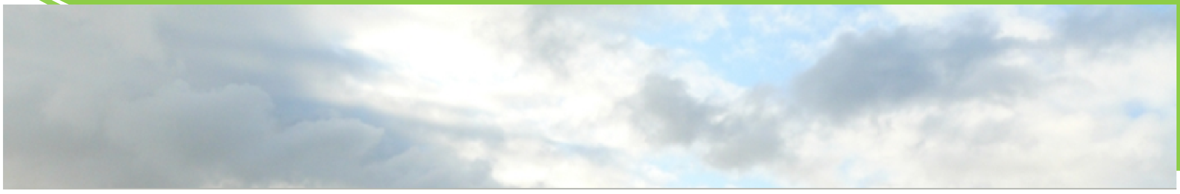
Specialist Bat (Chiroptera) Sensitivity Assessment

- For the proposed Happy Valley Wind Energy Facility on Portion 1 and remaining extent of Farm 810, near Humansdorp, Eastern Cape.



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Cover page photo: View on top of one of the ridges.

Terms of Reference

To assess the sensitivity of the study area with regards to bat (Chiroptera) fauna, in relation to the proposed wind energy facility and its associating impacts. The assessment aims to identify sensitive areas on the study site where bat activity may be the highest, and recommend applicable mitigation measures and recommendations to minimize negative impacts on bat fauna in the broader area. Impacts considered include foraging impacts, roost impacts and migration impacts.

Appointment of Specialist

Animalia Zoological & Ecological Consultation CC was appointed by Savannah Environmental (Pty) Ltd to undertake a specialist bat sensitivity study for the proposed Happy Valley Wind Energy Facility on Portion 1 and the remaining extent of farm 810, near Humansdorp, Eastern Cape.

Independence:

Animalia Zoological & Ecological Consultation CC has no connection with the developer. Animalia Zoological & Ecological Consultation CC is not a subsidiary, legally or financially of the developer; remuneration for services by the developer in relation to this proposal is not linked to approval by decision-making authorities responsible for permitting this proposal and the consultancy has no interest in secondary or downstream developments as a result of the authorisation of this project.

Applicable Legislation:

Legislation dealing with mammals applies to bats and includes the following:

NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT, 2004 (ACT 10 OF 2004; section 97): THREATENED OR PROTECTED SPECIES REGULATIONS:

All bats enjoy protection under this act. This act also calls for an environmental impact assessment for threatened and protected species.

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1. INTRODUCTION

1.1 Study Area

The site is located approximately 4km north-west of Humansdorp with the south-eastern boundary touching the N2 highway, in the Eastern Cape (**figure 1**). Portion 1 and the remaining extent of Farm 810 is collectively referred to as the study site and is approximately 1286 ha in size and located inside the quarter degree square S33E24DC. The dirt road cutting through the site is in the valley area and is bordered on both sides by ridges, with the northern ridges being much higher and larger. Turbine localities are proposed to be on the ridges and higher lying ground of the site (**figure 2**).

Renewable Energy Investments South Africa (Pty) Ltd (REISA) is proposing 20 wind turbines with a proposed total generating capacity of approximately 40 MW, with the broader site accommodating associated infrastructure which is required for such a facility. The wind turbines will have a hub height of 60 – 80 meters with concrete foundations and underground cabling (where practical) between them. An on-site substation to facilitate the connection between the wind energy facility and the grid will also be constructed, as well as new overhead power lines to connect to Eskom’s existing Melkhout Substation. Internal access roads to each turbine and a workshop area for maintenance and storage will also be located on the site.

Figure 1: Road map with an indication of the site locality (yellow outline), and an overview map with the site locality (red dot).

Figure 2: Satellite image of the site, the boundary is indicated in blue and preliminary proposed wind turbine localities as red dots; localities of the other 10 proposed turbines was not yet available during this study. All satellite images taken by Image © DigitalGlobe, retrieved from Google Earth.

1.2 Land use and existing impacts on the site

The existing impacts on the site are very limited and mostly includes farm houses and sheds in the valley area, with some livestock roaming the ridges and high lying areas (**figure 3**).

Figure 3: The natural state of the higher lying ridge areas (Top), and a view onto the larger northern ridge where some of the turbines are preliminarily proposed to be located (bottom).

1.3 Vegetation unit, geology and climate

The majority of the site is classified as the vegetation unit called Kouga Grassy Sandstone Fynbos with only the small south-western plain at the foot of the smaller southern ridge being Humansdorp Shale Renosterveld (**figure 4**).

The Kouga Grassy Sandstone Fynbos is found in the Western and Eastern Cape provinces from an altitude of 220 m to 1220 m with low shrubland of sparse emergent shrubs and dominated by grasses in the undergrowth. Lower dry slopes where leaching is less severe supports a higher grassy cover. Soils are acidic lithosol soils derived from sandstones of the Table Mountain Group as well as quartzitic sandstones of the Witteberg Group (Nardow Subgroup). Glenrosa and Mispah soil sorms are prominent (Mucina & Rutherford, 2006).

Rainfall is spread evenly throughout the year with a slight peak in March and October-November; MAP (Mean Annual Precipitation) is 270 – 800 mm. Mean daily maximum and minimum temperatures for February and July is 27°C and 4.2°C, respectively.

A Least Threatened conservation status is assigned to this vegetation unit with a target of 23% to be conserved. Currently about 22% falls within conservation areas and reserves, and 9% is transformed by cultivation, but much more is transformed to grassy pastures by too frequent burning. Some endemic taxa include: *Freylinia crispa, Argyrolobium parvifloru, Sutera cinerea, Lampranthus lavisii, Annesorhiza thunbergii, Aster laevigatus, Cyrtanthus flammosus, C. labiatus, Gasteria glauca, Restio vallis-simius* (Mucina & Rutherford, 2006).

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— Portion boundary
🟩 Kouga Grassy Sandstone Fynbos
🟦 Humansdorp Shale Renosterveld

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Figure 4: Vegetation units present on the site (Mucina & Rutherford, 2006).

1.4 The bats of South Africa

Bats are mammals from the order Chiroptera, and are the second largest group of mammals after the rodents. There are approximately 117 species of bats in the Southern African sub-region, of which 5 species have a global Red list status of Vulnerable and 12 are classified as Near Threatened (Monadjem, et al. 2010). More than 50 bat species occur in South Africa (Taylor, 2000; Friedman and Daly, 2004; Monadjem, et al. 2010).

Bats are the only mammals to have developed true powered flight and they have undergone various skeletal changes to accommodate this. The forelimbs are elongated, whereas the hind limbs are dramatically reduced and shortened to lessen the total body weight. This unique wing support frame allows bats to alter the camber of their wings in order to adapt the wing shape to different flight conditions while maximizing agility and maneuverability. This adaptability and versatility of the bat wing surpasses the more static design of the bird wings and enables bats to utilise a wide variety of food sources and diversity of insects (Neuweiler, 2000). The facial characteristics between species may differ considerably to suit the requirements of their life style especially with regard to their feeding and echolocation navigation strategies. The majority of South African bats are insectivorous, and can consume vast numbers of insects on a nightly basis (Taylor, 2000; Tuttle and Hensley, 2001), but may also consume other invertebrates, amphibians, fruit and nectar.

Insectivorous bats are therefore the only major predators of nocturnal flying insects in South Africa and contribute greatly in the control of their numbers. Their prey also includes agricultural insect pests, such as moths and vectors for diseases such as mosquitoes (Rautenbach, 1982; Taylor, 2000).

Urban development and agricultural practices have contributed to the decline in bat numbers globally. Public participation and funding of bat conservation are often hindered by the negative images of bats created by a lack of knowledge and certain misconceptions about bats. The fact that some species roost in domestic residences also contributes to the negative reputation of bats. Some species may occur in large numbers in buildings and besides being a nuisance, may become a health risk to the residents. Unfortunately, the negative association people have towards bats, obscures the fact that they are an essential component of the ecology and by en large beneficial to humans.

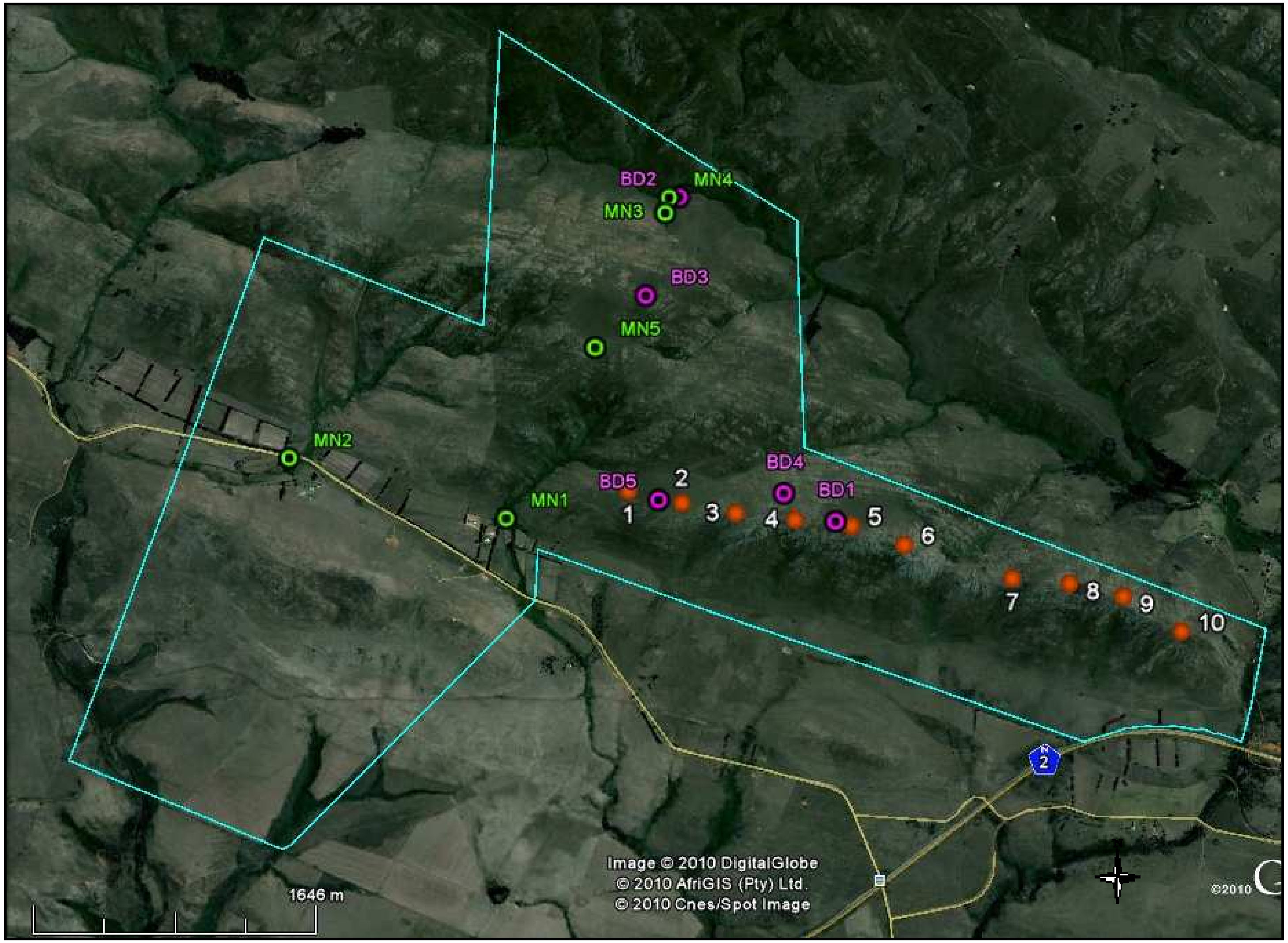
Many bat species roost in large aggregations and concentrate in small areas. Therefore, any major disturbance to that area can adversely impact many individuals of a population at the same time (Hester and Grenier, 2005). Secondly, the reproduction rates of bats are much lower than those of most other small mammals, because usually only one or two pups are born per female annually. According to O’Shea et al. (2003), bats may live for up to 30 years. Under natural circumstances, a population's numbers can build up over a long period of time, due to their longevity and the relatively low predation on bats, when compared to other small mammals. Therefore, the rate of recovery of bat populations is slow after major die-offs and roost disturbances.

2. Methods

The site was visited on the 25th and 26th of November 2010 at night and during the day. In daylight the site was investigated for possible bat roosting localities and the general terrain was studied. At night, time expansion type bat detectors and mist nets were deployed at various localities on the site, focusing on areas where the turbines are proposed to be located or areas where some success with the various methods are expected (**figure 5**).
A bat detector (**figure 6**) is a device capable of recording the ultrasonic echolocation calls of bats for analysis on a computer afterwards, and a mist net (**figure 6**) is a fine black net used to catch bats at strategic locations where they may fly regular paths. A time expansion type bat detector effectively slows an ultrasonic bat call down 10 times so that it is audible to the human ear, but still retains all the harmonics and other characteristics of the call. Although this type of bat detection technology is the most advanced currently commercially available, it is not necessarily possible to identify all bat species just by their echolocation calls. Recordings may be affected by the weather conditions and openness of the terrain, whereas the range of detecting a bat is dependent on the volume of the bat call.

In general the mist nets were not deployed at turbine localities, because this would have significantly lowered the possibility of the nets being successful. This is due to the fact that the turbines localities are in open areas, and not at any strategic points where bats may be drawn to, channeled or in habitual flight paths.

On the night of the 27th all the higher lying areas of the site where the turbines are proposed to be was covered in a very thick mist, with light rain carried on a strong cold wind (**figure 7**). Such weather conditions are very unfavourable for bat activity and makes monitoring extremely challenging. During monitoring on the 28th there was still a very cold and strong wind present, but it was not overcast and conditions were more favourable for monitoring. Although the usual weather conditions present on the high ridges are in general not favourable for high bat activity, according to current scientific knowledge of bats. Sampling localities were also influenced by accessibility and practicality issues.



▬ Portion boundary

● Proposed turbine localities

◎ Mist net localities

◎ Bat detector localities

Figure 5: Bat detector and mist net localities.

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Figure 6: (top) The time expansion type bat detector (BD3) set up with a field laptop and external long life battery to passively record bat echolocation calls; **(bottom)** a mist net set up across a drainage gully (MN3) where habitual bat flight is possible, the actual fine net is between the two poles and not visible in this photograph.

Figure 7: The wet weather conditions and thick mist that covered all ridges on the site as well as all proposed turbine localities on the night of the 27th.

3. RESULTS

3.1 Species probability of occurrence

Table 1: Table of species that may be roosting on the site, the possible site specific roosts, and their probability of occurrence. LC = Least Concern; NT = Near Threatened (Monadjem *et al.*, 2010).

Species	Common name	Probability of occurrence	Conservation status	Possible roosting habitat to be utilised on site
Rousettus aegyptiacus	Egyptian Rousette	Low	LC	Roosts gregariously in caves, no known caves close to the study site.
Hipposideros caffer	Sundevall's leaf-nosed bat	Medium	LC	Cavities, hollow tree trunks, aardvark burrows and culverts in valley.
Rhinolophus capensis	Cape horseshoe bat	Low	NT	Roosts gregariously in caves, no known caves close to the study site.
Rhinolophus clivosus	Geoffroy's horseshoe bat	Low	LC	Roosts gregariously in caves, no known caves close to the study site.
Rhinolophus simulator	Bushveld horseshoe bat	Low	LC	Roosts in caves. Also cavities, culverts.
Rhinolophus swinnyi	Swinny's horseshoe bat	Low	NT	Roosts in caves. Also cavities, culverts.
Taphozous mauritianus	Mauritian tomb bat	Low	LC	Roosts on rock faces, walls, large tree trunks. Some large trees in valley, lower lying rock faces.
Nycteris thebaica	Egyptian slit-faced bat	High	LC	Cavities, hollow tree trunks, and culverts in valley. Aardvark burrows.
Tadarida aegyptiaca	Egyptian free-tailed bat	Confirmed	LC	Crevices: buildings, rock crevices, under loose bark.
Miniopterus fraterculus	Lesser long-fingered bat	Low	LC	Roosts gregariously in caves, no known caves close to the study site.

Miniopterus natalensis	Natal long-fingered bat	Low	NT	Roosts gregariously in caves, no known caves close to the study site.
Eptesicus hottentotus	Long-tailed serotine	Medium	LC	Crevice dweller. Rock crevices.
Myotis tricolor	Temmink's myotis	Low	LC	Roosts gregariously in caves, no known caves close to the study site.
Neoromicia capensis	Cape serotine	High	LC	Under bark of trees and roofs of buildings.
Scotophilus viridis	Green house bat	Low	Not Evaluated	Hollows in trees and buildings; more associated with warmer climates.

3.2 Bat detection and mist netting

BD 5	
Sound recording	1
Dominant frequencies of 3 most powerful pulses	23.5 21.4
Average dominant freq.	22.5
Spieces	*T.a*

Table 2: Call parameters of the dominant frequency in kHz (Kilo Hertz) of the echolocation call detected by BD5. T.a = *Tadarida aegyptiaca* (Egyptian free-tailed bat).

A bat call consists of a series of ultrasonic sound pulses, with each species calling at a different sound frequency (**figure 8**). It is used for navigational and hunting purposes, comparable to but more sophisticated than modern sonar Pulses within a bat call can also vary in their sound frequency and characteristics, although this variation is within a certain range associated with a certain bat species. Certain call parameters are used to identify a bat species from its echolocation call: These include pulse length, pulse bandwidth, pulse interval and pulse dominant frequency (loudest frequency), of which dominant frequency are the most commonly used. The dominant frequencies of the three loudest pulses were chosen since the loudest pulse would be the one where the bat was the closest to the bat detector, limiting the ramifications that the Doppler Effect can have on the results of sound waves emitted by a moving bat.

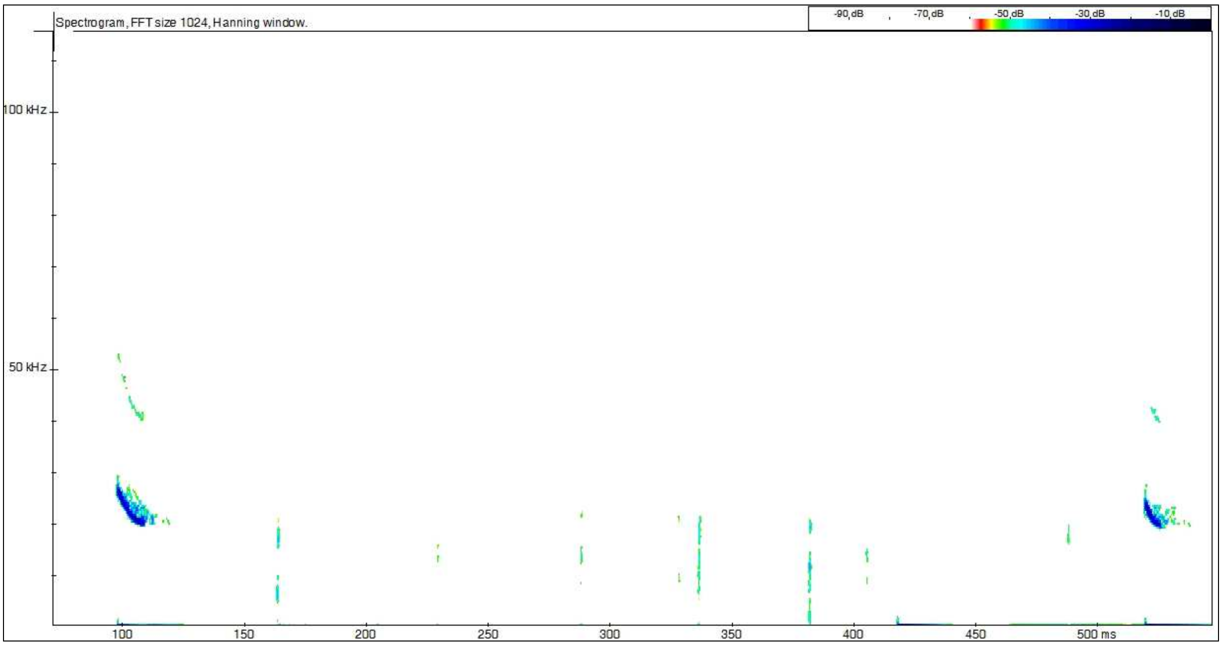


Figure 8: Spectrogram of the only two pulses of the *Tadarida aegyptiaca* (Egyptian free-tailed bat) call recorded by BD5 (Bat Detector 5).

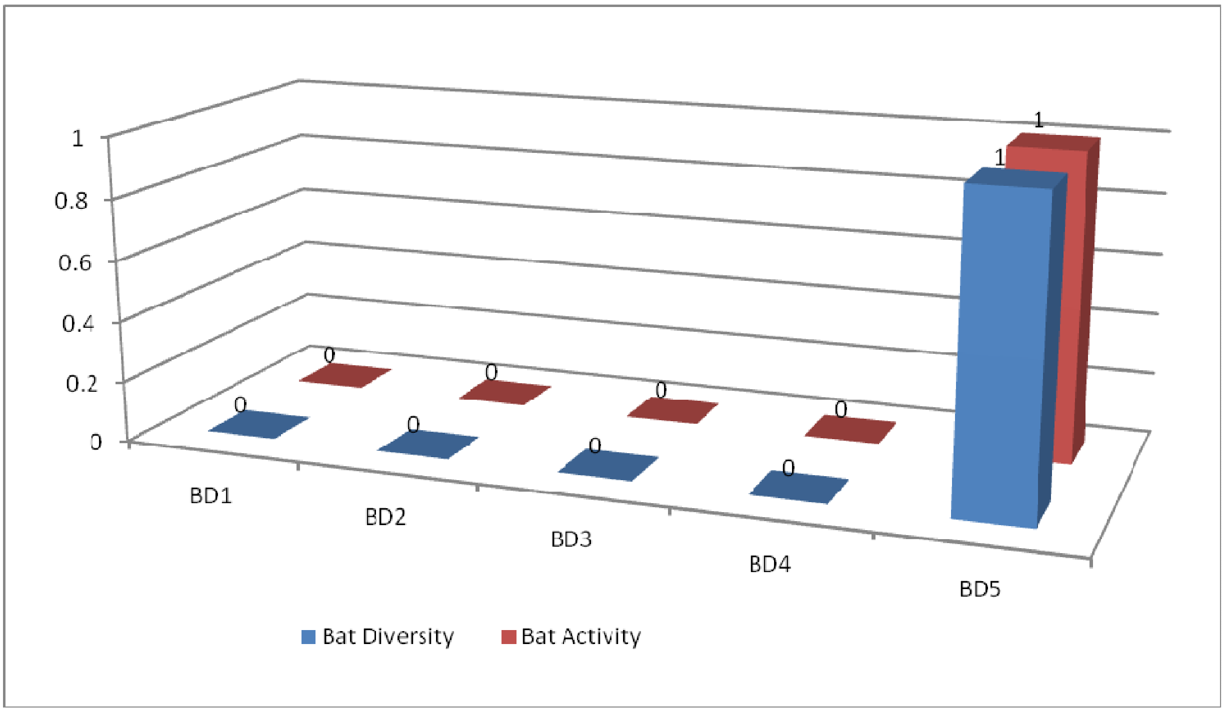
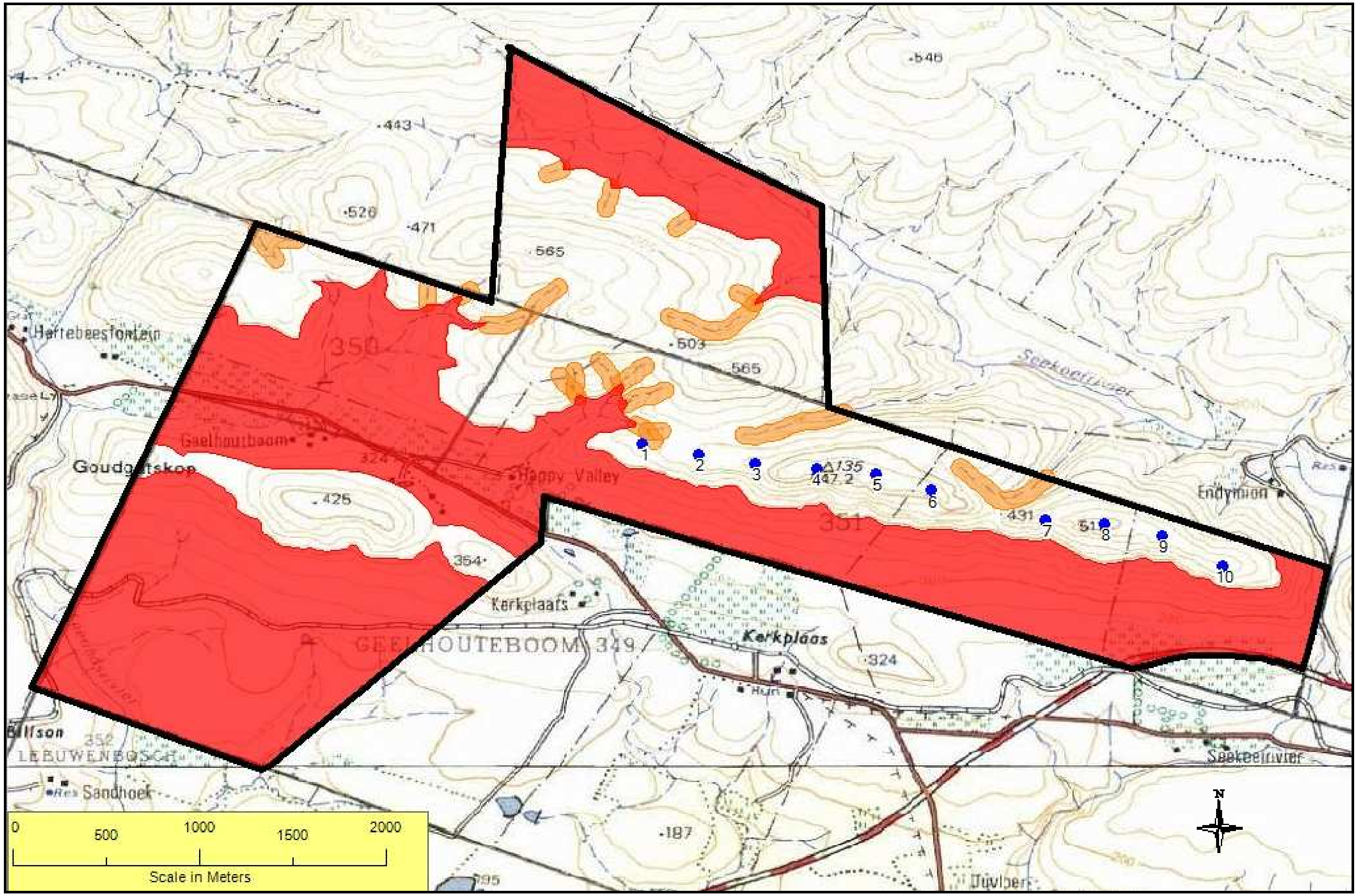


Figure 9: Summary of bat activity and bat diversity at the bat detector sampling localities; only BD5 recorded one occurrence of *Tadarida aegyptiaca* (Egyptian free-tailed bat).

None of the mist nets caught any bats, primarily due to the relatively low bat activity, relatively short sampling time and lack of strategic placement localities in the open terrain of the site.

3.3 Bat sensitivity map



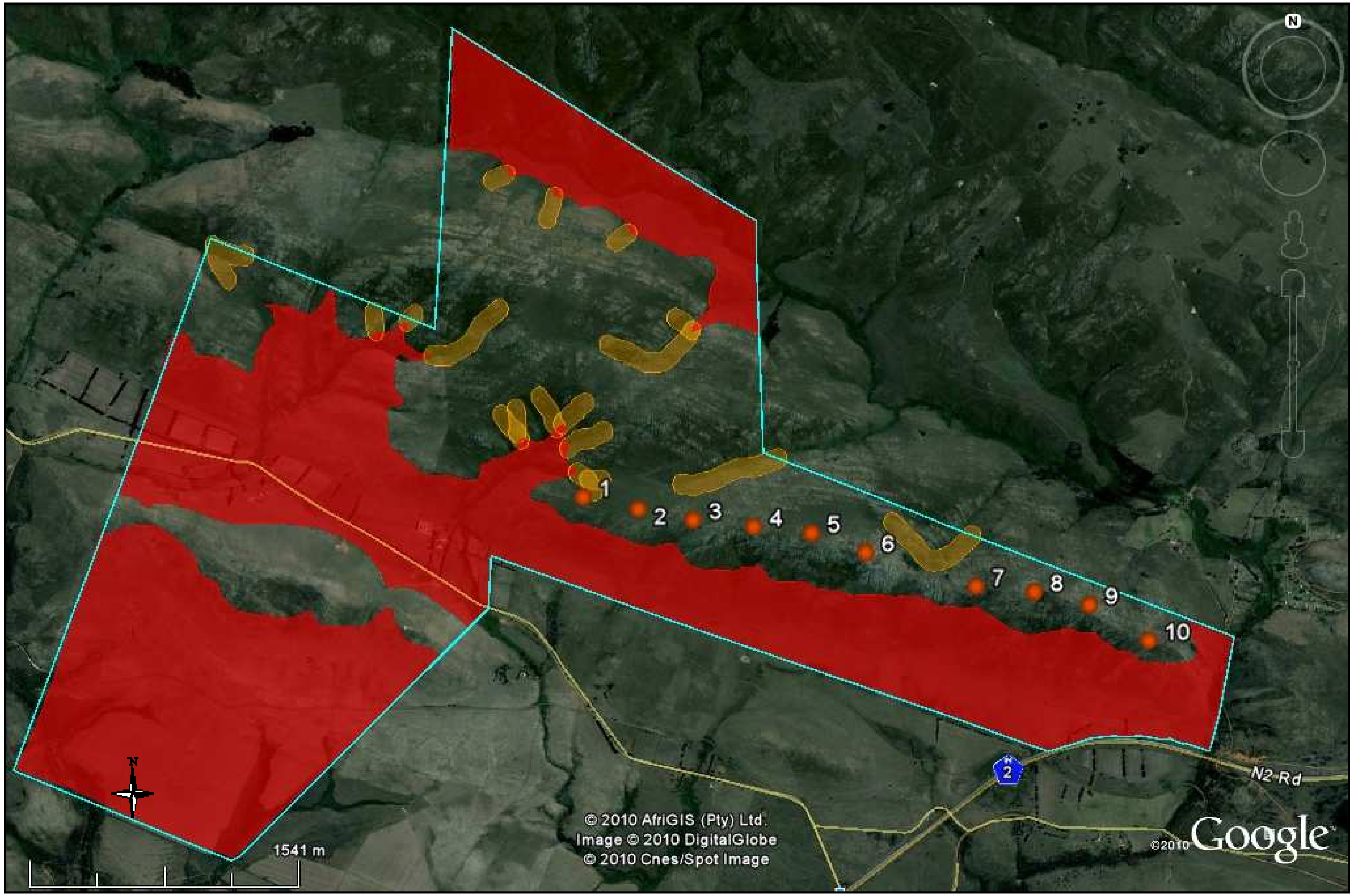
▬ Portion Boundary

● Proposed Turbine Localities

🟥 High Bat Sensitivity

🟧 Moderate Bat Sensitivity

Figure 10: Sensitive areas on the site where the highest bat activity and roosting is expected.



— Portion Boundary
● Proposed Turbine Localities
🟥 High Bat Sensitivity
🟨 Moderate Bat Sensitivity

Figure 11: Satellite image of sensitive areas on the site where the highest bat activity and roosting is expected.

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According to personal field observations and Arnett (June, 2005), bats are known to suppress their activity during periods of rain, low temperatures and strong winds, especially if these factors are combined. Since insect numbers are usually elevated at open water bodies, wetlands and riparian areas, it is logical that insectivorous will prefer to forage over such areas. In this specific case the valleys and lower lying areas provide shelter against strong winds and can support elevated numbers of insects, relative to the high, windy and cold ridges. Additionally bats may find roosting space in the rocks of the steep ridge slopes, and fly down to the valley and flatland areas to forage on a nightly basis.

Therefore the topography of the site was used to designate the valley and ridge slopes as having a High Bat Sensitivity. The areas assigned a Moderate Bat Sensitivity are the drainage channels (**figures 10 & 11**). These areas were designated as such due to their higher likelihood of providing shelter against wind and possibly supporting insects, thereby attracting bats.

Although there are no South African guidelines for the consideration of bats in relation to wind farm developments, however, international guidelines such as the Eurobats Guidance and the Natural England Technical Note (Mitchell-Jones & Carlin 2009) give some indication of buffer zones which may be applicable. The Eurobats Guidance (Rodrigues et al. 2008) proposes a minimum distance of 200m to forest edges where tree felling is necessary to establish a wind farm. The Natural England Interim Guidance suggests a 50 meter buffer from blade tip to the nearest feature important to bats.

For the purpose of this study a buffer of 50 meter is used around the drainage channels. The areas designated as having a High Bat Sensitivity must be treated as sensitive, implicating that no turbines are allowed to be placed in this zone due to the elevated impacts it can have on bat mortalities. Placement of turbines in areas with Moderate Bat Sensitivity should preferably be avoided, if this is not possible such turbines must receive special attention and preference with regards to bat monitoring and implementation of mitigations during the operational phase.

4. IMPACTS OF THE PROPOSED OPERATION and PROPOSED MITIGATION MEASURES AND RECOMMENDATIONS

4.1 Bat mortalities due to blade collisions and barotrauma during foraging

Since bats have highly sophisticated navigation by means of their echolocation, it is puzzling as to why they would get hit by rotating turbine blades. It may be theorized that under natural circumstances their echolocation is designed to track down and pursue smaller insect prey or avoid stationary objects, not primarily focused on unnatural objects moving sideways across the flight path. Apart from physical collisions, a major cause of bat mortality at wind turbines is barotrauma. This is a condition where the lungs of a bat collapse in the low air pressure around the moving blades, causing severe and fatal internal hemorrhage. One study done by Baerwald, *et al*. (2008) showed that 90% of bat fatalities around wind turbines involved internal hemorrhaging consistent with barotrauma.

Some studies propose that bats may be attracted to the large turbine structure as roosting space, or that swarms of insects get trapped in low air pockets around the turbine and subsequently attract bats.

Whatever the reason for bat mortalities around wind turbines, the facts indicate this to be a very serious and concerning problem. During a study by Arnett, et al. (2009), 10 turbines monitored over a period of 3 months showed 124 bat fatalities in South-central Pennsylvania (America), which can cumulatively have a catastrophic long term effect on bat populations, if such a rate is persistent. Most bat species only reproduce once a year, bearing one young per female, meaning their numbers are slow to recover.

Proposed mitigatory measures or recommendations

The correct placement of wind farms and of individual turbines can significantly lessen the impacts on bat fauna in an area. The proposed preliminary turbine placements indicated in figure 10 don't indicate any turbines to be an area of High Bat Sensitivity. The localities of the additional 10 turbines to be added later in the project must not be in the area of High Bat Sensitivity.

During the operational phase curtailment can be implemented as a mitigation measure to lessen bat mortalities, especially at turbines located in areas of Moderate Bat Sensitivity. Curtailment is when a turbine is kept stationary at a very low wind speed and then allowed to rotate once the wind exceeds a specific speed. The theory behind curtailment is that there is a negative correlation between bat activity and wind speed, causing bat activity to decrease as the wind speed increases.

A test done by Baerwald et al. (2008) where they altered the wind speed trigger of 15 turbines at a site with high bat fatalities in south-western Alberta, Canada, during the peak fatality period, showed a reduction of bat fatalities by 60%. Under normal circumstances the turbine would turn slowly in low wind speeds but only starts generating electricity when the wind speed reaches 4 m/s. During the experiment the Vestas V80 type turbines were kept stationary during low wind speeds and only allowed to start turning and generate electricity at a cut-in speed of 5.5 m/s. Another strategy used in the same experiment involved altering blade angles to reduce rotor speed, meaning the blades were near motionless in low wind speeds which resulted in a significant 57.5% reduction in bat fatalities.

Long term field experiments and studies done by Arnett et al. (2010) in Somerset County, Pennsylvania, showed a 44 – 93% reduction in bat fatalities with marginal annual power generation loss, when curtailment was implemented. However, when using a cut-in speed of 6.5 m/s the annual power loss was 3 times higher than when using a 5.0 m/s cut-in speed. Their study concluded that curtailment can be used as an effective mitigation measure to reduce bat fatalities at wind energy facilities.

It is recommended that the curtailment mitigation measure be implemented preferably at all turbines on the site, but at least prioritizing the ones in areas of Moderate Bat Sensitivity, and combined with bat mortality monitoring during the operational phase to quantify the effects of this mitigation. Although the optimum cut-in speed to reduce bat fatalities and keep power loss at a minimum needs to be researched and determined in the local context, a cut-in wind speed of 5.0 m/s to 5.5 m/s (meters per second) is preliminarily recommended.

An ultrasonic deterrent device is a device emitting ultrasonic sound in a broad range that is not audible to humans. The concept behind such devices is to repel bats from wind turbines by creating a disorientating or irritating airspace around the turbine. Research in the field of ultrasonic deterrent devices is progressing and yielding some promising results, although controversy about the effectiveness and a lack of large scale experimental evidence exists.

Nevertheless, a study done by Szewczak & Arnett (2008), who compared bat activity using an acoustic deterrent with bat activity without the deterrent, showed that when ultrasound was broadcasted only 2.5-10.4% of the control activity rate was observed. A lab test done by Spanjer (2006) yielded promising results, and a field test of such devices done by Horn et al. (2008) indicated that many factors are influencing the effectiveness of the device although it did deter bats significantly from turbines.

Due to the lack of knowledge on the impacts of wind farms on bats in the local context, at least one bat monitoring session during the operational phase is highly recommended for this site.

4.2 Bat mortalities due to blade collisions and barotrauma during migration

The migration paths of South African bats in the Eastern Cape Province are virtually unknown. Cave dwelling species like *Miniopterus natalensis* and *Myotis tricolor* undertakes annual migrations, although no caves are known to be in close proximity to the site, and the site is not located in any direct line of path between major caves.

<u>Proposed mitigatory measures or recommendations</u>

Nevertheless, it will be beneficial to collaborate with academic institutions to promote research on the subject, quantifying the risks more accurately.

4.3 Destruction of foraging habitat

Some foraging habitat will be destroyed by the construction of the turbines and associated infrastructure. This impact will be effective during the lifespan of the wind farm.

<u>Proposed mitigatory measures or recommendations</u>

Construction of any associated infrastructure in the areas designated as having a High Bat Sensitivity should be kept to a minimum.

4.4 Destruction of roosts

During the construction phase of the project bat roosts may be significantly impacted by earthworks and large machinery. Diggings related to the placement of underground cables can also damage bat roosts.

<u>Proposed mitigatory measures or recommendations</u>

All diggings and earthworks must be kept to a minimum especially in rocky outcrop areas, and blasting should be avoided.

5. CONCLUSION

Although the sampling time was limited and technically insufficient to quantify the risks completely, and bat activity were overall low, it is still most probable that bat activity will be elevated in the valley, low lying flat land, moist areas and associated drainage. Therefore the sensitivity map presented in **figures 10 & 11** should be strongly adhered to, and no turbines may be placed in the area indicated as having a High Bat Sensitivity. The preliminary localities of the proposed turbines are not in any area of high risk, and any additional turbine localities are not allowed to be placed in the areas of High Bat Sensitivity.

Turbines located in areas of Moderate Bat Sensitivity should preferably be considered to be moved to alternative locations, but if not possible they must at least be prioritized in post construction monitoring and implementation of mitigation measures.

The proposed mitigation measures and recommendations described in Section 4 should be implemented and their practicality and effectiveness researched with high priority at turbines located closest to areas of bat sensitivity. Post construction monitoring of bat fatalities during the operational phase is recommended for at least one study at the proposed wind energy facility on this site.

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(Zoological Science)

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