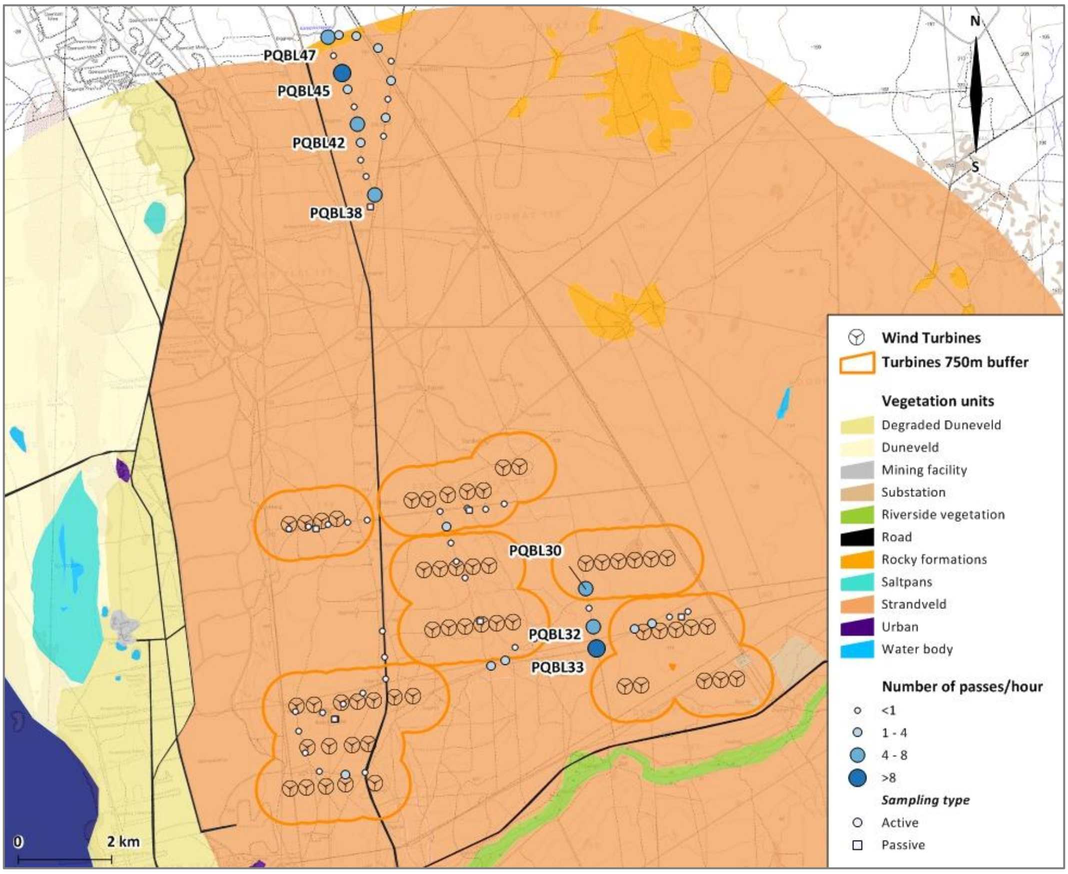


Figure 10 – Average number of passes recorded in each sampling point, in the Blue Wind Energy Facility site and Control area, between July 2013 and March 2014. Data from active detection.

3.3. Use of roosts

Potential bat roosts within the Blue Wind Energy Facility included buildings (suitable roofs and cracks in buildings) as well as trees (large densely leaved trees for fruit bats), and crevices (in any tree for crevice dweller) were searched for. During the sampling surveys conducted between July 2013 and March 2014 a total of 5 potential roost structures were identified: 2 buildings and 3 caves. The presence of bats traces/evidences or individuals was found in 3 of the structures inspected (Table 6; Appendix II). The confirmation of the site utilisation by bats was provided by the observation of bat droppings (guano), and occasionally the observation of individuals.

The confirmed bat roosts closest to a wind turbine were the ROBL04 and ROBL05, located at approximately 3km from the closest proposed wind turbine (Figure 11). Therefore is not expected that these roosts will suffer significant impacts from the implementation of the proposed project. Also, considering that at both locations were only observed accumulations of guano, it is not expected to be a particularly important roost for the bat community of the study area, as an ultra-sound sampling was performed in March survey, and no individuals were detected.

Table 6 – Structures with bat occupation identified during field work.

Roost reference	Description	Traces identified
ROBL01	Cave	Guano and one individual
ROBL02	Abandoned building	-
ROBL03	Reservoir with roof	-
ROBL04	Cave	Guano
ROBL05	Cave	Guano

These results do not exclude the possibility of other roosts being present within the site, and potentially supporting different bat species, that have not yet been recorded. Bat species may utilise two roosts during a 24 hour cycle, a day roost where they sleep for all daylight hours, and a night roost, which they use to rest in between foraging flights or to stop to eat a large insect prey. Therefore, during the remaining three surveys of the pre-construction monitoring programme roost search surveys will continue to be implemented.

Nevertheless, the low activity recorded at site and low availability of potential roosting structures indicate the area is of low sensitivity regarding bat roosting and it is not expected additional important bat roosts to be identified in the immediate vicinities of the site.

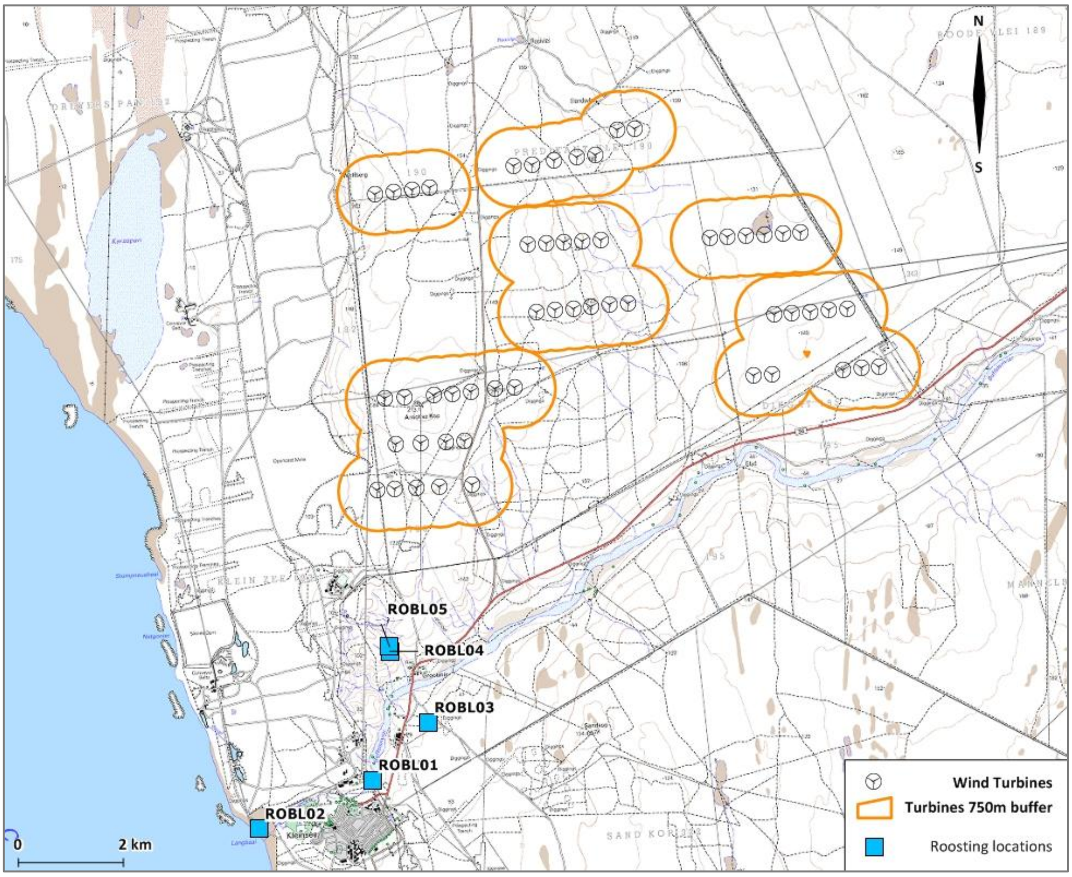


Figure 11 – Bat roosts locations on the site and immediate surroundings of Blue Wind Energy Facility.

4. Potential impacts identified on the bat community

4.1. Species with potential and confirmed occurrence on the site

Considering the species of potential occurrence at the Blue Wind Energy Facility, it is important to conduct a brief analysis of the main potential effects that the operation phase of this development may have on the bat community study area. Assuming that bat monitoring may not detect all bat species present in the study area in the first year of surveys, this analysis allows the prediction of the impacts to be considered in future assessments.

While wind energy facilities provide a clean source of energy with limited long term impacts on the planet, unlike fossil fuels, the existence of impacts over faunal resources was detected not long after its first implementation. However bats are considered as one of the most affected groups with the implementation of wind energy facilities, from high bat fatalities detected throughout North America and Europe (Fiedler 2004; Arnett *et al.* 2008; EUROBATS 2013; Hein, Gruver & Arnett 2013). Literature review and specialist expertise have suggested that the impacts that wind energy facilities have on bat species often result in fatalities, either caused by direct collision with the turbine tower, collision with rotation blades or barotraumas (Kunz *et al.* 2007; Cryan & Barclay 2009). Therefore the main impacts on bats that may arise from the implementation of Blue Wind Energy Facility can be:

- Bat fatalities by collision with wind turbines, turbine blades or barotrauma;
- Bat displacement from feeding areas;
- Disturbance and/or destruction of roosts;
- Mortality of frugivorous bat species by collision with power lines;
- Reduction of ecosystem services provided by bats;
- Cumulative impacts.

The consequences of bat fatalities or bat species displacement of the study area are beyond the simple impact on bat populations. Bats provide important services for the human population, especially through arthropod suppression, and pollination of a wide variety of plants (Kunz *et al.* 2011).

Bat fatalities by collision with wind turbines, turbine blades or barotrauma

Of the 14 bat species possible to occur in the study area presented in Table 3, approximately half (6 species) are considered to have low risk of collision with wind turbines, due to their flight and foraging behaviour (Figure 12). In this group of species with low risk of collision, one is considered to have a conservation status of concern (*Cistugo seabrai*), though none of these species were identified in the study area.

From the 8 remaining species, 1 have a medium risk of collision and 4 have a medium to high risk of collision with wind turbines since they have medium or high flight pattern and they are in general clutter-edge foragers, being possible that these species use the area surrounding the moving blades to forage (particularly if turbines are implemented in areas with tall vegetation), increasing the possibility of mortality by collision or barotrauma. The other 3 species have high risk of collision with wind turbines - *Tadarida aegyptiaca, Sauromys petrophilus* and *Taphozous mauritianus*. *Taphozous mauritianus* is not likely to occur in the study area, being therefore expected that the remaining species (that are likely to occur) will be potentially the most affected ones with the implementation of this project. These species are particularly prone to collision due to their flight characteristics as open-air foragers, which allow them to fly at high altitudes and enter the rotor swept area, increasing the probability of collision. However, all of these mentioned species present a "Least Concern" conservation status in South Africa and are both widespread and abundant species.

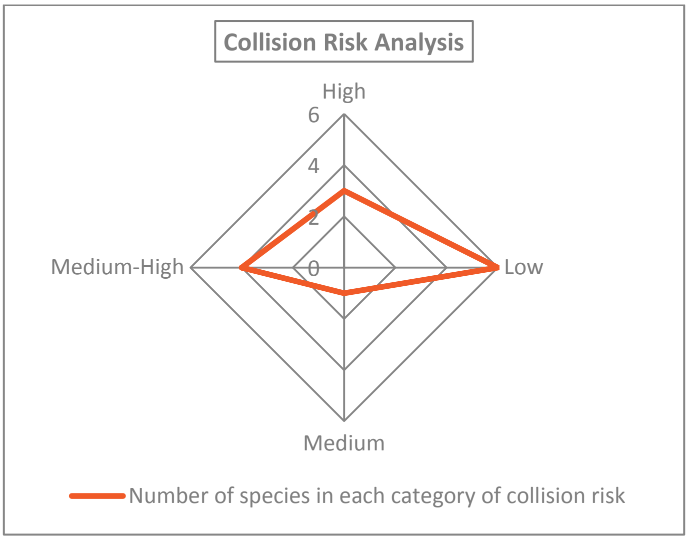


Figure 12 – Representation of the number of species (with potential occurrence in the Blue Wind Energy Facility) in each category of potential collision risk (Sowler & Stoffberg 2012).

It is important to analyse the species confirmed in the study area, and their predicted risk of collision with any of the wind turbines. Recent studies published have recorded the first events of bat mortality in South Africa due to wind turbines operation, with several bat fatalities of two species being recorded: *Neoromicia capensis* and *Tadarida aegyptiaca* (Aronson, Thomas & Jordaan 2013; Doty & Martin 2013). Considering the results of fatality records in Europe and North America, most of the species affected by wind energy infrastructures are *Tadarida sp.*, *Pipistrellus sp.*, *Miniopterus sp.* and *Eptesicus sp.* (Figure 13; Appendix III). The occurrence of 4 species was confirmed in the study area, including both species already identified to have fatalities records in South Africa: *Neoromicia capensis* and *Tadarida aegyptiaca* (Figure 13). For these 2 species there are also records of fatality events in wind energy facilities in several countries of Europe and North America for the same genus (*Tadarida sp.*) or similar genus (*Pipistrellus sp.* is considered ecologically and morphologically similar to *Neoromicia sp.*) (Arnett *et al.* 2008; EUROBATS 2013).

Other 2 of the species confirmed at Blue wind energy facility were *Eptesicus hottentotus* and *Miniopterus natalensis*. No records of bat fatalities of these species at wind energy facilities in South Africa have been recorded to date. However, fatalities of species of the *Eptesicus* genus have been detected in wind facilities in Europe and North America (Figure 13) (Arnett *et al.* 2008; EUROBATS 2013), and of *Miniopterus* genus in wind energy facility in Europe (EUROBATS 2013), though with very low frequencies.

The fact that these or similar species have already been found dead in other wind energy facilities around the world, indicate to some extent, with the limitations inherent to this comparison, the probability of having a similar behaviour at South Africa wind energy facilities. It is therefore likely that the species with confirmed occurrence in the study area and with records of fatalities elsewhere will collide with the proposed wind turbines at Blue wind energy facility site.

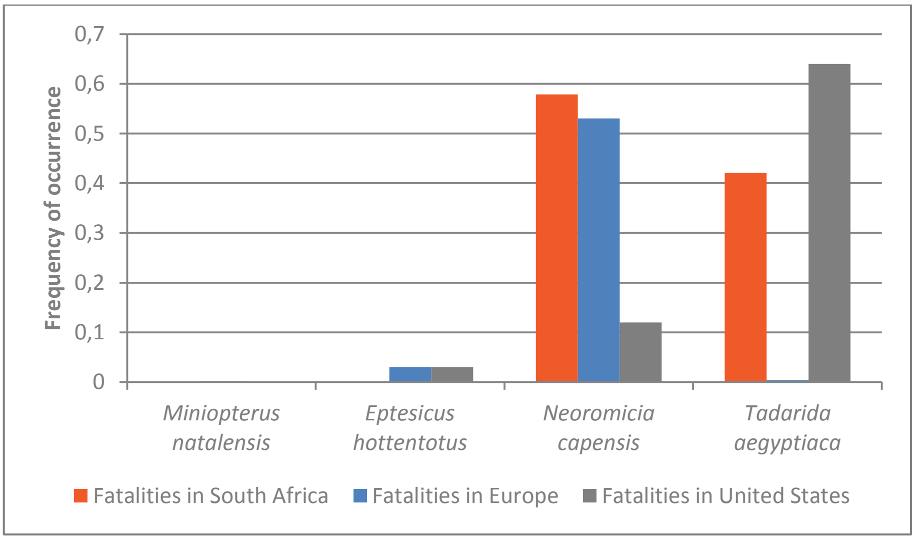


Figure 13 – Frequency of occurrence of bat fatalities of the confirmed bat species in the study area at wind energy facilities in South Africa (Aronson, Thomas & Jordaan 2013; Doty & Martin 2013), Europe – for species with the same or similar genus (EUROBATS 2013) and North America – for species with the same or similar genus (Arnett *et al.* 2008)**.**

Considering the rotor swept area between 30m and 180m, as suggested by the developer, it is expected that only bats that fly within the rotor swept area will to be affected by the operation of wind turbines (Barclay, Baerwald & Gruver 2007). In the study area 1 species with high altitude flight was confirmed, *Tadarida aegyptiaca* and one other is possible *Sauromys petrophilus.* In addition, one migratory species, the *Miniopterus natalensis was* also confirmed in the study area, can fly above 60 m as well (Barclay, Baerwald & Gruver 2007).

This potential impact significance is highly dependent on the species affected and the areas where the turbines are sited. Therefore, providing the mitigation measures proposed (refer to section 5.2) are implemented for the current layout, the potential impact significance is considered as moderate. These potential impacts would occur only after the wind energy facility becomes operational. Therefore, the implementation of an operational bat monitoring programme is considered essential to a) determine the extent of this impact on bat populations, b) verify and adjust the proposed mitigation measures where required, and c) if necessary provide additional mitigation measures.

Bat displacement from feeding areas

Considering the bat activity detected at the Blue Wind Energy Facility, and the assumption that this may represent a relatively unimportant area for foraging and feeding activities, it is not considered likely that impacts resulting from the proposed placement of wind turbines will affect foraging and feeding behaviours. The analysis of turbine installation, in relation to the vegetation present and activity was presented in section 3.2.3.3 and was concluded that the type of vegetation did not influenced significantly the bat activity observed. Nevertheless, this impact will depend mostly on the areas affected during the construction phase that will be occupied by the turbines, to implement the new accesses. It is considered of low significance at this stage provided the proposed mitigation measures are implemented (refer to section 5.2).

The implementation of an adequate monitoring protocol, including the assessment at a similar and suitable control area, will contribute to determining the extent of this impact.

This potential impact will occur during the construction phase and through the operational life of the wind energy facility.

Disturbance and/or destruction of roosts

Impacts to bat populations can also be as a result of affecting existing roosts, such as: temporary roosts, daytime use, or more importantly roosts for reproduction or hibernation that has an important role in bats life cycle. No reproduction roosts were yet identified at Blue study area at least three potential daytime roosts were identified however located at a reasonable distance from the study site to state that they shouldn't be affected. With the current information collected up to date this impact is considered to have a low significance, and no mitigation is considered necessary regarding this matter. Nonetheless, the continuation of the monitoring programme in the area should contribute to: 1) determining the importance of the identified roosts for the bat community; 2) identifying other roosts that potentially exist in the area; 3) determining the effects of the development on the already known roosting locations.

Mortality of frugivorous bat species by collision with power lines

Considering that no fruit eating bats were confirmed at the study area, this is not considered to be a very likely impact to occur. Additionally there are no known mortalities associated with the collision of insectivorous bats with power lines in Europe or elsewhere in the world (Rodrigues *et al.* 2008). Also no suitable habitat for these species was found at site, being very unlikely their occurrence.

Reduction of ecosystem services provided by bats

The Blue Wind Energy Facility is located within an area mostly occupied by natural vegetation, without human utilization. In this situation bats provide regulation services, by controlling insects population, by consuming several times their weight on arthropods per night (Cleveland *et al.* 2006; Kalka, Smith & Kalko 2008), though this may not manifest in a direct benefit for the community. Ultimately, in the case of the study area, bats can play a significant role in disease control, considering they can prey upon insects that are diseases vectors (Monadjem *et al.* 2010). It can be assumed that any significant impact on bat populations that play an important ecological role on the ecosystem will have also an important impact on the ecosystem services provided by these species. However, this is an impact difficult to assess. Nevertheless, the mitigation measures proposed for the other potential impacts identified will be translated on the mitigation of this particular potential impact as well.

Cumulative impacts

Cumulative impacts of a development project may be defined as "additional changes caused by a proposed development in conjunction with other similar developments or as the combined effect of a set of developments, taken together" (SNH 2012). This assumes the knowledge of other projects or actions whose effects could be added to the ones resulting from the project being assessed. As it is not reasonably viable to consider in the analysis all the existing or proposed projects for a certain region, the analysis should focus on (Masden *et al.* 2010; SNH 2012):

- The projects (for which there is information readily available) known for the area and its surroundings and that could be relevant in terms of the expected impacts, in relation to the project under assessment;
- The target species more relevant and/or susceptible to the expected impacts.

Even where fatality rates may appear low, adequate attention should be given to the assessment of cumulative effects, as the impact of several facilities on the same species could be considerable, particularly if these are located in the same region and impact on the same population of the species. Most of the long-lived and slow reproducing Red Listed species may not be able to sustain any additional mortality factors over and above existing factors.

The main activities or projects, relevant for the cumulative impacts analysis, known in the broader area of the Blue Wind Energy Facility are human activities, namely mining activities as well as other proposed wind energy facilities.

Mining activities:

The study area falls is adjacent to a severely transformed area, used to mining activities. This area is currently undergoing a process of vegetation recovery, and is not expected to expand to a broader area, so these activities should not contribute to enhance the impacts caused by the wind facility. On the other side, by recovering the natural vegetation, bats may have a higher extension of foraging grounds, being possibly a compensation for the vegetation lost with the implementation of turbines and associated infrastructure.

Other wind energy facilities:

At least another three wind energy development are planned to be implemented in the area. They will be implemented at a maximum distance of 100 km (Kangnas/Springbok WEF), 60km (Koignaas WEF) and a minimum distance of 20km (Kannikwa Vlakte WEF) (CSIR 2012).

What this implies in terms of the analysed impacts and attending to the data gathered so far during this pre-construction monitoring programme would be that the sum of the fatalities of the three other wind developments could have detrimental effects at the local scale for some of the species, such as the Cape Serotine, with fatalities already recorded in other facilities in South Africa.

It is not expected that these facilities result in additional cumulative impacts, as bats usually do not commonly travel distances of more than 50 km between summer and winter roosts (Monadjem *et al.* 2010). The main concern from the wind facilities located in the broader region relates to bat species that make medium to long migrations such as *Miniopterus natalensis*.

Baseline information on migration and dispersion of bat species in South Africa is deficient and it is possible that the individuals identified were not using the area while on migration, but rather as a foraging area. This diminishes the probability of impact on these species, from cumulative impacts. Other wind energy facilities may be proposed in the area, as the industry is rapidly expanding in South Africa but at the time of this report compilation, the known information has been presented.

4.2. Potential sensitive areas on the wind energy facility

Considering bat activity recorded to date in the area, the biotopes present and the number of species confirmed, the Blue Wind Energy Facility area is, in general, of low sensitivity to bats. No roosts were identified within the proposed facility site, and the ones found are located at more than 2km from the site, not being expected any influence over bat activity. Though some of the species identified can suffer fatality impacts, no areas of higher activity of these species where found within the site, as the activity was very low, throughout the area.

Considering these statements, the study area is considered of low sensitivity in terms of potential bat potential collision risk with wind turbines, and no-go areas are considered for this assessment.

In order to minimize potential impacts from the operational phase of the project (see section 4) some recommendations are proposed in section 5.2. Note that these are to be considered only as recommendations and should only be taken into consideration if possible and technically viable.

5. Conclusions and Recommendations

5.1. Main results of the pre-construction monitoring programme

The analysis conducted so far indicated that bat activity in the study area is very low in winter, higher in spring, decreasing in summer and autumn. In spring season, the area is less arid, with higher insect availability, and therefore more suitable for bats to forage for insects. When temperatures rise above acceptable and precipitation decreases, conditions cease to be adequate for bats, and a decrease in activity is observed. Comparing the levels of activity in Blue site and with other locations within the same Province and in other Provinces of South Africa it is noticed that the activity recorded is very low for the regional and national context.

Bat activity at the study area is shown to be influenced by some factors such as wind speed and temperature; negatively influenced by wind speed and positively influenced (up to a certain threshold) by the increase in temperature. Considering the featureless characteristics of the site, no association with the vegetation present was found.

In the study area, 3 species with possible occurrence are perceived as having a potential high risk of collision with wind turbines (Sowler & Stoffberg 2012) due to their behaviour, being 1 of them confirmed in the study area and one other possible (*Tadarida aegyptiaca* and *Sauromys petrophilus* respectively). Though both species are considered as “Least Concern” both nationally and internationally, *Sauromys petrophilus* is an endemic species to Southern Africa, being therefore of special concern if impacts are to happen. Their potential higher risk of collision is related with their foraging behaviour as open-air foragers, which promotes the entry of individuals in the turbine blade swept area, therefore increasing the probability of collision (EUROBATS 2013). There are also references to mortality incidents in wind facilities in Europe with several species of *Tadarida sp.*, same genus as *Tadarida aegyptiaca* and USA (*Tadarida brasiliensis*) for species of the same genus (Arnett *et al.* 2008; EUROBATS 2013).

Another 4 species with possible occurrence are considered to have medium to high risk fatality due to collision with wind turbines (Sowler & Stoffberg 2012). Two of these species have already been confirmed in the study area. These species are in general clutter-edge foragers with known wind turbine collisions in Europe and USA, from the same or similar genus, such as *Miniopterus* sp., *Pipistrellus* sp. (also similar to *Neoromicia* sp.) (Arnett *et al.* 2008; EUROBATS 2013).

The data collection analysis during the pre-construction phase, allowed the characterization of the bat community present at Blue Wind Energy Facility, and predicts the potential effects that the implementation of this project may have over bat populations in the study area. This study showed that the area is of low attractiveness for bats, and they use it very little. Therefore the overall site was considered of low sensitivity for bats. Nonetheless it is unavoidable that some species do occur at the site and that the probability of collision with turbines for some of them is high, being considered, however, that the significance of impacts to be low. For this reason some mitigation measures and general recommendations are made to mitigate potential impacts (refer to section 5.2) during operational phase. The implementation of an adequate operational phase monitoring programme will contribute to verification of the predicted impacts, and verify if the mitigation measures proposed and implemented are adequate and if necessary propose any adjustments in this regard. If other impacts are identified, then additional mitigation measures can be proposed, where necessary.

5.2. Recommendations for the next phases of the project

Considering the sensitivity analysis conducted (refer to section 4.2), the following recommendations are proposed to minimize the potential negative impacts of the wind energy facility, namely during its operational phase, in order to reduce the risk of bat collisions with the wind turbines located within sensitive areas. Considering the hypothesis that bat fatalities are anticipated during the operation of the facility, it is proposed that a monitoring programme is implemented during the operational phase of the project. A well planned and rigorous monitoring programme is one of the most effective management measures to determine and monitor any impacts, and propose adequate, site specific and cost-effective mitigation measures. During the operation phase, the bat monitoring programme will contribute to access the real bat mortality associated with the wind energy facility, verify the efficacy of the proposed and implemented mitigation measures and conduct adjustments if necessary. The identification of any critical areas or situations should be promptly evaluated by the bat specialist in order to implement adequate and specific mitigation measures.

No layout adjustments are considered necessary at this stage.

For the construction phase some measures are suggested in order to minimise the potential impacts identified:

- Adequate training should be provided to all the construction personnel. Everybody working in the area should be aware of the sensitive areas, be alert to the possible presence of bats, especially when working close to potential roosts (per example abandoned buildings);
- The construction works should be supervised, according to the plan to be detailed before construction, by a bat specialist on site, in order to further identify any conflict situations between the construction works and bats, and readily take actions to minimize any identified impacts;
- Minimise areas of construction as far as possible;
- If any building, trees, or any structure with potential to provide bat roosting, needs to be demolished, then it should be conducted a visit, prior to the commence of the works, by one specialist to verify the presence / absence of bats;
- In the case that any confirmed or potential bat roost needs to be affected (e.g. utilisation conversion, demolition, recuperation) a bat specialist should confirm bat occupancy and define the necessary measures to be implemented to minimize the impact if necessary;
- Sufficient and adequate drainage should be provided along access roads to prevent erosion and pollution of adjacent watercourses or wetlands;
- No chemical spills or any other material dumps should be conducted within the intervention area, with special focus on areas nearby riparian vegetation or drainage lines. All the maintenance of vehicles must be carried out in specially designated areas to prevent any type of pollution on the area.

The occurrence of at least one species considered having high collision risk with wind turbines and with recorded fatalities in wind energy facility in South Africa has been confirmed in the study area (i.e. *Tadarida aegyptiaca*). This species have high risk of collision due to their flight characteristics. It is an open-air forager, which may fly at high altitudes, therefore being potentially within the rotor swept area. Since this species is considered to be potentially affected by the operational phase of the project a set of measures are proposed in order to minimize the potential bat fatalities:

- If high collision risk areas are identified during the operational phase, or a high number of bat fatalities due to wind turbines are recorded, this should be evaluated by the designated bat specialists as soon as possible. Subsequent mitigation measures, adjusted to the risk situation identified, should be then proposed and implemented;
- If turbines are to be lit at night, lighting should be kept to a minimum[10];
- Lighting of wind energy facility (for example security lights) should be kept to a minimum and should be directed downwards (with the exception of avian security lighting);
- Ensure the implementation of a post-construction monitoring programme (operation phase) to survey bat communities on the wind energy facility and the impacts resulting from the installed infrastructure (refer to Appendix V);
- The results of the operational phase monitoring programme must be taken into account for the implementation of further mitigation measures, if necessary;
- The monitoring programme should have a minimum duration of at least 2 years, start as soon as the wind energy facility becomes operational and be revised upon completion. It should include both the continuation of the assessment of bat communities in the site, complementing the information gathered during the pre-construction phase and allowing determining any exclusion effects over the bat community. The operational phase monitoring programme should include carcass searches and the determination of correction factors (observer's efficiency and carcass removal) in order to accurately determine the impact of the wind turbine on bats and determine any potential critical area and/or wind turbines. This will allow proposing mitigation measures, if necessary, adjusted to the site specificities. This mitigation measures must be evaluated in a case by case scenario. An effective mitigation measures plan is one that shows an accurate determination of the most problematic areas and/or wind turbines and the characterization of the environmental variables with higher influence on bat fatalities (Arnett *et al.* 2013). Nonetheless the implementation of such measures should be implemented only if necessary and they should be carefully planned in order to maximize their efficacy in reducing bat mortality and assure the compatibility of the development with bat communities' conservation (Arnett *et al.* 2010, 2011).

To properly calculate the real mortality associated to wind energy facilities it is recommended that correction factors are assessed with a 15 days frequency; moreover it is essential to adopt a fatality estimator that adjusts the observed casualties with the estimated bias correction terms (Bernardino *et al.* 2013).

A rigorous and well planned monitoring programme is considered to be one of the most effective measures to validate the potential impacts identified and verify the effectiveness of the mitigation measures proposed. At this stage a well-designed monitoring programme of the subsequent phases of the development will provide important insights on the impacts of the wind energy facility at early stages allowing making any necessary adjustments to what have been previously proposed. It will also allow verifying if the mitigation measures are being effective or

[10] Provided this complies with all the legal requirements (e.g. Civil Aviation Authority regulations)

should be adjusted or interrupted and other more effective measures implemented. Mitigation of bat impacts on wind energy facilities should be site specific and an evolutionary process along the development life (Hundt 2012). The continuation of the monitoring programme will contribute to: increase knowledge about bat communities in the Blue Wind Energy Facility and verify the potential impacts identified during the pre-construction phase especially those concerning bat mortality with wind turbines. Although bat mortality may occur, based on pre-construction results, this is expected to affect mostly common and widespread species. However, if impacts identified in the subsequent phases of the project are more severe than expected additional mitigation measures may be evaluated, particularly if mortality occurs in levels that compromise the local population’s viability. Nonetheless such measures should only be implemented if necessary and they should be carefully planned in order to find the best trade off in reduction of the collision risk and minimize the loss in revenue resulting from mitigation.

The pre-construction bat monitoring programme will include three more surveys, to achieve a full year of monitoring, covering two more surveys in the autumn season and one survey in the beginning of winter season. Considering the results gathered up to date, is expected that bat activity will remain very low, possibly below the levels of activity detected in spring. If the activity levels remain the same, and no additional species of conservation concern are identified, the recommendations supplied above should not suffer any significant changes.

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7. APPENDICES

7.1. Appendix I - Figures

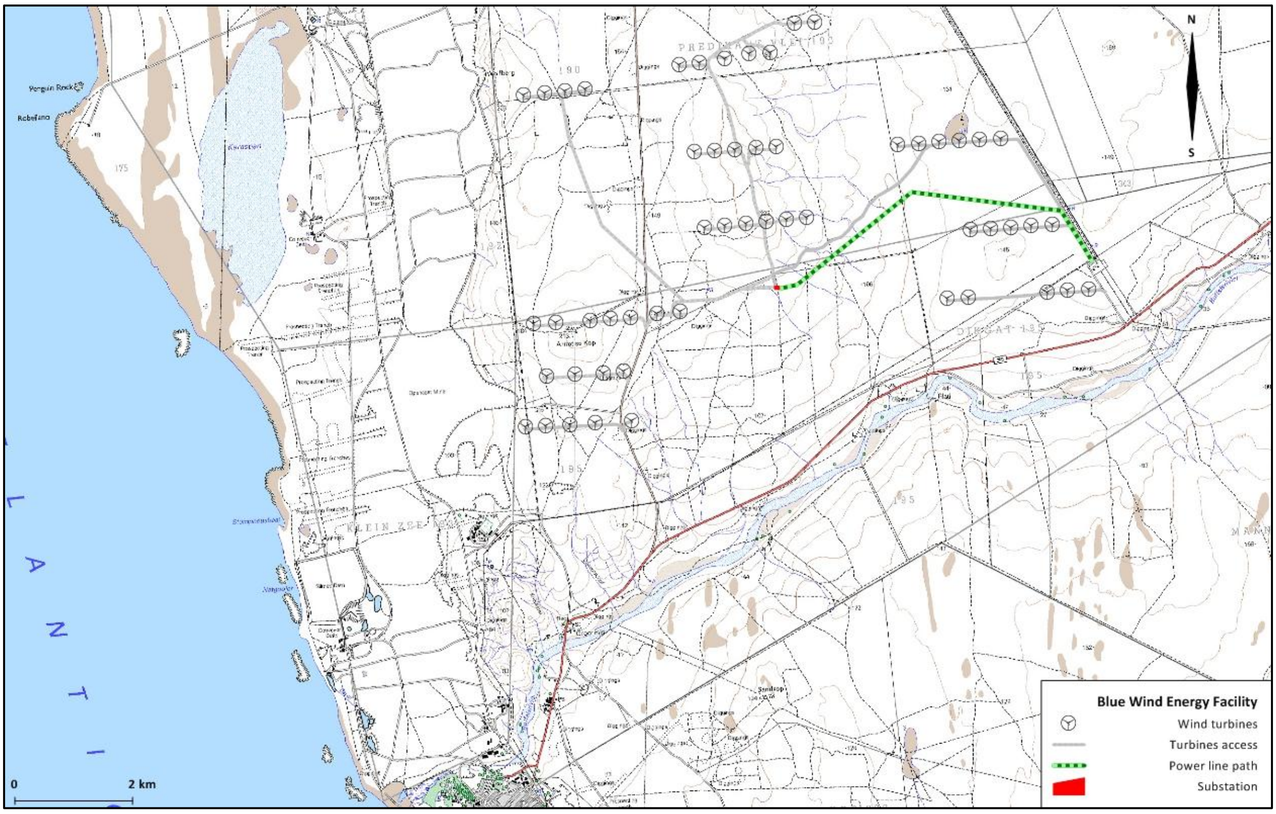

Figure 14 - Location of the proposed Blue wind energy facility turbine layout assessed in this report.

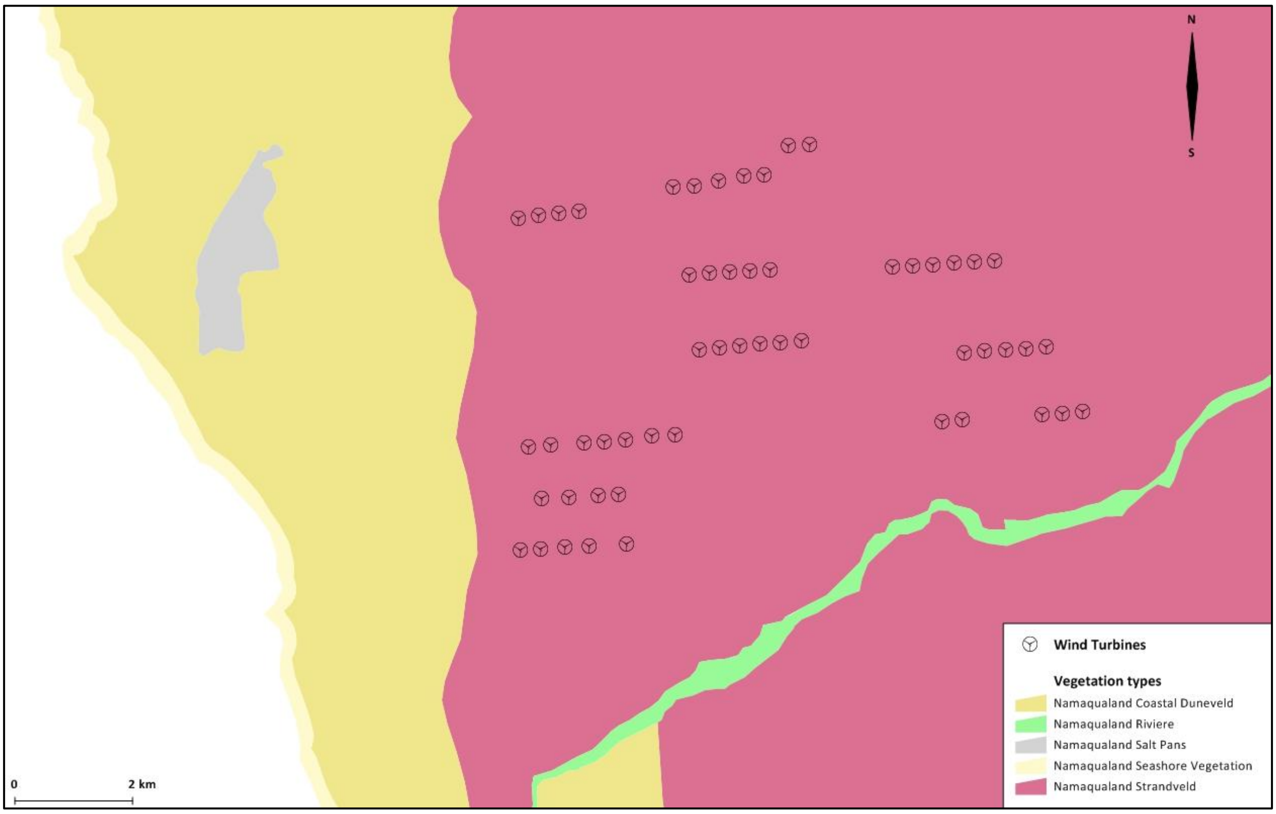

Figure 15 - Location of the study site in relation to the vegetation units as defined by Mucina & Rutherford (2006).

7.2. Appendix II - Roosts Description

Identification Code	Description	Photo
ROBL01	Type: Cave Minimum distance to future turbine location: 5491 m Traces: guano Species: Unidentifed Number of individuals: 1	
ROBL02	Type: Abandoned building Minimum distance to future turbine location: 6800 m Traces: - Species: - Number of individuals: 0	
ROBL03	Type: Reservoir with roof Minimum distance to future turbine location: 4444 m Traces: Guano Species: - Number of individuals: 0	
ROBL04	Type: Caves Minimum distance to future turbine location: 3050 m Traces: - Species: - Number of individuals: 0	
ROBL05	Type: Caves Minimum distance to future turbine location: 2960 m Traces: Guano Species: - Number of individuals: 0	

7.3. Appendix III - Collision risk analysis for the Bat Species occurring at the site

Legend: * - Collision known in Europe and USA for species within the same genus (EUROBATS, 2013); x – characteristic attributed to the species; ? – possible characteristic of the species.

Family	Specie	Common name	Migration or long movements	Clutter forager	Clutter-edge forager	Open air forager	High flight	Low flight	Attracted by light	Collision known (EUROBATS, 2013)
MINIOPTERIDAE	*Miniopterus natalensis*	Natal long-fingered bat	x		x					*
VESPERTILIONIDAE	*Eptesicus hottentotus*	Long-tailed serotine			x				?	*
VESPERTILIONIDAE	*Neoromicia capensis*	Cape serotine			x				?	*
MOLOSSIDAE	*Tadarida aegyptiaca*	Egyptian free-tailed bat				x			?	*

7.4. Appendix IV – Potential bat collision risk with wind turbines from accordingly to Sowler & Stoffberg (2012)

The likelihood of the risk of fatalities affecting bats, based on broad ecological features, excluding migratory behaviour.

Family / Genus	Relative Status	Likely risk of impact from wind turbine blades (direct collision / barotrauma)
Pteropodidae	Common – restricted distribution Some species known to move large distances	Medium – High
Molossidae	Common – widespread Species fly high enough to come into contact with turbine blades	High
Emballonuridae	Common – restricted distribution Species fly high enough to come into contact with turbine blades	High
Rhinolophidae	Species with restricted distributions	Low
Hipposideridae	Species with restricted distributions	Low
Nycteridae	Common – widespread and restricted distribution	Low
Miniopteridae	Common – widespread and restricted distribution Some species known to move large distances	Medium – High
Vespertilionidae	Common – widespread and restricted distribution	
Pipistrellus	Species with wide or restricted distributions	Medium
Hypsugo	Wide, but sparse distribution	Low
Nycticeinops	Common throughout restricted distribution	Medium
Neoromicia	Species with wide or restricted distributions	Medium - High
Kerivoula	Species with wide but sparse distributions	Low
Scotoecus	Sparse distributions	Medium – High
Cistugo	Restricted distributions – species endemic to Southern Africa or South Africa	Low
Laephotis	Species with restricted distributions	Low
Glauconycteris	Species with restricted distributions	Medium
Myotis	Species with wide or restricted distributions; some species may move large distances	Medium – High
Scotophilus	Species with widespread or restricted distributions	Medium - High
Eptesicus	Wide, but sparse distribution	Medium

7.5. Appendix V - Proposed bat monitoring programme for subsequent phases of the development

Objectives

The primary aims of this monitoring program are the assessment of the potential impacts resulting from the construction and operation of the wind energy facility over the bat community in the study area. Therefore the main objectives of this monitoring program are:

a) Identify the potential changes in the bat community present within the Blue wind energy facility site and the eventual exclusion effect (avoidance of the wind facility area during the operational phase of the project);

b) Assess the use of roosts in the wind energy facility development footprint as well as the surrounding area;

c) Quantify bat fatalities associated with the wind energy facility during the operation phase of the project;

d) Propose measures to monitor mitigate or, if unavoidable, compensate identified potential impacts.

In order to meet these objectives the same general methodological approach implemented during the pre-construction phase of the project should be implemented.

Active surveys should be conducted through implementation of fixed sampling points distributed within the wind energy facility area (may be defined along transects), covering all the different habitats present in the area. This sampling points should be conducted at least once each survey. A control area, with similar characteristics of the wind energy facility area should be defined and sampling points conducted with the same frequency and in similar biotopes.

The methodologies to be implemented should follow the 3rd edition of the guidelines presented in the *South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments* (Sowler & Stoffberg 2014).

Monitoring protocols

The overall monitoring program should be implemented throughout every phase of the wind energy facility project for at least three years after the facility becomes operational. The monitoring programme should be revised after this period, considering the results obtained its continuation should be evaluated.

The methodological approach to be implemented should be similar to the one implemented during the pre-construction phase and to which this report refers to (refer to section 2). It is proposed that the manual surveys should be implemented by means of sampling points and the general guidelines for this methodology are presented below.

Bellow the general guidelines for the additional methodologies, not included in the methodological approach presented in this report (section 2) necessary to implement during operational phase of the project, are presented.

Manual detection

The bat monitoring should be implemented in order to evaluate the activity patterns at the wind energy facility site and, at least, one control area. Collecting this information, should allow:

i. Determination of the bat species that use the site;

ii. Determination of bat activity index;

- *Methodology*

The methodology to be implemented should follow the general guidelines presented in the *South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments* (Sowler & Stoffberg 2014). The manual detection of ultrasounds should be conducted with a manual ultrasound detector that allows saving the bat recordings for further analysis and identification.

Manual surveys should comprise sample points of, at least, 5 minutes each, along vehicle transects. Each point should be characterised according to: minimum distance to the future turbines, slope, dominant orientation, biotope, minimum distance to a water source and minimum distance to known roosts, lunar phase, cloudiness, temperature and wind (speed and direction). At each 5 minute sampling point, all bat passes[11] heard and observed should be recorded, as well as all the passes detected between points. The surveys should start 30 minutes before the civil twilight sunset ensuring that bat species that emerge early in the evening can be included in the surveys (Sowler & Stoffberg 2014).

- *Sampling locations and Sampling periods*

Transects should be established in the wind energy facility and in a separate and similar control area(s), crossing the main biotopes present in the area. In each transect the sampling points, should be established with a minimum distance of 200m, in between each other to avoid pseudo-replication.

Surveys should be conducted at least once a month (a minimum of one survey per month). Each sampling point should be conducted at least once per month for at least a full calendar year during the construction phase, and at least three years after the project becomes operational (operational phase).

Active detection

- *Methodology*

The methodology to be implemented should follow the general guidelines presented in the Best *South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments* (Sowler & Stoffberg 2014) and the international best practices.

Fatality Assessment

At onshore facilities the fatality estimation is based on carcass searches around wind turbines. However, the number of carcasses found during the searches do not correspond to the real number of bats killed by the wind farm, since not all carcasses are detected by searchers or, some carcasses are removed given the time elapsed between searches, (e.g. by scavengers or decay) from the site. Thus, to estimate the real

[11] Contacts with bats detected by visual observation or ultrasonic detection of bat calls.

mortality it is necessary to determine the associated bias correction factor and adjust the observed mortality through the use of appropriate fatality estimators.

Whenever bat and bird monitoring plans are simultaneously being implemented at a wind energy facility the bat collisions and bird collisions assessment could be combined, following the same general methodological approach.

- *Carcass searches*

Regarding bat mortality evaluation, searches of dead bats around all the wind energy facility wind turbines during the operational phase are proposed. The search plot will depend on the wind turbine characteristics (hub height and rotor diameter) and should be larger than the area covered by the rotor diameter with an addition of at least 5 meters. This area should be regularly inspected for bat casualties. The observer should adjust its dislocation speed to the terrain characteristics, inspecting as much area as possible. According to the terrain characteristics the observer may conduct the survey through parallel transects, or by dividing the area in four different quadrants, and carefully searching for any signs of bat collision incidents (carcasses, dismembered body parts, injured bats). All evidence should be documented, being the evidence collected in adequate preserving conditions, for further laboratory analysis.

- *Searcher efficiency and carcass removal trials*

Field trials should be conducted to determine the observed mortality correction parameters such as carcass detection by observers and carcass removal (e.g. by scavengers).

In carcass removal trials, carcasses should be placed at a minimum distance of 500 m from each other. Once placed, carcasses should be checked to determine the time of removal for each one.

For the searcher efficiency trials, carcasses should be randomly placed around the turbines and then searched by the observers in order to assess their efficiency rate.

In both trials, the type of carcasses used should mimic the dimensions and body size of the existing wild species in the study area, such as rats.

- *Sampling locations and Sampling periods*

Mortality inspection, carcass detection and carcass removal should be implemented in the operational phase of the project for at least three years, except if stated otherwise. All the turbines implemented should be surveyed.

- *Carcass searches*

Preferably the mortality inspection surveys should be conducted weekly (if not possible, then the surveys must be conducted at least every 15 days, or monthly in the worst case scenario) (Strickland *et al.* 2011), covering the whole annual period (Bernardino 2008).

- *Searcher efficiency and carcass removal trials*

The carcass removal trials should be performed during four seasons: winter, spring, autumn and summer. In each campaign, the rat carcasses placed on site should be checked daily. The number of carcasses used should be limited, in order not to attract too many scavengers.

In searcher efficiency trials, carcasses should be placed within the search plot of each turbine, if the habitats have no significant variation throughout the year, the trial could only be performed during one season of the year.

In order to obtain an accurate measure of the observed mortality, search efficiency rates and scavenging rates should be assessed during the first operational year of the wind energy facility.

- *Data analysis*

The results from the trials conducted should provide the evaluation of the following parameters:

i. Correction factor for carcass detection by field observers;

ii. Correction factor for carcass removal by scavengers and environmental factors;

iii. Real mortality estimates in the wind energy facility, during its operational phase.

To properly calculate the real mortality associated to the wind energy facility it is essential to adopt a fatality estimator that adjusts the observed casualties by the estimated bias correction terms. In the last years research has been conducted on this matter and several estimators have been proposed. However, so far there is still lacking a universal estimator that ensures good quality estimates under all circumstances (Bernardino *et al.* 2013).

Therefore, when estimating the bat fatality associated to the wind energy facility the best estimator available at the time should be used, which performance must be demonstrated in peer-reviewed studies.

Reports preparation and contents

A technical report containing the parameters referred to in the previous chapters should be delivered at the end of each year of monitoring. In this document an evaluation of the adequacy of monitoring protocols applied should be conducted, as well as an evaluation of the existence of any detectable potential impacts occurring over the bat community in the impacted area, due to wind energy facility and associated infrastructures. In these reports, a data comparison from results of previous years should be performed, in order to obtain more reliable conclusions. For this reason, the final monitoring program reports should present review of results obtained over the previous years when the monitoring activities were implemented.

7.6. Appendix VI – Monitoring Programme Compliance with EIA and Guidelines

Recommendations from Guidelines (Sowler & Stoffberg, 2012)	EIA Report Requirements	Methodological approach at Blue WEF	Further information/Justification
General requirements			
Pre-construction monitoring design and effort should be site-specific and will depend on the information gathered as part of the scoping study which should be conducted and assessed by the specialist.	Bat monitoring according to the South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments (Sowler & Stoffberg, 2011), should be initiated as soon as possible.	Considering the number of proposed turbines and the bat assemblage identified at the draft EIA report, Blue WEF site was considered of medium to low sensitivity, being therefore applied a corresponding sampling effort.	Though 54 wind turbines are proposed to the site, which is a significant amount of structures, the area is very unappealing for bats. The arid vegetation and climate are expected to produce very low bat activities. The only feature that may attract bats to the site are the small caves and crevices of the cliffs at the Buffels River at approximately 2000m from the closest wind turbine
Pre-construction monitoring should take place for a minimum period of one year (12 consecutive months)		Monitoring surveys will be conducted 12 times throughout the 12 month monitoring period, including three visits every season.	
Survey area should represent adequate coverage of the developable area. Where turbine locations are not known, surveys should cover the maximum polygon that identifies the maximum size of all possible arrangements and also where turbine locations are known because provisional turbine layouts may change.		The survey area was designed to cover 1000m buffer around each proposed turbine location and a reference area with similar characteristics.	
Where mitigation and habitat enhancement for other ecological receptors is planned on-site an assessment of whether these measures may attract bats into the area following implementation should be considered. Where possible, the potential effects of such operational site management should also be assessed.	Final Turbine placement must reflect the findings and recommendations emerging from the above studies.	The results of the one-year pre-construction monitoring programme implemented at Blue WEF will allow to make recommendations for mitigation measures related to impacts assessed during the surveys conducted. These recommendations will be included in the final report produced at the end of the pre-construction monitoring.	The surveys conducted each month allowed to have a gradual perception of the activity at the study area, being BioInsight able to inform the developer of any major constraints regarding the layout proposed regarding bat activity throughout time.
Roost Surveys			
Roost surveys include survey of known roosts and identify potential roost sites		The present monitoring plan takes in consideration the search for potential roost sites and when detected, the monitoring of the roost will be undertaken.	

Recommendations from Guidelines (Sowler & Stoffberg, 2012)	EIA Report Requirements	Methodological approach at Blue WEF	Further information/Justification
Surveys to assess and identify potential key areas for roosting such as (but not limited to) buildings, underground sites, caves, mines, trees, should be carried out. Any areas with high potential on or adjacent to (if access is granted) the site should be investigated further in order to identify potentially important roost sites.		All structures that can potentially provide adequate roosts for bats will be identified in the study area and its surroundings by a desktop study. The locations inspected will be registered with GPS, as well as photographed, and it will be recorded: season, the individual's activity rate, presence of progeny, degree of human disturbance and type of roost. The occupation rate, species present and conservation status will be determined to each roost inspected.	According to the Faunal Assessment there are some low cliffs along the Buffels River in the vicinity of the site which may have suitable crevices. There are also some small caves in a tributary of the Buffels River near to Grootmis, which are potentially suitable for several species. As there are many old mining pits in the area, there may also be suitable roosting sites in these as well as in many of the old or disused buildings around Kleinsee, Grootmis and scattered about the site.
Known roosts, identified in the scoping report or during initial surveys, should be surveyed to identify species roosting there and should include activity surveys to identify main commuting routes to and from the roost and the use of the site by bats throughout the year.		No roost is known in the study area so all roost monitoring effort will be applied for suitable roost search. If any roost is identified trough the pre-construction surveys, specific visits will be conducted.	No roosts were identified in the scoping report.
The survey should include a daytime inspection of any structures that can be examined for evidence of roosting bats. At least one survey should be carried out at these locations at dusk, with the aim of observing emergence at features assessed as providing high potential for roost sites. Sites with evidence of roosting should be subject to additional surveys.		The identified locations will be inspected during field work in order to record evidence of the presence of bats (such as guano accumulation, bat corpses or insect remains). Other structures identified during the field surveys will also be registered and inspected. If presence of bats are identified a roost will be sampled at dusk using manual acoustic detection in order to determine the species presence.	
Active Surveys			
Manual activity surveys such as walked or driven transects, are necessary to gain an understanding of the bat species using the site and the features on site that the bats are using.		BioInsight manual bat monitoring is undertaken by acoustic detection at 5 minute sampling points located within driven transects.	
Manual bat surveys (i.e. walked transects) suggests that they only take place in optimum weather conditions in order to maximise the likelihood of recording bats if they use the site being surveyed. It is advised to avoid heavy rain, strong winds, and low temperatures.		The surveys will not be undertaken in adverse weather conditions (rain, wind, fog, thunderstorms).	

Recommendations from Guidelines (Sowler & Stoffberg, 2012)	EIA Report Requirements	Methodological approach at Blue WEF	Further information/Justification
Whenever possible, weather information should be recorded on site throughout the monitoring period. Data on wind speed, rainfall and temperature that is gathered over the entire year should be compared with the bat data (i.e. bat activity) of the site, particularly data collected from static detectors.		Each sampling point was characterised each survey according to: average wind speed, dominant wind speed and average air temperature.	
Manual surveys should commence 30 minutes before sunset to ensure that species of bat which emerge early in the evening, are included within the monitoring period.		Fieldwork is planned to start 30 minutes before sunset and the order of the sampling points will be rotated to ensure that species with different emergence times are included at all points.	
Manual surveys should focus on, but not be limited to, habitat features likely to be used by bats across the site (e.g. water bodies and associated vegetation) and be used to further investigate findings from the static monitoring.		The manual surveys will comprise 55 sampling points: 37 in the wind energy facility and 18 in a similar reference area. The points and transects location depend on the main biotope and composition of the habitat (shrubland, dunes, rocky outcrops) and are representative of the area.	
Sufficient transects should be set up to ensure that all identified features that may be used by bats, are sampled within three hours after dusk.		The manual surveys will comprise 55 sampling points of 5 minutes each located along 3 transects: 2 transects in the wind energy facility area (approximately 21 km with 37 points at least 200m apart) and 1 transect in the control area (approximately 7 km with 18 points). Bat sampling surveys start half an hour before sunset and end at most three hours after sunset.	
Sampling points can be identified along the transect routes to divide the route into comparable sections. These points should be evenly distributed in distance and amongst the habitats across the site and should include habitats considered of low value to bats (e.g. arable fields). Bat activity should be recorded for a set amount of time at each sampling point (BCT recommend at least three minutes) and continually between points and should aim to represent and compare bat activity across the site.		Bat activity will be recorded for 5 minutes at each sampling point set within the driven transects. Sampling points are located at least 200m apart. The sampling transects and points location are defined in order to cross all main biomes present in the site so that the bat activity is better represent the overall activity in the site (wind energy facility area and control area).	Collection of data between locations has the inconvenience of generating background noise which will hinder bat species echolocation identification. The location of the transects and sampling was designed having in mind the representation of the broader area of the WEF, and therefore is acknowledged that a good coverage of the area is achieved, without incurring in identification challenges due to ambience noise.

Recommendations from Guidelines (Sowler & Stoffberg, 2012)	EIA Report Requirements	Methodological approach at Blue WEF	Further information/Justification
The number of bat passes and species concerned should be recorded at each sampling point and between sampling points.		At each 5 minute sampling point bat passes are counted and later acoustic analysis will allow species identification.	
Surveys should be undertaken from opposite directions throughout the year to allow for the differing emergence times of bat species.		Transects are started from opposite directions every other survey.	
It is recommend two replicates per season (which is four site visits per year with two replicates for each site visit).		BioInsight will undertake 3 replicates per season (3 surveys per season) which is 12 visits per year.	
Passive Surveys			
Automated bat detector systems (remote acoustic monitoring) at ground level should be used to assess bat activity at proposed wind farm sites. On wind farm sites static monitoring is undertaken at height in addition to ground-level monitoring.		7 automated full spectrum detector systems will be installed: 6 at ground level and 1 at height at rotor swept area height.	
Static survey detectors should be installed at height with the aim of identifying the amount of bat activity occurring in habitat over the open ground, and in the rotor swept area. It is strongly recommended that the static detector microphones should be mounted at height within swept path area of rotor blades.		One detector is installed at height in the met mast placed within the wind energy facility site at approximately 50m height.	According to the draft EIA report, the turbine hub will be erected up to 120 m height and rotor diameter will up to 125 m. The detector installed at height (50 m) will be closely within rotor blade swept area. The exact specifications of the wind turbines were not know at the time the work was iniciated.
Static monitoring should commence half an hour before sunset and finish half an hour after sunrise to ensure that bat species which emerge early in the evening or return to roosts late are included within the monitoring period.		All static detectors have timers that will automatically adjust to start half an hour before sunset and finish half an hour after sunrise. This is done automatically by the detector internal software according to the detectors inputted location.	
The survey period when data collected should be 15-25% of one year (spread evenly throughout) for each location.		Static surveys will be implemented throughout the year (100%) at rotor height and in the same location at ground level. In the remaining locations sampling will occur for approximately 23% of the year.	

Recommendations from Guidelines (Sowler & Stoffberg, 2012)	EIA Report Requirements	Methodological approach at Blue WEF	Further information/Justification
Monitoring data collected by ground level static surveys should represent the maximum polygon of the development area.		Considering that each static detector has the capacity to survey 3.5 ha and that 5 locations were placed within the wind energy facility site, approximately 17,5 ha were sampled, corresponding to 276% of the wind facility area.	
Static detectors should be deployed in sufficient numbers or moved on rotation (ensuring even coverage of developable area) to enable collection of data on bat activity across the site, as informed by the scoping report and site 'walkover' surveys.		Static detectors were located at a minimum distance of 3 km from each other, surveying the entire area within a 1000m buffer from the turbine locations.	
Static detectors should be used to monitor proposed turbine locations, plus additional locations identified as features that may be used by bats for comparison.		6 Static detectors were placed within the WEF area, in locations coincident with proposed turbines; 1 Static detector was placed in a similar reference site for activity comparison.	
The same model of static detector should be used for all static detector surveys on a single site if direct comparisons in activity between locations within the site are to be made. In addition all detectors must be appropriately calibrated to allow for variation between detector units and to allow a valid comparison of recorded bat activity across a suite of detectors (Larson & Hayes, 2000).		All 7 detector to be installed are from same model (SM2BAT+).	
Microphones should be directed at an angle of 45 degrees towards the target area.		Microphones are placed at an angle of 45 degrees.	
Survey locations include vegetated areas and vegetation edges to provide information on the bat species assemblage and activity levels in these areas as a baseline for post-construction monitoring.		The sampling points are located near vegetated areas and vegetation edges. The specific detectors location is always validated on the field to ensure this aspects. Environmental characterization is undertaken for each point in terms of: slope, predominant land use, distance to water and to known roosts.	

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