Endangered Wildlife Trust
www.ewt.org.za

ESKOM GENERATION
WIND ENERGY FACILITY – WESTERN CAPE

AVIFAUNAL IMPACT ASSESSMENT

Prepared by:
Andrew Jenkins
Endangered Wildlife Trust
andrewj@ewt.org.za
021 650 4124

EXECUTIVE SUMMARY

Eskom plan to construct a wind energy facility (WEF) in the Western Cape on the west coast close to Vredendal, consisting of 100 wind turbines occupying a surface area of about 25km^2, and serviced by a 132 kV power line connecting the facility to the Juno Substation, about 35 km to the southeast.

EWT was briefed to assess the possible impacts of this proposed development on the local avifauna, under the following terms of reference:

- A detailed field investigation will be conducted for the preferred site in order to identify any potentially significant impacts on avifauna. The general impacts identified during scoping will be further investigated and the exact localities of all potential impacts will be determined.
- Identified alternative alignments for the Distribution line and access road to the site will be assessed in terms of potential impacts on avifauna. Recommendations will be made regarding a preferred alternative alignment.
- General recommendations will be made for mitigation for potentially significant impacts.
  If a need for a monitoring programme is evident, it will be highlighted and a programme proposed.

A comprehensive literature survey was done to inform assessments of impacts of Wind Energy Facilities (WEFs) on birds, and on likely effective mitigation, although the quality of information available even internationally is generally poor. A site visit was done in mid-October 2007 to evaluate the avifauna of the general area, and this direct assessment was supplemented by various sources detailing the local birdlife. The area features mainly open Strandveld vegetation, and supports up to 257 bird species, of which 24 species are Red-listed, 66 species are regional endemics or near-endemics, and eight species are Red-listed endemics, of which two – Ludwig's Bustard and Black Harrier - are likely to occur regularly, either within the immediate footprint area of the WEF, or within the broader impact area. Of the 6 avian microhabitats identified, the wetlands and pristine and degraded Strandveld and Fynbos areas support or partially support the bulk of the local avian diversity (124 and 113 species respectively), as well as most of the Red-listed and endemic species of highest conservation priority.

A short-list of 35 priority bird species was selected from the total assemblage on the grounds of conservation status, tendency to aggregate and commute overland in large numbers, and the relative importance of local populations. The impact of the WEF was then evaluated in terms of these species only, on the assumption that they serve well as surrogates for the total avifauna.

The most important potential impacts of the proposed WEF on the surrounding birdlife are: (i) inflated mortality of threatened and/or endemic species (especially Ludwig's Bustard and

Secretarybird) caused by collisions with the blades of the wind turbines and/or the overhead power line servicing the site, and (ii) loss of habitat for threatened and/or endemic species (especially Ludwig's Bustard and Black Harrier), either by direct destruction or degradation during construction or indirectly by disturbance during the operation of the wind farm.

The scale and significance of these impacts are unlikely to be restrictive, but it is essential that a rigorous pre- and post-construction monitoring programme be implemented so that (i) any important post-construction impacts can be recognised and minimised through effective mitigation, and (ii) we can start building a meaningful, quantitative understanding of the ACTUAL impacts of WEFs on South African birds, with a view to facilitating the sustainable use of this renewable power source in other parts of the country.

DECLARATION OF CONSULTANTS' INDEPENDENCE

A. Jenkins and J. Smallie (Avifaunal Specialists – Endangered Wildlife Trust) are independent consultants to Savannah Environmental Pty (Ltd). They have no business, financial, personal or other interest in the activity, application or appeal in respect of which they were appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of these specialists performing such work.

1. INTRODUCTION

Eskom plan to construct a wind energy facility (WEF) in the Western Cape on the west coast close to Vredendal. Savannah Environmental PTY (Ltd) were appointed to conduct the Environmental Impact Assessment study, and subsequently appointed the Endangered Wildlife Trust (EWT) to conduct the specialist avifaunal assessment.

The scoping study was conducted by Jon Smallie – Biologist for the Endangered Wildlife Trust. Mr Smallie has eight years of experience in the field of avifaunal interactions with various electrical infrastructure, including one other generation EIA, ten transmission and approximately 30 distribution EIA's. The follow up, full EIA study was done by Dr Andrew Jenkins – newly recruited member of the EWT Power Lines team. Dr Jenkins is an ornithologist with nearly 20 years of experience in avian research, including the development of a successful strategy for managing large eagles nesting on transmission lines, the design and/or execution of EIA and EMP studies for both of the existing (or at least approved) wind facilities in South Africa at Klipheuwel (operational) and Darling (moving into the construction phase), as well as sole or co-authorship on one transmission and six distribution EIAs.

The initial site visit for the scoping phase of the project was conducted during March 2007 and consisted of a visit to the study area and three potential sites proposed by Eskom in a two day field trip. Subsequent to this site visit, Eskom was required to supplement their original site identification process. The result was that one consolidated area was defined for examination during scoping. Since this area is within close proximity to the previous three sites examined, no additional site visit for scoping was needed for avifaunal purposes. The selected site was then visited and assessed as part of the EIA study in October 2007.

2. TERMS OF REFERENCE

The following are the terms of reference for the EIA phase, as supplied by Savannah Environmental PTY (Ltd):

- A detailed field investigation will be conducted for the preferred site in order to identify any potentially significant impacts on avifauna. The general impacts identified during scoping will be further investigated and the exact localities of all potential impacts will be determined.
- Identified alternative alignments for the power line and access road to the site will be assessed in terms of potential impacts on avifauna. Recommendations will be made regarding a preferred alternative alignment.
- General recommendations will be made for mitigation for potentially significant impacts.

- If a need for a monitoring programme is evident, it will be highlighted and a programme proposed.

3 STUDY METHODOLOGY

3.1. Approach

This study included the following steps:

- An extensive review of available published and 'grey' literature, pertaining to bird interactions with wind energy facilities was undertaken in order to fully understand the issues involved and the current level of knowledge in this field. Care was taken to adapt the international knowledge to local conditions and species wherever necessary.
- A preliminary field visit to the general study area was undertaken with the project team during March 2007. This was supplemented by a more focused assessment of the avifauna of the area on October 9-11 2007, in which the avian micro-habitats present on the site were recorded, key areas of habitat were surveyed for priority bird species, and the alternative routes for the power line feeding the site were compared.
- The various information sources listed below, including data on the birdlife of the area and previous studies of bird interactions with wind farm and electricity infrastructure, were obtained and examined.
- An inclusive, annotated list of the avifauna likely to occur within the impact zone of the WEF and its associated infrastructure was compiled using a combination of the existing distributional data, the species seen during the site visit, and previous experience of the avifauna of the general area.
- A short-list of priority bird species likely to occur in significant numbers in the area and possibly impacted by the proposed WEF was extracted from the total bird list.
- An impacts and mitigation matrix was drawn up based on this short-list of species, to summarise and highlight the critical avian conservation and management issues associated with the development, including the monitoring of actual impacts during and post construction of the WEF.

3.2. Data sources used

The following data sources and reports were used in varying levels of detail for this study:

- Bird distribution data of the Southern African Bird Atlas Project (SABAP – Harrison *et al.* 1997) and the Avian Demography Unit's Birds in Reserves Project (BIRP) were obtained from the SANBI website (http://www.birds.sanbi.org) for the four quarter-degree squares covering the proposed wind energy facility site and associated infrastructure (3118AC, CA, AD and CB) and for the Olifants River Mouth respectively. A composite list of species likely to occur in the impact zone of the WEF and its associated power line was drawn up as a combination of these two avifaunal data sets, refined by a more specific assessment of the actual habitats affected, based on the site inspection and general knowledge of the avifauna of the region (APPENDIX 2).

- Conservation status and endemicity of all species considered likely to occur in the area was determined as per the most recent iteration of the national Red-list for birds (Barnes 2000), and the most recent and comprehensive summary of southern African bird biology (Hockey *et al.* 2005).
- The Coordinated Wetland Avifaunal Count (CWAC) data (Taylor *et al.* 1999) and the Important Bird Areas report (Barnes 1998) were consulted for data on the Olifants River Estuary and Papendorp Salt Pans area.
- The conservation status of species occurring in the study areas was determined using Barnes (2000).
- Both the EIA report and the subsequent additional monitoring report on the potential impacts on birds of the Darling demonstration wind farm (Jenkins 2001, 2003)
- The bird specialist report for the Klipheuwel wind energy demonstration facility (van Rooyen 2001).
- The post-construction monitoring plan for the Klipheuwel facility, and the resulting report to Eskom Peaking Generation on the monitoring of bird mortalities at this facility (Küyler 2004).
- A thorough review of the published literature on avian interactions with wind energy facilities.

3.3. Limitations & assumptions

- Any inaccuracies in the above sources of information could limit this study. In particular, the Bird Atlas data is now ten years old (Harrison *et al.* 1997), but no reliable more recent data on bird species presence and abundance in the study area exists.
- The scope and time limitations of a project of this nature (i.e. for an EIA study) disallowed the collection of any significant primary data by the EWT on the proposed site. Ideally, pre-construction monitoring for at least one summer and winter season should be conducted on the site to establish more directly and immediately the composition and conservation value of the local avifauna and, with particular relevance to the potential impact of a WEF, the volume, nature and timing of bird ‘traffic’ commuting through the development area throughout the year (Jenkins 2003).

4. BACKGROUND TO THE STUDY

4.1 Background to interactions between wind energy facilities and birds

It is essential to review and understand the nature of the interactions between birds and wind energy installations, and to clarify the various issues and factors involved, before an accurate assessment of the impacts of a new facility on the local avifauna can be made. A relatively recent literature review (Kingsley & Whittam 2005), and the Avian Literature Database of the National Renewable Energy Laboratory (www.nrel.gov) are essential summaries and sources of information in this field. While the number of comprehensive, longer-term analyses of the effects of wind farms on birds is increasing, and the body of empirical data describing these effects is rapidly growing, scientific research in this field is still in its infancy (Madders & Whitfield 2006, Stewart *et al.* 2007), and much of the available information originates from short-term, unpublished, descriptive studies, most of which have been carried out in the United States, and more recently across western Europe, where wind power generation is a more established and burgeoning industry. Given that there is currently only one wind energy demonstration facility (with only 3 turbines) operative in South Africa, practical experience of the environmental effects of WEFs in this country is extremely limited, and we must base our estimates of the possible impacts of new wind farms largely on lessons learnt internationally. While many of the established, general principles can probably be usefully applied here, care should be taken in adapting international knowledge and experience to uniquely South African birds and conditions.

Concern about the impacts of wind facilities on birds first arose in the 1980s when numerous raptor mortalities were detected in California (Altamont Pass - US) and at Tarifa (Spain). These mortalities focused attention on the impact of wind energy on birds, and subsequently much monitoring has been done at a wide variety of wind farm sites. More recently, there has been additional concern about the degree to which birds avoid or are excluded from the areas occupied by wind energy facilities – either because of the action of the turbine blades or because of the noise they generate - and hence suffer a loss of habitat (Larsen & Guillemette 2007, Stewart *et al.* 2007).

According to Kingsley & Whittam (2005), **"With a few important exceptions, studies that have been completed to date suggest very low numbers of bird fatalities at wind energy facilities. The observed mortality caused by wind energy facilities is also very low compared to other existing sources of anthropogenic avian mortality on a per structure basis**". Curry and Kerlinger (www.currykerlinger.com) state that it appears now that the alarmingly high casualty rates at Altamont Pass were exceptional rather than typical. Documents comparing wind energy mortalities to other forms of human induced mortality are numerous (for example Crockford, 1992; Colson & associates, 1995; Gill *et al*, 1996, and Erickson *et al*, 2001) and all point towards the *relatively* low numbers of birds killed by wind turbines. As more monitoring has been conducted at a growing number of sites, bird mortality rates have ultimately been compared in terms of a common unit: mortalities per turbine per year. The following is a brief summary of some of the published international collision rate figures. Note that casualty totals should always take cognisance of (i) the proportion of actual casualties which are detected by observers (searcher efficiency), which is obviously influenced by (ii) the rate at which carcasses are removed by scavengers (scavenger removal rate), and that although collision rates may appear relatively low in many instances – **the cumulative effects over time, especially when applied to large, long lived, slow reproducing species (many of which are collision-prone), may be of considerable conservation significance.**

USA

The National Wind Co-ordinating Committee (NWCC 2004) estimates that 2.3 birds are killed per turbine per year in the US outside of California – correcting for searcher efficiency and scavenger rates. However, this index ranges from as low as 0.63 in Oregon to as high as 10 in Tennessee (NWCC 2004) illustrating the **wide variance in mortality rates between sites**. Curry & Kerlinger (2000) found that only 13% of the turbines at Altamont Pass, California were responsible for all Golden Eagle and Red-tailed Hawk collisions.

Australia

In Australia the recorded collision rates range from 0.23 to 2.7 birds per turbine per year (Australian Wind Energy Association – Wind Turbines, www.auswind.org). However, the monitoring site for this data consisted of only three wind turbines and one wind mast, so the results must be viewed with caution.

New Zealand

It seems that wind power in New Zealand is relatively new, and the only reference to bird mortalities is that there are no reports of rare, threatened or endangered species mortalities (New Zealand Wind Energy Association – Climate change and the environment Fact sheet, www.windenergy.org.nz).

Spain

At the Tarifa site, Janss (2000) estimated 0.03 birds killed per turbine per year. At the same site, collisions have also been found to be non-randomly distributed between turbines. A study by Acha (1997) found that 57% of the vulture casualties recorded at Tarifa were killed by only 28 of the 190 turbines at this facility.

Germany

The German Wind Energy Association (www.wind-energie.de) reports that German Friends of the Earth estimate an average of 0.5 bird deaths per turbine or a total of 8000 per year. However, the German Society for Nature Conservation (NABU) collated information from 127 case studies and concluded that less than 300 birds have been killed by turbines across Germany since 1989.

South Africa

To date, only three wind turbines have been constructed in South Africa at a single demonstration facility at Klipheuwel in the Western Cape. These turbines were installed in 2002 and 2003. A monitoring program was put in place once the turbines were operational (Küyler 2004), and involved site visits twice a month to monitor birds flying in the vicinity of the site, and to detect bird mortalities. Important findings of this monitoring, conducted from June 2003 to January 2004 are as follows:

- Between 9% and 57% of birds observed within 500m of the turbines were at blade height – there was great variation between months.
- Between 0% and 32% of birds sighted were close to the turbines defined as between turbines or within the arc of the rotors of the outermost turbines, and again showed great variation between months.
- Five bird carcasses were found on the site during this 8 month period. Two of these, a Helmeted Guineafowl *Numida meleagris* and a Spotted Dikkop *Burhinus capensis* were determined to be killed by predators. **A Horus Swift *Apus horus* and a Large-billed Lark *Galerida magnirostris* were thought to have been killed by collision with turbine blades.**
- Two mortalities in eight months at three turbines translates to a net collision rate of **1.00 mortalities per turbine per year**.
- Experimental assessment of the searcher efficiency revealed that 7 out of 9 (77%) carcasses placed in the study area were detected by the searcher.
- These nine carcasses were scavenged at between 12 and 117 days after their placement.

4.1.1. Factors influencing bird collisions with turbines

Multiple factors influence the number of birds killed at wind farms. These can be classified into three broad groupings: avian variables, location variables, and facility-related variables.

Avian variables

Although only one study has so far shown a direct relationship between the abundance of birds in an area and the number of collisions (Everaert 2003), it would seem logical to assume that **the more birds there are flying through an array of turbines, the higher the chances of a collision occurring**. The nature of the birds present in the area is also very important as **some species are more vulnerable to collision with turbines than others**. This is examined further below. Bird behaviour and activity differs between species – with certain hunting behaviours rendering certain species more vulnerable. For example, a falcon stooping after prey may be too focused on its target to notice other infrastructure. There may also be seasonal and temporal differences in behaviour, for example breeding males displaying may be particularly at risk. These factors can all influence the degree to which a given species is prone to colliding with the blades of a wind turbine.

A controlled experiment with homing pigeons was undertaken by Cade (1994) to examine their flight behaviour in the proximity of turbines. Pigeons released near turbines clearly recognised the turbines and adjusted their flight as required. Of about 2270 pigeon flights near turbines, three collisions occurred. In a radar study of the movement of ducks and geese in the vicinity of an off-shore wind facility in Denmark, less than 1% of bird flights were close enough to the turbines to be at risk (FIGURE 1, from Desholm & Kahlert 2005).

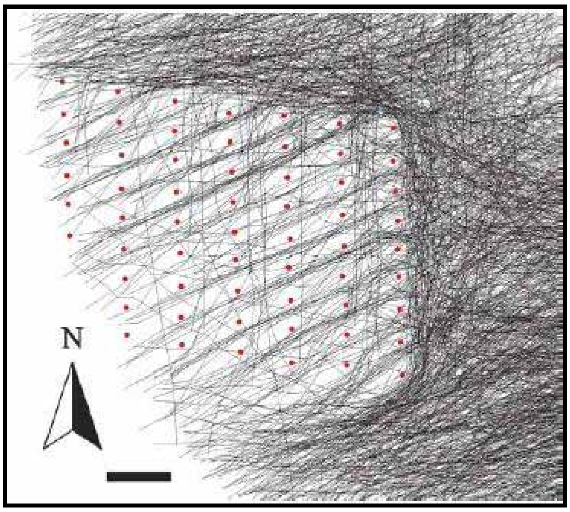

FIGURE 1. Radar tracked movement of ducks and geese relative to an offshore wind facility in Denmark (from Desholm & Kahlert 2005, scale bar = 1000m).

Location variables

Landscape features can potentially channel or funnel birds towards a certain area, and in the case of raptors, influence their flight and foraging behaviour. Elevation, ridges and slopes are all important factors in determining the extent to which an area is used by birds in flight. **High densities of prey** will attract raptors, increasing the time spent hunting, and as a result reducing the time spent being observant. Poor **weather affects visibility**. At the proposed site for the Eskom Wind Energy Facility, the fog that moves in off the sea at night and early morning will be an important factor. At Mountaineer Wind Energy Centre in Tucker County (US), 30 songbirds collided unexpectedly with a turbine during thick fog conditions in May 2003 (Cumberland Times). Very few collisions had been recorded prior to this weather-related incident. Birds **fly lower during strong headwinds** (Hanowski & Hawrot 2000, Richardson 2000). This means that, when the turbines are functioning at their maximum speed, birds are likely to be flying at their lowest, exponentially increasing collision risk.

Facility-related variables

According to Kingsley & Whittam (2005), "**More turbines will result in more collisions**". Although only two mortalities have been recorded at Klipheuwel, the difference between the 3 turbines at Klipheuwel and a potential 100 turbines at the proposed Eskom Wind Energy Facility is significant. **Larger facilities also have greater potential for disturbance and habitat destruction.**

To date it has been shown that large turbines kill the same number of birds as smaller ones (Howell 1995, Erickson *et al.* 1999). **With newer technology and larger turbines (FIGURE 2), fewer turbines are needed for the same quantity of power generation, possibly resulting in less mortalities per kW of power produced** (Erickson *et al.* 1999).

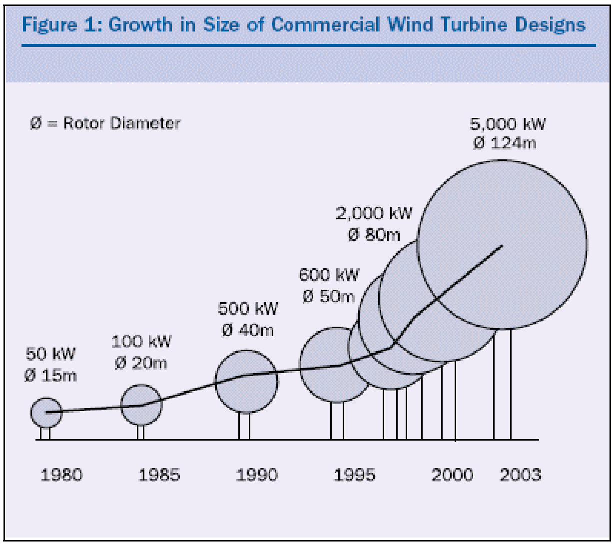

FIGURE 2. The development of turbine size since the 1980's – European Wind Energy Association (EWEA)

Certain **turbine tower structures, and particularly the old-fashioned lattice designs, present many potential perches** for birds, thereby increasing the chance of collisions as birds land at or leave these perching or roosting sites. It is anticipated that, with the exception of the flat top of the nacelle itself, the tubular structure of the towers proposed for use at the Eskom Wind Energy Facility will not present many perching opportunities as they are generally smooth and rounded, with few accessible, flat surfaces.

Turbine height and rotor size do not significantly influence collision risk by birds (Barclay *et al.* 2007), although bats are more likely to collide with taller turbines.

Lighting of turbines and other infrastructure has the potential to attract birds, thereby increasing the risk of collisions with turbines. In Sweden a large number of collisions were recorded with one turbine in one night. The turbine was not operational, but was lit (Karlsson 1983, cited in Winkelman 1995). At the Mountaineer site mentioned above, all collisions occurred on the three turbines closest to the substation (which was lit with a solid white light). No collisions occurred on any of the other 12 turbines which were lit with red strobe lights. The theory behind the relationship between lights and the number of collisions is that nocturnal migrants navigate using stars, and mistake lights for stars (Kemper 1964). Another partial explanation may be that lights attract insects which in turn attract birds. **Changing constant lighting to intermittent lighting has been shown to reduce attraction** (Richardson 2000) and mortality (APLIC 1994, Jaroslow 1979, Weir 1976) and **changing white flood light to red flood light resulted in an 80% reduction in mortality** (Weir 1976). Erickson *et al.* (2001) suggest that lighting is the single most critical attractant leading to collisions with tall structures.

One of the reasons suggested for bird collisions with turbine blades is 'motion smear' or retinal blur, terms used to describe the phenomenon in which rapidly moving objects become less visible the closer they are to the eye. The retinal image can only be processed up to a certain speed, after which the image cannot be perceived. It stands to reason then that the slower the blades move, the less motion smear – and this should translate into less collisions. Interestingly, it is believed that at night there is no difference between a moving blade and a stationary one in terms of number of collisions (Kingsley & Whittam 2005).

Infrastructure associated with the facility often also impacts on birds. Overhead power lines pose a collision and possibly an electrocution threat to certain bird species (Van Rooyen 2004a). Furthermore, the construction and maintenance of the power lines will result in some disturbance and habitat destruction. Some bird species may choose to perch, roost or nest on the towers, thereby possibly impacting on the quality of electrical supply through causing faults. New roads constructed will also have a disturbance and habitat destruction impact.

Spacing between turbines at a wind facility can have an effect on the number of collisions. Some authors have suggested that paths need to be left between turbines so that birds can move along these paths. For optimal wind generation, relatively large spaces are generally required between turbines in order to avoid wake and turbulence effects. In the case of the proposed Wind Energy Facility, turbines within a row will be spaced approximately 300m apart, and turbine rows between 500m and 700m apart.

Extending the literature review to look at the international experience in terms of the different broad groupings of species, and their vulnerability, reveals that **very few collisions have been recorded relating to water birds, water fowl, owls and shorebirds. The majority**

of bird mortalities at Altamont Pass were raptors, however, in the US outside of California raptors only accounted for 2.7% of mortalities (Erickson *et al.* 2001, Kerlinger 2001). **Songbirds comprise 78% of fatalities in the US** (Erickson et al. 2001). **Grassland species with aerial courtship displays – such as the Horned Lark in the US (Kerlinger & Dowdell, 2003) – may be particularly at risk**. Interestingly, at the Klipheuwel demonstration facility, a pair of Blue Cranes was recorded breeding only about 400m of the facility in 2003 (Küyler 2004).

4.1.2. Potential explanations for collisions of birds with turbines:

The three main hypotheses proposed for birds not seeing turbine blades are as follows (Hodos 2002):

- An inability to divide attention between prey and obstacles. This seems an unlikely explanation as birds have been found to maintain good acuity in the peripheral vision, have different foveal region in the eye for frontal and ground vision and they have various other optical methods for keeping objects at different distances simultaneously in focus.
- The phenomenon of motion smear or retinal blur, explained earlier in this report.
- The angle of approach. If a bird approaches from side on to the turbine, the blades present a very small profile and are even more difficult to detect.

Mitigation measures should therefore focus on solving the problem of motion smear both from front and side angles.

4.1.3. Mitigation measures

Painting turbines

In a study of visual acuity in raptors using laboratory-based behavioural testing methods (McIsaac 2001), the following key findings emerged:

- Acuity of kestrels appears superior when objects are viewed at a distance, suggesting that the birds may view nearby objects with one visual field and objects further away with another.
- Moderate motion of the stimulus significantly influences kestrel acuity. Kestrels may be unable to resolve all portions of turbine blades under some conditions such as blade rotation, low contrast of blade with background and dim illumination.
- Results **suggest that careful selection of blade pattern will increase conspicuity**. Blade patterns that were proven to be conspicuous to humans also proved to be conspicuous to kestrels. Patterns across the blade produce better conspicuity in humans and kestrels than patterns down the length of blades. **Maximum conspicuity was**

achieved using a pattern of square wave black and white components that run across the blade width.

In a further study of raptors under laboratory conditions, using electrode implants in the retinas of the birds to record the pattern electroretinogram, Hodos (2002) found that:

- The confusing effects of motion smear are reduced by maximising the time between successive stimulations of the same retinal region. Applying the same pattern to each blade does not achieve this. Each blade should have a different pattern so that a pattern on one blade is not repeated in the same position on another blade. This would have the effect of almost tripling the time between stimulations of the same retinal region.
- Various laboratory-based testing of seven blade patterns led to the conclusion that the **most visible blade pattern across the widest variety of backgrounds were the single black blade pattern (FIGURE 3) and the black thin stripe pattern staggered across the three blades (FIGURE 4). Since the single black blade pattern has the advantage of being easier and cheaper to implement, it is the most recommended option (Hodos 2002).**

Unfortunately these tests confirm only that the blades will be more visible if painted. They do not test what the psychological response of birds to the blades will be. Birds may be scared and repelled by marked blades, or they may be curious attracted closer. Only field testing can confirm these responses. To date, such field testing has not been done.
[NOTE: Should any collision casualties be recorded early in the life of the Eskom WEF, it is strongly recommended that a well designed experiment on the efficacy of blade patterning be implemented, expressly to improve our limited understanding of this mitigation measure, and possibly to prevent further collisions.]

FIGURE 3. Single solid black blade pattern (from Hodos 2002)

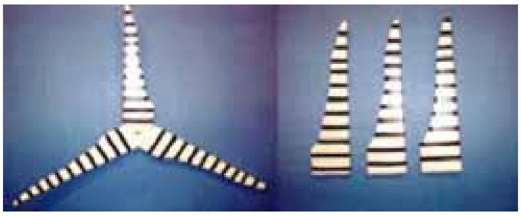

FIGURE 4. Thin black stripes on all three blades (from Hodos 2002)

Anti perching devices

Perching on turbines has been implicated in increasing collision rates, although this may have been predominantly on lattice type towers and not the more modern, tubular structures.

Construction of pylons:

It has been suggested (but not tested) that building pylons around the line of turbines would reduce the number of collisions as birds would be forced around the turbines. In other words a line of pylons could serve as a shield to the turbines. This is not considered a realistic option and is not discussed further.

4.1.4 Exclusion of birds from wind farm sites

Some studies have shown **significant decreases in the numbers of certain birds in areas where wind farms are operational as a direct result of avoidance of the noise or movement of the turbines** (e.g. Larsen & Guillemette 2007), while others have shown decreases which may attributed to a combination of collision casualties and avoidance or exclusion from the impact zone of the facility in question (Stewart *et al.* 2007). **The latter effect may be particularly relevant to populations of ducks and waders.**

Summary of the main points from the above literature review:

- With a few exceptions (such as at Altamont Pass and Tarifa), studies have found low numbers of bird mortalities at wind facilities.
- There is a huge variance in mortality between sites, and even between individual turbines within sites.
- The majority of collisions seem to involve raptors and/or songbirds.
- At the Klipheuwel site, monitoring for 8 months revealed only two mortalities.
- Factors affecting the number of mortalities at a facility include: bird species present, prey abundance, landscape features, weather, number of turbines, turbine size, turbine spacing and facility lighting.
- Associated infrastructure such as power lines also impact on birds.
- Intermittent lighting may be less attractive than continuous lighting, and red light may be less attractive than white light.
- The primary explanation for collisions is the phenomenon of motion smear or retinal blur. Mitigation measures should therefore focus on reducing motion smear effects.
- In laboratory testing, two studies have found that painting turbine blades increases their visibility to American Kestrels. The most effective patterns are black stripes across the blade, in different positions on each blade, or a single solid black blade with two solid white blades. Unfortunately these tests confirm only that the blades will be more visible if painted. The efficacy of these patterns has not been field tested.
- Some bird taxa – especially ducks and waders - may avoid the impact areas of wind energy facilities and suffer losses of available habitat as a result.

4.2. Description of the proposed wind energy facility

The current proposed wind farm will have the following characteristics:

- A wind farm consisting of up to 100 turbines (but initially of 50), covering a total area of approximately 25 square kilometres.
- Turbines will be situated in four to five, roughly straight, parallel lines, and will have a twenty year lifespan.
- Turbines will be sited 300m to 350m apart from each other, with rows being as much as 750m apart. This is to minimise wake effects and wind turbulence.
- Each turbine will consist of a tubular tower approximately 80m tall, with three blades approximately 45m long giving a total diameter of 90m. The foundation will be a 15m x 15m concrete platform.
- At this stage it is planned to light those turbines which are situated on the outer extremity of the wind farm with two red strobe lights per turbine.
- An access road to the site will be built, or if possible existing roads will be upgraded, as well as a road within the site linking all the turbines.
- A substation of 50m x 50m will be built, possibly in a central position.
- The substation will be linked to the turbines by 11 kV underground electrical cables.
- A small (150m square) visitor's centre/office may be built at the entrance to the facility.
- The wind farm will be linked into the grid by means of a double-circuit 132kV overhead power line, routed along one of two proposed alignments to the Juno substation outside Vredendal, carried on mono-pole pylons.

5. DESCRIPTION OF AFFECTED ENVIRONMENT

5.1 Vegetation of the study area

The affected environment straddles the gravel road between Koekenaap and the farm Skaapvlei, about 30-35 km northwest of Vredendal. The area falls within the southwestern extremity of the Succulent Karoo biome, and on the interface between the Namaqualand Sandveld (in the north) and the West Strandveld bioregions (Mucina & Rutherford 2006). In terms of an 'avicentric' classification of vegetation types (based largely on structural features deemed influential in affecting bird distributions), the site is predominantly Succulent Karoo (Harrison *et al.* 1997), while in terms of the most recent, purely botanical classification, it features a combination of Namaqualand Strandveld in the southern extension, Namaqualand Sand Fynbos in the north, and Arid Estuarine Saltmarsh (Mucina & Rutherford 2006) along the lower river courses in the extreme east of the impact zone where the proposed Juno-WEF power line approaches the Juno substation.

5.1.1. Succulent karoo

The Succulent Karoo biome occurs in the far west of the country, generally at altitudes of less than 800m. It is primarily defined by a low, winter rainfall regime (20-290 mm per annum),and consists of flat to undulating plains with some hilly and broken veld. It is characterised by dwarf succulent plants and an almost total absence of trees. Grasses are rare, except in some sandy areas, but overall species diversity is surprisingly high. "Heuweltjies", i.e. raised mounds of calcium rich soil, are a feature of the Succulent Karoo landscape, and are thought to have been created by termites. These mounds often support distinct plant communities which could, in turn, affect bird distribution. Namaqualand Sand Fynbos features dry, undulating dune fields, covered by 1-1.5 m high shrubs, interspersed by restios, while Namaqualand Strandveld is a flatter, more open habitat, with a high diversity of low shrubs, and a propensity for spectacular annual and perennial flowering in good rainfall years (Mucina & Rutherford 2006).

5.2 Bird microhabitats

The 'realised' avian microhabitats in the impact zone of the proposed WEF and its associated infrastructure are largely a function of the vegetation types described above, overlaid by various forms of human land use and anthropogenic degradation of the natural habitat. The following micro habitats were identified in and around the study site:

Open Strandveld / Sand Fynbos: This is the dominant microhabitat available to birds in the study area, covering most of the footprint area of the wind farm itself (APPENDIX 1A), and supports the bulk of the terrestrial species diversity and the key endemics. Important and characteristic taxa include a number of larger, terrestrial or raptorial species such as Ludwig's Bustard *Neotis ludwigii*, Southern Black Korhaan *Afrotis afra*, Black Harrier *Circus maurus*, Southern Pale Chanting Goshawk *Melierax canorus* and Cape Spurfowl *Pternistes capensis*, and small passerines such as Cape Long-billed Lark *Certhilauda curvirostris*, Karoo Lark *Certhilauda albescens*, Large-billed Lark *Galerida magnirostris*, Grey Tit *Parus afer* and Karoo Chat *Cercomela schlegelii*, Karoo Scrub Robin *Cercotrichas coryphoeus*, Rufous-eared Warbler *Malcorus pectoralis*, Layard's Titbabbler *Parisoma layardi*, Bokmakierie *Telephorus zeylonus*, Southern Double-collared Sunbird *Cinnyris chalybeus*, Black-headed Canary *Alario alario* and Yellow Canary *Serinus flaviventris*.

Adjacent to and (in some areas) integrated with, the more pristine tracts of Strandveld are 2-3 patches of previously cultivated Strandveld. These areas have not been planted for at least 12 years (N. Helme pers. comm.) and are in a state of natural rehabilitation. They are rather more sparsely vegetated than the entirely natural vegetation, and characteristic species include those listed above, supplemented by open-country species such as Secretarybird *Sagittarius serpentarius*, Black-shouldered Kite *Elanus caeruleus*, Red-capped Lark *Calandrella cinerea*, Cape Weaver *Ploceus capensis* and White-throated Canary *Serinus albogularis*.

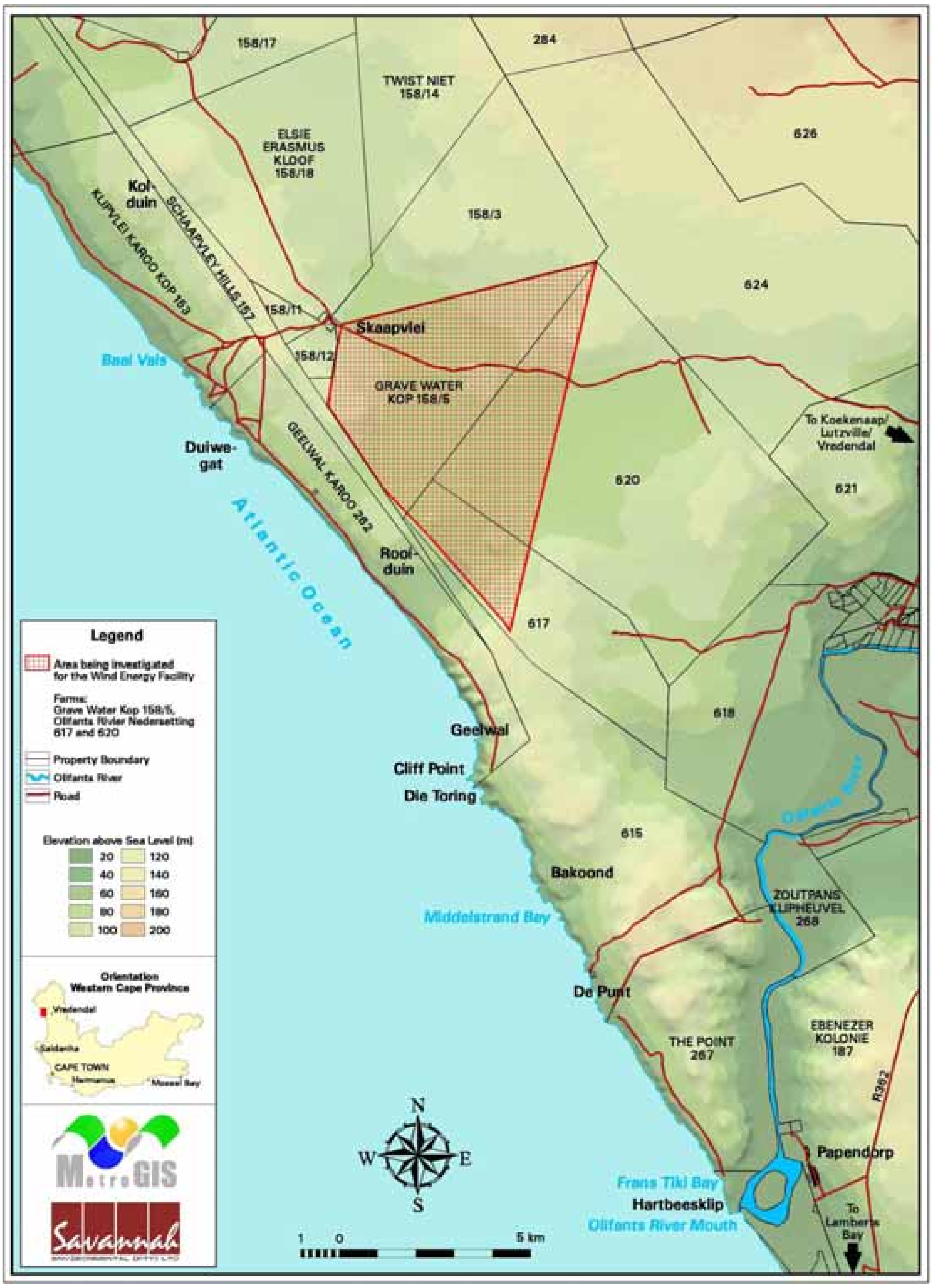

FIGURE 5. Layout of the study area showing the proposed site for the wind energy facility (map supplied by Savannah).

Permanent, seasonal and ephemeral wetlands: One small pan is evident on the proposed site, just north of the access road, and at least a further two to three other, low-lying, open areas are distinguishable on satellite images of the area which probably form ephemeral pans or damp areas in good rainfall years (and possibly attract a variety of common waterbirds, including species such as Yellow-billed Duck *Anas undulata*, South African Shelduck *Tadorna cana*, Blacksmith Plover *Vanellus armatus*, Black-winged Stilt *Himantopus himantopus* and a number of resident and migratory wader species. The fringes of these damp, pan areas could even be used as nesting areas by pairs of Black Harriers, which move into Namaqualand in wet years, and target pans and the edges of estuaries and lagoons as breeding sites (Pers obs, R. Simmons pers comm.).

Both of the proposed routes for the 132 kV power line cross the Holrivier, just before its confluence with the Olifants River, and Alternative 1 crosses the much smaller Moedverloorrivier just to the north of the Hol crossing. These riverbeds are probably generally quite dry, but when flowing are likely to support a variety of aquatic and water-associated species, and almost certainly function as flyways for many bird species commuting through the area. The reedbeds and thicker areas of vegetation associated with these watercourses are likely to hold nesting and roosting sites for granivorous birds (e.g. bishops and weavers), and to support riparian species such as Namaqua Warbler *Phragmacia substriata*, Lesser Swamp Warbler *Acrocephalus gracilirostris* and Little Rush Warbler *Bradypterus baboecala*, while sandbanks and cuttings on the Holrivier support breeding colonies of European Bee-eater *Merops apiaster*.

Within the broader landscape of the development area, the Olifants River Estuary (including the Papendorp Salt Works – APPENDIX 1B) lies about 16 km south of the closest boundary of the WEF. This wetland has been recognised as a national Important Bird Area (IBA - Barnes 1998). It is one of only four perennial estuaries on the west coast, making it an extremely attractive haven for many coastal bird species.

Approximately 125 bird species have been recorded there, most of which are water birds, regularly over 15 000 water birds occur on the estuary. Several Red Data species occur there such as: Greater Flamingo *Phoenicopterus ruber*, Lesser Flamingo *Phoenicopterus minor*, Caspian Tern *Sterna caspia*, African Marsh Harrier *Circus ranivorus* (breeds), African Black Oystercatcher *Haematopus moquini* (probably breeds on the coastline), White Pelican *Pelecanus onocrotalus*, Chestnut-banded Plover *Charadrius pallidus* and Damara Tern *Sterna balaenarum*. The estuary forms a vital staging ground for various species moving between waterbodies to the south such as Langebaan Lagoon, and the Orange River Mouth to the north, including large numbers of migrating Palaearctic waders, especially Curlew Sandpiper *Calidris ferruginea* (Taylor *et al.* 1999, Barnes 1998).

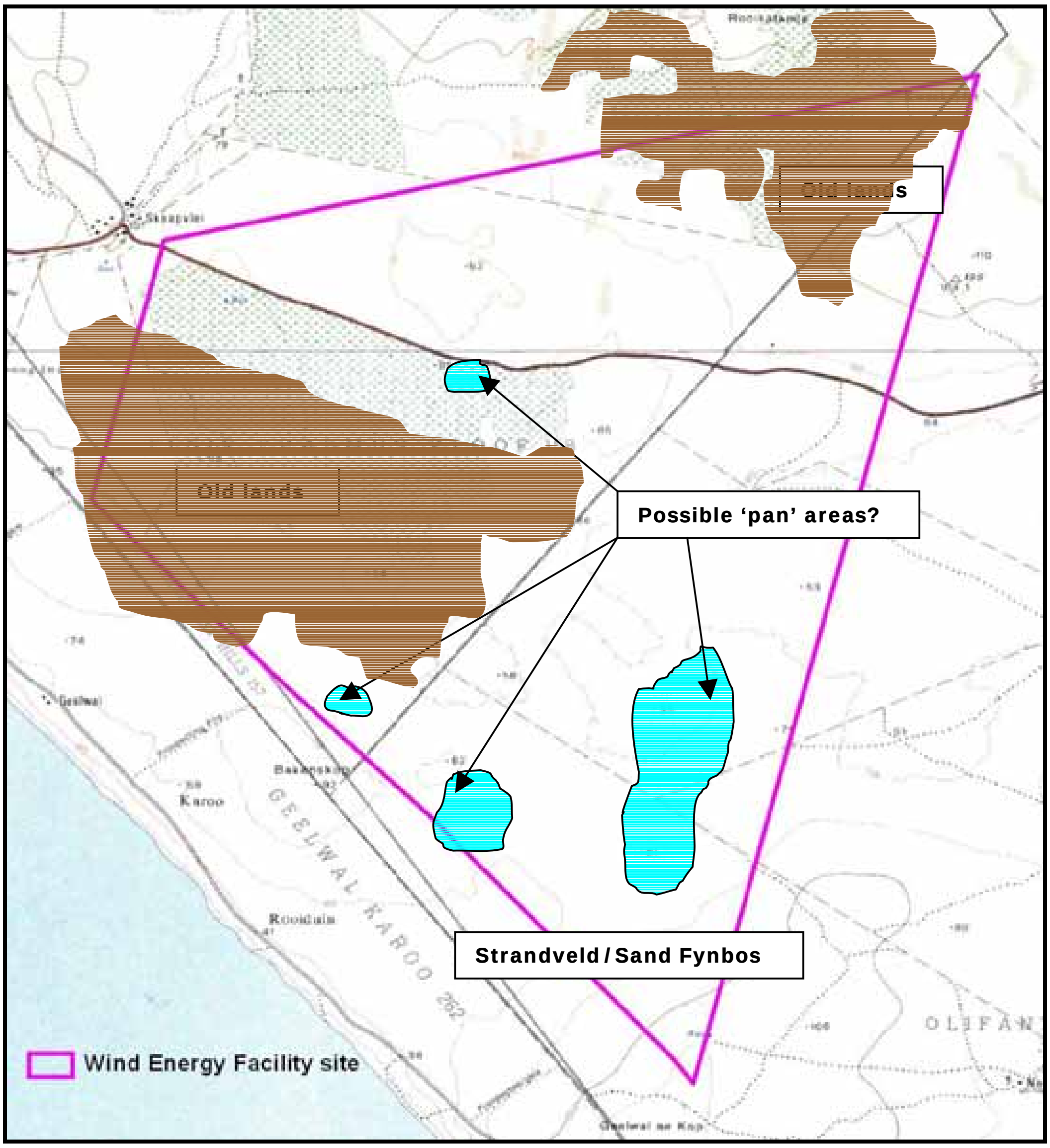

FIGURE 6. Proposed Wind Energy Facility site – showing micro habitats

Rocky coastline: This runs immediately west of the WEF area, and includes particularly the low cliffs at "Die Toring", "Robeiland" and "Cliff Point" (APPENDIX 1C). The birds most likely to congregate at these sites are cormorants – mainly Cape Cormorant *Phalacrocorax capensis* and White-breasted Cormorant *Phalacrocorax lucidus* and other marine species, generally unlikely to fly inland and to interact with the WEF. However, in poor weather conditions these birds may become disoriented or may be blown off course and end up further inland than normal. The cliffs might also support breeding pairs of cliff-nesting raptors such as Jackal Buzzard *Buteo rufofuscus*, Peregrine Falcon *Falco peregrinus* and Rock Kestrel *Falco rupicolus*, as well as White-necked Raven *Corvus albicollis*. The flatter areas of the coastline may support breeding African Black Oystercatchers *Haemantopus moquini*.

Alien trees: There are numerous stands of alien trees (mostly eucalypts and acacias) in the areas crossed by both of the proposed routes for the 132 kV power line running to the east of the WEF site. These are concentrated in the agricultural areas around Koekenaap and Lutzville, and may support reasonable numbers of arboreal and/or tree-nesting species, perhaps most importantly including raptors such as Black Kite *Milvus migrans*, Jackal Buzzard *Buteo rufofuscus*, Black Sparrowhawk *Accipiter melanoleucus* and possibly even Martial Eagle *Polemaetus bellicosus* and African Fish Eagle *Haliaeetus vocifer*.

Cultivated lands (including farmhouses, outbuildings and other rural infrastructure): These occur around the settlement of Lutzville and beyond towards Juno Substation, along both the proposed power line alignments. Particularly where they adjoin watercourses, these will attract numbers of small granivores, especially Southern Red Bishop *Euplectes orix*, and possibly flocks of Egyptian Goose *Alopochen aegyptiaca* and Spur-winged Goose *Plectropterus gambensis* on a seasonal basis, and may be used by Ludwig's Bustard on occasion.

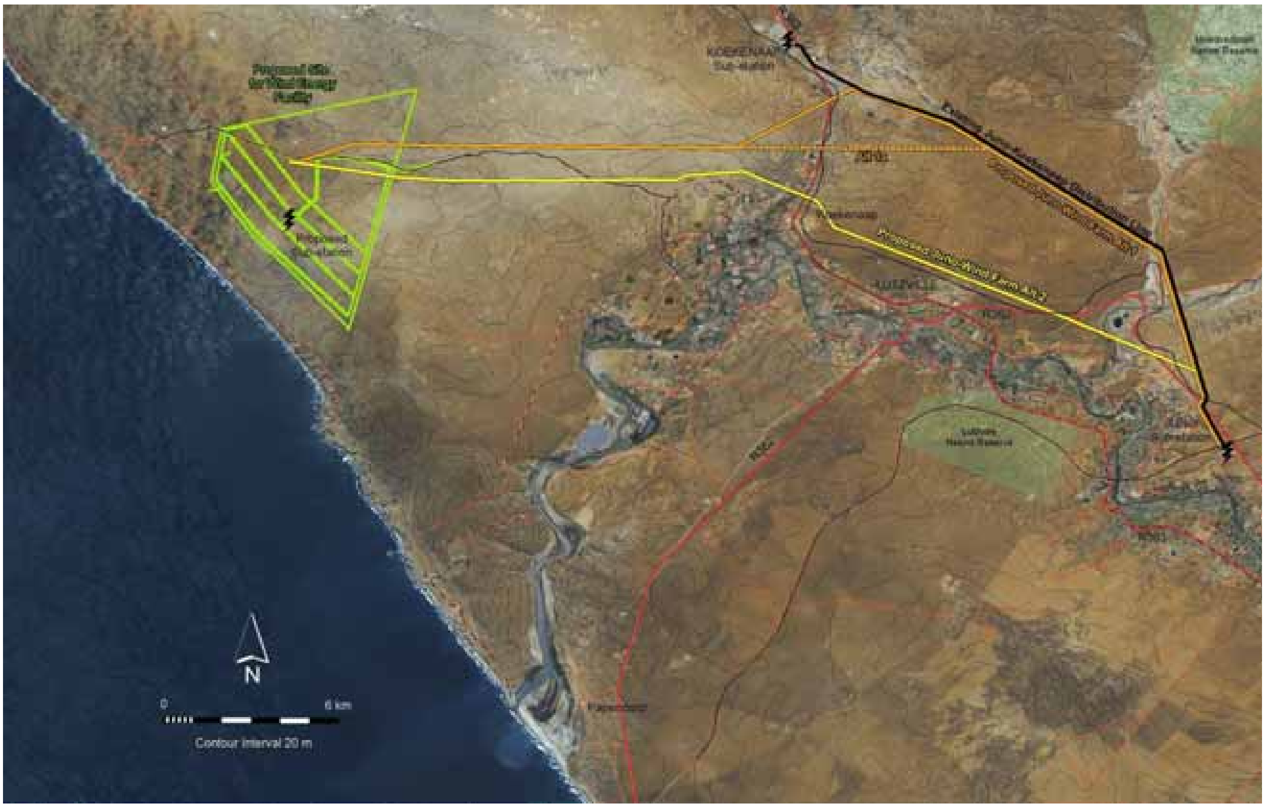

FIGURE 7. Expanded view of the WEF impact zone, indicating the two proposed 132 kV power line options connecting the facility to the Juno substation, and including sub-option 1a.

5.4 The avifauna of the impact zone

The impact zone of the WEF and its associated infrastructure is likely to support as many as 257 bird species (APPENDIX 2), of which 24 species are Red-listed, 66 species are regional endemics or near-endemics, and eight species are Red-listed endemics (Barnes 2000, Hockey *et al.* 2005), of which two – Ludwig's Bustard and Black Harrier - are likely to occur regularly within the immediate footprint area of the WEF. Of the 6 avian microhabitats identified, the wetlands and pristine and degraded Strandveld and Fynbos areas support or partially support the bulk of the local avian diversity (124 and 113 species respectively), as well as most of the Red-listed and endemic species of highest conservation priority (APPENDIX 2).

The general character and habitat affinities of the local avifauna have been described in 5.2 (above). A shortlist of 35 priority species (TABLE 1) was selected to include the following groups of species on the following basis:

- All Red-listed species considered likely to occur in the area with some regularity, particularly including those recorded in SABAP data for the general area in at least four months of the year and with an overall average reporting rate of >5% of submitted records (Harrison *et al.* 1997), and/or those recorded during visits to the site.
- All fully endemic, biome- or range-restricted species (*sensu* Barnes 1998) considered likely to occur in the area in significant numbers, particularly including those recorded in SABAP data for the general area in at least eight months of the year and with an overall average reporting rate of >20% of submitted records (Harrison et al. 1997), and/or those recorded in numbers during site visits.
- Those congregatory waterbird species regularly recorded in particularly high numbers at the Olifants River Estuary (Taylor *et al.* 1999), but not covered by the above criteria.

This exclusive suite of species is the core focus of the remainder of this report, and all potential impacts of the WEF and associated power lines on birds, as well as all required mitigation, are deemed to be adequately covered by catering only for these species, as effective surrogates for the entire avian assemblage.

The impact area of the WEF may occasionally support significant populations of Ludwig's Bustard and Black Harrier. Both are Red-listed, endemic or near-endemic species, and both (particularly Ludwig's Bustard) are highly responsive to seasonal and inter-annual changes in environmental conditions in the Succulent Karoo, and are prone to relatively large-scale influxes into this region during or immediately after substantial rainfall events (Allan 1994, Curtis *et al.* 2004, Hockey *et al.* 2005). The exact nature and pattern of these influxes is not well understood in either species, and is therefore not easy to predict. However, in both cases, when local conditions are suitable, and numbers of bustards or harriers move into the area, these populations will constitute the most significant avian attributes of the site at that time. Both species were seen in the area during site visits by members of the EIA team. In October there was perhaps as many 10-15 Ludwig's Bustards within the immediate impact area of the WEF, and there was a regular traffic of these birds flying through area, and several were seen moving south along the coastline. In good years, Black Harriers could conceivably have bred within the impact area, particularly in the vicinity of the ephemeral pans and in the dune slack areas of the coastal Strandveld.

TABLE 1. List of bird species of conservation priority considered likely to occur in significant numbers within the area of the proposed WEF site (see APPENDIX 2 for scientific names, criteria for selection are discussed in 5.4 above); * denotes biome restricted species, # denotes restricted range species, and @ denotes congregatory species, all *sensu* Barnes (1998).

Common name	Conservation status	Regional endemicity	Local status	Preferred habitat
Cape Spurfowl*	-	Endemic	Common resident	Strandveld/Sand Fynbos
South African Shelduck@	-	Endemic	Common resident	Wetland
Ludwig's Bustard	Vulnerable	Near-endemic	Common visitor	Strandveld/Sand Fynbos
Southern Black Korhaan	-	Endemic	Common resident	Strandveld/Sand Fynbos
Karoo Korhaan*	-	Endemic	Uncommon visitor	Strandveld/Sand Fynbos
Curlew Sandpiper@	-	-	Common migrant	Wetland/rocky coastline
African Black Oystercatcher	Near-threatened	Endemic	Common resident	Rocky coastline
Grey Plover@	-	-	Common migrant	Wetland/rocky coastline
Common Ringed Plover@	-	-	Common migrant	Wetland/rocky coastline
Chestnut-banded Plover	Near-threatened	-	Uncommon resident	Wetlands (saltpans)
Caspian Tern	Near-threatened	-	Common visitor	Rocky coastline & wetlands
Swift Tern@	-	-	Common visitor	Rocky coastline/wetlands
African Marsh-Harrier	Vulnerable	-	Uncommon resident	Wetlands
Black Harrier	Near-threatened	Endemic	Uncommon resident	Strandveld/Sand Fynbos
Martial Eagle	Vulnerable	-	Uncommon resident?	Strandveld/Sand Fynbos
Secretarybird	Near-threatened	-	Uncommon resident?	Strandveld/Sand Fynbos
Lesser Kestrel	Vulnerable	-	Uncommon migrant	Strandveld/Sand Fynbos
Lanner Falcon	Near-threatened	-	Uncommon visitor	Cultivated lands
Peregrine Falcon	Near-threatened	-	Uncommon resident?	Rocky coastline
White-breasted Cormorant@	-	-	Common resident	Rocky coastline/wetlands
Cape Gannet	Vulnerable	Breeding endemic	Common visitor	Rocky coastline
Crowned Cormorant	Near-threatened	Endemic	Uncommon visitor	Rocky coastline
Bank Cormorant	Vulnerable	Endemic	Uncommon visitor	Rocky coastline
Cape Cormorant@	Near-threatened	Breeding endemic	Common resident	Rocky coastline
Greater Flamingo@	Near-threatened	-	Common visitor	Wetlands
Lesser Flamingo@	Near-threatened	-	Common visitor	Wetlands
Great White Pelican@	Near-threatened	-	Uncommon visitor	Wetlands
Cape Bulbul*	-	Endemic	Common resident	Strandveld/Sand Fynbos
Layard's Tit-Babbler*	-	Endemic	Uncommon resident	Strandveld/Sand Fynbos
Namaqua Warbler*	-	Endemic	Common resident	Wetlands
Cape Clapper Lark#*	-	Endemic	Common resident	Strandveld/Sand Fynbos
Karoo Lark*	-	Endemic	Common resident	Strandveld/Sand Fynbos
Cape Long-billed Lark#*	-	Endemic	Common resident	Strandveld/Sand Fynbos
Sickle-winged Chat*	-	Endemic	Uncommon resident	Strandveld/Sand Fynbos
Black-headed Canary*	-	Endemic	Uncommon visitor	Strandveld/Sand Fynbos

Although the WEF is positioned over 15 km away from the Olifants River Mouth, this wetland is of sufficient importance for regional bird conservation, and the numbers and nature of the birds attracted to the site (especially flamingoes, Palaearctic shorebirds and waterfowl) are sufficiently likely to (a) gather in large flocks and (b) move over long distances between waterbodies, to raise the proximity of the estuary to the WEF as a legitimate concern.

6. IMPACTS OF THE PROPOSED FACILITY IDENTIFIED IN THE SCOPING PHASE

6.1 Wind energy facility

Disturbance
Construction, ongoing maintenance, and possibly the action and/or noise of the operational facility could disturb birds in the vicinity of the proposed WEF site, and particularly those resident and breeding in the immediate development area. (Species implicated: all).

Habitat destruction
Some existing vegetation would be destroyed during the construction of the facility. Although the completed footprint of the WEF is relatively small, heavy machinery needed during construction would cause at least temporary damage to habitat over a larger area. (Species implicated: all).

Collision with the turbines
Birds displaying in and/or commuting through the turbine rows might collide with the turbine blades. (Species implicated: raptors, larks, swallows, swifts and martins).

6.2 Associated infrastructure

The only significant associated infrastructure not located within the immediate footprint of the WEF is the 132kV power line linking the facility to the Juno Substation. The upgrading of an existing secondary road to service the site was considered irrelevant to an assessment of avian impacts.

Collision with the 132kV power line to Juno Substation
Birds may collide with the overhead cabling of the new power line. Collisions are one of the biggest single threats posed by overhead power lines to birds in southern Africa (van Rooyen 2004). The species most frequently affected are bustards, storks, cranes and various species of waterbirds. These are relatively heavy-bodied birds with limited manoeuvrability, less capable of avoiding aerial obstacles (van Rooyen 2004, Anderson

2001). Unfortunately, many collision sensitive birds are also long-lived, slow-reproducing species, demographically poorly equipped to absorb unnaturally inflated rates of adult mortality, and some of these species are now Red-listed, at least partly because of the long-term effects of collision casualties associated with power lines. (Species implicated: Ludwig's Bustard, Southern Black Korhaan, Secretarybird).

Electrocution on the 132kV power line

Birds may be electrocuted when perching, or attempting to perch on the pylons supporting the new line, by bridging the air gap between live components and/or live and earthed components (van Rooyen 2004) and causing a short circuit. The electrocution risk of the proposed 132kV line will be entirely dependent on the design of the tower structures used. (Species implicated: Verreaux's Eagle *Aquila verreauxii*).

Habitat destruction during construction and maintenance for the 132kV line

During the construction and maintenance of power lines some habitat loss and alteration will inevitably take place with the construction of access roads, and the clearing of servitudes. These activities may have an impact on birds breeding, foraging and roosting in or in close proximity to the servitude. (Species implicated: all).

Disturbance during construction and maintenance for the 132kV line

Similarly, construction and maintenance activities on the line may disturb resident and breeding species of birds. (Species implicated: all).

Impact of birds on quality of supply on the 132kV line

Birds may cause electrical faults on power lines. This can happen in various ways, and the higher the number of faults recorded, the lower the quality of electricity supplied to end users.

'Bird streamer' induced faulting is caused when a large bird produces a stream of faeces long enough to constitute an air gap intrusion between the conductor and the earthed structure, creating a short circuit. Bird pollution is a form of pre-deposit pollution. A flashover occurs when the insulator string gets coated with pollution, which compromises the insulation properties of the string. When the layer of pollution is dampened by rain or high humidity, the coating becomes conductive, insulation breakdown occurs and a flashover results. Bird's nests may also cause faults when nesting material protrudes into the air gap. Crows in particular often incorporate wire and other conductive material into their nests.

Streamer- , pollution- and nest-related faults could occur when birds regularly perch or nest on pylons or towers, directly above live conductors. The risk of bird-related faulting will be dependent on the design of the tower structures used. (Species implicated: Herons, ibises, eagles and crows).

6.3. Sensitive "no go" areas within the proposed site

The only sensitive features identified were three or four small pans which may hold water after rainfall, and subsequently attract birds. Several other areas observed on the satellite image of the area could potentially be similar pans. Where possible, the turbines should be sited away from these pans (and any other sources of water), although these areas were not considered to be absolute no go areas. Given that there is uncertainty about the exact location and extent of these pans, there should probably be a physical inspection of all the proposed turbine locations once these are provisionally finalized, to ensure that none of the selected sites are too close to possible pan areas. Also, turbines within the WEF should also be sited as far from the Olifants River as possible, and the 132kV line to Juno should follow a route as much adjacent/parallel to the existing infrastructure as possible in order to partially mitigate for collision impacts.

7. DETAILED ASSESSMENT OF IMPACTS OF THE WEF – EIA PHASE

The more detailed analysis of the impacts on birds of the proposed WEF and its associated infrastructure is focused primarily on the likely effects of the development on the 35 priority bird species identified in 5.4 (above) and listed in TABLE 1.

7.1 Wind energy facility

Disturbance

Short-term disturbance issues arising from construction of the WEF are only likely to impact birds currently resident within the footprint area. These include healthy populations of endemic, range and biome restricted passerine species (e.g. Cape Long-billed Lark *Certhilauda curvirostris*, Karoo Lark *Certhilauda subcoronata*, Layard's Tit-Babbler *Parisoma layardi*), which may well be displaced from the immediate area. However, given that construction disturbance will be localised and temporary, and allowing for the relative abundance of these smaller species over the broader landscape within which the WEF is sited, this impact is considered negligible (APPENDIX 3). It also is conceivable that at the time at which construction activities commence on the site there may be active nests of larger priority species (e.g. Ludwig's Bustard, Southern Black Korhaan, Karoo Korhaan *Eupodotis vigorsii*, African Marsh Harrier, Black Harrier, Martial Eagle and Secretarybird) located within the immediate vicinity. Given that these species occur at much lower densities in the environment, and that adequate protection of nest sites is therefore of far greater concern, it may be necessary to (a) survey the construction area immediately before work commences, and (b) to work around any such nest sites located in this pre-construction survey (APPENDIX 3). Such a survey would form part of the monitoring programme proposed for the WEF and detailed in Point 8 below, and should make a point of locating the regularly rain-filled pan areas referred to in the Scoping Phase, and/or those areas identified in the EIA by the wetland and heritage specialists), which could be important focal points for harriers (and possibly aggregations of waterbirds should sufficient surface area be seasonally inundated).

Longer-term disturbance stemming from maintenance and operational activities at the WEF site is unlikely to be of sufficient scale to warrant concern from an avian impacts perspective. Suffice it to say that environmental best practice should always be applied, and human activity and noise around the facility should be kept to a realistic minimum (APPENDIX 3). Should any important nest sites be located close to WEF in the pre-construction monitoring of the site, these should be given special consideration in the planning of all routine maintenance activities.

Another disturbance impact which was perhaps underplayed in the Scoping Phase of this assessment was the effect of the operating wind farm on the presence and distribution of the resident avifauna, and on the movement patterns of birds commuting through the area. Several recent studies have shown that these effects, which presumably are caused by either the movement or noise generated by the turbine blades, or possibly by just the size and general appearance of the completed facility, can be substantial (Huppop *et al.* 2006, Larsen & Guillemette 2007, Stewart *et al.* 2007). Given that we have no quantitative information on the densities of key resident bird species in the area of the proposed WEF, or on the scale and rates of passage of commuting species, the potential significance of this impact is difficult to evaluate at this point. Hence, the collection of such data will form a vital part of the survey and monitoring programme described in Point 8 below.

Habitat destruction

A relatively small area of habitat for birds will be completely destroyed/lost in the construction process, and a larger quantity will be degraded or damaged by the process. Every effort should be made to rehabilitate the damaged vegetation to minimise the habitat losses to resident priority bird species. However, given that most, if not all of the species affected by habitat loss in this way are relatively abundant over the broader landscape within which the WEF is sited, this impact is considered negligible (APPENDIX 3). Once again, the specific sites of each of the turbines, and those allocated to the auxiliary structures of the WEF, should be inspected immediately pre-construction as part of the monitoring programme (described below), to ensure that no critical avian micro-habitats are affected (APPENDIX 3).

Collision with the turbines

This is potentially the most significant impact of the proposed development, and could negatively affect a variety of collision prone species, most notably aggregations of waterfowl, flamingos, and possibly coastal seabirds, and individuals or loose flocks of Ludwig's Bustard, which might travel through the impact zone, especially when such movements occur during unfavourable weather conditions and/or at night, when visibility and control in flight are compromised. Also at risk of collision is the suite of both diurnal and nocturnal predatory birds present in the area, especially active pursuit hunters such as Peregrine Falcon and Lanner Falcon *Falco biarmicus*, which may not account for the rotation of the turbine blades when chasing prey through the impact area of the WEF. While numbers of smaller aerial species, such as swifts, swallows and martins, or smaller species with aerial displays, such as the resident, endemic lark taxa, may be killed in collisions with the rotors, and the cumulative effect of this over time should certainly be monitored, the relative abundance of these species in the general area of the facility probably renders this impact negligible.

Given (i) a current lack of quantitative data describing the nature, extent and timing of movements by priority bird species through the WEF area, and (ii) a general lack of locally-sourced information on the likely effects of commercially viable wind farms on South African avifauna, it is not possible at this stage to anticipate the possible scale and importance of this impact with any confidence. Hence, while certain measures to mitigate the possible negative impacts are suggested (APPENDIX 3), firm decisions on the applicability and efficacy of required mitigation can only be made in light of the outcomes of a comprehensive pre- and post-construction/operational monitoring programme (described below).

However, PLEASE NOTE that should any significant impacts of the WEF on priority bird populations be detected by the monitoring scheme, required mitigation could include:

- **(i) Painting the blades of selected, problem turbines.**
- **(ii) Temporarily or even permanently shutting down selected, problem turbines.**
- **(iii) Shutting down the entire facility at certain times and/or in certain weather conditions.**

7.2 Associated infrastructure

Collision with the 132kV power line to Juno Substation

The most important collision-prone species within the impact zone of the proposed power line are Ludwig's Bustard and Secretarybird, and mitigation of this impact should focus primarily on minimising collisions with the power line by these two species. In effect, this requires that all sections of the power line crossing open, relatively flat country frequented by both species should be marked on the earthwire with a suitable marking device (APPENDIX 3). In addition, any points where the power line crosses a watercourse, which might constitute a general flyway for local birds, should also be marked. The final selection of sections of the power line to be fitted with marking devices should be identified after the pole positions have been pegged, by way of a walk-through conducted jointly by Eskom and the EWT.

Ideally, a section of this power line should be regularly surveyed for collision casualties as part of the monitoring programme suggested for the WEF itself, to evaluate the efficacy of the marking devices used, and to ensure that unmarked sections of line where casualties are recorded are subsequently marked.

FIGURE 8. Double-circuit mono-pole pylon designs favoured to carry the Juno-WEF 132 kV power line: intermediate structure (left), standard strain (centre) and stayed strain (right), all with guard wires fitted.

Electrocution on the 132kV power line

The raptor fauna of the area are those most likely to suffer electrocution on the proposed line, with the larger species – Martial Eagle, Black-chested Snake Eagle *Circaetus pectoralis* and possibly others most at risk. The mono-pole pylon structures currently favoured to support the power line (FIGURE 8) are good options in terms of avian electrocution risk, provided that the clearances all-around, on all three options, are in excess of 2 m.

Ideally, a section of this line should be regularly surveyed for electrocution casualties as part of the monitoring programme suggested for the WEF itself, to verify that the selected tower design is a low electrocution risk option, and to ensure that should any electrocution casualties be picked up, the offending structures are accordingly fitted with bird guards in the appropriate places (APPENDIX 3).

Habitat destruction and disturbance during construction and maintenance for 132kV line
All construction and maintenance activities, including construction of the substation at the WEF site, should be carried out according to generally accepted environmental best practice, and the temporal and spatial footprint of the line should be kept to a minimum (APPENDIX 3). In particular, care should be taken in the construction of the power line in the vicinity of the river crossings, and existing roads must be used as far as possible for access during construction. Ideally, a pre-construction inspection of the substation site, and a walk-through of the selected power line alignment should be done by an experienced ornithologist to check key areas for nests of threatened species. Any bird nests that are found subsequently should be reported to the EWT to allow expert advice on how to deal with the situation.

Impact of birds on quality of supply on 132kV line
The favoured tower designs are poorly suited to use as nesting substrates by most bird species, and the perching areas are generally situated in areas either off-set or well away from the conductors, so the likelihood to birds having a significant negative impact on quality of supply is much reduced. However, any incidents of line faulting attributed to avian activities on the line should be reported to the EWT and will then be managed on a case-by-case basis (APPENDIX 3).

7.3 Evaluation of the two proposed power line routes

This is a fairly straightforward decision to make as the northernmost of the three options (Alternative 1, see FIGURE 7) runs for about 18 km parallel with and in close proximity to an existing wooden-pole power line, which gives a distinct advantage in terms of reducing collision risk for birds. By bringing multiple power lines into a single, narrow corridor, the combined assemblage is significantly more visible to overflying birds, and the likelihood of collisions occurring with any one of the aggregated lines is reduced. The new Juno-WEF 132 kV line is likely to stand taller than the existing line, so once the new line is marked with diverters on the earthwire in key areas (see 7.2 above), this will have the additional benefit of reducing any collision risk already associated with old line (which is currently unmarked). The late introduction of Alternative 1a (FIGURE 7) as an option to some extent negates this advantage, but still involves about 12 km of the new line running adjacent and parallel to the existing line.

In terms of the habitats traversed by the three alignment options, they all include similar distances of open Strandveld (where Ludwig's Bustards and Secretarybirds are most likely to occur), and they all involve two crossings of relatively major watercourses (which might function as all-purpose avian flyways), so the inherent collision risk of the three options is otherwise very similar. **Therefore, Alternative 1 is the preferred option, followed closely by 1b. Alternative 2 is not favoured.**

7.4 Methodology for scored assessment of impacts

Direct, indirect and cumulative impacts of the above issues are scored and compared (APPENDIX 3) in terms of the following criteria:

The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.

The **extent**, where it will be indicated whether the impact will be local (limited to the immediate area or site of development), regional, national or international. A score between 1 and 5 will be assigned as appropriate (with a score of 1 being low – likely to affect a relatively small segment of a widespread population - and a score of 5 being high – likely to affect a relatively large segment of a localized population).

The **duration**, where it will be indicated whether: the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1; the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2; medium-term (5–15 years) – assigned a score of 3; long term (> 15 years) - assigned a score of 4; or permanent - assigned a score of 5.

The **magnitude**, quantified on a scale from 0-10, where a score is assigned: 0 is small and will have no effect on the environment; 2 is minor and will not result in an impact on processes; 4 is low and will cause a slight impact on processes; 6 is moderate and will result in processes continuing but in a modified way; 8 is high (processes are altered to the extent that they temporarily cease); and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.

The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale, and a score of 1-5 assigned where: 1 is very improbable (probably will not happen); 2 is improbable (some possibility, but low likelihood); 3 is probable (distinct possibility); 4 is highly probable (most likely); 5 is definite (impact will occur regardless of any prevention measures).

The **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high. The relevant formula is: Significance weighting = (Extent + Duration + Magnitude) x Probability. Low: <30 points (i.e. where this impact would not have a direct influence on the decision to develop in the area), Medium: 30-60 points (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated), or High: >60 points (i.e. where the impact must have an influence on the decision process to develop in the area).

The **status**, which will be described as either positive, negative or neutral, the **reversibility** of the impact, and the nature and likely efficacy of proposed **mitigation**.

8. OUTLINE OF A PROPOSED MONITORING PROGRAMME

Objectives

The primary aims of this monitoring programme are:

(i) To determine the densities of birds resident within the impact area of the WEF before construction of the facility, and afterwards, once the facility is operational.

(ii) To document patterns of bird activity and movements in the vicinity of the proposed WEF before construction, and afterwards, once the facility is operational.

(iii) To monitor patterns of bird activity and movement in relation to weather conditions, time of day and season for at least a full calendar year after the WEF is commissioned.

(iv) To register and as far as possible document the circumstances surrounding of all avian collisions with the WEF turbines for at least a full calendar year after the facility becomes operational.

Bird density and activity monitoring should focus on rare and/or endemic, potentially disturbance or collision prone species, which occur with some regularity in the area (see TABLE 1). Ultimately, the study should provide much needed quantitative information on the affect of the WEF on the distribution and abundance of birds, and the actual risk it poses to the local avifauna, and serve to inform and improve mitigation measures to reduce this risk. It will also establish a precedent and a template for research and monitoring of avian impacts at possible, future Eskom wind farm sites in the region, including the second development phase of this installation, which will see the WEF expanded from an initial 50 operational turbines to a full complement of 100 units.

This programme outline is based substantially on those developed for both the Darling and the Klipheuwel wind power demonstration facilities (Jenkins 2003, Küyler 2004). The bulk of the work involved should be done by an expert ornithologist or under the supervision of such.

Monitoring protocols: Avian densities before and after

A set of at least 20 walk-transect routes, each of at least 1 km in length, should be established in the Strandveld/Sand Fynbos habitat within a 5 km radius of the WEF development site. Each of these should be walked at least once every two months over the six months preceding construction, and at least once every two months over the same calendar period, at least six months after the WEF is commissioned. The transects should be walked after 06h00 and before 09h00, and the species, number and perpendicular distance from the transect line of all birds seen should be recorded for subsequent analysis and comparison. In addition, and in the same field visits to the area, numbers of seabirds aggregated at points along the rocky shoreline around Cliff Point, and numbers of key waterbirds present at selected count sites at the Olifants River Estuary (e.g. one site at the mouth, and one at the Papendorp Salt works) should also be recorded.

Monitoring protocols: Bird activity monitoring

Monitoring of bird activity in the vicinity of the WEF should be done over a 2-3 day period at least every two months for the six months preceding construction, and at least once per quarter for a full calendar year starting at least six months after the WEF is commissioned. Each monitoring day should involve:

(i) Half-day counts of all priority species flying over or past the WEF impact area (see passage rates below)

(ii) Counts of priority waterbird species aggregated at any and all waterbodies in the general area of the facility (see waterbird counts below), including the Olifants River Mouth and the seabird colonies around Cliff Point.

(iii) Opportunistic surveys of raptors and Ludwig's Bustards seen when travelling to and from these sites (see waterbird counts below).

Monitoring protocols: Passage rates of priority bird species

Counts of bird traffic over and around the proposed/operational WEF should be conducted from suitable vantage points (and a number of these should be selected and used to provide coverage of avian flights in relation to all areas of the WEF), and extend alternately from dawn to midday, or from midday to dusk, so that the equivalent of four full days of counts is completed each count period. This should provide an adequate (if minimal) sample of bird movements around the facility in relation to a representative cross-section of conditions and times of day, for all seasons of the year.

Once in position at the selected count station, the observer should record (preferably on a specially designed data sheet) the date, count number, start-time and conditions at start - extent of cloud cover, temperature, wind velocity and visibility – and proceed with the count. The counts should detail all individuals or flocks of the stipulated priority bird species, all raptors, and any additional species of particular interest or conservation concern, seen flying within 500 m of the envisaged or actual periphery of WEF. Each record should include the following data: time, updated weather assessment, species, number, mode of flight (flapping, gliding, soaring), flight activity (commuting, hunting other), direction of flight, vertical zoning relative to the envisaged or actual turbine string (low – below or within the rotor arc, medium – within *c.*100 m of the upper rotor arc, high – >100 m above the upper rotor arc), and horizontal zoning relative to the envisaged or actual turbine string (near – through the turbine string or within the outer rotor arc, middle – within *c.*100 m of the outer rotor arc, distant - >100 m beyond the outer rotor arc) and, for post construction monitoring, notes on any obvious evasive behaviour or flight path changes observed in response to the WEF. The time and weather conditions should again be noted at the end of each count.

Monitoring protocols: Waterbird counts

These counts should be done at any significant wetland within a 15-20 km radius of the WEF, but particularly at a minimum of two count points at the Olifants River Mouth. All priority species, and any other birds of conservation significance, seen attending these sites should be counted, and the number and location of all Ludwig's Bustards, all raptors, and any other priority species encountered while driving to and from surveyed areas should also be noted. Waterbird and associated counts should be conducted on the mornings before or the afternoons after passage rate counts at the wind farm site.

Monitoring of avian collisions

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

Monitoring of avian collisions: 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 (Morrison 2002). To do this, a sample of suitable bird carcasses (of similar size and colour to the priority species – e.g. Egyptian Goose *Alopochen aegyptiacus*, domestic waterfowl and pigeons) should be obtained and distributed randomly around the site without the knowledge of the surveyor, some time before the site is surveyed. This process should be repeated opportunistically (as and when suitable bird carcasses become available) for the first two months of the monitoring period, with the total number of carcasses not less than 20. The proportion of the carcasses located in surveys will indicate the relative efficiency of the survey method.

Simultaneous to this process, the condition and presence of all the carcasses positioned on the site should be monitored throughout the initial two-month period, to determine the rates at which carcassess are scavenged from the area, or decay to the point that they are no longer obvious to the surveyor. This should 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 (Osborn *et al.* 2000, Morrison 2002). Scavenger numbers and activity in the area may vary seasonally so, ideally, scavenge and decomposition rates should be measured twice during the monitoring year, once in winter and once in summer.

Monitoring of collisions: Collision victim surveys

The area within a radius of at least 50 m of each of the turbines at the facility should be checked regularly for bird casualties (Anderson *et al.* 1999, Morrison 2002). The frequency of these surveys should be informed by assessments of scavenge and decomposition rates conducted in the initial stages of the monitoring period (see above), but they should be done at least weekly for the first two months of the study. The area around each turbine, or a larger area encompassing the entire WEF, should be divided into quadrants, and each should be carefully and methodically searched for any sign of a bird collision incident (carcasses, dismembered body parts, scattered feathers, injured birds). All suspected collision incidents should be comprehensively documented, detailing the precise location (preferably a GPS reading), date and time at which the evidence was found, and the site of the find should be photographed with all the evidence *in situ*. All physical evidence should then be collected, bagged and carefully labelled, and refrigerated or frozen to await further examination. If any injured birds are recovered, these should be contained, and 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).

9. IMPACT STATEMENT & CONCLUSIONS

The proposed WEF will probably have limited negative impacts on the avifauna in the surrounding area. The summary table of impacts (APPENDIX 3) lists only one moderate-highly significant, taxon-specific impact (Ludwig’s Bustard collisions with both the turbine blades and the 132 kV power line) and 25 moderately significant taxon-specific impacts, all of which have effective mitigation available. The threat of collision with the turbine blades is probably the most concerning issue, but the real extent of this threat is not currently well understood (see below). Unlike more problematic wind energy facilities identified in other parts of the world (possibly including the facility about to be constructed at Darling), this wind farm is not positioned overly close to any known avian fly-ways, and does not otherwise impose on a particularly bird-rich environment, so it is unlikely to result in significant numbers of avian casualties through collision with the turbine blades, or cause undue loss of habitat or disturbance to any locally, regionally or nationally important bird populations.

However, it is ESSENTIAL that the WEF:bird interactions which do take place with the establishment of the facility be fully documented, and that every opportunity to learn about birds and wind farms in the South African environment is fully exploited. To this end, the initiation of a comprehensive before-and-after monitoring programme, and a longer term scheme for surveying bird movements in relation to the WEF and fully documenting all collision casualties, is absolutely critical. Such a monitoring programme will also inform and refine any post-construction mitigation of impacts which might ultimately be required.

10. REFERENCES

Acha, A. 1997. Negative impact of wind generators on the Eurasian Griffon *Gyps fulvus* in Tarifa, Spain. *Vulture News* 38:10-18

Allan, D.G. 1994. The abundance and movements of Ludwig's Bustard. *Ostrich* 65:95-105.

Anderson, R., Morrison, M., Sinclair, K. & Strickland, D. 1999. Studying wind energy/bird interactions: a guidance document. National Wind Coordinating Committee, Washington.

Anderson, M.D. 2001. The effectiveness of two different marking devices to reduce large terrestrial bird collisions with overhead electricity cables in the eastern Karoo, South Africa. Draft report to Eskom Resources and Strategy Division. Johannesburg. South Africa.

Australian Wind Energy Association www.auswea.com.au (accessed 25/04/07)

Avian Literature Database – National Renewable Energy Laboratory – www.nrel.gov

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

Barclay, R.M.R, Baerwald, E.F. & Gruver, J.C. 2007. Variation in bat and bird fatalities at wind energy facilities: assessing the effects of rotor size and tower height. *Canadian Journal of Zoology* 85: 381-387.

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

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

Cade, T.J. 1994. Industry research: Kenetech Windpower. In: Proceedings of the National Avian-Wind Power Planning Meeting, 1994.

Colson & associates 1995. Avian interaction with wind energy facilities: a summary. Prepared for the American Wind Energy Association. Washington DC

Crockford, N.J. 1992. A review of the possible impacts of wind farms on birds and other wildlife. Joint Nature Conservation Committee. JNCC Report number 27. Peterborough. United Kingdom

Cumberland Times

Curry & Kerlinger, LCC www.currykerlinger.com (accessed 27/04/07)

Curry, R.C., & Kerlinger, P. 2000. Avian mitigation plan: Kenetech model wind turbines, Altamont Pass WRA, California. In: Proceedings of the National Avian-Wind Power Planning Meeting III, San Diego California, May 1998.

Curtis, O., Simmons, R.E. & Jenkins, A.R. 2004. Black Harrier *Circus maurus* of the Fynbos biome, South Africa: a threatened specialist or an adaptable survivor. *Bird Conservation International* 14:233-245.

Desholm, M. & Kahlert, J. 2005. Avian collision risk at an offshore wind farm. *Biology Letters* 1: 296-298.

Erickson, W.P., Johnson, G.D., Strickland, M.D., Kronner, K., & Bekker, P.S. 1999. Baseline avian use and behaviour at the CARES wind plant site, Klickitat county, Washington. Final Report. Prepared for the National Renewable Energy Laboratory.

Erickson, W.P., Johnson, G.D., Strickland, M.D., Young, D.P., Sernka, K.J., Good, R.E. 2001. Avian collisions with wind turbines: a summary of existing studies and comparison to other sources of avian collision mortality in the United States. National Wind Co-ordinating Committee Resource Document.

Erickson, W.P., Johnson, G.D., Strickland, M.D., Young, Good, R., Bourassa, M., & Bay, K. 2002. Synthesis and comparison of baseline avian and bat use, raptor nesting and mortality from proposed ans existing wind developments. Prepared for Bonneville Power Administration.

European Wind Energy Association www.ewea.org (accessed 27/04/07)

Everaert, J. 2003. Wind turbines and birds in Flanders: Preliminary study results and recommendations. *Natuur. Oriolus* 69: 145-155

German Wind Energy Association – www.wind-energie.de

Gill, J.P., Townsley, M. & Mudge, G.P. 1996. Review of the impact of wind farms and other aerial structures upon birds. *Scottish Natural Heritage Review* 21.

Hanowski, J.M., & Hawrot, R.Y. 2000. Avian issues in development of wind energy in western Minnesota. In Proceedings of the National Avian-Wind Power Planning Meeting III, San Diego California, May 1998.

Harrison, J.A., Allan, 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.

Hockey, P.A.R., Dean, W.R.J., Ryan, P.G. (Eds) 2005. Roberts – Birds of Southern Africa, VIIth ed. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

Hodos, W. 2002. Minimization of motion smear: Reducing avian collisions with turbines. Unpublished subcontractor report to the National Renewable Energy Laboratory. NREL/SR 500-33249

Howell, J.A. 1995. Avian mortality at rotor sweep areas equivalents Altamont Pass and Montezuma Hills, California. Prepared for Kenetech Wind Power, San Francisco, California.

http://www.wave- guide.org/archives/waveguide_3/birdkill.html.

Hunt, W.G. 2002. Golden Eagles in a perilous landscape: predicting the effects of migration for wind turbine blade strike mortality. Report to the California Energy Commission. Pier grant number 500-97-4033 to the University of California.

Huppop, O., Dierschke, J., Exo, K.M., Fredrich, E. & Hill, R. 2006. Bird migration studies and potential collision risk with offshore wind turbines. *Ibis* 148: 90-109.

Janss, G. 2000. Bird behaviour in and near a wind farm at Tarifa, Spain: Management considerations. In Proceedings of National Avian-Wind Power Planning Meeting III, San Diego California, May 1998

Jaroslow, B. 1979. A review of factors involved in bird-tower kills, and mitigation procedures. In: G.A. Swanson (Tech co-ord). The Mitigation symposium. A national workshop on mitigation losses of Fish and Wildlife Habitats. US Forest Service General Technical Report. RM-65.

Jenkins, A.R. 2001. The potential impact of a demonstration wind farm facility on the birds of the Darling / Yzerfontein area, Western Cape Province, South Africa. Unpublished report to the Environmental Evaluation Unit, University of Cape Town, Cape Town.

Jenkins, A.R. 2003. Populations and movements of priority bird species in the vicinity of the proposed Darling Demonstration Wind Farm facility. Unpublished report to the Environmental Evaluation Unit, University of Cape Town, Cape Town.

Karlsson. 1983. as cited in Winkelman 1995.

Kemper, C.A. 1964. A tower for TV: 30 000 dead birds. *Audubon Magazine* 66: 86-90

Kerlinger, P. 2001. Avian issues and potential impacts associated with wind power development of near shore waters of Long Island, New York. Prepared for Bruce Bailey, AWS Scientific.

Kerlinger, P. 2003. Addendum to the Phase I avian risk assessment for the Flat Rock Wind Power Project, Lewis County, New York: Phase One and Phase Two. March 31, 2003. Report to Flat Rock Wind Power, L.L.C

Kerlinger, P. & Dowdell, J. 2003. Breeding bird survey for the Flat Rock wind power project, Lewis County, New York. Prepared for Atlantic Renewable Energy Corporation.

Kingsley, A & Whittam, B. 2005. Wind turbines and birds – A background review for environmental assessment. Unpublished report for Environment Canada/Canadina Wildlife Service.

Küyler , E.J. 2004. The impact of the Eskom Wind Energy Demonstration Facility on local avifauna – Results from the monitoring programme for the time period June 2003 to Jan 2004. Unpublished report to Eskom Peaking Generation.

Larsen, J.K. & Guillemette, M. 2007. Effects of wind turbines on flight behaviour of wintering common eiders: implications for habitat use and collision risk. *Journal of Applied Ecology* 44: 516-522.

Madders, M. & Whitfield, D.P. 2006. Upland raptors and the assessment of wind farms impacts. *Ibis* 148: 43-56.

McIsaac, H.P. 2001. Raptor acuity and wind turbine blade conspicuity. Pp. 59-87. National Avian-Wind Power Planning Meeting IV, Proceedings. Prepared by Resolve, Inc., Washington DC.

Morrison, M.L. 1998. Avian risk and fatality protocol. National Renewable Energy Report SR-500-24997. NREL, Colorado.

Morrison, M.L. 2002. Searcher bias and scavenging rates in bird/wind energy studies. National Renewable Energy Report SR-500-30876. NREL, Colorado.

Mucina. L. & Rutherford, M.C. (Eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

National Wind Co-ordinating Committee. 2004. Wind turbine interactions with birds and bats: A summary of research results and remaining questions. Fact Sheet Second Edition.

New Zealand Wind Energy Association www.windenergy.org.nz (accessed 25/04/07)

Orloff, S., & Flannery, A. 1992. Wind turbine effects on avian activity, habitat use and mortality in Altamont Pass and Solano County Wind Resource Areas, 1989-1991. Prepared by Biosystems Analysis Inc, Tiburon, California. Prepared for the California Energy Commission, Sacramento, Grant 990-89-003.

Osborn, R.G, Higgins, K.F., Usgaard, R.E., Dieter, C.D. & Nieger, R.D. 2000. Bird mortality associated with wind turbines at the Buffalo Ridge wind resource area, Minnesota. *Amer. Midland Naturalist* 143:41-52.

Richardson, W.J. 2000. Bird migration and wind turbines: Migration timing, flight behaviour and collision risk. In Proceedings of the National Avian-wind Power Planning Meeting III, San Diego, California, May 1998.

Smit, I. 2007. Personal communication. Eskom Research and Innovation Department, Eskom Resources and Strategy Group.

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.

Van Rooyen, C. 2001. Bird Impact Assessment Study – Eskom Wind Energy Demonstration Facility, Western Cape South Africa. Prepared for Eskom Enterprises, TSI Division.

Van Rooyen, C.S. 2004a. 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.

Van Rooyen, C.S. 2004b. Investigations into vulture electrocutions on the Edwardsdam-Mareetsane 88kV feeder, Unpublished report, Endangered Wildlife Trust, Johannesburg.

Weir, R. D. 1976. Annotated bibliography of bird kills at manmade obstacles: a review of the state of the art and solutions. Canadian Wildlife Services, Ontario Region, Ottawa.

Winkelman, J.E. 1995. Bird/wind turbine investigations in Europe. In Proceedings of the National Avian- wind Power Planning Meeting 1994.

APPENDIX 1. PHOTOGRAPHS OF KEY AVIAN MICROHABITATS

A: Mix of pristine and degraded open Strandveld adjacent to the Lutzville-Skilpadsvlei road. Typical Ludwig's Bustard habitat.

B: Papendorp Salt Works, within the area of the Olifants River Estuary and close to the Mouth. An important area for both Greater and Lesser Flamingoes.

C: The rocky coastline at Cliff Point, which supports numbers of breeding Cape and White-breasted Cormorants.

APPENDIX 2. Annotated list of bird species likely to occur in the impact area of the WEF and its associated infrastructure.

				Preferred habitat					Susceptibility to:		
Common name	**Scientific name**	**Conservation status**	**Regional endemicity**	**Strandveld & Sand Fynbos**	**Wetlands**	**Rocky coastline**	**Alien trees**	**Cultivated lands**	**Collision**	**Electro-cution**	**Disturbance and habitat loss**
Common Ostrich	*Struthio camelus*	-	-	X				X	-	-	moderate
Grey-winged Francolin	*Scleroptila africanus*	-	Endemic	X	X			X	moderate	-	
Cape Spurfowl	*Pternistis capensis*	-	Endemic	X					moderate	-	moderate
Common Quail	*Coturnix coturnix*	-	-		X			X		-	moderate
Helmeted Guineafowl	*Numida meleagris*	-	-		X		X	X	moderate	-	moderate
Maccoa Duck	*Oxyura maccoa*	-	-		X				moderate	-	-
Egyptian Goose	*Alopochen aegyptiaca*	-	-		X				high	high	-
South African Shelduck	*Tadorna cana*	-	Endemic		X				high	-	-
Spur-winged Goose	*Plectropterus gambensis*	-	-		X				high	high	-
Cape Teal	*Anas capensis*	-	-		X				moderate	-	-
African Black Duck	*Anas sparsa*	-	-		X				moderate	-	-
Mallard	*Anas platyrhynchos*	-	-		X				moderate	-	-
Yellow-billed Duck	*Anas undulata*	-	-		X				moderate	-	-
Cape Shoveler	*Anas smithii*	-	Endemic		X				moderate	-	-
Red-billed Teal	*Anas erythrorhyncha*	-	-		X				moderate	-	-
Southern Pochard	*Netta erythrophthalma*	-	-		X				moderate	-	-
Greater Honeyguide	*Indicator indicator*	-	-				X		-	-	moderate
Ground Woodpecker	*Geocolaptes olivaceus*	-	Endemic	X		X			-	-	moderate
Cardinal Woodpecker	*Dendropicos fuscescens*	-	-				X		-	-	moderate
Acacia Pied Barbet	*Tricholaema leucomelas*	-	Near-endemic				X		-	-	moderate
African Hoopoe	*Upupa africana*	-	-				X	X	-	-	moderate
Malachite Kingfisher	*Alcedo cristata*	-	-		X				-	-	moderate
Giant	*Megaceryle*	-	-		X				-	-	moderate

				Preferred habitat					Susceptibility to:		
Common name	**Scientific name**	**Conservation status**	**Regional endemicity**	**Strandveld & Sand Fynbos**	**Wetlands**	**Rocky coastline**	**Alien trees**	**Cultivated lands**	**Collision**	**Electro-cution**	**Disturbance and habitat loss**
Common Ostrich	*Struthio camelus*	-	-	X				X	-	-	moderate
Kingfisher	*maximus*										
Pied Kingfisher	*Ceryle rudis*	-	-		X				-	-	moderate
European Bee-eater	*Merops apiaster*	-	-	X	X				-	-	moderate
White-backed Mousebird	*Colius colius*	-	Endemic	X					-	-	moderate
Speckled Mousebird	*Colius striatus*	-	-	X					-	-	moderate
Red-faced Mousebird	*Urocolius indicus*	-	-	X					-	-	moderate
Klaas's Cuckoo	*Chrysococcyx klaas*	-	-	X			X		-	-	-
Diderick Cuckoo	*Chrysococcyx caprius*	-	-	X			X		-	-	-
Burchell's Coucal	*Centropus burchellii*	-	-		X				-	-	moderate
Alpine Swift	*Tachymarptis melba*	-	-	X		X			-	-	-
Common Swift	*Apus apus*	-	-	X	X	X	X	X	-	-	-
African Black Swift	*Apus barbatus*	-	-	X		X			-	-	-
Little Swift	*Apus affinis*	-	-				X	X	-	-	-
Horus Swift	*Apus horus*	-	-	X	X				-	-	-
White-rumped Swift	*Apus caffer*	-	-		X		X	X	-	-	-
Barn Owl	*Tyto alba*	-	-	X		X	X	X	-	moderate	moderate
Cape Eagle-Owl	*Bubo capensis*	-	-			X			-	high	moderate
Spotted Eagle-Owl	*Bubo africanus*	-	-	X		X	X	X	-	high	moderate
Fiery-necked Nightjar	*Caprimulgus pectoralis*	-	-	X	X		X		-	-	moderate
Freckled Nightjar	*Caprimulgus tristigma*	-	-			X			-	-	moderate
Rufous-cheeked Nightjar	*Caprimulgus rufigena*	-	-	X			X		-	-	moderate
Rock Dove	*Columba livia*	-	-			X		X	-	-	-
Speckled Pigeon	*Columba guinea*	-	-			X		X	-	-	-

				Preferred habitat					Susceptibility to:		
Common name	**Scientific name**	**Conservation status**	**Regional endemicity**	**Strandveld & Sand Fynbos**	**Wetlands**	**Rocky coastline**	**Alien trees**	**Cultivated lands**	**Collision**	**Electro-cution**	**Disturbance and habitat loss**
Common Ostrich	*Struthio camelus*	-	-	X				X	-	-	moderate
Laughing Dove	*Streptopelia senegalensis*	-	-	X				X	-	-	moderate
Cape Turtle-Dove	*Streptopelia capicola*	-	-	X			X	X	-	-	moderate
Red-eyed Dove	*Streptopelia semitorquata*	-	-		X		X	X	-	-	moderate
Namaqua Dove	*Oena capensis*	-	-	X				X	-	-	moderate
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable	Near-endemic	X				X	high	-	moderate
Kori Bustard	*Ardeotis kori*	Vulnerable	-	X					high	-	moderate
Southern Black Korhaan	*Afrotis afra*	-	Endemic	X				X	moderate	-	moderate
Karoo Korhaan	*Eupodotis vigorsii*	-	Endemic	X					moderate	-	moderate
Blue Crane	*Anthropoides paradiseus*	Vulnerable	Endemic	X	X			X	high	-	moderate
Red-chested Flufftail	*Sarothrura rufa*	-	-		X				-	-	moderate
African Rail	*Rallus caerulescens*	-	-		X				-	-	-
Black Crake	*Amaurornis flavirostris*	-	-		X				-	-	-
African Purple Swamphen	*Porphyrio madagascariensis*	-	-		X				-	-	-
Common Moorhen	*Gallinula chloropus*	-	-		X				-	-	-
Red-knobbed Coot	*Fulica cristata*	-	-		X				-	-	-
Namaqua Sandgrouse	*Pterocles namaqua*	-	Near-endemic	X				X	-	-	-
African Snipe	*Gallinago nigripennis*	-	-		X				-	-	moderate
Bar-tailed Godwit	*Limosa lapponica*	-	-		X				-	-	-
Common Whimbrel	*Numenius phaeopus*	-	-		X	X			-	-	-
Eurasian Curlew	*Numenius arquata*	-	-		X	X			-	-	-
Marsh Sandpiper	*Tringa stagnatilis*	-	-		X				-	-	-
Common Greenshank	*Tringa nebularia*	-	-		X				-	-	-

				Preferred habitat					Susceptibility to:		
Common name	**Scientific name**	**Conservation status**	**Regional endemicity**	**Strandveld & Sand Fynbos**	**Wetlands**	**Rocky coastline**	**Alien trees**	**Cultivated lands**	**Collision**	**Electro-cution**	**Disturbance and habitat loss**
Common Ostrich	*Struthio camelus*	-	-	X				X	-	-	moderate
Wood Sandpiper	*Tringa glareola*	-	-		X				-	-	-
Terek Sandpiper	*Xenus cinereus*	-	-		X				-	-	-
Common Sandpiper	*Actitis hypoleucos*	-	-		X				-	-	-
Ruddy Turnstone	*Arenaria interpres*	-	-		X	X			-	-	-
Red Knot	*Calidris canutus*	-	-		X	X			-	-	-
Sanderling	*Calidris alba*	-	-		X	X			-	-	-
Little Stint	*Calidris minuta*	-	-		X	X			-	-	-
Curlew Sandpiper	*Calidris ferruginea*	-	-		X	X			-	-	-
Ruff	*Philomachus pugnax*	-	-		X				-	-	-
Wilson's Phalarope	*Steganopus tricolor*	-	-		X				-	-	-
Red-necked Phalarope	*Phalaropus lobatus*	-	-		X				-	-	-
Red Phalarope	*Phalaropus fulicaria*	-	-		X				-	-	-
Greater Painted-snipe	*Rostratula benghalensis*	Near-threatened	-		X				-	-	moderate
African Jacana	*Actophilornis africanus*	-	-		X				-	-	-
Water Thick-knee	*Burhinus vermiculatus*	-	-		X				-	-	moderate
Spotted Thick-knee	*Burhinus capensis*	-	-	X				X	-	-	moderate
African Black Oystercatcher	*Haematopus moquini*	Near-threatened	Endemic		X	X			-	-	-
Black-winged Stilt	*Himantopus himantopus*	-	-		X				-	-	-
Pied Avocet	*Recurvirostra avosetta*	-	-		X				-	-	-
Grey Plover	*Pluvialis squatarola*	-	-		X	X			-	-	-
Common Ringed Plover	*Charadrius hiaticula*	-	-		X	X			-	-	-
Kittlitz's Plover	*Charadrius pecuarius*	-	-		X			X	-	-	-
Three-banded Plover	*Charadrius tricollaris*	-	-		X				-	-	-

				Preferred habitat					Susceptibility to:		
Common name	**Scientific name**	**Conservation status**	**Regional endemicity**	**Strandveld & Sand Fynbos**	**Wetlands**	**Rocky coastline**	**Alien trees**	**Cultivated lands**	**Collision**	**Electro-cution**	**Disturbance and habitat loss**
Common Ostrich	*Struthio camelus*	-	-	X				X	-	-	moderate
Chestnut-banded Plover	*Charadrius pallidus*	Near-threatened	-		X				-	-	-
White-fronted Plover	*Charadrius marginatus*	-	-		X	X			-	-	-
Lesser Sand Plover	*Charadrius mongolus*	-	-		X				-	-	-
Greater Sand Plover	*Charadrius leschenaultii*	-	-		X				-	-	-
Blacksmith Lapwing	*Vanellus armatus*	-	-		X				-	-	-
Crowned Lapwing	*Vanellus coronatus*	-	-					X	-	-	moderate
Double-banded Courser	*Rhinoptilus africanus*	-	-					X	-	-	moderate
Subantarctic Skua	*Catharacta antarctica*	-	-			X			-	-	-
South Polar Skua	*Catharacta maccormicki*	-	-			X			-	-	-
Parasitic Jaeger	*Stercorarius parasiticus*	-	-			X			-	-	-
Kelp Gull	*Larus dominicanus*	-	-			X			-	moderate	-
Grey-headed Gull	*Larus cirrocephalus*	-	-		X	X			-	-	-
Hartlaub's Gull	*Larus hartlaubii*	-	Endemic		X	X			-	-	-
Caspian Tern	*Sterna caspia*	Near-threatened	-		X				-	-	-
Swift Tern	*Sterna bergii*	-	-		X	X			-	-	-
Sandwich Tern	*Sterna sandvicensis*	-	-		X	X			-	-	-
Common Tern	*Sterna hirundo*	-	-		X	X			-	-	-
Arctic Tern	*Sterna paradisaea*	-	-			X			-	-	-
Antarctic Tern	*Sterna vittata*	-	-			X			-	-	-
Little Tern	*Sterna albifrons*	-	-		X	X			-	-	-
Damara Tern	*Sterna balaenarum*	Endangered	-			X			-	-	-
White-winged Tern	*Chlidonias leucopterus*	-	-		X				-	-	-
Osprey	*Pandion haliaetus*	-	-		X				-	moderate	-
Black-	*Elanus caeruleus*	-	-	X			X	X	-	-	moderate

				Preferred habitat					Susceptibility to:		
Common name	**Scientific name**	**Conservation status**	**Regional endemicity**	**Strandveld & Sand Fynbos**	**Wetlands**	**Rocky coastline**	**Alien trees**	**Cultivated lands**	**Collision**	**Electro-cution**	**Disturbance and habitat loss**
Common Ostrich	*Struthio camelus*	-	-	X				X	-	-	moderate
shouldered Kite											
Black Kite	*Milvus migrans*	-	-	X			X	X	-	-	-
African Fish-Eagle	*Haliaeetus vocifer*	-	-		X				-	high	-
Black-chested Snake-Eagle	*Circaetus pectoralis*	-	-	X					-	moderate	moderate
African Marsh-Harrier	*Circus ranivorus*	Vulnerable	-	X	X			X	-	-	moderate
Black Harrier	*Circus maurus*	Near-threatened	Endemic	X	X			X	-	-	moderate
Pallid Harrier	*Circus macrourus*	Near-threatened	-	X	X			X	-	-	-
Montagu's Harrier	*Circus pygargus*	-	-	X	X			X	-	-	-
African Harrier-Hawk	*Polyboroides typus*	-	-				X		-	-	-
Southern Pale Chanting Goshawk	*Melierax canorus*	-	Near-endemic	X					-	moderate	moderate
Gabar Goshawk	*Melierax gabar*	-	-				X		-	-	moderate
Black Sparrowhawk	*Accipiter melanoleucus*	-	-				X		-	-	moderate
Steppe Buzzard	*Buteo vulpinus*	-	-	X			X	X	-	moderate	-
Jackal Buzzard	*Buteo rufofuscus*	-	Endemic	X		X	X	X	-	moderate	moderate
Tawny Eagle	*Aquila rapax*	Vulnerable	-	X					-	high	moderate
Verreauxs' Eagle	*Aquila verreauxii*	-	-			X			moderate	high	-
Booted Eagle	*Aquila pennatus*	-	-	X			X	X	-	-	-
Martial Eagle	*Polemaetus bellicosus*	Vulnerable	-	X			X		moderate	high	moderate
Secretarybird	*Sagittarius serpentarius*	Near-threatened	-	X				X	high	-	moderate
Lesser Kestrel	*Falco naumanni*	Vulnerable	-	X			X	X	-	-	moderate
Rock Kestrel	*Falco rupicolus*	-	-	X		X		X	-	-	moderate
Greater Kestrel	*Falco rupicoloides*	-	-	X					-	-	moderate
Lanner Falcon	*Falco biarmicus*	Near-threatened	-	X		X		X	high	moderate	moderate

				Preferred habitat					Susceptibility to:		
Common name	**Scientific name**	**Conservation status**	**Regional endemicity**	**Strandveld & Sand Fynbos**	**Wetlands**	**Rocky coastline**	**Alien trees**	**Cultivated lands**	**Collision**	**Electro-cution**	**Disturbance and habitat loss**
Common Ostrich	*Struthio camelus*	-	-	X				X	-	-	moderate
Peregrine Falcon	*Falco peregrinus*	Near-threatened	-	X		X		X	high	moderate	-
Little Grebe	*Tachybaptus ruficollis*	-	-		X				-	-	-
Great Crested Grebe	*Podiceps cristatus*	-	-		X				-	-	-
Black-necked Grebe	*Podiceps nigricollis*	-	-		X				-	-	-
Cape Gannet	*Morus capensis*	Vulnerable	Breeding endemic			X			-	-	-
African Darter	*Anhinga rufa*	-	-		X				-	-	-
Reed Cormorant	*Phalacrocorax africanus*	-	-		X				-	-	-
Crowned Cormorant	*Phalacrocorax coronatus*	Near-threatened	Endemic			X			-	-	-
White-breasted Cormorant	*Phalacrocorax lucidus*	-	-		X	X			-	moderate	-
Bank Cormorant	*Phalacrocorax neglectus*	Vulnerable	Endemic			X			-	-	-
Cape Cormorant	*Phalacrocorax capensis*	Near-threatened	Breeding endemic			X			-	-	-
Little Egret	*Egretta garzetta*	-	-		X	X			-	-	-
Yellow-billed Egret	*Egretta intermedia*	-	-		X				-	-	-
Great Egret	*Egretta alba*	-	-		X				-	-	-
Grey Heron	*Ardea cinerea*	-	-		X				-	moderate	-
Black-headed Heron	*Ardea melanocephala*	-	-		X			X	-	moderate	moderate
Purple Heron	*Ardea purpurea*	-	-		X				-	-	-
Cattle Egret	*Bubulcus ibis*	-	-		X			X	-	-	-
Black-crowned Night-Heron	*Nycticorax nycticorax*	-	-		X				-	-	-
Little Bittern	*Ixobrychus minutus*	-	-		X				-	-	-
Hamerkop	*Scopus umbretta*	-	-		X				-	-	-
Greater Flamingo	*Phoenicopterus ruber*	Near-threatened	-		X				high	-	-
Lesser Flamingo	*Phoenicopterus minor*	Near-threatened	-		X				high	-	-
Glossy Ibis	*Plegadis falcinellus*	-	-		X				-	-	-

				Preferred habitat					Susceptibility to:		
Common name	**Scientific name**	**Conservation status**	**Regional endemicity**	**Strandveld & Sand Fynbos**	**Wetlands**	**Rocky coastline**	**Alien trees**	**Cultivated lands**	**Collision**	**Electro-cution**	**Disturbance and habitat loss**
Common Ostrich	*Struthio camelus*	-	-	X				X	-	-	moderate
Hadeda Ibis	*Bostrychia hagedash*	-	-		X		X	X	-	-	-
African Sacred Ibis	*Threskiornis aethiopicus*	-	-		X			X	-	-	-
African Spoonbill	*Platalea alba*	-	-		X				-	-	-
Great White Pelican	*Pelecanus onocrotalus*	Near-threatened	-		X				high	-	-
Black Stork	*Ciconia nigra*	Near-threatened	-		X			X	high	moderate	-
White Stork	*Ciconia ciconia*	-	-	X	X			X	high	high	-
Fork-tailed Drongo	*Dicrurus adsimilis*	-	-				X		-	-	moderate
Bokmakierie	*Telophorus zeylonus*	-	Near-endemic	X					-	-	moderate
Pririt Batis	*Batis pririt*	-	Near-endemic	X					-	-	moderate
Cape Crow	*Corvus capensis*	-	-	X			X	X	-	-	moderate
Pied Crow	*Corvus albus*	-	-	X			X	X	-	-	moderate
White-necked Raven	*Corvus albicollis*	-	-	X		X	X	X	-	-	-
Red-backed Shrike	*Lanius collurio*	-	-	X					-	-	-
Common Fiscal	*Lanius collaris*	-	-	X			X	X	-	-	moderate
Cape Penduline-Tit	*Anthoscopus minutus*	-	Near-endemic	X					-	-	moderate
Grey Tit	*Parus afer*	-	Endemic	X					-	-	moderate
Sand Martin	*Riparia riparia*	-	-		X				-	-	-
Brown-throated Martin	*Riparia paludicola*	-	-		X				-	-	moderate
Banded Martin	*Riparia cincta*	-	-	X	X				-	-	-
Barn Swallow	*Hirundo rustica*	-	-	X	X			X	-	-	-
White-throated Swallow	*Hirundo albigularis*	-	-		X				-	-	moderate
Pearl-breasted Swallow	*Hirundo dimidiata*	-	-	X	X				-	-	moderate
Greater Striped Swallow	*Hirundo cucullata*	-	-	X	X			X	-	-	moderate
Rock Martin	*Hirundo fuligula*	-	-			X			-	-	moderate

				Preferred habitat					Susceptibility to:		
Common name	**Scientific name**	**Conservation status**	**Regional endemicity**	**Strandveld & Sand Fynbos**	**Wetlands**	**Rocky coastline**	**Alien trees**	**Cultivated lands**	**Collision**	**Electro-cution**	**Disturbance and habitat loss**
Common Ostrich	*Struthio camelus*	-	-	X				X	-	-	moderate
Cape Bulbul	*Pycnonotus capensis*	-	Endemic	X					-	-	moderate
Fairy Flycatcher	*Stenostira scita*	-	Endemic	X					-	-	moderate
Cape Grassbird	*Sphenoeacus afer*	-	Endemic	X					-	-	moderate
Long-billed Crombec	*Sylvietta rufescens*	-	-	X					-	-	moderate
Yellow-bellied Eremomela	*Eremomela icteropygialis*	-	-	X					-	-	moderate
Karoo Eremomela	*Eremomela gregalis*	-	Endemic	X					-	-	moderate
Little Rush-Warbler	*Bradypterus baboecala*	-	-		X				-	-	moderate
African Reed-Warbler	*Acrocephalus baeticatus*	-	-		X				-	-	moderate
Greater Swamp-Warbler	*Acrocephalus rufescens*	-	-		X				-	-	moderate
Lesser Swamp-Warbler	*Acrocephalus gracilirostris*	-	-		X				-	-	moderate
Layard's Tit-Babbler	*Parisoma layardi*	-	Endemic	X					-	-	moderate
Chestnut-vented Tit-Babbler	*Parisoma subcaeruleum*	-	Near-endemic	X					-	-	moderate
Cape White-eye	*Zosterops virens*	-	Endemic	X					-	-	moderate
Grey-backed Cisticola	*Cisticola subruficapilla*	-	Near-endemic	X					-	-	moderate
Levaillant's Cisticola	*Cisticola tinniens*	-	-	X	X				-	-	moderate
Zitting Cisticola	*Cisticola juncidis*	-	-					X	-	-	moderate
Cloud Cisticola	*Cisticola textrix*	-	Near-endemic					X	-	-	moderate
Karoo Prinia	*Prinia maculosa*	-	Endemic	X					-	-	moderate
Namaqua Warbler	*Phragmacia substriata*	-	Endemic		X				-	-	moderate
Rufous-eared Warbler	*Malcorus pectoralis*	-	Endemic	X					-	-	moderate
Bar-throated Apalis	*Apalis thoracica*	-	-	X					-	-	moderate

				Preferred habitat					Susceptibility to:		
Common name	**Scientific name**	**Conservation status**	**Regional endemicity**	**Strandveld & Sand Fynbos**	**Wetlands**	**Rocky coastline**	**Alien trees**	**Cultivated lands**	**Collision**	**Electro-cution**	**Disturbance and habitat loss**
Common Ostrich	*Struthio camelus*	-	-	X				X	-	-	moderate
Cape Clapper Lark	*Mirafra apiata*	-	Endemic	X				X	-	-	moderate
Karoo Lark	*Calendulauda albescens*	-	Endemic	X				X	-	-	moderate
Spike-heeled Lark	*Chersomanes albofasciata*	-	-	X				X	-	-	moderate
Cape Long-billed Lark	*Certhilauda curvirostris*	-	Endemic	X				X	-	-	moderate
Grey-backed Sparrowlark	*Eremopterix verticalis*	-	Near-endemic	X				X	-	-	moderate
Red-capped Lark	*Calandrella cinerea*	-	-	X				X	-	-	moderate
Large-billed Lark	*Galerida magnirostris*	-	Endemic	X				X	-	-	moderate
Cape Rock-Thrush	*Monticola rupestris*	-	Endemic			X			-	-	moderate
Sentinel Rock-Thrush	*Monticola explorator*	-	Endemic			X			-	-	moderate
Karoo Thrush	*Turdus smithi*	-	Endemic				X		-	-	moderate
Chat Flycatcher	*Bradornis infuscatus*	-	Near-endemic	X					-	-	moderate
Fiscal Flycatcher	*Sigelus silens*	-	Endemic	X			X		-	-	moderate
Spotted Flycatcher	*Mucicapa striata*	-	-				X		-	-	moderate
Cape Robin-Chat	*Cossypha caffra*	-	-	X			X		-	-	moderate
Karoo Scrub-Robin	*Cercotrichas coryphoeus*	-	Endemic	X					-	-	moderate
African Stonechat	*Saxicola torquatus*	-	-	X	X			X	-	-	moderate
Mountain Wheatear	*Oenanthe monticola*	-	Near-endemic	X		X			-	-	moderate
Capped Wheatear	*Oenanthe pileata*	-	-					X	-	-	moderate
Sickle-winged Chat	*Cercomela sinuata*	-	Endemic	X					-	-	moderate
Karoo Chat	*Cercomela schlegelii*	-	Near-endemic	X					-	-	moderate
Tractrac Chat	*Cercomela tractrac*	-	Near-endemic	X					-	-	moderate
Familiar Chat	*Cercomela familiaris*	-	-	X				X	-	-	moderate

				Preferred habitat					Susceptibility to:		
Common name	**Scientific name**	**Conservation status**	**Regional endemicity**	**Strandveld & Sand Fynbos**	**Wetlands**	**Rocky coastline**	**Alien trees**	**Cultivated lands**	**Collision**	**Electro-cution**	**Disturbance and habitat loss**
Common Ostrich	*Struthio camelus*	-	-	X				X	-	-	moderate
Ant-eating Chat	*Myrmecocichla formicivora*	-	Endemic	X					-	-	moderate
Red-winged Starling	*Onychognathus morio*	-	-	X		X		X	-	-	moderate
Pied Starling	*Spreo bicolor*	-	Endemic	X				X	-	-	moderate
Wattled Starling	*Creatophora cinerea*	-	-	X				X	-	-	moderate
Common Starling	*Sturnus vulgaris*	-	-					X	-	-	moderate
Malachite Sunbird	*Nectarinia famosa*	-	-	X			X		-	-	moderate
Southern Double-collared Sunbird	*Cinnyris chalybeus*	-	Endemic	X			X		-	-	moderate
Dusky Sunbird	*Cinnyris fuscus*	-	Near-endemic	X					-	-	moderate
Cape Weaver	*Ploceus capensis*	-	Endemic	X	X		X	X	-	-	moderate
Southern Masked-Weaver	*Ploceus velatus*	-	-	X	X		X	X	-	-	moderate
Red-billed Quelea	*Quelea quelea*	-	-	X	X			X	-	-	moderate
Southern Red Bishop	*Euplectes orix*	-	-	X	X			X	-	-	moderate
Yellow Bishop	*Euplectes capensis*	-	-	X					-	-	moderate
African Quailfinch	*Ortygospiza atricollis*	-	-					X	-	-	moderate
Common Waxbill	*Estrilda astrild*	-	-		X			X	-	-	moderate
Pin-tailed Whydah	*Vidua macroura*	-	-		X			X	-	-	moderate
House Sparrow	*Passer domesticus*	-	-					X	-	-	moderate
Cape Sparrow	*Passer melanurus*	-	Near-endemic	X			X	X	-	-	moderate
Cape Wagtail	*Motacilla capensis*	-	-	X	X	X		X	-	-	moderate
Cape Longclaw	*Macronyx capensis*	-	Endemic	X				X	-	-	moderate
African Pipit	*Anthus cinnamomeus*	-	-	X				X	-	-	moderate
Plain-backed	*Anthus*	-	-					X	-	-	moderate

				Preferred habitat					Susceptibility to:		
Common name	**Scientific name**	**Conservation status**	**Regional endemicity**	**Strandveld & Sand Fynbos**	**Wetlands**	**Rocky coastline**	**Alien trees**	**Cultivated lands**	**Collision**	**Electro-cution**	**Disturbance and habitat loss**
Common Ostrich	*Struthio camelus*	-	-	X				X	-	-	moderate
Pipit	*leucophrys*										
Long-billed Pipit	*Anthus similis*	-	-					X	-	-	moderate
Cape Canary	*Serinus canicollis*	-	Endemic	X					-	-	moderate
Black-headed Canary	*Serinus alario*	-	Endemic	X					-	-	moderate
Black-throated Canary	*Crithagra atrogularis*	-	-	X				X	-	-	moderate
Yellow Canary	*Crithagra flaviventris*	-	Near-endemic	X				X	-	-	moderate
White-throated Canary	*Crithagra albogularis*	-	Near-endemic					X	-	-	moderate
Lark-like Bunting	*Emberiza impetuani*	-	Near-endemic					X	-	-	moderate
Cape Bunting	*Emberiza capensis*	-	Near-endemic	X				X	-	-	moderate

APPENDIX 3. Summary table of impacts of the proposed WEF on the local avifauna. The scoring criteria are discussed in Section 7.4 (of main report). Impacts of medium-high significance (scoring 30+) appear in bold.

Bird species	Nature of impact	Status of impact	Extent of impact	Duration of impact	Magnitude of impact	Probability of impact	Significance rating	Reversibility of impact	Options for mitigation	Likelihood of mitigation succeeding
Cape Spurfowl	loss of habitat	negative	1	5	0	4	24 - low	low	minimise development foot-print	medium
	disturbance	negative	1	1	0	3	6 - low	medium	minimise activity around WEF	medium
	collision with turbines or powerlines	negative	1	5	0	3	18- -low	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
South African Shelduck	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	-	-	-	-	-	-	-	-	-
	collision with turbines or powerlines	negative	1	5	1	3	21 - low	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Ludwig's Bustard	loss of habitat	negative	1	5	4	4	**40 - moderate**	low	minimise development foot-print	medium
	disturbance	negative	1	2	4	4	28 - low	medium	minimise activity around WEF	medium
	collision with turbines or powerlines	negative	2	5	8	4	**60 – moderate-high**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Southern Black Korhaan	loss of habitat	negative	1	5	2	4	**32 - moderate**	low	minimise development foot-print	medium
	disturbance	negative	1	2	2	4	20 - low	medium	minimise activity around WEF	low

Bird species	Nature of impact	Status of impact	Extent of impact	Duration of impact	Magnitude of impact	Probability of impact	Significance rating	Reversibility of impact	Options for mitigation	Likelihood of mitigation succeeding
Cape Spurfowl	loss of habitat	negative	1	5	0	4	24 - low	low	minimise development foot-print	medium
	collision with turbines or powerlines	negative	2	5	4	3	**33 - moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Karoo Korhaan	loss of habitat	negative	1	5	2	4	**32 - moderate**	low	minimise development foot-print	medium
	disturbance	negative	1	2	2	4	20 - low	medium	minimise activity around WEF	low
	collision with turbines or powerlines	negative	2	5	4	3	**33 - moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Curlew Sandpiper	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	negative	1	5	2	2	16 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	negative	2	5	4	3	**33 - moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
African Black Oystercatcher	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	negative	1	5	2	2	16 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	-	-	-	-	-	-	-	-	-
	electrocution	-	-	-	-	-	-	-	-	-
Grey Plover	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	negative	1	5	2	2	16 - low	low	minimise activity around WEF	low

Bird species	Nature of impact	Status of impact	Extent of impact	Duration of impact	Magnitude of impact	Probability of impact	Significance rating	Reversibility of impact	Options for mitigation	Likelihood of mitigation succeeding
Cape Spurfowl	loss of habitat	negative	1	5	0	4	24 - low	low	minimise development foot-print	medium
	collision with turbines or powerlines	negative	2	5	4	3	**33 - low**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Common Ringed Plover	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	negative	1	5	2	2	16 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	negative	2	5	4	3	**33 - moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Chestnut-banded Plover	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	negative	1	5	2	2	16 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	-	-	-	-	-	-	-	-	-
	electrocution	-	-	-	-	-	-	-	-	-
Caspian Tern	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	negative	1	5	2	2	16 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	-	-	-	-	-	-	-	-	-
	electrocution	-	-	-	-	-	-	-	-	-
Swift Tern	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	negative	1	5	2	2	16 - low	low	minimise activity around WEF	low

Bird species	Nature of impact	Status of impact	Extent of impact	Duration of impact	Magnitude of impact	Probability of impact	Significance rating	Reversibility of impact	Options for mitigation	Likelihood of mitigation succeeding
Cape Spurfowl	loss of habitat	negative	1	5	0	4	24 - low	low	minimise development foot-print	medium
	collision with turbines or powerlines	negative	2	5	4	3	**33 - moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
African Marsh-Harrier	loss of habitat	negative	1	5	2	2	16 - low	low	minimise development foot-print	medium
	disturbance	negative	1	5	2	2	16 - low	medium	minimise activity around WEF	low
	collision with turbines or powerlines	negative	1	5	2	2	16 - low	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Black Harrier	loss of habitat	negative	2	5	4	4	**44 - moderate**	low	minimise development foot-print	medium
	disturbance	negative	2	5	4	4	**44 - moderate**	medium	minimise activity around WEF	low
	collision with turbines or powerlines	negative	2	5	4	3	**33 - moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Martial Eagle	loss of habitat	negative	2	5	4	3	**33 - moderate**	low	minimise development foot-print	medium
	disturbance	negative	2	5	4	3	**33 - moderate**	medium	minimise activity around WEF	low
	collision with turbines or powerlines	negative	2	5	4	3	**33 - moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme

Bird species	Nature of impact	Status of impact	Extent of impact	Duration of impact	Magnitude of impact	Probability of impact	Significance rating	Reversibility of impact	Options for mitigation	Likelihood of mitigation succeeding
Cape Spurfowl	loss of habitat	negative	1	5	0	4	24 - low	low	minimise development foot-print	medium
	electrocution	negative	2	5	4	3	**33 - moderate**	low	use bird-friendly tower structures; fit bird guards where required	high
Secretarybird	loss of habitat	negative	1	5	4	4	**40 - moderate**	low	minimise development foot-print	medium
	disturbance	negative	1	2	4	4	28 - low	medium	minimise activity around WEF	medium
	collision with turbines or powerlines	negative	2	5	6	4	**52 - moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Lesser Kestrel	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	-	-	-	-	-	-	-	-	-
	collision with turbines or powerlines	negative	1	5	4	2	20 **- moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Lanner Falcon	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	-	-	-	-	-	-	-	-	-
	collision with turbines or powerlines	negative	1	5	4	3	**40 - moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Peregrine Falcon	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	-	-	-	-	-	-	-	-	-
	collision with turbines or powerlines	negative	1	5	4	3	**40 - moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme

Bird species	Nature of impact	Status of impact	Extent of impact	Duration of impact	Magnitude of impact	Probability of impact	Significance rating	Reversibility of impact	Options for mitigation	Likelihood of mitigation succeeding
Cape Spurfowl	loss of habitat	negative	1	5	0	4	24 - low	low	minimise development foot-print	medium
	electrocution	-	-	-	-	-	-	-	-	-
White-breasted Cormorant	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	negative	1	5	2	2	16 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	negative	3	5	4	3	**36 - moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Cape Gannet	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	-	-	-	-	-	-	-	-	-
	collision with turbines or powerlines	negative	1	5	0	1	6 - low	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Crowned Cormorant	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	negative	1	5	2	2	16 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	negative	3	5	2	1	10 - low	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Bank Cormorant	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	negative	1	5	2	2	16 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	negative	3	5	2	1	10 - low	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-

Bird species	Nature of impact	Status of impact	Extent of impact	Duration of impact	Magnitude of impact	Probability of impact	Significance rating	Reversibility of impact	Options for mitigation	Likelihood of mitigation succeeding
Cape Spurfowl	loss of habitat	negative	1	5	0	4	24 - low	low	minimise development foot-print	medium
Cape Cormorant	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	negative	1	5	2	2	16 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	negative	3	5	4	3	**36 - moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Greater Flamingo	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	negative	1	5	2	2	16 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	negative	3	5	8	3	**48 - moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Lesser Flamingo	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	negative	1	5	2	2	16 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	negative	3	5	8	3	**48 - moderate**	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Great White Pelican	loss of habitat	-	-	-	-	-	-	-	-	-
	disturbance	negative	1	5	2	2	16 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	negative	3	5	6	2	28 - low	low	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-

Bird species	Nature of impact	Status of impact	Extent of impact	Duration of impact	Magnitude of impact	Probability of impact	Significance rating	Reversibility of impact	Options for mitigation	Likelihood of mitigation succeeding
Cape Spurfowl Cape Bulbul	loss of habitat	negative	1	5	0	4	24 - low	low	minimise development foot-print	medium
	loss of habitat	negative	1	5	1	4	28 - low	low	minimise development foot-print	medium
	disturbance	negative	1	5	1	4	28 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	-	-	-	-	-	-	-	-	-
	electrocution	-	-	-	-	-	-	-	-	-
Layard's Tit-Babbler	loss of habitat	negative	1	5	1	4	28 - low	low	minimise development foot-print	medium
	disturbance	negative	1	5	1	4	28 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	-	-	-	-	-	-	-	-	-
	electrocution	-	-	-	-	-	-	-	-	-
Namaqua Warbler	loss of habitat	negative	1	5	1	4	28 –low	low	minimise development foot-print	medium
	disturbance	negative	1	5	1	4	28 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	-	-	-	-	-	-	-	-	-
	electrocution	-	-	-	-	-	-	-	-	-
Cape Clapper Lark	loss of habitat	negative	1	5	1	4	28 - low	low	minimise development foot-print	medium
	disturbance	negative	1	5	1	4	28 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	negative	1	5	2	4	32 - low	medium	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Karoo Lark	loss of habitat	negative	1	5	1	4	28 - low	low	minimise development foot-print	medium
	disturbance	negative	1	5	1	4	28 - low	low	minimise activity around WEF	low

Bird species	Nature of impact	Status of impact	Extent of impact	Duration of impact	Magnitude of impact	Probability of impact	Significance rating	Reversibility of impact	Options for mitigation	Likelihood of mitigation succeeding
Cape Spurfowl	loss of habitat	negative	1	5	0	4	24 - low	low	minimise development foot-print	medium
	collision with turbines or powerlines	negative	1	5	2	4	32 - low	medium	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Cape Long-billed Lark	loss of habitat	negative	1	5	1	4	28 - low	low	minimise development foot-print	medium
	disturbance	negative	1	5	1	4	28 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	negative	1	5	4	4	**40 - moderate**	medium	mark powerlines or turbine blades; shut-down problem turbines; shut-down facility at certain times	medium, but must be informed by monitoring programme
	electrocution	-	-	-	-	-	-	-	-	-
Sickle-winged Chat	loss of habitat	negative	1	5	1	4	28 - low	low	minimise development foot-print	medium
	disturbance	negative	1	5	1	4	28 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	-	-	-	-	-	-	-	-	-
	electrocution	-	-	-	-	-	-	-	-	-
Black-headed Canary	loss of habitat	negative	1	5	1	4	28 - low	low	minimise development foot-print	medium
	disturbance	negative	1	5	1	4	28 - low	low	minimise activity around WEF	low
	collision with turbines or powerlines	-	-	-	-	-	-	-	-	-
	electrocution	-	-	-	-	-	-	-	-	-