Bat (Chiroptera) Sensitivity Assessment for the Establishment of the Langhoogte Wind Farm, Western Cape Province

Environmental Impact Report

Bat (Chiroptera) Sensitivity Assessment

Compiled by Monika Moir
BSc Hons Zoology (Cum laude)
monika@animalia-consult.co.za

Reviewed/Overseen by Werner Marais
MSc Biodiversity and Conservation
Pr.Sci.Nat. – SACNASP (Zoological Science)
werner@animalia-consult.co.za

November 2012

R-1207-31
DECLARATION OF INDEPENDENCE

I, Monika Moir as duly authorised representative of Animalia Zoological and Ecological Consultation CC, hereby confirm my independence (as well as that of Animalia Zoological and Ecological Consultation CC) as the Bat (Chiroptera) specialist for the proposed Langhoogte Wind Farm, Western Cape Province and declare that neither I nor Animalia Zoological and Ecological Consultation CC have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Arcus GIBB was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act) for the proposed Langhoogte Wind Farm, Western Cape Province. I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it. I have disclosed, to the environmental assessment practitioner, in writing, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act. I have further provided the environmental assessment practitioner with written access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not. I am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2010 and any other specific and relevant legislation (national and provincial), policies, guidelines and best practice.

Full Name: Monika Ilka Moir

Date: 25 July 2012
Title / Position: Bat Specialist
Qualification(s): BSc Hons Zoology
Experience (years/ months): 10 months
EXECUTIVE SUMMARY

Arcus Gibb (Pty) Ltd. has appointed Animalia Zoological and Ecological Consultation CC to conduct the Bat Sensitivity EIA for the proposed Langhoogte Wind Farm in the Western Cape. This report details the vegetation types, presence of possible roosting and foraging sites, and the bat species that were detected on site. These elements were then utilised to draw up a draft bat sensitivity map of the proposed site.

Negative impacts on bats by wind turbines that were identified are the following:

- Clearing of vegetation in turbine placement areas, for access roads and laying underground cables will ultimately result in loss of foraging habitat
- Barotrauma and direct blade collisions of resident bat populations during daily foraging activities
- Barotrauma and direct blade collisions of migratory species (Miniopterus natalensis and Myotis tricolor) during large-scale or local migratory movements

Several mitigation measures proposed for these negative impacts include rehabilitation of vegetation, curtailment, ultrasound deterrent devices and support of academic study of bat migratory paths.

A long-term (12 months) preconstruction monitoring programme is advised for the site and has commenced in September 2012.

Turbines LH27, LH29, LH30 LH36 are located within Moderate Bat Sensitivity areas and their respective buffer zones. These turbines must be prioritised for post-construction study and mitigation measures. Turbines LH16, LH24 and LH39 are in close proximity to High Bat Sensitivity buffers and it is recommended that they too be prioritised for post-construction study and mitigation.
# ENVIRONMENTAL IMPACT ASSESSMENT FOR THE ESTABLISHMENT OF THE PROPOSED LANGHOOGTE WIND FARM, WESTERN CAPE PROVINCE: ENVIRONMENTAL IMPACT REPORT

## CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>INTRODUCTION</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.1 Background</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>1.1.1 Details of the Langhoogte Wind Farm development</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>1.1.2 Bats and Wind Turbines</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>1.2 Legislative and Policy Context</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>1.2.1 Legislative requirements</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>1.2.2 Policy Requirements</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>1.2.3 Permit requirements</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>1.3 Scope and limitations</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>1.3.1 Scope of the Study</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>1.3.1 Assumptions and Limitations</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>1.4 Assessment Methodology</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>1.4.1 Study area sensitivity analysis</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>DESCRIPTION OF STUDY AREA</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>2.1 Land Use and Existing Impacts</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>2.2 Vegetation Units and Climate</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>2.3 Literature Based Species Probability of Occurrence</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>2.4 Bat Detection</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>2.5 Possible Roosting and Foraging Habitat</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>2.6 Draft Sensitivity Map</td>
<td>27</td>
</tr>
<tr>
<td>3</td>
<td>FORESEEN IMPACTS OF THE PROPOSED LANGHOOGTE WIND FARM</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>3.1 Identification of Impacts and Potential Mitigation Measures</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>3.1.1 Construction phase</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>3.1.1.1 Impact 1: Clearing of vegetation in turbine placement areas, for access roads and laying underground cables will ultimately result in loss of foraging habitat.</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>3.1.2 Operational phase</td>
<td>33</td>
</tr>
</tbody>
</table>
(a) **Impact 1:** Barotrauma and direct blade collisions of resident bat populations during daily foraging activities

(b) **Impact 2:** Barotrauma and direct blade collisions of migratory species (*Miniopterus natalensis* and *Myotis tricolor*) during large-scale or local migratory movements

(c) **Impact 3:** Development of proposed electrical sub-station and overhead power lines

3.1.3 Decommissioning phase

3.2 Impact Assessment – Proposed Development

3.2.1 Construction phase

3.2.2 Operational phase

Barotrauma and direct blade collisions of resident bat populations during daily foraging activities

4 **MONITORING PROGRAMME**

5 **CONCLUSION**

6 **REFERENCES**
TABLES

Table 1: Details of sampling effort
Table 2: Description of sensitivity categories utilized in the sensitivity map
Table 3: The roosting and foraging potential of the vegetation units present on the Langhoogte site
Table 4: Table of species that may be roosting or foraging on the study area, the possible site specific roosts, and their probability of occurrence based on literature

FIGURES

Figure 1: Extent of the site traversed for bat detection
Figure 2: Satellite imagery of the site for the proposed Langhoogte Wind farm with the final proposed turbine layout
Figure 3: The cultivated landscape
Figure 4: Vegetation units present on the Langhoogte site (Mucina & Rutherford, 2006)
Figure 5: Spectrogram of pulses from Miniopterus natalensis (Natal clinging bat) call
Figure 6: Bat species detected on site and their localities
Figure 7: Bat species detected on the southerly portion of the site and their localities
Figure 8: Possible roosting and foraging sites found across the study area
Figure 9: Possible roosting and foraging sites found in the western portion of the study area
Figure 10: Possible roosting and foraging sites found in the mid portion of the study area
Figure 11: Possible roosting and foraging sites found in the easterly portion of the study area
Figure 12: Bat sensitivity map of proposed Langhoogte Wind Farm
Figure 13: Bat sensitivity map of the westerly portion of proposed Langhoogte Wind Farm
Figure 14: Bat sensitivity map of the mid portion of proposed Langhoogte Wind Farm
Figure 15: Bat sensitivity map of the easterly portion of proposed Langhoogte Wind Farm
1 INTRODUCTION

1.1 Background

SAGIT Energy Ventures ("SAGIT") is proposing to establish a Wind Energy Facility and associated infrastructure on a site near Botrivier in the Theewaterskloof Municipality, Western Cape Province. Animalia Zoological and Ecological Consultation CC have subsequently been contracted to undertake a Bat Sensitivity Assessment for the EIA phase of the Langhoogte Wind Farm. This assessment details the bat species that may reside on the proposed site, the presence of possible roosting sites and habitat types utilised for foraging activities. In this report, the results of nocturnal surveys for bat activity with the use of a bat detector will be relayed. This information was utilised to draft a sensitivity map of the site (section 2.6), based on bat activity and the presence of roosting sites and foraging habitat. This sensitivity map will provide insight for a long-term sensitivity assessment. The significance of the foreseen impacts will be rated and recommendations and mitigation measures provided.

1.1.1 Details of the Langhoogte Wind Farm development

The proposed Langhoogte Wind Farm is in close proximity to the towns of Bot Rivier (approximately 1km north-east from Bot Rivier - straight line distance) and Caledon (approximately 11km north-west from Caledon – straight line distance) in the Western Cape Province. The N2 road intercepts the most southern portion of the site while the R43 road cuts through the middle of the site in south/north direction. The site is currently used primarily for agricultural purposes.

A total of 45 wind turbines are proposed to occupy the farm, generating between 112 - 162MW. The turbines will have a power generating capacity of 2.5 – 3.6MW each and are of 80 - 110m hub height and 40 - 60m blade length.

Required associated infrastructure includes:

- Concrete turbine foundations
- An on-site electrical sub-station
- Underground cabling connecting turbines with the substation
• 6m wide access roads to individual turbine positions

• A temporary construction camp.

A 132kV overhead power line is also required to be constructed for transferral of electricity to the Houhoek Sub-station (situated south of Bot Rivier). The power line would consist of steel monopoles and would be approximately 8 – 10km long.

1.1.2 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 haemorrhage. One study done by Baerwald et al. (2008) showed that 90% of bat fatalities around wind turbines involved internal haemorrhaging consistent with barotrauma.

A study carried out at Mountaineer Wind Energy Center in Tucker County, West Virginia by Horn et al. (2008a) made use of thermal infrared cameras to assess the flight behaviour of bats near wind turbines. Bats were observed actively foraging near operating turbines as well as approaching both rotating and non-rotating blades. Bats were observed to follow and become trapped in blade-tip vortices and to investigate the various parts of the turbine by means of repeated fly-bys. Horn et al. (2008a) suggest one of the causes of interest in turbines by bats is that bats may view turbine monopoles standing in open spaces as roost trees and thus investigate them for potential roosting spaces. Horn et al. (2008b) found bats to forage aerially for insects within the airspace swept by the turbine rotor thus making them prone to collision with blades.

Whatever the reason for bat mortalities around wind turbines, the facts indicate this to be a potentially serious and concerning problem if wind energy facilities are developed in areas of high bat activity and diversity. The locality of the wind energy facility and the environmental conditions of the area are of paramount importance to the extent of impact the facility will have on bat populations.
During a study by Arnett \textit{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.

\textbf{1.2 Legislative and Policy Context}

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

\textsc{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.

\textbf{1.2.1 Legislative requirements}

A specialist assessment pertaining to bats is forming part of the fauna component of the EIA, as informed by the National Environmental Management Act, 1998 (Act No. 107 of 1998).

\textbf{1.2.2 Policy Requirements}

The proposed development has commenced a 12 month pre-construction assessment as of September 2012. This 12 month preconstruction assessment will be in line with the South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments (Sowler & Stoffberg, 2012).

\textbf{1.2.3 Permit requirements}

No permits were required for the gathering of data, since only acoustic methods of surveying were used and no specimens were captured. According to best knowledge the proposed development will not trigger the requirement of any permits pertaining to bats.
1.3 Scope and limitations

1.3.1 Scope of the Study

The scope of the study includes:

- A brief description of the existing land use of the site and its associated impacts
- The vegetation units of the site will be described along with their respective bat roosting and foraging potentials
- An explanation of South African bats and the effects of wind turbines on bats as well as a literature based table of species probability of occurrence on the Langhoogte Wind Farm site
- Visual representation of bats that were detected on the site during field work
- Indication of the possible roosting and foraging habitats/areas on site
- Indication of the bat sensitive areas
- Discussion of the foreseen impacts of the development and their suggested mitigation measures or recommendations

1.3.1 Assumptions and Limitations

Distribution maps of South African bat species still require further refinement such that the bat species proposed to occur on the site (that were not detected) are assumed accurate. If a species has a distribution marginal to the site it was assumed to occur in the area. The literature based table of species probability of occurrence may include a higher number of bat species than actually present.

The migratory paths of bats are largely unknown, thus limiting the ability to determine if the wind farm will have a large scale effect on migratory species. This limitation however will be overcome with a long-term sensitivity assessment.

The satellite imagery partly used to develop the sensitivity map may be slightly imprecise due to land changes occurring since the imagery was taken. Satellite imagery from Google Earth for 2012 was utilized to minimize this limitation.

A significant limitation was that the field work was carried out during a winter cold front. Bat detection will be significantly lowered during periods of cold and consistent rainfall. The high
rainfall also limited the extent to which the site could be traversed for bat detection. This slightly compromises the assessment of the extent of habitat use by bats. However the assessment, in terms of bat species encountered and expected on site and the sensitivity map generated remains credible.

### 1.4 Assessment Methodology

Three factors need to be present for most South African bats to be prevalent in an area: availability of roosting space, food (insects/arthropods or fruit), and accessible open water sources. However, the dependence of a bat on each of these factors depends on the species, its behaviour and ecology. Nevertheless if all three of these factors are common in an area the bat activity, abundance and diversity will also most likely be high.

Concerning species of bats that may be impacted by wind turbines, the Langhoogte site was evaluated by comparing the amount of surface rock (possible roosting space), topography (influencing surface rock in most cases), vegetation (possible roosting spaces and foraging sites), climate (can influence insect numbers and availability of fruit), and presence of surface water (influences insects and acts as a source of drinking water). These comparisons were done chiefly by studying the geographic literature of each site and available satellite imagery. Species probability of occurrence based on the above mentioned factors were estimated for the site and the surrounding larger area.

The site was visited from the 12th to 14th of July 2012. It was inspected during the day for any possible roosting and foraging sites. At dusk and during the night, the sky was monitored for visual observation of bats and bat activity.

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. Refer to Table 1 for sampling effort in terms of time and distance traversed with the bat detector and Figure 1 for areas traversed.

A bat detector is a device capable of detecting and recording the ultrasonic echolocation calls of bats. These calls were then analyzed with the use of computer software. A time expansion type bat was utilised for the study, a time expansion detector effectively slows an
ultrasonic bat call down 10 times such that bat calls become audible to the human ear, but still retain all of the harmonics and characteristics of the call. Although this type of bat detection equipment is advanced technology, it is not necessarily possible to identify all bat species by just their echolocation calls. Recordings of bat calls may be negatively affected by the weather conditions (i.e. high humidity) and openness of the terrain. The range of detecting a bat is also dependent on the volume of the bat call.

Positive bat calls were analysed for species identification and are represented visually where they were detected (GPS co-ordinate) in Figures 6 – 8.

**Table 1:** Details of sampling effort

<table>
<thead>
<tr>
<th>Date</th>
<th>Time spent traversing site</th>
<th>Distance covered (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 July 2012</td>
<td>7 hrs 12 min</td>
<td>120.1</td>
</tr>
<tr>
<td>13 July 2012</td>
<td>6 hrs 4 min</td>
<td>74.4</td>
</tr>
<tr>
<td>14 July 2012</td>
<td>5 hrs 59 min</td>
<td>70.9</td>
</tr>
</tbody>
</table>

**Figure 1:** Extent of the site traversed for bat detection
1.4.1 Study area sensitivity analysis

Several features identified during field work and from satellite imagery were used to develop a sensitivity map of the study area with regards to bat foraging and roosting activities.

The features used to develop the sensitivity map include:

- The presence of man-made structures, such as farm houses, barns, sheds, road culverts and mine adits, these structures provide easily accessible roosting sites
- The presence of caves, rock faces, areas of exfoliating rocks and clumps of large woody plants. These features provide natural roosting spaces
- The different vegetation types and presence of clumped vegetation and riparian habitat is used as indicators of possible foraging areas
- Open water sources, be it man-made farm dams or natural streams and wetlands, are important sources of drinking water and provide habitat that host insect prey
- The localities of bats detected on site.

The California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development (2007) states that wind turbines within or near to sites of water and/or riparian habitat could increase the number of bat and bird collisions and that construction within and near to water bodies on a site should not be encouraged. This was considered when drawing up the sensitivity map.

The areas designated as having a High Bat Sensitivity implicates that no turbines should be placed in this zone due to the elevated impacts it can have on bat mortalities. These High Bat Sensitivity areas were assigned a 100m buffer zone. The areas designated with a Moderate Bat Sensitivity were assigned a 50m buffer zone. Turbines within Moderate Bat Sensitivity buffer zones must receive special attention and preference with regards to bat monitoring and implementation of mitigations during the operational phase. Pre and post-construction bat monitoring studies need to be carried out. From these monitoring studies mitigation measures may be devised. These measures should be applied to turbines, with priority of those situated within Moderate Bat Sensitivity areas and buffer zones, however the mitigation measures should not be limited to only the mentioned turbines.
Areas not depicted as having a Moderate or High Bat Sensitivity are considered of a Low Bat Sensitivity category. The wind farm development can proceed within these areas with minimal negative bat impact.

**Table 2:** Description of sensitivity categories utilized in the sensitivity map

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate Sensitivity</td>
<td>Areas of foraging habitat or roosting sites considered to have significant roles for bat ecology. Turbines within these areas must acquire priority for post-construction studies and mitigation measures.</td>
</tr>
<tr>
<td>High Sensitivity</td>
<td>Areas that are deemed critical for resident bat populations. These areas are ‘no-go’ areas and placement of turbines within these areas should be avoided. However no turbines from the layout of 14 November 2012 are located within these areas.</td>
</tr>
</tbody>
</table>
2 DESCRIPTION OF STUDY AREA

Figure 2: Satellite imagery of the site for the proposed Langhoogte Wind farm with the final proposed turbine layout
2.1 Land Use and Existing Impacts

The study area proposed for the Langhoogte Wind Farm development covers an approximate area of 3,940 ha of which the land use is primarily farming of crops and livestock. These farmed areas dominate the site with the absolute westerly tip of the farm being less developed as it is found at the foot of the mountain range of the Houwhoek Nature Reserve (Figure 3). This natural western portion of the site will easily support bat life. However agriculture does not necessarily pose a negative impact on resident bat populations. The construction of farm buildings and farm dams provide easily accessible roosting and foraging areas. The cultivated lands attract agricultural insect pests upon which insectivorous bats thrive. Bats have been found to show preference for foraging in livestock pastures. The pasture conditions and livestock faeces attract insects such that bat prey is plentiful in pastures.

Figure 3: The cultivated landscape
2.2 Vegetation Units and Climate

The site consists of three vegetation units: Western Ruens Shale Renosterveld, Kogelberg Sandstone Fynbos and Western Coastal Shale band of vegetation (Figure 4).

![Vegetation units present on the Langhooogte site (Mucina & Rutherford, 2006)](image)

The Western Ruens Shale Renosterveld unit consists of moderately undulating plains that are mostly stripped of natural vegetation. Where the vegetation is conserved, it consists of open to medium density, low to moderately tall grassy shrublands. The vegetation is dominated by renosterbos. Grazing by livestock removes the palatable grass component in pastures and the grass is replaced with shrubby Asteraceae. The mean annual precipitation of 360 – 700mm falls primarily in the winter months. This vegetation unit is Critically Endangered as only about 1% is currently under protection in a private nature reserve. Approximately 86% of the unit has undergone transformation by cultivation.
The Kogelberg Sandstone Fynbos falls on high mountains with steep to gentle slopes, and undulating plains and hills. The vegetation is low, closed shrubland with scattered emergent tall shrubs. The unit is dominated by proteoid, ericaceous and restioid fynbos. Patches of Cape Thicket are common in the northern portions of the unit. The winter-rainfall consists of a mean annual precipitation of 670 – 3 000mm. The unit is of Least Threatened conservation category with about 58% of the unit statutorily conserved. Some 17% has undergone transformation due to pine plantations, cultivation and urbanisation.

The Western Coastal Shale Band vegetation unit is a narrow (80 – 200m) linear feature that has a smooth and flat profile. The vegetation unit supports diverse renosterveld and fynbos shrublands. Rainfall of 280 – 2 000mm per year, peaks in the months from May to August. The unit is Least threatened with almost 75% of the unit being conserved. Approximately 6% is transformed by pine plantations.

**Table 3:** The roosting and foraging potential of the vegetation units present on the Langhoogte site

(This table serves as an indicator of the likelihood of use of each vegetation unit by bats. The potential was graded based on observation and findings on site)

<table>
<thead>
<tr>
<th>Vegetation Unit</th>
<th>Roosting Potential</th>
<th>Foraging Potential</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Ruens Shale Fynbos (FRs11)</td>
<td>Low</td>
<td>Medium - High</td>
<td>Natural roosting sites are minimal; however farm buildings and planted trees provide roosting sites. Natural and cultivated vegetation have high foraging potential. Bats were detected within this unit.</td>
</tr>
<tr>
<td>Kogelberg Sandstone Fynbos (FFs11)</td>
<td>Medium - High</td>
<td>Medium</td>
<td>The mountainous terrain provides roosting space such as rock crevices, caverns and exfoliating rock. Cape Thickets provide foraging habitat. A bat was detected near the boundary of this unit.</td>
</tr>
<tr>
<td>Western Coastal Shale Band Vegetation</td>
<td>Low</td>
<td>Medium</td>
<td>Natural vegetation does not support roosting vegetation. The linear flat feature may provide a foraging corridor from mountain top.</td>
</tr>
</tbody>
</table>
2.3 Literature Based Species Probability of Occurrence

“Probability of Occurrence” is assigned based on consideration of the presence of roosting sites and foraging habitats on the Langhoogte site, compared to literature described preferences. The probability of occurrence is described by a percentage indicative of the expected numbers of individuals present on site and the frequency at which the site will be visited by the species. Bat species that were positively detected on the site are noted as Confirmed in the “Probability of Occurrence” column.

The column of “Likely risk of impact” describes the likelihood of risk of fatality from direct collision or barotrauma with wind turbine blades for each bat species. The risk was assigned by Sowler & Stoffberg (2012) based on species distributions, altitudes at which they fly and distances they traverse.

Table 4: Table of species that may be roosting or foraging on the study area, the possible site specific roosts, and their probability of occurrence based on literature (Monadjem et al., 2010).

<table>
<thead>
<tr>
<th>Species name</th>
<th>Common Name</th>
<th>Probability of Occurrence (%)</th>
<th>Conservation status</th>
<th>Possible Roosting Sites Occupied in Study Area</th>
<th>Foraging Habits (indicative of possible foraging sites in study area)</th>
<th>Likely Risk of Impact (Sowler &amp; Stoffberg, 2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epomophorus wahlbergi</td>
<td>Wahlberg’s epauletted fruit bat</td>
<td>10 - 20</td>
<td>Least Concern</td>
<td>Roosts associated with forest and forest-edge habitats</td>
<td>Feeds on fruit, nectar, pollen and flowers. Fruit is farmed on site</td>
<td>Medium - High</td>
</tr>
<tr>
<td>Rousettus aegyptiacus</td>
<td>Egyptian rousette</td>
<td>20 - 30</td>
<td>Least Concern</td>
<td>Roosts gregariously in caves. No known caves in the immediate vicinity, however large surrounding mountain ranges may provide caves</td>
<td>Fruit consumer. Fruit is not farmed on site</td>
<td>Medium - High</td>
</tr>
<tr>
<td>Rhinolophus capensis</td>
<td>Cape horseshoe bat</td>
<td>40 - 50</td>
<td>Near Threatened</td>
<td>Roosts in caves and mine adits</td>
<td>Clutter forager</td>
<td>Low</td>
</tr>
<tr>
<td>Rhinolophus clivosus</td>
<td>Geoffroy’s horseshoe bat</td>
<td>10 - 20</td>
<td>Least Concern</td>
<td>Roosts in caves and mine adits</td>
<td>Clutter forager</td>
<td>Low</td>
</tr>
<tr>
<td>Rhinolophus darlingi</td>
<td>Darling’s horseshoe bat</td>
<td>10 - 20</td>
<td>Least Concern</td>
<td>Roosts in caves and mine adits</td>
<td>Clutter forager</td>
<td>Low</td>
</tr>
<tr>
<td>Rhinolophus simulator</td>
<td>Bushveld horseshoe bat</td>
<td>0 - 10</td>
<td>Least Concern</td>
<td>Roosts in caves and mine adits, where it forms colonies of up to 300 individuals. Also roosts in small caverns in rocky outcrops and culverts under the road</td>
<td>Clutter forager</td>
<td>Low</td>
</tr>
</tbody>
</table>
A bat call consists of a series of ultrasonic sound pulses, with each species calling at a characteristic sound frequency. It is used for navigational and hunting purposes, comparable to but more sophisticated than modern sonar. These ultrasonic pulses are detected and recorded with the use of a bat detector. These pulses can then be translated onto a
spectrogram (Figure 5) with the use of computer programs. A spectrogram is a graph indicating three variables; with time on the x-axis, frequency on the y-axis and amplitude/volume indicated as a colour plotted on the graph. 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. The spectrograms of pulses are then used to analyze call parameters such as pulse length, pulse bandwidth, pulse interval and pulse dominant frequency (loudest frequency). The bat species that emitted the pulse can then be identified from these parameters. 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 5: Spectrogram of pulses from *Neoromicia capensis* (Cape serotine bat) call.
This method of species identification was utilised for bat call data collected on site. Confidence in bat species identification is high.

For presentation purposes of bat detection Figures 6 – 7 were inserted. Figures 6 – 7 are a spatial and quantitative representation of bat detection, a single marker represents the detection of an individual bat.

Figure 6: Bat species detected on site and their localities
As depicted in Figures 6 – 7, very few bat calls were recorded on site. This may be attributed to the cold front weather conditions that were experienced during the field visit. Consistent rain interfered with sampling efforts as bat detectors cannot get wet and it made the terrain very muddy and difficult to traverse. High moisture in the air also dampens bat calls such that the ranges of calls are lessened and thus fewer calls were detected. Higher bat activity and bat numbers will most probably be detected during more hospitable weather conditions and warmer summer periods. Still, as with the majority of EIA assessments, due to time constraints the sensitivity assessment is informed by site habitat, terrain and all other observations applicable to bat biology.
2.5 Possible Roosting and Foraging Habitat

Several large open water sources, such as farm dams, drainage lines and pools, are available for use by bats. These water sources serve as pertinent foraging habitat and drinking water sources. These foraging habitats are quite evenly spread across the entire site such that the foraging potential of the site is not concentrated in any particular portion of the area. The areas highlighted as foraging habitat are most probably utilised for roosting purposes too creating an overlap of use for the highlighted areas.

Most roosting space provided on site is that of farm buildings and clumps of larger woody plants (Figure 8 – 11). The mountainous terrain directly west of the site seems to provide suitable roosting sites in the form of rock faces, rock crevices, exfoliating rock, possible caves and caverns.
Figure 8: Possible roosting and foraging sites found across the study area.
Figure 9: Possible roosting and foraging sites found in the western portion of the study area
Figure 10: Possible roosting and foraging sites found in the mid portion of the study area
Figure 11: Possible roosting and foraging sites found in the easterly portion of the study area.
2.6 Draft Sensitivity Map

**Figures 12 – 15** display the Moderate and High Bat Sensitivity areas and recommended buffer zones. These sensitivities are based on the findings of bat detection during the site visit and the probability of certain features and habitats to be utilised for roosting foraging purposes.

The High Bat Sensitivity areas are expected to have elevated levels of bat activity and support greater bat diversity. High Bat Sensitivity areas are considered ‘no – go’ areas due to expected elevated rates of bat fatalities due to wind turbines. These areas were designated 100m radial buffer zones.

Turbines located within Moderate Bat Sensitivity areas and their respective buffers must receive special attention and preference with regards to bat monitoring and implementation of mitigations during the operational phase. These turbines within Moderate Bat Sensitivity areas and buffer zones must thus be prioritised for mitigation, however not excluding all other turbines from post construction monitoring. Moderate Bat Sensitivity areas were assigned 50m buffers.

There are no South African guidelines for the consideration of buffer zones for bats in relation to wind farms. Guidance can be taken from other provinces and other country’s guidelines:

- Gauteng Department of Agriculture and Rural Development recommend a 500m buffer for natural bat caves and a 200m buffer on Class 1 ridge systems, 200m buffer on conservation important vegetation and a 50m buffer from riparian edge habitats.
- The Eurobats Guidance (Rodrigues *et al.*, 2008) proposes a minimum buffer distance of 200m from forest edges
- The Natural England Interim Guidance suggests a 50m buffer from turbine blade tip to the nearest bat important feature (Mitchell-Jones & Carlin, 2009)

The Moderate Bat Sensitivity and High Bat Sensitivity buffers assigned are a compromise deduced from these guidelines.
Turbines LH27, LH29, LH30 and LH36 are situated within Moderate Bat Sensitivity areas and their respective buffer zones, and must thus be prioritised for mitigation and pre/post-construction study. Turbines LH16, LH24 and LH39 are situated very near to the buffer zones of High Bat Sensitivity areas and thus should also be considered for mitigation and pre/post-construction study (as Moderate Bat Sensitivity areas).

The final turbine layout has respected the ‘No – go’ areas of High Bat Sensitivity, as the revised turbine layout (dated 14 November 2012) depicts all proposed turbines to be outside of High Bat Sensitivity areas and their respective buffer zones. Thus this turbine layout seems acceptable in terms of bat sensitive areas. A total of seven turbines are slightly encroaching upon bat sensitive habitat, however these are to be mitigated to limit the negative impacts of turbines on bat fauna.
Figure 12: Bat sensitivity map of proposed Langhoogte Wind Farm
Figure 13: Bat sensitivity map of the westerly portion of proposed Langhoogte Wind Farm.
Figure 14: Bat sensitivity map of the mid portion of proposed Langhoogte Wind Farm
Figure 15: Bat sensitivity map of the easterly portion of proposed Langhoogte Wind Farm
3 FORESEEN IMPACTS OF THE PROPOSED LANGHOOGTE WIND FARM

3.1 Identification of Impacts and Potential Mitigation Measures

3.1.1 Construction phase

(a) **Impact 1**: Clearing of vegetation in turbine placement areas, for access roads and laying underground cables will ultimately result in loss of foraging habitat.

**Proposed Mitigation**: The placement of turbines within areas identified as having a High or Moderate Bat Sensitivity (*Figure 12 - 15*) should be avoided.

These areas should be avoided when the placement of associated infrastructure is considered. If possible, underground cabling should not be laid in these areas. If cabling is located within these areas, vegetation rehabilitation can be carried out to rectify this impact.

3.1.2 Operational phase

(a) **Impact 1**: Barotrauma and direct blade collisions of resident bat populations during daily foraging activities

**Proposed Mitigations**: The correct placement of wind farms and of individual turbines can significantly lessen the impacts on bat fauna in an area. Therefore areas designated as having a High Bat Sensitivity (*Figures 12 – 15*) should be avoided in turbine placement. Additionally areas of Moderate Bat Sensitivity should be avoided where other alternatives are practical, if not, turbines in Moderate Bat Sensitivity areas should receive special attention and be prioritised in post construction monitoring and implementation of mitigation measures.

Curtailment is an operational phase mitigation measure that can be implemented to lessen bat mortalities caused by direct collisions with turbine blades. Curtailment is the practice of maintaining the turbine blades stationary or 'locked' at low wind speeds, and once the wind exceeds a specified speed the blades are then allowed to rotate normally. The theory behind curtailment is that there exists a negative correlation between bat activity and wind speed, causing bat activity to decline as wind speed increases.
Baerwald et al. (2008) carried out a study wherein the wind speed trigger of 15 turbines, on an operational wind farm in south-western Alberta, was altered. Under normal circumstances the turbine blades turn slowly in low wind speeds, however they only begin to generate 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 generating electricity at a cut-in speed of 5.5 m/s. During the peak bat fatality period, curtailment showed a reduction of bat fatalities by 60%.

Another strategy (used in the same experiment) involved altering blade angles to reduce rotor speed in low wind speed conditions, such that the blades were near motionless. This 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. Their study concluded that curtailment can be used as an effective mitigation measure to reduce bat fatalities at wind energy facilities. However, when using a cut-in speed of 6.5 m/s the annual power loss was 3 times higher than when implementing a 5.0 m/s cut-in speed.

The possible use of curtailment and the recommended cut in speed will have to be determined with conclusive results of a 12 month preconstruction monitoring study. Curtailment is more effective and economically viable when bat activity displays seasonal peaks.

A further mitigation measures involves the use of ultrasonic deterrent devices to repel bats from wind turbines. The device emits ultrasonic sound in a broad range that is inaudible to humans. This ultrasonic sound repels 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.

Szewczak & Arnett (2008) performed a study involving the comparison of bat activity in the presence of an acoustic deterrent device and without the deterrent. The study showed that when ultrasound was broadcasted, only 2.5-10.4% of the control activity rate was observed. Other studies demonstrating the usefulness of the deterrent devices were carried out by Spanjer (2006) and Horn et al. (2008).
It may be feasible to install such devices on selected functional turbines within the Moderate Bat Sensitivity areas, with the results being monitored by an appropriately qualified researcher. Progression in the technology of such devices can possibly yield favourable results.

Due to the lack of knowledge on the impacts of wind farms on bats in the local context, preconstruction monitoring in combination with bat mortality monitoring during the operational phase is recommended for this site. This will improve and determine the effectiveness of mitigations applied.

(b) **Impact 2**: Barotrauma and direct blade collisions of migratory species (*Miniopterus natalensis* and *Myotis tricolor*) during large-scale or local migratory movements

**Proposed Mitigation:** Cave dwelling species like *Miniopterus natalensis* (Natal clinging bat) and *Myotis tricolor* (Temmincks’ mytois) may undertake annual migrations on a large scale. Although no caves are known to be in close proximity to the study area, the migratory paths of bats in the Western Cape is largely unknown. To rectify this, collaboration with academic institutions to promote research on the migratory paths, and a long term preconstruction monitoring study can be carried out. This will contribute to identifying and quantifying the risks and possible mitigations more accurately.

(c) **Impact 3**: Development of proposed electrical sub-station and overhead power lines

**Proposed Mitigation:** The development of the proposed electrical sub-station is not foreseen to have a significant negative impact on bat fauna. When considering the foraging capacity of the area used to develop the sub-station, and the foraging ranges of most South African insectivorous bats, this area cleared and developed upon is considered to have an almost negligible contribution towards foraging of insectivorous bats. The same is thought for the roosting potential of the area.

The overhead power lines are not thought to interfere with flight, feeding or any other biological aspect of bat fauna.

Thus the development of the electrical sub-station and overhead power lines are considered to have negligible impact on bats and no mitigation measures are proposed.
3.1.3 Decommissioning phase

No impacts identified.

3.2 Impact Assessment – Proposed Development

3.2.1 Construction phase

<table>
<thead>
<tr>
<th>Impact</th>
<th>Nature</th>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Reversibility</th>
<th>Impact on Irreplaceable Resources</th>
<th>Consequence</th>
<th>Probability</th>
<th>Significance</th>
<th>Confidence</th>
</tr>
</thead>
</table>

**Impact 1: Vegetation clearing**

Clearing of vegetation in turbine placement areas, for access roads and laying underground cables will ultimately result in loss of foraging habitat.

<table>
<thead>
<tr>
<th>Without Mitigation</th>
<th>Negative</th>
<th>Medium</th>
<th>Medium-term</th>
<th>High</th>
<th>Low</th>
<th>Low</th>
<th>Medium</th>
<th>Probable</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
</table>

Proposed Mitigation:

The placement of turbines within areas identified as having a High Bat Sensitivity (Figure 12 - 15) should be avoided.

This has been fully achieved with the revised turbine layout (dated 14 November 2012), wherein no turbines are located within areas of High Bat Sensitivity.

With Mitigation | Neutral | Low | Short-term | Negligible | Medium | Low | Low | Improbable | Low | High |

Cumulative Impact:

Removal of vegetation along with barotraumas and blade collisions is of high significance without mitigation and of moderate significance with mitigation. However operational impacts such as collisions will not occur during construction, and hence no such cumulative impacts are expected.

3.2.2 Operational phase

<table>
<thead>
<tr>
<th>Impact</th>
<th>Nature</th>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Reversibility</th>
<th>Impact on Irreplaceable Resources</th>
<th>Consequence</th>
<th>Probability</th>
<th>Significance</th>
<th>Confidence</th>
</tr>
</thead>
</table>

**Impact 1: Barotrauma and blade collisions during foraging**

Barotrauma and direct blade collisions of resident bat populations during daily foraging activities.

| Without Mitigation | Negative | Medium | Long-term | High | High | High | High | Probable | High | High |

Proposed Mitigation:

The correct placement of wind farms and of individual turbines can significantly lessen the impacts on bat fauna in an area significantly. Therefore areas designated as having a High Bat Sensitivity (Figures 13 – 16) must be avoided in turbine placement; additionally areas of Moderate Bat Sensitivity should be avoided where other alternatives are practical, if not, turbines in Moderate Bat Sensitivity areas must receive special attention and be prioritised in post construction monitoring and implementation of the following mitigation measures.

This has been fully achieved with the revised turbine layout (dated 14 November 2012), wherein no turbines are located within areas of High Bat Sensitivity. Turbines LH27, LH29, LH30 and LH36 are located within areas of Moderate Bat Sensitivity and must receive special attention and prioritisation in post-construction monitoring and application of mitigation measures.
Curtailment is an operational phase mitigation measure that can be implemented to lessen bat mortalities caused by direct collisions with turbine blades. Curtailment is the practice of maintain the turbine blades stationary or ‘locked’ at low wind speeds, and once the wind exceeds a specified speed the blades are then allowed to rotate normally. The theory behind curtailment is that there exists a negative correlation between bat activity and wind speed, causing bat activity to decline as wind speed increases. Another strategy involved altering blade angles to reduce rotor speed in low wind speed conditions, such that the blades were near motionless. A further mitigation measures involves the use of ultrasonic deterrent devices to repel bats from wind turbines.

The preconstruction monitoring will determine what mitigation measure/s is most suitable for minimising impacts on bat fauna as well as economically viable. Specific details cannot be determined at this stage since the patterns of bat activity over a 12 month period needs to be considered holistically with environmental factors and correlations.

<table>
<thead>
<tr>
<th>With Mitigation</th>
<th>Negative</th>
<th>Low - Medium</th>
<th>Long-term</th>
<th>Low</th>
<th>Medium</th>
<th>Low - Medium</th>
<th>Improbable</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
</table>
| Cumulative Impact: Removal of vegetation along with barotraumas and blade collisions is of high significance without mitigation and of moderate significance with mitigation

Cumulative barotrauma and blade collision impacts with regards to the other wind farms proposed in the region can result in more bat fatalities and weigh heavy on resident bat populations, if sensitive bat habitat on the other sites are not buffered and continuity is not maintained between these sensitive habitats.

**Impact 2: Barotrauma and blade collisions during migration**

Barotrauma and direct blade collisions of migratory species (*Miniopterus natalensis* and *Myotis tricolor*) during large-scale or local migratory movements

<table>
<thead>
<tr>
<th>Without Mitigation</th>
<th>Negative</th>
<th>High</th>
<th>Long-term</th>
<th>High</th>
<th>High</th>
<th>High</th>
<th>High</th>
<th>Probable</th>
<th>High</th>
<th>Medium</th>
</tr>
</thead>
</table>
| Proposed Mitigation: Cave dwelling species like *Miniopterus natalensis* (Natal clinging bat) and *Myotis tricolor* (Temminck’s myotis) undertake annual migrations on a large scale. Although no caves are known to be in close proximity to the study area, the migratory paths of bats in the Western Cape is largely unknown. To rectify this, collaboration with academic institutions to promote research on the migratory paths, and a long term preconstruction monitoring study is currently underway as of September 2012. This will contribute to identifying and quantifying the risks and possible mitigations more accurately.

<table>
<thead>
<tr>
<th>With Mitigation</th>
<th>Negative</th>
<th>High</th>
<th>Long-term</th>
<th>Medium</th>
<th>Medium</th>
<th>Medium</th>
<th>Medium</th>
<th>Improbable</th>
<th>Medium</th>
<th>Medium</th>
</tr>
</thead>
</table>
| Cumulative Impact: Removal of vegetation along with barotraumas and blade collisions is of high significance without mitigation and of moderate significance with mitigation

Cumulative barotrauma and blade collision impacts with regards to the other wind farms proposed in the region can result in more bat fatalities and weigh heavy on resident bat populations, if sensitive bat habitat on the other sites are not buffered and continuity is not maintained between these sensitive habitats.

The proposed overhead powerlines and substations are expected to have a negligible effect on bat fauna found on the site.
4 MONITORING PROGRAMME

An appropriate monitoring programme consists of a passive long-term study utilizing static bat detectors. A number of static bat detectors are installed at height on meteorological and short masts across the site. These detectors then passively record bat calls over a 12 month period. Four additional seasonal site visits are advised to collect long – term data and carry out bat detection at ground level by surveying the site in transects.

Bat detector microphones are mounted 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. Monitoring of bats at height may not always increase number of species recorded in comparison with monitoring methods at ground level. However, there is a strong likelihood that the proportion of species present at height will differ from that at ground level, which could have significant impacts in relation to assessing impacts in sites with a high proportion of high-risk species (e.g. species commuting, migrating and foraging within the rotor swept area).

Depending on the height of vegetation at the proposed site, some bat species, for example larger bats such as free-tailed bats (Family Molossidae), may only forage high above the canopy in certain areas and may not be recorded if monitoring is only completed at ground level. It is therefore recommended that on proposed wind farm sites static monitoring is undertaken at height in addition to ground-level monitoring. Similarly some species forage at just above ground level and will be missed if only at-height monitoring is undertaken (Sowler & Stoffberg, 2011).

The bat call recording schedule can be programmed to automatically start recording at the commencement of sunset of each night and to conclude recording at sunrise each morning. Thus bat calls are recorded every night for a year’s period. Data of wind speed, humidity, temperature, barometric pressure and precipitation collected from site is then used to predict bat activity patterns and risks. This is then used to more accurately recommend mitigation measures.

Such a monitoring programme has already commenced in September 2012, and the need for an operational phase monitoring programme will be determined during the preconstruction monitoring.
CONCLUSION

From Table 4, three bat species were confirmed to be present on site. All of the confirmed species are vulnerable to the potentially fatal impacts of wind turbines. *Miniopterus natalensis* (Natal clinging bat) was confirmed to be present on site, and with a Near Threatened conservation status, are believed to forage over long distances at night and undertake large scale migrations. This species should receive attention during the pre/post-construction monitoring. The other two species from Table 4 (*Tadarida aegyptiaca* and *Neoromicia capensis*) currently retain Least Concern status, but have medium – high risk of fatality from wind turbines. These species should take a second priority during the pre/post-construction study.

As of the revised turbine layout (dated 14 November 2012) no turbines are located within areas of High Bat Sensitivity and thus turbine relocation is not required. Turbines within Moderate Bat Sensitivity areas and buffers should be prioritized in pre/post-construction monitoring and implementation of possible mitigation measures that will follow from pre/post-construction monitoring. Turbines LH27, LH29, LH30 and LH36 are situated within these Moderate Bat Sensitivity areas. Turbines LH16, LH24 and LH39 are located in close proximity to High Bat Sensitivity buffers and thus are proposed to also receive priority in pre/post-construction studies.

Barotrauma and blade collisions during foraging and migration are the most significant impact if not mitigated. The latest turbine layout (as of 14 November 2012) has satisfied the initial mitigation measure of locating turbines in Low or Moderate Bat Sensitive areas, and avoiding High Sensitivity areas. The need for any further mitigation that may be required (such as curtailment or ultrasonic deterrents), will be informed by the preconstruction monitoring results.

Pre-construction monitoring has commenced in September 2012, whereby passive long-term bat detectors are used to continuously detect and record bat calls for a 12 month duration. During this study, bat species present on site will be identified and species of concern mitigated for. This study aims to identify any temporal and spatial patterns in bat activity, and to find correlations of bat activity with environmental parameters. This information will then be used to determine the appropriate mitigation measures to be implemented.

The need for an operational phase monitoring programme will be determined during the preconstruction monitoring.
REFERENCES


Compiled by:

Monika Moir
Zoologist and Ecologist
BSc Hons (Zoology, UJ)

Reviewed and signed off by:

Werner Marais
Zoologist and Ecologist
MSc (Biodiversity & Conservation, UJ)
Pr.Sci.Nat. – SACNASP
(Zoological Science)
DISCLAIMER

The services carried out and reported in this document have been done as accurately and scientifically as allowed by the resources and knowledge available to Animalia Zoological & Ecological Consultation CC at the time on which the requested services were provided to the client. Animalia Zoological & Ecological Consultation CC reserves the right to modify aspects of the document including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

Although great care and pride have been taken to carry out the requested services accurately and professionally, and to represent the relevant data in a clear and concise manner; no responsibility or liability will be accepted by Animalia Zoological & Ecological Consultation CC. And the client, by receiving this document, indemnifies Animalia Zoological & Ecological Consultation CC and its staff against all claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by Animalia Zoological & Ecological Consultation CC; and by the use of the information contained in this document. The primary goal of Animalia’s services is to provide professionalism that is to the benefit of the environment as well as the community.

COPYRIGHT

This document may not be altered or added to without the prior written consent of the author. This also refers to electronic copies of this document which are supplied for the purposes of inclusion as part of other reports. Similarly, any recommendations, statements or conclusions drawn from or based on this document must make reference to this document.