Taaibos South Wind Farm

WKN Windcurrent SA (Pty) Ltd

Avifaunal Impact Assessment

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Submitted to:

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EXECUTIVE SUMMARY

WKN Windcurrent SA (Pty) Ltd (WKN Windcurrent) is currently developing a potential Wind Energy Facility (WEF) known as the Taaibos South Wind Farm in the Northern Cape province of South Africa. As part of the feasibility investigations towards obtaining Environmental Authorisation, WildSkies Ecological Services (Pty) Ltd previously conducted an avifaunal screening assessment for the site (WildSkies, 2020). WKN Windcurrent refined the developable area on the basis of identified avifaunal constraints. This included running the VERA (Verreaux's Eagle Risk Assessment) model to identify high and medium risk areas around seven Verreaux's Eagle nests that surround the site boundary. WKN Windcurrent then appointed WildSkies to conduct the necessary 12 months pre-construction bird monitoring for the developable area which has recently concluded. WildSkies has now been appointed to conduct this avifaunal impact assessment for the environmental authorisation application, managed by CES Environmental and Social Advisory Services (CES).

This report presents findings from the six pre-construction bird monitoring Site Visits spanning a year of avifaunal monitoring. Data from various methodologies have been analysed and are presented for the full site throughout the report. Site Visits were conducted as follows:

- Site Visit 1: 27 March – 1 April 2021
- Site Visit 2: 25 May – 3 June 2021
- Site Visit 3: 5 – 10 August 2021
- Site Visit 4: 9 – 16 October 2021
- Site Visit 5: 3 – 7 January 2022
- Site Visit 6: 20 – 23 March 2022 & 7 – 10 April 2022

We draw the following conclusions regarding the avifaunal community and potential impacts of the proposed wind farm:

- We classified two species as being at High risk should the project proceed, and three species at Medium risk. High risk species include: Martial Eagle (Endangered) and Verreaux's Eagle (Vulnerable). Ludwig's Bustard (Endangered), Black Harrier (Endangered) and Jackal Buzzard (near endemic, not Red Listed) were classified as Medium risk.
- It is estimated that approximately 0.32 bird fatalities could be recorded at the wind farm per year across the 15 target bird species recorded flying on site for a turbine rotor swept area of 30 – 270m. This includes: 0.08 Verreaux's Eagles; 0.02 Ludwig's Bustards; and 0.13 Jackal Buzzards. These estimates could be reduced with an increase in minimum blade height above ground as most bird flight was recorded closer to the ground than 30m. There are currently no established

thresholds for acceptable impacts on bird species in South Africa. In the absence of this information we are forced to make a subjective decision as to the acceptability of the above estimates. In our view the above fatality rates are of Low significance for all target species, however, we wish to include a caveat that these data are subject to limitations and represent an absolute minimum baseline.

CES has been appointed as the EAP and using the formal impact assessment methods supplied by CES our impact significance findings are presented in this Impact Assessment report. We assessed the potential impacts on birds during three Phases of development: Construction, Operation and Decommissioning, and made the following findings:

- Habitat destruction significance will be Low (or at worst Medium) Negative. Since this habitat destruction is largely unavoidable, we anticipate that the impact significance will remain unchanged by mitigation.
- Disturbance of birds during construction is likely to be of Low Negative significance (post-application of nest buffers).
- Disturbance of birds during operations will be of Low Negative significance.
- Displacement of birds during operations will be of Low Negative significance.
- The impact of bird collision with turbines is likely to be of Moderate Negative significance and must be effectively mitigated. Given the uncertainty around the effectiveness of the mitigation measures recommended, the significance is likely to remain at Moderate Negative post-mitigation.
- Bird electrocution and collision on overhead power lines have the potential to be of Moderate Negative significance pre-mitigation. If the above-ground power line is designed to be bird-friendly (for electrocution) and installed with line-marking devices (for collision) this impact may be relatively easily reduced to a Low Negative significance post-mitigation for electrocution, but remains at Moderate Negative for collisions, due to the mitigation not being 100% effective.

In addition to the avoidance measures already implemented by the project, the following mitigation is recommended:

1. The constraint areas identified by this study (which build on those identified in the screening phase) should be adhered to.
2. A pre-construction avifaunal walk down should be conducted to confirm final layout and identify any sensitivities that may arise between the conclusion of the EIA process and the construction phase.

3. All human activities associated with construction, operation and decommissioning should be strictly managed according to generally accepted environmental best practice standards, so as to avoid any unnecessary impact on the receiving environment.
4. Use should be made of existing roads as far as possible.
5. All staff, vehicle and machinery activities should be strictly controlled at all times so as to ensure that the absolute minimum of surface area is impacted.
6. Care should be taken not to introduce or propagate alien plant species/weeds during construction.
7. Any underground cabling should follow roads at all times to reduce the impact on the habitat by grouping these linear infrastructures.
8. A post-construction inspection must be conducted by an avifaunal specialist to confirm that all aspects have been appropriately handled and in particular that road and hard stand verges do not provide additional substrate for raptor prey species. It is essential that the new wind farm does not create favourable conditions for such mammals in high risk areas. We therefore recommend that within the first year of operations a full assessment of this aspect be made by the ornithologist contracted for post-construction monitoring. If such conditions have been created, case-specific solutions will need to be developed and implemented by the wind farm. It is strongly recommended that rodenticides not be used at the newly established Operation and Maintenance (O&M) buildings or around auxiliary infrastructure on the project site. While pest control of this nature may be effective, even so-called "environmentally friendly" rodenticides are toxic and pose significant secondary poisoning risk to predatory avifauna, especially owls.
9. A bird fatality threshold and adaptive management policy must be designed by an ornithologist for the site prior to the Commercial Operation Date (COD). This policy should form an annexure of the operational EMP for the facility. This policy should identify most importantly the number of bird fatalities of priority species which will trigger a management response, appropriate responses, and time lines for such responses. Fatalities of priority bird species are usually rare events (but with very high consequence) and it is difficult to analyse trends or statistics related to these fatalities as they occur. It is therefore important to have a threshold policy in place proactively to assist adaptive management.
10. An observer-led turbine Shutdown on Demand (SDOD) programme must be implemented on site from COD. This programme must consist of a suitably qualified, trained and resourced team of observers present on site for all daylight hours 365 days of the year. This team must be stationed at vantage points with full visible coverage of all turbine locations. The observers must detect incoming priority bird species, track their flights, judge when they enter a turbine proximity threshold, and alert the control room to shut down the relevant turbine until the risk has reduced. A full detailed method statement or protocol must be designed by an ornithologist prior to COD, and included as an annexure of the EMP.

11. The combination of hub height and rotor diameter must be optimised to maximise the lower blade tip height above ground. Raising the lower turbine blade tip height from a typical 30m above ground to 80m above ground will reduce collision risk for cranes, Ludwig's Bustards, Black Harrier and korhaans, which typically fly low over the ground. Raising the lower blade tip from 30 to 80m above ground as a mitigation measure benefited every target species (in terms of reduced predicted mortality). Low sample size in this study was a limitation although it has been predicted to significantly reduce fatality rates on similar projects and we recommend the implementation of this measure.
12. All turbine blades must be painted according to a protocol currently under development by the South African Wind Energy Association (SAWEA) from the outset. Provision must be made by the developer for the resolution of any technical, warranty, supplier challenges that this may present.
13. Any residual impacts after all possible mitigation measures have been implemented will need to be mitigated off site. The facility will need to address other sources of mortality of priority species in a measurable way so as to compensate for residual effects on the facility itself. This will need to be detailed in a Biodiversity Action Plan.
14. No internal medium voltage power lines should be overhead. All such cables should be buried along road verges. Only the 132kV collector lines and grid connection power line should be above ground.
15. Any overhead conductors or earth wires should be fitted with an Eskom approved anti-bird collision line-marking device to make cables more visible to birds in flight and reduce the likelihood of collisions.
16. The pole design of any overhead power line should be approved by an ornithologist in terms of the electrocution risk it may pose to large birds such as eagles.
17. All overhead power line within 6km of turbines should be regularly (at least quarterly) surveyed for eagle nests as part of the operational monitoring of the wind farm. The establishment of such nests would bring eagles closer to the turbines than currently the case, and increase collision risk. Any such nests should be reported to an avifaunal specialist for case specific advice.
18. Should more than one power line be constructed in parallel with another either new or pre-existing power line, the pylon structures should be staggered as per Pallett *et al*. (2022) to increase visibility to large, slow-moving species, especially bustards and cranes.
19. The "during construction" and "post-construction" monitoring programme outlined in **Appendix 7** should be implemented according to the latest available version of the Best Practice Guidelines at the time. The findings from operational phase monitoring should inform an adaptive management programme to mitigate any impacts on avifauna to acceptable levels. In particular, any Verreaux's Eagle fatalities should be reported to Dr Megan Murgatroyd in order to close the feedback loop back to the VERA modelling performed for this site.

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

PROPOSED TAAIBOS SOUTH WIND FARM

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
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Departmental Details

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Physical address:
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Attention: Chief Director: Integrated Environmental Authorisations Environment House 473 Steve Biko Road Arcadia Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at: Email: EIAAdmin@environment.gov.za

SPECIALIST INFORMATION

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B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	100
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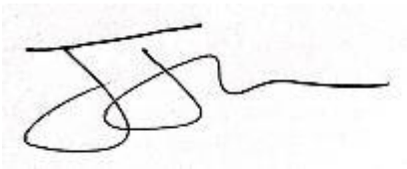
SPECIALIST DECLARATION

I, _____J SMALLIE_______________________________, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;

- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist: ____  ______________________

Name of Company: ____WILDSKIES ECOLOGICAL SERVICES_____________________

Date: _____10 October 2022____________________

GLOSSARY OF TERMS & ABBREVIATIONS

The following terms are used in this study:

Endemic/Near endemic	Occurring only here, southern African endemics as taken from BirdLife South Africa Checklist (2022).
Priority Species	Priority species are those that this study focuses on in more detail.
Red Listed – Globally	The latest global conservation status for the species as per IUCN (2022).
Red Listed – Regionally	The latest regional conservation status for the species as per Taylor *et al.* 2015.
EN	Endangered
IBA	Important Bird Areas
kV	Kilovolt (1000 volts)
LC	Least concern
NT	Near-threatened
Rec	Number of records
REDZ	Renewable Energy Development Zone
REDZ2	Renewable Energy Development Zone 2
VU	Vulnerable

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1. Introduction

The applicant, WKN Windcurrent SA (Pty) Ltd (hereafter WKN Windcurrent), is currently developing a pair of potential Wind Energy Facilities (WEFs) known as the Taaibos North and Taaibos South Wind Farms in the Northern Cape province of South Africa, approximately 20km south east of the town of Loxton. As part of the feasibility investigations, WildSkies Ecological Services (Pty) Ltd previously conducted an avifaunal screening assessment for the sites (WildSkies, 2020). WKN Windcurrent refined the developable area on the basis of several identified avifaunal constraints. WKN Windcurrent then appointed WildSkies to conduct the necessary 12 months pre-construction bird monitoring for the developable areas. WildSkies has now been appointed to conduct this avifaunal impact assessment for the environmental authorisation application, managed by CES Environmental and Social Advisory Services (CES).

This document is the Avifaunal Impact Assessment for the Taaibos South WEF, but presents data analysed from the 12 months of bird monitoring for both Taaibos North and South WEFs. While the spatial scope of our data collection presented here is slightly larger than the developable area of the Taaibos South WEF alone, the habitat, vegetation and resources concerned from an avian perspective are similar. The excellent mobility of birds as a whole warrants a study wider than within the strict boundary of the redesigned project site, and it is our opinion that this approach strengthens our confidence in the findings. The project area is presented below in **Figure 1**.

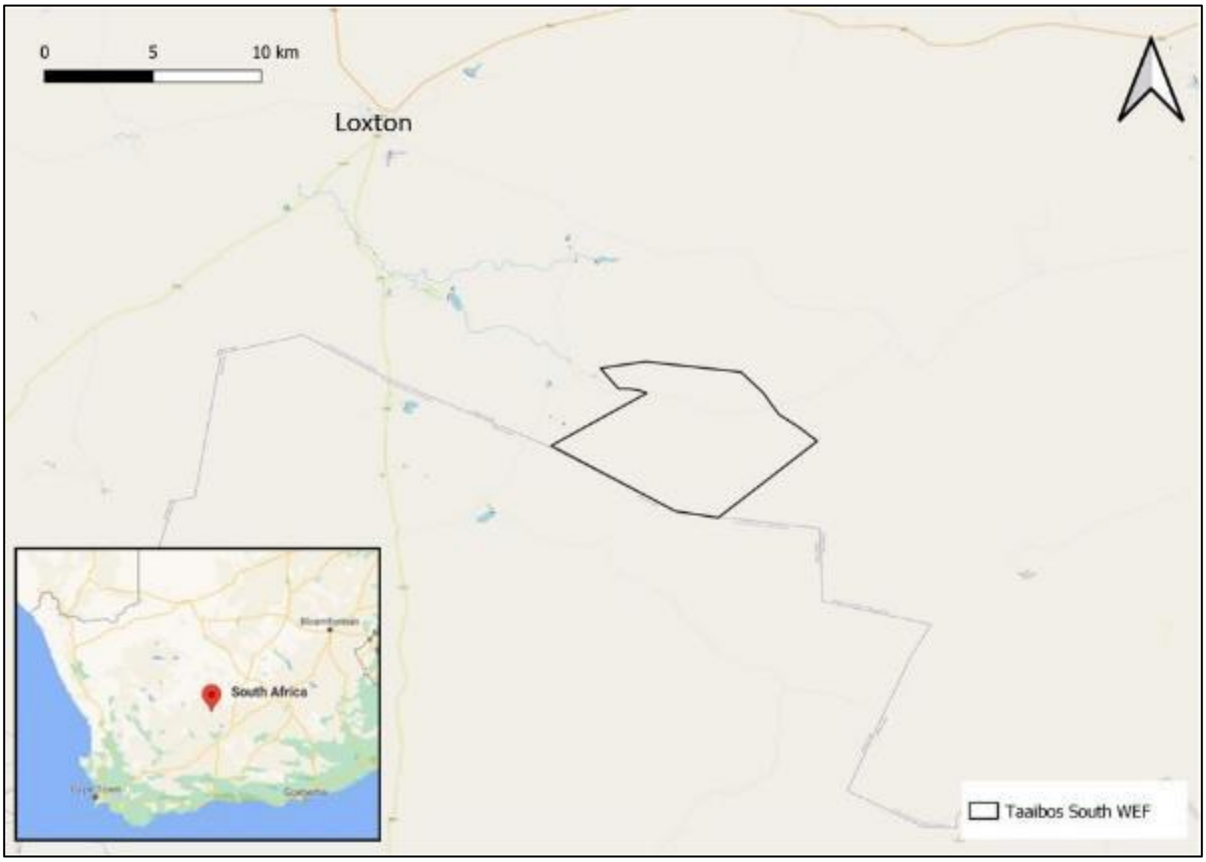

Figure 1. The position of the proposed Taaibos South Wind Farm

1.1 Project Description

An indicative turbine layout (including 36 turbine positions) has been provided by WKN Windcurrent. Exact turbine specifications are not yet confirmed, although the WEF Design Specifications have been provided and are shown in **Table 1** and **Table 2** below. **Figure 2** presents the proposed turbine layout.

Table 1. WEF Design Specifications for Taaibos South WEF

WEF DESIGN SPECIFICATIONS	
Number of turbines	Up to 36
Power output per turbine	Unspecified
Facility output	Up to 270 MW
Turbine hub height	Up to 200 m
Turbine rotor diameter	Up to 240 m
Turbine blade length	Up to 120 m
Turbine tip height	Up to 320 m
Turbine road width	14m to be rehabilitated to 8m

BESS Technology	Solid State (Li-Ion) or REDOX-Flow (High level risk assessment for both) – 10 ha / 2700 MWh

Table 2. Taaibos South WEF infrastructure specifications for development

FACILITY COMPONENT	CONSTRUCTION FOOTPRINT	FINAL FOOTPRINT AFTER REHABILITATION
Permanent Laydown Area	TOTAL 3000 m^2 x 36 turbines = 108 000 m^2 which equates to 10.8 ha	TOTAL 3000 m^2 x 36 turbines = 108 000 m^2 which equates to 10.8 ha
Temporary Laydown Area	TOTAL 3000 m^2 x 36 turbines = 108 000 m^2 which equates to 10.8 ha	TOTAL 0 m^2 x 36 turbines = 0m^2 which equates to 0 ha
Turbine Foundation	TOTAL Up to 900m^2 x 36 turbines = 32 400 m^2 which equates to 3.24 ha	TOTAL Up to 900m^2 x 36 turbines = 32 400 m^2 which equates to 3.24 ha
WEF Substation	33/132kV Substation – 1.5ha Offices and parking – 0.5ha Permanent Laydown – 1ha	33/132kV Substation – 1.5ha Offices and parking – 0.5ha Permanent Laydown – 1ha
BESS	TOTAL 10ha / 2700MWh	TOTAL 10ha / 2700MWh
Temporary Laydown Area, Concrete Tower Manufacturing Facility and Construction Compound	10 ha clearance includes Temporary laydown Construction compound Concrete batching plant Crusher plant All to become area cleared for BESS (above) afterwards.	10 ha clearance includes Temporary laydown Construction compound Concrete batching plant Crusher plant All to become area cleared for BESS (above) afterwards.
New Internal Access Roads (14 m construction, rehabilitated to 8 m during operation)	TOTAL (better estimate coming with civil layout) 36 000 m x 14m = 504 000 m^2 which equates to 50.4 ha	TOTAL (better estimate coming with civil layout) 36 000 m x 8m = 288 000 m^2 which equates to 28.8 ha
Upgraded Existing Internal Access Roads	TOTAL (better estimate coming with civil layout) 36 000 m x 14m = 504 000 m^2 which equates to 50.4 ha	TOTAL (better estimate coming with civil layout) 36 000 m x 8m = 288 000 m^2 which equates to 28.8 ha
TOTAL FOOTPRINT:	**138.64 ha *of clearing needed for the construction phase of the development of the proposed WEF***	**84.64 ha *of clearing remaining during the post-construction operational phase (after rehabilitation) of the proposed WEF***

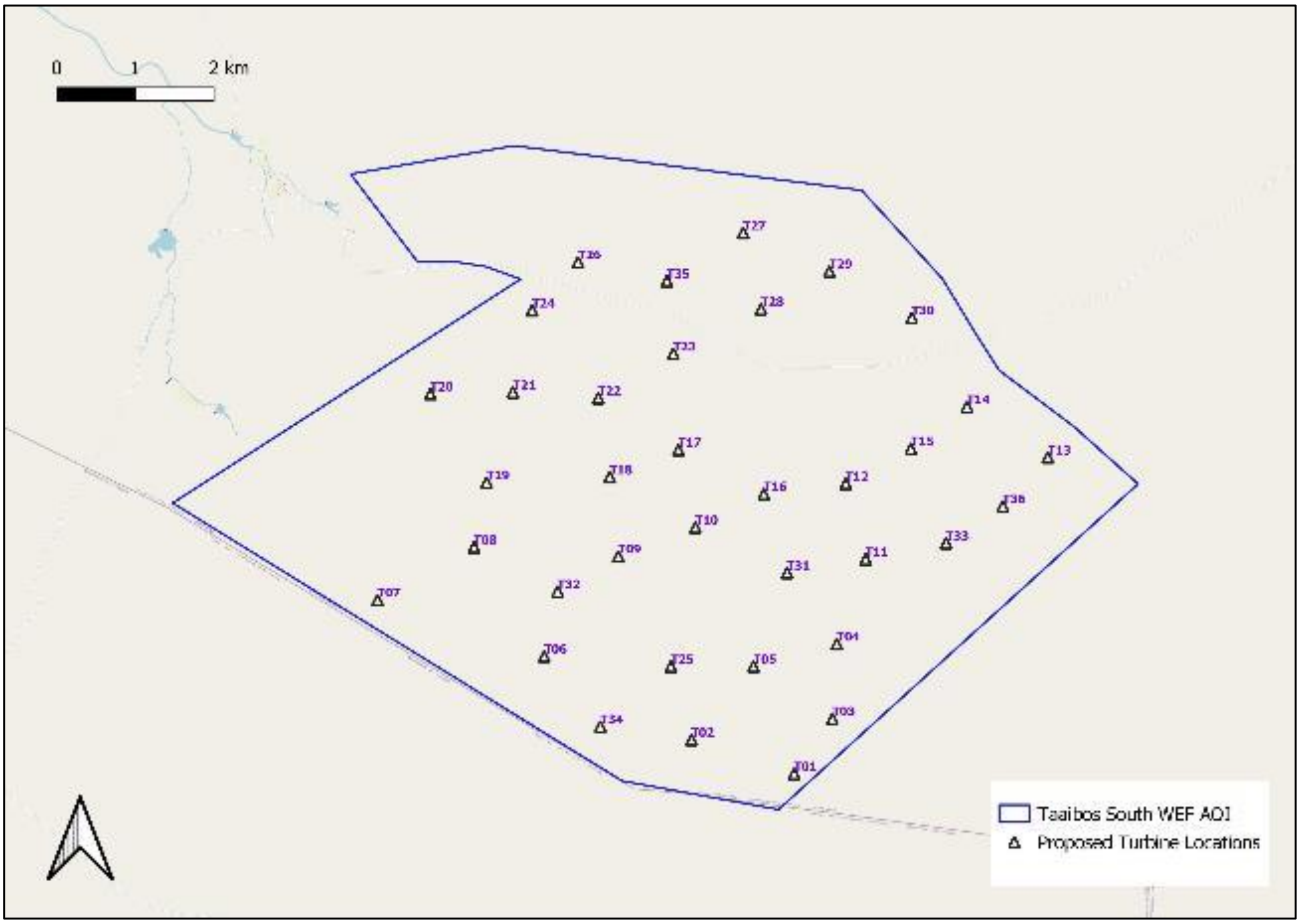

Figure 2. Indicative turbine layout (up to 36 turbines)

1.2 Background to wind energy facilities & birds

The interaction between birds and wind farms first documented was that of birds killed through collision with turbines, dating back to the 1970's. Certain sites in particular, such as Altamont Pass – California, and Tarifa – Spain, killed a lot of birds and focused attention on the issue. However it appears that sites such as these are the exception rather than the rule, with most facilities causing much lower fatality rates (Kingsley & Whittam, 2005; Rydell *et al.* 2012; Ralston-Paton *et al.* 2017; Perold *et al*. 2020). With time it became apparent that there are actually four ways in which birds can be affected by wind farms: 1) collisions – which is a direct mortality factor; 2) habitat alteration or destruction (less direct); 3) disturbance – particularly whilst breeding; and 4) displacement/barrier effects (various authors including Rydell *et al.* 2012). Whilst the impacts of habitat alteration and disturbance are probably fairly similar to those associated with other forms of development, collision and displacement/barrier effects are unique to wind energy. Associated infrastructure such as overhead power lines also has the potential to impact on birds. For example, they pose a collision and possibly electrocution threat to certain bird species.

1.2.1 Collision of birds with turbine blades

Without doubt, the impact of bird collision with turbines has received the most attention to date amongst researchers, operators, conservationists, and the public. The two most common measures for collision fatality used to date are number of birds killed per turbine per year, and number of birds killed per megawatt installed per year. Rydell *et al.* (2012) reviewed studies from 31 wind farms in Europe and 28 in North America and found a range between 0 and 60 birds killed per turbine per year, with a median of 2.3. European average bird fatality rates were much higher, at 6.5 birds per turbine per year compared to the 1.6 for North America. These figures include adjustment for detection (the efficiency with which monitors detect carcasses in different conditions) and scavenger bias (the rate at which birds are removed by scavengers between searches). These are important biases which must be accounted for in any study of mortality.

In South Africa, Ralston-Paton, Smallie, Pearson & Ramalho (2017) reviewed the results of operational phase bird monitoring at 8 wind farms ranging in size from 9 to 66 turbines and totalling 294 turbines (or 625MW). Hub height ranged from 80 to 115m (mean of 87.8m) and rotor diameter from 88 to 113m (mean of 102.4m). The estimated fatality rate at the wind farms (accounting for detection rates and scavenger removal) ranged from 2.06 to 8.95 birds per turbine per year. The mean fatality rate was 4.1 birds per turbine per year. This places South Africa within the range of fatality rates that have been reported for North America and Europe. The composition of the South African bird fatalities by family group was as follows: Unknown 5%; Waterfowl 3%; Water birds other 2%; Cormorants & Darters 1%; Shorebirds, Lapwings and gulls 2%; Large terrestrial birds 2%; Gamebirds 4%; Flufftails & coots 2%; Songbirds 26%; Swifts, swallows & martins 12%; Pigeons & doves 2%; Barbets, mousebirds & cuckoo's 1%; Ravens & crows 1%; Owls 1%; and Diurnal raptors 36%. Threatened species killed included Verreaux's Eagle *Aquila verreauxii* (5 - Vulnerable), Martial Eagle *Polemaetus bellicosus* (2 - Endangered), Black Harrier *Circus maurus* (5 - Endangered), and Blue Crane *Grus paradisea* (3 – Near-threatened). Although not Red Listed, a large number of Jackal Buzzard *Buteo rufofuscus* fatalities (24) were also reported. Ralston-Paton *et al.*'s review included the first year of operational monitoring at the first 8 facilities.

Perold *et al.* (2020) summarised the data on bird turbine collisions from 20 wind energy facilities across South Africa from 2014 to 2018. A total of 848 bird carcasses were recorded at a crude fatality rate of 1.0 ± 0.6 birds/turbine/year. When adjusted for biases, the fatality rate was 4.6 ± 2.9birds/turbine/year. This is slightly lower than rates reported in the northern hemisphere. One hundred and thirty species from 46 families were killed. Thirty-six percent of carcasses (or 23 species) were diurnal raptors, 30% were passerines, 11% waterbirds, 9% swifts, 5% large terrestrials, 4% pigeons and 1% other near-passerines. Species of conservation concern killed include: Cape Vulture *Gyps coprotheres* (10); Cape Cormorant *Phalacrocorax capensis* (1); Ludwig's Bustard *Neotis ludwigii* (1); Black Harrier (6); Martial Eagle (4); Southern Black Korhaan *Afrotis afra* (5); Secretarybird *Sagittarius serpentarius* (1); Blue Crane (8); Verreaux's Eagle (6); Lanner Falcon *Falco biarmicus* (6); Striped Flufftail *Sarothrura affinis* (1); Greater Flamingo *Phoenicopterus roseus* (1); and Agulhas Long-billed Lark *Certhilauda brevirostris* (1).

1.2.2 Loss or alteration of habitat during construction

The area of land directly affected by a wind farm and associated infrastructure is relatively small. As a result, in most cases habitat destruction or alteration in its simplest form (removal of natural vegetation) is unlikely to be of great significance. However, fragmentation of habitat can be an important factor for some smaller bird species. Construction and operation of a wind farm results in an influx of human activity to areas often previously relatively uninhabited (Kuvlesky *et al.* 2007). This disturbance could cause certain birds to avoid the entire site, thereby losing a significant amount of habitat (Langston & Pullan, 2003). In addition to this, birds are aerial species, spending much of their time above the ground. It is therefore simplistic to view the amount of habitat destroyed as the terrestrial land area only.

Ralston-Paton *et al.* (2017) did not review habitat destruction or alteration. From our own work to date, we have recorded a range of habitat destruction on 6 operational wind farms from 0.6 to 4% (mean of 2.4%) of the total site area (defined by a polygon drawn around the outermost turbines and other infrastructure) and 6.9 to 48.1ha (mean of 27.8ha) of aerial space.

1.2.3. Disturbance of birds

Disturbance effects can occur at differing levels and have variable levels of effect on bird species, depending on their sensitivity to disturbance and whether they are breeding or not. For smaller bird species, with smaller territories, disturbance may be absolute and the birds may be forced to move away and find alternative territories, with secondary impacts such as increased competition. For larger bird species, many of which are typically the subject of concern for wind farms, larger territories mean that they are less likely to be entirely displaced from their territory. For these birds, disturbance is probably likely to be significant only when breeding. Effects of disturbance during breeding could include loss of breeding productivity; temporary or permanent abandonment of breeding; or even abandonment of nest site.

Ralston-Paton *et al.* (2017) found no conclusive evidence of disturbance of birds at the sites reviewed. It may be premature to draw this conclusion after only one year as effects are likely to vary with time (Stewart *et al*. 2007) and statistical analysis was not as in depth as desired. At this stage in the industry, a simplistic view of disturbance has been applied whereby the presence or absence of active breeding at breeding sites of key species is used as the basis for findings.

1.2.4. Displacement & barrier effects

A barrier effect or displacement occurs when a wind energy facility acts as a barrier for birds in flight, which then avoid the obstacle and fly around it. This can reduce the collision risk, but will also increase the distance that the bird must fly. This has consequences for the birds' energy balance. Obviously the scale of this effect can vary hugely and depends on the scale of the facility, the species' territory and movement patterns, and the species' reactions.

Ralston-Paton *et al.* (2017) reported that little conclusive evidence for displacement of any species was reported for the 8 wind farms in South Africa, although once again this is an early and possibly simplistic conclusion.

1.2.5. Associated infrastructure

Infrastructure associated with wind energy facilities also has the potential to impact on birds, in some cases more than the turbines themselves. Overhead power lines pose a collision and possibly an electrocution threat to certain bird species (depending on the pole top configuration). Furthermore, the construction and maintenance of the power lines will result in some disturbance and habitat destruction. New access roads, substations and offices constructed will also have a disturbance and habitat destruction impact. Collision with power lines is one of the biggest single threats facing birds in southern Africa (van Rooyen 2004). For example, an estimated 47 000 Ludwig's Bustards fatally collide with power line infrastructure in South Africa annually (Pallett *et al.* 2022). Storks, cranes and various species of water birds (many of which occur in the area) are also heavily impacted upon. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with power lines (van Rooyen 2004, Anderson 2001). Unfortunately, many of the collision-sensitive species are considered threatened in southern Africa. The Red List species vulnerable to power line collisions are generally long living, slow reproducing species under natural conditions.

Electrocution refers to the scenario where a bird is perched or attempts to perch on the 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 2004). The larger bird species (such as eagles) are most affected since they are most capable of bridging critical clearances on hardware. Ralston-Paton *et al.* (2017) did not review power line impacts at the 8 sites.

1.2.6. Mitigation

Possible mitigation measures for bird turbine collision include: increasing turbine visibility (for example through painting turbine blades, restriction of turbine operation during high risk periods, automated turbine shutdown on demand, human-based turbine shutdown on demand, bird deterrents – both audible and visual, habitat management, and offsets). Most of these suggested mitigation measures are largely untested. In South Africa, observer led Shutdown on Demand has recently shown promise at an operational wind farm in the Western Cape. It is likely that by the time of construction of the proposed project more experience on this mitigation will be available in country. Likewise with blade painting, a paper out of Norway recently showed significant promise for the effectiveness of this measure (May *et al*. 2020). Trials of this method are likely to take place in SA in the near future and results should be available in time for the proposed project.

Mitigation for habitat destruction typically consists of avoiding sensitive habitats during layout planning. A certain amount of habitat destruction is unavoidable. For disturbance, mitigation takes the form of allowing sufficient spatial and temporal protection for breeding sites of sensitive species. Mitigation of power line impacts is relatively well understood and effective, and is described in more detail later in this report. It is also essential that internal power line connecting turbines be buried beneath the ground.

The primary means of mitigating bird impacts at wind farms therefore remains avoidance through correct siting, both of the entire facility, and of the individual turbines themselves. This has already been done in detail for the full facility during the screening phase in which detailed No-Go areas for avifauna were used in developing the layout being assessed.

1.2.7. Contextualising wind energy impacts on birds

Several authors have compared causes of mortality of birds (American Bird Conservancy, 2012; Sibley Guides, 2012; National Shooting Sports Foundation 2012; Drewitt & Langston 2008) in order to contextualise possible mortality at wind farms. In most of these studies, apart from habitat destruction which is the number one threat to birds (although not a direct mortality factor) the top killers are collision with building windows and cat predation. Overhead power lines rank fairly high up, and wind turbines only far lower down the ranking. These studies typically cite absolute number of deaths and rarely acknowledge the numerous biases in this data. For example a bird that collides with a high-rise building window falls to a pavement and is found by a passer-by, whereas a bird colliding with a wind turbine falls to the ground which is covered in vegetation and seldom passed by anyone. Other biases include: the number of windows; kilometres of power line; or cats which are available to cause the demise of a bird, compared to the number of wind turbines. Biases aside the most important shortcoming of these studies is a failure to recognise the difference in species affected by the different infrastructure. Species such as those of concern at wind farms, and particularly Red List species in South Africa are unlikely to frequent tall buildings or to be caught by cats. Since many of these bird species are already struggling to maintain sustainable populations, we should be striving, where possible based on the merits of the specific scenario, to avoid all additional, new and preventable impacts on these species, and not permitting these impacts simply because they are smaller than those anthropogenic impacts already in existence.

1.3 Relevant Legislation

The legislation relevant to this specialist field and development include the following:

- The Convention on Biological Diversity (CBD): dedicated to promoting sustainable development. The Convention recognizes that biological diversity is about more than plants, animals and micro-organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live. It is an international convention signed by 150 leaders at the Rio 1992 Earth Summit. South Africa is a signatory to this convention and should therefore abide by its' principles.

- An important principle encompassed by the CBD is the precautionary principle which essentially states that where serious threats to the environment exist, lack of full scientific certainty should not be used a reason for delaying management of these risks. The burden of proof that the impact will *not* occur lies with the proponent of the activity posing the threat.

- The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention): aims to conserve terrestrial, aquatic and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. Since the Convention's entry into force, its membership has grown steadily to include 117 (as of 1 June 2012) Parties from Africa, Central and South America, Asia, Europe and Oceania. South Africa is a signatory to this convention.

- The Agreement on the Conservation of African-Eurasian Migratory Water birds (AEWA): is the largest of its kind developed so far under the CMS. The AEWA covers 255 species of birds ecologically dependent on wetlands for at least part of their annual cycle, including many species of divers, grebes, pelicans, cormorants, herons, storks, rails, ibises, spoonbills, flamingos, ducks, swans, geese, cranes, waders, gulls, terns, tropic birds, auks, frigate birds and even the South African penguin. The agreement covers 119 countries and the European Union (EU) from Europe, parts of Asia and Canada, the Middle East and Africa.

- The National Environmental Management – Biodiversity Act - Threatened or Protected Species list (TOPS).

- The Provincial Nature Conservation Ordinance (Nature Conservation Ordinance 19 of 1974) identifies very few bird species as endangered, none of which are relevant to this study. Protected status is accorded to all wild bird species, except for a list of approximately 12 small passerine species, all corvids (crows and ravens) and all Mousebirds.

- The Civil Aviation Authority has certain requirements regarding the visibility of wind turbines to aircraft. It is our understanding that these may preclude certain mitigation measures for bird collisions, such as the painting of turbine blades in different colours.

- The Species Environmental Assessment Guideline (SANBI, 2020) is applicable, this report adheres to the guideline.

- The DFFE Online screening tool is relevant and has been consulted, see **Appendix 13.**

1.4 Terms of Reference for the specialist study

The following terms of reference apply:

- A description of the regional and local features
- A field survey to search for sensitive areas, receptors or habitats and species of special concern
- Mapping of the sensitive features
- Assessing (identifying and rating) the potential impacts on the environment
- Identification of relevant legislation and legal requirements; and
- Providing recommendations on possible mitigation measures and rehabilitation procedures/ management guidelines.

1.5 Details of the Specialist

See **Appendix 11** for details of the avifaunal specialist.

2. Methodology

2.1 General approach

The general approach to this study was as follows:

- An initial pre-feasibility or screening survey was conducted by WildSkies in August 2020 (WildSkies 2020). This included a survey for large eagle nests and other avifaunal constraints on site and within approximately six kilometres (based on the largest possible eagle nest buffer of 6km for Martial Eagle) of site.
- The developable area was refined by WKN Windcurrent based on the findings of these early studies.
- Twelve months (six Site Visits over all four seasons) of pre-construction bird monitoring was initiated on site in March 2021 and completed in April 2022. Each Site Visit consisted of between 5 and 10 consecutive days (varying for observer availability, team size and daylight length) on site by a team of skilled observers, to record data on bird species and abundance on and near site. These Site Visits covered: summer (when summer migrants are present); winter (when raptors breed and Blue Cranes flock); spring (when summer migrants are arriving on site and many species start to breed; and autumn (when summer migrants are leaving and many raptors are preparing to breed); we believe this sampling was sufficient to capture data representative of conditions on site.
- Site Visit dates were as follows:
  - Site Visit 1: 27 March – 1 April 2021
  - Site Visit 2: 25 May – 3 June 2021
  - Site Visit 3: 5 – 10 August 2021
  - Site Visit 4: 9 – 16 October 2021
  - Site Visit 5: 3 – 7 January 2022
  - Site Visit 6: 20 – 23 March 2022 & 7 – 10 April 2022
- Additional raptor nests were discovered throughout the year of pre-construction monitoring; WKN Windcurrent refined the developable area to exclude these further constraints.
- During September 2022, the current Avifaunal Impact Assessment report was compiled for WKN Windcurrent.

2.2 Data sources consulted for this study

Various existing data sources have been used in the design and implementation of this study, including the following:

- The pre-feasibility avifaunal study findings (WildSkies, 2020).
- The pre-construction bird monitoring raw data and progress reports (WildSkies 2021, 2022).
- The data captured by specialist site visits.
- The Southern African Bird Atlas Project 2 data, available at the pentad level (http://sabap2.adu.org.za/v1/index.php) (accessed at www.mybirdpatch.adu.org.za).
- The conservation status of all relevant bird species was determined using Taylor *et al.* (2015) & IUCN 2022.
- The vegetation classification of South Africa (Mucina & Rutherford, 2018) was consulted in order to determine which vegetation types occur on site.
- Aerial photography from the Surveyor General was used.
- The 'Avian Wind Farm Sensitivity Map' Criteria and procedures used. (Retief *et al.* 2011, updated 2014).
- The Important Bird Areas programme was consulted (Marnewick *et al*. 2015). No IBAs exist close enough to the site to be relevant.
- Two recent review reports entitled "Wind energy's impacts on birds in South Africa: a preliminary review of the results of operational monitoring at the first wind farms of the Renewable Energy Independent Power Producer Procurement Programme Wind Farms in South Africa" (Ralston-Paton, Smallie, Pearson, & Ramalho, 2017), and "On a collision course: the large diversity of birds killed by wind farms in South Africa" (Perold *et al.* 2020) were consulted extensively.
- Coordinated Avifaunal Road count data for the area (accessed at www.car.adu.org.za). No monitored CAR routes exist within 50km of the proposed WEF.
- Coordinated Waterbird Count (CWAC) data for the area (accessed at www.cwac.adu.org.za). Two registered CWAC sites exist within 50km of the Taaibos South WEF.
- The "Best Practice Guidelines for assessing and monitoring the impact of wind energy facilities on birds in southern Africa" Guidelines by BirdLife South Africa & Endangered Wildlife Trust (Jenkins *et al*. 2015, & more recent update in prep).
- The Best Practice Guidelines for Verreaux's Eagle and Wind Energy (BirdLife South Africa, 2017), and the more recent draft update of these: Verreaux's Eagles and Wind Farms (BirdLife South Africa, 2021).

2.3 Primary data collection methods

The following sections describe the pre-construction bird monitoring data collection activities on site. For more detail on the exact methods of any of the below activities see Jenkins *et al.* (2015).

2.3.1. Sample counts of small terrestrial species

Although not traditionally the focus of wind farm–bird studies and literature, small terrestrial birds are an important component of any pre-construction bird monitoring programme. Due to the rarity of many of our threatened bird species, it is anticipated that statistically significant trends in abundance and density may be difficult to observe for these species. More common, similar species could provide early evidence for trends and point towards the need for more detailed future study. Given the large spatial scale of most wind farms, these smaller species may also be particularly vulnerable to displacement and habitat level effects. Sampling these species is aimed at establishing indices of abundance for small terrestrial birds in the study area. These counts should be done when conditions are optimal. In this case, this means the times when birds are most active and vocal, i.e. early mornings. Transects were counted by two observers walking along a line recording all birds seen and heard within 200m either side. **Table 3** shows the number of transects conducted on site during the programme.

2.3.2. Counts of large terrestrial species & raptors

This is a very similar data collection technique to that above, the aim being to establish indices of abundance for large terrestrial species and raptors. These species are relatively easily detected from a vehicle, hence Vehicle-based or Driven Transects (DT) are conducted in order to determine the number of birds of relevant species in the study area. Transects were counted by driving slowly (40-50km/hr) along the transect scanning for birds. Every two kilometres or at suitable vantage points observers got out of the vehicle to stand and scan with binoculars. Detection of these large species is less dependent on their activity levels and calls, so these counts can be done later in the day. **Table 3** shows the number of transects conducted on site during the programme. These transects were each counted once on each Site Visit.

2.3.3. Focal Site surveys & monitoring

Focal Sites are surveyed at least once on each Site Visit, and comprise at least 15-20 minutes of observation for breeding activity around the nest of interest, or a count of the birds using a dam site. Raptor nests were mostly located during screening, although some additional nests were discovered by observers as time was spent in the broader area throughout the course of the year. Three of the larger dams on site were identified as important for waterfowl counts (FS 9, 11 & 12).

2.3.4 Incidental Observations

This monitoring programme comprises a significant amount of field time on site by the observers, much of it spent driving between the above activities. As such, it is important to record any other relevant information whilst on site. All other incidental sightings of priority species (and particularly those suggestive of breeding or important feeding or roosting sites or flight paths) within the broader study area were recorded. As far as possible, field teams attempted to avoid recording resident species in the same location on consecutive days, however some replication is highly probable, particularly between Site Visits.

2.3.5. Direct observation of bird flight on site

The aim of direct observation is to record bird flight activity on site. An understanding of this flight behaviour will help explain any future interactions between birds and the wind farm. Spatial patterns in bird flight movement may also be detected, which will allow for input into turbine placement. Direct observation was conducted through counts at a number of fixed Vantage Points (VPs) in the study area (**Table 3**, **Figure 3**). These VPs provided coverage of a reasonable and representative proportion of the entire study area. VP's were identified using GIS (Geographic Information Systems), and then fine-tuned during the project setup, based on access and other factors such as viewsheds and representativity of habitats. Since these VPs aim at capturing both usage and behavioural data, they were positioned mostly on high ground to maximise visibility. The survey radius for VP counts is 2 kilometres (although large birds are sometimes detected further). Vantage Point counts were conducted by two observers and birds were recorded 360° around observers. Data should be collected during representative conditions, so the sessions were spread throughout the day, with each VP being counted over 'early to mid-morning', 'mid-morning to early afternoon', and 'mid-afternoon to evening'. Each VP session was 4 hours long, which is believed to be towards the upper limit of observer concentration span, whilst also maximising duration of data capture relative to the travel time to the Vantage Points. A maximum of two VP sessions were conducted per day, to avoid observer fatigue compromising data quality. For more detail on exact criteria recorded for each flying bird observed, see Jenkins *et al.* (2015). At least 72 hours of Vantage Point observation was collected per Vantage Point per year, in compliance with the Verreaux's Eagle guidelines (BirdLife South Africa 2017, 2021).

One of the most important attributes of any bird flight event is its height above ground, since this will determine its risk of collision with turbine blades. Since it is possible that the turbine model (and hence the exact height of the rotor swept zone) could still change on this project, actual flight height was estimated rather than assigning flight height to broad bands (such as proposed by Jenkins *et al.* 2015). This 'raw' data will allow flexibility in assigning to classes later on depending on final turbine specifications.

It is not practical to record all bird species flying by this method, the method focuses rather on the physically large species and particularly Red Listed species, raptors and otherwise important species.

2.3.6. Control Site

A Control or Reference Site was monitored as part of this monitoring programme (Jenkins *et al.* 2015). At this site, two Vantage Points (12 hours per VP, per Site Visit), one Driven Transect and three Walked Transects were monitored in addition to the main site. The findings from the Control Site are not presented in this Avifaunal Impact Assessment Report but are available for comparison post-construction where necessary. **Figure 3** shows the layout of these monitoring activities on site.

The monitoring programme was slightly shortened as the Site Visits progressed, since VPs were removed from the schedule in response to the redesign of the developable area once new No-go buffers were implemented. The monitoring schedule has been summarised in **Table 3**.

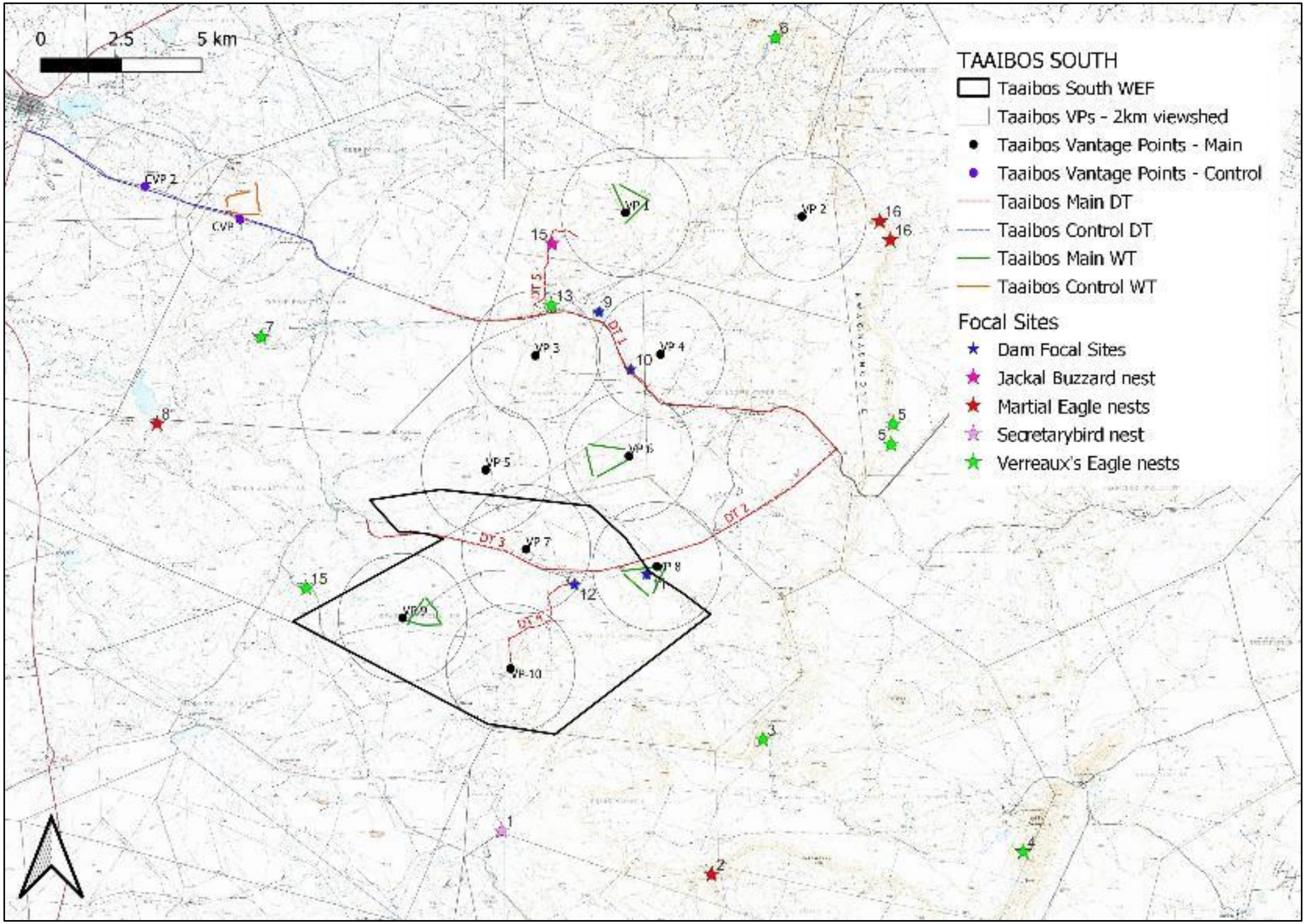

Figure 3. Layout of pre-construction bird monitoring activities on the Taaibos South Wind Farm site

Table 3. Summary of monitoring design over the six Site Visits.

Data Collection Method	Site Visit 1	Site Visit 2	Site Visit 3	Site Visit 4	Site Visit 5	Site Visit 6
Walked Transects	*12 km* *1a,b,c* *6a,b,c* *8a,b,c* *9a,b,c*	*12 km* *1a,b,c* *6a,b,c* *8a,b,c* *9a,b,c*	*12 km* *1a,b,c* *6a,b,c* *8a,b,c* *9a,b,c*	*12 km* *1a,b,c* *6a,b,c* *8a,b,c* *9a,b,c*	*9km* *6a,b,c* *8a,b,c* *9a,b,c*	*9km* *6a,b,c* *8a,b,c* *9a,b,c*
Driven Transects	40km DT 1 - 5 (once)	40km DT 1 - 5 (once)	40km DT 1 - 5 (once)	40km DT 1 - 5 (once)	40km DT 1 - 5 (once)	40km DT 1 - 5 (once)
Incidental Observations	All	All	All	All	All	All
Vantage Points	120 hours VP 1, 2, 3, 4, 5, 6, 7, 8, 9, 10	108 hours VP 1, 2, 4, 5, 6, 7, 8, 9, 10	108 hours VP 1, 2, 4, 5, 6, 7, 8, 9, 10	96 hours VP 1, 4, 5, 6, 7, 8, 9, 10	84 hours VP 4, 5, 6, 7, 8, 9, 10	84 hours VP 4, 5, 6, 7, 8, 9, 10

2.4 Limitations & Assumptions

Certain biases and challenges are inherent in the methods that have been employed to collect data in this programme. It is not possible to discuss all of them here, and some will only become evident with time and operational phase data, but the following are some of the key points:

- The presence of the observers on site is certain to have an effect on the birds itself. For example during walked transects, certain bird species will flush more easily than others (and therefore be detected), certain species may sit undetected, certain species may flee, and yet others may be inquisitive and approach the observers. Likewise with the Vantage Point counts, it is extremely unlikely that two observers sitting in position for four hours at a time will have no effect on bird flight. Some species may avoid the Vantage Point position, because there are people there, and others may approach out of curiosity. In almost all data collection methods large bird species will be more easily detected, and their position in the landscape more easily estimated. This is particularly relevant at the Vantage Points where a large eagle may be visible several kilometres away, but a smaller Rock Kestrel (*Falco rupicolus*) perhaps only within 800 metres. A particularly important challenge is that of estimating the height at which birds fly above the ground. With no reference points against which to judge, it is exceptionally difficult and subjective. It is for this reason that the flight height data has been treated cautiously by this report, and much of the analysis conducted using flights of all height. With time and data from multiple sites it will be possible to tease out these relationships and establish indices or measures of these biases.

- The questions that one can ask of the data collected by this programme are almost endless. Most of these questions however become far more informative once post-construction data has been collected and effects can be observed. For this reason some of the analysis in this report is relatively crude. The raw data has however been collected and will be stored until such time as more detailed analysis is possible and necessary.

- It is well known that the 2019-2021 period was a drought period in most of the country. As a result there is a risk that the data collected may not be perfectly typical of conditions in the area. Given that pre-construction bird monitoring for wind farms samples one year, and the wind farm will operate for at least 20 years (and may only be constructed five years from now), we will always face this challenge of greater variability in environmental conditions occurring during the project lifespan than during the impact assessment of the project. In general we would expect the abundance of certain bird species to decrease in drought periods, so the abundance data presented in this report should be considered a minimum. Fortunately towards the latter end of the monitoring programme good rainfall fell in the study area and this would have influenced bird abundance and diversity for the better.

- Spotting and identifying birds whilst walking is a significant challenge, particularly when only fleeting glimpses of birds are obtained. As such, there is variability between observers' ability and hence the data obtained. The data is therefore by necessity subjective to some extent. In order to control for this subjectivity, the same pairs of observers has largely been used for the full duration of the project, and it is hoped this can be maintained for the post-construction phase. Despite this subjectivity, and a number of assumptions that line transects rely on (for more details see Bibby *et al*. 2000), this field method returns the greatest amount of data per unit effort (Bibby *et al.* 2000) and was therefore deemed appropriate for the purposes of this programme. Likewise, in an attempt to maximise the returns from available resources, the walked transects were located close to each Vantage Point. This systematic selection may result in some as yet unknown bias in the data but it has numerous logistical benefits.

- No thresholds for fatality rates for priority species have been established in South Africa to date. This means that impact assessments need to make subjective judgements on the acceptability of the estimated predicted fatalities for each species.

3. Baseline Description & Results

3.1 Vegetation and habitat

The Taaibos South Wind Farm is comprised entirely of the 'Eastern Upper Karoo', vegetation unit with smaller areas of 'Upper Karoo Hardeveld' off-site to the east (Mucina & Rutherford, 2018, **Figure 4**). Effectively, a number of micro habitats are available to birds in the area which includes: man-made dams, wetlands, streams/drainage lines, rocky ridges & small cliffs, limited grassland, Karoo shrubland and small areas of pasture/crops (**Figure 1Figure 5**).

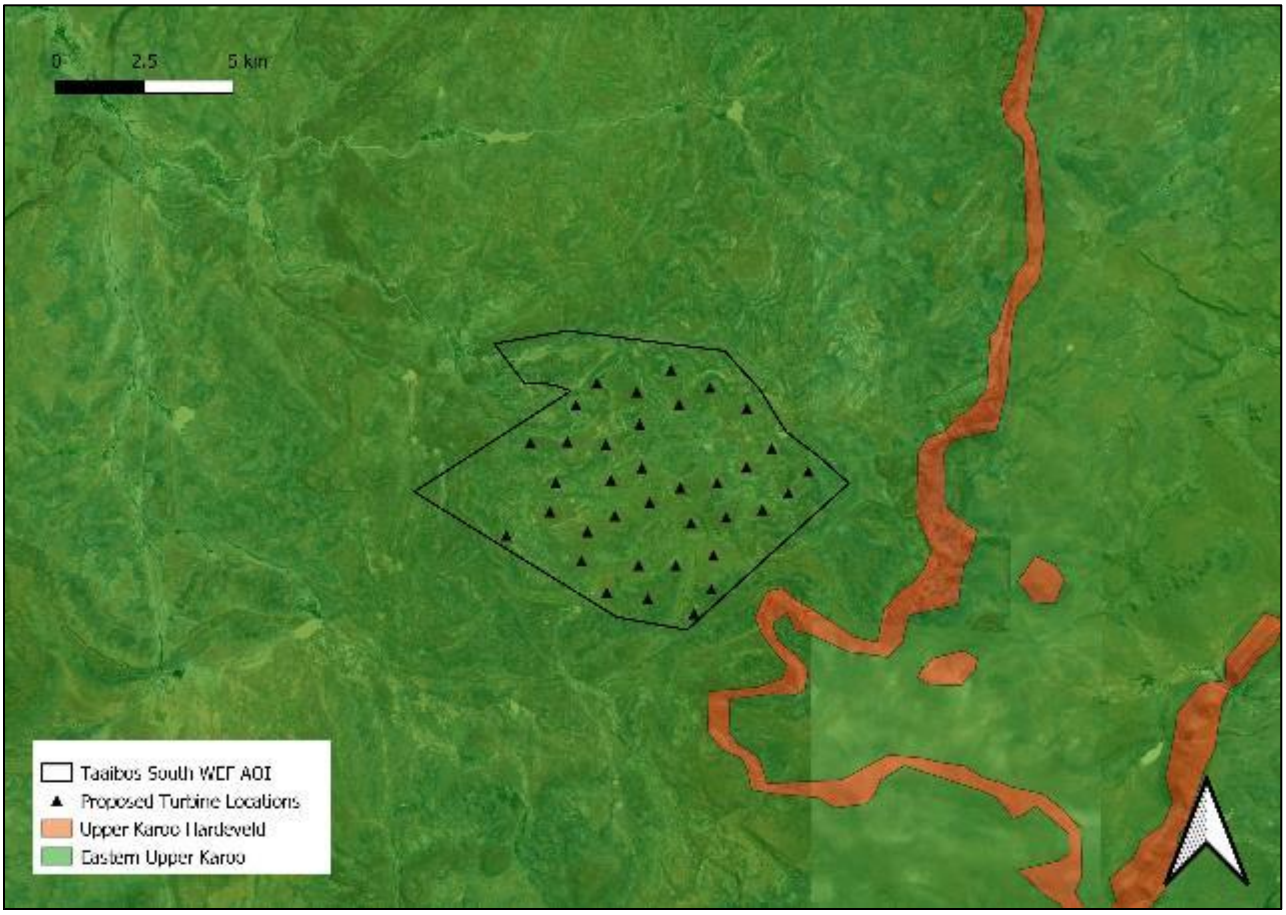

Figure 4. Vegetation units present on and surrounding Taaibos South Wind Farm (Mucina & Rutherford 2012)

3.1.1 Eastern Upper Karoo

Flats and gently sloping plains are found within the Eastern Upper Karoo vegetation unit, which is 'Least Threatened' and has the largest mapped area of all units in the country. All of the area within the site boundary is comprised of this vegetation unit. Dwarf microphyllous shrubs dominate this landscape and 'white' grasses (*Aristida* and *Eragrostis* species) are prominent after good summer rains. Karoo scrub species of *Pentzia*, *Eriocephalus*, *Rosenia* and *Lycium* are important taxa (Mucina & Rutherford 2012).

Beaufort Group sandstones and mudstones are common in this vegetation unit, and some Jurassic dolerites are also to be found. Mean annual precipitation ranges from 180 – 430mm per year (west to east), peaking in March, and frost incidence is relatively high (30 – 80 days per year).

Figure 5. Typical micro-habitats available to birds in and around the proposed Taaibos South Wind Farm

3.2 Avifaunal Community

Throughout the year of avifaunal monitoring, observers identified 124 bird species on site across all methodologies, and incidentally. Total species diversity per Site Visit was as follows: 105 species in Site Visit 1 (S1), 90 in S2, 79 in S3, 84 in S4, 97 in S5 and 95 in S6.

The South African Bird Atlas Project 2 (SABAP 2) has a relatively low reporting rate across the pentads that span the site boundary, ranging between 0 – 13 full protocol cards submitted per pentad. However, the species assemblage (160 reported species for SABAP 2) is slightly more comprehensive than what our monitors have reported; these SABAP 1 & 2 datasets are presented in addition to our findings. The full species list is presented in **Table A** in **Appendix 1.**

Ten species observed to occur on the site are regionally Red Listed: Ludwig's Bustard (*Neotis ludwigii*) and Black Harrier (*Circus maurus*) are Endangered; Verreaux's Eagle (*Aquila verreauxii*), Lanner Falcon (*Falco biarmicus*), and Secretarybird (*Sagittarius serpentarius*) are Vulnerable, and Blue Crane (*Grus paradisea*), Karoo Korhaan (*Eupodotis vigorsii*), Kori Bustard (*Ardeotis kori*) and African Rock Pipit (*Anthus crenatus*) are Near-Threatened. Eighteen of the recorded species are either near endemic to South Africa, or endemic to the subregion (South Africa, Lesotho and Swaziland).

Martial Eagle (*Polemaetus bellicosus,* Endangered) and Black Stork (*Ciconia nigra,* Vulnerable) were not recorded on site by our monitoring, although they have been recorded regularly in the area on similar observer-based renewable energy surveys (*pers. obs*) and occur in the SABAP database.

3.2.1 Small terrestrial bird species

A total of 48 bird species was recorded on the Walked Transects on the site through the year. This included 490 records of 1 694 individual birds. Transects were completed at four of the Vantage Points on site during the first four Site Visits and at three VPs during the last two Site Visits. Walked Transects totalled 66km overall. **Table 4** shows the data for the full year for the 20 most abundant species. **Appendix 2** shows the full species set and the breakdown across the six Site Visits. In each case the number of birds, number of records, and number of birds per kilometre of transect are presented, although the index of birds per kilometre is relatively crude. However, since this will be used primarily to compare the effects of the facility on these species post-construction, this index is considered adequate at this stage. If more complex analysis is required during post-construction monitoring in order to demonstrate effects, the raw data is available for this purpose.

The most abundant species encountered on the Walked Transects were not surprisingly all species already known to be common in the area, such as: Lark-like Bunting (*Emberiza impetuani,* 32 records of 248 birds), Cape Sparrow (*Passer melanurus,* 34 rec of 195 birds), White-throated Canary (*Crithagra albogularis,* 30 rec of 101 birds), Namaqua Sandgrouse (*Pterocles namaqua,* 10 records of 99 birds) and Yellow Canary (*Crithagra flaviventris,* 23 records of 94 birds).

Of the 48 species identified on the Walked Transects, one is endemic to South Africa, Lesotho and eSwatini - the Pied Starling (*Lamprotornis bicolor*), and a further seven are near endemic to South Africa. These species include: Black-eared Sparrow-lark, Large-billed Lark (*Galerida magnirostris*), Sickle-winged Chat (*Emarginata sinuata*), Black-headed Canary (*Serinus alario*), Grey Tit (*Melaniparus afer*), Karoo Eremomela (*Eremomela gregalis*) and Karoo Prinia (*Prinia maculosa*).

The small terrestrial bird community on site is as expected for a semi-arid Nama Karoo area, which is to say not greatly diverse or abundant. There are no particularly concerning species present on site from this sector of the avifauna.

3.2.2 Large terrestrial species & raptors

A total of 10 large terrestrial and raptor species were recorded across the six Drive Transects totalling 240 kilometres on the site through the year. This included 61 individual birds from 34 records. The data for the full year collectively are shown in **Table 5**, whilst **Appendix 3** has the breakdown per Site Visit. In each case, the species' regional and global Red List and endemism status are shown. Three species are regionally Red Listed: Ludwig's Bustard is Endangered; Verreaux's Eagle is Vulnerable; and Karoo Korhaan is Near-threatened (Taylor *et al*. 2015). Jackal Buzzard is near endemic to South Africa, and Grey-winged Francolin is endemic to SA, Lesotho and eSwatini. In terms of the number of individuals sighted, the most abundant species recorded by this method was Karoo Korhaan (10 records of 20 birds), followed by Jackal Buzzard (8 records of 10 birds) and Ludwig's Bustard (3 records of 10 birds). These data represent relatively low abundance and diversity of target species recorded by this method, and it is notable that no Secretarybird were observed on these drives; this methodology is typically relatively successful for locating this species. Karoo Korhaan was generally recorded in pairs or trios throughout the year of monitoring, flushing readily upon driving or walking, or recorded by duetting vocalisations within and between pairs.

The large terrestrial birds and raptors are the most important sector of the avifauna on this site, with a number of regionally Red Listed species included. Most of the priority species for the site come from this sector (**Section 3.3**).

3.2.3 Focal Site surveys

The results of the Focal Site surveys are summarised in **Table 6** and photographs of the nest Focal Sites are shown in **Appendix 4**.

» *Nests*

Raptor nests are typically the most sensitive receptor in avifaunal studies for renewable projects such as this. These findings have been discussed with WKN Windcurrent and appropriate impact avoidance action has already been taken in the form of protective No-go buffers around the nests.

Breeding behaviour was witnessed taking place at three Martial Eagle nests within 14km of the site boundary between 2020 and 2021. These nests (FS 2, 8 & 16) each require a 6km No-go turbine buffer. Two cliff nests (approximately 700m apart) exist for the north eastern territory (FS 16) and we suspect that these are alternate nests belonging to the same pair of birds. Presence of the pair at both nests was noted; thus we are confident in their identification.

Five Verreaux's Eagle nests within 18km of the site boundary were identified during the screening phase (winter 2020 - FS 3, 4, 5, 6 & 7). Additional visits to confirm breeding outcomes were completed during the breeding season which fell within pre-construction monitoring fieldwork in winter 2021. Two further Verreaux's Eagle nests within 7km of the current site boundary were discovered as the monitoring progressed (FS 13 & 15). VERA modelling has been conducted for all of these seven nests and the turbine layout has been adjusted accordingly.

Additional nests for non-priority species in the broader study area have been buffered as per **Section 4.2**, however these do not affect the current site layout and in many cases are too far off-site to be relevant.

» *Dams*

Initially, none of the significant water bodies on site identified as Focal Sites contained water, for at least the first four Site Visits during the monitoring year. Substantial rainfall began to fall across the landscape thereafter and waterbird counts were made possible on the remaining two Site Visits. The findings from these counts are presented in **Table 6**. Focal Site dams were designated as FS 9, 11 and 12. No significant sightings were reported at any of the dams, and counts consisted of the usual consignment of ducks, geese and a few small waders, none of which were present in large numbers. FS 10 was a seepage area with lusher vegetation. No significant sightings were made at this location. Dams did not appear to attract a large diversity or abundance of water-dependent species during the course of monitoring, although it cannot be ruled out that these Focal Sites are important features in an otherwise dry landscape for at least certain periods of time. They will receive 500m No-go turbine buffers as a precaution, should they be used as roosts for priority species such as cranes, flamingos and storks in the future.

Two CWAC (Coordinated Waterbird Count) sites are registered within 50km of the site, namely the Slangfontein Dam and the Sakrivierspoort Wetlands, although neither has been formally surveyed within the last 20 years. The data are thus not particularly relevant, however, notable records included maximum counts of 153 Greater Flamingo (*Phoenicopterus roseus*), 10 Maccoa Duck (*Oxyura maccoa*), 2 Yellow-billed Stork (*Mycteria ibis*) and single records of Western Osprey (*Pandion haliaetus*) and African Marsh Harrier (*Circus ranivorus*) made at the Sakrivierspoort Wetlands between 1995 and 1997.

3.2.4 Incidental Observations of target bird species

A total of 16 species were recorded on the site as Incidental Observations, the summary of which is provided in **Table 7**; **Appendix 5** presents the findings per Site Visit. The most abundant species (by a significant margin) recorded by this method was Karoo Korhaan, with 49 records made of 103 birds. Jackal Buzzard was the second most abundant species with 13 records of 15 birds. Six of the species recorded by this method are regionally Red Listed. These include one Endangered species (Ludwig's Bustard); three Vulnerable species (Verreaux's Eagle, Lanner Falcon, and Secretarybird); and two Near-threatened species (Blue Crane and Karoo Korhaan). Since these data are not the product of systematic data collection methods, they should be used cautiously and we do not discuss these findings any further here.

3.2.5 Bird flight activity on site

A total of 600 hours of bird flight observation was completed on site over the course of the monitoring year. Overall, 15 target bird species were recorded flying on the site during the Vantage Point surveys. These data are shown in **Table 8**, summarised for the full year, whilst the breakdown per Site Visit is shown in **Appendix 6**. Eight of these 15 species are regionally Red Listed (Taylor *et al.* 2015): Black Harrier and Ludwig's Bustard are Endangered; Verreaux's Eagle, Lanner Falcon and Secretarybird are all Vulnerable, and Karoo Korhaan, Kori Bustard and Blue Crane are Near-Threatened. Two species are near endemic: Karoo Korhaan and Jackal Buzzard. **Table 9** also presents each species' overall passage rate (birds/hour).

The species recorded flying most frequently on site during dedicated Vantage Point sessions was the Karoo Korhaan, with 32 individual birds recorded across 16 records. Ludwig's Bustard was the second most frequent flyer with 11 records of 28 birds. The third most frequent flyer was Pale Chanting Goshawk, with 21 records of 25 birds. The spatial representation of all flight activity is discussed in **Section 3.2.7** and presented in **Figure 6**. Recorded target bird species flight paths at the site (all species, full year) and **Figure 7**.

3.2.6 Estimating turbine collision fatality rates

Crude turbine collision fatality rates were calculated for each bird species in order to estimate how many bird fatalities could occur at the proposed wind farms once operational. This was based on the species' passage rates (number of birds recorded flying per hour) recorded on site. Generally speaking, we expect those species which fly more often to be more susceptible to turbine collision. In order to calculate crude passage rates for each species, we assumed that the 2 kilometre radius around Vantage Points was approximately equal to the maximum distance over which sightings were made, and that the coverage was approximately circular. This meant that at each vantage point an area of 12.57km² was sampled ($A = \pi r^2$). Secondly, we assumed that the area of the wind farm directly presenting a collision risk is described by the area of each turbine's rotor zone multiplied by the number of turbines. We assumed a turbine model with a rotor swept area of 45 238.93m² (turbines with rotor diameter of up to 240m) and a layout of 36 turbines. This equates to a wind farm collision risk area of 1.629km² (36 x 45 238.93m²). Thirdly, we assumed that the survey area around each of the Vantage Points was a representative sample of the area in which built turbines will operate. Fourthly we assumed that species passage rates calculated from our four Site Visits of sampling can be reasonably extrapolated to annual passage rates (by multiplying hourly passage rates by 12 x 365 in the case of resident diurnal species (12 daylight hours) and 12 x 365 x 0.5 in the case of migrants (present in the study area for only 6 months). We also assumed a 98% avoidance rate for these birds, i.e., 2% of birds passing through the rotor zone would collide with blades (as recommended by Scottish Natural Heritage guidance for species for which no established avoidance rate is available, www.project-gpwind.eu).

Fatality rates were calculated under two rotor swept area (RSA) scenarios:

- 1 - where RSA was 30m to 270m above ground. This is derived from the approximate lowest that the blade tip could be, and the maximum diameter rotor
- 2 – where RSA was 80 to 320m above ground (lower blade tip raised to the maximum envelope according to turbine specifications provided - as a mitigation measure since most bird flight activity on this site is <30m above ground)

Note these scenarios are used for indicative purposes and do not commit the developer to specific turbine parameters. The application remains for a Hub Height up to 200m and Rotor Diameter up to 240m.

No consideration has given to actual turbine locations relative to actual flight path positions, and a relatively conservative avoidance rate of 98% was used; this is without the application of any mitigation measures. However, we consider the flight activity to be considerably lower than expected based on the data from comparable studies in the vicinity. We consider the estimates to thus be under-estimates of the potential collision risk for species on site.

Although the calculations we have made are not a Collision Risk Model (CRM-Scottish Natural Heritage) some of the principles and assumptions made are similar. In South Africa, one of the main reasons CRM is not often used is that we have not established accurate species-specific avoidance rates yet, and the model is so sensitive to these avoidance rates. For example, if we used a 99% avoidance rate it would halve the estimated number of fatalities calculated as described below. Our confidence in these estimates is therefore low, but the exercise is worthwhile nonetheless.

Scenario 1 – Rotor Swept Area of 30 - 270m

Using the above-described methods, it is estimated that approximately 0.32 fatalities could be recorded at the wind farm per year across the target bird species recorded flying on site (**Table 9Table 9**). This includes the following regionally Red Listed species fatalities:

- 0.02 Ludwig's Bustards
- 0.08 Verreaux's Eagles

Other species' fatality estimates per year include:

- 0.02 Booted Eagles
- 0.02 Common Buzzards
- 0.04 Greater Kestrels
- 0.02 Pale Chanting Goshawks
- 0.13 Jackal Buzzards

Scenario 2 – Rotor Swept Area of 80 - 320m

When the lower blade tip is raised to 80m above ground, the fatality rates decreased for most species as shown **Table 9Table 9**. We are cautious to place too much emphasis on these findings, however, as the low sample number is a statistically limiting factor. We estimate a total of approximately 0.13 fatalities could be recorded at the wind farm per year across the target bird species recorded flying on site (**Table 9**). This includes the following regionally Red Listed species fatalities:

- 0.06 Verreaux's Eagles

Other species estimated fatalities per year include:

- 0.04 Greater Kestrels
- 0.04 Jackal Buzzards

Human caused fatalities of Red Listed or otherwise threatened bird species are always cause for concern and should be avoided as far as possible. In this and other studies of a similar nature, raising the minimum RSA has been predicted to reduce the risk to species that typically commute at low heights through the landscape. This is mostly true for Black Harrier, cranes, bustards and korhaans. There are currently no established thresholds for acceptable impacts on bird species in South Africa. In the absence of this information, we are forced to make a subjective finding as to the acceptability of the above estimates (**Section 4**). It is however essential that all mitigation measures recommended in this report be implemented to ensure that these fatality rates are reduced where possible. It is also essential that an adaptive management approach be adopted, ensuring that the wind farm is prepared to respond timeously and effectively if unsustainable impacts are detected.

Table 4. Small passerine bird data from Walked Transects for all six Site Visits for the 20 most abundant species (see Appendix 2 for full dataset)

			FULL YEAR			**Site Visit 1**		**Site Visit 2**		**Site Visit 3**		**Site Visit 4**		**Site Visit 5**		**Site Visit 6**	
		Transect length (km)	**66**			**12**		**12**		**12**		**12**		**9**		**9**	
		# Species	**48**			**28**		**27**		**25**		**27**		**28**		**29**	
Common Name	**Scientific Name**	**Endemism**	**Birds**	**Rec**	**Birds /km**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**
Lark-like Bunting	*Emberiza impetuani*		248	32	3.758	1	1			18	2	49	7	52	9	128	13
Cape Sparrow	*Passer melanurus*		195	34	2.955	23	8	35	10	51	4	33	5	28	4	25	3
White-throated Canary	*Crithagra albogularis*		101	30	1.530	40	13	18	6	13	4	17	3	7	3	6	1
Namaqua Sandgrouse	*Pterocles namaqua*		99	10	1.500	8	2					68	5	7	1	16	2
Yellow Canary	*Crithagra flaviventris*		94	23	1.424	16	4	11	4	11	3	13	3	20	4	23	5
Spike-heeled Lark	*Chersomanes albofasciata*		87	28	1.318	17	5	13	5	10	4	22	7	7	2	18	5
Rufous-eared Warbler	*Malcorus pectoralis*		74	52	1.121	24	16	13	10	5	4	13	9	9	7	10	6
Speckled Pigeon	*Columba guinea*		74	12	1.121	16	3	9	2	18	3	16	2	7	1	8	1
Black-eared Sparrowlark	*Eremopterix australis*	NE	70	2	1.061							70	2				
Karoo Chat	*Emarginata schlegelii*		64	52	0.970	10	10	10	10	11	9	9	5	14	10	10	8
Southern Red Bishop	*Euplectes orix*		57	6	0.864	15	4	42	2								
Grey-backed Sparrowlark	*Eremopterix verticalis*		44	6	0.667									11	2	33	4
Barn Swallow	*Hirundo rustica*		40	8	0.606	8	3							11	2	21	3
Black-headed Canary	*Serinus alario*	NE	38	3	0.576			35	2			3	1				
Tractrac Chat	*Emarginata tractrac*		34	20	0.515	15	9	2	1	2	2	11	6	2	1	2	1
Karoo Scrub Robin	*Cercotrichas coryphoeus*		32	16	0.485	6	3	8	4	4	2	6	3	4	2	4	2
Sickle-winged Chat	*Emarginata sinuata*	NE	32	17	0.485	14	6			4	2			8	6	6	3
Red-capped Lark	*Calandrella cinerea*		31	4	0.470			20	1	2	1	7	1	2	1		
Pied Starling	*Lamprotornis bicolor*	SLS	30	3	0.455			6	1	16	1	8	1				
Large-billed Lark	*Galerida magnirostris*	NE	26	20	0.394	6	6	1	1	2	1	4	2	6	4	7	6

**Regional Red List status according to Taylor* et al*. 2015 – most recent regional conservation status for species*
**Global Red List status according to IUCN 2022*
EN = Endangered; VU = Vulnerable; NT = Near-threatened; LC = Least Concern

***Endemism – whether the species is endemic (E) or near endemic (NE) to South Africa.*
E = Endemic; NE = Near-endemic; SLS = Endemic to South Africa, Lesotho & eSwatini; BNE = Breeding near endemic

Retief et al*. 2014 – the species ranking in terms of turbine collision risk – as per Avian Wind Farm Sensitivity Map*

(This key applies to all following species tables)

Table 5. Summary of large terrestrial & raptor species recorded on the Drive Transects at the site (see Appendix 3 for full dataset)

Common name	Taxonomic name	Red List: Regional, Global (Endemism)	Number of Birds	Number of Records	Birds/km
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC	20	10	0.08
Jackal Buzzard	*Buteo rufofuscus*	(NE)	10	8	0.04
Ludwig's Bustard	*Neotis ludwigii*	EN, EN	10	3	0.04
Verreaux's Eagle	*Aquila verreauxii*	VU, LC	8	5	0.03
Greater Kestrel	*Falco rupicoloides*		4	1	0.02
Pale Chanting Goshawk	*Melierax canorus*		3	3	0.01
Gabar Goshawk	*Micronisus gabar*		2	1	0.01
Grey-winged Francolin	*Scleroptila africanus*	(SLS)	2	1	0.01
Common Buzzard	*Buteo buteo*		1	1	0.00
Rock Kestrel	*Falco rupicolus*		1	1	0.00

Table 6. Summary of Focal Site survey findings on Taaibos South Wind Farm and surrounding areas

Focal Site	Name and type	Status and findings
FS 1	**Prins Kloof Secretarybird Nest**	• Nest inactive, but landowners report activity previously
FS 2	**Langberg Martial Eagle nest - cliff**	• 2020: Large chick present • 2021: Inactive
FS 3	**Dwarsberg Verreaux's Eagle nest - cliff**	• 2020: Chick present • 2021: Chick present
FS 4	**Taaiboschfontein Verreaux's Eagle nest - cliff**	• 2020: Territory occupied, two adults present close to nest • 2021: No breeding noted, but territory occupied by a pair of adults
FS 5	**Slypfontein Verreaux's Eagle nest - cliff**	• 2020: Active • 2021: Old whitewash present – no signs of breeding attempt • 2022: Alternate nest 1 Active – chick present
FS 6	**Grootkop Verreaux's Eagle nest - cliff**	• 2020: Nest active, significant fresh white wash • 2021: Territory occupied
FS 7	**Grootkrans Verreaux's Eagle nest - cliff**	• 2020: Active • 2021: Active
FS 8	**Laken Valley Martial Eagle nest - tree**	• 2020: Active • 2021: Fresh whitewash and bones present but breeding status unconfirmed
FS 9	**Dam**	• Dam remained dry until S5, after which assorted waders, waterfowl and aerial foragers were present. Sightings included 4 Pied Avocet in S5
FS 10	**Seepage**	• Remained dry – no waterfowl present
FS 11	**Dam**	• Dam filled from a very low water level between S5 and S6, although only limited waterfowl present
FS 12	**Dam**	• Dam filled to half by S6 after being dry for the majority of the year's monitoring. Maximum count of 6 Pied Avocet in S6.
FS 13	**Altona Verreaux's Eagle nest – pine tree**	• 2021: Active – chick present
FS 14	**Jackal Buzzard nest – pine tree**	• 2021: Initial nest building witnessed, although breeding attempt did not seem to proceed
FS 15	**Ramfontein Verreaux's Eagle – pine tree**	• 2021: Many dassie skulls beneath tree. No active breeding attempt noted
FS 16	**Slypfontein Martial Eagle nests (2) - cliff**	• 2021: Breeding activity reported at two cliff nests approximately 700m apart (two adults noted at nest site and lots of fresh whitewash present)

Table 7. Summary of Incidental Observations of relevant bird species on the site (see Appendix 5 for full dataset)

Common Name	Scientific Name	Red List: Regional, Global (Endemism)	Number of Birds	Number of Records
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC	103	49
Jackal Buzzard	*Buteo rufofuscus*	(NE)	15	13
Ludwig's Bustard	*Neotis ludwigii*	EN, EN	12	9
Pale Chanting Goshawk	*Melierax canorus*		13	11
Verreaux's Eagle	*Aquila verreauxii*	VU, LC	11	9
Grey-winged Francolin	*Scleroptila africana*	(SLS)	7	2
Secretarybird	*Sagittarius serpentarius*	VU, EN	6	3
Double-banded Courser	*Rhinoptilus africanus*		5	4
Rock Kestrel	*Falco rupicolus*		4	4
Common Buzzard	*Buteo buteo*		3	3
African Harrier-Hawk	*Polyboroides typus*		2	2
Blue Crane	*Grus paradisea*	NT, VU	2	1
Greater Kestrel	*Falco rupicoloides*		2	2
Gabar Goshawk	*Micronisus gabar*		1	1
Lanner Falcon	*Falco biarmicus*	VU, LC	1	1
Rufous-breasted Sparrow-hawk	*Accipiter rufiventris*	NT, LC	1	1

Table 8. Target bird species recorded during Vantage Point counts at the site (see Appendix 6 for full dataset)

Common Name	Scientific Name	Red List: Regional, Global (Endemism)	Number of Birds	Number of Records	Number of Birds/hr
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC	32	16	0.053
Ludwig's Bustard	*Neotis ludwigii*	EN, EN	28	11	0.047
Pale Chanting Goshawk	*Melierax canorus*		25	21	0.042
Jackal Buzzard	*Buteo rufofuscus*	(NE)	20	19	0.033
Blue Crane	*Grus paradisea*	NT, VU	8	4	0.013
Greater Kestrel	*Falco rupicoloides*		6	3	0.010
Verreaux's Eagle	*Aquila verreauxii*	VU, LC	4	4	0.007
Secretarybird	*Sagittarius serpentarius*	VU, EN	2	1	0.003
Black Harrier	*Circus maurus*	EN, EN (NE)	1	1	0.002
Black-winged Kite	*Elanus caeruleus*		1	1	0.002
Booted Eagle	*Hieraaetus pennatus*		1	1	0.002
Common Buzzard	*Buteo buteo*		1	1	0.002
Kori Bustard	*Ardeotis kori*	NT, NT	1	1	0.002
Lanner Falcon	*Falco biarmicus*	VU, LC	1	1	0.002
Rock Kestrel	*Falco rupicolus*		1	1	0.002

Table 9. Target bird species passage rates and estimated turbine collision fatalities at the site, calculated for 36 turbines

Common Name	Scientific Name	Red List: Regional, Global (Endemism)	Scenario 1: Rotor swept height 30m – 270m		Scenario 2: Rotor swept height 80m – 320m		% Collision risk reduction
			# Flights (S1-S6)	Ann. Fat. rate (98% avoidance)	# Flights (S1-S6)	Ann. Fat. rate (98% avoidance)	
Verreaux's Eagle	*Aquila verreauxii*	VU, LC	4	0.08	3	0.06	-25%
Jackal Buzzard	*Buteo rufofuscus*	(NE)	7	0.13	2	0.04	-73%
Greater Kestrel	*Falco rupicoloides*		2	0.04	2	0.04	0%
Booted Eagle	*Hieraaetus pennatus*		1	0.02	-	0	-100%
Common Buzzard	*Buteo buteo*		1	0.02	-	0	-100%
Ludwig's Bustard	*Neotis ludwigii*	EN, EN	1	0.02	-	0	-100%
Pale Chanting Goshawk	*Melierax canorus*		1	0.02	-	0	-100%

3.2.7 Spatial location of flight records

The spatial location of all target bird species flight records for the site, for all six Site Visits, can be seen below in **Figure 6**.

The flight path data for regionally Red Listed bird species only is presented in **Figure 7**, in order to eliminate the clutter created by more common species. The patterns in flight activity for each of the high risk Red Listed species are discussed in more detail in **Section 3.3**.

Overall, flight activity for all target species was greatest in the viewsheds of VPs 4, 6, 7 & 8 which generally fall in the centre and to the north east of the site and its boundary. Thirteen turbines are proposed within the viewsheds of VPs 7 & 8; seven priority species were recorded flying in this area: Karoo Korhaan, Blue Crane, Verreaux's Eagle, Lanner Falcon, Jackal Buzzard, Secretarybird and Ludwig's Bustard.

Black Harrier and a pair of Secretarybird were recorded only once each, flying in the viewsheds of VP 10 and VP 8 respectively.

It should be noted that flight activity for all target species (as well as via most methodologies in general) was judged to be significantly lower relative to what we would have expected for this ecosystem and the time dedicated to surveying it. Our quantitative and spatial findings are thus somewhat restricted, and the patterns in bird behaviour, habits and movements that tend to emerge with more comprehensive datasets are not clear. This is likely in large part due to the timing of monitoring; the almost decade-long drought experienced by the receiving environment certainly contributed to a decline in bird diversity and numbers, and while good rains fell towards the end of the monitoring year (S5 – S6), ecosystems may take considerable time to return to average carrying capacity or beyond. This being said, other proposed developments in the greater area have also been undergoing pre-construction avifaunal monitoring across similar terrain and vegetation units at roughly the same period, and have noted far greater metrics of birdlife onsite compared to our findings for this site. It is not clear to us at this stage whether the inter site differences in bird abundance and diversity that we have noticed are real (and therefore will persist into the future thereby making the Taaibos site a lower risk project than the others in the area), or if the difference is attributable to some other factors such as sampling or temporary environmental factors. To guard against this uncertainty we recommend that our data be treated as a minimum baseline for avian presence and activity on site. Once post-drought conditions persist in the area, it is highly probable that many species of birds will utilise the site to a far greater degree than our findings suggest. Should this project proceed, it is thus very important that the mitigation and management framework outlined in this report be adhered to in order to ensure that unpredicted risks are minimised.

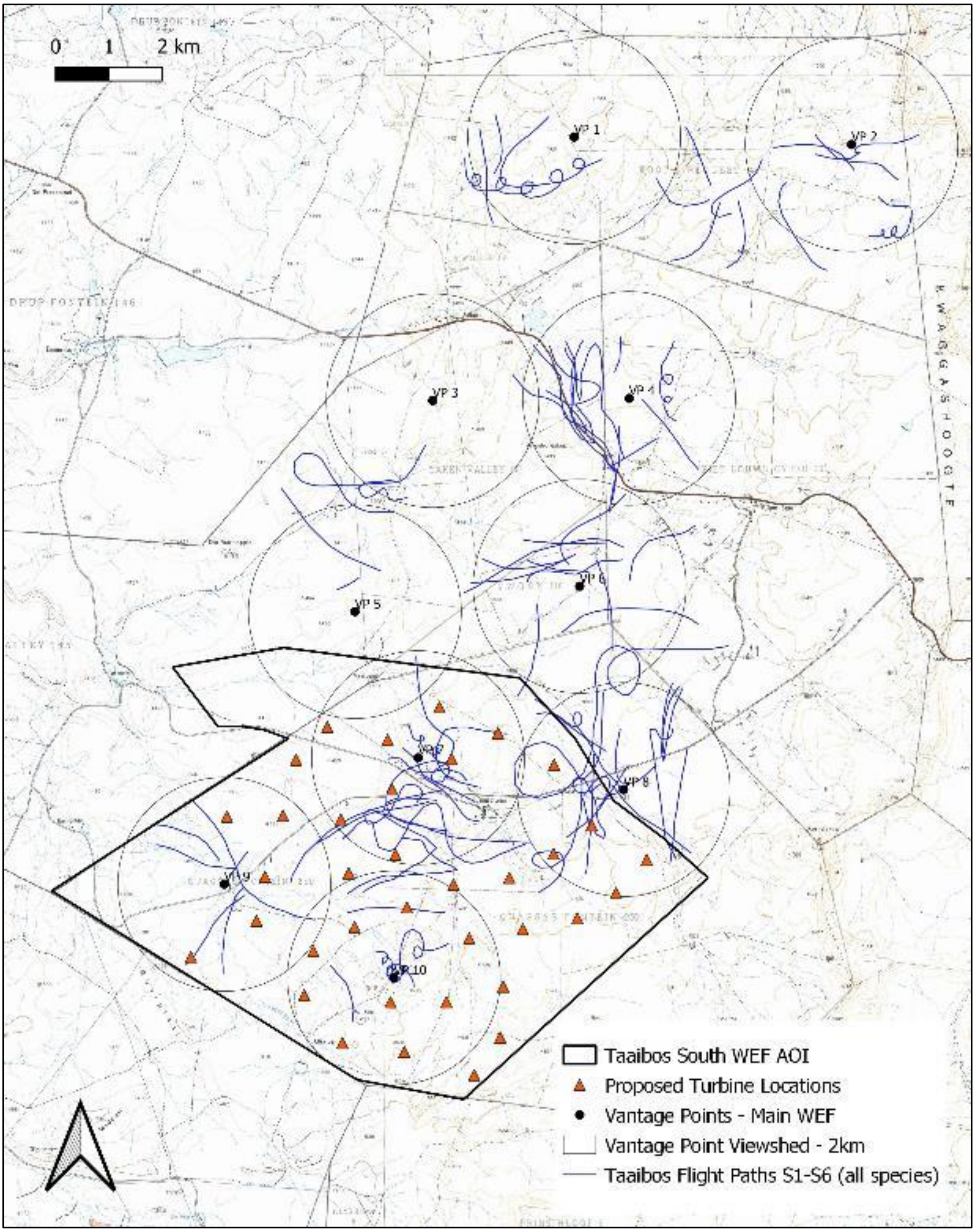

Figure 6. Recorded target bird species flight paths at the site (all species, full year)

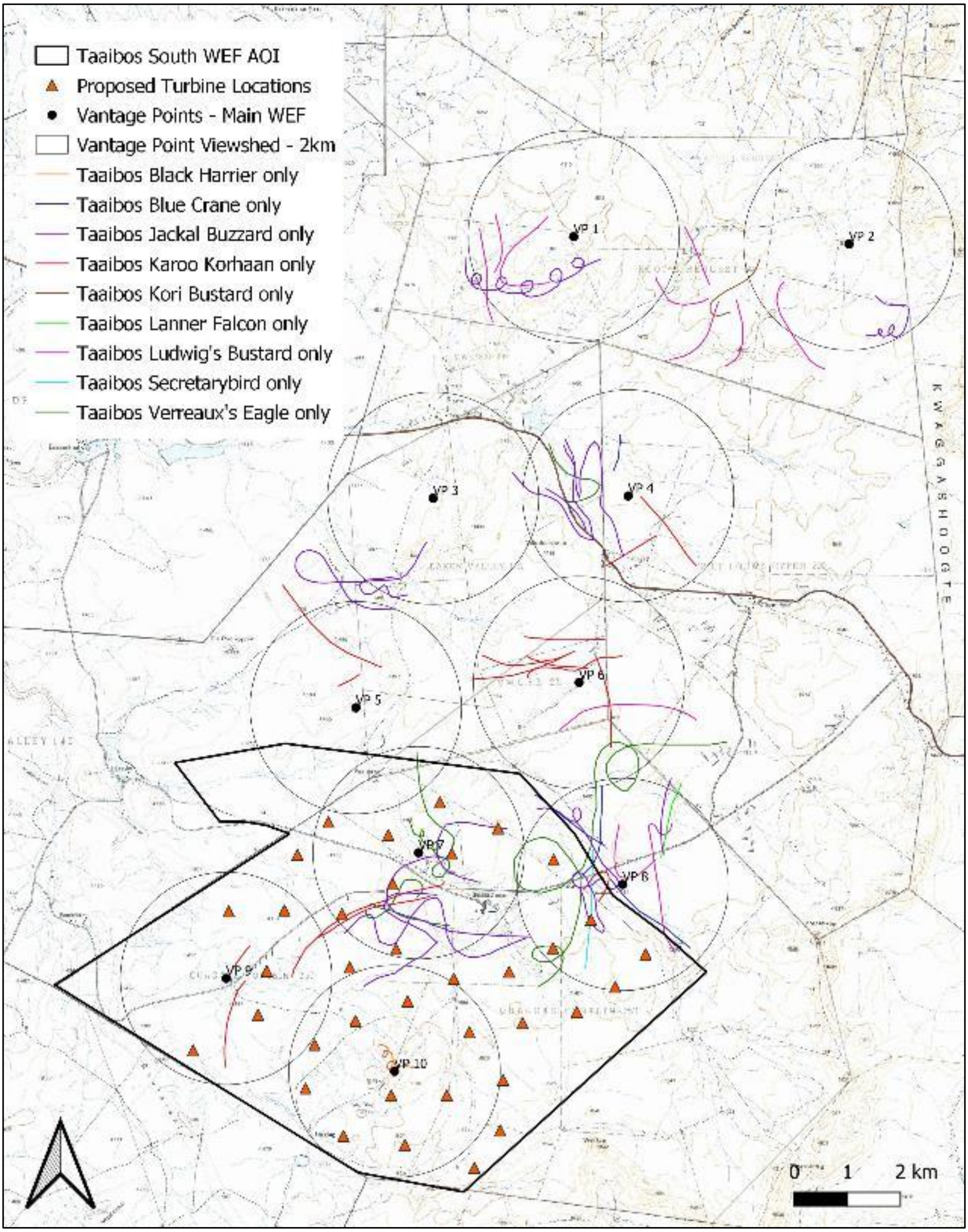

Figure 7. Regionally Red Listed species and Jackal Buzzard flight paths (full year)

3.3 Assessment of risk to priority bird species

Table 10 presents the seasonal presence of each priority species on the site and a qualitative assessment of the risk of each type of impact (pre-mitigation) occurring for each of the priority species if the proposed wind farm is built. Species are presented in descending order of regional conservation status. This assessment has been made on the basis of the data collected on site during this programme, reported on in **Section 3.2.** The proposed facility could pose risk to avifauna in five main ways: collision with turbines; collision with or electrocution on power lines; habitat destruction during construction; disturbance during construction and operation; and displacement from the site once operational. A discussion of each High and Medium risk species follows **Table 10**, in the order of risk category.

Table 10. Priority bird species assessment and risk profile for the site

Common Name	Scientific Name	Red List: Regional, Global (Endemism)	Collision risk (Retief *et al.* 2014)	S1	S2	S3	S4	S5	S6	Risk	Likely impacts
Bustard, Ludwig's	*Neotis ludwigii*	EN, EN	14	√	√			√	√	**Medium**	Collision with turbines
Eagle, Martial	*Polemaetus bellicosus*	EN, EN	4							**High**	Collision with turbines
Harrier, Black	*Circus maurus*	EN, EN (NE)	6	√						**Medium**	Collision with turbines
Eagle, Verreaux's	*Aquila verreauxii*	VU, LC	3	√	√	√	√	√	√	**High**	Collision with turbines
Falcon, Lanner	*Falco biarmicus*	VU, LC	24					√	√	**Low**	Collision with turbines
Secretarybird	*Sagittarius serpentarius*	VU, EN	13	√			√	√	√	**Low**	Collision with turbines, Disturbance & Dis-placement
Stork, Black	*Ciconia nigra*	VU, LC	10							**Low**	Collision with turbines
Bustard, Kori	*Ardeotis kori*	NT, NT	39	√						**Low**	Collision with turbines
Crane, Blue	*Grus paradisea*	NT, VU	11				√	√		**Low**	Collision with turbines, Disturbance & Dis-placement
Duck, Maccoa	*Oxyura maccoa*	NT, VU								**Low**	Collision with turbines
Flamingo, Greater	*Phoenicopterus ruber*	NT, LC	29							**Low**	Collision with turbines
Flamingo, Lesser	*Phoenicopterus minor*	NT, NT	28							**Low**	Collision with turbines
Korhaan, Karoo	*Eupodotis vigorsii*	NT, LC	51	√	√	√	√	√	√	**Low**	Collision with turbines, Disturbance & Dis-placement
Pipit, African Rock	*Anthus crenatus*	NT, LC (SLS)	78		√					**Low**	Collision with turbines, Disturbance & Dis-placement
Buzzard, Common (Steppe)	*Buteo buteo*		67					√	√	**Low**	Collision with turbines
Buzzard, Jackal	*Buteo rufofuscus*	(NE)	43	√	√	√	√	√	√	**Medium**	Collision with turbines
Courser, Double-banded	*Rhinoptilus africanus*		72	√	√		√	√	√	**Low**	Collision with turbines
Eagle, Booted	*Hieraaetus pennatus*		59	√	√					**Low**	Collision with turbines
Francolin, Grey-winged	*Scleroptila afra*	(SLS)	80	√				√		**Low**	Collision with turbines
Goshawk, Gabar	*Micronisus gabar*		131		√				√	**Low**	Collision with turbines

Goshawk, Pale Chanting	*Melierax canorus*		75	√	√	√	√	√	√	**Low**	Collision with turbines
Hawk, African Harrier-	*Polyboroides typus*		85	√	√					**Low**	Collision with turbines
Kestrel, Greater	*Falco rupicoloides*		95	√	√	√		√	√	**Low**	Collision with turbines
Kestrel, Rock	*Falco rupicolus*		111	√	√	√	√			**Low**	Collision with turbines
Kite, Black-winged	*Elanus caeruleus*		94		√					**Low**	Collision with turbines
Korhaan, Northern Black	*Afrotis afraoides*		90	√	√					**Low**	Collision with turbines

3.3.1 Verreaux's Eagle (High risk)

The Verreaux's Eagle has recently been up-listed in regional conservation status to Vulnerable (Taylor *et al.* 2015) in recognition of the threats it is facing. It was ranked at 22 on the list developed by Retief *et al.* (2011), but has been upgraded to 3rd in the 2014 update of this list. This species tends to occupy remote mountainous areas largely unaffected by development (until the advent of wind energy in SA, that is). Early observations on constructed wind farms under monitoring indicate that this species is susceptible to collision with turbines (*pers. obs*.; Ralston-Paton *et al*. 2017; Perold *et al*. 2020).

There are seven known Verreaux's Eagle nests within 17km of the Taaibos South Wind Farm (see **Error! Reference source not found.**). We recorded Verreaux's Eagle on site in all seasons. At Vantage Points, the passage rate recorded for Verreaux's Eagle was 0.01 birds/hour. We estimate based on the recorded passage rates that 0.08 Verreaux's Eagle fatalities could occur each year across the wind farm (all flight records considered). **Error! Reference source not found.** presents the location of flight paths for this species. Flights were not frequently recorded, or recorded across the site, but they were recorded outside of the High and Medium risk areas identified around known nests. This is possibly due to these resident pairs occasionally foraging further afield from nests, or it could be non-resident 'floater' eagles moving through the area. In order to comply with best practice requirements, the VERA (Verreaux's Eagle Risk Assessment) model was run for the site and the output used in designing the layout (see **Appendix 9**). No turbines currently impose on any High or Medium risk areas as determined by VERA modelling (Murgatroyd *et al*. 2020). However, given the number of known nests and their proximity to the site, as well as the ranking assigned by Retief *et al*. 2014, we conclude on a precautionary basis that the species is at High risk at the proposed site.

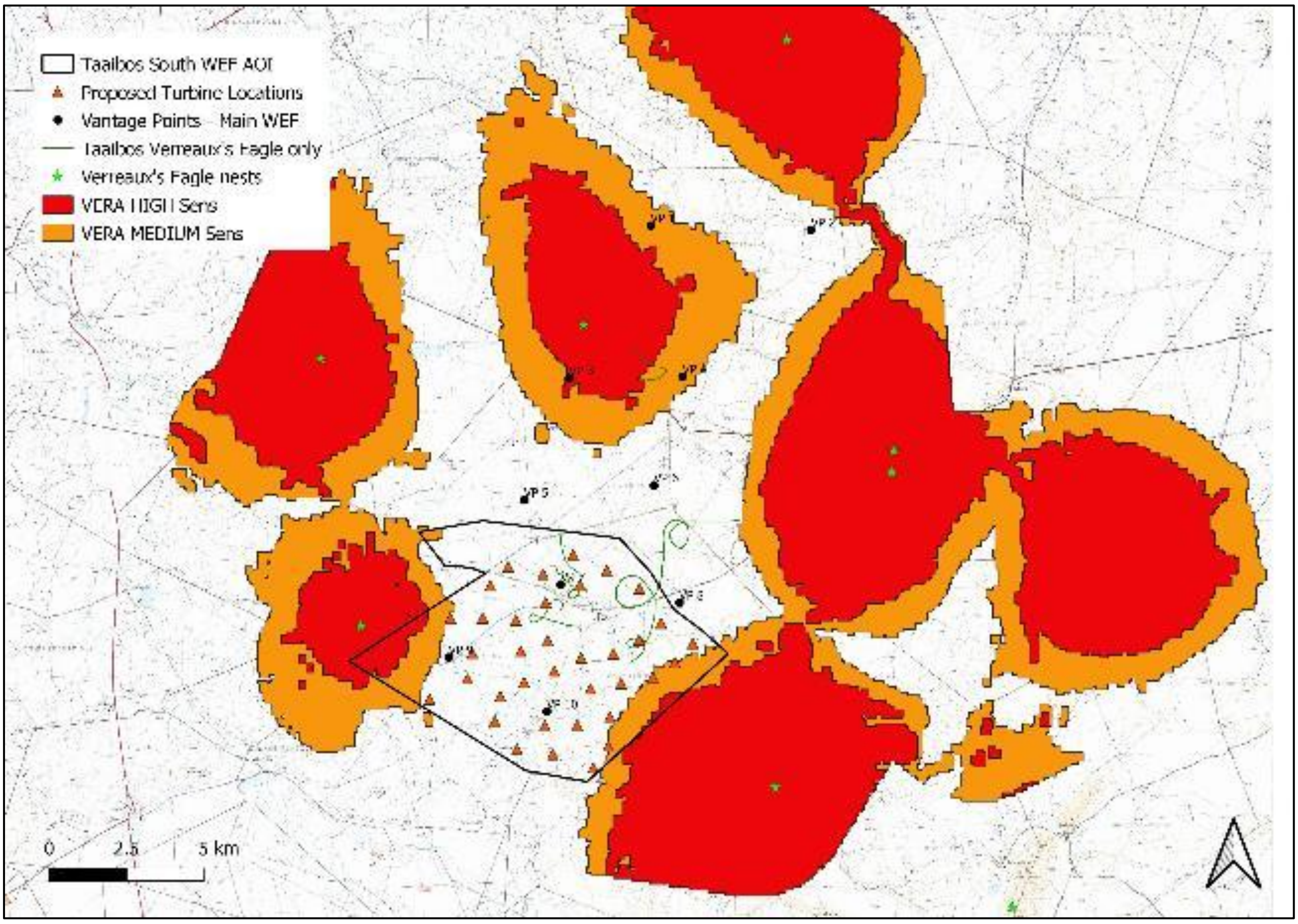

Figure 8. Verreaux's Eagle flight paths on site, with VERA modelling of High and Medium spatial risk

3.3.2 Martial Eagle (High risk)

The Martial Eagle is classified as regionally and globally Endangered (Taylor *et al.* 2015, IUCN 2020). Martial Eagle has proven susceptible to collision with wind turbines (Ralston-Paton *et al*. 2017, Perold *et al*. 2020) particularly in close association with nests (Simmons & Martins, 2016). This is a wide-ranging species, which can best be protected from wind turbine collision risk close to its' breeding sites.

Four nests in three territories are known within approximately 13km of the proposed site. These nests have each received a 6km no-go buffer to turbines and no turbines are proposed within these buffers. (see **Figure 12**). Flights were not observed for this species on site by means of Vantage Point surveys, or by any other methodology. We thus cannot provide any crude estimate of fatality rate for the species at the site, however given the species' Red List status, it's collision risk ranking by Retief *et al*. (2014) as well as the placement of site within the intersection of three active territories, we conclude on a precautionary basis that the species is at High risk at this development.

3.3.3 Black Harrier (Medium risk)

The Black Harrier is both regionally and globally Endangered as well as a South African endemic species

(Taylor *et al.* 2015, IUCN 2020). It is currently suffering population declines due to an ongoing loss of mature individuals, with wind energy a contributing factor alongside habitat loss, roadkill, landscape alteration and climate change. The population is estimated to be around 1 000 mature birds (IUCN 2020) and Cerventes *et al*. (2022) recently calculated their rate of decline to be 2.3% per year, with extinction possible within 100 years if 3-5 adult individuals are killed per year. With the advent of the extensive prospecting for wind energy in South Africa throughout the distribution of the species, this fatality rate may soon be reached or even exceeded.

We estimate that 0.02 Black Harriers could collide with turbines on the wind farm per year (all flight records considered). Although this is a very low fatality rate, it should not be considered in isolation, as the risk along the species' migratory routes is a cumulative one. Flight paths were only documented in the viewshed of VP 10 which falls within an area to receive many turbines, however the species almost certainly forages across the wider landscape. Because of the rarity of the species and its susceptibility to collision with turbines (Retief *et al*. 2014) we judge this species to be at Medium risk on site.

3.3.4 Ludwig's Bustard (Medium risk)

The Ludwig's Bustard is classified as regionally Endangered by Taylor *et al.* (2015). This physically large species is highly vulnerable to collision with overhead power lines (which leads us to believe it may be susceptible to collision with wind turbines), and is also likely to be affected by disturbance and habitat destruction. This species was listed as globally Endangered in 2010 because of potentially unsustainable power line collision mortality, exacerbated by the rapidly expanding power grid (Jenkins *et al.* 2011). Ludwig's Bustard is a wide-ranging bird endemic to the south-western region of Africa (Hockey *et al.* 2005). Ludwig's Bustards are both partially nomadic and migratory (Allan 1994, Shaw 2013, Shaw *et al*. 2015), with a large proportion of the population moving west in the winter months to the Succulent Karoo. In the arid and semi-arid Karoo environment, bustards are also thought to move in response to rainfall, so the presence and abundance of bustards in any one area are not predictable.

Ludwig's Bustard was classified as the 14th most at risk species in Retief's classification (2011, species list updated in 2014). Allan and Anderson (2010) rated the Ludwig's Bustard as the second most threatened (of 11 species), after the Denham's Bustard. Ludwig's Bustard is likely to be susceptible to four possible impacts associated with a wind farm: habitat destruction, disturbance, displacement and collision with turbine blades and power lines. In a recent update of their review work Ralston-Paton (2019) reports two Ludwig's Bustard fatalities at operational wind turbines in SA. This demonstrates that the species is susceptible to turbine collision. We also consider our experience to date with another bustard species, which has more operational wind farms in its range, the Denham's Bustard. At the operational Kouga Wind Farm, disturbance and displacement does not seem to have been significant (Strugnell 2016, 2017, Smallie 2018), since males are still displaying within 50 - 100m of operating turbines. To our knowledge only one turbine collision fatality has been recorded for this species at operational facilities to date at a wind farm in the Kouga area (Ralston-Paton *et al.* 2017; *pers obs*).

Bustard mortality is not sufficiently reduced by affixing bird diverters to power line earth wires, however, a recent study by Pallett *et al*. (2022) showed that staggering the pylon towers of parallel power lines increases the visibility of the infrastructure to bustards, and significantly reduces the number of fatal collisions. This mitigation could theoretically reduce mortality by up to 67% for new power lines.

We recorded Ludwig's Bustard in the study area in four of six Site Visits. The location of all recorded flight paths is presented in **Figure 9**. The overall passage rate for the species was 0.05 birds/hour and we estimated the Taaibos South Wind Farm could kill 0.53 birds per year (all flight records considered, or 0.02 under "Scenario 1", or none under "Scenario 2"). Lekking behaviour was noted in February 2022 on a farm within 30km of the site, and we conclude that the species favours the broader area for breeding behaviour at least in times of favourable conditions. It commutes across the landscape fairly regularly, albeit at a flight height generally below rotor swept area (<30m). We thus conclude the species is at Medium risk at the proposed site.

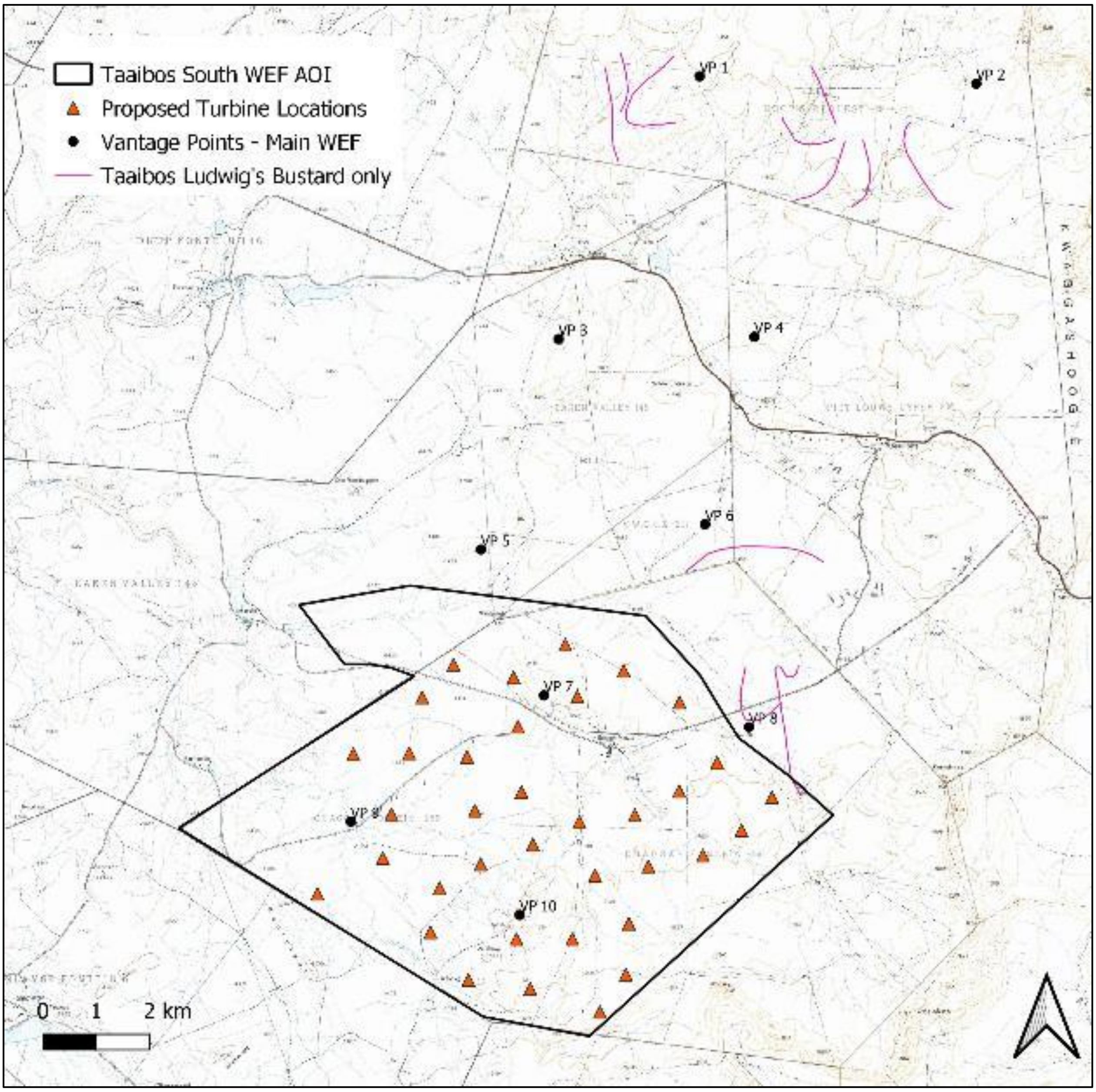

Figure 9. Ludwig's Bustard flight paths on site

3.3.5 Jackal Buzzard (Medium risk)

The Jackal Buzzard is a fairly common species throughout South Africa and on this site. It is a generalist in terms of habitat, although does favour shorter vegetation. It hunts mostly in flight, meaning that a large proportion of its time is spent flying, and thereby at some risk of collision with vertical obstacles. Early observations on constructed wind farms under monitoring indicate that this species is highly susceptible to collision with turbines (*pers. obs*; Ralston-Paton *et al.* 2017; Perold *et al*. 2020).

On the proposed site we recorded the species by all methods and in all seasons. Vantage Points recorded the species at 0.033 birds/hour. The location of recorded flight paths is shown in **Figure 10**. We estimate that 0.38 Jackal Buzzard fatalities could occur per year should all flight heights be considered (reduced to 0.13 per year under “Scenario 1” and 0.04 for “Scenario 2”). Due to its relatively common status this anticipated risk does not carry as much significance as it would if the species were Red Listed. However concern is growing for this species based on the number being killed at operational wind farms in SA. On a precautionary basis we conclude that this species is at Medium risk at the site.

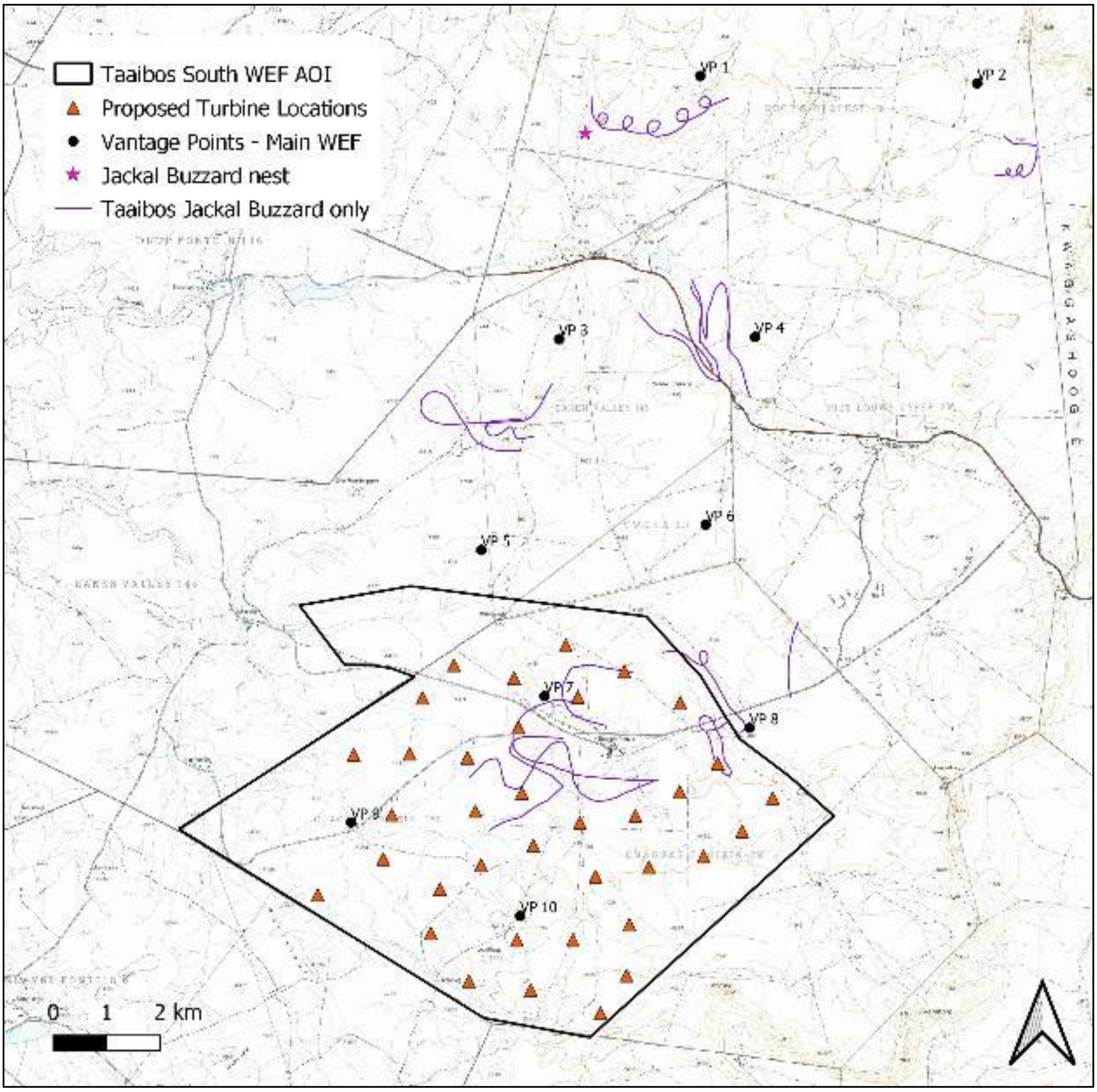

Figure 10. Jackal Buzzard flight paths on site

4. Avifaunal sensitivity of the site

4.1 National Sensitivity

The "Avian Wind Farm Sensitivity map for South Africa (Retief *et al.* 2011) and the Important Bird & Biodiversity Areas programme data (IBA - Marnewick *et al*. 2015) were consulted to determine the sensitivity of the project in national terms. **Figure 11** shows the position of the wind farm relative to the avian wind farm sensitivity map and the IBAs. The site falls in a Low sensitivity category in terms of avifauna (darker colours indicate higher risk). For a full discussion on the methods used in producing this map see Retief *et al.* (2011, 2014). The site is not located in or close to any IBAs (Marnewick *et al.* 2015). It also does not fall in a Renewable Energy Development Zone (REDZ or REDZ2), but is partially situated within an identified power corridor. Overall, it is our opinion that the proposed site falls in an area of Low to Moderate sensitivity on a national scale based on these factors.

A Site Sensitivity Verification has been conducted for avifauna and is presented in **Appendix 13**.

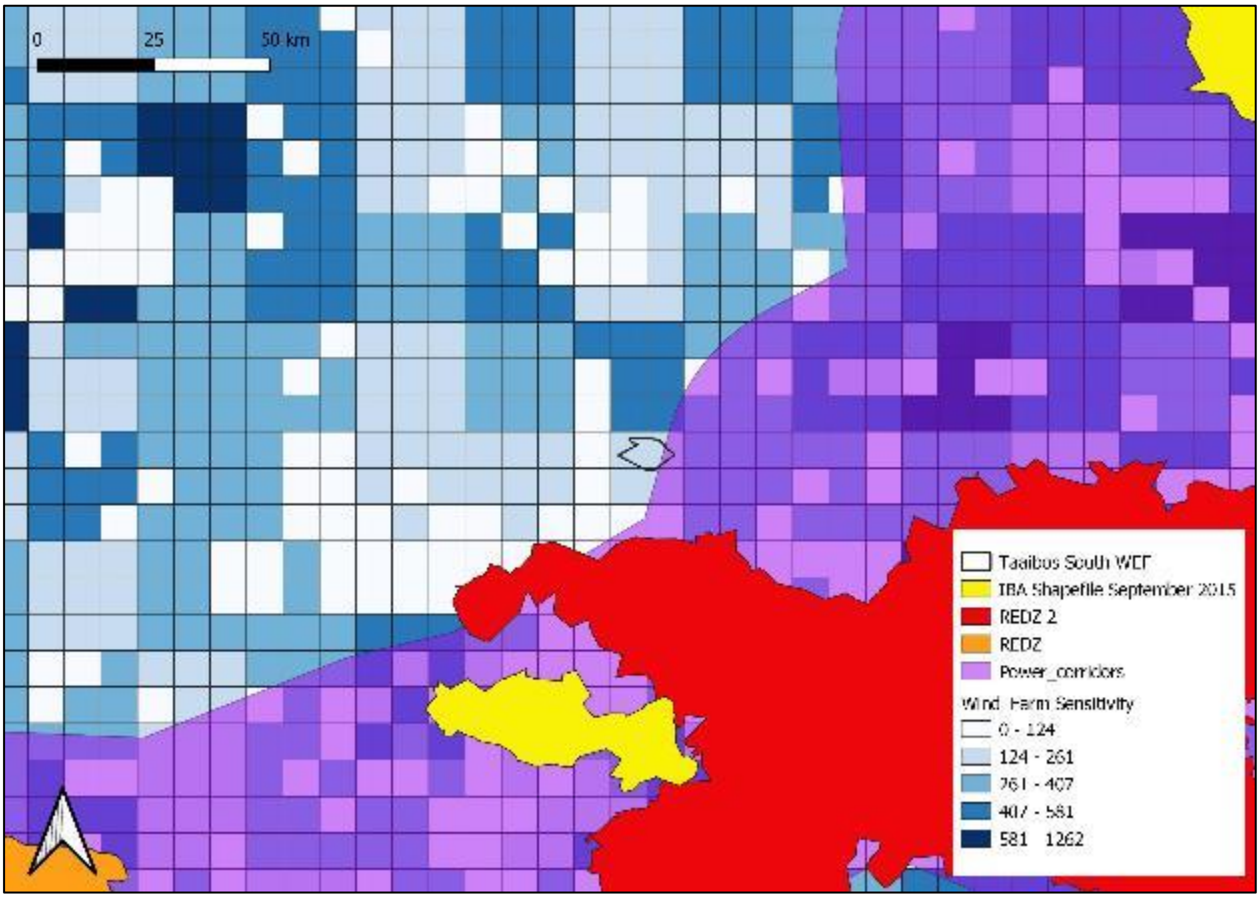

Figure 11. The position of the Taaibos South Wind Farm relative to the Avian wind farm sensitivity map (Retief *et al.* 2011), Important Bird & Biodiversity Areas (IBA - Marnewick *et al.* 2015), and Renewable Energy Development Zones (REDZ/2)

4.2 On-site Sensitivity

In terms of on-site avifaunal sensitivity, the following constraints have been identified:

- **Verreaux's Eagle nest buffers.** Seven Verreaux's Eagle nests exist within 17km of the site. The VERA model was run for all of these nests. The project was re-designed in the earlier stages of monitoring to exclude both the High and Medium risk areas identified by VERA.

- **Martial Eagle nest buffers.** Four Martial Eagle nests occur in the broader study area, the inter-nest distances of which are between approximately 22.5 and 23.5km. For Martial Eagle no guidelines exist yet and we have determined the buffer size using the best possible available literature on the species home range. To determine the size of the buffer we consulted the most recent and comprehensive tracking-based study of Martial Eagle breeding ecology that we are aware of (Van Eeden *et al.* 2017). This study was conducted in the Kruger National Park and determined a mean (n=6) home range size of 108km² implying a home range radius of 6km if a circular home range is assumed. We have therefore placed a 6km radius circular buffer around the Martial Eagle nesting sites – classified as No-Go for turbines. The current turbine layout has taken these constraints into consideration.

- **African Fish Eagle nest buffer.** One African Fish Eagle nest is known from the broader study area. This nest receives a 2km No-go turbine buffer, based on professional judgement; this does not infringe on the current project site.

- **Secretarybird nest buffer.** One Secretarybird nest is known from the broader study area. This nest receives a circular 2.5km No-go turbine buffer and an overhead power line buffer; this does not infringe on the current turine layout. Roads would be permitted up to 1km from the nest (not closer) if they are constructed outside of breeding season (approximately July to December, but variable according to rainfall and other conditions, would require confirmation in construction year). We have consulted two sources in determining this buffer size. The best available information we have on Secretarybird home range sizes is from Mr. Craig Whittington-Jones (Gauteng Department of Agriculture and Rural Development ornithologist) who communicated to us that a 2.5km buffer around Secretarybird nests was appropriate to avoid impacts on the birds. This was based on tracking studies of multiple pairs of Secretarybirds in Gauteng province. In addition, we also had a conversation with Melissa Whitecross (BirdLife South Africa) a year ago, who had stated in a presentation on Secretarybirds that a 3km No-Go buffer would be required. In our more recent discussion with her, Ms. Whitecross stated that 3km is probably overly cautious and that the buffer could perhaps be slightly reduced below 3km.

- **Jackal Buzzard nest buffer.** One Jackal Buzzard nest is known from the broader study area. This nest receives a 500m No-go turbine buffer based on professional judgement; this does not infringe on the current project site.

- **Other species nest buffers.** A number of nests of non-priority species (for example White-necked Raven and Pale Chanting Goshawk) also exist in the study area. These nests are mostly well outside of the current site boundary, and the proposed layout does not infringe on any of the 500m buffers placed around them.

- **Wetlands.** The National Wetland Map of the National Biodiversity Assessment (2018) was consulted. The current turbine layout avoids all such aqautic features (see NBA2018_NWM5 in **Figure 12**)

- **Dams.** Dams are important for general waterfowl, and are life-giving resources, particularly in arid to semi-arid environments. Dams are also important roosting sites for Blue Cranes which sleep at night in the shallows. While most of the water bodies in our study were dry or very empty throughout the majority of the Site Visits, the three dams designated as Focal Sites (FS 9, 11 & 12) have been buffered by 500m as a precaution against being used as roosts at some point in the future. FS 11 appears to be a newly constructed dam, as seen from satellite imagery. Although it is not included in our wetland databases, this dam should also receive the 500m buffer. One turbine ("T14") marginally infringes on this buffer.

The constraints identified above are all classified as 'No-go' areas for turbines. Other infrastructure may enter these areas if necessary and remaining on existing infrastructure as far as possible (e.g. roads). The remainder of the site would likely classify as Moderate to Low sensitivity.

Figure 12 shows the above information consolidated into one map. This spatial information has already been considered in designing the current turbine layout which largely avoids all of these areas, except for the slight infringement of 'T14' into the 500m dam buffer of FS 11. Micro-siting may be used to refine this placement and should not result in a significant adjustment.

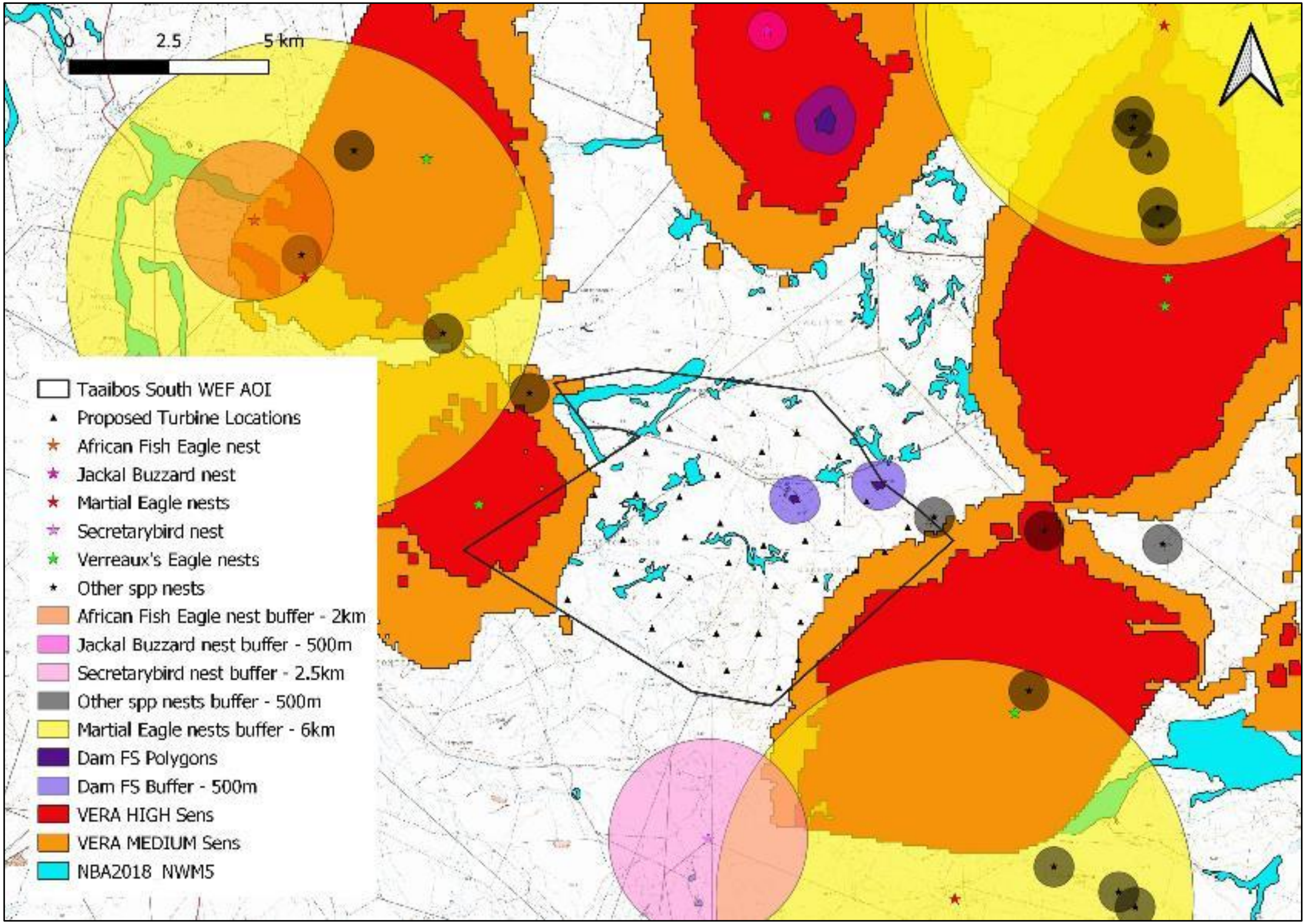

Figure 12. The avifaunal constraints map for the site

4.3 Application of the mitigation hierarchy

The avoidance of avifaunal risk at Taaibos South Wind Farm has been an iterative process resulting from ongoing communication between WildSkies and WKN Windcurrent. The degree to which mitigation or avoidance can make a material difference to avifaunal risk at a wind farm is higher earlier in the project. In the case of the Taaibos South Wind Farm, a significant amount of avifaunal risk avoidance has already been implemented. The various avoidance measures already applied have been summarised below:

- No-Go nest buffers identified by the VERA model imposed around seven Verreaux's Eagle nests
- 6km No-go buffers around four Martial Eagle nests
- Wetlands, according to the The National Wetland Map of the National Biodiversity Assessment (2018)
- Focal Site Dams

5. Impact Assessment

In general terms, the proposed project lies in a wilderness area, little disturbed by anthropogenic factors. Very few if any vertical man-made structures exist in this landscape currently. Human presence and noise pollution are very low. The proposed project would therefore result in a significant change from the *status quo* for avifauna.

The avifaunal community is comprised perhaps most importantly by raptors and large terrestrials. The larger raptors' breeding sites have been avoided by placing large No-go buffers around nests in accordance with current Best Practice Guidelines. These species have however still been recorded flying outside of these areas and on site. Large terrestrials such as cranes, bustards and korhaans are more dispersed on site but spend less time in flight. We assess the impacts via CES methodology for three Phases of the development: Construction, Operation and Decommissioning. The summary of these impacts (pre- and post-mitigation) and their significance is provided in **Table 14**. Mitigation measures are highlighted for each impact and are fully described in detail in **Section 7**. The explanation of CES assessment criteria is provided in **Appendix 8**.

5.1 Potential Construction Phase Impacts

5.2 Two impacts exist for the Construction Phase of development. These are detailed below in Impact Assessment Tables

Table 11.

5.3 Potential Operational Phase Impacts

We have identified six main impacts for the Operational Phase of the project, described below in **Table 12**.

5.4 Potential Decommissioning Phase Impacts

We identify one main impact for the Decommissioning Phase, described below in **Table 13**.

5.5 Impact Assessment Tables

Table 11. Construction Phase Impact Assessment

ISSUE	DESCRIPTION OF IMPACT	SIGNIFICANCE PRE-MITIGATION	MITIGATION MEASURES	SIGNIFICANCE POST-MITIGATION
CONSTRUCTION PHASE				
HABITAT DESTRUCTION	**This impact affects the following components of the Taaibos South WEF: New roads, laydown areas, turbine hardstands, O&M buildings and all other components that require habitat clearance during construction.** With the current proposed layout of up to 36 turbines and associated infrastructure such as roads, laydown areas, collector substations etc, the wind farm could impact on approximately 140 hectares of habitat for clearing. Given the relatively undisturbed nature of vegetation on site, most of this is likely to be natural vegetation. This is a small proportion of the overall site extent, and the habitat is neither particularly unique, nor threatened, or in limited availability. However, the fragmented nature of the remaining habitat will experience an "edge effect", whereby an area greater than the exact footprint of construction is affected by the impact under consideration. Of course, the effect on the avifaunal community is not as simple as the surface area affected. In addition to surface area alteration, the effect of large, dispersed infrastructure projects such as wind farms on birds is likely to be far more complex through factors such as habitat fragmentation, disruption of territories and other factors. These effects have however proven extremely difficult to measure. Since this habitat destruction is largely unavoidable, and our confidence in the effectiveness of habitat rehabilitation is uncertain, we anticipate that the impact significance will remain unchanged by mitigation.	**LOW -**	Mitigation and management measures for this impact (Refer to **Section 7**): Points 1, 2, 3, 4, 5, 6, 7 & 18	**LOW -**

ISSUE	DESCRIPTION OF IMPACT	SIGNIFICANCE PRE-MITIGATION	MITIGATION MEASURES	SIGNIFICANCE POST-MITIGATION
CONSTRUCTION PHASE				
DISTURBANCE	**This impact affects the following components of the Taaibos South WEF: All areas generating noise pollution, dust, and that introduce human and vehicle traffic.** Effects of disturbance on birds are particularly likely during breeding and could include loss of breeding productivity; temporary or permanent abandonment of breeding; or even abandonment of nest site. The avoidance measures (in the form of large No-go buffers) already taken to protect the various eagle nests and their breeding have reduced the significance of this impact to Low Negative significance pre-mitigation and it will remain Low Negative post-mitigation.	**LOW -**	Mitigation and management measures for this impact (Refer to **Section 7**): Points 1, 2, 3, 4, 5, 6, 7 & 18	**LOW -**

Table 12. Operational Phase Impact Assessment

ISSUE	DESCRIPTION OF IMPACT	SIGNIFICANCE PRE-MITIGATION	MITIGATION MEASURES	SIGNIFICANCE POST-MITIGATION
OPERATIONAL PHASE				
DISTURBANCE	**This impact affects the following components of the Taaibos South WEF: All areas generating noise pollution, dust, and that introduce human and vehicle traffic** The indications from operational wind farms are that this impact may be of fairly low importance, although it is acknowledged that a longer term or more detailed means of measuring this impact may be required. The impact of human-induced disturbance during the operational phase of the development is likely to be less severe than during the construction phase. Birds may be displaced from using the landscape for breeding, foraging and commuting purposes due to the loss of habitat, increased noise pollution and human presence. This may reduce population size or force individuals into suboptimal habitat. For the proposed project we consider this impact to be of Low Negative significance.	**LOW -**	Mitigation and management measures for this impact (Refer to **Section 7**): Points 3, 8 & 18	**LOW -**
DISPLACEMENT	**This impact affects the following components of the Taaibos South WEF: Operational facility footprint** As for disturbance above, the indications from operational wind farms are that this impact may be of fairly low importance, although it is acknowledged that a longer term or more detailed means of measuring this impact may be required. Birds may be displaced from using the landscape for breeding, foraging and commuting purposes due to the loss of habitat, increased noise pollution and human presence. This may reduce population size or force individuals into suboptimal habitat.	**LOW -**	Mitigation and management measures for this impact (Refer to **Section 7**): Points 3, 8 & 18	**LOW -**

ISSUE	DESCRIPTION OF IMPACT	SIGNIFICANCE PRE-MITIGATION	MITIGATION MEASURES	SIGNIFICANCE POST-MITIGATION
OPERATIONAL PHASE				
FATAL TURBINE COLLSIONS: RESIDENT SPECIES	**This impact affects the following components of the Taaibos South WEF: As a direct impact of collision with operational turbines** Turbine collisions have been discussed in depth in the literature section of this report. They represent the greatest risk to avifauna at this development. Turbine blades are not always visible to birds flying at rotor swept height and evasive action is not always possible. Striking a moving blade almost certainly results in death or serious injury. In the case of resident species, or those that occupy home ranges on a fairly permanent basis, fatalities represent the loss of individuals in the greater study area, both directly (due to fatalities themselves) as well as indirectly (due to the loss of breeding potential, particularly between monogamous pairs). Human caused fatalities of regionally Red Listed or otherwise threatened bird species are always cause for concern and should be avoided as far as possible. The estimated fatalities we have predicted are therefore of some concern for the relevant species, in particular Verreaux's Eagle, Ludwig's Bustard, Martial Eagle, Black Harrier and Jackal Buzzard. There are currently no established thresholds for acceptable impacts on bird species in South Africa. To establish these thresholds would require complex modelling incorporating accurate information on many factors for each species (including population size, age-specific fatality rates, breeding productivity, etc). Such modelling and information are not available in South Africa at present. In the absence of this information, we are forced to make a somewhat subjective decision as to the acceptability of the estimated annual fatalities.	**MODERATE -**	Mitigation and management measures for this impact (Refer to **Section 7**): Points 3, 8, 10, 11, 12, 13 & 18	**MODERATE -**

ISSUE	DESCRIPTION OF IMPACT	SIGNIFICANCE PRE-MITIGATION	MITIGATION MEASURES	SIGNIFICANCE POST-MITIGATION
OPERATIONAL PHASE				
FATAL TURBINE COLLSIONS: MIGRATORY SPECIES (Black Harrier)	**This impact affects the following components of the Taaibos South WEF: As a direct impact of collision with operational turbines** Turbine collisions have been discussed in depth in the literature section of this report. They represent the greatest risk to avifauna at this development. The impact for Black Harrier is of greater consequence and wider significance: this migratory species is near endemic to South Africa (more than 70% of the population occurs within the country), and loss of any individuals of this Endangered species thus jeopardise the global population. The "Probability" of this impact is rated as "May Occur", which is to say that with an already highly threatened population of only ~1 000 individuals, the likelihood of collision with turbines on this specific site is not particularly high. However, the implications of even a single fatality are far-reaching, long-lasting and cumulative. In the case of migratory species, we conclude that the impact of bird collision with turbines is of Moderate Negative significance. There are various mitigation measures described in **Section 7** and these will reduce the significance somewhat. The degree of this reduction is however uncertain, as the mitigation measures are largely unproven in these conditions. At this stage, we judge that the significance post-mitigation will be of Moderate Negative significance.	**MODERATE -**	Mitigation and management measures for this impact (Refer to **Section 7**): Points 3, 8, 10, 11, 12, 13 & 18	**MODERATE -**

ISSUE	DESCRIPTION OF IMPACT	SIGNIFICANCE PRE-MITIGATION	MITIGATION MEASURES	SIGNIFICANCE POST-MITIGATION
OPERATIONAL PHASE				
FATAL POWER LINE COLLISION	**This impact affects the following components of the Taaibos South WEF: As a direct impact of collision with power line infrastructure** Collision with power line infrastructure has been discussed in depth in the literature section of this report. Unmitigated, it represents a moderately high risk to avifauna at this development, particularly to bustards, storks, cranes and flamingos (collision). Large-bodied birds often lack the manoeuvrability to avoid poorly-marked power lines in flight when commuting in the landscape. This impact is relatively easily mitigated, however, our understanding from recent literature is that mitigation such as power line pylon staggering is not 100% effective and partial losses may still occur	MODERATE -	Mitigation and management measures for this impact (Refer to **Section 7**): Points 1, 2, 3, 5, 6, 7, 8, 13, 14, 15, 17 & 18	MODERATE -
FATAL POWER LINE ELECTROCUTION	**This impact affects the following components of the Taaibos South WEF: As a direct impact of electrocution on power line infrastructure** Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components. This is particularly true for raptors with larger wingspans such as Verreaux's and Martial Eagles. In a treeless landscape such as the proposed site the risk is exaggerated as the birds will certainly perch on pylons if available and may also nest on them. Once correctly installed, such infrastructure should not pose any danger to perching birds and no fatalities will occur	MODERATE -	Mitigation and management measures for this impact (Refer to **Section 7**): Points 1, 13, 16 & 18	LOW -

Table 13. Decommissioning Phase Impact Assessment

ISSUE	DESCRIPTION OF IMPACT	SIGNIFICANCE PRE-MITIGATION	MITIGATION MEASURES	SIGNIFICANCE POST-MITIGATION
DECOMMISSIONING PHASE				
DISTURBANCE	**This impact affects the following components of the Taaibos South WEF: All areas generating noise pollution, dust, and that introduce human and vehicle traffic** Activities associated with decommissioning of a wind farm can disturb birds in the receiving environment. Effects of disturbance during breeding could include loss of breeding productivity; temporary or permanent abandonment of breeding; or even abandonment of a nest site. The avoidance measures (in the form of large no-go buffers) already taken to protect the various eagle nests and their breeding have reduced the significance of this impact to Low Negative significance pre-mitigation and it will remain Low Negative post-mitigation.	**LOW -**	Mitigation and management measures for this impact (Refer to **Section 7**): Points 3 & 5	**LOW -**

Table 14. Impact Assessment Summary for Taaibos South WEF

PROJECT COMPONENTS	NATURE	EFFECT				SIGNIFICANCE BEFORE MITIGATION	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE AFTER MITIGATION
		DURATION	EXTENT	SEVERITY	PROBABILITY					
CONSTRUCTION PHASE										
Impact: HABITAT DESTRUCTION DURING CONSTRUCTION										
Taaibos South WEF: New roads, laydown areas, turbine hardstands, O&M buildings and all other components that require habitat clearance during construction	Negative	Long term	Localised	Slight	Definite	LOW NEGATIVE	Reversible	Partly Lost	Difficult	LOW NEGATIVE
Impact: DISTURBANCE DURING CONSTRUCTION										
Taaibos South WEF: All areas generating noise pollution, dust, and that introduce human and vehicle traffic	Negative	Short term	Study area	Slight	Probable	LOW NEGATIVE	Reversible	Partly lost	Achievable	LOW NEGATIVE
OPERATONAL PHASE										
Impact: DISTURBANCE DURING OPERATION										
Taaibos South WEF: All areas generating noise pollution, dust, and that introduce human and vehicle traffic	Negative	Long term	Localised	Slight	Probable	LOW NEGATIVE	Reversible	Partly lost	Achievable	LOW NEGATIVE
Impact: DISPLACEMENT DURING OPERATION										
Taaibos South WEF: Operational facility footprint	Negative	Long term	Localised	Slight	Probable	LOW NEGATIVE	Reversible	Not lost	Easy	LOW NEGATIVE
Impact: FATAL TURBINE COLLISIONS – RESIDENT & NON-MIGRATORY SPECIES										
Taaibos South WEF: As a direct impact of collision with operational turbines	Negative	Long term	Regional	Moderately severe	Probable	MODERATE NEGATIVE	Irreversible	Lost	Difficult	MODERATE NEGATIVE

PROJECT COMPONENTS	NATURE	EFFECT				SIGNIFICANCE BEFORE MITIGATION	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE AFTER MITIGATION
		DURATION	EXTENT	SEVERITY	PROBABILITY					
Impact: FATAL TURBINE COLLISIONS – MIGRATORY SPECIES (BLACK HARRIER)										
Taaibos South WEF: As a direct impact of collision with operational turbines	Negative	Long term	International	Moderately severe	Probable	**MODERATE NEGATIVE**	Irreversible	Lost	Difficult	**MODERATE NEGATIVE**
Impact: POWER LINE COLLISION & ELECTROCUTION										
Taaibos South WEF: As a direct impact of collision with power line infrastructure	Negative	Long term	Study area	Moderately severe	Probable	**MODERATE NEGATIVE**	Irreversible	Lost	Achievable	**MODERATE NEGATIVE**
Taaibos South WEF: As a direct impact of electrocution on power line infrastructure	Negative	Long term	Study area	Moderately severe	Probable	**MODERATE NEGATIVE**	Reversible	Not lost	Achievable	**LOW NEGATIVE**
DECOMMISSIONING PHASE										
Impact: DISTURBANCE DURING DECOMISSIONING PHASE										
Taaibos South WEF: All areas generating noise pollution, dust, and that introduce human and vehicle traffic	Negative	Short term	Study area	Slight	Probable	**LOW NEGATIVE**	Reversible	Partly lost	Achievable	**LOW NEGATIVE**

5.6 Assessment of the No-Go alternative

The No-Go alternative will result in the *status quo* persisting on site. The *status quo* is mixed farming land use. This land use is not entirely without impacts on avifauna. Birds are subject to a number of mortality factors such as agrochemical poisoning (accidental), fence entanglement, road kill, power line electrocution and collision, disturbance of breeding, subsistence hunting, snaring and others. Habitat is also occasionally altered or destroyed through the creation of new arable lands, other construction, burning regimes, livestock overgrazing and other factors. Although these impacts all affect the avifaunal community on site, they do not appear to have pushed key species towards extinction in most cases. Furthermore, these impacts would not be replaced by the proposed project, they would all still persist in addition to the new impacts associated with the wind farm. The No-Go alternative therefore has much lower impacts on avifauna than the proposed project, and would be preferred from an avifaunal perspective.

5.7 Cumulative Impacts of wind energy facilities on birds in this area

A cumulative impact, in relation to an activity, means the past, current and reasonable foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may be significant when added to the existing and reasonable foreseeable impacts eventuating from similar or diverse activities (as defined by NEMA EIA Reg 1).

The cumulative impacts of wind energy on avifauna in the project area will be carefully assessed in the EIA phase according to the guidance in the DEA (DEAT (2004) Cumulative Effects Assessment, Integrated Environmental Management, Information Series 7, Department of Environmental Affairs and Tourism (DEAT), Pretoria); and the IFC guidelines (Good Practice Handbook – "Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets").

6. Consideration of alternatives

The NEMA requires the consideration and assessment of feasible and reasonable alternatives in the EIA process. Alternatives can include: Location of the proposed activity; Type of activity; Layout alternatives; Technology alternatives; and No-Go alternative.

No macro alternatives, other than the No-Go option, have been assessed in this specialist report. The site and layout considered and assessed in this report are the preferred alternatives. Site alternatives were screened out of the project scope in the Screening Phase (see **Section 4.1**). Micro-siting of the proposed infrastructure will be required as the project progresses, and will result in a preferred layout that minimises the predicted negative impacts.

7. Management & mitigation of identified impacts

Although extensive avoidance of impacts (see **Section 4**) has already been applied on this project via a screening phase at this stage we recommend the following additional mitigation measures be applied to manage and further reduce the significance of impacts on birds:

1. The constraint areas identified by this study (which build on those identified in the screening phase) should be adhered to.
2. A pre-construction avifaunal walk down should be conducted to confirm final layout and identify any sensitivities that may arise between the conclusion of the EIA process and the construction phase.
3. All human activities associated with construction, operation and decommissioning should be strictly managed according to generally accepted environmental best practice standards, so as to avoid any unnecessary impact on the receiving environment.
4. Use should be made of existing roads as far as possible.
5. All staff, vehicle and machinery activities should be strictly controlled at all times so as to ensure that the absolute minimum of surface area is impacted.
6. Care should be taken not to introduce or propagate alien plant species/weeds during construction.
7. Any underground cabling should follow roads at all times to reduce the impact on the habitat by grouping these linear infrastructures.
8. A post-construction inspection must be conducted by an avifaunal specialist to confirm that all aspects have been appropriately handled and in particular that road and hard stand verges do not provide additional substrate for raptor prey species. It is essential that the new wind farm does not create favourable conditions for such mammals in high risk areas. We therefore recommend that within the first year of operations a full assessment of this aspect be made by the ornithologist contracted for post-construction monitoring. If such conditions have been created, case-specific solutions will need to be developed and implemented by the wind farm. It is strongly recommended that rodenticides not be used at the newly established Operation and Maintenance (O&M) buildings or around auxiliary infrastructure on the project site. While pest control of this nature may be effective, even so-called "environmentally friendly" rodenticides are toxic and pose significant secondary poisoning risk to predatory avifauna, especially owls.
9. A bird fatality threshold and adaptive management policy must be designed by an ornithologist for the site prior to the Commercial Operation Date (COD). This policy should form an annexure of the operational EMP for the facility. This policy should identify most importantly the number of bird fatalities of priority species which will trigger a management response, appropriate responses, and time lines for such responses. Fatalities of priority bird species are usually rare events (but with very high consequence) and it is difficult to analyse trends or statistics related to these

fatalities as they occur. It is therefore important to have a threshold policy in place proactively to assist adaptive management.

10. An observer-led turbine Shutdown on Demand (SDOD) programme must be implemented on site from COD. This programme must consist of a suitably qualified, trained and resourced team of observers present on site for all daylight hours 365 days of the year. This team must be stationed at vantage points with full visible coverage of all turbine locations. The observers must detect incoming priority bird species, track their flights, judge when they enter a turbine proximity threshold, and alert the control room to shut down the relevant turbine until the risk has reduced. A full detailed method statement or protocol must be designed by an ornithologist prior to COD.
11. The combination of hub height and rotor diameter must be optimised to maximise the lower blade tip height above ground. Raising the lower turbine blade tip height from a typical 30m above ground to 80m above ground will reduce collision risk for cranes, Ludwig's Bustards, Black Harrier and korhaans, which typically fly low over the ground. We estimated the effect this would have using pre-construction flight data. Raising the lower blade tip from 30 to 80m above ground as a mitigation measure benefited every target species (in terms of reduced predicted mortality). Low sample size in this study was a limitation although it has been predicted to significantly reduce fatality rates on similar projects and we do recommend the implementation of this measure.
12. All turbine blades must be painted according to a protocol currently under development by the South African Wind Energy Association (SAWEA) from the outset. Provision must be made by the developer for the resolution of any technical, warranty, supplier challenges that this may present.
13. Any residual impacts after all possible mitigation measures have been implemented will need to be mitigated off site. The facility will need to address other sources of mortality of priority species in a measurable way so as to compensate for residual effects on the facility itself. This will need to be detailed in a Biodiversity Action Plan.
14. No internal medium voltage power lines should be overhead. All such cables should be buried along road verges. Only the 132kV collector lines and grid connection power line should be above ground.
15. Any overhead conductors or earth wires should be fitted with an Eskom approved anti-bird collision line-marking device to make cables more visible to birds in flight and reduce the likelihood of collisions.
16. The pole design of any overhead power line should be approved by an ornithologist in terms of the electrocution risk it may pose to large birds such as eagles.
17. All overhead power line within 6km of turbines should be regularly (at least quarterly) surveyed for eagle nests as part of the operational monitoring of the wind farm. The establishment of such nests would bring eagles closer to the turbines than currently the case, and increase collision risk. Any such nests should be reported to an avifaunal specialist for case specific advice.

18. Should more than one power line be constructed in parallel with another either new or pre-existing power line, the pylon structures should be staggered as per Pallett *et al*. (2022) to increase visibility to large, slow-moving species, especially bustards and cranes.

19. The "during construction" and "post-construction" monitoring programme outlined in **Appendix 7** should be implemented according to the latest available version of the Best Practice Guidelines at the time. The findings from Operational Phase monitoring should inform an adaptive management programme to mitigate any impacts on avifauna to acceptable levels. In particular, any Verreaux's Eagle fatalities should be reported to Dr Megan Murgatroyd in order to close the feedback loop back to the VERA modelling performed for this site.

8. Conclusion & Recommendations

We draw the following conclusions regarding the avifaunal community and potential impacts of the proposed wind farm:

- We classified two species as being at High risk should the project proceed, and three species at Medium risk. High risk species include: Martial Eagle (Endangered) and Verreaux's Eagle (Vulnerable). Ludwig's Bustard (Endangered), Black Harrier (Endangered) and Jackal Buzzard (near endemic, not Red Listed) were classified as Medium risk.
- It is estimated that approximately 0.32 fatalities could be recorded at the wind farm per year across the 15 target bird species recorded flying on site for a rotor swept area of 30 – 270m. This includes: 0.08 Verreaux's Eagles; 0.02 Ludwig's Bustards; and 0.013 Jackal Buzzards. These estimates are reduced with an increase in minimum blade height above ground. There are currently no established thresholds for acceptable impacts on bird species in South Africa. In the absence of this information we are forced to make a subjective finding as to the acceptability of the above estimates. In our view the above fatality rates are of Low significance for all target species, however, we wish to include a caveat that these data are subject to limitations and represent an absolute minimum baseline.

CES Environmental and Social Advisory Services has been appointed as the EAP and using the formal impact assessment methods supplied, our impact significance findings are presented in this Impact Assessment report. We assessed the potential impacts on birds during three Phases of development: Construction, Operational and Decommissioning, and made the following findings:

- Habitat destruction significance will be Low (or at worst Medium) Negative. Since this habitat destruction is largely unavoidable, we anticipate that the impact significance will remain unchanged by mitigation.
- Disturbance of birds during construction is likely to be of Low Negative significance (post-application of nest buffers).
- Disturbance of birds during operations will be of Low Negative significance.
- Displacement of birds during operations will be of Low Negative significance.
- The impact of bird collision with turbines is likely to be of High Negative significance and must be effectively mitigated. Given the uncertainty around the effectiveness of the mitigation measures recommended, the significance is likely to remain at Moderate Negative post-mitigation.
- Bird electrocution and collision on overhead power lines have the potential to be of Moderate Negative significance pre-mitigation. If the above-ground power line is designed to be bird-friendly (for electrocution) or installed with line-marking devices (for collision) this impact may be relatively easily reduced to a Low Negative significance post-mitigation for electrocution, but

remains at Moderate Negative for collisions, due to the mitigation measures not being fully effective.

In addition to the avoidance measures already implemented, the following mitigation is recommended:

1. The constraint areas identified by this study (which build on those identified in the screening phase) should be adhered to.
2. A pre-construction avifaunal walk down should be conducted to confirm final layout and identify any sensitivities that may arise between the conclusion of the EIA process and the construction phase.
3. All human activities associated with construction, operation and decommissioning should be strictly managed according to generally accepted environmental best practice standards, so as to avoid any unnecessary impact on the receiving environment.
4. Use should be made of existing roads as far as possible.
5. All staff, vehicle and machinery activities should be strictly controlled at all times so as to ensure that the absolute minimum of surface area is impacted.
6. Care should be taken not to introduce or propagate alien plant species/weeds during construction.
7. Any underground cabling should follow roads at all times to reduce the impact on the habitat by grouping these linear infrastructures.
8. A post-construction inspection must be conducted by an avifaunal specialist to confirm that all aspects have been appropriately handled and in particular that road and hard stand verges do not provide additional substrate for raptor prey species. It is essential that the new wind farm does not create favourable conditions for such mammals in high risk areas. We therefore recommend that within the first year of operations a full assessment of this aspect be made by the ornithologist contracted for post-construction monitoring. If such conditions have been created, case-specific solutions will need to be developed and implemented by the wind farm. It is strongly recommended that rodenticides not be used at the newly established Operation and Maintenance (O&M) buildings or around auxiliary infrastructure on the project site. While pest control of this nature may be effective, even so-called "environmentally friendly" rodenticides are toxic and pose significant secondary poisoning risk to predatory avifauna, especially owls.
9. A bird fatality threshold and adaptive management policy must be designed by an ornithologist for the site prior to the Commercial Operation Date (COD). This policy should form an annexure of the operational EMP for the facility. This policy should identify most importantly the number of bird fatalities of priority species which will trigger a management response, appropriate responses, and time lines for such responses. Fatalities of priority bird species are usually rare events (but with very high consequence) and it is difficult to analyse trends or statistics related to these fatalities as they occur. It is therefore important to have a threshold policy in place proactively to assist adaptive management.

10. An observer-led turbine Shutdown on Demand (SDOD) programme must be implemented on site from COD. This programme must consist of a suitably qualified, trained and resourced team of observers present on site for all daylight hours 365 days of the year. This team must be stationed at vantage points with full visible coverage of all turbine locations. The observers must detect incoming priority bird species, track their flights, judge when they enter a turbine proximity threshold, and alert the control room to shut down the relevant turbine until the risk has reduced. A full detailed method statement or protocol must be designed by an ornithologist prior to COD.
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18. Should more than one power line be constructed in parallel with another either new or pre-existing power line, the pylon structures should be staggered as per Pallett *et al*. (2022) to increase visibility to large, slow-moving species, especially bustards and cranes.

19. The “during construction” and “post-construction” monitoring programme outlined in **Appendix 7** should be implemented according to the latest available version of the Best Practice Guidelines at the time. The findings from operational phase monitoring should inform an adaptive management programme to mitigate any impacts on avifauna to acceptable levels. In particular, any Verreaux’s Eagle fatalities should be reported to Dr Megan Murgatroyd in order to close the feedback loop back to the VERA modelling performed for this site.

The Applicant has redesigned the developable area of the proposed wind farm to avoid the constraints and their buffers detailed in this report. This has largely been as a result of the presence of several large raptor nests in the broader study area. VERA modelling has been consulted and the turbine layout of the proposed project has been adjusted to avoid both Medium and High Sensitivities indicated around seven Verreaux’s Eagle nests surrounding the site. Four Martial Eagle nests from three territories have similarly been buffered (by 6km) to mitigate the risk of turbine collisions. Aquatic sensitivities have also been largely avoided, with the exception of one turbine (‘T14’) proposed marginally within the 500m buffer of the FS 11 dam. Avifaunal impacts have been assessed in this document and have been mostly judged to be of Low Negative significance post-mitigation, with the exception of the impact of fatalities as a direct result of turbine and power line collisions (Moderate Negative). Our 12-month pre-construction data indicate that avifaunal abundance and diversity is relatively low on site, although given the timing of this study at the conclusion of an almost decade-long drought, our findings are almost certainly a below-average baseline. We thus urge adherence to the mitigation and management measures detailed in this report in light of our prediction that avifaunal presence on site will only increase post-drought.

According to available information consulted during this study to date, there are no fatal flaws from an avifaunal sensitivity perspective which should prevent the wind farm from receiving Environmental Authorisation.

9. References

Allan, D.G. & Anderson, M.D. 2010. Assessment of the threats faced by South African bustards. Unpublished BirdLife South Africa report.

Allan, D. G. 2003. Abundance sex ratio, breeding and habitat of Stanley's Bustard *Neotis denhami stanleyi* in western South Africa. Durban Museum, Novit 28: 1-10.

Alonso, J. A., & Alonso, J. C. 1999. Collision of birds with overhead transmission lines in Spain. In: Ferrer M and Janss F E (eds), Birds and powerlines, Quercus, Madrid, pp57 - 82.

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. Karoo Large Terrestrial Bird Powerline Project, Directorate Conservation & Environment (Northern Cape), Kimberley.

Barrios, L. & Rodriguez, A. 2004. Behavioral and environmental correlates of soaring-bird mortality at on-shore wind turbines. Journal of Applied Ecology 41: 72-81

Bevanger, K. 1994. Bird interactions with utility structures: collision and electrocution, causes and mitigating measures. Ibis 136: 412-425. 184

Bevanger, K. 1998. Biological and conservation aspects of bird mortality caused by electricity power lines: a review. Biological Conservation 86: 67-76.

Bevanger, K. 1999. Estimating bird mortality caused by collision and electrocution with power lines; a review of methodology. In: Ferrer, M. and Janss, G.F.E. (Eds.) Birds and Power Lines. Collision, Electrocution and Breeding: pages 29-56. Servicios Informativos Ambientales/Quercus, Madrid.

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

Bibby, C.J., Burgess, N.D., Hill, D.A., & Mustoe, S. 2000. Bird Census Techniques. Academic Press, London.

BirdLife South Africa. 2021. Verreaux's Eagle and Wind Farms: Guidelines for impact assessment, monitoring, and mitigation (compiled by Samantha Ralston-Paton and Dr Megan Murgatroyd).

Boshoff, A.F. 1993. Density, breeding performance and stability of Martial Eagles *Polemaetus bellicosus* breeding on electricity pylons in the Nama-Karoo, South Africa. In Wilson RT (ed) Birds and the African Environment: Proc. Of the 8th Pan-Afr. Ornithol. Congr. Pp 95-504

Brooke, R.K. 1984. An assessment of rare, vulnerable and endangered South African breeding birds. In: Ledger, J. (Ed.), Proceedings of the Fifth Pan-African Ornithological Congress, Lilongwe 1980, pp. 567-576. Johannesburg: Southern African Ornithological Society.

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

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

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

Drewitt, A.L., & Langston, R.H.W. 2008. Collision effects of wind-power generators and other obstacles on birds. Annals of the New York Academy of Science 1134: 233-266

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 and existing wind developments. Prepared for Bonneville Power Administration.

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

FitzPatrick Institute of African Ornithology & HawkWatch International. Verreaux's Eagle Risk Assessment.

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.

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.

Howell, J.A. Noone, J. 1992. Examination of avian use and mortality at a US Windpower wind energy development site, Montezuma Hills, Solano County, California. Final report. Prepared for Solano County Department of Environmental Management, Fairfield, California.

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.

IFC. Good Practice Handbook - Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets". International Finance Corporation.

IUCN 2021. IUCN Red List of Threatened Species. <www.iucnredlist.org>.

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., Van Rooyen, C.S., Smallie, J., Harrison, J.A., Diamond, M., Smit-Robbinson, H.A. & Ralston, S. 2015. "Best practice guidelines for assessing and monitoring the impact of wind energy facilities on birds in southern Africa" Unpublished guidelines

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

Krijgsveld, K.L. Akershoek, K. , Schenk, F., Dijk, F., & Dirksen, S. 2009. Collision risk of birds with modern large wind turbines. Ardea 97: 357-366

Kuvlevsky, W.P., Brennan, L.A., Morrison, M.L., Boydston, K.K., Ballard, B.M. & Bryant, F.C. 2007. Wind energy development and wildlife conservation: challenges and opportunities. Journal of Wildlife Management 71: 2487-2498.

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

Marnewick MD, Retief EF, Theron NT, Wright DR, Anderson TA. 2015. Important Bird and Biodiversity Areas of South Africa. Johannesburg: BirdLife South Africa.

Martinéz, J.E., Calco, J.F., Martinéz, J.A., Zuberogoitia, I., Cerezo, E., Manrique, J., Gómez, G.J., Nevado, J.C., Sánchez, M., Sánchez, R., Bayo, J. Pallarés, A., González, C., Gómez, J.M., Pérez, P. & Motos, J. 2010. Potential impact of wind farms on territories of large eagles in southeastern Spain. Biodiversity and Conservation 19: 3757-3767.

Masden EA, Fox AD, Furness RW, Bullman R and Haydon DT 2009. Cumulative impact assessments and bird/wind farm interactions: Developing a conceptual framework. Environmental Impact Assessment Review 30: 1-7.

May, R., Nygard, T., Lie Dahl, E., Reitan, O., & Bevanger, K. 2010. Collision risk in white-tailed eagles,Modelling kernel-based collision risk using satellite telemetry data in Smøla wind-power plant. NINA report 692.

May, R., Nygård, T., Falkdalen, U., Åström, J., Hamre, Ø. & Stokke, B.G. 2020. Paint it black: Efficacy of increasing wind turbine visibility to reduce avian fatalities. Ecology and Evolution 00: 1-9.

McIsaac HP 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.

Mucina, L., & Rutherford, C. 2006. The Vegetation of South Africa, Lesotho and Swaziland, South African National Biodiversity Institute, Pretoria.

Pallett, J., Simmons, RE. & Brown, C.J. 2022 Staggered towers on parallel transmission lines: a new mitigation measure to reduce collisions of birds, especially bustards. *Namibian Journal of Environment* 6 A: 14-21.

Perold, V., Ralston-Paton, S. & Ryan, P. 2020. On a collision course? The large diversity of birds killed by wind turbines in South Africa, Ostrich, DOI: 10.2989/00306525.2020.1770889

Ralston-Paton, S., Smallie, J., Pearson, A., & Ramalho, R. 2017. Wind energy's impacts on birds in South Africa: a preliminary review of the results of operational monitoring at the first wind farms of the

Renewable Energy Independent Power Producer Procurement Programme Wind Farms in South Africa. BirdLife South Africa Occasional Report Series No. 2. BirdLife South Africa, Johannesburg, South Africa.

Retief, E., Anderson, M., Diamond, M., Smit, H., Jenkins, A. & Brooks, M. 2011/2014. Avian Wind Farm Sensitivity Map for South Africa: Criteria and Procedures used.

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.

Rydell, J., Engstrom, H., Hedenstrom, A., Larson, J.K., Petterrson, J.& Green, M. 2012. The effect of wind power on birds and bats – a synthesis. Unpublished report by the Swedish Environmental Protection Agency. ISBN 978-91-620-6511-9

Shaw, J.M. 2009. The End of the Line for South Africa's National Bird? Modelling Power Line Collision Risk for the Blue Crane. Master of Science in Conservation Biology. Percy FitzPatrick Institute of African Ornithology

Shaw, J., Jenkins, A.R. and Ryan, P.G. 2010a. Modelling power line collision risk in the Blue Crane Anthropoides paradiseus in South Africa. Ibis 152: 590-599.

Shaw, J., Jenkins, A.R. and Ryan, P.G. 2010b. A preliminary survey of avian mortality on power lines in the Overberg, South Africa. Ostrich 81: 109-113.

Simmons R.E., Ralston-Paton S., Colyn R. and Garcia-Heras M.-S. 2020. Black Harriers and wind energy: guidelines for impact assessment, monitoring and mitigation. BirdLife South Africa, Johannesburg, South Africa

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.

Smallwood, K.S. & Thelander, C. 2008. Bird mortality in the Altamont Pass Wind Resource Area, California. Journal of Wildlife Management 72: 215-223.

Taylor, M. R, Peacock, F., & Wanless, R. 2015. The 2015 Eskom Red Data Book of Birds of South Africa, Lesotho & Swaziland.

Tarboton. W. 1989. Breeding behavior of Denham's Bustard. Bustard Studies 4: 160-165

Thelander, C.G., and Rugge, L. 2001. Examining relationships between bird risk behaviours and fatalities at the Altamont Wind Resource Area: a second years progress report In: Schwartz, S.S. (Ed), Proceedings of the National Avian – Wind Power Planning Meeting 4 Carmel, CA, May 16-17 2000.

van Rooyen , C.S. & Ledger, J.A. 1999. Birds and utility structures: Developments in southern Africa. Pp 205-230 in Ferrer, M. & G..F.M. Janns. (eds.) Birds and Power lines. Quercus, Madrid, Spain. 238pp.

van Eeden R, Whitfield DP, Botha A, Amar A (2017) Ranging behaviour and habitat preferences of the Martial Eagle: Implications for the conservation of a declining apex predator. PLoS ONE 12(3): e0173956. https://doi.org/ 10.1371/journal.pone.0173956

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

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.

WildSkies Ecological Services (Pty) Ltd, 2019. Cradock Wind Farm: Initial Avifaunal Assessment. Unpublished report submitted to AEP.

Young, D.J., Harrison, J.A., Navarro, R.A., Anderson, M.D., & Colahan, B.D. (eds) 2003. Big Birds on Farms: Mazda CAR Report 1993-2001. Avian Demography Unit. Cape Town.

Websites:

www.sabap2.adu.org.za. The Second Southern African Bird Atlas Project. In progress.
www.iucnredlist.org.
www.abcbirds.org American Bird Conservancy
www.sibleyguides.com Sibley Guides
www.nssf.org National Shooting Sports Foundation
www.project-gpwind.eu The Good Practice Wind project
www.birdlife.org Birdlife International
www.birdlife.org.za BirdLife South Africa
www.iucnredlist.org. Accessed 2022
www.car.adu.org.za. CAR project
www.cwac.adu.org.za CWAC project

Appendix 1. Bird species recorded on the site

Table A1. List of all bird species identified on site throughout the year of monitoring

	Common Name	Scientific Name	SABAP 1	SABAP 2	Collision Risk (Retief *et al*. 2014)	Red Data (Regional, Global)*	Endemism**	S1	S2	S3	S4	S5	S6
1	Bustard, Ludwig's	*Neotis ludwigii*	1	1	14	EN, EN		*1*	*1*			*1*	*1*
2	Eagle, Martial	*Polemaetus bellicosus*	1	1	4	EN,EN							
3	Harrier, Black	*Circus maurus*	1		6	EN, EN	NE	*1*					
4	Eagle, Verreaux's	*Aquila verreauxii*	1	1	3	VU, LC		*1*	*1*	*1*	*1*	*1*	*1*
5	Falcon, Lanner	*Falco biarmicus*	1		24	VU, LC						*1*	*1*
6	Secretarybird	*Sagittarius serpentarius*		1	13	VU, EN		*1*			*1*	*1*	*1*
7	Stork, Black	*Ciconia nigra*	1		10	VU, LC							
8	Bustard, Kori	*Ardeotis kori*	1		39	NT, NT		*1*					
9	Crane, Blue	*Grus paradisea*	1	1	11	NT, VU					*1*	*1*	
10	Duck, Maccoa	*Oxyura maccoa*		1		NT, VU							
11	Flamingo, Greater	*Phoenicopterus ruber*	1	1	29	NT, LC							
12	Flamingo, Lesser	*Phoenicopterus minor*		1	28	NT, NT							
13	Korhaan, Karoo	*Eupodotis vigorsii*	1	1	51	NT, LC		*1*	*1*	*1*	*1*	*1*	*1*
14	Pipit, African Rock	*Anthus crenatus*	1	1	78	NT, LC	SLS		*1*				
15	Sandpiper, Curlew	*Calidris ferruginea*	1			LC, NT							
16	Avocet, Pied	*Recurvirostra avosetta*	1	1							*1*	*1*	*1*
17	Barbet, Acacia Pied	*Tricholaema leucomelas*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
18	Batis, Pririt	*Batis pririt*	1		168								
19	Bee-eater, European	*Merops apiaster*	1	1	172						*1*		
20	Bee-eater, Swallow-tailed	*Merops hirundineus*	1										
21	Bishop, Southern Red	*Euplectes orix*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
22	Bittern, Little	*Ixobrychus minutus*	1										
23	Bokmakierie	*Telophorus zeylonus*	1	1				*1*	*1*	*1*	*1*	*1*	*1*

24	Bulbul, African Red-eyed	*Pycnonotus nigricans*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
25	Bunting, Cape	*Emberiza capensis*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
26	Bunting, Cinnamon-breasted	*Emberiza tahapisi*	1										
27	Bunting, Lark-like	*Emberiza impetuani*	1	1	126			*1*	*1*	*1*	*1*	*1*	*1*
28	Buzzard, Common (Steppe)	*Buteo buteo*	1	1	67							*1*	*1*
29	Buzzard, Jackal	*Buteo rufofuscus*	1	1	43		NE	*1*	*1*	*1*	*1*	*1*	*1*
30	Canary, Black-headed	*Serinus alario*	1	1	109		NE	*1*	*1*	*1*	*1*		*1*
31	Canary, Black-throated	*Crithagra atrogularis*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
32	Canary, Cape	*Serinus canicollis*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
33	Canary, White-throated	*Crithagra albogularis*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
34	Canary, Yellow	*Crithagra flaviventris*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
35	Chat, Ant-eating	*Myrmecocichla formicivora*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
36	Chat, Familiar	*Oenathe familiaris*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
37	Chat, Karoo	*Emarginata schlegelii*	1	1	177			*1*	*1*	*1*	*1*	*1*	*1*
38	Chat, Sickle-winged	*Emarginata sinuata*	1	1	158		NE	*1*	*1*	*1*	*1*	*1*	*1*
39	Chat, Tractrac	*Emarginata tractrac*	1	1	179			*1*	*1*	*1*	*1*	*1*	*1*
40	Cisticola, Desert	*Cisticola aridulus*						*1*	*1*	*1*			*1*
41	Cisticola, Grey-backed	*Cisticola subruficapilla*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
42	Cisticola, Levaillant's	*Cisticola tinniens*	1	1									
43	Cisticola, Zitting	*Cisticola juncidis*						*1*					
44	Cliff-swallow, South African	*Hirundo spilodera*	1	1	130								
45	Coot, Red-knobbed	*Fulica cristata*	1	1									
46	Cormorant, Reed	*Phalacrocorax africanus*	1	1									
47	Cormorant, White-breasted	*Phalacrocorax carbo*	1	1									
48	Courser, Double-banded	*Rhinoptilus africanus*	1	1	72	NT, LC		*1*	*1*		*1*	*1*	*1*
49	Crombec, Long-billed	*Sylvietta rufescens*	1	1				*1*		*1*	*1*		*1*
50	Crow, Cape	*Corvus capensis*	1					*1*	*1*	*1*	*1*	*1*	*1*

51	Crow, Pied	*Corvus albus*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
52	Cuckoo, Diderick	*Chrysococcyx caprius*	1	1									
53	Darter, African	*Anhinga rufa*	1										
54	Dove, Cape Turtle (Ring-necked)	*Streptopelia capicola*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
55	Dove, Laughing	*Spilopelia senegalensis*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
56	Dove, Namaqua	*Oena capensis*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
57	Dove, Red-eyed	*Streptopelia semitorquata*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
58	Dove, Rock	*Columba livia*	1	1									
59	Drongo, Fork-tailed	*Dicrurus adsimilis*	1	1									
60	Duck, African Black	*Anas sparsa*	1	1									
61	Duck, White-faced	*Dendrocygna viduata*	1										
62	Duck, Yellow-billed	*Anas undulata*	1	1									
63	Eagle, African Fish	*Haliaeetus vocifer*			31								
64	Eagle, Booted	*Hieraaetus pennatus*	1		59			*1*	*1*				
65	Eagle-owl, Cape	*Bubo capensis*	1	1	42								
66	Eagle-owl, Spotted	*Bubo africanus*	1	1	98								
67	Egret, Cattle	*Bubulcus ibis*	1		189								
68	Egret, Little	*Egretta garzetta*	1	1									
69	Egret, Yellow-billed	*Egretta intermedia*	1										
70	Eremomela, Karoo	*Eremomela gregalis*	1	1	154		NE	*1*			*1*	*1*	*1*
71	Eremomela, Yellow-bellied	*Eremomela icteropygialis*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
72	Finch, Red-headed	*Amadina erythrocephala*	1					*1*		*1*			*1*
73	Fiscal, Southern (Com-mon)	*Lanius collaris*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
74	Flycatcher, Chat	*Melaenornis infuscatus*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
75	Flycatcher, Fairy	*Stenostira scita*	1	1	170		NE	*1*	*1*	*1*	*1*	*1*	*1*
76	Flycatcher, Fiscal	*Melaenornis silens*	1	1	187		NE	*1*	*1*	*1*		*1*	
77	Flycatcher, Spotted	*Muscicapa striata*	1	1									
78	Francolin, Grey-winged	*Scleroptila afra*	1	1	80		SLS	*1*				*1*	
79	Goose, Egyptian	*Alopochen aegyptiaca*	1	1	162				*1*	*1*	*1*	*1*	*1*

80	Goose, Spur-winged	*Plectropterus gambensis*	1	1									
81	Goshawk, Gabar	*Micronisus gabar*	1	1	131				*1*				*1*
82	Goshawk, Pale Chanting	*Melierax canorus*	1	1	75			*1*	*1*	*1*	*1*	*1*	*1*
83	Grebe, Little	*Tachybaptus ruficollis*	1	1									
84	Greenshank, Common	*Tringa nebularia*	1	1									
85	Guineafowl, Helmeted	*Numida meleagris*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
86	Hamerkop	*Scopus umbretta*	1	1	118								
87	Hawk, African Harrier-	*Polyboroides typus*			85			*1*	*1*				
88	Heron, Black-headed	*Ardea melanocephala*	1	1	141				*1*				
89	Heron, Grey	*Ardea cinerea*	1	1									
90	Hoopoe, African	*Upupa africana*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
91	Ibis, African Sacred	*Threskiornis aethiopicus*	1	1				*1*	*1*				*1*
92	Ibis, Glossy	*Plegadis falcinellus*	1										
93	Ibis, Hadeda	*Bostrychia hagedash*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
94	Kestrel, Greater	*Falco rupicoloides*	1		95			*1*	*1*	*1*		*1*	*1*
95	Kestrel, Lesser	*Falco naumanni*	1	1	64								
96	Kestrel, Rock	*Falco rupicolus*	1	1	111			*1*	*1*	*1*	*1*		
97	Kingfisher, Giant	*Megaceryle maximus*	1										
98	Kingfisher, Malachite	*Alcedo cristata*	1										
99	Kingfisher, Pied	*Ceryle rudis*		1							*1*		
100	Kite, Black	*Milvus migrans*	1		62								
101	Kite, Black-winged	*Elanus caeruleus*	1	1	94				*1*				
102	Kite, Yellow-billed	*Milvus aegyptius*	1	1									
103	Korhaan, Northern Black	*Afrotis afraoides*		1	90			*1*	*1*				
104	Lapwing, Blacksmith	*Vanellus armatus*	1	1	159			*1*	*1*	*1*	*1*	*1*	*1*
105	Lapwing, Crowned	*Vanellus coronatus*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
106	Lark, Black-eared Sparrow-	*Eremopterix australis*	1	1	108		NE		*1*		*1*	*1*	*1*
107	Lark, Eastern Clapper	*Mirafra fasciolata*	1	1				*1*			*1*	*1*	*1*
108	Lark, Grey-backed Sparrow	*Eremopterix verticalis*	1	1				*1*	*1*			*1*	*1*
109	Lark, Karoo	*Calendulauda albescens*		1	124		NE	*1*	*1*		*1*	*1*	*1*

110	Lark, Karoo Long-billed	*Certhilauda subcoronata*	1	1	148			*1*	*1*	*1*	*1*	*1*	*1*
111	Lark, Large-billed	*Galerida magnirostris*	1	1	125		NE	*1*	*1*	*1*	*1*	*1*	*1*
112	Lark, Red-capped	*Calandrella cinerea*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
113	Lark, Sabota	*Calendulauda sabota*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
114	Lark, Spike-heeled	*Chersomanes albofasciata*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
115	Martin, Brown-throated	*Riparia paludicola*	1	1				*1*	*1*		*1*	*1*	*1*
116	Martin, Rock	*Ptyonoprogne fuligula*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
117	Masked-weaver, Southern	*Ploceus velatus*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
118	Mousebird, Red-faced	*Urocolius indicus*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
119	Mousebird, White-backed	*Colius colius*	1	1				*1*	*1*	*1*	*1*		*1*
120	Nightjar, Fiery-necked	*Caprimulgus pectoralis*	1		193								
121	Nightjar, Rufous-cheeked	*Caprimulgus rufigena*	1	1	195								
122	Ostrich, Common	*Struthio camelus*	1	1									
123	Owl, Barn	*Tyto alba*	1										
124	Penduline-tit, Cape	*Anthoscopus minutus*	1	1				*1*	*1*	*1*			*1*
125	Pigeon, Speckled	*Columba guinea*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
126	Pipit, African	*Anthus cinnamomeus*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
127	Pipit, Nicholson's	*Anthus similis*		1				*1*		*1*		*1*	*1*
128	Plover, Caspian	*Charadrius asiaticus*	1		166								
129	Plover, Kittlitz's	*Charadrius pecuarius*	1	1				*1*					
130	Plover, Three-banded	*Charadrius tricollaris*	1	1	140			*1*	*1*	*1*	*1*	*1*	*1*
131	Pochard, Southern	*Netta erythrophthalma*	1										
132	Prinia, Karoo	*Prinia maculosa*	1	1	157		NE	*1*	*1*	*1*	*1*	*1*	*1*
133	Quail, Common	*Coturnix coturnix*	1										
134	Quelea, Red-billed	*Quelea quelea*		1				*1*	*1*	*1*	*1*		*1*
135	Raven, White-necked	*Corvus albicollis*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
136	Reed-warbler, Great	*Acrocephalus arundinaceus*	1										
137	Robin, Karoo Scrub	*Cercotrichas coryphoeus*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
138	Robin-chat, Cape	*Cossypha caffra*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
139	Ruff, Ruff	*Philomachus pugnax*	1	1									

140	Rush-warbler, Little	*Bradypterus baboecala*	1										
141	Sandgrouse, Namaqua	*Pterocles namaqua*	1	1	112			*1*	*1*	*1*	*1*	*1*	*1*
142	Sandpiper, Common	*Actitis hypoleucos*	1	1									
143	Sandpiper, Marsh	*Tringa stagnatilis*	1	1									
144	Sandpiper, Wood	*Tringa glareola*	1										
145	Shelduck, South African	*Tadorna cana*	1	1				*1*	*1*	*1*		*1*	*1*
146	Shoveler, Cape	*Anas smithii*	1	1									
147	Shrike, Lesser Grey	*Lanius minor*										*1*	
148	Snipe, African	*Gallinago nigripennis*	1	1									
149	Sparrow, Cape	*Passer melanurus*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
150	Sparrow, House	*Passer domesticus*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
151	Sparrow, Southern Grey-headed	*Passer diffusus*	1	1				*1*				*1*	
152	Sparrowhawk, Rufous-breasted	*Accipiter rufiventris*	1	1	101			*1*					
153	Spoonbill, African	*Platalea alba*	1	1				*1*					
154	Starling, Cape Glossy	*Lamprotornis nitens*		1									
155	Starling, Common	*Sturnus vulgaris*	1	1									
156	Starling, Pale-winged	*Onychognathus nabouroup*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
157	Starling, Pied	*Lamprotornis bicolor*	1	1	116		SLS	*1*	*1*	*1*	*1*	*1*	*1*
158	Starling, Red-winged	*Onychognathus morio*	1	1									
159	Starling, Wattled	*Creatophora cinerea*	1	1				*1*				*1*	*1*
160	Stilt, Black-winged	*Himantopus himantopus*	1	1				*1*				*1*	
161	Stint, Little	*Calidris minuta*	1	1							*1*		
162	Stonechat, African	*Saxicola torquatus*	1	1					*1*	*1*			
163	Stork, White	*Ciconia ciconia*	1		61								
164	Sunbird, Dusky	*Cinnyris fuscus*	1	1	199			*1*	*1*	*1*	*1*	*1*	*1*
165	Sunbird, Malachite	*Nectarinia famosa*	1	1									
166	Sunbird, Southern Double-collared	*Cinnyris chalybeus*	1	1	184		NE						
167	Swallow, Barn	*Hirundo rustica*	1	1	127			*1*				*1*	*1*

168	Swallow, Greater Striped	*Cecropis cucullata*	1	1				*1*			*1*	*1*	*1*
169	Swallow, White-throated	*Hirundo albigularis*	1	1								*1*	
170	Swamp-warbler, Lesser	*Acrocephalus gracilirostris*	1	1									
171	Swift, African Black	*Apus barbatus*	1	1									
172	Swift, Alpine	*Tachymarptis melba*	1	1				*1*			*1*	*1*	
173	Swift, Common	*Apus apus*	1	1								*1*	*1*
174	Swift, Little	*Apus affinis*	1	1				*1*				*1*	*1*
175	Swift, White-rumped	*Apus caffer*	1	1				*1*				*1*	
176	Teal, Cape	*Anas capensis*	1	1									
177	Teal, Red-billed	*Anas erythrorhyncha*	1	1									
178	Tern, White-winged	*Chlidonias leucopterus*	1										
179	Thick-knee, Spotted	*Burhinus capensis*	1	1				*1*				*1*	*1*
180	Thrush, Karoo	*Turdus smithi*	1	1			NE	*1*	*1*	*1*		*1*	*1*
181	Thrush, Olive	*Turdus olivaceus*	1	1									
182	Tit, Grey	*Melaniparus afer*	1	1	186		NE	*1*	*1*	*1*	*1*	*1*	*1*
183	Tit-Babbler (Warbler), Chestnut-vented	*Sylvia subcoerulea*	1	1				*1*	*1*	*1*	*1*		
184	Tit-Babbler (Warbler), Lay-ard's	*Sylvia layardi*	1	1	155		NE	*1*	*1*	*1*	*1*	*1*	*1*
185	Wagtail, Cape	*Motacilla capensis*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
186	Warbler, African Reed	*Acrocephalus baeticatus*	1	1								*1*	
187	Warbler, Cinnamon-breasted	*Euryptila subcinnamomea*	1	1	145		NE						
188	Warbler, Namaqua	*Phragmacia substriata*	1	1									
189	Warbler, Rufous-eared	*Malcorus pectoralis*	1	1	149			*1*	*1*	*1*	*1*	*1*	*1*
190	Warbler, Willow	*Phylloscopus trochilus*	1	1									
191	Waxbill, Common	*Estrilda astrild*	1	1								*1*	
192	Weaver, Cape	*Ploceus capensis*	1	1	182		NE						
193	Wheatear, Capped	*Oenanthe pileata*	1	1	167			*1*	*1*	*1*	*1*	*1*	*1*
194	Wheatear, Mountain	*Myrmecocichla monticola*	1	1				*1*	*1*	*1*	*1*	*1*	*1*
195	White-eye, Cape	*Zosterops virens*	1	1	183		NE	*1*	*1*	*1*	*1*	*1*	*1*

196	White-eye, Orange River	*Zosterops pallidus*	1										
197	Whydah, Pin-tailed	*Vidua macroura*	1	1									
198	Woodpecker, Cardinal	*Dendropicos fuscescens*	1										
							TOTALS	**105**	**90**	**79**	**84**	**97**	**95**

'1' denotes presence, not abundance. Rec = Number of Records

**Regional Red List status according to Taylor* et al. *2015 – most recent regional conservation status for species*

**Global Red List status according to IUCN 2022*

EN = Endangered; VU = Vulnerable; NT = Near-threatened; LC = Least Concern

***Endemism – whether the species is endemic (E) or near endemic (NE) to South Africa.*

E = Endemic; NE = Near-endemic; SLS = Endemic to South Africa, Lesotho & Swaziland; BNE = Breeding near endemic

Retief et al. *2014 – the species ranking in terms of turbine collision risk – as per Avian Wind Farm Sensitivity Map*

(This key applies to all following species tables)

Appendix 2. Small passerine bird species recorded on the site

Table A2. Walked Transect data: all species

			FULL YEAR			Site Visit 1		Site Visit 2		Site Visit 3		Site Visit 4		Site Visit 5		Site Visit 6	
		Transect length (km)	66			12		12		12		12		9		9	
		# Species	48			28		27		25		27		28		29	
Common Name	**Scientific Name**	**Endemism**	**Birds**	**Rec**	**Birds /km**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**
Lark-like Bunting	*Emberiza impetuani*		248	32	3.758	1	1			18	2	49	7	52	9	128	13
Cape Sparrow	*Passer melanurus*		195	34	2.955	23	8	35	10	51	4	33	5	28	4	25	3
White-throated Canary	*Crithagra albogularis*		101	30	1.530	40	13	18	6	13	4	17	3	7	3	6	1
Namaqua Sandgrouse	*Pterocles namaqua*		99	10	1.500	8	2					68	5	7	1	16	2
Yellow Canary	*Crithagra flaviventris*		94	23	1.424	16	4	11	4	11	3	13	3	20	4	23	5
Spike-heeled Lark	*Chersomanes albofasciata*		87	28	1.318	17	5	13	5	10	4	22	7	7	2	18	5
Rufous-eared Warbler	*Malcorus pectoralis*		74	52	1.121	24	16	13	10	5	4	13	9	9	7	10	6
Speckled Pigeon	*Columba guinea*		74	12	1.121	16	3	9	2	18	3	16	2	7	1	8	1
Black-eared Sparrowlark	*Eremopterix australis*	NE	70	2	1.061							70	2				
Karoo Chat	*Emarginata schlegelii*		64	52	0.970	10	10	10	10	11	9	9	5	14	10	10	8
Southern Red Bishop	*Euplectes orix*		57	6	0.864	15	4	42	2								
Grey-backed Sparrowlark	*Eremopterix verticalis*		44	6	0.667									11	2	33	4
Barn Swallow	*Hirundo rustica*		40	8	0.606	8	3							11	2	21	3
Black-headed Canary	*Serinus alario*	NE	38	3	0.576			35	2			3	1				
Tractrac Chat	*Emarginata tractrac*		34	20	0.515	15	9	2	1	2	2	11	6	2	1	2	1
Karoo Scrub Robin	*Cercotrichas coryphoeus*		32	16	0.485	6	3	8	4	4	2	6	3	4	2	4	2
Sickle-winged Chat	*Emarginata sinuata*	NE	32	17	0.485	14	6			4	2			8	6	6	3
Red-capped Lark	*Calandrella cinerea*		31	4	0.470			20	1	2	1	7	1	2	1		
Pied Starling	*Lamprotornis bicolor*	SLS	30	3	0.455			6	1	16	1	8	1				
Large-billed Lark	*Galerida magnirostris*	NE	26	20	0.394	6	6	1	1	2	1	4	2	6	4	7	6

Ant-eating Chat	*Myrmecocichla for-micivora*		24	8	0.364			6	2	8	3	3	1	4	1	3	1
Pied Crow	*Corvus albus*		20	8	0.303	6	2	4	2	2	1	3	1	2	1	3	1
Karoo Eremomela	*Eremomela gregalis*	NE	16	6	0.242							6	2	7	3	3	1
Southern Masked Weaver	*Ploceus velatus*		16	3	0.242	4	1					12	2				
Cape Penduline Tit	*Anthoscopus minutus*		15	4	0.227	9	2			4	1					2	1
Chat Flycatcher	*Melaenornis infuscatus*		15	9	0.227	7	5					4	2	2	1	2	1
Karoo Long-billed Lark	*Certhilauda subcoronata*		15	13	0.227	1	1	1	1	4	4	6	5	1	1	2	1
Common Swift	*Apus apus*		14	1	0.212											14	1
Cape Turtle Dove	*Streptopelia capicola*		13	7	0.197	5	4	7	2	1	1						
Capped Wheatear	*Oenanthe pileata*		11	7	0.167	1	1							8	4	2	2
Grey Tit	*Melaniparus afer*	NE	9	6	0.136					2	2	4	2	1	1	2	1
Southern Fiscal	*Lanius collaris*		7	6	0.106	1	1	1	1	1	1			1	1	3	2
Grey-backed Cisticola	*Cisticola subruficapilla*		6	4	0.091	1	1			1	1			2	1	2	1
Bokmakierie	*Telophorus zeylonus*		4	3	0.061	2	1					1	1	1	1		
Egyptian Goose	*Alopochen aegyptiaca*		4	2	0.061					2	1					2	1
Karoo Lark	*Calendulauda albescens*		4	3	0.061			2	2			2	1				
Little Swift	*Apus affinis*		4	1	0.061											4	1
South African Shelduck	*Tadorna cana*		4	2	0.061			2	1							2	1
Three-banded Plover	*Charadrius tricollaris*		4	3	0.061	1	1	3	2								
Karoo Prinia	*Prinia maculosa*	NE	3	3	0.045			1	1	1	1	1	1				
Red-billed Quelea	*Quelea quelea*		3	2	0.045			3	2								
Yellow-bellied Eremomela	*Eremomela icteropygialis*		3	3	0.045	1	1					2	2				
Cape Bunting	*Emberiza capensis*		2	2	0.030			1	1	1	1						
Lesser Grey Shrike	*Lanius minor*		2	1	0.030									2	1		
Sabota Lark	*Calendulauda sabota*		2	2	0.030	2	2										
White-throated Swallow	*Hirundo albigularis*		2	1	0.030									2	1		
Mountain Wheatear	*Myrmecocichla monticola*		1	1	0.015			1	1								
White-necked Raven	*Corvus albicollis*		1	1	0.015			1	1								

Appendix 3. Large terrestrial & raptor data recorded on Drive Transects on the site

Table A3. Driven Transect data: all species

				FULL YEAR			Site Visit 1		Site Visit 2		Site Visit 3		Site Visit 4		Site Visit 5		Site Visit 6	
			Transect length (km)	**240**			**40**		**40**		**40**		**40**		**40**		**40**	
			# Species	**10**			**6**		**3**		**3**		**3**		**6**		**5**	
Common Name	**Taxonomic Name**	**Red List: Regional, Global**	**Endemism**	**Birds**	**Records**	**Birds/km**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC		20	10	0.08	2	1	5	3	9	6	6	4	6	3	7	3
Jackal Buzzard	*Buteo rufofuscus*		NE	10	8	0.04	2	1	1	1	4	4	1	1	4	4	3	2
Ludwig's Bustard	*Neotis ludwigii*	EN, EN		10	3	0.04	7	2							3	1		
Verreaux's Eagle	*Aquila verreauxii*	VU, LC		8	5	0.03	3	2			4	2	4	2	1	1	4	2
Greater Kestrel	*Falco rupicoloides*			4	1	0.02									4	1		
Pale Chanting Goshawk	*Melierax canorus*			3	3	0.01			2	2							1	1
Gabar Goshawk	*Micronisus gabar*			2	1	0.01											2	1
Grey-winged Francolin	*Scleroptila africanus*		SLS	2	1	0.01	2	1										
Common Buzzard	*Buteo buteo*			1	1	0.00									1	1		
Rock Kestrel	*Falco rupicolus*			1	1	0.00	1	1										

Appendix 4. Focal Site photographs

Figure A 1. Example of nest Focal Sites

Appendix 5. Incidental Observation data recorded on the site

Table A4. Incidental Observations of target bird species on site

			FULL YEAR		Site Visit 1		Site Visit 2		Site Visit 3		Site Visit 4		Site Visit 5		Site Visit 6	
		# Species	**16**		**10**		**9**		**3**		**6**		**10**		**7**	
Common Name	**Scientific Name**	**Red List: Regional, Global (Endemism)**	**Birds**	**Records**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC	103	49	15	8	64	29	29	14	10	5	13	7	11	5
Jackal Buzzard	*Buteo rufofuscus*	(NE)	15	13	6	5	4	4	2	1	2	2	3	3	2	1
Ludwig's Bustard	*Neotis ludwigii*	EN, EN	12	9	7	4	2	2							3	3
Pale Chanting Goshawk	*Melierax canorus*		13	11	7	6	3	3			2	2	3	2		
Verreaux's Eagle	*Aquila verreauxii*	VU, LC	11	9	6	5	3	3							2	1
Grey-winged Francolin	*Scleroptila africana*	(SLS)	7	2	5	1							2	1		
Secretarybird	*Sagittarius serpentarius*	VU, EN	6	3	3	1					2	1	1	1	2	1
Double-banded Courser	*Rhinoptilus africanus*		5	4			2	1			1	1	1	1	2	2
Rock Kestrel	*Falco rupicolus*		4	4			4	4	2	1						
Common Buzzard	*Buteo buteo*		3	3									2	2	1	1
African Harrier-Hawk	*Polyboroides typus*		2	2	1	1	1	1								
Blue Crane	*Grus paradisea*	NT, VU	2	1							1	1	2	1		
Greater Kestrel	*Falco rupicoloides*		2	2	1	1							1	1		
Gabar Goshawk	*Micronisus gabar*		1	1			1	1								
Lanner Falcon	*Falco biarmicus*	VU, LC	1	1									1	1		
Rufous-breasted Spar-rowhawk	*Accipiter rufiventris*	NT, LC	1	1	1	1										

Appendix 6. Bird flight activity data for priority species on the site

Table A5. Flight activity summary from Vantage Point surveys on site

			FULL YEAR			Site Visit 1		Site Visit 2		Site Visit 3		Site Visit 4		Site Visit 5		Site Visit 6	
						Jul-Aug 2021		Oct-Nov 2021		Feb 2022		May 2022		Jan-22		Mar/Apr 2022	
		# Hours	600			120		108		108		96		84		84	
		# Species	15			9		7		2		4		5		7	
Common Name	**Scientific Name**	**Red List: Regional, Global (Endemism)**	**Birds**	**Rec**	**Birds/hr**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC	32	16	0.053	4	2	8	3			6	4	11	5	3	2
Ludwig's Bustard	*Neotis ludwigii*	EN, EN	28	11	0.047	26	9	1	1							1	1
Pale Chanting Goshawk	*Melierax canorus*		25	21	0.042	1	1	11	9	2	2	2	2	5	3	4	4
Jackal Buzzard	*Buteo rufofuscus*	(NE)	20	19	0.033	2	2	1	1	4	3	2	2	3	3	8	8
Blue Crane	*Grus paradisea*	NT, VU	8	4	0.013							8	4				
Greater Kestrel	*Falco rupicoloides*		6	3	0.010									2	1	4	2
Verreaux's Eagle	*Aquila verreauxii*	VU, LC	4	4	0.007	2	2	1	1					1	1		
Secretarybird	*Sagittarius serpentarius*	VU, EN	2	1	0.003	2	1										
Black Harrier	*Circus maurus*	EN, EN (NE)	1	1	0.002	1	1										
Black-winged Kite	*Elanus caeruleus*		1	1	0.002			1	1								
Booted Eagle	*Hieraaetus pennatus*		1	1	0.002	1	1										
Common Buzzard	*Buteo buteo*		1	1	0.002											1	1
Kori Bustard	*Ardeotis kori*	NT, NT	1	1	0.002	1	1										
Lanner Falcon	*Falco biarmicus*	VU, LC	1	1	0.002											1	1
Rock Kestrel	*Falco rupicolus*		1	1	0.002			1	1								

Appendix 7. During and post-construction bird monitoring framework

The work done to date on the proposed site has established a baseline understanding of the distribution, abundance and movement of key bird species on and near the site. However this is purely the 'before' baseline and aside from providing input into turbine micro-siting, it is not very informative until compared to post-construction data. The following programme has therefore been developed to meet these needs. It is recommended that this programme be implemented by the wind farm if constructed. The findings from operational phase monitoring should inform an adaptive management programme to mitigate any impacts on avifauna to acceptable levels. In particular, any Verreaux's Eagle fatalities should be reported to Dr Megan Murgatroyd in order to close the feedback loop back to the VERA modelling performed for this site.

During construction monitoring

It will be necessary to monitor the breeding status and productivity of the nesting raptors during all breeding seasons during construction. This can be done by a minimum of 3 specialist visits to the nest site per breeding season, or close enough to observe the birds without disturbing them. Detailed requirements as follows:

- Independent avifaunal specialist to make 3 visits to nest site in each breeding season (May to October) during construction.
- Breeding status & productivity to be determined.
- Any response by eagles to construction disturbance to be documented.

Operational phase monitoring

The intention with operational phase bird monitoring is to repeat as closely as possible the methods and activities used to collect data pre-construction. This work will allow the assessment of the impacts of the proposed facility and the development of active and passive mitigation measures that can be implemented in the future where necessary. One very important additional component needs to be added, namely mortality estimates through carcass searches under turbines. The following programme has therefore been developed to meet these needs, and should start as soon as possible after the operation of the first phase of turbines (not later than 3 months):

Note that this framework is an interim draft. The most up-to-date version of the Best Practice Guidelines (Jenkins *et al.* 2015) should inform the programme design at the time.

Live bird monitoring

Note that due to the construction of the wind farm and particularly new roads it may be necessary to update the location of the below monitoring activities from those used pre-construction.

- The 18 walked transects of 1km each that have been done during pre-construction monitoring on the site should be continued.
- The 6 vehicle-based road count routes on the site should be continued, and conducted once on each Site Visit.
- The Focal Sites on the site should be monitored. If any sensitive species are found breeding on site in future these nest sites should be defined as additional Focal Sites.
- All other incidental sightings of priority species (and particularly those suggestive of breeding or important feeding or roosting sites or flight paths) within the broader study area should be carefully plotted and documented.
- The Vantage Points already established on the overall site should be used to continue data collection post-construction. The exact positioning of these may need to be refined based on the presence of new turbines and roads. A total of 72 hours direct observation per Vantage Point should be conducted per year.
- The activities at the Control Site should be continued, i.e. 2 Vantage Points, 3 Walked Transects, 1 Vehicle-based transect, and Focal Sites.

Bird Fatality estimates

This is now an accepted component of the post-construction monitoring program and the newest guidelines (Jenkins *et al*. 2015) will be used to design the monitoring program. It is important that in addition to searching for carcasses under turbines, an estimate of the detection (the success rate that monitors achieve in finding carcasses) and scavenging rates (the rate at which carcasses are removed and hence not available for detection) is also obtained (Jenkins *et al*. 2015). Both of these aspects can be measured using a sample of carcasses of birds placed out in the field randomly. The rate at which these carcasses are detected and the rate at which they decay or are removed by scavengers should also be measured.

Fatality searches should be conducted as follows:

- The area surrounding the base of turbines should be searched (up to a radius equal to 75% of the maximum height of turbine) for collision victims.
- All turbines on the wind farm should be searched at least once a week (Monday to Friday).
- Any suspected collision casualty should be comprehensively documented (for more detail see Jenkins *et al*. 2015).
- A team of carcass searchers will need to be employed and these carcass searchers will work on site every day searching the turbines for mortalities.
- It is also important that associated infrastructure such as power lines and wind masts be searched for collision victims according to similar methods.

The most up to date version of the Best Practice Guidelines (Jenkins *et al*. 2015) should inform the programme design at the time.

The above programme should be reported on, quarterly, to the wind farm operator, who should submit these reports to the DEA and BirdLife South Africa. These reports should include a comparison of actual measured fatality rates with those predicted by this study.

Appendix 8. CES Impact Assessment Methodology and Impact Summary

The following standard rating scales have been defined for assessing and quantifying the identified impacts. This is necessary since impacts have a number of parameters that need to be assessed. The identified impacts have been assessed against the criteria discussed below.

Six factors are considered when assessing the significance of the identified issues, namely:

1. **Significance** - Each of the below criterion (points 2-5 below) are ranked with scores assigned, as presented in Tables A2 and A3 to determine the overall significance of an activity. The total scores recorded for the effect (which includes scores for duration; extent; severity and probability) are then read off the matrix presented in Table A4, to determine the overall significance of the issue (Table A5). The overall significance is either negative or positive.
2. **Severity** - the consequence scale is used in order to objectively evaluate how severe a number of negative impacts might be on the issue under consideration, or how beneficial a number of positive impacts might be on the issue under consideration.
3. **Extent** - the spatial scale defines the physical extent of the impact.
4. **Duration** - the temporal scale defines the significance of the impact at various time scales, as an indication of the duration of the impact.
5. The **probability** of the impact occurring - the likelihood of impacts taking place as a result of project actions arising from the various alternatives. There is no doubt that some impacts would occur (e.g., loss of vegetation), but other impacts are not as likely to occur (e.g., vehicle accident) and may or may not result from the proposed development and alternatives. Although some impacts may have a severe effect, the likelihood of them occurring may affect their overall significance.
6. **Reversibility/Mitigation** – The degree of difficulty of reversing and/or mitigating the various impacts ranges from very difficult to easily achievable. The four categories used are listed and explained in Table A6 below. Both the practical feasibility of the measure, the potential cost and the potential effectiveness is taken into consideration when determining the appropriate degree of difficulty.

The relationship of the issue to the temporal scale, spatial scale and the severity are combined to describe the overall importance rating, namely the significance of the assessed impact.

The impact is first classified as a positive (+) or negative (-) impact. The impact then undergoes an evaluation according to a set of criteria.

Table A1. Temporal, Spatial, Likelihood Scales defined

Duration (Temporal Scale)		Score
Short term	Less than 5 years	1
Medium term	Between 5-20 years	2
Long term	Between 20 and 40 years (a generation) and from a human perspective also permanent	3
Permanent	Over 40 years and resulting in a permanent and lasting change that will always be there	4
Extent (Spatial Scale)		
Localised	At localised scale and a few hectares in extent	1
Study Area	The proposed site and its immediate environs	2
Regional	District and Provincial level	3
National	Country	3
International	Internationally	4
Probability (Likelihood)		
Unlikely	The likelihood of these impacts occurring is slight	1
May Occur	The likelihood of these impacts occurring is possible	2
Probable	The likelihood of these impacts occurring is probable	3
Definite	The likelihood is that this impact will definitely occur	4

Table A2. Impacts Severity Rating

Impact severity *(The severity of negative impacts, or how beneficial positive impacts would be on an affected system or affected party)*	
Very severe	**Very beneficial**
An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated. For example the permanent loss of land.	A permanent and very substantial benefit to the affected system(s) or party(ies), with no real alternative to achieving this benefit. For example the vast improvement of sewage effluent quality.
Severe	**Beneficial**
Long term impacts on the affected system(s) or party(ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming, or some combination of these. For example, the clearing of forest vegetation.	A long term impact and substantial benefit to the affected system(s) or party(ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these. For example an increase in the local economy.
Moderately severe	**Moderately beneficial**
Medium to long term impacts on the affected system(s) or party (ies), which could be mitigated. For example constructing a sewage treatment facility where there was vegetation with a low conservation value.	A medium to long term impact of real benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way. For example a 'slight' improvement in sewage effluent quality.
Slight	**Slightly beneficial**
Medium or short term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary. For	A short to medium term impact and negligible benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are

example a temporary fluctuation in the water table due to water abstraction.	easier, cheaper and quicker, or some combination of these.
No effect	**Don't know/Can't know**
The system(s) or party(ies) is not affected by the proposed development.	In certain cases it may not be possible to determine the severity of an impact.

Table A3. Matrix used to determine the overall significance of the impact based on the likelihood and effect of the impact

SEVERITY		COMPOSITE DURATION, EXTENT & PROBABILITY SCORE									
		3	4	5	6	7	8	9	10	11	12
	Slight	3	4	5	6	7	8	9	10	11	12
	Mod severe	3	4	5	6	7	8	9	10	11	12
	Severe	3	4	5	6	7	8	9	10	11	12
	Very severe	3	4	5	6	7	8	9	10	11	12

Table A4. Overall Significance Rating

OVERALL SIGNIFICANCE *(THE COMBINATION OF ALL THE ABOVE CRITERIA AS AN OVERALL SIGNIFICANCE)*	
VERY HIGH NEGATIVE	**VERY BENEFICIAL (VERY HIGH +)**
These impacts would be considered by society as constituting a major and usually permanent change to the (natural and/or social) environment, and usually result in severe or very severe effects, or beneficial or very beneficial effects. Example: The loss of a species would be viewed by informed society as being of VERY HIGH significance. Example: The establishment of a large amount of infrastructure in a rural area, which previously had very few services, would be regarded by the affected parties as resulting in benefits with VERY HIGH significance.	
HIGH NEGATIVE	**BENEFICIAL (HIGH +)**
These impacts will usually result in long term effects on the social and/or natural environment. Impacts rated as HIGH will need to be considered by society as constituting an important and usually long term change to the (natural and/or social) environment. Society would probably view these impacts in a serious light. Example: The loss of a diverse vegetation type, which is fairly common elsewhere, would have a significance rating of HIGH over the long term, as the area could be rehabilitated. Example: The change to soil conditions will impact the natural system, and the impact on affected parties (such as people growing crops in the soil) would be HIGH.	
MODERATE NEGATIVE	**SOME BENEFITS (MODERATE +)**
These impacts will usually result in medium to long term effects on the social and/or natural environment. Impacts rated as MODERATE will need to be considered by society as constituting a fairly important and usually medium term change to the (natural and/or social) environment. These impacts are real but not substantial.	

Example: The loss of a sparse, open vegetation type of low diversity may be regarded as MODERATELY significant.	
LOW NEGATIVE	**FEW BENEFITS (LOW +)**
These impacts will usually result in medium to short term effects on the social and/or natural environment. Impacts rated as LOW will need to be considered by the public and/or the specialist as constituting a fairly unimportant and usually short term change to the (natural and/or social) environment. These impacts are not substantial and are likely to have little real effect. Example: The temporary changes in the water table of a wetland habitat, as these systems are adapted to fluctuating water levels. Example: The increased earning potential of people employed as a result of a development would only result in benefits of LOW significance to people who live some distance away.	
NO SIGNIFICANCE	
There are no primary or secondary effects at all that are important to scientists or the public. Example: A change to the geology of a particular formation may be regarded as severe from a geological perspective, but is of NO significance in the overall context.	
DON'T KNOW	
In certain cases it may not be possible to determine the significance of an impact. For example, the primary or secondary impacts on the social or natural environment given the available information. Example: The effect of a development on people's psychological perspective of the environment.	

Table A5. Criteria considered post mitigation

Reversibility	
Reversible	The activity will lead to an impact that can be reversed provided appropriate mitigation measures are implemented.
Irreversible	The activity will lead to an impact that is permanent regardless of the implementation of mitigation measures.
Irreplaceable loss	
Resource will not be lost	The resource will not be lost/destroyed provided mitigation measures are implemented.
Resource will be partly lost	The resource will be partially destroyed even though mitigation measures are implemented.
Resource will be lost	The resource will be lost despite the implementation of mitigation measures.
Mitigation potential	
Easily achievable	The impact can be easily, effectively and cost effectively mitigated/reversed.
Achievable	The impact can be effectively mitigated/reversed without much difficulty or cost.
Difficult	The impact could be mitigated/reversed but there will be some difficultly in ensuring effectiveness and/or implementation, and significant costs.
Very Difficult	The impact could be mitigated/reversed but it would be very difficult to ensure effectiveness, technically very challenging and financially very costly.

All feasible alternatives and the "no-go option" will be equally assessed in order to evaluate the significance of the "as predicted" impacts (prior to mitigation) and the "residual" impacts (that remain after mitigation measures are taken into account). The reason(s) for the judgement will be provided when necessary.

All impacts must have a “cause and comment”, a significance rating before mitigation, after mitigation and for the no-go option. Impacts should also indicate applicable mitigation measure/ recommendations to reduce the impact significance.

Appendix 9. Verreaux's Eagle Risk Assessment (VERA) report for the site

Verreaux's Eagle Risk Assessment: VERA Modelling

Site: Taaibos Wind Farm (Loxton / Victoria West)

Developer: WKN Windcurrent SA (Pty) Ltd

Processed on: November 18 2021

The locations of 21 Verreaux's eagle nests, from 13 territories, have been used for the Verreaux's Eagle Risk Assessment (VERA) modelling to predict collision risk around the proposed development area (Figure 1). Known nest locations up to 12 km from the development boundary have been included in modelling, and any nests <1.5 km apart have been treated as belonging to the same pair.

The collision risk estimates are dependent on accurate information on nest locations and will only be reliable if all nest locations have been found and provided for this analysis. Additional nests located after this analysis could significantly change the outcomes of the collision risk predictions. Recommendations are intended to minimise collision risk to resident adult eagles but will not be relevant to non-breeding eagles using the area. The modelling methods used follow this publication:

Murgatroyd, M., Bouten, W. & Amar, A. 2020. [A predictive model for improving placement of wind turbines to minimise collision risk potential for a large soaring raptor](). Journal of Applied Ecology. DOI: 10.1111/1365-2664.13799

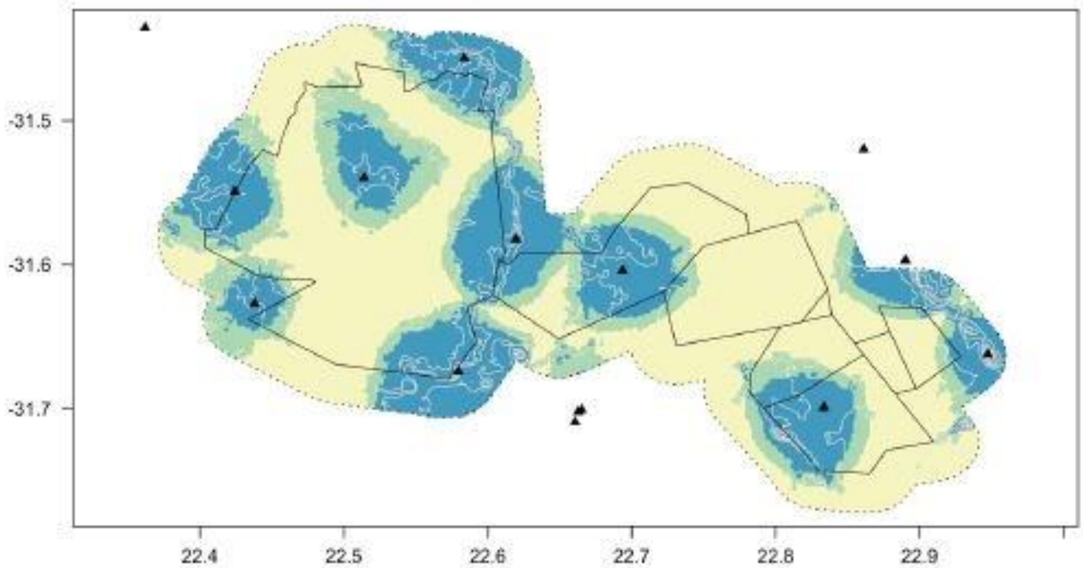
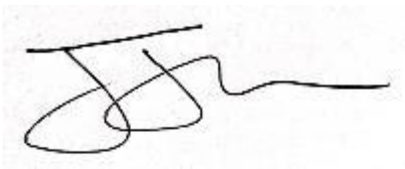


Figure 1. Verreaux's eagle collision risk potential for the proposed Taaibos Wind Farm within the Area of Interest (AOI) [dotted line], which extends 3 km from development boundaries [solid lines]. VERA has been modelled using all known nest locations up to 12 km from the development boundaries [triangles, n=21]. Collision risk potential within the development boundaries is represented in high risk [blue]; medium risk [light blue] and low risk [yellow].

Appendix 10. Specialist Declaration

I, _____J SMALLIE_____________________________, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist: ____  _____________________

Name of Company: ____WILDSKIES ECOLOGICAL SERVICES____________________

Date: _____10 October 2022____________________

Appendix 11. Specialist CV

JONATHAN JAMES SMALLIE
WildSkies Ecological Services (2011/131435/07)
Curriculum Vitae

Background
Date of birth: 20 October 1975
Qualifications: BSC – Agriculture (Hons) (completed 1998)
University of Natal – Pietermaritzburg
MSC – Environmental Science (completed 2011)
University of Witwaterstrand
Occupation: Specialist avifaunal consultant
Profession registration: South African Council for Natural Scientific Professions

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Cell number: 082 444 8919
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Postal: 36 Utrecht Avenue, Bonnie Doon, East London, 5210
ID #: 7510205119085

Professional experience
IFC PS6 experience:
Amakhala Emoyeni Wind Farm – in collaboration with Simon Hulka (IFC) designed and implemented an operational phase monitoring programme and Biodiversity Monitoring & Mitigation Plan; Golden Valley Wind Farm – in collaboration with Leon Bennun (The Biodiversity Consultancy - TBC) compiled a Critical Habitat Assessment and Biodiversity Action Plan for the wind farm; Jeffrey's Bay Wind Farm – in collaboration with TBC compiled a Biodiversity Management Plan for the wind farm.

Renewable energy:

Post construction bird monitoring for wind energy facilities:
Dassieklip (Caledon) –initiated in April 2014 (2yrs); Dorper Wind Farm (Molteno) – initiated in July 2014 (5yrs); Jeffreys Bay Wind Farm – initiated in August 2014 (4yrs); Kouga Wind Farm – started Feb 2015 (2yrs); Cookhouse Wind Farm – started March 2015 (1yr); Grassridge Wind Farm – initiated in April 2015 (2yrs); Chaba Wind Farm – initiated December 2015 (1yr); Amakhala Emoyeni 01 Wind Farm initiated August 2016 (5yrs) – IFC funded project; Gibson Bay Wind Farm – initiated March 2017 (4yrs); Nojoli Wind Farm initiated March 2017 (4yrs); Sere Wind Farm (2yrs); Golden Valley Wind Farm (started Sep 2021 – 1 yr).

Pre-construction bird monitoring & EIA for wind energy facilities:
Golden Valley 1; Middleton; Dorper; Qumbu; Ncora; Nqamakhwe; Ndakana; Thomas River; Peddie; Mossel Bay; Hluhluwe; Richards Bay; Garob; Outeniqua; Castle; Wolf; Inyanda-Roodeplaat; Dassiesridge; Great Kei; Bayview; Grahamstown; Bakenskop; Umsobomvu; Stormberg; Zingesele; Oasis; Gunstfontein; Naumanii; Golden Valley Phase 2; Ngxwabangu; Hlobo; Woodstock; Scarlet Ibis; Albany; Golden Valley 1 2nd monitoring; Umtathi Emoyeni; Serenje Zambia; Unika 1 Zambia; Impofu East, West, and North; Nuweveld East, West and North; Elands Wind Farm; Ingwe Wind Farm; Hoogland Wind Farm; Cradock Wind Farm Cluster; Canyon Springs Wind Farm; Loxton Wind Farm; Taaibos Wind Farm; Aberdeen Wind

Farm.

Screening studies for wind energy facilities:
Tarkastad Wind Farm; Quanti Wind Farm; Ruitjies Wind Farm; Beaufort West Wind Farm; Success Wind Farm; Cradock Wind Farm; Britstown Wind Farm; Clanwilliam Wind Farm; Ebenhezer Wind Farm.

Avifaunal walk through for wind energy facilities:
Garob Wind Farm; Golden Valley 1 wind farm; Nxuba Wind Farm.

Pre-construction bird monitoring and EIA for Solar energy facilities:
Bonnievale Solar Energy Facility; Dealesville Solar Energy Facility; Rooipunt Solar Energy Facility; De Aar Solar Energy Facility; Noupoort Solar Energy Facility, Aggeneys Solar Energy Facility; Eskom Concentrated Solar Power Plant; Bronkhorstspruit Solar Photovoltaic Plant; De Aar Solar Energy Facility; Paulputs Solar Energy Facility; Kenhardt Solar Energy Facility; Wheatlands Solar Energy Facility; Nampower CSP project; Dwaalboom PV; Slurry PV; De Hoek PV; Suikerbekkie PV; Springhaas PV.

Other Electricity Generation:
Port of Nqura Power Barge EIA; Tugela Hydro-Electric Scheme; Mmamabula West Coal Power Station (Botswana).

Electricity transmission & distribution:
Overhead transmission power lines (>132 000 kilovolts):
Oranjemund Gromis 220kv; Perseus Gamma 765kv; Aries Kronos 765kv; Aries Helios 765kv; Perseus Kronos 765kv; Helios Juno 765kv; Borutho Nzelele 400kv; Foskor Merensky 275kv; Kimberley Strengthening; Mercury Perseus 400kV; Eros Neptune Grassridge 400kV; Kudu Juno 400kV; Garona Aries 400kV; Perseus Hydra 765Kv; Tabor Witkop 275kV; Tabor Spencer 400kV; Moropule Orapa 220kV (Botswana); Coega Electrification; Majuba Venus 765kV; Gamma Grassridge 765kV; Gourikwa Proteus 400KV; Koeberg Strengthening 400kV; Ariadne Eros 400kV; Hydra Gamma 765kV; Zizabona transmission – Botswana; Maphutha Witkop 400kv; Makala B 400kv; Aggeneis Paulputs 400kv; Northern Alignment 765kv; Kappa Omega 765kv; Isundu 400kv and Substation; Senakangwedi B Integration; Oranjemund Gromis;

Overhead distribution power lines (<132 000 kilovolts):
Kanoneiland 22KV; Hydra Gamma 765kV; Komani Manzana 132kV; Rockdale Middelburg 132kV; Irenedale 132 kV; Zandfontein 132kV; Venulu Makonde 132 kV; Spencer Makonde 132 kV; Dalkeith Jackal Creek 132Kv; Glen Austin 88kV; Bulgerivier 132kV; Ottawa Tongaat 132kV; Disselfontein 132kV; Voorspoed Mine 132kV; Wonderfontein 132kV; Kabokweni Hlau Hlau 132kV; Hazyview Kiepersol 132kV; Mayfern Delta 132kV; VAAL Vresap 88kV; Arthursview Modderkuil 88kV; Orapa, AK6, Lethakane substations and 66kV lines (Botswana); Dagbreek Hermon 66kV; Uitkoms Majuba 88kV; Pilanesberg Spitskop 132kV; Qumbu PG Bison 132kV; Louis Trichardt Venetia 132kV; Rockdale Middelburg Ferrochrome 132kV; New Continental Cement 132KV; Hillside 88kV; Marathon Delta 132kV; Malelane Boulder 132kV; Nondela Strengthening 132kV; Spitskop Northern Plats 132kV; West Acres Mataffin 132kV; Westgate Tarlton Kromdraai 132kV; Sappi Elliot Ugie 132kV; Melkhout Thyspunt 132kV; St Francis Bay 66kv; Etna Ennerdale 88kv; Kroonstad 66kv; Firham Platrand; Paradise Fondwe 132kv; Kraal Mafube 132kv; Loeriesfontein 132kv; Albany Mimosa 66kv; Zimanga 132kv; Grootpan Brakfontein; Mandini Mangethe; Valkfontein Substation; Sishen Saldanha; Corinth Mzongwana 132kv; Franklin Vlei 22kv; Simmerpan Strengthening; Ilanga Lethemba 132kv; Cuprum Burchell Mooidraai 132; Oliphantskop Grassridge 132;

Risk Assessments on existing power lines:
Hydra-Droerivier 1,2 & 3 400kV; Hydra-Poseidon 1,2 400kV; Butterworth Ncora 66kV; Nieu-Bethesda

22kV; Maclear 22kV (Joelshoek Valley Project); Wodehouse 22kV (Dordrecht district); Burgersdorp Aliwal North Jamestown 22kV; Cradock 22kV; Colesberg area 22kV; Loxton self build 11kV; Kanoneiland 22kV; Stutterheim Municipality 22kV; Majuba-Venus 400kV; Chivelston-Mersey 400kV; Marathon-Prairie 275kV; Delphi-Neptune 400kV; Ingagane – Bloukrans 275kV; Ingagane – Danskraal 275kV; Danskraal – Bloukrans 275kV

Avifaunal "walk through" (EMP's):
Kappa Omega 765kv; Rockdale Marble Hall 400kv; Beta Delphi 400kV; Mercury Perseus 765kV; Perseus 765kV Substation; Beta Turn 765kV in lines; Spencer Tabor 400kV line; Kabokweni Hlau Hlau 132kV; Mayfern Delta 132Kv; Eros Mtata 400kV; Cennergi Grid connect 132kV; Melkhout Thyspunt 132kv; Imvubu Theta 400kv; Outeniqua Oudshoorn 132kv; Clocolan Ficksburg 88kv.

Strategic Environmental Assessments for Master Electrification Plans:
Northern Johannesburg area; Southern KZN and Northern Eastern Cape; Northern Pretoria; Western Cape Peninsula

Other electrical infrastructure work
Investigation into rotating Bird Flapper saga – Aberdeen 22Kv; Special investigation into faulting on Ariadne-Eros 132kV; Special investigation into Bald Ibis faulting on Tutuka Pegasus 275kV; Special investigation into bird related faulting on 22kV Geluk Hendrina line; Special investigation into bird related faulting on Camden Chivelston 400kV line

Water sector:
Umkhomazi Dam and associated tunnel and pipelines; Rosedale Waste Water Treatment Works; Lanseria Outfall Sewer; Lanseria Wastewater Treatment Works;

Wildlife airport hazards:
Kigali International Airport – Rwanda; Port Elizabeth Airport – specialist study as part of the EIA for the proposed Madiba Bay Leisure Park; Manzini International Airport (Swaziland); Polokwane International Airport; Mafekeng International Airport; Lanseria Airport. Namibia Airports Company – wildlife hazard management plans for three airports.

Conservation planning:
East Cape Biodiversity Strategy & Action Plan – avifaunal input; City of Ekurhuleni Biodiversity Plan – avifaunal input.

Other sectors:
Submarine telecommunications cables project; Lizzard Point Golf Estate – Vaaldam; Lever Creek Estates housing development; East Cape Biodiversity Strategy and Action Plan 2017; Cathedral Peak Road diversion; Dube Tradeport; East London Transnet Ports Authority Biodiversity Management Plan; Leazonia Feedlot; Carisbrooke Quarry; Senekal Sugar Development; Frankfort Paper Mill;

Employment positions held to date:
- August 1999 to May 2004: Eastern Cape field officer for the South African Crane Working Group of the Endangered Wildlife Trust
- May 2004 to November 2007: National Field officer for Eskom-EWT Strategic Partnership and Airports Company SA – EWT Strategic Partnership (both programmes of Endangered Wildlife Trust)
- November 2007 to August 2011: Programme Manager – Wildlife & Energy Programme – Endangered Wildlife Trust

- August 2011 to present: Independent avifaunal specialist – Director at WildSkies Ecological Sevices (Pty) Ltd

Relevant achievements:

- Recipient of BirdLife South Africa's Giant Eagle Owl in 2011 for outstanding contribution to bird conservation in SA
- Founded and chaired for first two years – the Birds and Wind Energy Specialist Group (BAWESG) of the Endangered Wildlife Trust & BirdLife South Africa.

Conferences attended & presented at:

- 2021. African Conference on Linear Infrastructure and Environment
- 2018. Raptor Research Foundation conference, Kruger National Park.
- 2019. Conference on Wind Energy and Wildlife, Stirling, Scotland.
- 2017. Conference on Wind Energy and Wildlife, Estoril, Portugal.
- 2012-2020. Windaba Conference. Various attendance.
- May 2011. Conference of Wind Energy and Wildlife, Trondheim, Norway.
- March 2011. Chair and facilitator at Endangered Wildlife Trust – Wildlife & Energy Programme – "2011 Wildlife & Energy Symposium", Howick, SA
- September 2010 – Raptor Research Foundation conference, Fort Collins, Colorado. Presented on the use of camera traps to investigate Cape Vulture roosting behaviour on transmission lines
- May 2010 - Wind Power Africa 2010. Presented on wind energy and birds
- October 2008. Session chair at Pan-African Ornithological Conference, Cape Town, South Africa
- March 27 – 30 2006: International Conference on Overhead Lines, Design, Construction, Inspection & Maintenance, Fort Collins Colorado USA. Presented a paper entitled "Assessing the power line network in the Kwa-Zulu Natal Province of South Africa from a vulture interaction perspective".
- June 2005: IASTED Conference at Benalmadena, Spain – presented a paper entitled "Impact of bird streamers on quality of supply on transmission lines: a case study"
- May 2005: International Bird Strike Committee 27th meeting – Athens, Greece. Presented a paper entitled Bird Strike Data analysis at SA airports 1999 to 2004.
- 2003: Presented a talk on "Birds & Power lines" at the 2003 AGM of the Amalgamated Municipal Electrical Unions – in Stutterheim - Eastern Cape
- September 2000: 5th World Conference on Birds of Prey in Seville, Spain.

Papers & publications:

- Jenkins, A.R., Van Rooyen, C.S., Smallie, J., Harrison, J.A., Diamond, M., Smit-Robinson, H.A. & Ralston, S. 2015. "Best practice guidelines for assessing and monitoring the impact of wind energy facilities on birds in southern Africa" Unpublished guidelines
- Ralston-Paton, S., Smallie, J., Pearson, A., & Ramalho, R. 2017. Wind energy's impacts on birds in South Africa: a preliminary review of the results of operational monitoring at the first wind farms of the Renewable Energy Independent Power Producer Procurement Programme Wind Farms in South Africa. BirdLife South Africa Occasional Report Series No. 2. BirdLife South Africa, Johannesburg, South Africa.
- Prinsen, H.A.M., J.J. Smallie, G.C. Boere, & N. Pires. (compilers), 2011. Guidelines on how to avoid or mitigate impacts of electricity power grids on migratory birds in the African-Eurasian Region. CMS Technical Series Number XX. Bonn, Germany.
- Prinsen, H.A.M., J.J. Smallie, G.C. Boere, & N. Pires. (compilers), 2011. Review of the conflict between migratory birds and electricity power grids in the African-Eurasian region. CMS Technical Series Number XX, Bonn, Germany.

- Jenkins, A.R., van Rooyen, C.S, Smallie, J.J, Harrison, J.A., Diamond, M.D., Smit-Robinson, H.A & Ralston, S. 2014. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa
- Jenkins, A.R., Shaw, J.M., Smallie, J.J., Gibbons, B., Visagie, R. & Ryan, P.G. 2011. Estimating the impacts of power line collisions on Ludwig's Bustards *Neotis ludwigii*. Bird Conservation International.
- Jordan, M., & Smallie, J. 2010. A briefing document on best practice for pre-construction assessment of the impacts of onshore wind farms on birds. Endangered Wildlife Trust, Unpublished report
- Smallie, J., & Virani, M.Z. 2010. A preliminary assessment of the potential risks from electrical infrastructure to large birds in Kenya. Scopus 30: p32-39
- Shaw, J.M., Jenkins, A.R., Ryan, P.G., & Smallie, J.J. 2010. A preliminary survey of avian mortality on power lines in the Overberg, South Africa. Ostrich 2010. 81 (2) p109-113
- Jenkins, A.R., Smallie, J.J., & Diamond, M. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. Bird Conservation International 2010. 20: 263-278.
- Shaw, J.M., Jenkins, A.R., Ryan, P.G., & Smallie, J.J. 2010. Modelling power line collision risk for the Blue Crane *Anthropoides paradiseus* in South Africa. Ibis 2010 (152) p590-599.
- Jenkins, A.R., Allan, D.G., & Smallie, J.J. 2009. Does electrification of the Lesotho Highlands pose a threat to that countries unique montane raptor fauna? Dubious evidence from surveys of three existing power lines. Gabar 20 (2).
- Smallie, J.J., Diamond, M., & Jenkins, A.R. 2008. Lighting up the African continent – what does this mean for our birds? Pp 38-43. In Harebottle, D.M., Craig, A.J.F.K., Anderson, M.D., Rakotomanana, H., & Muchai. (eds). Proceedings of the 12th Pan-african Ornithological Congress. 2008. Cape Town. Animal Demography Unit. ISBN (978-0-7992-2361-3)
- Van Rooyen, C., & Smallie, J.J. 2006. The Eskom –EWT Strategic Partnership in South Africa: a brief summary. Nature & Faunae Vol 21: Issue 2, p25
- Smallie, J. & Froneman, A. 2005. Bird Strike data analysis at South African Airports 1999 to 2004. Proceedings of the 27th Conference of the International Bird Strike Committee, Athens Greece.
- Smallie, J. & Van Rooyen, C. 2005. Impact of bird streamers on quality of supply on transmission lines: a case study. Proceedings of the Fifth IASTED International Conference on Power and Energy Systems, Benalmadena, Spain.
- Smallie, J. & Van Rooyen, C. 2003. Risk assessment of bird interaction on the Hydra-Droërivier 1 and 2 400kV. Unpublished report to Eskom Transmission Group. Endangered Wildlife Trust. Johannesburg. South Africa
- Van Rooyen, C. Jenkins, A. De Goede, J. & Smallie J. 2003. Environmentally acceptable ways to minimise the incidence of power outages associated with large raptor nests on Eskom pylons in the Karoo: Lessons learnt to date. Project number 9RE-00005 / R1127 Technology Services International. Johannesburg. South Africa
- Smallie, J. J. & O'Connor, T. G. (2000) Elephant utilization of *Colophospermum mopane*: possible benefits of hedging. African Journal of Ecology 38 (4), 352-359.

Courses & training:

- Successfully completed a 5 day course in High Voltage Regulations (modules 1 to 10) conducted by Eskom – Southern Region
- Successfully completed training on, and obtained authorization for, live line installation of Bird Flappers

Appendix 12. Compliance with Section 6 of the 2014 EIA Regulations (as amended)

Requirements of Appendix 6 (Specialist Reports) of Government Notice R326 (Environmental Impact Assessment (EIA) Regulations of 2014, as amended)	***Section where this has been addressed in the Specialist Report***
1. (1) A specialist report prepared in terms of these Regulations must contain - *a) details of -* *i. the specialist who prepared the report; and* *ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;*	Section 1.5, Appendix 11
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Appendix 10
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1.4
(cA) an indication of the quality and age of base data used for the specialist report;	Section 2
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 5
d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 2
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 2
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 4
g) an identification of any areas to be avoided, including buffers;	Section 4
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 4
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 2.4
j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Sections 3 & 4
k) any mitigation measures for inclusion in the EMPr;	Section 7
l) any conditions for inclusion in the environmental authorisation;	Section 7
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 7, Appendix 7
n) a reasoned opinion- *i. whether the proposed activity, activities or portions thereof should be authorised;* *(iA) regarding the acceptability of the proposed activity or activities; and* *ii. if the opinion is that the proposed activity, activities, or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;*	Section 8
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 2.2

Requirements of Appendix 6 (Specialist Reports) of Government Notice R326 (Environmental Impact Assessment (EIA) Regulations of 2014, as amended)	***Section where this has been addressed in the Specialist Report***
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Section 2.2
q) any other information requested by the competent authority.	n/a
(2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Appendix 13

Appendix 13. Site Sensitivity Verification

In accordance with GN 320 and GN 1150 (20 March 2020) of the NEMA EIA Regulations of 2014 (as amended), prior to commencing with a specialist assessment, a site sensitivity verification must be undertaken to confirm the current land use and environmental sensitivity of the proposed project area as identified by the National Web-Based Environmental Screening Tool (i.e., Screening Tool).

We examined the Screening Tool output (dated 30 September 2022) and found the following:

- The Animal Theme is classed as High sensitivity (**Figure A2**), with Verreaux's Eagle, Ludwig's Bustard, Riverine Rabbit (*Bunolagus monticularis*) and Karoo Dwarf Tortoise (*Chersobius boulengeri*) highlighted.
- The Avian Theme is classified as Low sensitivity (**Figure A3**). No bird species are highlighted.
- The Terrestrial Biodiversity Theme is classified as Very High sensitivity (**Figure A4**). This is due to the presence of Critical Biodiversity Areas 1 & 2, Ecological Support Areas and FEPA Subcatchments on site, as well as the Protected Areas Expansion Strategy being relevant.

Based on our work on site (described in **Section 3**) we can confirm the presence of the above identified avian species, however, we deviate from the Avian Theme to judge the site to be of Moderate to Low sensitivity for avifauna.

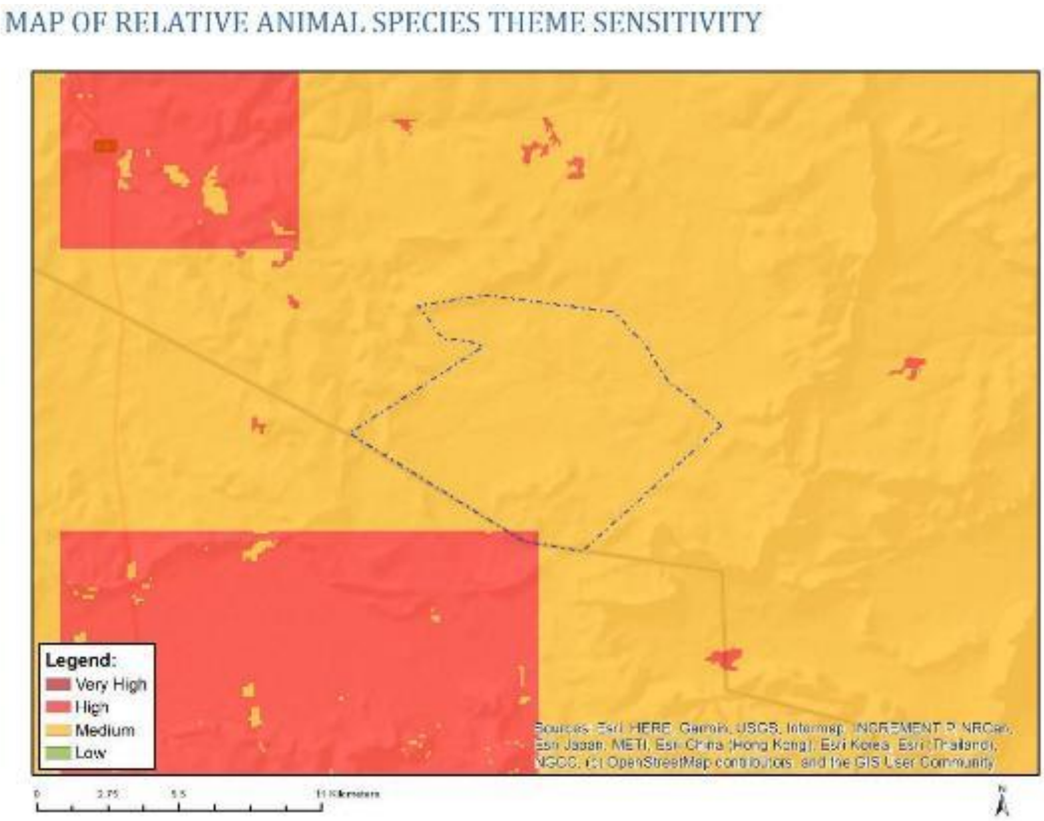

Figure A2. DFFE Screening Tool output for Animal Theme

MAP OF RELATIVE AVIAN (WIND) THEME SENSITIVITY

Figure A3. DFFE Screening tool output for Avian Theme

MAP OF RELATIVE TERRESTRIAL BIODIVERSITY THEME SENSITIVITY

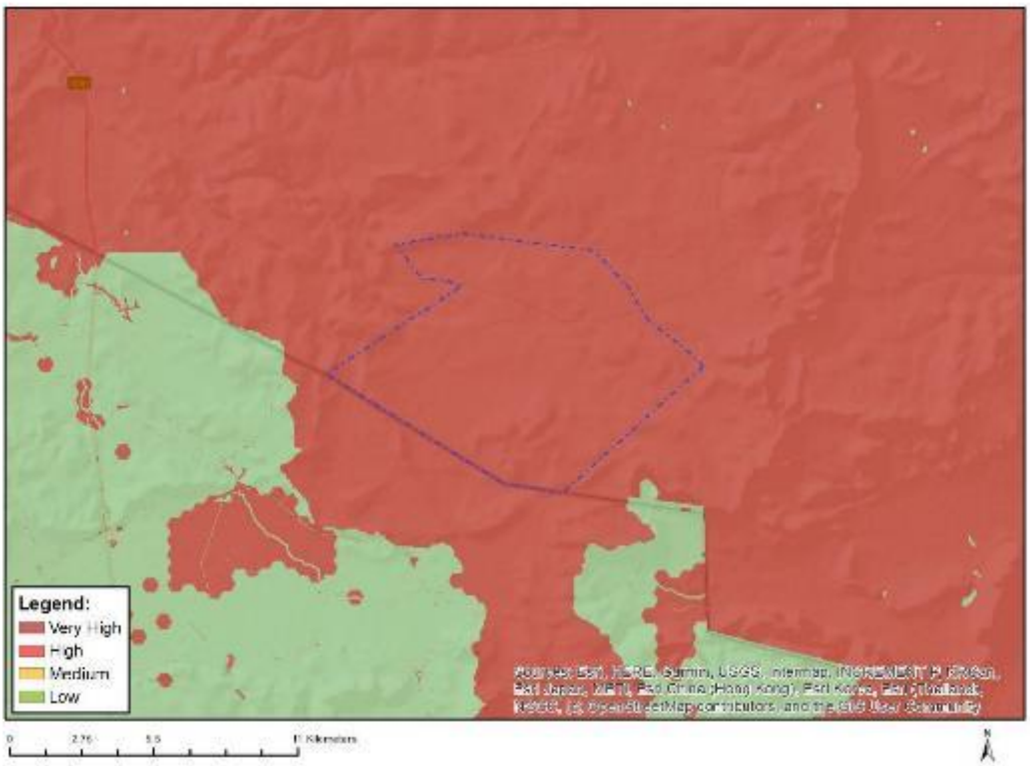

Figure A4. DFFE Screening Tool output for Terrestrial Biodiversity Theme