Appendix 8.2

Avifaunal Impact Assessment

Kerrie Fontein and Darling Wind Farm, Western Cape

Bird Impact Assessment Study

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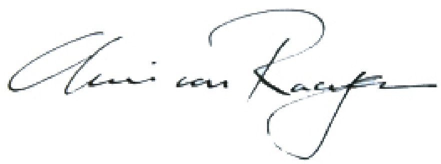
DECLARATION OF INDEPENDENCE

I, Chris van Rooyen as duly authorised representative of Chris van Rooyen Consulting, hereby confirm my independence as a specialist and declare that neither I nor Chris van Rooyen Consulting have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which the Environmental Evaluation Unit of the University of Cape Town 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 worked performed, specifically in connection with the Environmental Impact Assessment for the proposed Kerrie Fontein and Darling Wind Farm.



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Executive summary

The proposed Kerrie Fontein and Darling Wind Farm will be an extension of the existing Darling National Demonstration Wind Farm which was conceptualised in 1996 by the Oelsner Group. The capacity of the Project will be 20-21 MW depending on the technology and the number of turbines used. Nordex, a German manufacturer of wind turbines, is the preferred supplier and the N60 or N77 are the models under consideration. Depending on the model, either 16 or 14 turbines will be erected, each with a nominal power of 1.5 MW or 1.3 MW each. The option utilising 14 turbines are referred to as Option 1, and the one utilising 16 turbines are referred to as Option 2.

Collisions

In total 116 hours of monitoring at the site was completed between January 2002 and February 2011. Counts of priority bird species and all raptor species commuting over the development site were conducted from the crest of Moedmaag Hill, facing west along the proposed turbine line. It would seem from analysing the data collected that the wind facility will not pose a significant collision mortality risk to priority species, with Jackal Buzzards emerging as the highest potential risk at an estimated 0.49 mortalities per year. The greatest collision risk is posed by the 7 turbines on the slope of Moedmaag Hill (i.e. 4 existing and 3 proposed), in the following conditions:

- Between 11h00 and 17h00
- In spring/early summer i.e. between October and December
- In moderate to strong winds with a southerly and westerly orientation

With Jackal Buzzards specifically, the estimated avoidance rate may me more than 98%, as the birds observed on site are most likely a resident pair. These birds have clearly become used to the four existing turbines and are even using them as hunting perches when stationary (pers. obs., Van der Westhuizen 2011). During 30 hours of monitoring no instances were observed where Jackal Buzzards exhibited any “flaring” behaviour i.e. panicky behaviour to avoid the moving blades, they always seem to be aware of the moving blades and avoided them seemingly with ease. Whether this would also be the case with inexperienced, juvenile birds remains to be seen. It is therefore essential for carcass searches to commence as soon as possible to verify the estimates made in this study.

Fortunately, the phenomenon of mass migrations involving thousands of birds is not a feature of the Project site, as this can result in significant mortality risks. However, migratory raptors, i.e. Steppe Buzzard *Buteo vulpinus* and Yellow-billed Kite *Milvus aegyptius* were recorded at passage rates of 0.74 and 1.39 birds per hour during the summer and autumn monitoring period, when the species are present in southern Africa. This translates into an estimated collision rate of 0.61 and 0.63 birds per year for kites and buzzards respectively. In terms of existing information on the impacts of wind farm developments, raptors, and particularly species constantly migrating over and through a turbine string, are particularly prone to collision with the blades (Madders & Whitfield 2006). While Yellow-billed Kite and Steppe Buzzard are not threatened species, if the Project causes high numbers of casualties of these migrant raptors, this would constitute a significant negative impact of the facility. Given the potential inaccuracy of the predicted collision rate, the only way to verify this would again be to conduct carcass searches during the period when the birds are present.

The effects of night-time illumination on collision risks have not been adequately tested, and the results of studies are contradictory. The consensus among researchers is to avoid lighting the turbines if possible, but that is against South African civil aviation regulations (Civil Aviation Regulations 1997). The potential for collisions with the wind turbines due to presence of lights is not envisaged to be significant, primarily because the phenomenon of mass nocturnal passerine migrations is not a feature of the study area. However, the potential effect on nocturnal flamingo movement is unknown. Post – construction monitoring (carcass searches) will be required to assess, if possible, the extent (if any) of nocturnal fatalities that may be linked to the lighting on the turbines.

Because the estimated collision rate is merely a rough indicator of risk, it is necessary to verify this estimate with actual carcass searches on site. It is particularly important to commence carcass searches in the winter season to assess whether here are any flamingo casualties due to nocturnal collisions with the existing turbines. These searches must take place according to the attached protocol (Appendix 1), which is in accordance with the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa – Version 1* (Jenkins *et al* 2011). The frequency of these surveys will be informed by assessments of scavenge and decomposition rates conducted in the initial stages of the monitoring period. Subject to the results of the decomposition/scavenge trials, it is proposed that a site survey is conducted twice a month for an initial minimum period of 12 months. After the initial 12 month period, the need for further monitoring will be evaluated again. If the results of the monitoring indicate a significant mortality rate for priority species, appropriate mitigation measures would need to be implemented. These could include any or a combination of the following:

- Relocation of turbines responsible for particular collision mortality.
- Halting operation during peak flight periods, or reducing rotor speed, to reduce the risk of collision mortality.
- Negotiating appropriate off-set compensation for turbine related collision mortality.

Collisions with the proposed power line

No mitigation will be required for this impact, as it is not expected to materialise.

Displacement

Although more studies are needed and more should be peer-reviewed in the public domain, research indicates that, with few exceptions, the displacement effect of wind developments on raptors is low to negligible (Madders and Whitfield 2008). This trend seems to be supported by the results of the limited post-construction monitoring conducted at the existing 4 turbines. Due to the relatively minor significance of this impact on priority species, no specific mitigation measures are recommended.

Habitat loss

At the Project site, direct habitat loss is not regarded as a major impact on avifauna, relative to other potential impacts such as disturbance or collisions. The infrastructure footprint must be restricted to the minimum, in accordance with the recommendations in the Botanical Impact Assessment Report (Helme 2011).

Cumulative impacts

It is impossible to say at this stage what the cumulative impact of all the proposed developments along the West Coast will be on birds, firstly because there is no baseline to measure it against, and secondly because the extent of actual impacts will only become known once a few wind farms are developed. It is therefore imperative that pre-construction and post-construction monitoring is implemented at all the new proposed sites, in accordance with the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa – Version 1* (Jenkins *et al* 2011), which was released by the Endangered Wildlife Trust and Birdlife South Africa in April 2011. This will provide the necessary data to better assess the cumulative impact of wind development along the West Coast.

Preferred alternative

From a potential bird impact perspective, there is very little to choose between the two proposed alternatives. The 7 turbines on slope of Moedmaag Hill are likely to pose the biggest risk of collision, and the position of these is identical for both lay-outs. The potential displacement footprint of the two alternative lay-outs is also very similar, resulting in no clear preference from a bird impact perspective.

Glossary of abbreviations

ADU	Animal Demography Unit
EEU	Environmental Evaluation Unit
CAR	Coordinated Avifaunal Roadcounts
CEF	Central Energy Fund
DARLIPP	Darling Independent Power Producer (Pty) Ltd
DEA	Department of Environmental Affairs
DBSA	Development Bank of Southern Africa
DNDWF	Darling National Demonstration Wind Farm
EIA	Environmental Impact Assessment
IBA	Important Bird Area
SABAP1	Southern African Bird Atlas Project 1
SABAP2	South African Bird Atlas Project 2
BIRP	Birds in Reserves Project
QDGC	Quarter degree grid cell corresponds to the area shown on a 1:50 000 map (15' x 15') and is approximately 27 km long (north-south) and 23 km wide (east-west).
Bonn Convention	Convention on the Conservation of Migratory Species of Wild Animals

Section 1: Introduction

The proposed Kerrie Fontein and Darling Wind Farm will be an extension of the existing Darling National Demonstration Wind Farm which was conceptualised in 1996 by the Oelsner Group. Darling Independent Power Producer (Pty) Ltd (known as DARLIPP) was established to develop the wind farm as an Independent Power Producer (IPP). The environmental authorisation process was contested and protracted and included appeals. The original proposal was for 10 turbines of 1.3MW output; however only a first phase of four turbines was approved and became known officially as the Darling National Demonstration Wind Farm. The Record of Decision (RoD) was issued in February 2005. The Danish agency DANIDA, the Central Energy Fund (CEF) and the Development Bank of Southern Africa (DBSA) were funders of the development. A new company, Darling Wind Power (Pty) Ltd was then formed to develop the wind farm, equity holders being CEF, DBSA and DARLIPP. In 2006, Darling Wind Power (Pty) Ltd entered into a Power Purchase Agreement with the City of Cape Town for a term of 20 years and contributes towards the City achieving its targets for renewable energy. The applicant for the Darling Demonstration Wind Farm was DARLIPP, while the present applicant is the Oelsner Group.

Wind turbines are made up of three key components: a steel tower, a nacelle which is positioned on top of the tower; and the rotor which comprises the three blades and a hub in the centre. Energy is produced when wind blows over the turbine blades, causing them to lift and rotate. Components in the nacelle convert this kinetic 'movement' energy to electrical energy and control the operation of the machine. The electricity that is produced is converted to a voltage that can be fed into the local electricity grid. The capacity of the Project will be 20-21 MW depending on the technology and the number of turbines used. Nordex, a German manufacturer of wind turbines, is the preferred supplier and the N60 or N77 are the models under consideration. Depending on the model, either 16 or 14 turbines will be erected, each with a nominal power of 1.5 MW or 1.3 MW each. The option utilising 14 turbines are referred to as Option 1, and the one utilising 16 turbines are referred to as Option 2.

There are two components to the project as it falls onto two different farm portions. The proposed infrastructure on Slangkop (3/552), commonly known as Windhoek Farm, is as follows:

- 5-6 Nordex turbines;
- underground cabling linking turbines to (existing) substation; and
- internal roads - stabilised dirt tracks to access each turbine.

The proposed infrastructure on Kerrie Fontein (0/555) is as follows:

- 9-10 Nordex turbines;
- new 66/11kv substation;
- underground cabling linking turbines to substation;
- connection with existing overhead power lines linking substation to national electricity grid;
- internal roads – stabilised dirt tracks to access each turbine.

Figure 1: Proposed lay-out of the wind farm with 14 N77 turbines (Option 1).

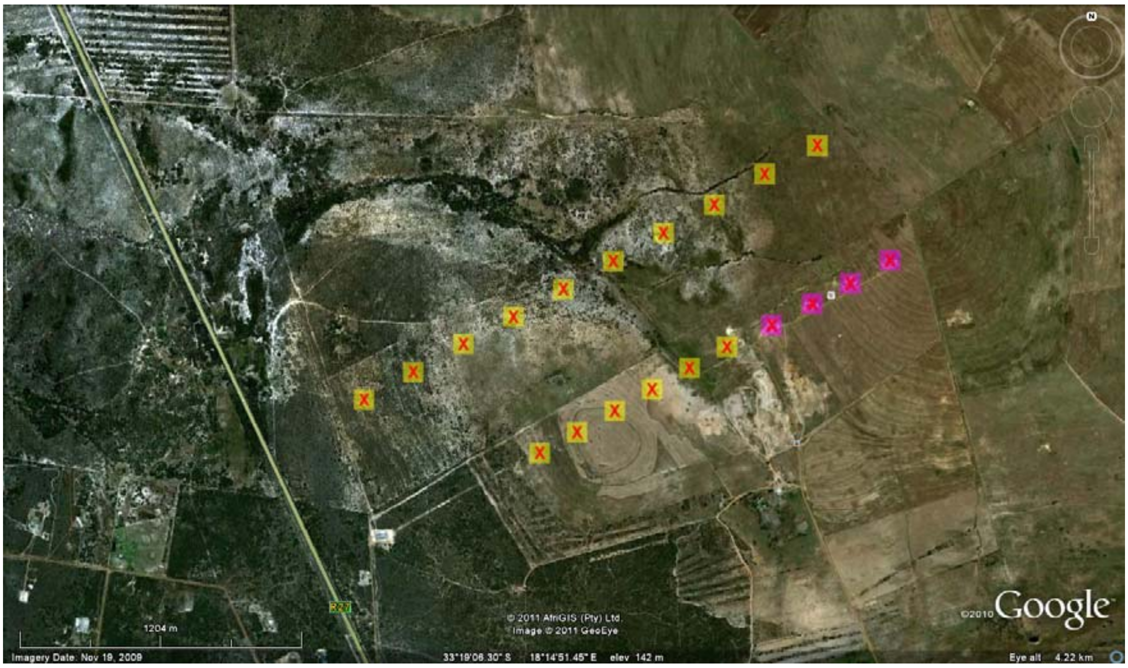

Figure 2: Proposed lay-out of the wind farm with 16 N60 turbines (Option 2).

1.1 Scope and terms of reference

This Bird Impact Assessment Study follows on from the Bird Scoping Assessment Study which was completed earlier in the EIA process. The generic terms of reference for specialist consultants can be found in section 10.5 of the Final Scoping Report (EEU 2011). The impact assessment criteria which is used in this report is likewise set out in the Final Scoping Report (EEU 2011).

As far as the avifauna specifically is concerned, this specialist report is centred on the following **terms of reference**:

- Description of the receiving environment (habitat) from an avifaunal perspective.
- Identification of high risk species, particularly Red listed and other priority species that might be impacted by the proposed facility.
- Description and assessment of potential impacts on priority avifauna.
- Provision of mitigation measures to reduce the envisaged impacts.

Section 2: Legislative Framework and Applicable Regulations or Guidelines

It is important to note that since the investigations into potential bird impacts at the Darling National Demonstration Wind Farm commenced in 2003 (Jenkins 2003), many significant developments have taken place as far as birds and wind turbines in South Africa is concerned. The most important development was the compilation of the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa – Version 1* (Jenkins *et al* 2011), which was released by the Endangered Wildlife Trust and Birdlife South Africa in April 2011. Because these guidelines were only released in April 2011, it could not be applied to the specialist investigations pertaining to this project. Any future investigations that might be required will have to be done according to this protocol. It should also be noted that guidelines are still evolving, and the current document will be adapted as avifaunal specialist become more knowledgeable and experienced in investigation and assessment of bird related impacts associated with wind farm developments in South Africa.

From an international perspective, the Convention on Biological Diversity (1992) is applicable; of which South Africa is a signatory. The overall objective of the Convention is the "…conservation of biological diversity and the sustainable use of its components and the fair and equitable sharing of the benefits…".

Another international convention which is applicable is the Convention on the Conservation of Migratory Species of Wild Animals (http://www.unep-aewa.org). This Convention, commonly referred to as the Bonn Convention, (after the German city where it was concluded in 1979), came into force in 1983. The goal of the Convention is to provide conservation for migratory terrestrial, marine and avian species over the whole of their range. This is very important, because failure to conserve these species at any particular stage of their life cycle could adversely affect any conservation efforts elsewhere. The fundamental principle of the Bonn Convention therefore, is that the Parties of the Bonn Convention acknowledge the importance of migratory species being conserved and of Range States agreeing to take action to this end whenever possible and appropriate, paying special attention to migratory species, the conservation status of which is unfavourable, and taking individually or in co-operation appropriate and necessary steps to conserve such species and their habitat. Parties acknowledge the need to take action to avoid any migratory species becoming endangered. In particular, the Parties:

- shall endeavour to provide immediate protection for migratory species included in Appendix I;
- shall endeavour to conclude Agreements covering the conservation and management of migratory species included in Appendix II.

Agreements are the primary tools for the implementation of the main goal of the Bonn Convention. Moreover, they are more specific than the Convention itself, involve more deliberately the Range States of the species to be conserved, and are easier to put into practice than the whole Bonn Convention. One such agreement is the African-Eurasian Waterbird Agreement, is an international agreement aiming at the conservation of migratory waterbirds. Priority species at the Project site covered by this agreement are Great White Pelican, Greater Flamingo, Lesser Flamingo, Blue Crane and several other non-priority species.

Section 3: Methodology and Approach

3.1 Sources of information

The following information sources were consulted in the compilation of this report:

- Bird distribution data of the Southern African Bird Atlas Project (SABAP – Harrison *et al,* 1997) obtained from the Animal Demography Unit of the University of Cape Town, as a point of departure to ascertain which species have been recorded within the greater study area, i.e. the two quarter degree grid cells (QDGCs) within which the development will take place, namely 3318AD and 3318AC. A QDGC corresponds to the area shown on a 1:50 000 map (15' x 15') and is approximately 27 km long (north-south) and 23 km wide (east-west).
- The SABAP data was supplemented with SABAP2 data for the relevant QDGCs. This data is much more recent, as SABAP2 was only launched in May 2007, and therefore provides a more accurate picture of the general birdlife as it currently exists in the applicable QDGCs.
- Additional information on avifaunal habitat use in the Swartland was obtained from the Coordinated Avifaunal Roadcounts (CAR) and Birds in Reserves Project (BIRP) project of the Animal Demographic Unit (ADU) of the University of Cape Town.
- Information on Important Bird Areas such as Dassen Island and the West Coast National Park was obtained from the Important Bird Areas of Southern Africa (Barnes 1998).
- The national conservation status of all bird species occurring in the aforementioned QDGCs was determined with the use of Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland (Barnes 2000).
- A classification of the vegetation types from an avifaunal perspective in the QDGCs was obtained from SABAP1.
- Detailed satellite imagery from Google Earth was used in order to view the study area on a landscape level and to assist with the identification of bird habitat on the ground.

- An extensive review of relevant international literature on birds and wind farm impacts was conducted, which is referenced in Section 7 of this report. This was done in order to contextualise the current proposed development from an international perspective.
- The bird impact assessment study titled “Populations and movements of priority bird species in the vicinity of the proposed Darling National Demonstration Wind Farm facility” completed in February 2003 by Dr. Andrew Jenkins, and the subsequent review by Dr. Andre Boshoff, was consulted to establish which priority avifaunal species were actually recorded at the site of the proposed wind facility.
- In addition to the 86 hours of avifaunal monitoring done on site by Jenkins (2003), two additional monitoring periods were implemented, one in November 2010 and one in February 2011, totalling 30 hours, using the same protocol as Jenkins (2003).
- Information on Black Harrier nesting sites on the West Coast was obtained from Dr. Rob Simmons at the Percy FitzPatrick Institute at University of Cape Town.
- The results of 3 hours and 15 minutes of observations done by students from the University of Cape Town on 9 September 2010 under the guidance of Dr. Rob Simmons at the project site was used as supplementary information to supplement the data gathered through formal monitoring. The results could not be incorporated into the monitoring data for analysis as the protocols were different.
- Information on power line impacts on avifauna in the vicinity of the Project site was obtained from the Endangered Wildlife Trust’s central incident register, for the period 1996 - 2007.

3.2 Assumptions and limitations

This study made the basic assumption that the sources of information used are reliable. However, it must be noted that there are factors that may potentially detract from the accuracy of the information.

- The SABAP1 data covers the period 1986 -1997. Bird distribution patterns fluctuate continuously according to availability of food and nesting substrate. There are sources of error in the SABAP1 database, particularly inadequate coverage of some QDGCs. This means that the reporting rates of species may not be an accurate reflection of the true densities in QDGCs that were sparsely covered during the data collecting period (for a full discussion of potential inaccuracies in SABAP1 data, see Harrison *et al*. 1997). In this instance, the relevant QDGCs were not equally well covered with 164 checklists completed for 3318AD and 233 for 3318AC.
- Wind facilities are a relatively new development in South Africa. An extensive body of knowledge of avian interactions with wind generation facilities in a southern African context has yet to emerge; therefore strong reliance had to be placed on studies from overseas. Some speculation with regard to how South African birds are likely to interact with the proposed wind facility is therefore unavoidable.
- With certain classes of birds, including cranes and bustards, very little research has been conducted on potential impacts with wind facilities world-wide. The precautionary principle was therefore applied in assessing the potential impacts on species belonging to these classes. The World Charter for Nature, which was adopted by the UN General Assembly in 1982, was the first international endorsement of the precautionary principle. 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 Rio Declaration 1992 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."**

- Jenkins (2003) made the following recommendation with regard to Darling Demonstration Wind Farm: "Further monitoring of impacts both during and especially after the construction of the facility is essential. This should focus on recovering and recording all avian casualties at the site, and on modelling the movements of birds through the area sufficiently accurately to allow pre-emptive closure of the wind farm in conditions of peak avian activity. In the event that significant numbers of bird casualties (see Jenkins 2001) are recorded, the environmental sustainability of the development must be open to review". Unfortunately, the recovering and recording all avian casualties at the site did not happen, therefore scientifically verifiable information on actual casualties that may have occurred at the experimental facility is not available at this point in time.
- The monitoring focused primarily on the site itself, specifically with regard to movement through the site, but the occurrence of important habitat adjacent to the Project site was noted. The assumption was made that birds could be moving through the proposed Project site en route to suitable roosting and foraging habitat outside the Project site. e.g. flamingos commuting between Yzerfontein, Slangkop, Swartwater and Droëvlei pans.
- In calculating estimated collision rates, an avoidance rate of 98% was assumed, based on the default recommended by the Scottish Natural Heritage Avoidance Rate Information and Guidance Note. It is recognised that avoidance rates are key to the calculation of estimated collision rates, and that variations of as little as 1% can result in significant variation in estimated collision rates. No estimated collision rates for southern African bird species exist at this point in time.

3.3 Recording and analysis of data

Up until November 2010, the 86 hours of observations conducted by Jenkins in 2002 – 2003 constituted the only pre-construction avifaunal data ever recorded in South Africa at a proposed wind farm site. It was therefore decided to continue with the same monitoring protocol for the additional 30 hours of monitoring, conducted over four days in November 2010 and February 2011, for the sake of continuity and comparison. The purpose of the additional monitoring was to include a period for spring/early summer, as this period was not covered by Jenkins, and to do additional monitoring in late summer/autumn during a period of high migrant raptor activity along the West Coast. In total 116 hours of monitoring at the site was completed between January 2002 and February 2011. Counts of priority bird species and all raptor species commuting over the development site were conducted from the crest of Moedmaag Hill, facing west along the proposed turbine line. Estimated climatic conditions (cloud cover - 0/8 to 8/8's; temperature – cool, mild or warm; wind strength – light, moderate or strong; wind direction – compass points) on the site were recorded at the start of and throughout each count period. In 14 counts, details of the mode of flight (flapping, gliding, soaring), direction of travel, and approximate horizontal (crest, slope, plain) and vertical (low (<20 m), medium (20-80m), high (>80m) relative to turbine height) zoning of bird flight paths was also recorded.

The following analyses were performed to assist in the assessment of collision risk (see results and discussion under Section 5 Impact Assessments):

- Total number of individual birds (priority species and all raptors)
- Passage rate (priority species and all raptors)
- Passage rate (priority species)
- Passage rate vs wind direction (priority species)
- Relative use of horizontal and vertical zones (priority species)
- Percentage of site use for medium height zone only (priority species)
- Percentage of site use for medium height zone only vs wind direction (priority species)
- Passage rate per season (priority species)
- Passage rate vs time of day (priority species)
- Passage rate vs wind strength (priority species)
- Potential annual collision rate (priority species and 2 species of migratory raptors)

3.4 Literature review

3.4.1 Collision mortality on wind turbines

Internationally, it is widely accepted that bird mortalities from collisions with wind turbines contribute a relatively small proportion of the total mortality from all causes. The US National Wind Coordinating Committee (NWCC) conducted a comparison of wind farm bird mortality with that caused by other man-made structures in the USA (Anon. (b) 2000). The NWCC did not conduct its own study, but analyzed all of the research done to date on various causes of avian mortality, including commercial wind farm turbines. It reports that "data collected outside California indicate an average of 1.83 avian fatalities per turbine (for all species combined), and 0.006 raptor fatalities per turbine per year. Based on current projections of 3,500 operational wind turbines in the US by the end of 2001, excluding California, the total annual mortality was estimated at approximately 6,400 bird fatalities per year for all species combined". The NWCC report states that its intent is to "put avian mortality associated with windpower development into perspective with other significant sources of avian collision mortality across the United States". It further reports that: "Based on current estimates, windplant related avian collision fatalities probably represent from 0.01% to 0.02% (i.e. 1 out of every 5,000 to 10,000) of the annual avian collision fatalities in the United States". That is, commercial wind turbines cause the direct deaths of only 0.01% to 0.02% of all of the birds killed by collisions with man-made structures and activities in the USA.

Also in the USA, a Western EcoSystems Technology Inc. study found a range of between 100 million to 1 billion bird fatalities due to collisions with artificial structures such as vehicles, buildings and windows, power lines and communication towers, in comparison to 33,000 fatalities attributed to wind turbines. The study (see Anon. (a) 2003) reports that “windplant-related avian collision fatalities probably represent from 0.01% to 0.02% (i.e. one out of every 5,000 to 10,000 avian fatalities) of the annual avian collision fatalities in the United States, while some may perceive this level of mortality as small, all efforts to reduce avian mortality are important”. A Finnish study reported 10 bird fatalities from turbines, and 820,000 birds killed annually from colliding with other structures such as buildings, electricity pylons and lines, telephone and television masts, lighthouses and floodlights (Anon. (a) 2003).

The majority of studies on collisions caused by wind turbines have recorded relatively low mortality levels (Madders & Whitfield 2006). This is perhaps largely a reflection of the fact that many of the studied wind farms are located away from large concentrations of birds. It is also important to note that many records are based only on finding corpses, with no correction for corpses that are overlooked or removed by scavengers (Drewitt & Langston in *Ibis* 2006).

Relatively high collision mortality rates have been recorded at several large, poorly sited wind farms in areas where large concentrations of birds are present (including Important Bird Areas (IBAs)), especially among migrating birds, large raptors or other large soaring species, e.g. in the Altamont Pass in California, USA, and in Tarifa and Navarra in Spain. In these cases actual deaths resulting from collision are high, notably of Golden Eagle *Aquila chrysaetos* and Eurasian Griffon *Gyps fulvus*, respectively.

In a study in Spain, it was found that the distribution of collisions with wind turbines was clearly associated with the frequencies at which soaring birds flew close to rotating blades (Barrios & Rodriguez 2004). Patterns of risky flights and mortality included a temporal component (deaths concentrated in some seasons), a spatial component (deaths aggregated in space), a taxonomic component (a few species suffered most losses), and a migration component (resident populations were more vulnerable). Clearly, the risk is likely to be greater on or near areas regularly used by large numbers of feeding or roosting birds, or on migratory flyways or local flight paths, especially where these are intercepted by the turbines. Risk also changes with weather conditions, with evidence from some studies showing that more birds collide with structures when visibility is poor due to fog or rain, although this effect may to some extent be offset by lower levels of flight activity in such conditions (Madders & Whitfield 2005). Strong headwinds also affect collision rates and migrating birds in particular tend to fly lower when flying into the wind (Drewitt & Langston 2006). The same applies for Blue Cranes flying between roosting and foraging areas (pers. obs.).

Accepting that many wind farms may only cause low levels of mortality, even these levels of additional mortality may be significant for long-lived species with low productivity and slow maturation rates (e.g. Blue Crane, Denham's Bustard, Martial Eagle and Secretarybird), especially when rarer species of conservation concern are affected. In such cases there could be significant effects at the population level (locally, regionally or, in the case of rare and restricted species, nationally), particularly in situations where cumulative mortality takes place as a result of multiple installations (Carette *et. al.* 2009).

Large birds with poor manoeuvrability (such as cranes, bustards and secretarybirds) are generally at greater risk of collision with structures, and species that habitually fly at dawn and dusk or at night are perhaps less likely to detect and avoid turbines (e.g. cranes arriving at a roost site after sunset, or flamingos flying at night). Collision risk may also vary for a particular species, depending on age, behaviour and stage of annual cycle (Drewitt & Langston 2006). While the flight characteristics of cranes, flamingos and bustards make them obvious candidates for collisions with power lines, it is noted that these classes of birds (unlike raptors) do not feature prominently in literature as wind turbine collision victims. It may be that they avoid wind farms entirely, resulting in lower collision risks (see the discussion on Displacement in section 3.1.2 below). However, this can only be verified through on-site post-construction monitoring.

The precise location of a wind farm site can be critical. Soaring species may use particular topographic features for lift (Barrios & Rodriguez 2004; De Lucas *et. al.* 2008) or such features can result in large numbers of birds being funnelled through an area of turbines (Drewitt & Langston 2006). For example, absence of thermals on cold, overcast days may force larger, soaring species (e.g. Martial Eagle and Secretarybird) to use slopes for lift, which may increase their exposure to turbines. Birds also lower their flight height in some locations, for example when following the coastline or crossing a ridge, which might place them at greater risk of collision with rotors.

The size and alignment of turbines and rotor speed are likely to influence collision risk; however, physical structure is probably only significant in combination with other factors, especially wind speed, with moderate winds resulting in the highest risk (Barrios & Rodriguez 2004; Stewart *et. al.* 2007). Lattice towers are generally regarded as more dangerous than tubular towers because many raptors use them for perching and occasionally for nesting; however Barrios & Rodriguez (2004) found tower structure to have no effect on mortality, and that mortality may be directly related to abundance for certain species (e.g. Common Kestrel *Falco tinnunculus*). De Lucas *et. al.* (2008) found that turbine height and higher elevations may heighten the risk (taller/higher = higher risk), but that abundance was not directly related to collision risk, at least for Eurasian Griffon Vulture *Gyps fulvus*.

A review of the available literature indicates that, where collisions have been recorded, the rates per turbine are highly variable with averages ranging from 0.01 to 23 bird collisions annually (the highest figure is the value, following correction for scavenger removal, for a coastal site in Belgium and relates to gulls, terns and ducks among other species) (Drewitt & Langston 2006). Although providing a helpful and standardised indication of collision rates, average rates per turbine must be viewed with some caution as they are often cited without variance and can mask significantly higher rates for individual turbines or groups of turbines (Everaert *et. al.* 2001 as cited by Drewitt & Langston 2006).

Some of the highest mortality levels have been for raptors in the Altamont Pass in California (Howell & DiDonato 1991, Orloff & Flannery 1992 as cited by Drewitt & Langston 2006) and at Tarifa and Navarre in Spain (Barrios & Rodriguez unpublished data as cited by Drewitt & Langston 2006). These cases are of particular concern because they affect relatively rare and long-lived species such as Griffon Vulture *Gyps fulvus* and Golden Eagle *Aquila chrysaetos* that have low reproductive rates and are vulnerable to additive mortality. Golden Eagles congregate in Altamont Pass to feed on super-abundant prey which supports very high densities of breeding birds. In the Spanish cases, extensive wind farms were built in topographical bottlenecks where large numbers of migrating and local birds fly through a relatively confined area due to the nature of the surrounding landscape, for example through mountain passes, or use rising winds to gain lift over ridges (Barrios & Rodriguez 2004). Although the average numbers of annual fatalities per turbine (ranging from 0.02 to 0.15 collisions/turbine) were generally low in the Altamont Pass and at Tarifa, overall collision rates were high because of the large numbers of turbines involved (over 7 000 in the case of Altamont). At Navarre, corrected annual estimates ranging from 3.6 to 64.3 mortalities/turbine were obtained for birds and bats (unpublished data). Thus, a minimum of 75 Golden Eagles are killed annually in Altamont and over 400 Griffon Vultures are estimated (following the application of correction factors) to have collided with turbines at Navarre. Work on Golden Eagles in the Altamont Pass indicated that the population was declining in this area thought to be due, at least in part, to collision mortality (Hunt *et. al.* 1999, Hunt 2001 as cited by Drewitt & Langston 2006).

3.4.2 Displacement due to disturbance

The displacement of birds from areas within and surrounding wind farms due to visual intrusion and disturbance effectively 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* (a species related to the Denham's Bustard) are displaced by wind farms within one kilometre of the facility (Langgemach 2008).

Studies of 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 80 m of the turbines, indicating that displacement did occur at least in this case. 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. In the absence of any reliable information on the effects of displacement on birds, it is precautionary to assume that significant displacement will lead to a population reduction (Drewitt & Langston 2006).

Studies show that the scale of disturbance caused by wind farms varies greatly. This variation is likely to depend on a wide range of factors including seasonal and diurnal patterns of use by birds, location with respect to important habitats, availability of alternative habitats and perhaps also turbine and wind farm specifications. Behavioural responses vary not only between different species, but between individuals of the same species, depending on such factors as stage of life cycle (wintering, moulting, breeding), flock size and degree of habituation. The possibility that wintering birds in particular might habituate to the presence of turbines has been raised (Langston & Pullin 2003), though it is acknowledged that there is little evidence and few studies of long enough duration to show this, and at least one study has found that habituation may not happen (Altamont Pass Avian Monitoring Team 2008). A systematic review of the effects of wind turbines on bird abundance has shown that increasing time since operation resulted in greater declines in bird abundance (Stewart *et al*. 2004 as cited by Drewitt & Langston 2006). This evidence that impacts are likely to persist or worsen with time suggests that habituation is unlikely, at least in some cases (Drewitt & Langston 2006, Altamont Pass Avian Monitoring Team 2008).

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.

3.4.3 Habitat change and loss

The scale of direct habitat loss resulting from the construction of a wind farm and associated infrastructure depends on the size of the project but, generally speaking, 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).

3.4.4 Mitigation measures

Despite the fact that wind power has been a feature of the energy industry in the developed world for more than a decade, best practices with regard to bird mitigation are still far from clear and universally accepted. In the USA, for example, best practices are sorely lacking (Smallwood 2008). Mitigation measures would be more effective if based on scientifically founded conclusions of factors affecting bird collisions with wind turbines. It is essential to perform scientifically rigorous pre- and post-construction monitoring of bird fatalities and flight behaviours in wind farms, as well as ecological investigations. These types of investigations have not been performed at most wind farms in the USA so the scientific basis for mitigation measures remains weak (Smallwood 2008). Avoidance and minimisation measures will be the most effective mitigation at wind farms, but these have yet to be implemented at USA wind farms. Adaptive management is often promised in environmental review documents, but in practice it seldom happens. Off-site compensation may be the only substantial means of mitigating impacts following wind farm development. A scientifically defensible nexus between project impacts and mitigation benefits still needs to be established for compensation ratios directed toward wind farms (Smallwood 2008).

The situation described above is even more applicable to South Africa at this point in time. It must be accepted that appropriate best practices and mitigation measures with regard to impacts on birds in a South African context will take a number of years to crystallise, and a measure of trial and error will inevitably be part of the process.

Mitigation measures fall into two broad categories: best-practice measures which could be adopted by any wind farm development and should be adopted as an industry standard, and additional measures which are aimed at reducing an impact specific to a particular development (Drewitt & Langston 2006).

Examples of **generic best practice** measures are listed below (Drewitt & Langston 2006). Many of these measures have significant economic implications, and may meet with resistance from the developer on the grounds that it will effectively torpedo the project on economic grounds. This is a reality which would need to be addressed on a per project basis, and underscores again the importance of basing conclusions and recommendations on sound scientific grounds:

- Ensuring that key areas of conservation importance and sensitivity are avoided. This implies that adequate baseline monitoring should be implemented pre-construction. This is the most important and effective mitigation measure, and if applied consistently, can largely prevent damaging and costly conflicts later in the project cycle;
- Implementing appropriate working practices to protect sensitive habitats;
- Providing adequate briefing for site personnel and, in particularly sensitive locations, employing an on-site ecologist during construction;
- Implementing a post-construction monitoring programme to assess the actual impacts;
- Siting turbines close together to minimise the development footprint (subject to technical constraints such as the need for greater separation between larger turbines);

- Grouping turbines to avoid alignment perpendicular to main flight paths and to provide corridors between clusters, aligned with main flight trajectories, within large wind farms;
- Where possible, installing transmission cables underground (subject to habitat sensitivities and in accordance with existing best practice guidelines for underground cable installation);
- Marking overhead cables using Bird Flight Diverters and avoiding use over areas of high bird concentrations, especially for species vulnerable to collision;
- Timing construction to avoid sensitive periods. This measure is not widely applied as it has significant practical and economic implications;
- Implementing habitat enhancement for species using the site. This may be counter-productive if it increases the collision risks by drawing birds into the wind farm;
- Increasing the visibility of rotor blades. Research indicates that high contrast patterns might help reduce collision risk, although this may not always be acceptable on landscape grounds. Another suggested, but untested possibility is to paint blades with UV paint, which may enhance their visibility to birds. However, there is consensus that birds generally avoid the turbines, even if not painted in optimal patterns (Madders & Whitfield 2006; SNH 2010), and it may be against South African aviation regulations (Civil Aviation Regulations 1997).
- Relocation of proposed or actual turbines responsible for particular collision mortality.
- Halting operation during peak flight periods, or reducing rotor speed, to reduce the risk of collision mortality.

Section 4: Baseline environmental conditions

4.1 Vegetation types and bird habitats

The Project site is located in the Swartland, and consists of a portion of the Farm 555 (Kerrie Fontein) and a portion of the Farm 552 (Slangkop), and is about 450ha in extent. The Project site lies east of the R27 and north of the Yzerfontein to Darling road (R315).

The land use in the Swartland is mostly a mixture of wheat and pastures and it has been that way for decades. The 1999 figures indicate that 61% of the region is under dry-land cultivation, while irrigated crops occur on 4%. The remaining area is covered by 24% natural vegetation and 11% other (i.e. alien trees, plantations etc.). Wheat is the predominant form of dry-land cultivation (36%), followed by old lands (24%), hay and silage crops (10%), fallow land (8%), medic pastures (7%), oats (5%), lupin (4%), barley (3%) and canola (2%). Dry-land cultivation is practised over the whole region whereas irrigation farming - table grapes and, to a lesser degree, deciduous fruit – is confined to the river valleys and the foothills of the mountains. The high percentage of old lands (lands left after the last harvest and not cultivated for some time) is indicative of the economic instability of wheat farming. Along the coast and river courses, alien invasive plants (mostly Australian *Eucalyptus* and *Acacia* species) have become established (Young *et al* 2003).

About 16% of the Project site is essentially fallow agricultural land with very little natural vegetation. Natural vegetation in moderate or good condition thus covers an estimated 84% of the study area, and most of the vegetation in good condition is either on previously uncultivated small, rocky outcrops, in drainage lines (wetlands), or in the western parts, dominated by infertile sandy soils, which are not suitable for cultivation (Helme 2010).

It is widely accepted that vegetation structure is more critical in determining bird habitat, than the actual plant species composition (Harrison *et al* 1997). The description of vegetation presented in this report therefore concentrates on factors relevant to the bird species present, and is not an exhaustive list of plant species present. The description of the vegetation types occurring in the study area makes extensive use of information presented in SABAP1 (Harrison *et al* 1997). The criteria used by the SABAP1 authors to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations. The natural vegetation in the greater study area where the proposed wind facility is located is classified as **fynbos** vegetation (Harrison *et al* 1997).

Fynbos is dominated by low shrubs and can be divided into two categories, fynbos proper and renosterveld, both of which occur on the study site. Despite having a high diversity of plant species, fynbos and renosterveld has a relatively low diversity of bird species. The only Red listed priority species that is closely associated with fynbos in this study area, is the Black Harrier *Circus maurus* (which often breeds in fynbos), (Harrison *et al* 1997). An estimated 5-10 pairs breed in the West Coast National Park (Barnes 1998.) At least one breeding pair is located on the edge of the Yzerfontein Pan (Jenkins 2003; Simmons pers. com). Black Harriers made up 1.2% of priority species sightings during the 116 hour monitoring period at the site. A Black Harrier was also recorded by Van Beuningen and Retief during their 3 hour stint of monitoring of the site in September 2010. An average of 4-6 pairs of Black Harrier breed annually on Jakkalsfontein Nature Reserve and neighbouring Rondeberg Flats, which are situated roughly 5km to the south of the study site (Marais 2010).

Other Red listed species that sometimes use this habitat are Secretarybirds *Sagittarius serpentarius* (1.8% of priority species recorded) which are sometimes found in fynbos and renosterveld (pers. obs.), while Martial Eagles *Polemaetus bellicosus* (3.6% of priority species recorded) on occasion forage in this habitat. Other priority species which were recorded on site foraging in this habitat are Lanner Falcon *Falco biarmicus* (20% of priority species recorded), Jackal Buzzard *Buteo rufofuscus* (39% of priority species recorded) and Peregrine Falcon *Falco peregrines* (4.2% of priority species recorded). Much of the fynbos and renosterveld in the Swartland have been transformed for agriculture. Whilst this obviously resulted in substantial natural habitat being destroyed, several species have in fact adapted well to this transformation. One such species, which is relevant to this study, is the Blue Crane *Anthropoides paradiseus*. This species has thrived on the grain lands and pastures in the southern and western Cape. This will be further discussed when the micro-habitats are discussed below.

In addition to natural vegetation, the following bird micro-habitats are present at the Project site and within a 5km radius around the site:

2.1.1 Cereal crops and pastures

The natural vegetation at the study area at the Project is surrounded by a typical mosaic of grain fields interspersed with pastures. It is of specific importance to the endemic, Red listed Blue Crane.

The Swartland holds an important population of Blue Cranes (Young *et al* 2003), probably second only in importance to the Overberg Wheatbelt. The Blue Crane has relatively recently expanded its range into the Swartland, where it feeds on *inter alia* fallen grain and recently germinated crops. They also feed on supplementary food put out for small stock, and can congregate in huge numbers around these feed lots. The Blue Cranes favour agricultural areas above natural vegetation. Blue Cranes were recorded in pastures and fallow fields within a radius of around 5km from the proposed Project site, mostly to the east of the actual site (Jenkins 2003, Van der Westhuizen 2011, Van Rooyen pers. obs). According to Jenkins (2003), at least one pair of Blue Cranes breeds very close to the eastern edge of the site and occasionally moves through the area to croplands below and to the west of Moedmaag. Relatively few Blue Cranes were recorded at the site itself during 116 hours of monitoring (6.6% of priority species recorded).

During the site visits in June and November 2010, the following priority species were recorded in croplands and pastures adjacent to the study site, to the east behind Moedmaag Hill:

- Blue Crane
- Jackal Buzzard
- Secretarybird
- Lanner Falcon

In addition, Jackal Buzzard, African Marsh Harrier *Circus ranivorus*, Black Harrier and Lanner Falcon were all recorded "quite commonly" foraging in pastures and croplands both east and west of the Project site by Jenkins (2003).

2.1.2 Drainage lines and wetlands

The Swartland contains many drainage lines and associated wetlands, some of which are sometimes used as roosting areas for Blue Cranes, as well as for foraging and breeding African Marsh-Harrier. Apart from these Red listed species, wetlands are also important for several common species such as Egyptian Goose *Alopochen aegyptiacus*, White Stork *Ciconia ciconia* and Spur-winged Goose *Plectropterus gambensis*.

There is a single main seasonal drainage line on the Project site, with four tributaries. A small vlei area, Segarevlei, is also present south of the homestead adjacent to the R27. None of these are of particular importance for priority species, with the possible exception of the African Marsh-harrier, which may on occasion forage at Segarevlei if conditions are favourable. However, the species was not recorded at the Project site itself during 116 hours of observation which means that the habitat is probably not suitable.

Of more importance are the large wetlands adjacent surrounding the study site, namely Yzerfontein, Slangkop, Swartwater and Droëvlei pans. Greater Flamingo is also occasionally observed during particularly wet winters on pans in the Jakkalsfontein Nature Reserve (Marais 2010). These pans hold significant numbers of Great White

Pelican *Pelecanus onocrotalus* and both species of flamingo (Jenkins 2003), and movement to and fro between these water bodies could be expected, particularly in winter (see also Section 5 below).

4.2 Avifauna in the study area

The proposed wind facility is located within 3318AD and 3318AC. TABLE 1 below lists the Red listed species that have been recorded in these QDGCs. It also states the national conservation status, habitat preferences as well as whether it was recorded flying over the site during 116 hours of observation between 2002 and 2011.

Jenkins (2003) identified the following priority species potentially occurring at the Project site, or in suitable habitat adjacent to the site.

- White Pelican *Pelecanus onocrotalus*
- Greater Flamingo *Phoenicopterus ruber*
- Lesser Flamingo *Phoeniconaias minor*
- Secretarybird *Sagittarius serpentarius*
- Martial Eagle *Polemaetus bellicosus*
- Jackal Buzzard *Buteo rufofuscus*
- African Marsh Harrier *Circus ranivorus*
- Black Harrier *C. maurus*
- Lanner Falcon *Falco biarmicus*
- Peregrine Falcon *F. peregrinus*
- Lesser Kestrel *F naumanni*
- Blue Crane *Anthropoides paradiseus*

Table 1: Red listed species (excluding marine species) and other priority species recorded in 3318AD and 3318AC QDGCs by SABAP1 and SABAP2 (Harrison *et al* 1997; http://sabap2.adu.org.za).

Common Name	**Scientific Name**	**National Conservation Status (Barnes 2000)**	**% of records of priority species recorded at the site. Number of individual sightings is indicated in brackets**	**Habitat requirements (Barnes 1998; Barnes 2000; Hockey *et al* 2005; Young *et al* 2003; Harrison *et al* 1997; personal observations)**
Secretarybird	*Sagittarius serpentarius*	NT	1.8% (3)	Grassland, old lands, open woodland. Most likely to forage in pastures and old agricultural areas, but also in low fynbos.
African Marsh-Harrier	*Circus ranivorus*	VU	Not recorded	Large permanent wetlands with dense reed beds. Sometimes forages over smaller wetlands and grassland. Could be present at wetlands associated with pans adjacent to the study area. Recorded by Jenkins in croplands adjacent to the Project site. There is a small likelihood of the species occurring at Segarevlei when conditions are favourable.
Black harrier	*Circus maurus*	NT	1.2% (2)	Forages both over fynbos and agricultural land. An average of 4-6 pairs of Black Harrier breed annually on Jakkalsfontein Nature Reserve and neighbouring Rondeberg Flats, which are situated roughly 5km to the south of the study site.
Peregrine Falcon	*Falco peregrinus*	NT	4.2% (7)	A wide range of habitats, but cliffs (or tall buildings) are a prerequisite for breeding. May hunt over agricultural areas and to a lesser extent fynbos.

Lanner Falcon	*Falco biarmicus*	NT	20% (33)	Generally prefers open habitat, but exploits a wide range of habitats. May hunt over agricultural areas and to a lesser extent fynbos.
Lesser Kestrel	*Falco naumanni*	VU	Not recorded	Summer migrant most likely to be encountered hunting over agricultural areas.
Blue Crane	*Anthropoides paradiseus*	VU	6.6% (11)	Cereal crops, old lands, pastures, wetlands, dams and pans for roosting.
Great White Pelican	*Pelecanus onocrotalus*	NT	23% (38)	Large dams and estuaries. Occurs on Dassen Island and at pans adjacent to the Project site.
Barlow's Lark	*Calendulauda barlowi*	NT	Not recorded	Arid scrubland and vegetated dunes.
Greater Flamingo	*Phoenicopterus ruber*	NT	Not recorded at the site, but recorded in adjacent wetlands	The species is present at Yzerfontein, Slangkop, Swartwater and Droëvlei pans. May commute over the Project site, but this has to be confirmed.
Lesser Flamingo	*Phoenicopterus minor*	NT	Not recorded at the site, but recorded in adjacent wetlands	The species is present at Yzerfontein, Slangkop, Swartwater and Droëvlei pans. May commute over the Project site, but this has to be confirmed.
Martial Eagle	*Polemaetus bellicosus*	V	3.6% (6)	Most likely to be encountered over fynbos and old agricultural lands habitat at the Project site.
Jackal Buzzard	*Buteo rufofuscus*	Not threatened endemic	39% (65)	Most likely to be encountered over fynbos and old agricultural lands habitat at the Project site.

VU = Vulnerable
NT = Near threatened

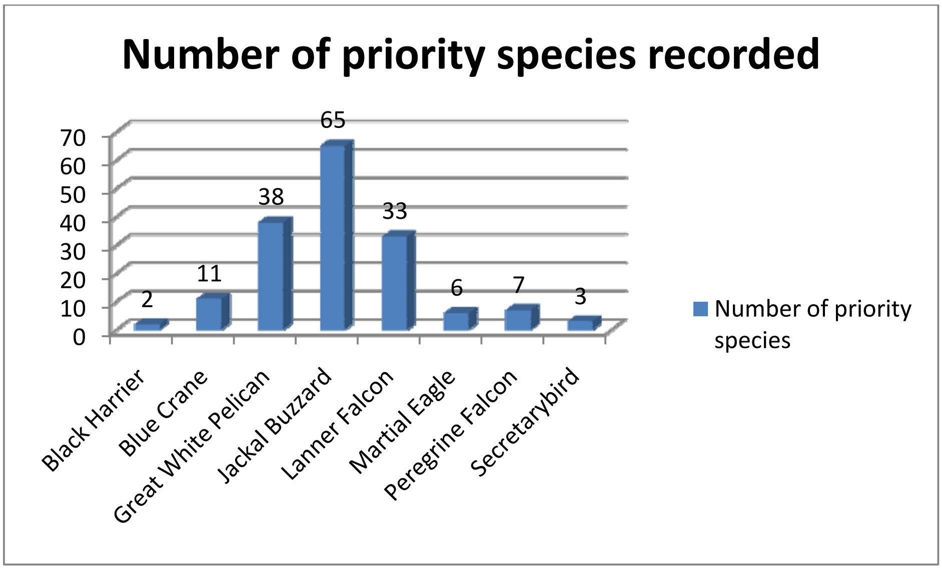

Figure 3: Priority species recorded at the site during 116 hours of monitoring

Section 5: Impact assessments

5.1 Collisions with the turbines

5.1.1 Analysis of monitoring data

The protocol originally designed by Jenkins (2003) was aimed primarily at assessing the collision risk posed by the proposed wind farm development. The analyses that have been performed on the dataset gathered during 116 hours of monitoring therefore focus primarily on quantifying this risk.

A total of 513 individual raptors and priority species were recorded. The passage rate for a number of classes of birds travelling across the Project site was also calculated. The passage rate for the priority species and all raptors combined is 4.44 birds per hour. The rate for priority species only is 1.42 birds per hour. A passage rate for priority species in different wind directions was also calculated (see Figure 3 below).

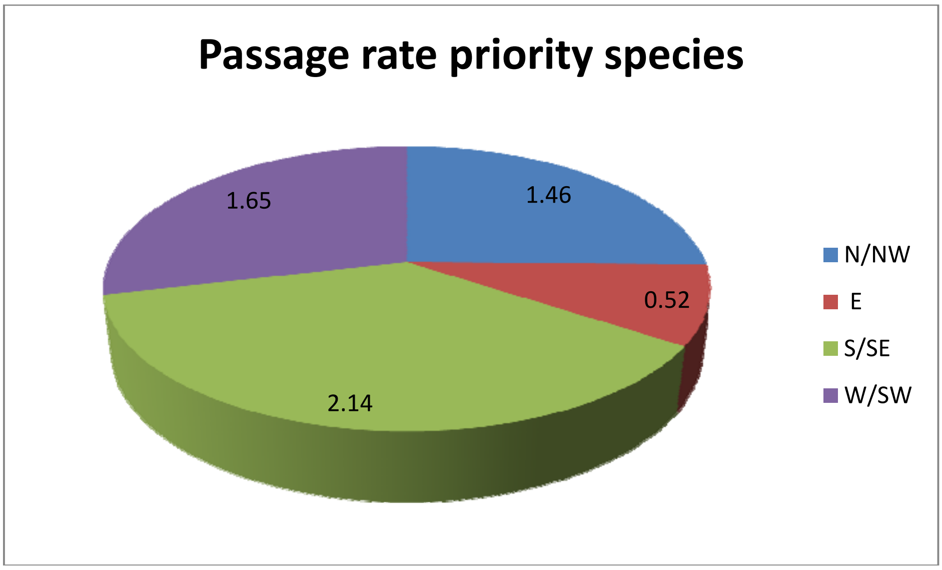

Figure 3: Passage rate for priority species for different wind directions

It is clear from Figure 3 above that the Project site is used most by priority species when winds with a westerly and southerly orientation prevail. This is to be expected as these wind conditions create maximum lift conditions against the slope of Moedmaag Hill.

As mentioned earlier, the turbine area was delineated in horizontal zones for data capture purposes. The zones are as follows:

- plain
- slope
- crest

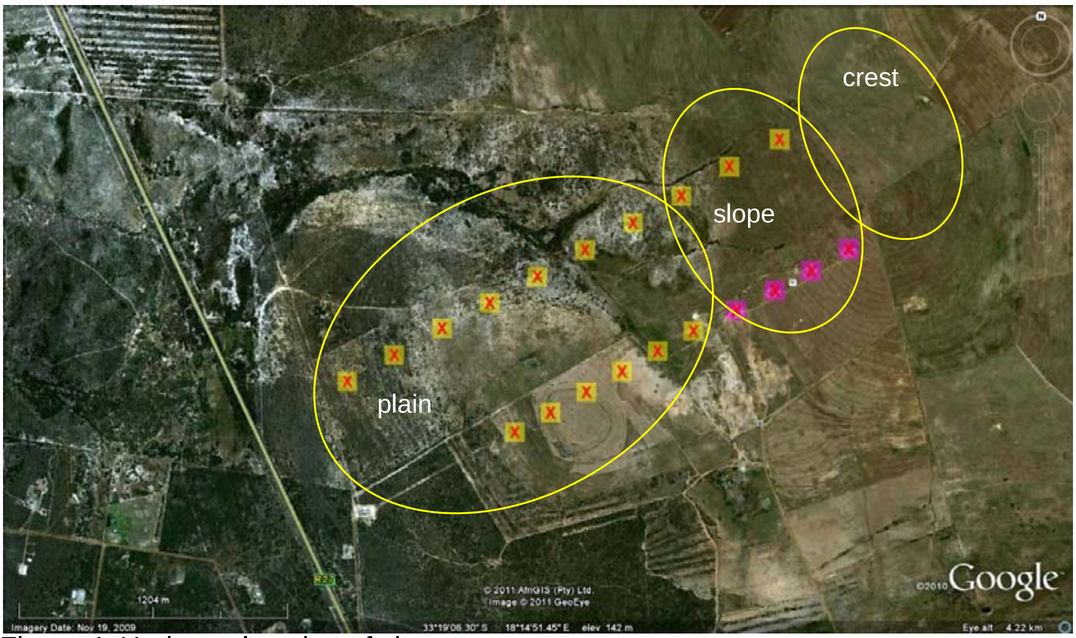

Figure 4: Horizontal zoning of site

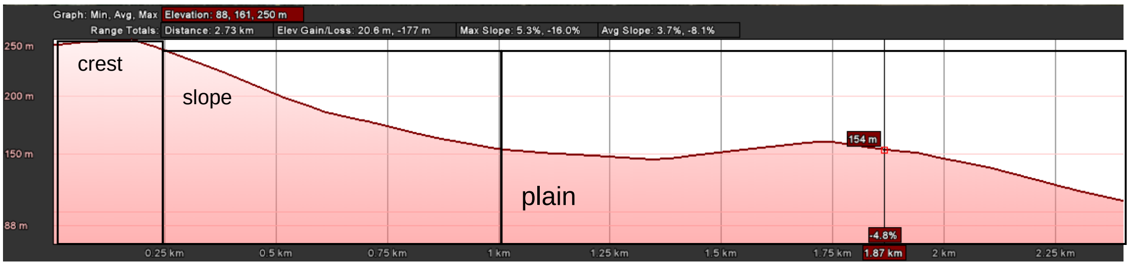

Figure 5: Elevation profile of the turbine area

The use of the site relative to the horizontal zoning for priority species was calculated. Most priority species flights were recorded on the plain and slope, with a combined figure of 82% of all recorded priority species flights. The slope is used most with 50% of recorded flights.

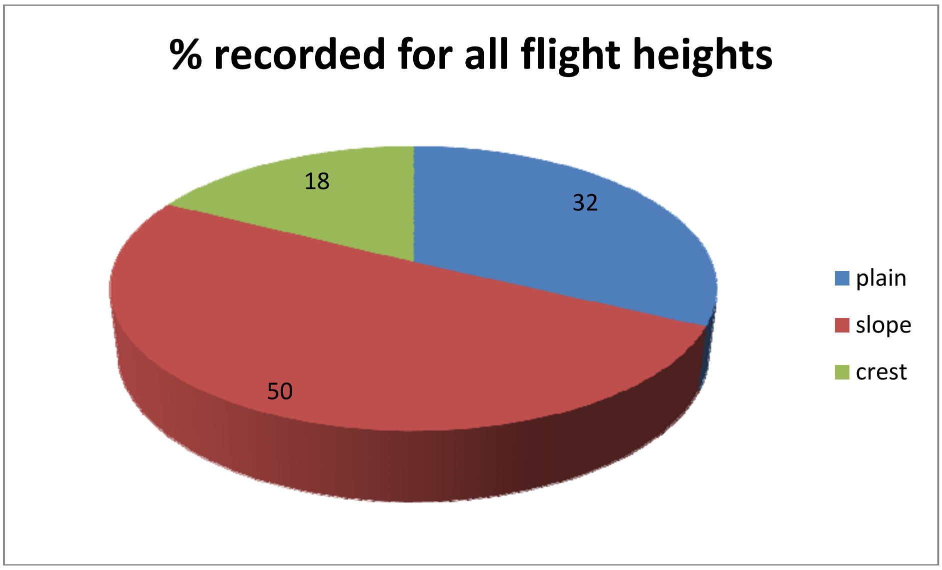

Figure 6: Recorded flights relative to the horizontal zoning for priority species

In order to assess the risk to priority species more accurately, the percentage of priority species flights recorded at medium height, i.e. potentially within the rotor swept area, was calculated for each of the horizontal zones. 27% of all priority species flights were at medium height on the plain and slope (slope = 23% and plain = 4%). This translates into a passage rate of 0.44 priority species flights per hour for priority species flights at medium height for the slope and plain combined, and 0.33 and 0.06 priority species flights per hour for priority species at medium height for the slope and the plain respectively.

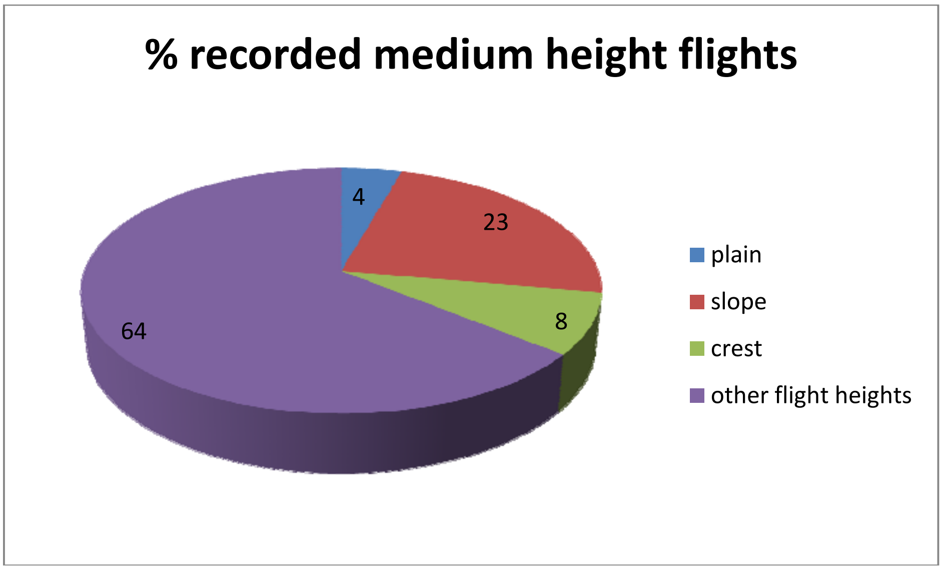

Figure 7: Recorded medium height flights relative to the horizontal zoning for priority species

The passage rate for priority species at different wind strengths was also analysed. The passage rates for moderate and strong winds was the highest, namely 1.44 and 1.63 birds per hour respectively.

An analysis of seasonal usage of the site was also done. The results showed that most flights of priority species happen in spring/early summer, followed by late summer/autumn (see figure 8 below).

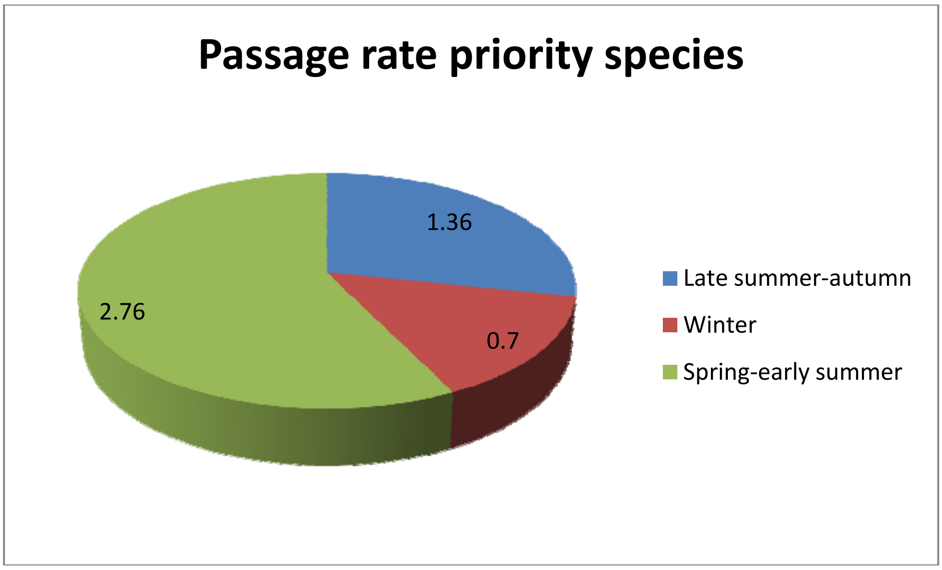

Figure 8: Passage rate for priority species relative to time of year

Lastly, the time of day when most flights of priority species take place was analysed. The results are given in Figure 9 below.

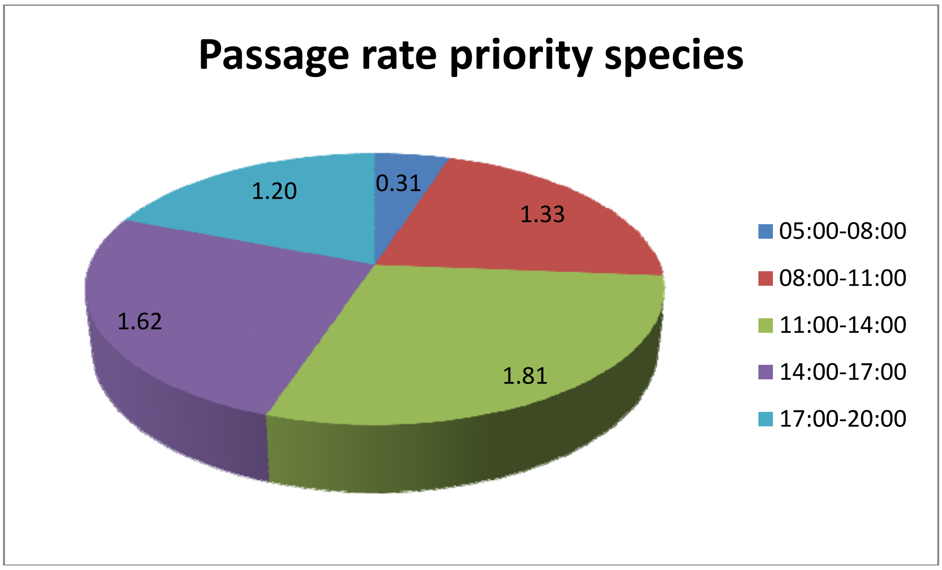

Figure 9: The passage rate of priority species relative to time of day

In order to gain an idea of the potential risk to specific priority species, the passage rate for individual priority species (all flights and all horizontal zones combined) was calculated. The passage rates are given below in Figure 10:

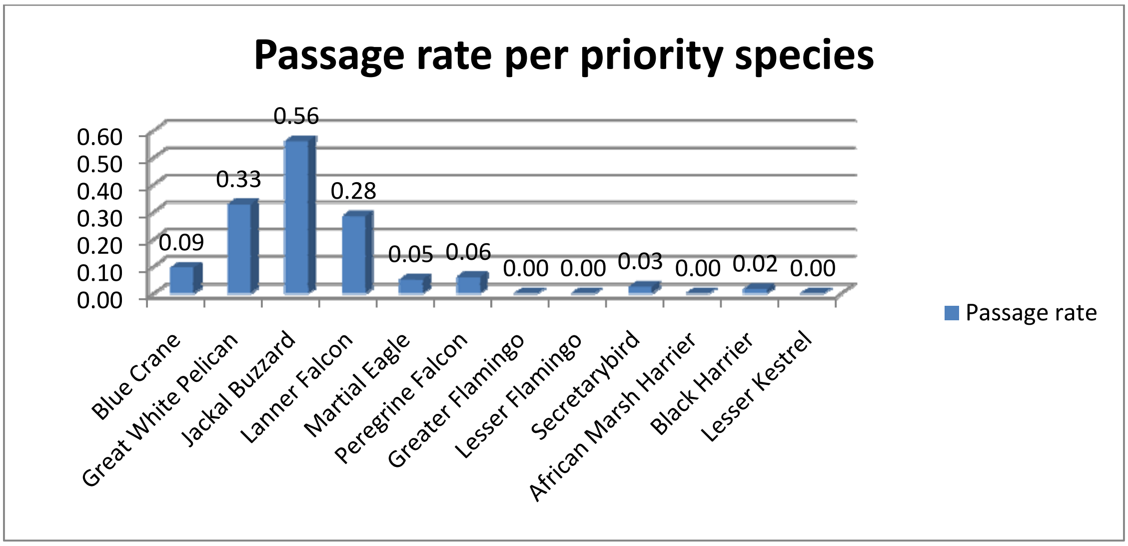

Figure 10: Passage rate per priority species, all flights and zones combined

The recorded flights for each priority species at medium height on the slope was then calculated as a percentage of that priority species total flights. This is given in Figure 11 below:

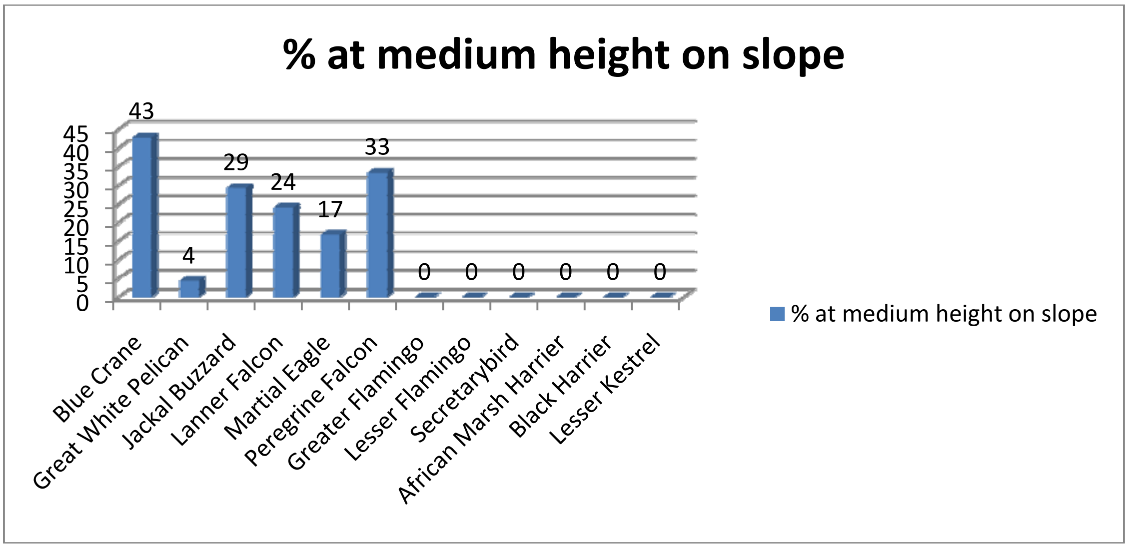

Figure 11: Percentage of flight time spent by each priority species at medium height on the slope.

A passage rate per hour for each species at medium height on the slope was calculated by multiplying the overall passage rate of the species with the percentage of time that the species spent at medium height on the slope. This is given in Figure 12 below:

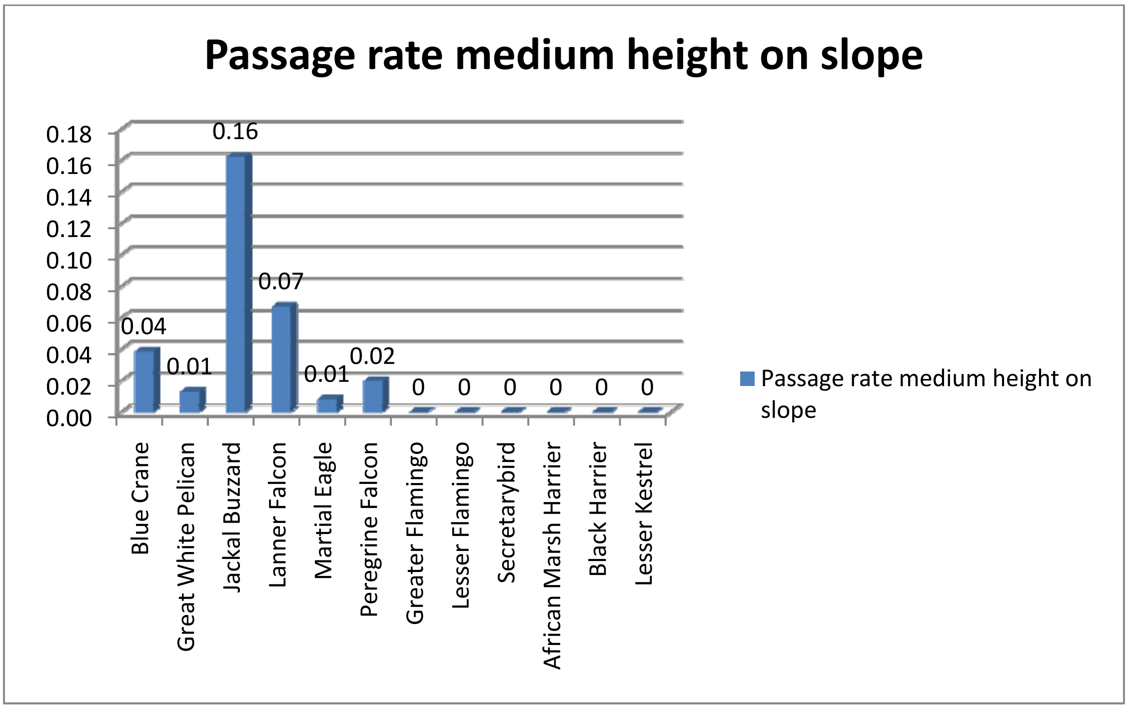

Figure 12: The estimated passage rate p/h for priority species at medium height on the slope

Finally an estimated collision rate for each species per year was calculated in the following manner: The passage rate was multiplied by 12 to arrive at an average passage rate per day, assuming an average of 12 hours per day potential flight time. This rate was multiplied by 365 to get to an annual passage rate. The surface area of the slope covered by the observer was estimated to be approximately 100 hectares. Within this slope area, there are 4 existing turbines, and another three are planned. It was assumed that the blades would cover a radius of 40m around the centre of the turbine, which is effectively the area in which a bird could be killed through collision with the blades (the high risk area). The surface area covered by the combined high risk areas of the 7 turbines amounts to 7 x 0.5 hectares, i.e 3.5 hectares. This is 3.5% of the total slope area. Based on this it was assumed that a bird that entered the slope area at medium height, had a 96.5% chance of finding itself in safe airspace, regardless of whether it took any evasive action to avoid the turbines, or put differently, 3.5% of birds entering the slope air space at medium height could potentially collide with one of the turbines. This figure was then multiplied by 0.02, on the assumption that 98% of all birds will avoid the turbines by taking evasive action (SNH 2010). The results are given in Figure 13 below:

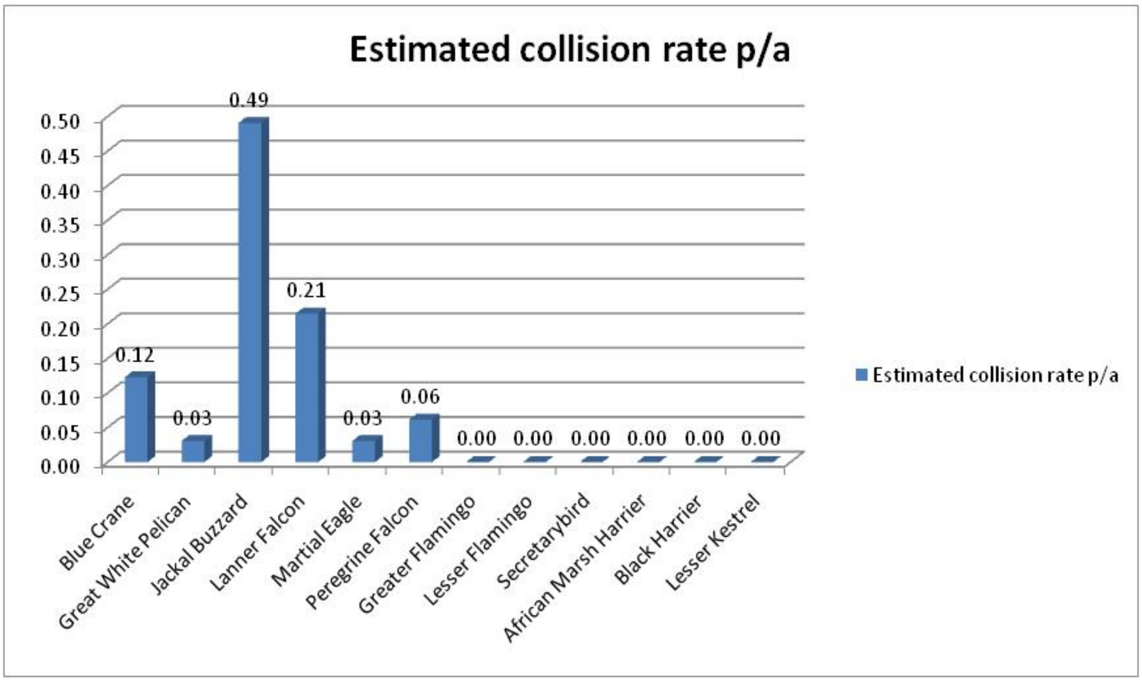

Figure 13: Estimated annual collision rate for priority species

It is important to note the estimated collision rates should be qualified:

- The rates do not take into account nocturnal collisions, as no data on nocturnal flights are available for that at this stage.
- The rates do not take into account the fact that the turbines may not be operating for 12 hours per day for 365 days per year.
- The rates do not take into account that different species will have different avoidance rates, based on different flight characteristics.
- The rates do not take into account that a bird will not be automatically collide if it entered the high risk zone of a turbine (as defined above).

<u>The estimated collision rate as calculated above is therefore a rough indicator and should not be taken as exact figure by any means, but merely as a guideline.</u>

In summary then, it would seem from the analysis above that the wind facility will not pose a significant collision mortality risk to priority species. The greatest collision risk is posed by the 7 turbines on the slope of Moedmaag Hill (i.e. 4 existing and 3 proposed), in the following conditions:

- Between 11h00 and 17h00
- In spring/early summer i.e. between October and December
- In moderate to strong winds with a southerly and westerly orientation

With Jackal Buzzards specifically, the estimated avoidance rate may me more than 98%, as the birds observed on site are most likely a resident pair. These birds have clearly become used to the four existing turbines and are even using them as hunting perches when stationary (pers. obs., Van der Westhuizen 2011). During 30 hours of monitoring no instances were observed where Jackal Buzzards exhibited any “flaring” behaviour i.e. panicky behaviour to avoid the moving blades, they always seem to be aware of the moving blades and avoided them seemingly with ease. Whether this would also be the case with inexperienced, juvenile birds remains to be seen. It is therefore essential for carcass searches to commence as soon as possible to verify the estimates made in this study.

Fortunately, the phenomenon of mass migrations involving thousands of birds is not a feature of the Project site, as this can result in significant mortality risks. However, migratory raptors, i.e. Steppe Buzzard *Buteo vulpinus* and Yellow-billed Kite *Milvus aegyptius* were recorded at passage rates of 0.74 and 1.39 birds per hour during the summer and autumn monitoring period, when the species are present in southern Africa. This translates into an estimated collision rate of 0.61 and 0.63 birds per year for kites and buzzards respectively. In terms of existing information on the impacts of wind farm developments, raptors, and particularly species constantly migrating over and through a turbine string, are particularly prone to collision with the blades (Madders & Whitfield 2006). While Yellow-billed Kite and Steppe Buzzard are not threatened species, if the Project causes high numbers of casualties of these migrant raptors, this would constitute a significant negative impact of the facility. Given the potential inaccuracy of the predicted collision rate, the only way to verify this would again be to conduct carcass searches during the period when the birds are present.

The effects of night-time illumination on collision risks have not been adequately tested, and the results of studies are contradictory (Gregory *et al* 2007). Studies involving lighted objects or towers indicate that lights may attract birds, rather than disorient or repel them, resulting in collision mortality (Johnson *et al* 2007). This is mostly a problem for nocturnal migrants (primarily passerines) during poor visibility conditions. Different colour lights vary in their attractiveness to birds and their effect on orientation. Several studies have shown that intermittent lights have less than an effect on birds than constant lights, with reduced rates of mortality. In addition, some studies suggest that replacing white lights with red coloured lights may reduce mortality by up to 80%. This may be due to the change in light intensity rather than the change in wavelength (Johnson *et al* 2007). However, Ugoretz (2001) suggest that birds are more sensitive to red lights and may be attracted to them. Quickly flashing white strobe lights appear to be less attractive. The issue is however far from settled - a study at Buffalo Ridge, Minnesota, where most of the collision fatalities were classified as nocturnal migrants, found little difference between lighted and unlighted turbines (Johnson *et al* 2000).The consensus among researchers is to avoid lighting the turbines if possible, but that is against South African civil aviation regulations (Civil Aviation Regulations 1997). The potential for collisions with the wind turbines due to presence of lights is not envisaged to be significant, primarily because the phenomenon of mass nocturnal passerine migrations is not a feature of the study area. However, the potential effect on nocturnal flamingo movement is unknown. Post – construction monitoring (carcass searches) will be required to assess, if possible, the extent (if any) of nocturnal fatalities that may be linked to the lighting on the turbines.

5.1.2 Impact assessment

An evaluation of the expected collision impact is provided in summary for below (see Final Scoping Report for a description of the assessment criteria).

DESCRIPTION OF THE IMPACT	NATURE / STATUS	EXTENT	DURATION	INTENSITY	PROBABILITY	SIGNIFICANCE (WITHOUT MITIGATION)	MITIGATION	SIGNIFICANCE (WITH MITIGATION)
CONSTRUCTION								
N/A								
OPERATION								
Bird mortality due to collisions with the turbine blades	Negative	Local	Long term	Medium	Probable	Low	Post-construction monitoring Relocation of turbines responsible for particular collision mortality. Halting operation during peak flight periods, or reducing rotor speed, to reduce the risk of collision mortality. Negotiating appropriate off-set compensation for turbine related collision mortality.	Low

DESCRIPTION OF THE IMPACT	NATURE / STATUS	EXTENT	DURATION	INTENSITY	PROBABILITY	SIGNIFICANCE (WITHOUT MITIGATION)	MITIGATION	SIGNIFICANCE (WITH MITIGATION)
DECOMMISSIONING								
N/A								

5.1.3 Proposed mitigation measures

Because the estimated collision rate is merely a rough indicator of risk it, it is necessary to verify this estimate with actual carcass searches on site. It is particularly important to commence carcass searches in the winter season to assess whether here are any flamingo casualties due to nocturnal collisions with the existing turbines. These searches must take place according to the attached protocol (Appendix 1), which is in accordance with the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa – Version 1* (Jenkins *et al* 2011). The frequency of these surveys will be informed by assessments of scavenge and decomposition rates conducted in the initial stages of the monitoring period. Subject to the results of the decomposition/scavenge trials, it is proposed that a site survey is conducted twice a month for an initial minimum period of 12 months. After the initial 12 month period, the need for further monitoring will be evaluated again. If the results of the monitoring indicate a significant mortality rate for priority species, appropriate mitigation measures would need to be implemented. These could include any or a combination of the following (Smallwood 2008):

- Relocation of turbines responsible for particular collision mortality.
- Halting operation during peak flight periods, or reducing rotor speed, to reduce the risk of collision mortality.
- Negotiating appropriate off-set compensation for turbine related collision mortality.

5.2 Collisions with the proposed power line

5.2.1 Nature of impact

Because of their size and prominence, electrical infrastructures constitute an important interface between wildlife and man. Negative interactions between wildlife and electricity structures take many forms, but two common problems in southern Africa are electrocution of birds (and other animals) and birds colliding with power lines (Ledger & Annegarn 1981; Ledger 1983; Ledger 1984; Hobbs & Ledger 1986a; Hobbs & Ledger 1986b; Ledger *et.al.* 1992; Verdoorn 1996; Kruger & Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000).

Collisions kill far more birds annually in southern Africa than electrocutions (Van Rooyen 2007). Most heavily impacted upon are bustards, storks, cranes and various species of water birds. These species are mostly heavy-bodied birds with limited maneuverability, which makes it difficult for them to take the necessary evasive action to avoid colliding with power lines (van Rooyen 2004, Anderson 2001). Unfortunately, many of the collision sensitive species are considered threatened in southern Africa - of the 2369 avian mortalities on distribution lines recorded by the Endangered Wildlife Trust (EWT) between August 1996 and October 2007, 1512 (63.8%) were Red listed species (Van Rooyen 2007).

In the Overberg region of the Western Cape, which has a very similar Red listed species composition and habitat use as the current study area, power line collisions have long been recorded as a major source of avian mortality (Van Rooyen 2007). Most numerous amongst power line collision victims are Blue Crane and Denham’s Bustard (Shaw

2007). It has been estimated that as many as 10% of the Blue Crane population in the Overberg are killed annually on power lines, and figure for Denham's Bustard might be as high as 30% of the Overberg population (Shaw 2009). These figures are extremely concerning, as it represents a possible unsustainable source of unnatural mortality.

Unfortunately, the dynamics of the collision problem is poorly understood. In the most recent study on this problem in the Overberg, Shaw (2009) identified cultivated land and region as the significant factors influencing power line collision risk. Lines that cross cultivated land pose a higher risk, as expected, as this is the preferred habitat of Blue Cranes in the Overberg. In the current study area, it can be postulated that the old lands and pastures will be higher risk from a power line collision perspective, as this constitutes primary habitat for Blue Crane. Collision rates are higher for birds in flocks, as they may panic, or lack visibility and room for maneuver because of the close proximity of other birds (APLIC, 1994). Other factors, such as proximity to dams, wind direction and proximity to roads and dwellings did not emerge as significant factors, but she readily admits that her broad-scale analysis may have been too crude to demonstrate their effects. It is for example a well known fact that cranes are particularly vulnerable to power lines skirting water bodies used as roosts, as they often arrive there or leave again in low light conditions (pers. obs.).

Flamingos are another group of birds that is particularly vulnerable to collisions with power lines. Between November 1996 and March 1997, at least twenty-four Greater Flamingos were killed by collisions with transmission lines running through the large wetlands adjacent to the Project site, namely Slangkop, Swartwater and Droëvlei pans (Van Rooyen 2007). It is not known what the actual mortality figures are, but it could be significant as regular monitoring of the site has not taken place since, but it is likely to be an ongoing cause of mortality.

The Project will make use of underground cabling to link each turbine with the respective substation, therefore no collision risk will be posed by these cables. An existing 66 kV line running parallel to the R27 connects the existing substation to the national grid. It is proposed that the new substation on the Kerrie Fontein Farm is located along this alignment to facilitate a new connection. The positive result of this arrangement is that no new overhead power lines will need to be constructed, which means that this additional potential source of unnatural mortality is effectively negated.

5.1.2 Impact assessment

This impact is not expected to materialise.

5.1.3 Proposed mitigation measures

No mitigation will be required for this impact, as it is not expected to materialise.

5.2 Displacement

5.2.1 Nature of impact

Although the 116 hours of monitoring at the site was primarily designed to assess the collision risks to priority species, it also provides an indication of the suitability of the site for foraging and breeding purposes. Amongst the priority species, raptors are the birds most likely to be using the site for foraging purposes, and therefore are potentially most susceptible to this impact. No indication of raptor or other priority species breeding activity was recorded during any of the monitoring periods. The following raptors have been recorded at the site:

- African Fish Eagle *Haliaeetus vocifer*
- Black-chested Snake-eagle *Circaetus pectoralis*
- Booted Eagle *Aquila pennatus*
- Black-shouldered Kite *Elanus caeruleus*
- Black Sparrowhawk *Accipiter melanoleucus*
- African Harrier-hawk *Polyboroides typus*
- Jackal Buzzard *Buteo rofufuscus*
- Lanner Falcon *Falco biarmicus*
- Martial Eagle *Polemaetus bellicosus*
- Peregrine Falcon *Falco peregrinus*
- Rock Kestrel *Falco rupicolus*
- Steppe Buzzard *Buteo buteo*
- Secretarybird *Sagittarius serpentarius*
- Yellow-billed Kite *Milvus migrans*
- Black Harrier *Circus maurus*

Although more studies are needed and more should be peer-reviewed in the public domain, research indicates that, with few exceptions, the displacement effect of wind developments on raptors is low to negligible (Madders and Whitfield 2008). This trend seems to be supported by the results of the limited post-construction monitoring conducted at the existing 4 turbines. The following raptor species were recorded at the site during 30 hours of formal post-construction monitoring and 3 hours of informal post-construction monitoring (Van Beuningen and Retief 2010).

- Booted Eagle
- Black-shouldered Kite
- Jackal Buzzard
- Lanner Falcon
- Martial Eagle
- Peregrine Falcon
- Rock Kestrel
- Steppe Buzzard
- Secretarybird
- Yellow-billed Kite

In the present study area, it can be reasonably postulated that sensitive species such as Blue Crane could be affected by the noise (and the movement) of the construction and operation of the turbines. Morrison (1998) found that the probability of finding Blue Crane nests decrease as the number of roads in an area increase. She further found that Blue Cranes actively avoided tar and gravel roads, houses and areas of agricultural activity when selecting a nest site. The habitat at the Project site is not particularly suitable for Blue Cranes as a foraging and nesting area, as they prefer agricultural areas to natural vegetation in the Swartland (Young 2003). Only 16% of the current Project site is agricultural land, therefore the displacement effect on Blue Cranes should be relatively minimal.

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. It has to be assumed that it could be a factor for several species, including Red listed species such as Blue Crane, Great White Pelican and both species of flamingo, but it is very difficult to measure. As mentioned earlier, raptors and vultures may be less prone to displacement and avoidance effects (Madders & Whitfield 2006), which unfortunately put them at a greater risk of collision.

5.1.3 Impact assessment

An evaluation of the expected displacement impact is provided in summary for below (see Final Scoping Report for a description of the assessment criteria).

DESCRIPTION OF THE IMPACT	NATURE / STATUS	EXTENT	DURATION	INTENSITY	PROBABILITY	SIGNIFICANCE (WITHOUT MITIGATION)	MITIGATION	SIGNIFICANCE (WITH MITIGATION)
CONSTRUCTION								
Displacement of priority species	Negative	Local	Temporary	Low	Probable	Low	Due to the relatively minor significance of this impact on priority species, no specific mitigation measures are recommended.	Low
OPERATION								
Displacement of priority species	Negative	Local	Long term	Low	Improbable	Low	Due to the relatively minor significance of this impact on priority species, no specific mitigation measures are recommended.	Low
DECOMMISSIONING								
Displacement of priority species	Negative	Local	Temporary	Low	Probable	Low	Due to the relatively minor significance of this impact on priority species, no specific mitigation measures are recommended.	Low

5.1.3 Proposed mitigation measures

Due to the relatively minor significance of this impact on priority species, no specific mitigation measures are recommended.

5.3 Habitat loss

5.3.1 Nature of impact

The scale of direct habitat loss resulting from the construction of a wind farm and associated infrastructure depends on the size of the project but, generally speaking, 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 sited 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 sited by Drewitt & Langston 2006). At the Project site, direct habitat loss is not regarded as a major impact on avifauna, relative to other potential impacts such as disturbance or collisions.

5.3.2 Impact assessment

An evaluation of the expected habitat loss impact is provided in summary for below (see Final Scoping Report for a description of the assessment criteria).

DESCRIPTION OF THE IMPACT	NATURE / STATUS	EXTENT	DURATION	INTENSITY	PROBABILITY	SIGNIFICANCE (WITHOUT MITIGATION)	MITIGATION	SIGNIFICANCE (WITH MITIGATION)
CONSTRUCTION								
Displacement of priority species due to footprint of wind farm	Negative	Local	Long term	Low	Definite	Low	Apply mitigation as prescribed in the Botanical Impact Assessment Study	Low
OPERATION								
Displacement of priority species due to footprint of wind farm	Negative	Local	Long term	Low	Definite	Low	Apply mitigation as prescribed in the Botanical Impact Assessment Study	Low
DECOMMISSIONING								
Displacement of priority species due to footprint of wind farm	Negative	Local	Long term	Low	Definite	Low	Apply mitigation as prescribed in the Botanical Impact Assessment Study	Low

5.3.3 Recommendations

The infrastructure footprint must be restricted to the minimum, in accordance with the recommendations in the Botanical Impact Assessment Report (Helme 2011).

5.4 Cumulative impacts

In his review of the original bird impact assessment study by Jenkins, Boshoff (2004) made the following comment: *"Based on current knowledge, bird mortalities resulting from collisions with wind turbine blades occur, in general, relatively infrequently. This, taken together with the characteristics of the proposed DDWF site, strongly suggests that the proposed DDWF will not have a significant impact on populations of the priority bird species in the vicinity… given the situation described above, it can be safely assumed that the many hundreds of kilometers of powerlines (from rural 11kV lines to large 400kV lines) in the Swartland, and its adjacent coastal strip, pose a far greater threat to the priority species (especially pelicans, flamingos and cranes) listed by Jenkins (2003) than will the four wind turbines, affecting a linear area of less than 800 metres, that will operate during the first phase of the proposed DDWF project."* Since this statement was made, the wind farm industry has undergone significant changes, and the number of applications for wind farms along the West Coast has increased more than tenfold. Figure 13 below give an indication of proposed wind farm developments as at May 2011.

In view of the huge increase in proposed wind farm developments along the West Coast, the statement by Boshoff (2004) needs to be approached with caution. It is impossible to say at this stage what the cumulative impact of all these developments will be on birds, firstly because there is no baseline to measure it against, and secondly because the extent of actual impacts will only become known once a few wind farms are developed. It is therefore imperative that pre-construction and post-construction monitoring is implemented at all the new proposed sites, in accordance with the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa – Version 1* (Jenkins *et al* 2011), which was released by the Endangered Wildlife Trust and Birdlife South Africa in April 2011. This will provide the necessary data to better assess the cumulative impact of wind development along the West Coast.

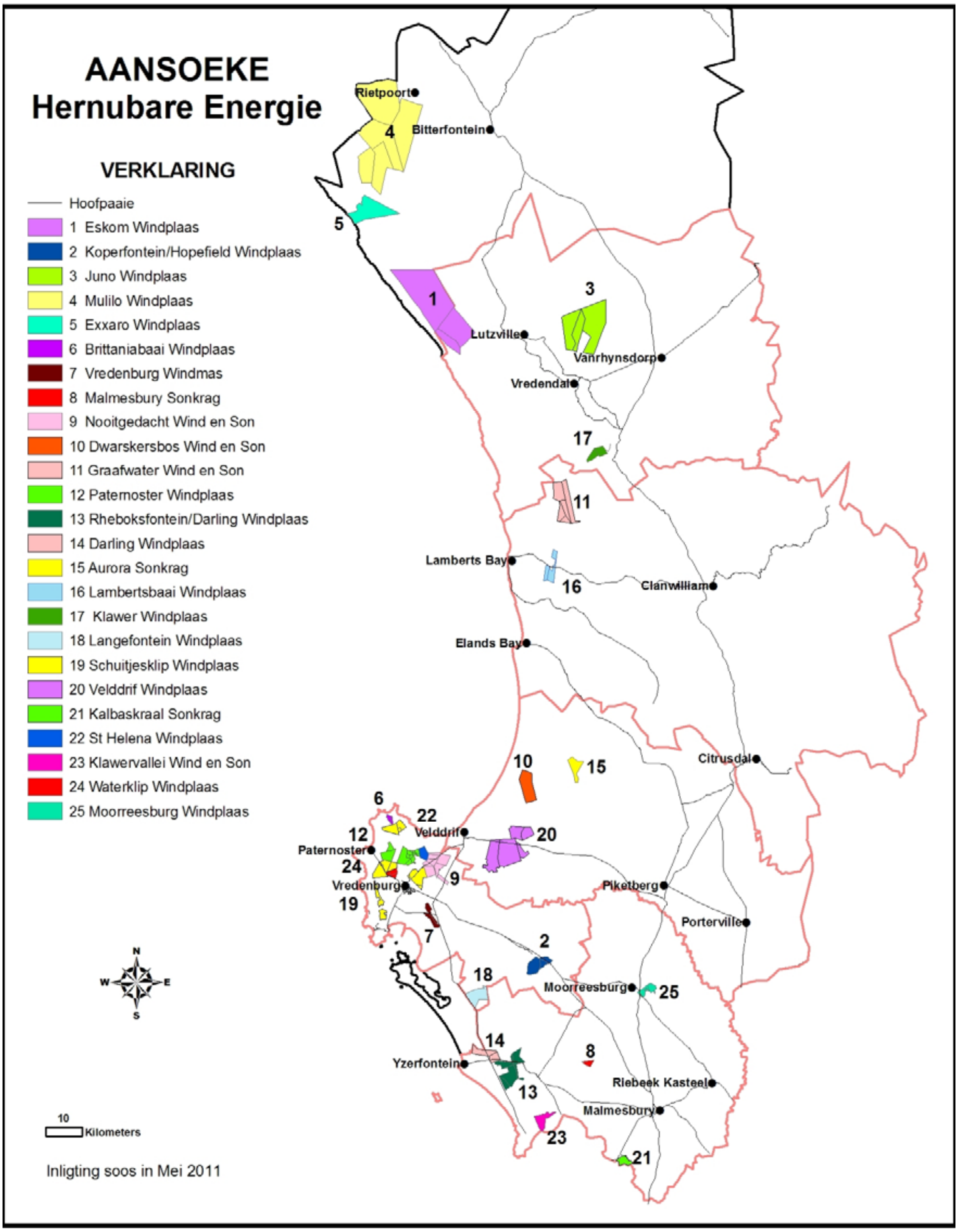

Figure 13: Proposed wind farm developments along the West Coast

Section 6: Conclusions and Recommendations

6.1 Collisions

In summary then, it would seem from the analysis above that the wind facility will not pose a significant collision mortality risk to priority species. The greatest collision risk is posed by the 7 turbines on the slope of Moedmaag Hill (i.e. 4 existing and 3 proposed), in the following conditions:

- Between 11h00 and 17h00
- In spring/early summer i.e. between October and December
- In moderate to strong winds with a southerly and westerly orientation

With Jackal Buzzards specifically, the estimated avoidance rate may be more than 98%, as the birds observed on site are most likely a resident pair. These birds have clearly become used to the four existing turbines and are even using them as hunting perches when stationary (pers. obs., Van der Westhuizen 2011). During 30 hours of monitoring no instances were observed where Jackal Buzzards exhibited any "flaring" behaviour i.e. panicky behaviour to avoid the moving blades, they always seem to be aware of the moving blades and avoided them seemingly with ease. Whether this would also be the case with inexperienced, juvenile birds remains to be seen. It is therefore essential for carcass searches to commence as soon as possible to verify the estimates made in this study.

Fortunately, the phenomenon of mass migrations involving thousands of birds is not a feature of the Project site, as this can result in significant mortality risks. However, migratory raptors, i.e. Steppe Buzzard *Buteo vulpinus* and Yellow-billed Kite *Milvus aegyptius* were recorded at passage rates of 0.74 and 1.39 birds per hour during the summer and autumn monitoring period, when the species are present in southern Africa. This translates into an estimated collision rate of 0.61 and 0.63 birds per year for kites and buzzards respectively. In terms of existing information on the impacts of wind farm developments, raptors, and particularly species constantly migrating over and through a turbine string, are particularly prone to collision with the blades (Madders & Whitfield 2006). While Yellow-billed Kite and Steppe Buzzard are not threatened species, if the Project causes high numbers of casualties of these migrant raptors, this would constitute a significant negative impact of the facility. Given the potential inaccuracy of the predicted collision rate, the only way to verify this would again be to conduct carcass searches during the period when the birds are present.

The effects of night-time illumination on collision risks have not been adequately tested, and the results of studies are contradictory (Gregory et al 2007). Studies involving lighted objects or towers indicate that lights may attract birds, rather than disorient or repel them, resulting in collision mortality (Johnson *et al* 2007). This is mostly a problem for nocturnal migrants (primarily passerines) during poor visibility conditions. Different colour lights vary in their attractiveness to birds and their effect on orientation. Several studies have shown that intermittent lights have less than an effect on birds than constant lights, with reduced rates of mortality. In addition, some studies suggest that replacing white lights with red coloured lights may reduce mortality by up to 80%. This may be due to the change in light intensity rather than the change in wavelength (Johnson *et al* 2007). However, Ugoretz (2001) suggest that birds are more sensitive to red lights and may be attracted to them. Quickly flashing white strobe lights appear to be less attractive. The issue is however far from settled - a study at Buffalo Ridge, Minnesota, where most of the collision fatalities were classified as nocturnal migrants, found little difference between lighted and unlighted turbines (Johnson *et al* 2000).The consensus among researchers is to avoid lighting the turbines if possible, but that is against South African civil aviation regulations (Civil Aviation Regulations 1997). The potential for collisions with the wind turbines due to presence of lights is not envisaged to be significant, primarily because the phenomenon of mass nocturnal passerine migrations is not a feature of the study area. However, the potential effect on nocturnal flamingo movement is unknown. Post – construction monitoring (carcass searches) will be required to assess, if possible, the extent (if any) of nocturnal fatalities that may be linked to the lighting on the turbines.

Because the estimated collision rate is merely a rough indicator of risk it, it is necessary to verify this estimate with actual carcass searches on site. It is particularly important to commence carcass searches in the winter season to assess whether there are any flamingo casualties due to nocturnal collisions with the existing turbines. These searches must take place according to the attached protocol (Appendix 1), which is in accordance with the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa – Version 1* (Jenkins *et al* 2011). The frequency of these surveys will be informed by assessments of scavenge and decomposition rates conducted in the initial stages of the monitoring period. Subject to the results of the decomposition/scavenge trials, it is proposed that a site survey is conducted twice a month for an initial minimum period of 12 months. After the initial 12 month period, the need for further monitoring will be evaluated again. If the results of the monitoring indicate a significant mortality rate for priority species, appropriate mitigation measures would need to be implemented. These could include any or a combination of the following (Smallwood 2008):

- Relocation of turbines responsible for particular collision mortality.
- Halting operation during peak flight periods, or reducing rotor speed, to reduce the risk of collision mortality.
- Negotiating appropriate off-set compensation for turbine related collision mortality.

6.2 Collisions with the proposed power line

No mitigation will be required for this impact, as it is not expected to materialise.

6.3 Displacement

Although more studies are needed and more should be peer-reviewed in the public domain, research indicates that, with few exceptions, the displacement effect of wind developments on raptors is low to negligible (Madders and Whitfield 2008). This trend seems to be supported by the results of the limited post-construction monitoring conducted at the existing 4 turbines. Due to the relatively minor significance of this impact on priority species, no specific mitigation measures are recommended.

6.4 Habitat loss

At the Project site, direct habitat loss is not regarded as a major impact on avifauna, relative to other potential impacts such as disturbance or collisions. The infrastructure footprint must be restricted to the minimum, in accordance with the recommendations in the Botanical Impact Assessment Report (Helme 2011).

6.5 Cumulative impacts

It is impossible to say at this stage what the cumulative impact of all the proposed developments along the West Coast will be on birds, firstly because there is no baseline to measure it against, and secondly because the extent of actual impacts will only become known once a few wind farms are developed. It is therefore imperative that pre-construction and post-construction monitoring is implemented at all the new proposed sites, in accordance with the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa – Version 1* (Jenkins *et al* 2011), which was released by the Endangered Wildlife Trust and Birdlife South Africa in April 2011. This will provide the necessary data to better assess the cumulative impact of wind development along the West Coast.

6.5 Preferred alternative

From a potential bird impact perspective, there is very little to choose between the two proposed alternatives. The 7 turbines on slope of Moedmaag Hill are likely to pose the biggest risk of collision, and the position of these is identical for both lay-outs. The potential displacement footprint of the two alternative lay-outs are also very similar, resulting in no clear preference from a bird impact perspective.

Section 7: References

Africa-Eurasia Waterbird Agreement. http://www.unep-aewa.org. Accessed 14 July 2010.

Altamont Pass Avian Monitoring Team. 2008. Bird Fatality Study at Altamont Pass Wind Resource Area October 2005 – September 2007. Draft Report prepared for the Almeda County Scientific Review Committee.

Avian Powerline Interation Committee (APLIC). 1994. Mitigating bird collisions with power lines: the state of the art in 1994. Edison Electric Institute. Washington DC.

Barrios, L. & Rodriguez, A. 2004. Behavioural and environmental correlates of soaring-bird mortality at on-shore wind turbines. J. Appl. Ecol. 41: 72–81.

Barnes, K.N. (ed.) 2000. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg.

Barnes, K.N. 1998. The Important Bird Areas of southern Africa. BirdLife South Africa: Johannesburg.

Boshoff, A. 2004. Commissioned to estimate the potential impact of a demonstration wind farm on the birds of the Darling-Yzerfontein area, Western Cape Province. Report to Environmental Evaluation Unit (EEU), University of Cape Town.

Carette, M., Zapata-Sanchez, J.A., Benitez, R.J., Lobon, M. & Donazar, J.A. (In press) Large scale risk-assessment of wind farms on population viability of a globally endangered long-lived raptor. Biol. Cons. (2009), doi: 10.1016/j.biocon.2009.07.027.

De Lucas, M., Janss, G.F.E., Whitfield, D.P. & Ferrer, M. 2008. Collision fatality of raptors in wind farms does not depend on raptor abundance. Journal of Applied Ecology 45, 1695 – 1703.

Drewitt, A.L. & Langston, R.H.W. 2006. Assessing the impacts of wind farms on birds. Ibis 148, 29-42.

Environmental Evaluation Unit. 2011. The proposed Kerrie Fontein and Darling Wind Farm. Final Scoping Report. DEA Ref: 12/12/20/1928EEU, University of Cape Town.

Everaert, J., Devos, K. & Kuijken, E. 2001. Windtrubines en vogels in Vlaaneren: Voorlopige Onderzoeksresultaten En Buitenlandse Bevindingen [Wind Turbines and Birds in Flanders (Belgium): Preliminary Study Results in a European Context]. Instituut Voor Natuurbehoud. Report R.2002.03. Brussels B.76pp. Brussels, Belgium: Institut voor Natuurbehoud.

Fox, A.D., Desholm, M., Kahlert, J., Christensen, T.K. & Krag Petersen, I.B. 2006. Information needs to support environmental impact assessments of the effects of European marine offshore wind farms on birds. In Wind, Fire and Water: Renewable Energy and Birds. Ibis 148 (Suppl. 1): 129–144

Harrison, J.A., Drewitt, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V & Brown, C.J. (eds). 1997. The atlas of southern African birds. Vol. 1&2. BirdLife South Africa, Johannesburg.

Helme, N. 2010. Botanical scoping assessment of the Kerrie Fontein and Darling Phase 2 wind farm, Darling, Western Cape. Compiled for: Environmental Evaluation Unit, UCT.

Hobbs, J.C.A. & Ledger J.A. 1986a. The Environmental Impact of Linear Developments; Power lines and Avifauna. Third International Conference on Environmental Quality and Ecosystem Stability. Israel, June 1986.

Hobbs, J.C.A. & Ledger J.A. 1986b. Power lines, Birdlife and the Golden Mean. Fauna and Flora 44:23-27.

Howell, J.A. & DiDonato, J.E. 1991. Assessment of avian use and mortality related to wind turbine operations: Altamont Pass, Alameda and Contra Costa Counties, California, September 1988 Through August 1989. Final report prepared for Kenentech Windpower.

Hunt, W.G. 2001. Continuing studies of golden eagles at Altamont Pass. Proceedings of the National Avian-Wind Power Planning Meeting IV.

Hunt, W.G., Jackman, R.E., Hunt, T.L., Driscoll, D.E. & Culp, L. 1999. A Population Study of Golden Eagles in the Altamont Pass Wind Resource Area: Population Trend Analysis 1994–97. Report to National Renewable Energy Laboratory, Subcontract XAT-6-16459–01. Santa Cruz: University of California.

Jenkins, A 2003. Populations and movements of priority bird species in the vicinity of the proposed Darling National Demonstration Wind Farm facility. Results of pre-construction monitoring supplementary to the initial EIA, completed on contract to the Environmental Evaluation Unit, UCT.

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.

Kruckenberg, H. & Jaene, J. 1999. Zum Einfluss eines Windparks auf die Verteilung weidender Bläßgänse im Rheiderland (Landkreis Leer, Niedersachsen). Natur Landsch. 74: 420–427.

Kruger, R. & Van Rooyen, C.S. 1998. Evaluating the risk that existing power lines pose to large raptors by using risk assessment methodology: the Molopo Case Study. 5th World Conference on Birds of Prey and Owls: 4 - 8 August 1998. Midrand, South Africa.

Kruger, R. 1999. Towards solving raptor electrocutions on Eskom Distribution Structures in South Africa. M. Phil. Mini-thesis. University of the Orange Free State. Bloemfontein. South Africa.

Langston, R.H.W. & Pullan, J.D. 2003. Wind farms and birds: an analysis of the effects of wind farms on birds, and guidance on environmental assessment criteria and site selection issues. Report written by Birdlife International on behalf of the Bern Convention. Council Europe Report T-PVS/Inf

Larsen, J.K. & Madsen, J. 2000. Effects of wind turbines and other physical elements on field utilization by pink-footed geese (Anser brachyrhynchus): A landscape perspective. Landscape Ecol. 15: 755–764.

Ledger, J. 1983. Guidelines for Dealing with Bird Problems of Transmission Lines and Towers. Escom Test and Research Division Technical Note TRR/N83/005.

Ledger, J.A. & Annegarn H.J. 1981. Electrocution Hazards to the Cape Vulture (Gyps coprotheres) in South Africa. Biological Conservation 20:15-24.

Ledger, J.A. 1984. Engineering Solutions to the problem of Vulture Electrocutions on Electricity Towers. The Certificated Engineer. 57:92-95.

Ledger, J.A., J.C.A. Hobbs & Smith T.V. 1992. Avian Interactions with Utility Structures: Southern African Experiences. Proceedings of the International Workshop on Avian Interactions with Utility Structures, Miami, Florida, 13-15 September 1992. Electric Power Research Institute.

Madders, M. & Whitfield, D. P. 2006. Upland raptors and the assessment of wind farm impacts. Ibis (2006), 148, 43 – 56.

Marais, S. 2010. Issues and Responses Report (Draft Scoping Comment Period): 12 October – 21 November 2010. Environmental Evaluation Unit. UCT.

Pedersen, M.B. & Poulsen, E. 1991. Impact of a 90 m/2MW wind turbine on birds. Avian responses to the implementation of the Tjaereborg wind turbine at the Danish Wadden Sea. Danske Vildtunderogelser Haefte 47. Rønde, Denmark: Danmarks Miljøundersøgelser.

Orloff, S. & Flannery, A. 1992. Wind turbine effects on avian activity, habitat use and mortality in Altamont Pass and Solano County Wind Resource Areas, 1989–91. California. Energy Commission.

Shaw, J.M. 2009. The End of the Line for South Africa's National Bird? Modelling power line collision risk for the Blue Crane. Unpublished MSc Thesis. Percy FitzPatrick Institute of African Ornithology University of Cape Town.

Smallwood, S. 2008. Mitigation in US wind farms. In: Documentation of International Workshop on Birds of Prey and Wind Farms. 21st and 22nd of October 2008, Berlin. Michael Otto Institut im NABU.

Southern African Bird Atlas Project 2. Accessed on 14 July 2010. http://sabap2.adu.org.za.

Stewart, G.B., Coles, C.F. & Pullin, A.S. 2004. Effects of Wind Turbines on Bird Abundance. Systematic Review no. 4. Birmingham, UK: Centre for Evidence-based Conservation.

Stewart, G.B., Pullin, A.S. & Coles, C.F. 2007. Poor evidence-base for assessment of windfarm impacts on birds. Environmental Conservation. 34, 1-11.

Thelander, C.G., Smallwood, K.S. & Rugge, L. 2003. Bird Risk Behaviours and Fatalities at the Altamont Pass Wind Resource Area . Report to the National Renewable Energy Laboratory, Colorado.

Van der Westhuizen, A. 2011. Proposed wind farm development: Kerrie fontein 555 and Darling national demonstration wind farm phase 2 (Slangkop 552) Darling, Western Cape. Monitoring Report. Arnwalt Enviro Watch.

Van Rooyen, C.S. 1998. Raptor mortality on power lines in South Africa. 5th World Conference on Birds of Prey and Owls: 4 - 8 August 1998. Midrand, South Africa.

Van Rooyen, C.S. 1999**.** An overview of the Eskom - EWT Strategic Partnership in South Africa. EPRI Workshop on Avian Interactions with Utility Structures 2-3 December 1999, Charleston, South Carolina.

Van Rooyen, C.S. 2000. An overview of Vulture Electrocutions in South Africa. Vulture News 43: 5-22. Vulture Study Group, Johannesburg, South Africa.

Van Rooyen, C.S. 2004. The Management of Wildlife Interactions with overhead lines. In: The Fundamentals and practice of Overhead Line Maintenance (132kV and above), pp217-245. Eskom Technology, Services International, Johannesburg 2004.

Van Rooyen, C.S. (2007). Eskom-EWT Strategic Partnership: Progress Report April-September 2007. Endangered Wildlife Trust, Johannesburg.

Verdoorn, G.H. 1996. Mortality of Cape Griffons *Gyps coprotheres* and African Whitebacked Vultures *Pseudogyps africanus* on 88kV and 132kV power lines in Western Transvaal, South Africa, and mitigation measures to prevent future problems. 2nd International Conference on Raptors: 2-5 October 1996. Urbino, Italy.

Appendix 1: Post-construction collision victim search protocol at the Kerrie Fontein and Darling Wind Facility

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1 Introduction

The Darling Demonstration Wind Farm at Kerrie Fontein near Darling was conceptualised by the Oelsner Group (Pty) Ltd and has been in operation since 2008. It consists of 4 turbines generating a maximum of 5.2 MW of electricity. There are two components to the Kerrie Fontein and Darling Phase 2 Wind Farm (the Project). These comprise 6 wind turbines on the existing Darling Wind Farm (Slangkop Farm 552) and 10 turbines on the adjacent farm Kerrie Fontein 555, bringing the total number of new turbines to 16 with a generation capacity of 20.8MW. A bird impact assessment report was compiled for the proposed development in July 2010, which contained a set of recommendations for the EIA phase of the project. One of the recommendations was that carcass searches should be conducted at the existing four turbines at Kerrie Fontein, according to an internationally acceptable best practice protocol. This protocol has now become available with the publication of the **"Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa"** (Jenkins et al 2011).

2 Objectives of carcass searches

The primary aims of avian collision monitoring at Kerri Fontein are to:

- Record and document the circumstances surrounding any avian collisions with the existing four turbines;
- To quantify the direct effects of the existing infrastructure on collision susceptible species;
- To mitigate impacts by informing final operational planning and ongoing management of the existing facility, as well as the proposed new infrastructure.

The collision monitoring will have two components: (i) experimental assessment of search efficiency and scavenging rates of bird carcasses on the site, (ii) regular searches of the vicinity of the wind farm for collision casualties (Jenkins et al 2011).

2.1.1 Assessing search efficiency and scavenging rates

The value of surveying the area for collision victims only holds if some measure of the accuracy of the survey method is developed (Jenkins et al 2011). To do this, a sample of suitable bird carcasses (if possible of similar size and colour to a variety of the priority species – e.g. Egyptian Goose *Alopochen aegyptiacus*, domestic waterfowl and pigeons) will be obtained and distributed randomly around the site, some time before the site is surveyed. The number of carcasses will be limited to 2 per survey plot (survey plot = 100 x 100m centred around a turbine), to prevent scavenger swamping. Position of each carcass will be recorded using a GPS. The proportion of the carcasses located in the initial survey will indicate the relative efficiency of the survey method (Jenkins et.al.2011).

Simultaneous to this process, the condition and presence of all the carcasses positioned on the site will be monitored throughout the initial survey period, to determine the rates at which carcasses are scavenged from the area, or decay to the point that they are no longer obvious to the field workers. This will provide an indication of scavenge rate that should inform subsequent survey work for collision victims, particularly in terms of the frequency of surveys required to maximise survey efficiency and/or the extent to which estimates of collision frequency should be adjusted to account for scavenge rate (Jenkins et al 2011). Scavenger numbers and activity in the area may vary seasonally so, ideally, scavenge and decomposition rates will be measured at least twice over a monitoring year, once in winter and once in summer. An initial survey period of 14 days will be implemented, to record scavenger removal rates. During this period, the site will be searched daily and the percentage of carcasses remaining each day will be recorded.

2.1.2 Collision victim surveys

A survey plot will be established around each turbine. The size of the survey plot will be 100m x 100m, with the turbine in the centre of the plot (see Figure 1)

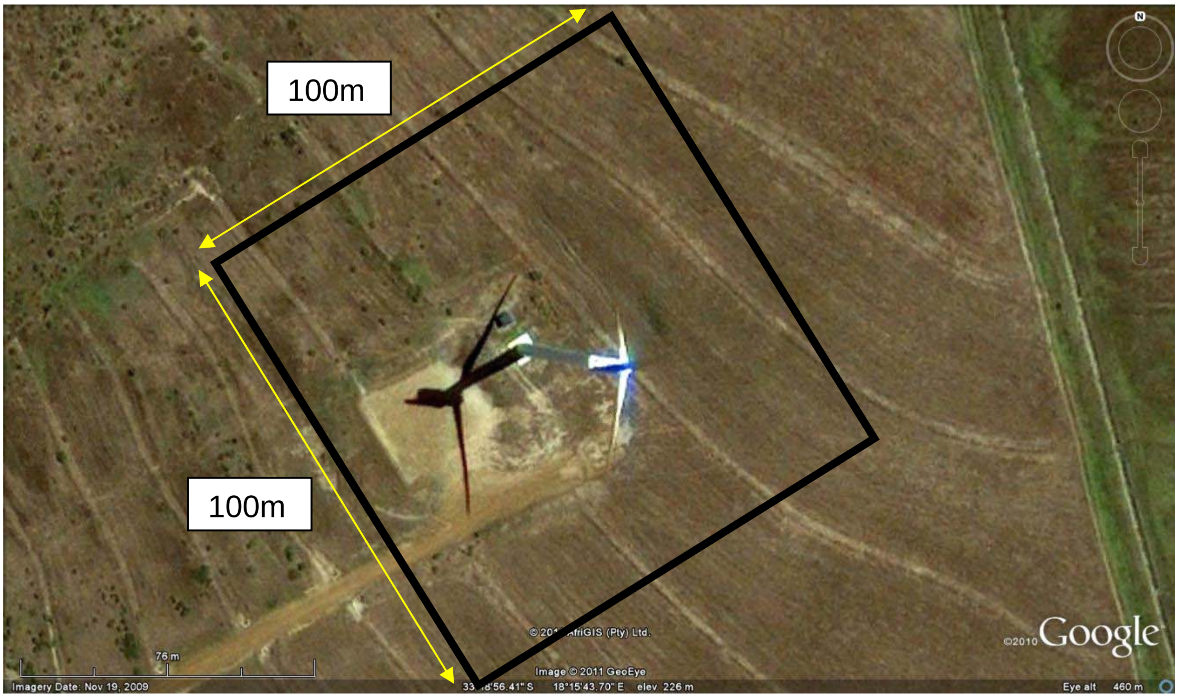

Figure 1: Survey area per individual turbine

The survey plot will be methodically searched for any sign of a bird collision incident (carcasses, dismembered body parts, scattered feathers, injured birds). All suspected collision incidents will be comprehensively documented, detailing the following variables:

- Project name
- Date
- Time
- Species
- Number adults/juveniles
- GPS location

- Condition of remains
- Nearest turbine number
- Distance to nearest turbine
- Compass bearing to nearest turbine
- Habitat type/mix of habitats
- Gradient of slope (flat, gentle, steep)
- Aspect of slope (none, north, north-east, east…)
- Plot on map
- Photograph the collision site as it was located

All physical evidence will then be collected, bagged and carefully labelled, and refrigerated or frozen to await further examination. If any injured birds are recovered, each should be contained in a suitably-sized cardboard box. The local conservation authority should be notified and requested to transport casualties to the nearest reputable veterinary clinic or wild animal/bird rehabilitation centre. In such cases, the immediate area of the recovery should be searched for evidence of impact with the turbine blades, and any such evidence should be fully documented (as above).

The frequency of these surveys will be informed by assessments of scavenge and decomposition rates conducted in the initial stages of the monitoring period. Subject to the results of the decomposition/scavenge trials, it is proposed that a site survey is conducted twice a month for an initial minimum period of 12 months. After the initial 12 month period, the need for further monitoring will be evaluated again.

3 References

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.