Appendix G.4

AVIFAUNAL REPORT

AVIFAUNAL SPECIALIST REPORT

Scoping and Environmental Impact Assessment (EIA)

For the Proposed Development of the Phefumula Emoyeni One Wind Energy Facility and associated infrastructure, near Ermelo, Mpumalanga Province

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April 2025

Executive Summary

The proposed up to 550MW Phefumula Emoyeni One WEF is located approximately 16km north of the town of Ermelo in the Msukaligwa Local Municipality and Gert Sibande District Municipality, in Mpumalanga Province, South Africa. The proposed Phefumula Emoyeni One WEF will be developed within a project area of approximately 33 660 hectares (ha). The site will be accessed via the N11 and existing access roads.

This report serves as the Avifaunal Impact Assessment (IA) Report prepared as part of the Scoping and Environmental Impact Assessment (S&EIA) for the proposed Project.

Avifauna

A total of 224 species could potentially occur within the Broader Area where the Project Site is located (see **Appendix E**). Of these, 40 are classified as priority species for wind energy developments. Of these 40 priority species, 37 have a medium to high likelihood of occurring regularly in the Project Area of Influence (Project Site). Of the 40 priority species, 37 have been recorded during the on-site field surveys (four sets of surveys completed). Eighteen (18) priority species recorded in the Broader Area are also Species of Conservation Concern (SCC). Twelve (12) SCC have been recorded during the on-site field surveys namely, African Marsh Harrier (Regionally Endangered), Black Harrier (Globally and Regionally Endangered), Black Stork (Regionally Vulnerable), Black-winged Pratincole (Globally and Regionally Near-Threatened), Blue Crane (Globally Vulnerable and Regionally Near-Threatened), Cape Vulture (Globally Vulnerable and Regionally Endangered), Denham's Bustard (Globally Near-Threatened and Regionally Vulnerable), Lanner Falcon (Regionally Vulnerable), Martial Eagle (Globally and Regionally Endangered), Pallid Harrier (Globally and Regionally Near-Threatened), Secretarybird (Globally Endangered and Regionally Vulnerable) and Southern Bald Ibis (Globally and Regionally Vulnerable).

Identification of Potential Impacts/Risks on Priority Avifauna

The potential impacts identified during the study are listed below.

<u>Construction Phase</u>

- Total or partial displacement due to noise disturbance and habitat transformation associated with the construction of the wind turbines and associated infrastructure.

<u>Operational Phase</u>

- Total or partial displacement due to habitat transformation associated with the presence of the wind turbines and associated infrastructure.
- Collisions with the wind turbines.
- Electrocutions at the on-site substation and on the overhead sections of the internal 33kV network.
- Collisions with overhead sections of the internal 33kV network.

<u>Decommissioning Phase</u>

- Total or partial displacement due to disturbance associated with the decommissioning of the wind turbines and associated infrastructure.

Cumulative Impacts

- Total or partial displacement due to disturbance and habitat transformation associated with the construction and decommissioning of the wind energy facility and associated infrastructure.
- Displacement due to habitat transformation associated with the presence of the wind turbines.
- Collisions with the wind turbines.
- Collisions with the internal 33kV network.
- Electrocutions at the on-site substations and on the internal 33kV network.

Sensitivities identified by the National Web-Based Environmental Screening Tool

The Project Site contains confirmed habitat for Species of Conservation Concern (SCC), primarily for African Grass Owl and Secretarybird (Globally Endangered and Regionally Vulnerable), as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020). Twelve (12) SCC have been recorded during the on-site field surveys thus far namely, African Marsh Harrier (Regionally Endangered), Black Harrier (Globally and Regionally Endangered), Black Stork (Regionally Vulnerable), Black-winged Pratincole (Globally and Regionally Near-Threatened), Blue Crane (Globally Vulnerable and Regionally Near-Threatened), Cape Vulture (Globally Vulnerable and Regionally Endangered), Denham's Bustard, Lanner Falcon (Regionally Vulnerable), Martial Eagle, Pallid Harrier (Globally and Regionally Near-Threatened), Secretarybird and Southern Bald Ibis.

Based on the Site Sensitivity Verification survey and the integrated pre-construction monitoring conducted at the Project Site, the classification of **High Sensitivity** for avifauna is advocated for the Phefumula Emoyeni One WEF.

Specialist Sensitivity Analysis and Verification

- ***Very High Sensitivity: All Infrastructure Exclusion Zones***

Included in this category are:

Martial Eagle nest: a 2.5km all infrastructure exclusion zone should be implemented and maintained around the identified Martial Eagle nest (coordinates can be provided) to avoid displacement and/or breeding failure due to disturbance.

Secretarybird nests: a 500m all infrastructure exclusion buffer zone should be implemented and maintained around the two identified Secretarybird nests (coordinates can be provided) to avoid displacement and/or breeding failure due to disturbance. Given the lack of nest site fidelity of this species, and in order to manage the risk of known shifts in nest sites across breeding seasons[1], we recommend a proactive adaptive risk management plan that is underpinned by routine and systematic nest surveys in medium risk areas identified through habitat and flight risk modelling for this species (**Appendix K**). The proposed approach includes hierarchal tiers of risk management.

[1] A Secretarybird breeding event is characterized by behaviours associated with the establishment of a nest, including nest building and pre-breeding display flights. Secretarybird nesting and breeding will be monitored throughout the WEF site using a hierarchal tiered approach and SDoD will be applied accordingly to reduce the risk of displacement and/or turbine collisions. Refer to **Appendix K** for details.

Prior to the Operational Phase of the WEF all tree structures across the Project Site will be mapped by generating a canopy height model and applying a tree structure criteria-based model (Appendix K, Tier 0, action 1). Secretarybird management zones across the WEF site will be delineated (tier 0 action 2) using the mapped tree structures, known nests sites and flight risk modelled outputs. During the operational phase of the WEF monthly orthophoto assessments will be conducted to monitor the prioritized management zones to identify active nest and roost structures (Appendix K, tier 1). If active nests/roosts are identified SDoD and/or automated curtailment is recommended to be implemented. Refer to **Appendix K** for further details.

Southern Bald Ibis colonies: a 1km all infrastructure exclusion buffer zone should be implemented and maintained around the three identified Southern Bald Ibis colonies (coordinates can be provided) to avoid displacement and/or breeding failure due to disturbance.

Avifaunal wetland use/delineation[2]: modelled core buffer zones using habitat preference of key focal species: African Marsh Harrier, African Grass Owl, Striped Flufftail, Grey Crowned Crane.

- ***High Sensitivity: Turbine Exclusion Zones (Other Infrastructure Allowed)***

Included in this category are:

Wetland habitat suitability modelling was used to inform and determine Turbine Exclusion Zones. The buffer zones must be classified as rotor swept free zones. Wetlands (including dam margins) are important breeding, roosting, and foraging habitat for a variety of Species of Conservation Concern (SCC), most notably for African Grass Owl (Regionally Vulnerable), Greater Flamingo (Regionally Near Threatened), Yellow-billed Stork (Regionally Endangered), and Blue Crane (Regionally Near Threatened) – See Section **5.9.7 Flight Risk & Habitat Suitability Modelling** for detailed methodology explanation.

Modelled Rudd's Lark habitat areas to prevent displacement of the birds due to disturbance and habitat destruction – See Section **5.9.7 Flight Risk & Habitat Suitability Modelling** for detailed methodology explanation.

Modelled Yellow-breasted Pipit habitat areas to prevent displacement of the birds due to disturbance and habitat destruction – See Section **5.9.7 Flight Risk & Habitat Suitability Modelling** for detailed methodology explanation.

Modelled suitable habitat buffers around core habitat areas for **Lesser Flamingo and Greater Flamingo** to prevent displacement of the birds due to disturbance and to reduce the risk of turbine collisions – See Section **5.9.7 Flight Risk & Habitat Suitability Modelling** for detailed methodology explanation.

Avifaunal wetland use/delineation: modelled turbine exclusion buffer zones using habitat preference of key focal species: African Marsh Harrier, African Grass Owl, Striped Flufftail, Grey Crowned Crane.

Southern Bald Ibis colonies - A shaped turbine exclusion zone has been delineated based on modelled flight activity. The modelling workflow incorporated all the flight data collected within the area

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[2] An aquatic specialist primarily focuses on the infrastructure footprint, while considerations from an avian perspective involve more aspects, such as suitable avifaunal microhabitats (such as moist grasslands) surrounding the actual wetland footprint. For this reason, bird habitats were evaluated from both wetland and aquatic viewpoints, independent of the aquatic specialist's perspective. A delineation was made with an associated buffer area to account for the blade swept area. It is also essential to consider the flight paths of birds and their movements across the landscape, which significantly differs from what the aquatic specialist would take into account. Thus, there is a clear differentiation between these two aspects from both an avifauna and aquatic perspective.

during the pre-construction monitoring. The model identifies high risk flight areas by considering associations between the underlying habitat and topography in relation to the recorded Southern Bald Ibis flight data and proximity to roosts – See Section **5.9.7 Flight Risk & Habitat Suitability Modelling** for detailed methodology explanation.

Secretarybird nests - A shaped turbine exclusion zone has been delineated based on modelled flight activity. The modelling workflow incorporated all the flight data collected within the area during the pre-construction monitoring. The model identifies high risk flight areas by considering associations between the underlying habitat and topography in relation to the recorded Secretarybird flight data and proximity to nests.

Black Sparrowhawk nests: a 250m wind turbine exclusion zone (including the rotor swept area) should be implemented and maintained around the two identified Black Sparrowhawk nests (coordinates can be provided (one nest is located on site while the other nest was located approximately 5-6km south of the project area) to minimise the risk of collisions and to avoid displacement due to disturbance.

Martial Eagle nest: A shaped turbine exclusion zone has been delineated based on modelled flight activity. The modelling workflow incorporated all the flight data collected within the area during the pre-construction monitoring. The model identifies high risk flight areas by considering associations between the underlying habitat and topography in relation to the recorded Secretarybird flight data and proximity to nests.

Heronry: a 300m wind turbine exclusion zone (including the rotor swept area) should be implemented and maintained around the heronry to minimize the risk of collisions and to avoid displacement due to disturbance.

Natural pans: A 2km wind turbine exclusion zone (including the rotor swept area) should be implemented and maintained around natural pans.

- ***Medium Sensitivity: Limited Infrastructure & Mitigation Zone***

A similar flight risk modelling workflow was used to delineate medium risk sensitivity zones where proactive mitigation measures (e.g. Turbine Shutdown on Demand, either observer led or automated) will be required. The modelling was done for the following species:

- Secretarybird,
- Southern Bald Ibis,
- Black-winged Pratincole,
- Rudd's Lark,
- Yellow-breasted Pipit.

Flocks of priority species: A Radar-based Shutdown on Demand (SDoD) system (or similar suitable alternative), operated by trained personnel is recommended for use to identify flocks of priority bird species at the site. Turbines that could pose a risk to these flocks will be shut down to reduce the likelihood of collisions. This type of system will also detect nocturnal movements of species such as flamingos, which often fly in flocks, and trigger turbine shutdowns when such movements are observed at night. The system's ability to differentiate specific species based on their unique size and flight characteristics, such as potentially Secretarybirds and Blue Cranes, will be used to initiate appropriate turbine shutdowns.

Flocking species of conservation concern that could regularly traverse Phefumula Emoyeni One WEF			
Species Name	**Scientific Name**	**Global Conservation Status**	**Regional Conservation Status**
Black Stork	Ciconia nigra	-	VU
Black-winged Pratincole	Glareola nordmanni	NT	NT
Blue Crane	Grus paradisea	VU	NT
Blue Korhaan	Eupodotis caerulescens	NT	LC
Denham's Bustard	Neotis denhami	NT	VU
Greater Flamingo	Phoenicopterus roseus	-	NT
Lesser Flamingo	Phoeniconaias minor	NT	NT
Maccoa Duck	Oxyura maccoa	EN	NT
Southern Bald Ibis	Geronticus calvus	VU	VU

High Sensitivity grassland: Natural grassland. Development in the remaining natural grassland in the Project Site must be limited as far as possible. Where possible, infrastructure must be located near margins, with the shortest routes taken from the existing roads. The natural grassland is a vital breeding, roosting, and foraging habitat for a variety of SCC. These include African Grass-owl (Globally Least Concern, Regionally Vulnerable), and Secretarybird (Globally Endangered, Regionally Vulnerable).

Figure i below is a combined avifaunal sensitivity map, indicating avifaunal sensitivity areas identified for the Phefumula Emoyeni One WEF Project Site.

The WEF layout has taken all the recommended avifaunal buffer zones into account. For more detailed maps please refer to Section 5.7 Specialist Sensitivity Analyses and Verification.

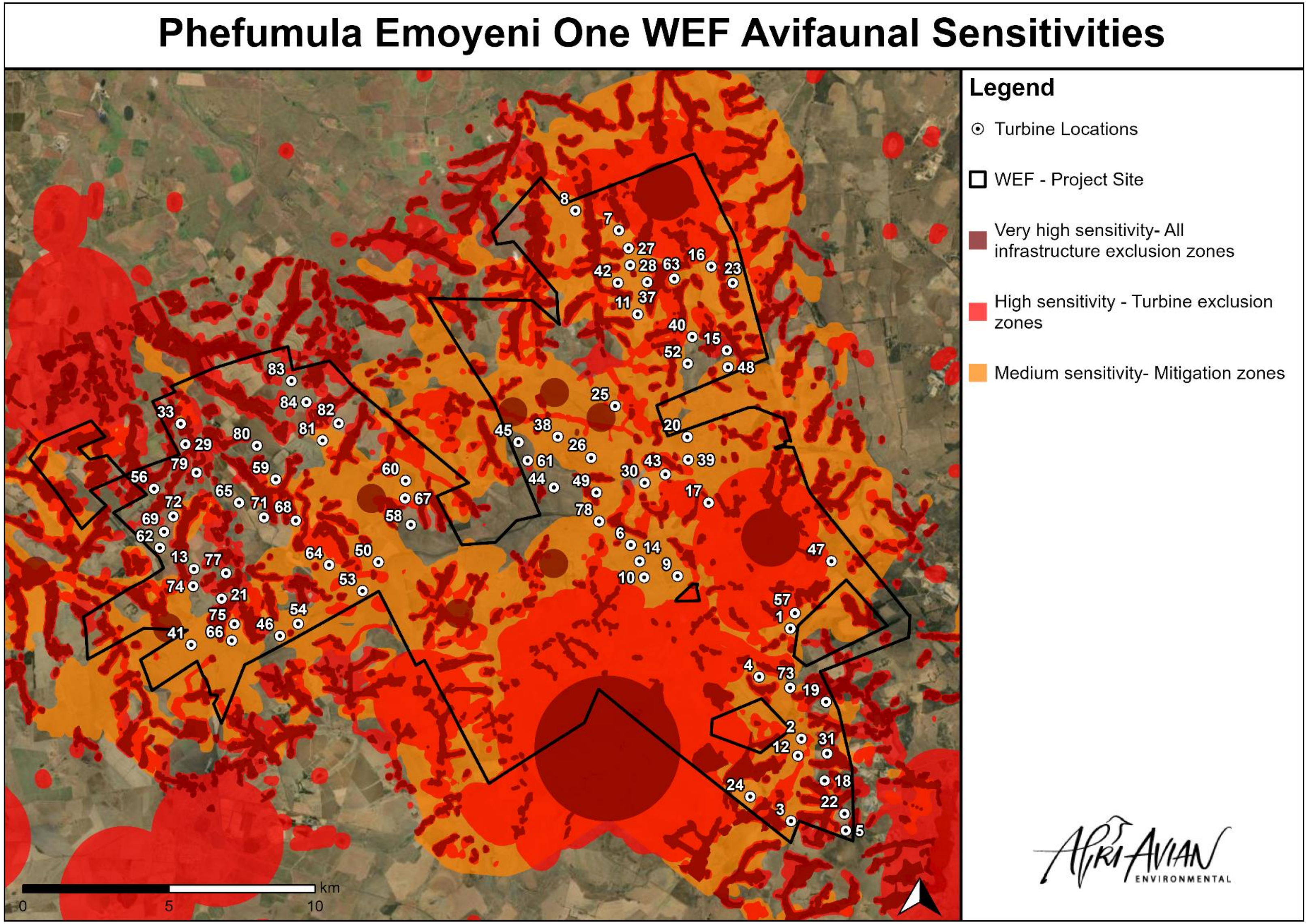

Figure i: Combined Avifaunal Sensitivities Map for the Phefumula Emoyeni One WEF. All Infrastructure Exclusion Zones = Dark Red, Wind Turbine Exclusion Zones = Red, Medium Risk Mitigation Zones = Orange.

Impact Assessment Summary

The overall impact significance is provided in the table below, in terms of pre- and post-mitigation.

Executive Summary Table: Overall Average Impact Significance (Pre- and Post-Mitigation)

Phase	Overall Impact Significance (Pre-Mitigation)	Overall Impact Significance (Post Mitigation)
Construction	Moderate	Moderate
Operational	High	Moderate
Decommissioning	Moderate	Moderate

Conclusions

The proposed Phefumula Emoyeni One WEF will have high and medium impacts on avifauna that could be reduced to medium and low impacts through the implementation of appropriate mitigation measures. During the EIA Phase of the Project individual turbine locations were assessed and evaluated on a case-by-case basis to determine the best placement in order to avoid high risk zones. No fatal flaws are expected; however, **the mitigation measures listed in this report (Section 7.8 and Appendix H) should be strictly applied and adhered to. See Section 5.7 for maps of the current exclusion areas.**

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List of Abbreviations

BLSA	BirdLife South Africa
DFFE	Department of Forestry, Fisheries and Environment
NEMA	National Environmental Management Act 107 of 1998 (as amended)
REDZ	Renewable Energy Development Zone
S&EIA	Scoping and Environmental Impact Assessment
SABAP	Southern African Bird Atlas Project
SACNASP	South African Council for Natural and Scientific Professions
SANBI	South African National Biodiversity Institute
SCC	Species of Conservation Concern

WEF Wind Energy Facility

Table 1: Definitions of key terminology in this impact assessment report

Definitions	
Wind Priority Species	Priority species for wind development were identified from the updated list of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Ralston-Paton *et al*., 2017; Retief *et al*., 2012).
Broader Area	The area encompassed by the four pentads where the Project Site is located.
Project Site	The area covered by the land parcels where the project will be located, totalling approximately 33 660 hectares.
Pentad	A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km.

1. Project Description

The proposed up to 550MW Phefumula Emoyeni One WEF is located approximately 16km north of the town of Ermelo in the Msukaligwa Local Municipality and Gert Sibande District Municipality, in Mpumalanga Province, South Africa (**Figure 1**). The proposed Phefumula Emoyeni One WEF will be developed within a project area of approximately 33 660 hectares (ha). The site will be accessed via the N11 and existing access roads.

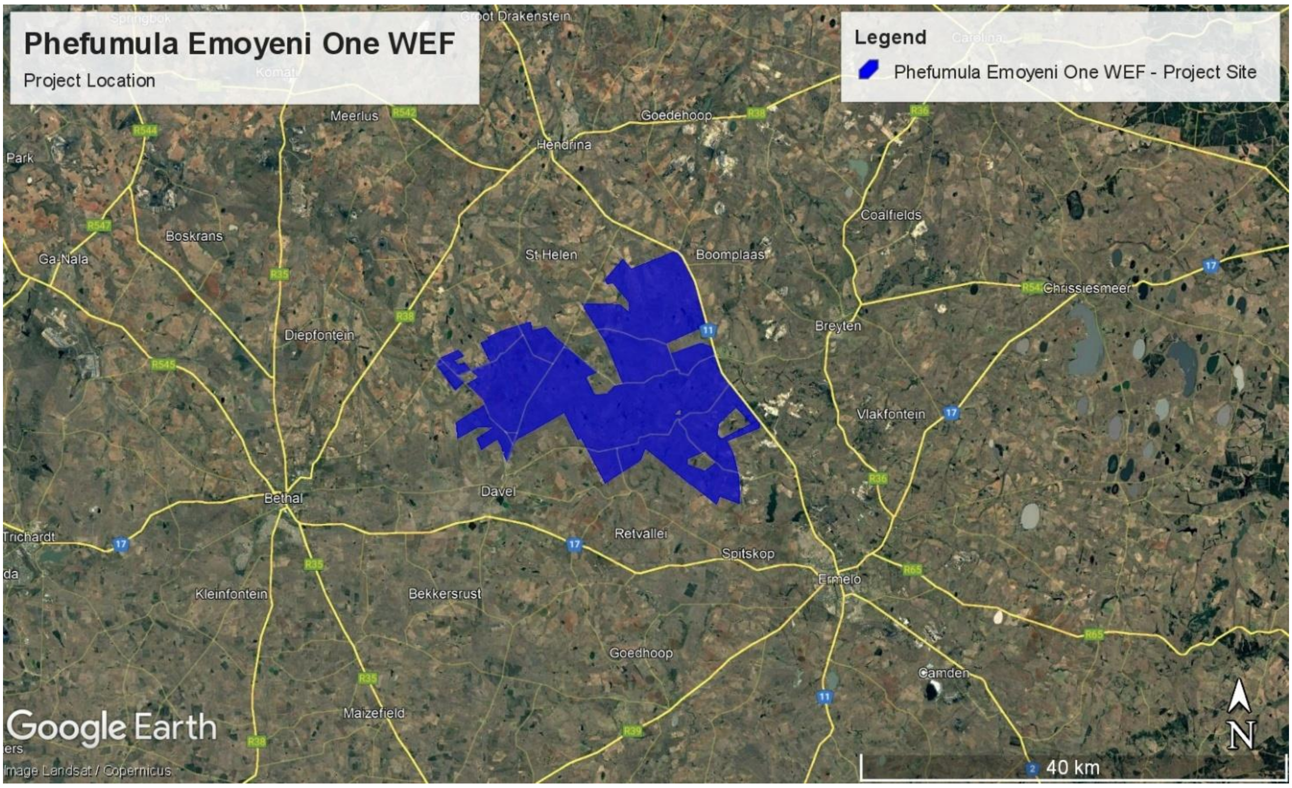

Figure 1: Phefumula Emoyeni One WEF - Locality Map.

The details of the properties associated with the proposed Phefumula Emoyeni One WEF are outlined below. There are 93 affected farm portions:

FARM NAME AND NUMBER	PORTION	21 DIGIT SURVEYOR GENERAL CODE OF EACH CADASTRAL LAND PARCEL
ISRAEL 207 IS	0	T0IS00000000020700000
BOSMANSKRANS 217 IS	0	T0IS00000000021700000
BOSMANSKRANS 217 IS	3	T0IS00000000021700003
BOSMANSKRANS 217 IS	4	T0IS00000000021700004
BOSMANSKRANS 217 IS	6	T0IS00000000021700006
BOSMANSKRANS 217 IS	7	T0IS00000000021700007
BOSMANSKRANS 217 IS	8	T0IS00000000021700008
BOSMANSKRANS 217 IS	9	T0IS00000000021700009
VAALBANK 233 IS	6	T0IS00000000023300006
KUILFONTEIN 234 IS	1	T0IS00000000023400001
KUILFONTEIN 234 IS	2	T0IS00000000023400002

FARM NAME AND NUMBER	PORTION	21 DIGIT SURVEYOR GENERAL CODE OF EACH CADASTRAL LAND PARCEL
KUILFONTEIN 234 IS	7	T0IS00000000023400007
KUILFONTEIN 234 IS	8	T0IS00000000023400008
KUILFONTEIN 234 IS	9	T0IS00000000023400009
KUILFONTEIN 234 IS	11	T0IS00000000023400011
KUILFONTEIN 234 IS	12	T0IS00000000023400012
KUILFONTEIN 234 IS	14	T0IS00000000023400014
KUILFONTEIN 234 IS	15	T0IS00000000023400015
KUILFONTEIN 234 IS	16	T0IS00000000023400016
KUILFONTEIN 234 IS	17	T0IS00000000023400017
KUILFONTEIN 234 IS	21	T0IS00000000023400021
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BOSMANSHOEK 235 IS	3	T0IS00000000023500003
WITBANK 236 IS	2	T0IS00000000023600002
WITBANK 236 IS	4	T0IS00000000023600004
WITBANK 236 IS	5	T0IS00000000023600005
WITBANK 236 IS	7	T0IS00000000023600007
WITBANK 236 IS	10	T0IS00000000023600010
WITBANK 236 IS	11	T0IS00000000023600011
WITBANK 236 IS	13	T0IS00000000023600013
NOOITGEDACHT 237 IS	0	T0IS00000000023700000
NOOITGEDACHT 237 IS	2	T0IS00000000023700002
NOOITGEDACHT 237 IS	4	T0IS00000000023700004
NOOITGEDACHT 237 IS	5	T0IS00000000023700005
NOOITGEDACHT 237 IS	7	T0IS00000000023700007
NOOITGEDACHT 237 IS	8	T0IS00000000023700008
NOOITGEDACHT 237 IS	9	T0IS00000000023700009
NOOITGEDACHT 237 IS	10	T0IS00000000023700010
NOOITGEDACHT 237 IS	11	T0IS00000000023700011
NOOITGEDACHT 237 IS	12	T0IS00000000023700012
NOOITGEDACHT 237 IS	13	T0IS00000000023700013
ORPENSKRAAL 238 IS	0	T0IS00000000023800000
ORPENSKRAAL 238 IS	2	T0IS00000000023800002
GELIKSDRAAI 240 IS	1	T0IS00000000024000001

FARM NAME AND NUMBER	PORTION	21 DIGIT SURVEYOR GENERAL CODE OF EACH CADASTRAL LAND PARCEL
GELIKSDRAAI 240 IS	2	T0IS00000000024000002
ELIM 247 IS	0	T0IS00000000024700000
KRANSPOORT 248 IS	0	T0IS00000000024800000
KRANSPOORT 248 IS	2	T0IS00000000024800002
KRANSPOORT 248 IS	3	T0IS00000000024800003
KRANSPOORT 248 IS	4	T0IS00000000024800004
KRANSPOORT 248 IS	6	T0IS00000000024800006
KRANSPOORT 248 IS	8	T0IS00000000024800008
KRANSPOORT 248 IS	9	T0IS00000000024800009
KRANSPOORT 248 IS	10	T0IS00000000024800010
KRANSPOORT 248 IS	11	T0IS00000000024800011
KRANSPOORT 248 IS	12	T0IS00000000024800012
KRANSPOORT 248 IS	13	T0IS00000000024800013
KRANSPOORT 248 IS	18	T0IS00000000024800018
KRANSPOORT 248 IS	19	T0IS00000000024800019
KRANSPOORT 248 IS	21	T0IS00000000024800021
KRANSPOORT 248 IS	22	T0IS00000000024800022
KRANSPOORT 248 IS	23	T0IS00000000024800023
TWEEFONTEIN 249 IS	1	T0IS00000000024900001
TWEEFONTEIN 249 IS	2	T0IS00000000024900002
TWEEFONTEIN 249 IS	3	T0IS00000000024900003
TWEEFONTEIN 249 IS	8	T0IS00000000024900008
TWEEFONTEIN 249 IS	9	T0IS00000000024900009
VOORZORG 250 IS	0	T0IS00000000025000000
NOOITGEDACHT 251 IS	0	T0IS00000000025100000
NOOITGEDACHT 251 IS	2	T0IS00000000025100002
NOOITGEDACHT 251 IS	5	T0IS00000000025100005
NOOITGEDACHT 251 IS	6	T0IS00000000025100006
NOOITGEDACHT 251 IS	7	T0IS00000000025100007
NOOITGEDACHT 251 IS	9	T0IS00000000025100009
NOOITGEDACHT 251 IS	10	T0IS00000000025100010
NOOITGEDACHT 251 IS	11	T0IS00000000025100011
SPION KOP 252 IS	1	T0IS00000000025200001
SPION KOP 252 IS	2	T0IS00000000025200002

FARM NAME AND NUMBER	PORTION	21 DIGIT SURVEYOR GENERAL CODE OF EACH CADASTRAL LAND PARCEL
UITZICHT 266 IS	4	T0IS00000000026600004
UITZICHT 266 IS	15	T0IS00000000026600015
DAVELFONTEIN 267 IS	7	T0IS00000000026700007
MIDDELPLAAT 271 IS	2	T0IS00000000027100002
MIDDELPLAAT 271 IS	3	T0IS00000000027100003
MIDDELPLAAT 271 IS	4	T0IS00000000027100004
MIDDELPLAAT 271 IS	5	T0IS00000000027100005
MIDDELPLAAT 271 IS	8	T0IS00000000027100008
DRIEHOEK 273 IS	0	T0IS00000000027300000
DRIEHOEK 273 IS	2	T0IS00000000027300002
DRIEHOEK 273 IS	1	T0IS00000000027300001
DRIEHOEK 273 IS	3	T0IS00000000027300003
DRIEHOEK 273 IS	7	T0IS00000000027300007
SPITSKOP 276 IS	59	T0IS00000000027600059
SPITSKOP 276 IS	68	T0IS00000000027600068
KRANSPOORT 827 IS	0	T0IS00000000082700000

This report serves as the Avifaunal Impact Assessment (IA) Report prepared as part of the Scoping and Environmental Impact Assessment (S&EIA) for the proposed Project.

The key project details for the Phefumula Emoyeni One WEF and associated infrastructure are in Table 2 below:

Table 2: Key project details for the Phefumula Emoyeni One WEF and associated infrastructure

Facility Name	Phefumula Emoyeni One Wind Energy Facility (WEF)
Applicant	Phefumula Emoyeni One (Pty) Ltd
Municipalities	Msukaligwa Local Municipality Gert Sibande District Municipality
Extent	33 660 ha
Buildable Area	Subject to finalization based on technical and environmental requirements
Capacity	Up to 550MW
No. of turbines	Up to 76
Turbine capacity	Between 6 MW and 15 MW each
Rotor Diameter	Up to 200m
Hub Height	Up to 200m
Turbine Foundations	Diameter of up to 40m per turbine – excavation up to 6 m deep, constructed of reinforced concrete to support the mounting ring. Once tower established, footprint of foundation is covered with soil.
Turbine Hardstand	Approximately 75m x 120m
Substation and internal powerlines	• 33kV cabling to connect the wind turbines to the onsite collector substations, to be laid underground where practical. • 3 x 33kV/132kV onsite collector substation (IPP Portion), each being up to 5ha.

	• Cabling between turbines, to be laid underground where practical
Construction camp and laydown area	• Construction compounds including site office (approximately 300m x 300m in total but split into 3ha each of 150m x 200m): • 3 x Batching plant of up to 4ha to 7ha. • 3 x construction compound / laydown area, including site office of 3ha each (150m x 200m each). • Laydown and crane hardstand areas (approximately 75m x 120m).
Internal Roads	12-13m wide roads with 12m radius turning circles, gravel surface
O&M Building	3 x O&M office of approximately 1.5ha each adjacent to each collector Sub Station.
Batching Plant	Up to 3 x Batching plants of up to 4ha to 7ha.
BESS	• Battery Energy Storage System (BESS) (200MW/800MWh). Type has not been confirmed at this stage. It is proposed that all impacts related to both types be assessed in the EIA. • Export Capacity of up to 200MW • Total storage capacity 800MW • Storage capacity of up to 6-8 hours • The BESS will be housed in containers covering a total approximate footprint of up to 5ha. • Battery types to be considered: Solid State Batteries as the preferred (Lithium Ion) and Redox Flow Batteries as the alternative (Vanadium Redox).

2. Legislative Context

2.1. Agreements and Conventions

Table 3 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 3: Agreements and conventions which South Africa is party to, and which is relevant to the conservation of avifauna[3].

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 to establish coordinated conservation and management of migratory waterbirds throughout their entire migratory range.	Regional

[3] (BirdLife International (2021) Country profile: South Africa. Available from: http://www.birdlife.org/datazone/country/south_africa.

Convention Name	Description	Geographic Scope
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 biological diversity The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.	Global
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

2.3. National Legislation

2.3.1. 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
- (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

2.3.2. The National Environmental Management Act 107 of 1998, as amended (NEMA)

The National Environmental Management Act 107 of 1998, as amended, (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 or basic 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.

The Protocol for the specialist assessment and minimum report content requirements for environmental impacts avifaunal species by onshore wind energy generation facilities where the electricity output is 20MW or more (Government Gazette No. 43110 – 20 March 2020) is applicable in the case of wind developments.

2.3.3. 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 (as amended) (NEMBA) 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.

2.3.4. Provincial Legislation

The current legislation applicable to the conservation of fauna and flora in Mpumalanga is the Mpumalanga Nature Conservation Act 10 of 1998. It consolidated and amended the laws relating to nature conservation within the province and provides for matters connected therewith. All birds are classified as Protected Game (Section 4 (1) (b)), except those listed in Schedule 3, which are classified as Ordinary Game (Section 4 (1)(c)).

3. Assumptions and Limitations

This study assumed that the sources of information used in this report are reliable. In this respect, the following must be noted:

- The SABAP2 data is regarded as an adequate indicator of the avifauna which could occur at the Project Site, and it is further supplemented with data collected during the on-site surveys.
- The focus of the study was on the potential impacts of the proposed WEF on wind energy priority species.
- 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 (Ralston-Paton *et al*., 2017; Retief *et al*., 2012).
- Despite the growing body of peer reviewed literature investigating the collision risks of birds with wind turbines and overhead power lines in South Africa (Section 6), relevant information for many individual species remains limited. 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: "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."
- The assessment of impacts is based on the baseline environment as it currently exists at the Project Site.
- Conclusions drawn in this study are based on experience of the specialists on the species found on site and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will be valid under all circumstances.
- The **Broader Area** is defined as the area encompassed by the 12 Second Southern African Bird Atlas Project (SABAP2) pentads where the project is located (**Figure *2***).
- The **Project Site** is defined as all the affected land parcels where the development will be located.

4. Description of Methodology

4.1. Scope and Objectives of This Specialist Input to the EIA Report

The purpose of the report is to determine the main issues and potential impacts of the proposed project/s on avifauna, through a combination of desktop analysis and field work. The report was prepared to provide inputs to the Draft EIA Report for the project as required by the EIA Regulations promulgated in terms of the National Environmental Management Act 107 of 1998, as amended, (NEMA).

4.2. Details of Specialists

This specialist assessment has been undertaken by Albert Froneman and Megan Loftie-Eaton of AfriAvian Environmental (Formerly Chris van Rooyen Consulting). Albert Froneman is registered with the South African Council for Natural and Scientific Professions (SACNASP), with Registration Number 400177/09 in the field of Zoological Science. Megan Loftie-Eaton is also registered with SACNASP in the field of Ecology (Registration Number 135161). Curriculum Vitae are included in Appendix A of this specialist input report.

4.3. Terms of Reference

The terms of reference for this impact assessment report are as follows:
- Describe the affected environment from an avifaunal perspective.
- Discuss gaps in baseline data and other limitations and describe the expected impacts associated with the wind energy facility and associated infrastructure.
- Identify potential sensitive environments and receptors that may be impacted on by the proposed facility
- Determine the nature and extent of potential impacts.
- Identify 'No-Go' areas, where applicable.
- Identification and assessment of the potential impacts of the proposed development on avifauna including cumulative impacts.
- Provision of sufficient mitigation measures to include in the Environmental Management Programme (EMPr).
- Individual turbine locations were assessed and evaluated on a case-by-case basis to determine the best placement in order to avoid high risk zones.

4.4. Approach and Methodology

The following methods were used to compile this report:
- Bird distribution data of the Second Southern African Bird Atlas (SABAP2) was obtained from the University of Cape Town, to ascertain which species occur within the Broader Area of 12 pentad grid cells within which the proposed Project is located (**Figure *2***). A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 9 km. From 2007–present, a total of 122 full protocol lists (i.e., surveys of at least two hours each) have been completed for this area. In addition,

121 *ad hoc* protocol lists (i.e., surveys lasting less than two hours but still yielding valuable data) have been completed.

- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa (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 (2025) International Union for Conservation of Nature (IUCN) Red List of Threatened Species (http://www.iucnredlist.org/).
- A classification of the habitat in the Project Site was obtained from the First Atlas of Southern African Birds (SABAP1) (Harrison *et al*., 1997a, 1997b) and the National Vegetation Map (2018) from the South African National Biodiversity Institute (SANBI) BGIS map viewer (http://bgisviewer.sanbi.org/) (Mucina & Rutherford, 2006; SANBI, 2018). The Project Site is the area where the primary impacts on avifauna are expected.
- The Important Bird Areas of Southern Africa (Marnewick *et al*., 2015) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- The database on the Key Biodiversity Areas (KBAs) of South Africa (Key Biodiversity Areas in South Africa - SANBI) was consulted for information on potentially relevant KBAs near the Project.
- Satellite imagery (Google Earth ©2024) was used to view the Project Site and Broader Area on a landscape level and to help identify sensitive bird habitat.
- Priority species for wind development were identified from the updated list of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Ralston-Paton et al., 2017; Retief et al., 2012).
- The 2022 South Africa Protected Areas Database compiled by the Department of Environment, Forestry and Fisheries (DFFE) was used to identify Nationally Protected Areas, National Protected Areas Expansion Strategy (NPAES) near the Project Site (DFFE, 2022).
- The Department of Forestry, Fisheries, and the Environment (DFFE) National Screening Tool was used to determine the assigned avian sensitivity of the Project Site.
- Data collected during previous site visits to the Broader Area as far as habitat classes and the occurrence of priority species are concerned was also considered.
- The following sources were used to determine the investigation protocol that is required for the site:
    - Protocol for the specialist assessment 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).
    - BirdLife South Africa's (BLSA) 'Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa' (Jenkins *et al*., 2015) – hereafter referred to as the 'Windfarm Guidelines' – were consulted to determine the level of survey effort that is required.
- The main source of information on the avifaunal diversity and abundance at the Project Site and Broader Area is an integrated pre-construction monitoring programme which was implemented at the Project Site over a period of four seasons. All surveys have been completed.

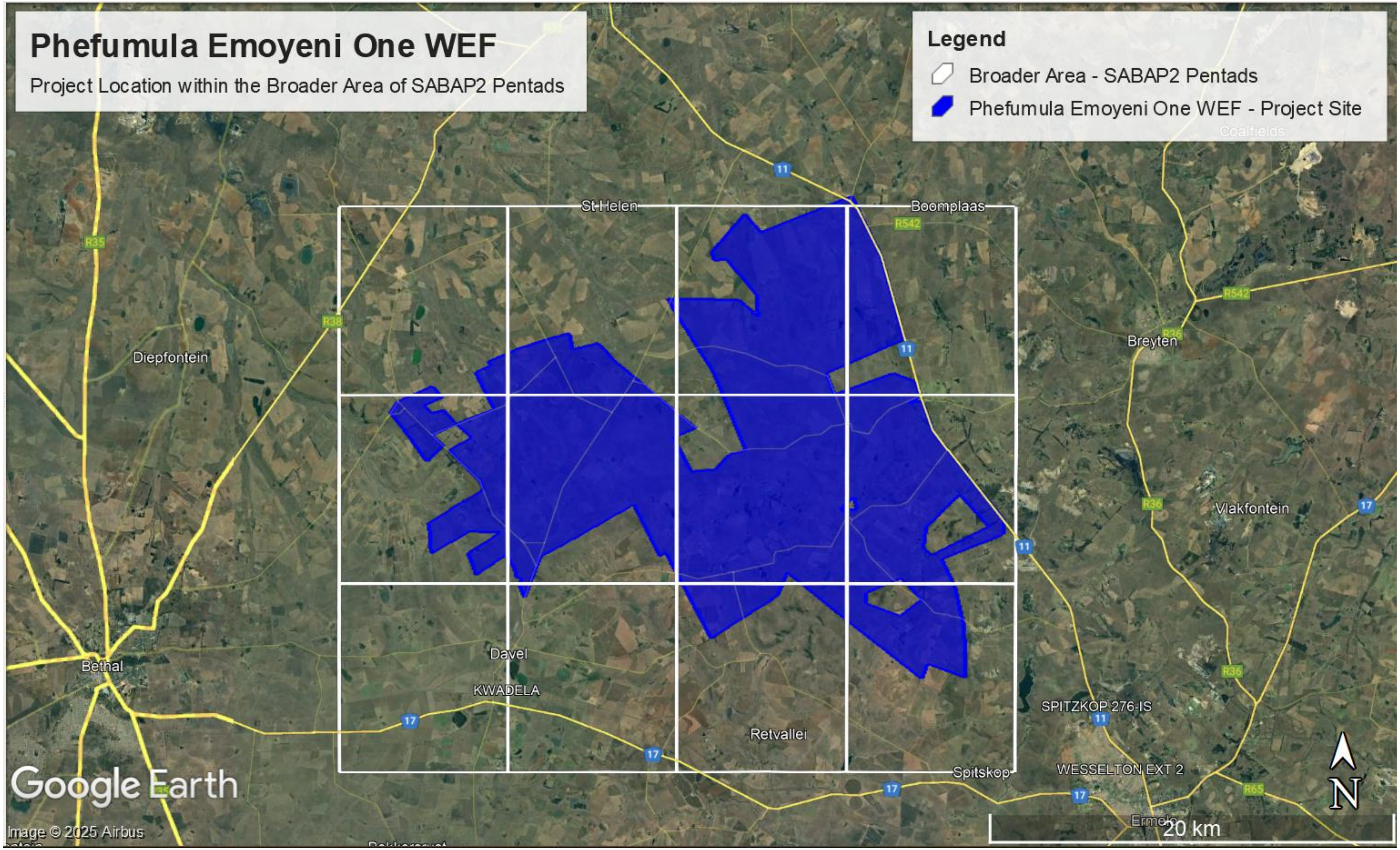


Figure 2: Project location within the Broader Area of SABAP2 Pentads.

4.5. Information Sources

The following data sources were used to compile this report:

Table 4: Data sources employed in the scoping report for the proposed Phefumula Emoyeni One WEF

Data / Information	Source	Date	Type	Description
South African Protected Areas Database (SAPAD)	Department of Forestry, Fisheries, and the Environment (DFFE)	2022, Q3	Spatial	Spatial delineation of protected areas in South Africa. Updated quarterly
First Atlas of Southern African Birds (SABAP1)	University of Cape Town	1987-1991	Spatial, reference	SABAP1, which took place from 1987-1991.
Southern African Bird Atlas Project 2 (SABAP2)	University of Cape Town	May 2024	Spatial, database	SABAP2 is the follow-up project to the SABAP1. The second bird atlas project started on 1 July 2007 and is still growing. The project aims to map the distribution and relative abundance of birds in southern Africa.
National Vegetation Map	South African National Biodiversity Institute (SANBI) (BGIS)	2018	Spatial	The National Vegetation Map Project (VEGMAP) is a large collaborative project established to classify, map, and sample the vegetation of South Africa, Lesotho, and Swaziland.
Red Data Book of Birds of South Africa, Lesotho, and Swaziland	BirdLife South Africa	2015	Reference	The 2015 Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland is an updated and peer-reviewed conservation status assessment of the 854 bird species occurring in South Africa undertaken in collaboration between BirdLife South Africa, the Animal Demography Unit of the University of Cape Town, and the SANBI.
IUCN Red List of Threatened Species (2022.1)	IUCN	2022.1	Online reference source	Established in 1964, the International Union for Conservation of Nature's Red List of Threatened Species is the world's most comprehensive information source on the global extinction risk status of animal, fungus and plant species.
Important Bird and Biodiversity Areas of South Africa	BirdLife South Africa	2015	Reference work	Important Bird and Biodiversity Areas (IBAs), as defined by BirdLife International, constitute a global network of over 13 500 sites, of which 112 sites are found in South Africa. IBAs are sites of global significance for

Data / Information	Source	Date	Type	Description
				bird conservation, identified nationally through multi-stakeholder processes using globally standardized, quantitative, and scientifically agreed criteria.
Strategic Environmental Assessment for wind and solar photovoltaic energy in South Africa	Department of Environmental Affairs, 2015. Strategic Environmental Assessment for wind and solar photovoltaic energy in South Africa. CSIR Report Number: CSIR/CAS/EMS/ER/2015/0001/B. Stellenbosch.	2015	SEA	The SEA identifies areas where large scale wind and solar energy facilities can be developed in terms of Strategic Infrastructure Project (SIP) and in a manner that limits significant negative impacts on the natural environment, while yielding the highest possible socio-economic benefits to the country. These areas are referred to as Renewable Energy Development Zones (REDZs).
The National Screening Tool	Department of Forestry, Fisheries and Environment	May 2023	Spatial	The National Web based Environmental Screening Tool is a geographically based web-enabled application which allows a proponent intending to apply for environmental authorisation in terms of the Environmental Impact Assessment (EIA) Regulations 2014, as amended to screen their proposed site for any environmental sensitivity.
National Protected Areas and National Protected Areas Expansion Strategy (NPAES)	DFFE	2016	Spatial	The goal of NPAES is to achieve cost effective protected area expansion for ecological sustainability and adaptation to climate change. The NPAES sets targets for protected area expansion, provides maps of the most important areas for protected area expansion, and makes recommendations on mechanisms for protected area expansion.
Protocol for the specialist assessment and minimum report content requirements for environmental impacts on avifaunal species by onshore wind energy generation facilities where the electricity	NEMA	2020	Legislation	This protocol provides the criteria for the specialist assessment and minimum report content requirements for impacts on avifaunal species associated with the development of onshore wind energy generation facilities, where the electricity output is 20 megawatts or more, which

Data / Information	Source	Date	Type	Description
output is 20MW or more (Government Gazette No. 43110 – 20 March 2020).				require environmental authorisation. This protocol replaces the requirements of Appendix 6 of the Environmental Impact Assessment Regulations.
Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa (2015). Jenkins, A., van Rooyen, C. S., Smallie, J. J., Anderson, M. D., & Smit, A. H.	BirdLife South Africa	2015	Guidelines	These guidelines were developed to ensure that any negative impacts on threatened, or potentially threatened bird species are identified and effectively mitigated using structured, methodical. and scientific methods. The guidelines prescribe the best practice approach to gathering bird data at proposed utility-scale wind energy plants, primarily for the purposes of accurate and effective impact assessment.
Guidelines for the Implementation of the Terrestrial Flora & Terrestrial Fauna Species Protocols for EIAs in South Africa produced by the South African National Biodiversity Institute on behalf of the Department of Environment, Forestry and Fisheries (2020)	South African National Biodiversity Institute (SANBI) (BGIS)	2022.v3.1	Guidelines	The purpose of the Species Environmental Assessment Guideline is to provide background and context to the assessment and minimum reporting criteria contained within the Terrestrial Animal and Plant Species Protocols; as well as to provide guidance on sampling and data collection methodologies for the different taxonomic groups that are represented in the respective protocols. This guideline is intended for specialist studies undertaken for activities that have triggered a listed and specified activity in terms of the National Environmental Management Act, 1998 (No. 107 of 1998) (NEMA), as identified by the EIA Regulations, 2014 (as amended) and Listing Notices 1-3.
Results of the pre-construction monitoring according to the best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in	Chris van Rooyen Consulting	June 2020 – January 2022.		The data set consists of the results of the pre-construction monitoring conducted over four seasons between June 2020 and January 2022. Data was collected by means of transect counts, vantage point watches and focal point inspections.

Data / Information	Source	Date	Type	Description
southern Africa. Produced by the Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa. Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2015.				

5. Description of Baseline Environment – including Sensitivity Mapping

5.1. Biomes and Vegetation Types

The Project Site is situated in the Grassland Biome, in the Mesic Highveld Grassland Bioregion (Mucina & Rutherford 2006) (**Figure 3**). Vegetation on site consists predominantly of Soweto Highveld Grassland and Eastern Highveld Grassland (**Figure 4**). Soweto Highveld Grassland is found on gently to moderately undulating landscapes and consists of short to medium-high, dense, tufted grassland dominated almost entirely by *Themeda triandra* and accompanied by a variety of other grasses. In places that are not disturbed, scattered small wetlands, narrow stream alluvia, pans and occasional ridges or rocky outcrops interrupt the continuous grassland cover. Eastern Highveld Grassland is found on undulating grassland plains, with small, scattered patches of dolerite outcrops in areas, low hills, and pan depressions. The vegetation is comprised of a short, closed grassland cover, largely dominated by a dense *Themeda triandra* sward, often severely grazed to form a short lawn (Mucina & Rutherford 2006).

Ermelo has a temperate climate. January is the warmest month with a maximum temperature of 24.4 C°. June and July are the coldest months, with a minimum temperature of 0.2 C°. The driest month is June with an average of 3 mm of precipitation. Most of the precipitation falls in December, averaging 151 mm. The average annual precipitation is around 756 mm (Climate – data.org 2021). The topography in the project area is characterised by gentle undulating plains. The predominant land use for this area is livestock grazing with some crop farming.

The First Southern African Bird Atlas Project (SABAP1) recognises six primary vegetation divisions (biomes) within South Africa, namely (1) Fynbos (2) Succulent Karoo (3) Nama Karoo (4) Grassland (5) Savanna and (6) Forest (Harrison *et al.* 1997). The criteria used by the authors to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations. Using this classification system, the natural vegetation in the Project Site is classified as Grassland (Harrison *et al*. 1997).

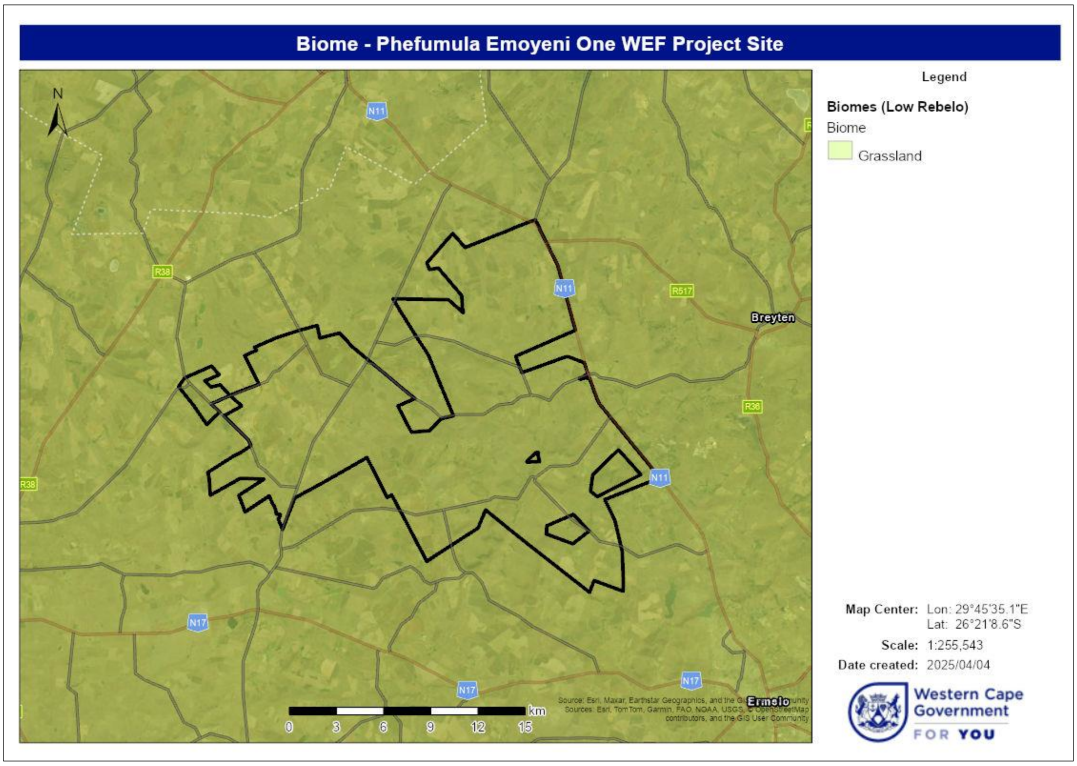


Figure 3: The Phefumula Emoyeni One WEF Project Site (outlined in black) falls within the Grassland Biome.

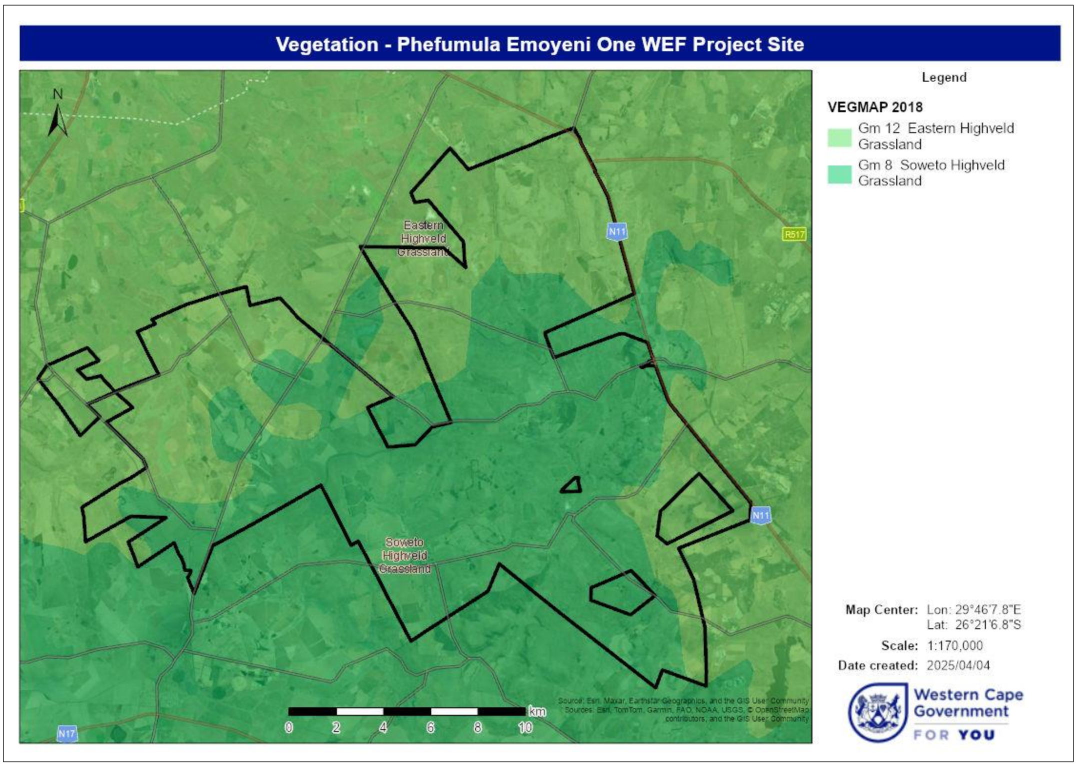


Figure 4: Vegetation Map of the Phefumula Emoyeni One WEF Project Site (outlined in black).

5.2. Habitat Classes and Land-use within the Project Site

The proposed Phefumula Emoyeni One WEF Project Site is situated on the gently undulating plains of the Mpumalanga Highveld countryside. The avian habitat features in the Phefumula Emoyeni One WEF Project Site were identified as:

- Grassland
- Woodland and Alien Trees
- Drainage Lines and Wetlands
- Dams
- Agriculture
- High Voltage Power Lines

5.2.1. Grassland

This habitat feature is described above under Section 5.1 (**Figure 5**).

Figure 5: Grassland habitat at the Project Site.

Priority species that could utilise this habitat are listed in **Table 5**.

5.2.2. Woodland and Alien Trees

The Project Site contains patches of woodland (trees and shrubs) with a grass-dominated herbaceous layer (**Figure 6**). Depending on local conditions, trees form semi-open to closed thickets or woodlands and can range from short deciduous bush cover to medium-tall *Senegalia sp.* and *Vachellia sp.* trees. The Project Site also contains stands of alien trees (usually near homesteads of planted as wind breaks).

Figure 6: Woodland habitat within the Project Site.

Priority species that could utilise this habitat are listed in **Table 5**.

5.2.3. Drainage Lines and Wetlands

Drainage lines and wetlands are important habitats, especially for several priority species. Raptors may also use these areas to hunt other bird species, and the African Grass Owl could potentially be attracted to some of the grass in the wetland areas. There are drainage lines with associated wetlands and farm dams that transect the Project Site. The Broader Area also contains several drainage lines, seeps, and wetlands (**Figure 8**).

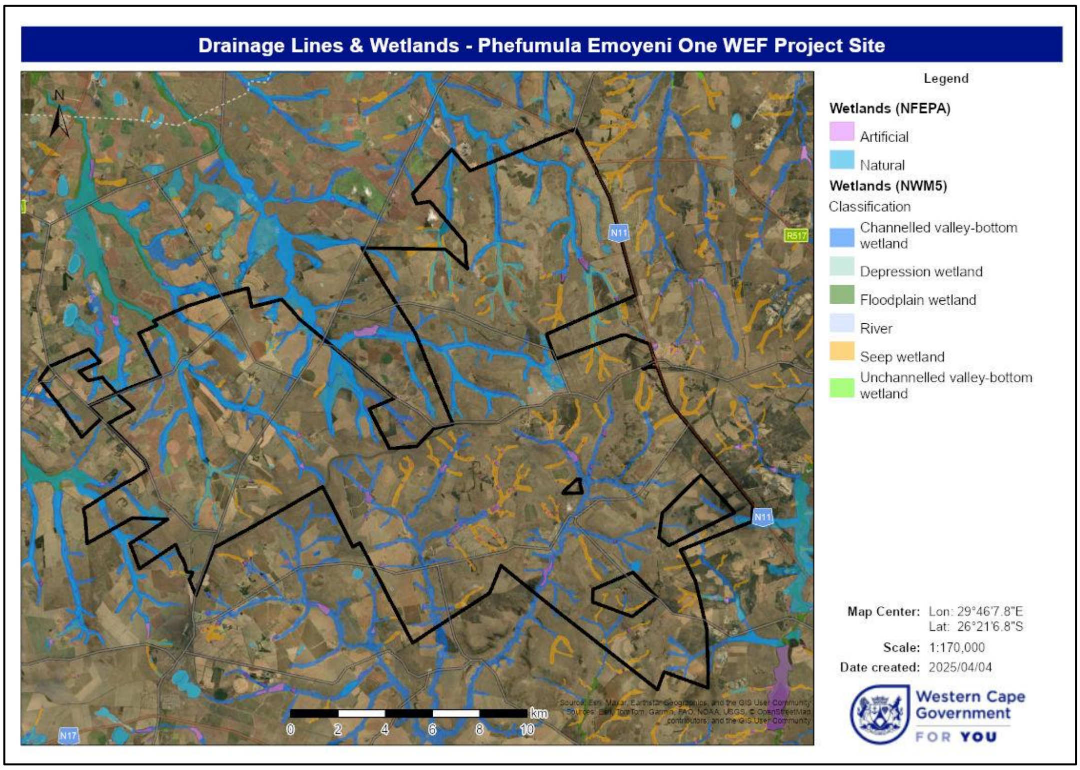


Figure 7: Drainage line and wetlands within the Project Site.

Priority species that could utilise this habitat are listed in **Table 5**.

5.2.4. Dams

Surface water is important to several avifauna for drinking, bathing, and foraging. There are several dams located within the Project Site (**Figure 8**).

Figure 8: Large dam within the Project Site.

Priority species that could utilise this habitat are listed in **Table 5**.

5.2.5. Agriculture

Agricultural activity present within the Project Site comprises cultivated commercial annuals crops (DEA & DALRRD, 2020), predominately dedicated towards planted pastures (**Figure 9**). Avian species richness in these areas is likely to be low. However, periods of ploughing, seeding, and harvesting are likely to create foraging opportunities for certain avian species.

Figure 9: Agricultural activities, cultivated land, within the Project Site.

Priority species that could utilise this habitat are listed in **Table 5**.

5.2.6. High Voltage Power Lines

High voltage (HV) power lines are present along the eastern border of the Project Site (**Figure 10**). Birds often use HV power lines as perching and/or roosting sites, and some birds may even construct their nests on HV power line structures (e.g., Pied Crow).

Figure 10: High voltage overhead power line within the Project Site.

Priority species that could utilise this habitat are listed in **Table 5**.

5.3 Site Ecological Importance

The Animal Species Protocol require specialists to identify:

- the nature and the extent of the potential impact of the proposed development on SCC occurring on the proposed project site;
- the potential impact of the proposed development on the habitat of the SCC; and
- any alternative development footprints within the preferred development site which would be of 'low' sensitivity as identified by the screening tool and verified through the site sensitivity verification.

In order to spatially identify the different areas of importance for a species for a proposed development site and to facilitate transparent and comparable reporting of the potential impacts of development, a standardised metric, **Site Ecological Importance (SEI)** has been developed for identifying site-based ecological importance for species, in relation to a proposed project with a specific footprint/ project areas of influence (PAOI) and suite of anticipated activities. It allows for rapid spatial inspection and evaluation of impacts of proposed developments within the context of on-site habitats and Species of Conservation Concern (SCC) and also facilitates integration of inputs from different specialist studies. This process is necessary because the screening tool evaluates 'environmental sensitivity' at a larger scale than that of a proposed development site and frequently includes modelled data that require field verification.

This assessment relies on the data collected during the necessary specialist surveys to provide a current evaluation of the on-site habitat conditions. This assessment does not replace the output of the screening tool but is more specific to the proposed development footprint/PAOI and proposed project activities. Where the site-specific assessment produces lower or higher SEI classification than the 'environmental sensitivity' output of the screening tool for that particular site, it is the responsibility of the specialist to provide a clear and defensible justification for the difference.

The **SEI is considered to be a function of** the **biodiversity importance (BI)** of the receptor (e.g., species of conservation concern, the vegetation/fauna community or habitat type present on the site) **and** its resilience to impacts (**receptor resilience [RR]**) as follows: **SEI = BI + RR**

BI in turn is a **function of conservation importance (CI)** and the **functional integrity (FI)** of the receptor as follows: **BI = CI + FI**

The different habitat types within the Project Site have been delineated and identified based on observations during the field assessment and available satellite imagery. These habitat types have been assigned Ecological Importance (EI) categories based on their ecological integrity, conservation value, the presence of species of conservation concern and their ecosystem processes. There are two main natural habitat types within the Project Site to evaluate for SEI. These habitats are 1) grassland and 2) wetlands (with their associated drainage lines).

1) Grassland Habitat within the Project Site

Given the confirmed presence of and confirmed available habitat for several avifaunal SCC the **CI** of the grassland habitat within the Phefumula Emoyeni One Project Site is rated as **High**. The **FI** is rated as **Medium** due to narrow corridors of good habitat connectivity or larger areas of poor habitat connectivity and an actively used road network between intact habitat patches.

Therefore, the **Biodiversity Importance** of the grassland habitat within the Phefumula Emoyeni One Project Site is rated as **Medium** (as per the matrix below):

Matrix used to derive Biodiversity Importance (BI) from Functional Integrity (FI) and Conservation Importance (CI)

Biodiversity Importance		Conservation Importance				
		Very high	High	Medium	Low	Very low
Functional Integrity	Very high	Very high	Very high	High	Medium	Low
	High	Very high	High	Medium	Medium	Low
	Medium	High	Medium	Medium	Low	Very low
	Low	Medium	Medium	Low	Low	Very low
	Very low	Medium	Low	Very low	Very low	Very low

The fulfilling criteria to evaluate RR are based on the estimated recovery time required to restore an appreciable portion of functionality to the receptor (the habitat on site). The **RR** is rated as **Medium** as the intact grassland habitats will very likely recover slowly (~ will take more than 10 years to recover). **With a Medium BI and a Medium RR, the SEI of the grassland habitat is rated as Medium**.

In terms of the species assessment guidelines, the implications for the Medium SEI rating for suitable SCC habitat at the site indicates that the following general measures are considered appropriate for these areas – "*Minimisation and restoration mitigation – development activities of medium impact acceptable followed by appropriate restoration activities*". These minimisation and mitigation measures are integrally linked to the avoidance and or mitigation measures proposed for avian species that are linked to associated habitat areas (e.g. pro-active mitigation and / or avoidance for grassland species and avoidance for wetland species).

2) Wetland Habitat within the Project Site

Given the confirmed presence of and confirmed available habitat for several Avifaunal SCC the **CI** of the wetland habitat within the Phefumula Emoyeni One Project Site is rated as **High**. The **FI** is rated as **High** due to good habitat connectivity, with potentially functional ecological corridors and a regularly used road network between intact habitat patches.

Therefore, the **Biodiversity Importance** of the wetland habitat within the Phefumula Emoyeni One Project Site is rated as **High**. The fulfilling criteria to evaluate RR are based on the estimated recovery time required to restore an appreciable portion of functionality to the receptor (the habitat on site). The **RR** is rated as **Medium** as the intact wetland habitats will very likely recover slowly (~ will take more than 10 years to recover). **With a High BI and a Medium RR, the SEI of the wetland habitat is rated as High.**

In terms of the species assessment guidelines, the implications for the High SEI rating for suitable SCC habitat at the site indicates that the following general measures are considered appropriate for these areas – "*Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted, limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities"*.

5.4. Protected areas in/around the Project Site

5.4.1. Important Bird Areas (IBAs) and Key Biodiversity Areas (KBAs)

The Project Site is located within the Amersfoort-Bethal-Carolina IBA (SA018) (**Figure 11**) and 18km west of the Chrissie Pans IBA (SA019).

According to Barnes (1998), the Amersfoort-Bethal-Carolina IBA holds a large proportion (>10%) of the global population of Botha's Lark *Spizocorys fringillaris*, although confirmation is required as to whether this is still the case. This lark generally avoids rocky areas, tall grass in bottomlands, vleis, croplands and planted pastures, but its preferred habitat – short, dense, natural grassland found on plateaus and upper hill slopes – occurs within this IBA. Data regarding the IBA's current species composition is limited, but the grassland areas occasionally hold Denham's Bustard, White-bellied Bustard, Blue Korhaan, African Grass Owl, Buff-streaked Chat, Southern Bald Ibis, Black-winged Pratincole and Secretarybird.

The key species within this IBA is the globally threatened Botha's Lark. Other globally threatened species are Blue Crane, Southern Bald Ibis, Black Harrier, Blue Korhaan, Black-winged Pratincole, Secretarybird, Martial Eagle and Denham's Bustard. Regionally threatened species are African Grass Owl, White-bellied Bustard and Lanner Falcon.

As per communication from BirdLife South Africa (July 2024) it should be noted that IBA's have been replaced by Key Biodiversity Areas (KBA's).

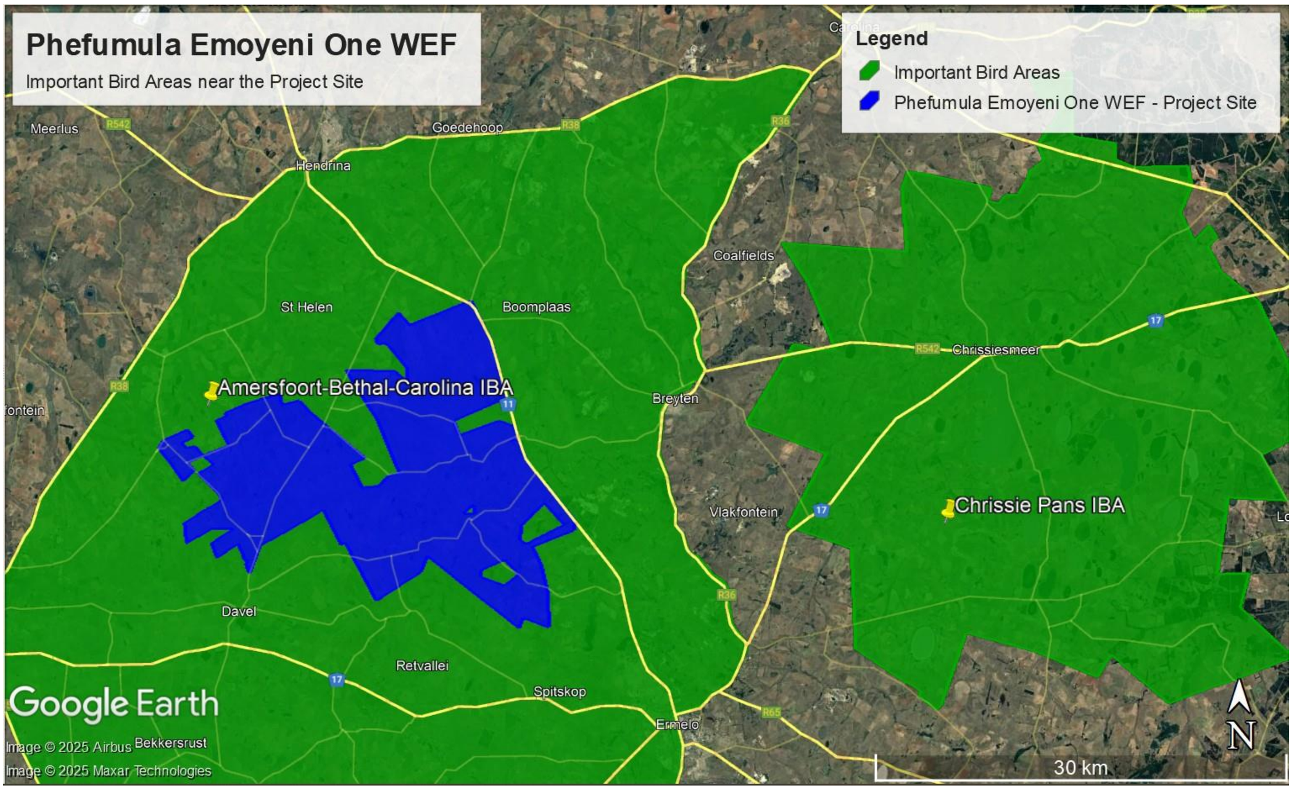


Figure 11: Important Bird Areas near the Project Site.

Key Biodiversity Areas (KBA's) are 'sites that contribute significantly to the global persistence of biodiversity', which means they are the most important places in the world for species and their habitats – whether these be in terrestrial, freshwater, estuarine or marine ecosystem.

The Global Standard for the Identification of Key Biodiversity Areas, published in 2016, sets out internationally agreed scientific criteria for the identification of KBAs worldwide. Sites qualify as global KBAs if they meet the specific standardised criteria and quantitative thresholds focused on one or more of five trigger aspects:

1. Threatened biodiversity
2. Geographically restricted biodiversity
3. Ecological integrity
4. Biological processes
5. Irreplaceability through quantitative analysis

The Project Site only marginally overlaps with a KBA, namely the Chrissie Pans KBA (KBA ID 47) (**Figure 12**).

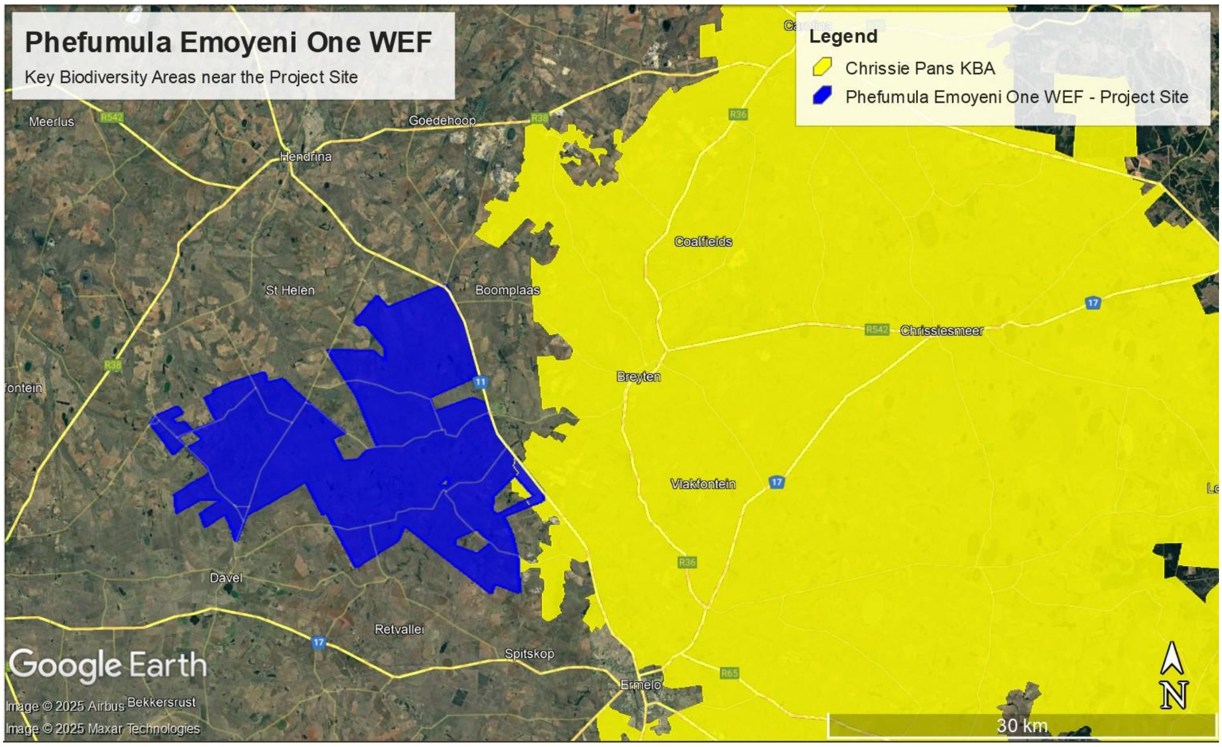


Figure 12: Key Biodiversity Areas near the Project Site.

It is important that from an avifaunal habitat use perspective, it be noted that birds will still use suitable habitats (at a more fine site specific scale as opposed to the broad landscape level delineations being considered for defining KBA boundaries). Therefore, from an avifaunal perspective, it is essential to initially focus on avoidance strategies and then investigate appropriate mitigation measures.

Understanding the avian communities in the landscape is crucial and this has been informed by the on-site findings based on the monitoring and associated species-specific modelling (Refer to **Section 5.9. Results of Pre-Construction Monitoring**). This approach ensures that regardless of whether a site or species is present within a Key Biodiversity Area (KBA) or a previously defined Important Bird Area (IBA), it receives the same level of attention and protection.

5.4.2. National Protected Areas and National Protected Areas Expansion Strategy (NPAES) Focus Areas

The Project Site falls within Mesic Highveld Grasslands NPAES Key Focus Area (DFFE, 2018) (**Figure 13**).

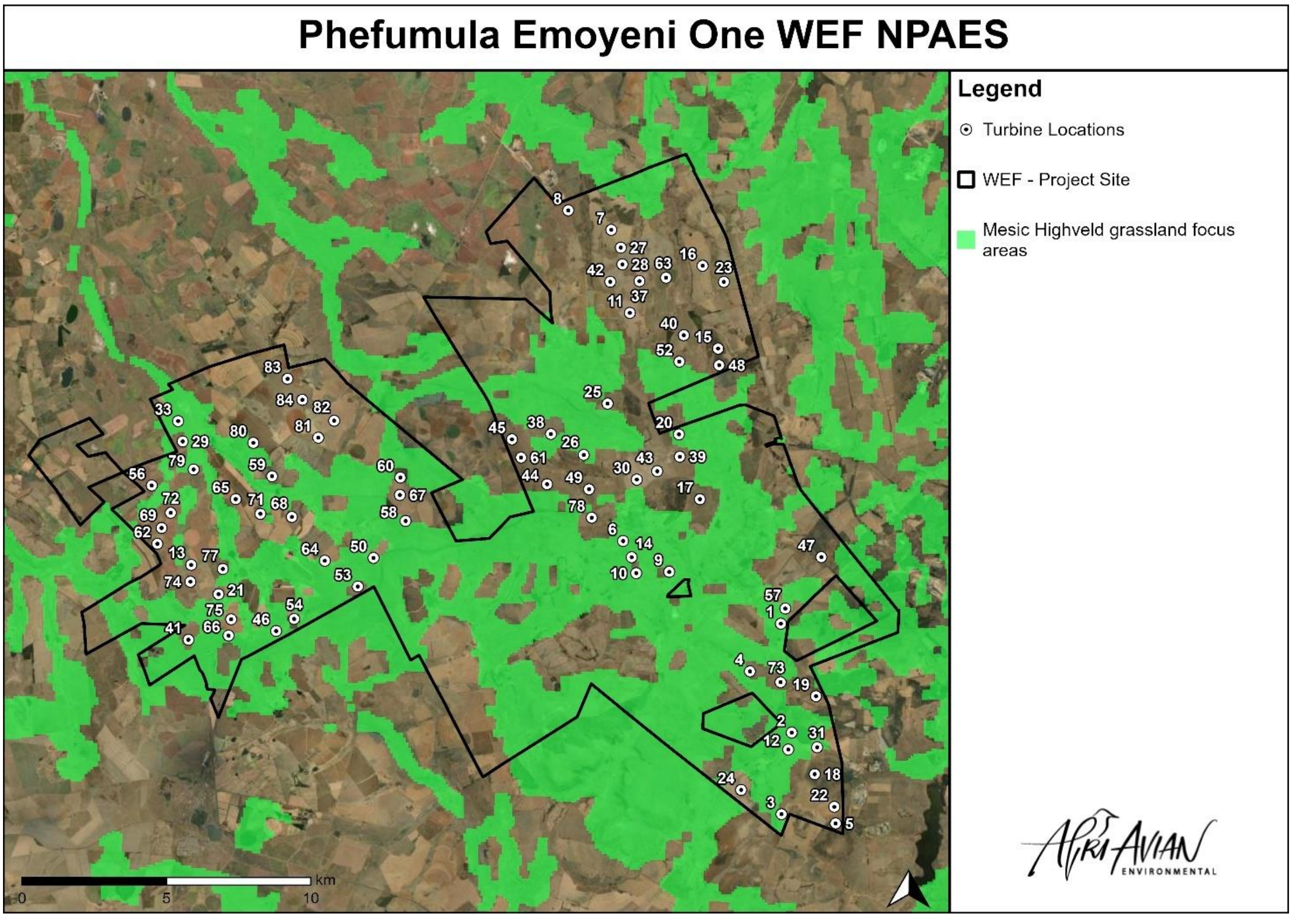


Figure 13: Project Site in relation to Mesic Highveld Grasslands NPAES Key Focus Area.

5.4.3. The Renewable Energy Development Zones (REDZ)

The Project Site is not located in a REDZ.

5.5. Avifauna within the Project Site

A total of 224 species could potentially occur within the Broader Area where the Project Site is located (see **Appendix E – Bird Species List for the Broader Area**). Of these, 40 are classified as priority species for wind energy developments. Of these 40 priority species, 37 have a medium to high likelihood of occurring regularly in the Project Area of Influence (Project Site). Of the 40 priority species, 37 have been recorded during the on-site field surveys (four sets of surveys completed).

Eighteen (18) priority species recorded in the Broader Area are also Species of Conservation Concern (SCC). Twelve (12) SCC have been recorded during the on-site field surveys namely, African Marsh Harrier (Regionally Endangered), Black Harrier (Globally and Regionally Endangered), Black Stork (Regionally Vulnerable), Black-winged Pratincole (Globally and Regionally Near-Threatened), Blue Crane (Globally Vulnerable and Regionally Near-Threatened), Cape Vulture (Globally Vulnerable and Regionally Endangered), Denham's Bustard (Globally Near-Threatened and Regionally Vulnerable), Lanner Falcon (Regionally Vulnerable), Martial Eagle (Globally and Regionally Endangered), Pallid Harrier (Globally and Regionally Near-Threatened), Secretarybird (Globally Endangered and Regionally Vulnerable) and Southern Bald Ibis (Globally and Regionally Vulnerable).

The likelihood of priority species occurring in the Project Site, habitat classes, and potential long-term impacts of the proposed WEF are listed in **Table 5** below.

Table 5: Priority species that could occur in the Project Site, habitat classes within the Project Site, and the potential impacts of the Phefumula Emoyeni One WEF on avifauna.

Global and Regional (South African) Red List Status: CR = Critically Endangered; EN = Endangered.
VU = Vulnerable; NT = Near Threatened; LC = Least Concern

Common Name	Scientific Name	Full Protocol	Ad Hoc Protocol	Global Conservation Status	Regional Conservation Status	Recorded during monitoring	Likelihood of Regular Occurrence	Grassland	Woodland & Alien Trees	Drainage Lines & Wetlands	Dams	Agriculture	High Voltage Power Lines	Collision with turbines	Displacement - habitat transformation	Displacement - disturbance	MV Lines - Electrocution	MV Lines - Collision
African Fish Eagle	*Haliaeetus vocifer*	10,66	0,83	-	-	x	H		x	x	x		x	x		x	x	
African Harrier-Hawk	*Polyboroides typus*	8,20	0,00	-	-	x	M		x		x		x	x		x	x	
African Marsh Harrier	*Circus ranivorus*	0,00	0,00	-	EN	x	M	x		x	x		x	x	x	x	x	
Amur Falcon	*Falco amurensis*	13,93	4,96	-	-	x	M	x	x		x	x	x	x			x	
Black Harrier	*Circus maurus*	0,82	0,00	EN	EN	x	M	x	x	x			x	x		x	x	
Black Sparrowhawk	*Accipiter melanoleucus*	17,21	1,65	-	-	x	H		x		x		x	x		x	x	
Black Stork	*Ciconia nigra*	0,82	0,00	-	VU	x	M			x	x		x	x		x	x	x
Black-chested Snake Eagle	*Circaetus pectoralis*	3,28	1,65	-	-	x	M	x	x		x		x	x		x	x	
Black-winged Kite	*Elanus caeruleus*	85,25	28,93	-	-	x	H	x	x		x	x	x	x	x	x	x	
Black-winged Lapwing	*Vanellus melanopterus*	0,82	0,00	-	-	x	M	x		x	x	x		x	x			
Black-winged Pratincole	*Glareola nordmanni*	0,00	0,00	NT	NT	x	M	x		x	x	x		x	x			
Blue Crane	*Grus paradisea*	3,28	0,00	VU	NT	x	M	x		x	x	x		x	x	x		x
Blue Korhaan	*Eupodotis caerulescens*	30,33	3,31	NT	LC	x	H	x				x		x	x	x		x
Booted Eagle	*Hieraaetus pennatus*	0,00	0,00	-	-	x	M		x		x		x	x		x	x	
Brown Snake Eagle	*Circaetus cinereus*	1,64	0,00	-	-	x	M		x		x		x	x		x	x	
Cape Vulture	*Gyps coprotheres*	0,00	0,00	VU	EN	x	L	x	x		x		x	x		x	x	x

Common Name	Scientific Name	Full Protocol	Ad Hoc Protocol	Global Conservation Status	Regional Conservation Status	Recorded during monitoring	Likelihood of Regular Occurrence	Grassland	Woodland & Alien Trees	Drainage Lines & Wetlands	Dams	Agriculture	High Voltage Power Lines	Collision with turbines	Displacement - habitat transformation	Displacement - disturbance	MV Lines - Electrocution	MV Lines - Collision
Caspian Tern	*Hydroprogne caspia*	0,82	0,00	-	VU		L				x			x				
Common Buzzard	*Buteo buteo*	27,05	8,26	-	-	x	H	x	x			x	x	x			x	
Denham's Bustard	*Neotis denhami*	0,00	0,00	NT	VU	x	M	x				x		x	x	x		x
Greater Flamingo	*Phoenicopterus roseus*	13,93	11,57	-	NT		M				x			x				x
Greater Kestrel	*Falco rupicoloides*	4,92	0,00	-	-	x	M	x	x			x	x	x		x	x	
Grey-winged Francolin	*Scleroptila afra*	45,08	2,48	-	-	x	H	x				x		x	x	x		
Jackal Buzzard	*Buteo rufofuscus*	15,57	0,00	-	-	x	H	x	x			x	x	x		x	x	
Lanner Falcon	*Falco biarmicus*	9,02	1,65	-	VU	x	M	x	x	x	x	x	x	x		x	x	
Lesser Flamingo	*Phoeniconaias minor*	6,56	2,48	NT	NT		M			x	x			x				x
Long-crested Eagle	*Lophaetus occipitalis*	0,00	0,83	-	-	x	M		x		x		x	x		x	x	
Marsh Owl	*Asio capensis*	19,67	0,83	-	-	x	H	x		x				x	x	x	x	x
Martial Eagle	*Polemaetus bellicosus*	6,56	0,00	EN	EN	x	M	x	x		x		x	x		x	x	
Northern Black Korhaan	*Afrotis afraoides*	0,00	0,00	-	-	x	M	x				x		x	x	x		x
Pallid Harrier	*Circus macrourus*	0,00	0,00	NT	NT	x	M	x	x		x		x	x			x	
Peregrine Falcon	*Falco peregrinus*	0,00	0,00	-	-	x	M	x	x		x		x	x		x	x	
Rufous-breasted Sparrowhawk	*Accipiter rufiventris*	0,00	0,00	-	-	x	M		x		x		x	x		x	x	
Saddle-billed Stork	*Ephippiorhynchus senegalensis*	0,82	0,00	-	EN		L			x	x			x		x		x
Secretarybird	*Sagittarius serpentarius*	17,21	3,31	EN	VU	x	H	x			x	x		x	x	x		x
Southern Bald Ibis	*Geronticus calvus*	25,41	4,96	VU	VU	x	H	x				x		x	x	x	x	x
Spotted Eagle-Owl	*Bubo africanus*	5,74	0,00	-	-	x	M		x					x		x	x	x

Common Name	Scientific Name	Full Protocol	Ad Hoc Protocol	Global Conservation Status	Regional Conservation Status	Recorded during monitoring	Likelihood of Regular Occurrence	Grassland	Woodland & Alien Trees	Drainage Lines & Wetlands	Dams	Agriculture	High Voltage Power Lines	Collision with turbines	Displacement - habitat transformation	Displacement - disturbance	MV Lines - Electrocution	MV Lines - Collision
Wahlberg's Eagle	*Hieraaetus wahlbergi*	0,00	0,00	-	-	x	M		x		x		x	x		x	x	
White Stork	*Ciconia ciconia*	4,92	2,48	-	-	x	M	x		x	x	x		x	x			x
White-bellied Bustard	*Eupodotis senegalensis*	2,46	0,00	-	VU		L	x						x	x	x		x
Yellow-billed Stork	*Mycteria ibis*	2,46	0,83	-	EN		L			x	x			x				x

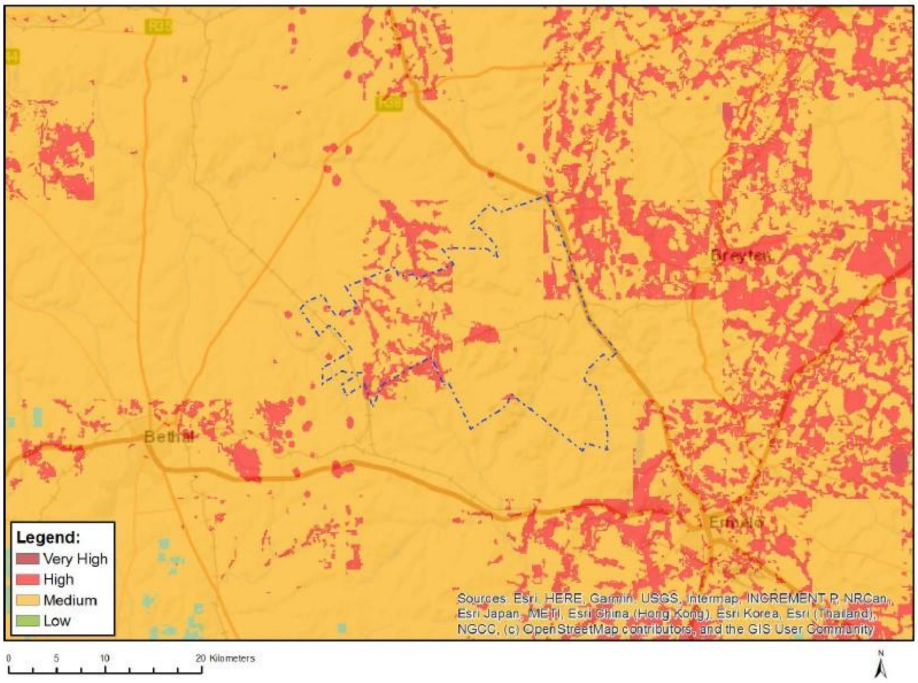
5.6. Identification of Environmental Sensitivities

The Project Site and immediate environment is classified as **Medium** and **High Sensitivity** for bird species according to the Animal Species Theme (**Figure *14***). The Medium and/or High sensitivity classification is linked to the potential occurrence of Denham's Bustard *Neotis denhami* (Globally Near-Threatened and Regionally Vulnerable), Secretarybird *Sagittarius serpentarius* (Globally Endangered and Regionally Vulnerable), Southern Bald Ibis *Geronticus calvus* (Globally and Regionally Vulnerable), African Grass Owl *Tyto capensis* (Regionally Vulnerable), Martial Eagle *Polemaetus bellicosus* (Globally and Regionally Endangered), White-bellied Bustard *Eupodotis senegalensis* (Regionally Vulnerable), and Caspian Tern *Hydroprogne caspia* (Regionally Vulnerable). The Project Site contains confirmed habitat for Species of Conservation Concern (SCC), primarily for African Grass Owl and Secretarybird (Globally Endangered and Regionally Vulnerable), as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020).

Twelve (12) SCC have been recorded during the on-site field surveys thus far namely, African Marsh Harrier (Regionally Endangered), Black Harrier (Globally and Regionally Endangered), Black Stork (Regionally Vulnerable), Black-winged Pratincole (Globally and Regionally Near-Threatened), Blue Crane (Globally Vulnerable and Regionally Near-Threatened), Cape Vulture (Globally Vulnerable and Regionally Endangered), Denham's Bustard, Lanner Falcon (Regionally Vulnerable), Martial Eagle, Pallid Harrier (Globally and Regionally Near-Threatened), Secretarybird and Southern Bald Ibis.

Based on the Site Sensitivity Verification survey and the integrated pre-construction monitoring conducted at the Project Site thus far, the classification of **High Sensitivity** for avifauna is supported for the Phefumula Emoyeni One WEF Project Site. Therefore, all mitigation measures as outlined in this Avifaunal Specialist Study should be strictly implemented.

MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY



Where only a sensitive plant unique number or sensitive animal unique number is provided in the screening report and an assessment is required, the environmental assessment practitioner (EAP) or specialist is required to email SANBI at eiadatarequests@sanbi.org.za listing all sensitive species with their unique identifiers for which information is required. The name has been withheld as the species may be prone to illegal harvesting and must be protected. SANBI will release the actual species name after the details of the EAP or specialist have been documented.

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	x		

Figure 14: The National Web-Based Environmental Screening Tool map of the Project Site, indicating sensitivities for the Terrestrial Animal Species theme.

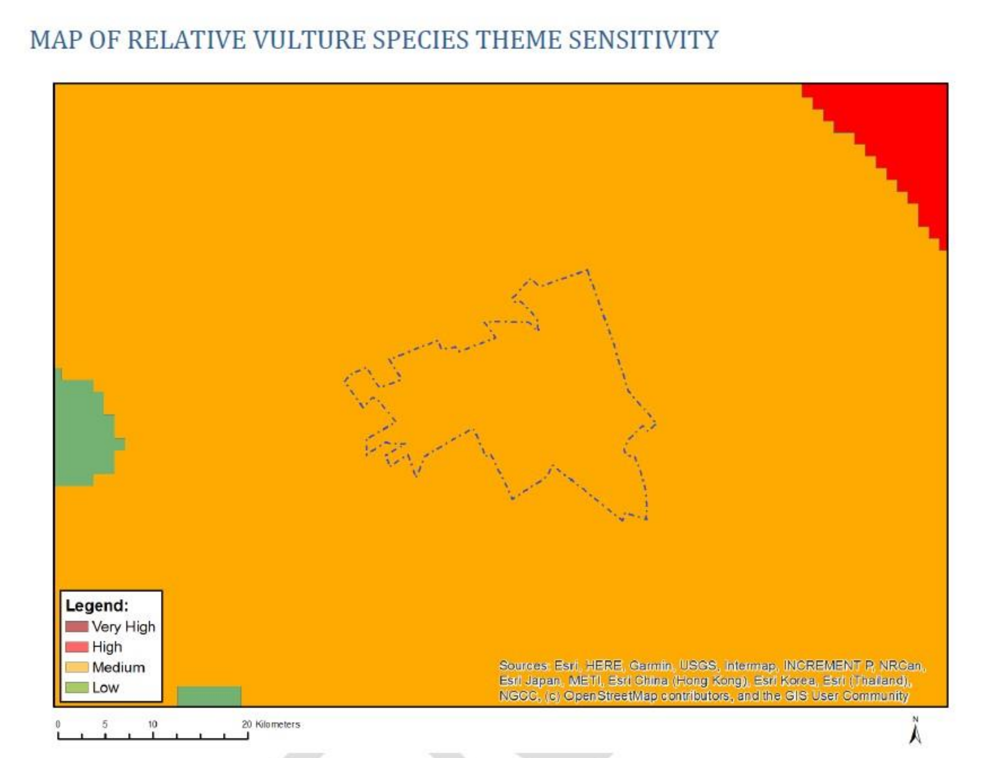
The WEF Project Site and immediate environment is classified as **Medium Sensitivity** for vultures according to the Vulture Species Theme (**Figure *15***). The Medium sensitivity is due to the Project Site possibly affecting an area with between 5%–10% of the vulture population.

During the pre-construction monitoring (885 hours of vantage point observations) only four (4) Cape Vultures were observed, during the April 2023 survey in total, only 16 minutes of Cape Vulture flights were recorded at medium height (i.e. within rotor-swept height). The passage rate for Cape Vultures after 885 hours of monitoring was 0.004 birds per hour, which amounts to about 1 Cape Vulture every 17 days.

According to the Cervantes Population Utilization Distribution outputs the Phefumula Emoyeni One WEF Project Site is rated **Low** sensitivity (Cervantes *et al* 2023) (**Figure *16***).

Analysis currently underway by AfriAvian as part of an updated assessment for the Renewable Energy Development Zones (REDZ) in South Africa that incorporates data sources from various NGOs and conservation authorities also support the finding that the area constitutes a low vulture risk.

The Medium Sensitivity classification is therefore considered inaccurate, and a Low Sensitivity rating is considered more appropriate.



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Figure 15: The National Web-Based Environmental Screening Tool map of the Project Site, indicating sensitivities for the Vulture Species Theme.

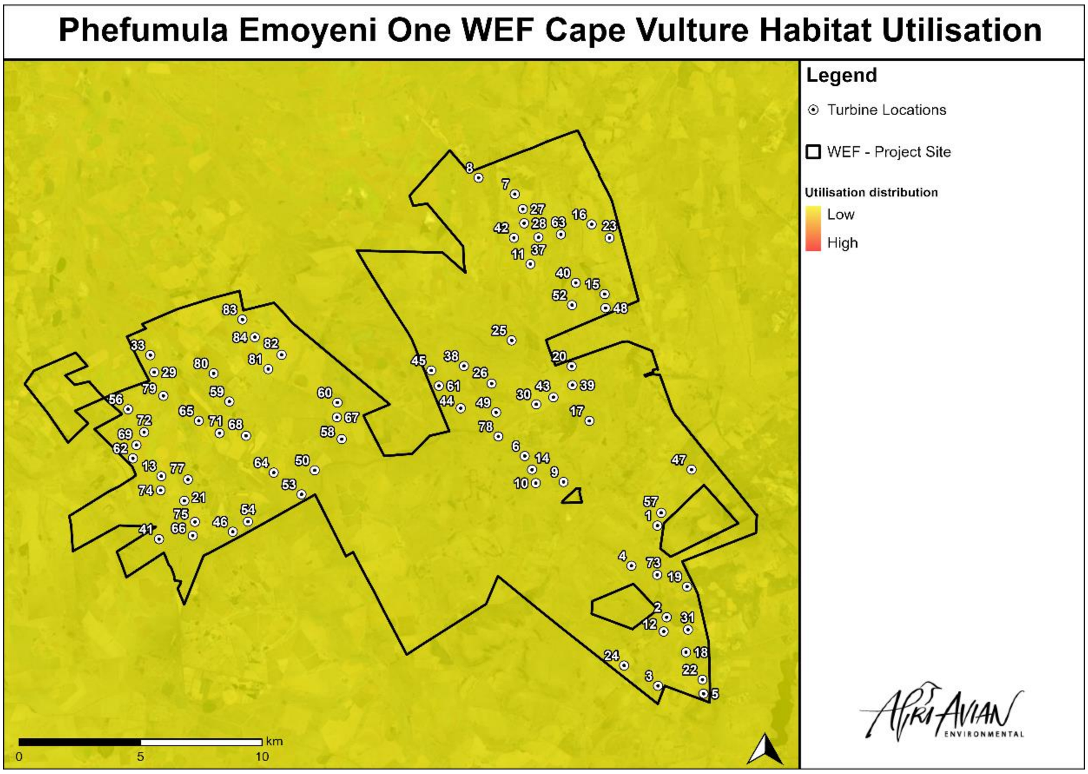


Figure 16: Cervantes Population Utilization Distribution output for the WEF Project Site indicating low usage for Cape Vulture.

5.7. Specialist Sensitivity Analyses and Verification

The entire Project Site is highly sensitive for birds from a wind turbine collision and power line impact perspective. The following avifaunal sensitivities have been identified:

5.7.1 Very High Sensitivity: All Infrastructure Exclusion Zones

Included in this category are:

Martial Eagle nest: a 2.5km all infrastructure exclusion zone should be implemented and maintained around the identified Martial Eagle nest (coordinates can be provided) to avoid displacement and/or breeding failure due to disturbance (**Figure *17***).

Secretarybird nests: a 500m all infrastructure exclusion buffer zone should be implemented and maintained around the two identified Secretarybird nests (coordinates can be provided) to avoid displacement and/or breeding failure due to disturbance (**Figure *18***). However, given the lack of nest site fidelity of this species, and in order to better manage the risk of known shifts in nest sites across breeding seasons[4], we recommend a proactive adaptive risk management plan that is underpinned by routine and systematic nest surveys in medium risk areas identified through habitat and flight risk modelling for this species (**Appendix K**). The proposed approach includes hierarchal tiers of risk management.

Prior to the Operational Phase of the WEF all tree structures across the Project Site will be mapped by generating a canopy height model and applying a tree structure criteria-based model (Appendix K, Tier 0, action 1). Secretarybird management zones across the WEF site will be delineated (tier 0 action 2) using the mapped tree structures, known nests sites and flight risk modelled outputs. During the operational phase of the WEF monthly orthophoto assessments will be conducted to monitor the prioritized management zones to identify active nest and roost structures (Appendix K, tier 1). If active nests/roosts are identified it is recommended that SDoD and/or automated curtailment will be implemented. Refer to **Appendix K** for further details.

Southern Bald Ibis colonies: a 1km all infrastructure exclusion buffer zone should be implemented and maintained around the three identified Southern Bald Ibis colonies (coordinates can be provided) to avoid displacement and/or breeding failure due to disturbance (**Figure *19***).

Avifaunal wetland use/delineation[5]: Wetland habitat suitability modelling was used to inform and determine all infrastructure exclusion zones. Modelled core buffer zones using habitat preference of key focal species: African Marsh Harrier, African Grass Owl, Striped Flufftail, Grey Crowned Crane (**Figure *20***) See Section **5.9.7 Flight Risk & Habitat Suitability Modelling** for detailed methodology explanation.

5.7.2 High Sensitivity: Turbine Exclusion Zones

Included in this category are:

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[4] A Secretarybird breeding event is characterized by behaviours associated with the establishment of a nest, including nest building and pre-breeding display flights. Secretarybird nesting and breeding will be monitored throughout the WEF site using a hierarchal tiered approach and it is recommended that SDoD will be applied accordingly to reduce the risk of displacement and/or turbine collisions. Refer to **Appendix K** for details.

[5] An aquatic specialist primarily focuses on the infrastructure footprint, while considerations from an avian perspective involve more aspects, such as suitable avifaunal microhabitats (such as moist grasslands) surrounding the actual wetland footprint. For this reason, bird habitats were evaluated from both wetland and aquatic viewpoints, independent of the aquatic specialist's perspective. A delineation was made with an associated buffer area to account for the blade swept area. It is also essential to consider the flight paths of birds and their movements across the landscape, which significantly differs from what the aquatic specialist would take into account. Thus, there is a clear differentiation between these two aspects from both an avifauna and aquatic perspective.

Wetland habitat suitability modelling (See Section **5.9.7 Flight Risk & Habitat Suitability Modelling)** was used to inform and determine Turbine Exclusion Zones (**Figure *20***). The buffer zones must be classified as rotor swept free zones. Wetlands (including dam margins) are important breeding, roosting, and foraging habitat for a variety of Species of Conservation Concern (SCC), most notably for African Grass Owl (Regionally Vulnerable), Greater Flamingo (Regionally Near Threatened), Yellow-billed Stork (Regionally Endangered), and Blue Crane (Regionally Near Threatened). Modelled turbine exclusion buffer zones using habitat preference of key focal species: African Marsh Harrier, African Grass Owl, Striped Flufftail, Grey Crowned Crane.

Modelled Rudd's Lark habitat areas to prevent displacement of the birds due to disturbance and habitat destruction (**Figure *21***) – See Section **5.9.7 Flight Risk & Habitat Suitability Modelling** for detailed methodology explanation.

Modelled Yellow-breasted Pipit habitat areas to prevent displacement of the birds due to disturbance and habitat destruction (**Figure *21***) – See Section **5.9.7 Flight Risk & Habitat Suitability Modelling** for detailed methodology explanation.

Modelled suitable habitat buffers around core habitat areas for **Lesser Flamingo and Greater Flamingo** to prevent displacement of the birds due to disturbance and to reduce the risk of turbine collisions (**Figure *22***) – See Section **5.9.7 Flight Risk & Habitat Suitability Modelling** for detailed methodology explanation.

Southern Bald Ibis colonies - A shaped turbine exclusion zone has been delineated based on modelled flight activity (**Figure *19***). The modelling workflow incorporated all the flight data collected within the area during the pre-construction monitoring. The model identifies high risk flight areas by considering associations between the underlying habitat and topography in relation to the recorded Southern Bald Ibis flight data and proximity to roosts – See Section **5.9.7 Flight Risk & Habitat Suitability Modelling** for detailed methodology explanation.

Secretarybird nests - A shaped turbine exclusion zone has been delineated based on modelled flight activity (**Figure *18***). The modelling workflow incorporated all the flight data collected within the area during the pre-construction monitoring. The model identifies high risk flight areas by considering associations between the underlying habitat and topography in relation to the recorded Secretarybird flight data and proximity to nests.

Black Sparrowhawk nests: a 250m wind turbine exclusion zone (including the rotor swept area) should be implemented and maintained around the two identified Black Sparrowhawk nests (coordinates can be provided (one nest is located on site while the other nest was located approximately 5-6km south of the project area) to minimise the risk of collisions and to avoid displacement due to disturbance (**Figure 23**).

The Black Sparrowhawk is classified as a wind priority species with a conservation status of least concern. These birds typically nest and hunt around stands of alien trees within grassland habitats. Although a 750-meter buffer was initially assigned to their nests, this was deemed excessive given that these raptors primarily focus their hunting activities around tree stands in these habitats. A 250-meter buffer is recommended, aligning with buffer delineations for other similar-sized raptors. It is also important to note that nest locations may change regularly. Therefore, it is advised that risk management regarding Black Sparrowhawks be approached through adaptive management strategies.

Martial Eagle nest: A shaped turbine exclusion zone has been delineated based on modelled flight activity. The modelling workflow incorporated all the flight data collected within the area during the pre-construction monitoring. The model identifies high risk flight areas by considering associations between the underlying habitat and topography in relation to the recorded Martial Eagle flight data and proximity to nests.

Heronry: a 300m wind turbine exclusion zone (including the rotor swept area) should be implemented and maintained around the heronry to minimize the risk of collisions and to avoid displacement due to disturbance (**Figure *23***).

Natural pans: A 2km wind turbine exclusion zone (including the rotor swept area) should be implemented and maintained around natural pans (**Figure *22***).

5.7.3 Medium Sensitivity: Limited Infrastructure & Mitigation Zones

A similar flight risk modelling workflow (**5.9.7 Flight Risk & Habitat Suitability Modelling**) was used to delineate medium risk sensitivity zones where proactive mitigation measures (e.g. Turbine Shutdown on Demand, either observer led or automated) will be required. The modelling was done for the following species:

- Secretarybird (**Figure *18***),
- Southern Bald Ibis (**Figure *19***),
- Black-winged Pratincole (**Figure *24***),
- Rudd's Lark (**Figure *21***),
- Yellow-breasted Pipit (**Figure *21***).

<u>Flocks of priority species:</u> A Radar-based Shutdown on Demand (SDoD) system (or similar suitable alternative), operated by trained personnel is recommended for use to identify flocks of priority bird species at the site. Turbines that could pose a risk to these flocks will be shut down to reduce the likelihood of collisions. This type of system will also detect nocturnal movements of species such as flamingos, which often fly in flocks, and trigger turbine shutdowns when such movements are observed at night. The system's ability to differentiate specific species based on their unique size and flight characteristics, such as potentially Secretarybirds and Blue Cranes, will be used to initiate appropriate turbine shutdowns.

Flocking species of conservation concern that could regularly traverse Phefumula Emoyeni One WEF			
Species Name	**Scientific Name**	**Global Conservation Status**	**Regional Conservation Status**
Black Stork	Ciconia nigra	-	VU
Black-winged Pratincole	Glareola nordmanni	NT	NT
Blue Crane	Grus paradisea	VU	NT
Blue Korhaan	Eupodotis caerulescens	NT	LC
Denham's Bustard	Neotis denhami	NT	VU
Greater Flamingo	Phoenicopterus roseus	-	NT
Lesser Flamingo	Phoeniconaias minor	NT	NT
Maccoa Duck	Oxyura maccoa	EN	NT
Southern Bald Ibis	Geronticus calvus	VU	VU

High Sensitivity grassland: Natural grassland. Development in the remaining natural grassland in the Project Site must be limited as far as possible. Where possible, infrastructure must be located near margins, with the shortest routes taken from the existing roads. The natural grassland is a vital breeding, roosting, and foraging habitat for a variety of SCC. These include African Grass-owl (Globally Least Concern, Regionally Vulnerable), and Secretarybird (Globally Endangered, Regionally Vulnerable).

Secretarybirds: Given the lack of nest site fidelity of this species, and in order to manage the risk of known shifts in nest sites across breading seasons[6], we recommend a proactive adaptive risk management plan that is underpinned by routine and systematic nest surveys in medium risk areas identified through habitat and flight risk modelling for this species (**Appendix K**). The proposed approach includes hierarchal tiers of risk management.

Prior to the Operational Phase of the WEF all tree structures across the Project Site will be mapped by generating a canopy height model and applying a tree structure criteria-based model (Appendix K, Tier 0, action 1). Secretarybird management zones across the WEF site will be delineated (tier 0 action 2) using the mapped tree structures, known nests sites and flight risk modelled outputs. During the operational phase of the WEF monthly orthophoto assessments will be conducted to monitor the prioritized management zones to identify active nest and roost structures (Appendix K, tier 1). If active nests/roosts are identified SDoD and/or automated curtailment is recommended to be implemented. Refer to **Appendix K** for further details

Figures 17–24 illustrate all the identified avifaunal sensitivities for the proposed Phefumula Emoyeni One WEF, the WEF layout has taken all the recommended avifaunal buffer zones into account.

[6] A Secretarybird breeding event is characterized by behaviours associated with the establishment of a nest, including nest building and pre-breeding display flights. Secretarybird nesting and breeding will be monitored throughout the WEF site using a hierarchal tiered approach and SDoD is recommended to be applied accordingly to reduce the risk of displacement and/or turbine collisions. Refer to **Appendix K** for details.

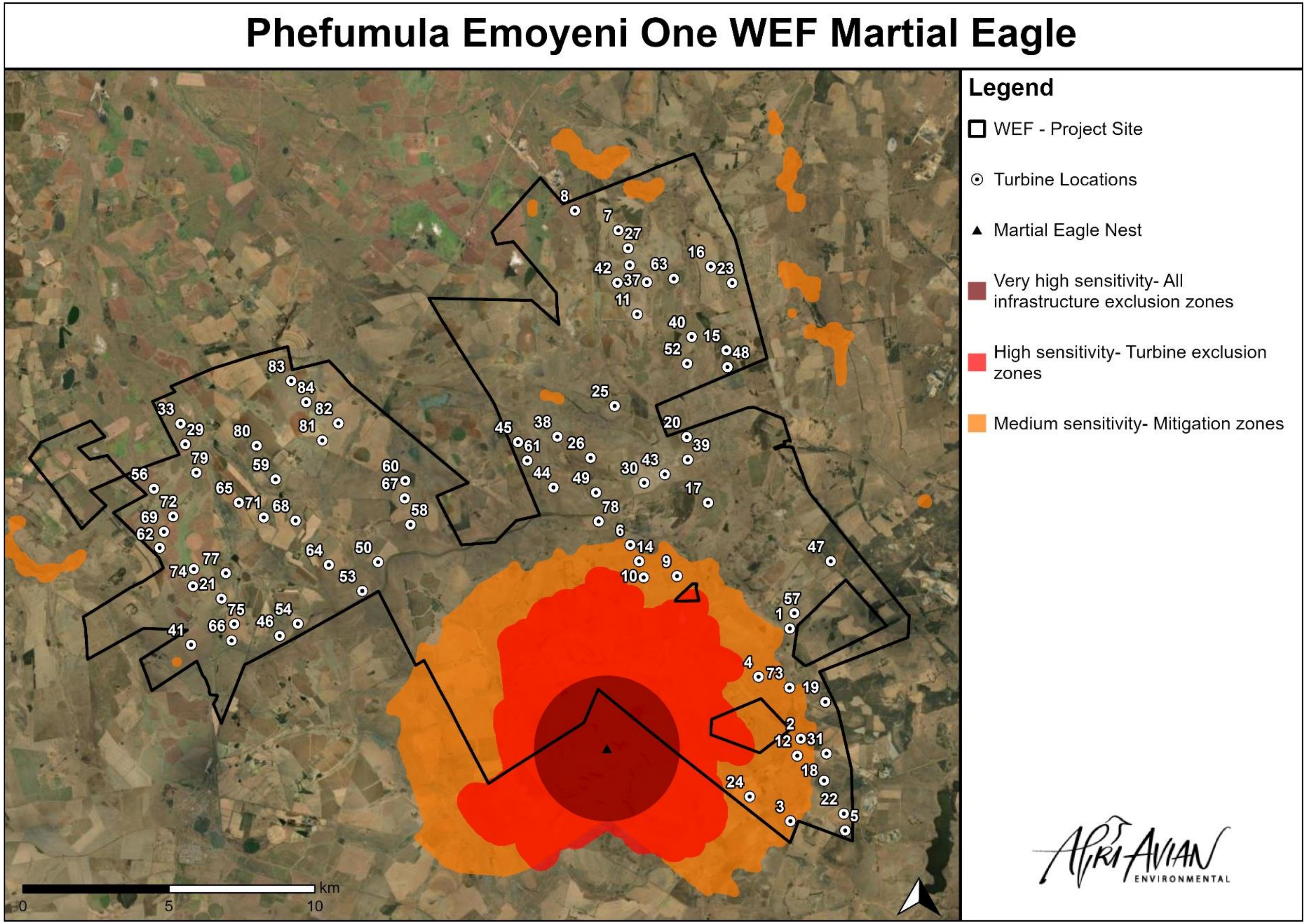

Figure 17: Phefumula Emoyeni One WEF Avifaunal Sensitivities Map for Martial Eagle. All Infrastructure Exclusion Zones = Dark Red, Wind Turbine Exclusion Zones = Red, Medium Risk Mitigation Zones = Orange.

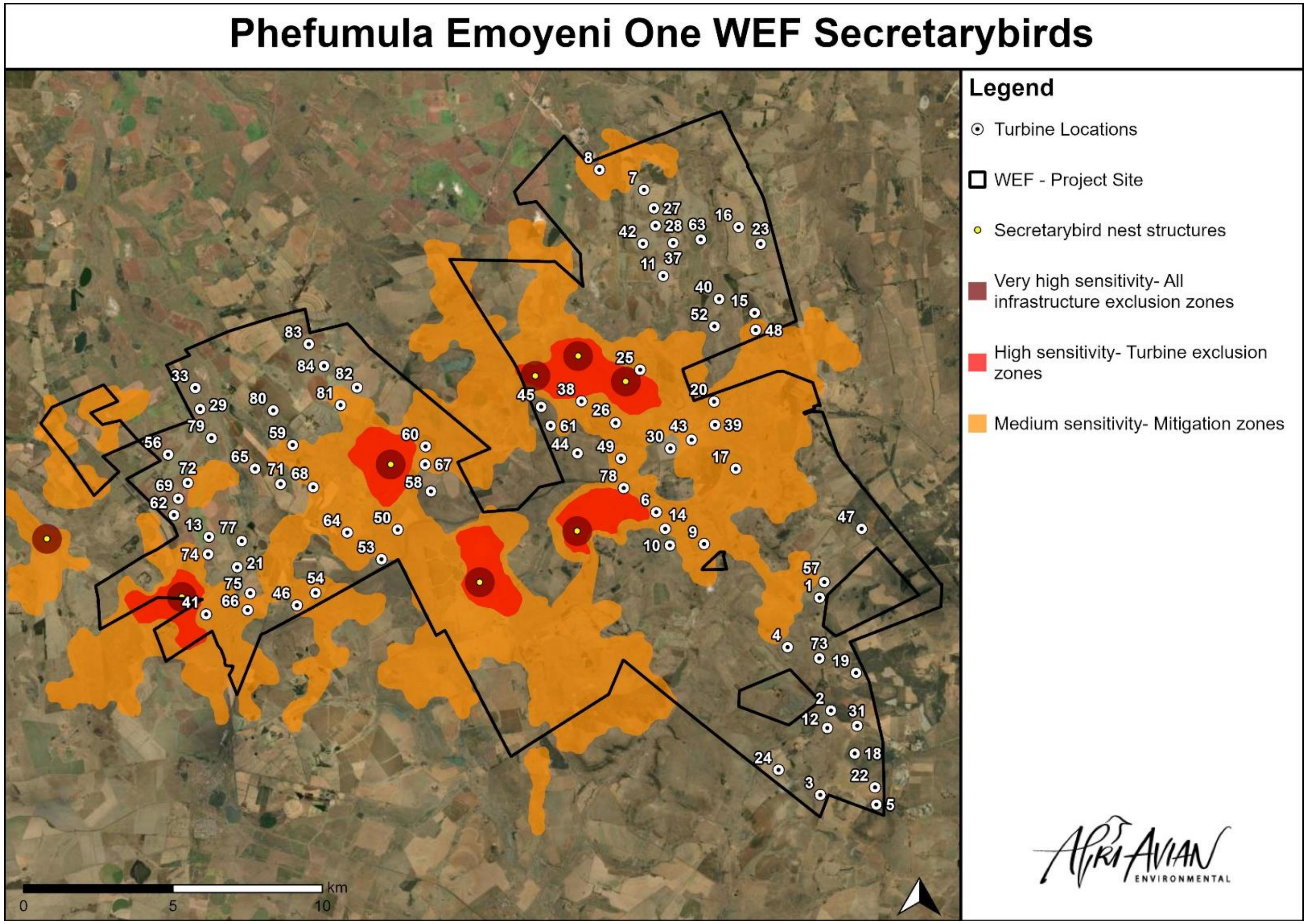

Figure 18: Phefumula Emoyeni One WEF Avifaunal Sensitivities Map for Secretarybirds. All Infrastructure Exclusion Zones = Dark Red, Wind Turbine Exclusion Zones = Red, Medium Risk Mitigation Zones = Orange.

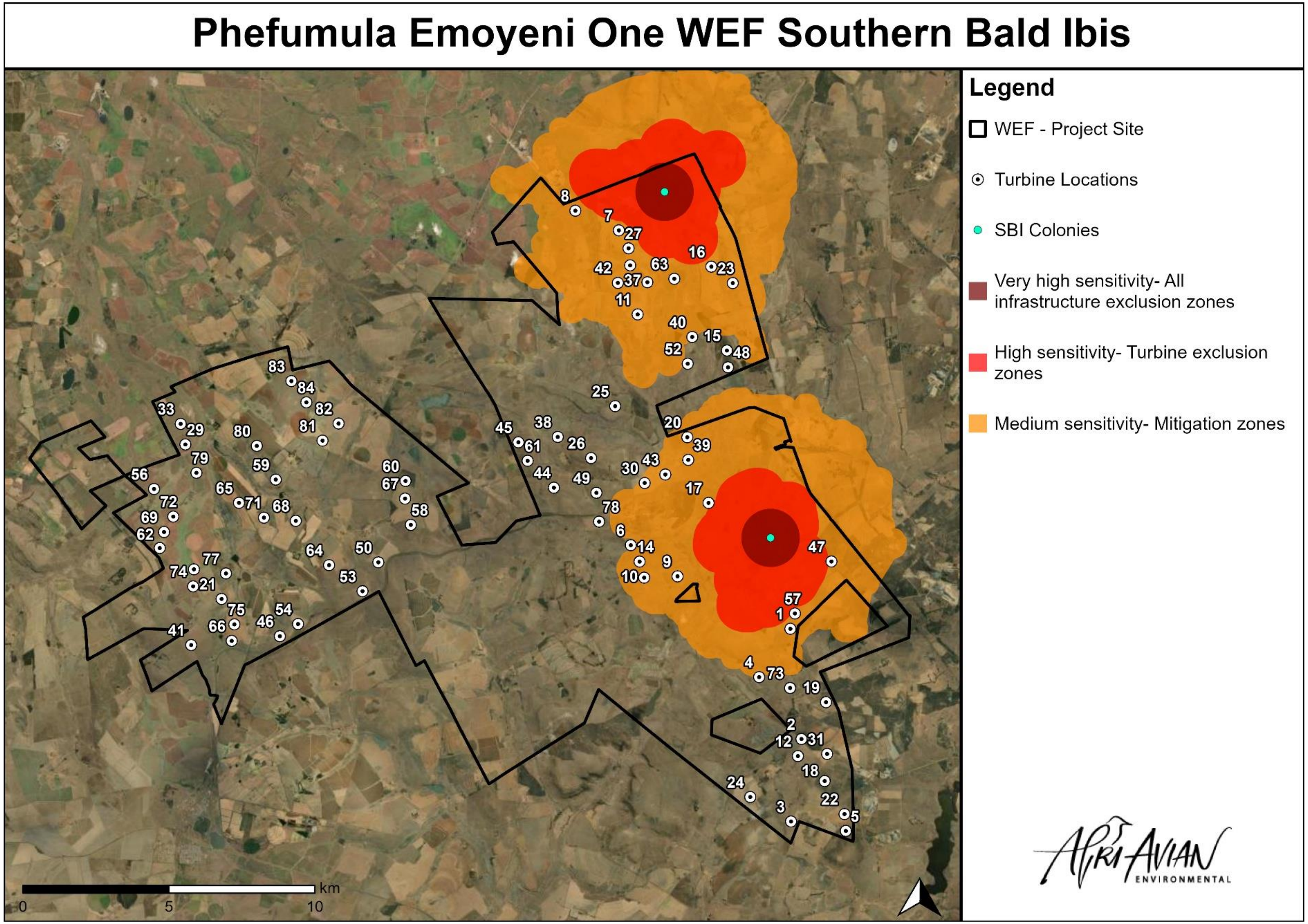

Figure 19: Phefumula Emoyeni One WEF Avifaunal Sensitivities Map for Southern Bald Ibis (SBI). All Infrastructure Exclusion Zones = Dark Red, Wind Turbine Exclusion Zones = Red, Medium Risk Mitigation Zones = Orange.

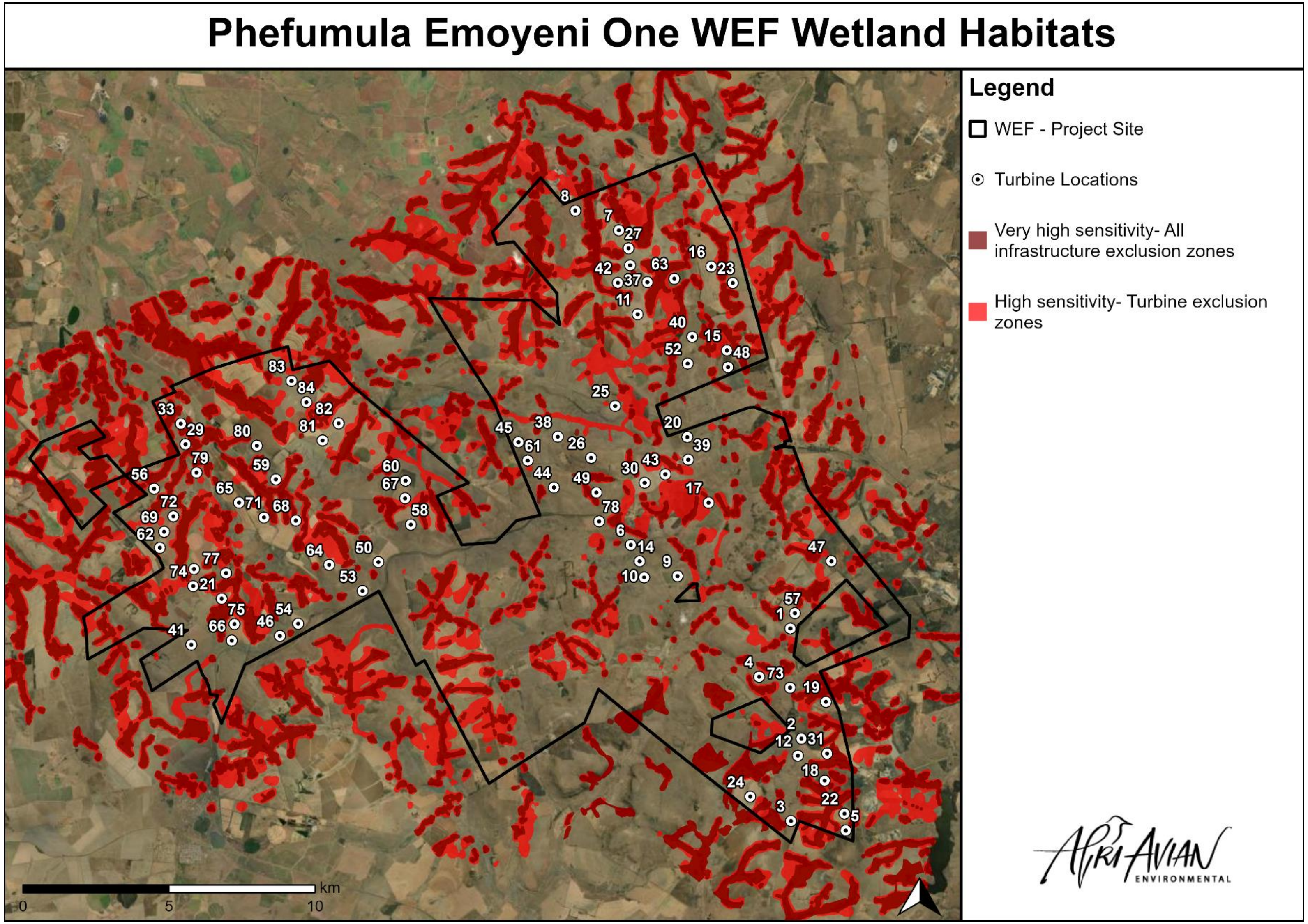

Figure 20: Phefumula Emoyeni One WEF Avifaunal Sensitivities Map for Avifaunal Specific Wetland Habitat. All Infrastructure Exclusion Zones = Dark Red, Wind Turbine Exclusion Zones = Red.

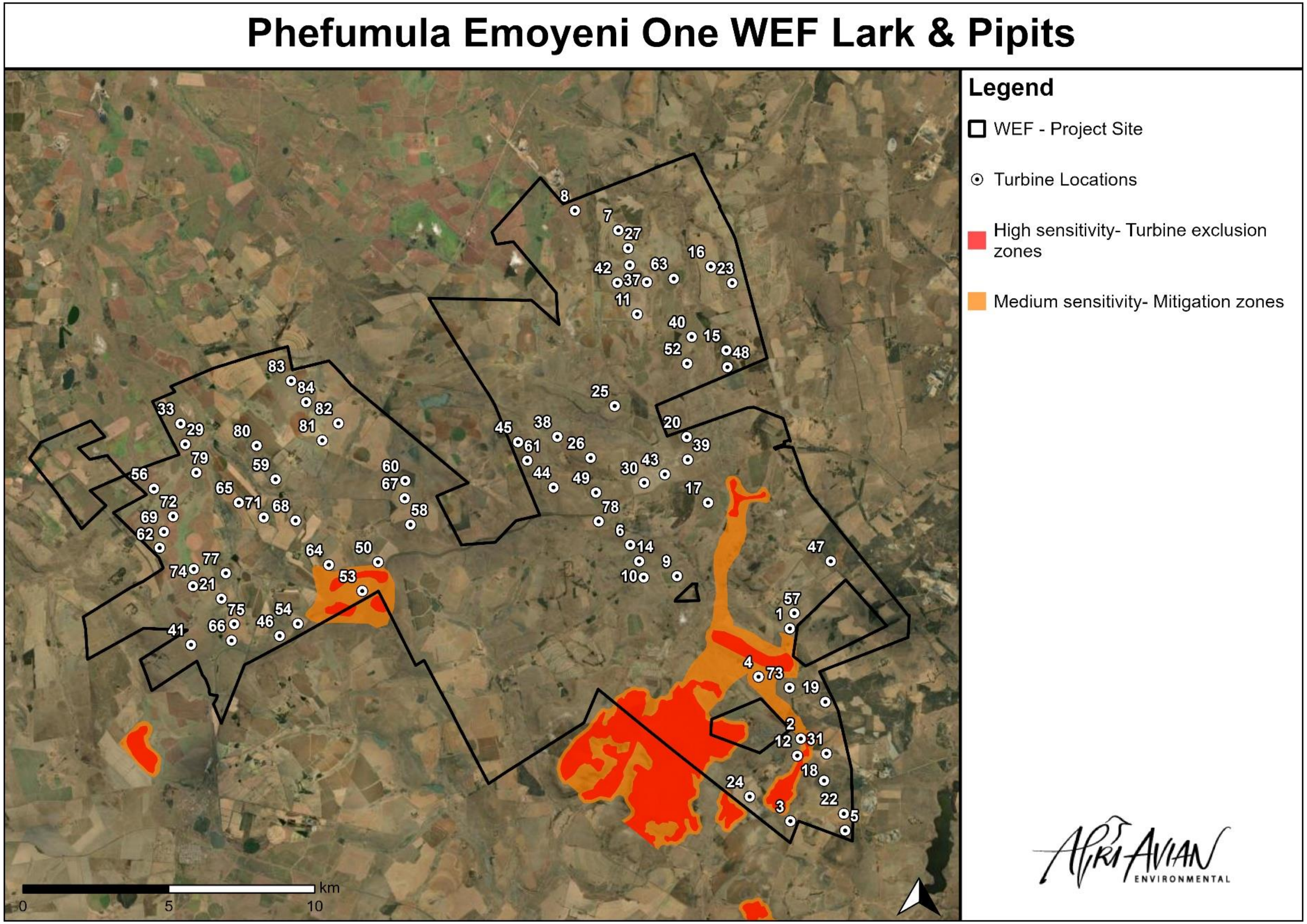

Figure 21: Phefumula Emoyeni One WEF Avifaunal Sensitivities Map for Yellow-breasted Pipit and Rudd's Lark and Sensitive Grassland Habitat. Wind Turbine Exclusion Zones = Red, Medium Risk Mitigation Zones = Orange.

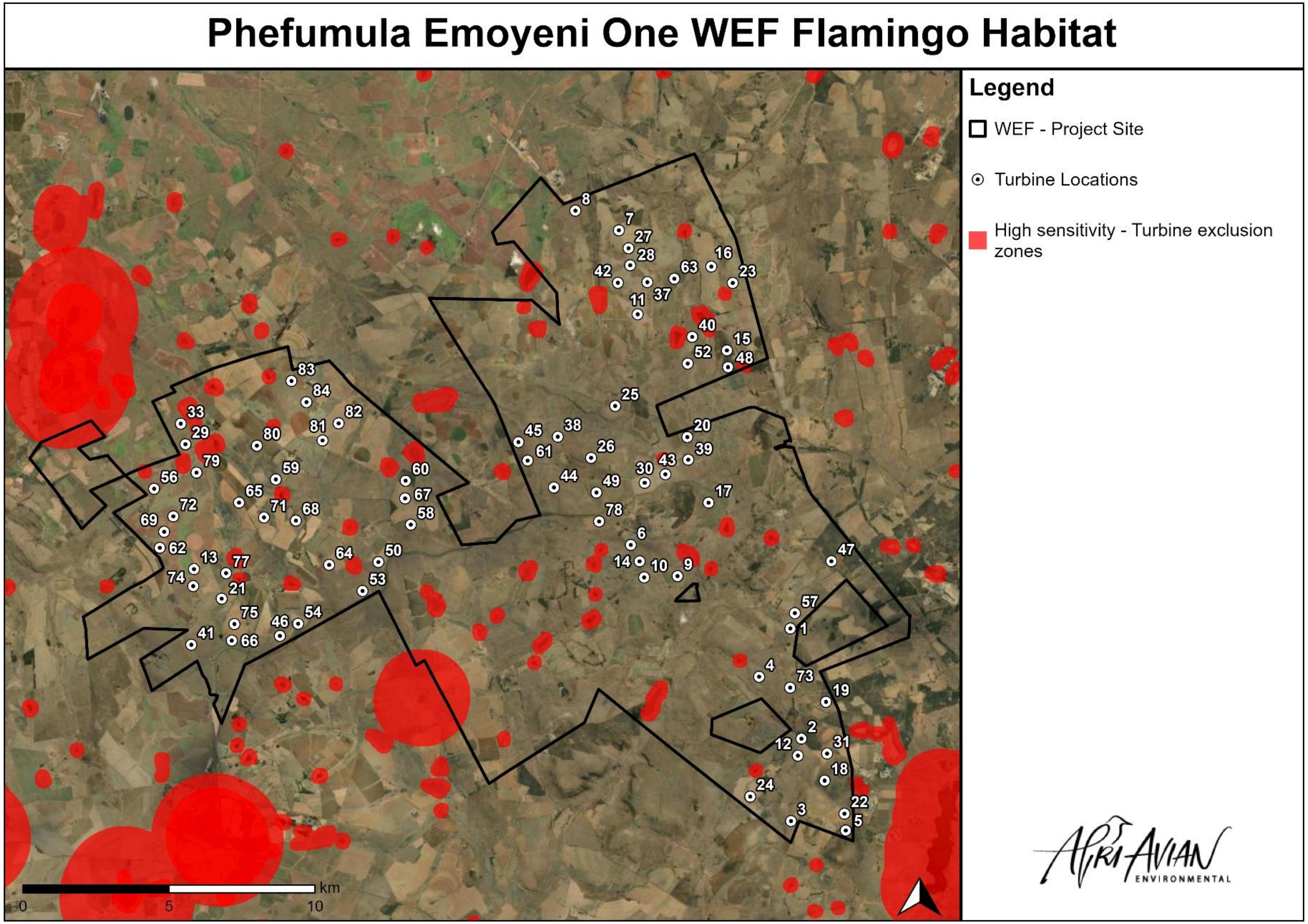

Figure 22: Phefumula Emoyeni One WEF Avifaunal Sensitivities Map for Flamingos, including pans and other suitable habitat. Wind Turbine Exclusion Zones = Red.

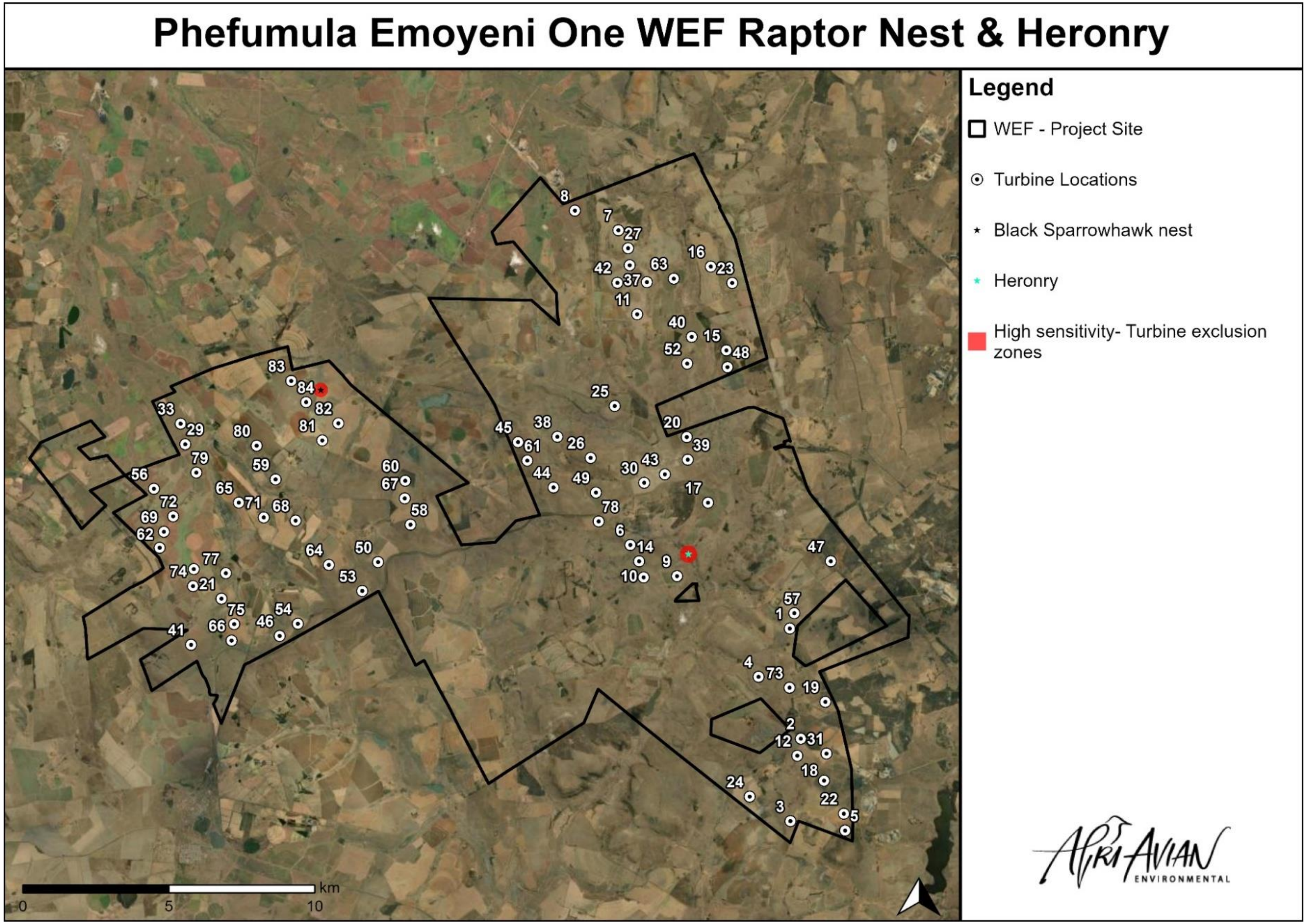

Figure 23: Phefumula Emoyeni One WEF Avifaunal Sensitivities Map for Black Sparrowhawk Nest and a Heronry. Wind Turbine Exclusion Zones = Red.

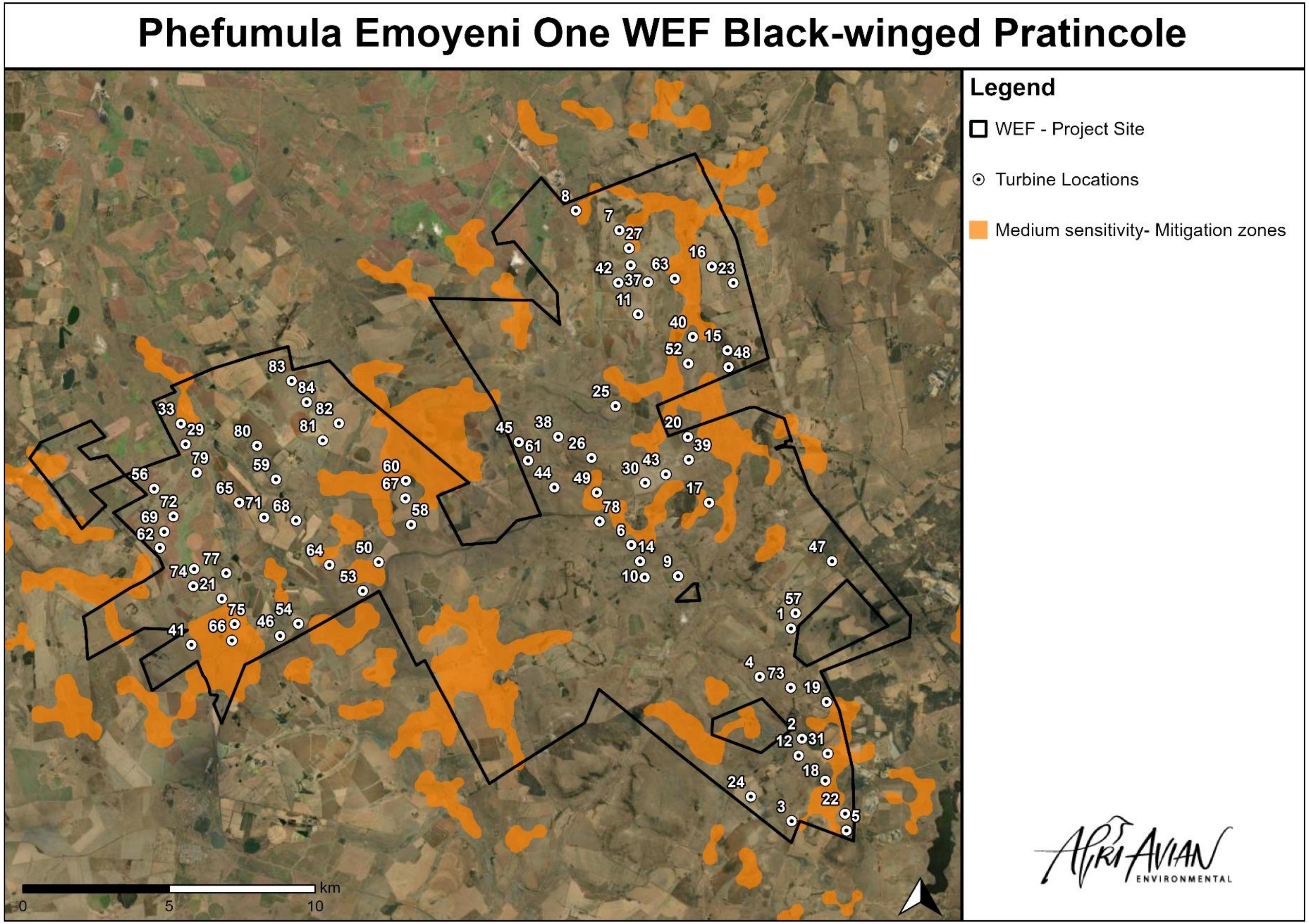

Figure 24: Phefumula Emoyeni One WEF Avifaunal Sensitivities Map for Black-winged Pratincole Habitat. Medium Risk Mitigation Zones = Orange.

5.8 Sensitivity Analysis Summary Statement

Based on the Site Sensitivity Verification survey and the integrated pre-construction monitoring conducted at the Project Site, a classification of **High sensitivity** for avifauna is suggested for the Phefumula Emoyeni One WEF. Therefore, all mitigation measures as outlined in this Avifaunal Specialist Study should be strictly implemented.

5.9. Results of Pre-Construction Monitoring

The objective of the pre-construction monitoring at the proposed Phefumula Emoyeni One WEF is to gather baseline data over a period of four seasons on the following aspects pertaining to avifauna at the development area:

- The abundance and diversity of birds to measure the potential displacement effect of the wind farm.
- Flight patterns of priority species to assess the potential collision risk with the turbines.

The monitoring protocol for the WEF site was designed according to the following set of 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.

The results of the pre-construction monitoring conducted are detailed in the sections below. The monitoring surveys completed to were conducted in the following time periods:

- **Survey 1:** 05–16 November 2022, 17–20 January 2023, and 14–20 February 2023
- **Survey 2:** 11 April – 02 May 2023
- **Survey 3:** 13 June – 4 August 2023
- **Survey 4:** 04–21 October 2023

Refer to **Appendix F** for details on the pre-construction monitoring protocol.

5.9.1 Transect Counts

The results of the transect counts in the Project Site are presented in **Table 6** below.

Table 6: Transect count results after four surveys.

Turbine Site	
Species Composition	
All Species	185
Priority Species (11%)	20
Non-Priority Species	165
Total Count	
Drive Transects	9605
Walk Transects	25306
Grand Total	34911
Control Site	
Species Composition	
All Species	105
Priority Species (11%)	12
Non-Priority Species	93

Total Count	
Drive Transects	6431
Walk Transects	5043
Grand Total	11474

An Index of Kilometric Abundance (IKA = birds/km) was calculated for each priority species recorded during transects counts across all four seasons (**Figures 25and 26**).

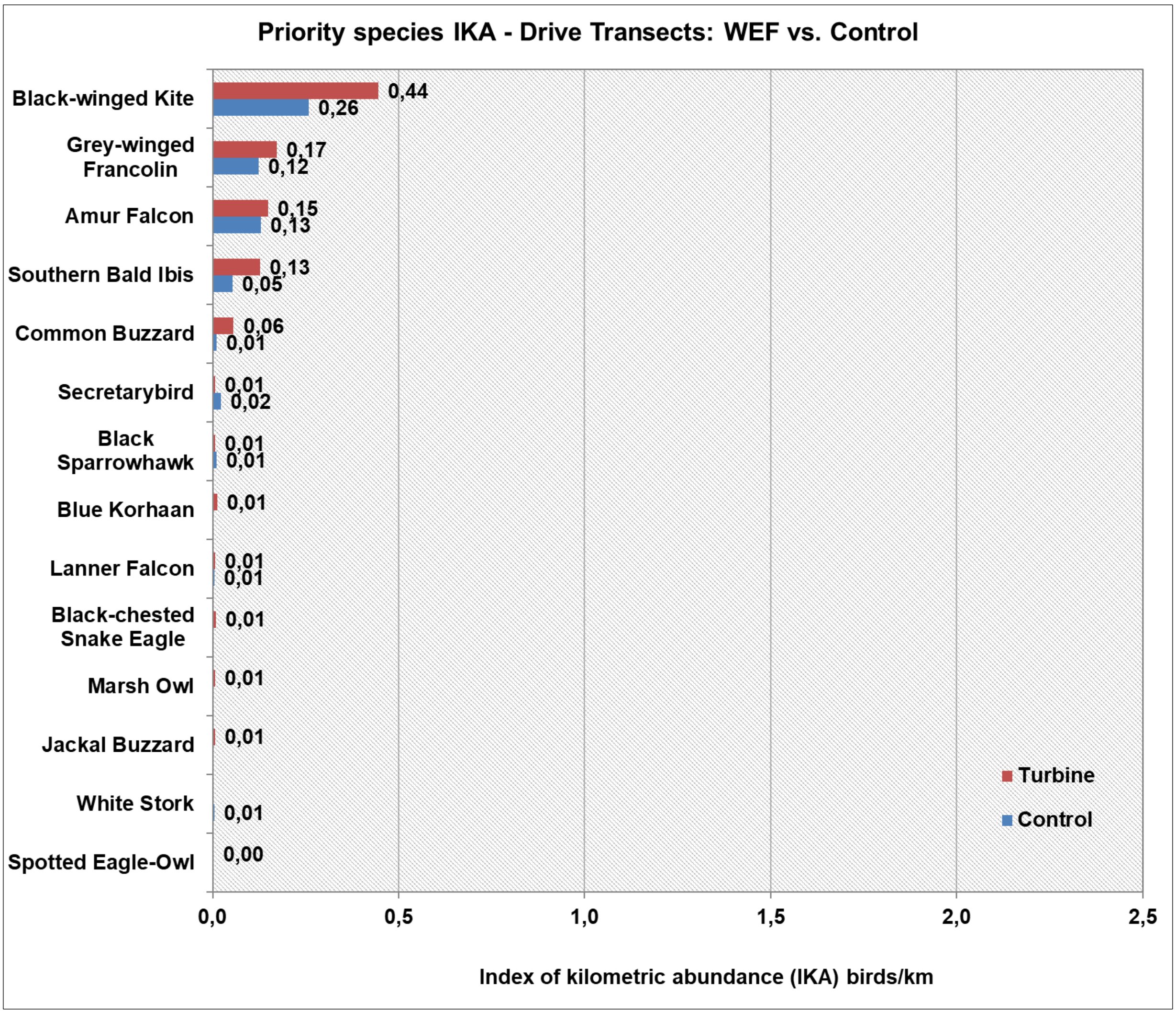

Figure 25: Index of kilometric abundance of priority species recorded at the WEF Site and Control Site during drive transect surveys– all seasonal surveys completed.

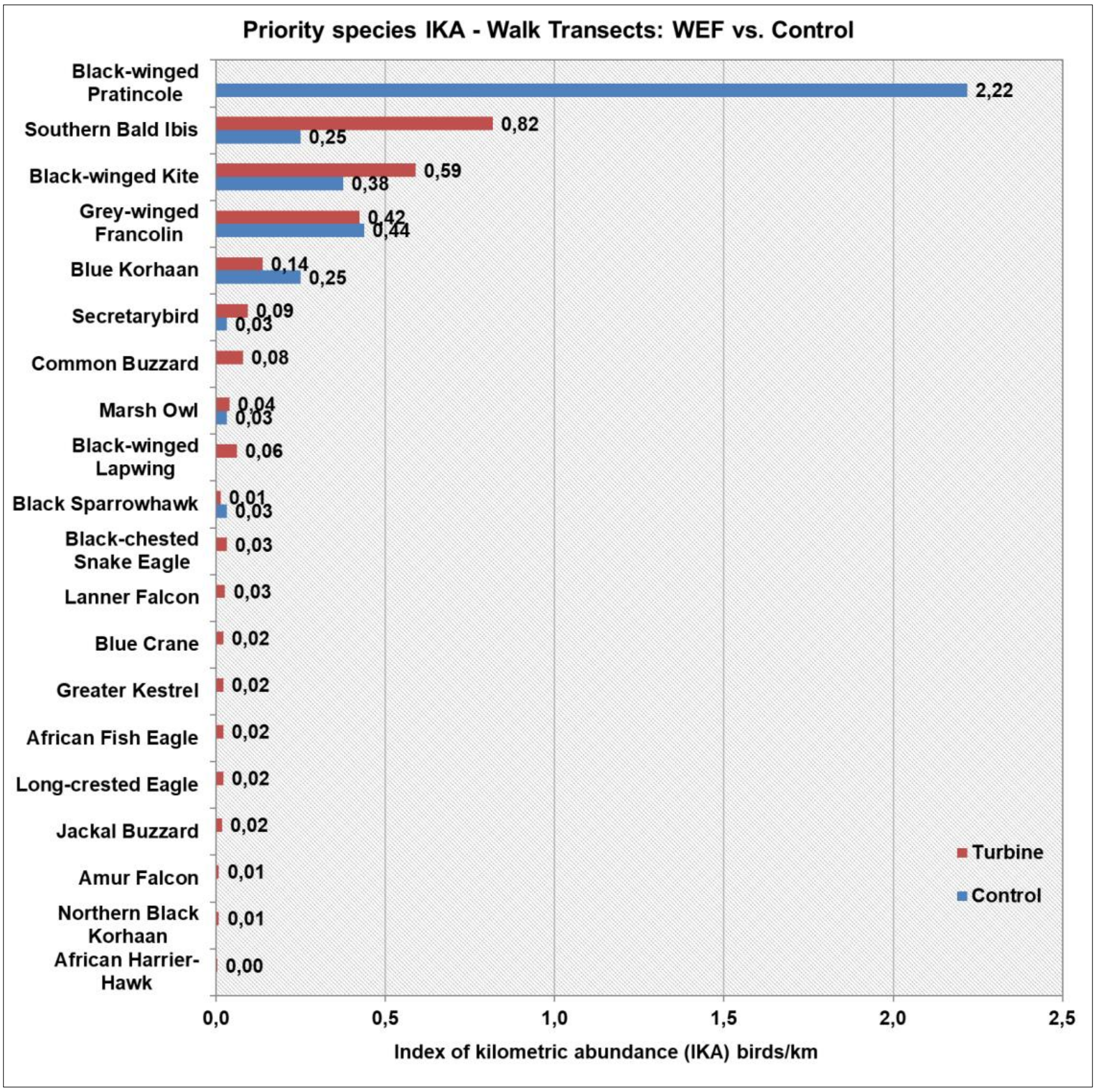

Figure 26: Index of kilometric abundance of priority species recorded at the WEF Site and a Control Site during walk transect surveys – all seasonal surveys completed.

5.9.2 Focal Points

See **Table 7** for the results of the focal point counts.

Table 7: The results of the focal point counts – all seasonal surveys completed.

Focal Points	Survey 1	Survey 2	Survey 3	Survey 4
FP1: Southern Bald Ibis colony	3 individuals including a juvenile	No Southern Bald Ibis, whitewash indicates current activity, Lanner Falcons also seen	Lanner Falcon, Rock Kestrels seen and 2 Southern Bald Ibis only for a short time	1 Adult Southern Bald Ibis tending to fledgeling in nest, 2nd adult seen flying in. No other nests active
FP2: Dam	Dam full, Black-Winged Kite seen	Black-Winged Kite and non-priority species seen	No priority species seen, except for 4 Southern Bald Ibis foraging close by	1 Black-Winged Kite seen foraging and non-priority species
FP3: Heronry	3 Black-Headed Herons, no surface water (dam wall	Dry dam, wall broke thus all nest vacated	Heronry active and primarily used by Black-headed Herons	Not Checked

Focal Points	Survey 1	Survey 2	Survey 3	Survey 4
	collapsed) but 2 active nests			
FP3: Heronry	NA	A lot of Reed Cormorants, no signs of nests or nest building	Nothing reported	Not Checked
FP4: Southern Bald Ibis roost	Southern Bald Ibis seen	Southern Bald Ibis seen roosting	3 Southern Bald Ibis nests under active construction and individuals seen throughout the day.	No Southern Bald Ibis found, 4 immature Lanner Falcons that mobbed the Southern Bald Ibis
FP5: African Fish Eagle Dam	No African Fish Eagle seen	No African Fish Eagle seen	African Fish Eagle heard	African Fish Eagle heard calling
FP6: Martial Eagle nest	Degraded nest, no signs of use or Martial Eagle	1 adult Martial Eagle and 1 subadult, no interest in nest	Nest looks degraded and no Martial Eagle seen, possibly found a new nesting site we are not aware of yet	Nest intact, nest does not appear to be in use, no priority species recorded
FP7: Secretary bird nest	NA	No activity or birds seen	Nothing reported	Both Secretarybirds on nest
FP8: Secretary bird Roost	NA	Single bird flying into tree	Only Black-winged Kite seen	1 Secretarybird leaving roost to forage observed
FP9: Secretary bird nest	NA	NA	NA	Nest in good condition, no Secretarybirds present
FP10: Black Sparrow hawk nest	NA	NA	NA	2 Black Sparrowhawk with a nest. 2 Spotted Eagle Owls roosting in same area
FP11: Black Sparrow hawk nest	NA	NA	NA	2 immature Black Sparrowhawk foraging and occupying area
FP12: Secretary bird nest	NA	NA	NA	No Secretarybirds seen
FP13: Secretary bird nest	NA	NA	NA	No Secretarybirds seen
FP14: Secretary bird nest	NA	NA	NA	1 Secretarybird roosting on tree

5.9.3 Incidental Counts

Table 8 provides an overview of the incidental sightings of priority species recorded during the pre-construction surveys (all seasonal surveys completed).

Table 8: Incidental Sightings of Priority Species.

Priority Species		V1	V2	V3	V4	Grand Total
Control Site						
Black Sparrowhawk	*Accipiter melanoleucus*	0	0	0	1	**1**
Black-winged Kite	*Elanus caeruleus*	1	0	1	2	**4**
Blue Korhaan	*Eupodotis caerulescens*	1	2	0	0	**3**
Common Buzzard	*Buteo buteo*	1	0	0	0	**1**
Grey-winged Francolin	*Scleroptila afra*	11	2	0	6	**19**
Marsh Owl	*Asio capensis*	1	0	0	0	**1**
Secretarybird	*Sagittarius serpentarius*	0	0	1	0	**1**
WEF Site						
African Fish Eagle	*Haliaeetus vocifer*	1	3	5	2	**11**
African Harrier-Hawk	*Polyboroides typus*	0	1	1	0	**2**
Amur Falcon	*Falco amurensis*	12	0	0	0	**12**
Black Sparrowhawk	*Accipiter melanoleucus*	5	0	2	5	**12**
Black-winged Kite	*Elanus caeruleus*	41	86	167	41	**335**
Blue Crane	*Grus paradisea*	0	2	7	1	**10**
Blue Korhaan	*Eupodotis caerulescens*	8	15	38	25	**86**
Booted Eagle	*Hieraaetus pennatus*	1	0	0	0	**1**
Cape Vulture	*Gyps coprotheres*	0	4	0	0	**4**
Common Buzzard	*Buteo buteo*	17	0	0	2	**19**
Denham's Bustard	*Neotis denhami*	0	0	4	0	**4**
Greater Flamingo	*Phoenicopterus roseus*	0	0	0	912	**912**
Greater Kestrel	*Falco rupicoloides*	0	1	4	1	**6**
Grey-winged Francolin	*Scleroptila afra*	72	37	111	53	**273**
Jackal Buzzard	*Buteo rufofuscus*	1	3	2	0	**6**
Lanner Falcon	*Falco biarmicus*	0	0	1	2	**3**
Lesser Flamingo	*Phoeniconaias minor*	0	0	0	268	**268**
Long-crested Eagle	*Lophaetus occipitalis*	2	0	2	3	**7**
Marsh Owl	*Asio capensis*	1	3	9	3	**16**
Martial Eagle	*Polemaetus bellicosus*	1	3	1	0	**5**
Pallid Harrier	*Circus macrourus*	1	0	0	0	**1**
Rufous-breasted Sparrowhawk	*Accipiter rufiventris*	0	2	0	0	**2**
Secretarybird	*Sagittarius serpentarius*	3	5	7	9	**24**
Southern Bald Ibis	*Geronticus calvus*	39	89	8	2	**138**
Spotted Eagle-Owl	*Bubo africanus*	0	4	6	10	**20**
Western Osprey	*Pandion haliaetus*	0	0	0	1	**1**
White Stork	*Ciconia ciconia*	2	3	0	0	**5**

5.9.4 Vantage Point Observations

Vantage points were surveyed for 1226 hours (~12 hours per VP/visit) at 25 vantage points at the WEF site in three altitude bands (high i.e. >300m i.e. above rotor altitude; medium 30–300m i.e. at rotor altitude; low i.e. <30m i.e. below rotor altitude). Approximate flight altitude was visually judged by an observer with the aid of binoculars. After four surveys, priority species have been observed for 157 hours 41 minutes and 09 seconds during the observation periods, at the WEF Site. **Figure *27* and Figure *28*** display the data gathered during vantage point watches at the WEF Site. The flight lines of priority species recorded after all seasonal surveys are shown in **Figure *28***. A total of 1918 individual flights have been recorded to date. The passage rate for priority species was 1.5 birds/hour[7]. This amounts to approximately 20 birds (priority species) per day.[8] See **Figure *27*** below for the duration and altitude of flights for each recorded priority species[9].

[7] A distinction was drawn between passages and flights. A passage may consist of several flights e.g., every time an individual bird changes height or mode of flight; this was recorded as an individual flight, although it still forms part of the same passage.
[8] Assuming 13 hours daylight averaged over all four seasons.
[9] 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.

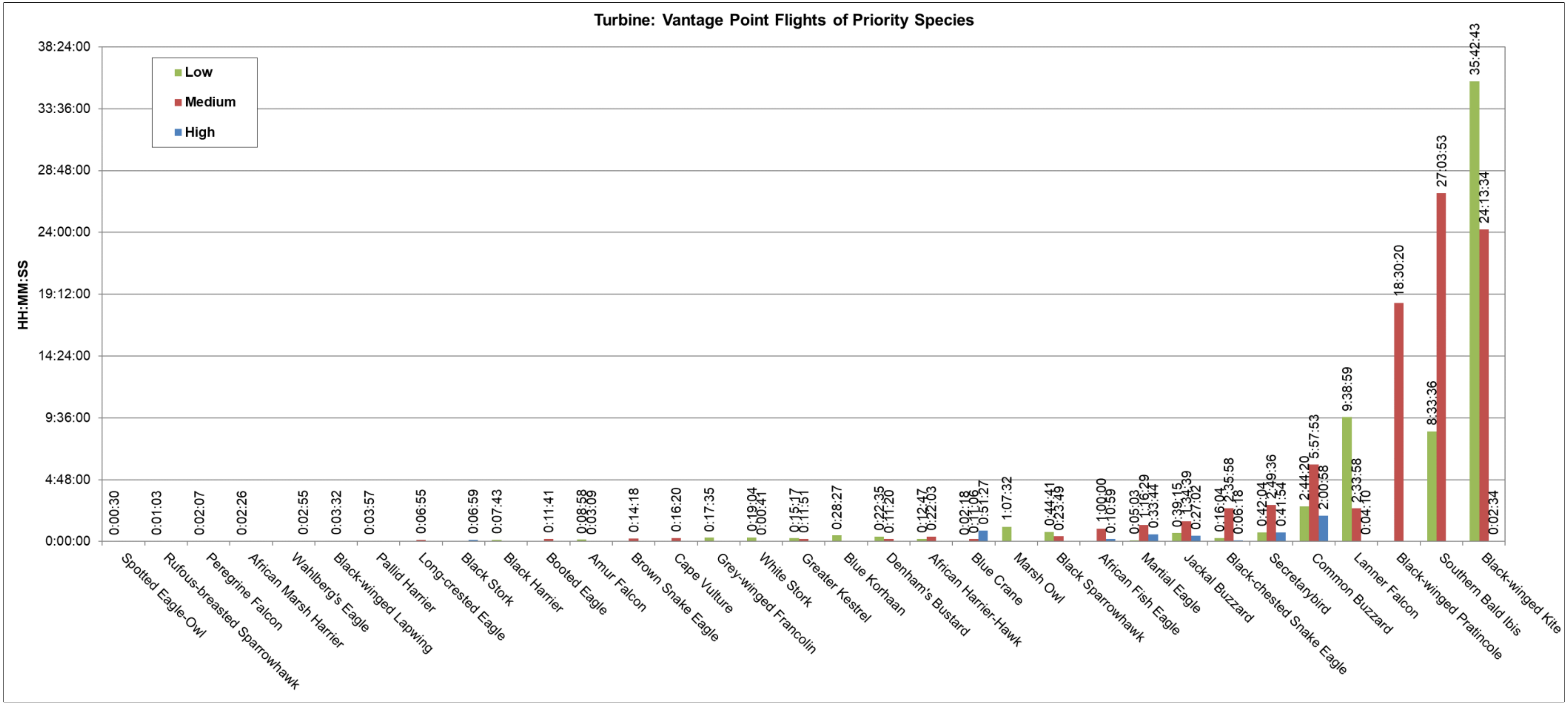

Figure 27: Flight times (hours) and altitudes recorded for all individuals of priority species at the WEF Site (1226 hours of observation). Time is indicated in hours: minutes: seconds. Flight altitude is indicated as low = green/below rotor altitude, medium = red/at rotor altitude, high = blue/above rotor altitude.

5.9.5 Flight Lines of Priority Species

Flight lines of priority species were recorded at the WEF site during Vantage Point watches for each of the four surveys. The recorded flight lines for priority species after four surveys are shown in **Figure *28*.**

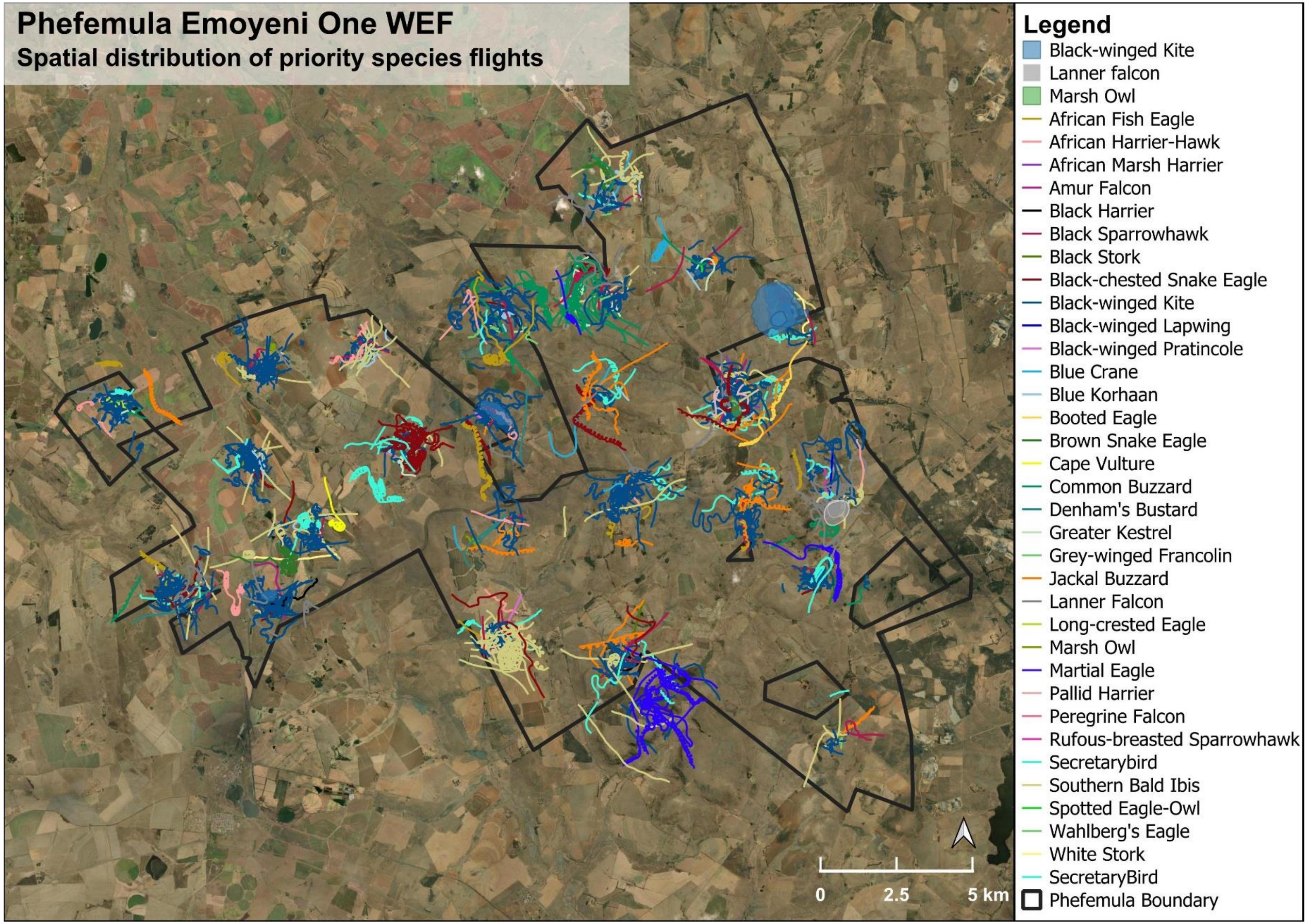

Figure 28: Recorded flight lines for priority species – all seasonal surveys completed.

5.9.6 Collision Risk Modelling

A Bayesian approach to collision risk modelling was utilised in assessing fatality rates for wind priority species. This framework allows for the use of the best available biological data and other survey data to inform prior distributions as parameters, whilst posterior distributions reflect the site-specific data collected pre-construction (New et al. 2015). Three crucial components that contribute to the risk of collisions and associated fatalities were incorporated into the analysis, namely bird exposure, collision probability and hazardous area exposure (New et al. 2015). Prior distributions reflecting both exposure and collision probability were generated for a number of species using data from multiple post-construction facilities in South Africa. Defining parameters for exposure and the probability of collision using local data related to the respective species greatly increases the validity of fatality predictions as demonstrated by New et al. (2015) and further confirmed by a local South African case study (Colyn et al. 2024 in prep).

Three fatality estimate scenarios have been produced (**Figure *29***):

1. No avoidance or mitigation (orange bars): several species approach or are well over the threshold of one fatality per year. Southern Bald Ibis, in particular, has a fatality estimate of more than seven birds per year.
2. Avoidance (nests sites) and no mitigation (dark blue bars). Flight risk modelling was conducted surrounding only known nests sites for three species – Southern Bald Ibis, Martial Eagle and Secretarybird. This incorporates these species-specific avoidance areas. For Southern Bald Ibis, the avoidance alone did not reduce the fatality estimate greatly. This is largely due to extensive flight activity being recorded across the WEF Project Site well away from the colony localities.
3. Avoidance and Shutdown on Demand (SDoD) mitigation assuming an 80% efficacy (light blue bars). Three species yielded estimates reaching or exceeding a fatality rate of one bird/year – Black-winged Pratincole, Jackal Buzzard and Southern Bald Ibis.

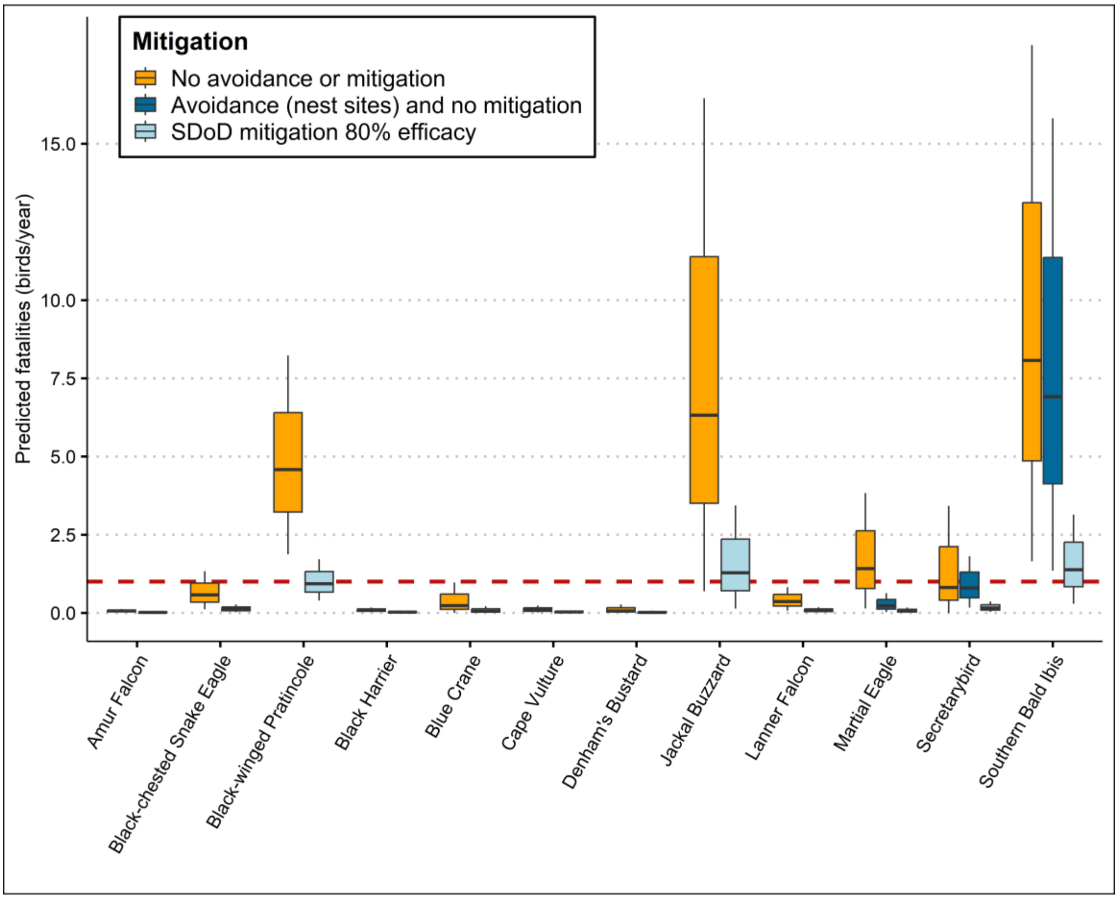

Figure 29: Collision risk modelling predicted fatalities with 1) no mitigation (orange bars), 2) with nest avoidance for the three known species nesting sites (dark blue bars), and 3) with nest avoidance and SDoD implementation (light blue bars).

5.9.7 Flight Risk & Habitat Suitability Modelling

The various methodologies outlined below were used to spatially model risk for various species and were used to inform the wind farm layout through avoidance and to inform mitigation zones, as well as assist with mitigation implementation. The outputs are shown in the sensitivity maps in **Section 5.7 Specialist Sensitivity Analyses and Verification**.

Habitat suitability modelling

Habitat suitability modelling was undertaken for sensitive grassland species: Yellow-breasted Pipit (VU), Rudd's Lark (EN) and Black-winged Pratincole (NT); and for sensitive wetlands species: Grey Crowned Crane (EN), African Marsh Harrier (EN), Species 23 (CR), Striped Flufftail (VU) and African Grass Owl (VU). **Model outputs were informed and validated by data obtained from site-specific fieldwork and surveys conducted in the surrounding area.**

An R workflow was scripted and used to prepare, pre-process and analyse remote sensing data acquired by the Sentinel 2 satellite platform (Copernicus 2023). A classification modelling framework, which included the use of an ensemble model, was used to assess habitat suitability for target species[10]. A stepwise variable selection technique was used to conduct a data driven process of variable selection. Variable selection includes the removal of highly correlated variables, thereby preventing autocorrelation and improving the interpretation of final model results (Vignali *et al.* 2020).

The modelling workflow included data partitioning, model training, variable selection, model testing, model optimization through hyperparameter tuning and final model predictions. Occurrence data were sourced by an extensive internal database, supplemented with *in-situ* data collected at the Project Site across the reporting period. The overall occurrence and absence dataset was partitioned into training (80%) and testing (20%) subsets. Subsequently, we trained the primary models using the Random Forest and ANN algorithms, followed by hyperparameter tuning and model optimization using the genetic algorithm (Vignali *et al*. 2020). Variable importance and partial dependence plots were generated for the final set of variables selected following initial model training and optimization. A final global model was trained using the entire training occurrence dataset for each species, and this model was then used to make predictions of habitat suitability within the local area of interest (i.e. proposed development footprint) for specific species.

Model performance was assessed using the Receiver-operating characteristic (ROC) and associated area under the curve (AUC-ROC) value (Freeman and Moisen 2008). ROC plots compare the true positive and false positive rates and are commonly used as a metric of model performance in classification studies (Jimenez-Valverde 2012; Sofaer *et al*. 2018).

Wetland Habitat Modelling[11]

For the primary threatened avian species associated with wetlands that are likely to occur on-site, namely African Grass Owl, Blue Crane, and African Marsh Harrier, a wetland sensitivity layer was generated from the species-specific predictive models. The species models are focused on identifying core habitats for the respective species, with a focus on breeding habitat, where relevant, as well as associated foraging habitat. For Blue Crane, this largely focused on potential roost sites (see below). Due to the habitat flexibility of both African Grass Owl and that of Blue Crane, habitats highlighted may include agricultural fringes and other

[10] An ensemble modelling approach incorporates the use of more than one classification algorithm, drawing on the strengths of each and resisting any inherent bias that could be present in a single model. This general modelling process has been previously used in multiple peer-reviewed avian habitat suitability studies (Colyn et al. 2020a; Colyn et al. 2020b; Colyn et al. 2020c).

[11] An aquatic specialist primarily focuses on the infrastructure footprint, while considerations from an avian perspective involve more aspects, such as suitable avifaunal microhabitats (such as moist grasslands) surrounding the actual wetland footprint. For this reason, bird habitats were evaluated from both wetland and aquatic viewpoints, independent of the aquatic specialist's perspective. A delineation was made with an associated buffer area to account for the blade swept area. It is also essential to consider the flight paths of birds and their movements across the landscape, which significantly differs from what the aquatic specialist would take into account. Thus, there is a clear differentiation between these two aspects from both an avifauna and aquatic perspective.

habitats surrounding wetlands, seeps, and other rank vegetation. Not all wetland habitats will be highlighted by the model, as the models are trained to try to identify those habitats with the correct vegetation structure as determined from the satellite imagery.

Wetland surveys were also conducted on site as part of the avifaunal monitoring campaign, wetland habitat surveys and dedicated avian surveys.

Flamingos

A habitat suitability model has been developed to determine high-risk areas for flamingos based on algal blooms in the respective pans, and turbine exclusion zones were delineated. The associated risk model is a data-driven framework designed to inform the buffering of waterbodies and pans within a wind energy facility's area of interest (AOI). The model integrates multiple environmental and ecological datasets to determine suitable habitat conditions for foraging flamingo, ensuring appropriate setback distances for wind turbines to mitigate potential impacts (**Figure *30***). The model incorporated data collected through systematic counts that were conducted by AfriAvian in the broader area during 2023 and 2024. These data were further supplemented with CWAC data collected across known highly productive flamingo sites in Mpumalanga and Free State, as well as vetted BirdLasser data for the waterbodies in the given region. The model accounts for algal productivity using multi-year remote sensing data, combined with multiple metrics characterising the size and seasonality of the waterbody. The extent of turbine exclusion zones delineated around the waterbodies were generated as a product of the derived waterbody productivity score. Larger, more productive waterbodies have a higher probability of attracting and supporting larger numbers of flamingos and subsequently would yield a much larger exclusion zone compared to smaller, lower productivity waterbodies.

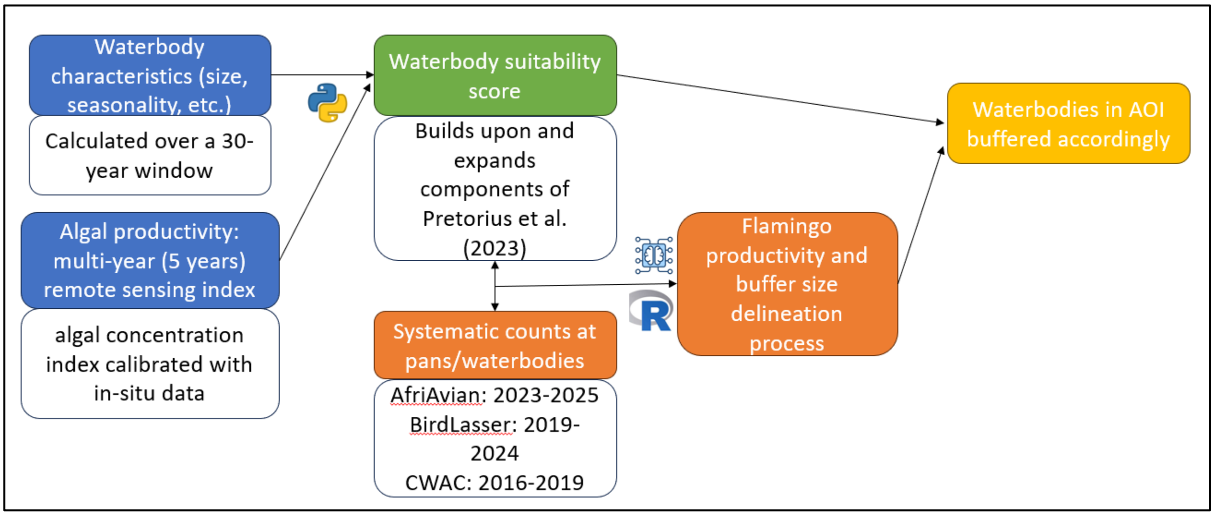

Figure 30: The workflow used to generate waterbody suitability and flamingo productivity scores for all pans/waterbodies in the AOI and associated sensitivity buffers.

<u>Tracking data currently being collected as part of the MDARDLEA / EWT Mpumalanga bird flyway research project indicates how a flamingo traversed the Phefumula Emoyeni One WEF Project Site and surrounding landscape. The Flamingo was present on a pan on the site for three days during the dry spring season of 2024. See **Figure 31** below for an indication of how the flamingo traversed the landscape.</u>

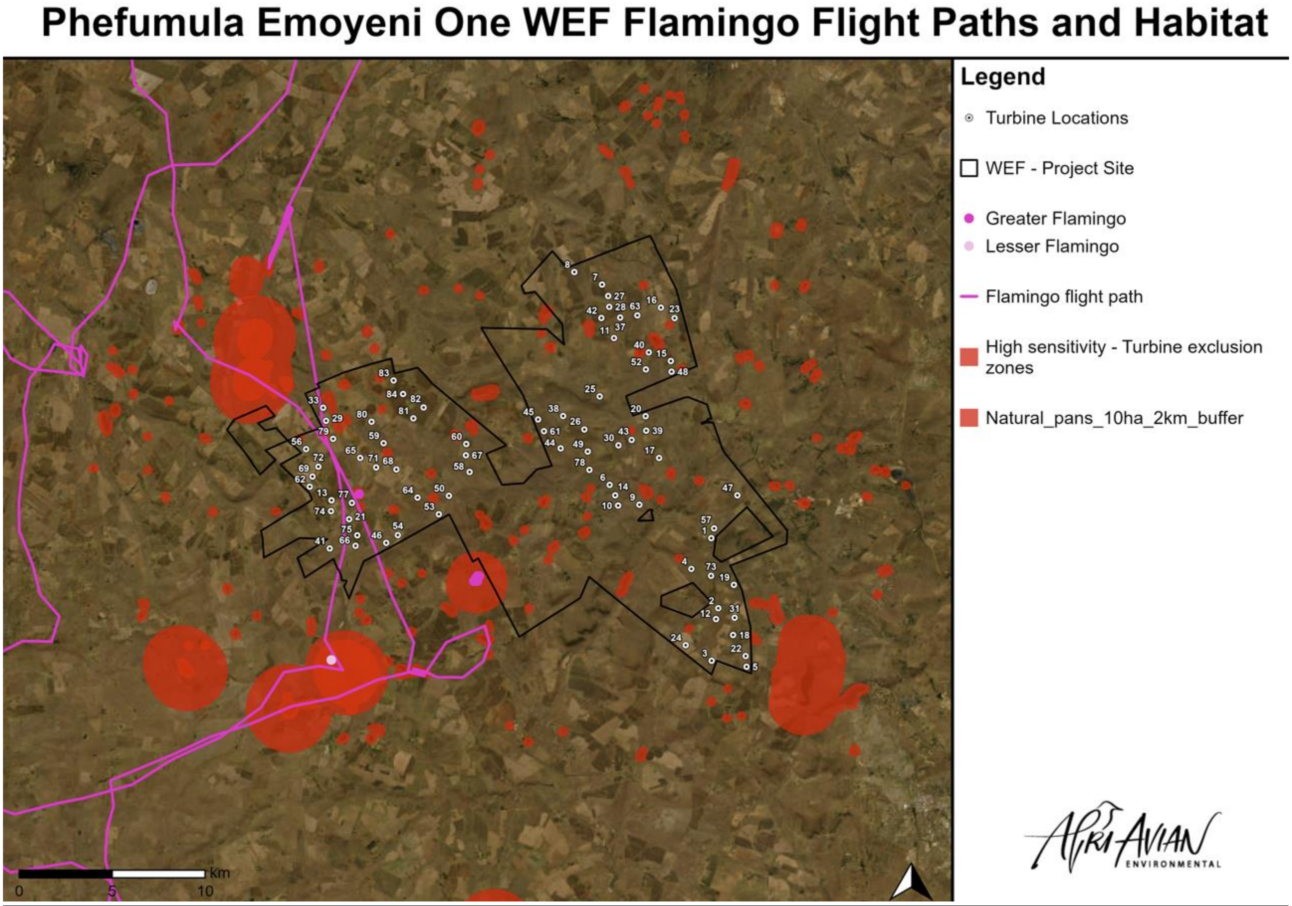

Figure 31: Tracking data currently being collected as part of the MDARDLEA / EWT Mpumalanga bird flyway research project indicates how a flamingo traversed the Phefumula Emoyeni One WEF Project Site and surrounding landscape.

Southern Bald Ibis roosts

AfriAvian scripted and used R and python workflows to prepare, pre-process and analyse all predictor variables with specific relevance to Southern Bald Ibis known habitat presence and behaviour. Predictor variables represented distance from colony, distance from roost, various facets of topography, drainage, and vegetation (grassland) productivity. Topographical features included ruggedness, drainage, topographical relief and thermal uplift, whilst aspects of vegetation productivity were derived from remote sensing indices. We utilised an Artificial Neural Network (ANN) predictive modelling workflow to train flight risk models (FRM). ANNs are capable of learning complex patterns and relationships in data, making them suitable for a wide range of classification problems. The modelling workflow included data partitioning, model training, optimization of algorithms and hyperparameters, and model testing and validation. Flight data was classified into high risk (1) and low risk (0) flights based on flight heights intersecting with typical blade swept heights (30-300m). High risk flights were processed using an internal workflow to convert flightlines into point data (Colyn et al. 2024). Flight data were sourced by an extensive internal database, supplemented with in-situ data collected across all in-situ site surveys. We partitioned the overall occurrence and absence dataset into training (80%) and testing (20%) subsets, which resulted in 16747 and 4186 training and independent test data points, respectively. Model performance was assessed using measures of accuracy, recall, precision and F1 score derived from independent test datasets. The final global model yielded a precision, recall and F1 score of 0.82, 0.79 and 0.80, respectively. The strongest contributors to predictive performance and associated flight risk were distance from colony and roost, the productivity of underlying grassland habitat, productivity of dryland agricultural crops, topographical ruggedness and thermal yield.

Secretarybird potential breeding areas

Secretarybird nest structures were identified on-site during the survey efforts. Some structures are only ever used as roosts and nest-building can continue indefinitely (Tarboton, 2001). Prior to the Operational Phase of the WEF all tree structures across the Project Site must be mapped by generating a canopy height model and applying a tree structure criteria-based model. Secretarybird management zones across the WEF site will be delineated using the mapped tree structures, known nests sites and flight risk modelled outputs. During the operational phase of the WEF monthly orthophoto assessments will be conducted to monitor the prioritized management zones to identify active nest and roost structures. If active nests/roosts are identified SDoD and/or automated curtailment will be implemented.

5.9.8 Sensitive Species 23 Habitat Suitability Assessment

A comprehensive Species 23 assessment report, which includes detailed modelling and survey efforts, is attached as an addendum (Appendix J – Sensitive Species 23 Wetland Surveys Report). The core findings include:

<u>Methodology</u>

- A deep learning-based CNN (Convolutional Neural Network) model was used to assess fine scale habitat suitability using Sentinel-2 remote sensing data.
- In-situ wetland assessments were conducted in Nov/Dec 2024, with further acoustic monitoring planned for the summer of 2024/2025.

<u>Key Findings</u>

- Fine-scale habitat modelling found no suitable habitat (probability >0.25) within the PAOI, suggesting low risk to Species 23.
- Field surveys assessed seven wetland habitat units across the PAOI, covering 20 individual sites.
- Given the lack of any suitable habitat identified within the AOI, both through modelling and in-situ surveys, no passive acoustic monitoring was undertaken.
- Most wetlands (Sites A-E) were dominated by graminoid riparian and channelled valley-bottom habitats, but extensive degradation (e.g., overgrazing, trampling by livestock) reduced suitability for Species 23.
- No highly suitable breeding or foraging habitat was found in the PAOI.

<u>Implications & Sensitivity Rating</u>

- The combination of modelling and field assessments confirms that Species 23 is unlikely to be affected by the proposed WEF development.
- The probability of species occurrence and associated risk is considered low.
- This supports the feasibility of the WEF project from a species 23 perspective.

It should further be noted that the wetland habitat sites in the area were flagged as low suitability based on various factors (climate, land-use, land management practices) at both local and district levels. The closest area with better habitat suitability for the species is located about 25–50 kilometres east, where the habitat profile shifts to more moist, highland grasslands. Suitability decreases in a westerly direction due to changes in the habitat profile.

6 Identification of Impacts

The potential impacts identified during the study are listed below.

6.1 Construction Phase

- Total or partial displacement due to noise disturbance and habitat transformation associated with the construction of the wind turbines and associated infrastructure.

6.2 Operational Phase

- Total or partial displacement due to habitat transformation associated with the presence of the wind turbines and associated infrastructure.
- Collisions with the wind turbines.
- Electrocutions at the on-site substation and on the overhead sections of the internal 33kV network.
- Collisions with overhead sections of the internal 33kV network.

6.3 Decommissioning Phase

- Total or partial displacement due to disturbance associated with the decommissioning of the wind turbines and associated infrastructure.

6.4 Cumulative Impacts

- Total or partial displacement due to disturbance and habitat transformation associated with the construction and decommissioning of the WEF and associated infrastructure.
- Total or partial displacement due to habitat transformation associated with the operation of the wind turbines.
- Collisions with the wind turbines.
- Electrocutions and collisions with the on-site substations and internal 33kV network.

7. Impact Assessment

The impacts wind farms have on bird populations are dependent upon a range of factors, including the specification of the development, the local/regional topography, the habitats affected, the abundance, species diversity, and characteristics of birds present.

Potential impacts can be:
- discrete – acting in isolation of other impacts (i.e., priority species response to wind farms are idiosyncratic).
- cumulative – exacerbating other the severity of other impacts (i.e., wind turbines and overhead power lines may pose similar collision risks to a given bird population).
- counter-active – reducing the severity of other impacts (i.e., bird population reduction through habitat loss lowers collision mortality rates)

The multi-faceted impacts that wind farms have on bird populations necessitates that new developments should be assessed on a case-by-case basis. The major concerns surrounding the impacts of wind farms on birds are detailed below:
- 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 and collisions with the medium voltage overhead lines

It should be noted that environmental impact assessments are localised to the present-day pre-construction conditions of a given development site. Impacts to the regional landscape are not considered as 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 near future due to climatic limitations.

7.1. Construction Phase – displacement due to disturbance associated with the construction of the wind turbines and associated infrastructure.

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 development site [Fox *et al*. (2006) as cited by Drewitt & Langston (2006)], with a further 3-14% of airspace altered by turbines (Marques *et al*., 2020) (see Section 6.5). The effects of habitat loss could be more widespread where developments interfere with hydrological patterns or flows on wetland or peatland sites (unpublished data). Some changes could also be beneficial. For example, habitat transformation following the development of the Altamont Pass Wind Farm in California led to increased mammal prey availability for some species of raptor, such as higher abundance of Pocket Gophers *Thomomys bottae* burrows around turbine bases), although this may also have increased collision risk [Thelander *et al*., (2003) as cited by Drewitt & Langston (2006)].

Despite overall habitat loss resulting from wind farm development being limited, the associated infrastructure such as roads and power lines fragment previously continuous habitat. Beyond the increased mortality risks to local bird populations posed by such infrastructure, the resulting habitat fragmentation can degrade adjacent habitats, potentially changing the way birds interact within the immediate environment (Fletcher et al., 2018). It remains disputed whether habitat fragmentation is always an environmental detriment (Fahrig et al., 2019), yet the effects of this landscape change have been observed in bird species vulnerable to wind farms. Lane et al. (2001) noted that Great Bustard *Otis tarda* flocks in Spain were significantly larger further from power lines than at control points. Shaw (2013) found that Ludwig's Bustard *Neotis ludwigii* in South Africa generally avoid the immediate proximity of roads within a 500m buffer. Bidwell (2004) found that Blue Cranes in South Africa select nesting sites away from roads.

The physical encroachment increases the disturbance and barrier effects that contribute to the overall habitat fragmentation effect of the infrastructure (Raab et al., 2011). It has been shown that fragmentation of natural grassland in Gauteng (in that case by afforestation) has had a detrimental impact on the densities and diversity of grassland species (Allan et al., 1997).

The species that could be most affected by this impact are listed in **Table 5**. The recommended mitigation measures are detailed in **Table 11 in Section 7.8** below.

7.2. Operational Phase – total or partial displacement of avifauna due to habitat transformation associated with the operation of the wind turbines and associated infrastructure.

This impact relates to the total or partial displacement of avifauna due to habitat transformation associated with the presence of the horizontal-axis wind turbines and associated infrastructure. This impact is rated as negative, with a site-specific spatial extent and a long-term duration due to the extended timeframe of the operational phase (lifetime estimated at 20 years).

The displacement of birds away from areas in and around wind farms due to visual intrusion and airspace disturbance can be considered functional habitat loss. This disturbance can be detrimental to migratory bird populations if wind farms disrupt migration routes (Marques et al., 2020, 2021).

The population displacement effect of wind turbines is observable across avian taxonomic orders and has been better studied in raptors (Accipitriformes and Falconiformes), land fowl (Galliformes), shorebirds (Charadriiformes), waterfowl (Anseriformes), and songbirds (Passeriformes) (Marques et al., 2021).

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 (Scottish Natural Heritage, 2010).

Displacement may occur during both the construction and operation phases of wind farms, manifesting from turbines themselves through visual, noise and vibration impacts, as well as vehicle and personnel movements related to site construction and maintenance (Campedelli et al., 2014; May, 2015). Disturbance magnitude varies across sites and species, necessitating assessments on a site-by-site basis (Dohm et al., 2019; Drewitt & Langston, 2006). A recent meta-analysis study found that of long-term studies into avian displacement around wind farms found that half ~50% of studies reported limited displacement from wind turbines, 46% reported a decrease in some bird populations, and 7.7% found an increased abundance of certain species around wind farms (Marques et al., 2021). Unfortunately, few studies provide comprehensive before- and-after and control-impact (BACI) assessments, limiting current insights.

The operational phase is thought to impose the greatest displacement threat to bird populations, although these impacts may be temporary (Dohm et al., 2019; Pearce-Higgins et al., 2012). Local raptor populations around wind farms may rebound within 7-8 years post-construction (Dohm et al., 2019). Bustards may retain high affinity for historic lek sites (courtship display areas) on wind farms, as has been documented for Great Bustard in Spain (A. Camiña, *personal communications*, 17 November 2012) and Denham's Bustard in South Africa (Ralston-Paton et al., 2017). It should be noted that Great Bustard elsewhere in Europe can be displaced by 0.6km [Wurm & Kollar (2000), as quoted by Raab et al. (2009)] to 1km (Langgemach, 2008) of an operational wind farm, although Denham's Bustards populations do not appear to be displaced by wind farms in South Africa (Ralston-Paton et al., 2017). It should be noted that for raptors and large terrestrial species, site-fidelity and species longevity may mask short- and medium-term impacts that wind farms may have on these species, and that the true impact severity may only manifest in the long-term – such as through diminishing recruitment of new individuals over the course of multiple generations (Ferrer et al., 2012; Santos et al., 2020).

The limited research into shorter-lived bird species around wind farms may offer insights into the long-term response of birds more generally. Leddy et al., (1999) reported increased densities of breeding grassland passerines with increased distance (>80m) from wind turbines, and review study by Hötker et al. (2006) found that the minimum avoidance distances of eleven breeding passerines species ranged 14–93m of wind turbines. However, Hale et al. (2014) and Stevens et al. (2013) found limited evidence for permanent displacement of grassland passerines in North America. Passerine resilience to wind farms is further observed in the UK in species such as Skylark (despite some evidence of turbine avoidance) (Pearce-Higgins et al., 2012), and Thekla Lark populations in Southern Spain (Farfán et al., 2009). Across nine wind farms in Scotland, seven out of twelve bird species across a range of taxa exhibited significantly lower frequencies of occurrence close to the turbines, after accounting for habitat variation, with demonstrable turbine avoidance behaviour in a further two species (Pearce-Higgins et al., 2009). No species preferentially occurred close to the turbines, and breeding pair densities decreased 15-53% within 500m of wind turbines for several species. Follow-up monitoring reported breeding densities of certain species (such as Red Grouse) recovered post-construction, whereas others (such as Snipe and Curlew) did not. Conversely, breeding densities of certain species (such as Skylark and Stonechat) increased on wind farms during construction.

Species response to wind farm construction and operation appears highly idiosyncratic, and although the local populations of many bird species may recover, the long-term impacts of wind farms on bird populations remains to be better elucidated.

The impact is rated with a high reversibility (meaning that the potential impact is highly reversible at the end of the project life); and low irreplaceability (meaning there is a low irreplaceability of avifaunal species). The potential impact is allocated a severe consequence and highly likely probability, which will render the impact significance as high without the implementation of mitigation measures. With the implementation of mitigation measures, the significance of the impact is reduced to moderate.

The species that could be most affected by this impact are listed in **Table 5**. The recommended mitigation measures are detailed in **Table 11** in Section 7.8 below.

7.3. Operational Phase – bird mortality and injury from collisions with the wind turbines[12]

This impact relates to bird mortalities because of potential collisions with the wind turbines. This impact is rated as negative, with a site-specific spatial extent and a long-term duration due to the extended timeframe of the operational phase (lifetime estimated at 20 years).

Wind energy generation has experienced rapid worldwide development over recent decades as its environmental impacts are considered to be relatively lower than those caused by traditional energy sources, with reduced environmental pollution and water consumption (Saidur et al., 2011). However, bird fatalities due to collisions with wind turbines have been consistently identified as a major ecological drawback to wind energy (Drewitt & Langston, 2006).

Collisions with wind turbines kill fewer birds than collisions with other man-made infrastructure, such as power lines, buildings, or even traffic (Erickson et al., 2005). Nevertheless, estimates of bird deaths from collisions with wind turbines worldwide range from 0-40 deaths per turbine per year (Sovacool, 2013). Bird mortality rates vary across sites, as do the number of sensitive bird species impacted (Hull et al., 2013; May, 2015). Estimated mortalities are likely lower than the true number of bird deaths from wind farm infrastructure, given that studies may fail to account for detection biases caused by scavenging, search efficiency and search radius (Bernardino et al., 2013; Erickson et al., 2005; Huso et al., 2015, 2021). Additionally, even for low mortality rates, collisions with wind turbines may disproportionately affect certain species. For long-lived species with low reproductivity and slow maturation rates (e.g. raptors), even low mortality rates can have a significant impact at the population level (Carrete et al., 2009; De Lucas et al., 2008; Drewitt & Langston, 2006). The situation is even more critical for species of conservation concern and those with restricted distributions, which sometimes are most at risk (Osborn et al., 1998).

High bird mortality 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 fatality of Golden eagles *Aquila chrysaetos*, Tarifa in Southern Spain for Griffon vultures *Gyps fulvus*, Smøla in Norway for White-tailed eagles *Haliaeetus albicilla*, and the port of Zeebrugge in Belgium for *Larus* gulls and *Sterna* terns (Barrios & Rodríguez, 2004; Drewitt & Langston, 2006; Huso et al., 2015; Stienen et al., 2008; Thelander et al., 2003). Due to their specific features and location, and characteristics of their bird communities, these wind farms have been responsible for many 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 and the diversity of species occurring there (Hull et al., 2013; Marques et al., 2014) An understanding of the factors that explain bird collision risk and how they interact with one another is therefore crucial to proposing and implementing valid mitigation measures. In southern Africa, vultures – followed by larger eagle species – are highlighted as being especially susceptible to collisions with wind turbines (McClure et al., 2021).

The potential impact is allocated a severe consequence and highly likely probability, which will render the impact significance as high without the implementation of mitigation measures. The impact will be reduced to moderate with the implementation of mitigation measures. The severity of impact for this risk will vary according to species- and site-specific factors, as detailed in Sections 6.5.1 and Sections 6.5.2.

The species that could be most affected by this impact are listed in Table 5. The recommended mitigation measures are detailed in **Table 11** in Section 7.8 below.

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[12] 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.

7.3.1 Species-specific Factors

1. 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 thus 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 not related with their local abundance (Barrios & Rodríguez, 2004; De Lucas et al., 2008). High wing-loading is associated with low flight maneuverability (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 Phefumula Emoyeni One Wind Energy Facility was not available at the time of writing. However, based on general observations, and research on related species, it can be confidently assumed that regularly occurring priority species that could potentially be vulnerable to wind turbine collisions due to morphological features (high wing loading) are korhaans, making them less manoeuvrable (Keskin et al., 2019).

2. Bird Vision

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 & Langston, 2006; 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 (Guichard, 2017; Krijgsveld et al., 2009; May et al., 2015; Mitkus et al., 2018). The visual acuity of birds seems to be slightly superior to that of other vertebrates (Martin et al., 2010; McIsaac, 2001; Mitkus et al., 2018). 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 et al., 2010, 2012; Mitkus et al., 2018). Relatively small frontal binocular fields have been described for several species that are particularly vulnerable to power line collisions, such as vultures (Gyps spp.) cranes and bustards (Martin, 2011; Martin et al., 2010, 2012; Martin & Katzir, 1999). Furthermore, for some species, their high-resolution vision areas are often found in the lateral fields of view, rather than frontally (Martin, 2011; Martin et al., 2010, 2012; O'Rourke et al., 2010; Päckert et al., 2012). Finally, some birds tend to look downwards when in flight, searching for conspecifics or food, which puts the direction of flight completely inside the blind zone of some species (Martin et al., 2010).

Some of the regularly occurring priority species at the Project Site have high-resolution vision areas found in the lateral fields of view, rather than frontally, e.g., the korhaans and storks. The exceptions to this are the priority raptors which all have wider binocular fields, although as pointed out by Martin et al. (2010), this does not necessarily result in these species being able to avoid obstacles better.

3. Phenology

Turbine collision mortalities within raptors may be higher for resident than for migratory birds of the same species/taxon group. This disparity is possibly due to resident birds frequenting areas occupied by wind farms more readily that migratory birds, which typically cross these wind farms *en route* to destinations further afield (Krijgsveld et al., 2009). However, factors like bird behaviour remain 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 more frequently over cliffs and steep slopes, using low altitude slope updrafts, while migratory eagles flew more frequently over flat areas and gentle slopes 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, the phenomenon of migratory flyways where birds are concentrated in large numbers for a limited period (Martín et al., 2018), such as the African Rift Valley or Mediterranean Red Sea flyways, is not a feature of the landscape. The migratory priority species which could occur regularly at the Project Site with some regularity (e.g., Amur Falcon, Common Buzzard, and White Stork) will behave much the same as the resident birds once they arrive in the area.

4. Bird Behaviour

Flight type seems to play a significant role in collision risk, especially when associated with 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, California (Hoover & Morrison, 2005), and could also be a factor in contributing to the high collision rate for Jackal Buzzards in South Africa (Ralston-Patton & 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 & Rodríguez, 2004). This may also explain the high mortality rate of Rock Kestrels *Falco rupicolus* at wind farms in South Africa (Ralston-Patton & Camagu, 2019). Kiting and hovering are associated with strong winds, which often produce unpredictable gusts that may suddenly change a bird's position (Hoover & Morrison, 2005). Additionally, while birds are hunting and focused on prey, they might 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 momentarily 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 (Carrete et al., 2012; Janss, 2000), and territoriality and courtship displays may override aversion to wind turbines (Walker et al., 2005). 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, e.g. indications are that bustards, which are highly vulnerable to power line collisions, are not prone to wind turbine collisions – a Spanish database of over 7000 recorded turbine collisions contains no Great Bustards *Otis tarda* (A. Camiña, personal communications, 12 April 21012). Similarly, in South Africa, very few bustard collisions with wind turbines have been reported to date, all Ludwig's Bustards (Ralston-Patton & Camagu, 2019). No Denham's Bustards *Neotis denhami* turbine fatalities have been reported to date, despite the species occurring at several wind farm sites.

Relative to this wind farm, flocking behaviour (Amur Falcon) and display activity (Northern Black Korhaan) could place these species at risk of turbine collisions.

5. Avoidance Behaviour

Two types of avoidance 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 Project Site will avoid the wind turbines, as is generally the case at all wind farms (Scottish Natural Heritage, 2010). Exceptions already mentioned are raptors that engage in hunting behaviour which may serve to distract them and place them at risk of collision, birds engaged in display behaviour or inter- and intraspecific aggressive interaction. It is unlikely that the entire regional/local population of each priority species present around the proposed WEF will engage in complete meso- and macro-avoidance strategies of the wind energy infrastructure.

6. Bird Abundance

Some authors suggest that fatality rates are related to bird abundance, density, or site utilization rates (Carrete et al., 2012; Kitano & Shiraki, 2013; Smallwood & Karas, 2009), while others highlight as birds utilize territories in non-random ways, and so mortality rates do not depend on bird abundance alone (Ferrer et al., 2012; Hull et al., 2013). Instead, fatality rates depend on other factors such as discriminatory use of specific areas within a wind farm (De Lucas et al., 2008). For example, at Smøla, Norway, White-tailed Eagle flight activity is correlated with collision fatalities (Dahl et al., 2013). In the APWRA, California, 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). Should there be good rainfall at the site; flocks of Amur Falcon could be expected at the site, which may heighten the risk of collisions.

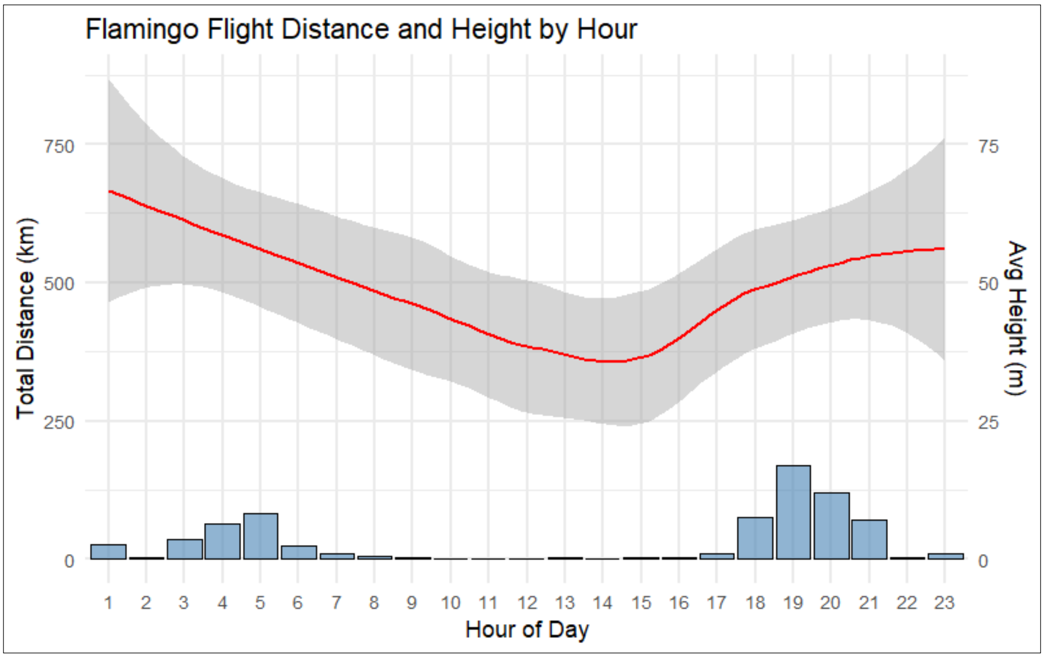
7. Diurnal vs. Nocturnal Bird Species

Wind turbines impact both nocturnal and diurnal birds, though the effects differ due to variations in their behaviour, sensory adaptations, and activity patterns. Nocturnal birds, particularly migratory species and waterbirds known to move at night, face higher risks of collision with wind turbines, especially during poor visibility conditions like fog. Their reliance on celestial cues for navigation may be disrupted by turbine lighting, and studies suggest that steady, non-flashing lights increase collision risks, while flashing lights mitigate them to some extent (Kerlinger *et al.* 2010). Additionally, nocturnal birds may fail to detect turbines until too late, making them more vulnerable to direct mortality (Kunz *et al.* 2007).

Both the Greater Flamingo *Phoenicopterus roseus* and the Lesser Flamingo *Phoeniconaias minor* are known for their nocturnal flying habits, particularly when migrating between feeding sites or during long-distance seasonal movements (**Figure *32***). These night flights are typically undertaken at low to medium altitudes, which from recent MDARDLEA / EWT Mpumalanga Bird Flyway Research Project GPS tracking data yielded a mean flight height of 32m and range of 16–479m (**Figures 32–33**). Given that ca. 90% of flights were recorded within typical wind turbine blade swept area height, namely 25–300m, suggests the species could be vulnerable to collision with wind turbines and associated infrastructure. Additionally, distance travelled was greatest across low-light crepuscular and nocturnal periods, potentially increasing the vulnerability to collisions with power lines and wind energy infrastructure. The latest BLSA Bird Monitoring Report for Operational Wind Farms reported one Greater Flamingo fatality due to a wind turbine collision (BirdLife South Africa 2025).

Reduced visibility at night, especially during poor weather conditions or in unfamiliar areas, increases the risk of these collisions. In South Africa, power line collisions are a cause of mortality for both species, contributing to population declines. As wind energy developments expand, there is also growing concern about the potential impact of wind turbines on their flight paths. Conservation efforts include marking power lines to improve visibility and conducting careful site assessments for wind turbines to minimize collision risks for these nocturnal fliers.

Conversely, diurnal birds are generally more visually adept and able to avoid structures during daylight hours. However, raptors and other species that soar at turbine height are at significant risk of collisions. Behavioural changes, such as avoidance of turbine-dense areas, are observed in both nocturnal and diurnal birds, but the implications differ. Diurnal species often exhibit reduced usage of these areas for feeding or breeding, while nocturnal birds may be displaced from their migratory corridors, increasing energy expenditure and risk of predation (Kerlinger *et al.* 2010).



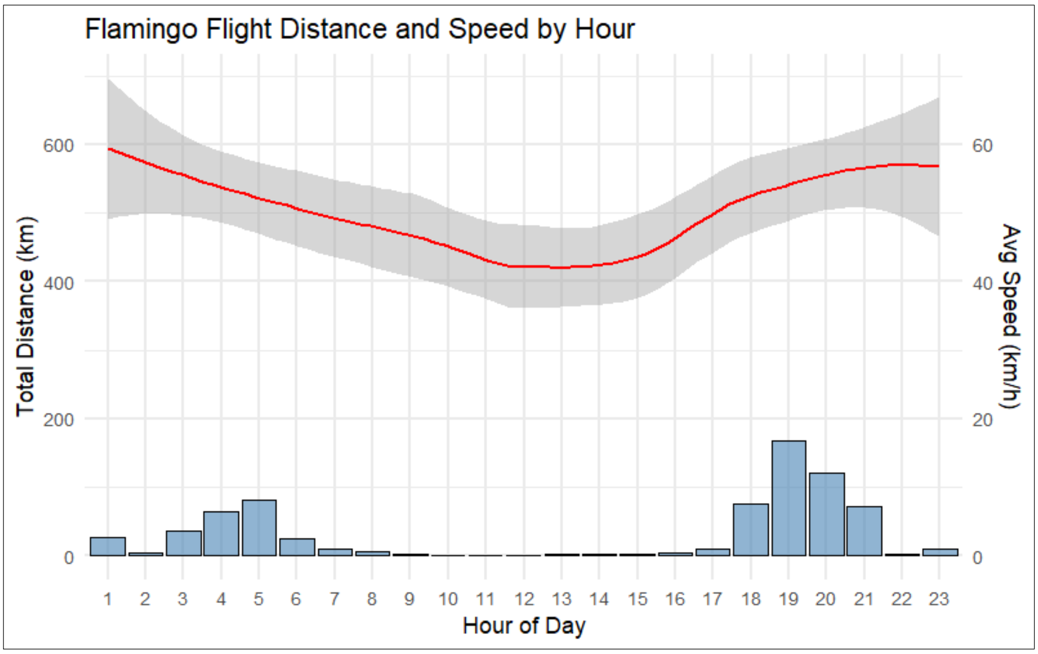


Figure 32: Distance travelled (km), average height (m) [top] and average speed (km/h) [bottom] per hour recorded across four EWT/MDARLEA GPS tracked Greater Flamingos.

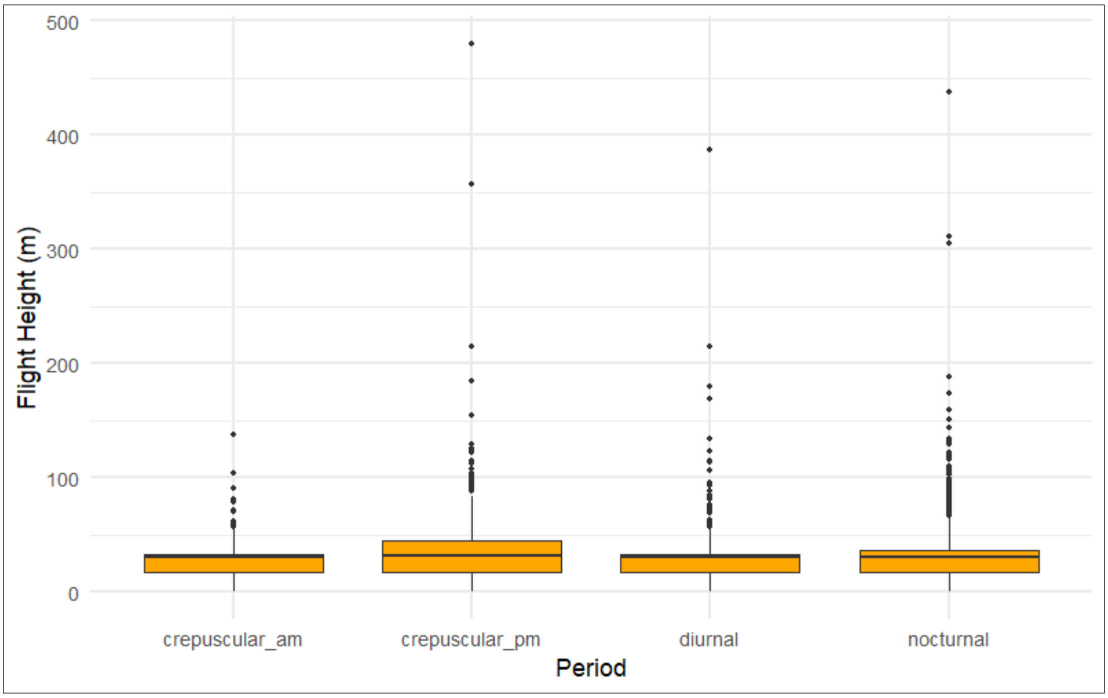


Figure 33: Flight height grouped by time period (Diurnal, crepuscular and nocturnal) recorded across four MTPA GPS tracked Greater Flamingo.

7.3.2. Site-specific Factors

8. 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 more frequently used by some birds, for example for hunting or during migration (Barrios & Rodríguez, 2004; Drewitt & Langston, 2008; Healy & Braithwaite, 2010; Katzner et al., 2012; Thelander et al., 2003). In South Africa, Verreaux's Eagle *Aquila verreauxii* is expected to incur higher fatality rates from at higher elevations and along steeper slopes (Murgatroyd et al., 2021). In Lesotho, Bearded Vultures *Gypaetus barbatus* preferentially forage upper mountain slopes and high ridges which are favourable sites for wind turbine construction (Rushworth & Krüger, 2014).

In APWRA, California, 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 & 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.

Landscape features are unlikely to play a significant role at the Phefumula Emoyeni One WEF site as the proposed development is located on a flat area.

9. Flight Paths

The foraging behaviour of breeding, or otherwise territorial, raptors is often constrained to the vicinity nearest to the nest/home range (Watson et al., 2018). For example, in Scotland 98% of Golden Eagle *Aquila chrysaetos* movements were registered at ranges less than 6 km from the nest, and the core areas were located within a 2-3 km radius (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, 2008).

There are relatively few telemetry studies the foraging behaviour of breeding raptors in South Africa. Breeding Verreaux's Eagles largely forage within 3.7km of their nest (Brink, 2020), with turbine collision risk potential falling substantially further away from the nest, becoming a negligible concern after 8km (Murgatroyd et al., 2021). Breeding African Crowned Eagles demonstrate more restrictive foraging behaviour largely confined to 1.62km of their nest, whereas breeding Martial Eagle *Polemaetus bellicosus* forage generally forage within 5.39km of their nests (Brink, 2020). Male Black Sparrowhawks *Accipiter melanoleucus* have been observed to display year-round territoriality, mostly foraging within 2.27 (breeding) and 2.43km (non-breeding) of the nest (Brink, 2020; Sumasgutner et al., 2016). The home range size for foraging female Long-crested Eagles *Lophaetus occipitalis* in KwaZulu-Natal undergo substantial contractions to within a close vicinity of the nest (<25ha for one observed female) during the breeding season (Maphalala et al., 2020). Breeding Black Harrier *Circus maurus* pairs forage further afield (within 7.1–33.4km of their nests) (Garcia-Heras et al., 2019), as do Bearded Vultures (10km of their nests), and especially Lappet-faced Vultures (110.98km of their nest) (Brink, 2020).

Several raptor nests and Southern Bald Ibis colonies have been recorded in and near the WEF site. Flight concentration of priority species at the proposed WEF site will also be associated with drainage lines, wetlands, and dams.

10. 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, California, 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 & Morrison, 2005; Smallwood et al., 2009). 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 suggested 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).

Depending on the availability of insect prey in the natural grassland at the proposed Phefumula Emoyeni One WEF site, flocks of Amur Falcons and White Stork of varying sizes might be present in the summer months.

7.4 Operational Phase – electrocution of priority species in the on-site substations and internal 33kV network

This impact deals with the potential electrocution of priority species in the on-site substations and any overhead sections of the 33kV power lines. This impact is rated as negative, with a local spatial extent and a long-term duration due to the extended timeframe of the operational phase (lifetime estimated at 20 years).

Electrocution refers to instances where birds perch, or attempt to perch, upon electrical structure in a manner that physically bridges the air gap between live components and/or live and earthed components, causing a fatal electrical short circuit through the birds (Bevanger, 1994; van Rooyen, 2000). The electrocution risk is largely determined by the design of the electrical hardware, with medium voltage electricity poles posing a potential electrocution risk to raptors (Cole & Dahl, 2013; Haas et al., 2006; Loss et al., 2014).

The impact is rated with a high reversibility (meaning that the potential impact is highly reversible at end of the project life); and low irreplaceability (meaning there is a low irreplaceability of avifaunal species). The potential impact is allocated a severe consequence but unlikely probability, which will result in an impact significance of moderate, without the implementation of mitigation measures. With the implementation of mitigation measures (i.e., reactive insulation of electrical hardware), the significance of the impact is reduced to very low.

The raptors that could be most affected by this impact are listed in Table 5. The recommended mitigation measures are detailed in Table 11 in Section 7.8 below.

7.5 Operational Phase – collision of priority species with the internal 33kV network

A related concern to that addressed in Section 6.6 is bird collisions with medium voltage overhead power lines. Overhead line collisions are arguably the greatest threat posed by overhead lines to birds in southern Africa (van Rooyen, 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds, and to a lesser extent, vultures (Shaw et al., 2010; van Rooyen, 2004). 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).

Power line 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 a recent 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 bird flappers) were approximately equally effective (Shaw *et al*. 2017).

The impact is rated with a high reversibility (meaning that the potential impact is highly reversible at end of the project life); and low irreplaceability (meaning there is a low irreplaceability of avifaunal species). The potential impact is allocated a severe consequence and high probability, which will result in a high impact significance, without the implementation of mitigation measures. With the implementation of mitigation measures (i.e., marking of line with bird flight diverters), the significance of the impact is reduced to low.

The species that could be most affected by this impact are listed in **Table 5**. The recommended mitigation measures are detailed in **Table 11 in Section 7.8** below.

7.6 Decommissioning Phase - displacement due to disturbance associated with the decommissioning of the wind turbines and associated infrastructure.

The noise and movement associated with the potential decommissioning activities will be a source of disturbance which would lead to the displacement of avifauna from the area. This impact is rated as negative, with a site-specific spatial extent and a short-term duration. The impact is rated with a high reversibility (meaning that the potential impact is highly reversible at end of the project life); and low irreplaceability (meaning there is a low irreplaceability of avifaunal species). The potential impact is allocated a substantial consequence and highly likely probability, which will render the impact significance as moderate, without the implementation of mitigation measures. With the implementation of mitigation measures, the significance of the impact is reduced to low.

The species that could be most affected by this impact are listed in **Table 5**. The recommended mitigation measures are detailed in **Table 11 in Section 7.8** below.

7.7 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 is considering all renewable energy projects within a 100 km radius that have received or are in the process of receiving an EA at the time of starting the environmental impact process, as well as the proposed Phefumula Emoyeni One WEF Project. There are currently 17 renewable energy projects authorised, or in process, within a 100 km radius of the proposed Phefumula Emoyeni One WEF. The projects were identified using the DFFE's Renewable Energy EIA Application Database for South Africa (2024, Q3) 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 as such there may be other renewable energy projects proposed within the 100 km radius. The localities of renewable energy projects (affected properties) are displayed in **Figure 34**.

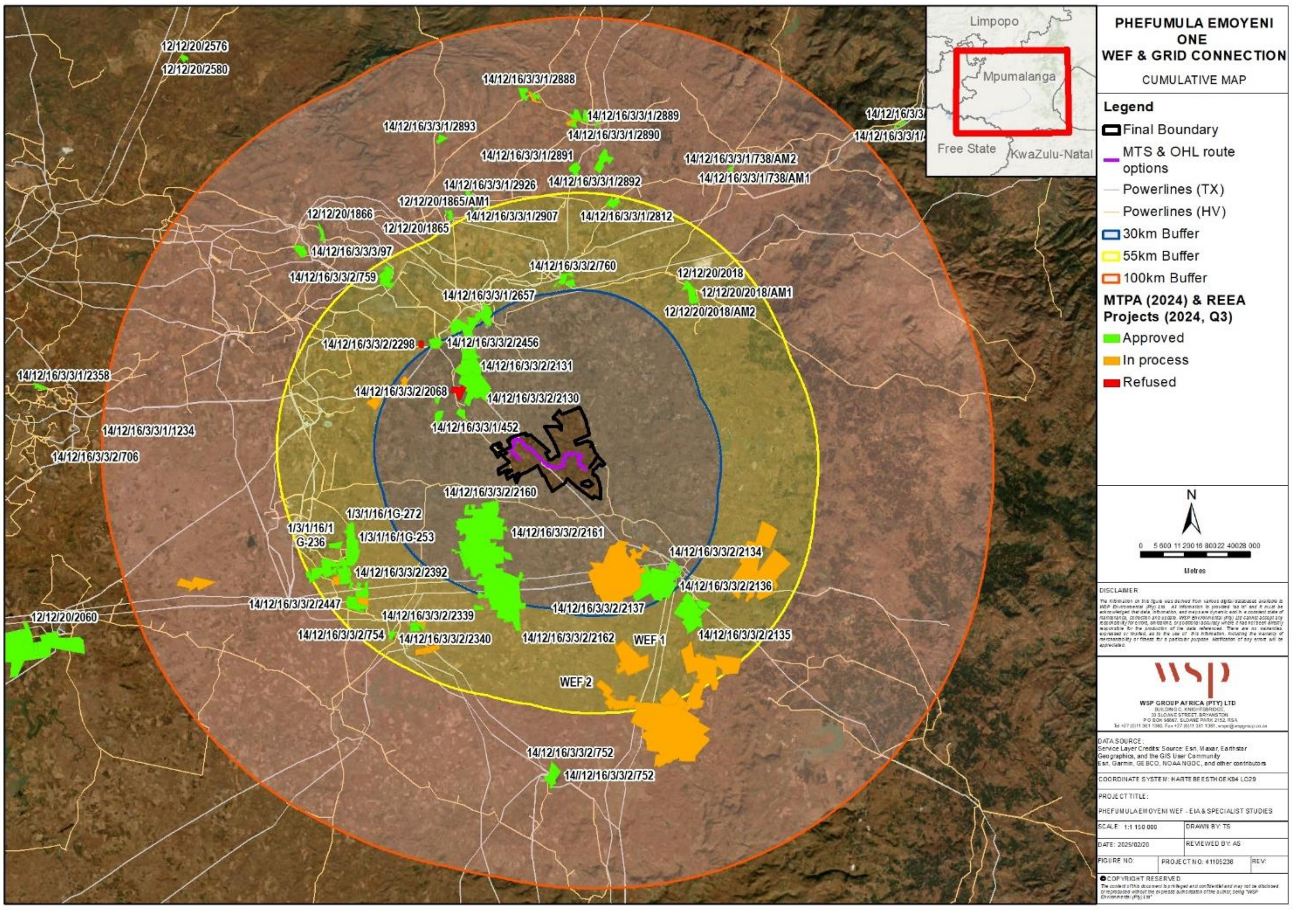


Figure 34: Renewable Energy Projects within a 100 km of the proposed Phefumula Emoyeni One WEF.

The total affected land parcel area taken up by <u>other</u> renewable energy projects within the 100 km radius is approximately 1,979 km² (197,898 ha). The total land parcel area affected by the Phefumula Emoyeni One Wind Energy Facility equates to approximately 337 km² (33 660 ha). The <u>combined</u> land parcel area affected by authorised or proposed renewable energy developments within the 100 km radius of similar habitat around the proposed Phefumula Emoyeni Wind Energy Facility, inclusive of the Phefumula Emoyeni Wind Energy Facility, thus equals approximately 2,316 km² (231,558 ha). Of this, the proposed Phefumula Emoyeni One WEF project constitutes ~14.5%. The cumulative impact of the proposed Phefumula Emoyeni One WEF is thus anticipated to be **moderate to high** after mitigation.

The total area within a 100 km radius around the proposed projects equates to about 31,416 km² (3,141,593 ha) of similar habitat. The total combined size of the land parcels potentially affected by renewable energy projects will equate to ~7.4% of the available habitat in a 100 km radius. The actual physical footprint of the renewable energy facilities will be smaller than the land parcel areas themselves.

It is acknowledged that, ideally, cumulative impact assessments (CIAs) should be informed by government-led regional assessments that establish guiding principles and minimum standards. However, in the absence hereof, it is advocated for the establishment of government-led CIAs by the authorities and NGOs to determine targets and thresholds to address the challenge of evaluating impacts linked to other developments. Once available, these can be integrated into Biodiversity Management Plans (BMPs) to measure the impact of projects. Effective CIAs could inform spatial planning, project mitigation, and conservation actions, with targets based on biodiversity goals. Further, we acknowledge effective collaboration through stakeholder consultation with other project proponents, environmental NGOs, and civil society as being crucial for implementing collective mitigation, compensation, and monitoring actions at appropriate spatial scales.

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 to high.**

It is imperative that ALL Wind Energy Facilities within the region strictly apply the mitigation measures as outlined in their respective Avifaunal Specialist Studies and that compliance with the recommended mitigation measures be audited by the governing Authorities (such as DFFE).

7.8 Environmental Impact Scores and Impact Mitigation Recommendations

Pre-mitigation assessment scores of expected environmental impacts from the proposed Phefumula Emoyeni One WEF are detailed below in **Table 9**. The **post-mitigation impact assessments** are detailed in **Table 10**. The impact assessment methodology (i.e. scoring criteria of impacts) is listed in **Appendix D**.

Mitigation measures for each expected environmental impact are detailed below in **Table 11**.

Table 9: Assessment of Pre-Mitigation Environmental Impacts of the Phefumula Emoyeni One WEF during Construction, Operation, and Decommissioning Phases.

Phase	Impact	Consequence	Status	Impact Magnitude (M)	Impact Extent (E)	Impact Reversibility (R)	Impact Duration (D)	Occurrence Probability (P)	Impact Significance (S)
Construction	Noise pollution and environmental disruption from construction activity.	Displacement of priority species from breeding/feeding/roosting areas	Negative (-ve)	High (4)	Site only (1)	Recoverable (3)	Short-term 0-5 years (2)	Definite (5)	Moderate (50)
Operation	Habitat transformation resulting from the wind turbines and associated infrastructure.	Displacement of priority species from breeding/feeding/roosting areas	Negative (-ve)	High (4)	Local (2)	Recoverable (3)	Long term Project life (4)	Definite (5)	High (65)
Operation	Bird mortality and injury resulting from collisions with the wind turbines.	Population reduction of priority species	Negative (-ve)	High (4)	International (migrants) (5)	Reversible (2)	Long term Project life (4)	Definite (5)	High (75)
Operation	Electrocution of priority species on the on-site sub-stations and internal 33kV network.	Population reduction of priority species	Negative (-ve)	Medium (3)	International (migrants) (5)	Reversible (1)	Long term Project life (4)	Highly probable (4)	Moderate (52)
Operation	Collisions of priority species with the internal 33kV network.	Population reduction of priority species	Negative (-ve)	High (4)	International (migrants) (5)	Reversible (2)	Long term Project life (4)	Definite (5)	High (75)

Phase	Impact	Consequence	Status	Impact Magnitude (M)	Impact Extent (E)	Impact Reversibility (R)	Impact Duration (D)	Occurrence Probability (P)	Impact Significance (S)
Decommission	Noise pollution and environmental disruption during the decommissioning phase.	Total/partial displacement of priority species from breeding/feeding/roosting areas	Negative (-ve)	High (4)	Site only (1)	Recoverable (3)	Short-term 0-5 years (2)	Definite (5)	Moderate (50)

Table 10: Assessment of Post-Mitigation Environmental Impacts of the Phefumula Emoyeni One WEF during Construction, Operation, and Decommissioning Phases.

Phase	Impact	Consequence	Status	Impact Magnitude (M)	Impact Extent (E)	Impact Reversibility (R)	Impact Duration (D)	Occurrence Probability (P)	Impact Significance (S)
Construction	Noise pollution and environmental disruption from construction activity.	Displacement of priority species from breeding/feeding/roosting areas	Negative (-ve)	High (4)	Site only (1)	Recoverable (2)	Short-term 0-5 years (2)	Definite (5)	Moderate (45)
Operation	Habitat transformation resulting from the wind turbines and associated infrastructure.	Displacement of priority species from breeding/feeding/roosting areas	Negative (-ve)	High (4)	Site only (1)	Recoverable (3)	Long term Project life (4)	Definite (5)	Moderate (60)
Operation	Bird mortality and injury resulting from collisions with the wind turbines.	Population reduction of priority species	Negative (-ve)	High (4)	International (migrants) (5)	Reversible (2)	Long term Project life (4)	Highly Probable (4)	Moderate (60)

Phase	Impact	Consequence	Status	Impact Magnitude (M)	Impact Extent (E)	Impact Reversibility (R)	Impact Duration (D)	Occurrence Probability (P)	Impact Significance (S)
Operation	Electrocution of priority species on the on-site sub-stations and internal 33kV network.	Population reduction of priority species	Negative (-ve)	Medium (3)	International (migrants) (5)	Reversible (1)	Long term Project life (4)	Low Probability (2)	Low (26)
Operation	Collisions of priority species with the internal 33kV network.	Population reduction of priority species	Negative (-ve)	High (4)	International (migrants) (5)	Reversible (2)	Long term Project life (4)	Probable (3)	Moderate (45)
Decommission	Noise pollution and environmental disruption during the decommissioning phase.	Total/partial displacement of priority species from breeding/feeding/roosting areas	Negative (-ve)	Medium (3)	Site only (1)	Reversible (2)	Short-term 0-5 years (2)	Highly Probable (4)	Moderate (32)

Table 11: Proposed Mitigation Measures for The Identified Environmental Disturbances.

Phase	Impact	Consequence	Initial impact score	Post-mitigation impact score	Mitigation Measures	Confidence level
Construction	Noise pollution and habitat loss during construction	Total/partial displacement of priority species	Moderate (50)	Moderate (45)	The All-Infrastructure Exclusion Zones should be implemented and maintained (**Section 5.7**). No turbines should be constructed in the turbine exclusion buffer zones as indicated in the sensitivity maps in **Section 5.7**.	High

Phase	Impact	Consequence	Initial impact score	Post-mitigation impact score	Mitigation Measures	Confidence level
		from breeding/feeding/ roosting areas			Restrict construction to the immediate infrastructural footprint. Access to remaining areas should be strictly controlled to minimise disturbance of priority species. This recommendation especially applies within the very high and high sensitivity areas depicted in the sensitivity maps in Figures 17–24 **(Specialist Sensitivity Analyses and Verification)**. Minimise removal of natural vegetation and rehabilitate natural vegetation post-construction where possible. Prioritise upgrading existing roads (where the requisite roads authority permission has been issued) over constructing new roads Apply noise and dust control measures according to best practice in the industry Strictly implement the recommendations of ecological and botanical specialists to reduce the level of habitat loss.	
Operation	Habitat transformation resulting from the wind turbines and associated infrastructure	Total/partial displacement of priority species from breeding/feeding/ roosting areas	High (65)	Moderate (60)	The All-Infrastructure Exclusion Zones should be implemented and maintained (**Figures 17–24**). No turbines should be constructed in the turbine exclusion buffer zones as indicated in the sensitivity maps in Figures 17–24**.** Restrict construction to the immediate infrastructural footprint where possible. Access to remaining areas should be strictly controlled to minimise disturbance of priority species. This recommendation especially applies within the very high and high sensitivity areas depicted in the sensitivity map in **Section 5.7.** Once operational, vehicle and pedestrian access to the site should be controlled and restricted to the facility footprint as much as possible to prevent unnecessary destruction of vegetation.	High

Phase	Impact	Consequence	Initial impact score	Post-mitigation impact score	Mitigation Measures	Confidence level
					Formal live-bird monitoring should commence following initial turbine operation, as per the Best Practice Guidelines (Jenkins et al. 2015), to determine the extent to which priority species displacement has occurred. Avifaunal monitoring should take place annually for the operational lifespan of the WEF.	
Operation	Bird mortality and injury resulting from collisions with the wind turbines.	Population reduction of priority species	High (75)	Moderate (60)	The All-Infrastructure Exclusion Zones should be implemented and maintained (**Figures 17–24**). No turbines should be constructed in the turbine exclusion buffer zones as indicated in the sensitivity maps in **Section 5.7.**	High
					Formal live-bird monitoring and carcass searches should be conducted in the operational phase, as per the Best Practice Guidelines at the time (Jenkins et al. 2015) to assess collision rates.	
					A biodiversity management plan for the site must be developed prior to commercial operation, potential biological removal (PBR) values for all priority species on-site will be determined. The calculation of PBR values will consider population sizes of the species and thus determine annual fatality thresholds for the site. If fatality numbers exceed these annual thresholds, additional mitigation measures must be implemented as part of the adaptive management strategy. The choice of additional mitigation measures will be dependent on the measures in place at the time and could involve the implementation of additional SDoD measures or selective curtailment of specific turbines during high-risk periods.	
					All wind turbines must have one blade patterned according to a South African Civil Aviation Authority (SACAA) approved	

Phase	Impact	Consequence	Initial impact score	Post-mitigation impact score	Mitigation Measures	Confidence level
					pattern to reduce the risk of raptor collisions. Refer to **Appendix I** for details. **It is recommended that all wind turbines (WTGs) be subjected to either Observer-led Shutdown on Demand (OSDoD), Auto SDoD (ASDoD) or similar technology during daylight hours and radar flight detection technology for flocks of target species at night.** A Radar-based Shutdown on Demand (SDoD) system (or similar suitable alternative), operated by trained personnel is recommended for use to identify flocks of priority bird species at the site. Turbines that could pose a risk to these flocks will be shut down to reduce the likelihood of collisions. This type of system will also detect nocturnal movements of species such as flamingos, which often fly in flocks, and trigger turbine shutdowns when such movements are observed at night. The system's ability to differentiate specific species based on their unique size and flight characteristics, such as potentially Secretarybirds and Blue Cranes, will be used to initiate appropriate turbine shutdowns.	
					Given the lack of Secretarybird nest site fidelity, and in order to manage the risk of known shifts in nest sites across breading seasons, we recommend a proactive adaptive risk management plan that is underpinned by routine and systematic nest surveys in medium risk areas identified through habitat and flight risk modelling for this species (Appendix K). The proposed approach includes hierarchal tiers of risk management.	

Phase	Impact	Consequence	Initial impact score	Post-mitigation impact score	Mitigation Measures	Confidence level
					Prior to the Operational Phase of the WEF all tree structures across the Project Site will be mapped by generating a canopy height model and applying a tree structure criteria-based model (Appendix K, Tier 0, action 1). Secretarybird management zones across the WEF site will be delineated (tier 0 action 2) using the mapped tree structures, known nests sites and flight risk modelled outputs. During the operational phase of the WEF monthly orthophoto assessments will be conducted to monitor the prioritized management zones to identify active nest and roost structures (Appendix K, tier 1). If active nests/roosts are identified SDoD and/or automated curtailment will be implemented. Refer to Appendix K for further details.	
Operation	Electrocution of priority species on the on-site sub-stations and internal 33kV network.	Population reduction of priority species	Moderate (52)	Low (26)	Use underground cabling as much as is practically possible. Where the use of overhead lines is unavoidable, raptor-friendly pylon design should be used, with appropriate mitigation measures for complicated pole structures (e.g., insulation of live components to prevent electrocutions on terminal structures and pole transformer), as recommended by the Avifaunal Specialist. Apply insulation reactively in the substation if electrocutions of SCC are recorded.	High
Operation	Collisions of priority species with the internal 33kV network.	Population reduction of priority species	High (75)	Moderate (45)	Use underground cabling as much as is practically possible. All above-ground internal medium voltage lines must be marked with Eskom approved Bird Flight Diverters according to the applicable Eskom standard.	High

Phase	Impact	Consequence	Initial impact score	Post-mitigation impact score	Mitigation Measures	Confidence level
Decommissioning	Noise pollution and environmental disruption during the decommissioning phase.	Total/partial displacement of priority species from breeding/feeding/ roosting areas	Moderate (50)	Moderate (32)	Restrict dismantling to the immediate infrastructural footprint where possible. Access to remaining areas should be strictly controlled to minimise disturbance of priority species. This recommendation especially applies within the very high and high sensitivity areas depicted in the sensitivity maps in **Figures 17–24.**	High
					Apply noise and dust control measures according to best practice in the industry	
					Prioritise the use of existing access roads during the decommissioning phase and avoid construction of new roads where feasible.	
					The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the activity footprint is concerned	

7.9 Impact Statement

The overall impact significance is provided in this section, in terms of pre- and post-mitigation.

Table 12: Summary of avifaunal impact significances anticipated for the proposed Phefumula Emoyeni One WEF

Phase	Overall Impact Significance (Pre-Mitigation)	Overall Impact Significance (Post Mitigation)
Construction	Moderate	Moderate
Operational	High	Moderate
Decommissioning	Moderate	Moderate

8. Post-Construction Monitoring

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 G** for a proposed programme.

9. Public Participation – Comments Received

The following comments were received during the Scoping Phase of the Project:

Comments received on the Avifaunal Specialist Assessment inputs to the Final Scoping Report for the proposed Phefumula Emoyeni One Wind Energy Facility – 20 May 2024.

Commenting Authority	Comments	Responses
BirdLife South Africa Dr Marlize Muller Steenkampsberg Conservation Officer Email: marlize.muller@birdlife.org.za Samantha Ralston-Paton Birds and Renewable Energy Project Manager Email: energy@birdlife.org.za	BirdLife South Africa supports the responsible development of renewable energy infrastructure. However, we are concerned that the location of the proposed facility(ies) may not be compatible with the desired state of the habitat as indicated in provincial and national conservation plans. The proposed development site falls within an Important Bird and Biodiversity Area (Amersfoort-Bethal-Carolina IBA) and includes threatened ecosystems, critical biodiversity areas, ecological support areas, and habitat for several threatened species.	All efforts will be made to preserve habitat, critical biodiversity areas and the species that inhabit them. Habitat suitability modelling has been done for several species of conservation concern, and prime areas for these species are being conserved and excluded from the buildable area for the proposed windfarm. Wetlands were buffered to protect species associated with this habitat type, and flight risk models were developed for species at risk of collisions with turbines, and turbines were either excluded, or mitigation measures recommended. **As per communication from BirdLife South Africa (July 2024) it should be noted that IBA's are being replaced by Key Biodiversity Areas (KBA's).**
	The Amersfoort-Bethal-Carolina IBA hosts globally and regionally threatened species that are not found in similar abundance in other provinces. Several species are at risk of becoming extinct, some of which have be found at the proposed site (e.g., regionally threatened African Marsh Harrier	The WEF Project Site and immediate environment is classified as Medium Sensitivity for vultures according to the Vulture Species Theme in the Screening tool. (The Medium

Commenting Authority	Comments	Responses
	(Endangered), Blue Crane (Near Threatened), Denham's Bustard (Vulnerable) and Cape Vulture (Endangered)). These high-elevation habitats are often used for breeding during the wet season. Given the relatively small remaining portion of untransformed Grasslands and Wetlands in the highveld of Mpumalanga, every step should be taken to safeguard what is left of these habitat types for biodiversity.	sensitivity is due the Project Site possibly affecting an area with between 5%–10% of the vulture population). During the pre-construction monitoring (885 hours of vantage point observations) only four (4) Cape Vultures were observed, during the April survey. In total, only 16 minutes of Cape Vulture flights were recorded at medium height (i.e. within rotor-swept height). The passage rate for Cape Vultures after 885 hours of monitoring was 0.004 birds per hour which amounts to about 1 Cape Vulture every 17 days. According to the Cervantes Population Utilization Distribution outputs the Phefumula Emoyeni One WEF Project Site is rated low sensitivity (Cervantes et al 2023). Additional analysis has been conducted, to identify suitable wetland and grassland habitat. Habitat suitability modelling has been conducted to delineate wetland and grassland habitat based on key wetland and grassland species. The wetland layer is based on suitable aquatic and adjacent habitat as informed by the following Species of Conservation Concern (SCC) namely African Grass Owl, Blue Crane, African

Commenting Authority	Comments	Responses
		Marsh Harrier, and Grey Crowned Crane. Rudd's Lark, Botha's Lark and Yellow-breasted Pipit informed a habitat suitability model to identify high quality grassland patches specifically preferred by these threatened species. At the proposed project site, suitable habitat was largely driven by Yellow-breasted Pipit, while no suitable habitat for either Rudd's Lark or Botha's lark were flagged by the fine scale habitat suitability model. In addition to the above species-specific habitat suitability model, the high-quality grassland areas (CBAs etc.) identified and avoided by the biodiversity and vegetation specialists, provides additional protection for other grassland specialists such as Denham's Bustard and Secretarybird. **As per communication from BirdLife South Africa (July 2024) it should be noted that IBA's are being replaced by Key Biodiversity Areas (KBA's).**
	We support the Avifaunal Site Sensitivity Verification, which increased the sensitivity of the avifauna assessment from low to high sensitivity and the vulture species theme from medium to high sensitivity as obtained from the DFFE Screening Tool. Given this sensitivity within the Project Area of Influence, we note that just four seasons of avifaunal surveys will be	Data collection has been completed at this time. Although the data collection surveys were centred to collect data during four seasons, the monitoring time was spread over 6 visits to cover a larger proportion of the year. This

Commenting Authority	Comments	Responses
	conducted. We are concerned that this may not be adequate to robustly assess impacts and determine appropriate and feasible mitigation measures. Additional, surveys, targeted at addressing key risks and uncertainties may be required.	enabled us to capture as much seasonal variability as possible. The date ranges during which surveys took place are as follows: 05–16 November 2022, 17–20 January 2023, 14–20 February 2023, 11 April–02 May 2023, 13 June–4 August 2023 and 4–21 October 2023. This deliberate extended spread of survey effort was done to capture seasonal variability on-site, to best encompass spatial-temporal distribution of SCC which we acknowledge requires extensive effort. The data collected from these surveys, as well as the data collected during the initial screening between 31 Oct - 3 November 2022, has been utilised during to delineate habitats and high usage avifaunal areas to best inform avoidance and mitigation areas.
	We are concerned that the wetlands at the site would offer stop-over sites for migrants transitioning through the landscape. Given the likely sensitivity avifauna using the area, we suggest that tracking data should be acquired from past studies/literature to identify which migrants are using this area and when. Alternatively, other methods (e.g., radar or tracking studies) should be included in the plan of study for impact assessment in order to assess the risk to migratory birds. Please also refer to BirdLife South Africa's guidelines for Cape Vulture and Black Harrier and wind energy.	It is acknowledged that the wetlands in the area can play a pivotal role for migratory species. To address this concern, detailed wetland habitat modelling for a suite of species of conservation concern has been conducted. See comment #2 above regarding Cape Vultures and similarly, three Black Harrier flights (of short duration <5min) was recorded on site during

Commenting Authority	Comments	Responses
		June thus also confirming a low risk for the species.
	Are we correct that no night surveys were conducted? How will collision risk to nocturnal threatened species such as Grass Owl (Vulnerable) be assessed and mitigated?	Despite not having specifically surveyed for a cryptic, nocturnal species, African Grass Owl habitat has been modelled as part of the wetland sensitive areas to avoid. The modelled output is based on an extensive dataset of known African Grass Owl nest localities and associated surrounding habitat characteristics. The habitat delineated and avoided as part of the modelling is thus considered an adequate substitute for nocturnal surveys, specifically for this species. The current WEF layout avoids all very high and high sensitivity zones.
	We caution that while the updated list of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Ralston-Paton et al., 2017; Retief et al., 2012) is a useful starting point, it has limitations in the context of this region. The priority list published by BirdLife South Africa does not include most wetland species, and the sensitivity was weighted based on the overlap with wind energy facilities at the time. This did not include Mpumalanga. We therefore recommend that a site-specific list of priority species should be developed.	Following on the wetland delineation exercise, please note that all wetland SCC (beyond that of the outdated list of priority species published) that occur or can occur on site will be included, and this will provide the necessary provisions for the wetland guild. Additional analysis has been conducted, to identify suitable wetland and grassland habitat. Habitat suitability modelling has been conducted to delineate wetland and grassland habitat based on key wetland and grassland species.

Commenting Authority	Comments	Responses
		The current WEF layout avoids all very high and high sensitivity zones.
	During the construction phase of the turbines, there could be a direct loss of avifauna, e.g., being hit by trucks. A possible mitigation measure would be implementing speed restrictions (Avifauna, page 150 of 190).	Operational controls to manage and regulate contractor activity will be advocated through strictly enforceable requirements in the Environmental Management Programme for the facility
	We recognise that a more detailed strategy for identifying no-go zones and areas needing mitigation during the operational phase will be implemented in the next stage of EIA process. However, we want to stress that the proposed nest buffers are unlikely to adequately address biodiversity impacts. Nest buffers should be supplemented with a habitat-based approach. BirdLife South Africa opposes large-scale wind energy development in large, intact grassland habitats, especially if these areas are designated as Critical Biodiversity Areas. These areas are crucial for supporting species like the Secretarybird (Endangered). For more details, please refer to the attached guidance note on development in Secretarybird habitat.	The circular buffers proposed during the scoping phase of the project have been replaced with more clearly defined buffers, based on habitats used and flight risk, derived from actual flight data collected on-site and known species characteristics. Habitat suitability and flight risk models for the following species has been developed to inform turbine exclusion zones and mitigation zones: • Martial Eagle • Southern Bald Ibis • Secretarybird • Black-winged Pratincole In addition to the above buffers, circular infrastructure exclusion buffers to mitigate disturbance, will be maintained around identified nest sites. **The current WEF layout avoids all very high and high sensitivity zones.**

Commenting Authority	Comments	Responses
	We note that shutdown on demand has been proposed as mitigation in some areas, and also if "any mortality of collision prone species of conservation concern (e.g. Verreaux's Eagle) is recorded shutdown on demand should be considered" (emphasis added). While we welcome shutdown on demand as a mitigation measure, we suggest that given the high avifaunal sensitivity of the site, and that the risk to some species (e.g. Cape Vultures) may not be limited to specific areas, a more proactive approach to shut down on demand may be more appropriate. In our experience it can take many years before specialists' recommendations to for shutdown on demand are implemented (if at all). We also suggest that monitoring of fatalities should be implemented for the lifespan of the project and overseen by a bird specialist.	Minimisation measures are challenging since bird species have different sensory faculties, flight manoeuvrability, and behavioural aspects to consider. Currently, there is not a single solution that can be applied to all sites and species. The recording of fatalities, as part of the operational monitoring and adaptive management programme will be included as a requirement in the EMPr. Measures proposed in line with the mitigation hierarchy include: Avoidance of all known high-risk areas based on habitat and known flight-risk. **All wind turbines (WTGs) to be subjected to either Observer-led Shutdown on Demand (OSDoD) or Auto SDoD (ASDoD) during daylight hours and radar flight detection technology for flocks of target species at night**.
	In conclusion, BirdLife South Africa is concerned much of the proposed development site may be unsuitable for the development of wind energy infrastructure. We suggest that the site sensitivity calls for more robust data collection and impact assessment. If development is deemed appropriate, precautionary (i.e. proactive), clear and enforceable operational phase mitigation measures are likely to be required to ensure impacts are within acceptable levels.	It is our view that the data collected as part of the preconstruction monitoring process (per comments in point 3) has been sufficiently robust in terms of the timelines (elaborated on in point 3); this data has been further subjected to more in-depth interrogation and analysis which includes extensive habitat suitability and flight-risk

Commenting Authority	Comments	Responses
		modelling to delineate high-risk areas. These high-risk areas will minimise the risk to grassland and wetland species, as well as Secretarybird and Martial Eagles. All high-risk areas have been avoided. All wind turbines will be subject to SDoD. Further, clear, and enforceable operational phase mitigation measures will be implemented through an adaptive management programme. Rapid implementation of mitigation measures will have to be a requirement and will be stipulated in the EMPr. Further, the requisite specific and measurable impact management outcomes and actions will be included in the Environmental Management Programme (EMPr).
Department of Agriculture, Rural Development & Environmental Affairs, Mpumalanga Province Ms R Luyt (Director Environmental Impact Management) Dr Mervyn Lotter mervyn.lotter@mtpa.co.za Mr Frans Krige frans.krige@mtpa.co.za	The proposed Phefumula Emoyeni One Wind Energy Facility is located in areas identified as CBA Irreplaceable, CBA Optimal, ESAs, Priority Focus Area, Freshwater Ecosystem Priority Areas and Threatened Ecosystems. Furthermore, the entire site falls within the Amersfoort- Bethal-Carolina Important Bird Area (IBA) and 18km west of the Chrissie Pans IBA.	This is correct, please see monitoring efforts and suggested buffers based on modelling for habitat suitability and flight risk for species of conservation concern in the subsequent responses.
	DARDLEA is concerned that the proposed location of the Phefumula Emoyeni One Wind Energy Facility (WEF) is therefore not compatible with the desired land use. The WEF and all associated infrastructure is not a land use, in accordance with the Mpumalanga Biodiversity Sector Plan (MBSP), that will support the inherent biodiversity values of CBAs.	All efforts will be made to preserve habitat, critical biodiversity areas, and the species that inhabit them. Habitat suitability modelling has been done for several species of conservation concern, and prime areas for these species are being conserved and excluded from the buildable area for

Commenting Authority	Comments	Responses
Mr M Essop messop@dffe.gov.za Mr C Agenbach cagenbach@dffe.gov.za		the proposed windfarm. Wetlands were buffered to protect species associated with this habitat type, and flight risk models were developed for species at risk of collisions with turbines, and turbines were excluded, or mitigation measures suggested for these.
	The proposed Phefumula Emoyeni One WEF is located in an area comprising a high diversity of threatened bird species, a number of which are known to be vulnerable to wind turbine collisions. These include Botha's Lark, Blue Crane, Southern Bald Ibis colonies, Black Harrier, Blue Korhaan, Black-winged Pratincole, Secretarybird (and nest), Martial Eagle (and nest), Denham's Bustard, Grass Owl, White-bellied Bustard and Lanner Falcon	Habitat suitability modelling has subsequently been conducted to delineate wetland and grassland habitat based on key wetland and grassland species. Neither Botha’s Lark nor Rudd’s Lark has been observed on site during the bird monitoring surveys. However, the national species distribution models indicate that the broader area could contain suitable habitat. Therefore, fine scale habitat suitability modelling was conducted for Rudd's Lark, Botha's Lark and Yellow-breasted Pipit to identify high quality grassland patches specifically preferred by these threatened species. At the proposed project site, suitable habitat was largely driven by Yellow-breasted Pipit, while no suitable habitat for either Rudd’s Lark or Botha’s Lark was flagged by the fine scale habitat suitability model.

Commenting Authority	Comments	Responses
		The wetland layer is based on suitable aquatic and adjacent habitat as informed by the following Species of Conservation Concern (SCC) namely African Grass Owl, Blue Crane, African Marsh Harrier, and Grey Crowned Crane.
	Jackal buzzard was also confirmed on site. It must be noted that this species is known to be particularly vulnerable to turbine collision, and it is understood that because of this, its threat status is likely to be moved from least concern to near threatened. Furthermore, night-flying greater and lesser flamingos were confirmed on site, and there is currently no known technology to mitigate for the collision of night flying birds	We recognise that the near-endemic Jackal Buzzard is prone to turbine collisions at certain wind energy facility sites. An adaptive risk management plan for the site will stipulate that should collision mortalities occur in numbers that exceed thresholds determined through Collision Risk Modelling, mitigation measures will be elevated, and Jackal Buzzard will be considered a trigger species for SDoD. The scoping report covered three of the bird monitoring surveys. Subsequently, in survey 4, the flamingo observations increased dramatically, posing an increased risk for these two species. As the commenting authority mentions, there are currently no mitigation measures for night flying birds, but algal blooms over several years will be investigated to determine which pans may be suitable for flamingos and buffers around these will be increased accordingly. In addition, flamingos will

Commenting Authority	Comments	Responses
		be included as a SDoD trigger species should they fly during the day. Modelled suitable habitat buffers around core habitat areas for Lesser Flamingo and Greater Flamingo were used to inform the WEF layout to prevent displacement of the birds due to disturbance and to reduce the risk of turbine collisions. **The current WEF Layout avoids all the recommended buffer zones.**
	We disagree with the assignment of impact significance as "medium" on Page 163 in respect of loss and fragmentation of fauna habitats during both construction and operation phases. Intact grasslands, as indicated above, are essential to ensure that species are able to thrive. Loss of intact grasslands directly impacts species' ability to breed and disperse. There is no clear justification or reasoning provided as to how significance score of "medium" was established (were the 2022 Species Assessment Guidelines followed?). The significance rating should therefore be "High".	The EAP provided the bird specialists with impact rating methodologies to include in the scoping study. These methodologies are aligned with the Species Environmental Assessments Guidelines for interpreting sites of Ecological importance SEI. The Impact Assessment Methodology is included in the Avifaunal Specialist Report Scoping (Appendix D). However, the impact ratings have been well thought through and is deemed appropriate.
	Similarly, we disagree with the assignment of impact significance as "medium" on Page 165 in respect of all avifaunal impacts. The significance of the impact on Avifauna in terms of Habitat transformation, collision risk and electrocution of priority species is "High".	As above

Commenting Authority	Comments	Responses
	The plan of study for EIA must include and address the following: 1) A site-specific list of priority avifaunal species for wind farms must be developed, which must include all wetland species.	Habitat suitability modelling has been conducted to delineate wetland and grassland habitat based on key wetland and grassland species. The wetland layer is based on suitable aquatic and adjacent habitat as informed by the following Species of Conservation Concern (SCC).
	2) The avifaunal sensitivity map needs to incorporate more than just the 4 nesting birds and the heronry.	Subsequent to the Scoping report, additional surveys, habitat suitability modelling and flight risk modelling and analysis has been conducted.
	3)The avifaunal sensitivity map must include all species of conservation concern.	Additional modelling has been conducted subsequent to the Scoping report, additional species of concern have been included on the sensitivity maps in the EIA phase of the project.
	4) Birdlife's species distribution models must be used and included in the avifaunal sensitivity map.	BLSA species distribution models are national models – they are used to identify risks on site, we have, however, developed fine-scale habitat models & flight-risk models for particular species when needed. Additional analysis has been conducted and included in sensitivity maps. **Also NOTE: the current WEF layout avoids all avifaunal buffer zones (very high and high sensitivity areas).**

Commenting Authority	Comments	Responses
	5) Due to the sensitivity of the avifauna using the area, more than four seasons of avifaunal surveys are required to assess impacts and determine mitigation that is appropriate	Data collection has been completed at this time. Although the data collection surveys were centred to collect data during four seasons, the monitoring time was spread over 6 visits to cover a larger proportion of the year. This enabled us to capture as much seasonal variability as possible. The date ranges during which surveys took place are as follows: 05–16 November 2022, 17–20 January 2023, 14–20 February 2023, 11 April–02 May 2023, 13 June–4 August 2023 and 04–21 October 2023. This deliberate extended spread of survey effort was to capture seasonal variability on-site to best encompass spatio-temporal distribution of SCC which we acknowledge requires extensive effort. The data collected from these surveys, as well as the data collected during the initial screening between 31 Oct - 3 November 2022, has been utilised during to delineate habitats and high usage avifaunal areas to best inform avoidance and mitigation areas.
	6)Due to the sensitivity of avifauna using the area, and the presence of pans and wetlands on and adjacent to the site, as well as the presence of night-flying birds, tracking data must be acquired to augment the 2D models used.	Tracking of numerous bird species is not within the scope of the EIA process nor that of the project. Additional modelling has been conducted subsequent to the Scoping

Commenting Authority	Comments	Responses
		report, and additional species of concern have been included on the sensitivity maps of this EIA report.
	7) Surveys and tracking must be undertaken to determine the collision risks for nocturnal species 8) The avifaunal assessment must account for the required turbine hub height and blade lengths in all surveys.	Tracking of numerous bird species is not within the scope of the EIA process and of the project. Additional modelling has been conducted subsequent to the Scoping report, and additional species of concern have been included on the sensitivity maps of this EIA report.
	9)Nest buffers must be determined using a site-specific, habitat-based approach, and must account for technology design (i.e. turbine hub height, blade length).	The circular buffers proposed during the scoping phase of the project has been replaced with more clearly defined buffers, based on habitats used and flight risk, derived from actual flight data collected on-site and known species characteristics. Habitat suitability and flight risk models for the following species has been developed to inform turbine exclusion zones and mitigation zones: • Martial Eagle • Southern Bald Ibis • Secretarybird • Black-winged Pratincole In addition to the above buffers, circular infrastructure exclusion buffers to mitigate disturbance, will be maintained around identified nest sites. Collision Risk Modelling will be conducted for all site-specific priority

Commenting Authority	Comments	Responses
		species to quantify the risk posed by the proposed facility in terms of anticipated mortalities. The implementation of mitigation measures will be required as part of the EMPr. The EMPr will also require that the effectiveness of the mitigation measures be measured and require that additional mitigation measures be implemented if mortality thresholds are exceeded.
	10)Buffers must be determined and assigned to all waterbodies on and adjacent to the site, including all pans, wetlands, and dams.	The report took note of the aquatic specialist's buffer zones on-site. In addition, specific avifaunal wetland habitat modelling has been conducted to identify and delineated wetland and associated surrounding moist grassland habitat on the site. These results have been incorporated into the EIA phase of the study.
	11)We are not in agreement with the avifauna specialist's conclusion that the significance of the impact on avifauna is "medium". The specialist must clearly demonstrate these findings.	The EAP provided the bird specialists with impact rating methodologies to include in the scoping study. These methodologies are aligned with the Species Environmental Assessments Guidelines for interpreting sites of Ecological importance SEI. The ratings provided were given with thorough thought and deliberation. All mitigation measures proposed will be implemented too.
	12)As per the requirements in the avifauna section in the Species Environmental Assessment Guideline, existing	In our opinion, the assessment of determining impact significance is

Commenting Authority	Comments	Responses
	guidance must be consulted where available and applicable to a certain development. All relevant Birdlife guidelines, guidance notes and position statements must therefore be consulted.	aligned to that as provided for in the Species Environmental Assessment Guidelines for interpreting sites of ecological importance SEI in the context of the proposed development activities. Birdlife South Africa Guidelines have been consulted where relevant.
Mpumalanga Tourism and Parks Agency MR. MH Vilakazi Chief Executive Officer	The threat of this WEF to the Important Bird Area and the current status of globally threatened bird species such as the Botha's lark is of concern. The status of a list of the threatened bird species must be established	The list of threatened species for this project has been assessed. Habitat suitability modelling has subsequently been conducted to delineate wetland and grassland habitat based on key wetland and grassland species. We determined the presence of threatened bird species during 6 visits to the site. Botha's Lark and Rudd's Lark were not observed on site. Nevertheless, Rudd's Lark, Botha's Lark and Yellow-breasted Pipit informed a habitat suitability model to identify high quality grassland patches specifically preferred by these threatened species. At the proposed project site, suitable habitat was largely driven by Yellow-breasted Pipit, while no suitable habitat for either Rudd's Lark or Botha's lark was flagged by the fine scale habitat suitability model.
	The whole of the proposed Phefumula Emoyeni wind farm falls within an Important Bird Area (IBA), which underscores the need	All efforts will be made to preserve habitat, critical biodiversity areas, and the species that inhabit it. Habitat

Commenting Authority	Comments	Responses
	to consider its implications on metapopulation dynamics and the need to avoid wind farms in “source” areas	suitability modelling has been done for several species of conservation concern, and prime areas for these species are being conserved and excluded from the buildable area for the proposed windfarm. Wetlands were buffered to protect species associated with this habitat type, and flight risk models were developed for species at risk of collisions with turbines, and turbines were excluded, or mitigation measures suggested for these.
	The identification of actual avifaunal source areas may be difficult, but as these intact grassland patches occur within an Important Bird Area (IBA) where there are several nesting and roosting avifaunal species of conservation concern, it highlights their significance and our confidence in confirming these as “source” areas. The presence of these intact grassland patches, CBAs, and the IBAs, is probably the biggest concern that the MTPA may have about the proposed wind farm.	The high-quality grassland areas (CBA’s etc.) identified and avoided by the biodiversity and vegetation specialists, provides additional protection for other grassland specialists.
	Wind farms should not be placed in IBAs or intact grassland areas as these are important areas where avifauna should be allowed to thrive and then disperse to other areas.	IBAs often already contain many transformed habitats and development in these areas should not be precluded so long as high sensitivity areas are adequately avoided.
	Already several wind farms have been approved in slightly less sensitive areas and in relatively close proximity, which would result in further impacts on bird species. Approval of the project in such a location could have far-reaching consequences for threatened bird species, potentially disrupting vital source areas critical for population sustainability	As per the Assessment Guidelines, the minimum requirements are that current impacts, anticipated project-related impacts and additional potential impacts from other proposed developments within the region must be considered in combination and

Commenting Authority	Comments	Responses
		described in a cumulative impact assessment.
	Specific avifaunal concerns	
	1) The presence of 34 priority bird species for wind energy developments were recorded within the footprint area. 2) Of these, 12 were Species of Conservation Concern, of which four were nesting.	Noted
	3) A Martial Eagle nest (Endangered) occurs within footprint area. These are South Africa's largest eagles and travel over vast areas. They are also suspectable to collision with turbines and wind farms are of serious concern. 4) Three Bald Ibis colonies (Vulnerable) occur within footprint area. 5) A Secretarybird nest (Endangered) was found and assigned a 500 m buffer. Considering that the blade tip height alone may be up to 300 m high, this does not be sufficient as a recommended buffer.	The circular buffers proposed during the scoping phase of the project has been replaced with more clearly defined buffers, based on habitats used and flight risk, derived from actual flight data collected on-site and known species characteristics. These irregular shaped buffers are based on habitat and flight behaviour of specific threatened species recorded onsite. Habitat suitability and flight risk models for the following species has been developed to inform turbine exclusion zones and mitigation zones: • Martial Eagle • Southern Bald Ibis • Secretarybird • Black-winged Pratincole In addition to the above buffers, circular infrastructure exclusion buffers to mitigate disturbance, will be

Commenting Authority	Comments	Responses
		maintained around identified nest sites. The 500m buffer around the Secretarybird nest was an infrastructure exclusion buffer, the commenting authority overlooked the 1.5km turbine exclusion buffer and the 2.5km mitigation buffer. Nevertheless, subsequently habitat and flight risk modelling has been done for the Secretarybird, and the circular turbine exclusion buffer and mitigation buffer were replaced with more appropriate exclusion zones according to the flight behaviour of the birds. These buffers and maps have been included in the EIA report.
	6) Birds are very mobile and with the proposed turbine height and blade lengths, the current proposed buffers seem inadequate.	The flight-risk models that have subsequently been developed address flight-risk envelopes in a more informed manner based on topography, underlying habitat and actual fight data recorded on site.
	7) This raises particular concern as these birds may continuously collide with the blades of the wind turbines and the continuous loss of several of these long-lived birds every year may have a significant impact on population status.	The collision risk models developed in the EIA phase will inform the estimated number of fatalities of all SCC on an annual basis. This has been included in Section 5.9.6.
	8) The MTPA have mapped all the dams in detail across Mpumalanga. There are 344 artificial water bodies within the footprint area that may be important for flamingos and other water-dependent birds. 9) Buffers of 2km have been recommended for natural pans (not sure if they were mapped – they do not appear on the avifaunal	The report took note of the aquatic specialist's buffer zones on-site. It is not realistic to expect a 2km buffer around all 344 artificial waterbodies.

Commenting Authority	Comments	Responses
	sensitivities map), however, should many of the 344 dams that occur within the footprint area also not be buffered? Many of these would provide similar habitat to that of pans.	All waterbodies are included in the wetland habitat modelling and fall under turbine exclusion zones. Modelled suitable habitat buffers around core habitat areas for Lesser Flamingo and Greater Flamingo were used to inform the WEF layout to prevent displacement of the birds due to disturbance and to reduce the risk of turbine collisions. The current WEF Layout avoids all the recommended buffer zones
	10)The avifaunal sensitivity map only considers four of the identified Species of Conservation Concern (SCC) and the heronry. Other field observations and the Birdlife SA species distribution models were not considered, potentially overlooking crucial habitat for vulnerable species like the Grass Owl.	Habitat suitability modelling has been conducted to delineate wetland and grassland habitat based on key wetland and grassland species. The wetland layer is based on suitable aquatic and adjacent habitat as informed by the following Species of Conservation Concern (SCC) namely African Grass Owl, Blue Crane, African Marsh Harrier, and Grey Crowned Crane. These results have been incorporated into the EIA phase of the study.
	The MTPA does have the Birdlife SA species distribution models and can confirm that:	
	1) Grass Owl (Vulnerable) have a strong probability of occurring on site although there is no indication as to whether any focused surveys were conducted to search for Grass Owls.	African Grass Owl habitat has been modelled as part of the wetland sensitive areas to avoid. The modelled output is based on an extensive dataset of known African Grass Owl nest localities and associated surrounding habitat characteristics.

Commenting Authority	Comments	Responses
		The habitat delineated and avoided as part of the modelling is thus considered an adequate substitute for nocturnal surveys, specifically for this species.
	2) Black Harrier (and confirmed during avifaunal field work)	Three (3) Black Harrier flights (of short duration <5min) were recorded on site during June (non-breeding season), confirming a low risk for the species.
	1) Botha's Lark may be present but not much is mentioned in report as to survey effort or whether any surveys for this species were specifically targeted during its breeding season. 2) Blue Crane (confirmed) 3) Grey Crowned Crane (not yet confirmed) 4) Rudd's Lark (although low probability) 5) Southern Bald Ibis (confirmed) 6) Secretary Bird (confirmed) 7) Verreaux's Eagle (although low probability) 8) Wattled Crane 9) White-bellied Bustard (confirmed) 10) White-winged Flufftail (low probability) 11) Yellow-breasted Pipit (low probability)	Habitat suitability modelling has been conducted to delineate wetland and grassland habitat based on key wetland and grassland species. The wetland layer is based on suitable aquatic and adjacent habitat as informed by the following Species of Conservation Concern (SCC) namely African Grass Owl, Blue Crane, and Grey Crowned Crane. Wattled Crane and other sensitive wetland species with a Critically Endangered status are similarly addressed in this wetland layer. Similarly, grassland species such as Botha's Lark, Rudd's Lark, and Yellow-breasted Pipit has been included in the habitat suitability modelling and has been presented in EIA report Section 5.7). White-bellied and Denham's Bustard habitats are included in the high-quality grassland habitats, as delineated by the biodiversity specialists.

Commenting Authority	Comments	Responses
		Habitat suitability and flight risk models for the following species has been developed to inform turbine exclusion zones and mitigation zones for Secretarybird and Southern Bald Ibis. There is little to no suitable habitat on site for Verreaux's Eagle and they have not been recorded on surveys to date.
	For the avifaunal assessment, it is not clear how the specialist could go from "very high", "high", and "medium" sensitivity to an overall impact score of "moderate" pre-mitigation and "low" post mitigation. The report concludes that the proposed wind farm will have a **medium** impact on avifauna. I struggle to understand the reasoning given the high sensitivity	The EAP provided the bird specialists with impact rating methodologies to include in the scoping study. These methodologies are aligned with the Species Environmental Assessments Guidelines for interpreting sites of Ecological importance SEI. The Impact Assessment Methodology is included in the Avifaunal Specialist Report Scoping (Appendix D). However, the impact ratings have been well thought through and is deemed appropriate.
	Recommendations: Revise the avifaunal sensitivity map to incorporate all identified SCCs and utilize Birdlife species distribution models. Field observations and the species distribution models could have been incorporated into the avifaunal sensitivity map. It is of concern that only a few of the sensitive and threatened bird species recorded were included in the avifaunal sensitivities map.	The habitat analysis has been conducted and incorporated into the revised risk maps for particular species See Section 5.7.

Commenting Authority	Comments	Responses
	Increase buffer zones for endangered bird nesting sites to reflect their wider flight ranges relative to the height of the turbines.	The flight-risk models that have subsequently been developed address flight-risk envelopes in a more informed manner.

10. Conclusions

The proposed Phefumula Emoyeni One WEF will have high and medium impacts on avifauna that could be reduced to medium and low impacts through the implementation of appropriate mitigation measures. During the EIA Phase of the Project individual turbine locations were assessed and evaluated on a case-by-case basis to determine the best placement in order to avoid high risk zones. No fatal flaws are expected; however, **the mitigation measures listed in this report (Section 7.8 and Appendix H) should be strictly applied and adhered to. See Section 5.7 for maps of the current exclusion areas.**

11. References

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Appendix A – Specialist Expertise

Curriculum Vitae: Albert Froneman

Profession/Specialisation	:	Avifaunal Specialist
Highest Qualification	:	MSc (Conservation Biology)
Nationality	:	South African
Years of experience	:	25 years

Key Qualifications

Albert Froneman **(**Pr.Sci.Nat) has more than 18 years' experience in the management of avifaunal interactions with industrial infrastructure. He holds a M.Sc. degree in Conservation Biology from the University of Cape Town. He managed the Airports Company South Africa (ACSA) – Endangered Wildlife Trust Strategic Partnership from 1999 to 2008 which has been internationally recognized for its achievements in addressing airport wildlife hazards in an environmentally sensitive manner at ACSA's airports across South Africa. Albert is recognized worldwide as an expert in the field of bird hazard management on airports and has worked in South Africa, Swaziland, Botswana, Namibia, Kenya, Israel, and the USA. He has served as the vice chairman of the International Bird Strike Committee and has presented various papers at international conferences and workshops. At present, he is consulting to ACSA with wildlife hazard management on all their airports. He also an accomplished specialist ornithological consultant outside the aviation industry and has completed a wide range of bird impact assessment studies. He has co-authored many avifaunal specialist studies and pre-construction monitoring reports for proposed renewable energy developments across South Africa. He also has vast experience in using Geographic Information Systems to analyse and interpret avifaunal data spatially and derive meaningful conclusions. Since 2009 Albert has been a registered Professional Natural Scientist (reg. nr 400177/09) with The South African Council for Natural Scientific Professions, specialising in Zoological Science.

Key Project Experience

Renewable Energy Facilities – avifaunal monitoring projects in association with Chris van Rooyen Consulting

1. Jeffrey's Bay Wind Farm – 12-months preconstruction avifaunal monitoring project
2. Oyster Bay Wind Energy Project – 12-months preconstruction avifaunal monitoring project
3. Ubuntu Wind Energy Project near Jeffrey's Bay – 12-months preconstruction avifaunal monitoring project
4. Bana-ba-Pifu Wind Energy Project near Humansdorp – 12-months preconstruction avifaunal monitoring project
5. Excelsior Wind Energy Project near Caledon – 12-months preconstruction avifaunal monitoring project
6. Laingsburg Spitskolakte Wind Energy Project – 12-months preconstruction avifaunal monitoring project
7. Loeriesfontein Wind Energy Project Phase 1, 2 & 3 – 12-months preconstruction avifaunal monitoring project
8. Noupoort Wind Energy Project – 12-months preconstruction avifaunal monitoring project
9. Vleesbaai Wind Energy Project – 12-months preconstruction avifaunal monitoring project

10. Port Nolloth Wind Energy Project – 12-months preconstruction avifaunal monitoring project
11. Langhoogte Caledon Wind Energy Project – 12-months preconstruction avifaunal monitoring project
12. Lunsklip – Stilbaai Wind Energy Project – 12-months preconstruction avifaunal monitoring project
13. Indwe Wind Energy Project – 12-months preconstruction avifaunal monitoring project
14. Zeeland St Helena bay Wind Energy Project – 12-months preconstruction avifaunal monitoring project
15. Wolseley Wind Energy Project – 12-months preconstruction avifaunal monitoring project
16. Renosterberg Wind Energy Project – 12-months preconstruction avifaunal monitoring project
17. De Aar – North (Mulilo) Wind Energy Project – 12-months preconstruction avifaunal monitoring project (2014)
18. De Aar – South (Mulilo) Wind Energy Project – 12-months bird monitoring
19. Namies – Aggenys Wind Energy Project – 12-months bird monitoring
20. Pofadder – Wind Energy Project – 12-months bird monitoring
21. Dwarsrug Loeriesfontein – Wind Energy Project – 12-months bird monitoring
22. Waaihoek – Utrecht Wind Energy Project – 12-months bird monitoring
23. Amathole – Butterworth Utrecht Wind Energy Project – 12-months bird monitoring & EIA specialist study
24. De Aar and Droogfontein Solar Pre- and Post-construction avifaunal monitoring
25. Makambako Wind Energy Facility (Tanzania) 12-month bird monitoring & EIA specialist study (Windlab)
26. R355 Wind Energy Facility 12-month bird monitoring (Mainstream)
27. Groenekloof Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
28. Tsitsikamma Wind Energy Facility 24-months post-construction monitoring (Cennergi)
29. Noupoort Wind Energy Facility 24-months post-construction monitoring (Mainstream)
30. Kokerboom Wind Energy Facility 12-month bird monitoring & EIA specialist study (Business Venture Investments)
31. Kuruman Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
32. Mañhica Wind Energy Facility 12-month bird monitoring & EIA specialist study (Windlab)
33. Kwagga Wind Energy Facility, Beaufort West, 12-months pre-construction monitoring (ABO)
34. Pienaarspoort Wind Energy Facility, Touws River, Western Cape, 12-months pre-construction monitoring (ABO). Koup 1 and 2 Wind Energy Facilities, Beaufort West, Western Cape, 12 months pre-construction monitoring (Genesis Eco-energy)
35. Duiker Wind Energy Facility, Vredendal, Western Cape 12 months pre-construction monitoring (ABO)
36. Perdekraal East Wind Energy Facility, Touws River, Western Cape, 18 months construction phase monitoring (Mainstream).
37. Swellendam Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (Veld Renewables)
38. Lombardskraal Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (Enertrag SA)
39. Mainstream Kolkies & Heuweltjies Wind Energy Facilities, Western Cape, 12-month pre-construction monitoring (Mainstream)
40. Great Karoo Wind Energy Facility, Northern Cape, 12-month pre-construction monitoring

(African Green Ventures).

41. Gauteng & Gauteng Wind and Hybrid Energy Facilities (6x), pre-construction monitoring (Enertrag SA)
42. Dordrecht Wind Energy Facilities, Eastern Cape, Screening Report (Enertrag SA)
43. Dordrecht Wind Energy Facilities, Eastern Cape, Screening Report (ACED)
44. Nanibees North & South Wind Energy Facilities, Northern Cape, Screening Report (juwi)
45. Sutherland Wind Energy Facilities, Northern Cape, Screening Report (WKN Windcurrent)
46. Pofadder Wind Energy Facility, Northern Cape, Screening Report (Atlantic Energy)
47. Haga Haga Wind Energy Facility, Eastern Cape, Amendment Report (WKN Windcurrent)
48. Banken Wind Energy Facility, Northern Cape, Screening Report (Atlantic Energy)
49. Hartebeest Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (juwi).

Bird Impact Assessment studies and / or GIS analysis:

1. Aviation Bird Hazard Assessment Study for the proposed Madiba Bay Leisure Park adjacent to Port Elizabeth Airport.
2. Extension of Runway and Provision of Parallel Taxiway at Sir Seretse Khama Airport, Botswana Bird / Wildlife Hazard Management Specialist Study
3. Maun Airport Improvements Bird / Wildlife Hazard Management Specialist Study
4. Bird Impact Assessment Study – Bird Helicopter Interaction – The Bitou River, Western Cape Province South Africa
5. Proposed La Mercy Airport – Bird Aircraft interaction specialists study using bird detection radar to assess swallow flocking behaviour.
6. KwaZulu Natal Power Line Vulture Mitigation Project – GIS analysis
7. Perseus-Zeus Power Line EIA – GIS Analysis
8. Southern Region Pro-active GIS Blue Crane Collision Project.
9. Specialist advisor ~ Implementation of a bird detection radar system and development of an airport wildlife hazard management and operational environmental management plan for the King Shaka International Airport
10. Matsapha International Airport – bird hazard assessment study with management recommendations
11. Evaluation of aviation bird strike risk at candidate solid waste disposal sites in the Ekurhuleni Metropolitan Municipality
12. Gateway Airport Authority Limited – Gateway International Airport, Polokwane: Bird hazard assessment; Compile a bird hazard management plan for the airport
13. Bird Specialist Study – Evaluation of aviation bird strike risk at the Mwakirunge Landfill site near Mombasa Kenya
14. Bird Impact Assessment Study – Proposed Weltevreden Open Cast Coal Mine Belfast, Gauteng
15. Avian biodiversity assessment for the Mafube Colliery Coal mine near Middelburg Gauteng
16. Avifaunal Specialist Study – SRVM Volspruit Mining project – Mokopane Limpopo Province
17. Avifaunal Impact Assessment Study (with specific reference to African Grass Owls and other Red List species) Stone Rivers Arch
18. Airport bird and wildlife hazard management plan and training to Swaziland Civil Aviation Authority (SWACAA) for Matsapha and Sikhupe International Airports

19. Avifaunal Impact Scoping & EIA Study – Renosterberg Wind Farm and Solar site
20. Bird Impact Assessment Study – Proposed 60-year Ash Disposal Facility near to the Kusile Power Station
21. Avifaunal pre-feasibility assessment for the proposed Montrose dam, Gauteng
22. Bird Impact Assessment Study – Proposed ESKOM Phantom Substation near Knysna, Western Cape
23. Habitat sensitivity map for Denham's Bustard, Blue Crane and White-bellied Korhaan in the Kouga Municipal area of the Eastern Cape Province
24. Swaziland Civil Aviation Authority – Sikhuphe International Airport – Bird hazard management assessment
25. Avifaunal monitoring – extension of Specialist Study – SRVM Volspruit Mining project – Mokopane Limpopo Province
26. Avifaunal Specialist Study – Rooikat Hydro Electric Dam – Hope Town, Northern Cape
27. The Stewards Pan Reclamation Project – Bird Impact Assessment study
28. Airports Company South Africa – Avifaunal Specialist Consultant – Airport Bird and Wildlife Hazard Mitigation

Geographic Information System analysis & maps

1. ESKOM Power line Makgalakwena EIA – GIS specialist & map production
2. ESKOM Power line Benficosa EIA – GIS specialist & map production
3. ESKOM Power line Riversong EIA – GIS specialist & map production
4. ESKOM Power line Waterberg NDP EIA – GIS specialist & map production
5. ESKOM Power line Bulge Toulon EIA – GIS specialist & map production
6. ESKOM Power line Bulge DORSET EIA – GIS specialist & map production
7. ESKOM Power lines Marblehall EIA – GIS specialist & map production
8. ESKOM Power line Grootpan Lesedi EIA – GIS specialist & map production
9. ESKOM Power line Tanga EIA – GIS specialist & map production
10. ESKOM Power line Bokmakierie EIA – GIS specialist & map production
11. ESKOM Power line Rietfontein EIA – GIS specialist & map production
12. Power line Anglo Coal EIA – GIS specialist & map production
13. ESKOM Power line Camcoll Jericho EIA – GIS specialist & map production
14. Hartbeespoort Residential Development – GIS specialist & map production
15. ESKOM Power line Mantsole EIA – GIS specialist & map production
16. ESKOM Power line Nokeng Flourspar EIA – GIS specialist & map production
17. ESKOM Power line Greenview EIA – GIS specialist & map production
18. Derdepoort Residential Development – GIS specialist & map production
19. ESKOM Power line Boynton EIA – GIS specialist & map production
20. ESKOM Power line United EIA – GIS specialist & map production
21. ESKOM Power line Gutshwa & Malelane EIA – GIS specialist & map production
22. ESKOM Power line Ohrigstad EIA – GIS specialist & map production
23. Zilkaatsnek Development Public Participation –map production
24. Belfast – Paarde Power line – GIS specialist & map production
25. Solar Park Solar Park Integration Project Bird Impact Assessment Study – avifaunal GIS analysis.
26. Kappa-Omega-Aurora 765kV Bird Impact Assessment Report – Avifaunal GIS analysis.
27. Gamma – Kappa 2nd 765kV – Bird Impact Assessment Report – Avifaunal GIS analysis.

28. ESKOM Power line Kudu-Dorstfontein Amendment EIA – GIS specialist & map production.
29. Proposed Heilbron filling station EIA – GIS specialist & map production
30. ESKOM Lebatlhane EIA – GIS specialist & map production
31. ESKOM Pienaars River CNC EIA – GIS specialist & map production
32. ESKOM Lemara Phiring Ohrigstad EIA – GIS specialist & map production
33. ESKOM Pelly-Warmbad EIA – GIS specialist & map production
34. ESKOM Rosco-Bracken EIA – GIS specialist & map production
35. ESKOM Ermelo-Uitkoms EIA – GIS specialist & map production
36. ESKOM Wisani bridge EIA – GIS specialist & map production
37. City of Tshwane – New bulk feeder pipeline projects x3 Map production
38. ESKOM Lebohang Substation and 132kV Distribution Power Line Project Amendment GIS specialist & map production
39. ESKOM Geluk Rural Power Line GIS & Mapping
40. Eskom Kimberley Strengthening Phase 4 Project GIS & Mapping
41. ESKOM Kwaggafontein – Amandla Amendment Project GIS & Mapping
42. ESKOM Lephalale CNC – GIS Specialist & Mapping
43. ESKOM Marken CNC – GIS Specialist & Mapping
44. ESKOM Lethabong substation and power lines – GIS Specialist & Mapping
45. ESKOM Magopela- Pitsong 132kV line and new substation – GIS Specialist & Mapping

Professional affiliations

South African Council for Natural Scientific Professions (SACNASP) registered Professional Natural Scientist (reg. nr 400177/09) – specialist field: Zoological Science. Registered since 2009.

Curriculum Vitae: Megan Loftie-Eaton

FORMAL EDUCATION

UNIVERSITY OF CAPE TOWN – (PhD – Biological Sciences)

- Completed PhD in Biological Sciences, Animal Demography Unit, Department of Biological Sciences, UCT (December 2018) Thesis: The impacts of bush encroachment on bird distributions in the Savanna Biome of South Africa

UNIVERSITY OF CAPE TOWN – (MSc – Zoology)

- Completed MSc in Zoology, Animal Demography Unit, Department of Biological Sciences, UCT (June 2014)

UNIVERSITY OF ALBERTA – (BSc in Environmental and Conservation Sciences)

- Completed with Distinction. June 2011

PROFESSIONAL REGISTRATIONS AND INDUSTRY AFFILIATIONS

- **Professional Natural Scientist in Ecology (Member #135161)** registered with the South African Council for Natural Scientific Professions (SACNASP)

- **Environmental Assessment Practitioner (Number 2021/3690)** registered with the Environmental Assessment Practitioners Association of South Africa (EAPASA)
- **Member** of the Zoological Society of Southern Africa (ZSSA)

EXPERIENCE AND QUALIFICATIONS

2022-2023:

- Environmental Assessment Practitioner for Resource Management Services, Durbanville
- Avifaunal Impact Assessment assistant with Chris van Rooyen Consulting, now AfriAvian Environmental
- Citizen Science Projects Coordinator and Social Media Manager at The Biodiversity and Development Institute

2021:

- Environmental Assessment Practitioner for Resource Management Services, Durbanville (Part-time)
- Completed Avifaunal Impact Assessment for Robben Island Museum (Blue Stone Quarry Wall Restoration)
- Conducted avifaunal field work for proposed wind farms near Laingsburg, Karoo
- OdonataMAP (African Atlas of Odonata) Project Coordinator and Social Media Manager at The Biodiversity and Development Institute (contracted by the Freshwater Research Centre)
- Senior Environmental Consultant with Terramanzi Group Pty Ltd.
- SACNASP Registered Professional Natural Scientist in Ecology (Member #135161)

2020:

- Senior Environmental Consultant with Terramanzi Group Pty Ltd.
- Completed Global Environmental Management – an online course authorized by Technical University of Denmark (DTU) and offered through Coursera
- Ecologist and Researcher (contracted by Hoedspruit Hub) for Kruger To Canyons Biosphere Reserve, conducting sustainable agriculture research in the village of Phiring, Limpopo as part of the "Agroecology as a Climate Change Adaptation Strategy" output of the Dinkwanyane Water Stewardship Project

2019:

- Participated in the Karkloof 50 Miler trail run, where I placed third, and raised funds (R30,000) for ReWild NPC (a wildlife rehabilitation and conservation organization)
- OdonataMAP (African Atlas of Odonata) Project Coordinator at The Biodiversity and Development Institute (contracted by the Freshwater Research Centre)
- Ecologist and Researcher and Social Media Manager at Hoedspruit Hub
- Communications, Social Media, and Citizen Science Project Coordinator at The Biodiversity & Development Institute – ongoing
- Organized, planned, and orchestrated the Hoedspruit Hub's Open Day event
- Obtained qualification for NQF Level 5, Unit Standard 115753, Conduct Outcomes-based Assessment through Ndzalama Training (Pty) Ltd

2017-2018:

- Completed contract projects for the Hoedspruit Hub's Agroecology Division in partnership with Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ). I built, installed, and provided training materials for pollinator stations, artificial bat roosts and earthworm composting bins
- Awarded PhD in Biological Sciences, University of Cape Town (December 2018)
- Ecologist for WildArk on Pridelands Conservancy (Hoedspruit, Limpopo), conducting biodiversity surveys and ecological monitoring, as well as creating content for WildArk's social media
- Project coordinator and communications officer of the Atlas of African Odonata (OdonataMAP), Animal Demography Unit (funded by JRS Biodiversity Foundation).
- Facilitated and assessed a four-day Ecology Course for students at Tsakane Conservation in Balule Nature Reserve (Limpopo Province, South Africa) as part of the EcoLife student programme (University of Pretoria)
- Presented several biodiversity mapping and bird atlasing workshops (SABAP2, Southern African Bird Atlas Project) across South Africa, Nigeria, Tanzania, and Europe (Poland, Finland, Germany)

2016-2018:

- Presented and assessed bird atlasing (http://sabap2.adu.org.za/) and BioMAPping (http://vmus.adu.org.za) workshops to field guide students at Bushwise Field Guide Training Academy, Limpopo Province, South Africa
- Attended a Snake Awareness and Venomous Snake Handling Course as well as an Introductory Course to Scorpions (accredited by FGASA and HPCSA), hosted by the African Snakebite Institute in Hoedspruit (12-13 November 2016)

2014−2018:

- Completed doctoral (PhD) studies in Biological Sciences at the University of Cape Town (Animal Demography Unit). Research title: The impacts of bush encroachment on bird distributions in the savanna biome of South Africa
- Project coordinator and communications officer of the Atlas of African Lepidoptera (LepiMAP): LepiMAP is a project aimed at determining the distribution and conservation priorities of butterflies and moths on the African continent. It is a joint project of the Animal Demography Unit (Department of Biological Sciences, University of Cape Town) and LepSoc, The Lepidopterists' Society of Africa
- BirdMAP Assistant: helping with the Animal Demography Unit's bird atlas project in African countries north of South Africa, assisting the project teams in Kenya, Nigeria, Zimbabwe, Namibia, Zambia and Rwanda with everything from observer queries to social media aspects

Appendix B – Specialist Statement of Independence

Appendix C – Site Sensitivity Verification

Prior to commencing with the specialist assessment in accordance with Appendix 6 of the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) Environmental Impact Assessment (EIA) Regulations of 2014, a site sensitivity verification was undertaken to confirm the current land use and environmental sensitivity of the proposed project area as identified by the National Web-Based Environmental Screening Tool (Screening Tool). The Protocol for the specialist assessment and minimum report content requirements for environmental impacts avifaunal species by onshore wind energy generation facilities where the electricity output is 20MW or more (Government Gazette No. 43110 – 20 March 2020) is applicable in the case of wind developments.

The details of the site sensitivity verification (SSV) surveys are noted below:

Date of Site Visits	05–16 Nov 2022 17–20 Jan and 14–20 Feb 2023 11 Apr–2 May 2023 13 Jun–4 Aug 2023
Supervising Specialist Name	Albert Froneman
Professional Registration Number	MSc Conservation Biology (SACNASP Zoological Science Registration number 400177/09)
Specialist Affiliation / Company	AfriAvian Environmental

C1. Methodology

The following methods were used to compile this report:

- Bird distribution data of the Second Southern African Bird Atlas (SABAP2) was obtained from the University of Cape Town, to ascertain which species occur within the Broader Area of 12 pentad grid cells within which the proposed Project is located (**Figure 2**). A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 9 km. From 2007–present, a total of 122 full protocol lists (i.e., surveys of at least two hours each) have been completed for this area. In addition, 121 *ad hoc* protocol lists (i.e., surveys lasting less than two hours but still yielding valuable data) have been completed.
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa (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 (2025) International Union for Conservation of Nature (IUCN) Red List of Threatened Species (http://www.iucnredlist.org/).
- A classification of the habitat in the Project Site was obtained from the First Atlas of Southern African Birds (SABAP1) (Harrison *et al*., 1997a, 1997b) and the National Vegetation Map (2018) from the South African National Biodiversity Institute (SANBI) BGIS map viewer (http://bgisviewer.sanbi.org/) (Mucina & Rutherford, 2006; SANBI, 2018). The Project Site is the area where the primary impacts on avifauna are expected.
- The Important Bird Areas of Southern Africa (Marnewick *et al*., 2015) was consulted for information on potentially relevant Important Bird Areas (IBAs).

- Satellite imagery (Google Earth ©2024) was used to view the Project Site and Broader Area on a landscape level and to help identify sensitive bird habitat.
- Priority species for wind development were identified from the updated list of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Ralston-Paton *et al*., 2017; Retief *et al*., 2012).
- The 2022 South Africa Protected Areas Database compiled by the Department of Environment, Forestry and Fisheries (DFFE) was used to identify Nationally Protected Areas, National Protected Areas Expansion Strategy (NPAES) near the Project Site (DFFE, 2022).
- The Department of Forestry, Fisheries, and the Environment (DFFE) National Screening Tool was used to determine the assigned avian sensitivity of the Project Site.
- Data collected during previous site visits to the Broader Area as far as habitat classes and the occurrence of priority species are concerned was also considered.
- The following sources were used to determine the investigation protocol that is required for the site:
    - Protocol for the specialist assessment 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).
    - BirdLife South Africa's (BLSA) 'Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa' (Jenkins *et al*., 2015) – hereafter referred to as the 'Windfarm Guidelines' – were consulted to determine the level of survey effort that is required.
- The main source of information on the avifaunal diversity and abundance at the Project Site and Broader Area is an integrated pre-construction monitoring programme which was implemented at the Project Site over a period of four seasons. All surveys have been completed.

C2. Results of Site Assessment

The Project Site is situated in the Grassland Biome, in the Mesic Highveld Grassland Bioregion (Mucina & Rutherford 2006) (**Figure 3**). Vegetation on site consists predominantly of Soweto Highveld Grassland and Eastern Highveld Grassland (**Figure 4**). Soweto Highveld Grassland is found on gently to moderately undulating landscapes and consists of short to medium-high, dense, tufted grassland dominated almost entirely by *Themeda triandra* and accompanied by a variety of other grasses. In places that are not disturbed, scattered small wetlands, narrow stream alluvia, pans and occasional ridges or rocky outcrops interrupt the continuous grassland cover. Eastern Highveld Grassland is found on undulating grassland plains, with small, scattered patches of dolerite outcrops in areas, low hills, and pan depressions. The vegetation is comprised of a short, closed grassland cover, largely dominated by a dense *Themeda triandra* sward, often severely grazed to form a short lawn (Mucina & Rutherford 2006).

Ermelo has a temperate climate. January is the warmest month with a maximum temperature of 24.4 C°. June and July are the coldest months, with a minimum temperature of 0.2 C°. The driest month is June with an average of 3 mm of precipitation. Most of the precipitation falls in December, averaging 151 mm. The average annual precipitation is around 756 mm (Climate – data.org 2021). The topography in the project area is 111ha characterized by gentle undulating plains. The predominant land use for this area is livestock grazing with some crop farming.

The proposed Phefumula Emoyeni One WEF Project Site is situated within gently undulating plains of the Gauteng Highveld countryside. The avian habitat types in the Phefumula Emoyeni One WEF were identified as:

- Grassland
- Woodland and Alien Trees
- Drainage Lines and Wetlands
- Dams
- Agriculture
- High Voltage Power Lines

The Project Site and immediate environment is classified as **Medium** and **High Sensitivity** for bird species according to the Terrestrial Animal Species Theme (**Figure C.1**). The Medium and/or High sensitivity classification is linked to the potential occurrence of Denham's Bustard *Neotis denhami* (Globally Near-Threatened and Regionally Vulnerable), Secretarybird *Sagittarius serpentarius* (Globally Endangered and Regionally Vulnerable), Southern Bald Ibis *Geronticus calvus* (Globally and Regionally Vulnerable), African Grass Owl *Tyto capensis* (Regionally Vulnerable), Martial Eagle (Globally and Regionally Endangered), White-bellied Bustard *Eupodotis senegalensis* (Regionally Vulnerable), and Caspian Tern *Hydroprogne caspia* (Regionally Vulnerable). The Project Site contains confirmed habitat for Species of Conservation Concern (SCC), primarily for African Grass Owl and Secretarybird (Globally Endangered and Regionally Vulnerable), as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020).

Twelve (12) SCC have been recorded during the on-site field surveys thus far namely, African Marsh Harrier (Regionally Endangered), Black Harrier (Globally and Regionally Endangered), Black Stork (Regionally Vulnerable), Black-winged Pratincole (Globally and Regionally Near-Threatened), Blue Crane (Globally Vulnerable and Regionally Near-Threatened), Cape Vulture (Globally Vulnerable and Regionally Endangered), Denham's Bustard, Lanner Falcon (Regionally Vulnerable), Martial Eagle, Pallid Harrier (Globally and Regionally Near-Threatened), Secretarybird and Southern Bald Ibis.

Based on the Site Sensitivity Verification survey and the integrated pre-construction monitoring conducted at the Project Site thus far, the classification of **High Sensitivity** for avifauna is supported for the Phefumula Emoyeni One WEF.

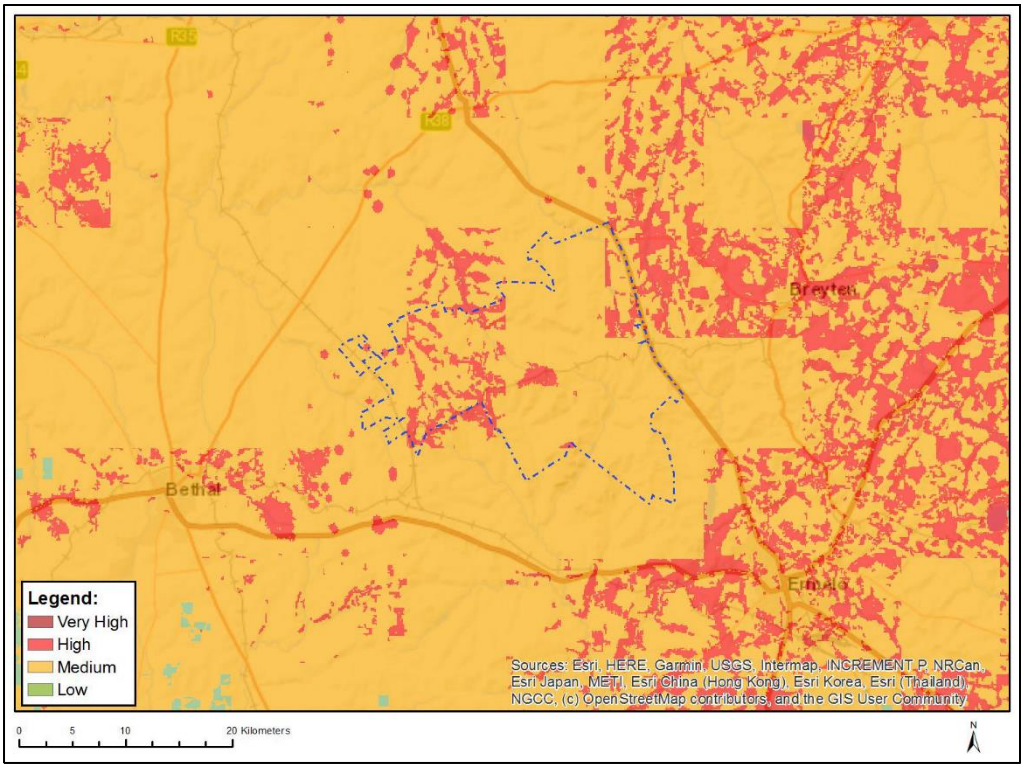

Figure C.1: The National Web-Based Environmental Screening Tool map of the Project Site, indicating sensitivities for the Terrestrial Animal Species theme.

Appendix D – Impact Assessment Methodology

Appendix 2 of GNR 982, as amended, requires the identification of the significance of potential impacts during scoping. To this end, an impact screening tool has been used in the scoping phase. The screening tool is based on two criteria, namely probability (Figure D1); and consequence (Figure D2), where the latter is based on general consideration to the intensity, extent, and duration.

SCORE	DESCRIPTOR
4	**Definite**: The impact will occur regardless of any prevention measures
3	**Highly Probable**: It is most likely that the impact will occur
2	**Probable**: There is a good possibility that the impact will occur
1	**Improbable:** The possibility of the impact occurring is very low

Figure D1: Probability scores and descriptors

SCORE	NEGATIVE	POSITIVE
4	Very severe: An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated.	Very beneficial: A permanent and very substantial benefit to the affected system(s) or party(ies), with no real alternative to achieving this benefit.
3	Severe: A long term impacts on the affected system(s) or party(ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming or some combination of these.	Beneficial: A long term impact and substantial benefit to the affected system(s) or party(ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these.
2	Moderately severe: A medium to long term impacts on the affected system(s) or party (ies) that could be mitigated.	Moderately beneficial: A medium to long term impact of real benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way.
1	Negligible: A short to medium term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary.	Negligible: A short to medium term impact and negligible benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are easier, cheaper and quicker, or some combination of these.

Figure D2: Consequence score descriptions

The impact assessment includes:

1. Impact magnitude
2. Impact extent
3. Impact reversibility
4. Impact duration
5. Probability of impact occurrence
6. Impact significance

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low: No impact on processes	Low: Slight impact on processes	Medium: Processes continue but in a modified way	High: Processes temporarily cease	Very High: Permanent cessation of processes
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probability	Definite
Significance (S) is determined by combining the above criteria in the following formula:	$[S = (E + D + R + M) \times P]$ $Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$				
IMPACT SIGNIFICANCE RATING					
Total Score	**4 to 15**	**16 to 30**	**31 to 60**	**61 to 80**	**81 to 100**
Environmental Significance Rating (Negative (-))	**Very low**	**Low**	**Moderate**	**High**	**Very High**
Environmental Significance Rating (Positive (+))	**Very low**	**Low**	**Moderate**	**High**	**Very High**

Figure D3: Impact assessment scoring metric used in this scoping report.

As per the DFFE Guideline 5: Assessment of Alternatives and Impacts, the following methodology is applied to the prediction and assessment of impacts and risks. Potential impacts and risks have been rated in terms of the direct, indirect, and cumulative:

- Direct impacts are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.
- Indirect impacts of an activity are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken, or which occur at a different place as a result of the activity.
- Cumulative impacts are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably near future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period and can include both direct and indirect impacts.

The impact assessment methodology includes the following aspects:
Nature of impact/risk - The type of effect that a proposed activity will have on the environment.

- Impact status - whether the impact/risk on the overall environment will be:
    - Positive - environment overall will benefit from the impact/risk
    - Negative - environment overall will be adversely affected by the impact/risk; or
    - Neutral - environment overall not be affected.
- Impact spatial extent – The size of the area that will be affected by the impact/risk:
    - Site specific
    - Local (<10 km from site)
    - Regional (<100 km of site)
    - National; or
    - International (e.g. Greenhouse Gas emissions or migrant birds).
- Impact reversibility - the ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change:
    - Reversible (recovery without pro-active rehabilitation)
    - Recoverable (recovery with pro-active rehabilitation)
    - Irreversible (not possible despite action)
- Impact duration – the timeframe during which the impact/risk will be experienced:
    - Very short term (instantaneous);
    - Short term (0-5 year);
    - Medium term (5- 15 years);
    - Long term (the impact will cease after the operational life of the activity (i.e., the impact or risk will occur for the project duration)); or
    - Permanent/indefinite (mitigation will not occur in such a way or in such a time span that the impact can be considered transient (i.e., the impact will occur beyond the project decommissioning)).
- Probability of impact occurrence:
    - Improbable (little to no chance of occurring)
    - Low Probability (<30% chance of occurring)
    - Probable (30-50% chance of occurring)
    - Highly Probability (51 – 90% chance of occurring); or
    - Definite (>90% chance of occurring regardless of prevention measures).

- Impact significance – the product of the impact occurrence probability with the sum of impact magnitude, extent, duration, and reversibility

$Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$:

IMPACT SIGNIFICANCE RATING					
Total Score	**4 to 15**	**16 to 30**	**31 to 60**	**61 to 80**	**81 to 100**
Environmental Significance Rating (Negative (-))	**Very low**	**Low**	**Moderate**	**High**	**Very High**
Environmental Significance Rating (Positive (+))	**Very low**	**Low**	**Moderate**	**High**	**Very High**

Figure D4: Impact significance rating

- Significance – Will the impact cause a notable alteration of the environment?
  - Very low (the risk/impact may result in very minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making);
  - Low (the risk/impact may result in minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making);
  - Moderate (the risk/impact will result in moderate alteration of the environment and can be reduced or avoided by implementing the appropriate mitigation measures, and will only have an influence on the decision-making if not mitigated);
  - High (the risk/impact will result in major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making); and
  - Very high (the risk/impact will result in very major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making (i.e., the project cannot be authorised unless major changes to the engineering design are carried out to reduce the significance rating)).

With the implementation of mitigation measures, the residual impacts/risks are ranked as follows in terms of significance:

- Very low = 5
- Low = 4
- Moderate = 3
- High = 2
- Very high = 1.

Confidence – The degree of confidence in predictions based on available information and specialist knowledge:

- Low
- Medium
- High.

Appendix E – Bird Species List for the Broader Area

Common Name	Scientific Name	SABAP2 Reporting Rate %		Global Conservation Status	Regional Conservation Status
		Full protocol	Ad hoc protocol		
Abdim's Stork	*Ciconia abdimii*	0,82	0,00	-	NT
Acacia Pied Barbet	*Tricholaema leucomelas*	4,10	0,00	-	-
African Black Duck	*Anas sparsa*	9,02	0,00	-	-
African Black Swift	*Apus barbatus*	0,82	0,00	-	-
African Darter	*Anhinga rufa*	31,15	4,96	-	-
African Dusky Flycatcher	*Muscicapa adusta*	0,00	0,00	-	-
African Firefinch	*Lagonosticta rubricata*	0,82	0,00	-	-
African Fish Eagle	*Haliaeetus vocifer*	10,66	0,83	-	-
African Harrier-Hawk	*Polyboroides typus*	8,20	0,00	-	-
African Hoopoe	*Upupa africana*	4,10	0,00	-	-
African Marsh Harrier	*Circus ranivorus*	0,00	0,00	-	EN
African Olive Pigeon	*Columba arquatrix*	0,82	0,00	-	-
African Palm Swift	*Cypsiurus parvus*	1,64	0,00	-	-
African Paradise Flycatcher	*Terpsiphone viridis*	1,64	0,00	-	-
African Pipit	*Anthus cinnamomeus*	85,25	19,83	-	-
African Reed Warbler	*Acrocephalus baeticatus*	10,66	0,00	-	-
African Sacred Ibis	*Threskiornis aethiopicus*	58,20	13,22	-	-
African Snipe	*Gallinago nigripennis*	18,85	0,83	-	-
African Spoonbill	*Platalea alba*	26,23	4,13	-	-
African Stonechat	*Saxicola torquatus*	95,90	18,18	-	-
African Swamphen	*Porphyrio madagascariensis*	3,28	0,00	-	-
African Wattled Lapwing	*Vanellus senegallus*	25,41	0,83	-	-
Amethyst Sunbird	*Chalcomitra amethystina*	0,82	0,00	-	-
Amur Falcon	*Falco amurensis*	13,93	4,96	-	-
Ant-eating Chat	*Myrmecocichla formicivora*	72,95	6,61	-	-
Banded Martin	*Riparia cincta*	32,79	4,13	-	-
Barn Swallow	*Hirundo rustica*	45,90	6,61	-	-
Bar-throated Apalis	*Apalis thoracica*	0,82	0,00	-	-
Black Crake	*Zapornia flavirostra*	1,64	0,00	-	-

Common Name	Scientific Name	SABAP2 Reporting Rate %		Global Conservation Status	Regional Conservation Status
		Full protocol	Ad hoc protocol		
Black Harrier	*Circus maurus*	0,82	0,00	EN	EN
Black Sparrowhawk	*Accipiter melanoleucus*	17,21	1,65	-	-
Black Stork	*Ciconia nigra*	0,82	0,00	-	VU
Black-chested Prinia	*Prinia flavicans*	68,85	8,26	-	-
Black-chested Snake Eagle	*Circaetus pectoralis*	3,28	1,65	-	-
Black-collared Barbet	*Lybius torquatus*	17,21	0,00	-	-
Black-crowned Night Heron	*Nycticorax nycticorax*	2,46	0,00	-	-
Black-headed Heron	*Ardea melanocephala*	75,41	18,18	-	-
Black-headed Oriole	*Oriolus larvatus*	2,46	0,00	-	-
Black-necked Grebe	*Podiceps nigricollis*	4,10	0,00	-	-
Blacksmith Lapwing	*Vanellus armatus*	80,33	15,70	-	-
Black-throated Canary	*Crithagra atrogularis*	72,13	5,79	-	-
Black-winged Kite	*Elanus caeruleus*	85,25	28,93	-	-
Black-winged Lapwing	*Vanellus melanopterus*	0,82	0,00	-	-
Black-winged Pratincole	*Glareola nordmanni*	0,00	0,00	NT	NT
Black-winged Stilt	*Himantopus himantopus*	15,57	1,65	-	-
Blue Crane	*Grus paradisea*	3,28	0,00	VU	NT
Blue Korhaan	*Eupodotis caerulescens*	30,33	3,31	NT	LC
Blue-billed Teal	*Spatula hottentota*	0,82	0,00	-	-
Bokmakierie	*Telophorus zeylonus*	46,72	3,31	-	-
Booted Eagle	*Hieraaetus pennatus*	0,00	0,00	-	-
Brown Snake Eagle	*Circaetus cinereus*	1,64	0,00	-	-
Brown-throated Martin	*Riparia paludicola*	47,54	2,48	-	-
Cape Bunting	*Emberiza capensis*	4,92	0,00	-	-
Cape Canary	*Serinus canicollis*	58,20	9,92	-	-
Cape Crow	*Corvus capensis*	2,46	1,65	-	-
Cape Grassbird	*Sphenoeacus afer*	1,64	0,00	-	-
Cape Longclaw	*Macronyx capensis*	94,26	14,88	-	-
Cape Robin-Chat	*Cossypha caffra*	52,46	5,79	-	-
Cape Shoveler	*Spatula smithii*	27,87	4,96	-	-
Cape Sparrow	*Passer melanurus*	86,89	13,22	-	-

Common Name	Scientific Name	SABAP2 Reporting Rate %		Global Conservation Status	Regional Conservation Status
		Full protocol	Ad hoc protocol		
Cape Starling	*Lamprotornis nitens*	11,48	0,00	-	-
Cape Teal	*Anas capensis*	4,10	0,83	-	-
Cape Turtle Dove	*Streptopelia capicola*	92,62	14,05	-	-
Cape Vulture	*Gyps coprotheres*	0,00	0,00	VU	EN
Cape Wagtail	*Motacilla capensis*	78,69	5,79	-	-
Cape Weaver	*Ploceus capensis*	13,93	0,83	-	-
Cape White-eye	*Zosterops virens*	24,59	0,83	-	-
Capped Wheatear	*Oenanthe pileata*	45,90	4,13	-	-
Cardinal Woodpecker	*Dendropicos fuscescens*	1,64	0,00	-	-
Caspian Tern	*Hydroprogne caspia*	0,82	0,00	-	VU
Cinnamon-breasted Bunting	*Emberiza tahapisi*	4,10	0,83	-	-
Cloud Cisticola	*Cisticola textrix*	31,97	4,13	-	-
Common Buttonquail	*Turnix sylvaticus*	1,64	0,00	-	-
Common Buzzard	*Buteo buteo*	27,05	8,26	-	-
Common Greenshank	*Tringa nebularia*	10,66	0,83	-	-
Common House Martin	*Delichon urbicum*	3,28	0,83	-	-
Common Moorhen	*Gallinula chloropus*	18,03	4,96	-	-
Common Myna	*Acridotheres tristis*	11,48	0,00	-	-
Common Ostrich	*Struthio camelus*	8,20	3,31	-	-
Common Quail	*Coturnix coturnix*	59,84	6,61	-	-
Common Ringed Plover	*Charadrius hiaticula*	1,64	0,00	-	-
Common Waxbill	*Estrilda astrild*	81,97	13,22	-	-
Crested Barbet	*Trachyphonus vaillantii*	9,84	0,00	-	-
Crowned Lapwing	*Vanellus coronatus*	82,79	8,26	-	-
Dark-capped Bulbul	*Pycnonotus tricolor*	42,62	3,31	-	-
Denham's Bustard	*Neotis denhami*	0,00	0,00	NT	VU
Diederik Cuckoo	*Chrysococcyx caprius*	21,31	2,48	-	-
Domestic Goose	*Anser anser domesticus*	0,82	0,83	-	-
Eastern Clapper Lark	*Mirafra fasciolata*	4,10	0,00	-	-
Egyptian Goose	*Alopochen aegyptiaca*	87,70	18,18	-	-
Eurasian Reed Warbler	*Acrocephalus scirpaceus*	5,74	0,83	-	-

Common Name	Scientific Name	SABAP2 Reporting Rate %		Global Conservation Status	Regional Conservation Status
		Full protocol	Ad hoc protocol		
European Bee-eater	*Merops apiaster*	1,64	0,00	-	-
Fairy Flycatcher	*Stenostira scita*	1,64	0,00	-	-
Fan-tailed Widowbird	*Euplectes axillaris*	37,70	4,13	-	-
Fiscal Flycatcher	*Melaenornis silens*	27,87	0,83	-	-
Giant Kingfisher	*Megaceryle maxima*	5,74	0,00	-	-
Glossy Ibis	*Plegadis falcinellus*	31,97	4,13	-	-
Golden-breasted Bunting	*Emberiza flaviventris*	1,64	0,00	-	-
Goliath Heron	*Ardea goliath*	4,10	0,83	-	-
Great Crested Grebe	*Podiceps cristatus*	9,02	0,00	-	-
Great Egret	*Ardea alba*	13,93	1,65	-	-
Greater Flamingo	*Phoenicopterus roseus*	13,93	11,57	-	NT
Greater Honeyguide	*Indicator indicator*	0,82	0,00	-	-
Greater Kestrel	*Falco rupicoloides*	4,92	0,00	-	-
Greater Striped Swallow	*Cecropis cucullata*	49,18	8,26	-	-
Green Wood Hoopoe	*Phoeniculus purpureus*	4,10	0,00	-	-
Grey Heron	*Ardea cinerea*	45,08	6,61	-	-
Grey-headed Gull	*Chroicocephalus cirrocephalus*	1,64	0,00	-	-
Grey-winged Francolin	*Scleroptila afra*	45,08	2,48	-	-
Hadada Ibis	*Bostrychia hagedash*	89,34	14,05	-	-
Hamerkop	*Scopus umbretta*	12,30	2,48	-	-
Helmeted Guineafowl	*Numida meleagris*	66,39	12,40	-	-
Horus Swift	*Apus horus*	0,82	0,00	-	-
House Sparrow	*Passer domesticus*	32,79	2,48	-	-
Intermediate Egret	*Ardea intermedia*	35,25	4,96	-	-
Jackal Buzzard	*Buteo rufofuscus*	15,57	0,00	-	-
Karoo Thrush	*Turdus smithi*	6,56	0,00	-	-
Kittlitz's Plover	*Charadrius pecuarius*	9,02	0,83	-	-
Kurrichane Thrush	*Turdus libonyana*	0,82	0,00	-	-
Lanner Falcon	*Falco biarmicus*	9,02	1,65	-	VU
Lark-like Bunting	*Emberiza impetuani*	0,82	0,00	-	-
Laughing Dove	*Spilopelia senegalensis*	62,30	7,44	-	-

Common Name	Scientific Name	SABAP2 Reporting Rate %		Global Conservation Status	Regional Conservation Status
		Full protocol	Ad hoc protocol		
Lesser Flamingo	*Phoeniconaias minor*	6,56	2,48	NT	NT
Lesser Honeyguide	*Indicator minor*	0,82	0,00	-	-
Lesser Swamp Warbler	*Acrocephalus gracilirostris*	7,38	0,83	-	-
Levaillant's Cisticola	*Cisticola tinniens*	88,52	18,18	-	-
Little Egret	*Egretta garzetta*	18,85	0,83	-	-
Little Grebe	*Tachybaptus ruficollis*	57,38	8,26	-	-
Little Rush Warbler	*Bradypterus baboecala*	3,28	0,00	-	-
Little Stint	*Calidris minuta*	9,84	0,83	-	-
Little Swift	*Apus affinis*	13,93	2,48	-	-
Long-crested Eagle	*Lophaetus occipitalis*	0,00	0,83	-	-
Long-tailed Widowbird	*Euplectes progne*	86,07	19,01	-	-
Maccoa Duck	*Oxyura maccoa*	4,10	0,00	EN	NT
Malachite Kingfisher	*Corythornis cristatus*	11,48	1,65	-	-
Malachite Sunbird	*Nectarinia famosa*	3,28	0,83	-	-
Marsh Owl	*Asio capensis*	19,67	0,83	-	-
Marsh Sandpiper	*Tringa stagnatilis*	4,10	0,00	-	-
Martial Eagle	*Polemaetus bellicosus*	6,56	0,00	EN	EN
Mocking Cliff Chat	*Thamnolaea cinnamomeiventris*	4,10	0,00	-	-
Mountain Wheatear	*Myrmecocichla monticola*	4,10	0,83	-	-
Namaqua Dove	*Oena capensis*	22,13	4,13	-	-
Neddicky	*Cisticola fulvicapilla*	10,66	0,00	-	-
Northern Black Korhaan	*Afrotis afraoides*	0,00	0,00	-	-
Orange River Francolin	*Scleroptila gutturalis*	0,82	0,00	-	-
Orange-breasted Waxbill	*Amandava subflava*	32,79	5,79	-	-
Pale-crowned Cisticola	*Cisticola cinnamomeus*	13,11	4,13	-	-
Pallid Harrier	*Circus macrourus*	0,00	0,00	NT	NT
Peregrine Falcon	*Falco peregrinus*	0,00	0,00	-	-
Pied Avocet	*Recurvirostra avosetta*	6,56	0,00	-	-
Pied Crow	*Corvus albus*	13,11	2,48	-	-
Pied Kingfisher	*Ceryle rudis*	16,39	1,65	-	-
Pied Starling	*Lamprotornis bicolor*	64,75	7,44	-	-

Common Name	Scientific Name	SABAP2 Reporting Rate %		Global Conservation Status	Regional Conservation Status
		Full protocol	Ad hoc protocol		
Pink-billed Lark	*Spizocorys conirostris*	7,38	1,65	-	-
Pin-tailed Whydah	*Vidua macroura*	68,85	7,44	-	-
Plain-backed Pipit	*Anthus leucophrys*	2,46	0,00	-	-
Purple Heron	*Ardea purpurea*	2,46	1,65	-	-
Quailfinch	*Ortygospiza atricollis*	53,28	9,09	-	-
Red-billed Quelea	*Quelea quelea*	72,13	10,74	-	-
Red-billed Teal	*Anas erythrorhyncha*	42,62	4,13	-	-
Red-capped Lark	*Calandrella cinerea*	83,61	14,05	-	-
Red-chested Cuckoo	*Cuculus solitarius*	2,46	0,00	-	-
Red-collared Widowbird	*Euplectes ardens*	5,74	0,83	-	-
Red-eyed Dove	*Streptopelia semitorquata*	67,21	9,92	-	-
Red-faced Mousebird	*Urocolius indicus*	1,64	0,00	-	-
Red-headed Finch	*Amadina erythrocephala*	0,82	0,00	-	-
Red-knobbed Coot	*Fulica cristata*	78,69	14,88	-	-
Red-throated Wryneck	*Jynx ruficollis*	19,67	0,00	-	-
Red-winged Francolin	*Scleroptila levaillantii*	7,38	0,00	-	-
Red-winged Starling	*Onychognathus morio*	2,46	0,83	-	-
Reed Cormorant	*Microcarbo africanus*	71,31	9,09	-	-
Rock Dove	*Columba livia*	6,56	1,65	-	-
Rock Kestrel	*Falco rupicolus*	15,57	2,48	-	-
Rock Martin	*Ptyonoprogne fuligula*	12,30	0,00	-	-
Ruff	*Calidris pugnax*	5,74	1,65	-	-
Rufous-breasted Sparrowhawk	*Accipiter rufiventris*	0,00	0,00	-	-
Saddle-billed Stork	*Ephippiorhynchus senegalensis*	0,82	0,00	-	EN
Secretarybird	*Sagittarius serpentarius*	17,21	3,31	EN	VU
Sentinel Rock Thrush	*Monticola explorator*	0,82	0,00	NT	LC
South African Cliff Swallow	*Petrochelidon spilodera*	65,57	8,26	-	-
South African Shelduck	*Tadorna cana*	38,52	7,44	-	-
Southern Bald Ibis	*Geronticus calvus*	25,41	4,96	VU	VU
Southern Fiscal	*Lanius collaris*	89,34	15,70	-	-
Southern Grey-headed Sparrow	*Passer diffusus*	68,03	4,96	-	-

Common Name	Scientific Name	SABAP2 Reporting Rate %		Global Conservation Status	Regional Conservation Status
		Full protocol	Ad hoc protocol		
Southern Masked Weaver	*Ploceus velatus*	91,80	22,31	-	-
Southern Pochard	*Netta erythrophthalma*	13,93	0,83	-	-
Southern Red Bishop	*Euplectes orix*	95,08	28,10	-	-
Speckled Mousebird	*Colius striatus*	18,85	1,65	-	-
Speckled Pigeon	*Columba guinea*	78,69	9,92	-	-
Spike-heeled Lark	*Chersomanes albofasciata*	50,00	3,31	-	-
Spotted Eagle-Owl	*Bubo africanus*	5,74	0,00	-	-
Spotted Thick-knee	*Burhinus capensis*	22,13	0,00	-	-
Spur-winged Goose	*Plectropterus gambensis*	42,62	7,44	-	-
Streaky-headed Seedeater	*Crithagra gularis*	2,46	0,00	-	-
Striated Heron	*Butorides striata*	1,64	0,00	-	-
Swainson's Spurfowl	*Pternistis swainsonii*	78,69	10,74	-	-
Swallow-tailed Bee-eater	*Merops hirundineus*	0,82	0,00	-	-
Tawny-flanked Prinia	*Prinia subflava*	4,10	0,00	-	-
Three-banded Plover	*Charadrius tricollaris*	57,38	10,74	-	-
Village Weaver	*Ploceus cucullatus*	0,82	0,83	-	-
Wahlberg's Eagle	*Hieraaetus wahlbergi*	0,00	0,00	-	-
Wailing Cisticola	*Cisticola lais*	5,74	0,00	-	-
Western Barn Owl	*Tyto alba*	2,46	0,00	-	-
Western Cattle Egret	*Bubulcus ibis*	60,66	17,36	-	-
Whiskered Tern	*Chlidonias hybrida*	18,03	2,48	-	-
White Stork	*Ciconia ciconia*	4,92	2,48	-	-
White-backed Duck	*Thalassornis leuconotus*	6,56	0,83	-	-
White-bellied Bustard	*Eupodotis senegalensis*	2,46	0,00	-	VU
White-breasted Cormorant	*Phalacrocorax lucidus*	36,07	2,48	-	-
White-browed Sparrow-Weaver	*Plocepasser mahali*	5,74	0,00	-	-
White-faced Whistling Duck	*Dendrocygna viduata*	4,10	0,00	-	-
White-rumped Swift	*Apus caffer*	22,13	3,31	-	-
White-throated Swallow	*Hirundo albigularis*	45,90	1,65	-	-
White-winged Widowbird	*Euplectes albonotatus*	18,85	0,83	-	-
Willow Warbler	*Phylloscopus trochilus*	1,64	0,00	-	-

Common Name	Scientific Name	SABAP2 Reporting Rate %		Global Conservation Status	Regional Conservation Status
		Full protocol	Ad hoc protocol		
Wing-snapping Cisticola	*Cisticola ayresii*	43,44	4,13	-	-
Wood Sandpiper	*Tringa glareola*	12,30	0,83	-	-
Yellow Canary	*Crithagra flaviventris*	40,16	2,48	-	-
Yellow-billed Duck	*Anas undulata*	69,67	11,57	-	-
Yellow-billed Kite	*Milvus aegyptius*	0,82	0,83	-	-
Yellow-billed Stork	*Mycteria ibis*	2,46	0,83	-	EN
Yellow-crowned Bishop	*Euplectes afer*	38,52	4,13	-	-
Yellow-fronted Canary	*Crithagra mozambica*	4,92	0,00	-	-
Zitting Cisticola	*Cisticola juncidis*	53,28	2,48	-	-

Appendix F – Pre-Construction Monitoring Protocol

The objective of the pre-construction monitoring at the proposed Phefumula Emoyeni Wind Energy Facility (WEF) is to gather baseline data over a period of four seasons on the following aspects pertaining to avifauna at the development area:

- The abundance and diversity of birds to measure the potential displacement effect of the wind farm.
- Flight patterns of priority species to assess the potential collision risk with the turbines.

The monitoring protocol for the WEF site was designed according to the following set of 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.

The monitoring surveys completed to date were conducted in the following time periods:

- **Survey 1:** 05 - 16 November 2022, 17 – 20 January 2023, and 14 – 20 February 2023
- **Survey 2:** 11 April – 02 May 2023
- **Survey 3:** 13 June – 4 August 2023

Monitoring was conducted in the following manner:

- Two (2) drive transects were identified totalling 13.3km and 12.5km on the turbine site and one drive transect in the Control Site with a total length of 15.5km.
- Two monitors travelling slowly (± 10km/h) in a vehicle records 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, ten (10) walk transects of 1km each were identified at the turbine site, and two (2) at the Control Site, and are counted four (4) times per sampling season. All birds are recorded during walk transects.
- The following variables are 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 with drive transects is primarily to record large priority species (i.e. raptors and large terrestrial species), while walk transects are primarily aimed at recording small passerines. The objective of the transect monitoring is to gather baseline data on the use of the site by birds in order to measure potential displacement by the wind farm activities.

- Twenty-two (22) vantage points (VPs) were identified for the first survey and a further three (3) vantage points were added during the second survey (total of 25 VPs) from which the proposed turbine area can be observed, to record the flight altitude and patterns of priority species. One VP was also identified on the Control Site. The following variables were 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. >300m above turbine altitude; medium 30m – 300m i.e. at turbine altitude; low <30m i.e. below turbine altitude);
  - 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. Priority species were identified using the latest (November 2014) BirdLife SA (BLSA) list of priority species for wind farms.

Two following focal points of potential bird activity have been identified to date:

- FP1: Southern Bald Ibis colony
- FP2: Farm dam
- FP3: Heronry
- FP4: Southern Bald Ibis roost
- FP5: Farm dam
- FP6: Martial Eagle nest
- FP7: Secretarybird nest

Figure 1 below indicates the proposed turbine and control areas where monitoring is taking place.

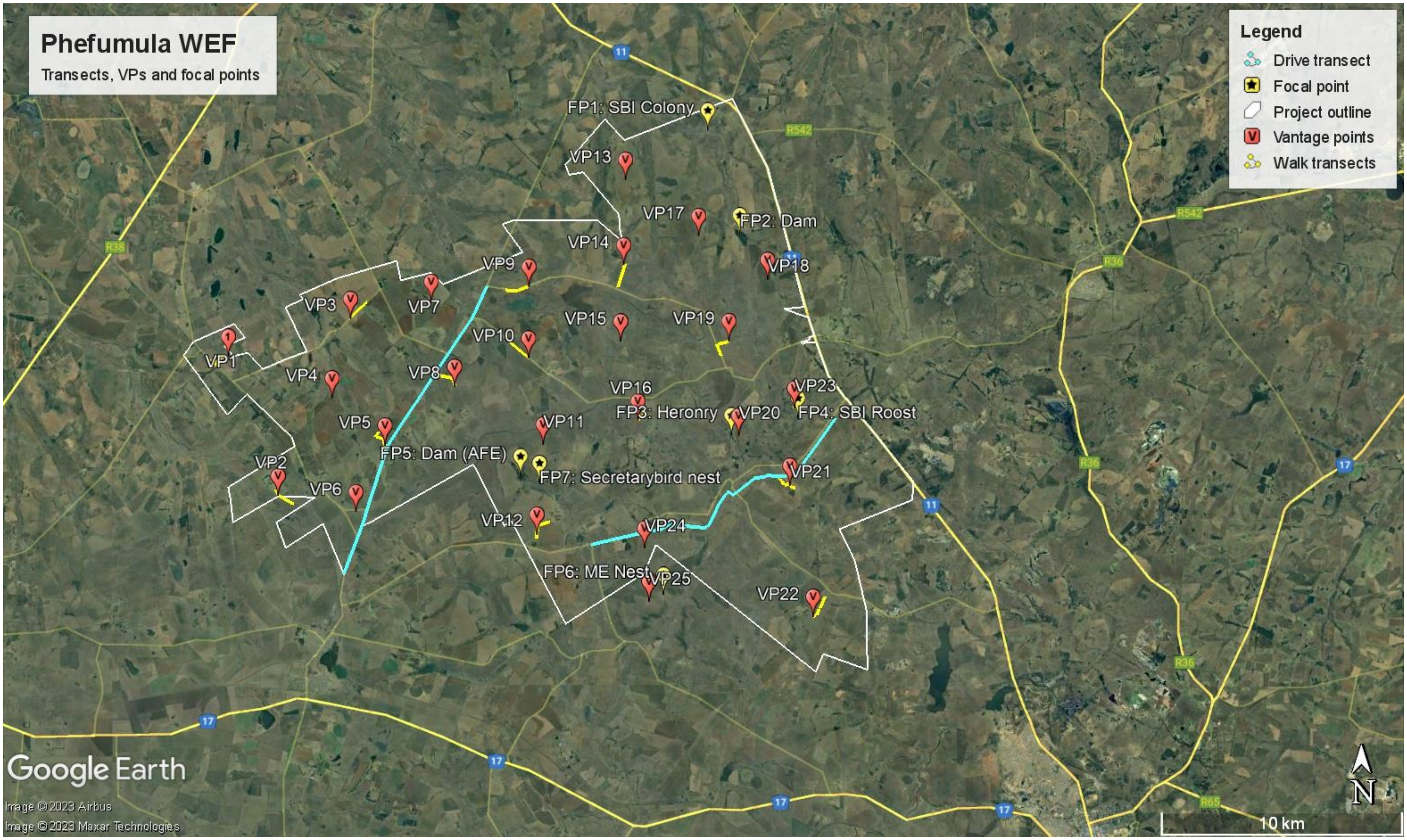

Figure 1: Area where monitoring is taking place, with position of VPs, drive transects, walk transects and the project outline. The control area is to the south-west of the site.

Appendix G – Post-Construction Monitoring

1 INTRODUCTION

The avifaunal post-construction monitoring at the proposed Phefumula Emoyeni One 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)[13].

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 necessary (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.

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[13] 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.

4 DURATION

Monitoring should take place annually for the operational lifespan of the WEF. After the first year of monitoring, the programme should be reviewed 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

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 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 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, labelled, 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 impact 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.

Appendix H – Environmental Management Plan

MANAGEMENT PLAN FOR THE PLANNING AND DESIGN PHASE

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
AVIFAUNA: DISPLACEMENT DUE TO DISTIURBANCE AND HABITAT TRANSFORMATION					
Displacement of priority avifauna due to disturbance and habitat transformation	Prevent mortality of priority avifauna	1. Restrict construction to the immediate infrastructural footprint. Access to remaining areas should be strictly controlled to minimise disturbance of priority species. This recommendation especially applies within the very high and high sensitivity areas depicted in the sensitivity maps **(Section 5.7 Specialist Sensitivity Analyses and Verification)**. 2. Prioritise upgrading existing roads (where the requisite roads authority permission has been issued) over constructing new roads. 3. Strictly implement the recommendations of ecological and botanical specialists to reduce the level of habitat loss.	Design lay-out around the proposed buffer zones	Once-off during the planning phase.	Project Developer
AVIFAUNA: MORTALITY DUE TO COLLISIONS WITH THE TURBINES					

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
Mortality of priority avifauna due to collisions with the wind turbines	Prevent mortality of priority avifauna	1. No turbines should be constructed in the turbine exclusion buffer zones as indicated in the sensitivity maps (**Section 5.7 Specialist Sensitivity Analyses and Verification**). 2. All wind turbines must have one blade patterned according to a South African Civil Aviation Authority (SACAA) approved pattern to reduce the risk of raptor collisions. All wind turbines must have one blade patterned according to a South African Civil Aviation Authority (SACAA) approved pattern to reduce the risk of raptor collisions. Refer to **Appendix I** for details. 3. It is recommended that all wind turbines (WTGs) be subjected to either Observer-led Shutdown on Demand (OSDoD) or Auto SDoD (ASDoD) during daylight hours and radar flight detection technology for flocks of target species at night. 4. Formal live-bird monitoring should commence following initial turbine operation, as per	Design lay-out around the proposed buffer zones.	1. Once-off during the planning phase. 2. As soon as the first turbines start turning.	Project Developer

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
		the Best Practice Guidelines (Jenkins et al. 2015), to determine the extent to which priority species displacement has occurred. Avifaunal monitoring should take place annually for the operational lifespan of the WEF.			

AVIFAUNA: MORTALITY DUE TO ELECTROCUTION					
Electrocution of avifauna on the internal 33kV network	Prevent mortality of priority avifauna	1. All medium voltage cables should be buried as far as practically possible. 2. A raptor-friendly pylon design must be used, and the pylon design must be approved by the avifaunal specialist.	Design engineers to consult with avifaunal specialist on the final design of the poles.	Once-off during the planning phase.	Project Developer

MANAGEMENT PLAN FOR THE CONSTRUCTION PHASE (INCLUDING PRE- AND POST-CONSTRUCTION ACTIVITIES)

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
AVIFAUNA: DISPLACEMENT DUE TO DISTURBANCE					

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
The noise and movement associated with the construction activities at the development footprint will be a source of disturbance which would lead to the displacement of avifauna from the area	Prevent unnecessary displacement of priority avifauna by ensuring that contractors are aware of the requirements of the Construction Environmental Management Programme (CEMPr.)	A site-specific CEMPr must be implemented, which gives appropriate and detailed description of how construction activities must be conducted. All contractors are to adhere to the CEMPr and should apply good environmental practices during construction. The CEMPr must specifically include the following: 1. No off-road driving. 2. Maximum use of existing roads. 3. Measures to control noise and dust according to latest best practice. 4. Restricted access to the rest of the property. 5. Strict application of all recommendations in the botanical and biodiversity specialist reports pertaining to the limitation and rehabilitation of the footprint.	1. Implementation of the CEMPr. Oversee activities to ensure that the CEMPr is implemented and enforced via site audits and inspections. Report and record any non-compliance. 2. Ensure that construction personnel are made aware of the impacts relating to off-road driving. 3. Construction access roads must be demarcated clearly. Undertake site inspections to verify. 4. Monitor the implementation of noise control mechanisms via site inspections and record and report non-compliance. 5. Ensure that the construction area is demarcated clearly and that construction personnel are made aware of these demarcations. Monitor	1. On a daily basis 2. Monthly 3. Monthly 4. Monthly 5. Monthly	1. Contractor and ECO 2. Contractor and ECO 3. Contractor and ECO 4. Contractor and ECO 5. Contractor and ECO

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
			via site inspections and report non-compliance.		
AVIFAUNA: DISPLACEMENT DUE TO HABITAT TRANSFORMATION					
Total or partial displacement of avifauna due to habitat transformation associated with the vegetation clearance and the presence of the wind turbines and associated infrastructure.	Prevent unnecessary displacement of avifauna by ensuring that the rehabilitation of transformed areas is implemented according to the recommendations of the biodiversity/vegetation specialist.	1 Ensure that all the recommendations for mitigation from the biodiversity/botanical specialist, including rehabilitation of disturbed areas, are strictly implemented.	1. Appointment of specialist to coordinate and monitor the rehabilitation of the vegetation.	1. Once-off	1. Wind farm operator

AVIFAUNA: MORTALITY DUE TO COLLISIONS ON THE 33KV NETWORK					
Bird collisions with the internal 33kV cables.	Prevent mortality of priority avifauna.	1. Overhead lines should be restricted to an absolute minimum and should only be allowed if underground cabling is unfeasible due technical (not financial) constraints. 2. 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.	Fit Eskom approved Bird Flight Diverters on the entire overhead section of the 33kV network.	1. Once-off	1. Contractor

MANAGEMENT PLAN FOR THE OPERATIONAL PHASE

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
AVIFAUNA: MORTALITY DUE TO COLLISIONS WITH THE WIND TURBINES					
Bird collisions with the wind turbines	Prevention of priority species collision mortality on the wind turbines.	1. Formal live-bird monitoring and carcass searches should be implemented at the start of the operational phase, as per the most recent edition of the Best Practice Guidelines at the time (Jenkins *et al*. 2015) to assess collision rates. The	1. Appoint Avifaunal Specialist to compile operational monitoring plan, including live bird monitoring and carcass searches. 2. Implement operational monitoring plan.	1. Once-off 2. Years 1, 2, 5 and every five years after that for the duration of the operational lifetime of the facility.	1. Wind farm operator 2. Wind farm operator 3. Wind farm operator 4. Wind farm operator/avifaunal specialist 5. Wind farm operator/avifaunal specialist

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
		exact time when operational monitoring should commence, will depend on the construction schedule, and should commence when the first turbines start operating. Avifaunal monitoring should take place annually for the operational lifespan of the WEF. 2. A procedure for the immediate removal of carcasses within the development area must be implemented to prevent vultures from being attracted to the area where they could be at risk of collision with the turbines. 3. It is recommended that all wind turbines (WTGs) to be subjected to either Observer-led Shutdown on Demand (OSDoD) or Auto SDoD (ASDoD) during daylight hours and radar flight detection technology for flocks of target species at night. 4. Furthermore, if annual estimated collision rates of	3. Engage with the landowner to design and implement an effective system to locate a carcass promptly and ensure the immediate removal of the carcass before it can attract vultures. 4. Appoint a team of suitably qualified, trained, dedicated, and resourced team of observers to be present on site for all daylight hours throughout the year. It is absolutely essential that passionate, hardworking staff is hired for this role. This team must be stationed at observation points with full visible coverage of all turbine locations. The observers must detect incoming priority bird species, track their flights, judge when they enter a turbine proximity threshold,	3. Before the first turbines start turning. 4. As and when required, within six months of threshold having been exceeded. 5. Quarterly and annually	

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
		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.	and alert the control room to shut down the relevant turbine until the risk has reduced. 5. A full detailed method statement must be designed by an avifaunal specialist prior to the commercial operations date (COD) and must be in place by the time that the wind farm starts operating. 6. Compile quarterly and annual progress reports detailing the results of the operational monitoring and progress with any recommended mitigation measures.		
AVIFAUNA: MORTALITY DUE TO ELECTROCUTIONS ON THE 33KV NETWORK/SUBSTATIONS					
Electrocution of priority species on the on-site sub-stations and internal 33kV network	Prevention of electrocution mortality on the overhead sections of the 33kV internal cable network/on-site substation.	1. Conduct regular inspections of the overhead sections of the internal reticulation network to look for carcasses. 2. Apply insulation reactively in the substation if	1. Carcass searchers under the supervision of the Avifaunal Specialist. 2. Design and implement mitigation measures if mortality thresholds are exceeded.	1. At least once every two months. 2. As and when required, within six months of threshold having been exceeded.	1. Operations Manager/Avifaunal specialist 2. Wind farm operator/Avifaunal specialist 3. Wind farm operator/Avifaunal specialist

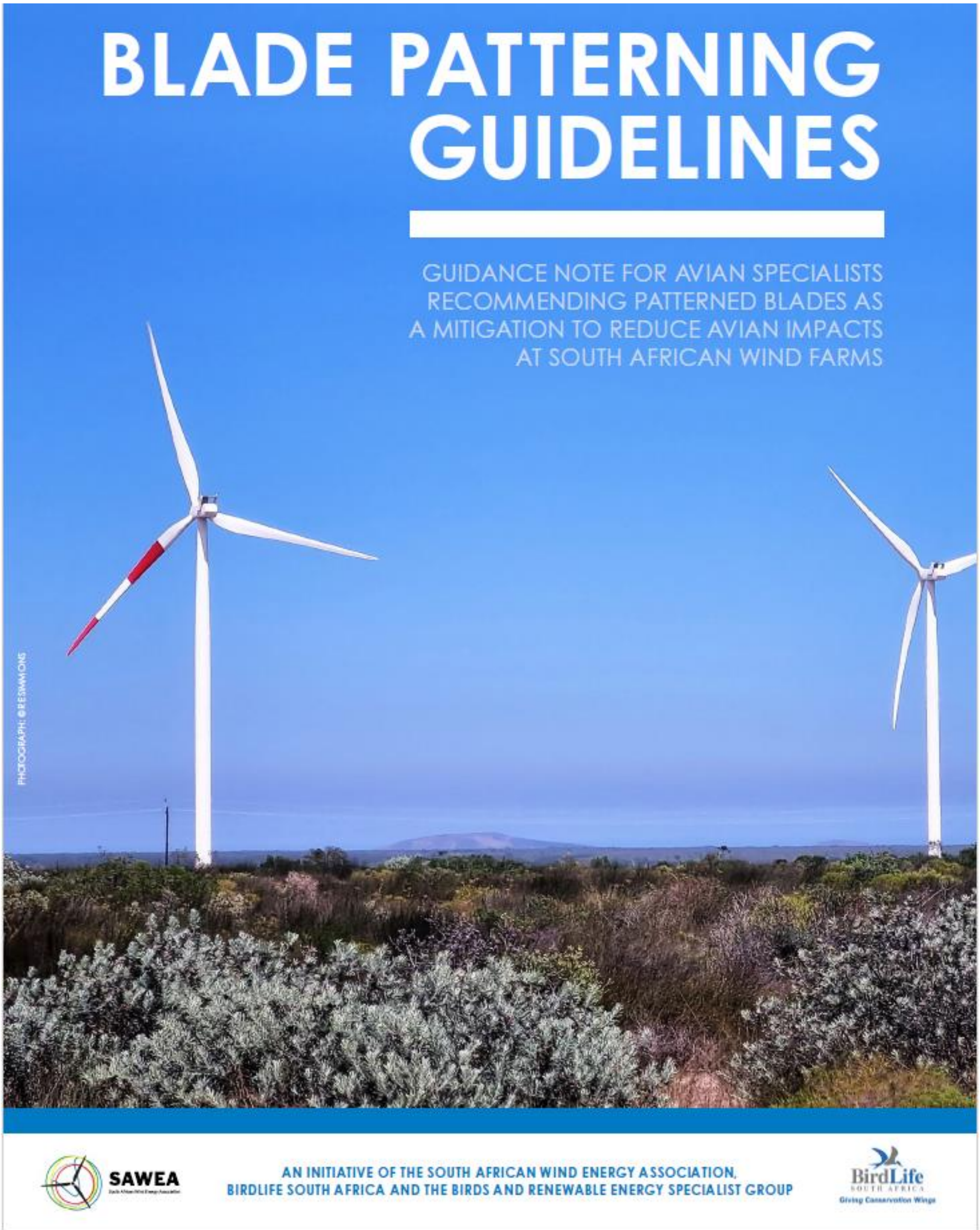
Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
		electrocutions of SCC are recorded.	3. Compile quarterly and annual progress reports detailing the results of the operational monitoring and progress with any recommended mitigation measures.	3. Quarterly and annually	

MANAGEMENT PLAN FOR THE DECOMMISSIONING PHASE

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
AVIFAUNA: DISPLACEMENT DUE TO DISTURBANCE ASSOCIATED WITH THE DISMANTLING ACTIVITIES					
The noise and movement associated with the de-commissioning activities at the WEF footprint will be a source of disturbance which would lead to the displacement of avifauna from the area	Prevent unnecessary displacement of avifauna by ensuring that contractors are aware of the requirements of the EMPr.	A site-specific EMPr must be implemented, which gives an 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 must specifically include the following: 1. No off-road driving. 2. Maximum use of existing roads. 3. Measures to control noise and dust according to latest best practice.	1. Implementation of the EMPr. Oversee activities to ensure that the EMPr is implemented and enforced via site audits and inspections. Report and record any non-compliance. 2. Ensure that construction personnel are made aware of the impacts relating to off-road driving. 3. Access roads must be demarcated clearly. Undertake site inspections to verify.	1. On a daily basis 2. Monthly 3. Monthly 4. Monthly 5. Monthly	1. Contractor and ECO 2. Contractor and ECO 3. Contractor and ECO 4. Contractor and ECO 5. Contractor and ECO 6. Contractor and ECO

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
		4. Restricted access to the rest of the property. 5. Strict application of all recommendations in the biodiversity/vegetation specialist report pertaining to the limitation of the footprint.	4. Monitor the implementation of noise control mechanisms via site inspections and record and report non-compliance. 5. Ensure that the footprint area is demarcated and that construction personnel are made aware of these demarcations. 6. Monitor via site inspections and report non-compliance.		

Appendix I – Blade Patterning Guidelines



1. AIM

This document provides guidance to avian specialists wishing to recommend blade patterning to mitigate bird strikes, especially raptors, at South African wind farms. It aims to promote consistency in the application of blade patterning by Independent Power Producers (IPPs), Eskom and their designated avian specialists within South Africa, based on the latest avian scientific research and the requirements of the South African Civil Aviation Authority's (SACAA) Alternative Means of Compliance (AMoC)[1].

In practice, the patterning design and the number of blades to be patterned at a particular site should be determined by an appointed Avifaunal Specialist (registered with the South African Council of Natural Scientific Professions (SACNASP)), taking into consideration site-specific requirements, species present on site, site-specific avifaunal risks and the latest scientific evidence regarding patterning, augmented by results from patterning tests at operational wind farms across South Africa.

The patterning recommended here is based on published international studies regarding birds and their ability to see and avoid turbines with high-contrast colours applied to white turbine blades, as well as a pilot project undertaken in South Africa (2023 – 2024) (Birds & Bats Unlimited 2024). As a new field of passive mitigation, it is important that avian specialists use evidence-based best practices to mitigate avian fatalities by recommending appropriate colours and patterns for turbine blades.

2. BACKGROUND

Following a SAWEA briefing note on Considerations for Blade Patterning as a Mitigation Measure to Reduce Avifaunal Collisions with Wind Turbines in South Africa[2] (Morkel et al. 2023), SAWEA motivated to the SACAA for a blanket approval to allow all wind farms an AMoC to pattern blades. This request was approved by the SACAA on 18 January 2024, allowing IPPs to deviate from white (as required by the current regulations[3]) and apply a "different colour" to their turbine blades to reduce bird strikes.

Condition 5.1 of the AMoC approval requires that "the final designs of the alternative markings must be submitted to the SACAA for consideration and approval, prior to implementation". The SACAA have indicated that final designs must be accompanied by a full motivation of such markings from a SACNASP-registered avifaunal specialist ensuring that the markings achieve the purpose of the AMoC approval.

Recognising the benefit of standardising submissions to the SACAA, this paper has been drafted to assist avian specialists in recommending designs appropriate to reducing bird strikes based on the best available science in this field.

PHOTOGRAPH: © ALBERT FRONEMAN

3. RATIONALE

Birds, particularly raptors, are highly susceptible to impacts by spinning turbine blades (Thaxter et al. 2017, Perold et al. 2020). Experiments in the lab indicate that increasing contrast by painting one turbine blade black increases the chances that raptors will react to spinning blades. The single blade is assumed to reduce "motion smear" (lack of reaction on the retina to a fast-spinning blade: Hodos 2003) by breaking up the "blur".

By experimenting with different patterns, McIsaac (2001) found that two large black stripes across a blade were more conspicuous to raptors in the lab than plain white, plain grey, multiple zebra stripes or longitudinal stripes. This was confirmed in the first field trial several years later in Norway by May et al. (2020), which significantly reduced all bird fatalities by 72% by painting two-thirds of one blade solid black at four turbines. Umoya Wind Farm near Hopefield, Western Cape, employing patterns (i.e. two stripes) rather than a solid design, released preliminary, but promising results in July 2024, complementing these studies (Birds & Bats Unlimited 2024).

Further trials involving different species, environments and blade patterns are encouraged to determine this new mitigation's general applicability and effectiveness.

72 The percentage by which bird fatalities were reduced when painting two-thirds of one blade solid black in a field trial.

[1] The AMoC application was submitted in terms of Civil Aviation Regulation (CAR) 11.04.6, read with CAR 11.04.2 and 11.04.3, for turbine blades at wind farms not conforming strictly with CATS 139.01.30 (3) (b), in which SAWEA sought approval for deviation. [2] https://www.birdlife.org.za/wp-content/uploads/2023/09/SAWEA-Birdlife-BARESG-Blade-Patterning-Media-Briefing-Note_Final_14092023.pdf [3] CATS 139.01.30 (3)(b) requires that rotor blades, nacelle and the upper 2/3 of the supporting mast of a wind turbine shall be painted white, unless otherwise indicated by an aeronautical study.

4. GUIDELINES FOR BLADE PATTERNING

The following guidelines for patterning turbine blades are understood to be acceptable to the SACAA[4]:

4.1. Colours

■ The turbine blade should be painted Red to comply with the SACAA regulations, and both the front and back of the blade must coloured[5].

4.2. Number of blades patterned

■ A single turbine blade patterned in accordance with the terms of the AMoC approval is currently considered the best means of reducing motion smear (Hodos 2003). However, if multiple blades are patterned, the pattern must be asymmetrical (**see Figure 3 below**). That is, the pattern on the following blade must be positioned in different sections of the blade to produce a flicker effect[6] to increase conspicuousness (Martin and Banks 2023).

4.3. Patterning

■ The pattern should be either (i) alternating red-white-red-white bands from the blade tip to the base, with each band representing 25% of the blade's length (**Figure 1**) or (ii) three quarters (¾) of the blade painted solid red (**Figures 2**).

■ A striped patterning design (like Hopefield) and a solid pattern (like Smøla) may give different results, but both are acceptable designs.

■ While no field tests of thermal load have been undertaken, a patterned design, as opposed to a solid design, may reduce any differential heating of the blade (because the white sections will reflect light). Thus, wind farms in hot environments might prefer a pattern to a solid colour.

■ Alternative approaches to blade patterning that do not align with the above guidance are not recommended as suitable avian mitigation. For example, simply painting turbine blades with a colour other than those stipulated above, especially just the tips, is not recommended.

Similarly, all three blades should not be patterned identically; this approach is unlikely to break up motion smear and does not guarantee that birds will see and avoid them. "Aviation Stripes" used on some turbines, for example, in China, were not designed to be more visible to birds. They are designed to warn pilots of distances to the closest airports or to warn pilots of nearby wind farms. These are not recommended for bird mitigation (**see Figure 4**).

■ Applying a narrow strip on the leading edge of turbine blades un-patterned (i.e. white) for Leading Edge Protection (LEP) is sometimes unavoidable and required by the manufacturer. This is not expected to reduce the effectiveness of blade patterning, provided it does not exceed 1-2% of the blade width.

4.4. Number of patterned turbines within the wind farm

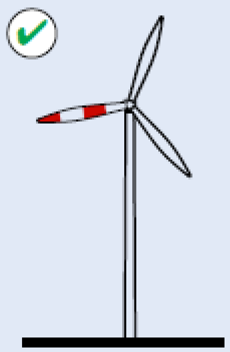
The number of turbines patterned within the wind farm can be approached in two ways:

■ Some turbines can be left un-patterned to act as controls as part of a nation-wide experiment to test the effectiveness of blade-patterning for different species in different environments (without controls, background fatality rates are difficult to determine), or

■ All turbines can be patterned to minimise conservation concerns. This approach is unlikely to contribute to any experimental verification (because of the lack of control turbines), but it may be necessary where the wind farm occurs near particularly sensitive sites.

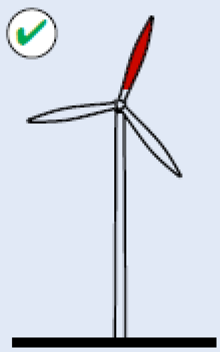
VISUAL ILLUSTRATION OF BLADE PATTERNING

FIGURE 1



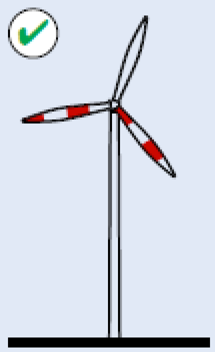
Alternating red-white-red-white bands from the blade tip to the base, with each band representing 25% of the blade's length are acceptable.

FIGURE 2



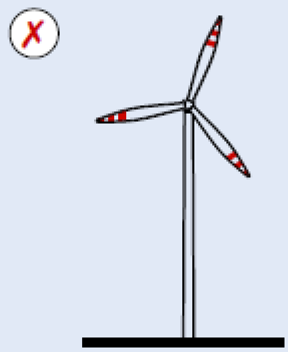
Red paint covering two-thirds of an entire blade in a solid design, as shown, is also an acceptable pattern.

FIGURE 3



Two blades patterned in an asymmetrical fashion are acceptable.

FIGURE 4



Aviation stripes on blades cover ~20% of the surface and are not recommended as an avian mitigation. They have not been tested on birds and are unlikely to disrupt "motion smear" as the pattern occurs on all three blades

[4] Based on the approved AMoC application which was submitted by SAWEA in terms of Civil Aviation Regulation (CAR) 11.04.6, read with CAR 11.04.2 and 11.04.3, for turbine blades at wind farms not conforming strictly with CATS 139.01.30 (3) (b). [5] As the colour 'red' aligns with colours referenced within the CAA regulations and AMoC approval, and that 'red' provides enough of a contrast from white to be visible to birds, this guidance note speaks only to the use of the colour red. Other colours, which may be deemed acceptable from an avifaunal perspective, such as black, would be subject to a separate application for AMoC with the SACAA. [6] Not to be confused with 'shadow flicker' which is the repetitive casting of shadows from turbine blades as they pass between the line of sight between a receiver and the sun.

4.4.1. Experimentation

Because only two field tests have been undertaken utilising patterned blade mitigation (one in Norway: May et al. 2020, and one in South Africa: Birds & Bats Unlimited 2024), BirdLife South Africa and BARESG encourages IPPs to help test blade patterning for effectiveness as a mitigation in different environments. To this end, half turbines in medium to low risk areas (or for operational farms, high fatality turbines) should be patterned, and the other half left un-patterned as controls. The same approach should be applied to low-risk areas (or low fatality turbines) with half to be patterned, and half as controls.

It is for the appointed SACNASP registered Avifaunal Specialist (in consultation with a recognised statistician, if required) to advise on the experimental/statistical design for a programme of blade patterning and associated carcass monitoring at the wind farm. Taking account of all relevant site, species and project specific factors, appropriate statistical tests must be applied to the fatality results to evaluate the effectiveness of the mitigation over a 24-month period. This experimentation may involve different (but appropriate) patterning designs applied to single and/or multiple blades as, detailed above.

4.4.2. All turbines patterned

In cases where wind farms are planned or operational near high-risk areas for threatened species, BirdLife South Africa and BARESG do not recommend the experimental approach. High risk areas are defined for some species by specific guidelines (e.g. Pfeifer and Ralston-Paton 2018, Simmons et al. 2020, Ralston-Paton and Murgatroyd 2021), VERA modelling (Murgatroyd et al. 2020) or Flight Risk/Collision Risk Modelling (Colyn and Froneman 2023). Wherever roosts, breeding colonies, or other sensitive areas for red data birds occur within the home range of that species, all blades should be patterned. Killing such species at control turbines is not acceptable and will incur future costs for additional tiers of mitigation. In these cases, BirdLife South Africa and BARESG suggest that all turbines should be patterned for conservation purposes. However, avoidance of High-Risk areas should first be prioritised and blade patterning should be complemented with additional mitigation until blade patterning as a stand-alone mitigation has been proven to be effective.

5. CONCLUSION

The methods presented above provide a simple yet robust set of guidelines to standardise appropriate blade patterns, colour, and number of patterned turbines within South African wind farms, based on the available science and existing approvals with regard to the AMoC.

It is for the appointed SACNASP registered Avifaunal Specialist, taking full responsibility for the careful consideration of these guidelines, to determine the appropriate mitigation for the applicable site, and to avoid inappropriate actions that could undermine the concept and potential of this promising mitigation measure.

This document should be appended to the avian specialist's letter of endorsement which needs to accompany all final designs of the alternative markings submitted to the SACAA for the final design approval as per condition 5.1 of the AMoC.

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Document finalised September 2024 following review by SAWEA, BLSA and BARESG committees with input from, inter alia: Dr Rob Simmons (Birds & Bats Unlimited) • Sam Ralston-Paton (Birdlife SA) • John Gibbs (Birdlife SA) • Caryn du Rand (nee Clarke) (SAWEA Project Development SC/G7 Renewable Energies) • Matthew Law (SAWEA Project Development SC/ Red-Cap Energy) • Shaun Taylor (SAWEA Project Development SC/ Mainstream Renewable Power) • Dr Meg Murgatroyd (HawkWatch International) • Andrea Gibb (SAWEA Project Development SC/ Globeleq) • Santosh Sookgrim (SAWEA)

Appendix J – Sensitive Species 23 Wetland Surveys Report

Phefumula WIND ENERGY FACILITY

Species 23 wetland surveys

March 2025

1. Executive Summary

Methodology

- A deep learning-based CNN (Convolutional Neural Network) model was used to assess fine scale habitat suitability using Sentinel-2 remote sensing data.
- In-situ wetland assessments were conducted in Nov/Dec 2024, with further acoustic monitoring planned for the summer of 2024/2025.

Key Findings

- Fine-scale habitat modeling found no suitable habitat (probability >0.25) within the PAOI, suggesting low risk to Species 23.
- Field surveys assessed seven wetland habitat units across the PAOI, covering 20 individual sites.
- Given the lack of any suitable habitat identified within the AOI, both through modelling and in-situ surveys, no passive acoustic monitoring was undertaken.
- Most wetlands (Sites A-E) were dominated by graminoid riparian and channelled valley-bottom habitats, but extensive degradation (e.g., overgrazing, trampling by livestock) reduced suitability for Species 23.
- No highly suitable breeding or foraging habitat was found in the PAOI.

Implications & Sensitivity Rating

- The combination of modeling and field assessments confirms that Species 23 is unlikely to be affected by the proposed WEF development.
- The probability of species occurrence and associated risk is considered low.
- This supports the feasibility of the WEF project from a species 23 perspective.

2. Scope of Work

AfriAvian Environmental were tasked to undertake species 23 habitat assessments across the Phefumula WEF proposed area of interest (PAOI) (Figure 1).
The scope of works included:

1. Wetland in-situ habitat surveys:
    a. Conduct wetland habitat surveys for species 23, assessing wetland type, vegetation structure and other biotic and abiotic component of habitats.
    b. Conduct passive acoustic species monitoring at select sites that are deemed suitable or likely to be suitable.

2. Fine scale habitat suitability model – species 23:
    a. Delineate suitable breeding and foraging habitats within the PAOI. A core habitat layer will be provided as the deliverable. Linkages and corridors connecting core patches need to be considered separately.

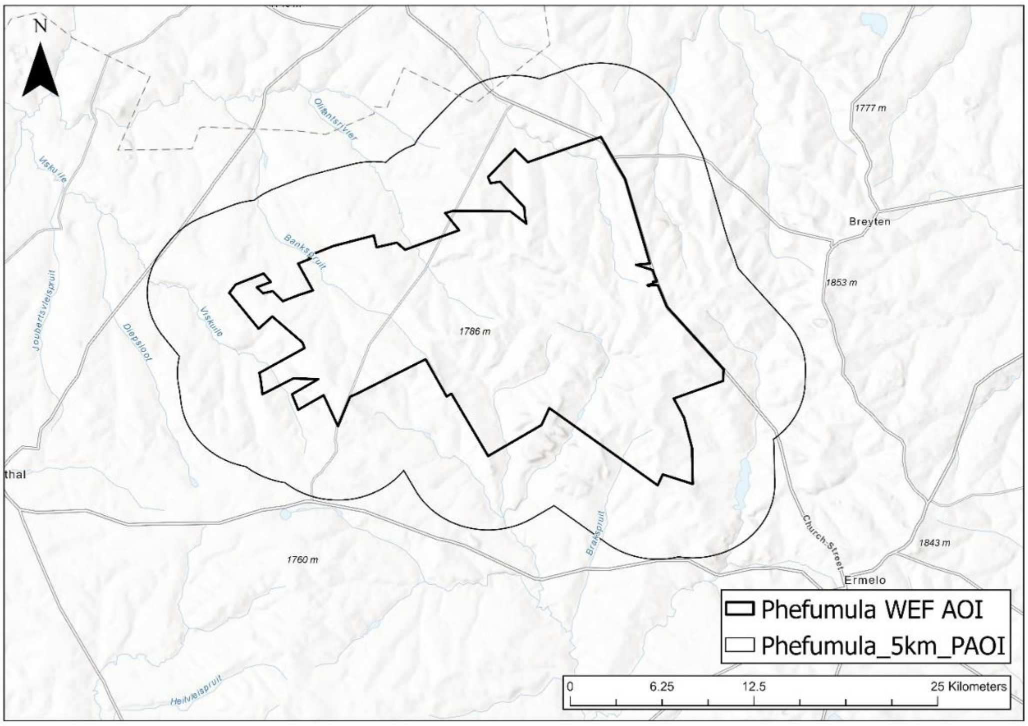

Figure 35: The locality of the proposed Phefumula Emoyeni One WEF within the Mpumalanga Province.

3. Methods

3.1 Habitat suitability modelling

We scripted and used an R workflow to prepare, pre-process and analyse remote sensing data acquired by the Sentinel 2 satellite platform (Copernicus 2023). A classification modelling framework, which included the use of a deep machine learning convolutional neural network (CNN), was used to assess habitat suitability for target species. CNNs are widely used in wildlife research and conservation for automating image and video analysis. Their ability to extract patterns from visual data makes them particularly useful in habitat monitoring and mapping studies, including wetland habitats (Mainali et al. 2023). This general modelling process has been previously used in multiple peer-reviewed wildlife habitat suitability studies (Norman et al. 2022; Mainali et al. 2023). We used a stepwise variable selection technique to conduct a data driven process of variable selection. Variable selection includes the removal of highly correlated variables, thereby preventing autocorrelation and improving the interpretation of final model results (Vignali et al. 2020).

The modelling workflow included data partitioning, model training, variable selection, model testing, model optimization through hyperparameter tuning and final model predictions. Occurrence data were sourced by an extensive internal database, supplemented with in-situ data collected across the reporting period. We partitioned the overall occurrence and absence dataset into training (80%) and testing (20%) subsets. Subsequently, we trained the primary models using the Random Forest and ANN algorithms, followed by hyperparameter tuning and model optimization using the genetic algorithm (Vignali et al. 2020). Variable importance and partial dependence plots were generated for the final set of variables selected following initial model training and optimization. A final global model was trained using the entire training occurrence dataset for each species, and this model was then used to make predictions of habitat suitability within the local area of interest (i.e. proposed development footprint).

Model performance was assessed using the Receiver-operating characteristic (ROC) and associated area under the curve (AUC-ROC) value, as well as accuracy, recall, precision and F1 score derived from independent test datasets (Freeman and Moisen 2008). ROC plots compare the true positive and false positive rates and are commonly used as a metric of model performance in classification studies (Jimenez-Valverde 2012; Sofaer et al. 2018).

This fine scale habitat suitability model developed for species 23 has be deployed to great effect across the species range, accurately predicting occupied sites confirmed through in-situ passive surveys in central and southern Mpumulanga, as well as eastern Free State. Multiple new sites have been confirmed through the use of this model, supporting its accuracy and usage in this regard.

3.2 Wetland in-situ habitat assessments

Wetland habitat assessments were conducted in November/December 2024, with further passive acoustic monitoring planned over the 2024/2025 summer season at any highly suitable sites identified through the assessments. Wetland habitat assessments were focused across all palustrine wetland habitats that were likely to have suitable habitat as defined by the national species distribution model for species 23, as well as the fine scale habitat suitability model generated for the local WEF as part of task 2 of this scope of work.

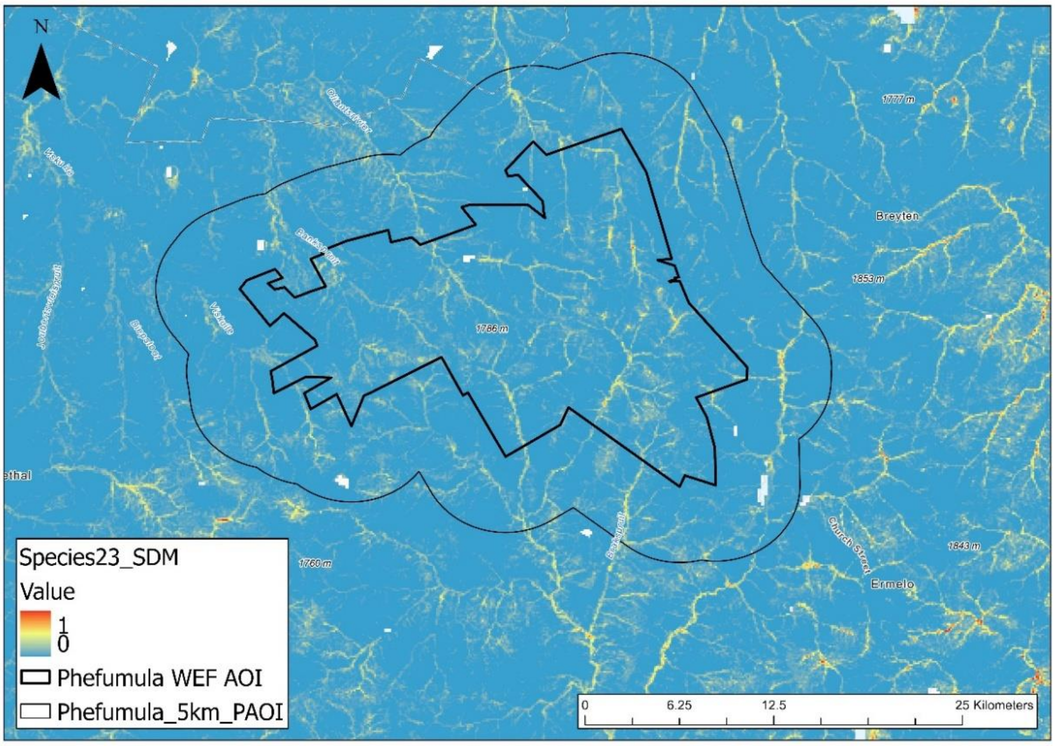

Figure 36: The species distribution model for species 23 suggested an array of wetlands within the Phefumula Emoyeni One WEF PAOI with low to moderate probability (0.2-0.4, i.e. yellow) of suitability. Wetlands with higher probabilities of suitability (0.4-0.6) were located >10km south-east and east of the Phefumula AOI.

4. Results

Fine scale habitat suitability model

The fine scale habitat suitability model which was aimed at segmenting/classifying sedge dominant palustrine wetland habitats yielded no habitat features with probabilities >0.25 within the PAOI. These results indicate that no suitable habitat was flagged within the PAOI and highlight generally low risk sensitivity for species 23.

In-situ wetland habitat assessments

A total of seven broader wetland habitat units were assessed across the Phefumula AOI during the November 2024 surveys, which included more than 20 individual habitat site assessments (Figure 3).

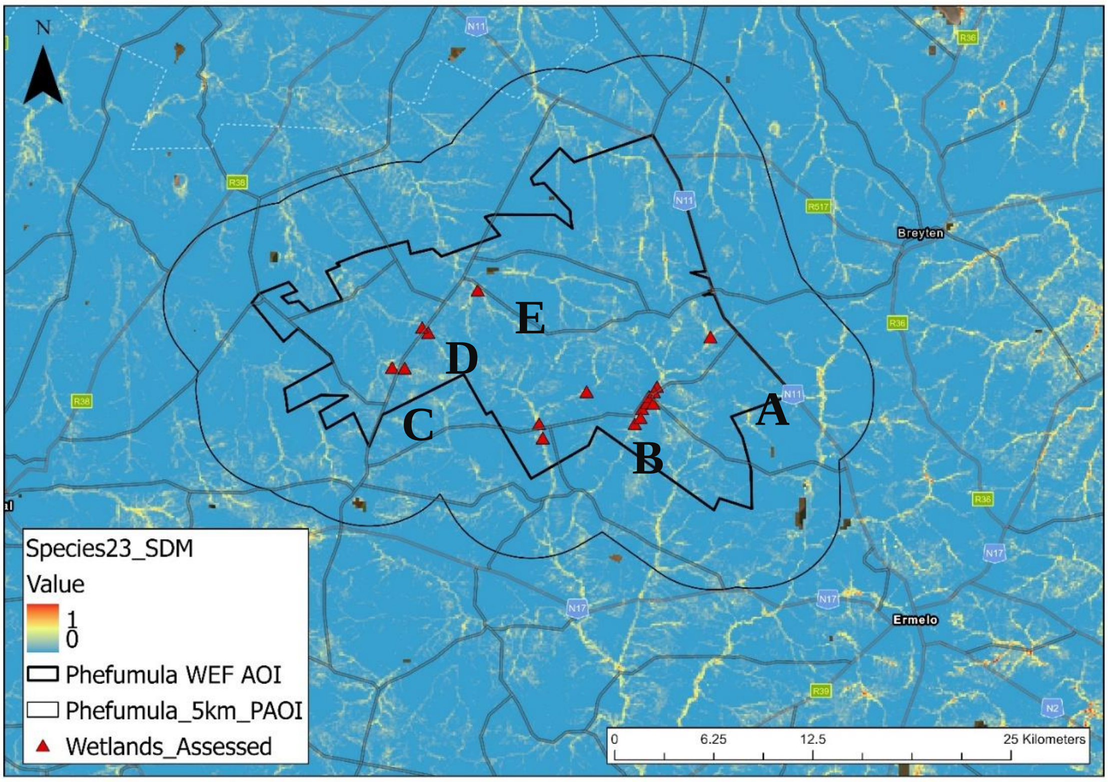

Figure 37: Wetland sites screened and assessed (red triangles) during the November 2024 habitat assessments.

<u>Wetland site A</u>

The wetland habitats across this site were flagged by BirdLife South Africa and the associated national distribution model as hosting potentially suitable habitat for species 23. The area screened spanned multiple km's (ca. 8km) of riparian and channelled valley bottom wetland habitats. The majority of sites surveyed were characterised by degraded grassland and wetland habitats, largely a result of extensive overgrazing. Heavy cattle stocking densities were noted across most management units surveyed and signs of extensive trampling and defoliation were noted across all wetland habitat sites surveyed (Figures 4 and 5). The vast majority of the wetland habitats present constituted riparian habitats with little to no lateral seepage, as well as marginally and poorly vegetated (overgrazed/trampled) channelled valley bottom wetland habitats, both of which were deemed unsuitable for species 23 given its extent and state (Figure 6).

Figure 38: Large herds of cattle (high stocking densities) were noted across all wetland sites surveyed. All sites surveyed displayed extensive impacts of defoliation and trampling.

Figure 39: A tiny (<1ha) channeled valley bottom wetland was located at wetland site A but had been severely degraded due to extensive trampling by cattle.

Figure 40: Some small, localised sections of the riparian system had sections of Phragmites vegetation lining the riverbanks (bottom). Extensive cattle grazing (defoliation) and trampling were noted across the majority of the area surveyed (top and bottom).

<u>Wetland site B</u>

Wetland site B was almost exclusively characterised by graminoid dominant channelled valley bottom and riparian habitats with no established/mature palustrine wetland habitat noted (Figure 7). All sites sampled/assessed were deemed unsuitable for species 23.

Figure 41: Wetland sites C, D and E were largely characterised by graminoid dominant channelled valley bottom wetland and riparian habitats.

<u>Wetland sites C, D and E</u>

Wetland sites C-E were almost exclusively characterised by grassland habitats. Habitats assessed included a few small moist grassland depressions, extensive tracts of grassland riparian channels dominated by very short, narrow and steep grassland banks (Figures 8 and 9). No sites were deemed potentially suitable for species 23.

Figure 42: Wetland site C included an array of very short-grazed grassland with patches of moist grassland/wetland depressions (below) and some riparian habitats (above).

Figure 43: Typical wetland habitat across most of the Phefumula AOI are characterised by grassland dominant riparian channels.

Passive acoustic monitoring

Given the lack of any suitable habitat identified within the PAOI, no passive acoustic monitoring was undertaken during the given season.

5. Implications and Sensitivity Rating

In-situ habitat assessments did not identify any suitable habitat for species23 within the Phefumula AOI (Figure 1). This finding is further supported by the lack of any suitable habitat flagged by the fine scale habitat suitability model created for the AOI and the generally low probability produced by the national species distribution model for the PAOI (Figure 2). The probability of species occurrence and associated risk with regard to the proposed development is regarded as low.

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Appendix K – Secretarybird Mitigation Strategy

Background & Justification

Secretarybirds (*Sagittarius serpentarius*) are large, ground-nesting raptors vulnerable to habitat disturbance and collision risk from wind energy infrastructure. Given their low reproductive rates and territorial fidelity, effective mitigation strategies must be proactive rather than reactive. While Secretarybirds exhibit territorial fidelity, they do not consistently reuse a single nest structure across breeding seasons. Instead, breeding pairs may switch between multiple tree structures within their core territory, utilizing different nest sites over time. This behaviour highlights the importance of monitoring all potential nesting structures within a given territory, rather than focusing on a single nest location. Furthermore, a mitigation strategy would need to account for this in order to be effective.

Our suggested tiered approach (**Figure 1**) provides adaptive management, combining remote sensing, artificial intelligence (AI)-based monitoring, and real-time mitigation actions to minimize potential impacts on breeding Secretarybirds.

The mitigation framework consists of five tiers, from pre-operational site assessments to active curtailment and phased shutdown on demand (SDoD) during confirmed breeding activity.

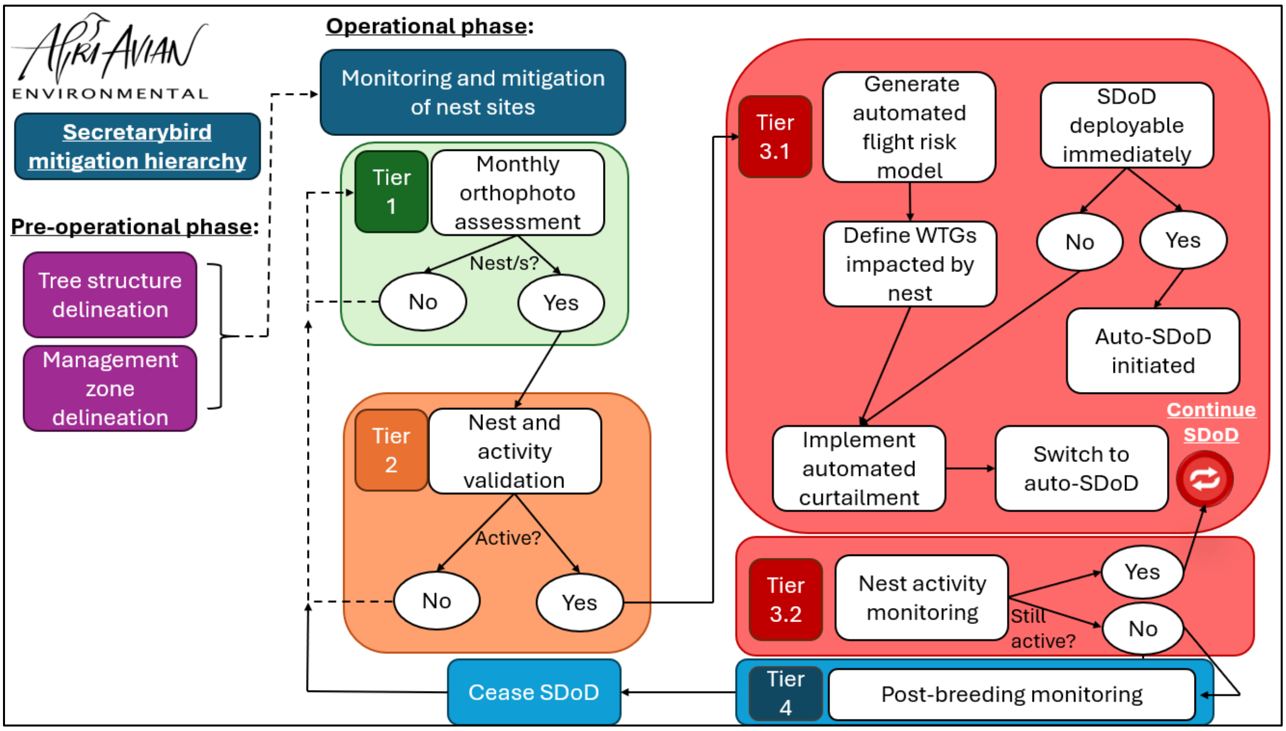

Figure 1: A hierarchal tiered proactive mitigation approach is recommended for Secretarybirds given the observed lack of nest site fidelity. This approach will allow for the identification of any active (new and/or old) nests and mitigate accordingly.

Tier 0: Pre-Operational Assessments

1. Tree Structure Delineation (Nest Habitat Mapping)

Objective: Identify and map all potential nest structures within the Project Area of Influence (PAOI)—including the WEF site and a 3 km buffer—before construction begins.

Methods:

- Canopy Height Model (CHM) generation from LiDAR or high-resolution aerial or satellite imagery.

- Tree structure classification using a trained/developed criteria-based model, which incorporates metrics of tree structure, topography and land-use types of tree structures.
- This training data incorporated a local database of tree structures used for roosting and breeding, with the resultant trained model yielding high precision (0.97) and recall (0.96). As a precautionary approach, lowering the probabilistic threshold used to define suitable tree structures would potentially increase the areas searched during tier 1, but offer greater protection to birds.

2. Management Zone Delineation

Objective: Define Secretarybird Management Zones that integrate:

- Tree structure mapping results (tier 0.1 above).
- Existing nest records (historical or confirmed active nests), as well as prominent roost sites.
- Flight risk model outputs (larger medium-risk areas).

<u>Tier 1: Monthly Orthophoto Monitoring (AI-Based Nest Detection)</u>

Objective: Systematic drone-based monitoring to proactively detect activity at nest and roost structures.

Methods:

- Drone surveys conducted monthly over Management Zones identified in Tier 0.
- Captured high-resolution orthophotos are rapidly processed to detect potential nest and roost structures by the below Nest Detection Model.
- Deep machine learning-Based Nest Detection Model:
- State-of-the-art object detection with high speed & accuracy.
- Trained on an extensive annotated dataset of Secretarybird nest and roost structures.
- Achieves 98% detection accuracy.
- Uses real-time object detection to pinpoint nest structures in the imagery.
- Baseline data collection should begin during the construction phase to inform operational monitoring.
- Results guide Tier 2 validation efforts.

<u>Tier 2: In-Situ Validation of Nesting Activity</u>

Trigger: A nest or frequently used roost structure is identified via drone imagery.

Validation protocol:

- On-site field validation is conducted by an experienced ornithological field specialist.
- Key observations recorded:
- Nest status: Early nest building, incubation, or active chick-rearing.
- Adult behaviour: Courtship displays, nest defence, or feeding interactions.
- Nest usage frequency: To differentiate between roosting sites and active breeding attempts.

Outcome: If breeding activity is confirmed, proceed to Tier 3 for immediate mitigation measures.

<u>Tier 3: Risk Mitigation (Curtailment & SDoD Activation)</u>

Trigger: Confirmed breeding or pre-breeding activity detected in Tier 2 validation.

Immediate Mitigation Actions:

1. Flight Risk Model Application

- Immediate real-time deployment of flight risk model through a respective AfriAvian webapp.
- Determines specific wind turbine generators (WTGs) that pose the highest risk to breeding pairs (nest site).

2. Automated Curtailment of Identified WTGs
   - Immediate response measure—curtailment initiated for all identified high-risk turbines near the nest site.
3. Phased Implementation of SDoD (Shutdown on Demand)
   - Where possible, observer-based or automated (e.g. radar) SDoD is phased in across the respective WTGs.
   - Until full SDoD implementation, curtailment remains in effect to offer protection.
     Objective: Minimize collision risk while maximizing Secretarybird breeding success

Tier 4: Post-Breeding Monitoring & Recovery

Trigger: Breeding activity ceases or concludes (fledged young or nest abandonment).

Validation protocol:

- An experienced ornithologist conducts on-site field validation to confirm post-breeding conditions are met.

Post-Breeding Protocol:

- Curtailment and/or SDoD measures cease.
- Revert to Tier 1 monitoring (monthly drone surveys continue).
- Adjustments to Management Zones if needed (e.g., changes in nest site fidelity, new territory identified, etc.).

Long-Term Impact:

Continuous monitoring and adaptive management ensure that mitigation measures remain effective over consecutive breeding seasons.

Flight Risk Prediction Model for Automated Curtailment (Tier 3, action 2):

1. Background & Justification

Mitigating collision risks for Secretarybirds in wind energy facilities requires a proactive, real-time response system that minimizes risk while maintaining operational efficiency. To support Tier 3 mitigation measures, a Flight Risk Prediction Model was developed to:

- Predict high-risk periods for Secretarybird flight based on weather conditions, time of day, and time of year.
- Trigger automated curtailment of wind turbines near active nests during elevated risk periods.
- Reduce false negatives (missed risky periods) to ensure maximum protection for Secretarybirds.
- This model leverages machine learning to dynamically assess risk in near-real-time using local meteorological data.

2. Model development and training

The Flight Risk Model was trained on an extensive dataset of Secretarybird flight lines, capturing:

- Temporal Flight Patterns: Time of day & time of year influence on flight activity.
- Weather Conditions: Wind speed, wind direction, temperature, and humidity.
- Distance from Nest: Flight probability relative to nest location.
- Topographic: ruggedness and other related metrics.

Model Testing & Selection

A sensitivity analysis was conducted to evaluate multiple classification models. The goal was to minimize false negatives (periods incorrectly predicted as "low risk" when they were actually high-risk), as these could lead to Secretarybirds being exposed to unmitigated collision hazards.

The best-performing model achieved:

- Recall: 84% (high ability to correctly identify risky periods).
- Precision: 72% (moderate ability to avoid false positives).
- Overall Accuracy: 75%

These results indicate strong predictive capability, ensuring that most hazardous flight periods are correctly identified while minimizing unnecessary turbine curtailment.

3. <u>Model Predictions & Risk Temporal Trends</u>

Applying the model to historical flight data revealed that:

- During the peak breeding season, risky periods typically occur in 10–30% of diurnal hours.
- Time of day, wind speed and nest proximity significantly influence risk probabilities.
- By leveraging this predictive framework, mitigation efforts can be strategically optimized, avoiding indiscriminate curtailment while focusing only on periods of elevated risk.

4. <u>Integration with the Mitigation Program</u>

The Flight Risk Model is fully integrated into the Proactive Mitigation Program under Tier 3 (Triggered Curtailment).

Automated Curtailment Process:

1. Weather Data Acquisition: The model retrieves real-time meteorological data from local weather masts via an API connection.
2. Risk Calculation: Based on weather, time of day, and seasonal patterns, the model predicts the probability of Secretarybird flight risk in the immediate period (e.g., next 30–60 minutes).
3. Curtailment Activation: If flight risk exceeds a predefined threshold, a curtailment notification is automatically triggered for high-risk WTGs near the active nest. This notification can be sent to the designated receiver within the control room.
4. Observer or Automated Shutdown on Demand (SDoD): If (or once) available, SDoD is phased in to provide more targeted protection and lowering the shutdown time (i.e. only issue shutdowns when birds fly).

This Flight Risk Prediction Model provides science-driven, near-real-time curtailment activation, ensuring Secretarybirds are protected when flight risk is highest while minimizing unnecessary disruptions to wind farm operations.

Potential future refinements include:

- Expanding the dataset with additional flight observations to improve model robustness.
- Integrating vantage point observations, imaging or radar tracking to enhance validation.
- Adaptive model recalibration based on ongoing flight monitoring data.

By continuously refining and deploying this model, Secretarybird conservation efforts can be proactively strengthened, setting a new standard for avian-wind energy mitigation strategies.