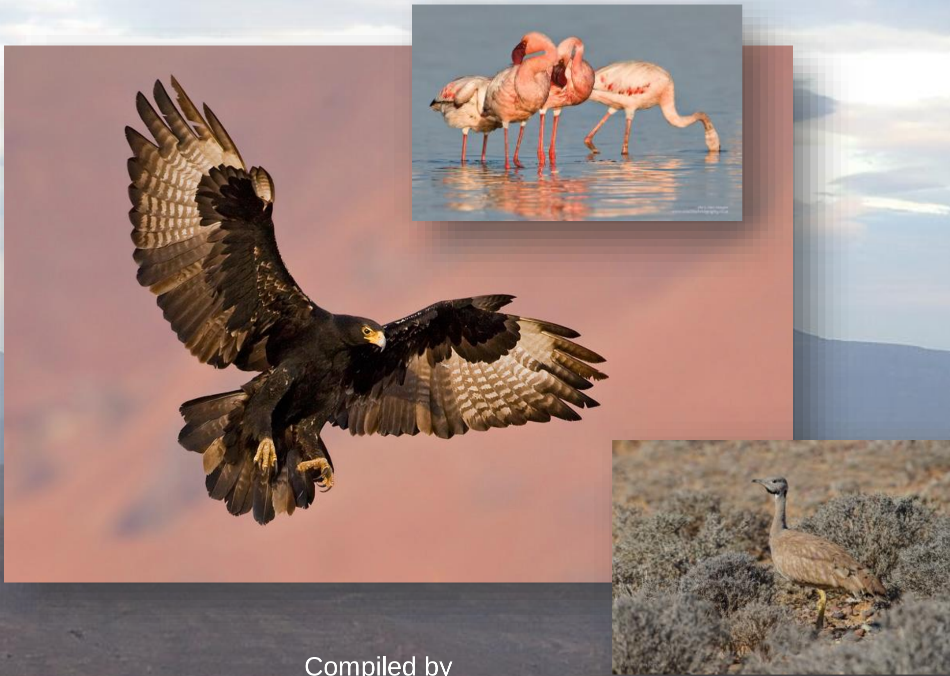
BIOTHERM MARALLA EAST WIND PROJECT

SPECIALIST INPUT INTO THE SCOPING REPORT: AVIFAUNA



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APRIL 2016

EXECUTIVE SUMMARY

BioTherm Energy (BioTherm) is proposing to develop three wind energy facilities (WEFs) in the vicinity of Sutherland, in the Western Cape and Northern Cape. The planned sites are called Maralla East and West (2 x sites) and Esizayo (1 x site). The localities are located in the proposed Komsberg Renewable Energy Development Zone (REDZ) (DEA 2015). This report is specific to Maralla East.

The potential impacts on avifauna which may result due to the proposed developments are listed below.

MARALLA EAST

MARALLA EAST: DISPLACEMENT OF PRIORITY SPECIES DUE TO DISTURBANCE (CONSTRUCTION AND DE-COMMISSIONING)

The construction (and de-commissioning) of the wind farm and associated infrastructure will result in a significant amount of movement and noise, which will lead to temporary displacement of avifauna from the site. It is highly likely that most priority species listed in Table 2 will vacate the area for the duration of these activities.

Suggested mitigation measures are as follows:

- Restrict the construction activities to the construction footprint area.
- Do not allow any access by construction teams to the remainder of the property during the construction period.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.
- It is recommended that appropriate no-turbine buffer zones are implemented around priority raptor nests, should any be discovered in the course of the pre-construction monitoring, which is currently ongoing. If an eagle's nest is recorded, this will entail a 3km pre-cautionary buffer zone.
- A 1km no infrastructure buffer zone is recommended around a Martial Eagle roosting area.

MARALLA EAST: PRIORITY SPECIES MORTALITY DUE TO COLLISION WITH THE TURBINES (OPERATION)

Priority species that could potentially be vulnerable to wind turbine collisions are listed in Table 2. It is noted though that no Ludwig's Bustard mortalities have as yet been reported at wind farms in South Africa, despite initial concerns that the species might be vulnerable in this respect (Ralston, M. in litt. 2016).

Proposed mitigation measures are:

- Pre-construction monitoring should be completed to guide the lay-out of the turbines.
- Once the turbines have been constructed, post-construction monitoring should be implemented to compare actual collision rates with predicted collision rates.
- No turbines should be constructed on west facing slopes (i.e. those facing the dominant wind direction) to minimise the risk of collisions of slope soaring species, particularly raptors.

- If actual collision rates indicate high mortality levels, curtailment of selective turbines should be implemented.

MARALLA EAST: DISPLACEMENT OF PRIORITY SPECIES DUE TO HABITAT TRANSFORMATION (OPERATION)

Priority species that could potentially be vulnerable to displacement due to habitat transformation are listed in Table 2. The direct habitat transformation at the proposed wind farm is likely to be fairly minimal. The indirect habitat transformation (habitat fragmentation) is likely to have a bigger impact on priority species. It is expected that the densities of some terrestrial priority species (e.g. Karoo Korhaan, Southern Black Korhaan and Grey-winged Francolin) will decrease due to this impact, but complete displacement is unlikely. Raptors are unlikely to be affected. Indications are that bustards continue to use the wind farm areas (M. Langlands 2016 pers. comm, Rossouw 2016 pers.comm,).

Suggested mitigation measures are as follows:

- The recommendations of the specialist ecological study must be strictly adhered to.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.

CONTENTS

1. INTRODUCTION

BioTherm Energy (Pty) Ltd (BioTherm) is looking at developing three wind energy facilities (WEFs) in the vicinity of Sutherland, in the Western Cape and Northern Cape. The localities are located in the proposed Komsberg Renewable Energy Development Zone (REDZ) (DEA 2015).

The proposed sites are called Maralla East and West (2 x sites) and Esizayo (1 x site). This report is specific to Maralla East.

The proposed infrastructure will consist of the following:

Maralla East Wind Facility

- Generation capacity of potentially up to 250MW per facility;
- Up to 125 Wind Turbines Generators. Turbines will have a generating capacity of between 2 and 4MW each. The turbines will have a hub height of up to 120m and rotor diameter of up to 150m;
- Concrete foundation to support the Turbines;
- Onsite IPP 132kV Substation, with the transformers for voltage step up from medium voltage to high voltage. Substation will occupy an area of 150mx 150m;
- A power line of up to 132kV that will run from the onsite IPP substation to the onsite Eskom Substation;
- The medium voltage collector system will comprise of cables (1kV up to and including 33kV) that will be run underground, expect where a technical assessment suggest that overhead lines are applicable, in the facility connecting the turbines to the onsite substation;
- A laydown area for the temporary storage of materials during the construction activities. The laydown area will be a maximum of 4ha in size;
- Temporary site compound for Contractors;
- Permanent turbine crane platforms;
- Septic tanks;
- Access roads and internal roads;
- Construction of a car park and fencing;
- Administration, control and warehouse buildings;
- Operations and Maintenance compound area including O&M building, car park and storage area.

See Figure 1 below for a map of the study area.

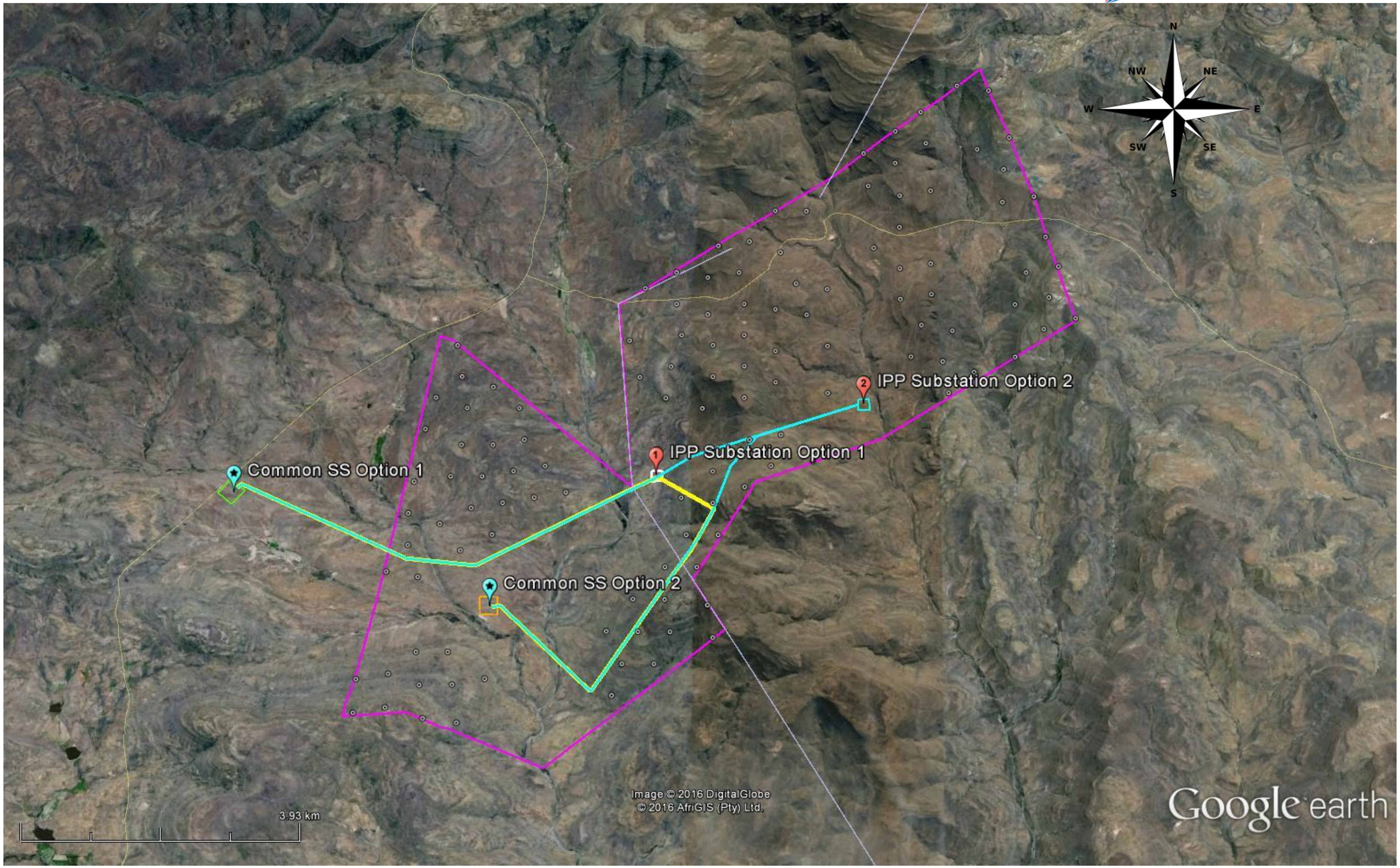

Figure 1: A Google Earth screen capture of the study area indicating the various project components for Maralla East.

1.1. SCOPE AND LIMITATIONS

1.1.1 INFORMATION SOURCES

The report made use of the following information sources:

- Bird distribution data of the Southern African Bird Atlas Project2 (SABAP 2) (sabap2.adu.org.za) (see Figures 2).
- Atlas of Southern African Birds 1 (SABAP1) (Harrison *et al.*1997)
- The power line bird mortality incident database of the Endangered Wildlife Trust (1996 to 2008) (Jenkins *et al.* 2010).
- National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006).
- Red Data Book of Birds of South Africa, Lesotho and Swaziland (Taylor *et al.* 2015),
- Roberts Birds of Southern Africa VII (Hockey *et al.* 2005).
- The (2015.4) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- The Birdlife South Africa (BLSA) Important Bird Areas of South Africa directory (http://www.birdlife.org.za/conservation/important-bird-areas) (Marnewick *et al.* 2015).
- Satellite imagery from Google Earth.
- Information on bird diversity and abundance at the sites is being obtained through a 12-months monitoring programme which is currently underway at the sites. Data is collected through transect counts, incidental sightings, inspection of focal points and the recording of flight behaviour from vantage points.
- Information on the dominant wind direction at all the sites was obtained from BioTherm (2016).
- Information on existing raptor nests were obtained from avifaunal specialists Dr. Andrew Jenkins (Avisense Consulting) and Andrew Pearson (Arcus), as well as from the staff of the Komsberg Nature Reserve.

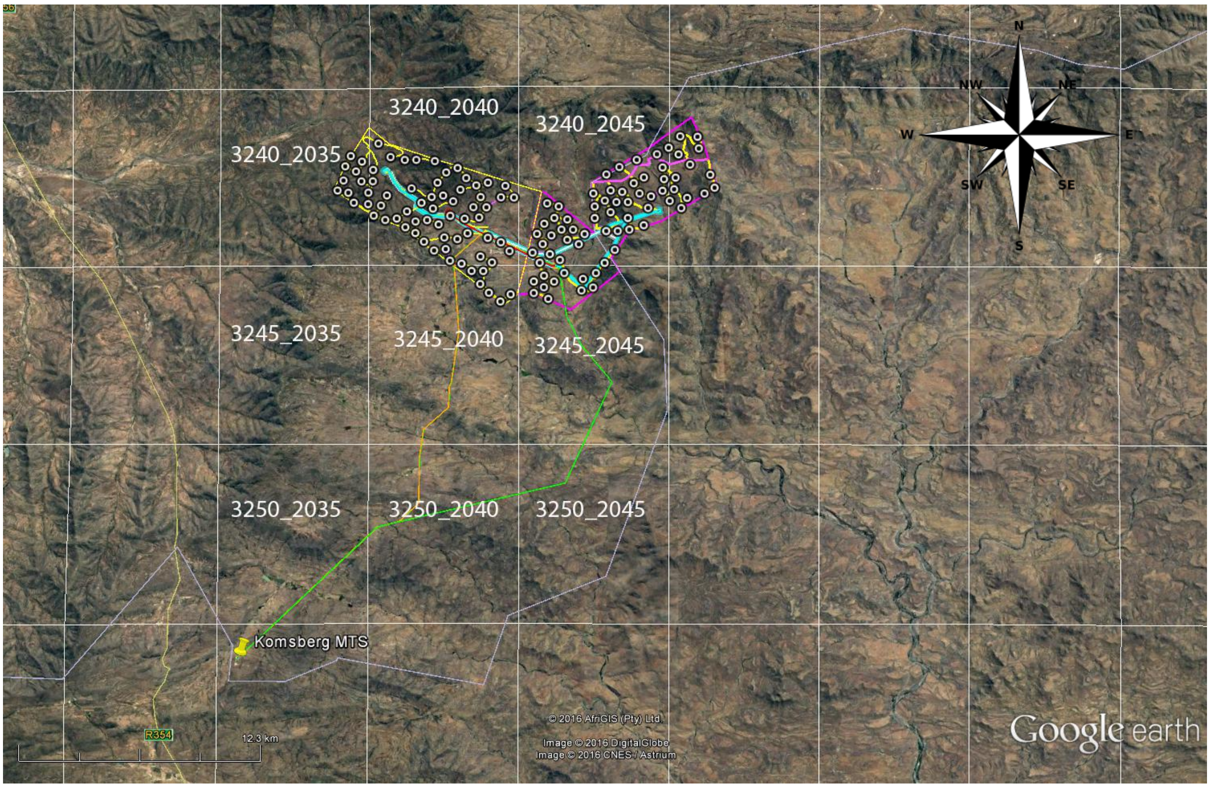

Figure 2: Area covered by the SABAP2 pentads – Maralla East.

1.1.2 ASSUMPTIONS AND LIMITATIONS

This study made the assumption that the sources of information used in this report are reliable. However, in this respect, the following must be noted:

- A total of 32 full protocol lists have been completed to date to date for the 9 pentads for the Maralla study area (i.e. lists surveys lasting a minimum of two hours or more each). This is a fairly comprehensive dataset which provides a reasonably accurate snapshot of the avifauna which could occur in the study area. For purposes of completeness, the list of species that could be encountered was supplemented with personal observations, general knowledge of the area, SABAP1 records (Harrison *et al.* 1997), and data from the pre-construction monitoring.
- Conclusions in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will be valid under all circumstances, especially for a relatively new field such as wind energy. However, power line and substation impacts can be predicted with a fair amount of certainty, based on a robust body of research stretching back over thirty years (see References Section 9).
- To date no peer-reviewed scientific papers are available on the impacts of wind farms on birds in South Africa. The precautionary principle was therefore applied throughout. The World Charter for Nature, which was adopted by the UN General Assembly in 1982, was the first international endorsement of the precautionary principle (http://www.unep.org). The principle was implemented in an international treaty as early as the 1987 Montreal Protocol and, among other international treaties and declarations, is reflected in the 1992 Rio Declaration on Environment and Development. Principle 15 of the 1992 Rio Declaration states that: "in order to protect the

environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall be not used as a reason for postponing cost-effective measures to prevent environmental degradation."

- Predicted mortality rates are often inaccurate, indicating that this is still a fledgling science in many respects, even in developed countries like Spain with an established wind industry (Ferrer *et al.* 2012). Mortality data from post-construction monitoring programmes currently implemented at wind farms in South Africa was used to assist with the priority species risk assessments (Ralston, M. in litt. 2016).
- Priority species were taken from the updated list of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Retief *et al.* 2012).
- The study area was defined as the areas which comprise the wind farm development area site and the proposed grid connection alternatives (see Figures 4 and 5).

2. APPROACH AND METHODOLOGY

The following methods were applied to compile this report:

- Bird distribution data of the South African Bird Atlas 2 (SABAP 2) was obtained from the Animal Demography Unit of the University of Cape Town, as a means to ascertain which species occurs within the broader area i.e. within a block consisting of nine pentad grid cells within which the proposed wind facilities are situated (see Figures 1). A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. From 2008 to date, a total of 32 full protocol cards (i.e. 32 surveys lasting a minimum of two hours or more each) have been completed for the Maralla area.
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa (Taylor 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the latest (2015.4) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- A classification of the vegetation types in the study area was obtained from the Atlas of Southern African Birds 1 (SABAP1) and the National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006).
- The Important Bird and Biodiversity Areas of South Africa (Marnewick *et al.* 2015) was consulted for information on Important Bird Areas (IBAs).
- Satellite imagery was used in order to view the broader development area on a landscape level and to help identify sensitive bird habitat.
- Priority species were taken from the updated list of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Retief *et al.* 2012).
- The 12-months pre-construction monitoring commenced in January 2016 at all three sites[1]. See Appendix 3 for a summary of the methodology employed in the pre-construction programme at Maralla East and West.

[1] Three surveys have been completed to date.

2.1. IMPACT SCREENING TOOL

To ensure a direct comparison between various specialist studies, an impact screening tool has been developed to assess the significance of identified impacts. The screening tool will allow any impacts of very low significance to be excluded from the detailed studies in the impact assessment phase. The screening tool is based on two criteria, namely probability and severity.

		Severity / Beneficial Scale			
		1	2	3	4
Probability Scale	1	Very Low	Very Low	Low	Medium
	2	Very Low	Low	Medium	Medium
	3	Low	Medium	Medium	High
	4	Medium	Medium	High	High

Probability Scale

4	**Definite**
	Where the impact will occur regardless of any prevention measures
3	**Highly Probable**
	Where it is most likely that the impact will occur
2	**Probable**
	Where there is a good possibility that the impact will occur
1	**Improbable**
	Where the possibility of the impact occurring is very low

Severity / Beneficial Scale

4	**Very severe**	**Very beneficial**
	An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated.	A permanent and very substantial benefit to the affected system(s) or party(ies), with no real alternative to achieving this benefit.
3	**Severe**	**Beneficial**
	A long term impacts on the affected system(s) or party(ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming or some combination of these.	A long term impact and substantial benefit to the affected system(s) or party(ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these.
2	**Moderately severe**	**Moderately beneficial**

	A medium to long term impacts on the affected system(s) or party(ies) that could be mitigated.	A medium to long term impact of real benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way.
1	**Negligible**	**Negligible**
	A short to medium term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary.	A short to medium term impact and negligible benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are easier, cheaper and quicker, or some combination of these.

3. REGIONAL OVERVIEW

3.1 BIRD HABITATS

3.1.1 MARALLA EAST

The proposed Maralla sites are situated approximately 33km south of the town of Sutherland, in the Karoo Hoogland Local Municipality of the Northern Cape Province. The sites are situated in the proposed Komsberg Renewable Energy Zone (REDZ) and the proposed Central Corridor of the national Electricity Grid Infrastructure (EGI) (DEA 2015). The two sites straddle the slopes of the Klein Roggeveld Mountains below the escarpment, and is bisected by numerous ephemeral rivers, the largest being the Komsberg River and the Venter's River. The habitat in the study area is extremely rugged, consisting of rolling hills with boulder-strewn slopes and exposed ridge lines. The two highest points in the study area is Graskop (1430m a.s.l) and Perdekop (1478m a.s.l.). The study area contains a number of man-made dams used for the irrigation of a few crops (mostly pastures), which is grown as supplementary fodder for small stock farming. Sheep farming is the main economic activity. Maralla East is traversed by the Laingsburg / Roggeveld 1 66kV distribution power line, and Eskom's Droërivier-Muldersvlei and Bachus-Droërivier 400kV transmission lines pass about 10km to the south of the two sites.

The natural vegetation is dominated by Central Mountain Shale Renosterveld which exists in a transitional zone between the Fynbos and Succulent Karoo Biomes (Mucina & Rutherford 2006). The vegetation type is found on slopes and broad ridges of low mountains and escarpments. It consists of tall shrubland dominated by renosterbos and large suites of mainly non-succulent karoo shrubs with a rich geophytic flora in the undergrowth or in more open, wetter or rocky habitats (Mucina & Rutherford 2006). In the extreme west of the Maralla West site, Tanqua Escarpment Shrubland is found on steep slopes. In the south closer to Komsberg Main Transmission Substation (MTS) the Central Mountain Shale Renosterveld is replaced by Koedoesberge – Moordenaars Karoo which is found on slightly undulating to hilly landscapes consisting of low succulent scrub and dotted by scattered tall shrubs and patches of "white" grass (Mucina & Rutherford 2006).

The climate is arid to semi-arid with a mean average precipitation of 228mm, with relatively even rainfall with a slight peak in autumn and winter. Mean daily maximum and minimum temperatures in Sutherland range between 27°C and -3°C for January and July (http://www.worldweatheronline.com/sutherland-weather-averages/northern-cape/za.aspx).

While the development area is large, and the altitude range it encompasses considerable, the habitat in the study area from an avian perspective is relatively uniform, dominated by open, rocky, undulating or montane renosterbos, with steep, rocky slopes, ridges and low cliffs, denser, woody vegetation along the bigger drainage lines (and stands of alien trees), and both natural and artificial wetlands - river courses, vleis and dams. The larger artificial impoundments in the area probably support good numbers of waterbirds in wet years, and the Eskom power pylons are used as roosting, hunting and/or nesting habitat by certain species (e.g. raptors and corvids).
The site is not located within 50 km of any of the currently registered national Important Bird Areas (Marnewick *et al.* 2015).

3.2 AVIFAUNA

3.1.1 MARALLA EAST

A total of 161 species could potentially occur in the study area. Of these, 19 are classified as priority species. Table 1 below lists the priority species that could potentially occur in the study area, as well as the potential impact on the species in the study area.

See Appendix 1 for a list of species that could occur at Maralla East and Maralla West.

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Table 1: Priority species potentially occurring at the Maralla East site.

LC = Least concern

NT = Near threatened

VU = Vulnerable

EN = Endangered

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)	Maralla East	Maralla West	Recorded during pre-construction monitoring	Collisions with associated power line	Collisions with turbines	Displacement through disturbance	Displacement through habitat transformation
Bustard, Ludwig's	*Neotis ludwigii*	x	EN	EN		Near-endemic	6.25	✓ 10.42	x	x		x		x	
Buzzard, Jackal	*Buteo rufofuscus*	x			Near endemic	Endemic	53.13	✓ 22.22	x	x	x		x		
Buzzard, Steppe	*Buteo vulpinus*	x					15.63	✓ 17.65	x	x			x		
Eagle, Booted	*Aquila pennatus*	x					3.13	✓ 10.71	x	x			x		
Eagle, Martial	*Polemaetus*	x	VU	EN			21.88	✓ 10.42	x	x	x		x		
Eagle, Verreaux's	*Aquila verreauxii*	x	LC	VU			6.25	✓ 16.67	x	x	x		x		
Eagle-owl, Spotted	*Bubo africanus*	x					28.13	✓ 5.88	x	x	x		x		
Flamingo, Greater	*Phoenicopterus*	x	LC	NT			0	✓ 18.18		x		x	x		
Francolin, Grey-winged	*Scleroptila*	x			Endemic (SA, Lesotho, Swaziland)	Endemic	40.63	✓ 8.33	x	x	x			x	x
Goshawk, Southern Pale Chanting	*Melierax canorus*	x				Near-endemic	34.38	✓ 30.00	x	x	x		x		
Harrier, Black	*Circus maurus*	x	VU	EN	Near endemic	Endemic	0	✓ 12.00	x	x			x		
Kestrel, Lesser	*Falco naumanni*	x					3.13	✗ 0.00	x	x	x			x	
Kite, Black-shouldered	*Elanus caeruleus*	x					0	✓ 29.41	x	x			x		
Korhaan, Karoo	*Eupodotis vigorsii*	x	LC	NT		Endemic	15.63	✓ 15.00	x	x		x		x	x
Korhaan, Southern Black	*Afrotis afra*	x	VU	VU	Endemic	Endemic	25	✓ 16.00	x	x	x	x	x	x	x
Snake-eagle, Black-chested	*Circaetus pectoralis*	x					3.13	✓ 16.67	x	x	x		x		
Sparrowhawk, Rufous-chested	*Accipiter rufiventris*	x					9.38	✗ 0.00	x	x	x		x		
Stork, Black	*Ciconia nigra*	x	LC	VU			0	✓ 5.88	x	x			x		
Falcon, Lanner	*Falco biarmicus*	x	LC	VU			0	0	x	x	x		x		

4. IMPACTS AND ISSUES IDENTIFICATION

4.1 DESCRIPTION OF EXPECTED IMPACTS

The effects of a wind farm on birds are highly variable and depend on a wide range of factors including the specification of the development, the topography of the surrounding land, the habitats affected and the number and species of birds present. With so many variables involved, the impacts of each wind farm must be assessed individually. The principal areas of concern with regard to effects on birds are listed below. Each of these potential effects can interact with each other, either increasing the overall impact on birds or, in some cases, reducing a particular impact (for example where habitat loss or displacement causes a reduction in birds using an area which might then reduce the risk of collision):

- Collision mortality on the wind turbines;
- Displacement due to disturbance during construction and operation of the wind farm;
- Displacement due to habitat change and loss;
- Collision with the proposed power line grid connections; and
- Displacement due to disturbance during the construction of the power line grid connection.

It is important to note that the assessment is made on the status quo as it is currently in the study area. The possible change in land use in the broader development area is not taken into account because the extent and nature of future developments are unknown at this stage. It is however highly unlikely that the land use will change in the foreseeable future.

4.2 COLLISION MORTALITY ON WIND TURBINES[2]

Wind energy generation has experienced rapid worldwide development over recent decades as its environmental impacts are considered to be relatively lower than those caused by traditional energy sources, with reduced environmental pollution and water consumption (Saidur *et al.*, 2011). However, bird fatalities due to collisions with wind turbines have been consistently identified as a main ecological drawback of wind energy (Drewitt and Langston, 2006).

Collisions with wind turbines appear to kill fewer birds than collisions with other man-made infrastructures, such as power lines, buildings or even traffic (Calvert *et al.* 2013; Erickson *et al.* 2005). Nevertheless, estimates of bird deaths from collisions with wind turbines worldwide range from 0 to almost 40 deaths per turbine per year (Sovacool, 2009). The number of birds killed varies greatly between sites, with some sites posing a higher collision risk than others, and with some species being more vulnerable (e.g. Hull *et al.* 2013; May *et al.* 2012a). These numbers may not reflect the true magnitude of the problem, as some studies do not account for detectability biases such as those caused by scavenging, searching efficiency and search radius (Bernardino *et al.* 2013; Erickson *et al.* 2005; Huso and Dalthorp 2014). Additionally, even for low fatality rates, collisions with wind turbines may have a disproportionate effect on some species. For long-lived species with low productivity and slow maturation rates (e.g. raptors), even low mortality rates can have a significant impact at the population level (e.g. Carrete *et al.* 2009; De Lucas *et al.* 2012a; Drewitt and Langston, 2006). The situation is

[2] This section is adapted from a recent (2014) review paper by Ana Teresa Marques, Helena Batalha, Sandra Rodrigues, Hugo Costa, Maria João Ramos Pereira, Carlos Fonseca, Miguel Mascarenhas, Joana Bernardino. *Understanding bird collisions at wind farms: An updated review on the causes and possible mitigation strategies*. Biological Conservation 179 (2014) 40–52

even more critical for species of conservation concern, which sometimes are most at risk (e.g. Osborn *et al.* 1998).

High bird fatality rates at several wind farms have raised concerns among the industry and scientific community. High profile examples include the Altamont Pass Wind Resource Area (APWRA) in California because of high fatality of Golden eagles (*Aquila chrysaetos*), Tarifa in Southern Spain for Griffon vultures (*Gyps fulvus*), Smøla in Norway for White-tailed eagles (*Haliaatus albicilla*), and the port of Zeebrugge in Belgium for gulls (*Larus* sp.) and terns (*Sterna* sp.) (Barrios and Rodríguez, 2004; Drewitt and Langston, 2006; Everaert and Stienen, 2008; May *et al.* 2012a; Thelander *et al.* 2003). Due to their specific features and location, and characteristics of their bird communities, these wind farms have been responsible for a large number of fatalities that culminated in the deployment of additional measures to minimize or compensate for bird collisions. However, currently, no simple formula can be applied to all sites; in fact, mitigation measures must inevitably be defined according to the characteristics of each wind farm and the diversity of species occurring there (Hull *et al.* 2013; May *et al.* 2012b). An in-depth understanding of the factors that explain bird collision risk and how they interact with one another is therefore crucial to proposing and implementing valid mitigation measures.

4.2.1 SPECIES-SPECIFIC FACTORS

- Morphological features

Certain morphological traits of birds, especially those related to size, are known to influence collision risk with structures such as power lines and wind turbines. The most likely reason for this is that large birds often need to use thermal and orographic updrafts to gain altitude, particularly for long distance flights. Thermal updrafts (thermals) are masses of hot, rising wind that form over heated surfaces, such as plains. Being dependent on solar radiation, they occur at certain times of the year or the day. Conversely, orographic lift (slope updraft), is formed when wind is deflected by an obstacle, such as mountains, slopes or tall buildings. Soaring birds use these two types of lift to gain altitude (Duerr *et al.* 2012). Janss (2000) identified weight, wing length, tail length and total bird length as being collision risk determinant. Wing loading (ratio of body weight to wing area) and aspect ratio (ratio of wing span squared to wing area) are particularly relevant, as they influence flight type and thus collision risk (Bevanger, 1994; De Lucas *et al.* 2008; Herrera-Alsina *et al.* 2013; Janss, 2000). Birds with high wing loading, such as the Griffon Vulture (*Gyps fulvus*), seem to collide more frequently with wind turbines at the same sites than birds with lower wing loadings, such as Common Buzzards (*Buteo buteo*) and Short-toed Eagles (*Circaetus gallicus*), and this pattern is not related with their local abundance (Barrios and Rodríguez, 2004; De Lucas *et al.* 2008). High wing-loading is associated with low flight manoeuvrability (De Lucas *et al.* 2008), which determines whether a bird can escape an encountered object fast enough to avoid collision.

Priority species that could potentially be vulnerable to wind turbine collisions due to morphological features (high wing loading) are Southern Black Korhaan, Karoo Korhaan, Grey-winged Francolin, Greater Flamingo and Ludwig's Bustard. It is noted though that no Ludwig's Bustard mortalities have as yet been reported at wind farms in South Africa, despite initial concerns that the species might be vulnerable in this respect (Ralston, M. in litt. 2016).

- Sensorial perception

Birds are assumed to have excellent visual acuity, but this assumption is contradicted by the large numbers of birds killed by collisions with man-made structures (Drewitt and Langston, 2008; Erickson *et al.* 2005). A common explanation is that birds collide more often with these structures in conditions of low visibility, but recent studies have shown that this is not always the case (Krijgsveld *et al.* 2009). The visual acuity of birds seems to be slightly superior to that of other vertebrates (Martin, 2011; McIsaac, 2001). Unlike humans, who have a broad horizontal binocular field of 120°, some birds have two high acuity areas that overlap in a very narrow horizontal binocular field (Martin, 2011). Relatively small frontal binocular fields have been described for several species that are particularly vulnerable to power line collisions, such as vultures (Gyps *sp.*) cranes and bustards (Martin and Katzir, 1999; Martin and Shaw, 2010; Martin, 2012, 2011; O'Rourke *et al.* 2010). Furthermore, for some species, their high resolution vision areas are often found in the lateral fields of view, rather than frontally (e.g. Martin and Shaw, 2010; Martin, 2012, 2011; O'Rourke *et al.* 2010). Finally, some birds tend to look downwards when in flight, searching for conspecifics or food, which puts the direction of flight completely inside the blind zone of some species (Martin and Shaw, 2010; Martin, 2011). For example, the visual fields of vultures (*Gyps sp.*) include extensive blind areas above, below and behind the head and enlarged supra-orbital ridges (Martin *et al.* 2012). This, combined with their tendency to angle their head toward the ground in flight, might make it difficult for them to see wind turbines ahead, which might at least partially explain their high collision rates with wind turbines (Martin, 2012).

Currently, there is little information on whether noise from wind turbines can play a role in bird collisions with wind turbines. Nevertheless, wind turbines with whistling blades are expected to experience fewer avian collisions than silent ones, with birds hearing the blades in noisy (windy) conditions. However, the hypothesis that louder blade noises (to birds) result in fewer fatalities has not been tested so far (Dooling, 2002).

Many of the priority species at the proposed wind farms probably have high resolution vision areas found in the lateral fields of view, rather than frontally, e.g., the bustards, korhaans and passerines. The possible exceptions to this are the raptors which all have wider binocular fields, although as pointed out by Martin (2011, 2012), this does not necessarily result in these species being able to avoid obstacles better.

- Phenology

It has been suggested that resident birds would be less prone to collision, due to their familiarity with the presence of the structures (Drewitt and Langston, 2008). However, recent studies have shown that, within a wind farm, raptor collision risk and fatalities are higher for resident than for migrating birds of the same species. An explanation for this may be that resident birds generally use the wind farm area several times while a migrant bird crosses it just once (Krijgsveld *et al.* 2009). However, other factors like bird behaviour are certainly relevant. Katzner *et al.* (2012) showed that Golden Eagles performing local movements fly at lower altitudes, putting them at a greater risk of collision than migratory eagles. Resident eagles flew more frequently over cliffs and steep slopes, using low altitude slope updrafts, while migratory eagles flew more frequently over flat areas and gentle slopes, where thermals are generated, enabling the birds to use them to gain lift and fly at higher altitudes. Also, Johnston *et al.* (2014) found that during migration when visibility is good Golden Eagles can adjust their flight altitudes and avoid the wind turbines.

At two wind farms in the Strait of Gibraltar, the majority of Griffon Vulture deaths occurred in the winter. This probably happened because thermals are scarcer in the winter, and resident vultures in that season probably relied more on slope updrafts to gain lift (Barrios and Rodríguez, 2004). The strength of these updrafts may not have been sufficient to lift the vultures above the turbine blades, thereby exposing them to a higher collision risk. Additionally, migrating vultures did not seem to follow routes that crossed these two wind farms, so the number of collisions did not increase during migratory periods. Finally, at Smøla, collision risk modelling showed that White-tailed Eagles are most prone to collide during the breeding season, when there is increased flight activity in rotor swept zones (Dahl *et al.* 2013).

The case seems to be different for passerines, with several studies documenting high collision rates for migrating passerines at certain wind farms, particularly at coastal or offshore sites. However, comparable data on collision rates for resident birds is lacking. This lack of information may result from fewer studies, lower detection rates and rapid scavenger removal (Johnson *et al.* 2002; Lekuona and Ursua, 2007). One of the few studies reporting passerine collision rates (from Navarra, northern Spain) documents higher collision rates in the autumn migration period, but it is unclear if this is due to migratory behaviour or due to an increase in the number of individuals because of recently fledged juveniles (Lekuona and Ursua, 2007).

Migratory priority species that could be encountered at the wind development site are Steppe Buzzard, Booted Eagle and Lesser Kestrel.

- Bird behaviour

Flight type seems to play an important role in collision risk, especially when associated with hunting and foraging strategies. Kiting flight, which is used in strong winds and occurs in rotor swept zones, has been highlighted as a factor explaining the high collision rate of Red-tailed Hawks (*Buteo jamaicensis*) at APWRA (Hoover and Morrison, 2005). The hovering behaviour exhibited by Common Kestrels (*Falco tinnunculus*) when hunting may also explain the fatality levels of this species at wind farms in the Strait of Gibraltar (Barrios and Rodríguez, 2004). Kiting and hovering are associated with strong winds, which often produce unpredictable gusts that may suddenly change a bird's position (Hoover and Morrison, 2005). Additionally, while birds are hunting and focused on prey, they might lose track of wind turbine positions (Krijgsveld *et al.* 2009; Smallwood *et al.* 2009).

Collision risk may also be influenced by behaviour associated with a specific sex or age. In Belgium, only adult Common Terns (*Sterna hirundo*) were impacted by a wind farm (Everaert and Stienen, 2007) and the high fatality rate was sex-biased (Stienen *et al.* 2008). In this case, the wind farm is located in the foraging flight path of an important breeding colony, and the differences between fatality of males and females can be explained by the different foraging activity during egg-laying and incubation (Stienen *et al.* 2008). Another example comes from Portugal, where recent findings showed that the mortality of the Skylark (*Alauda arvensis*) is sex and age biased, and affecting mainly adult males. This was related with the characteristic breeding male song-flights that make them more vulnerable to collision with wind turbines (Morinha *et al.* 2014). It seems this may also be responsible for mortalities of Red-capped Lark (*Calandrella cinerea*) at a wind farm in South Africa (Ralston, M. in litt. 2016).

Social behaviour may also result in a greater collision risk with wind turbines due to a decreased awareness of the surroundings. Several authors have reported that flocking behaviour increases collision risk with power lines as opposed to solitary flights (e.g. Janss, 2000). However, caution must be exercised when comparing the particularities of wind farms with power lines, as some species appear to be vulnerable to collisions with power lines but not with wind turbines, e.g. indications are that bustards, which are highly vulnerable to power line collisions, are not prone to wind turbine collisions – a Spanish database of over 7000 recorded turbine collisions contains no Great Bustards *Otis tarda* (A. Camiña 2012a). The same may be true for Blue Crane, as preliminary indications are that the species are not particularly vulnerable to turbine collisions (Ralston, M. in litt. 2016), despite being highly vulnerable to powerlines collisions.

Several collision risk models incorporate other variables related to bird behaviour. Flight altitude is widely considered important in determining the risk of bird collisions with offshore and onshore wind turbines, as birds that tend to fly at the height of rotor swept zones are more likely to collide (e.g. Band *et al.* 2007; Furness *et al.* 2013; Garthe and Hüppop, 2004).

The priority species at the wind farm can be classified as either terrestrial species or soaring species. Terrestrial species spend most of the time foraging on the ground. They do not fly often and then generally short distances at low to medium altitude, usually powered flight. At the wind farm site, korhaans and bustards are included in this category. Some larger species undertake longer distance flights at higher altitudes (specifically Ludwig's Bustard). Soaring species spend a significant time on the wing in a variety of flight modes including soaring, kiting, hovering and gliding at medium to high altitudes. At the wind farm site, the raptor and stork species are included in this class. Based on the potential time spent potentially flying at rotor height, soaring species are likely to be at greater risk of collision, especially Jackal Buzzard, which is clearly highly vulnerable to turbine collisions (Ralston, M. in litt. 2016). However, specific behaviour of some terrestrial species might put them at risk of collision, e.g. display flights of Southern Black Korhaan might place them within the rotor swept zone.

- Avoidance behaviours

Collision fatalities are also related to displacement and avoidance behaviours, as birds that do not exhibit either of these behaviours are more likely to collide with wind turbines. The lack of avoidance behaviour has been highlighted as a factor explaining the high fatality of White-tailed Eagles at Smøla wind farm, as no significant differences were found in the total amount of flight activity within and outside the wind farm area (Dahl *et al.* 2013). However, the birds using the Smøla wind farm are mainly sub-adults, indicating that adult eagles are being displaced by the wind farm (Dahl *et al.* 2013).

Two types of avoidance have been described (Furness *et al.*, 2013): 'macro-avoidance' whereby birds alter their flight path to keep clear of the entire wind farm (e.g. Desholm and Kahlert, 2005; Plonczkier and Simms, 2012; Villegas-Patraca *et al.* 2014), and 'micro-avoidance' whereby birds enter the wind farm but take evasive actions to avoid individual wind turbines (Band *et al.* 2007). This may differ between species and may have a significant impact on the size of the risk associated with a specific species. It is generally assumed that 95-98% of birds will successfully avoid the turbines (SNH 2010). It is also important to note that there is not necessarily a direct correlation between time spent at rotor height, and the likelihood of collision.

Displacement due to wind farms, which can be defined as reduced bird breeding density within a short distance of a wind turbines, has been described for some species (Pearce-Higgins *et al.* 2009). Birds exhibiting this type of displacement behaviour when defining breeding territories are less vulnerable to collisions, not because of morphological or site-specific factors, but because of altered behaviour (see also section 6.2 below).

It is anticipated that most birds at the proposed wind farm will successfully avoid the wind turbines. Possible exceptions might be some raptors (especially Lesser Kestrel, Jackal Buzzard and possibly Verreaux's Eagle, Black Harrier and Lanner Falcon) engaged in hunting which might serve to distract them and place them at risk of collision, or birds engaged in display behaviour, e.g. Southern Black Korhaan (see earlier point). Despite being potential collision candidates based on morphology and flight behaviour, bustards do not seem to be particularly vulnerable to wind turbine collisions, indicating a high avoidance rate (A. Camiña 2012a). To date, no Ludwig's Bustard collisions have been recorded at operational South African wind farms (Ralston, M. in litt. 2016). Obviously it is too early to make conclusive statements about the vulnerability of the species to wind turbine collisions, but these early indications are promising.

- Bird abundance

Some authors suggest that fatality rates are related to bird abundance, density or utilization rates (Carrete *et al.* 2012; Kitano and Shiraki, 2013; Smallwood and Karas, 2009), whereas others point out that, as birds use their territories in a non-random way, fatality rates do not depend on bird abundance alone (e.g. Ferrer *et al.* 2012; Hull *et al.* 2013; Smallie 2015). Instead, fatality rates depend on other factors such as differential use of specific areas within a wind farm (De Lucas *et al.* 2008). For example, at Smøla, White-tailed Eagle flight activity is correlated with collision fatalities (Dahl *et al.* 2013). In the APWRA, Golden Eagles, Red-tailed Hawks and American Kestrels (*Falco spaverius*) have higher collision fatality rates than Turkey Vultures (*Cathartes aura*) and Common Raven (*Corvus corax*), even though the latter are more abundant in the area (Smallwood *et al.* 2009), indicating that fatalities are more influenced by each species' flight behaviour and turbine perception. Also, in southern Spain, bird fatality was higher in the winter, even though bird abundance was higher during the pre-breeding season (De Lucas *et al.* 2008).

The abundance of priority species at the proposed wind farm site will fluctuate depending on season of the year, and particularly in response to rainfall. This is a common phenomenon in arid ecosystems, where stochastic rainfall events can trigger irruptions of insect populations which in turn attract large numbers of birds, e.g. Ludwig' Bustard. In general, higher populations of priority species are likely to be present when the veld conditions are good, especially in the rainy season.

4.2.2 SITE-SPECIFIC FACTORS

- Landscape features

Susceptibility to collision can also heavily depend on landscape features at a wind farm site, particularly for soaring birds that predominantly rely on wind updrafts to fly (see previous section). Some landforms such as ridges, steep slopes and valleys may be more frequently used by some birds, for example for hunting or during migration (Barrios and Rodríguez, 2004; Drewitt and Langston, 2008; Katzner *et al.* 2012; Thelander *et al.* 2003). In APWRA, Red-tailed Hawk fatalities occur more frequently than expected by chance at wind turbines located on ridge tops and swales, whereas Golden Eagle fatalities are higher at wind turbines located on slopes (Thelander *et al.* 2003). Other birds may follow other landscape features, such as peninsulas and shorelines, during dispersal and migration periods. Kitano and Shiraki (2013) found that the collision rate of White-tailed Eagles along a coastal cliff was extremely high, suggesting an effect of these landscape features on fatality rates.

Landscape features are likely to play an important role at the site. The site basically consists of rolling hills and low mountains with steep slopes, exposed ridge lines and low cliffs. The dominant wind direction throughout the year is westerly (BioTherm 2016). West facing slopes are likely to be important landscape features for soaring species, particularly raptors such as Jackal Buzzard, Booted Eagle, Verreaux's Eagle and Martial Eagle, due to the presence of declivity currents. These are likely to be the areas where most of the soaring raptor flight activity will take place at turbine height.

- Flight paths

Although the abundance of a species per se may not contribute to a higher collision rate with wind turbines, as previous discussed, areas with a high concentration of birds seem to be particularly at risk of collisions (Drewitt and Langston, 2006), and therefore several guidelines on wind farm construction advise special attention to areas located in migratory paths (e.g. Atienza *et al.* 2012; CEC, 2007; USFWS, 2012). As an example, Johnson *et al.* (2002) noted that over two-thirds of the carcasses found at a wind farm in Minnesota were of migrating birds. At certain times of the year, nocturnally migrating passerines are the most abundant species at wind farm, particularly during spring and fall migrations, and are also the most common fatalities (Strickland *et al.* 2011).

For territorial raptors like Golden Eagles, foraging areas are preferably located near to the nest, when compared to the rest of their home range. For example, in Scotland 98% of movements were registered at ranges less than 6 km from the nest, and the core areas were located within a 2–3 km radius (McGrady *et al.* 2002). These results, combined with the terrain features selected by Golden Eagles to forage such as areas closed to ridges, can be used to predict the areas used by the species to forage (McLeod *et al.* 2002), and therefore provide a sensitivity map and guidance to the development of new wind farms (Bright *et al.* 2006). In Spain, on the other hand, a study spanning 7 provinces with an estimated Golden Eagle population of 384 individuals, with a combined total of 46 years of post-construction monitoring, involving 5 858 turbines, collisions did not occur at the nearest wind farm to the nest site but occurred in hunting areas with high prey availability far from the breeding territories, or randomly. A subset of data was used to investigate, inter alia, the relationship between collision mortality and proximity to wind turbines. Data was gathered for over a 12-year period. Analysis revealed that collisions are not related with the distance from the nest to the nearest turbine (Camiña 2014).

Wind farms located within flight paths can increase collision rates, as seen for the wind farm located close to a seabird breeding colony in Belgium (Everaert and Stienen, 2008). In this case, wind turbines were placed along feeding routes, and several species of gulls and terns were found to fly between wind turbines on their way to marine feeding grounds. Additionally, breeding adults flew closer to the structures when making frequent flights to feed chicks, which potentially increased the collision risk.

The proposed windfarm sites are not located on any known migration route. It is likely that the soaring raptors will hug the steeper slopes making use of the declivity currents.

- Food availability

Factors that increase the use of a certain area or that attract birds, like food availability, also play a role in collision risk. For example, the high density of raptors at the APWRA and the high collision fatality due to collision with turbines is thought to result, at least in part, from high prey availability in certain areas (Hoover and Morrison, 2005; Smallwood *et al.* 2001). This may be particularly relevant for birds that are less aware of obstructions such as wind turbines while foraging (Krijgsveld *et al.* 2009; Smallwood *et al.* 2009). It is speculated that the mortality of three Verreaux's Eagles in 2015 at a wind farm site in South Africa may have been linked to the opportunistic foraging due to availability of food (Smallie 2015).

In semi-arid zones such as where this proposed wind farm is located, food availability is often linked to rainfall. It is a well-known fact that insect outbreaks may occur after rainfall events, which could draw in various priority species such as Ludwig's Bustard, and possibly Lesser Kestrel. This in turn could heighten the risk of collisions

- Weather

Certain weather conditions, such as strong winds that affect the ability to control flight manoeuvrability or reduce visibility, seem to increase the occurrence of bird collisions with artificial structures (Longcore *et al.* 2013). Some high bird fatality events at wind farms have been reported during instances of poor weather. For example, at an offshore research platform in Helgoland, Germany, over half of the bird strikes occurred on just two nights that were characterized by very poor visibility (Hüppop *et al.* 2006). Elsewhere, 14 bird carcasses were found at two adjacent wind turbines after a severe thunderstorm at a North American wind farm (Erickson *et al.* 2001). However, in these cases, there may be a cumulative effect of bad weather and increased attraction to artificial light. Besides impairing visibility, low altitude clouds can in turn lower bird flight height, and therefore increasing their collision risk with tall obstacles (Langston and Pullan, 2003). For wind farms located along migratory routes, the collision risk may not be the same throughout a 24-h period, as the flight altitudes of birds seem to vary. The migration altitudes of soaring birds have been shown to follow a typically diurnal pattern, increasing during the morning hours, peaking toward noon, and decreasing again in the afternoon, in accordance with general patterns of daily temperature and thermal convection (Kerlinger, 2010; Shamoun-Baranes *et al.* 2003).

Collision risk of raptors is particularly affected by wind. For example, Golden Eagles migrating over a wind farm in Rocky Mountain showed variable collision risk according to wind conditions, which decreased when the wind speed raised and increased under head- and tailwinds when compared to western crosswinds (Johnston *et al.* 2014).

Weather conditions at the proposed wind farm are likely to influence flight behaviour in much the same manner as has been recorded elsewhere at wind farms. The flight behaviour of priority species are currently being recorded at the site, together with various environmental parameters such as weather conditions and wind speeds. Provided enough flight data is collected, this could be used to detect any statistically significant relationships between flight behaviour and various environmental parameters.

4.2.3 WIND FARM-SPECIFIC FACTORS

- Turbine features

Turbine features may play a role in collision risk. Older lattice-type towers have been associated with high collision risk, as some species exhibiting high fatality rates used the turbine poles as roosts or perches when hunting (Osborn *et al.* 1998; Thelander and Rugge, 2000). However, in more recent studies, tower structure did not influence the number of bird collisions, as it was not higher than expected according to their availability when compared to collisions with tubular turbines (Barrios and Rodríguez, 2004).

Turbine size has also been highlighted as an important feature, as higher towers have a larger rotor swept zone and, consequently, a larger collision risk area. While this makes intuitive sense, the majority of published scientific studies indicate that an increase in rotor swept area do not automatically translate into a larger collision risk. Turbine dimensions seem to play an insignificant role in the magnitude of the collision risk in general, relative to other factors such as topography, turbine location, morphology and a species' inherent ability to avoid the turbines, and may only be relevant in combination with other factors, particularly wind strength and topography (see Howell 1997, Barrios & Rodriguez 2004; Barclay *et al.* 2007, Krijgsveld *et al.* 2009, Smallwood 2013; Everaert 2014). Only two studies so far found a correlation between turbine hub height and mortality (De Lucas *et al.* 2008; Loss *et al.* 2013).

Rotor speed (revolutions per minute) also seems to be relevant, as faster rotors are responsible for higher fatality rates (Thelander *et al.* 2003). However, caution is needed when analysing rotor speed alone, as it is usually correlated with other features that may influence collision risk as turbine size, tower height and rotor diameter (Thelander *et al.* 2003), and because rotor speed is not proportional to the blade speed. In fact, fast spinning rotors have fast moving blades, but rotors with lower resolutions per minute may drive higher blade tip speeds.

Due to the fact that the turbine dimensions are constantly changing as newer models are introduced, it is best to take a pre-cautionary approach in order to anticipate any future potential changes in the turbine dimensions. The pre-construction monitoring programme is currently working on a potential rotor swept area of 30m – 220m to incorporate a wide range of models, which accommodates the current proposed turbines.

- Blade visibility

When turbine blades spin at high speeds, a motion smear (or motion blur) effect occurs, making wind turbines less conspicuous. This effect occurs both in the old small turbines that have high rotor speed and in the newer high turbines that despite having slower rotor speeds, achieve high blade tip speeds. Motion smear effect happens when an object is moving too fast for the brain to process the images and, as a consequence, the moving object appears blurred or even transparent to the observer. The effect is dependent on the velocity of the moving object and the distance between the object and the observer. The retinal-image velocity of spinning blades increases as birds get closer to them, until it eventually surpasses the physiological limit of the avian retina to process temporally changing stimuli. As a consequence, the blades may appear transparent and perhaps the rotor swept zone appears to be a safe place to fly (Hodos, 2003). For example, McIsaac (2001) showed that American Kestrels were not always able to distinguish moving turbine blades within a range of light conditions.

Motion smear is inherent to all wind turbines and will therefore also be a potential risk factor at the proposed wind farm.

- Wind farm configuration

Wind farm lay-out can also have a critical influence on bird collision risk. For example, it has been demonstrated that wind farms arranged perpendicularly to the main flight path may be responsible for a higher collision risk (Everaert *et al.* 2002 & Isselbacher and Isselbacher, 2001 in Hötker *et al.* 2006). At APWRA, wind farms located at the ends of rows, next to gaps in rows, and at the edge of local clusters were found to kill disproportionately more birds (Smallwood and Thellander, 2004). In this wind farm, serially arranged wind turbines that form wind walls are safer for birds (suggesting that birds recognize wind turbines and towers as obstacles and attempt to avoid them while flying), and fatalities mostly occur at single wind turbines or wind turbines situated at the edges of clusters (Smallwood and Thellander, 2004). However, this may be a specificity of APWRA. For instance, De Lucas *et al.* (2012a) found that the positions of the wind turbines within a row did not influence the turbine fatality rate of Griffon Vultures at Tarifa. Additionally, engineering features of the newest wind turbines require a larger minimum distance between adjacent wind turbines and in new wind farms it is less likely that birds perceive rows of turbines as impenetrable walls. In fact, in Greece it was found that the longer the distance between wind turbines, the higher is the probability that raptors will attempt to cross the space between them (Cárcamo *et al.* 2011).

The turbine lay-out at the proposed wind farm has not yet been finalised. This will only be done after the completion of the pre-construction monitoring and the results have been considered in the lay-out.

4.3 DISPLACEMENT DUE TO DISTURBANCE

The displacement of birds from areas within and surrounding wind farms due to visual intrusion and disturbance in effect can amount to habitat loss. Displacement may occur during both the construction and operational phases of wind farms, and may be caused by the presence of the turbines themselves through visual, noise and vibration impacts, or as a result of vehicle and personnel movements related to site maintenance. The scale and degree of disturbance will vary according to site- and species-specific factors and must be assessed on a site-by-site basis (Drewitt & Langston 2006).

Unfortunately, few studies of displacement due to disturbance are conclusive, often because of the lack of before-and-after and control-impact (BACI) assessments. Onshore, disturbance distances (in other words the distance from wind farms up to which birds are absent or less abundant than expected) up to 800 m (including zero) have been recorded for wintering waterfowl (Pedersen & Poulsen 1991 as cited by Drewitt & Langston 2006), though 600 m is widely accepted as the maximum reliably recorded distance (Drewitt & Langston 2006). The variability of displacement distances is illustrated by one study which found lower post-construction densities of feeding European White-fronted Geese *Anser albifrons* within 600 m of the turbines at a wind farm in Rheiderland, Germany (Kruckenberg & Jaene 1999 as cited by Drewitt & Langston 2006), while another showed displacement of Pink-footed Geese *Anser brachyrhynchus* up to only 100–200 m from turbines at a wind farm in Denmark (Larsen & Madsen 2000 as cited by Drewitt & Langston 2006). Indications are that Great Bustard *Otis tarda* could be displaced by wind farms up to one kilometre from the facility (Langgemach 2008). An Austrian study found displacement for Great Bustards up to 600m (Wurm & Kollar as quoted by Raab *et al.* 2009). However, there is also evidence to the contrary; information on Great Bustard received from Spain points to the possibility of continued use of leks at operational wind farms (Camiña 2012b). Research on small grassland species in North America indicates that permanent displacement is uncommon and very species specific (e.g. see Stevens *et al.* 2013, Hale *et al.* 2014). There also seem to be little evidence for a persistent decline in passerine populations at wind farm sites in the UK (despite some evidence of turbine avoidance), with some species, including Skylark, showing increased populations after wind farm construction (see Pierce-Higgins *et al.* 2012). Populations of Thekla Lark *Galerida theklae* were found to be unaffected by wind farm developments in Southern Spain (see Farfan *et al.* 2009).

The consequences of displacement for breeding productivity and survival are crucial to whether or not there is likely to be a significant impact on population size. However, studies of the impact of wind farms on breeding birds are also largely inconclusive or suggest lower disturbance distances, though this apparent lack of effect may be due to the high site fidelity and long life-span of the breeding species studied. This might mean that the true impacts of disturbance on breeding birds will only be evident in the longer term, when new recruits replace existing breeding birds. Few studies have considered the possibility of displacement for short-lived passerines (such as larks), although Leddy *et al.* (1999) found increased densities of breeding grassland passerines with increased distance from wind turbines, and higher densities in the reference area than within 80m of the turbines. A review of minimum avoidance distances of 11 breeding passerines were found to be generally <100m from a wind turbine ranging from 14 – 93m (Hötker *et al.* 2006). A comparative study of nine wind farms in Scotland (Pearce-Higgens *et al.* 2009) found unequivocal evidence of displacement: Seven of the 12 species studied exhibited significantly lower frequencies of occurrence close to the turbines, after accounting for habitat variation, with equivocal evidence of turbine avoidance in a further two. No species were more likely to occur close to the turbines. Levels of turbine avoidance suggest breeding bird densities may be reduced within a 500m buffer of the turbines by 15–53%, with Common Buzzard *Buteo buteo*, Hen Harrier *Circus cyaneus*, Golden Plover *Pluvialis apricaria*, Snipe *Gallinago gallinago*, Curlew *Numenius arquata* and Wheatear *Oenanthe oenanthe* most affected. In a follow-up study, monitoring data from wind farms located on unenclosed upland habitats in the United Kingdom were collated to test whether breeding densities of upland birds were reduced as a result of wind farm construction or during wind farm operation. Red Grouse *Lagopus lagopus scoticus*, Snipe *Gallinago gallinago* and Curlew *Numenius arquata* breeding densities all declined on wind farms during construction. Red Grouse breeding densities recovered after construction, but Snipe and Curlew densities did not. Post-construction Curlew breeding densities on wind farms were also significantly lower than reference sites. Conversely, breeding densities of Skylark *Alauda arvensis* and Stonechat *Saxicola torquata* increased on wind farms during construction. Overall, there was little evidence for consistent post-construction population declines in any species, suggesting that wind farm construction can have greater impacts upon birds than wind farm operation (Pierce-Higgens *et al.* 2012).

The effect of birds altering their migration flyways or local flight paths to avoid a wind farm is also a form of displacement. This effect is of concern because of the possibility of increased energy expenditure when birds have to fly further, as a result of avoiding a large array of turbines, and the potential disruption of linkages between distant feeding, roosting, moulting and breeding areas otherwise unaffected by the wind farm. The effect depends on species, type of bird movement, flight height, distance to turbines, the layout and operational status of turbines, time of day and wind force and direction, and can be highly variable, ranging from a slight 'check' in flight direction, height or speed, through to significant diversions which may reduce the numbers of birds using areas beyond the wind farm (Drewitt & Langston 2006). A review of the literature suggests that none of the barrier effects identified so far have significant impacts on populations (Drewitt & Langston 2006). However, there are circumstances where the barrier effect might lead indirectly to population level impacts; for example where a wind farm effectively blocks a regularly used flight line between nesting and foraging areas, or where several wind farms interact cumulatively to create an extensive barrier which could lead to diversions of many tens of kilometres, thereby incurring increased energy costs.

None of the priority species are likely to be permanently displaced due to disturbance, although displacement in the short term during the construction phase is very likely. The risk of permanent displacement is larger for large species such as Ludwig's Bustard, although displacement of the closely related Denham's Bustard (*Neotis denhami*) is evidently not happening at existing wind farms in the Eastern Cape (M. Langlands 2016 pers. comm, Rossouw 2016 pers.comm). If the wind farm follows the modern trend of fewer, larger turbines, the risk of displacement is also lower. However, this will only be established through a post-construction monitoring programme.

To date no nests of cliff nesting raptors (Verreaux's Eagle, Booted Eagle, Lanner Falcon and Jackal Buzzard) have been found at the sites. This may be due to unsuitability of habitat. The cliff areas where these species could potentially be attracted to are readily accessible to predators such as baboons, which may explain the absence of any raptor breeding activity. The cliffs (exposed ridgelines) themselves are small and are best described as rocky outcrops, rather than cliffs. However, the monitoring of the cliff areas continues and will be repeated again in autumn and winter to make sure that the initial conclusions are indeed correct.

4.4 DISPLACEMENT DUE TO HABITAT LOSS

The scale of permanent habitat loss resulting from the construction of a wind farm and associated infrastructure depends on the size of the project but, in general it, is likely to be small per turbine base. Typically, actual habitat loss amounts to 2–5% of the total development area (Fox *et al.* 2006 as cited by Drewitt & Langston 2006), though effects could be more widespread where developments interfere with hydrological patterns or flows on wetland or peatland sites (unpublished data). Some changes could also be beneficial. For example, habitat changes following the development of the Altamont Pass wind farm in California led to increased mammal prey availability for some species of raptor (for example through greater availability of burrows for Pocket Gophers *Thomomys bottae* around turbine bases), though this may also have increased collision risk (Thelander *et al.* 2003 as cited by Drewitt & Langston 2006).

However, the results of habitat transformation may be subtler, whereas the actual footprint of the wind farm may be small in absolute terms, the effects of the habitat fragmentation brought about by the associated infrastructure (e.g. power lines and roads) may be more significant. Sometimes Great Bustard can be seen close to or under power lines, but a study done in Spain (Lane *et al.* 2001 as cited by Raab *et al.* 2009) indicates that the total observation of Great Bustard flocks were significantly higher further from power lines than at control points. Shaw (2013) found that Ludwig's Bustard generally avoid the immediate proximity of roads within a 500m buffer. This means that power lines and roads also cause loss and fragmentation of the habitat used by the population in addition to the potential direct mortality. The physical encroachment increases the disturbance and barrier effects that contribute to the overall habitat fragmentation effect of the infrastructure (Raab *et al.* 2010). It has been shown that fragmentation of natural grassland in Mpumalanga (in that case by afforestation) has had a detrimental impact on the densities and diversity of grassland species (Alan *et al.* 1997).

The direct habitat transformation at the proposed wind farm is likely to be fairly minimal. The indirect habitat transformation (habitat fragmentation) is likely to have a bigger impact on priority species. It is expected that the densities of most priority species will decrease due to this impact, but complete displacement is unlikely. Indications are that bustards continue to use the wind farm areas (M. Langlands 2016 pers. comm, Rossouw 2016 pers.comm,).

4.6 MARALLA EAST

5.6.1 MARALLA EAST: DISPLACEMENT OF PRIORITY SPECIES DUE TO DISTURBANCE (CONSTRUCTION AND DE-COMMISSIONING)

The construction (and de-commissioning) of the wind farm and associated infrastructure will result in a significant amount of movement and noise, which will lead to temporary displacement of avifauna from the site. It is highly likely that most priority species listed in Table 2 will vacate the area for the duration of these activities.

MARALLA EAST: DISPLACEMENT DUE TO DISTURBANCE ASSOCIATED WITH THE CONSTRUCTION AND DE-COMMISSIONING OF THE WIND FARM AND ASSOCIATED INFRASTRUCTURE (CONSTRUCTION AND DE-COMMISSIONING)					
	Severity / Beneficial Scale				
		1	2	3	4
Probability Scale	1	Very Low	Very Low	Low	Medium
	2	Very Low	Low	Medium	Medium
	3	**Low**	Medium	Medium	High
	4	Medium	Medium	High	High

4.6.2 MARALLA EAST: PRIORITY SPECIES MORTALITY DUE TO COLLISION WITH THE TURBINES (OPERATION)

Priority species that could potentially be vulnerable to wind turbine collisions are listed in Table 2. It is noted though that no Ludwig's Bustard mortalities have as yet been reported at wind farms in South Africa, despite initial concerns that the species might be vulnerable in this respect (Ralston, M. in litt. 2016). West facing slopes (i.e. those facing the dominant wind direction) are likely to be the most sensitive areas for slope soaring raptors.

MARALLA EAST: PRIORITY SPECIES MORTALITY DUE TO COLLISION WITH THE TURBINES (OPERATION)					
	Severity / Beneficial Scale				
Probability Scale		1	2	3	4
	1	Very Low	Very Low	Low	Medium
	2	Very Low	Low	Medium	Medium
	3	Low	Medium	**Medium**	High
	4	Medium	Medium	High	High

4.6.3 MARALLA EAST: DISPLACEMENT OF PRIORITY SPECIES DUE TO HABITAT TRANSFORMATION (OPERATION)

Priority species that could potentially be vulnerable to displacement due to habitat transformation are listed in Table 2. The direct habitat transformation at the proposed wind farm is likely to be fairly minimal. The indirect habitat transformation (habitat fragmentation) is likely to have a bigger impact on priority species. It is expected that the densities of some terrestrial priority species (e.g. Karoo Korhaan, Southern Black Korhaan and Grey-winged Francolin) will decrease due to this impact, but complete displacement is unlikely. Raptors are unlikely to be affected. Indications are that bustards continue to use the wind farm areas (M. Langlands 2016 pers. comm, Rossouw 2016 pers.comm,).

MARALLA EAST: DISPLACEMENT DUE TO HABITAT TRANSFORMATION ASSOCIATED WITH THE OPERATION OF THE WIND FARM (OPERATION)					
Severity / Beneficial Scale					
Probability Scale		1	2	3	4
	1	Very Low	Very Low	Low	Medium
	2	Very Low	**Low**	Medium	Medium
	3	Low	Medium	Medium	High
	4	Medium	Medium	High	High

5. TERMS OF REFERENCE FOR THE IMPACT ASSESSMENT PHASE

The Birds and Renewable Energy Specialist Group (BARESG), convened by BirdLife South Africa and the Wildlife and Energy Programme of the Endangered Wildlife Trust, proposes the following guidelines and monitoring protocols for evaluating utility-scale wind energy development proposals. The Guidelines are aimed at environmental assessment practitioners, avifaunal specialists, developers and regulators and propose a tiered assessment process, including:

- Initial screening or scoping – an initial assessment of the likely avifauna and possible impacts, preferably informed by a brief site visit and by desk-top collation of available data; also including the design of a site-specific survey and monitoring project should this be deemed necessary. This has been completed.
- Data collection – further accumulation and consolidation of the relevant avian data, possibly including the execution of baseline data collection work as specified by the scoping study, intended to inform the avian impact study. This is currently happening through an onsite monitoring programme which is aimed at providing a baseline picture of the avifauna over a period of a year.
- Impact assessment - a full assessment of the likely impacts and available mitigation options, based on the results of systematic and quantified monitoring which is currently taking place. This will include the systematic assessment of all the identified impacts, using methodology adapted from T Hacking, AATS-Envirolink,1988: An innovative approach to structuring environmental impact assessment reports. In: IAIA SA 1998 Conference Papers and Notes.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 MARALLA EAST

6.1.1 MARALLA EAST: DISPLACEMENT OF PRIORITY SPECIES DUE TO DISTURBANCE (CONSTRUCTION AND DE-COMMISSIONING)

The construction (and de-commissioning) of the wind farm and associated infrastructure will result in a significant amount of movement and noise, which will lead to temporary displacement of avifauna from the site. It is highly likely that most priority species listed in Table 2 will vacate the area for the duration of these activities.

Suggested mitigation measures are as follows:

- Restrict the construction activities to the construction footprint area.
- Do not allow any access by construction teams to the remainder of the property during the construction period.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.
- It is recommended that appropriate no-turbine buffer zones are implemented around priority raptor nests, should any be discovered in the course of the pre-construction monitoring, which is currently ongoing. If an eagle’s nest is recorded, this will entail a 3km pre-cautionary buffer zone.
- A 1km no infrastructure buffer zone is recommended around a Martial Eagle roosting area.

6.1.2 MARALLA EAST: PRIORITY SPECIES MORTALITY DUE TO COLLISION WITH THE TURBINES (OPERATION)

Priority species that could potentially be vulnerable to wind turbine collisions are listed in Table 2. It is noted though that no Ludwig’s Bustard mortalities have as yet been reported at wind farms in South Africa, despite initial concerns that the species might be vulnerable in this respect (Ralston, M. in litt. 2016).

Proposed mitigation measures are:

- Pre-construction monitoring should be completed to guide the lay-out of the turbines.
- Once the turbines have been constructed, post-construction monitoring should be implemented to compare actual collision rates with predicted collision rates.
- No turbines should be constructed on west facing slopes (i.e. those facing the dominant wind direction) to minimise the risk of collisions of slope soaring species, particularly raptors.
- If actual collision rates indicate high mortality levels, curtailment of selective turbines should be implemented.

6.1.3 MARALLA EAST: DISPLACEMENT OF PRIORITY SPECIES DUE TO HABITAT TRANSFORMATION (OPERATION)

Priority species that could potentially be vulnerable to displacement due to habitat transformation are listed in Table 2. The direct habitat transformation at the proposed wind farm is likely to be fairly minimal. The indirect habitat transformation (habitat fragmentation) is likely to have a bigger impact on priority species. It is expected that the densities of some terrestrial priority species (e.g. Karoo Korhaan, Southern Black Korhaan and Grey-winged Francolin) will decrease due to this impact, but complete displacement is unlikely. Raptors are unlikely to be affected. Indications are that bustards continue to use the wind farm areas (M. Langlands 2016 pers. comm, Rossouw 2016 pers.comm,).

Suggested mitigation measures are as follows:

- The recommendations of the specialist ecological study must be strictly adhered to.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.

7. EXCLUSION ZONES

7.1 MARALLA EAST

The following exclusion zones are applicable:

- The west-facing slopes and Martial Eagle roosting area as indicated in Figure 3 below.

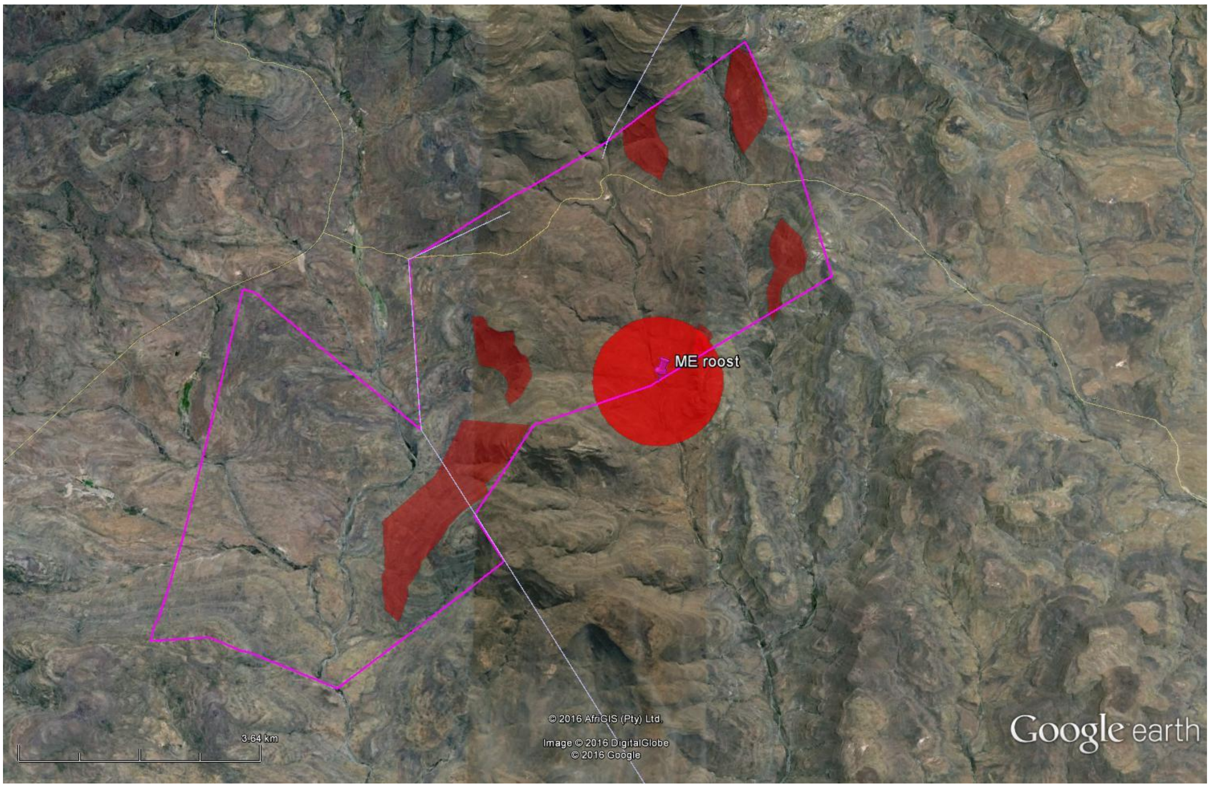

Figure 3: Buffered areas at Maralla East.

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APPENDIX 1: SPECIES LIST MARALLA EAST

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Bustard, Ludwig's	*Neotis ludwigii*	x	EN	EN		Near-endemic	6.25	✓ 10.42
Buzzard, Jackal	*Buteo rufofuscus*	x			Near endemic	Endemic	53.13	✓ 22.22
Buzzard, Steppe	*Buteo vulpinus*	x					15.63	✓ 17.65
Eagle, Booted	*Aquila pennatus*	x					3.13	✓ 10.71
Eagle, Martial	*Polemaetus bellicosus*	x	VU	EN			21.88	✓ 10.42
Eagle, Verreaux's	*Aquila verreauxii*	x	LC	VU			6.25	✓ 16.67
Eagle-owl, Spotted	*Bubo africanus*	x					28.13	✓ 5.88
Flamingo, Greater	*Phoenicopterus ruber*	x	LC	NT			0	✓ 18.18
Francolin, Grey-winged	*Scleroptila africanus*	x			Endemic (SA, Lesotho, Swaziland)	Endemic	40.63	✓ 8.33
Goshawk, Southern Pale Chanting	*Melierax canorus*	x				Near-endemic	34.38	✓ 30.00
Harrier, Black	*Circus maurus*	x	VU	EN	Near endemic	Endemic	0	✓ 12.00
Kestrel, Lesser	*Falco naumanni*	x					3.13	✗ 0.00
Kite, Black-shouldered	*Elanus caeruleus*	x					0	✓ 29.41
Korhaan, Karoo	*Eupodotis vigorsii*	x	LC	NT		Endemic	15.63	✓ 15.00
Korhaan, Southern Black	*Afrotis afra*	x	VU	VU	Endemic	Endemic	25	✓ 16.00
Snake-eagle, Black-chested	*Circaetus pectoralis*	x					3.13	✓ 16.67
Sparrowhawk, Rufous-chested	*Accipiter rufiventris*	x					9.38	✗ 0.00
Stork, Black	*Ciconia nigra*	x	LC	VU			0	✓ 5.88
Falcon, Lanner	*Falco biarmicus*	x	LC	VU			0	0
Kestrel, Rock	*Falco rupicolus*						43.75	✓ 54.17

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Apalis, Bar-throated	*Apalis thoracica*							✓ 8.33
Avocet, Pied	*Recurvirostra avosetta*							✓ 11.11
Barbet, Acacia Pied	*Tricholaema leucomelas*					Near-endemic	3.13	✓ 39.58
Batis, Pririt	*Batis pririt*					Near-endemic	3.13	✓ 29.73
Bee-eater, European	*Merops apiaster*							✓ 10.34
Bishop, Southern Red	*Euplectes orix*						6.25	✓ 25.00
Bokmakierie	*Telophorus zeylonus*						90.63	✓ 66.67
Bulbul, African Red-eyed	*Pycnonotus nigricans*					Near-endemic		✓ 10.00
Bulbul, Cape	*Pycnonotus capensis*				Endemic	Endemic	12.5	✓ 21.74
Bunting, Cape	*Emberiza capensis*					Near-endemic	68.75	✓ 70.83
Bunting, Lark-like	*Emberiza impetuani*					Near-endemic	34.38	✓ 19.35
Canary, Black-headed	*Serinus alario*				Near endemic	Endemic	31.25	✓ 29.17
Canary, Cape	*Serinus canicollis*					Endemic	9.38	✓ 9.09
Canary, White-throated	*Crithagra albogularis*					Near-endemic	50	✓ 58.33
Canary, Yellow	*Crithagra flaviventris*					Near-endemic	53.13	✓ 43.75
Chat, Anteating	*Myrmecocichla formicivora*					Endemic	15.63	✓ 16.00
Chat, Familiar	*Cercomela familiaris*						46.88	✓ 39.58
Chat, Karoo	*Cercomela schlegelii*					Near-endemic	50	✓ 77.08
Chat, Sickle-winged	*Cercomela sinuata*				Near endemic	Endemic	50	✓ 24.00
Chat, Tractrac	*Cercomela tractrac*					Near-endemic		✓ 25.00
Cisticola, Grey-backed	*Cisticola subruficapilla*					Near-endemic	62.5	✓ 52.08
Coot, Red-knobbed	*Fulica cristata*						3.13	✓ 16.67

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Cormorant, Reed	*Phalacrocorax africanus*						3.13	✓ 8.33
Cormorant, White-breasted	*Phalacrocorax carbo*						3.13	✗ 0.00
Crombec, Long-billed	*Sylvietta rufescens*						9.38	✓ 18.75
Crow, Cape	*Corvus capensis*							✓ 17.65
Crow, Pied	*Corvus albus*						56.25	✓ 27.59
Cuckoo, Diderick	*Chrysococcyx caprius*							✓ 25.00
Dove, Laughing	*Streptopelia senegalensis*						9.38	✓ 29.17
Dove, Namaqua	*Oena capensis*						9.38	✓ 20.00
Dove, Red-eyed	*Streptopelia semitorquata*						18.75	✓ 25.00
Duck, African Black	*Anas sparsa*						3.13	✓ 24.14
Duck, Yellow-billed	*Anas undulata*						15.63	✓ 22.92
Egret, Cattle	*Bubulcus ibis*							✓ 5.88
Eremomela, Karoo	*Eremomela gregalis*				Near endemic	Endemic	25	✓ 20.00
Eremomela, Yellow-bellied	*Eremomela icteropygialis*						28.13	✓ 14.58
Fiscal, Common (Southern)	*Lanius collaris*						65.63	✓ 66.67
Flycatcher, Chat	*Bradornis infuscatus*					Near-endemic		✓ 9.09
Flycatcher, Fairy	*Stenostira scita*				Near endemic	Endemic	12.5	✓ 17.39
Flycatcher, Fiscal	*Sigelus silens*				Near endemic	Endemic	3.13	✓ 16.22
Flycatcher, Spotted	*Muscicapa striata*							✓ 8.33
Goose, Egyptian	*Alopochen aegyptiacus*						46.88	✓ 41.67
Goose, Spur-winged	*Plectropterus gambensis*						18.75	✓ 9.09
Grebe, Black-necked	*Podiceps nigricollis*							✓ 9.09

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Grebe, Little	*Tachybaptus ruficollis*						6.25	✓ 15.79
Greenshank, Common	*Tringa nebularia*						6.25	✓ 11.11
Guineafowl, Helmeted	*Numida meleagris*						28.13	✓ 6.90
Hamerkop	*Scopus umbretta*						6.25	✓ 17.39
Heron, Black-headed	*Ardea melanocephala*						12.5	✓ 11.76
Heron, Grey	*Ardea cinerea*						3.13	✓ 16.22
Honeyguide, Lesser	*Indicator minor*						3.13	✗ 0.00
Hoopoe, African	*Upupa africana*							✓ 6.90
Ibis, African Sacred	*Threskiornis aethiopicus*						9.38	✓ 10.34
Ibis, Hadeda	*Bostrychia hagedash*						65.63	✓ 16.22
Kingfisher, Malachite	*Alcedo cristata*							✓ 8.33
Lapwing, Blacksmith	*Vanellus armatus*						9.38	✓ 50.00
Lapwing, Crowned	*Vanellus coronatus*						21.88	✓ 5.88
Lark, Cape Clapper	*Mirafra apiata*				Near endemic	Endemic	21.88	✓ 11.76
Lark, Eastern Clapper	*Mirafra fasciolata*					Near-endemic	3.13	✓ 11.76
Lark, Karoo	*Calendulauda albescens*				Near endemic	Endemic	15.63	✓ 8.11
Lark, Karoo Long-billed	*Certhilauda subcoronata*					Endemic	62.5	✓ 33.33
Lark, Large-billed	*Galerida magnirostris*				Near endemic	Endemic	56.25	✓ 35.42
Lark, Red-capped	*Calandrella cinerea*						28.13	✓ 16.67
Lark, Spike-heeled	*Chersomanes albofasciata*					Near-endemic	6.25	✓ 19.44
Martin, Brown-throated	*Riparia paludicola*						3.13	✓ 29.17
Martin, Rock	*Hirundo fuligula*						68.75	✓ 52.08

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Masked-weaver, Southern	*Ploceus velatus*						40.63	✓ 52.08
Moorhen, Common	*Gallinula chloropus*						3.13	✗ 0.00
Mousebird, Red-faced	*Urocolius indicus*						15.63	✓ 19.35
Mousebird, White-backed	*Colius colius*					Endemic	28.13	✓ 35.42
Night-Heron, Black-crowned	*Nycticorax nycticorax*							✓ 16.67
Nightjar, Rufous-cheeked	*Caprimulgus rufigena*							✗ 0.00
Penduline-tit, Cape	*Anthoscopus minutus*					Near-endemic	21.88	✗ 0.00
Pigeon, Speckled	*Columba guinea*						43.75	✓ 31.25
Pipit, African	*Anthus cinnamomeus*						18.75	✓ 16.22
Pipit, Long-billed	*Anthus similis*							✓ 8.00
Plover, Kittlitz's	*Charadrius pecuarius*						3.13	✓ 12.50
Plover, Three-banded	*Charadrius tricollaris*						40.63	✓ 31.25
Pochard, Southern	*Netta erythrophthalma*							✓ 9.09
Prinia, Karoo	*Prinia maculosa*				Near endemic	Endemic	75	✓ 62.50
Quail, Common	*Coturnix coturnix*							✓ 12.50
Raven, White-necked	*Corvus albicollis*						59.38	✓ 29.17
Reed-warbler, African	*Acrocephalus baeticatus*							✓ 8.33
Robin-chat, Cape	*Cossypha caffra*						37.5	✓ 25.00
Ruff	*Philomachus pugnax*							✓ 12.50
Sandgrouse, Namaqua	*Pterocles namaqua*					Near-endemic	46.88	✓ 18.92
Sandpiper, Curlew	*Calidris ferruginea*		NT	LC				✓ 12.50

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Sandpiper, Marsh	*Tringa stagnatilis*							✓ 9.09
Sandpiper, Wood	*Tringa glareola*							✓ 5.88
Scrub-robin, Karoo	*Cercotrichas coryphoeus*					Endemic	65.63	✓ 58.33
Seedeater, Streaky-headed	*Crithagra gularis*							✓ 9.09
Shelduck, South African	*Tadorna cana*					Endemic	56.25	✓ 54.17
Shoveler, Cape	*Anas smithii*					Near-endemic	3.13	✓ 21.05
Sparrow, Cape	*Passer melanurus*					Near-endemic	71.88	✓ 70.83
Sparrow, House	*Passer domesticus*						34.38	✓ 29.73
Sparrow, Southern Grey-headed	*Passer diffusus*						3.13	✓ 8.33
Sparrowlark, Black-eared	*Eremopterix australis*				Near endemic	Endemic		✓ 8.33
Sparrowlark, Grey-backed	*Eremopterix verticalis*					Near-endemic		✓ 12.50
Spoonbill, African	*Platalea alba*						3.13	✓ 12.50
Spurfowl, Cape	*Pternistis capensis*				Near endemic	Endemic	53.13	✓ 40.54
Starling, Common	*Sturnus vulgaris*						28.13	✓ 25.00
Starling, Pale-winged	*Onychognathus nabouroup*					Near-endemic	12.5	✓ 47.92
Starling, Pied	*Spreo bicolor*				Endemic (SA, Lesotho, Swaziland)	Endemic	71.88	✓ 58.33
Starling, Wattled	*Creatophora cinerea*						3.13	✓ 6.90
Stilt, Black-winged	*Himantopus himantopus*							✓ 15.79
Stint, Little	*Calidris minuta*						3.13	✓ 12.50
Sunbird, Dusky	*Cinnyris fuscus*					Near-endemic	3.13	✓ 30.43

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Sunbird, Malachite	*Nectarinia famosa*						25	✓ 29.17
Sunbird, Southern Double-collared	*Cinnyris chalybeus*				Near endemic	Endemic	18.75	✓ 33.33
Swallow, Barn	*Hirundo rustica*						37.5	✓ 18.92
Swallow, Greater Striped	*Hirundo cucullata*						46.88	✓ 20.83
Swallow, White-throated	*Hirundo albigularis*							✓ 12.50
Swamp-warbler, Lesser	*Acrocephalus gracilirostris*						3.13	✓ 16.67
Swift, African Black	*Apus barbatus*						3.13	✓ 8.00
Swift, Alpine	*Tachymarptis melba*						3.13	✓ 5.88
Swift, Common	*Apus apus*						3.13	✓ 5.88
Swift, Little	*Apus affinis*						15.63	✓ 25.81
Swift, White-rumped	*Apus caffer*						18.75	✓ 13.89
Teal, Cape	*Anas capensis*						3.13	✓ 11.11
Teal, Red-billed	*Anas erythrorhyncha*							✓ 10.53
Tern, White-winged	*Chlidonias leucopterus*							✓ 12.50
Thick-knee, Spotted	*Burhinus capensis*						3.13	✗ 0.00
Thrush, Karoo	*Turdus smithi*				Near endemic	Endemic	12.5	✓ 8.70
Thrush, Olive	*Turdus olivaceus*						6.25	✓ 8.70
Tit, Grey	*Parus afer*				Near endemic	Endemic	21.88	✓ 33.33
Tit-babbler, Chestnut-vented	*Parisoma subcaeruleum*					Near-endemic		✓ 37.84
Tit-babbler, Layard's	*Parisoma layardi*				Near endemic	Endemic	9.38	✓ 15.00
Turtle-dove, Cape	*Streptopelia capicola*						40.63	✓ 56.25

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Wagtail, Cape	*Motacilla capensis*						56.25	✓ 68.75
Warbler, Namaqua	*Phragmacia substriata*				Near endemic	Endemic	15.63	✓ 37.84
Warbler, Rufous-eared	*Malcorus pectoralis*					Endemic	31.25	✓ 16.67
Warbler, Willow	*Phylloscopus trochilus*							✓ 8.33
Waxbill, Common	*Estrilda astrild*						25	✓ 29.17
Weaver, Cape	*Ploceus capensis*				Near endemic	Endemic	46.88	✓ 14.58
Wheatear, Capped	*Oenanthe pileata*							✓ 22.22
Wheatear, Mountain	*Oenanthe monticola*					Near-endemic	40.63	✓ 45.83
White-eye, Cape	*Zosterops virens*				Near endemic	Endemic	3.13	✓ 40.00
White-eye, Orange River	*Zosterops pallidus*					Endemic		✓ 40.00
Whydah, Pin-tailed	*Vidua macroura*							✓ 8.33
Woodpecker, Cardinal	*Dendropicos fuscescens*							✓ 16.67
Woodpecker, Ground	*Geocolaptes olivaceus*				Endemic (SA, Lesotho, Swaziland)	Endemic	12.5	✓ 12.50

APPENDIX 3: PRE-CONSTRUCTION MONITORING AT MARALLA EAST

1. Objectives

The objective of the pre-construction monitoring at the proposed Maralla East and West Projects is to gather baseline data over a period of four seasons on the following aspects pertaining to avifauna:

- The abundance and diversity of birds at the wind farm site and a suitable control site to measure the potential displacement effect of the wind farm.
- Flight patterns of priority species at the wind farm site to measure the potential collision risk with the turbines.

2. Methods

The monitoring protocol for the site is designed according to the latest version (2012) of *Jenkins A R; Van Rooyen C S; Smallie J J; Anderson M D & Smit H A. 2011. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. Endangered Wildlife Trust and Birdlife South Africa.*

Monitoring is conducted in the following manner:

- Two drive transect were identified totalling 15.74km on the turbine site and one drive transect in the control site with a total length of 10.2km.
- Two observers travelling slowly (± 10km/h) in a vehicle records all species on both sides of the transect. The observers stop at regular intervals (every 500 m) to scan the environment with binoculars. Drive transects are counted three times per sampling session.
- In addition, six walk transects of 1km each were identified at the turbine site, and two at the control site, and counted 4 times per sampling season. All birds are recorded during walk transects.
- The following variables are recorded:
    - Species;
    - Number of birds;
    - Date;
    - Start time and end time;
    - Distance from transect (0-50 m, 50-100 m, >100 m);
    - Wind direction;
    - Wind strength (calm; moderate; strong);
    - Weather (sunny; cloudy; partly cloudy; rain; mist);
    - Temperature (cold; mild; warm; hot);
    - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground); and
    - Co-ordinates (priority species only).

- Six vantage points (VPs) were identified from which the majority of the proposed turbine area can be observed (the "VP area"), to record the flight altitude and patterns of priority species. One VP was also identified on the control site. The following variables were recorded for each flight:
    - Species;
    - Number of birds;
    - Date;
    - Start time and end time;
    - Wind direction;
    - Wind strength (estimated Beaufort scale 1-7);
    - Weather (sunny; cloudy; partly cloudy; rain; mist);
    - Temperature (cold; mild; warm; hot);

- Flight altitude (high i.e. >220m; medium i.e. 30m – 220m; low i.e. <30m);
- Flight mode (soar; flap; glide ; kite; hover); and
- Flight time (in 15 second-intervals).

The aim with drive transects is primarily to record large priority species (i.e. raptors and large terrestrial species), while walk transects are primarily aimed at recording small passerines. The objective of the transect monitoring is to gather baseline data on the use of the site by birds in order to measure potential displacement by the wind farm activities. The objective of vantage point counts is to measure the potential collision risk with the turbines. Priority species were identified using the November 2014 BLSA list of priority species for wind farms.

A number of focal points consisting of cliffs and ridges along the escarpment which are potentially suitable for breeding raptors adjoining the study areas are regularly inspected for any signs of cliff-nesting raptors. On the sites themselves, a number of potential roosting and breeding areas are also inspected regularly. In addition, counts are conducted at several dams to record all waterbirds.