Specialist Chiroptera (Bat) Sensitivity Assessment

For the Proposed Copperton Wind Energy Facility on Struisbult Farm (Farm No. 103), Northern Cape (Project Nr 106563).

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14 October 2011

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Ref:R-1110-24

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 associated impacts. The assessment aims to identify sensitive areas on the study site where bat activity may be the highest or Red Data and/or endemic species may be found, and recommend applicable mitigation measures and recommendations to minimize negative impacts on bat fauna in the broader area. A brief review of national and international literature on bat-wind farm interactions is also to be included. Assess potential direct, indirect and cumulative impacts and issues foreseen in relation to the proposed wind energy facility and its associated impacts. Impacts considered include foraging impacts, roost impacts and migration impacts.

Appointment of Specialist

Animalia Zoological & Ecological Consultation CC was appointed by Aurecon South Africa (Pty) Ltd to undertake a specialist bat sensitivity assessmentfor the proposed CoppertonWind Energy Facility on portions 4 and 7 of Struisbult farm(No. 103) near Copperton, Northern Cape (Project Nr 106563). The study was carried out by Monika Moir and reviewed and overseen by Werner Marais (CV's available on request).

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; Especially sections 2, 56 & 97).

The act calls for the management and conservation of all biological diversity within South Africa. Bats constitute an important component of South African biodiversity and therefore all species of bats receive attention additional to those listed as Threatened or Protected.

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1. INTRODUCTION

1.1 Study Area

The site of the proposed wind energy facility is distributed over Portions 4 and 7 of Struisbult farm in the Copperton area of Northern Cape. The study area under consideration consists of a total area of approximately 3 000 ha (figure 1 and 2). Both portions of the locality are collectively referred to as the study area. The entire study area falls within the quarter degree square S29E22CD.

The wind turbines are proposed to be relatively evenly spaced and spread over the wind farm. The turbine localities are depicted in figure 3. Plan 8 Infinite Energy(Pty) Ltd is proposing an approximate total of 56 wind turbines with a proposed cumulative generating capacity of approximately 140MW, with associated infrastructure required for such a facility.

The proposed project would consist of three phases constructed over a number of years dependent on Eskom's timelines for purchase of the energy.

The turbine foundations would be approximately 20 m x 20 m and an average of 3 m deep. The foundation would be cast in situ and could be covered with top soil to allow vegetation growth around the 6 m diameter steel tower.

A hardstanding for a crane made of an impermeable material such as concrete or tar and approximately 20 m x 6 m, would be constructed adjacent to each turbine. Access roads of 6 m wide would also be required between each turbine.

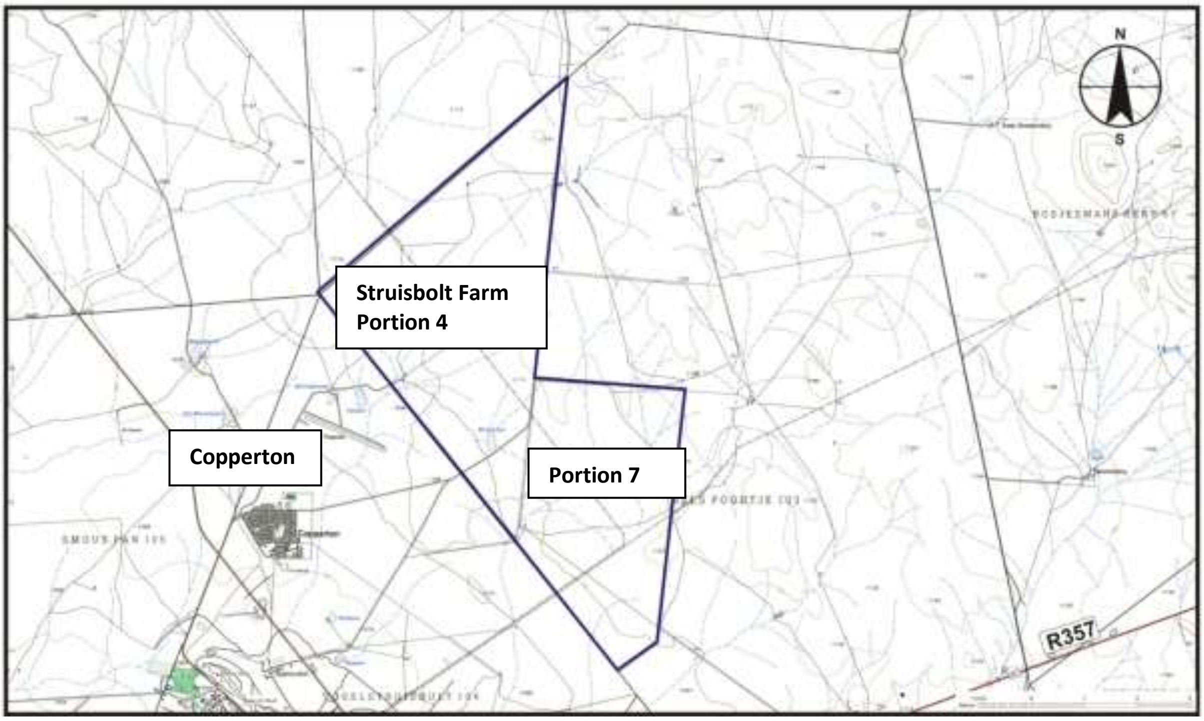


Figure 1: Map depicting the portions of Struisbult Farm in relation to Copperton**.**

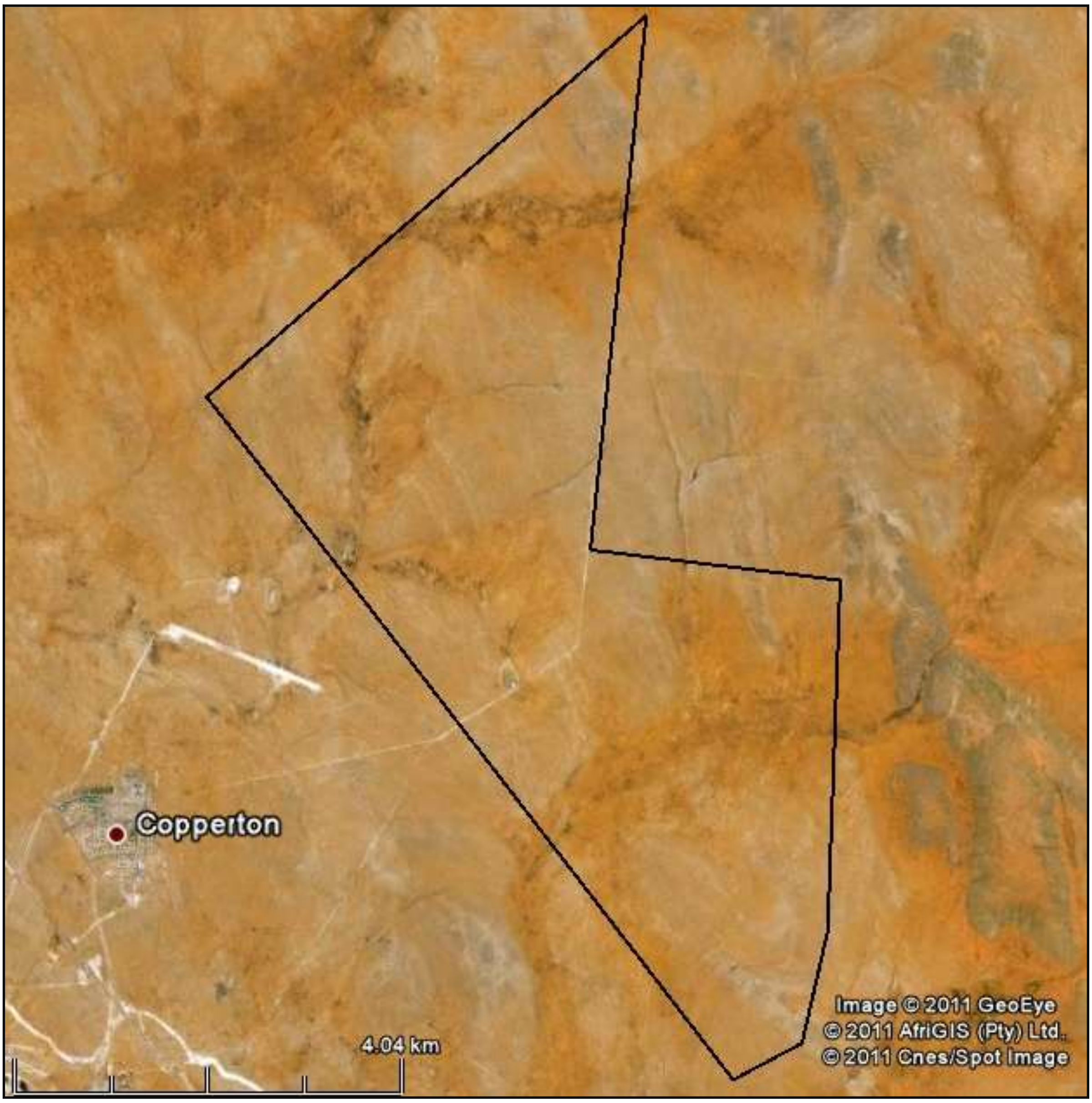


Figure 2: Satellite image of outlined study area (courtesy of Google Earth).

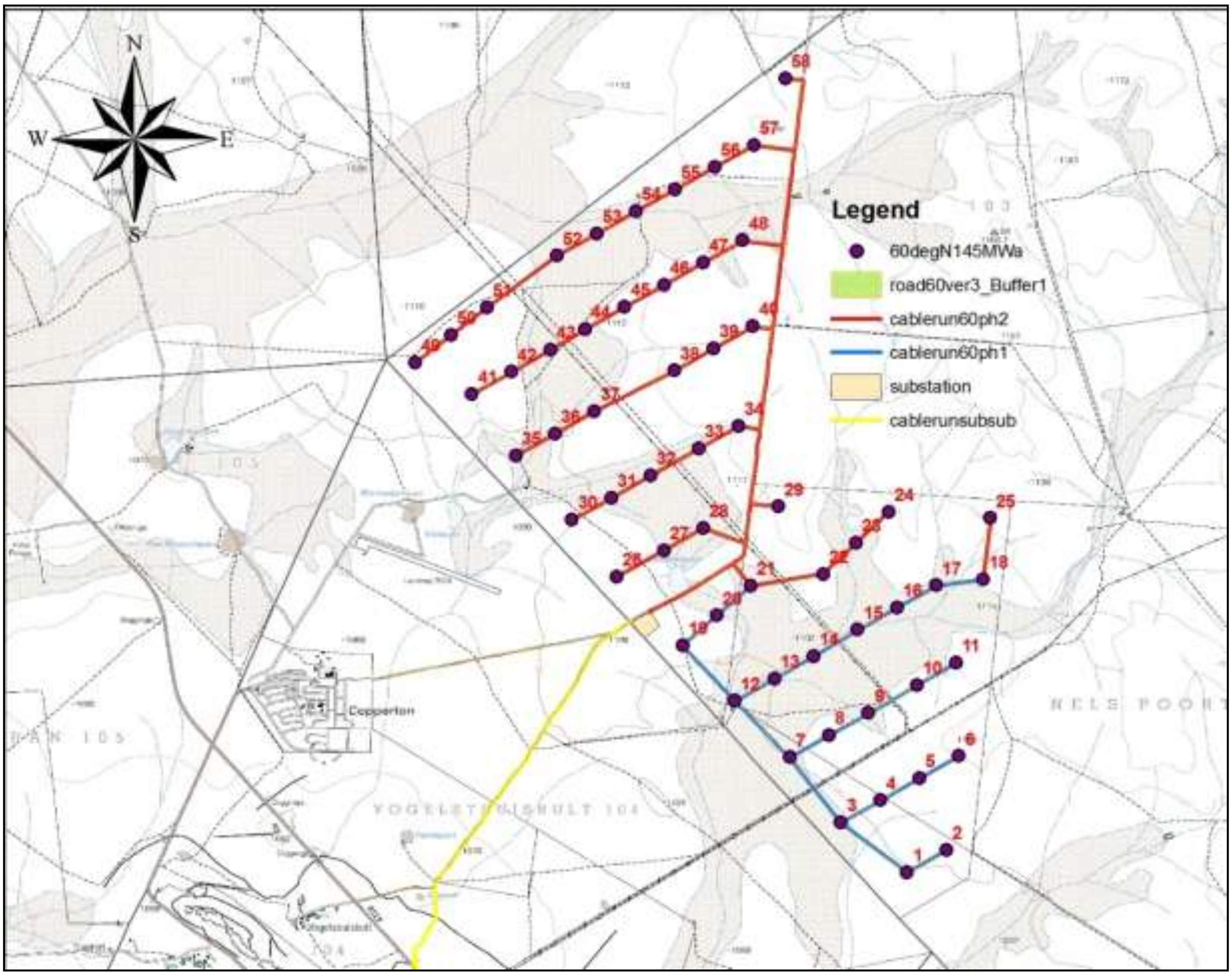


Figure 3: Map depicting the wind turbine positioning and some associated infrastructure.

1.2 Land use and existing impacts on the study area

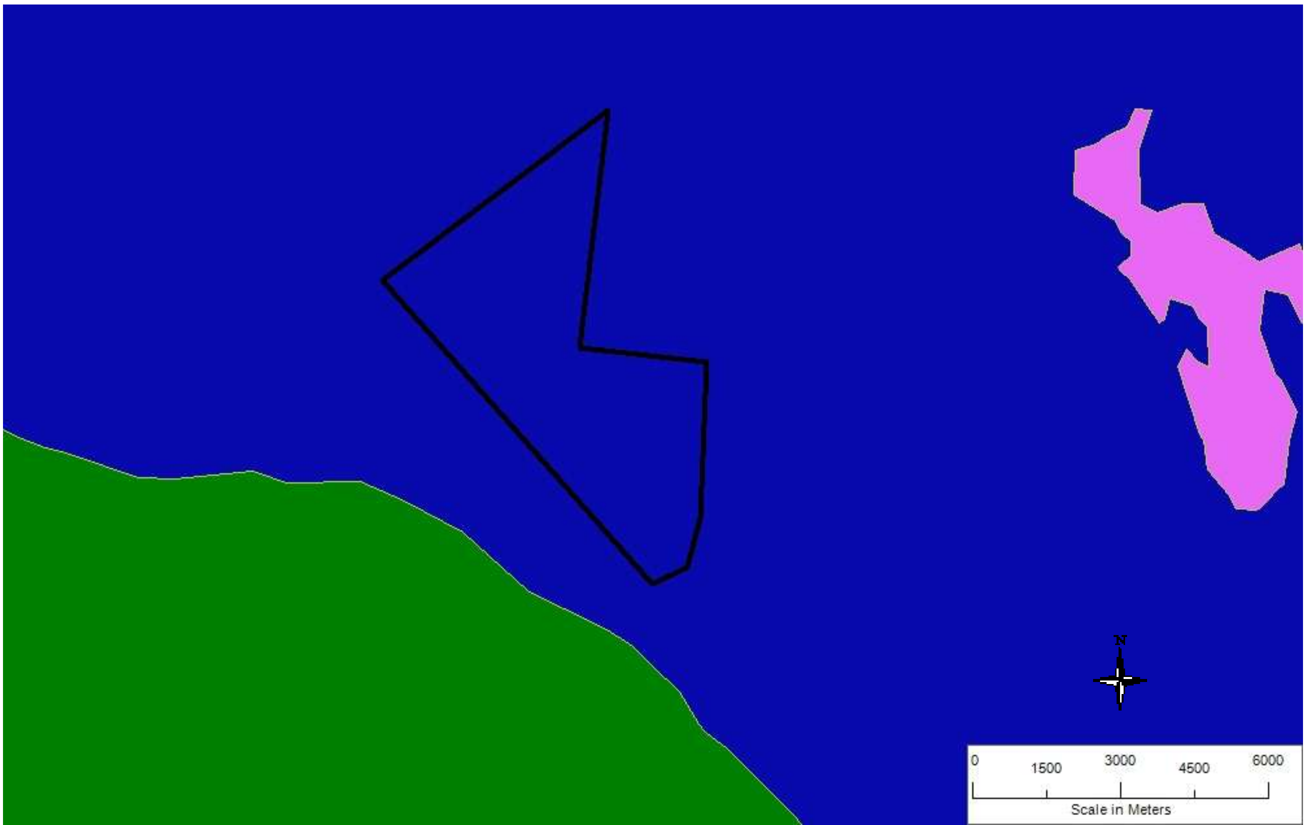
The existing impact on the study area islimited to livestock farming (sheep, cattle and goats) and agricultural practices (olive farming). There are minimal developmental modifications evident on the site, however a number of 132 kV transmission lines cross the site. Grazing activities of livestock is the only pertinent factor impacting natural vegetation, as agriculture is kept to a minimum. Although the siteprovides suitable foraging habitat for bats, available roosting sitesmay be limited to buildings, large trees and some rocky habitats in the general larger area.However there is an abundance of roosting sites within the Copperton town found in close proximity to the farm perimeter, such that the farm may be easily accessible to the bats resident to these roosts.

1.3 Vegetation, geology and climate of site

The study area is within the Nama-Karoo biome (figure 4) characterised by Bushmanland Arid Grassland vegetation and relatively flat topography, with almost no high ridges present. The Bushmanland Arid Grasslandvegetation type is considered to be Least Threatened, however only less than 1% of this vegetation type is currently protected in South Africa. Tussock grasses and dwarf shrubland dominate this vegetation type with no endemic plants present (figure 5). Shallow lime-rich soils support the plant life and underneath the soil are the Ecca and Beaufort groups.The study siteoccurs ina typical semi-desert and desert area. Thus the summers are hotand dry with an average daily maximum of 36°C, while winters are icy cold with an averagedaily minimum of 4°C. The average annual rainfall is 189 mm with peaks in late autumn and early summer, but varies considerably from year to year (Mucina& Rutherford, 2006).

The Bushmanland Basin Shrubland is close to the site towards the south west. This unit close to the site has slightly irregular plains and no major rock outcrops or valleys. Rainfall occurs in late summer and early autumn with an average annually of 100-200mm.

A small portion of Lower Gariep Broken Veld occurs to the east of the site. This unit has hills and low mountains and some rugged terrain (Mucina& Rutherford, 2006), rocky outcrops are common and can provide roosting space for bats.



Bushmanland Arid Grassland
Bushmanland Basin Shrubland
Lower Gariep Broken Veld

Figure 4: Map showing the vegetation units in relation to the study site (black outline).

Figure 5: Picture depicting the vegetation and general topography of Struisbult Farm

1.4 The bats of South Africa

Bats are mammals of the order Chiroptera, and are the second largest group of mammals following the rodents. There are approximately 117 bat species 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 alone (Taylor, 2000; Monadjem*et al.*, 2010).

Bats are the only mammals to have developed true powered flight and they have undergone various skeletal changes in an effort to be more efficient and economical in flight. The forelimbs are highly 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 an effort to adapt the wing shape for different flight conditions while maximizing agility and manoeuvrability. This adaptability and versatility of the bat wing surpasses the more static design of the bird wings thus enabling bats to utilise a wider variety of food sources and diversity of insect groups (Neuweiler, 2000). The facial characteristics amongst species may differ considerably to satisfy the requirements of their life style, with regard to their feeding and echolocatory navigation strategies. The majority of South African bats are insectivorous, and can consume vast numbers of insects on a nightly basis (Taylor, 2000; Tuttle & Hensley, 2001), but they may feed on 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 insect numbers. Their prey also includes agricultural insect pests (such as moths) and disease vectors(such as mosquitoes) (Rautenbach, 1982; Taylor, 2000).

Urban development and agricultural practices have contributed to the decline in bat abundance. Public participation and funding of bat conservation projects are often hindered by the negative connotations associated with bats which are created purely by misunderstanding and a lack of knowledge. The fact that some species roost in domestic residences contributes to the negative standing of bats with humans. Some species may occur in large numbers in buildings; they then pose a health risk to the residents and tend to be an annoyance. Unfortunately, the negative feelings people have towards bats, obscure the fact that they are an essential component of the ecology and by enlarge beneficial to humans.

Many bat species roost in large aggregations and concentrate in small areas. Therefore any major disturbance to that area will adversely impact whole populations (Hester &Grenier, 2005). Secondly, the reproductive rates of bats are much lower than those of most other small mammals; 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. This longevity and relatively low predation rates would ensure a stable population size under natural circumstances.However, the rate of recovery of bat populations from major anthropogenic disturbances,such as major die-offs and roost disturbances would be stunted and slow taking years to once again attain equilibrium.

1.5 Bats and wind turbines

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. A study done by Arnett (2005) recorded a total of 398 and 262 bat fatalities were found during searches at Mountaineer Wind Energy Center in Tucker County, near Thomas, West Virginia, and at the Meyersdale Wind Energy Center in Somerset County near Meyersdale, Pennsylvania, respectively. This was during a 6-week study period from 31 July 2004 to 13 September 2004.

Some studies (Horn *et al.*, 2008) suggests that bats may be attracted to the large turbine structure as roosting space, and popular believe indicates 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. Mitigation measures are being researched and experimented with globally, but are still only effective on a small scale. An exception to this is a mitigation measure called curtailment, where the turbine cut-in speed is raised to a higher wind speed. This relies on the principle that bats will be less active in strong winds due to the fact that their insect food can't fly in strong wind speeds, and the small insectivorous bat species need to use more energy to fly in strong winds. Therefore they are less likely to be impacted by a fast moving turbine blade than a slow moving blade, however this mitigation is not as effective yet to move this threat to a category of low concern.

2. METHODS

The site was visited on the 9th and 10th of September 2011. The site was inspected during the day for any possible roosting sites. At dusk and during the night, the sky was monitored for visual observation of bats and bat activity. Mist nets (figure 6) were erected at strategic positions of the farm for physical detection and identification of bat species present in the area. The main method of bat detection involved the use of a bat detector to record bat echolocation calls on a continuous basis throughout most of the night while traversing the study area. Only sections of the farm that were accessible by vehicle were traversed .

A bat detector (figure 7) is a device capable of detecting and recording the ultrasonic echolocation calls of bats which may then beanalyzed with the use of computer software. A time expansion type bat detector effectively slows an ultrasonic bat call down 10 times such that bat calls become audible to the human ear, but still retains all of the harmonics and characteristics of the call. Although this type of bat detection equipment is the most advanced technology that is currently commercially available, it is not necessarily possible to identify all bat species by just their echolocation calls. Recordings may be affected by the weather conditions (i.e. humidity); openness of the terrain and the range of detecting a bat is dependent on the volume of the bat call.

Figure 6: Erected mist net

Figure 7: A Time expansion type bat detector connected to a laptop

3. RESULTS

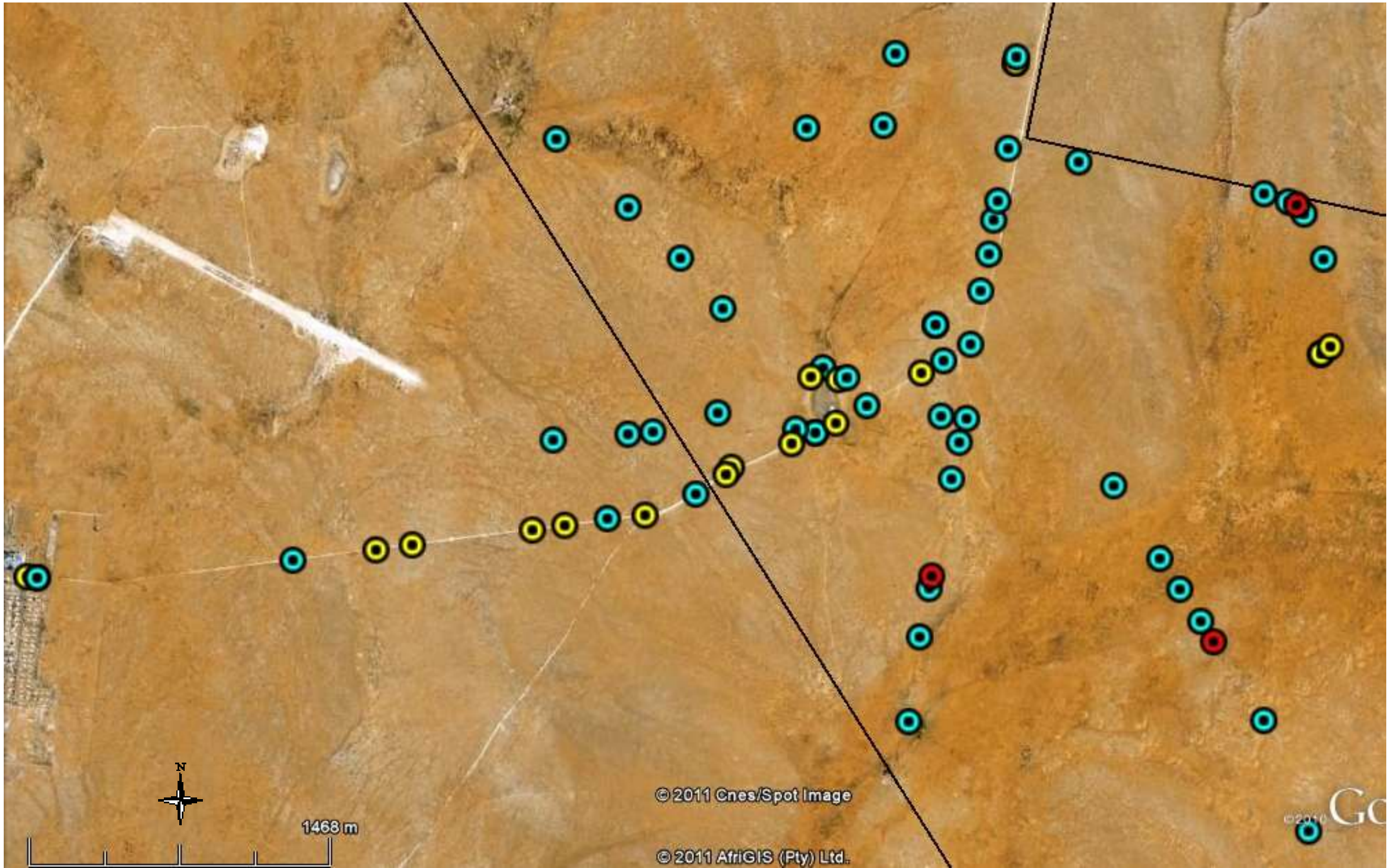
3.1 Species probability of occurrence

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

Species Name	Common Name	Probability of Occurence	Conservation status	Echolocation call	Possible Roosting Sites Occupied in Study Area	Foraging Habits (indicative of possible foraging sites in study area)
Rhinolophus clivosus	Geoffroy's horseshoe bat	Low	LC	High peak frequency 91.7±1 kHz, long duration 37.4±6.2 ms	Caves and mine adits (an almost horizontal entrance to a mine) in arid savanna, woodland,riparian forest and mountainous areas.	Clutter forager
Rhinolophus darlingi	Darling's horseshoe bat	Low	LC	High peak frequency 87.1±2.1 kHz, long duration 39.5±10.6 ms	Caves and mine adits, culverts or in cavities in piles of boulders, is associated with arid savanna in the west and broken, hilly terrain.	Clutter forager
Rhinolophus denti	Dent's horseshoe bat	Low	Data deficient	High peak frequency 111.2±1.8 kHz, long duration 23.4±4 ms	Caves, semi-dark caverns and crevices in rocky outcrops. Roost under the thatched roofs and in a road culvert. Is associated with arid habitats, typically restricted tobroken country with rocky outcrops or suitable caves.	Clutter forager
Nycteris thebaica	Egyptian slit-faced bat	High	LC	High main peak frequency 90±1.3 kHz, short duration 1.7±0.5 ms	Tree trunks, caves, culverts. It appears to occur throughout the savanna and karoo biomes, butavoids open grasslands.	Forages by flying low above the ground

Sauromys petrophilus	Roberts's flat-headed bat	**Confirmed**	LC	Low peak frequency 29.9±1.8 kHz, intermediate duration 5.3±2.5 ms	Roosts in narrow cracks and under slabs of exfoliating rock. Closely associated with rocky habitats in drywoodland, mountain fynbos or arid scrub.	Open-air forager
Tadarida aegyptiaca	Egyptian free-tailed bat	**Confirmed**	LC	Low peak frequency 22.7±2.2 kHz, long duration 9.6±3.4 ms	Caves, rock crevices, under exfoliating rocks, in hollow trees, and behind the bark of dead trees.	Fly well above the canopy of the vegetation. Open air.
Miniopterus natalensis	Natal long-fingered bat	Low	LC	Intermediate peak 49.7±1.0 kHz, intermediate duration 5.3±0.8 ms	Savannas and grasslands, cave dependent.	Clutter-edge forager
Cistugo seabrae	Angolan wing-gland bat	Medium	NT	Intermediate peak frequency 47±1.8 kHz short duration 3.1±0.7 ms	Typically in desert and semi-desert conditions.	Clutter-edge forager
Eptesicus hottentotus	Long-tailed serotine bat	Low - medium	LC	Intermediate peak frequency 30.6±1.7 kHz, intermediate duration 5.5±2.1 ms	Caves and rock crevices, may require suitable roosting sites in rocky outcrops.	Clutter-edge forager
Myotis tricolor	Temmink'smyotis bat	Low	LC	Intermediate peak frequency 47.8±3.1 kHz, short duration 3.3±0.6 ms	Roosts gregariously in caves, close association withmountainous areas.	Clutter-edge forager
Neoromicia capensis	Cape serotine bat	**Confirmed**	LC	Intermediate peak frequency 39.4±1.6 kHz, intermediate duration 5.1±1.3 ms	Under the bark of trees, at the base of aloe leaves, tolerates arid semi-desert areas to montane grasslands.	Clutter-edge forager
Chaerephon nigeriae	Nigerian free-tailed bat	Low	LC	Low peak frequency 17 kHz, long duration 10 ms	Roosts beneath the bark of dead trees, in small caves and buildings.	Open-air forager

3.2 Bat detection



Tadarida aegyptiaca *Neormicia capensis* *Sauromys petrophilus*

Figure 8: Overview of bat species and activity detected on the site.

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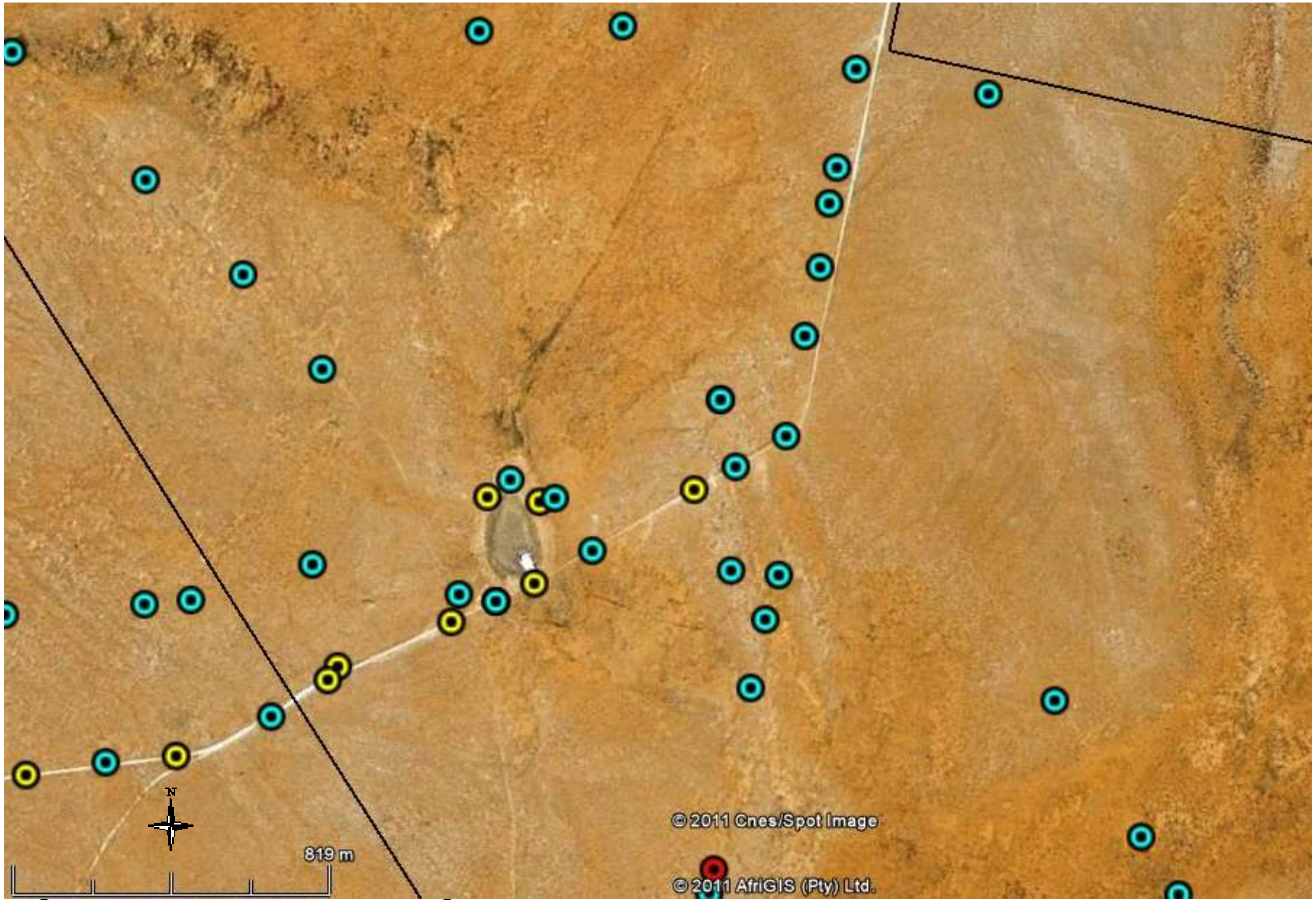


Tadarida aegyptiaca *Neormicia capensis*
Sauromys petrophilus

Figure 9: Bat species and activity detected in the central part of the site, indicating activity around the pan.

Numerous bat calls were recorded on the roads within the site (Figures 8&9). From the distribution of the calls it is possiblethat bats may alsobe present at some of the areas of the site that were not accessible by means of roads, but the distribution model of bat activity suggests that it is possible for *T. aegyptiaca* and *N. capensis* to be roosting in the town of Copperton and utilise the areas of the site closest to the town as part of their foraging range. Recordings of bat calls were made on the premises of housing within the Copperton town; these bats too would be affected by the construction and operation of the wind energy facility since it is possible for them to utilise the site as part of their foraging range.

A bat call consists of a series of ultrasonic sound pulses, with each species calling at a characteristic sound frequency (figure 10). It is used for navigational and hunting purposes, comparable to but more sophisticated than modern sonar. Pulses within a bat call may also vary by means of their sound frequency and characteristics, although this variation is within a certain range restricted to a specific 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 is the most commonly used parameter. The dominant frequencies of the three loudest pulses recorded were chosen since the loudest pulse is produced when the bat is in close proximity to the bat detector, limiting the ramifications the Doppler Effect has on the results of sound waves emitted by a moving bat. A feeding buzz is the common term used to describe the change in echolocation call when a bat is approaching its prey. A feeding buzz is a series of very short pulses that dramatically become more rapid as the bat is closing in on the insect prey, giving it a clear image of the prey. A feeding buzz is proof of bats actively foraging. Species identification with the use of echolocation is less accurate when compared to morphological identification, nevertheless it is a very certain and accurate indication of bat activity and their presence.

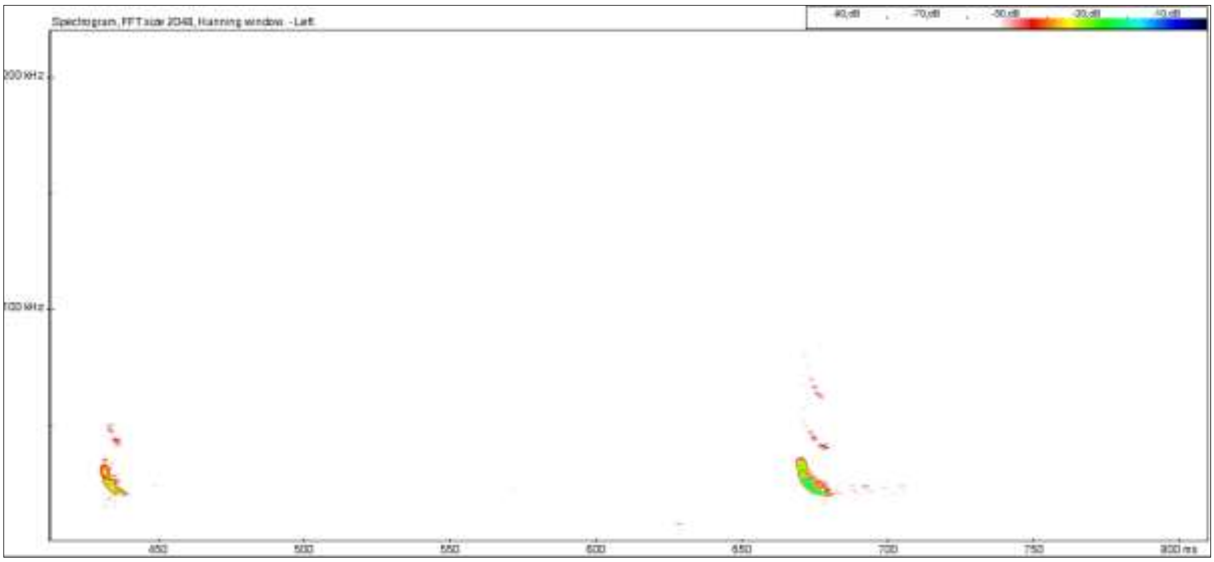
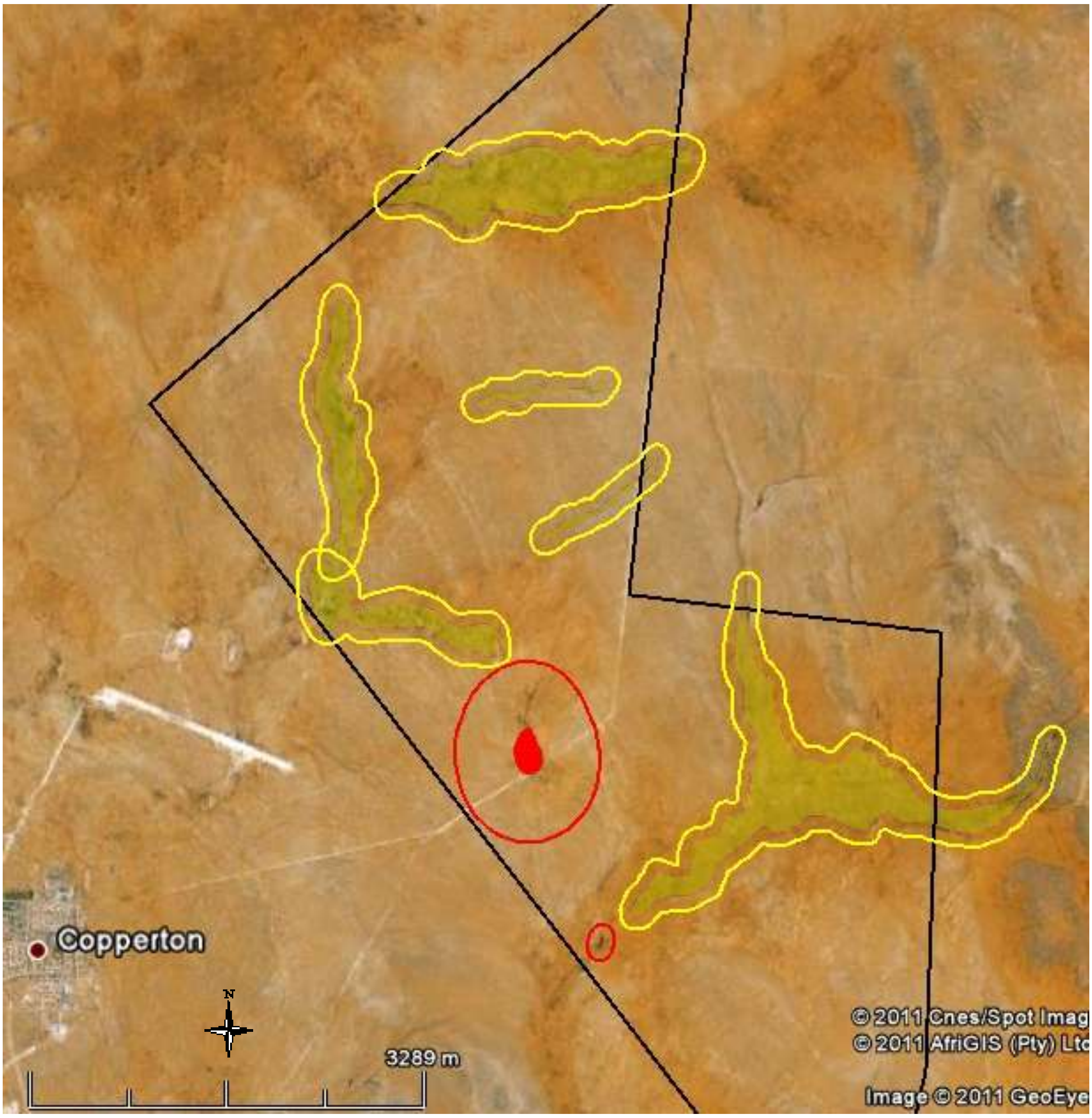


Figure 10: Spectrogram of pulses from *Tadarida aegyptiaca*(Egyptian Free-tailed bat) call.

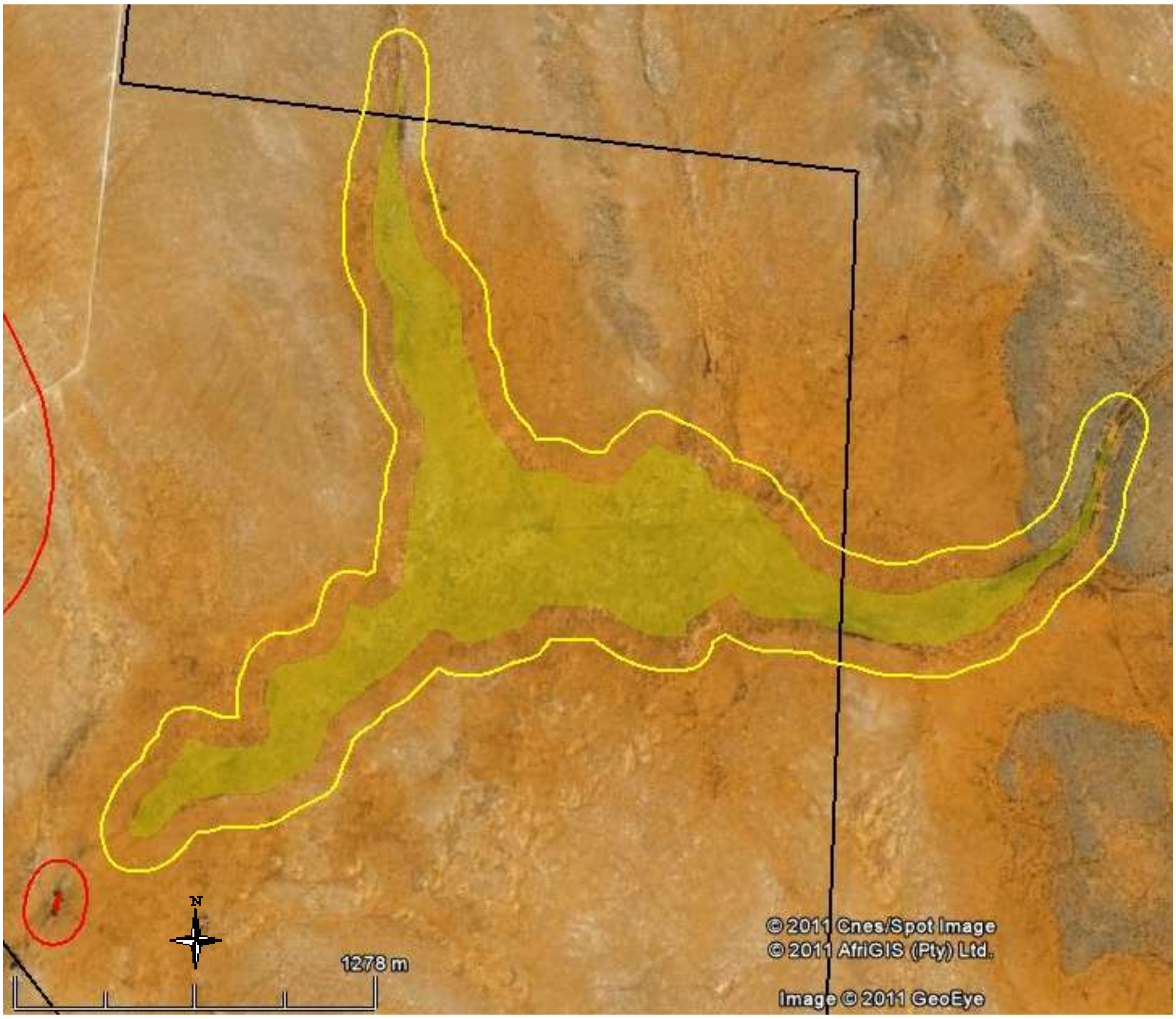
3.3 Sensitivity map



Site Boundary — *High Sensitivity* — *Moderate Sensitivity*

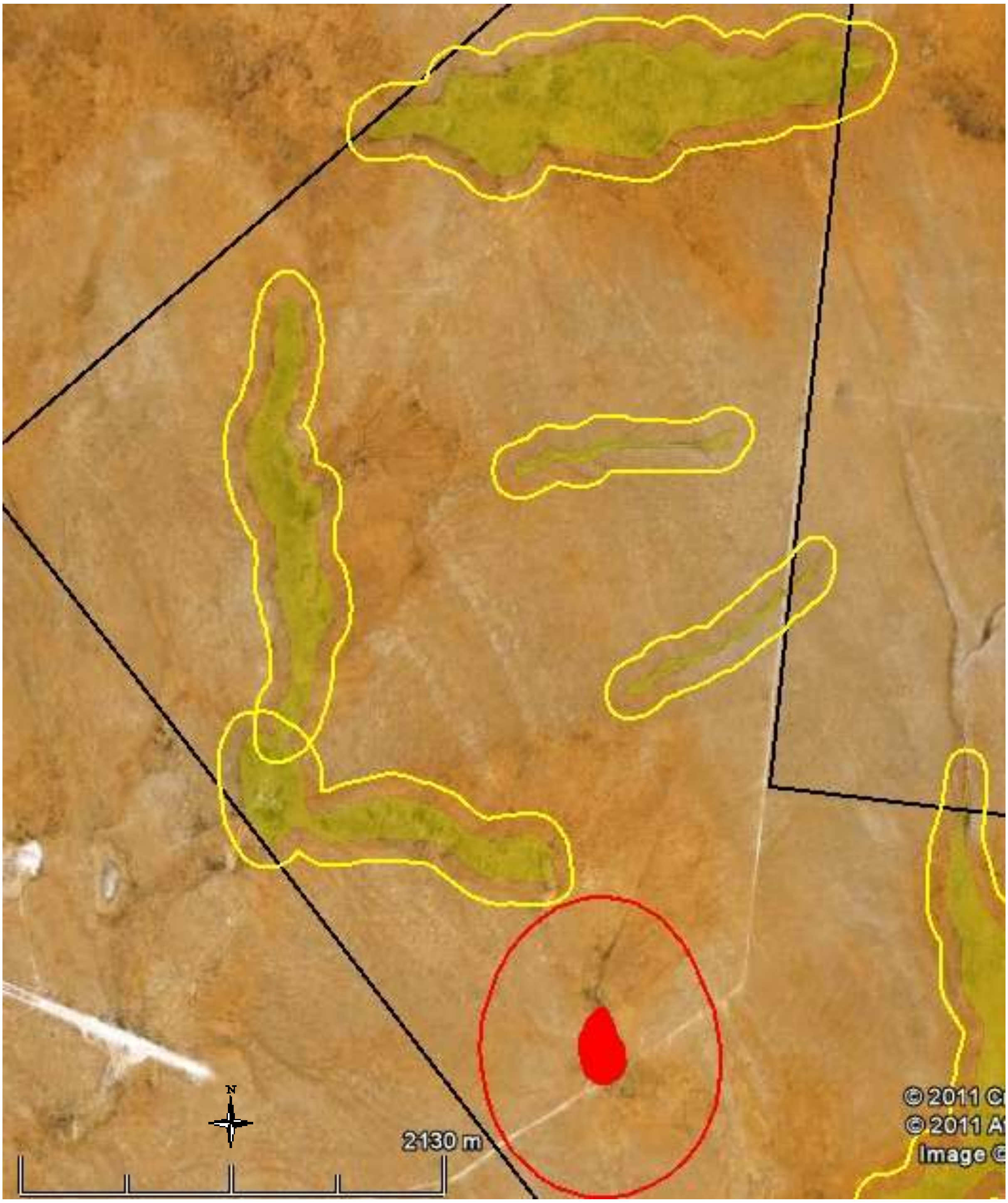
High Sensitivity Buffer — *Moderate Sensitivity Buffer*

Figure 11: Sensitivity map for Copperton site.



Site Boundary *High Sensitivity* *Moderate Sensitivity*
High Sensitivity Buffer *Moderate Sensitivity Buffer*

Figure 12: Sensitivity for Portion 4 of Struisbult, the building with its large trees have been assigned a High Sensitivity a 100 meter buffer, in the far lower left corner of this image.



Site Boundary | High Sensitivity | Moderate Sensitivity
High Sensitivity Buffer | Moderate Sensitivity Buffer

Figure 13: Sensitivity for Portion 7 of Struisbult, the only source of definite seasonal open surface water has been assigned a High Sensitivity and a 500 meter buffer.

The sensitivity maps indicated by Figures 11 - 13are based on the bat activity detected with the use of the bat detector as well as the probability of certain areas and features to be used as foraging space and roosting sites.

Any structure on the site such as buildings and large trees (either singly or in clusters) are probable to be used as roosting structures for the Cape serotine bat (*Neoromicia capensis*) and the buildings for Egyptian free-tailed bat (*Tadarida aegyptiaca*). Both species were found to be common in the study area. Robert’s flat-headed bat (*Sauromys petrophilus*) was also confirmed to be present within the site; this species makes use of cracks within rocks and areas below exfoliating rock slabs for roosting areas and are probably roosting somewhere in the larger area around the site. Water bodies and small seasonal streams offer valuable foraging terrain for bats in the area. Insects tend to be more abundant at open surface water and would therefore attract insectivorous bats on a nightly basis, and additionally the abovementioned species also need water to drink.

Although there are no South African guidelines for the consideration of specific buffer distances with regards to bats and wind farm developments, international guidelines such as the Eurobats Guidance and Natural England Technical Note (Mitchell-Jones & Carlin, 2009) give some indication of buffer zones which may be applicable. The Natural England Interim Guidance suggests a 50 meter buffer zone from blade tip to the nearest feature important to bats. Thepossibleroosting structures at the farm residence and it's large trees have been assigned a high sensitivity and 100m buffer, the only source of definite seasonal open surface water have been assigned a high sensitivity and 500 m buffer. Last mentionedhave been done so to accommodate the probable concentration of bats that will be found around the water body during the wetter season, and additionally this water body is close to the town of Copperton where most of the bats may be roosting. Possible foraging areaswhere more moisture may be accumulated during the wet season have been assigned a moderate sensitivity and a 100 meter buffer.

4. FORESEEN IMPACTS OF THE PROPOSED OPERATION and PROPOSED MITIGATION MEASURES

4.1 Bat mortalities due to blade collisions and barotrauma during foraging

In section 1.5 the concern of bats and possible wind turbine blade collisions/barotrauma have been discussed, however international research has been unable to propose sustainable large scale mitigation measures that can downgrade this threat to a category of very low concern.

Proposed mitigatory measures or recommendations

The correct placement of wind farms and of individual turbines can significantly lessen the impacts on bat fauna in the planned area, the sensitivity map (Figures 10 - 12) should be adhered to.

During the operational phase curtailment can be implemented as a mitigation measure to lessen bat mortalities. 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 strongly recommended that the curtailment mitigation measure be implemented at all turbines on the site, prioritizing the turbines proposed to be within the moderate sensitivity areas. Light bat mortality monitoring during the operational phase to quantify the effects of this mitigation will help to refine the method. 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 by means of long term studies in the general area, 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.

It may be feasible to install such devices on selected functional turbines, and the results being monitored by an appropriately qualified researcher.

Nature of Impact: Bat mortalities due to wind turbine blade collisions and barotrauma during foraging (operational phase)		
	Without mitigation	**With mitigation**
Extent	High (5)	High (5)
Duration	Long term (4)	Long term (4)
Magnitude	High (6)	Low (3)
Probability	Highly Probable (4)	Probable (3)
Significance	**60 (Medium)**	**36 (Medium)**
Status (positive or negative)	Negative	Negative
Reversibility	None	Medium
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	
Mitigation: See Section 4.1		
Cumulative impacts: Bat populations are slow to recover to equilibrium numbers once major mortalities take place. If the mortalities due to blade collisions are allowed to continue without mitigation for a long period of time, the mortality rate is highly likely to exceed the reproductive rates of local bat populations, causing a high cumulative impact.		
Residual Impacts: If bat numbers rapidly decline it will take years for the populations to recover and restore their original size. Throughout this period the insect numbers within the area and surrounding Copperton town will elevate to such a point that they may become serious pests and medical issues may arise.		

4.2 Bat mortalities due to blade collisions and barotrauma during migration

The migration paths of South African bats in the Northern Cape Province are not well studied and are virtually unknown. Cave dwelling species such *Miniopterus natalensis* and *Myotis tricolor* undertake annual migrations between caves. However, no caves are known to be in close proximity to the study area, and it is not located within any known direct line of path between major caves such that the threat to migrating bats becomes nominal.

<u>Suggested Terms of Reference for assessing/addressing the issue</u>

It will be beneficial to collaborate with academic institutions to promote research on the subject, doing affordable long term monitoring and quantifying the risks more accurately to effectively fine tune mitigation.

<table>
<tr><td colspan="3">Nature of Impact: Bat mortalities due to turbine blade collisions and barotrauma during migration (operational phase)</td></tr>
<tr><td></td><td>Without mitigation</td><td>With mitigation</td></tr>
<tr><td>Extent</td><td>Medium (3)</td><td>Low (2)</td></tr>
<tr><td>Duration</td><td>Long-term (4)</td><td>Long-term (4)</td></tr>
<tr><td>Magnitude</td><td>Moderate (6)</td><td>Low (3)</td></tr>
<tr><td>Probability</td><td>Highly probable (4)</td><td>Probable (3)</td></tr>
<tr><td>Significance</td><td>52 (Medium)</td><td>27 (Low)</td></tr>
<tr><td>Status (positive or negative)</td><td>Negative</td><td>Negative</td></tr>
<tr><td>Reversibility</td><td>None</td><td>Medium</td></tr>
<tr><td>Irreplaceable loss of resources?</td><td>Yes</td><td>No</td></tr>
<tr><td>Can impacts be mitigated?</td><td>Yes</td><td></td></tr>
<tr><td colspan="3">Mitigation: See Section 4.2</td></tr>
<tr><td colspan="3">Cumulative impacts: Events of mass mortalities resulting in population crashes will disrupt bat numbers for many years as they have low reproductive rates. If these events are allowed to continue for a long period of time without mitigation, the mortality rate is highly likely to exceed the reproductive rates of the impacted bat populations, resulting in a high cumulative impact. Migrating bats have been recorded to migrate several hundred kilometres in South Africa, such that the cumulative impact of several wind farms along migration routes operating without mitigation will be catastrophic to the population sizes of these migrating bats. Mitigation is of uttermost importance. The proposed Mainstream WEF close to Prieska may have a Low significance on the cumulative impacts on bats, unless it is also situated within a migration path. The EIA and monitoring for the proposed Mainstream WEF close to Prieska will have to confirm whether the cumulative impact will be low.</td></tr>
<tr><td colspan="3">Residual Impacts: If bat numbers rapidly decline it will take years for the populations to recover and restore their original size. Throughout this period the insect numbers within the area and surrounding areas will elevate to such a point that they may become serious pests and medical issues may arise. If migrating bat populations are negatively impacted, the residual impacts will be regional.</td></tr>
</table>

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 throughout the lifespan of the wind farm.

Suggested Terms of Reference for assessing/addressing the issue

Construction of any turbines in the areas designated as having a High Bat Sensitivity should be avoided.

Nature of Impact: Destruction of foraging habitat due to turbine and infrastructure construction (during construction phase, operational phase and decommissioning).		
	Without mitigation	**With mitigation**
Extent	Low (1)	Low (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Low (4)	Low (3)
Probability	Highly probable (4)	Highly probable (4)
Significance	**32 (Medium)**	**28 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	None	None
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes, turbine placement	
Mitigation: See Section 4.3		
Cumulative impacts: None		
Residual Impacts: Small areas of natural vegetation and foraging habitat will be replaced by infrastructure and turbines for the duration of the project and after decommissioning, until the area becomes sufficiently rehabilitated.		

4.4 Destruction of roosts

During the construction phase of the project, bat roosts can be negatively impacted by earthworks and large machinery, although highly unlikely. Diggings related to the placement of underground cables can also damage bat roosts. However, the study area does not have any major rocky outcrops or known underground roosts.

Nature of Impact: Destruction/disturbance of roosts (construction and decommissioning phases).		
	Without mitigation	**With mitigation**
Extent	Low (1)	Low (1)
Duration	Very short duration (1)	Very short duration (1)

Magnitude	Minor (2)	Small (2)
Probability	Probable (3)	Improbable (2)
Significance	**12 (Low)**	**8 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	High
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	
Mitigation: See Section 4.4		
Cumulative impacts: None		
Residual Impacts: Once a specific natural roost is destroyed it can't be rehabilitated with high success. Roost disturbances will not have a significant residual impact if the disturbance is of a short duration.		

5. CONCLUSION

At least three species were considered to be common on site. The species confirmed to be present in the study area, as well as the species with a high probability of occurrence, are of Least Concern conservation status. It is probable that the majority of bats detected on the site are roosting within the Copperton town, and utilises the close parts of the site as part of their foraging habitat.

The potential impacts on bats were considered to be of Low significance without mitigation and Medium - High significance with mitigation. Areas identified on the sensitivity map indicated in Figures 10 - 12 should be avoided and no turbines are allowed to be placed within the areas designated as having a high sensitivity and their associated buffers. Turbines may be allowed inside the areas of moderate sensitivity but these turbines should receive special attention and priority when mitigation measures are implemented or when post construction monitoring is done. The recommended mitigation measures discussed in Section 4 must be followed and if not practical a suitable bat specialist should be consulted, and the mitigation measure of curtailment should be implemented on all turbines on the site, prioritising those within areas of moderate sensitivity. For curtailment a cut-in wind speed of 5.0 m/s to 5.5 m/s (meters per second) is preliminarily recommended. To determine the correct cut in speed and whether the site falls within a bat migration route, 12 month long term monitoring (preferably prior to construction) must be done where bat detectors are deployed on the site and passively recording bat activity every night. Additionally the site needs to be visited by a bat specialist quarterly (4 times during the period) to assess and compare the bat activity on a seasonal basis. The wind speed data gathered by meteorological masts can then be corrolated with bat activity to determine the most feasible cut-in speed.

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