Avifaunal Impact Assessment Report

FE Tango Wind Energy Facility

Aberdeen, Eastern Cape Province

August 2023

AfriAvian Environmental
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Albert Froneman (Pr.Sci.Nat)
Albert has a M. Sc. in Conservation Biology from the University of Cape Town and started his career in the natural sciences as a Geographic Information Systems (GIS) specialist at Council for Scientific and Industrial Research (CSIR). He is a registered Professional Natural Scientist in the field of zoological science with the South African Council of Natural Scientific Professionals (SACNASP). In 1998, he joined the Endangered Wildlife Trust (EWT) where he headed up the Airports Company South Africa – EWT Strategic Partnership, a position he held until he resigned in 2008 to work as a private ornithological consultant. Albert's specialist field is the management of wildlife, especially bird related hazards at airports. His expertise is recognized internationally; in 2005 he was elected as Vice Chairman of the International Bird Strike Committee. Since 2010, Albert has worked closely with Chris van Rooyen in developing a protocol for pre-construction monitoring at wind energy facilities, and he is currently coordinating pre- and post-construction monitoring programmes at several wind farm facilities. Albert also works outside the renewable energy industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Dr Megan Loftie-Eaton (Pr.Sci.Nat)
Megan is a registered Professional Natural Scientist with the South African Council of Natural Scientific Professionals (SACNASP) in the field of Ecology, and she is a member of the Zoological Society of Southern Africa (ZSSA). Megan is also a registered Environmental Assessment Practitioner and assists with Environmental Impact Assessments (EIAs), Basic Assessments (BAs) and provides specialist input within the avifaunal and ecological fields. She obtained her BSc in Environmental & Conservation Sciences with distinction through the University of Alberta in Edmonton, Canada. After moving back to South Africa in 2011 she completed her MSc in Zoology (2014) at the University of Cape Town, and her PhD in Biological Sciences (2018, UCT), looking at the impacts of bush encroachment on bird distributions in the savanna biome of South Africa. Megan has conducted avifaunal field surveys and has good experience with conducting avifaunal impact assessments.

DECLARATION OF INDEPENDENCE

<insert signed DFFE Aug23 declaration>

forestry, fisheries
& the environment

Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

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SPECIALIST DECLARATION FORM – AUGUST 2023

Specialist Declaration form for assessments undertaken for 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)

REPORT TITLE
FE Tango Wind Energy Facility, Eastern Cape Province

Kindly note the following:

1. This form must always be used for assessment that are in support of 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 August 2023. 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.dffe.gov.za/documents/forms.
3. An electronic copy of the signed declaration form must be appended to all Draft and Final Reports submitted to the department for consideration.
4. The specialist must be aware of and comply with '*the Procedures for the assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the act, when applying for environmental authorisation - GN 320/2020)*', where applicable.

1. SPECIALIST INFORMATION

Title of Specialist Assessment	Avifaunal Assessment
Specialist Company Name	AfriAvian Environmental
Specialist Name	Albert Froneman
Specialist Identity Number	730815 5080 081
Specialist Qualifications:	M.Sc. Conservation Biology
Professional affiliation/registration:	SACNASP – Zoological Science 400177/09
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2. DECLARATION BY THE SPECIALIST

I, Albert Froneman declare that –

- I act as the independent specialist in this application;
- I am aware of the procedures and requirements for the assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the National Environmental Management Act (NEMA), 1998, as amended, when applying for environmental authorisation which were promulgated in Government Notice No. 320 of 20 March 2020 (i.e. "the Protocols") and in Government Notice No. 1150 of 30 October 2020.
- 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 NEMA Act.

Signature of the Specialist

AfriAvian Environmental

Name of Company:

18 Aug 2023

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, _ Albert Froneman________, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

AfriAvian Environmental

Name of Company

Click or tap here to enter text.

Date

Signature of the Commissioner of Oaths

21 AUGUST 2021

Date

BRUCE MORRISON C. A. (S. A.)
COMMISSIONER OF OATHS
1995-12-05
REF: 9/1/8/2 SPRINGS (A3)
79 FIFTH STREET, SPRINGS

EXECUTIVE SUMMARY

FE Tango (Pty) Ltd is proposing the development of a wind energy facility and associated infrastructure on a site located approximately 20km west of Aberdeen in the Eastern Cape Province. The project is located within the Dr Beyers Naude Local Municipality and the greater Sarah Baartman District Municipality. The project site comprises a single affected property, Portion 1 of Farm Klipstavel 72. The project is known as the FE Tango Wind Energy Facility. The project is planned as part of a cluster of renewable energy projects, which includes a second facility, FE Kudu Wind Energy Facility, located approximately 20km to the west of the site.

The entire extent of the site falls within the Beaufort West Renewable Energy Development Zones (i.e. REDZ Focus Area 11). The undertaking of a basic assessment process for the project is in line with the requirements stated in GNR 114 of 16 February 2018.

The Tango Wind Energy Facility will have a contracted capacity of up to 150MW and comprise wind turbines with a capacity of up to 7.5MW each. The project has a preferred project site of approximately ~2 250ha. Access to the site will be via an existing road off of the nearby R61.

The project is intended to provide electricity to the national grid through the Department of Mineral Resource and Energy's (DMRE) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme or other public or private off-taker programmes.

1 AVIFAUNA IN THE STUDY AREA

The Southern African Bird Atlas Project (SABAP2) data indicates that 206 bird species have been recorded and could potentially occur within the Broader Area – **Appendix C** provides a comprehensive list of all the species. Of these, 29 species are classified as priority species for wind energy developments (see definition of priority species in Section 1.3) and 15 of these priority species are also South African Red List species. Of the 29 priority species, 21 are likely to occur regularly in the Project Site (**Table 2**).

According to the Aberdeen Wind Facility 1 Avifaunal Impact Assessment study (Birds and Bats Unlimited, 2023) Black Harriers are breeding in the Camdeboo Mountains – a new nest site was located during the latter part of 2022. Their study included detailed mapping of the home ranges of two satellite tracked Black Harriers over several years. The tracking data revealed that the harriers make extensive use of the plains below the mountains for foraging. Tracking data for the period October 2022 – January 2023 indicated that the harrier roamed over a wide area extending to the plains on the west and south of the mountain. On average, Black Harriers cover an extensive area around their nests (7.1 – 33.4km) to forage during the breeding season (Garcia-Heras *et al.* 2019). The karoo habitat on the plains below the mountain is largely uniform. Due to the stochastic nature of rainfall and hence prey availability in the area, the foraging range of the harriers could at times extend over the FE Tango WEF Site. Although Black Harriers were not observed during the FE Tango pre-construction monitoring campaign, it is recommended that a precautionary approach be adopted, and mitigation measures be considered to minimise the potential risk of the proposed FE Tango WEF to Black Harriers. Also refer to Section 6.1.2.

2 SUMMARY OF FINDINGS

The proposed FE Tango WEF will have several potential impacts on priority avifauna. The impacts are the following:

- Mortality as a result of collision with wind turbines
- Displacement due to disturbance
- Displacement due to habitat transformation

- Mortality as a result of electrocution on the 33kV MV overhead cables and in the substation yard.
- Mortality due to the collisions with the 33kV overhead lines.

2.1 Displacement of priority species due to disturbance and habitat transformation

It is inevitable that a measure of displacement will take place for all priority species during the construction phase, due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species the most, as this could temporarily disrupt their reproductive cycle. Species that fall in this category are Ludwig’s Bustard, Blue Crane, Karoo Korhaan, Southern Black Korhaan and Spotted Eagle-Owl. Some raptors, such as Greater Kestrel that often breed on crow nests constructed on wind pumps, may also be affected. Some species might be able to recolonise the area after the completion of the construction phase, while others may return only partially, resulting in reduced densities once the wind farm is operational. In summary, the following species could be impacted by disturbance during the construction phase: African Harrier-Hawk, African Rock Pipit, Black Harrier, Black Stork, Black-winged Kite, Blue Crane, Booted Eagle, Brown Snake Eagle, Burchell's Courser, Double-banded Courser, Greater Kestrel, Grey-winged Francolin, Jackal Buzzard, Karoo Korhaan, Kori Bustard, Lanner Falcon, Ludwig's Bustard, Martial Eagle, Pale Chanting Goshawk, Sclater's Lark, Secretarybird, Southern Black Korhaan, Spotted Eagle-Owl, and Verreaux's Eagle.

The new network of roads is likely to result in significant habitat fragmentation that could have an effect on the densities of several species, particularly larger terrestrial species such as Ludwig’s Bustard, Blue Crane, Southern Black Korhaan and Karoo Korhaan. Given the proposed turbine layout and associated road infrastructure, it is not expected that any priority species will be displaced permanently from the Project Site. The building infrastructure and substation will be situated in the same habitat, i.e., Karoo scrub. The impact of habitat transformation on avifauna will be low as the current habitat is not highly sensitive. This is due to the ample availability of the same habitat and the small size of the transformation footprint. In summary, the following species are likely to be affected by habitat transformation: African Rock Pipit, Blue Crane, Burchell's Courser, Double-banded Courser, Grey-winged Francolin, Karoo Korhaan, Kori Bustard, Ludwig's Bustard, Sclater's Lark, Secretarybird, and Southern Black Korhaan.

2.2 Mortality of priority species due to collisions with the wind turbines

The proposed FE Tango WEF will pose a collision risk to several priority species which could regularly occur at the site. Large terrestrial species that are sensitive to this risk are mostly bustards such as Karoo Korhaan, Southern Black Korhaan, Ludwig’s Bustard, Kori Bustard, and Blue Crane - although bustards and cranes generally seem to be less vulnerable to turbine collisions than was originally anticipated (Ralston-Paton & Camagu 2019). Soaring priority species most at risk at the Project Site include: Martial Eagle, Pale Chanting Goshawk, Lanner Falcon, Booted Eagle, Verreaux’s Eagle, Greater Kestrel, and Lesser Kestrel. In summary, the following priority species could be at risk of collisions with the turbines: African Harrier-Hawk, Amur Falcon, Black Harrier, Black Stork, Black-winged Kite, Blue Crane, Booted Eagle, Brown Snake Eagle, Burchell's Courser, Common Buzzard, Double-banded Courser, Greater Kestrel, Grey-winged Francolin, Jackal Buzzard, Karoo Korhaan, Kori Bustard, Lanner Falcon, Lesser Kestrel, Ludwig's Bustard, Martial Eagle, Pale Chanting Goshawk, Sclater's Lark, Secretarybird, Southern Black Korhaan, Spotted Eagle-Owl, Verreaux's Eagle, White Stork and Black Harrier.

2.3 Mortality of priority species due to electrocutions on the 33kV MV reticulation network and in the substation yard

While the intention, where possible, is to place the medium voltage reticulation network underground, there are areas where the lines could be run above ground for technical reasons. In these instances, the poles could potentially pose an electrocution risk to raptors. In summary, the following priority species could be vulnerable to electrocution: African Harrier-Hawk, Amur Falcon, Black Harrier, Black Stork, Black-winged Kite, Booted Eagle, Brown Snake Eagle, Common Buzzard, Greater Kestrel, Jackal Buzzard, Lanner Falcon, Lesser Kestrel, Martial Eagle, Pale Chanting Goshawk, Spotted Eagle-Owl, and Verreaux's Eagle. Electrocutions within the proposed substation yard are also possible, particularly for smaller species such as Greater Kestrel and Spotted Eagle-Owl. The larger Red Data raptors, such as Martial Eagle, should not be affected as they are unlikely to use the infrastructure within the substation yard for perching or roosting.

2.4 Mortality of priority species due to collisions with the 33kV overhead lines

While the intention is to place most of the medium voltage reticulation network at the wind farm underground, there are areas where the lines will run above ground. Priority species which are most at risk of collisions with the medium voltage powerlines are the following: Black Stork, Blue Crane, Karoo Korhaan, Kori Bustard, Ludwig's Bustard, Secretarybird, Southern Black Korhaan, Spotted Eagle-Owl, Verreaux's Eagle, White Stork. Where the reticulation network will occur near large dams and agricultural fields would be considered high-risk areas.

2.5 Conclusions

The assessment of the potential impacts of the proposed development on avifauna included existing bird records of the broader area (SABAP2), and pre-construction monitoring of the proposed development area (6 surveys during January 2021 - October 2022). The results of the investigation do not reveal any fatal flaws that would preclude the development of the proposed WEF. However, this conclusion is subject to the implementation of the recommendations listed in this report.

2.6 Cumulative Impacts

The total affected area taken up by other authorised renewable energy projects within the 30 km radius is approximately 163 km². The total land parcel area affected by the FE Tango Wind Energy Facility equates to approximately 22.5 km². The combined land parcel areas affected by authorised renewable energy developments within the 30 km radius of similar habitat around the proposed FE Tango Wind Energy Facility (inclusive of the FE Tango Wind Energy Facility), thus equals approximately 185.5 km². Of this, the proposed FE Tango WEF project constitutes ~12% (22.5 km²). The cumulative impact of the proposed FE Tango WEF after mitigation is anticipated to be **low** to **moderate**.

The total area within the 30km radius around the proposed projects equates to about 2827.4 km² of similar habitat. The total combined size of the land parcels potentially affected by renewable energy projects will equate to ~6.6% of the available untransformed habitat in the 30km radius. However, the actual physical footprint of the renewable energy facilities will be smaller than the land parcel areas themselves. Furthermore, each of these projects must still be subject to a competitive bidding process where only the most competitive projects will win a power purchase agreement required for the project to proceed to construction. The cumulative impact of all the proposed renewable energy projects is estimated to be **moderate**.

3 CONCLUDING STATEMENT

The proposed FE Tango WEF will have a medium impact on avifauna which, in most instances, could be reduced to a low impact through the appropriate mitigation measures. The current proposed 18-turbine layout which was assessed in this report avoids all the recommended avifaunal turbine exclusion zones and is therefore deemed acceptable. The development is supported, provided the mitigation measures listed in this report (Section 6 and Appendix G) are strictly applied and adhered to. See **Figure i** and **Appendix E** for a map of the exclusion areas.

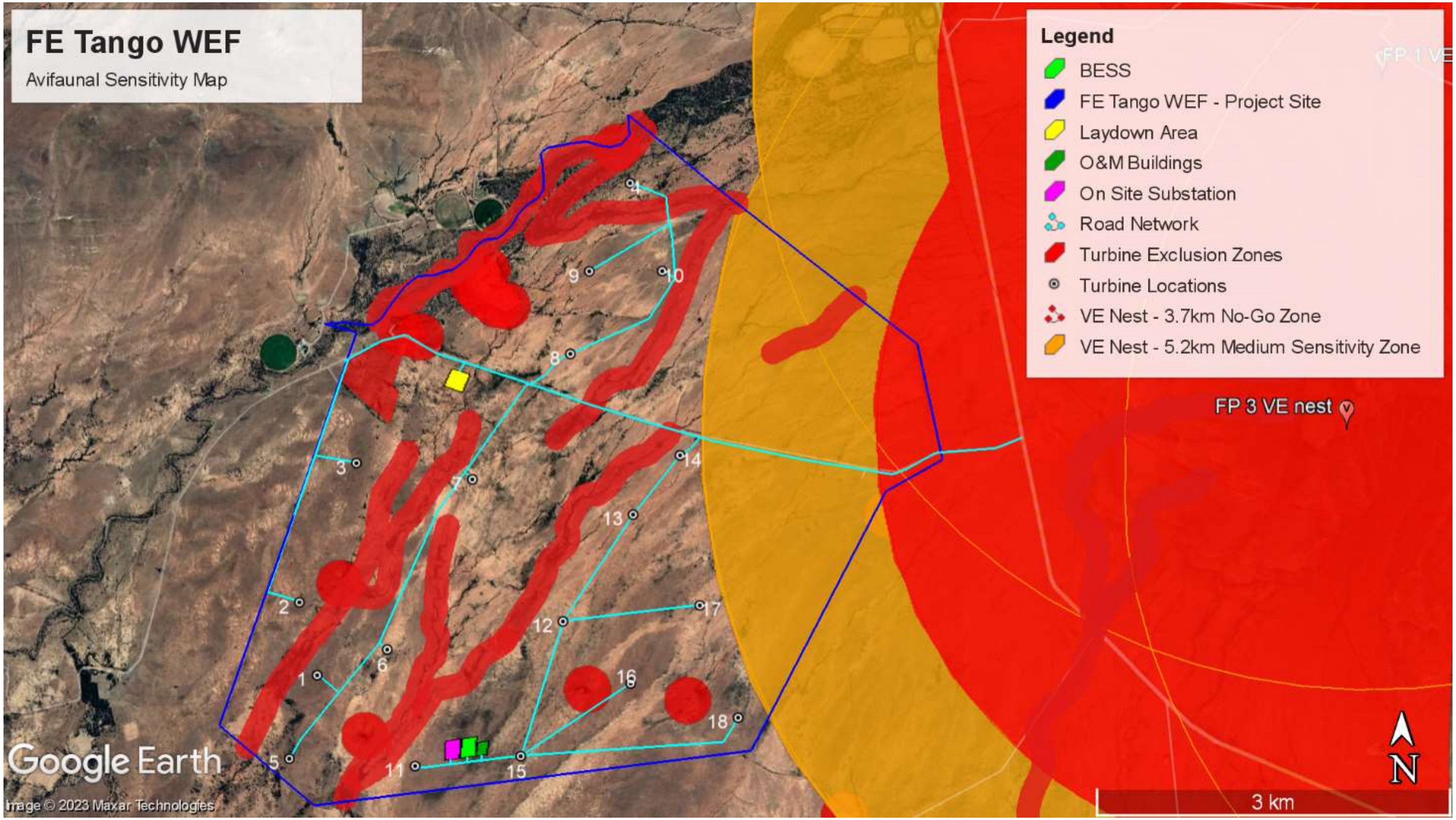

Figure i: Avifaunal sensitivities identified for the proposed FE Tango WEF Project.

CONTENTS

1. INTRODUCTION

FE Tango (Pty) Ltd is proposing the development of a wind energy facility and associated infrastructure on a site located approximately 20km west of Aberdeen in the Eastern Cape Province. The project is located within the Dr Beyers Naude Local Municipality and the greater Sarah Baartman District Municipality. The project site comprises a single affected property, Portion 1 of Farm Klipstavel 72. The project is known as the FE Tango Wind Energy Facility. The project is planned as part of a cluster of renewable energy projects, which includes a second facility, FE Kudu Wind Energy Facility, located approximately 20km to the west of the site.

The entire extent of the site falls within the Beaufort West Renewable Energy Development Zones (i.e. REDZ Focus Area 11). The undertaking of a basic assessment process for the project is in line with the requirements stated in GNR 114 of 16 February 2018.

The Tango Wind Energy Facility will have a contracted capacity of up to 150MW and comprise wind turbines with a capacity of up to 7.5MW each. The project has a preferred project site of approximately ~2 250ha. Access to the site will be via an existing road off of the nearby R61. The FE Tango Wind Energy Facility project site is proposed to accommodate the following infrastructure:

» Up to 18 wind turbines, turbine foundations and turbine hardstands
» An on-site substation hub incorporating:
  - A132kV on-site facility substation
  - Switchyard with collector infrastructure
  - Battery Energy Storage System (BESS)
  - Operation and Maintenance buildings
» A balance of plant area incorporating:
  - Temporary laydown areas
  - A construction camp laydown and temporary concrete batching plant
» Power lines internal to the wind farm, trenched and located adjacent to internal access roads, where feasible[1].
» Access roads to the site and between project components with a width up to 8m for primary access routes.

A technically viable development footprint was proposed by the developer and assessed as part of the studies.

The details of the project is as follows:

Project Name	FE Tango Wind Energy Facility
Location	Portion 1 of Farm Klipstavel 72
Applicant	FE Tango (Pty) Ltd
Contracted capacity	Up to 150MW (turbines up to 7.5MW in capacity)
Number of turbines	Up to 18 turbines
Turbine hub height	Up to 164m
Turbine top tip height	Up to 250m
Rotor swept area	up to 21 000m^2
Capacity of on-site substation	132kV

[1] The intention is for internal project cabling to follow the internal roads.

Area occupied by the on-site substation	~ 2ha in extent
Underground cabling	Underground cabling, with a capacity of 33kV, will be installed to connect the turbines to the on-site facility substation.
Battery Energy Storage System (BESS)	Solid state battery technology (e.g. Lithium-ion technology) as a preferred technology. BESS will be housed in containers approximately 20m long, 3m wide, and 5m high with an approximate footprint of up to 5ha.
Operation and maintenance (O&M) buildings	~ 1ha in extent
Balance of plant area	Temporary laydown areas with an extent up to 6ha. Temporary warehouse of 1 ha Temporary site camp establishment and concrete batching plants of 1 ha.
Access and internal roads – Main road	Main access road to the site and between project components with a width up to 8m and a servitude of 13.5m.
Access and internal roads – internal network	Road network between project components with a width up to 8m
Turbine hardstand footprint	For each turbine the following will be relevant: ~up to 7500m^2 for the turbine hardstand area
Turbine foundation footprint	~ 1000m^2 per turbine

The project is intended to provide electricity to the national grid through the Department of Mineral Resource and Energy's (DMRE) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme or other public or private off-taker programmes.

See **Figure 1** for a map of the proposed layout of the WEF.

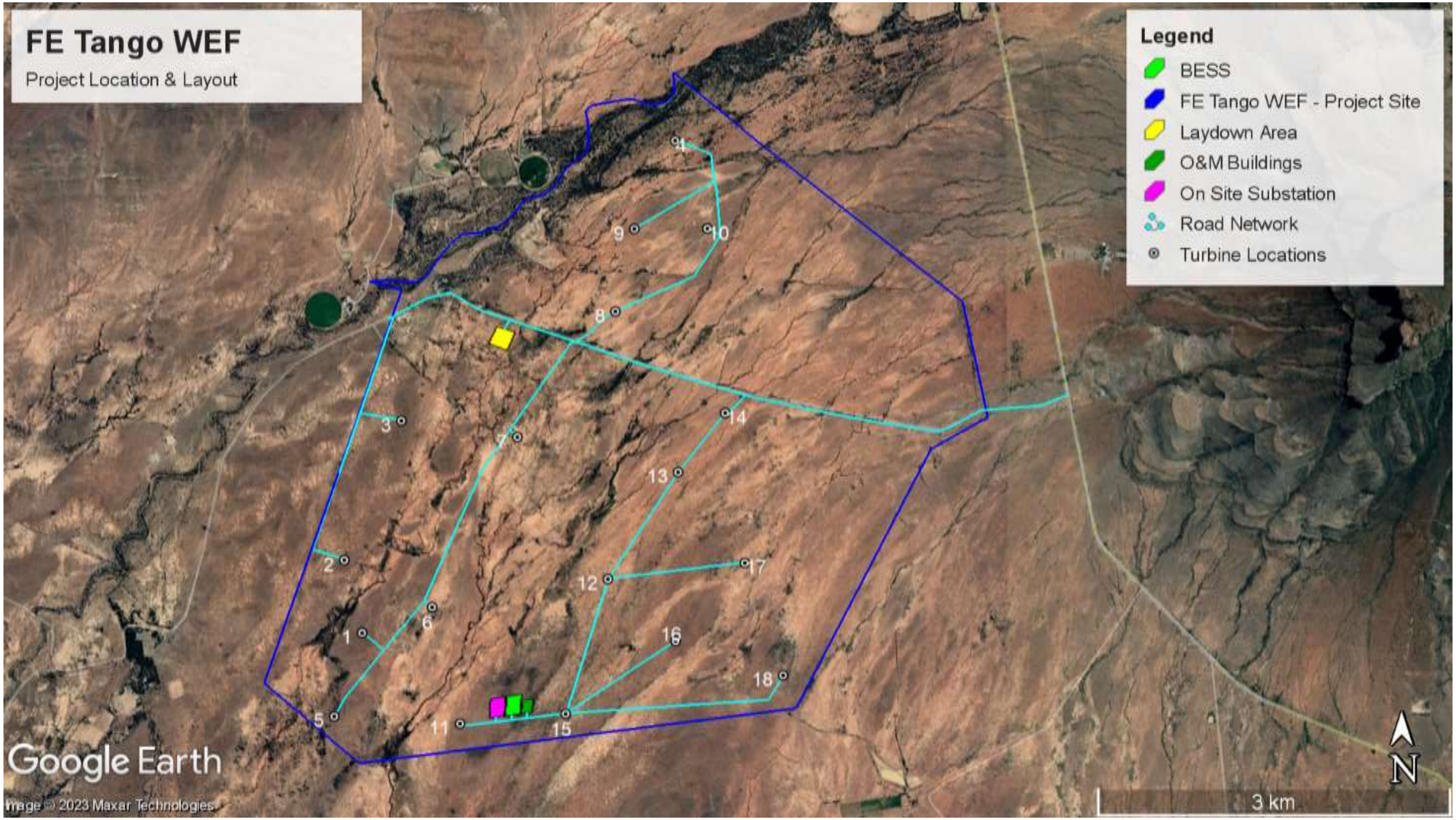

Figure 1: Layout of proposed FE Tango WEF.

1.1 Terms of Reference

The terms of reference for this report are the following:

- Describe the affected environment from an avifaunal perspective;
- Discuss gaps in baseline data and other limitations;
- List and describe the expected impacts;
- Assess and evaluate the potential impacts;
- Give a considered opinion whether the project is fatally flawed from an avifaunal perspective; and
- If not fatally flawed, recommend mitigation measures to reduce the expected impacts.

1.2 Sources of Information

The following information sources were consulted to conduct this study:

- Bird distribution data from the Second Southern African Bird Atlas Project (SABAP2) was obtained (https://sabap2.birdmap.africa/) to ascertain which species occur in the pentads where the proposed Project is located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5' × 5'). Each pentad is approximately 9 × 8 km in size. To get a representative impression of the bird species in the area a consolidated dataset was obtained for a total of nine (9) pentads some of which intersect and others that are near the Project Site, henceforth referred to as "the Broader Area" (**Figure 2**). The nine pentad grid cells are the following: 3220_2340, 3220_2345, 3220_2350, 3225_2340, 3225_2345, 3225_2350, 3230_2340, 3230_2345, and 3230_2350. To date, a total of 123 full protocol lists (i.e. intensive bird listing surveys lasting at least two hours each) and 188 ad hoc protocol lists (surveys lasting less than two hours but still yielding valuable data) have been completed for the nine pentads where the Project Site is located.
- The SABAP2 data was regarded as a reliable reflection of the avifauna which occur in the Broader Area, but the data was also supplemented with data collected during the on-site surveys and with general knowledge of the area.
- A classification of the vegetation types in the Project Site was obtained from the First Atlas of Southern African Birds (SABAP1) and the National Vegetation Map (2018) compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006).
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red List Book of Birds of South Africa, Lesotho and Swaziland (Taylor *et al.* 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the latest (2022.2) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- The Important Bird and Biodiversity Areas of South Africa (Marnewick *et al.* 2015; http://www.birdlife.org.za/conservation/important-bird-areas) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- An intensive internet search was conducted to source information on the impacts of wind energy facilities on avifauna.
- Satellite imagery (Google Earth © 2023) was used to view the broader area on a landscape level and to help identify bird habitat on the ground.
- The South African National Biodiversity BGIS map viewer was used to determine the locality of the Project Site relative to National Protected Areas.
- The DFFE National Screening Tool was used to determine the assigned avian sensitivity of the Project Site.
- The following sources were consulted to determine the investigation protocol that is required for the site:
    - Procedures for the Assessment and Minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of NEMA when applying for Environmental Authorisation (Gazetted October 2020)

- Protocol for the specialist assessment and minimum report content requirements for environmental impacts om avifaunal species by onshore wind energy generation facilities where the electricity output is 20MW or more (Government Gazette No. 43110 – 20 March 2020).
- Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2015. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy Project Sites in southern Africa. Produced by the Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa.

- Findings of Black Harrier foraging behaviour based on satellite tracking data as presented in the nearby Aberdeen Wind Facility 1 – Avifaunal Specialist report (2023).
- The primary source of information on avifaunal diversity, abundance, and flight patterns at the site are the results of a pre-construction monitoring programme conducted over four seasons at the proposed FE Tango WEF Project Site. The primary methods of data capturing were walk transect counts, drive transect counts, vantage point watches and incidental sightings (**Appendix A**).

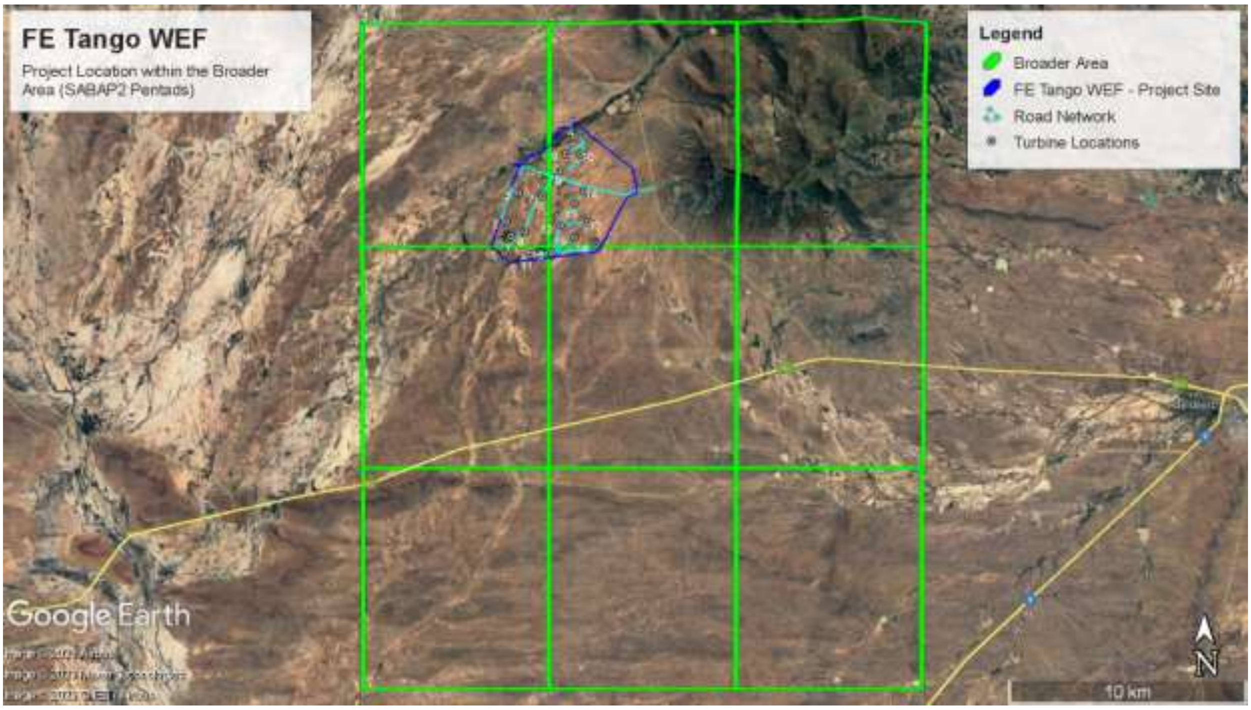

Figure 2: The Broader Area covered by the nine SABAP2 pentads.

1.3 Assumptions and Limitations

This study made the basic assumption that the sources of information used are reliable and accurate. The following must be noted:

- The SABAP2 dataset is a comprehensive dataset that provides a reasonably accurate snapshot of the avifauna which could occur at the proposed site. For purposes of completeness, the list of species that could be encountered was supplemented with personal observations, general knowledge of the area, and the results of the pre-construction monitoring conducted at the Project Site.
- Conclusions in this report are based on experience of these and similar species at wind farm developments in different parts of South Africa. However, bird behaviour can never be predicted with absolute certainty.

- To date, only one peer-reviewed scientific paper has been published on the impacts of wind farms on birds in South Africa (Perold *et al*. 2020). The precautionary principle was therefore applied throughout. The World Charter for Nature, which was adopted by the UN General Assembly in 1982, was the first international endorsement of the precautionary principle. The principle was implemented in an international treaty as early as the 1987 Montreal Protocol and, among other international treaties and declarations, is reflected in the 1992 Rio Declaration on Environment and Development. Principle 15 of the 1992 Rio Declaration states that: "in order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall be not used as a reason for postponing cost-effective measures to prevent environmental degradation."
- According to the specifications received from the proponent, the 33kV medium-voltage lines will be buried where practically feasible. It was therefore assumed that there could be 33kV overhead lines which could pose an electrocution risk to priority species.
- The Development Area is area (located within the Project Site) where the FE Tango WEF is planned to be located. This area has been selected as a practicable option for the facility, considering technical preference and constraints.
- The broader area refers to the area covered by the six SABAP2 pentads (see **Figure 2**).
- Priority species for wind developments were identified from the updated list of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Retief *et al*. 2012).

2 LEGISLATIVE CONTEXT

2.1 Agreements and Conventions

Table 1 below lists agreements and conventions which South Africa is party to, and which is directly relevant to the conservation of avifauna (BirdLife International 2021).

Table 1: Agreements and conventions which South Africa is party to and which is relevant to the conservation of avifauna.

Convention Name	Description	Geographic Scope
African-Eurasian Waterbird Agreement (AEWA)	The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) is an intergovernmental treaty dedicated to the conservation of migratory waterbirds and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland and the Canadian Archipelago. Developed under the framework of the Convention on Migratory Species (CMS) and administered by the United Nations Environment Programme (UNEP), AEWA brings together countries and the wider international conservation community in an effort to establish coordinated conservation and management of migratory waterbirds throughout their entire migratory range.	Regional
Convention on Biological Diversity (CBD), Nairobi, 1992	The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has 3 main objectives: The conservation of biological diversity The sustainable use of the components of	Global

Convention Name	Description	Geographic Scope
	biological diversity The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.	
Convention on the Conservation of Migratory Species of Wild Animals, (CMS), Bonn, 1979	As an environmental treaty under the aegis of the United Nations Environment Programme, CMS provides a global platform for the conservation and sustainable use of migratory animals and their habitats. CMS brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.	Global
Convention on the International Trade in Endangered Species of Wild Flora and Fauna, (CITES), Washington DC, 1973	CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	Global
Ramsar Convention on Wetlands of International Importance, Ramsar, 1971	The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.	Global
Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia	The Signatories will aim to take co-ordinated measures to achieve and maintain the favourable conservation status of birds of prey throughout their range and to reverse their decline when and where appropriate.	Regional

2.2 National Legislation

2.2.1 Constitution of the Republic of South Africa, 1996

The Constitution of the Republic of South Africa provides in the Bill of Rights that: Everyone has the right –

(a) to an environment that is not harmful to their health or well-being; and

(b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –

- (i) prevent pollution and ecological degradation;
- (ii) promote conservation; and
- (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

2.2.2 The National Environmental Management Act (Act No. 107 of 1998) (NEMA)

The National Environmental Management Act (Act No. 107 of 1998) (NEMA) creates the legislative framework for environmental protection in South Africa and is aimed at giving effect to the environmental right in the Constitution. It sets out several guiding principles that apply to the actions of all organs of state that may significantly affect the environment. Sustainable development (socially, environmentally and economically) is one of the key principles, and internationally accepted principles of environmental management, such as the precautionary principle and the polluter pays principle, are also incorporated.

NEMA also provides that a wide variety of listed developmental activities, which may significantly affect the environment, may be performed only after an environmental impact assessment has been done and authorization has been obtained from the relevant authority. Many of these listed activities can potentially have negative impacts on bird populations in a variety of ways. The clearance of natural vegetation, for instance, can lead to a loss of habitat and may depress prey populations, while erecting structures needed for generating and distributing energy, communication, and so forth can cause mortalities by collision or electrocution.

NEMA makes provision for the prescription of procedures for the assessment and minimum criteria for reporting on identified environmental themes (Sections 24(5)(a) and (h) and 44) when applying for environmental authorisation. The Protocol for the Specialist Assessment and Minimum Report Content Requirements of Environmental Impacts on Avifauna by Onshore Wind and/or Solar PV Energy Generation Facilities where the Electricity Output is 20 MW or more published on 20 March 2020 (GG 43110 / GNR 320, 20 March 2020). This protocol replaces the requirements of Appendix 6 of the 2014 NEMA EIA Regulations (as amended).

2.2.3 The National Environmental Management: Biodiversity Act 10 of 2004 (NEMBA) and the Threatened or Protected Species Regulations, February 2007 (TOPS Regulations)

The most prominent statute containing provisions directly aimed at the conservation of birds is the National Environmental Management: Biodiversity Act 10 of 2004 read with the Threatened or Protected Species Regulations, February 2007 (TOPS Regulations). Chapter 1 sets out the objectives of the Act, and they are aligned with the objectives of the Convention on Biological Diversity, which are the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of the benefits of the use of genetic resources. The Act also gives effect to CITES, the Ramsar Convention, and the Bonn Convention on Migratory Species of Wild Animals. The State is endowed with the trusteeship of biodiversity and has the responsibility to manage, conserve and sustain the biodiversity of South Africa.

2.3 Provincial Legislation

The current legislation applicable to the conservation of fauna and flora in the Eastern Cape is the Draft Eastern Cape Environmental Management Bill. The Draft Eastern Cape Environmental Management Bill, 2019 was published in the Eastern Cape Provincial Gazette for comment on 22 July 2019.

Its professed objectives are to rationalize, consolidate and reform the law regulating environmental management and to provide for the harmonisation of provincial legislation with national legislation regulating protected areas, biodiversity, waste management and air quality; and to provide for matters connected therewith.

It is proposed in the draft bill that the following Acts applying in the Eastern Cape are repealed:

- Nature and Environmental Conservation Ordinance, 1974
- Nature Conservation Act, 1987 (Ciskei)
- Environmental Conservation Decree, 1992 (Transkei)
- Mountain Catchment Areas Act, 1970

2.4 Best Practice Guidelines

The pre-construction monitoring was designed according to the following best practice guidelines (hereafter referred to as the wind guidelines):

Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2015. *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy Project Sites in southern Africa.* Produced by the Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Natural Environment

The Project Site falls within the Nama-Karoo Biome (Mucina & Rutherford 2006). The Nama-Karoo covers an extensive part of the south-central plateau of South Africa - an area of 248 284 km^2 (Mucina and Rutherford, 2006). The biome is characterized by low rainfall (70 to 500 mm per year) that falls mostly in late summer (Mucina & Rutherford 2006) resulting in a high summer aridity index (Rutherford & Westfall 1985). The biome is classified as arid (Mucina & Rutherford 2006). Summers are hot (maximum >30^{o}C), winters are cold (minimum close to 0^{o}C) and frost is common. The vegetation of the Nama-Karoo is dominated by chamaephytes (low-growing shrubs) and hemicryptophytes (graminoids) in a grassy, dwarf shrubland. The main vegetation types within the Project Site are Southern Karoo Riviere (Inland Saline Vegetation Bioregion) and Eastern Lower Karoo (Lower Karoo Bioregion) (**Figure 3**). The Southern Karoo Riviere vegetation type occurs along the rivers of the semi-arid regions of the Nama-Karoo. It is dominated by *Vachellia karroo* trees and is tolerant of severe flooding. Associated species include *Diospyros dichrophylla*, *Lycium oxycarpum*, *Cenchrus ciliaris* and *Gymnosporia heterophylla*. The Eastern Lower Karoo is characterised by flat plains interrupted by some dolerite dykes, butts, and mesas (koppies). The dominant vegetation is low to middle-height microphyllous shrubland with drought-resistant ‘white’ grasses becoming abundant in places, especially on sandy and silty bottomlands. Leaf-succulent dwarf shrubs of the families Aizoaceae and Crassulaceae can also be encountered.

The Project Site also contains several non-perennial rivers (**Figure 4**) with their associated drainage line woody vegetation. These areas are of particular importance to avifauna for roosting, nesting, and foraging. Raptors may also use these areas to hunt other bird species. There is a prominent mountain and its associated rocky cliffs and ridges ~2km east of the Project Site, which could be utilized by several priority species, especially raptors.

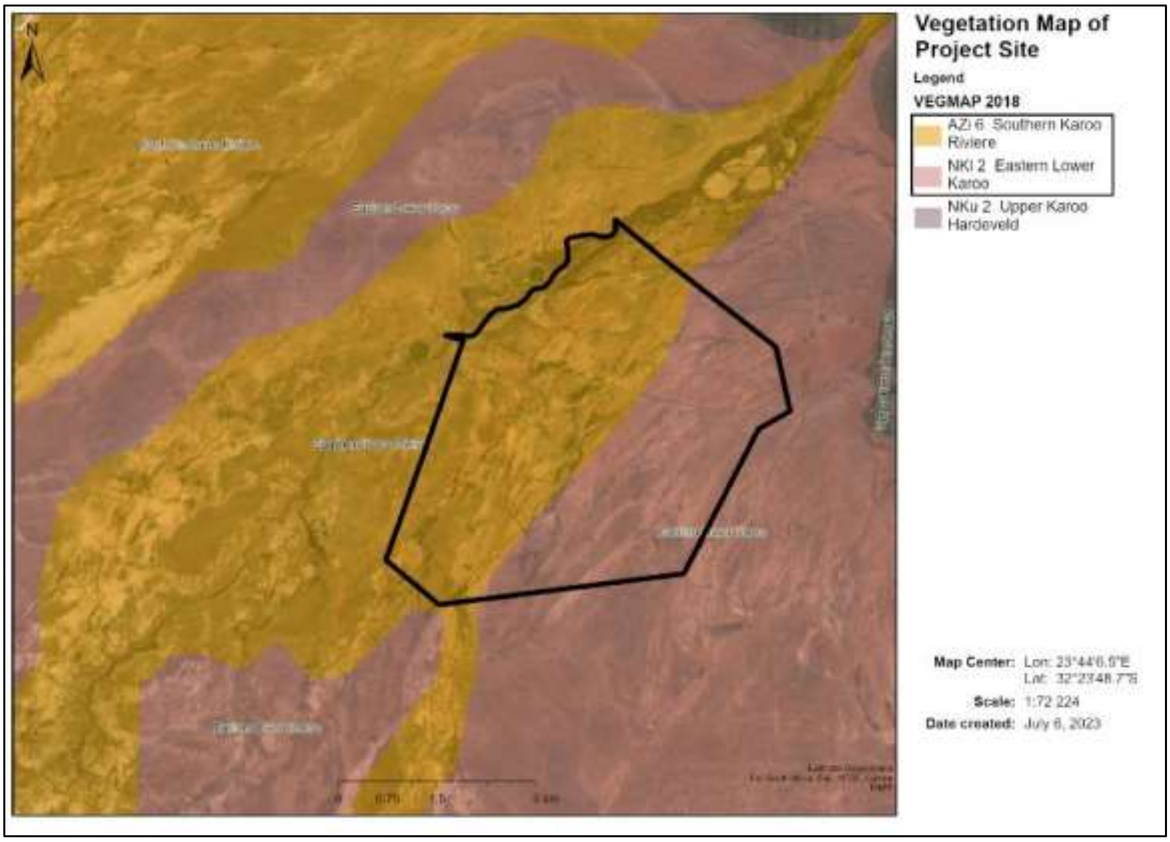

Figure 3: Vegetation types in and near the Project Site (outlined in black).

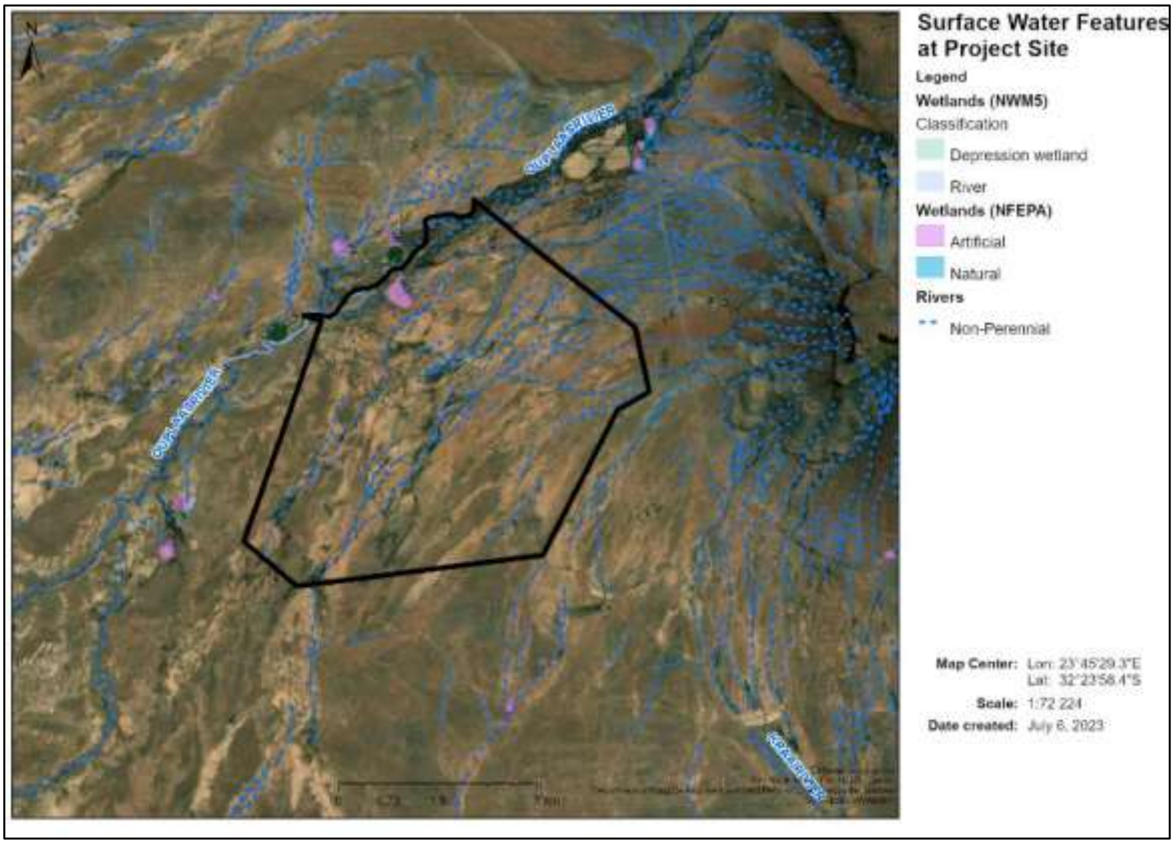

Figure 4: Surface water features in and near the Project Site (outlined in black).

3.2 Modified Environment

Whilst the distribution and abundance of the bird species in and near the Project Site is mostly associated with natural vegetation, as this comprises virtually all the habitat, it is also necessary to examine the anthropogenic modifications to the environment that have relevance for birds.

The following avifaunal-relevant anthropogenic habitat modifications were recorded within the Project Site:

- **Surface Water:** The Project Site contains sources of permanent surface water, namely boreholes with water troughs or cement dams. There are also several earth dams. The land use in the broader area is mostly small stock and game farming. The entire area is divided into large grazing camps with associated boreholes and drinking troughs. In this arid environment, open water is a big attraction for birds that use the open water troughs to bath and drink.
- **Agriculture:** The land use in the broader area is mostly small stock (sheep) and game farming. The Project Site and nearby areas contain irrigated fields, usually lucerne, or planted grazing pasture for sheep. Birds such as Blue Cranes could utilize these areas for foraging.

Appendix B provides a photographic record of the habitat at the Project Site.

3.3 Important Bird Areas (IBAs)

There are no Important Bird Areas (IBAs) within a 50km radius of the proposed FE Tango WEF. The closest IBAs to the Project Site are the Karoo National Park (IBA SA102), located 105km west of the Project Site, and the Camdeboo National Park SA090, 62km east of the Project Site. It is unlikely that the proposed development will have a negative impact on these IBAs due to the distance from the Project Site.

3.4 The DFFE National Screening Tool

The Project Site and immediate environment is classified as **HIGH** sensitivity for avifauna according to the Animal Species Theme (**Figure 5**). The sensitivity classification is linked to the possible occurrence of Ludwig's Bustard *Neotis ludwigii* (Globally and Regionally Endangered), Southern Black Korhaan *Afrotis afra* (Globally and Regionally Vulnerable) and Black Harrier *Circus maurus* (Globally and Regionally Endangered). The Project Site contains confirmed habitat for species of conservation concern (SCC) as defined in the Protocol for specialist assessments and minimum report content requirements for environmental impacts on avifaunal species by onshore wind energy generation facilities where the electricity output is 20MW or more (Government Gazette No. 43110 – 20 March 2020). SCCs are listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered, Near-threatened or Vulnerable.

The occurrence of SCC at the Project Site was confirmed during the six pre-construction monitoring surveys (January 2021 to October 2022) with observations of Ludwig's Bustard, Blue Crane *Grus paradisea* (Globally Vulnerable and Regionally Near-threatened), Karoo Korhaan *Eupodotis vigorsii* (Regionally Near-threatened), Kori Bustard *Ardeotis kori* (Globally and Regionally Near-threatened), Martial Eagle *Polemaetus bellicosus* (Globally and Regionally Endangered), Southern Black Korhaan, Secretarybird Sagittarius serpentarius (Globally Endangered and Regionally Vulnerable), Verreaux's Eagle *Aquila verreauxii* (Regionally Vulnerable) and Lanner Falcon *Falco biarmicus* (Regionally Vulnerable) recorded on-site. Based on the confirmed habitat and the field surveys, the classification of **HIGH** sensitivity for avifauna according to the Screening Tool is supported.

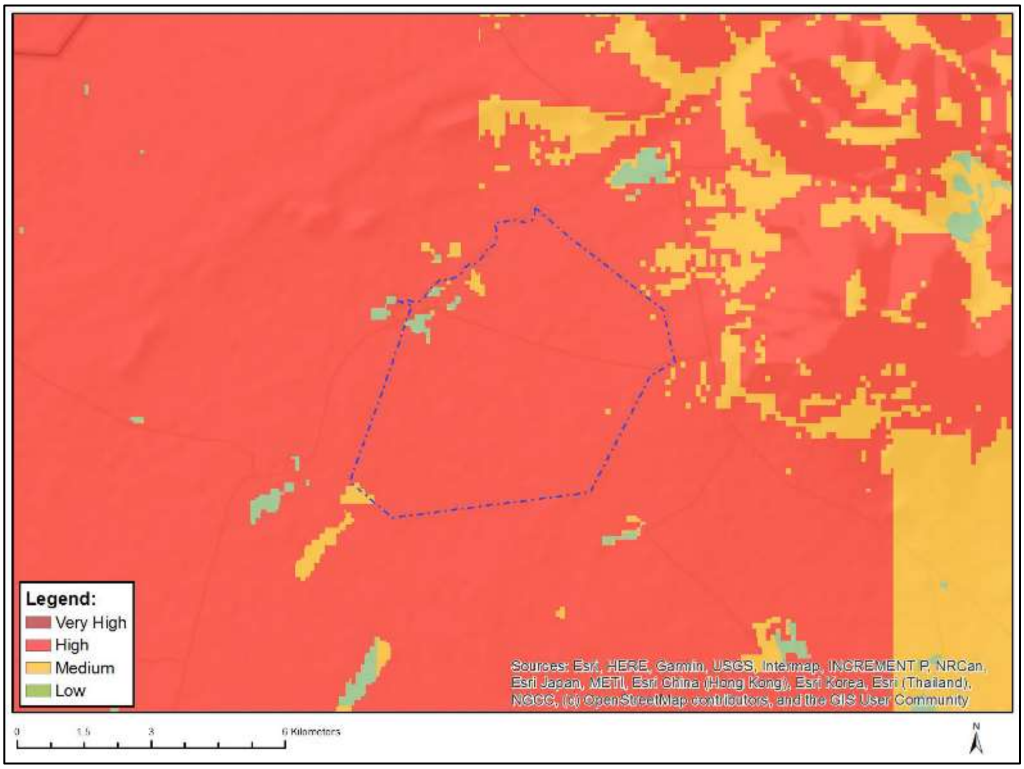

Figure 5: The classification of the FE Tango WEF Project Site according to the animal species theme in the DFFE National Screening Tool. The High and Medium sensitivity classification is linked to the potential occurrence of Ludwig's Bustard (Globally and Regionally Endangered), Southern Black Korhaan (Globally and Regionally Vulnerable) and Black Harrier (Globally and Regionally Endangered).

3.5 Other Potential Sensitivities – Black Harrier Presence in The Broader Area.

According to the Aberdeen Wind Facility 1 Avifaunal Impact Assessment study (Birds and Bats Unlimited, 2023) Black Harriers are breeding in the Camdeboo Mountains – a new nest site was located during the latter part of 2022. Their study included detailed mapping of the home ranges of two satellite tracked Black Harriers over several years. The tracking data revealed that the harriers make extensive use of the plains below the mountains for foraging. Tracking data for the period October 2022 – January 2023 indicated that the harrier roamed over a wide area extending to the plains on the west and south of the mountain. On average, Black Harriers cover an extensive area around their nests (7.1 – 33.4km) to forage during the breeding season (Garcia-Heras *et al.* 2019). The karoo habitat on the plains below the mountain is largely uniform. Due to the stochastic nature of rainfall and hence prey availability in the area, the foraging range of the harriers could at times extend over the FE Tango WEF Site. Although Black Harriers were not observed during the FE Tango pre-construction monitoring campaign, it is recommended that a precautionary approach be adopted, and mitigation measures be considered to minimise the potential risk of the proposed FE Tango WEF to Black Harriers. Also refer to Section 6.1.2.

4. AVIFAUNA IN THE STUDY AREA

The SABAP2 data indicates that 206 bird species have been recorded and could potentially occur within the Broader Area – **Appendix C** provides a comprehensive list of these species. Of these, 29 species are classified as priority species for wind energy developments (see definition of priority species in Section 1.3) and 15 of these are South African Red List species. Of the 29 priority species, 21 are likely to occur regularly in the Project Site (**Table 2**).

Table 2 below lists all the priority species that are likely to occur regularly on the Project Site and the possible impact on the respective species by the proposed WEF. The following abbreviations and acronyms are used:

Conservation Status: NT = Near Threatened, VU = Vulnerable, EN = Endangered
Probability of Occurrence: H = High, M = Medium, L = Low

Table 2: Priority species potentially occurring at the Project Site (Red List species are shaded yellow).

Species Name	Scientific Name	SABAP2 Reporting Rate %		Global Status	Regional Status	Recorded during monitoring	Likelihood of Regular Occurrence	Nama Karoo Shrubland	Drainage Line Woodland	Surface Water	Alien Trees	Agriculture	Wind - Collision with turbines	Wind - Displacement: habitat transformation	Wind - Displacement: disturbance	Powerline - Electrocution MV	Powerline - Collision
		Full Protocol	Ad hoc Protocol														
African Harrier-Hawk	*Polyboroides typus*	0,81	0,53	-	-		L			x	x		x		x	x	
African Rock Pipit	*Anthus crenatus*	0,81	0,00	NT	NT		L	x				x		x	x		
Amur Falcon	*Falco amurensis*	0,81	3,19	-	-		M			x	x		x			x	
Black Harrier	*Circus maurus*	4,88	1,60	EN	EN		M	x	x	x		x	x		x	x	
Black Stork	*Ciconia nigra*	2,44	0,00	-	VU		L			x		x	x		x	x	x
Black-winged Kite	*Elanus caeruleus*	0,81	0,00	-	-		L	x		x			x		x	x	
Blue Crane	*Grus paradisea*	37,40	24,47	VU	NT	x	H	x		x		x	x	x	x		x
Booted Eagle	*Hieraaetus pennatus*	10,57	4,26	-	-	x	M	x	x	x			x		x	x	
Brown Snake Eagle	*Circaetus cinereus*	0,00	0,00	-	-	x	M	x	x	x	x	x	x		x	x	
Burchell's Courser	*Cursorius rufus*	0,81	0,00	-	VU		L	x				x	x	x	x		
Common Buzzard	*Buteo buteo*	7,32	8,51	-	-	x	M	x	x	x			x			x	
Double-banded Courser	*Rhinoptilus africanus*	14,63	2,13	-	-	x	H	x				x	x	x	x		
Greater Flamingo	*Phoenicopterus roseus*	0,81	1,06	-	NT		L			x			x				x
Greater Kestrel	*Falco rupicoloides*	6,50	4,79	-	-	x	M	x	x	x		x	x		x	x	
Grey-winged Francolin	*Scleroptila afra*	4,07	0,53	-	-	x	M	x				x	x	x	x		

Species Name	Scientific Name	SABAP2 Reporting Rate %		Global Status	Regional Status	Recorded during monitoring	Likelihood of Regular	Nama Karoo Shrubland	Drainage Line Woodland	Surface Water	Alien Trees	Agriculture	Wind - Collision with turbines	Displacement: habitat	Wind - Displacement:	Powerline - Electrocution MV	Powerline - Collision
Jackal Buzzard	*Buteo rufofuscus*	9,76	1,06	-	-	x	M	x	x	x			x		x	x	
Karoo Korhaan	*Eupodotis vigorsii*	57,72	25,00	-	NT	x	H	x				x	x	x	x		x
Kori Bustard	*Ardeotis kori*	16,26	4,26	NT	NT	x	H	x				x	x	x	x		x
Lanner Falcon	*Falco biarmicus*	8,13	1,60	-	VU	x	M	x	x	x			x		x	x	
Lesser Kestrel	*Falco naumanni*	3,25	3,19	-	-	x	M	x		x		x	x			x	
Ludwig's Bustard	*Neotis ludwigii*	36,59	11,70	EN	EN	x	H	x				x	x	x	x		x
Martial Eagle	*Polemaetus bellicosus*	6,50	1,06	EN	EN	x	M	x	x	x			x		x	x	
Pale Chanting Goshawk	*Melierax canorus*	54,47	22,87	-	-	x	H	x		x	x		x		x	x	
Sclater's Lark	*Spizocorys sclateri*	0,81	0,53	NT	NT		L	x				x	x	x	x		
Secretarybird	*Sagittarius serpentarius*	8,13	5,85	EN	VU	x	M	x		x		x	x	x	x		x
Southern Black Korhaan	*Afrotis afra*	42,28	10,11	VU	VU	x	H	x				x	x	x	x		x
Spotted Eagle-Owl	*Bubo africanus*	8,94	0,53	-	-		M		x		x		x		x	x	x
Verreaux's Eagle	*Aquila verreauxii*	15,45	3,72	-	VU	x	H	x	x	x			x		x	x	x
White Stork	*Ciconia ciconia*	3,25	3,19	-	-		L			x			x				x

4.1 Results of Bird Monitoring

Table 3, Figures 6 and 7 below present the results of the pre-construction monitoring conducted at the Project Site and a Control Site. The monitoring surveys were conducted by two field monitors in the following time periods (Surveys 5 and 6 did not include Transect Counts):

- Survey 1: 21 – 26 January 2021
- Survey 2: 23 – 30 April 2021
- Survey 3: 20 August – 6 September, 10 September 2021
- Survey 4: 19 November – 01 December 2021
- Survey 5: 30 August – 04 September 2022
- Survey 6: 06 – 09 October 2022

4.1.1 Transects

The results of the transect counts in the Project Site are presented in **Table 3** below:

Table 3: The results of the transect counts – four surveys.

TURBINE SITE	
Species Composition	
All Species	114
Priority Species (11%)	12
Non-Priority Species	102
Total Count	
Drive transects	1943
Walk transects	1781
	3724
CONTROL SITE	
Species Composition	
All Species	67
Priority Species (12%)	8
Non-Priority Species	59
Total Count	
Drive transects	1251
Walk transects	412
	1663

An Index of Kilometric Abundance (IKA = birds/km) was calculated for each priority species recorded during transects counts across all four seasons (**Figures 6 and 7**).

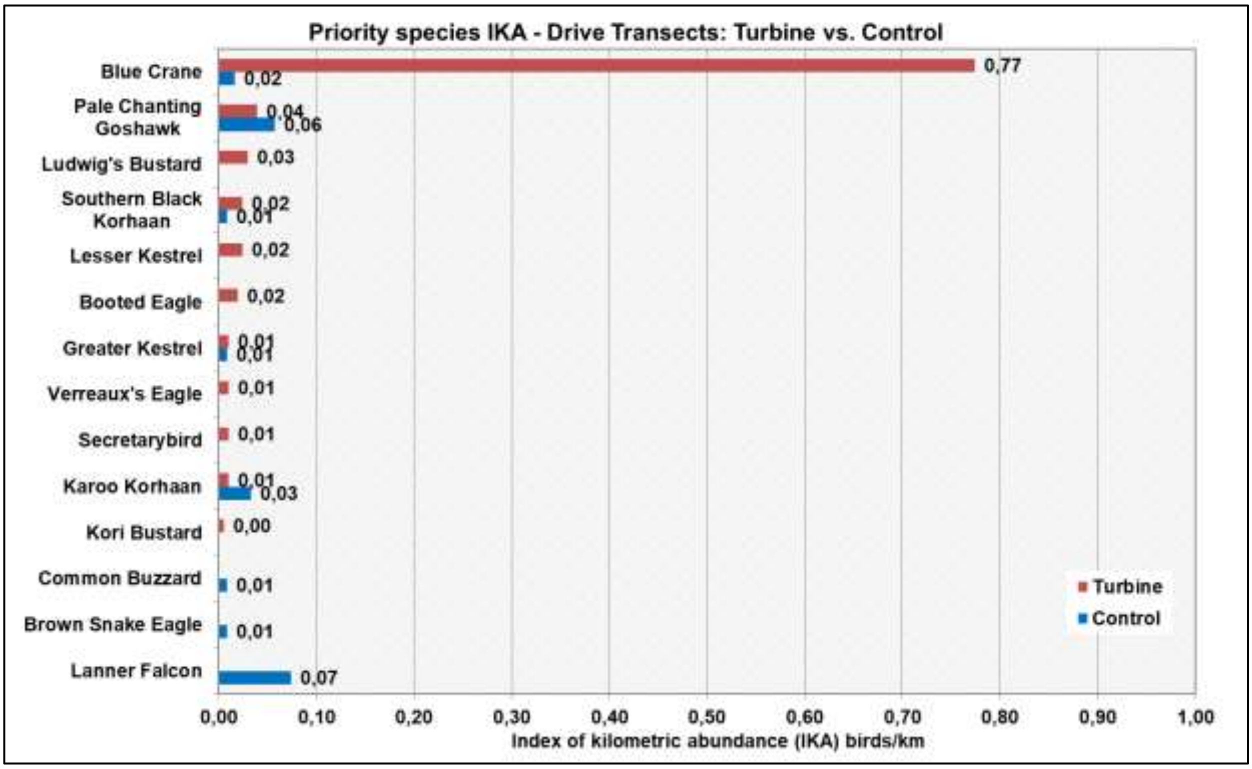

Figure 6: Index of kilometric abundance of priority species recorded at the WEF and control site during drive transect surveys after four surveys.

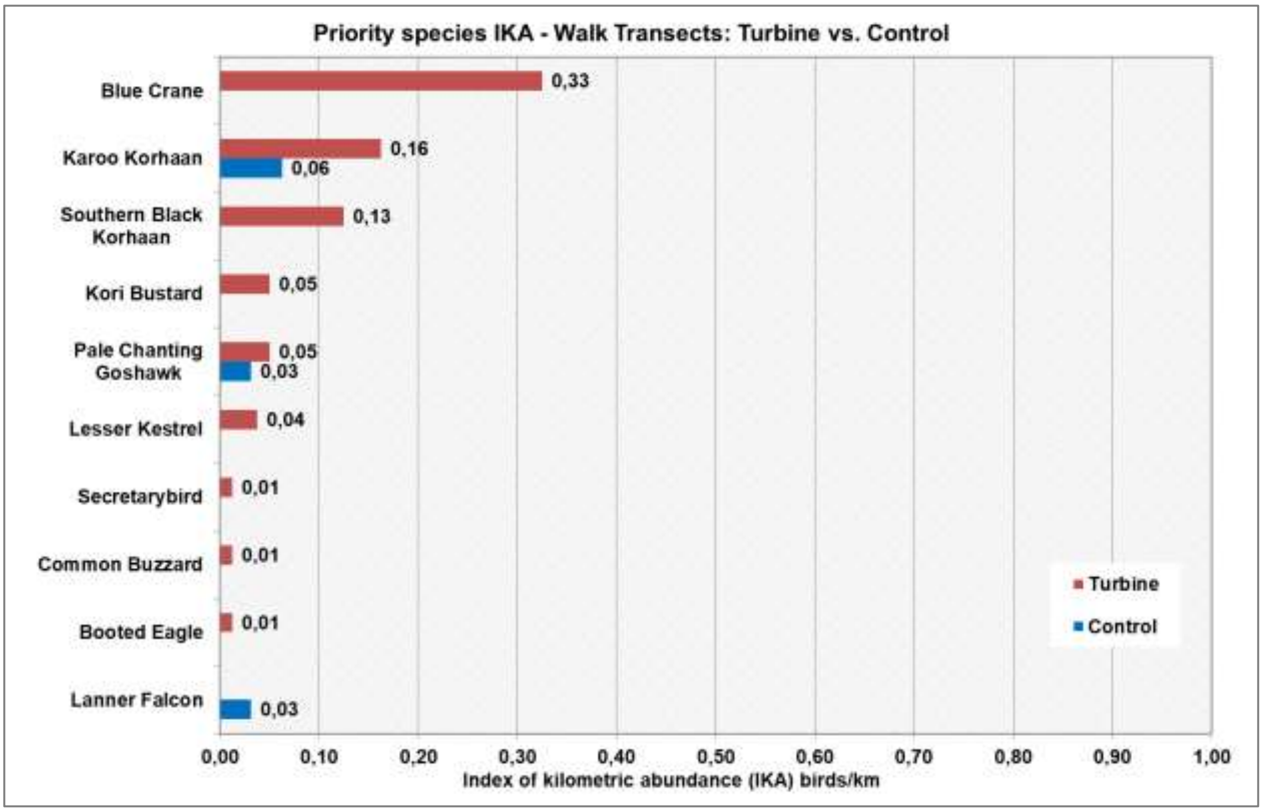

Figure 7: Index of kilometric abundance of priority species recorded at the WEF during walk transect surveys after four surveys.

Figure 8 below shows the spatial distribution of the priority species recorded during transect counts and incidental sightings across all six surveys.

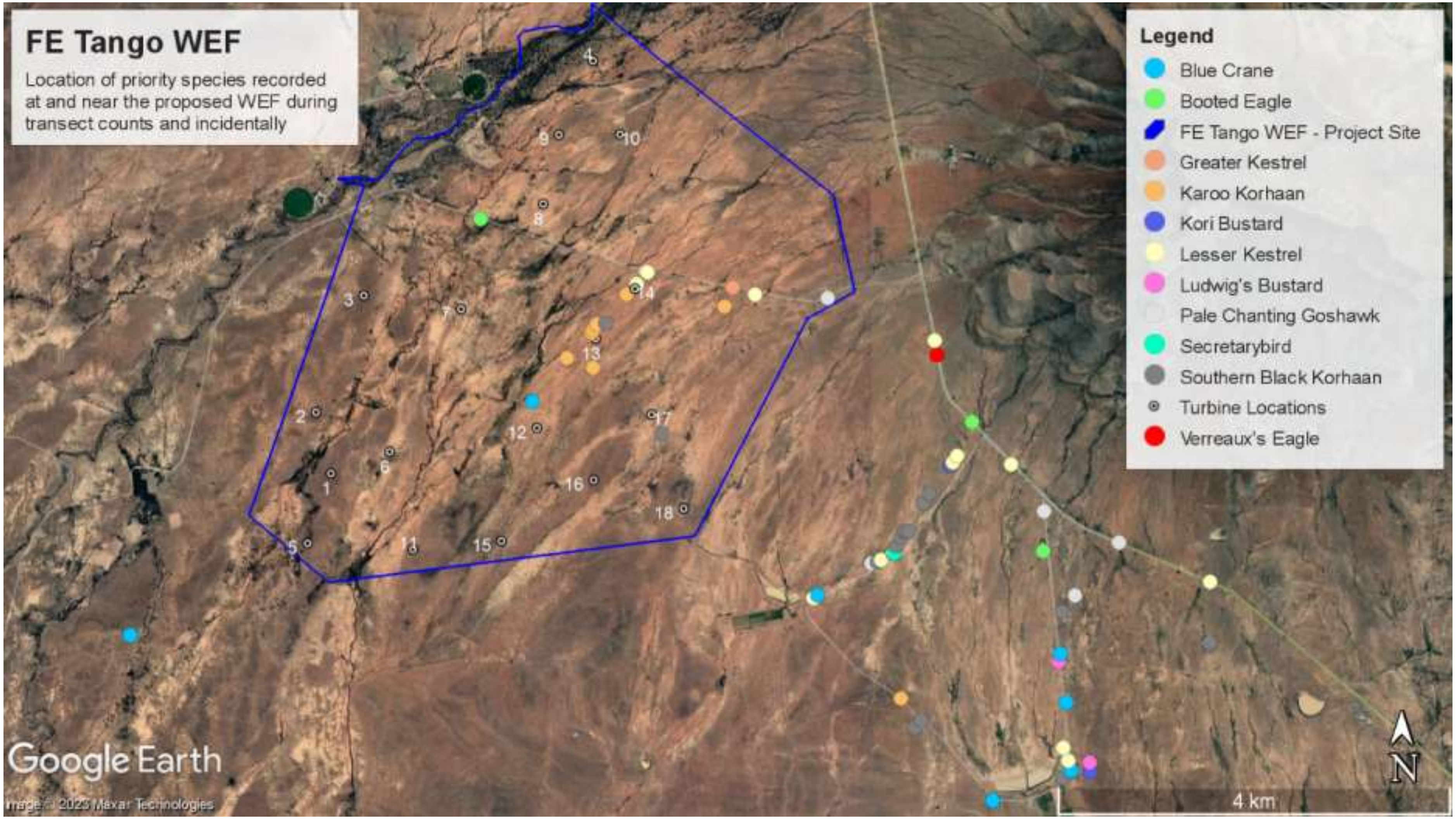

Figure 8: The location of priority species recorded at and near the proposed WEF during transect counts and incidental observations.

4.1.2 Focal Points

A total of eight (8) potential focal points (FPs) of bird activity were identified and monitored during the surveys. The results of the focal point monitoring were as follows:

SURVEY 1				
FP	**Description**	**Survey**	**Territory active?**	**Notes**
FP1	Verreaux's' Eagle nest	1	Yes	Two adult Verreaux's Eagles were observed in the area around the nest.
FP2	Black Harrier breeding site	1	No	Historical breeding site. No birds were observed during this survey. Birds were present in November 2020.
FP3	Verreaux's' Eagle nest	1	No	Historical breeding site. No birds were observed during this survey.
FP4	Potential Verreaux's' Eagle nest	1	No	No nest was recorded during this survey. Will be inspected again with a drone to make sure.
FP5	Earth dam	1	n/a	Dam was about 40% full. No priority species were recorded.
FP6	Earth dam	1	n/a	Dam was about 50% full. No priority species were recorded.
FP7	Earth dam	1	n/a	Dam was about 20% full. No priority species were recorded.
FP8	Earth dam	1	n/a	Dam was about 50% full. No priority species were recorded.
SURVEY 2				
FP	**Description**	**Survey**	**Territory active?**	**Notes**
FP1	Verreaux's' Eagle nest	2	Yes	Two adult Verreaux's Eagles were observed in the area.
FP2	Black Harrier breeding site	2	No	Historical breeding site. No birds were observed during this survey.
FP3	Verreaux's' Eagle nest	2	No	Historical breeding site. No birds were observed during this survey. Drone inspection will be done during the next survey. Nest still there but looks inactive at this stage.
FP4	Potential Verreaux's Eagle nest	2	No	No nest was recorded
FP5	Earth dam	2	n/a	Dam was about 25% full. No priority species were recorded.
FP6	Earth dam	2	n/a	Dam was about 20% full. Sixty-six (66) Blue Cranes were observed in the area.
FP7	Earth dam	2	n/a	Dam was about 10% full. No priority species were recorded.
FP8	Earth dam	2	n/a	Dam was about 30% full. No priority species were recorded.
FP9	Verreaux's' Eagle nest on cliff	2	Yes	New nest that was recorded during this survey. Two adult Verreaux's Eagles were recorded in the area.
SURVEY 3				
FP	**Description**	**Survey**	**Territory active?**	**Notes**
FP1	Verreaux's' Eagle nest	3	Yes	Two adult Verreaux's Eagles were recorded in the area around the nest. A chick was recorded on the nest.
FP2	Black Harrier breeding site	3	?	No birds seen during this survey. Landowner said he has occasionally observed a Black Harrier in the area, but he did not report any signs of breeding.
FP3	Verreaux's' Eagle nest	3	No	The nest looks worn, no birds were recorded in the area. Seems to be currently inactive.
FP4	Potential Verreaux's' Eagle nest	3	No	No nest was recorded

FP5	Earth dam	3	No	Dam was dry during this survey. No birds were recorded.
FP6	Earth dam	3	No	Dam was dry during this survey. No birds were recorded.
FP7	Earth dam	3	No	Dam was dry during this survey. No birds were recorded.
FP8	Earth dam	3	No	Dam was dry during this survey. No birds were recorded.
FP9	Verreaux's Eagle nest on cliff	3	Yes	Two adult Verreaux's Eagles were recorded in the area.
SURVEY 4				
FP	**Description**	**Survey**	**Territory active?**	**Notes**
FP1	Verreaux's Eagle nest	4	Yes	Nest remains in place. Uncertain whether the birds bred successfully this year. Adult birds observed hunting in the mountain above the nest.
FP2	Black Harrier breeding site	4	No	No birds seen during this survey.
FP3	Verreaux's Eagle nest	4	No	Historical nest. No signs of recent activity.
FP4	Potential Verreaux's Eagle nest	4	No	No nest was recorded
FP5	Earth dam	4	No	No birds seen during this survey. Dam was dry.
FP6	Earth dam	4	No	No birds seen during this survey. Dam was dry.
FP7	Earth dam	4	No	No birds seen during this survey. Dam was dry.
FP8	Earth dam	4	No	No birds seen during this survey. Dam was dry.
FP9	Verreaux's Eagle nest on cliff	4	Yes	Nest was not visited during this survey but two adult Verreaux's eagles were observed flying in the vicinity.
SURVEY 5				
FP	**Description**	**Survey**	**Territory active?**	**Notes**
FP1	Verreaux's Eagle nest	5	Yes	Adult birds observed hunting in the area.
FP2	Black Harrier breeding site	5	No	No birds recorded during this survey.
FP3	Verreaux's Eagle nest	5	No	No activity recorded during this survey.
FP4	Potential Verreaux's Eagle nest	5	No	No nest was recorded
FP5	Earth dam	5	No	No birds seen during this survey. Dam was dry.
FP6	Earth dam	5	No	No birds seen during this survey. Dam was dry.
FP7	Earth dam	5	No	No birds seen during this survey. Dam was dry.
FP8	Earth dam	5	No	No priority species recorded.
FP9	Verreaux's' Eagle nest on cliff	5	Yes	Both adults seen hunting in area. Saw also what looked like last year's chick at the site
SURVEY 6				
FP	**Description**	**Survey**	**Territory active?**	**Notes**
FP1	Verreaux's Eagle nest	5	Yes	Adult birds observed hunting in the area.
FP2	Black Harrier breeding site	5	No	No birds recorded during this survey.
FP3	Verreaux's Eagle nest	5	No	Historical nest, no activity recorded during this survey.
FP4	Potential Verreaux's Eagle nest	5	No	No nest was recorded
FP5	Earth dam	5	No	No birds seen during this survey. Dam was dry.
FP6	Earth dam	5	No	No birds seen during this survey. Dam was dry.
FP7	Earth dam	5	No	No birds seen during this survey. Dam was dry.
FP8	Earth dam	5	No	No priority species recorded.
FP9	Verreaux's Eagle nest on cliff	5	Yes	Both adults were seen around nest area

4.1.3 Incidental Counts

Table 4 provides an overview of the incidental sightings of priority species recorded during the six surveys.

Table 5: Incidental sightings of Priority Species (Surveys 1 – 6).

Species Name	Scientific Name	V1	V2	V3	V4	V5	V6	Grand Total
Southern Black Korhaan	*Afrotis afra*	5	2	4	1	1	5	**18**

Species Name	Scientific Name	V1	V2	V3	V4	V5	V6	Grand Total
Pale Chanting Goshawk	*Melierax canorus*	3	1	1	1	1	6	**13**
Blue Crane	*Grus paradisea*	0	3	1	1	1	6	**12**
Karoo Korhaan	*Eupodotis vigorsii*	0	1	3	0	3	2	**9**
Lesser Kestrel	*Falco naumanni*	6	0	0	0	0	0	**6**
Ludwig's Bustard	*Neotis ludwigii*	0	1	3	0	0	0	**4**
Kori Bustard	*Ardeotis kori*	1	0	1	0	0	0	**2**
Booted Eagle	*Hieraaetus pennatus*	0	0	0	0	0	2	**2**
Secretarybird	*Sagittarius serpentarius*	1	0	0	0	0	0	**1**
Grey-winged Francolin	*Scleroptila afra*	0	0	0	0	0	1	**1**

See **Appendix C** for a list of all species recorded during the pre-construction monitoring at the project site.

4.1.4 Vantage Point Observations

Flight patterns of priority species were recorded for 144 hours (12 hours per VP) at 2 vantage points at the FE Tango WEF Site in three bands (high - above rotor altitude; medium - at rotor altitude; low - below rotor altitude). Approximate flight altitude was visually judged by an observer with the aid of binoculars. The total combined flight observation time for priority species after six surveys was 1 hour, 05 minutes, and 45 seconds. See **Figure 9** below for the duration and altitude of flights for each priority species[2].

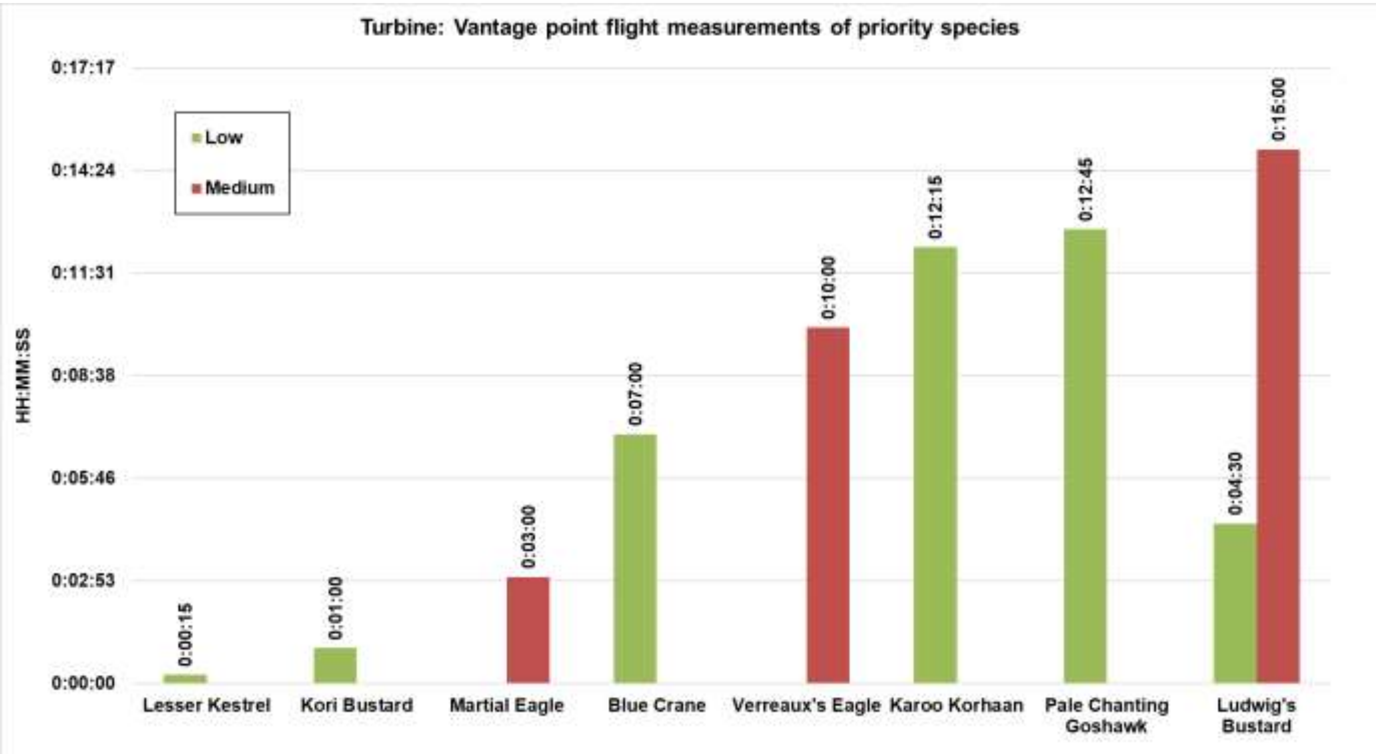

Figure 9: Flight durations and altitudes recorded for priority species at the Project Site after six surveys (144 hours of observation).

[2] Flight duration was calculated by multiplying the flight time with the number of individuals in the flight e.g., if the flight time was 30 seconds and it contained two individuals, the flight duration was 30 seconds x 2 = 60 seconds.

4.1.5 *Site Specific Collision Risk Rating*

To determine which priority species are most at risk of turbine collisions, a site-specific rating was calculated. Values for each priority species was calculated considering the following factors:

- The duration of rotor altitude flights;
- Collision rating: The susceptibility to collisions, based on morphology (size) and behaviour (soaring, predatory, ranging behaviour, flocking behaviour, night flying, aerial display and habitat preference) using the ratings for priority species in the Avian Wind Farm Sensitivity Map of South Africa (Retief *et al*., 2012); and
- The number of turbines.

The formula used is as follows[3]:

Duration of rotor altitude flights (as a fraction of 24 hours)) x collision rating (Avian Wind Farm Sensitivity Map) x number of turbines ÷100.

The results are presented in **Table** 6**6 and Figure** 10**10** below. These risk values are site specific and do not represent a percentage of risk per species. It represents the collision risk of a certain species in relation to other species that occur at the same site.

Table 6: Site specific collision risk rating

Species	Duration of rotor altitude flights	Collision Rating	Number of turbines	Risk value
Lesser Kestrel	0	77	18	0,00
Kori Bustard	0	75	18	0,00
Blue Crane	0	85	18	0,00
Karoo Korhaan	0	65	18	0,00
Pale Chanting Goshawk	0	70	18	0,00
Martial Eagle	0,002083	100	18	0,04
Verreaux's Eagle	0,006944	115	18	0,14
Ludwig's Bustard	0,010417	85	18	0,16

[3] It is important to note that the formula does not incorporate avoidance behaviour. This may differ between species and may have a significant impact on the size of the risk associated with a specific species. It is generally assumed that 95-98% of bird flights will successfully avoid the turbines (SNH, 2010).

Figure 10: Site specific collision risk rating for priority species. It represents a visual estimation of the risk of a certain species in relation to other species that occur at the same site. The red line indicates the average collision risk rating for priority species at the Project Site, based on the recorded flight behaviour after six surveys.

4.1.6 Flight Lines of Priority Species

Flight lines of priority species were recorded at the WEF site during Vantage Point watches for each of the six surveys. The recorded flight lines for priority species after four surveys is shown in **Figure 11.**

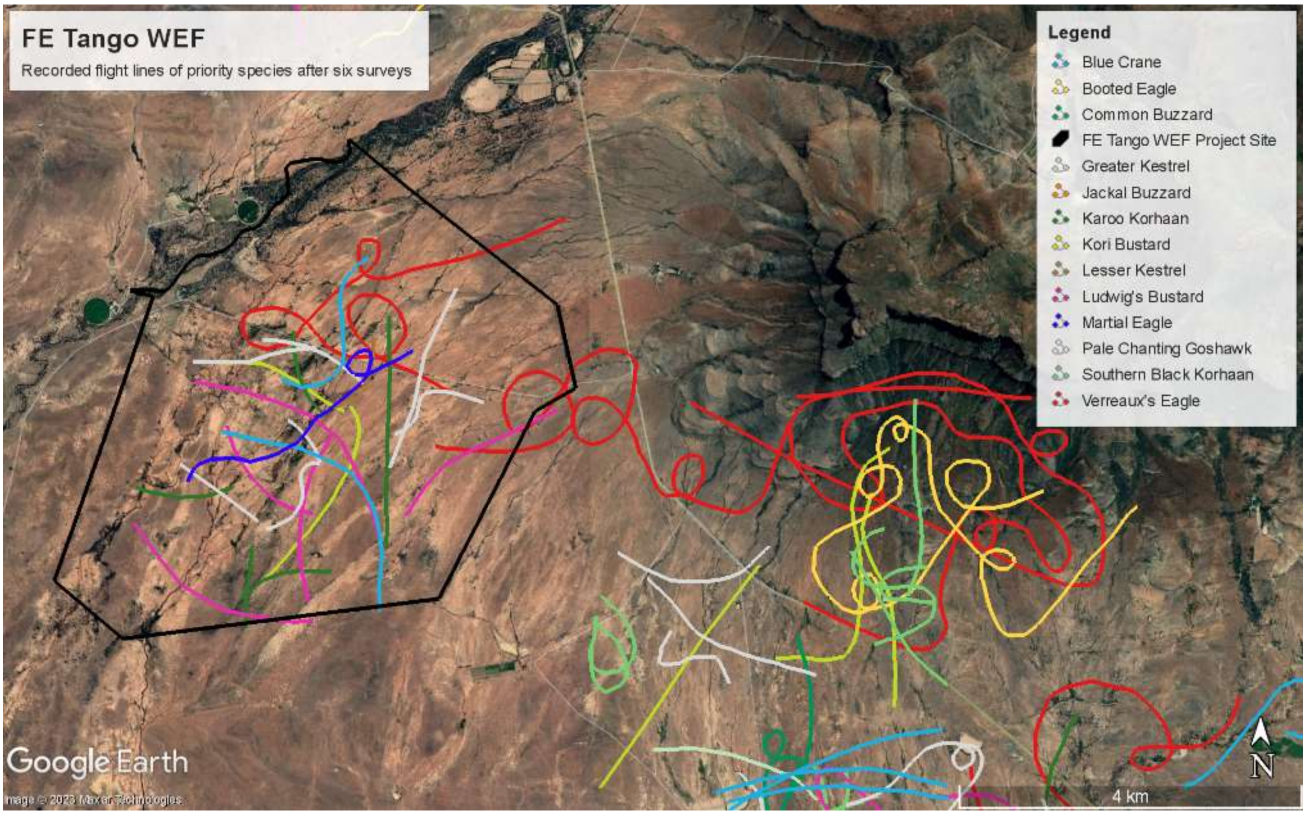

Figure 11: Recorded flight lines of Priority Species after six surveys.

5 DESCRIPTIONS OF EXPECTED IMPACTS

5.1 Wind Energy Facility

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

- Mortality due to collisions with the wind turbines
- Displacement due to disturbance during construction and operation of the wind farm
- Displacement due to habitat change and loss at the wind farm
- Mortality due to electrocution on the electrical infrastructure
- Collisions with the 33kV overhead lines

It is important to note that the assessment is made on the *status quo* as it is currently on site. The possible change in land use in the broader Project Site is not taken into account because the extent and nature of future developments (not only wind energy development) are unknown at this stage. It is however highly unlikely that the land use will change in the foreseeable future due to climatic limitations.

5.1.1 Collision Mortality on Wind Turbines[4]

Wind energy generation developed rapidly worldwide over recent decades as its environmental impacts, with reduced environmental pollution and water consumption, are considered to be relatively lower than those caused by traditional energy sources (Saidur *et al.*, 2011). However, bird fatalities due to collisions with wind turbines are the main and consistent ecological drawback to wind energy (Drewitt and Langston, 2006).

Collisions with wind turbines appear to kill fewer birds than collisions with other man-made infrastructures, such as power lines, buildings or even traffic (Calvert *et al.* 2013; Erickson *et al.* 2005). Nevertheless, estimates of bird deaths from collisions with wind turbines worldwide range from 0 to almost 40 deaths per turbine per year (Sovacool, 2009). The number of birds killed varies greatly between sites, with some sites posing a higher collision risk than others, and some species are more vulnerable than others (e.g. Hull *et al.* 2013; May *et al.* 2012a). These numbers may not reflect the true magnitude of the problem, as some studies do not account for detectability biases such as those caused by scavenging, searching efficiency and search radius (Bernardino *et al.* 2013; Erickson *et al.* 2005; Huso and Dalthorp 2014). In addition, even for low fatality rates, collisions with wind turbines may have a disproportionately skewed effect for some species. For long-lived species with low productivity and slow maturation rates (e.g. raptors), even low mortality rates can have a significant impact at the population level (e.g. Carrete *et al.* 2009; De Lucas *et al.* 2012a; Drewitt and Langston, 2006). The situation is even more critical for species of conservation concern, which sometimes are most at risk (Osborn *et al.* 1998).

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

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

Species-specific Factors

- **Morphological Features**

Certain morphological traits of birds, especially those related to size, are known to influence collision risk with structures such as power lines and wind turbines. Janss (2000) identified weight, wing length, tail length and total bird length as being collision risk determinant. Wing loading (ratio of body weight to wing area) and aspect ratio (ratio of wingspan squared to wing area) are particularly relevant, as they influence flight type and therefore collision risk (Bevanger, 1994; De Lucas *et al.* 2008; Herrera-Alsina *et al.* 2013; Janss, 2000). Birds with high wing loading, such as the Griffon Vulture (*Gyps fulvus*), seem to collide more frequently with wind turbines at the same sites than birds with lower wing loadings such as Common Buzzards (*Buteo buteo*) and Short-toed Eagles (*Circaetus gallicus*), and this pattern is unrelated to their local abundance (Barrios and Rodríguez, 2004; De Lucas *et al.* 2008). High wing-loading is associated with low flight manoeuvrability (De Lucas *et al.* 2008), which determines whether a bird can escape an encountered object fast enough to avoid collision.

Information on the wing loading of the priority species potentially occurring regularly at the FE Tango WEF was not available at the time of writing. However, based on general observations, and research on related species, it can be confidently assumed that priority species that could potentially be vulnerable to wind turbine collisions due to morphological features (high wing loading) are bustards and vultures, because they are less manoeuvrable (Keskin et al. 2019).

- **Visual Perception**

Birds are assumed to have excellent visual acuity, but this assumption is contradicted by the large numbers of birds killed by collisions with man-made structures (Drewitt and Langston, 2008; Erickson *et al.* 2005). A common explanation is that birds collide more often with these structures in conditions of low visibility, but recent studies have shown that this is not always the case (Krijgsveld *et al.* 2009). The visual acuity of birds seems to be slightly superior to that of other vertebrates (Martin, 2011; McIsaac, 2001). Unlike humans, who have a broad horizontal binocular field of 120°, some birds have two high acuity areas that overlap in a very narrow horizontal binocular field (Martin, 2011). Relatively small frontal binocular fields have been described for several species that are particularly vulnerable to power line collisions, such as vultures (Gyps sp.) cranes and bustards (Martin and Katzir, 1999; Martin et.al, 2010; Martin, 2012, 2011; O'Rourke *et al.* 2010). Furthermore, for some species, their high-resolution vision areas are often found in the lateral fields of view, rather than frontally (e.g. Martin et.al, 2010; Martin, 2012, 2011; O'Rourke *et al.* 2010). Finally, some birds tend to look downwards when in flight, searching for conspecifics or food, which renders the direction of flight completely inside the blind zone of some species (Martin et.al, 2010; Martin, 2011).

Some of the regularly occurring priority species at the proposed FE Tango WEF have high resolution vision areas found in the lateral fields of view, rather than frontally, e.g., bustards and cranes. The exceptions to this are the priority raptors which all have wider binocular fields, although as pointed out by Martin (2011, 2012), this does not necessarily result in a better ability to avoid obstacles in these species.

- **Phenology**

Recent studies have shown that, within a wind farm, raptor collision risk and fatalities of the same species are higher for resident as compared to migrating birds. An explanation for this may be that resident birds generally use the wind farm area frequently; while a migrant bird crosses it just once (Krijgsveld *et al.* 2009). However, other factors like bird behaviour are certainly relevant. Katzner *et al.* (2012) showed that Golden Eagles performing local movements fly at lower altitudes, putting them at a greater risk of collision than migratory eagles. Resident eagles flew over cliffs and steep slopes more frequently, using low altitude slope updrafts, while migratory eagles flew over flat areas and gentle slopes more often where thermals are generated, enabling the birds to use them to gain lift and fly at higher altitudes.

South Africa is at the end of the migration path for summer migrants; therefore, migratory flyways where birds are concentrated in large numbers for a limited period of time, e.g. the African Rift Valley or Mediterranean Red Sea flyways, is not a feature of the landscape. The migratory priority species which could occur at the proposed FE Tango WEF with some regularity, e.g., Booted Eagle, Lesser Kestrel and Common Buzzard will behave much the same as the resident birds once they arrive in the area. The same is valid for local migrants such as the Ludwig's Bustard, Kori Bustard, and Blue Crane. It is expected that, for the period when they are present, these species will be exposed to the same risks as resident species.

- **Bird Behaviour**

Flight type seems to play an important role in collision risk, especially when associated with certain behaviours such as hunting and foraging strategies. Kiting flight (hanging in the wind with almost motionless wings), which is used in strong winds and occurs in rotor swept zones, has been highlighted as a factor explaining the high collision rate of Red-tailed Hawks *Buteo jamaicensis* at APWRA (Hoover and Morrison, 2005), and could also contribute to the high collision rate for Jackal Buzzards in South Africa (Ralston-Paton & Camagu 2019). The hovering behaviour exhibited by Common Kestrels *Falco tinnunculus* when hunting may also explain the fatality levels of this species at wind farms in the Strait of Gibraltar (Barrios and Rodríguez, 2004). Similar behaviour is exhibited by Rock Kestrels *Falco rupicolus* and could account for the high mortality rate of this species at wind farms in South Africa (Ralston-Paton & Camagu 2019). Kiting and hovering are associated with strong winds, that often produce unpredictable gusts that may suddenly change a bird's position (Hoover and Morrison, 2005). In addition, while birds are hunting and focus on prey, they could lose track of wind turbine positions (Krijgsveld *et al.* 2009; Smallwood *et al.* 2009). In the case of raptors, aggressive interactions may play an important role in turbine fatalities, in that birds involved in these interactions are distracted, putting them at risk. At least one eye-witness account of a Martial Eagle getting killed by a turbine in South Africa in this fashion is on record (Simmons & Martins 2016)

Social behaviour may also result in a greater collision risk with wind turbines due to a decreased awareness of the surroundings. Several authors have reported that flocking behaviour increases collision risk with power lines as opposed to solitary flights (e.g. Janss, 2000). However, caution must be exercised when comparing the particularities of wind farms with power lines, as some species appear to be vulnerable to collisions with power lines but not with wind turbines, for example bustards are highly vulnerable to power line collisions, but are less prone to wind turbine collisions – a Spanish database of over 7000 recorded turbine collisions contains no Great Bustards *Otis tarda* (A. Camiña 2012a). Similarly, in South Africa, only two bustard collisions with wind turbines have been reported to date, both Ludwig's

Bustards (Ralston-Paton & Camagu 2019). No Denham's Bustards *Neotis denhami* turbine fatalities have been reported to date, despite the species occurring at several wind farm sites.

The priority species that could occur with some regularity at the proposed FE Tango WEF can be classified as either terrestrial species, soaring species, or occasional long-distance fliers. Terrestrial species spend most of their time foraging on the ground. They do not fly often and when they do, they generally fly for short distances at low to medium altitude. At the Project Site, Ludwig's Bustard, Kori Bustard, Southern Black Korhaan, and Karoo Korhaan are included in this category. Occasional long-distance fliers generally behave as terrestrial species but can and do undertake long distance flights sporadically. Species in this category are Ludwig's Bustard, Blue Crane, and Kori Bustard. Soaring species spend a significant time on the wing in a variety of flight modes including soaring, kiting, hovering and gliding at medium to high altitudes. At the project site, these include all the raptors, vultures and storks that could occur there i.e., Lanner Falcon, Booted Eagle, Martial Eagle, Greater Kestrel, Pale Chanting Goshawk, Jackal Buzzard, Verreaux's Eagle, Black Stork, Blue Crane (which soars on occasion) and Black Harrier. Based on the time spent flying at rotor height, soaring species are likely to be at greater risk of collision.

- **Avoidance Behaviours**

Two types of avoidance behaviours have been described (Furness *et al.*, 2013): 'macro-avoidance' whereby birds alter their flight path to keep clear of the entire wind farm (e.g. Desholm and Kahlert, 2005; Plonczkier and Simms, 2012; Villegas-Patraca *et al.* 2014), and 'micro-avoidance' whereby birds enter the wind farm but take evasive actions to avoid individual wind turbines (Band *et al.* 2007). This may differ between species and may have a significant impact on the size of the risk associated with a specific species. It is generally assumed that 95-98% of birds will successfully avoid the turbines (SNH 2010).

It is anticipated that most birds at the proposed FE Tango WEF will avoid the wind turbines, as is generally the case at all wind farms (SNH 2010). Exceptions already mentioned are raptors that engage in hunting which might serve to distract them and place them at risk of collision, birds engaged in display behaviour or inter- and intraspecific aggressive interactions. Complete macro-avoidance of the WEF is unlikely for any of the priority species likely to occur at the proposed FE Tango WEF.

- **Bird Abundance**

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

The abundance of priority species at the proposed FE Tango WEF will fluctuate depending on the season of the year, and especially in response to rainfall e.g., Ludwig's Bustard, Kori Bustard, Lesser Kestrel, Greater Kestrel, and Blue Crane.

Site-specific Factors

- **Landscape Features**

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

The Project Site does not contain many significant landscape features as it is situated on a vast, slightly undulating plain, but there are ridges which provide potential for slope soaring for raptors. The most significant landscape features from a collision risk perspective are the borehole dams, drinking troughs and the drainage lines (when flowing). Surface water attracts many birds, including Red List species such as Martial Eagle, Secretarybird, Blue Crane, Black Stork, and Lanner Falcon.

- **Flight Paths**

For territorial raptors like Golden Eagles (and Verreaux's Eagles – see Ralston-Patton 2017), foraging areas are preferably located near the nest, when compared to the rest of their home range. For example, in Scotland 98% of Golden Eagle movements were recorded at ranges less than 6 km from the nest, and the core areas were located within a 2– 3 km radius from nests (McGrady *et al.* 2002). These results, combined with the terrain features selected by Golden Eagles to forage such as areas close to ridges, can be used to predict the areas used by the species to forage (McLeod *et al.* 2002), and therefore provide a sensitivity map and guidance to the development of new wind farms (Bright *et al.* 2006).

The boreholes and water troughs are likely to act as focal points for flight activity as birds fly towards and away from these surface waterpoints to forage, drink, or bathe. Raptors will also scan these areas for potential prey. Other distinctive potential flight paths identified at the Site are the drainage lines, which may serve as a flight path for waterbirds when they flow. However, they are dry most of the time.

- **Food Availability**

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

Food availability can fluctuate greatly depending on rainfall. Above average rainfall could result in better foraging conditions and therefore higher bird activity in the area.

- **Summary**

The proposed FE Tango WEF will pose a collision risk to several priority species that could occur regularly at the site. Species exposed to this risk are large terrestrial species i.e., mostly bustards such as Karoo Korhaan, Southern Black Korhaan, Ludwig's Bustard, Kori Bustard, and Blue Crane, although bustards and cranes generally seem to be not as vulnerable to turbine collisions as was originally anticipated (Ralston-Paton & Camagu 2019). Soaring priority species, i.e., species such as Martial Eagle, Pale Chanting Goshawk, Lanner Falcon, Booted Eagle, Verreaux's Eagle, Greater Kestrel and Lesser Kestrel are most at risk of all the priority species likely to occur at the project site. In summary, the following priority species could be at risk of collisions with the turbines: African Harrier-Hawk, Amur Falcon, Black Harrier, Black Stork, Black-winged Kite, Blue Crane, Booted Eagle, Brown Snake Eagle, Burchell's Courser, Common Buzzard, Double-banded Courser, Greater Kestrel, Grey-winged Francolin, Jackal Buzzard, Karoo Korhaan, Kori Bustard, Lanner Falcon, Lesser Kestrel, Ludwig's Bustard, Martial Eagle, Pale Chanting Goshawk, Sclater's Lark, Secretarybird, Southern Black Korhaan, Spotted Eagle-Owl, Verreaux's Eagle, and White Stork.

5.1.2 Displacement due to Disturbance

The displacement of birds from within the immediate surroundings of a wind farms is due to the effect of visual interference and disturbance. This can be interpreted as a loss of available habitat for the species displaced in this way. Displacement may occur during both the construction and operation phases of wind farms and may be caused by the presence of the turbines themselves through visual, noise and vibration impacts, or as a result of vehicle and personnel movements related to site maintenance. The scale and degree of disturbance will vary according to site- and species-specific factors and must be assessed on a site-by-site basis (Drewitt & Langston 2006).

Unfortunately, few studies of displacement due to disturbance are conclusive, often because of the lack of before- and-after and control-impact (BACI) assessments. Indications are that Great Bustard *Otis tarda* could be displaced up to one kilometre from wind facilities (Langgemach 2008). An Austrian study found displacement for Great Bustards of up to 600m (Wurm & Kollar as quoted by Raab *et al.* 2009). However, there is also evidence to the contrary; Great Bustards in Spain appear to continue the use of leks at operational wind farms (Camiña 2012b). The same situation seems to prevail at wind farms in the Eastern Cape where Denham's Bustard is still using wind farm sites as leks.[5] Research on small grassland species in North America indicates that permanent displacement is uncommon and very species specific (Stevens et.al 2013, Hale et.al 2014). There also seems to be little evidence for a persistent decline in passerine populations at wind farm sites in the UK (despite some evidence of turbine avoidance), with some species, including Skylark *Alauda arvensis*, showing increased populations after wind farm construction (see Pierce-Higgins et. al 2012). Populations of Thekla Lark *Galerida theklae* were found to be unaffected by wind farm developments in Southern Spain (see Farfan *et al*. 2009).

The impact on the population size largely depends on whether displacement affects the breeding productivity and survival of a species. However, studies of the impact of wind farms on breeding birds are also largely inconclusive or suggest lower disturbance distances, though this apparent lack of effect may be due to the high site fidelity and long lifespan of the breeding species studied. This might mean that the true impacts of disturbance on breeding birds will only be evident on a longer term, when new recruits replace existing breeding birds. Few studies have considered the possibility of displacement for short-lived passerines (such as larks), although Leddy *et al.* (1999) found the densities of breeding grassland passerines increased with distance from wind turbines, and higher bird densities in the reference (control) area compared to within 80m of the turbines. A review of minimum avoidance distances of 11 breeding passerines were found to be

[5] Personal communication by Wessel Rossouw, bird monitor based in Jeffreys Bay, from personal observations in the Kouga municipal area.

generally <100m from a wind turbine ranging from 14 – 93m (Hötker *et al.* 2006). A comparative study of nine wind farms in Scotland (Pearce-Higgens *et al.* 2009) found unequivocal evidence of displacement: Seven of the 12 species studied exhibited significantly lower frequencies of occurrence close to the turbines, after accounting for habitat variation, with equivocal evidence of turbine avoidance in a further two. No species were more likely to occur close to the turbines. Levels of turbine avoidance suggest breeding bird densities may be reduced within a 500m buffer of the turbines by 15– 53%, with Common Buzzard *Buteo buteo*, Hen Harrier *Circus cyaneus*, Golden Plover *Pluvialis apricaria*, Snipe *Gallinago gallinago*, Curlew *Numenius arquata* and Wheatear *Oenanthe oenanthe* most affected. In a follow-up study, monitoring data from wind farms located on unenclosed upland habitats in the United Kingdom were collated to test whether breeding densities of upland birds were reduced as a result of wind farm construction or during wind farm operation. Red Grouse *Lagopus lagopus scoticus*, Snipe *Gallinago gallinago* and Curlew *Numenius arquata* breeding densities all declined on wind farms during construction. Red Grouse breeding densities recovered after construction, but Snipe and Curlew densities did not. Post-construction Curlew breeding densities on wind farms were also significantly lower than reference sites. Conversely, breeding densities of Skylark *Alauda arvensis* and Stonechat *Saxicola torquata* increased on wind farms during construction. Overall, there was little evidence for consistent post-construction population declines in any species, suggesting that wind farm construction can have greater impacts on birds than wind farm operation (Pierce-Higgens *et al.* 2012).

It is inevitable that a measure of displacement will take place for all priority species during the construction phase due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species the most, as this could temporarily disrupt their reproductive cycle. Species that fall in this category are Ludwig's Bustard, Blue Crane, Karoo Korhaan, Southern Black Korhaan and Spotted Eagle-Owl. Some raptors might also be affected, e.g, Greater Kestrel which often breeds on crow nests which have been constructed on wind pumps. Some species might be able to recolonise the area after the completion of the construction phase, but other species may onlypartially return to their habitat resulting in lower densities than before once the wind farm is operational, due to the disturbance factor of the operational turbines. In summary, the following species could be impacted by disturbance during the construction phase: African Harrier-Hawk, African Rock Pipit, Black Harrier, Black Stork, Black-winged Kite, Blue Crane, Booted Eagle, Brown Snake Eagle, Burchell's Courser, Double-banded Courser, Greater Kestrel, Grey-winged Francolin, Jackal Buzzard, Karoo Korhaan, Kori Bustard, Lanner Falcon, Ludwig's Bustard, Martial Eagle, Pale Chanting Goshawk, Sclater's Lark, Secretarybird, Southern Black Korhaan, Spotted Eagle-Owl, Verreaux's Eagle.

5.1.3 Displacement due to Habitat Loss

The scale of permanent habitat loss resulting from the construction of a wind farm and associated infrastructure depends on the size of the project but, in general it, is likely to be small per turbine base. Typically, actual habitat loss amounts to 2–5% of the total Project Site (Fox *et al.* 2006), though effects could be more widespread where developments interfere with hydrological patterns or flows on wetland or peatland sites -. Some structural changes to the habitat could be attractive for small burrowing mammals, to the detriment of raptors that prey on them. For example, following the development of the Altamont Pass wind farm in California, Pocket Gophers *Thomomys bottae* burrowed around turbine bases, leading to increased prey availability for some species of raptor close to the turbines, increasing their collision risk with the turbines (Thelander *et al.* 2003).

However, the results of habitat transformation may be more subtle, whereas the actual footprint of the wind farm may be small in absolute terms; the effects of the habitat fragmentation brought about by the associated infrastructure (e.g. power lines and roads) may be more significant. Sometimes Great Bustard can be seen close to or under power lines, (Lane *et al.* 2001) however, in Spain, the presence of Great Bustard flocks was significantly higher further from power lines (Lane *et al.* 2001). Shaw (2013) found that Ludwig's Bustard generally avoids an area of about 500m around roads, while Blue Cranes select nesting sites away from roads (Bidwell et al. 2004). This means that power lines and roads also cause loss and fragmentation of the habitat used by the population in addition to the potential direct mortality. The physical encroachment increases the disturbance and barrier effects that contribute to the overall habitat fragmentation effect of the infrastructure (Raab *et al.* 2010). It has been shown that fragmentation of natural grassland in Mpumalanga (in that case by afforestation) had a detrimental impact on the densities and diversity of grassland bird species (Alan *et al.* 1997).

The network of roads is likely to result in significant habitat fragmentation, and it could affect the density of several species, particularly larger terrestrial species such as Ludwig's Bustard, Blue Crane, Southern Black Korhaan and Karoo Korhaan. Given the proposed turbine layout and associated road infrastructure, it is not expected that any priority species will be permanently displaced from the Project Site. The building infrastructure and substation will all be situated in the same habitat, i.e., Karoo scrub. The habitat is not particularly sensitive as far as avifauna is concerned, therefore the impact of the habitat transformation will be low given the extent of available habitat and the small size of the footprint. In summary, the following species are likely to be affected by habitat transformation: African Rock Pipit, Blue Crane, Burchell's Courser, Double-banded Courser, Grey-winged Francolin, Karoo Korhaan, Kori Bustard, Ludwig's Bustard, Sclater's Lark, Secretarybird, Southern Black Korhaan.

5.2. Associated Infrastructure

5.2.1 Electrocution in the Substation and on the 33kV Medium Voltage Network

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 2000). The electrocution risk is largely determined by the design of the electrical hardware.

While the intention is to place the medium voltage reticulation network underground where possible, there are areas where the lines might have to run above ground for technical reasons. In these instances, the poles could potentially pose an electrocution risk to raptors. In summary, the following priority species could be vulnerable to electrocution: African Harrier-Hawk, Amur Falcon, Black Harrier, Black Stork, Black-winged Kite, Booted Eagle, Brown Snake Eagle, Common Buzzard, Greater Kestrel, Jackal Buzzard, Lanner Falcon, Lesser Kestrel, Martial Eagle, Pale Chanting Goshawk, Spotted Eagle-Owl, Verreaux's Eagle. Electrocutions within the proposed substation yard are also possible, particularly smaller species such as Greater Kestrel and Spotted Eagle-Owl but should not affect the larger Red Data raptors such as Martial Eagle, as these species are unlikely to use the infrastructure within the substation yard for perching or roosting.

5.2.2 Collisions with the 33kV OHL

While the intention is to place the 33kV reticulation network underground where possible, there are areas were the lines might have to run above ground for technical reasons. This includes an option to construct a 33kV OHL of approximately 10km to link the two Project Sites. This could pose a collision risk to several priority species.

Collisions are the biggest threat posed by electrical overhead lines to birds in southern Africa (Van Rooyen 2004). Most heavily impacted on are bustards, storks, cranes and various species of waterbirds, and to a lesser extent, vultures. 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 transmission lines (Van Rooyen 2004, Anderson 2001).

From incidental record keeping by the Endangered Wildlife Trust, it is possible to give a measure of what species are generally susceptible to power line collisions in South Africa (**Figure 12**).

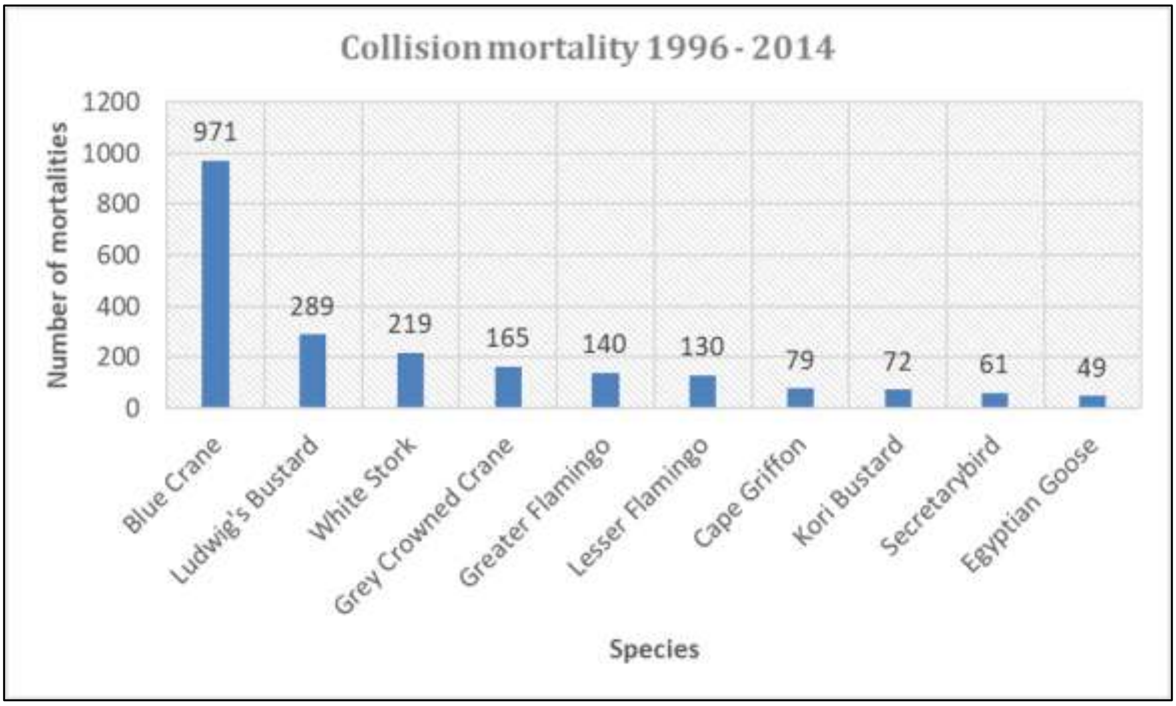

Figure 12: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/Endangered Wildlife Trust Strategic Partnership central incident register 1996 - 2014 (EWT unpublished data)

Powerline collisions are generally accepted as a key threat to bustards (Raab *et al*. 2009; Raab *et al*. 2010; Jenkins & Smallie 2009; Barrientos *et al*. 2012, Shaw 2013). In one study, carcass surveys were performed under high voltage transmission lines in the Karoo for two years, and low voltage distribution lines for one year (Shaw 2013). Ludwig's Bustard was the most common collision victim (69% of carcasses), with bustards generally comprising 87% of mortalities recovered. Karoo Korhaan was also recorded, but to a much lesser extent than Ludwig's Bustard. The reasons for the relatively low collision risk of this species probably include their smaller size (and hence greater agility in flight) as well as their more sedentary lifestyles, as local birds are familiar with their territory and are less likely to collide with power lines (Shaw 2013).

Using a controlled experiment spanning a period of nearly eight years (2008 to 2016), the Endangered Wildlife Trust (EWT) and Eskom tested the effectiveness of two types of line markers in reducing power line collision mortalities of large birds on three 400kV transmission lines near Hydra substation in the Karoo. Marking was highly effective for Blue Cranes, with a 92% reduction in mortality, and large birds in general with a 56% reduction in mortality, but not for bustards, including the endangered Ludwig's Bustard. The two different marking devices (spirals and flappers) were approximately equally effective (Shaw *et al*. 2017).

While the intention is to place the majority of the medium voltage reticulation network underground at the wind farm, there are areas where the lines will run above ground. Priority species which are most at risk of collisions with the medium voltage powerlines are the following: Black Stork, Blue Crane, Karoo Korhaan, Kori Bustard, Ludwig's Bustard, Secretarybird, Southern Black Korhaan, Spotted Eagle-Owl, Verreaux's Eagle, White Stork. In particular, high-risk areas would be where the reticulation network occurs near large dams and agricultural fields.

6. ASSESSMENT OF IMPACTS ON AVIFAUNA

The assessment criteria used for the assessment of the impacts on avifauna is attached as **Appendix D**.

6.1 Impact Tables

6.1.1 Construction Phase

Nature: ***Displacement of priority species due to disturbance during construction phase***		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Very short (1)	Very short (1)
Magnitude	High (8)	Moderate (6)
Probability	Definite (5)	Definite (5)
Significance	**Medium (50)**	**Medium (40)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	To some extent	
Mitigation: • Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible, and in particular to the proposed road network. Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Removal of vegetation must be restricted to a minimum and must be rehabilitated to its former state where possible after construction. • Construction of new roads should only be considered if existing roads cannot be upgraded. • Vehicle and pedestrian access to the site should be controlled and restricted as much as possible to prevent unnecessary disturbance of priority species.		
Residual Impacts: Due to the nature of the construction activities, it is inevitable that temporary displacement of priority species will happen as a result. While this can be mitigated to some extent, the significance of the residual impacts will remain at a medium level.		

6.1.2 Operational Phase

Nature: ***Displacement of priority species due to habitat loss in the operation phase***		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (33)**	**Low (27)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	To some extent	
Mitigation: • Once operational, vehicle and pedestrian access to the site should be controlled and restricted to prevent unnecessary destruction of vegetation. • Formal live-bird monitoring should resume once the turbines have been constructed, as per the most recent edition of the Best Practice Guidelines (Jenkins *et al*. 2015). The purpose of this would be to establish whether displacement of priority species has occurred and to what extent. The exact time when operational monitoring should commence, will depend on the construction schedule, and should commence when the first turbines start operating. The Best Practice Guidelines require that, as an		

absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter for the operational lifetime of the facility. • The mitigation measures proposed by the botanical specialist, including rehabilitation, must be strictly implemented. • Excavated rocks should be removed, or all infilling for road construction should be compacted and all lose rock piles at the base or periphery of such infilling should be covered and packed down to eliminate all potential crevices and shelter for small mammals such as Rock Hyraxes (the primary food source for Verreaux's Eagles).
Residual Impacts: Due to the nature of the infrastructure, it is highly likely that long term partial displacement of priority species will happen, particularly because of the habitat fragmentation caused by the associated road network. The habitat transformation can be limited to some extent through mitigation measures, to keep the significance of the residual impacts at a low level.

Nature: Mortality of priority species due to collisions with the turbines in the operation phase		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Moderate (6)
Probability	Highly probable (4)	Probable (3)
Significance	**Medium (44)**	**Medium (33)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	

Mitigation:

- A 200m turbine exclusion zone should be implemented around boreholes and dams and a 100m turbine exclusion zone should be maintained on either side of drainage lines. Drainage lines are indicated in **Appendix E** (a KMZ with coordinates of dams can be provided). Turbine rotor swept areas should not extend into these zones.
- All wind turbines must have one blade painted according to a CAA approved pattern to reduce the risk of raptor collisions. It is acknowledged that blade painting as a mitigation strategy is still in an experimental phase in South Africa, but research indicates that it has a very good chance of reducing raptor mortality, based on research conducted in Norway (see Simmons et al. 2021 (Appendix H) for an explanation of the science and research behind this mitigation method).
- Carcass searches must commence to establish mortality rates, as per the most recent edition of the Best Practice Guidelines (Jenkins *et al*. 2015). The exact time when operational monitoring should commence will depend on the construction schedule and should commence when the first turbines start operating. The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter for the operational lifetime of the facility.
- Should any mortalities of the following collision prone species of conservation concern (Black Harrier (see section 3.5 above) and Verreaux's Eagle) be recorded, an observer led shutdown on demand (SDoD) programme should be considered for rapid implementation at the WEF, targeting these species.
- Furthermore, if annual estimated collision rates of other species of conservation concern indicate unsustainable mortality levels of priority species, i.e. if natural background mortality together with the estimated mortality caused by turbine collisions exceeds a critical mortality threshold as determined by the avifaunal specialist in consultation with other experts e.g. BLSA, additional measures will have to be implemented which could include shutdown on demand. This must be undertaken in consultation with a qualified avifaunal specialist.

Residual Impacts: It is not possible to completely eliminate the risk of turbine collisions, but through mitigation measures, it could be reduced to a low level.

Nature: Mortality of priority species due to electrocutions on the overhead MV network (where applicable) and in the substation yard.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	High (8)	High (8)
Probability	Highly probable (4)	Improbable (1)
Significance	**Medium (52)**	**Low (13)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	
Mitigation: • Overhead lines should be restricted to an absolute minimum and should only be allowed if underground cabling is unfeasible due to technical constraints. • The final pole designs must be signed off by the bird specialist to ensure that a bird-friendly design is used. • Bi-monthly inspections of the overhead sections of the MV network must be conducted to look for carcasses under the poles. • With regard to the infrastructure within the substation yard, the hardware is too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if any impacts are recorded once operational, site-specific mitigation be applied reactively and in consultation with a qualified avifauna specialist.		
Residual Impacts: It is possible to largely eliminate the risk of electrocutions with the use of bird-friendly designs, although all structures carry some risk of electrocution.		

Nature: Mortality of priority species due to collisions with the 33kV OHL		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	High (8)	Moderate (6)
Probability	Highly probable (4)	Probable (3)
Significance	**Medium (52)**	**Medium (33)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To a limited extent	To a limited extent
Mitigation: • Overhead lines should be restricted to an absolute minimum and should only be allowed if underground cabling is unfeasible due to technical constraints. • Bird flight diverters should be installed on all 33kV overhead lines on the full span length on the earthwire (according to Eskom guidelines - five metres apart). Light and dark colour devices must be alternated to provide contrast against both dark and light backgrounds respectively. These devices must be installed when the conductors are strung.		
Residual Risks:		

There will be an ongoing residual risk of collisions with the OHL, but mitigation should reduce the risk by some extent.

6.1.3 Decommissioning Phase

Nature: Displacement of priority species due to disturbance during the decommissioning phase		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Very short (1)	Very short (1)
Magnitude	High (8)	Moderate (6)
Probability	Definite (5)	Definite (5)
Significance	**Medium (50)**	**Medium (40)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	To some extent	
Mitigation: • Decommissioning activity should be restricted to the immediate footprint of the infrastructure as far as possible, and in particular to the proposed road network. Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Construction of new roads should only be considered if existing roads cannot be utilised / upgraded. • Vehicle and pedestrian access to the site should be controlled and restricted as much as possible to prevent unnecessary disturbance of priority species.		
Residual Impacts: Due to the nature of the decommissioning activities, it is inevitable that temporary displacement of priority species will happen as a result. While this can be mitigated to some extent, the significance of the residual impacts will remain at a medium level.		

6.2 Inputs into the Environmental Management Plan (EMPr)

Please see **Appendix G** for suggested inputs into the EMPr.

7 CUMULATIVE IMPACTS

Cumulative effects are commonly understood to be impacts from different projects that combine to result in significant change, which could be larger than the sum of all the individual impacts. The assessment of cumulative effects therefore considers all renewable energy projects within a 30 km radius that have received an Environmental Authorisation at the time of starting the environmental impact assessment process, including the proposed FE Tango WEF Project. There are currently four (4) renewable energy projects authorised within a 30 km radius of the proposed FE Tango WEF. These projects were identified using the DFFE's Renewable Energy EIA Application Database for South Africa in conjunction with information provided by Independent Power Producers (IPPs) operating in the broader region. It should be noted that this list is based on information available at the time of writing this report and there may be other renewable energy projects proposed within the 30 km radius. The locality of renewable projects (affected properties) that are authorised are displayed in **Figure 13**.

7.1 The cumulative impact of the proposed FE Tango WEF

The total affected land parcel area covered by other authorised renewable energy projects within the 30 km radius is approximately 163 km². The total land parcel area affected by the FE Tango Wind Energy Facility equates to approximately 22.5 km². The combined land parcel area affected by authorised renewable energy developments within the 30 km radius of similar habitat around the proposed FE Tango Wind Energy Facility, inclusive of the FE Tango Wind Energy Facility, thus equals approximately 185.5 km². Of this, the proposed FE Tango WEF project constitutes ~12% (22.5 km²). The cumulative impact of the proposed FE Tango WEF is thus anticipated to be **low** to **moderate** <u>after mitigation</u>.

The total area within the 30km radius around the proposed projects equates to about 2827.4 km² of similar habitat. The total combined size of the land parcels potentially affected by renewable energy projects will equate to ~6.6% of the available untransformed habitat in the 30km radius. However, the actual physical footprint of the renewable energy facilities will be smaller than the land parcel areas themselves. Furthermore, each of these projects must still be subject to a competitive bidding process where only the most competitive projects will win a power purchase agreement required for the project to proceed to construction. The cumulative impact of all the proposed renewable energy projects is estimated to be **moderate**.

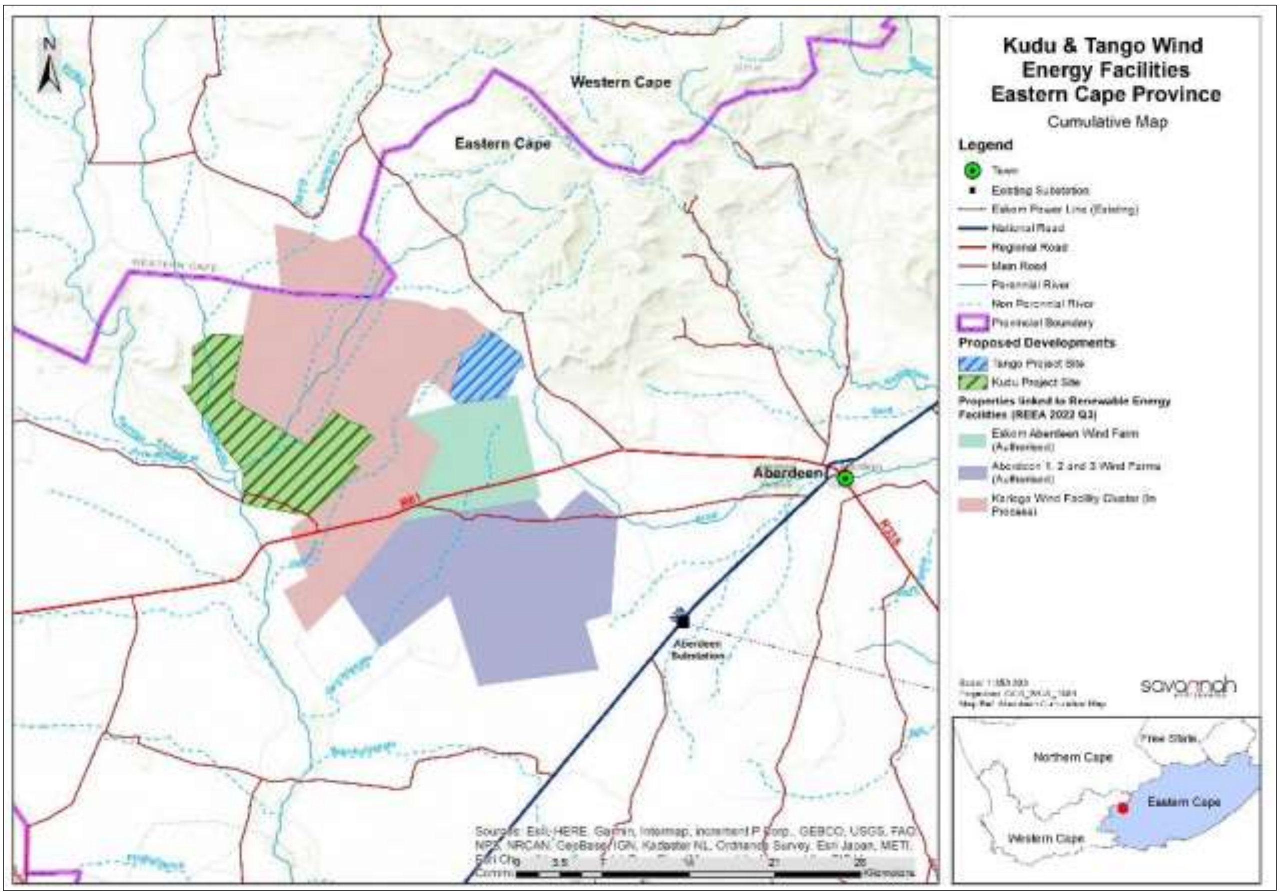

Figure 13: Regional EA applications for renewable energy projects located within a 30 km radius of the proposed FE Tango WEF (Source: DFFE – Q1, 2023).

Nature: **Cumulative impacts in terms of:**

- **Displacement of priority species due to disturbance during construction phase**
- **Displacement of priority species due to habitat loss in the operation phase**
- **Mortality of priority species due to collisions with the turbines in the operation phase**
- **Mortality of priority species due to electrocutions on the overhead MV network and in the substation yard.**
- **Mortality of priority species due to collisions with the 33kV medium voltage overhead lines in the operation phase**

	Overall impact of the proposed project considered in isolation (post mitigation)	***Cumulative impact of the project and other projects in the area (post mitigation)***
Extent	Low (1)	High (3)
Duration	Long term (4)	Long term (4)
Magnitude	Low (4)	Moderate (6)
Probability	Probable (3)	Probable (3)
Significance	**Low (27)**	**Medium (39)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	Yes

Mitigation:

All the mitigation measures which have been listed in the bird impact assessment reports for all the

relevant wind energy projects must be applied to the relevant projects. These include the following: • Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible. • Burying of internal MV cables. • Rehabilitation of disturbed vegetation. • Using bird-friendly structures for the MV poles. • Marking of overhead lines with Bird Flight Diverters. • Blade painting: All wind turbines must have one blade painted (according to a local civil aviation authority approved pattern to reduce the risk of raptor collisions). • Curtailment of turbines if mortality thresholds are exceeded. • Maximum use of existing roads. • Implementation of operational monitoring to assess mortality levels. • Avoidance of no-go buffers around sensitive areas, including raptor nests.
Residual Impacts: The implementation of the proposed mitigation measures will result in a reduction of the cumulative impacts, but it will still have a medium residual impact at a regional level.

8 NO-GO ALTERNATIVE

The no-go alternative will result in the current *status quo* being maintained as far as the avifauna is concerned. The low human population in the area is definitely advantageous to avifauna. The no-go option would therefore eliminate any additional impact on the ecological integrity of the proposed Project Site as far as avifauna is concerned.

9 SUMMARY OF FINDINGS AND CONCLUDING STATEMENT

The proposed FE Tango WEF will have several potential impacts on priority avifauna. The impacts are the following:

- Collision mortality on the wind turbines
- Displacement due to disturbance
- Displacement due to habitat transformation
- Electrocution on the 33kV MV overhead cables and in the substation yard
- Mortality due to the collisions with the 33kV overhead lines

9.1 Displacement of priority species due to disturbance and habitat transformation

It is inevitable that a measure of displacement will take place for all priority species during the construction phase, resulting from disturbance associated with the construction activities. This is likely to affect ground nesting species the most, as this could temporarily disrupt their reproductive cycle. Species which fall in this category are Ludwig’s Bustard, Blue Crane, Karoo Korhaan, Southern Black Korhaan and Spotted Eagle-Owl. Some raptors might also be affected, e.g., Greater Kestrel which often breeds on crow nests which have been constructed on wind pumps. Some species might be able to recolonise the area after the completion of the construction phase, but for some species this might only be partially the case, resulting in lower densities than before once the wind farm is operational, due to disturbance resulting from of the operational turbines. In summary, the following species could be impacted by disturbance during the construction phase: African Harrier-Hawk, African Rock Pipit, Black Harrier, Black Stork, Black-winged Kite, Blue Crane, Booted Eagle, Brown Snake Eagle, Burchell's Courser, Double-banded Courser, Greater Kestrel, Grey-winged Francolin, Jackal Buzzard, Karoo Korhaan, Kori Bustard, Lanner Falcon, Ludwig's Bustard, Martial Eagle, Pale Chanting Goshawk, Sclater's Lark, Secretarybird, Southern Black Korhaan, Spotted Eagle-Owl, Verreaux's Eagle.

The network of roads is likely to result in significant habitat fragmentation, and it could affect the density of several species, particularly larger terrestrial species such as Ludwig's Bustard, Blue Crane, Southern Black Korhaan and Karoo Korhaan. Given the proposed turbine layout and associated road infra-structure, it is not expected that any priority species will be permanently displaced from the Project Site. The building infrastructure and substation will all be situated in the same habitat, i.e., Karoo scrub. The habitat is not particularly sensitive, as far as avifauna is concerned, therefore the impact of the habitat transformation will be low given the extent of available habitat and the small size of the footprint. In summary, the following species are likely to be affected by habitat transformation: African Rock Pipit, Blue Crane, Burchell's Courser, Double-banded Courser, Grey-winged Francolin, Karoo Korhaan, Kori Bustard, Ludwig's Bustard, Sclater's Lark, Secretarybird, Southern Black Korhaan.

9.2 Priority species mortality due to collisions with the wind turbines

The proposed FE Tango WEF will pose a collision risk to several priority species which could occur regularly at the site. Species exposed to this risk are large terrestrial species i.e., mostly bustards such as Karoo Korhaan, Southern Black Korhaan, Ludwig's Bustard, Kori Bustard, and Blue Crane, although bustards and cranes appear to be less vulnerable to turbine collisions as was originally anticipated (Ralston-Paton & Camagu 2019). Soaring priority species, i.e., species such as Martial Eagle, Pale Chanting Goshawk, Lanner Falcon, Booted Eagle, Verreaux's Eagle, Greater Kestrel and Lesser Kestrel are most at risk of all the priority species likely to occur at the project site. In summary, the following priority species could be at risk of collisions with the turbines: African Harrier-Hawk, Amur Falcon, Black Harrier, Black Stork, Black-winged Kite, Blue Crane, Booted Eagle, Brown Snake Eagle, Burchell's Courser, Common Buzzard, Double-banded Courser, Greater Kestrel, Grey-winged Francolin, Jackal Buzzard, Karoo Korhaan, Kori Bustard, Lanner Falcon, Lesser Kestrel, Ludwig's Bustard, Martial Eagle, Pale Chanting Goshawk, Sclater's Lark, Secretarybird, Southern Black Korhaan, Spotted Eagle-Owl, Verreaux's Eagle, White Stork and Black Harrier.

9.3 Priority species mortality due to electrocutions on 33kV MV reticulation network and in substation

While the intention is to place the medium voltage reticulation network underground where possible, there are areas where the lines might have to run above ground, for technical reasons. In these instances, the poles could potentially pose an electrocution risk to raptors. In summary, the following priority species could be vulnerable to electrocution: African Harrier-Hawk, Amur Falcon, Black Harrier, Black Stork, Black-winged Kite, Booted Eagle, Brown Snake Eagle, Common Buzzard, Greater Kestrel, Jackal Buzzard, Lanner Falcon, Lesser Kestrel, Martial Eagle, Pale Chanting Goshawk, Spotted Eagle-Owl, Verreaux's Eagle. Electrocutions within the proposed substation yard are also possible, particularly smaller species such as Greater Kestrel and Spotted Eagle-Owl but should not affect the larger Red Data raptors such as Martial Eagle, as these species are unlikely to use the infrastructure within the substation yard for perching or roosting.

9.4 Priority species mortality due to collisions with the 33kV overhead lines

While the intention is to place the majority of the medium voltage reticulation network underground at the wind farm, there are areas where the lines will run above ground. Priority species which are most at risk of collisions with the medium voltage powerlines are the following: Black Stork, Blue Crane, Karoo Korhaan, Kori Bustard, Ludwig's Bustard, Secretarybird, Southern Black Korhaan, Spotted Eagle-Owl, Verreaux's Eagle, White Stork. In particular, where the reticulation network occurs near large dams and agricultural fields are high-risk areas.

9.5 Conclusions

The investigations into the potential impacts on avifauna, including the avifaunal pre-construction monitoring, by means of six surveys in the period January 2021 to October 2022, have not revealed any fatal flaws which precludes the development of the proposed WEF. <u>However, this conclusion is subject to the implementation of the recommendations listed in this report</u>.

9.6 Cumulative Impacts

The total affected land parcel area taken up by other authorised renewable energy projects within the 30 km radius is approximately 163 km². The total land parcel area affected by the FE Tango Wind Energy Facility equates to approximately 22.5 km². The combined land parcel area affected by authorised renewable energy developments within the 30 km radius of similar habitat around the proposed FE Tango Wind Energy Facility, inclusive of the FE Tango Wind Energy Facility, thus equals approximately 185.5 km². Of this, the proposed FE Tango WEF project constitutes ~12% (22.5 km²). The cumulative impact of the proposed FE Tango WEF is thus anticipated to be **low** to **moderate** <u>after mitigation</u>.

The total area within the 30km radius around the proposed projects equates to about 2827.4 km² of similar habitat. The total combined size of the land parcels potentially affected by renewable energy projects will equate to ~6.6% of the available untransformed habitat in the 30km radius. However, the actual physical footprint of the renewable energy facilities will be smaller than the land parcel areas themselves. Furthermore, each of these projects must still be subject to a competitive bidding process where only the most competitive projects will win a power purchase agreement required for the project to proceed to construction. The cumulative impact of all the proposed renewable energy projects is estimated to be **moderate**.

10 CONCLUDING STATEMENT

The proposed FE Tango WEF will have a medium impact on avifauna which, in most instances, could be reduced to a low impact through the appropriate mitigation measures. The current proposed 18-turbine layout that was assessed in this report avoids all the recommended avifaunal turbine exclusion zones and is therefore deemed acceptable. <u>The development is supported, provided the mitigation measures listed in this report (Section 6 and Appendix G) are strictly applied and adhered to. See **Appendix E** for a map of the exclusion areas.</u>

11 POST-CONSTRUCTION MONITORING PROGRAMME

Procedures and minimum criteria for reporting on identified environmental themes in terms of Sections 24(5)(a) and (h) and 44 of NEMA came into force in March 2020. According to these regulations, a detailed post-construction monitoring programme must be included as part of the bird specialist study. See **Appendix F** for a proposed programme.

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APPENDIX A: PRE-CONSTRUCTION MONITORING

Objectives

The objective of the pre-construction monitoring at the proposed FE Tango and Sleeping Giant Wind Energy Facilities is to gather baseline data over a period of two years on the following aspects pertaining to avifauna:

- The abundance and diversity of birds at the Project Site, and a suitable control site, to measure the potential displacement effect of the WEF.
- Flight patterns of priority species at the Project Site to assess the potential collision risk with the turbines.

Methods

The monitoring was designed according to the following best practice guidelines:

- Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2015. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. Produced by the Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa. Hereafter referred to as the wind guidelines.
- Ralston-Patton S. & Murgatroyd, M. 2021. Verreaux's Eagles and Wind Farms. Guidelines for impact assessment, monitoring and mitigation (Second Edition). BirdLife South Africa, November 2021. Henceforth referred to as the VE guidelines.
- Simmons RE, 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. Hereafter referred to as the Black Harrier guidelines.

The wind guidelines form the basis of the protocol for the assessment of avifaunal related impacts by wind energy facilities of 20MW or higher, that was gazetted in March 2020.[6] However, where the proposed project overlaps with one or more Verreaux's Eagle territories, BirdLife South Africa (BLSA) recommends the use of the VE guidelines, Likewise, if the project site is within the foraging range of an active Black Harrier nest, the use of the Black Harrier guidelines are recommended. It was, therefore, decided in consultation with the developer, to extend the monitoring with an additional year to comply with the requirements of the latter two sets of guidelines. Wind priority species were identified using the latest (November 2014) BirdLife SA (BLSA) list of priority species for wind farms.

Pre-construction monitoring at the Tango and Sleeping Giant WEF Project Sites and a Control Site was conducted during the following time periods:

- Survey 1: 21 – 26 January 2021
- Survey 2: 23 – 30 April 2021
- Survey 3: 20 August – 6 September, 10 September 2021
- Survey 4: 19 November – 01 December 2021
- Survey 5: 30 August – 04 September 2022
- Survey 6: 06 – 09 October 2022

[6] Government Gazette No 320, 20 March 2020. Procedures for the assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, when applying for environmental authorisation.

Monitoring at FE Tango WEF was conducted in the following manner:

- One (1) drive transect of 12.5km was identified on the development site, and one drive transect of 10.2km in the control site, (which is shared with the FE Kudu WEF)..
- Two monitors travelling slowly (± 10km/h) in a vehicle record all birds on both sides of the transect. The observers stop at regular intervals (every 500m) to scan the environment with binoculars. Drive transects are counted three times per sampling session.
- In addition, two (2) walk transects of 1km each were identified. The transects are counted four (4) times per survey. All birds are recorded during walk transects.
- The following variables were recorded:
    - Species
    - Number of birds
    - Date
    - Start time and end time
    - Estimated distance from transect
    - Wind direction
    - Wind strength (estimated Beaufort scale)
    - Weather (sunny; cloudy; partly cloudy; rain; mist)
    - Temperature (cold; mild; warm; hot)
    - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground) and
    - Co-ordinates (priority species only)

The aim of drive transects is primarily to record large priority species (i.e. raptors and large terrestrial species), while walk transects are aimed at recording small passerines. The objective of the transect monitoring is to gather baseline data on the use of the site by birds to measure potential displacement by the wind and solar farm activities.

- Two (2) vantage points (VPs) were identified from which the majority of the wind turbine buildable area can be observed, to record the flight altitude and patterns of priority species. One (1) VP was also identified on the control site. The following variables are recorded for each flight:
    - Species
    - Number of birds
    - Date
    - Start time and end time
    - Wind direction
    - Wind strength (estimated Beaufort scale 1-7)
    - Weather (sunny; cloudy; partly cloudy; rain; mist)
    - Temperature (cold; mild; warm; hot)
    - Flight altitude (high i.e. >220m; medium i.e. 30m – 220m; low i.e. <30m)
    - Flight mode (soar; flap; glide; kite; hover) and
    - Flight time (in 15 second intervals).

The objective of vantage point counts is to measure the potential collision risk with the turbines.

A total of eight (8) potential focal points (FPs) of bird activity were identified and monitored. The focal points were as follows:

- FP 1: Verreaux's Eagle nest on a cliff
- FP 2: Black Harrier nest in a wetland
- FP 3: Verreaux's Eagle nest on a cliff
- FP 4: Raptor species nest

- FP 5: Dam
- FP 6: Dam
- FP 7: Dam
- FP 8: Verreaux's Eagle nest on a cliff

Figure 1 below indicates the location of the transects and VPs where monitoring took place.

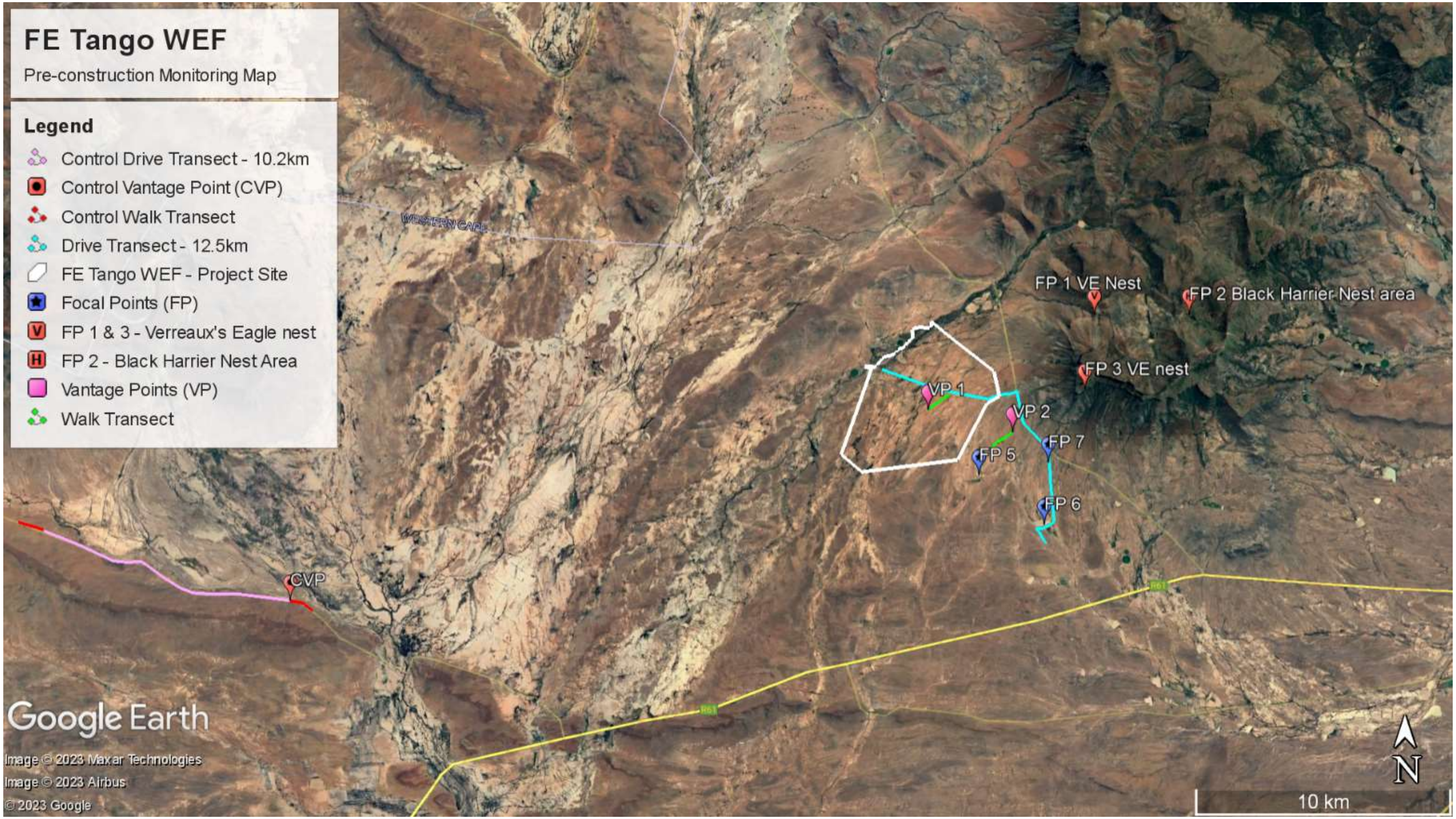


Figure 1: Area where pre-construction monitoring was conducted, indicating the location of vantage points, focal points, drive transects, and walk transects. The Control Site is located west of the Project Sites (shared with FE Kudu WEF).

APPENDIX B: BIRD HABITAT

Figure 1: Typical Nama Karoo shrubland habitat of the Project Site.

Figure 2: Drainage line woodland on the Project Site.

Figure 3: Large dam on the Project Site.

Figure 4: Agriculture (planted pastures) near the Project Site.

Figure 5: Borehole with water trough on the Project Site.

Figure 5: Rocky ridges and mountain habitat ~2km east of the Project Site.

APPENDIX C: SPECIES LIST FOR BROADER AREA

Species name	Scientific name	SABAP2 Reporting Rate %		Recorded during monitoring
		Full protocol	Ad hoc protocol	
Acacia Pied Barbet	*Tricholaema leucomelas*	65,85	23,40	x
African Black Duck	*Anas sparsa*	0,81	1,06	
African Black Swift	*Apus barbatus*	3,25	1,06	
African Firefinch	*Lagonosticta rubricata*	1,63	0,53	
African Harrier-Hawk	*Polyboroides typus*	0,81	0,53	
African Hoopoe	*Upupa africana*	10,57	2,13	x
African Paradise Flycatcher	*Terpsiphone viridis*	1,63	0,00	
African Pipit	*Anthus cinnamomeus*	49,59	13,83	x
African Red-eyed Bulbul	*Pycnonotus nigricans*	25,20	3,19	x
African Rock Pipit	*Anthus crenatus*	0,81	0,00	
African Sacred Ibis	*Threskiornis aethiopicus*	5,69	1,06	
African Spoonbill	*Platalea alba*	4,88	1,06	
African Stonechat	*Saxicola torquatus*	3,25	0,00	
Alpine Swift	*Tachymarptis melba*	15,45	1,60	x
Amethyst Sunbird	*Chalcomitra amethystina*	3,25	0,00	
Amur Falcon	*Falco amurensis*	0,81	3,19	
Ant-eating Chat	*Myrmecocichla formicivora*	44,72	11,70	x
Barn Swallow	*Hirundo rustica*	21,14	17,02	x
Bar-throated Apalis	*Apalis thoracica*	17,07	3,19	x
Black Harrier	*Circus maurus*	4,88	1,60	
Black Stork	*Ciconia nigra*	2,44	0,00	
Black-chested Prinia	*Prinia flavicans*	0,00	0,53	
Black-eared Sparrow-Lark	*Eremopterix australis*	4,88	0,00	
Black-headed Canary	*Serinus alario*	17,89	3,19	x
Black-headed Heron	*Ardea melanocephala*	4,07	0,00	x
Blacksmith Lapwing	*Vanellus armatus*	19,51	4,26	x
Black-throated Canary	*Crithagra atrogularis*	16,26	1,60	x
Black-winged Kite	*Elanus caeruleus*	0,81	0,00	
Black-winged Stilt	*Himantopus himantopus*	13,01	2,13	
Blue Crane	*Grus paradisea*	37,40	24,47	x
Bokmakierie	*Telophorus zeylonus*	33,33	3,19	x
Booted Eagle	*Hieraaetus pennatus*	10,57	4,26	x
Brown Snake Eagle	*Circaetus cinereus*	0,00	0,00	x

Species name	Scientific name	SABAP2 Reporting Rate %		Recorded during monitoring
Brown-hooded Kingfisher	*Halcyon albiventris*	6,50	1,06	x
Brown-throated Martin	*Riparia paludicola*	3,25	0,00	
Burchell's Courser	*Cursorius rufus*	0,81	0,00	
Cape Bulbul	*Pycnonotus capensis*	1,63	0,00	
Cape Bunting	*Emberiza capensis*	16,26	3,72	x
Cape Canary	*Serinus canicollis*	10,57	1,06	x
Cape Crow	*Corvus capensis*	34,15	21,81	x
Cape Longclaw	*Macronyx capensis*	7,32	0,53	
Cape Penduline Tit	*Anthoscopus minutus*	5,69	5,32	x
Cape Robin-Chat	*Cossypha caffra*	31,71	2,13	x
Cape Rock Thrush	*Monticola rupestris*	0,00	0,00	x
Cape Shoveler	*Spatula smithii*	4,07	0,00	
Cape Sparrow	*Passer melanurus*	51,22	14,36	x
Cape Teal	*Anas capensis*	4,07	0,00	
Cape Turtle Dove	*Streptopelia capicola*	47,97	9,57	x
Cape Wagtail	*Motacilla capensis*	34,96	2,13	x
Cape Weaver	*Ploceus capensis*	6,50	1,06	
Cape White-eye	*Zosterops virens*	18,70	0,53	x
Capped Wheatear	*Oenanthe pileata*	23,58	7,98	x
Cardinal Woodpecker	*Dendropicos fuscescens*	4,88	0,53	x
Chat Flycatcher	*Melaenornis infuscatus*	26,83	8,51	x
Chestnut-vented Warbler	*Curruca subcoerulea*	48,78	14,89	x
Cinnamon-breasted Bunting	*Emberiza tahapisi*	8,13	2,13	x
Common Buzzard	*Buteo buteo*	7,32	8,51	x
Common Greenshank	*Tringa nebularia*	4,07	0,00	
Common House Martin	*Delichon urbicum*	0,00	1,06	
Common Quail	*Coturnix coturnix*	13,82	2,13	x
Common Starling	*Sturnus vulgaris*	0,81	0,00	
Common Swift	*Apus apus*	6,50	1,06	x
Common Waxbill	*Estrilda astrild*	8,13	1,60	x
Crowned Lapwing	*Vanellus coronatus*	8,94	2,66	
Desert Cisticola	*Cisticola aridulus*	26,02	5,85	
Diederik Cuckoo	*Chrysococcyx caprius*	2,44	0,53	
Double-banded Courser	*Rhinoptilus africanus*	14,63	2,13	x
Dusky Sunbird	*Cinnyris fuscus*	21,95	6,38	x
Eastern Clapper Lark	*Mirafra fasciolata*	43,09	13,83	x
Egyptian Goose	*Alopochen aegyptiaca*	40,65	17,02	x
European Bee-eater	*Merops apiaster*	1,63	0,00	
Fairy Flycatcher	*Stenostira scita*	9,76	1,06	x

Species name	Scientific name	SABAP2 Reporting Rate %		Recorded during monitoring
Familiar Chat	*Oenanthe familiaris*	39,84	7,98	x
Fiery-necked Nightjar	*Caprimulgus pectoralis*	0,81	0,53	
Fiscal Flycatcher	*Melaenornis silens*	17,89	1,06	x
Fork-tailed Drongo	*Dicrurus adsimilis*	5,69	0,00	
Gabar Goshawk	*Micronisus gabar*	0,81	0,00	
Glossy Ibis	*Plegadis falcinellus*	0,81	0,00	
Golden-breasted Bunting	*Emberiza flaviventris*	6,50	1,06	x
Greater Flamingo	*Phoenicopterus roseus*	0,81	1,06	
Greater Kestrel	*Falco rupicoloides*	6,50	4,79	x
Greater Striped Swallow	*Cecropis cucullata*	30,08	7,98	x
Grey Heron	*Ardea cinerea*	5,69	0,00	x
Grey Tit	*Melaniparus afer*	26,83	5,32	x
Grey-backed Cisticola	*Cisticola subruficapilla*	20,33	4,79	x
Grey-backed Sparrow-Lark	*Eremopterix verticalis*	33,33	24,47	x
Grey-winged Francolin	*Scleroptila afra*	4,07	0,53	x
Ground Woodpecker	*Geocolaptes olivaceus*	2,44	0,53	
Hadada Ibis	*Bostrychia hagedash*	34,96	7,98	x
Hamerkop	*Scopus umbretta*	4,07	0,00	x
Helmeted Guineafowl	*Numida meleagris*	26,83	6,38	x
House Sparrow	*Passer domesticus*	22,76	3,19	x
Jackal Buzzard	*Buteo rufofuscus*	9,76	1,06	x
Karoo Chat	*Emarginata schlegelii*	26,83	3,72	x
Karoo Eremomela	*Eremomela gregalis*	1,63	0,53	
Karoo Korhaan	*Eupodotis vigorsii*	57,72	25,00	x
Karoo Lark	*Calendulauda albescens*	1,63	0,53	
Karoo Long-billed Lark	*Certhilauda subcoronata*	22,76	5,32	x
Karoo Prinia	*Prinia maculosa*	46,34	11,70	x
Karoo Scrub Robin	*Cercotrichas coryphoeus*	51,22	15,96	x
Karoo Thrush	*Turdus smithi*	10,57	0,00	
Kittlitz's Plover	*Charadrius pecuarius*	3,25	0,00	x
Kori Bustard	*Ardeotis kori*	16,26	4,26	x
Lanner Falcon	*Falco biarmicus*	8,13	1,60	x
Large-billed Lark	*Galerida magnirostris*	30,08	6,91	x
Lark-like Bunting	*Emberiza impetuani*	54,47	32,45	x
Laughing Dove	*Spilopelia senegalensis*	31,71	6,38	x
Layard's Warbler	*Curruca layardi*	11,38	0,00	x
Lesser Grey Shrike	*Lanius minor*	0,00	0,53	
Lesser Honeyguide	*Indicator minor*	0,81	0,00	
Lesser Kestrel	*Falco naumanni*	3,25	3,19	x

Species name	**Scientific name**	**SABAP2 Reporting Rate %**		**Recorded during monitoring**
Lesser Striped Swallow	*Cecropis abyssinica*	0,81	0,53	
Levaillant's Cisticola	*Cisticola tinniens*	0,81	0,53	
Little Grebe	*Tachybaptus ruficollis*	4,07	0,00	
Little Stint	*Calidris minuta*	2,44	0,00	
Little Swift	*Apus affinis*	5,69	0,53	x
Long-billed Crombec	*Sylvietta rufescens*	13,82	3,72	x
Long-billed Pipit	*Anthus similis*	2,44	0,53	x
Ludwig's Bustard	*Neotis ludwigii*	36,59	11,70	x
Malachite Sunbird	*Nectarinia famosa*	13,01	4,79	x
Martial Eagle	*Polemaetus bellicosus*	6,50	1,06	x
Mountain Wheatear	*Myrmecocichla monticola*	21,95	2,66	
Namaqua Dove	*Oena capensis*	30,08	10,64	x
Namaqua Sandgrouse	*Pterocles namaqua*	9,76	4,79	x
Namaqua Warbler	*Phragmacia substriata*	0,81	0,00	
Neddicky	*Cisticola fulvicapilla*	34,15	15,96	x
Nicholson's Pipit	*Anthus nicholsoni*	5,69	0,53	
Olive Bushshrike	*Chlorophoneus olivaceus*	1,63	0,00	
Pale Chanting Goshawk	*Melierax canorus*	54,47	22,87	x
Pale-winged Starling	*Onychognathus nabouroup*	3,25	1,60	x
Pearl-breasted Swallow	*Hirundo dimidiata*	3,25	0,00	
Pied Avocet	*Recurvirostra avosetta*	10,57	2,66	
Pied Crow	*Corvus albus*	73,17	31,38	x
Pied Starling	*Lamprotornis bicolor*	14,63	4,26	x
Pink-billed Lark	*Spizocorys conirostris*	8,13	2,13	
Pin-tailed Whydah	*Vidua macroura*	3,25	1,06	
Plain-backed Pipit	*Anthus leucophrys*	5,69	1,60	x
Pririt Batis	*Batis pririt*	34,15	9,04	x
Quailfinch	*Ortygospiza atricollis*	14,63	2,13	x
Red-backed Shrike	*Lanius collurio*	0,81	1,60	
Red-billed Firefinch	*Lagonosticta senegala*	10,57	1,06	x
Red-billed Quelea	*Quelea quelea*	26,83	7,98	x
Red-billed Teal	*Anas erythrorhyncha*	7,32	0,53	
Red-capped Lark	*Calandrella cinerea*	13,01	1,60	x
Red-chested Cuckoo	*Cuculus solitarius*	1,63	0,53	
Red-eyed Dove	*Streptopelia semitorquata*	8,94	1,60	
Red-faced Mousebird	*Urocolius indicus*	23,58	1,06	x
Red-headed Finch	*Amadina erythrocephala*	13,82	3,19	x
Red-knobbed Coot	*Fulica cristata*	4,88	0,53	
Red-winged Starling	*Onychognathus morio*	32,52	5,85	x

Species name	Scientific name	SABAP2 Reporting Rate %		Recorded during monitoring
Reed Cormorant	*Microcarbo africanus*	0,81	0,00	
Rock Dove	*Columba livia*	2,44	0,53	
Rock Kestrel	*Falco rupicolus*	29,27	10,64	x
Rock Martin	*Ptyonoprogne fuligula*	32,52	2,66	x
Ruff	*Calidris pugnax*	1,63	0,00	
Rufous-eared Warbler	*Malcorus pectoralis*	64,23	18,62	x
Sabota Lark	*Calendulauda sabota*	38,21	15,96	x
Scaly-feathered Weaver	*Sporopipes squamifrons*	9,76	5,32	x
Sclater's Lark	*Spizocorys sclateri*	0,81	0,53	
Secretarybird	*Sagittarius serpentarius*	8,13	5,85	x
Short-toed Rock Thrush	*Monticola brevipes*	0,00	1,06	x
Sickle-winged Chat	*Emarginata sinuata*	39,84	6,91	x
Sombre Greenbul	*Andropadus importunus*	11,38	0,53	
South African Shelduck	*Tadorna cana*	27,64	8,51	x
Southern Black Korhaan	*Afrotis afra*	42,28	10,11	x
Southern Boubou	*Laniarius ferrugineus*	7,32	1,60	
Southern Double-collared Sunbird	*Cinnyris chalybeus*	11,38	0,53	x
Southern Fiscal	*Lanius collaris*	37,40	9,57	x
Southern Grey-headed Sparrow	*Passer diffusus*	30,08	5,85	x
Southern Masked Weaver	*Ploceus velatus*	39,84	6,38	x
Southern Pochard	*Netta erythrophthalma*	1,63	0,00	
Southern Red Bishop	*Euplectes orix*	5,69	1,60	x
Southern Tchagra	*Tchagra tchagra*	4,07	0,00	
Speckled Mousebird	*Colius striatus*	8,94	0,53	
Speckled Pigeon	*Columba guinea*	35,77	3,19	x
Spike-heeled Lark	*Chersomanes albofasciata*	44,72	17,02	x
Spotted Eagle-Owl	*Bubo africanus*	8,94	0,53	
Spotted Flycatcher	*Muscicapa striata*	0,00	0,53	x
Spotted Thick-knee	*Burhinus capensis*	22,76	1,06	x
Spur-winged Goose	*Plectropterus gambensis*	10,57	3,19	x
Streaky-headed Seedeater	*Crithagra gularis*	2,44	0,00	
Swee Waxbill	*Coccopygia melanotis*	0,81	0,53	x
Three-banded Plover	*Charadrius tricollaris*	20,33	3,72	x
Tractrac Chat	*Emarginata tractrac*	0,81	0,53	x
Verreaux's Eagle	*Aquila verreauxii*	15,45	3,72	x
Village Indigobird	*Vidua chalybeata*	0,81	0,00	
Wattled Starling	*Creatophora cinerea*	10,57	2,13	x
Western Barn Owl	*Tyto alba*	1,63	0,00	
Western Cattle Egret	*Bubulcus ibis*	0,81	0,00	

Species name	Scientific name	SABAP2 Reporting Rate %		Recorded during monitoring
Whiskered Tern	*Chlidonias hybrida*	0,81	0,00	
White Stork	*Ciconia ciconia*	3,25	3,19	
White-backed Mousebird	*Colius colius*	14,63	2,13	x
White-browed Scrub Robin	*Cercotrichas leucophrys*	2,44	0,53	
White-browed Sparrow-Weaver	*Plocepasser mahali*	0,81	0,00	
White-faced Whistling Duck	*Dendrocygna viduata*	0,81	0,00	
White-necked Raven	*Corvus albicollis*	26,83	6,38	x
White-rumped Swift	*Apus caffer*	5,69	1,60	
White-throated Canary	*Crithagra albogularis*	25,20	3,19	x
White-throated Swallow	*Hirundo albigularis*	10,57	0,53	x
Yellow Canary	*Crithagra flaviventris*	5,69	0,00	x
Yellow-bellied Eremomela	*Eremomela icteropygialis*	39,02	9,57	x
Yellow-billed Duck	*Anas undulata*	17,89	3,72	x
Yellow-billed Kite	*Milvus aegyptius*	1,63	0,53	
Yellow-fronted Canary	*Crithagra mozambica*	0,81	0,00	
Yellow-throated Bush Sparrow	*Gymnoris superciliaris*	3,25	2,13	x
Zitting Cisticola	*Cisticola juncidis*	5,69	1,60	x

APPENDIX D: ASSESSMENT CRITERIA

Assessment of Impacts

Direct, indirect and cumulative impacts associated with the projects must be assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3;
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5;
- The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- the **status**, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:

$S=(E+D+M)P$

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),

- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

Assessment of impacts must be summarised in the following table format. The rating values as per the above criteria must also be included.

Example of Impact table summarising the significance of impacts (with and without mitigation)

Nature: **[Outline and describe fully the impact anticipated as per the assessment undertaken]**		
	Without mitigation	**With mitigation**
Extent	High (3)	Low (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (36)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	
Mitigation: "Mitigation", means to anticipate and prevent negative impacts and risks, then to minimise them, rehabilitate or repair impacts to the extent feasible. Provide a description of how these mitigation measures will be undertaken keeping the above definition in mind		
Residual Impacts: "Residual Risk", means the risk that will remain after all the recommended measures have been undertaken to mitigate the impact associated with the activity (Green Leaves III, 2014).		

Assessment of Cumulative Impacts

As per DEA's requirements, specialists are required to assess the cumulative impacts. In this regard, please refer to the methodology below that will need to be used for the assessment of Cumulative Impacts.

"Cumulative Impact", in relation to an activity, means the past, current and reasonably 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 become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities[7].

The role of the cumulative assessment is to test if such impacts are relevant to the proposed project in the proposed location (i.e. whether the addition of the proposed project in the area will increase the impact). This section should address whether the construction of the proposed development will result in:

- Unacceptable risk

[7] Unless otherwise stated, all definitions are from the 2014 EIA Regulations, GNR 326.

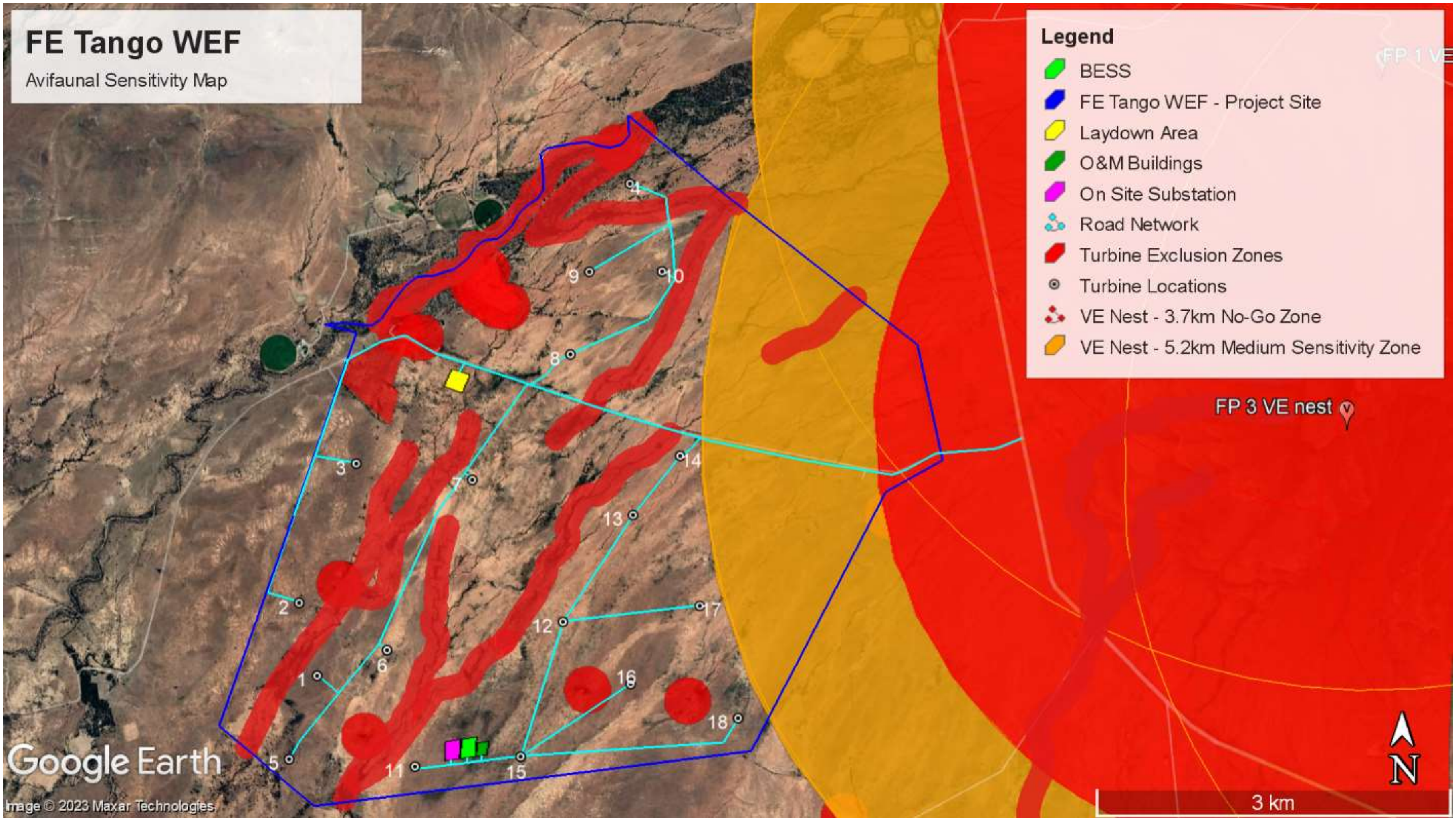
» Unacceptable loss
» Complete or whole-scale changes to the environment or sense of place
» Unacceptable increase in impact

The specialist is required to conclude if the proposed development will result in any unacceptable loss or impact considering all the projects proposed in the area.

Example of a cumulative impact table:
Nature: Complete or whole-scale changes to the environment or sense of place (example)

Nature: **[Outline and describe fully the impact anticipated as per the assessment undertaken]**		
	Overall impact of the proposed project considered in isolation	***Cumulative impact of the project and other projects in the area***
Extent	Low (1)	High (3)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Low (4)	Moderate (6)
Probability	Probable (3)	Probable (3)
Significance	**Low (24)**	**Medium (36)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	No	Yes
Can impacts be mitigated?	Yes	Yes
Mitigation: "Mitigation", means to anticipate and prevent negative impacts and risks, then to minimise them, rehabilitate or repair impacts to the extent feasible. Provide a description of how these mitigation measures will be undertaken keeping the above definition in mind		
Residual Impacts: "Residual Risk", means the risk that will remain after all the recommended measures have been undertaken to mitigate the impact associated with the activity (Green Leaves III, 2014).		

APPENDIX E: AVIFAUNAL SENSITIVITY MAP



APPENDIX F: POST-CONSTRUCTION MONITORING

1 INTRODUCTION

The avifaunal post-construction monitoring at the proposed FE Tango WEF must be conducted in accordance with the latest version of the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy Project Sites in southern Africa* (Jenkins *et al*. 2011)[8].

2 AIM OF POST-CONSTRUCTION MONITORING

The avifaunal post construction monitoring aims to assess the impact of the wind farm by comparing pre- and post- construction monitoring data and to measure the extent of bird fatalities caused by the wind farm. Post-construction monitoring is therefore necessary to:

- Confirm as far as possible what the actual impacts of the wind farm are on avifauna; and
- Determine what mitigation is required if need be (adaptive management).

The proposed post-construction monitoring can be divided into three categories:

- Habitat classification;
- Quantifying bird numbers and movements (replicating baseline pre-construction monitoring)
- Quantifying bird mortalities.

Post-construction monitoring will aim to answer the following questions:

- How has the habitat available to birds in and around the wind farm changed?
- How has the number of birds and species composition changed?
- How have the movements of priority species changed?
- How has the wind farm affected priority species' breeding success?
- How many birds collide with the turbines? And are there any patterns to this?
- What mitigation is necessary to reduce the impacts on avifauna?

3 TIMING

Post-construction monitoring should commence as soon as possible after the first turbines become operational to ensure that the immediate effects of the facility on resident and passing birds are recorded, before they have time to adjust or habituate to the development. However, it should be borne in mind that it is also important to obtain an understanding of the impacts of the facility as they would be over the lifespan of the facility. Over time the habitat within the wind farm may change, birds may become habituated to, or learn to avoid the facility. It is therefore necessary to monitor over a longer period than just an initial one year.

4 DURATION

[8] Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2011. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. Produced by the Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa.

Monitoring should take place in Year 1 and 2 of the operational phase, and then repeated in Year 5 and every five years after that. After the first year of monitoring, the programme should be reviewed in order to incorporate significant findings that have emerged. This may entail the revision of the number of turbines to be searched, and the size of the search plots, depending on the outcome of the first year of monitoring. If significant impacts are observed and mitigation is required, the matter should be taken up with the operator to discuss potential mitigation. In such instances the scope of monitoring could be reduced to focus only on the impacts of concern.

5 HABITAT CLASSIFICATION

Any observed changes in bird numbers and movements at a wind farm may be linked to changes in the available habitat. The avian habitats available must be mapped at least once a year (at the same time every year), using the same methods which were used during pre-construction.

6 BIRD NUMBERS AND MOVEMENTS

In order to determine if there are any impacts relating to displacement and/or disturbance, all methods used to estimate bird numbers and movements during baseline monitoring must be applied as far as is practically possible in the same way to post-construction work in order to ensure maximum comparability of these two data sets. This includes sample counts of small terrestrial species, counts of large terrestrial species and raptors, focal site surveys and vantage point surveys according to the current best practice.

7 COLLISIONS

The collision monitoring must have three components:

- Experimental assessment of search efficiency and scavenging rates of bird carcasses on the site;
- Regular searches in the immediate vicinity of the wind farm turbines for collision casualties;
- Estimation of collision rates.

8 SEARCHER EFFICIENCY AND SCAVENGER REMOVAL

The value of surveying the area for collision victims is only valid if some measure of the accuracy of the survey method is developed. The probability of a carcass being detected and the rate of removal/decay of the carcass must be accounted for when estimating collision rates and when designing the monitoring protocol. This must be done in the form of searcher and scavenger trails twice a year.

9 COLLISION VICTIM SURVEYS

9.1 Aligning search protocols

The search protocol must be agreed upon between the bat and bird specialists to constitute an acceptable compromise between the current best practice guidelines for bird and bat monitoring.

Searches must begin as early in the mornings as possible to reduce carcass removal by scavengers. A carcass searcher must walk in straight line transects, 6 m apart, covering 3 m on each side. A team of searchers and one supervisor must be trained to implement the carcass searches. The searchers must have a vehicle available for transport per site. The supervisor must assist with the collation of the data at each site and to provide the data to the specialist in electronic format on a weekly basis. The specialists must ensure that the supervisor is completely familiar with all the procedures concerning the management of the data. The following must be sent to the specialist on a weekly basis:

- Carcass fatality data (hardcopy and scans as well as data entered into Excel spreadsheets);
- Pictures of any carcasses, properly labelled;
- GPS tracks of the search plots walked; and
- Turbine search interval spreadsheets.

When a carcass is found, it must be bagged, labeled and kept refrigerated for species confirmation when the specialist visits the site.

9.2 Estimation of collision rates

Observed mortality rates need to be adjusted to account for searcher efficiency and scavenger removal. There have been many different formulas proposed to estimate mortality rates. The available methodologies must be investigated, and an appropriate method will be applied. The current method which is used widely is the GenEst method.

10 DELIVERABLES

10.1 Annual report

An operational monitoring report must be completed at the end of each year of operational monitoring. As a minimum, the report must attempt to answer the following questions:

- How has the habitat available to birds in and around the wind farm changed?
- How has the number birds and species composition changed?
- How have the movements of priority species changed?
- How has the wind farm affected priority species' breeding success?
- What are the likely drivers of any changes observed?
- How many, and which species of birds collided with the turbines and
- associated infrastructure? And are there any patterns to this?
- What is the significance of any impacts observed?
- What mitigation measures are required to reduce the impacts?

10.2 Quarterly reports

Concise quarterly reports must be provided with basic statistics and any issues that need to be red flagged.

OBJECTIVE: Minimizing the displacement of priority species due to disturbance during the construction phase

Project component/s	All infrastructure
Potential Impact	Displacement of priority species
Activity/risk source	Construction activities resulting in the displacement of priority species due to disturbance
Mitigation: Target/Objective	Reducing sources of disturbance to the absolute minimum to minimise the potential displacement of priority species

Mitigation: Action/control	**Responsibility**	**Timeframe**
A site-specific Environmental Management Plan (EMPr) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted. All contractors are to adhere to the EMPr and should apply good environmental practice during construction. The EMPr should include the following directives: • Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible, and in particular to the proposed road network. Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Removal of vegetation must be restricted to a minimum and must be rehabilitated to its former state where possible after construction. • Construction of new roads should only be considered if existing roads cannot be upgraded. • Vehicle and pedestrian access to the site should be controlled and restricted as much as possible to prevent unnecessary disturbance of priority species.	Contractor	Construction Phase

Performance Indicator	Audit reports by the Environmental Control Officer (ECO)
Monitoring	Weekly inspections by the ECO to assess if the requirements of the EMPr are adhered to by the Contractor

OBJECTIVE: Preventing the displacement of priority species due to habitat transformation during the operational phase

Project component/s	Infrastructure footprint, including the turbines, roads and buildings
Potential Impact	Displacement of priority species

Activity/risk source	Operational activities resulting in the displacement of priority species due to habitat transformation
Mitigation: Target/Objective	Reducing sources of habitat transformation to the absolute minimum to minimise the potential displacement of priority species

Mitigation: Action/control	**Responsibility**	**Timeframe**
A site-specific Environmental Management Plan (EMPr) must be implemented, which gives appropriate and detailed description of how operational activities must be conducted. All operational staff and contractors are to adhere to the EMPr and should apply good environmental practice during operations. The EMPr should include the following directives: • Once operational, vehicle and pedestrian access to the site should be controlled and restricted to prevent unnecessary destruction of vegetation. • Formal live-bird monitoring should be resumed once the turbines have been constructed, as per the most recent edition of the Best Practice Guidelines (Jenkins et al. 2015). The purpose of this would be to establish if displacement of priority species has occurred and to what extent. The exact time when operational monitoring should commence, will depend on the construction schedule, and should commence when the first turbines start operating. The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter for the operational lifetime of the facility. • The mitigation measures proposed by the botanical specialist, including rehabilitation, must be strictly implemented. • Excavated rocks should be removed, or all infilling for road construction should be compacted and all lose rock piles at the base or periphery of such infilling should be covered and packed down to eliminate all potential crevices and shelter for small mammals such as Rock Hyraxes (the primary source of food for the Verreaux's Eagles).	Wind farm operator	Operation Phase

Performance Indicator	Quarterly and annual reports by vegetation and avifaunal specialists
Monitoring	Weekly carcass searches under turbines and quarterly live bird surveys

OBJECTIVE: Preventing the mortality of priority species due to turbine collisions during the operation phase

Project component/s	Wind turbines
Potential Impact	Mortality of priority species
Activity/risk source	Operational activities resulting in the mortality of priority species due to collisions with the turbines
Mitigation: Target/Objective	Keeping the annual estimated mortality of local populations of priority species due to turbine collisions to below the threshold determined by the avifaunal specialist in consultation with other avifaunal experts e.g., BLSA.

Mitigation: Action/control	**Responsibility**	**Timeframe**
A site-specific Environmental Management Plan (EMPr) must be implemented, which gives appropriate and detailed description of how operational activities must be conducted. All operational staff and contractors are to adhere to the EMPr and should apply good environmental practice during operations. The EMPr should include the following directives: • A 200m turbine exclusion zone should be implemented around boreholes and dams and a 100m turbine (including rotor-swept area) exclusion zone on either side of drainage lines (**Appendix E**) – a KMZ with coordinates of dams can be provided. The exclusion zone should also exclude the rotor swept area of the turbines. • All wind turbines must have one blade painted according to a CAA approved pattern to reduce the risk of raptor collisions. It is acknowledged that blade painting as a mitigation strategy is still in an experimental phase in South Africa, but research indicates that it has a very good chance of reducing raptor mortality, based on research conducted in Norway (see Simmons et al. 2021 (Appendix H) for an explanation of the science and research behind this mitigation method). • Carcass searches must commence to establish mortality rates, as per the most recent edition of the Best Practice Guidelines (Jenkins et al. 2015). The exact time when operational monitoring should commence, will depend on the construction schedule, and should commence when the first turbines start operating. The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter for the operational lifetime of the facility.	Contractor Wind farm operator	Operational phase The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated in year 5, and again every five years thereafter for the operational lifetime of the facility.

• Should any mortalities of the following collision prone species of conservation concern (Black Harrier (see section 3.5 above) and Verreaux's Eagle) be recorded, an observer led shutdown on demand (SDoD) programme should be considered for rapid implementation at the WEF, targeting these species. • Furthermore, if annual estimated collision rates of other species of conservation concern indicate unsustainable mortality levels of priority species, i.e. if natural background mortality together with the estimated mortality caused by turbine collisions exceeds a critical mortality threshold as determined by the avifaunal specialist in consultation with other experts e.g. BLSA, additional measures will have to be implemented which could include shutdown on demand. This must be undertaken in consultation with a qualified avifaunal specialist.		

Performance Indicator	Quarterly and annual reports by avifaunal specialist
Monitoring	Weekly carcass searches under turbines

OBJECTIVE: Preventing the mortality of priority species on the 33kV overhead lines and substations

Project component/s	MV network and substation
Potential Impact	Mortality of priority species
Activity/risk source	Operational activities resulting in the mortality of priority species due to electrocution and collisions
Mitigation: Target/Objective	Keeping the annual estimated mortality of local populations of priority species due to powerline mortality to below the threshold determined by the avifaunal specialist in consultation with other avifaunal experts e.g. BLSA.

Mitigation: Action/control	**Responsibility**	**Timeframe**

• Overhead lines should be restricted to an absolute minimum and should only be allowed if underground cabling is unfeasible due technical (not financial) constraints.
• The final pole designs must be signed off by the bird specialist to ensure that a bird-friendly design is used, where relevant.
  • Bi-monthly inspections of the overhead sections of the MV network must be conducted to look for carcasses under the poles.
  • With regards to the infrastructure within the substation yard, the hardware is
	Wind farm developer
	
	Wind farm operator
		Design phase and Operational Phase
		
		The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated in year 5, and again every five years thereafter for the operational lifetime of the facility.

too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if any impacts are recorded once operational, site specific mitigation be applied reactively. This must be undertaken in consultation with the avifauna specialist. • Bird flight diverters should be installed on all 33kV overhead lines on the full span length on the earthwire (according to Eskom guidelines - five metres apart). Light and dark colour devices must be alternated to provide contrast against both dark and light backgrounds respectively. These devices must be installed as soon as the conductors are strung.		This should include the monthly inspections of the overhead sections of the MV network, where relevant.

Performance Indicator	Quarterly and annual reports by avifaunal specialist
Monitoring	Bi-monthly powerline inspections

APPENDIX H: BLADE PAINTING AS MITIGATION

Coloured-blade mitigation at Africa's wind farms to reduce eagle deaths: implementation, challenges and solutions

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Introduction

The recent publication of the ground-breaking experimental study of black-blade mitigation at an operational wind farms in Norway (May et al. 2020) has opened up a new and exciting method that could reduce avian fatalities at wind farms in other, more biologically diverse area of the world where renewable energies are being rolled out. This contribution :

- Explains what black/coloured-blade mitigation is
- Outlines the theory behind the black-blade mitigation
- Outlines the field test of the idea
- Summarises the challenges for rolling it out in Africa
- Assesses what it could mean for reducing raptor fatalities in Africa

Figure 1: The single black-blade in the process of being painted in situ, at the Smøla Wind Farm. Painting white blades black after they are erected is more expensive than producing them at source.

Rationale

Research around the world has shown that avian populations are declining due to climate change effects arising from increasing temperature and decreased rainfall in arid areas (www.ipcc.ch/, Thomas et al. 2004, Simmons et al. 2004, Phipps et al. 2017). In the USA, non-renewable fossil fuel energy sources are estimated to kill ~14.5 million birds annually, whereas green wind energy kills about 234 000 birds per year (Sovacool 2013, Loss et al. 2013). That is a 62-fold difference and a powerful environmental argument in support of renewable energy for our future needs. But while wind farms have many positive effects, they also pose some environmental challenges, particularly where wind farms are poorly positioned (on migration corridors for example Smallwood references).

In Africa two data sets on avian fatalities indicate that an average of 2.0 bird (adjusted) fatalities occur per MW per year in South Africa (Perold et al. 2020), and at one farm 1 raptor per month is killed of which 17% are breeding red data raptors (Simmons and Martins 2018). With about 2294 MW already being produced by 27 operational farms here in 2019 (energy.org.za), the cumulative impacts of South African wind farms alone are in excess of 4500 birds annually. If about 36% (>1600 birds per annum) are predicted to be raptors (Ralston-Paton et al. 2017) and about 17% (Simmons and Martins 2018) are known to be red data species, then an estimated 280 red data raptors are likely to be killed per year in South Africa in 2020. Since taller and longer-bladed turbines kill significantly more birds (Loss et al. 2013) and bats (Barclay et al. 2007) then Africa's threatened birds face increasing risks.

The need for urgent mitigations to reduce these costs is at a premium. Enter the coloured-blade mitigation.

What is coloured-blade mitigation?

This is a new mitigation technique in which one of the three white blades on a wind turbine are painted black (figure 1). About two thirds of the blade to the tip is painted this way. This is designed to increase visibility and decrease avian impacts (May et al. 2020). Since Civil Aviation in South Africa does not allow black but does allow "Signal Red" we propose that this is used in experiments here in South Africa. The amount of paint required can also be reduced by using the two-strip patterning shown in the experiments of McIsaac (see below).

Why black-blade mitigation?

Several innovative mitigation measures have recently been proposed for wind farms (flashing UV lights, automated shut-down-on demand, habitat management: May et al. 2017) and in a few cases have reduced collisions. However, developers are reticent to implement these.

The idea for **Black-blade mitigation** arose from work by Hodos (2003) who argued that a bird's retina views moving objects differently at different distances and as the bird gets close to a fast-moving object, the retinal image is moving so fast that the birds' brain can no longer process it. This was dubbed "motion smear" and means that birds approaching a fast-moving object no longer see it, with disastrous consequences. He suggested that a single coloured-blade may break up the motion smear. This is supported by recent work from Sweden (Potier et al. 2018) who show that raptors, despite their very high visual acuity, have very poor contrast abilities (poorer than humans). So, a coloured blade may be even better than a black one. So, a light (white) blade against a bright background is unlikely to be seen. But a black or coloured one is.

What is the evidence that it works?

Black-blade mitigation was field-tested by May et al. (2020) at the Smøla wind farm in 2013 in Norway over 3.5 years. On Smøla, White-tailed Eagles *Haliaeetus albicilla* are being killed at a very high rate by collision with the turbine blades. Four turbines were painted with a single black-painted blade in summer 2013. The black-painted turbines killed (i) 71% fewer total birds and (ii) 100% fewer eagles relative to unpainted blades.

Even more exciting in 2020 still no eagles have been killed at the coloured-blade turbines since 2013. In other words, no more eagles were killed in the 11-year experiment (starting 7.5 years before painting (2006-2013) and in situ 3.5 years after painting (2013-2016) (May et al.

2020). This despite 45-50 territorial pairs present on the island of Smøla (Dahl et al. 2012). The white-bladed turbines, however, are still killing birds at an average of 6 eagles per year (B. Iuell in litt.).

We see little reason why coloured blade – in the form of **Signal-red**, approved by Civil Aviation, would not work as well. This is because raptors see well in the colour spectrum (i.e. with the cones in the retina as opposed to the rods which see in black and white).

What are the visual impacts?

Discussions with wind farm managers in South Africa and Kenya suggest that visual effects are among the possible negative perceptions. We, therefore, requested the Smøla managers to supply us with images and videos of the turning blades to determine the effects.

Figure 1: The black-blade set up on a cloudy day in Norway is shown left. The black-blade (far turbine) is little different to the shadow cast by the all-white blades in the foreground © Bjorn Iuell.

The effect can be seen in the video kindly provided by Arild Soleim at www.birds-and-bats.com/specialist-studies. This shows little to no visual flicker or intrusion on the landscape from a single coloured-blade, and this concern is largely negated for all but the most sensitive human observer. It also has the effect of making the blade appear slower as one follows the black blade itself.

We argue that the benefits (no eagles killed) far outweigh the costs (initial costs to produce the coloured-blades). And once the blades are installed there will be no further costs as there are with competing mitigations (DT bird, or observer-operated shut-downs).

Black blade and Civil Aviation – white blades are not the most conspicuous

South African Civil Aviation state that white is "to provide the maximum daytime conspicuousness" However this statement was tested by McIsaac (2003) and he found that white is NOT the most conspicuous colour for either a moving blade or a stationary one

Embedded in the experiments undertaken by McIsaac's (2003) on kestrels is this very revealing graphic showing how human observers perceive the same patterns (including pure white).

Raptor Acuity and Wind-Turbine Blade Conspicuity

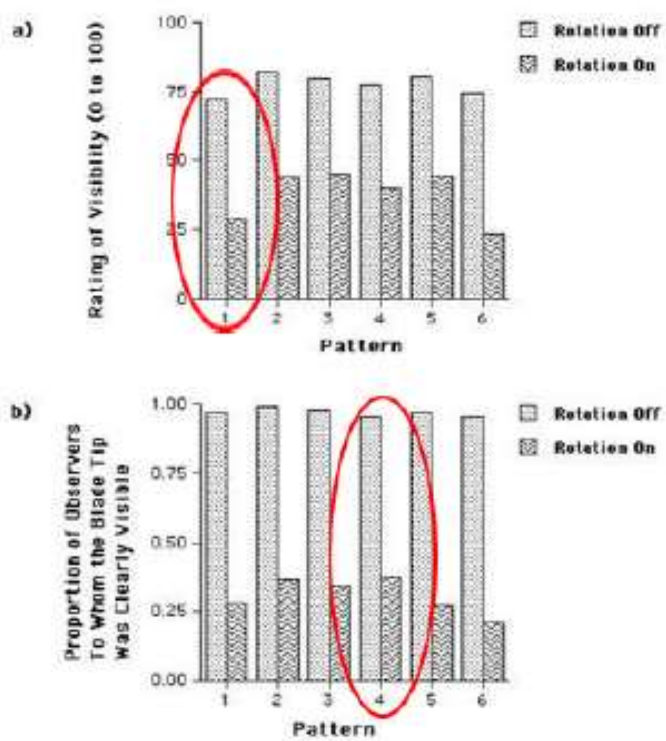

FIGURE 10. Human-perceived blade-pattern conspicuity: two-factor interactions of pattern and rotation. *These diagrams show the relationship between blade-pattern conspicuity and the effects of rotation. Illustrations of the blade patterns are presented in Fig. 9. Both blade pattern and rotation significantly affected conspicuity. Two ratings of pattern conspicuity are presented, a) full-blade visibility ratings, b) blade-tip visibility ratings.*

- **The pure white blade [pattern 1] was perceived as <u>less visible</u> by human observers than 5 of the other 6 patterns used whether the blades were spinning or not (top graph)**
- The <u>tip</u> of the pure white blade [pattern 1] was also perceived as less visible by human observers than 4 of the other 6 patterns used whether the blades were spinning or not (bottom graph)
- Like the Kestrels being tested, human observers saw patterned blades (patterns 2,3,4,5,6) better than pure white [pattern 1].

So, the CAA assumption that white is the most conspicuous colour for humans is not supported by experimentation with either raptorial birds or humans.

Patterned blades are better for both humans and raptors.

It is very important the South African Civil Aviation Authority is aware of these findings. Why? Because their guiding documents on painting of tall structures (**139.01.30 OBSTACLE LIMITATIONS AND MARKINGS OUTSIDE AERODROME OR HELIPORT (effective 1 August 2012)**) makes the following statement under section in **1.14. Wind turbine generators (Windfarms)**

- (4) Windfarm Markings (page 12 of 16)
  Wind turbines shall be painted bright white to provide the maximum daytime conspicuousness. The colours grey, blue and darker shades of white should be avoided altogether. If such colours have been used, the wind turbines shall be supplemented with daytime lighting, as required.

While this assumption that "bright white" would be most obvious to pilots and others, the experiments of McIsaac (2001) indicate that this is a false assumption. The pure white blade performed very poorly in the experiments of McIsaac (2001) and the patterned blade (No. 4 below) performed best of all.

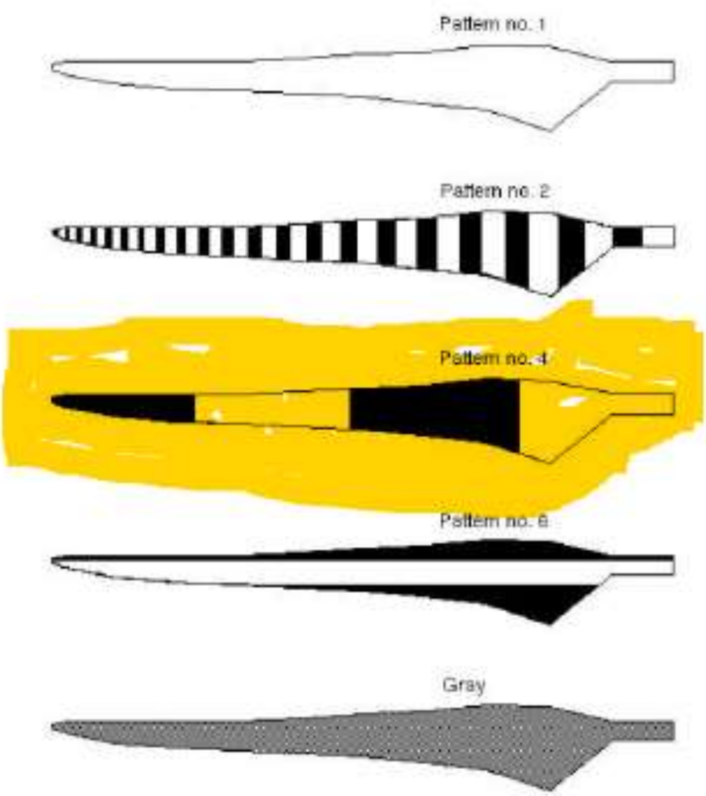

FIGURE 12. Kestrel-perceived blade-pattern conspicuity: stimulus blade patterns. *Depicted are the four black-and-white test patterns and the gray control pattern that were used to determine pattern conspicuity as perceived by a kestrel.*

Can it be applied in an African setting?

Given that eagles and raptors the world over probably see the landscape in similar ways there is a high probability that African eagles will see coloured-blades similarly well. Recent research on other raptors shows that despite their high visual acuity they see contrast more poorly than do humans (Potier, Milbus & Kelber 2019). This nicely explains why raptors take no avoiding action and are struck by white blades in the first place, and second why painting a blade black (increasing the contrast) increases the avoidance of those blades by eagles.

It also breaks up the "motion smear" researched by Hodos (2003) because he predicted a single black or coloured blade would increase the ability of birds to see movement in a set of fast-moving blade (the same effect can be seen by pilots of prop-driven planes, where one blade is painted differently). In an African setting the same can be seen on farmers' metal windmills where a blade is missing or painted on the rapidly spinning blades. Both increase the visual contrast and effect of movement.

The coloured-blade mitigation has yet to be rolled out in Africa – where it is urgently needed, given that we have over 100 species of raptors – more than any other continent (Clark and Davies 2018). Red blade tips have, however, already been used at the Ysterfontein Wind farm in the Western Cape, setting a precedent for their use elsewhere in South Africa.

Figure 2: Red-tipped turbine-blades on turbines at the Ysterfontein wind farm north west of Clanwilliam in the Western Cape (S 32° 9'23.42" E 18°49'7.10"). While these mitigations are not used in the correct single-blade configuration used by the Norwegians, they set a precedent for turbine blades to be red-painted in South Africa © RE Simmons

We have been informed that this mitigation is indeed being rolled out at the Kobe wind farm site in Japan. And there are plans for testing it in the Netherlands (Arjen Schultinga of Innogy, to Iuell Bjorn, Senior Environmental Advisor at Smøla Wind farm.)

This suggests that General Electric Renewables (GE), a manufacture of wind turbine blades, are already in the market for coloured blades. Attempts to engage with GE Renewables through the internet have proven unsuccessful despite contact with officials there.

We as avian specialist recommend the coloured-blade version of the black blade mitigation because (i) it is likely to be seen even more clearly by raptors than black, (ii) South African Civil Aviation (Lizell Stroh) in correspondence with Birdlife SA and Birds & Bats Unlimited have suggested that "signal red" would be preferable to black as it already used for marking structures such as towers, and is approved by them and (iii) the red paint may heat up less than a black blade in an African environment.

Four more aspects to consider from experience at the Smøla wind farm:

(i) It will cost a fraction to paint while the rotor blades are still on the ground instead of installed at the hub. At Smøla the painting was done with the blades up on the tower in situ and proved quite costly. The cost of painting one blade (with the crane lift and specialised personnel) was K55,000 ($5900). For all four blades and all fees and disbursements included over 2 weeks (due mainly to inclement weather) the total cost was c. K750 000 ($79 000). This would have been negligible had the blades been painted on the ground or come pre-painted (B. Iuell pers comm).

(ii) Although not an issue at Smøla, potentially a black blade may increase the blade temperature with potential consequences for blade quality and operation. We noticed that the temperature in the turbine tower at ground level with a painted tower base was high in summer (Stokke et al. 2020); there the surface area is large and more localized, and, of course, is not moving. No such effect was noticed for the black-painted turbine blades and there was no effect of any imbalance of the blades from differential heating of the black blade.

(iii) Smøla wind farm was not allowed to paint turbines which were constructed in the second construction stage due to insurance issues. Thus, guarantees with the blade manufacturers must be secured before the painting takes places – and preferably come pre-manufactured with a blade already painted red or black.

(iv) Each blade weighed 9 tonnes and the blade were painted with Carboline Windmastic TopCoat HSX. Two coats were applied and weighed approximately 60 kg. This is about 0.66% the weight of the blade and no mechanical effects were apparent. On inspection of the paint there was no wear or cracking apparent (B Iuell pers comm).

It is for influential players such as those in the South African Wind Energy Association and other wind farm developers, their governing bodies and avian conservation organisations to lobby the main players such as General Electric and Siemens to roll out this form of mitigation to reduce to a minimum the thousands of raptors deaths likely in future years. Without black or coloured blades on Africa's turbines we will continue to see the high fatality rates already apparent at some wind farms in South Africa (Simmons and Martins 2018, Perold et al. 2020).

With black-blade mitigation now shown to be highly effective in reducing eagle deaths in Norway, there is a great incentive for wind farm developers elsewhere to enact the coloured blade mitigation to reduce raptor deaths, particularly since it has no operational costs once installed.

Acknowledgments

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Figure 3: A 4-year old Martial Eagle, struck by a white-bladed turbine, plummets to the earth at an Eastern Cape wind farm. Deaths like this could be reduced or avoided with black/coloured blade mitigation . © RE Simmons

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