AMAKHALA EMOYENI WIND ENERGY FACILITY

Avian impact assessment

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EXECUTIVE SUMMARY

This study contains an extensive review of relevant literature on wind energy impacts on avifauna, and identifies potential impacts of the proposed Amakhala Emoyeni Wind Energy Facility on the avifauna of the area. These expected impacts are: habitat destruction by construction of the facility itself and any associated power lines or substation/s, disturbance by both activities and possible displacement or disturbance of sensitive species by the operation of the facility, collision with blades of the wind turbines and other associated infrastructure.

The impact zone of the proposed wind energy facility features lightly wooded, dry grassland, with thicket along the southern periphery, and scattered, small wetlands. The area is likely to support over 280 bird species, including 16 red-listed species, 70 endemics, and five species - Ludwig's Bustard *Neotis ludwigii*, Blue Crane *Anthropoides paradiseus*, Cape Vulture *Gyps coprotheres*, Black Harrier *Circus maurus* and Melodius Lark *Mirafra cheniana*, which are both red-listed and endemic. The species of greatest conservation significance which may be impacted by the wind energy facility, both in terms of the collision and disturbance impacts of the facility itself, and of the disturbance and mortality risks posed by its peripheral infrastructure, are: (i) Large terrestrial birds: flocks or breeding pairs of Blue Crane *Anthropoides paradiseus*, resident Denham's Bustard *Neotis denhami* and White-bellied Korhaan *Eupodotis senegalensis*, and seasonal influxes of Ludwig's Bustard *Neotis ludwigii*, (ii) Raptors: locally resident or visiting species, particularly including Cape Vulture, Black Harrier, Martial Eagle *Polemaetus bellicosus*, Secretarybird *Sagittarius serpentarius*, Lesser Kestrel *Falco naumanni* and Lanner Falcon *F. biarmicus*, and (iii) a suite of restricted range endemic passerines, including Melodius Lark.

The proposed facility is likely to have a moderate, long-term impact on the avifauna of the area, and may negatively affect key rare, red-listed and/or endemic species. The most important negative impacts are likely to be on Cape Vulture, Denham's Bustard *Neotis denhami* and Blue Crane. These birds (and other priority species) may be disturbed by construction of the facility, lose foraging habitat to the construction footprint or be displaced from the area by the operating turbines (bustards and cranes), or may suffer mortalities in collisions with the turbine blades and power lines (vultures, other raptors, bustards and cranes). Such effects can probably be reduced to acceptable and sustainable levels by adherence to a proposed mitigation scheme, mainly involving careful and responsible development and management of the facility, with sensitivity to potential, negative impacts and a preparedness to adjust operating procedures in a sincere effort to mitigate such impacts. A comprehensive programme to fully monitor the actual impacts of the facility on the broader avifauna of the area is recommended and outlined, from pre-construction and into the operational phase of the project.

It is imperative that the impacts of this project be viewed in the context of cumulative effects generated by multiple wind energy facility proposals for this general area, and that mitigation of these cumulative impacts be managed accordingly.

CONSULTANT’S DECLARATION OF INDEPENDENCE

Andrew Jenkins (*AVISENSE* Consulting) is an independent consultant to Savannah Environmental Pty (Ltd) and Windlab Developments South Africa (Pty) Ltd. He has 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 this specialist performing such work.

1. INTRODUCTION

Windlab Developments South Africa (Pty) Ltd is planning to construct a wind energy facility (project name 'Amakhala Emoyeni Wind Energy Facility') on portions of several farms located between Bedford and Cookhouse the Eastern Cape Province, South Africa (Fig. 1). Savannah Environmental Pty (Ltd) were appointed to do the Environmental Impact Assessment study, and subsequently appointed *AVISENSE* Consulting to conduct the specialist avifaunal assessment. The study was conducted by Dr Andrew Jenkins, an ornithologist with over 20 years of experience in avian research and impact assessment work. He has been involved in the design and/or execution of many of the completed EIA and EMP studies for wind energy facilities in South Africa to date, including the only two operational facilities at Darling and Klipheuwel, Western Cape Province.

2. TERMS OF REFERENCE

The terms of reference for this environmental impact study, as supplied by Savannah Environmental Pty (Ltd), were to provide:

- An indication of the methods used in determining the significance of potential impacts.
- A description of all the environmental issues (pertaining to birds) identified during the EIA process.
- An assessment of the significance of each of the identified direct, indirect and cumulative impacts, in terms of the expected nature, extent, duration, probability and severity of each, as well as in terms of the reversibility of impacts, and the degree to which each can be mitigated.
- A description and comparative assessment of alternatives in the development plan.
- Recommendations on practical mitigation of potentially significant negative impacts for inclusion in the Environmental Management Plan, with an indication of the expected efficacy of such mitigation measures.
- A description of any assumptions, uncertainties or knowledge gaps affecting this assessment.
- An environmental impact statement with a summary of key findings, an assessment of positive and negative implications of the proposed development, and a comparative assessment of identified alternatives.

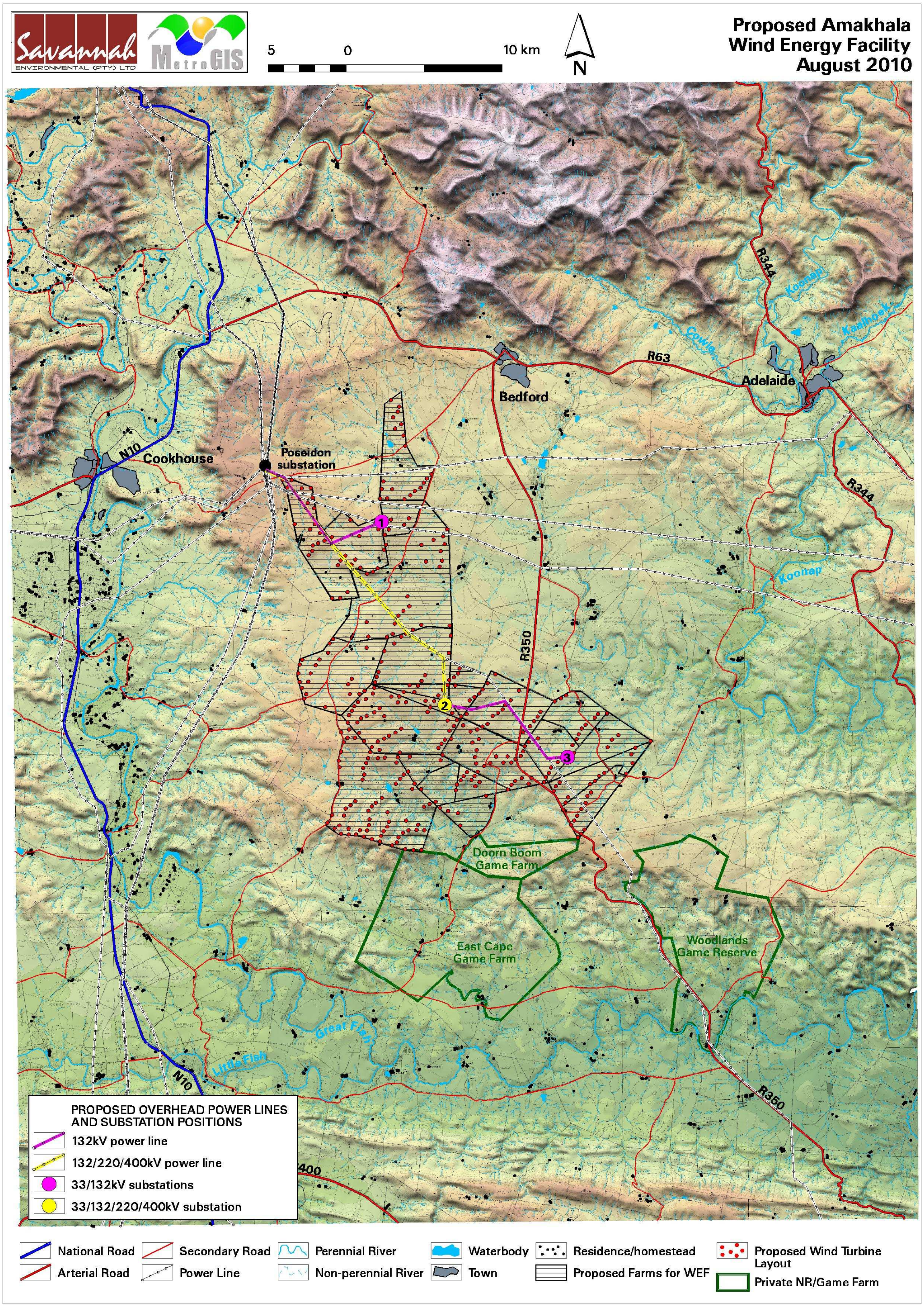

FIGURE 1. General location and layout of the proposed Amakhala Emoyeni Wind Energy Facility.

3. STUDY METHODS

3.1. Approach

The initial scoping study, which forms the background to this report, included the following steps:

- A review of available published and unpublished literature pertaining to bird interactions with wind energy facilities is provided summarising the issues involved and the current level of knowledge in this field. Various information sources (listed below), including data on the birdlife of the area and previous studies of bird interactions with wind energy facility and electricity infrastructure, were examined.
- An inclusive, annotated list of the avifauna likely to occur within the impact zone of the proposed wind energy facility was compiled using a combination of the existing distributional data and previous experience/knowledge of the avifauna of the general area.
- A short-list of priority bird species (defined in terms of conservation status and endemicity) which could possibly be impacted by the proposed wind energy facility was extracted from the total bird list. These species were subsequently considered as adequate surrogates for the local avifauna generally, and mitigation of impacts on these species was considered likely to accommodate any less important bird populations that may also potentially be affected.
- A summary of more likely and significant impacts of the wind energy facility on the local avifauna was drawn up, and a brief methodology was devised for the EIA phase for confirming these impacts and developing an effective mitigation strategy.

The present EIA report builds on the scoping study, with emphasis on the outcome of a site visit, made on 02-03 July 2010. While the scoping phase identified potential avifaunal issues associated with the proposed wind energy facility and its possible associated infrastructure, the EIA investigates these issues in more detail and includes:

- Field surveys of large terrestrial species, raptors and endemic passerines within the study area to determine the relative importance of local populations of these key taxa.
- Refinement of the expected species and priority species lists based on (i), and compilation of SABAP 2 atlas lists for the pentads visited during the site visit.
- Estimates of the extent and direction of possible movements of these species within/through the anticipated impact zone of the wind energy facility, in relation to the distribution of available resources – nesting or roosting sites (cliff-lines,

wetlands, stands of trees, existing power lines), foraging areas (croplands, wetlands), sources of list for slope soaring birds (ridge lines).

- Identification of any sensitive/high risk areas to locate wind turbines and new lengths of power line within the broader study area, in terms of (i) to (iii) above.
- Recommendations on mitigation where necessary (particularly with reference to the siting of turbines and power lines).
- A comprehensive, long-term programme for monitoring actual impacts from pre- to post-construction phases of the development, and improving our understanding of the long-term effects of wind energy developments on South African avifauna.

3.2. Data sources used

The following data sources and reports were used in the compilation of this report:

- Bird distribution data of the Southern African Bird Atlas Project (SABAP – Harrison *et al.* 1997) were obtained from the Animal Demography Unit website (http://sabap2.adu.org.za/index.php) for the relevant quarter-degree squares (SABAP 1: 3225DD Golden Valley – 35 cards submitted over the atlas period, 156 species recorded, and 3226CC Herbert's Hope – 19 cards, 176 species) or pentads (SABAP 2: 3240_2600 to 3255_2600, 3245_2555 to 3255_2555, 3250_2605 to 3255_2605). A composite list of species likely to occur in the impact zone of the wind energy facility was drawn up as a combination of these data, refined by a more specific assessment of the actual habitats affected, based on general knowledge of the avifauna of the region (APPENDIX 1).
- 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), informed by a more recent revision for raptors (Jenkins 2008a), the most recent iteration of the global list of threatened species (http://www.iucnredlist.org), and the most recent and comprehensive summary of southern African bird biology (Hockey *et al.* 2005).
- Data from the Animal Demography Unit's Coordinated Avifaunal Roadcount project (CAR: http://car.adu.org.za/, Young *et al.* 2003), and Coordinated Waterbird Counts (CWAC: http://cwac.adu.org.za/, Taylor *et al.* 1999).
- Data from the Endangered Wildlife Trust's (EWT) Migrating Kestrel Project, with summer roost counts for Lesser Kestrel *Falco naumanni*, Amur Falcon *Falco amurensis*, and Red-footed Falcon *Falco vespertinus* for much of southern Africa (http://www.kestreling.com/).

- Data from the Animal Demography Unit's Coordinated Avifaunal Roadcount project (CAR: http://car.adu.org.za/, Young *et al.* 2003).
- EIA reports and any subsequent monitoring reports on the potential impacts on birds of other proposed and/or constructed and operational wind energy facilities in South Africa (van Rooyen 2001a, Jenkins 2001, 2003, Küyler 2004, Jenkins 2008b, 2009), and including facilities proposed for the same general area (Smallie & Strugnell 2010).

3.3. Limitations & assumptions

Any inaccuracies in the above sources of information could limit this study. The SABAP 1 data for this area was quite sparse originally (only 54 cards submitted across both quarter-degree squares) and is now >15 years old (Harrison *et al.* 1997). Unfortunately, no SABAP 2 data has yet been recorded for any of the affected pentads. This deficiency was partially addressed by the short visit to the site, but with limited time available, first-hand knowledge of the avifauna on site remains less than comprehensive.

Given that there are currently only three, very small wind energy facilities operative in South Africa (totaling only 8 turbines between them), practical experience of the environmental effects of wind energy facilities in this country is extremely limited, and we must base our estimates of the possible impacts of new facilities 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.

4. BACKGROUND TO THE STUDY

4.1 Interactions between wind energy facilities and birds

Recent literature reviews (www.nrel.gov), Kingsley & Whittam 2005, Drewitt & Langston 2006, Kuvlevsky *et al.* 2007, Stewart *et al.* 2007, Drewitt & Langston 2008, Krijgsveld *et al.* 2009, Sovacool 2009) are essential summaries and sources of information in this field. While the number of comprehensive, longer-term analyses of the effects of wind energy facilities 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 developed industry.

Concern about the impacts of wind facilities on birds first arose in the 1980s when numerous raptor mortalities were detected at facilities at Altamont Pass Wind Resource Area (California, USA) and Tarifa (southern Spain). 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 visible 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, Devereaux *et al.* 2008. Pearce-Higgins *et al.* 2009). With a few important exceptions, most studies completed to date suggest low absolute numbers of bird fatalities at wind energy facilities (Kingsley & Whittam 2005), and low casualty rates relative to other existing sources of anthropogenic avian mortality on a per structure basis (Crockford 1992, Colson & associates 1995, Gill *et al.* 1996, and Erickson *et al*. 2001).

4.1.1 Collisions with turbines

Collision rates

As more monitoring has been conducted at a growing number of sites, some generic standards and common units have been established, with bird collisions with turbine blades generally measured in mortalities/turbine/year, mortalities/Mega-Watt/year, or mortalities /Giga-Watt Hour (Smallwood & Thelander 2008, Sovacool 2009). Wherever possible, measured collision rates should allow for (i) casualty remains which are not detected by observers (searcher efficiency - Newton & Little 2009), and (ii) casualties which are removed by scavengers before detection, and the rate at which this occurs (scavenger removal rate). Also, although collision rates may appear relatively low in many instances, cumulative effects over time, especially when applied to large, long lived, slow reproducing and/or threatened species (many of which are collision-prone), may be of considerable conservation significance.

The National Wind Co-ordinating Committee (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 mortalities/turbine/year in Oregon, to as high as 10 mortalities/turbine/year in Tennessee (NWCC 2004), illustrating the wide variance in mortality rates between sites. Curry & Kerlinger (2000) found that only 13% of the >5000 turbines at Altamont Pass, California were responsible for all Golden Eagle *Aquila chrysaetos* and Red-tailed Hawk *Buteo jamaicensis* collisions, but the most recent aggregate casualty estimates for Altamont run to >1000 raptor mortalities/turbine/year, and nearly 3000 mortalities/turbine/year overall (Smallwood & Thelander 2008), including >60 Golden Eagles, and at a mean rate of about 2-4 mortalities/MW/year.

At the Tarifa and Navarre wind energy facilities on the Straits of Gibraltar, southern Spain, about 0.04-0.08 birds are killed per turbine/year (Janss 2000a, de Lucas *et al.* 2008), with relatively high collision rates for threatened raptors such as Griffon Vulture *Gyps fulvus*, of particular concern (Table 1). At the same sites, collisions have also been found to be non-randomly distributed between turbines, with >50% of the vulture casualties recorded at Tarifa being killed by only 15% of the turbine array at the facility (Acha 1997). Collision rates from other European sites are equally variable, with certain locations sporadically problematic (Everaert 2003, Newton & Little 2009, Table 1).

To date, only eight wind turbines have been constructed in South Africa at two pilot wind energy facilities at Klipheuwel and Darling in the Western Cape (van Rooyen 2001, Jenkins 2001, 2003) and, more recently, one turbine in the first phase of a proposed bigger development at Coega in the Eastern Cape. An avian mortality monitoring program was established at the Klipheuwel facility once the turbines were operational, involving regular site visits to monitor both bird traffic through the area and detect bird mortalities (Küyler 2004). This study found that (i) 9-57% of birds observed within 500m of the turbines were flying at blade height, and (ii) 0-32% of birds sighted were flying either between the turbines or within the arc of the rotors of the outermost turbines. Five bird carcasses were found on the three-turbine site during the 8-month monitoring period, of which two, a Horus Swift *Apus horus* and a Large-billed Lark *Galerida magnirostris*, were thought to have been killed by collision with turbine blades, indicating a net collision rate for birds of about 1.00 mortality/turbine/year.

It is important to note here that simple estimates of aggregate collision rates for birds are not an adequate expression of biodiversity impact. Rather, consideration must be given to the conservation status of the species affected or potentially affected, and the possibility that even relatively low collision rates for some threatened birds may not be sustainable in the long term.

Table 1. Results of recent published studies of the effects of wind energy facilities on local avifauna.

Location	*n* wind farm/s assessed	Turbine hub height (m)	*n* turbines	Habitat	Bird groups assessed	Evidence of displacement?	Collision rate (birds/turbine/year)	Reference
Tarifa, Southern Spain	2	18-36	66-190	Hilly woodland	Raptors	N/A	Raptors = 0.27, Griffon Vultures = 0.12	Barrios & Rodríguez 2004
Tarifa, Southern Spain	2	28-36	66-190	Hilly woodland	Raptors	N/A	0.04-0.07, mostly Griffon Vultures	de Lucas *et al.* 2008
East Anglia, UK	2	60	8	Croplands	Gamebirds, corvids, larks and see-eaters	Minimal, only gamebirds significantly affected	N/A	Devereaux *et al.* 2008
Altamont Pass, California	1	14-43	5400	Hilly grassland	Various	N/A	4.67 , raptors = 1.94	Smallwood & Thelander 2008
Southern Spain	1	44	16	Hilly woodland	Various	Yes, >75% reduction in raptor sightings	0.03	Farfán *et al.* 2009
Netherlands	3	67-78	7-10	Farmland	Various	N/A	27.0-39.0	Krijgsveld *et al.* 2009
Northumberland, UK	1	30	9	Coastal	Seabirds	N/A	16.5-21.5, mostly large gulls	Newton & Little 2009
N England & Scotland	12	30-70	14-42	Moorland	Gamebirds, shorebirds, raptors, passerines	Yes, 53% reduction in Hen Harrier *Circus cyaneus* sightings, other species also decreased	N/A	Pearce-Higgins *et al.* 2009

Causes of collision

Multiple factors influence the number of birds killed at wind energy facilities. These can be classified into three broad groupings: (i) avian variables, (ii) location variables, and (iii) facility-related 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, and feature disproportionately frequently in collision surveys (Drewitt & Langston 2006, 2008, de Lucas *et al.* 2008). Species-specific variation in behaviour, from general levels of activity to particular foraging or commuting strategies, also affect susceptibility to collision (Barrios & Rodríguez 2004, Smallwood *et al.* 2009). There may also be seasonal and temporal differences in behaviour, for example breeding males displaying may be particularly at risk.

Landscape features can potentially channel birds towards a certain area, and in the case of raptors, influence their flight and foraging behaviour. Ridges and steep slopes are important factors in determining the extent to which an area is used by gliding and soaring birds (Barrios & Rodríguez 2004). 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. Birds fly lower during strong headwinds (Hanowski & Hawrot 2000, Richardson 2000), so when the turbines are functioning at their maximum speed, birds are likely to be flying at their lowest, exponentially increasing collision risk (Drewitt & Langston 2006, 2008).

Larger wind energy facilities, with more turbines, are almost by definition more likely to incur significant numbers of bird casualties (Kingsley & Whittam 2005), and turbine size may be proportional to collision risk, with taller turbines associated with higher mortality rates in some instances (e.g. de Lucas *et al.* 2009, but see Howell 1995, Erickson *et al.* 1999, Barclay *et al.* 2007), although with newer technology, fewer, larger turbines are needed to generate equivalent or even greater quantities of power, possibly resulting in fewer collisions per Megawatt of power produced (Erickson *et al.* 1999). Certain turbine tower structures, and particularly the old-fashioned lattice designs, present many potential perches for birds, increasing the likelihood of collisions occurring as birds land at or leave these perch or roost sites. This generally is not a problem associated with more modern, tubular tower designs (Drewitt & Langston 2006, 2008), such as those proposed to be used for this project.

Illumination of turbines and other infrastructure is often associated with increased collision risk (Winkelman 1995, Erickson *et al.* 2001), either because birds moving long distances at night do so by celestial navigation, and may confuse lights for stars (Kemper 1964), or because lights attract insects, which in turn attract birds. Changing constant lighting to intermittent lighting has been shown to reduce nocturnal collision rates

(Richardson 2000, APLIC 1994, Jaroslow 1979, Weir 1976) and changing flood-lighting from white to red can reduce mortality rates by up to 80% (Weir 1976).

Spacing between turbines at a wind facility can have an effect on the number of collisions. Some authors have suggested that paths should be left between turbines to allow free passage through the turbine strings (Drewitt & Langston 2006, Kuvlevsky *et al.* 2007, Drewitt & Langston 2008). This approach tallies well with wind energy generation principles, which require relatively large spaces between turbines in order to avoid wake and turbulence effects. An alternative perspective suggests that all attempts by birds to fly through wind energy facilities, rather than over or around them, should be discouraged to minimise collision risk (Drewitt & Langston 2006, Kuvlevsky *et al.* 2007, Drewitt & Langston 2008). This approach effectively renders the entire footprint of the facility as lost habitat (see below).

Collision prone birds

Collision prone birds are generally either (i) large species and/or species with high ratios of body weight to wing surface area (wing loading), which confers low maneuverability (cranes, bustards, vultures, gamebirds, waterfowl, falcons), (ii) species which fly at high speeds (gamebirds, pigeons and sandgrouse, swifts, falcons), (iii) species which are distracted in flight - predators or species with aerial displays (many raptors, aerial insectivores, some open country passerines), (iv) species which habitually fly in low light conditions, and (v) species with narrow fields of forward binocular vision (Drewitt & Langston 2006, 2008, Jenkins *et al.* 2010, Noguera *et al.* 2010). These traits confer high levels of *susceptibility*, which may be compounded by high levels of *exposure* to man-made obstacles such as overhead power lines and wind turbine areas (Jenkins *et al.* 2010). Exposure is greatest in (i) very aerial species, (ii) species inclined to make regular and/or long distance movements (migrants, any species with widely separated resource areas - food, water, roost and nest sites), (iii) species that regularly fly in flocks (increasing the chances of incurring multiple fatalities in single collision incidents).

Soaring species may be particularly prone to colliding with wind turbines where the latter are placed along ridges to exploit the same updrafts favoured by such birds - vultures, storks, cranes, and most raptors - for cross-country flying (Erickson et al. 2001, Kerlinger & Dowdell 2003, Drewitt & Langston 2006, 2008, Jenkins *et al.* 2010, Noguera *et al.* 2010). Large soaring birds – for example, many raptors and storks - depend heavily on external sources of energy for sustainable flight (Pennycuick 1989). In terrestrial situations, this generally requires that they locate and exploit pockets or waves of rising air, either in the form of bubbles of vertically rising, differentially heated air – thermal soaring - or in the form of wind forced up over rises in the landscape, creating waves of rising turbulence – slope soaring.

Certain species are morphologically specialised for flying in open landscapes with high relief and strong prevailing winds, and are particularly dependent on slope soaring opportunities for efficient aerial foraging and travel. South African examples might include Bearded Vulture *Gypaetus barbatus* and Cape Vulture *Gyps coprotheres*, Verreaux's Eagle *Aquila verreauxii*, Jackal Buzzard *Buteo rufofuscus*, Rock Kestrel *Falco rupicolus*, Peregrine Falcon *Falco peregrinus*, Lanner Falcon *Falco biarmicus* and Black Stork *Ciconia nigra* and, to a lesser extent, most other open-country raptors. Such species are potentially threatened by wind energy developments where turbines are situated to exploit the wind shear created by hills and ridge-lines. In these situations, birds and industry are competing for the same wind resource, and the risk that slope soaring birds will collide with the turbine blades, or else be prevented from using foraging habitat critical for their survival, is greatly increased. Evidence of these effects has been obtained from several operational wind energy facilities in other parts of the world – for example relatively high mortality rates of large eagles, buzzards and kestrels at Altamont Pass, California (>1100 raptors killed annually or 1.9 raptor casualties/MW/year, Smallwood & Thelander 2008), and of vultures and kestrels at Tarifa, Spain (0.15-0.19 casualties/turbine/year, Barrios & Rodríguez 2004, de Lucas *et al.* 2008, Table 1), and displacement of raptors generally in southern Spain (Farfán *et al.* 2009) and of large eagles in Scotland (Walker *et al.* 2005) – and one study has shown that the additive impact of wind farm mortality on an already threatened raptor could theoretically cause its localised extinction (Carrete *et al.* 2009).

Mitigating collision risk

The most direct way to reduce the risk of birds colliding with turbine blades is to make the blades more conspicuous and hence easier to avoid. Blade conspicuity is compromised by a phenomenon known as 'motion smear' or retinal blur, in which rapidly moving objects become less visible the closer they are to the eye (McIsaac 2001, Hodos 2002). The retinal image can only be processed up to a certain speed, after which the image cannot be perceived. This effect is magnified in low light conditions, so that even slow blade rotation can be difficult for birds to see.

Laboratory-based studies of visual acuity in raptors have determined that (i) visual acuity 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, (ii) moderate motion of the visual stimulus significantly influences acuity, and kestrels may be unable to resolve all portions of an object such as a rotating turbine blade because of motion smear, especially under low contrast or dim lighting conditions, (iii) this deficiency can be addressed by patterning the blade surface in a way which maximises the time between successive stimulations of the same retinal region, and (v) the easiest, cheapest and most visible blade pattern for this purpose, effective across the widest variety of backgrounds, is a single black blade in an array of white blades (McIsaac 2001, Hodos 2002). Hence blade marking may be an important means to reduce collision rates by making the rotating turbine blades as conspicuous as possible under the least favourable visual conditions, particularly at facilities where raptors are known or likely to be frequent collision casualties.

Even if the turbine rotors are marked in this way, many species may still be susceptible to colliding with them, especially during strong winds (when the rotor speed is high and birds tend to fly low and with less control) and when visibility is poor (at night or in thick mist). All other collision mitigation options operate indirectly, by reducing the frequency with which collision prone species are exposed to collision risk. This is achieved mainly by (i) siting farms and individual turbines away from areas of high avifaunal density or aggregation, regular commute routes or hazardous flight behavior, (ii) using low risk turbine designs and configurations, which discourage birds from perching on turbine towers or blades, and allow sufficient space for commuting birds to fly safely through the turbine strings, and (iii) carefully monitoring collision incidence, and being prepared to shut-down problem turbines at particular times or under particular conditions.

Effective mitigation can only be achieved with a commitment to rigorous pre- and post-construction monitoring (see below), ideally using a combination of occasional, direct observation of birds commuting or foraging through and around the wind energy facility, coupled with constant, remote tracking of avian traffic using specialised radar equipment (e.g. see http://www.detect-inc.com/wind.html). Such systems can be programmed to set the relevant turbines to idle as birds enter a pre-determined danger zone around the turbine array, and to re-engage those turbines once the birds have safely passed.

4.1.2 Habitat loss – destruction, disturbance and displacement

Although the final, destructive footprint of most wind energy facilities is likely to be relatively small, the construction phase of development inevitably incurs quite extensive temporary damage or permanent destruction of habitat, which may be of lasting significance in cases where wind energy facility sites coincide with critical areas for restricted range, endemic and/or threatened species. Similarly, construction, and to a lesser extent ongoing maintenance activities, are likely to cause some disturbance of birds in the general surrounds, and especially of shy and/or ground-nesting species resident in the area. Mitigation of such effects requires that generic best-practice principles be rigorously applied - sites are selected to avoid the destruction of key habitats, and construction and final footprints, as well as sources of disturbance of key species, must be kept to an absolute minimum. Some studies have shown significant decreases in the numbers of certain birds in areas where wind energy facilities are operational as a direct result of avoidance of the noise or movement of the turbines (e.g. Larsen & Guillemette 2007, Farfán *et al.* 2009, Table 1), while others have shown decreases which may be attributed to a combination of collision casualties and avoidance or exclusion from the impact zone of the facility in question (Stewart *et al.* 2007). Such displacement effects are probably more relevant in situations where wind energy facilities are built in natural habitat (Pearce-Higgins *et al.* 2009, Madders & Whitfield 2006) than in more modified environments such as farmland (Devereaux *et al.* 2008), and are highly species-specific in operation.

Note that the only post-construction monitoring that has been done at a wind energy facility in South Africa located a successful Blue Crane Anthropoides paradiseus nest only 400 m from the operating turbine array at Klipheuwel (Küyler 2004).

4.1.3 Impacts of associated infrastructure

Infrastructure commonly associated with wind energy facilities may also have detrimental effects on birds. The construction and maintenance of substations, power lines, servitudes and roadways causes both temporary and permanent habitat destruction and disturbance, and overhead power lines pose a collision and possibly an electrocution threat to certain species (Van Rooyen 2004a, Lehman *et al.* 2007, Jenkins *et al.* 2010).

Construction and maintenance of power lines and substations
Some habitat destruction and alteration inevitably takes place during the construction of power lines, substations and associated roadways. Also, power line service roads or servitudes have to be cleared of excess vegetation at regular intervals in order to allow access to the line for maintenance, and to prevent vegetation from intruding into the legally prescribed clearance gaps between the ground and the conductors. These activities have an impact on birds breeding, foraging and roosting in or in close proximity to the servitude, and retention of cleared servitudes can have the effect of altering bird community structure along the length of any given power line (e.g. King & Byers 2002).

Collision with power lines
Power lines pose at least an equally significant collision risk to wind turbines, probably affecting the same suite of collision prone species (Bevanger 1994, 1995, 1998, Janss 2000b, Anderson 2001, van Rooyen 2004a, Drewitt & Langston 2008, Jenkins *et al.* 2010). Mitigation of this risk involves the informed selection of low impact alignments for new power lines relative to movements and concentrations of high risk species, and the use of either static or dynamic marking devices to make the lines, and in particular the earthwires, more conspicuous. While various marking devices have been used globally, many remain largely untested in terms of their efficacy in reducing collision incidence, and those that have been fully assessed have all been found to be only partially effective (Drewitt & Langston 2008, Jenkins *et al.* 2010).

Electrocution on power infrastructure
Avian electrocutions occur when a bird perches or attempts to perch on an electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004b, Lehman *et al.* 2007). Electrocution risk is strongly influenced by the voltage and design of the power lines erected (generally occurring on lower voltage infrastructure where air gaps are relatively small), and mainly affects larger, perching species, such as vultures, eagles and storks, easily capable of spanning the spaces between energised components. Mitigation of electrocution risk involves the use of bird-safe structures (ideally with critical air gaps >2 m), the physical exclusion of birds from high risk areas of live

infrastructure, and comprehensive insulation of such areas (van Rooyen 2004b, Lehman *et al.* 2007).

4.2. Description of the proposed wind energy facility

The proposed wind energy facility will be located on portions of various farms to the south-east of Cookhouse, to the south-west of Bedford, and straddling the R350 (Fig. 1). It will extend over an area of about 350 km^2, and will comprise up to 350 wind turbines, three dedicated substations and a network of access and service roads. There will be three short sections of medium-high voltage power line required to link different sectors of the facility (which will follow existing power line corridors as far as possible), with a very short line (700 m) connecting it to the national power grid at the Poseidon substation (Fig. 1).

5. DESCRIPTION OF THE AFFECTED ENVIRONMENT

5.1 Vegetation of the study area

The study area falls within the Albany Thicket Biome, at the interface between the Albany Thicket and the Sub-escarpment Grassland Bioregions (Mucina & Rutherford 2006). The natural vegetation is dominated by Bedford Dry Grassland (undulating terrain with shortish, open, dry grassland with scattered *Acacia Karroo* woodland - Mucina & Rutherford 2006), with some Great Fish Thicket (sloped terrain with short-tall thicket, featuring woody trees, shrubs and succulents – Mucina & Rutherford 2006) on the extreme western periphery and in the major river valleys.

5.2 Avian microhabitats

The area features open, hilly grassland (in many areas covered by a high density of termite mounds), grading into wooded and succulent-rich thicket vegetation along the drainage lines. The climate is mild, with mean minimum and maximum temperatures 13ºC and 22ºC respectively, and mean annual rainfall of about 550 mm, which falls year-round but mostly in summer. Altitude averages about 750 m above sea level, rising to about 900 m a.s.l. in places. Land use is predominantly stock-farming – cattle, sheep and game, with very limited areas of agriculture around the farmsteads and adjacent to watercourses. There are multiple farm houses and associated outhouses within the development area, which is crossed by a major thoroughfare – the R350 between Bedford and Grahamstown - and a network of lesser, gravel roads and farm tracks. Several major transmission and distribution power lines cross the study area, converging on Eskom's Poseidon Substation, situated just outside the north-west corner of the site.

FIGURE 2a. Bedford Dry Grassland, dotted with termite mounds, is the dominant vegetation type and avian habitat at the proposed Amakhala Emoyeni Wind Energy site.

FIGURE 2b. Tracts of Great Fish Thicket occur in the deeper drainage lines and attract woodland bird species.

FIGURE 2c. Small farm dams occur across the study site, and support a limited community of wetland birds.

Avian habitats within the impact zone comprise (i) extensive tracts of degraded, lightly wooded **grassland** (Fig. 2a), (ii) areas of thicker, thornveld or **thicket**, including riparian strips (Fig. 2b), and (iii) a network of **wetlands** (Fig. 2c), including vleis, rivers and artificial impoundments. Mountains to the north of the project site are likely to support cliff-nesting raptors which probably forage out over the study area, and wetland species associated with the Great Fish River, which flows 5-10 km away to the west and south, may pass through the impact zone of the development on their way to and from the river valley.

5.3 Avifauna of the impact area

The study area is not located close to any recognised national Important Bird Areas (Barnes 1998), but because it falls at the interface between the Albany Thicket and Sub-escarpment Grassland Bioregions (Mucina & Rutherford 2006), it is likely to support a relatively diverse avifauna, possibly including some important populations of rare, threatened and/or endemic species. At least 283 bird species could occur with some regularity within the anticipated impact zone of the wind energy facility (Appendix 1), including 71 endemic or near-endemic species, 17 red-listed species, and five species – Ludwig's Bustard *Neotis ludwigii*, Blue Crane *Anthropoides paradiseus*, Cape Vulture *Gyps coprotheres*, Black Harrier *Circus maurus* and Melodius Lark *Mirafra cheniana* – which are both endemic and red-listed (Barnes 1998, 2000, Table 1). Fifty species were seen during site visit on July 2-3 2010 (Appendix 1), during a spell of windy weather. The area was adequately covered by vehicle and on foot (Fig. 3), and SABAP 2 atlas cards were completed for the pentads 3245_2600 (12 spp.), 3245_2555 (35 spp.), and 3255_2605 (26 spp.).

The most significant information gathered during the site visit included:

(i) Multiple sightings of both Denham's Bustard *Neotis denhami* (two birds together and a singleton on Brakkefonteyn 218 and Brakfontein 220 respectively) and White-bellied Korhaan *Eupodotis senegalensis* (four birds on Brakfontein 141, two birds on Brakkefonteyn 218 - Fig. 3).

(ii) Confirmation from local landowner, hunter and keen birdwatcher, Mark Whitehead, that Melodius Lark *Mirafra cheniana* occurs in the area at least sporadically, and that Martial Eagle *Polemaetus bellicosus* and Black Harrier are regular visitors.

Note that Martial Eagle, Lanner Falcon *Falco biarmicus* and up to six Cape Vultures were seen during a site visit in April 2010 to the Cookhouse Wind Energy Facility (Jenkins 2010), which is proposed for an area which directly abuts the present project. Also, large numbers of migrating kestrels (including some Lesser Kestrels) have been counted at roosts in Pearston, Cradock and occasionally at Somerset East in the last 10-15 years (A.J. van Zyl pers. comm., http://www.kestreling.com/).

Table 2. Priority bird species considered central to the avian impact assessment process for the Amakhala Emoyeni Wind Energy Facility, selected on the basis of South African (Barnes 2000) or global conservation status (www.iucnredlist.org or http://www.birdlife.org/datazone/species/), level of endemicity, relative abundance on site (SABAP reporting rates, direct observation), and estimated conservation or ecological significance of the local population. Red-listed endemic species are shaded in grey.

Common name	Scientific name	SA conservation status/ (Global conservation status)	Regional endemicity	Average SABAP reporting rate (*N* = 54 cards)	Estimated importance of local population	Preferred habitat	Risk posed by		
							Collision	Electro-cution	Disturbance / habitat loss
Denham's Bustard	*Neotis denhami*	Vulnerable (Near-threatened)	-	13.0	Moderate	Open grassland	High	-	High
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable (Endangered)	Near-endemic	7.4	Low	Open grassland	High	_	Moderate
White-bellied Korhaan	*Eupodotis senegalensis*	Near-threatened	Endemic	0.0	High	Open grassland	Moderate	-	High
Blue Crane	*Anthropoides paradiseus*	Vulnerable (Vulnerable)	Endemic	25.9	Moderate	Open grassland, wetlands	High	-	Moderate
Cape Vulture	*Gyps coprotheres*	Vulnerable (Vulnerable)	Endemic	0.0	Moderate	Open grassland (ridges)	High	-	-
Black Harrier	*Circus maurus*	Near-threatened (Vulnerable)	Endemic	3.7	Moderate	Open grassland, wetlands	Moderate	-	Moderate
Martial Eagle	*Polemaetus bellicosus*	Vulnerable (Near-threatened)	-	5.6	Moderate	Open grassland	High	High	Moderate
Secretarybird	*Sagittarius serpentarius*	Near-threatened	-	13.0	Moderate	Open grassland	High	-	Moderate
Lesser Kestrel	*Falco naumanni*	Vulnerable	-	3.7	Low	Open grassland	High	-	-
Lanner Falcon	*Falco biarmicus*	Near-threatened	-	1.9	Moderate	Open grassland (ridges)	High	Moderate	-
Black Stork	*Ciconia nigra*	Near-threatened	-	1.9	Moderate	Wetlands	High	Moderate	-
Melodius Lark	*Mirafra cheniana*	Near-threatened	Endemic	3.7	Moderate	Open grassland	-	-	High

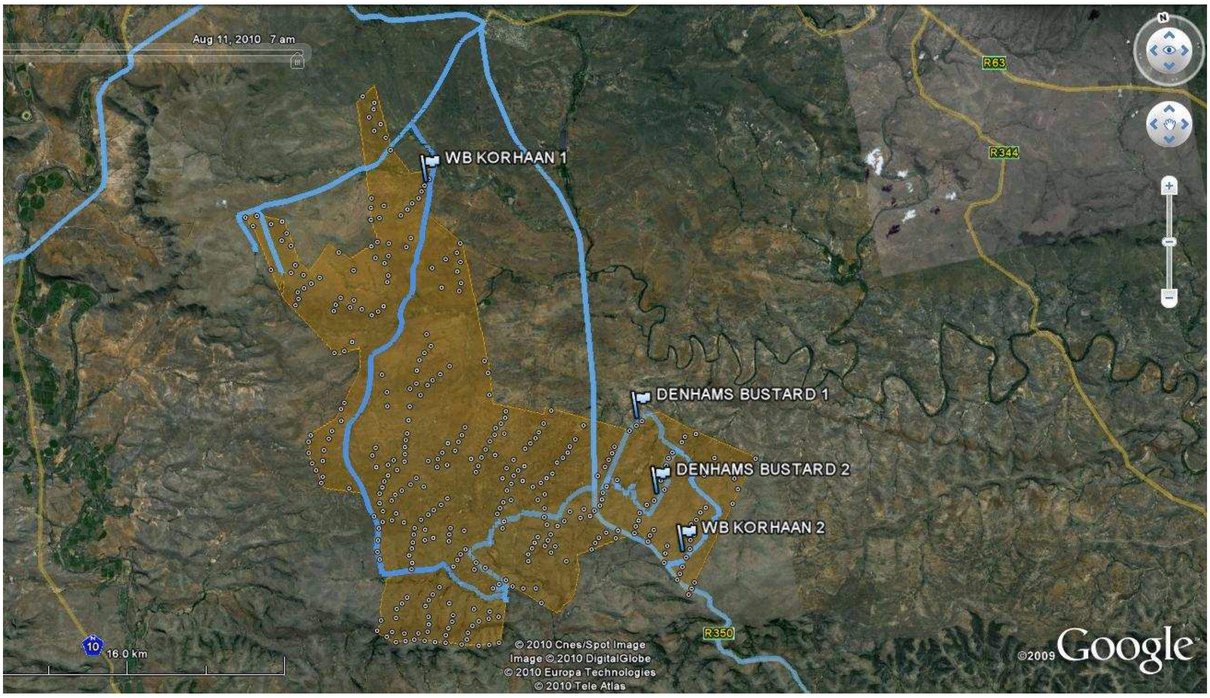

FIGURE 3. Area covered (blue lines) and locations of the most significant bird sightings recorded during the site visit in July 2010, in relation to the proposed location and turbine layout (white circles) of the Amakhala Emoyeni Wind Energy Facility.

On the basis of these on-site observations, and in combination with the available SABAP atlas data for the general area, 12 priority species are recognised as key in the assessment of avian impacts of the proposed Amakhala Emoyeni Wind Energy Facility (Table 2), and as suitable surrogates for impacts on other species. These are mostly nationally and/or globally threatened species which are known to occur, or could occur in relatively high numbers in the development area and which are likely to be, or could be, negatively affected by the wind energy project.

In summary, the birds of greatest potential relevance and importance in terms of the possible impacts of the proposed wind energy facility are likely to be:

(i) Erratic incursions and/or seasonal influxes of non-breeding Cape Vulture, drawn down from higher lying areas to the north-east to feed on stock losses (Boshoff *et al.* 2009a & b). Cape Vulture numbers in South Africa have been decreasing steadily over the last century, and more sharply in recent decades, and the species is classed as both nationally and globally 'Vulnerable' (Barnes 2000, http://www.iucnredlist.org) (Hockey *et al.* 2005). This decline has been particularly evident in the Eastern Cape (Boshoff *et al.* 2009a & b), at least partly because of high mortality rates caused by collisions with overhead lines. It seems likely that the birds which visit the broader Cookhouse area are from an established roost at "Agieskloof", some 10 km to the north-east. This is believed to be mainly a summer roost, used by up to 120 birds in the off-season, and much depleted in the winter (from Feb-March to Sept-Oct) when most of these birds move east to breed (Boshoff *et al.* 2009). Cape Vultures may be attracted to the development area by the combination of (i) open, grassy slopes with good slope soaring conditions, (ii) small stock farming with heavy losses associated with drought and/or lambing and carcasses left where they fall, and (iii) convenient lines of power line pylons to provide safe perch/roost sites. If / when Cape Vultures visit the Amakhala Emoyeni site, they will almost certainly make use of the higher-lying ridges on the site as sources of lift for cross-country flying, possibly bringing them into direct conflict with the development (see 4.1.1 above).

(ii) Flocks or breeding pairs of Blue Crane, resident and/or seasonal influxes of Denham's Bustard and White-bellied Korhaan, and possibly seasonal influxes of Ludwig's Bustard (Young *et al.* 2003, Hockey *et al.* 2005). These are all Red-listed, collision prone (Jenkins *et al.* 2010, Shaw *et al.* 2010b) and possibly displacement prone species.

(iii) A range of locally resident or visiting raptors (including Black Harrier, Martial Eagle, Secretarybird *Sagitarrius serpentarius*, Lesser Kestrel *Falco naumanni* and Lanner Falcon *F. biarmicus*) foraging in or moving through the area. These are all collision and possibly displacement prone species, likely to use ridges occupied by wind turbines as sources of slope lift, bringing them into direct conflict with the development (see 4.1.1 above).

(iv) A suite of restricted range endemic passerines, including Melodius Lark (see Appendix 1), possibly susceptible to loss of habitat and/or displacement from the area by the development of the wind energy facility.

6. IMPACT ASSESSMENT

Impacts of the proposed Wind Energy Facility are most likely to be manifest in the following ways:

(i) Mortality of Cape Vultures foraging in the area, using ridge lines targeted by the development for turbine placements as sources of slope lift, and colliding with the turbine blades or any new power lines associated with the facility.

(ii) Disturbance and displacement of resident/breeding large terrestrial birds (Denham's and Ludwig's Bustards, Blue Crane and White-bellied Korhaan) from nesting and/or foraging areas by construction and/or operation of the facility, and

/or mortality of these species in collisions with the turbine blades or associated new power lines while commuting between resource areas (croplands, nest sites, roost sites/wetlands).

(iii) Displacement of resident/visiting raptors (especially Black Harrier, Martial Eagle, Secretarybird, Lesser Kestrel and Lanner Falcon) from foraging areas by construction and/or operation of the facility, and /or mortality of these species in collisions with the turbine blades or associated new power lines while slope-soaring along the high-lying ridges or hunting in the valleys, or by electrocution when perched on power infrastructure.

(iv) Disturbance and displacement of resident/breeding Grassland endemics (especially Melodious Lark), by construction and/or operation of the facility.

(v) The above impacts may be exacerbated by the cumulative effects of multiple wind energy facilities being developed in the near vicinity. These include at least two projects planned for areas immediately to the east of the Amakhala Emoyeni site – the ACED Cookhouse site (up to 200 turbines – Smallie & Strugnell 2010), which has already been authorised by the DEA, and the Terra Power Cookhouse site (up to 55 turbines) which has already been assessed but not yet authorised. Viewed in isolation, each of these projects may pose only a moderate potential threat to the local avifauna. However, collectively they may amount to >600 turbines spread over >800 km^2, creating (a) a significant deterrent to continued occupation of the area by important populations of threatened species, (b) a substantial barrier to energy-efficient travel between resource areas for such birds, and/or (c) significant levels of artificial mortality in these populations, in collisions with what will be an extensive array of turbines, stretching across many regular flight paths (Masden *et al.* 2010).

Mitigation of these impacts will be best achieved in the following ways:

(i) Minimising the disturbance impacts associated with the construction of the facility, by abbreviating construction time, scheduling activities around avian breeding and/or movement schedules (actual timing to be refined by the results of pre-construction monitoring), and lowering levels of associated noise.

(ii) Minimising habitat destruction caused by the construction of the facility by keeping the lay-down areas as small as possible, building as few temporary roads as possible, and reducing the final extent of developed area to a minimum.

(iii) Minimising the disturbance impacts associated with the operation of the facility, by abbreviating maintenance times, scheduling activities in relation to avian breeding and/or movement schedules (actual timing to be refined by the results of pre-construction monitoring), and lowering levels of associated noise.

(iv) Possibly excluding development from certain high-lying areas where Cape Vultures and other soaring species might be most likely to fly. A decision on if and where to delineate exclusion zones on these peaks and ridges to minimise collision risk for slope soaring birds cannot be made at this stage, in the absence of adequate information on how often, when, under what conditions, and expressly where Cape Vultures and other affected species use these ridges for cross-country flying. This information will require additional observations to be done at the site (e.g. see pre-construction monitoring below).

(v) Ensuring that all dead stock are removed from the land as soon as possible (and perhaps relocated to safe 'restaurant' area for vultures at least 20 km from the site, and that all landowners within a wide radius (>10 km) of the facility are asked to do the same. This should reduce the numbers of vultures attracted to the area and lower the risk of collision.

(vi) Painting one blade of each turbine black to maximise conspicuousness to oncoming birds. The evidence for this as an effective mitigation measure is more suggestive than conclusive. A good option might be to select a number of pairs of neighbouring turbines in potentially high risk locations (determined by pre-construction monitoring), and mark the blades on one and not on the other of each pair. Post-construction monitoring would then provide important empirical evidence for or against blade marking.

(vii) Ensuring that lighting on the turbines is kept to a minimum, and is coloured (red or green) and intermittent, rather than permanent and white, to reduce confusion effects for nocturnal migrants.

(viii) Minimising the length of any new power lines installed, ensuring that all new lines are marked with bird flight diverters (Jenkins *et al.* 2010) from origin to destination, and that all new power infrastructure is adequately insulated and bird friendly in configuration (Lehman *et al.* 2007). Note that current understanding of power line collision risk in birds precludes any guarantee of successfully distinguishing high risk from medium or low risk sections of a new line (Jenkins *et al.* 2010). The relatively low cost of marking the entire length of a new line during construction, especially quite a short length of line in an area frequented by collision prone birds, more than offsets the risk of not marking the correct sections, causing unnecessary mortality of birds, and then incurring the much greater cost of retro-fitting the line post-construction. In situations where new lines run in parallel with existing, unmarked power lines, this approach has the added benefit of reducing the collision risk posed by the older line.

(ix) Carefully monitoring the local avifauna pre- and post-construction (see below), and implementing appropriate additional mitigation as and when significant changes are recorded in the number, distribution or breeding behaviour of any of the priority species listed in this report, or when collision or electrocution mortalities are recorded for any of the priority species listed in this report.

(x) Ensuring that the results of pre-construction monitoring are applied to project-specific impact mitigation in a way that allows for the potentially considerable cumulative effects on the local/regional avifauna of multiple wind energy projects proposed for this area.

(xi) Additional mitigation might include re-scheduling construction or maintenance activities on site, shutting down problem turbines either permanently or at certain times of year or in certain conditions, or installing a 'DeTect' or similar radar tracking system to monitor bird movements and institute temporary shut-downs as and when required.

The latter is an expensive option, but may be requisite if the interface between vultures and turbines is deemed to be too frequent and too direct to avoid significant numbers of vulture fatalities. The size of the proposed facility may compromise the efficacy of this system, but intelligent application in identified, critical areas may be essential.

Table 3. Assessment tables for construction impacts of the proposed Amakhala Emoyeni Wind Energy Facility on the local avifauna.

(A) Disturbance

Nature: Noise, movement and temporary occupation of habitat during the building process. Likely to impact all birds in the area to some extent, but sensitive, sedentary and/or habitat specific species will most adversely affected.

	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Short (1)	Short (1)
Magnitude	High (9)	Medium (7)
Probability	Definite (5)	Definite (5)
Significance	**60 (Medium-High)**	**50 (Medium)**
Status	Negative	Negative
Reversibility	Medium	High
Irreplaceable loss?	Possible	Probably not
Can impacts be mitigated?	Yes	

Mitigation: Abbreviating construction time as far as possible, scheduling activities around avian breeding and/or movement schedules (specifics to be determined by pre-construction monitoring), lowering levels of associated noise, and reducing the size of the inclusive development footprint.

Cumulative impacts: Considerable if, as it seems likely that other wind energy developments could be under construction nearby at the same time.

Residual impacts: Some priority species may move away regardless of mitigation.

(B) Habitat loss

Nature: Destruction of habitat for priority species, either temporary – resulting from construction activities peripheral to the built area, or permanent - the area occupied by the completed development.

	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Medium-High (7)	Low-Medium (5)
Probability	Definite (5)	Definite (5)
Significance	**70 (High)**	**60 (Medium-High)**
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss?	Possible	Probably not
Can impacts be mitigated?	Yes	

Mitigation: Minimising habitat destruction caused by the construction of the facility by keeping the lay-down areas as small as possible, building as few temporary roads as possible, and reducing the final extent of developed area to a minimum.

Cumulative impacts: Yes, more wind energy developments in the area will increase habitat losses exponentially.

Residual impacts: Some species may be permanently lost to the area regardless of mitigation.

Table 4. Assessment tables for operational impacts of the proposed Amakhala Emoyeni Wind Energy Facility on the local avifauna.

(A) Disturbance

Nature: Noise and movement generated by operating turbines and maintenance activities is sufficient to disturb priority species, causing displacement from the area, adjustments to commute routes with energetic costs, or otherwise affecting nesting success or foraging efficiency.

	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Lifetime of the facility (4)	Lifetime of the facility (4)
Magnitude	Moderate (8)	Moderate (7)
Probability	Highly probable (4)	Highly probable (4)
Significance	**56 (Medium)**	**52 (Medium)**
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss?	Possible	Possible
Can impacts be mitigated?	Slightly	

Mitigation: Abbreviating maintenance times as far as possible, scheduling activities in relation to avian breeding and/or movement schedules (specifics to be determined by pre-construction momitoring), and lowering levels of associated noise.

Cumulative impacts: Considerable. At least two more wind energy facilities are proposed for the same general area, substantially raising disturbance levels, and extending the displacement or barrier effect across a broader front.

Residual impacts: Some priority species may be permanently lost from the area.

(B) Mortality

Nature: Collision of priority species with the wind turbine blades and/or any new power lines, or electrocution of the same on new power infrastructure.

	Without mitigation	**With mitigation**
Extent	Regional (3)	Local (2)
Duration	Lifetime of the facility (4)	Lifetime of the facility (4)
Magnitude	High (8)	Low (4)
Probability	Highly probable (4)	Probable (3)
Significance	**60 (Medium-High)**	**30 (Medium)**
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss?	Yes	Possibly not
Can impacts be mitigated?	Yes	

Mitigation: Careful siting of turbines, painting turbine bladesmarking power lines, bird friendly power hardware, monitoring priority bird movements and collisions, turbine management sensitive to these data – radar assisted if necessary.

Cumulative impacts: Yes, if more turbines are built in the same general area, more collision hot-spots are likely, and mortality rates may increase exponentially.

Residual impacts: Some casualties may be incurred regardless of mitigation.

IMPACT STATEMENT

This is a medium-large wind energy project, proposed for a site with few significant conflicting issues in terms of its avifauna. Although the development area does not impinge significantly on any known major bird fly-ways or unique landscape features, it will potentially affect populations of regionally or nationally threatened (and impact susceptible) bird species likely to occur within or close to the proposed turbine arrays. The facility may have a detrimental impact on these birds, particularly during its operational phase, unless significant commitment is made to mitigating these effects. Careful and responsible implementation of the required mitigation measures should reduce construction and operational phase impacts to tolerable and sustainable levels, especially if every effort is made to monitor impacts throughout and to learn as much as possible about the effects of wind energy developments on South Africa avifauna. The impacts of this development must be viewed in the context of the potentially substantial, cumulative effects generated by multiple wind energy projects proposed for the immediate vicinity.

7. MONITORING PROGRAMME

The primary aims of a long-term monitoring programme would be to:

(i) Determine the densities of birds resident within the impact area of the wind energy facility before construction of the facility, and afterwards, once the facility, or phases of the facility, become operational.

(ii) Document patterns of bird activity and movements in the vicinity of the proposed wind energy facility before construction, and afterwards, once the facility is operational.

(iii) 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 facility is commissioned.

(iv) Register and as far as possible document the circumstances surrounding all avian collisions with the 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 (Table 6.1, Appendix 1). Ultimately, the study should provide much needed quantitative information on the effects of the facility 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 wind energy sites in the region. This programme outline is informed by monitoring studies established in other countries (e.g. Erickson *et al.* 1999, Scottish National Heritage 2005), but is based substantially on those developed for both the Darling and the Klipheuwel wind power demonstration facilities in South Africa (Jenkins 2003, Küyler 2004). The bulk of the work involved should be done by an expert ornithologist or under the supervision of such.

7.1 Monitoring protocols

7.1.1 Avian densities before and after

A set of at least 10 walk-transect routes, each of at least 1000 m in length, should be established in areas representative of all the avian habitats present within a 10 km radius of the centre of the 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 facility 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, any cliff-lines within the development area should surveyed for cliff-nesting raptors at least every six months using documented protocols (Malan 2009), and all sightings of key species (Table 6.1) on site should carefully plotted and documented, and the major waterbodies on and close to the development area should be surveyed for wetland species on each visit to the study area, using the standard protocols set out by the CWAC initiative (Taylor *et al.* 1999).

7.1.2 Bird activity monitoring

Monitoring of bird activity in the vicinity of the facility 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 facility is commissioned. Each monitoring day should involve:

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

(ii) Opportunistic surveys of large terrestrial species and raptors seen when travelling around the site.

7.1.3 Passage rates of priority bird species

Counts of bird traffic over and around the proposed/operational facility 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 site), 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 the facility. 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 wind energy facility. The time and weather conditions should again be noted at the end of each count.

7.2 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.

7.2.1 Assessing search efficiency and scavenging rates

The value of surveying the area for collision victims only holds if some measure of the accuracy of the survey method is developed (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.

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

In tandem with surveys of the wind farm for collision casualties, sample sections of any new lengths of power line associated with the development should also be surveyed for collision victims using established protocols (see Jenkins *et al.* 2009, Jenkins *et al.* 2010, Shaw *et al.* 2010 a & b).

8. INPUTS TO THE ENVIRONMENTAL MANAGEMENT PLAN

OBJECTIVE:	A wind energy facility that is sustainable in terms of its impacts on local avifauna
Project components	Conducting comprehensive pre- and post-construction monitoring of local avifauna (as per 7. Above) Getting the monitoring protocols right Securing the strategic use of radar (if required) Selecting and training a good monitoring team Collecting and collating sufficient accurate survey data pre-construction Analysing the the pre-construction survey data to inform the final layout and the construction schedule Collecting and collating sufficient accurate survey data post-construction Analysing the post-construction survey data to inform the sustainable management of the facility
Activity/risk source	Starting pre-construction monitoring too late Appointment of unqualified personnel to do the monitoring Use of radar (if required) as a monitoring tool is not approved by the client Results of pre-construction monitoring not integrated into the final layout and/or the mitigation scheme Lack of clear communication between the scientist analysing the monitoring data and the client Misinterpetation of either the pre- or post-construction monitoring data
Mitigation: Target/Objective	The delivery of an effective impact mitigation scheme for the facility, informed initially by influence of pre-construction monitoring on final construction plans, and refined by post-construction monitoring of actual impacts, and resulting adjustments in management practices and mitigation measures applied

Mitigation: Action/control	Responsibility	Timeframe
Appoint advising scientist and agency to conduct pre- and post-construction monitoring	Client	As soon as possible / practical
Refine monitoring protocol and determine the extent of radar deployment required	Advising scientist, in negotiation with the client	As soon as possible / practical
Appoint radar technologists to service the project, and acquire/hire hardware, software and relevant expertise, IF radar use is required and approved	Advising scientist, in negotiation with the client	As soon as possible / practical
Start pre-construction monitoring	Monitoring agency	1 year before construction is due to start
Periodically collate an analyse pre-construction monitoring	Advising scientist and radar specialist (if	Every 3 months of monitoring

data	applicable)	
Review report on the full year of pre-construction monitoring, and integrate findings into construction EMP and broader mitigation scheme	Advising scientist, monitoring agency and radar specialist (if applicable), in negotiation with the client	After a year of pre-construction monitoring
Ensure construction EMP is applied	Relevant Environmental Control Officer	During construction
Refine post-construction monitoring protocol in terms of results pre-construction, and determine the extent of radar deployment required	Advising scientist, monitoring agency and radar specialist (if applicable), in negotiation with the client	As soon as possible / practical after construction completed
Start post-construction monitoring	Monitoring agency	6 months after construction is completed
Periodically collate an analyse post-construction monitoring data	Advising scientist and radar specialist (if applicable)	Every 3 months of monitoring
Review report on the full year of post-constrcution monitoring, and integrate findings into operational EMP and broader mitigation scheme	Advising scientist, monitoring agency and radar specialist (if applicable), in negotiation with the client	1 year post-construction
Review the need for further post-construction monitoring	Advising scientist, monitoring agency and radar specialist (if applicable), in negotiation with the client	1 year post-construction

Performance indicator	Regular provision of clearly worded, logical and objective information on the interface between the local avifauna and the proposed/operating wind energy facility Clear and logical recommendations on why, how and when to institute mitigation measures to reduce avian impacts of the development, from pre-construction to operational phase Quantifiable reductions in avian impacts once the facility is operational
Monitoring	3-monthly and annual reports produced by the scientist advising the monitoring project

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Appendix 1. Annotated list of the bird species considered likely to occur within the impact zone of the proposed Amakhala Emoyeni Wind Energy Facility. Species seen during the July site visit appear in **bold**.

SPECIES	SCIENTIFIC NAME	CONSERVATION STATUS	ENDEMICITY	HABITAT		
				Grasslands (incl. light *Acacia* woodland)	**Thicket** (incl. dense riparian woodland)	**Wetlands** (incl. vleis, rivers and dams)
Common Ostrich	*Struthio camelus*			X		
Grey-winged Francolin	*Scleroptila africanus*		Endemic	X		
Common Quail	*Coturnix coturnix*			X		
Helmeted Guineafowl	***Numida meleagris***			**X**		
Egyptian Goose	***Alopochen aegyptiaca***					**X**
South African Shelduck	***Tadorna cana***		**Endemic**			**X**
Spur-winged Goose	*Plectropterus gambensis*					X
African Black Duck	*Anas sparsa*					X
Yellow-billed Duck	***Anas undulata***					**X**
Cape Shoveler	*Anas smithii*		Endemic			X
Red-billed Teal	*Anas erythrorhyncha*					X
Greater Honeyguide	*Indicator indicator*				X	
Lesser Honeyguide	*Indicator minor*				X	
Red-throated Wryneck	*Jynx ruficollis*				X	
Cardinal Woodpecker	*Dendropicos fuscescens*				X	
Acacia Pied Barbet	***Tricholaema leucomelas***		**Near-endemic**		**X**	
Black-collared Barbet	*Lybius torquatus*				X	
Red-fronted Tinkerbird	*Pogoniulus pusillus*				X	
Crowned Hornbill	*Tockus alboterminatus*				X	
African Hoopoe	***Upupa africana***				**X**	
Green Wood-Hoopoe	*Phoeniculus purpureus*				X	
European Roller	*Coracias garrulus*			X		
Malachite Kingfisher	*Alcedo cristata*					X
Brown-hooded Kingfisher	*Halcyon albiventris*				X	
Giant Kingfisher	*Megaceryle maximus*					X
Pied Kingfisher	*Ceryle rudis*					X

SPECIES	SCIENTIFIC NAME	CONSERVATION STATUS	ENDEMICITY	HABITAT		
				Grasslands (incl. light *Acacia* woodland)	**Thicket** (incl. dense riparian woodland)	**Wetlands** (incl. vleis, rivers and dams)
European Bee-eater	*Merops apiaster*			X		
White-backed Mousebird	*Colius colius*				X	
Speckled Mousebird	*Colius striatus*				X	
Red-faced Mousebird	***Urocolius indicus***				**X**	
Jacobin Cuckoo	*Clamator jacobinus*				X	
Great Spotted Cuckoo	*Clamator glandarius*				X	
Red-chested Cuckoo	*Cuculus solitarius*				X	
Black Cuckoo	*Cuculus clamosus*				X	
Common Cuckoo	*Cuculus canorus*				X	
Klaas's Cuckoo	*Chrysococcyx klaas*				X	
Diderick Cuckoo	*Chrysococcyx caprius*				X	
Burchell's Coucal	*Centropus burchellii*					X
Alpine Swift	*Tachymarptis melba*			X		
Common Swift	*Apus apus*			X		
African Black Swift	*Apus barbatus*			X		
Little Swift	*Apus affinis*			X		
Horus Swift	*Apus horus*			X		
White-rumped Swift	*Apus caffer*			X		
Barn Owl	*Tyto alba*			X	X	
Cape Eagle-Owl	*Bubo capensis*			X		
Spotted Eagle-Owl	*Bubo africanus*			X	X	
Fiery-necked Nightjar	*Caprimulgus pectoralis*				X	
Rufous-cheeked Nightjar	*Caprimulgus rufigena*				X	
Rock Dove	*Columba livia*			X		
Speckled Pigeon	*Columba guinea*			X		
African Olive-Pigeon	*Columba arquatrix*				X	
Laughing Dove	***Streptopelia senegalensis***			**X**	**X**	
Cape Turtle-Dove	***Streptopelia capicola***			**X**	**X**	
Red-eyed Dove	***Streptopelia semitorquata***				**X**	

SPECIES	SCIENTIFIC NAME	CONSERVATION STATUS	ENDEMICITY	HABITAT		
				Grasslands (incl. light *Acacia* woodland)	**Thicket** (incl. dense riparian woodland)	**Wetlands** (incl. vleis, rivers and dams)
Namaqua Dove	*Oena capensis*			X		
Denham's Bustard	***Neotis denhami***	**Vulnerable**		**X**		
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable	Near-endemic	X		
Kori Bustard	*Aredeotis kori*	Vulnerable		X		
Southern Black Korhaan	***Afrotis afra***		**Endemic**	**X**		
Karoo Korhaan	*Eupodotis vigorsii*		Endemic	X		
White-bellied Korhaan	***Eupodotis senegalensis***	**Vulnerable**		**X**		
Blue Crane	*Anthropoides paradiseus*	Vulnerable	Endemic	X		X
African Rail	*Rallus caerulescens*					X
Black Crake	*Amaurornis flavirostris*					X
Common Moorhen	*Gallinula chloropus*					X
Red-knobbed Coot	*Fulica cristata*					X
Namaqua Sandgrouse	*Pterocles namaqua*		Near-endemic	X		
African Snipe	*Gallinago nigripennis*					X
Marsh Sandpiper	*Tringa stagnatilis*					X
Common Greenshank	*Tringa nebularia*					X
Common Sandpiper	*Actitis hypoleucos*					X
African Jacana	*Actophilornis africanus*					X
Spotted Thick-knee	*Burhinus capensis*			X		
Black-winged Stilt	*Himantopus himantopus*					X
Pied Avocet	*Recurvirostra avosetta*					X
Kittlitz's Plover	*Charadrius pecuarius*			X		X
Three-banded Plover	*Charadrius tricollaris*					X
Blacksmith Lapwing	***Vanellus armatus***					**X**
Crowned Lapwing	***Vanellus coronatus***			**X**		
Double-banded Courser	*Rhinoptilus africanus*			X		
Grey-headed Gull	*Larus cirrocephalus*					X
White-winged Tern	*Chlidonias leucopterus*					X
Black-shouldered Kite	*Elanus caeruleus*			X	X	

SPECIES	SCIENTIFIC NAME	CONSERVATION STATUS	ENDEMICITY	HABITAT		
				Grasslands (incl. light *Acacia* woodland)	**Thicket** (incl. dense riparian woodland)	**Wetlands** (incl. vleis, rivers and dams)
Black Kite	*Milvus migrans*			X	X	
African Fish-Eagle	*Haliaeetus vocifer*				X	X
Cape Vulture	*Gyps coprotheres*	Vulnerable	Endemic	X		
African Marsh-Harrier	*Circus ranivorus*	Vulnerable				X
Black Harrier	*Circus maurus*	Near-threatened	Endemic	X		X
Pallid Harrier	*Circus macrourus*	Near-threatened		X		
African Harrier-Hawk	*Polyboroides typus*			X	X	
Southern Pale Chanting Goshawk	***Melierax canorus***		**Near-endemic**	**X**	**X**	
Gabar Goshawk	*Melierax gabar*				X	
African Goshawk	*Accipiter tachiro*				X	
Little Sparrowhawk	*Accipiter minullus*				X	
Rufous-chested Sparrowhawk	*Accipiter rufiventris*			X	X	
Black Sparrowhawk	*Accipiter melanoleucus*				X	
Steppe Buzzard	*Buteo vulpinus*			X	X	
Jackal Buzzard	*Buteo rufofuscus*		Endemic	X	X	
Verreaux's Eagle	*Aquila verreauxii*			X		
Booted Eagle	*Aquila pennatus*			X		
Martial Eagle	*Polemaetus bellicosus*	Vulnerable		X	X	
Secretarybird	*Sagittarius serpentarius*	Near-threatened		X		
Lesser Kestrel	*Falco naumanni*	Vulnerable		X		
Rock Kestrel	***Falco rupicolus***			**X**		
Greater Kestrel	*Falco rupicoloides*			X		
Amur Falcon	*Falco amurensis*			X		
Eurasian Hobby	*Falco subbuteo*			X	X	
Lanner Falcon	***Falco biarmicus***	**Near-threatened**		**X**		
Peregrine Falcon	*Falco peregrinus*	Near-threatened		X		
Little Grebe	*Tachybaptus ruficollis*					X
African Darter	*Anhinga rufa*					X
Reed Cormorant	*Phalacrocorax africanus*					X

SPECIES	SCIENTIFIC NAME	CONSERVATION STATUS	ENDEMICITY	HABITAT		
				Grasslands (incl. light *Acacia* woodland)	**Thicket** (incl. dense riparian woodland)	**Wetlands** (incl. vleis, rivers and dams)
White-breasted Cormorant	*Phalacrocorax lucidus*					X
Little Egret	*Egretta garzetta*					X
Yellow-billed Egret	*Egretta intermedia*					X
Great Egret	*Egretta alba*					X
Grey Heron	*Ardea cinerea*					X
Black-headed Heron	*Ardea melanocephala*			X		X
Goliath Heron	*Ardea goliath*					X
Purple Heron	*Ardea purpurea*					X
Cattle Egret	*Bubulcus ibis*			X		X
Squacco Heron	*Ardeola ralloides*					X
Black-crowned Night-Heron	*Nycticorax nycticorax*					X
Little Bittern	*Ixobrychus minutus*					X
Hamerkop	*Scopus umbretta*					X
Glossy Ibis	*Plegadis falcinellus*					X
Hadeda Ibis	***Bostrychia hagedash***				**X**	**X**
African Sacred Ibis	*Threskiornis aethiopicus*					X
African Spoonbill	*Platalea alba*					X
Yellow-billed Stork	*Mycteria ibis*	Near-threatened				X
Black Stork	*Ciconia nigra*	Near-threatened		X		X
White Stork	*Ciconia ciconia*			X		X
Eurasian Golden Oriole	*Oriolus oriolus*				X	
Black-headed Oriole	*Oriolus larvatus*				X	
Fork-tailed Drongo	***Dicrurus adsimilis***				**X**	
African Paradise-Flycatcher	*Terpsiphone viridis*				X	
Black-backed Puffback	*Dryoscopus cubla*				X	
Southern Tchagra	*Tchagra tchagra*		Endemic		X	
Southern Boubou	*Laniarius ferrugineus*		Endemic		X	
Bokmakierie	*Telophorus zeylonus*		Near-endemic		X	
Olive Bush-Shrike	*Telophorus olivaceus*		Near-endemic		X	

SPECIES	SCIENTIFIC NAME	CONSERVATION STATUS	ENDEMICITY	HABITAT		
				Grasslands (incl. light *Acacia* woodland)	**Thicket** (incl. dense riparian woodland)	**Wetlands** (incl. vleis, rivers and dams)
Cape Batis	*Batis capensis*		Endemic		X	
Chinspot Batis	***Batis molitor***				**X**	
Pririt Batis	*Batis pririt*		Near-endemic		X	
Cape Crow	***Corvus capensis***			**X**		
Pied Crow	***Corvus albus***			**X**	**X**	
White-necked Raven	***Corvus albicollis***			**X**		
Red-backed Shrike	*Lanius collurio*			X	X	
Lesser Grey Shrike	*Lanius minor*			X		
Common Fiscal	***Lanius collaris***			**X**	**X**	
Cape Penduline-Tit	*Anthoscopus minutus*		Near-endemic		X	
Grey Tit	*Parus afer*		Endemic	X	X	
Southern Black Tit	***Parus niger***			**X**	**X**	
Sand Martin	*Riparia riparia*			X		X
Brown-throated Martin	*Riparia paludicola*					X
Banded Martin	*Riparia cincta*			X		X
Barn Swallow	*Hirundo rustica*			X		X
White-throated Swallow	*Hirundo albigularis*					X
Pearl-breasted Swallow	*Hirundo dimidiata*			X		X
Greater Striped Swallow	*Hirundo cucullata*			X		X
Lesser Striped Swallow	*Hirundo abyssinica*			X		X
South African Cliff-Swallow	*Hirundo spilodera*		Breeding endemic	X		
Rock Martin	*Hirundo fuligula*			X		
Common House-Martin	*Delichon urbicum*			X		X
Black Saw-wing	*Psalidoprocne holomelaena*				X	
Dark-capped Bulbul	*Pycnonotus tricolor*				X	
African Red-eyed Bulbul	*Pycnonotus nigricans*		Near-endemic		X	
Cape Bulbul	*Pycnonotus capensis*		Endemic		X	
Sombre Greenbul	***Andropadus importunus***				**X**	
Fairy Flycatcher	*Stenostira scita*		Endemic	X	X	

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				Grasslands (incl. light *Acacia* woodland)	**Thicket** (incl. dense riparian woodland)	**Wetlands** (incl. vleis, rivers and dams)
Cape Grassbird	*Sphenoeacus afer*		Endemic	X		
Long-billed Crombec	*Sylvietta rufescens*				X	
Yellow-bellied Eremomela	*Eremomela icteropygialis*				X	
Karoo Eremomela	***Eremomela gregalis***		**Endemic**	**X**		
Little Rush-Warbler	*Bradypterus baboecala*					X
African Reed-Warbler	*Acrocephalus baeticatus*					X
Lesser Swamp Warbler	*Acrocephalus gracilirostris*					X
Willow Warbler	*Phylloscopus trochilus*				X	
Layard's Tit-Babbler	*Parisoma layardi*		Endemic	X	X	
Chestnut-vented Tit-Babbler	***Parisoma subcaeruleum***		**Near-endemic**	**X**	**X**	
Garden Warbler	*Sylvia borin*				X	
Cape White-eye	*Zosterops virens*		Endemic		X	
Orange River White-eye	*Zosterops pallidus*		Endemic		X	
Lazy Cisticola	*Cisticola aberrans*			X		
Grey-backed Cisticola	*Cisticola subruficapilla*			X	X	
Wailing Cisticola	*Cisticola lais*				X	
Levaillant's Cisticola	*Cisticola tinniens*					X
Neddicky	***Cisticola fulvicapilla***			**X**		
Zitting Cisticola	*Cisticola juncidis*			X		
Desert Cisticola	*Cisticola aridulus*			X		
Cloud Cisticola	*Cisticola textrix*		Near-endemic	X		
Karoo Prinia	*Prinia maculosa*		Endemic	X	X	
Namaqua Warbler	*Phragmacia substriata*		Endemic		X	
Rufous-eared Warbler	***Malcorus pectoralis***		**Endemic**	**X**		
Bar-throated Apalis	*Apalis thoracica*				X	
Yellow-breasted Apalis	*Apalis flavida*				X	
Melodious Lark	*Mirafra cheniana*	Near-threatened	Endemic	X		
Rufous-naped Lark	*Mirafra africana*			X		
Cape Clapper Lark	*Mirafra apiata*		Endemic	X		

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				Grasslands (incl. light *Acacia* woodland)	**Thicket** (incl. dense riparian woodland)	**Wetlands** (incl. vleis, rivers and dams)
Eastern Clapper Lark	*Mirafra fasciolata*		Near-endemic	X		
Sabota Lark	*Calendulauda sabota*		Near-endemic	X		
Spike-heeled Lark	***Chersomanes albofasciata***			**X**		
Eastern Long-billed Lark	*Certhilauda semitorquata*		Endemic	X		
Grey-backed Sparrowlark	*Eremopterix verticalis*		Near-endemic	X		
Red-capped Lark	***Calandrella cinerea***			**X**		
Large-billed Lark	***Galerida magnirostris***		**Endemic**	**X**		
Cape Rock-Thrush	*Monticola rupestris*		Endemic	X		
Sentinel Rock-Thrush	*Monticola explorator*		Endemic	X		
Karoo Thrush	*Turdus smithi*		Endemic	X	X	
Chat Flycatcher	*Bradornis infuscatus*		Near-endemic	X		
Fiscal Flycatcher	***Sigelus silens***		**Endemic**		**X**	
Spotted Flycatcher	*Muscicapa striata*				X	
African Dusky Flycatcher	*Muscicapa adusta*				X	
Cape Robin-Chat	*Cossypha caffra*				X	
White-browed Scrub-Robin	***Cercotrichas leucophrys***				**X**	
Karoo Scrub-Robin	*Cercotrichas coryphoeus*		Endemic	X	X	
African Stonechat	*Saxicola torquatus*			X		
Mountain Wheatear	*Oenanthe monticola*		Near-endemic	X		
Capped Wheatear	*Oenanthe pileata*			X		
Sickle-winged Chat	***Cercomela sinuata***		**Endemic**	**X**		
Karoo Chat	*Cercomela schlegelii*		Near-endemic	X		
Familiar Chat	***Cercomela familiaris***			**X**		
Ant-eating Chat	***Myrmecocichla formicivora***		**Endemic**	**X**		
Mocking Cliff-Chat	*Thamnolaea cinnamomeiventris*			X		
Pale-winged Starling	*Onychognathus nabouroup*		Near-endemic	X		
Red-winged Starling	***Onychognathus morio***			**X**		
Cape Glossy Starling	***Lamprotornis nitens***				**X**	

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				Grasslands (incl. light *Acacia* woodland)	**Thicket** (incl. dense riparian woodland)	**Wetlands** (incl. vleis, rivers and dams)
Pied Starling	***Spreo bicolor***		**Endemic**	**X**		
Wattled Starling	*Creatophora cinerea*			X	X	
Common Starling	*Sturnus vulgaris*				X	
Amethyst Sunbird	*Chalcomitra amethystina*				X	
Malachite Sunbird	*Nectarinia famosa*			X	X	
Southern Double-collared Sunbird	*Cinnyris chalybeus*		Endemic	X	X	
Greater Double-collared Sunbird	***Cinnyris afer***		**Endemic**	**X**		
Dusky Sunbird	*Cinnyris fuscus*		Near-endemic	X		
Scaly-feathered Finch	*Sporopipes squamifrons*		Near-endemic	X		
White-browed Sparrow-Weaver	*Plocepasser mahali*			X		
Spectacled Weaver	*Ploceus ocularis*				X	
Cape Weaver	*Ploceus capensis*		Endemic	X	X	X
Southern Masked-Weaver	*Ploceus velatus*			X	X	X
Village Weaver	*Ploceus cucullatus*				X	
Red-billed Quelea	***Quelea quelea***			**X**		**X**
Yellow-crowned Bishop	*Euplectes afer*					X
Southern Red Bishop	*Euplectes orix*			X		X
Yellow Bishop	*Euplectes capensis*			X		X
Long-tailed Widowbird	***Euplectes progne***			**X**		**X**
Red-collared Widowbird	*Euplectes ardens*			X		
African Quailfinch	*Ortygospiza atricollis*			X		
Red-headed Finch	*Amadina erythrocephala*		Near-endemic	X	X	
Swee Waxbill	*Coccopygia melanotis*		Endemic		X	
Common Waxbill	*Estrilda astrild*			X	X	X
Red-billed Firefinch	*Lagonosticta senegala*				X	
African Firefinch	*Lagonosticta rubricata*				X	
Bronze Mannikin	*Spermestes cucullatus*			X		X
Pin-tailed Whydah	*Vidua macroura*			X		

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				Grasslands (incl. light *Acacia* woodland)	**Thicket** (incl. dense riparian woodland)	**Wetlands** (incl. vleis, rivers and dams)
Dusky Indigobird	*Vidua funerea*				X	
House Sparrow	*Passer domesticus*			X	X	X
Cape Sparrow	***Passer melanurus***		**Near-endemic**	**X**		
Southern Grey-headed Sparrow	*Passer diffusus*			X		
Yellow-throated Petronia	*Petronia superciliaris*				X	
African Pied Wagtail	*Motacilla aguimp*					X
Cape Wagtail	***Motacilla capensis***			**X**		**X**
Yellow Wagtail	*Motacilla flava*					X
Cape Longclaw	***Macronyx capensis***		**Endemic**	**X**		
African Rock Pipit	*Anthus crenatus*		Endemic	X		
African Pipit	***Anthus cinnamomeus***			**X**		
Plain-backed Pipit	*Anthus leucophrys*			X		
Buffy Pipit	*Anthus vaalensis*			X		
Long-billed Pipit	***Anthus similis***			**X**		
Cape Canary	*Serinus canicollis*		Endemic	X	X	
Black-headed Canary	*Serinus alario*		Endemic	X		
Yellow-fronted Canary	*Crithagra mozambicus*			X	X	
Black-throated Canary	*Crithagra atrogularis*			X		
Forest Canary	*Crithagra scotops*		Endemic		X	
Yellow Canary	*Crithagra flaviventris*		Near-endemic	X		
Brimstone Canary	*Crithagra sulphuratus*			X	X	
White-throated Canary	*Crithagra albogularis*		Near-endemic	X		
Streaky-headed Seedeater	*Crithagra gularis*			X	X	
Lark-like Bunting	*Emberiza impetuani*		Near-endemic	X		
Cinnamon-breasted Bunting	*Emberiza tahapisi*			X		
Cape Bunting	*Emberiza capensis*		Near-endemic	X		
Golden-breasted Bunting	*Emberiza flaviventris*				X	