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AVIFAUNAL SPECIALIST ASSESSMENT FOR THE PROPOSED UMMBILA EMOYENI RENEWABLE ENERGY DEVELOPMENT NEAR BETHAL, MPUMALANGA

For

Emoyeni Renewable Energy Farm (Pty) Ltd

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Prepared By:

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NON-TECHNICAL SUMMARY

- The preferred site covers a large area comprising a matrix of heavily modified agricultural land and natural or near-natural grassland vegetation experiencing various levels of grazing pressure (from moderate to high);
- The terrain is relatively flat and gently undulating, with several rivers, wetlands and dams scattered throughout;
- The proposed Solar PV facilities are unlikely to pose a higher potential impact risk to the avifaunal community of the receiving environment than the Wind Energy Facility;
- Relatively low numbers of flight activity were recorded across the preferred site; however, a few flights consisted of a large number of individual birds (i.e. big flocks of birds all flying together) resulting in elevated passage rates calculated across some areas;
- The northern portions of the preferred site recorded higher passage rates than the middle and southern portions, which had comparatively low numbers of flights and birds recorded;
- Levels of flight activity was highest in summer, with a few large flocks of migrant species such as White Stork and Black-winged Pratincole contributing to the number of records;
- Of the resident species, Southern Bald Ibis were regularly recorded throughout the pre-application monitoring period, but were concentrated in the north of the preferred site with some flights in the far south;
- Secretarybird were encountered multiple times in the middle portion of the preferred site;
- Of the 45 avifaunal species identified during the screening study, reconnaissance study and scoping report to potentially be most relevant to the proposed development (e.g. Priority Species, Species of Conservation Concern and other notable species), flight activity of only 26 were recorded within the preferred site;
- No Black Harrier, African Marsh Harrier, Wattled Crane, Botha's Lark, Rudd's Lark or Yellow-breasted Pipit were recorded during the pre-application monitoring surveys despite concerted effort to locate these species;
- The initial Site Ecological Importance determined during the scoping phase was therefore lower than predicted based on the species and levels of flight activity recorded during the pre-application monitoring programme;
- Remaining wetland and natural or near-natural grasslands on the preferred site nevertheless remain areas of elevated avifaunal sensitivity;
- Wetlands and aquatic environments were considered to be of Very High Avifaunal Sensitivity due to their contribution to conservation targets in the broader area, their susceptibility to alterations in flow regimes and water tables and importance to birds (WTG No-Go);
- Areas of preferred flight movement corridors were considered to be of High Avifaunal Sensitivity (WTGs permitted with additional mitigation conditions);
- Natural or near-natural grasslands were considered to be of Medium Avifaunal Sensitivity;
- Areas heavily modified through agricultural practices were considered to be of Low Avifaunal Sensitivity;
- Overall, large areas of the preferred site are suitable for the development of renewable energy facilities and associated infrastructure;
- The proposed development is acceptable from an avifaunal perspective, following the implementation of mitigation and is unlikely to have a significant negative impact on the long-term viability and persistence of avifaunal species in the area.

GLOSSARY OF TERMS AND ABBREVIATIONS

BESS: Battery Energy Storage System
BLSA: BirdLife South Africa
CAR: Coordinated Avifaunal Road-count
CBA: Critical Biodiversity Area
CR: Critically Endangered
CWAC: Coordinated Waterbird Counts
DD: Data Deficient
DT: Drive Transect
EN: Endangered
ESA: Ecological Support Area
EWT: Endangered Wildlife Trust
GPS: Global Positioning System
IBA: Important Bird Area
MTS: Main Transmission Substation
MW: Megawatt
NT: Near Threatened
OHPL: Over-head Power Line
PAAMP: Pre-Application Avifaunal Monitoring Plan
PV: Photovoltaic
RSH: Rotor Swept Height
SABAP2: South African Bird Atlas Project 2
SCC: Species of Conservation Concern (see below)
SEF: Solar Energy Facility
SEI: Site Ecological Importance
Threatened: CR, EN and VU species
VP: Vantage Point
VU: Vulnerable
WEF: Wind Energy Facility
kV: Kilovolt
WT: Walk Transect
WTG: Wind Turbine Generator

Priority species: all species occurring on the Birdlife South Africa (BLSA) and Endangered Wildlife Trust (EWT) Avian Sensitivity Map priority species list[1]. This list consists of 107 species with a priority score of 170 or more. The priority score was determined by BLSA and EWT after considering various factors including bird families most impacted upon by WEFs including physical size, species behaviour, endemism, range size and conservation status.

Red Data species: Species whose regional conservation status is listed as Near Threatened, Vulnerable, Endangered or Critically Endangered in the Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland (Taylor et al. 2015)[2].

Endemic or Near-endemic: Endemic or near endemic (i.e., ~70% or more of population in RSA) to South Africa or endemic to South Africa, Lesotho and Swaziland. Taken from BLSA Checklist of Birds in South Africa, 2022.

Species of Conservation Concern (SCC): all species that are assessed according to the IUCN Red List Criteria as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) or Data Deficient (DD), as well as range-restricted species which are not declining and are nationally listed as Rare or Extremely Rare (also referred to in some Red Lists as Critically Rare)[3]. These species and subspecies are important for South Africa's conservation decision-making processes.

Target species: those particular bird species that are to be recorded by a specific survey method. Target species per survey method:

- Vantage Point (VP) Surveys: all raptors; all large (non-passerine) priority species;
- Drive Transects (DT): all raptors; all large (non-passerine) priority species;
- Walked Transects (WT): all birds;
- Incidental Observations: all raptors; all large (non-passerine) priority species.

[1] Retief, E, Anderson, M., Diamond, M., Smit, H., Jenkins, A. & Brooks, M., 2011. Avian Wind Farm Sensitivity Map for South Africa: Criteria and Procedures used. Priority species list updated in 2014 by BLSA.
[2] Taylor, M.R., Peacock, F., and Wanless, R.M., 2015. Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. Updated in 2020 by BLSA.

1 INTRODUCTION

1.1 Background

Arcus Consultancy Services South Africa (Pty) Ltd ('Arcus) was appointed to conduct an avifaunal specialist study for the proposed Ummbila Emoyeni ('UmmE') Wind Energy Facility ('WEF') and Solar Energy Facility ('SEF') located approximately 10 km south-east of the town of Bethal in the Mpumalanga Province of South Africa (Figure 1).

1.2 Project Description

The facility will have a contracted capacity of up to 666 MW and will be known as the Ummbila Emoyeni Wind Energy Facility. The project is planned as part of a larger cluster of renewable energy projects (to be known as the Ummbila Emoyeni Renewable Energy Farm), which include one 666 MW wind energy facility and one 150 MW solar PV facility. The grid connection infrastructure for both facilities will include a 400/132 kV Main Transmission Substation ('MTS'), to be located between Camden and SOL Substations, which will be looped in and out of the existing Camden-Sol 400 kV transmission line; on-site switching stations (132 kV in capacity) at each renewable energy facility (Eskom Portion); and 132 kV power lines from the switching stations at each renewable energy facility to the new 400/132 kV MTS.

1.2.1 Ummbila Emoyeni Wind Energy Facility

Emoyeni Renewable Energy Farm (Pty) Ltd is proposing the development of a commercial Wind Energy Facility ('WEF') and associated infrastructure on a site located ~6 km south-east of Bethal and 1 km east of Morgenzon, within the Mpumalanga Province. The project site is located across the Govan Mbeki, Lekwa, and Msukaligwa Local Municipalities within the Gert Sibande District on the properties listed in Table 1 below.

Table 1: Properties affected by the Ummbila Emoyeni Wind Energy Facility

Parent Farm Number	Farm Portions
Farm 261 – Naudesfontein	15, 21
Farm 264 – Geluksplaats	0, 1, 3, 4, 5, 6, 8, 9, 11, 12
Farm 268 – Brak Fontein Settlement	6,7,10,11,12
Farm 420 – Rietfontein	8,9,10,11,12,15,16,18,19,22,32
Farm 421 - Sukkelaar	2, 2, 7, 9, 9 10, 10 11, 11 12, 12, 22 ,25, 34, 35, 36, 37, 37, 38, 39, 40, 42, 42
Farm 422 – Klipfontein	0, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23
Farm 423 – Bekkerust	0, 1, 2, 4, 5, 6, 10, 11, 12, 13 14, 15, 17, 19, 20, 22, 23, 24, 25
Farm 454 – Oshoek	4, 13, 18
Farm 455 – Ebenhaezer	0, 1, 2, 3
Farm 456 – Vaalbank	1, 2, 3, 4, 7, 8, 13, 15, 16, 17, 18, 19
Farm 457 – Roodekrans	0, 1, 4, 7, 22, 23, 23
Farm 458 – Goedgedacht	0, 2, 4, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 21, 22, 25, 26, 27, 28, 29, 31, 32, 33, 34, 35, 37, 39
Farm 467 – Twee Fontein	0, 1, 4, 5, 6, 7, 8, 10
Farm 469 – Klipkraal	5, 6, 7, 8
Farm 548 – Durabel	0

Infrastructure associated with the Ummbila Emoyeni Wind Energy Facility will include:

- Up to 111 wind turbines with a maximum hub height of up to 200 m. The tip height of the turbines will be up to 300 m.
- 33 kV cabling to connect the wind turbines to the onsite collector substations ('SS'), to be laid underground where practical.
- 3 x 33 kV/132 kV Onsite Collector Substation (IPP Portion), each being 5 ha.
- Battery Energy Storage System ('BESS').

- Cabling between turbines, to be laid underground where practical.
- Construction compounds including site office (approximately 300 m x 300 m in total but split into 3 ha each of 150 m x 200 m):
    - Batching plant of up to 4 ha to 7 ha.
    - 3 x O&M office of approximately 1.5 ha each adjacent to each collector SS.
    - 3 x construction compound / laydown area, including site office of 3 ha each (150 m x 200 m each).
    - Laydown and crane hardstand areas (approximately 75 m x 120 m).
    - Access roads of 12 -13 m wide, with 12 m at turning circles.

A summary of the details and dimensions of the planned infrastructure associated with the project is provided in Table 2 below.

Table 2: Details or dimensions of typical infrastructure required for the 666 MW Ummbila Emoyeni Wind Energy Facility

Infrastructure	Footprint and dimensions
Number of turbines	Up to 111 turbines
Hub Height	Up to 200 m
Tip Height	Up to 300 m
Contracted Capacity	Up to 666 MW (individual turbines between 6 MW and 15 MW in capacity each)
Tower Type	Steel or concrete towers can be utilised at the site. Alternatively, the towers can be of a hybrid nature, comprising concrete towers with top steel sections.
Area occupied by the on-site collector substations (IPP Portion)	3 x on-site collector substations (IPP Portion) of 5 ha each
Capacity of on-site collector substations (IPP Portion)	33kV/132kV
Cabling between the turbines	Cabling will be installed underground where feasible at a depth of up to 1.5 m to connect the turbines to the on-site facility substation. Where not technically feasible to place cabling underground, this will be installed above-ground. The cabling will have a capacity of up to 33 kV.
Laydown and Operations and Maintenance (O&M) hub	~300 m x 300 m, comprising: * Batching plant of up to 7 ha * Construction compound (temporary) of approximately 6 ha. * O&M office of approximately 1.5 ha.
Access and internal roads	Wherever possible, existing access roads will be utilised to access the project site and development area. It is unlikely that access roads will need to be upgraded as part of the proposed development. Internal roads of up to 12–13 m in width will be required to access each turbine and the on-site substation.
Laydown and crane hardstand areas (at each turbine position)	~75 m x 120 m
Turbine foundation	To be determined
Grid connection	The grid connection infrastructure will include a 400/132 kV Main Transmission Substation (MTS), to be located between Camden and SOL Substations, which will be looped in and out of the existing Camden-Sol 400 kV transmission line; on-site switching stations (132 kV in capacity) at each renewable energy facility (Eskom Portion); and 132 kV power lines from the switching stations at each renewable energy facility to the new 400/132 kV MTS. The grid connection infrastructure will be assessed as part of a separate Environmental Impact Assessment process in support of an application for Environmental Authorisation.
Temporary infrastructure	Temporary infrastructure, including laydown areas, hardstand areas and a concrete batching plant, will be required during the construction phase. All temporary infrastructure will be rehabilitated following the completion of the construction phase, where it is not required for the operation phase.

1.2.2 Ummbila Emoyeni Solar Energy Facility

The Solar Energy Facility project site is located across the Govan Mbeki, Lekwa, and Msukaligwa Local Municipalities within the Gert Sibande District on the properties listed in Table 3 below.

Table 3: Properties affected by the Ummbila Emoyeni Solar Energy Facility

Parent Farm Number	Farm Portions
Farm 264 – Geluksplaats	0, 11
Farm 423 – Bekkerust	0, 1, 5, 22
Farm 420 – Rietfontein	8,9,10, 32

The facility will have a contracted capacity of up to 150 MW and will be known as the Ummbila Emoyeni Solar Energy Facility.

Infrastructure associated with the Ummbila Emoyeni Solar Energy Facility will include:

- PV modules in the range of 330 Wp to 450 Wp mounted on either a fixed tilt or single axis tracker structure, dependent on optimisation, technology available and cost.
- Inverters and transformers.
- 33 kV cabling to connect to the onsite collector substation, to be laid underground where practical.
- 33 kV/132 kV onsite collector substation (IPP Portion).
- Battery Energy Storage System (BESS).
- Cabling between project components.
- Laydown and O&M hub (approximately 300 m x 300 m):
    - Construction compound (temporary).
    - Maintenance office.
- Access roads (up to 12 m wide) and internal distribution roads (up to 12 m wide).

A summary of the details and dimensions of the planned infrastructure associated with the project is provided in Table 4 below.

Table 4: Details or dimensions of typical infrastructure required for the 150MW Ummbila Emoyeni Solar Energy Facility

Infrastructure	Footprint and dimensions
Number of Panels	To be determined
Panel Height	Up to 5 m
Technology	Use of fixed-tilt, single-axis tracking, and/or double-axis tracking PV technology. Monofacial or bifacial panels are both considered.
Contracted Capacity	Up to 150 MW
Area occupied by the solar array	To be determined
Area occupied by the on-site facility substation (IPP Portion)	~5 ha
Capacity of on-site facility substation (IPP Portion)	33 kV/132 kV
Underground cabling between the PV array and the onsite substation	Cabling will be installed underground where feasible at a depth of up to 1.5 m to connect the PV panels to the on-site facility substation. Where not technically feasible to place cabling underground, this will be installed above-ground. The cabling will have a capacity of up to 33 kV.
Laydown and Operations and Maintenance (O&M) hub	~300 m x 300 m, comprising: * Construction compound (temporary) of approximately 6 ha. * O&M office of approximately 1.5 ha.
Area occupied by laydown area	~75 m x 120 m
Access and internal roads	Wherever possible, existing access roads will be utilised to access the project site and development area. It is unlikely that access roads will need to be upgraded as part of the proposed development. Internal roads of up to 12–13 m in width will be required to access the PV panels and the on-site substation.
Grid connection	The grid connection infrastructure will include a 400/132 kV Main Transmission Substation (MTS), to be located between Camden and SOL Substations, which will be looped in and out of the existing Camden-Sol 400 kV transmission line; on-site switching stations (132 kV in capacity) at each renewable energy facility (Eskom Portion); 132 kV power lines from the switching stations at each renewable energy facility to the new 400/132 kV MTS; and a collector substation with 2 x 132 kV bus bars and 4 x 132 kV IPP feeder bays to onsite IPP Substation The grid connection infrastructure will be assessed as part of a separate Environmental Impact Assessment process in support of an application for Environmental Authorisation.

Infrastructure	Footprint and dimensions
Temporary infrastructure	Temporary infrastructure, including laydown areas, hardstand areas and a concrete batching plant, will be required during the construction phase. All areas affected by temporary infrastructure will be rehabilitated following the completion of the construction phase, where it is not required for the operation phase.

1.2.3 Ummbila Electrical Grid Infrastructure

Emoyeni Renewable Energy Farm (Pty) Ltd is proposing the development of Electrical Grid Infrastructure ('EGI') to support the Ummbila Emoyeni Renewable Energy Farm (which will comprise a 666 MW Wind Energy Facility and a 150 MW Solar Energy Facility), which aims to export energy to the national electricity grid. The project is located ~6 km south-east of Bethal and 1 km east of Morgenzon, within the Mpumalanga Province on the properties listed in Table 5 below.

Table 5: Properties affected by the Ummbila Emoyeni Electrical Grid Infrastructure

Parent Farm Number	Farm Portions
Farm 261 – Naudesfontein	15, 21
Farm 264 – Geluksplaats	0, 1, 3, 4, 5, 6, 8, 9, 11, 12
Farm 268 – Brak Fontein Settlement	6,7,10,11,12
Farm 420 – Rietfontein	8,9,10,11,12,15,16,18,19,22,32
Farm 421 - Sukkelaar	2, 2, 7, 9, 9 10, 10 11, 11 12, 12, 22 ,25, 34, 35, 36, 37, 37, 38, 39, 40, 42, 42
Farm 422 – Klipfontein	0, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23
Farm 423 – Bekkerust	0, 1, 2, 4, 5, 6, 10, 11, 12, 13 14, 15, 17, 19, 20, 22, 23, 24, 25
Farm 454 – Oshoek	4, 13, 18
Farm 455 – Ebenhaezer	0, 1, 2, 3
Farm 456 – Vaalbank	1, 2, 3, 4, 7, 8, 13, 15, 16, 17, 18, 19
Farm 457 – Roodekrans	0, 1, 4, 7, 22, 23, 23
Farm 458 – Goedgedacht	0, 2, 4, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 21, 22, 25, 26, 27, 28, 29, 31, 32, 33, 34, 35, 37, 39
Farm 467 – Twee Fontein	0, 1, 4, 5, 6, 7, 8, 10
Farm 469 – Klipkraal	5, 6, 7, 8
Farm 548 – Durabel	0

The grid connection infrastructure will include:

- A new 400/132 kV Main Transmission Substation (MTS), to be located on the Camden SOL Lines.
- Two 400 kV loop-in loop-out power lines to the existing Camden-Sol 400 kV transmission line.
- On-site switching stations (Eskom Portion) (132 kV in capacity) at each renewable energy facility.
- Collector substation with 2 x 132 kV bus bars and 4 x 132 kV IPP feeder bays to onsite IPP SSs.
- 132 kV power lines from the switching stations to a new MTS.
- Access roads up to 8m wide.

A summary of the details and dimensions of the planned infrastructure associated with the project is provided in Table 6 below.

Infrastructure	Footprint and dimensions
Onsite substations (Eskom Portion)	Development footprint: 4 IPP collector substations of 5 ha each • Capacity: 33 kV/132 kV
Collector Substation	Collector substation with 2 x 132 kV bus bars and 4 x 132 kV IPP feeder bays to onsite IPP substation.

Infrastructure	Footprint and dimensions
132 kV power lines	• Servitude width: 18 m • Height: up to 40 m • Length: To be determined • Corridor width for assessment 300 m
Main Transmission Substation	• Development footprint: 600 m x 600 m • Capacity: 400/132 kV • Height: Up to 30 m
Power line connection to national grid	• Capacity and circuit: 400 kV loop-in loop-out • Servitude: 55 m per line • Height: Up to 40 m • Corridor width for assessment: 300 m
Height of the power line towers (pylons)	40 m
Access and internal roads	Access will likely be via the main road between Bethal and Morgenzon. This is the R35, a tarred and provincial road. Existing roads on the affected properties will be used where feasible and practical to provide direct access to the EGI. Where necessary, new access roads (up to 12 wide) will be established to provide access to the Main Transmission Substation (MTS). During construction, a permanent access road along the length of the power line corridor (300 m wide) between 4–6m wide will be established to allow for large crane movement. This track will then be utilised for maintenance during operation.
Temporary infrastructure	Temporary infrastructure, including laydown areas and a concrete batching plant, will be required during the construction phase. All temporary infrastructure will be rehabilitated following the completion of the construction phase, where it is not required for the operation phase.

The route of the overhead power line corridor will be assessed in a separate report as the proposed routes were not available at the time of the compilation of this report.

1.3 Study Area Description

1.3.1 Regional Context

The proposed development site falls within a gently to moderately undulating landscape on the Highveld plateau that has been extensively modified through agricultural practices with some remaining natural patches of dense, tufted grassland classified as Soweto Highveld Grassland (Figure 1). The Amersfoort-Bethal-Carolina (SA018) Important Bird and Biodiversity Area ('IBA') is a large IBA is bounded by the roads connecting Bethal, Carolina, Ermelo and Amersfoort (Figure 1, insert). The proposed development area is largely located within this IBA.

1.3.2 Local Context

A large portion of the proposed development site has been transformed through agricultural practices such as ploughed maize fields as well as cattle and small stock grazing, which occurs throughout. Available avifaunal habitats also include watercourses and drainage lines cross the site with several wetlands and man-made farm dams under various degrees of existing impact and transformation from farming practices. Unploughed grassland areas have been considered to be in a natural or near-natural state of function for avifauna even if utilised for low density grazing (Figure 2).

1.4 Terms of Reference

This report was developed to align with Government Gazette 43110 (GN. 320) "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 20 Megawatts or more" dated 20 March 2020 ('The

Protocol'), the Species Environmental Assessment Guideline[3] and the Birds and Wind-Energy Best-Practice Guidelines[4] and the requirements prescribed therein. The Protocol generally exceeds the assessment and reporting requirements for Solar PV Facilities and grid connection infrastructure with respect to avifauna. This report also takes into consideration the National Environment Management Act, 1998 (NEMA) (Act 107 0f 1998).

The aims of the study were to:

- Describe the study area and map avifaunal aspects identified during the site investigation;
- Describe and map (where relevant) the methodology used to undertake the site-specific pre-application avifauna monitoring programme;
- Present the outcomes of the reconnaissance study and resultant site-specific pre-application avifaunal monitoring, including:
    - Bird abundance and movement within the preferred site;
    - Presence of target species and Species of Conservation Concern ('SCCs'), their occurrence across the site and heights which could pose collision risks; and
    - Identification of preferential bird routes or corridors.
- Present an avifaunal sensitivity map of the preferred site indicating areas to be avoided;
- Assess, predict and discuss the expected impact and fatality risk for target and general avifaunal species of the proposed development on the preferred site;
- Provide recommended mitigation measures to reduce the potential impact on avifauna;
- Map and assess the cumulative impact of existing (or potential) renewable energy facilities within a 30 km radius of the preferred site;
- Provide a substantiated statement indicating the acceptability (or not) of the proposed development on the preferred site from an avifaunal perspective; and
- Provide details of the applicable post-construction monitoring programme.

2 METHODS

The Protocol indicates that a site-specific Avifaunal Specialist Assessment be undertaken for *all sensitivity ratings* provided by the National Web-based Screening Tool, as the present level of knowledge on bird behaviour and species population precludes confident predictions on the sustainability of priority or threatened species nationally.

The process for undertaking the Avifaunal Impact Assessment therefore comprised:

- A Reconnaissance Study including:
    - Desktop Study; and
    - Initial Site Visit.
- The preparation of a Pre-Application Avifaunal Monitoring Plan ('PAAMP');
- Seasonal Pre-Application Avifaunal Monitoring Data collection; and
- The Avifaunal Specialist Assessment and Reporting.

2.1 Reconnaissance Study

2.1.1 Desktop Study

The desktop study included data obtained from the following sources:

[3] South African National Biodiversity Institute (SANBI). 2020. Species Environmental Assessment Guideline. Guidelines for the implementation of the Terrestrial Fauna and Terrestrial Flora Species Protocols for environmental impact assessments in South Africa. South African National Biodiversity Institute, Pretoria. Version 2.1 2021.

[4] Jenkins, A.R., van Rooyen, C.S., Smallie, J.J., Harrison, J.A., Diamond, M., Smit-Robinson, H.A. and Ralston, S. 2015. Birds and Wind-Energy Best-Practice Guidelines: Best-Practice Guidelines for assessing and monitoring the impact of wind-energy facilities on birds in southern Africa. Third Edition. BirdLife South Africa / Endangered Wildlife Trust.

- Broad vegetation types present on the project site were obtained from the updated National Vegetation Map 2018 (NVM 2018) database[5] and the vegetation descriptions were obtained from Mucina & Rutherford (2006)[6];
- Bird distribution data of the Southern African Bird Atlas Project 2 (SABAP2) obtained from the Avian Demography Unit of the University of Cape Town[7];
- Co-ordinated Avifaunal Road Count (CAR) project[8];
- Co-ordinated Water-bird Count (CWAC) project[9];
- The Important Bird Areas of southern Africa (IBA) project[10];
- Output from the National Web-based Screening Tool[11] ('Screening Tool');
- Habitat suitability maps compiled by BirdLife South Africa;
- Desk-top pre-screening study of possible impacts on birds of the proposed Ummbila Emoyeni Wind Farm in the Ermelo area of Mpumalanga, South Africa. Avisense Consulting, June 2020[12].
- Publically available satellite imagery; and
- The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland[13].

2.1.2 Initial Site Visit

- Date: 2021-05-26 to 2021-05-29
- Duration: 2 days.
- Season: Autumn.
- Season Relevance: The site inspection was timed to coincide with the expected presence of avifaunal SCCs of relevance to WEFs, particularly Black Harrier, and was sufficient to determine the current land-use in the area as well as the identification of suitable vantage points (VPs) for the avifaunal monitoring programme.

2.2 Pre-Application Avifaunal Monitoring Programme

The resultant site-specific pre-application monitoring programme included the identification of twelve suitable VPs across the preferred site as well as two VPs at a suitable control site. VPs were selected to maximize their viewshed coverage across the site and available habitat types. Five Drive Transects (DT 1 = 8.59 km, DT 2 = 27.2 km, DT 3 = 25.8 km, DT 4 = 13.1 km and DT 5 = 13.2 km) were located across the site and 15 walk transects of 500 m in length were identified to cover different vegetation and habitat types across the site (Figure 1). Transects were conducted twice each per survey.

As the Reconnaissance Study did not indicate that the area is of particular importance for species such as Black Harrier, Cape Vulture or Verreaux's Eagle, it was assumed that the species-specific guidelines for those species need not apply. Vantage points were therefore monitored for 12 hours per season and conducted once per season to account for variability in the utilisation of the site by various avifaunal species. This resulted in 48 hours of VP

[5] South African National Biodiversity Institute (2006-2018). The Vegetation Map of South Africa, Lesotho and Swaziland, Mucina, L., Rutherford, M.C. and Powrie, L.W. (Editors), Online, http://bgis.sanbi.org/Projects/Detail/186, Version 2018 accessed January 20 2020.

[6] Mucina, L. and Rutherford, M.C. (eds) 2006. The vegetation of South Africa, Lesotho and Swaziland, in Strelitzia 19. South African National Biodiversity Institute, Pretoria.

[7] http://sabap2.birdmap.africa/ Accessed 17 June 2021.

[8] Young, D.J., Harrison, J.A, Navarro, R.A., Anderson, M.A., & Colahan, B.D. (Eds). 2003. Big birds on farms: Mazda CAR Report 1993-2001. Avian Demography Unit: Cape Town.

[9] Taylor, P.B., Navarro, R.A., Wren-Sargent, M., Harrison, J.A. & Kieswetter, S.L. 1999. Coordinated waterbird Counts in South Africa, 1992-1997. Avian Demography Unit, Cape Town.

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

[11] https://screening.environment.gov.za/

[12] Unpublished report prepared for Windlab Developments South Africa (Pty) Ltd.

[13] Taylor, M.R., Peacock, F., and Wanless, R.M. 2015. Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland.

monitoring per VP over the monitoring period. Pre-application avifaunal monitoring surveys included the periods when Black Harrier were expected to be in the area (i.e. April 2022) as recommended by the monitoring plan.

All avifaunal surveys were conducted by experienced bird observers operating in pairs. VPs were conducted in 360 degrees through visual means using 10 x 42 binoculars. Flight heights were estimated and assigned to broad height categories: 1 = < 20 m, 2 = 20 – 70 m, 3 = 70 – 160 m, 4 = 160 – 280 m, 5 > 280 m at 15 sec intervals. Drive transects were conducted from a vehicle driving ~20 km/h and stopping at regular intervals to scan the landscape for target species. GPS locations were captured using a Garmin eTrex10. Walk transects were conducted by recording all bird species seen or heard within a perpendicular distance of 150 m along a 500 m transect. Bird observers were familiar with lark species and their identification and were instructed to pay particular attention to their positive identification given the possibility of several important lark species to be present.

Avisense (2020) noted that the potential presence of these species in the area would largely depend on the level of habitat modification present on the site and suggested that any vestigial areas of open Highveld grassland that might still remain could support small populations of these species and recommended that these areas be surveyed, particularly from September/October into mid-summer to coincide with the peak during breeding/display period when the birds are at their most conspicuous. Surveys were therefore timed accordingly and a survey was conducted in September/October 2021.

The first pre-application avifaunal monitoring survey was conducted between the 04th and 14th August 2021 (winter). The second was conducted in two parts, between 21st September 2021 and 30 September 2021 and between 21st October 2021 and 31st October 2021 (spring). This strategy was employed to increase the number of days observers spent on the preferred site and likelihood of recording seasonal variation/breeding behaviour of certain species (e.g. larks). The third was conducted between 07th January 2022 and 17th January 2022 (summer). The fourth was conducted between 01st April 2022 and 22nd April 2022 (autumn), again to increase the likelihood of recording certain species (e.g. Black Harrier).

2.3 Avifaunal Sensitivity

2.3.1 Habitats

Prior to the analysis of pre-application avifaunal monitoring data, the relevant avifaunal aspects of the preferred site and Site Ecological Importance ('SEI') were determined for each species through the combination of various attributes (e.g. conservation importance) and consideration of site-specific factors (e.g. land-use, habitat functionality etc.) in combination with the nature of the potential impacts associated with the proposed development. The primary output of this exercise was a map identifying the relative site ecological importance of broader preferred habitats of relevant species across the preferred site (Figure 3) to inform the avifaunal sensitivity following the analysis of pre-application monitoring data, and ultimately the avifaunal impact assessment.

The highest calculated SEI corresponding with each habitat/land-use category that represented the preferred habitats used by each species was mapped. This effectively resulted in the initial identification of wetland environments to be of Very High avifaunal SEI, natural grasslands to be of High avifaunal SEI and agricultural/cultivated fields to be of Very Low avifaunal SEI. Wetland environments were buffered by 100 m for classification.

2.3.2 Flight Activity

Observed flight sensitivity was determined by creating a Grid Cell Sensitivity Score (GCSS), falling within either a Low, Medium, Medium-High or High classification for a 200 m x 200

m grid covering the preferred site. The GCSS was derived by analysing the following characteristics of all mapped priority species and raptors flight lines passing through each grid cell:

- Priority species score and the number of individuals associated with each flight line;
- Risk height factor, which considered if the flight was within the Rotor Swept Height;
- The duration of the flight; and
- The length of the flight.

These factors were considered in the following equation to determine a Flight Section Sensitivity Score (FSSS), for each section of flight within a grid cell. The GCSS is the sum of these flight sections within the grid cell, giving a sensitivity score specific to the cell.

$$\mathbf{FSSS = PSS \times N \times (X/Y \times D) \times (P+1)}$$

Where:

- PSS is the Priority Species Score (Retief et al. 2011, updated 2014).
- N is the number of birds that are associated with the flight line.
- X is the length of the flight line section that is within a particular Grid Square.
- Y is the length of the whole flight line.
- D is the duration of the whole flight.
- P is the proportion of the flight line at Risk Height.

The resultant GCSS scores were categorised as follows: Low (0.1 – 15,000); Medium (15 000 – 40 000); Medium-High (40 000 – 110 000); and High (> 110 000). Grid cells classified as Medium-High and High were considered to be preferential movement corridors in areas of elevated risk and therefore buffered by 200 m. A large farm dam with open water, known to attract Greater Flamingo was buffered by 1 000 m, as was a tree-line in which Secretarybird was observed perching. While no nest structure was directly observed the precautionary principle was applied based on the body of observational records made for this species.

2.4 Impact Assessment Rating System

Significance ratings of the potential impacts was determined following the methods outlined in Appendix A. The impact assessment is to consider the results of the pre-application avifaunal monitoring programme in the context of the receiving environment, the conservation status of the species observed/expected, the susceptibility of species to the potential impacts and the species' utilisation of the proposed development site.

3 RESULTS

3.1 Assumptions and Limitations

Many areas of South Africa have not been well studied, with the result that the species lists derived for an area do not always adequately reflect the actual species present at a site. To address this potential limitation database searches were extended well beyond the proposed development site.

The preferred site is characterised by gentle undulations with limited areas of elevation to provide extensive viewsheds. The standard approach used to survey the avifaunal baseline relying primarily on VPs was therefore considered to be impractical given the site-specific context. As large portions of the preferred site are largely homogenous in terms of available avifaunal habitat, VP locations were selected to maximise the number of viewsheds to include the full suite of available habitats, with a bias towards more important avifaunal features. Drive transects were positioned to provide coverage of areas outside of direct viewsheds to address this limitation as it allowed for regular surveys of both depressions

and elevated viewpoints over a larger area. Similarly, the VP schedule was designed to increase the time spent travelling through these areas to increase the likelihood of incidental records being made outside of formal survey periods. During site investigation this was considered to be the most appropriate course of action given that a number of the potential SCCs relevant to the proposed development area are largely terrestrial foragers likely to spend the bulk of their time standing in the grasslands, fields and wetlands. To further address this limitation; there was an assumption that the areas selected for VPs monitoring would likely represent areas of highest avifaunal activity across the site and therefore the assessment would be based off a 'worst-case scenario' in terms of avifaunal activity. The strategy provided a good representation of the avifaunal community in the receiving environment, allowed for the identification of areas with elevated avifaunal sensitivity and a good understanding of the utilisation of the preferred site by birds, particularly SCCs. This, combined with the precautionary principal followed, resulted in the avifaunal specialist having a high level of confidence in the validity of the impact assessment as well as the identification and efficacy of recommended mitigation measures to further reduce the potential impacts of the proposed development to avifauna.

The Reconnaissance Study did not identify Cape Vulture as having a high likelihood of being present in the study area, however a single Cape Vulture flight was recorded during the pre-application monitoring programme. This record was unexpected and the species is assumed to only be an infrequent visitor to the area. The very low passage rate and the high altitude of the single flight recorded indicates that the proposed development would pose a low risk to this species.

3.2 Avifaunal Baseline

3.2.1 Reconnaissance Study and Site Investigation

Detailed results of the Reconnaissance Study were presented in the Scoping Report. A list of Threatened, Near-Threatened, Endemic/Near-endemic and Priority Species was consolidated from the results of the desktop study and initial site investigation as potential impact receptors of the proposed development. The resultant list identified 45 potential avifaunal species in the area of particular relevance to the proposed development (Appendix C). However, several of these were not considered likely to occur within the preferred site itself. For example, Botha's Lark, Rudd's Lark and Yellow-breasted Pipit were not listed by the Screening Tool despite habitat suitability layers for those species existing in the Screening Tool. This indicated that the habitat suitability for those species is likely to be low across the preferred site and they are unlikely to be present. Avifaunal monitoring nevertheless included surveys designed to increase the likelihood of locating these species if they were present across the proposed development site.

The site investigation also identified several current, existing impacts already present across the preferred site. These included highly modified ploughed agricultural fields, road networks and areas used for various levels of livestock grazing. Some areas of overgrazing and subsequent erosion are present, channelling water and draining smaller wetlands that would otherwise have existed. Relatively high levels of disturbance exist across the project site associated with the regular use of agricultural machinery required for commercial crop production, this not only includes the operational farmland but remaining areas of natural or near-natural habitat surrounded by crops. Man-made farm dams are scattered throughout and impede the natural flow of water, but provide habitat for species attracted to these features.

3.2.2 Pre-application Avifaunal Monitoring

A total of 26 target species were recorded during VP monitoring over the pre-application monitoring period, during which time 405 flight paths were recorded, comprising 1502 birds

(Table 1). The majority of flight paths were recorded during the summer monitoring period (213 flights comprising 1007 birds). A total of 93 flights (286 birds), 49 flights (107 birds) and 50 flights (102 birds) were recorded during winter, spring and autumn surveys respectively. This translated into average passage rates ranging from 7.35 birds/hour at VP2, to 0.46 birds/hour at VP5 (Table 2, Figure 4). The maximum passage rate recorded was 24.67 birds/hour at VP2 during summer (Table 3). The elevated passage rates recorded were due to large flocks of White Stork, Southern Bald Ibis, Black-winged Pratincole and Amur Falcon recorded during the summer months (Table 1). The highest average passage rate per species was recorded for Southern Bald Ibis at VP1 (3.98 birds/hour) and VP2 (3.52 birds/hour, Table 3).

Table 1: Total number of flight paths and birds (in parentheses) recorded per species per season of pre-application avifaunal monitoring. It must be noted that the number of birds does not necessarily represent the number of unique individuals in an area but rather an indication of flight activity as the same individual may have been recorded on multiple occasions.

Species	Winter (S1)	Spring (S2)	Summer (S3)	Autumn (S4)	Total
African Harrier-hawk	1 (1)	-	2 (2)	1 (1)	**4 (4)**
Amur Falcon	-	-	37 (162)	-	**37 (162)**
Black Sparrowhawk	2 (2)	-	6 (6)	2 (2)	**10 (10)**
Black-chested Snake-eagle	-	-	3 (3)	-	**3 (3)**
Black-winged Kite	36 (55)	23 (25)	30 (34)	23 (35)	**112 (149)**
Black-winged Pratincole	-	-	7 (117)	-	**7 (117)**
Blue Crane	2 (6)	1 (2)	4 (7)	4 (15)	**11 (30)**
Blue Korhaan	-	-	-	4 (8)	**4 (8)**
Cape Vulture	-	-	1 (1)	-	**1 (1)**
Common Buzzard	-	3 (3)	31 (33)	-	**34 (36)**
Greater Kestrel	5 (7)	-	9 (10)	-	**14 (17)**
Grey-crowned Crane	-	1 (2)	-	-	**1 (2)**
Grey-winged Francolin	-	1 (1)	-	-	**1 (1)**
Lanner Falcon	3 (5)	3 (4)	7 (9)	1 (1)	**14 (19)**
Marsh Owl	4 (6)	-	-	2 (2)	**6 (8)**
Martial Eagle	1 (1)	-	1 (1)	1 (1)	**3 (3)**
Montagu's Harrier	-	1 (1)	8 (8)	-	**9 (9)**
Northern Black Korhaan	7 (21)	6 (10)	4 (10)	-	**17 (41)**
Pallid Harrier	-	-	5 (5)	-	**5 (5)**
Peregrine Falcon	-	-	-	1 (1)	**1 (1)**
Rock Kestrel	6 (6)	-	1 (1)	1 (1)	**8 (8)**
Secretarybird	2 (3)	5 (7)	8 (11)	5 (6)	**20 (27)**
Southern Bald Ibis	21 (170)	4 (51)	17 (335)	5 (29)	**47 (585)**
Spotted Eagle-owl	1 (1)	-	-	-	**1 (1)**
White Stork	-	-	31 (251)	-	**31 (251)**
Yellow-billed Kite	2 (2)	1 (1)	1 (1)	-	**4 (4)**
Total	**93 (286)**	**49 (107)**	**213 (1007)**	**50 (102)**	**405 (1502)**

Flights and foraging activity of Southern Bald Ibis was largely concentrated towards the northern section of the preferred site as was White Stork (Figure 5). Martial Eagle were only recorded on three occasions across the site and a single record of Cape Vulture was made, albeit well above Rotor-swept Height ('RSH').

Table 2: Average Passage Rate (birds/hour) recorded per Vantage Point during full the Pre-Application Avifaunal Monitoring period.

Vantage Point No.	Winter (S1)	Spring (S2)	Summer (S3)	Autumn (S4)	Total
1	0.92	0.00	20.67	0.50	**5.52**
2	0.42	0.25	24.67	4.08	**7.35**
3	4.00	0.50	21.08	0.50	**6.52**
4	1.50	0.08	3.50	0.42	**1.38**
5	0.42	0.25	0.83	0.33	**0.46**
6	1.17	0.67	0.25	0.33	**0.60**
7	0.67	0.17	1.33	0.50	**0.67**
8	0.58	0.33	0.92	0.08	**0.48**
9	1.67	0.08	4.83	0.33	**1.73**
10	7.17	4.50	1.75	0.50	**3.48**
11	4.58	0.67	0.67	0.00	**1.48**
12	0.17	0.83	1.58	0.17	**0.69**
CVP1	0.58	0.42	1.50	0.08	**0.65**
CVP2	0.00	0.17	0.33	0.67	**0.29**

Table 3: Average Passage Rate (birds/hour) recorded per Species during the full Pre-Application Avifaunal Monitoring Period.

Species	Vantage Point													
	1	2	3	4	5	6	7	8	9	10	11	12	CVP 1	CVP 2
African Harrier-hawk	-	-	-	0.02	-	-	-	0.02	-	-	0.02	0.02	-	-
Amur Falcon	0.02	**1.90**	0.04	0.25	-	-	0.04	-	0.46	0.38	0.04	0.19	0.06	-
Black Sparrowhawk	0.02	0.06	-	0.06	-	-	0.04	-	-	-	-	0.02	-	-
Black-chested Snake-eagle	-	-	-	-	-	-	-	-	0.04	-	0.02	-	-	-
Black-winged Kite	0.08	0.48	0.13	0.08	0.29	0.27	0.15	0.21	0.40	0.13	0.21	0.27	0.27	0.18
Black-winged Pratincole	-	-	**2.27**	-	0.02	-	0.13	-	0.02	-	-	-	-	-
Blue Crane	0.21	0.13	0.06	-	-	-	-	-	0.15	0.04	-	0.04	-	-
Blue Korhaan	-	0.02	-	-	-	-	0.04	-	0.04	-	-	-	-	0.08
Cape Vulture	-	-	-	-	-	-	0.02	-	-	-	-	-	-	-
Common Buzzard	0.02	0.08	0.02	-	0.13	-	0.04	0.13	0.06	0.02	0.02	0.10	0.08	0.05
Greater Kestrel	-	-	0.13	-	-	-	-	-	0.21	-	-	-	0.02	-
Grey-crowned Crane	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-
Grey-winged Francolin	-	0.02	-	-	-	-	-	-	-	-	-	-	-	-
Lanner Falcon	-	-	0.04	0.10	-	0.04	0.02	-	0.17	0.02	-	-	-	-
Marsh Owl	-	0.02	0.10	-	-	0.02	-	-	-	-	-	-	0.02	-
Martial Eagle	-	-	-	0.02	-	-	0.02	0.02	-	-	-	-	-	-
Montagu's Harrier	0.04	-	0.04	0.06	-	-	-	-	0.04	-	-	-	-	-
Northern Black Korhaan	-	0.06	0.04	0.38	-	0.13	0.13	-	-	0.04	-	-	0.08	-
Pallid Harrier	0.04	0.02	-	0.02	-	-	0.02	-	-	-	-	-	-	-
Peregrine Falcon	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-
Rock Kestrel	-	0.02	0.10	-	-	-	-	-	0.04	-	-	-	-	-
Secretarybird	-	0.15	-	0.06	-	0.02	0.02	-	0.02	0.02	0.10	0.04	0.08	0.05
Southern Bald Ibis	**3.98**	**3.52**	0.65	-	-	0.13	-	-	-	**2.83**	1.06	-	0.02	-
Spotted Eagle-owl	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-
White Stork	**1.04**	0.88	**2.85**	0.29	-	-	-	0.08	0.08	-	-	-	-	-
Yellow-billed Kite	0.02	-	-	0.02	0.02	-	-	0.02	-	-	-	-	-	-
Total	**5.52**	**7.35**	**6.52**	1.38	0.46	0.60	0.67	0.48	1.73	**3.48**	1.48	0.69	0.65	0.36

A total of 72 observations of 18 target species (comprising 235 birds) were recorded during 703.12 km of drive transect observations, with Southern Bald Ibis representing the highest number of records, frequently encountered along DT1 (Table 4) particularly in the north of the preferred site foraging in a mixture of modified and natural habitat (Figure 4). A number of Greater Flamingo were observed along DT3 in a larger farm dam with open water. Blue Korhaan records were associated with areas of natural or near-natural vegetation and Secretarybird were recorded on multiple occasions towards the centre of the preferred site (Figure 4). Secretarybird were observed perched in a tree-line and while no nest structure was located, this area has been buffered as it appears to be relatively central to the incidental and transect records made for this species in that area.

Table 4: Species and Number of Individuals Recorded During Drive Transects, Each Conducted Twice Per Survey Across the Full Pre-Application Avifaunal Monitoring Period.

Species	DT 1	DT 2	DT 3	DT 4	DT 5	Total
African Fish Eagle	1					**1**
African Spoonbill	2					**2**
Amur Falcon			3	2		**5**
Black Sparrowhawk	2					**2**
Black-winged Kite	1	10	11	6		**28**
Blue Crane				2		**2**
Blue Korhaan	8		2			**10**
Common Buzzard			5	3		**8**
Greater Flamingo	4		30			**34**
Greater Kestrel		1				**1**
Grey-winged Francolin	13					**13**
Lanner Falcon				2	1	**3**
Marsh Owl		2		1		**3**
Montagu's Harrier				1		**1**
Rock Kestrel			1	1		**2**
Secretarybird		3	1	1		**5**
Southern Bald Ibis	92				21	**113**
White Stork				2		**2**
Total	**123**	**16**	**53**	**21**	**22**	**235**

A total of 102 species (5 805 birds) were recorded during the walk transects conducted across the full pre-application monitoring period (Appendix D). Red-billed Quelea accounted for 711 of these records as they are known to travel in large flocks and utilise agricultural resources. Notably, no Botha's Lark, Rudd's Lark or Yellow-breasted Pipit were recorded in the preferred site.

3.3 Avifaunal Sensitivity

Many SCCs in the broader area identified during the Reconnaissance Study as having potential to occur in the preferred site were not recorded during the full pre-application avifaunal monitoring programme. Notably no Black Harrier, African Marsh Harrier, Black Stork, Wattled Crane, African Grass Owl, Botha's Lark, Rudd's Lark or Yellow-breasted Pipit were recorded. This is likely due to the high level of existing habitat modification and existing impacts across the preferred site. Nevertheless, impacts to remaining areas of natural or near-natural habitat should be avoided or reduced as far as practically possible.

To reduce or avoid impacts on sensitive habitats such as wetland environments these areas are to be avoided where practical and flow-control measures are to be implemented to reduce potential effects of erosion or sedimentation altering the hydrology of the area. These areas are considered to have the highest avifaunal sensitivity for WTG development, as such features attract birds (such as Blue Crane, Black-winged Pratincole, Greater Flamingo, Grey-crowned Crane and waterfowl) and rivers/drainage lines are often used as movement corridors. Other patches of natural vegetation are considered to be medium sensitivity due to their overall contribution to habitat connectivity for species within the IBA and foraging areas for species such as Secretarybird, Blue Korhaan, Denham's Bustard and Black-winged Pratincole, amongst others (Figures 6 and 7).

The optimised layout of the associated infrastructure such as substations, MTS and temporary construction compounds, laydown areas and batching plants (Figure 7) are acceptable from an avifaunal perspective assuming that appropriate mitigation measures outlined by the aquatic specialist and this report (e.g. erosion control) are implemented to reduce the potential impact on aquatic ecosystems. From an avifaunal perspective, the relatively small total area of habitat destruction from permanent infrastructure associated with the proposed development is unlikely to pose a significant impact on the long-term persistence or viability of avifaunal species in the area.

The primary threat to these species is likely to rather be associated with the risk of collision fatalities, therefore areas and flights that appeared to represent preferred foraging or movement corridors for avifaunal SCCs were considered to have high avifaunal sensitivity. Species utilising the highly modified agricultural areas are likely resilient to disturbance and ongoing activity, including habitat modification. These areas are of low avifaunal sensitivity and are the preferred areas for development activities as well as permanent and temporary structures such as site buildings and lay-down areas. However, species utilising these areas, such as Southern Bald Ibis, remain at risk to collision when commuting to and from foraging areas. Flight paths that represented an elevated risk or preferred movement corridors have been considered to be of high avifaunal sensitivity and are to be avoided where possible, however WTG development in these areas is still permitted following the implementation of additional mitigation requirements. Very High sensitivity areas are no-go for the development of WTGs and blade tips are not to encroach on these areas. Linear infrastructure can traverse these areas where necessary following the implementation of appropriate mitigation measures (e.g. bird flight diverters). Development in medium sensitivity areas should be avoided and reduced wherever practically possible.

The resultant avifaunal sensitivity of the preferred site was mapped in relation to the initial development layout (Figure 6).

Several wind turbines (plus 100 m radius representing an assumed blade length) encroach on the revised areas of high avifaunal sensitivity. Note that the 100 m is a conservative blade length (blade length and not radius is the important figure) but nonetheless, these will be considered to be relocated, should it be possible to achieve the target generating output of the development within fewer wind turbines, or additional mitigation implemented as recommended in the avifaunal assessment. These include WTGs 6, 9, 11, 13, 19, 24, 26, 28, 29, 30, 32, 34, 36, 49, 52, 59, 61, 64, 82, 83, 84, 96, 100, 101. Nevertheless, all WTGs in the proposed layout avoid areas identified to be of Very High Avifaunal Sensitivity (WTG no-go) areas.

The layout was further optimised to avoid areas of elevated avifaunal sensitivity (Figure 7) resulting in the relocation of six WTGs to lower sensitivity areas. The optimised layout is preferred from an avifaunal perspective as it further reduces the potential impact and the high sensitivity areas are acceptable for the development of WTGs following the implementation of additional the mitigation measures listed below.

All WTGs in the proposed layout avoid areas identified to be of Very High Avifaunal Sensitivity (WTG No-Go) areas and the optimised layout as presented is acceptable from an avifaunal perspective.

4 IMPACT ASSESSMENT

The following key potential impacts on avifauna, arising from the proposed development of the WEF and Solar PV facilities (and associated infrastructure) have been identified for assessment.

4.1 Ummbila Emoyeni Wind Energy Facility

- Construction Phase:
  - Direct Habitat Destruction – modification, removal and clearing of vegetation for development of infrastructure such as temporary laydown areas, site buildings, WTG bases and access roads;
  - Disturbance/Displacement – indirect habitat loss and/or reduced breeding success due to displacement by noise and activity associated with machinery and construction activity; and
  - Direct Mortality – fatalities of avifauna due to vehicle collision, entrapment, entanglement or collision with temporary infrastructure (e.g. fencing), entrapment in uncovered excavations and increased predation pressure.
- Operational Phase:
  - Disturbance/Displacement – indirect habitat loss, reduced breeding success, obstruction of movement corridors due to displacement by infrastructure and noise/activity associated with ongoing, routine operational tasks/maintenance activity; and
  - Direct Mortality – fatalities of avifauna due to WTG collision, collision or entrapment with perimeter fencing, collision with internal power lines, and electrocution from electrical components.
- Decommissioning Phase:
  - As per construction phase.

4.2 Ummbila Emoyeni Solar Energy Facility

- Construction Phase:
  - Direct Habitat Destruction – modification, removal and clearing of vegetation for development of infrastructure such as temporary laydown areas, site buildings, Solar PV arrays and access roads;
  - Disturbance/Displacement – indirect habitat loss and/or reduced breeding success due to displacement by noise and activity associated with machinery and construction activity; and
  - Direct Mortality – fatalities of avifauna due to vehicle collision, entrapment, entanglement or collision with temporary infrastructure (e.g. fencing), entrapment in uncovered excavations and increased predation pressure.
- Operational Phase:
  - Direct Habitat Destruction – Contamination of habitats due to routine operational maintenance activity (e.g. cleaning of Solar PV arrays);
  - Disturbance/Displacement – indirect habitat loss, reduced breeding success, obstruction of movement corridors due to displacement by infrastructure and noise/activity associated with ongoing, routine operational tasks/maintenance activity; and

- Direct Mortality – fatalities of avifauna due collision with Solar PV arrays, collision or entrapment with perimeter fencing, collision with internal power lines, and electrocution from electrical components.

- Decommissioning Phase:
  - As per construction phase.

4.3 Ummbila Emoyeni Wind Energy Facility Assessment

4.3.1 Construction Phase

4.3.1.1 Direct Habitat Destruction

Direct habitat destruction associated with WEFs is generally low relative to the overall size of the project area. This impact is largely unavoidable, resulting in some birds being displaced from the project site.

The habitats present in the proposed development site are not unique to the site and the agricultural/natural matrix is similar throughout the broader area. The more natural or near-natural grasslands that remain in these areas are, however, under increasing pressure from various other impacts such coal mining, especially strip-mining (which is expanding rapidly in Mpumalanga), urban sprawl, commercial crop production and rangeland grazing/burning mismanagement[14].

The loss of habitat associated with clearing will not likely have a significant negative impact on the long-term viability or persistence of avifaunal species or populations in the area following the implementation of appropriate mitigation measures. Mitigation measures largely include avoiding areas of elevated sensitivity wherever possible, utilising existing access routes as far as possible and implementing appropriate erosion control measures to reduce down-stream effects of erosion, associated habitat loss, sedimentation and changes to infiltration/flow regimes.

Impact phase: Construction		
Nature: Habitat destruction due to clearing of vegetation in the development footprint for the construction of infrastructure such as temporary laydown areas, site buildings, WTG bases, servitudes and access roads. This results in loss of area available to avifaunal species for foraging and breeding.		
	Without mitigation	With mitigation
Extent	Local (2)	Footprint (1)
Duration	Long-term (4)	Short-term (2)
Magnitude	Low (4)	Minor (2)
Probability	Definite (5)	Definite (5)
Significance	**Medium (55)**	**Low (25)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Partially	
Mitigation: • Infrastructure to avoid Very High Sensitivity areas, linear infrastructure permitted; • The footprint within Medium Sensitivity areas should be minimized and avoided wherever possible;		

[14] SANBI. 2013. Grasslands Ecosystem Guidelines: landscape interpretation for planners and managers. Compiled by Cadman, M., de Villiers, C., Lechmere-Oertel, R. and D. McCulloch. South African National Biodiversity Institute, Pretoria.

• Pre-construction walk-through of the approved development footprint must be undertaken to ensure that sensitive habitats and species are avoided wherever possible; • Laydown and other temporary infrastructure to be placed within Low sensitivity areas, preferably previously transformed areas, wherever possible; • Appropriate run-off and erosion control measures are to be implemented where required; • A site specific environmental management programme (EMPr) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat (e.g. no open fires outside of designated areas); • All contractors are to adhere to the EMPr and should apply good environmental practice during construction; • All hazardous materials should be stored in the appropriate manner to prevent contamination of the site and downstream environments. Any accidental chemical, fuel and oil spills that occur at the site should be cleared as appropriate for the nature of the spill; • Existing roads and farm tracks should be used where possible; • The minimum footprint areas of infrastructure should be used wherever possible, including road widths and lengths; • No off-road driving should be permitted in areas not identified for clearing; • An Environmental Site Officer (ESO) must form part of the on-site team to ensure that the EMPr is implemented and enforced and an Environmental Control Officer (ECO) must be appointed to oversee the implementation activities and monitor compliance for the duration of the construction phase; and • Following construction, rehabilitation of areas disturbed by temporary laydown areas and facilities must be undertaken.
Residual Impacts: Habitat cleared for the construction of permanent facilities will not be available for use by many avifaunal species during the operational lifespan of the development. No long-term residual impacts are likely to negatively influence the viability or persistence of the avifaunal community of the receiving environment.

4.3.1.2 Disturbance and Displacement

Indirect loss of habitat from disturbance during the construction phase is temporary in nature and is expected to result largely from the presence of heavy machinery and increased activity of construction personnel. The remaining patches of natural or near-natural vegetation that occur across the site are already under existing levels of disturbance from agricultural activities that include the regular use of large agricultural machinery required for commercial crop production in immediately adjacent fields. Similarly, disturbance resulting from grazing of livestock occur within the natural or near-natural areas themselves and therefore it is expected that any species particularly sensitive to anthropogenic disturbance are unlikely to occur within the proposed project area through displacement by existing impacts.

In addition, the habitats present in vicinity of the proposed development are not unique to the site and are relatively widespread in the area so any displacement from the immediate vicinity that may occur will not likely incur a high energetic cost as suitable habitat is widely available nearby. The proximity of nearby suitable habitat makes it likely that species will return to areas that have not been physically altered by the proposed development once construction activity ceases.

There are no confirmed active nest locations in proximity to the proposed development site where breeding success is likely to be negatively impacted upon through disturbance or displacement during the construction phase.

Impact phase: Construction
Nature: Disturbance or displacement of birds due to increased noise and activity levels associated with construction machinery and personnel resulting in an indirect loss of habitat available for foraging

and breeding. Project area already experiences relatively high levels of regular disturbance from commercial crop production activities.

	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Very Short-term (1)	Very Short-term (1)
Magnitude	Minor (2)	Minor (2)
Probability	Low Likelihood (2)	Low Likelihood (2)
Significance	**Low (10)**	**Low (10)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	Unlikely	Unlikely
Can impacts be mitigated?	Yes	

Mitigation:

- A site specific EMPr must be implemented, which gives appropriate and detailed description of how construction activities must be conducted;
- All contractors are to adhere to the EMPr and should apply good environmental practice during construction;
- Environmental Officer to oversee activities and ensure that the site specific EMPr is implemented and enforced;
- Maximum use of existing access road and servitudes;
- Existing and novel access roads are to be suitably upgraded or constructed to prevent damage and erosion resulting from increased vehicular traffic and construction vehicles;
- No off-road driving in undesignated areas;
- Speed limits (30 km/h) should be strictly enforced on site to reduce unnecessary noise;
- Construction camps should be lit with as little light as practically possible, with the lights directed downwards where appropriate;
- The movement of construction personnel should be restricted to the construction areas on the project site;
- No dogs or cats other than those of the landowners should be allowed on site;
- The appointed Environmental Officer must be trained to identify the potential Red Data species as well as the signs that indicate possible breeding by these species;
- The Environmental Officer must then, during audits/site visits, make a concerted effort to look out for such breeding activities of SCCs (e.g. cranes, Secretarybird), and such efforts may include the training of construction staff (e.g. in Toolbox talks) to identify Red Data species, followed by regular questioning of staff as to the regular whereabouts on site of these species;
- If any avifaunal SCCs are confirmed to be breeding (e.g. if a nest site is found), construction activities within 500 m of the breeding site must cease, and an avifaunal specialist is to be contacted immediately for further assessment of the situation and instruction on how to proceed;
- Prior to construction, an avifaunal specialist should conduct a site walkthrough, covering the final road and power line routes as well as temporary laydown areas and facilities, to identify any nests/breeding/roosting activity of sensitive species;
- The results of which may inform the final construction schedule in close proximity to that specific area, including abbreviating construction time, scheduling activities around breeding activity, and lowering levels of associated noise.

Residual Impacts:

None.

4.3.1.3 Direct Mortality

Fatalities of avifaunal species can occur through collision with vehicles as traffic in the area increases due to construction activity. Large-bodied and ground dwelling species (e.g. korhaans and bustards) are at increased risk, but this impact can be effectively mitigated against. Temporary fencing can result in collisions, entrapment or entanglement if not suitably installed. Similarly ground dwelling avifauna (particularly chicks) can fall into uncovered excavations and become entrapped.

Impact phase: Construction		
Nature: Avifaunal fatalities caused by construction activity including vehicle collision (i.e. roadkill), entrapment within security fencing or uncovered excavations.		
	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Very Short-term (1)	Very Short-term (1)
Magnitude	Minor (2)	Minor (2)
Probability	Distinct Possibility (3)	Low Likelihood (2)
Significance	**Low (15)**	**Low (10)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation: • Maximum use of existing access road and servitudes; • No off-road driving in undesignated areas; • Speed limits (30 km/h) should be strictly enforced on site to reduce probability of vehicle collisions; • The movement of construction personnel should be restricted to the construction areas on the project site; • No dogs or cats other than those of the landowners should be allowed on site; • Any holes dug e.g. for foundations of pylons should not be left open for extended periods of time to prevent entrapment by ground dwelling avifauna or their young and only be dug when required and filled in soon thereafter; • Temporary fencing must be suitably constructed, e.g. if double layers of fencing are required for security purposes they should be positioned at least 2 m apart to reduce the probability of entrapment by larger bodied species that may find themselves between the two fences; • Roadkill is to be reported to the ECO and removed as soon as possible.		
Residual Impacts: None.		

4.3.2 Operational Phase

4.3.2.1 Direct Habitat Destruction

Mesic Highveld grasslands receive relatively high rainfall and habitats are sensitive to alterations of flow regimes and infiltration rates, with wetlands forming an important component for many avifaunal species in the area. Several potential risks to the long-term functioning and persistence of these environments exist which, if unmitigated, could result in the long-term degradation or permanent loss of habitats. Fortunately, the potential risks

are relatively easy to mitigate very effectively and are largely standard practice for these types of developments.

Increased runoff from hard surfaces during the operational phase (e.g. pylon bases, roads etc.) has the potential to increase the risk of habitat destruction through erosion which can alter flow regimes and water tables, drain wetland environments or increase sedimentation downstream. These potential impacts are also easy to mitigate through the appropriate use of flow and erosion control measures.

Impact phase: Operational		
Nature: Habitat destruction due to contamination or altered flow regimes impacting the water table and wetlands.		
	Without mitigation	With mitigation
Extent	Local (2)	Footprint (1)
Duration	Long-term (4)	Short-term (2)
Magnitude	High (8)	Minor (2)
Probability	Definite (5)	Improbable (2)
Significance	**High (70)**	**Low (10)**
Status (positive or negative)	Negative	Negative
Reversibility	Difficult	Yes
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Very Effectively.	
Mitigation: • Flow- and erosion control measures are to be implemented where appropriate to reduce uncontrolled runoff from hard surfaces; • The operational environmental management programme must include site specific measures for the effective management and treatment of any wastewater to be produced.		
Residual Impacts: None.		

4.3.2.2 Disturbance and Displacement

Indirect loss of habitat from disturbance during the operational phase is associated with ongoing operational activity as well as more discrete periods of routine maintenance tasks. Similar to the construction phase, the avifauna in the area already experience levels of disturbance and therefore species particularly sensitive to disturbance are unlikely to frequent the area.

Impact phase: Operational		
Nature: Disturbance or displacement of birds due to increased noise and activity levels associated with operational activities resulting in an indirect loss of habitat available for foraging and breeding. Project area already experiences relatively high levels of regular disturbance from commercial crop production activities.		
	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Very Short-term (1)	Very Short-term (1)
Magnitude	Minor (2)	Minor (2)

Probability	Low Likelihood (2)	Low Likelihood (2)
Significance	**Low (10)**	**Low (10)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	Unlikely	Unlikely
Can impacts be mitigated?	Yes	
Mitigation: • A site specific operational EMPr must be implemented, which gives appropriate and detailed description of how operational and maintenance activities must be conducted to reduce unnecessary disturbance; • All contractors are to adhere to the environmental management programme and should apply good environmental practice during all operations; and • Operational phase bird monitoring, in line with the latest available guidelines, must be implemented.		
Residual Impacts: None.		

4.3.3 Direct Mortality

4.3.3.1 Collision with Infrastructure

WEFs can cause bird fatalities through the collision of birds with moving turbine blades, the most effective mitigation for collision impacts currently available is wind farm placement, as well as specific turbine placement within a WEF to avoid high use areas[15]. Collisions with large (132 kV or above) power lines are a well-documented threat to birds in southern Africa[16,17]. Heavy-bodies birds such as bustards, cranes and waterbirds, with limited manoeuvrability, are susceptible to this impact[16]. The most common mitigation measures currently available (i.e. bird flight diverters) appear to be more effective at reducing collisions for some species (e.g. cranes) than others (e.g. bustards and korhaans)[18].

There is currently no widely accepted effective mitigation for reducing the collisions of bustards with overhead power lines, however there is some indication that bustards collide more often with mid-span areas than they do nearer the supporting pylons suggesting that they see the pylons and take avoiding action[19]. It is recommended that the overhead power line transmission corridor follows existing linear infrastructure wherever possible and that the pylons be placed in a staggered manner relative to existing pylon locations. The staggering of pylons for novel transmission infrastructure between pylons (rather than next

[15] Murgatroyd, M, Bouten, W, Amar, A. A predictive model for improving placement of wind turbines to minimise collision risk potential for a large soaring raptor. J Appl Ecol. 2020; 00: 1– 12. https://doi.org/10.1111/1365-2664.13799.

[16] van Rooyen, C.S. 2004. The Management of Wildlife Interactions with over-headlines. In The fundamentals and practice of Over-head Line Maintenance (132kV and above), pp217-245. Eskom Technology, Services International, Johannesburg.

[17] Shaw, J.M, Jenkins, A.R., Smallie, J.J & Ryan, P.G. 2010. Modelling power-line collision risk for the Blue Crane *Anthropoids paradiseus* in South Africa. Ibis 152: 590-599

[18] Shaw, J.M., Reid, T.A., Gibbons, B.K., Pretorius, M., Jenkins, A.R., Visage, R., Michael, M.D., Ryan, P.G. 2021. A large-scale experiment demonstrates that line marking reduces power line collision mortality for large terrestrial birds, but not bustards, in the Karoo, South Africa, Ornithological Applications, Volume 123, Issue 1, 1 February 2021, duaa067, https://doi.org/10.1093/ornithapp/duaa067

[19] Pallett, J., Simmons, R.E. and Brown, C.J. 2022. Staggered towers on parallel transmission lines: a new mitigation to reduce collisions of birds, especially bustards. Namibian Journal of the Environment 6: 14-21

to, i.e. in the mid-span) of adjacent transmission lines may reduce bustard collisions by ~45%[19].

The significance of this potential impact is often the most critical to understand during the assessment process and can be highly dependent on site-specific attributes, infrastructure layout and WTG positions. Notable records of Southern Bald Ibis and Secretarybird were made during pre-application avifaunal monitoring, however these are relatively localised in their utilisation of the preferred site. Prior to the implementation of mitigation measures, the probability of individual collisions of these species occurring nevertheless remains distinct. Should collisions of these species occur, however, the levels of potential collisions would likely be low given the relatively low number of flight-paths of target species recorded across the site. Therefore, even prior to the implementation of mitigation measures, low incidence of collision fatalities would not likely result in population level impacts beyond the broader area. Environmental processes are likely to continue, but in a modified way. The extent, magnitude and probability if this potential impact will be further reduced through the implementation of the mitigation hierarchy such as avoidance mitigation through informed infrastructure layouts, bird flight diverters and explicit threshold-actuated adaptive management (if required).

Impact phase: Operational		
Nature: Bird fatalities due to collision with infrastructure (WTGs and overhead power lines).		
	Without mitigation	With mitigation
Extent	Broader Area (4)	Local (3)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Highly Probable (4)	Distinct Possibility (3)
Significance	**Medium (56)**	**Medium (33)**
Status (positive or negative)	Negative	Negative
Reversibility	Partial	Partial
Irreplaceable loss of resources?	Possible	Possible
Can impacts be mitigated?	Yes	
Mitigation: • WTGs must not be constructed within any designated Very High Sensitivity (WTG no-go) areas; • Additional mitigation (as detailed below) must be implemented for WTGs placed within High and Medium sensitivity areas. • Observer-based Shut-down-on-demand or similar technology is to be implemented for all WTGs placed in High Sensitivity areas as well as those WTGs that remain within 3 000 m of VPs 1 (-26.517517; 29.543310), 2 (-26.528714; 29.584312), 3 (-26.486937; 29.604685) and 10 (-26.682103; 29.631712); • The painting (red or black) of a single blade of each WTG in these areas should be investigated and employed pending approval from the Civil Aviation Authority (CAA); • Internal power lines should be buried wherever possible; • Novel overhead power lines to be constructed adjacent to existing transmission infrastructure where possible and pylons to be staggered (where possible) relative to existing pylon positions to increase the overall visibility of transmission infrastructure to avifauna such as bustards; • Appropriate (approved) Bird flight diverters (BFDs) to be affixed to the entire length of novel overhead power lines; • If one or more avifaunal SCC carcasses are located and determined likely to have resulted from collisions with infrastructure in any sensitivity area over the lifespan of the		

facility the fatality is to be appropriately recorded and reported to an avifaunal specialist to determine the most appropriate action; • If double layers of fencing are required for security purposes they should be positioned at least 2 m apart to reduce the probability of entrapment by larger bodied species that may find themselves between the two fences; • Develop and implement a carcass search and bird activity monitoring programme in-line with the latest applicable guidelines; • Regular reviews of operational phase monitoring data (activity and carcass) and results to be conducted by an avifaunal specialist; • The above reviews should strive to identify sensitive locations including WTGs and areas of increased collisions that may require additional mitigation; • An operational monitoring programme for any novel overhead power lines must be implemented to locate potential collision fatalities; and • Any fatalities located should be reported to Birdlife South Africa (BLSA) and the Endangered Wildlife Trust (EWT).
Residual Impacts: Current mitigation measures, while effective, are not capable of completely preventing collisions and some residual impact will remain. Residual impacts will be reduced through mitigation measures and regularly monitored and reviewed to inform additional mitigation actions such as elevated levels of shut-down-on-demand or curtailment (if required). It is unlikely that the proposed development will have a significant negative impact on the long-term viability and persistence of SCCs in the area.

4.3.3.2 Electrocution

Electrocution refers to the scenario where a bird is perched or attempts to perch on energized structures and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components. Internal overhead power line infrastructure with a capacity of 132 kV or more do not generally pose a risk of electrocution due to the large size of the clearances between the electrical infrastructure components. Electrocutions are therefore more likely for larger species whose wingspan is able to bridge the gap such as eagles or vultures. Mitigation measures nevertheless remain effective at reducing the potential risk of electrocution.

Impact phase: Operational		
Nature: Avifaunal fatalities caused by electrocution from energized infrastructure.		
	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Minor (2)	Small (0)
Probability	Low Likelihood (2)	Improbable (1)
Significance	**Low (16)**	**Low (6)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation: • Internal power lines should be buried wherever possible; • All new overhead power line pylons must be of a design that minimizes electrocution risk by using adequately insulated 'bird friendly' structures, with sufficient clearances between live components to reduce the risk of electrocution for large species such as vultures and Martial Eagle;		

• An operational monitoring programme for the overhead power line route must be implemented to locate potential collision fatalities; and • Any fatalities located should be reported to Birdlife South Africa (BLSA) and the Endangered Wildlife Trust (EWT). • Prevent birds from nesting in substation infrastructure through exclusion covers or spikes if required (determined on a case-by-case basis).
Residual Impacts: None.

4.4 Ummbila Emoyeni Solar Energy Facility

4.4.1 Construction Phase

4.4.1.1 Direct Habitat Destruction

The removal and/or destruction and/or alteration of habitat during the construction phase is potentially the most significant impact associated with solar PV developments as the vegetation within the development footprint is cleared for the installation of the solar PV arrays. This could result in the exclusion of several species from the development footprint for the duration of the operation of the facility. Contamination of the immediate and local downstream environment could occur through leaks or spills of hazardous material.

The habitats present in the proposed development site are not unique to the site and the agricultural/natural matrix is similar throughout the broader area. The more natural or near-natural grasslands that remain in these areas are, however, under increasing pressure from various other impacts such coal mining, especially strip-mining (which is expanding rapidly in Mpumalanga), urban sprawl, commercial crop production and rangeland grazing/burning mismanagement[14].

The loss of habitat associated with clearing will not likely have a significant negative impact on the long-term viability or persistence of avifaunal species or populations in the area following the implementation of appropriate mitigation measures. Mitigation measures largely include avoiding areas of elevated sensitivity wherever possible, utilising existing access routes as far as possible and implementing appropriate erosion control measures to reduce down-stream effects of erosion, associated habitat loss, sedimentation and changes to infiltration/flow regimes.

Impact phase: Construction		
Nature: Habitat destruction due to clearing of vegetation in the development footprint for the construction of infrastructure such as solar PV arrays, temporary laydown areas, site buildings, servitudes and access roads. This results in loss of area available to avifaunal species for foraging and breeding.		
	Without mitigation	With mitigation
Extent	Local (2)	Footprint (1)
Duration	Long-term (4)	Short-term (2)
Magnitude	Low (4)	Minor (2)
Probability	Definite (5)	Definite (5)
Significance	**Medium (55)**	**Medium (35)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	No	No

Can impacts be mitigated?	Partially

Mitigation:

- Infrastructure to avoid Very High Sensitivity areas;
- The footprint within High and Medium Sensitivity areas should be minimized and avoided wherever possible;
- Pre-construction walk-through of the approved development footprint must be undertaken to ensure that sensitive habitats and species are avoided wherever possible;
- Laydown and other temporary infrastructure to be placed within Low sensitivity areas, preferably previously transformed areas, wherever possible;
- Appropriate run-off and erosion control measures are to be implemented where required;
- A site specific environmental management programme (EMPr) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat (e.g. no open fires outside of designated areas);
- All contractors are to adhere to the EMPr and should apply good environmental practice during construction;
- All hazardous materials should be stored in the appropriate manner to prevent contamination of the site and downstream environments. Any accidental chemical, fuel and oil spills that occur at the site should be cleared as appropriate for the nature of the spill;
- Existing roads and farm tracks should be used where possible;
- The minimum footprint areas of infrastructure should be used wherever possible, including road widths and lengths;
- No off-road driving should be permitted in areas not identified for clearing;
- An Environmental Site Officer (ESO) must form part of the on-site team to ensure that the EMPr is implemented and enforced and an Environmental Control Officer (ECO) must be appointed to oversee the implementation activities and monitor compliance for the duration of the construction phase; and
- Following construction, rehabilitation of areas disturbed by temporary laydown areas and facilities must be undertaken.

Residual Impacts:

Habitat cleared for the construction of permanent facilities will not be available for use by many avifaunal species during the operational lifespan of the development. No long-term residual impacts are likely to negatively influence the viability or persistence of the avifaunal community of the receiving environment.

4.4.1.2 Disturbance and Displacement

Indirect loss of habitat from disturbance during the construction phase is temporary in nature and is expected to result largely from the presence of heavy machinery and increased activity of construction personnel. The remaining patches of natural or near-natural vegetation that occur across the site are already under existing levels of disturbance from agricultural activities that include the regular use of large agricultural machinery required for commercial crop production in immediately adjacent fields. Similarly, disturbance resulting from grazing of livestock occur within the natural or near-natural areas themselves and therefore it is expected that any species particularly sensitive to anthropogenic disturbance are unlikely to occur within the proposed project area through displacement by existing impacts.

In addition, the habitats present in vicinity of the proposed development are not unique to the site and are relatively widespread in the area so any displacement from the immediate vicinity that may occur will not likely incur a high energetic cost as suitable habitat is widely available nearby. The proximity of nearby suitable habitat makes it likely that species will return to areas that have not been physically altered by the proposed development once construction activity ceases.

There are no confirmed active nest locations in proximity to the proposed development site where breeding success is likely to be negatively impacted upon through disturbance or displacement during the construction phase.

Impact phase: Construction		
Nature: Disturbance or displacement of birds due to increased noise and activity levels associated with construction machinery and personnel resulting in an indirect loss of habitat available for foraging and breeding. Project area already experiences relatively high levels of regular disturbance from commercial crop production activities.		
	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Very Short-term (1)	Very Short-term (1)
Magnitude	Minor (2)	Minor (2)
Probability	Low Likelihood (2)	Low Likelihood (2)
Significance	**Low (10)**	**Low (10)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	Unlikely	Unlikely
Can impacts be mitigated?	Yes	
Mitigation: • A site specific EMPr must be implemented, which gives appropriate and detailed description of how construction activities must be conducted; • All contractors are to adhere to the EMPr and should apply good environmental practice during construction; • Environmental Officer to oversee activities and ensure that the site specific EMPr is implemented and enforced; • Maximum use of existing access road and servitudes; • Existing and novel access roads are to be suitably upgraded or constructed to prevent damage and erosion resulting from increased vehicular traffic and construction vehicles; • No off-road driving in undesignated areas; • Speed limits (30 km/h) should be strictly enforced on site to reduce unnecessary noise; • Construction camps should be lit with as little light as practically possible, with the lights directed downwards where appropriate; • The movement of construction personnel should be restricted to the construction areas on the project site; • No dogs or cats other than those of the landowners should be allowed on site; • The appointed Environmental Officer must be trained to identify the potential Red Data species as well as the signs that indicate possible breeding by these species; • The Environmental Officer must then, during audits/site visits, make a concerted effort to look out for such breeding activities of SCCs (e.g. cranes, Secretarybird), and such efforts may include the training of construction staff (e.g. in Toolbox talks) to identify Red Data species, followed by regular questioning of staff as to the regular whereabouts on site of these species; • If any avifaunal SCCs are confirmed to be breeding (e.g. if a nest site is found), construction activities within 500 m of the breeding site must cease, and an avifaunal specialist is to be contacted immediately for further assessment of the situation and instruction on how to proceed; • Prior to construction, an avifaunal specialist should conduct a site walkthrough, covering the final road and power line routes as well as temporary laydown areas and facilities, to identify any nests/breeding/roosting activity of sensitive species; • The results of which may inform the final construction schedule in close proximity to that specific area, including abbreviating construction time, scheduling activities around breeding activity, and lowering levels of associated noise.		

Residual Impacts: None.

4.4.1.3 Direct Mortality

Fatalities of avifaunal species can occur through collision with vehicles as traffic in the area increases due to construction activity. Large-bodied and ground dwelling species (e.g. korhaans and bustards) are at increased risk, but this impact can be effectively mitigated against. Temporary fencing can result in collisions, entrapment or entanglement if not suitably installed. Similarly ground dwelling avifauna (particularly chicks) can fall into uncovered excavations and become entrapped.

Impact phase: Construction		
Nature: Avifaunal fatalities caused by construction activity including vehicle collision (i.e. roadkill), entrapment within security fencing or uncovered excavations.		
	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Very Short-term (1)	Very Short-term (1)
Magnitude	Minor (2)	Minor (2)
Probability	Distinct Possibility (3)	Low Likelihood (2)
Significance	**Low (15)**	**Low (10)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation: • Maximum use of existing access road and servitudes; • No off-road driving in undesignated areas; • Speed limits (30 km/h) should be strictly enforced on site to reduce probability of vehicle collisions; • The movement of construction personnel should be restricted to the construction areas on the project site; • No dogs or cats other than those of the landowners should be allowed on site; • Any holes dug e.g. for foundations of pylons should not be left open for extended periods of time to prevent entrapment by ground dwelling avifauna or their young and only be dug when required and filled in soon thereafter; • Temporary fencing must be suitably constructed, e.g. if double layers of fencing are required for security purposes they should be positioned at least 2 m apart to reduce the probability of entrapment by larger bodied species that may find themselves between the two fences; • Roadkill is to be reported to the ECO and removed as soon as possible.		
Residual Impacts: None.		

4.4.2 Operational Phase

4.4.2.1 Direct Habitat Destruction

Mesic Highveld grasslands receive relatively high rainfall and habitats are sensitive to alterations of flow regimes and infiltration rates, with wetlands forming an important component for many avifaunal species in the area. Several potential risks to the long-term functioning and persistence of these environments exist which, if unmitigated, could result in the long-term degradation or permanent loss of habitats. Fortunately, the potential risks are relatively easy to mitigate very effectively and are largely standard practice for these types of developments.

The utilisation of dust suppression or cleaning chemicals used on solar PV arrays could impose a risk of contamination of pollution of water resources. However, this potential impact can be easily mitigated. The production of wastewater is to be appropriately collected and not released into the receiving environment prior to appropriate treatment to reduce the likelihood of downstream habitat contamination.

Increased runoff from hard surfaces during the operational phase (e.g. solar PV arrays, roads etc.) has the potential to increase the risk of habitat destruction through erosion which can alter flow regimes and water tables, drain wetland environments or increase sedimentation downstream. These potential impacts are also easy to mitigate through the appropriate use of flow and erosion control measures.

Impact phase: Operational		
Nature: Habitat destruction due to contamination or altered flow regimes impacting the water table and wetlands.		
	Without mitigation	With mitigation
Extent	Local (2)	Footprint (1)
Duration	Long-term (4)	Long-term (2)
Magnitude	High (8)	Minor (2)
Probability	Definite (5)	Improbable (2)
Significance	**High (70)**	**Low (10)**
Status (positive or negative)	Negative	Negative
Reversibility	Difficult	Yes
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Very Effectively.	
Mitigation: • Flow- and erosion control measures are to be implemented where appropriate to reduce uncontrolled runoff from hard surfaces; • All cleaning products used on the site should be environmentally friendly and bio-degradable; and • The operational environmental management programme must include site specific measures for the effective management and treatment of any wastewater to be produced.		
Residual Impacts: None.		

4.4.2.2 Disturbance and Displacement

Indirect loss of habitat from disturbance during the operational phase is associated with ongoing operational activity as well as more discrete periods of routine maintenance tasks. Similar to the construction phase, the avifauna in the area already experience levels of disturbance and therefore species particularly sensitive to disturbance are unlikely to frequent the area.

Impact phase: Operational		
Nature: Disturbance or displacement of birds due to increased noise and activity levels associated with operational activities resulting in an indirect loss of habitat available for foraging and breeding. Project area already experiences relatively high levels of regular disturbance from commercial crop production activities.		
	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Very Short-term (1)	Very Short-term (1)
Magnitude	Minor (2)	Minor (2)
Probability	Low Likelihood (2)	Low Likelihood (2)
Significance	**Low (10)**	**Low (10)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	Unlikely	Unlikely
Can impacts be mitigated?	Yes	
Mitigation: • A site specific operational EMPr must be implemented, which gives appropriate and detailed description of how operational and maintenance activities must be conducted to reduce unnecessary disturbance; • All contractors are to adhere to the environmental management programme and should apply good environmental practice during all operations; and • Operational phase bird monitoring, in line with the latest available guidelines, must be implemented.		
Residual Impacts: None.		

4.4.3 Direct Mortality

4.4.3.1 Collision with Infrastructure

Relatively few studies have been published on the impacts of avifaunal collision with solar PV facilities and there is a general lack of compelling evidence that collisions are a cause of large-scale mortality among birds at PV facilities. Collisions with perimeter fencing and internal transmission likes would likely be more significant than collisions with PV panels, but still of low significance. While the lack of systematic, standardised data collection is likely a contributing factor limiting our understanding of this impact, in the absence of rigorous scientific investigation indicating otherwise it appears appropriate to consider the potential impact to be of low significance. A study conducted in the Northern Cape of South

Africa[20] had similarly inconclusive findings, but did indicate that passerine (songbird) and resident species accounted for most of the avifaunal collision mortalities recorded.

Even prior to the implementation of mitigation measures, low incidence of collision fatalities would not likely result in population level impacts even at a local scale. The magnitude and significance is likely to be lower still given that no Botha's Lark, Stark's Lark or Yellow-breasted Pipit were recorded across the proposed development area.

Impact phase: Operational		
Nature: Bird fatalities due to collision with infrastructure (Solar PV arrays and overhead power lines).		
	Without mitigation	With mitigation
Extent	Local (3)	Local (3)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Low Likelihood (2)	Low Likelihood (2)
Significance	**Low (22)**	**Low (22)**
Status (positive or negative)	Negative	Negative
Reversibility	Partial	Yes
Irreplaceable loss of resources?	Possible	Unlikely
Can impacts be mitigated?	Yes	
Mitigation: • Internal power lines should be buried wherever possible; • Novel overhead power lines to be constructed adjacent to existing transmission infrastructure where possible and pylons to be staggered (where possible) relative to existing pylon positions to increase the overall visibility of transmission infrastructure to avifauna such as bustards; • Appropriate (approved) Bird flight diverters (BFDs) to be affixed to the entire length of novel overhead power lines; • If one or more avifaunal SCC carcasses are located and determined likely to have resulted from collisions with infrastructure in any sensitivity area over the lifespan of the facility the fatality is to be appropriately recorded and reported to an avifaunal specialist to determine the most appropriate action; • If double layers of fencing are required for security purposes they should be positioned at least 2 m apart to reduce the probability of entrapment by larger bodied species that may find themselves between the two fences; • Develop and implement a carcass search and bird activity monitoring programme in-line with the latest applicable guidelines; • Regular reviews of operational phase monitoring data (activity and carcass) and results to be conducted by an avifaunal specialist; • The above reviews should strive to identify sensitive locations and areas of increased collisions that may require additional mitigation (e.g. exclusion devices); • An operational monitoring programme for the overhead power line route must be implemented to locate potential collision fatalities; and • Any fatalities located should be reported to Birdlife South Africa (BLSA) and the Endangered Wildlife Trust (EWT).		
Residual Impacts:		

[20] Visser, E., Perold, V., Ralston-Paton, S., Cardenal, A.C., Ryan, P.G. 2018. Assessing the impacts of a utility-scale photovoltaic solar energy facility on birds in the Northern Cape, South Africa. https://doi.org/10.1016/j.renene.2018.08.106 Renewable Energy 133 (2019) 1285 – 1294.

Current mitigation measures, while effective, are not capable of completely preventing collisions and some residual impact will remain. However, it is unlikely that the proposed development will have a significant negative impact on the long-term viability and persistence of SCCs in the area.

4.4.3.2 Electrocution

Electrocution refers to the scenario where a bird is perched or attempts to perch on energized structures and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components. Internal overhead power line infrastructure with a capacity of 132 kV or more do not generally pose a risk of electrocution due to the large size of the clearances between the electrical infrastructure components. Electrocutions are therefore more likely for larger species whose wingspan is able to bridge the gap such as eagles or vultures. Mitigation measures nevertheless remain effective at reducing the potential risk of electrocution.

Impact phase: Operational		
Nature: Avifaunal fatalities caused by electrocution from energized infrastructure.		
	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Minor (2)	Small (0)
Probability	Low Likelihood (2)	Improbable (1)
Significance	**Low (16)**	**Low (6)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation: • Internal power lines should be buried wherever possible; • All new overhead power line pylons must be of a design that minimizes electrocution risk by using adequately insulated 'bird friendly' structures, with sufficient clearances between live components to reduce the risk of electrocution for large species such as vultures and Martial Eagle; • An operational monitoring programme for the overhead power line route must be implemented to locate potential collision fatalities; and • Any fatalities located should be reported to Birdlife South Africa (BLSA) and the Endangered Wildlife Trust (EWT). • Prevent birds from nesting in substation infrastructure through exclusion covers or spikes if required (determined on a case-by-case basis).		
Residual Impacts: None.		

4.5 Decommissioning Phase

The impacts of the decommissioning phase are similar to those of the construction phase, with the exception of a reduced impact of habitat destruction. Temporary disassembly and storage areas associated with the decommission phase are to be positioned on the same

sites as those used for temporary laydown areas during the construction phase where possible to reduce the incidence of novel habitat destruction.

4.6 Cumulative Impact

The Screening Tool has identified one solar PV facility within 30 km of the proposed project area, namely Tutuka Solar Energy Facility (DFFE Ref. No. 14/12/16/3/3/2/754), a 65.9 MW solar energy facility within the Tutuka coal fired power station. Other than the Tutuka power station the remaining area is largely dominated by commercial agricultural activity.

While not yet reflected on the Screening Tool, applications were submitted for the Hendrina North (14/12/16/3/3/2/2130) and Hendrina South (14/12/16/3/3/2/2131) 200 MW WEFs comprising up to 27 and 26 WTGs respectively (and associated infrastructure), located approximately 25 km to the north of the preferred development site (Figure 1, inset). The cumulative impact to avifauna of those facilities was considered to be of low significance following the implementation of mitigation measures. The proposed development will unlikely result in a significant contribution to the cumulative impact on avifauna in the area with respect to WEFs.

The highest potential impacts prior to mitigation would relate to the effects on aquatic habitats (particularly during the operational phase), such as possible contamination and uncontrolled runoff from hard surfaces that may result in erosion and subsequent degradation of wetlands. However, highly effective mitigation measures exist to address these impacts. The highest potential impacts following the implementation of mitigation measures relate to the direct destruction of habitat (primarily during the construction phase). While habitat destruction is generally low relative to the overall size of WEFs, the construction of solar PV arrays is often associated with vegetation clearing and the loss of habitat excluding avifaunal species from the area over the longer-term. This impact is nevertheless unlikely to have a significant negative effect on the long-term viability or persistence of avifaunal populations in the area given the species observed and their site utilisation.

Impact phase: Cumulative		
Nature: The cumulative impact of the proposed development in the context of the land-use activities found in the broader local area.		
	Without mitigation	With mitigation
Extent	Local (2)	Footprint (1)
Duration	Long-term (4)	Long-term (2)
Magnitude	H (8)	Minor (2)
Probability	Definite (5)	Definite (5)
Significance	**High (70)**	**Medium (35)**
Status (positive or negative)	Negative	Negative
Reversibility	Difficult	Yes
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Very Effectively.	Partially
Mitigation: • As listed above.		
Residual Impacts:		

Habitat cleared for the construction of permanent facilities will not be available for use by many avifaunal species during the operational lifespan of the development. No long-term residual impacts are likely to negatively influence the viability or persistence of the avifaunal community of the receiving environment.

4.7 'No-Go' Alternative

The 'No-Go' alternative considers that the proposed development is not constructed. Most of the potential impacts associated with the development itself and assessed above would therefore not be imposed on the avifaunal community of the receiving environment.

From an avifaunal perspective, however, the proposed development presents an opportunity to afford some level of long-term protection for the habitats present across the proposed development area from activities potentially less compatible with the persistence and rehabilitation of avifaunal habitats (e.g. wetlands) such as coal mining.

Furthermore, the 'No-Go' alternative reduces the opportunity to progress the de-carbonisation transition of the economy and achieve various climate change mitigation targets outlined by the South Africa's Low Emission Development Strategy, The National Development Plan, The National Climate Change Response Policy, Integrated Resource Plan, the National Climate Change Adaptation Strategy (amongst others) and ultimately South Africa's commitment to the Paris Agreement. The proposed development site appears to be well suited for the development of renewable energy facilities as proposed.

5 DISCUSSION

The proposed Solar PV developments do not pose as much of a potential impact risk to the avifaunal community of the receiving environment as the wind energy facility. The most significant potential impact associated with the Solar PV developments relate to habitat destruction and disturbance/displacement. The area currently experiences high levels of existing impacts such as highly modified areas used for commercial agriculture and grazing as well as high levels of disturbance associated with the agricultural activity. The avifaunal community, even in the remnant patches of natural or near-natural vegetation scattered amongst the agricultural fields, is likely accustomed to the ongoing habitat disturbance and movement of large machinery. None of the pre-application avifaunal monitoring surveys conducted recorded the presence of smaller passerine SCCs identified during the reconnaissance study to potentially be of particular relevance to the proposed development, such as Botha's Lark, Rudd's Lark or Yellow-breasted Pipit. The Solar PV facility is therefore unlikely to pose a significant negative impact on the avifaunal community of the receiving environment. The positions provided in the optimised layout of associated infrastructure are acceptable and unlikely to have a significant negative impact on the long-term viability or persistence of the avifaunal community of the receiving environment provided mitigation measures indicated in this report and the aquatic specialist report are implemented as appropriate.

Despite some elevated passage rates (birds/hour) being recorded in some areas during portions of the pre-application avifaunal monitoring programme, the monitoring indicated that this was largely a result of relatively few flight paths of flocking species comprising large numbers of individuals. The number of flight paths was relatively low in contrast-indicating that discrete events made up the majority of the total number of birds recorded rather than the site having an overall high level of aerial flight activity. This, combined with the spatio-temporal distribution of the high passage rates allows for the collision risk to avifaunal species to be relatively easy to mitigate following the mitigation hierarchy.

Firstly, the avoidance of areas identified to be of very high avifaunal sensitivity for the construction of WTGs and avoidance of high avifaunal sensitivity as far as practical. This will likely be the most effective mitigation measure to reduce the overall impact of the

proposed WEF on the avifaunal community of the receiving environment and the optimised layout has already been informed by these considerations. Secondly the implementation of additional mitigation measures such as observer-based shut-down-on-demand in areas of elevated recorded passage rates will likely be highly effective at further reducing the likelihood of collisions as large flocks of birds are easily detected. Mitigation measures such as affixing appropriate bird flight diverters on all spans of novel OHPLs will reduce the likelihood of collisions with this infrastructure and avifaunal SCCs are unlikely to utilise the transmission substations.

Based on the screening study, reconnaissance study and results of the pre-application avifaunal monitoring programme conducted for the Ummbila Emoyeni Solar PV, WEF and associated infrastructure (including cumulative impacts), it is the avifaunal specialist's informed opinion that the proposed development will not have a significant negative impact on the viability or persistence of avifaunal populations (particularly avifaunal SCCs) in the area following the implementation of mitigation measures. The indicative positions of all 111 WTGs and solar PV facilities provided in the layout are acceptable.

It is the specialist opinion that the proposed development can be approved from an avifaunal perspective.

6 POST-CONSTRUCTION MONITORING PROGRAMME

6.1 Wind Energy Facility

6.1.1 Avifaunal Abundance and Flight Activity Monitoring

As a minimum, survey protocols used in the pre-application monitoring should be repeated during the first two years of operation and should be combined with monitoring of fatalities. Requirements of the latest available guidelines should be included wherever necessary. The need for further monitoring of bird abundance and movements should be reviewed at the end this of period to determine if it is necessary to continue with some, or all, components of the monitoring.

Any observed changes in bird numbers and movements at a WEF could be linked to changes in the available habitat (e.g. agricultural expansion, mining, as well as changes in weather conditions, rainfall, etc.). The avifaunal habitats available on both the development and reference sites should therefore be mapped at least once a year (at the same time every year), using the same approach used in the reconnaissance and assessment.

6.1.2 Fatality Monitoring

In addition to avifaunal abundance, flight activity monitoring and habitat mapping the post-construction monitoring programme must include fatality monitoring that incorporates carcass searches as well as scavenger removal (carcass persistence) and searcher efficiency trials.

The aims of fatality estimates are to:

- Estimate the number and rate of fatalities at a WEF;
- Describe the species composition of fatalities (as well as the age and sex where possible);
- Record and document the circumstances and site characteristics associated with avian
- fatalities at turbines and ancillary infrastructure of the WEF (this could aid in understanding the cause of fatalities, and hence possible mitigation measures); and
- Mitigate impacts by informing final operational planning and ongoing management.

There are normally three separate components to estimating fatalities:

- Regular searches for collision casualties;
- Experimental assessment of search efficiency and scavenging rates of bird carcasses on the site; and
- Estimating fatality rates based on these data.

6.1.3 Carcass Searching

The search schedule will ultimately be dependent on the number of WTGs developed and their location. No fewer than 30% of the total number of WTGs constructed should be surveyed using intensive sampling methods. WTGs should be selected randomly, or through stratified random sampling where habitat variation is pronounced. The same turbines are searched at regular intervals and once the subset of turbines has been selected, these should be fixed for the rest of the monitoring period, unless there is good reason to change this.

As a minimum, the radius of the search area should be equal to 75% of the turbine height (ground to vertical blade-tip). The size of the search area should remain the same throughout the study. The area around each turbine should be searched using transects located no more than 10 m apart; this width should be reduced where thick groundcover hampers visibility. Transects should be walked slowly, and the target area searched

carefully and methodically for any sign of a bird-collision incident (carcasses, dismembered body parts, scattered feathers, injured birds).

It may be acceptable to search only a subset of the search area if the habitat is such that surveying the entire area is not possible (e.g. tall crops), although such circumstances should be carefully documented. All guyed masts and sample sections of any new lengths of power line associated with the development should also be surveyed for collision and/or electrocution victims and included in the search schedule.

The search interval must be adjusted to ensure that WTG search intervals are shorter than scavenger removal rates.

All physical evidence associated with located carcasses should be photographed, referenced (including accurately geo-referenced using a GPS), checked for age and sex (where possible). Carcasses should be collected, bagged and carefully labelled (label inside and outside the bag(s) – if double-bagged, put one label inside the outer bag), and refrigerated or frozen to await further examination.

If an injured bird is recovered, it should be contained in a suitably sized cardboard box. The local conservation authority should be notified that the bird will be transported to the nearest veterinary clinic or wild-animal/bird rehabilitation centre. In such cases, the immediate area of the recovery should be searched for evidence of impact with the turbine blades, and any such evidence should be fully documented (as above).

Maintenance staff should be required to report bird mortalities through a formalised reporting system throughout the lifespan of the facility. This should be additional to post-construction monitoring and does not replace formal carcass searches. All information should be recorded as far as possible.

Where there are incidental carcass finds at turbines that are being formally monitored, the carcass should be left in place where they may be detected during formal searches.

Details of carcasses found incidentally must be included in post-construction monitoring reports. Where bird carcasses are found in years where there is no formal monitoring, carcasses should be labelled, bagged and frozen. Fatalities should be reported annually to BirdLife South Africa, EWT, the Department of Environmental Affairs/SANBI and any relevant species specialists (more often if significant incidents occur).

An avifaunal specialist is to be notified of any significant (e.g. avifaunal SCCs) carcasses located as soon as possible to consider the most appropriate course of action.

6.1.4 Searcher Efficiency and Scavenger Trials

Scavenger removal trial must occur prior to the spinning of any WTG to determine the appropriate, initial search interval.

Fresh carcasses of birds of similar size and colour to a variety of the priority species should be placed randomly at sites around the search area and the location of each carcass recorded. As far as possible, carcasses used in trials should mimic the species characteristics and state of carcasses from WTG collisions.

Care should be taken to avoid tainting carcasses with human scent and the total number of carcasses set out should not be less than 20, but not so plentiful as to saturate the food-supply for the local scavengers.

These sites should be checked daily for the first week to record any changes in the presence, location and condition of each carcass. After the first week, the search interval can be increased and searches should continue for up to a month.

Scavenge and decomposition rates should therefore be measured at least twice over a monitoring year, once in winter and once in summer. Scavenger removal rates may also

differ according to ground-cover and proximity to modified habitats and agricultural activity (e.g. from farm cats) and scavenger removal rate trials must be stratified to account for this.

To estimate the probability of an observer detecting a carcass, a sample of suitable bird carcasses should be obtained and distributed randomly around the search area. The number and location of the paced carcasses should be recorded, and these carcasses should be of similar size and colour to the priority species. The proportion of the carcasses located in surveys will indicate the relative efficiency of the survey method. These trials should be done under the supervision of the avifaunal specialist during the scheduled carcass searches, without the knowledge of the field teams. Separate trials should be conducted for each individual searcher or search team. The location of all carcasses not detected by the survey team should be checked subsequently to discriminate between error due to search efficiency (those carcasses still in place which were missed) and scavenge rate (those immediately removed from the area).

Observed mortality rates need to be adjusted to account for searcher efficiency, scavenger removal and the probability that some carcasses may be outside the search area. It is recommended that the GenEst model is used when estimating fatality rates.

The need for further monitoring of fatalities should also be reviewed after the first two years, and then again on an annual basis. Carcass searches must always be repeated in the fifth year of operation, and again every five years thereafter.

6.2 Solar PV Facility

The avifaunal post construction monitoring aims to assess the impact of the SEF by comparing pre- and post- construction monitoring data and to measure the extent of bird fatalities caused by the SEF and should take the recommendations of the most recent applicable monitoring guidelines into consideration at the time of commencement of the activity. It is recommended that the following considerations be included.

Post-construction monitoring is to:

- Determine as far as possible the realised impacts of the SEF are on the avifaunal community of the receiving environment, particularly avifaunal SCCs; and
- Determine what mitigation is required if need be (adaptive management).

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

- Habitat availability;
- Quantification of avifaunal numbers and movements for comparative analyses (replicating baseline pre-construction monitoring); and
- Quantification of avifaunal mortalities.

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

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

6.2.1 Timing

Post-construction monitoring should commence as soon as possible during the commencement of the construction phase 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 in the area 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.

6.2.2 Duration

Monitoring should take place in Year 1 and 2 of the operational phase, and then repeated in Year 5 and every five years after that. After the first year of monitoring, the programme should be reviewed in order to incorporate significant findings that have emerged. This may entail the revision of the search protocol, 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.

6.2.3 Habitat Classification

Any observed changes in bird numbers and movements in and around a SEF 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.

6.2.4 Bird Numbers and Movements

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

6.2.5 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 facility for collision casualties; and
- Estimation of fatality rates.

6.2.6 Searcher Efficiency and Scavenger Removal Rates

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 fatality rates and when designing the monitoring protocol. This must be done in the form of searcher and scavenger trails once per season where possible but a minimum of twice per year.

6.2.7 Collision Fatality Surveys

The area searched should be selected through stratified random sampling and should be clearly defined at the outset of post-construction monitoring and based off the actual PV array area finally constructed. Search plots are to be selected from within concentric areas at varying distance from the core of each development, e.g. project core, project perimeter

and project periphery. The total search area should cover a minimum of 20% of the total solar PV array area.

Carcass searches must begin as early in the mornings as possible to reduce carcass removal by scavengers. The searchers must have a vehicle available for transport per site. The supervisor must assist with the collation of the data at each site and to provide the data to the specialist in electronic format on a weekly basis. The specialists must ensure that the supervisor is completely familiar with all the procedures concerning the management of the data.

The following must be sent to the specialist on a weekly basis:

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

6.2.8 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.

6.3 Reporting

Quarterly monitoring reports should be completed for each site, presenting the results of the previous three months monitoring. Quarterly reports must include the details of carcasses found, including the species, date found, carcass condition (e.g. fresh, decomposed, feathers only), age class and sex (if possible), nearest turbine number, GPS location and proximity to relevant impact receptors (e.g. nests).

A post-construction monitoring report analysing the results of monitoring should be completed at the end of each year of monitoring. These reports must be submitted to the competent authority and relevant stakeholders

Post-construction monitoring reports must also be made available to environmental assessment practitioners, specialists and scientists for the purposes of environmental audits, environmental impacts assessments, cumulative impact assessments and scientific research.

The annual report is to investigate the following:

- Has the habitat available to birds in and around the facility changed?
- Has the abundance of birds and/or species composition changed?
- Have the distributions and/or movements of priority species changed?
- Where the answer is yes to any of the above four questions, what is the nature of the observed changes? (Compare these changes before (during) and after construction).
- What is the nature, and likely drivers, of any changes observed?
- What is the likely demographic and ecological significance of any observed changes in bird populations at the site (including consideration of the magnitude and direction of change) at both the local and broader population scale?
- What are the collision rates and the total number of bird fatalities at the facility? (Collision rates should be reported per MW (nameplate capacity) and per turbine for

different size classes of birds. Data should be reported in both raw and corrected formats, and the GPS locations of carcasses must be included).
- What is the species and, as far as possible, age and sex composition of fatalities?
- What proportion of fatalities is likely to be due to collisions with wind turbines?
- Are there any factors (e.g. site characteristics and proximity to wind turbines) that may contribute to these fatalities?
- Is additional monitoring and/or mitigation necessary and if so, what needs to be done?

The outcomes of the post-construction monitoring, including data and specialist's reports, must be uploaded onto the national bird monitoring database, to be accessed at https://www.environment.gov.za/birddatabase, once operational.

APPENDIX A: IMPACT ASSESSMENT SCORING METHODOLOGY

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

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

S = (E + D + M) * P

where:

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

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

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

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

APPENDIX B: VANTAGE POINT SURVEY DATES AND TIMES

VP	Date	Start Time	End Time	Watch Duration	VP	Date	Start Time	End Time	Watch Duration
1	05-Aug-21	08:00	12:00	04:00	2	05-Aug-21	14:00	18:00	04:00
	07-Aug-21	14:00	18:00	04:00		08-Aug-21	08:00	12:00	04:00
	09-Aug-21	13:45	17:45	04:00		09-Aug-21	08:05	12:05	04:00
	24-Sep-21	13:47	17:47	04:00		26-Sep-21	07:38	11:38	04:00
	26-Sep-21	13:14	17:14	04:00		22-Oct-21	14:00	18:00	04:00
	22-Oct-21	06:00	10:00	04:00		25-Oct-21	07:00	11:00	04:00
	07-Jan-22	06:20	10:20	04:00		07-Jan-22	10:30	14:30	04:00
	10-Jan-22	13:45	17:45	04:00		10-Jan-22	06:00	10:00	04:00
	12-Jan-22	12:46	16:46	04:00		12-Jan-22	08:45	12:45	04:00
	05-Apr-22	12:20	16:20	04:00		05-Apr-22	07:45	11:45	04:00
	10-Apr-22	06:25	10:25	04:00		14-Apr-22	07:55	11:55	04:00
	18-Apr-22	06:55	10:55	04:00		18-Apr-22	11:14	15:14	04:00
3	06-Aug-21	08:00	12:00	04:00	4	09-Aug-21	08:00	12:00	04:00
	08-Aug-21	14:00	18:00	04:00		10-Aug-21	14:00	18:00	04:00
	10-Aug-21	08:00	12:00	04:00		11-Aug-21	14:00	18:00	04:00
	23-Oct-21	07:00	11:00	04:00		28-Sep-21	13:15	17:15	04:00
	25-Oct-21	14:00	18:00	04:00		26-Oct-21	07:00	11:00	04:00
	27-Oct-21	07:00	11:00	04:00		27-Oct-21	14:00	18:00	04:00
	08-Jan-22	05:50	09:50	04:00		10-Jan-22	11:50	15:50	04:00
	10-Jan-22	06:10	10:10	04:00		12-Jan-22	05:50	09:50	04:00
	13-Jan-22	14:30	18:30	04:00		14-Jan-22	13:10	17:10	04:00
	07-Apr-22	07:12	11:12	04:00		06-Apr-22	14:40	18:40	04:00
	14-Apr-22	12:52	16:52	04:00		12-Apr-22	07:00	11:00	04:00
	22-Apr-22	07:14	11:14	04:00		21-Apr-22	08:52	12:52	04:00
5	07-Aug-21	08:00	12:00	04:00	6	09-Aug-21	14:00	18:00	04:00
	12-Aug-21	14:00	18:00	04:00		10-Aug-21	14:04	18:04	04:00
	10-Aug-21	07:50	11:50	04:00		12-Aug-21	08:00	12:00	04:00
	24-Sep-21	07:50	11:50	04:00		27-Sep-21	14:15	18:15	04:00

VP	Date	Start Time	End Time	Watch Duration	VP	Date	Start Time	End Time	Watch Duration
	27-Sep-21	07:24	11:24	04:00		26-Oct-21	14:00	18:00	04:00
	29-Oct-21	14:00	18:00	04:00		29-Oct-21	07:00	11:00	04:00
	10-Jan-22	07:59	11:59	04:00		12-Jan-22	11:40	15:40	04:00
	13-Jan-22	08:01	12:01	04:00		13-Jan-22	05:45	09:45	04:00
	13-Jan-22	14:40	18:40	04:00		13-Jan-22	12:50	16:50	04:00
	04-Apr-22	06:40	10:40	04:00		06-Apr-22	10:10	14:10	04:00
	13-Apr-22	09:00	13:00	04:00		12-Apr-22	13:39	17:39	04:00
	15-Apr-22	13:35	17:35	04:00		21-Apr-22	13:55	17:55	04:00
	06-Aug-21	14:00	18:00	04:00		08-Aug-21	13:50	17:50	04:00
	07-Aug-21	08:00	12:00	04:00		11-Aug-21	08:00	12:00	04:00
	12-Aug-21	07:57	11:57	04:00		12-Aug-21	13:35	17:35	04:00
	29-Sep-21	07:18	11:18	04:00		25-Sep-21	13:30	17:30	04:00
	23-Oct-21	14:00	18:00	04:00		29-Sep-21	12:45	16:45	04:00
	24-Oct-21	07:00	11:00	04:00		28-Oct-21	07:00	11:00	04:00
7	08-Jan-22	10:35	14:36	04:01	**8**	09-Jan-22	05:40	09:40	04:00
	11-Jan-22	05:45	09:45	04:00		11-Jan-22	13:35	17:35	04:00
	14-Jan-22	07:50	11:50	04:00		16-Jan-22	10:59	14:59	04:00
	01-Apr-22	07:00	11:00	04:00		04-Apr-22	13:00	17:00	04:00
	09-Apr-22	13:30	17:30	04:00		09-Apr-22	11:40	15:40	04:00
	20-Apr-22	08:18	12:18	04:00		10-Apr-22	10:56	14:56	04:00
	05-Aug-21	14:00	18:00	04:00		05-Aug-21	08:00	12:00	04:00
	11-Aug-21	14:00	18:00	04:00		11-Aug-21	07:56	11:56	04:00
	13-Aug-21	08:00	12:00	04:00		13-Aug-21	14:00	18:00	04:00
	22-Sep-21	13:00	17:00	04:00		22-Sep-21	06:42	10:42	04:00
9	28-Oct-21	14:00	18:00	04:00	**10**	28-Sep-21	07:12	11:12	04:00
	30-Oct-21	07:30	11:30	04:00		30-Oct-21	13:30	17:30	04:00
	08-Jan-22	13:28	17:28	04:00		08-Jan-22	06:50	10:50	04:00
	13-Jan-22	10:00	14:00	04:00		09-Jan-22	11:45	15:45	04:00
	14-Jan-22	06:20	10:20	04:00		16-Jan-22	06:26	10:26	04:00

VP	Date	Start Time	End Time	Watch Duration	VP	Date	Start Time	End Time	Watch Duration
	02-Apr-22	13:00	17:00	04:00		03-Apr-22	06:56	10:56	04:00
	13-Apr-22	13:30	17:30	04:00		09-Apr-22	07:15	11:15	04:00
	20-Apr-22	12:42	16:42	04:00		11-Apr-22	11:26	15:26	04:00
11	06-Aug-21	14:00	18:00	04:00	12	06-Aug-21	07:40	11:40	04:00
	07-Aug-21	14:00	18:00	04:00		08-Aug-21	08:15	12:15	04:00
	13-Aug-21	07:45	11:45	04:00		13-Aug-21	12:40	17:00	04:20
	23-Sep-21	13:00	17:00	04:00		23-Sep-21	06:40	10:40	04:00
	30-Sep-21	11:32	15:32	04:00		25-Sep-21	07:40	11:40	04:00
	24-Oct-21	14:00	18:00	04:00		30-Sep-21	06:25	10:25	04:00
	09-Jan-22	12:00	16:00	04:00		09-Jan-22	06:40	10:40	04:00
	11-Jan-22	10:45	14:45	04:00		11-Jan-22	07:29	11:29	04:00
	15-Jan-22	07:00	11:00	04:00		17-Jan-22	05:55	09:55	04:00
	03-Apr-22	12:20	16:20	04:00		02-Apr-22	07:43	11:43	04:00
	15-Apr-22	08:00	12:00	04:00		11-Apr-22	06:54	10:54	04:00
	19-Apr-22	06:50	10:50	04:00		17-Apr-22	07:01	11:01	04:00
CVP1	04-Aug-21	14:00	18:00	04:00	CVP2	04-Aug-21	14:10	18:10	04:00
	14-Aug-21	08:00	12:00	04:00		21-Sep-21	13:57	17:57	04:00
	14-Aug-21	12:00	16:00	04:00		01-Oct-21	06:47	10:47	04:00
	21-Oct-21	14:00	18:00	04:00		01-Oct-21	10:47	14:47	04:00
	31-Oct-21	10:00	14:00	04:00		07-Jan-22	11:30	15:30	04:00
	31-Oct-21	06:00	10:00	04:00		07-Jan-22	07:30	11:30	04:00
	07-Jan-22	15:05	19:05	04:00		15-Jan-22	11:45	15:45	04:00
	09-Jan-22	11:30	15:30	04:00		01-Apr-22	13:25	16:25	03:00
	09-Jan-22	06:00	10:00	04:00		08-Apr-22	12:35	16:35	04:00
	31-Mar-22	13:30	17:30	04:00		19-Apr-22	11:20	15:20	04:00
	08-Apr-22	07:00	11:00	04:00					
	16-Apr-22	11:10	15:10	04:00					

APPENDIX C: RECONNAISSANCE STUDY CONSOLODATED LIST OF AVIFAUNAL SPECIES MOST RELEVANT TO THE PROPOSED DEVELOPMENT

Species	Global Status	Regional Status	Priority Score	Data Source					
				IBA	Screening Tool	SABAP2	CAR	CWAC	Avisense (2020)
African Fish-eagle	LC	LC	290			x			
African Grass Owl	LC	VU (A2c; C1)	289	x	x				x
African Harrier-hawk	LC	LC	190			x			
African Marsh Harrier	LC	EN (A2c+3c+4c; C1)	300		x				x
Amur Falcon	LC	LC	210			x			x
Black Harrier	EN (C2a(ii))	EN (C1+2a(ii))	345	x		x			x
Black Sparrowhawk	LC	LC	170			x			
Black Stork	LC	VU (A2c; D1)	330						x
Black-chested Snake-eagle	LC	LC	230			x			
Black-winged Kite	LC	LC	174			x			
Black-winged Pratincole	NT (A2bc+3bc+4bc)	NT (A2bc+3bc+4bc)	202	x		x			x
Blue Crane	VU (A3cde+4cde)	NT (A2acde)	320	x		x	x		x
Blue Korhaan	NT (A3c; C1)	LC	270	x		x	x		x
Botha's Lark	EN (A3c+4c)	EN (B2ab(ii,iii,iv,v); C1+2a(i))	-	x					x
Buff-streaked Chat	LC	LC	-	x					
Burchell's Courser	LC	VU (A2c+4c; C1+2a(i))	210						x
Cape Eagle-owl	LC	LC	250						x
Cape Vulture	VU (A2acde+3cde+4acde; C2a(ii))	EN (A2a)	405						x
Caspian Tern	LC	VU (A2a;C1; D1, D2)	240						x
Chestnut-banded Plover	LC	NT (C1+2a(i))	230	x					
Common Buzzard	LC	LC	210			x			
Denham's Bustard	LC	VU (A2bcd+3bcd+4bcd; C1)	300	x	x				x

Species	Global Status	Regional Status	Priority Score	Data Source					
				IBA	Screening Tool	SABAP2	CAR	CWAC	Avisense (2020)
Greater Flamingo	LC	NT (A2bd)	290			x		x	x
[Redacted]	**EN (A2acd+ 4acd)**	**EN (A2acd+ 4acd)**	**[Red]**		x	x			x
Grey-winged Francolin	LC	LC	190			x			
Jackal Buzzard	LC	LC	250			x			
Kurrichane Thrush	LC	LC	-	x					
Lanner Falcon	LC	VU (A2bc; C1)	300	x		x			x
Lesser Flamingo	NT (A2c+3c+ 4c)	NT (A2c+3c+ 4c)	290	x		x			x
Maccoa Duck	EN (A2acde)	NT (C1)	-			x			x
Marsh Owl	LC	LC	190			x			
Martial Eagle	EN (A2acde+ 3cde+4ac de)	EN (A2cde ; C1)	350	x					x
Montagu's Harrier	LC	LC	210			x			
Northern Black Korhaan	LC	LC	180				x		
Pallid Harrier	NT (A2cde+3 cde+4cde)	NT (A2cde+3c de+4cde)	260			x			
Rudd's Lark	EN (A2bc+3b c+4bc)	EN(A2c+3c+4 c; B2ab(i,ii,iii, iv,v); C1)	230						x
Secretarybird	EN (A2acde+ 3cde+4ac de)	VU (A4acd; C1)	320	x	x	x			x
Southern Bald Ibis	VU (C1+2a(ii))	VU (C1+2a(ii))	330	x	x	x			x
Spotted Eagle-owl	LC	LC	170			x			
Wattled Crane	VU (A2acde+ 3cde+4ac de)	CR (C1+2a(ii))	349	x					
White Stork	LC	LC	220			x	x		
White-bellied Korhaan	LC	VU (A2c+3c+ 4c; C1)	270	x					x
Yellow-billed Stork	LC	EN (B2c(i,v); D)	330						x
Yellow-breasted Pipit	VU (A3c; C2a(i); D1)	VU (A2b,c+4c	245						x

Species	Global Status	Regional Status	Priority Score	Data Source					
				IBA	Screening Tool	SABAP2	CAR	CWAC	Avisense (2020)
		;B1b,c,+2 b,c; C1)							

**Greater Kestrel was recorded on site despite this species not being identified in the list above.*

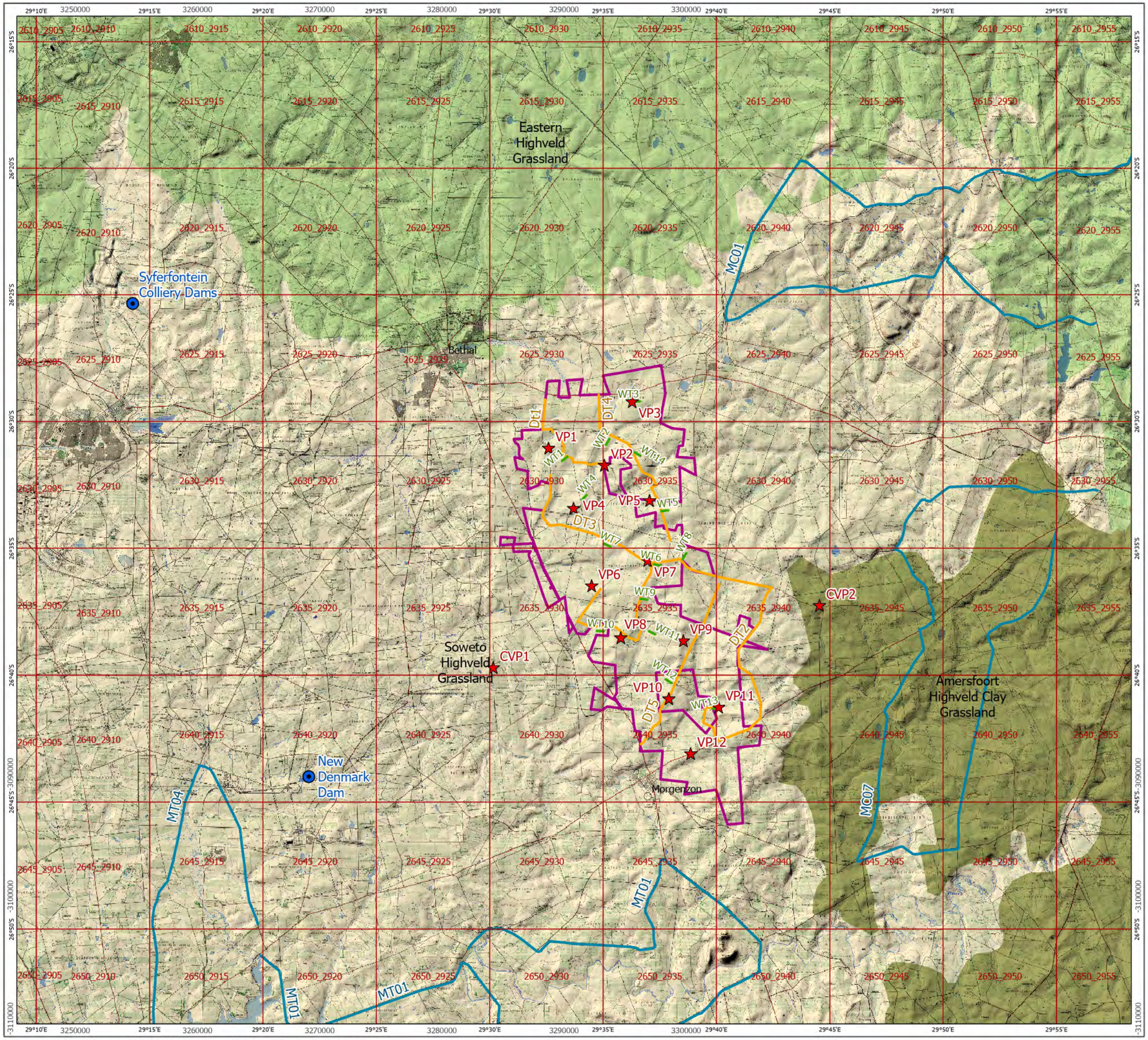
APPENDIX D: SPECIES AND NUMBER OF INDIVIDUALS RECORDED DURING WALK TRANSECTS OVER THE FULL PRE-APPLICATION MONITORING PERIOD

Species	Walk Transect															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
African Barred Owlet					1											**1**
African Crake						1										**1**
African Cuckoo-Hawk										1						**1**
African Emerald Cuckoo														1		**1**
African Pipit	10		8	40	1	6	31		8	4	9	14	2		1	**134**
African Reed Warbler					1											**1**
African Sacred Ibis	2	2		1			1		1		5			1		**13**
African Spoonbill											2		1	1	1	**5**
African Stonechat			4		2	2			3	15	13	9			2	**50**
Amur Falcon				10												**10**
Ant-eating Chat	3	2		4	4	15	3	1	11	2	28		3			**76**
Banded Martin								1					9			**10**
Barn Swallow	1	3		21		20	3	36	81	4	77		1	3	6	**256**
Black-chested Prinia			11		1											**12**
Black-collared Barbet					2											**2**
Black-headed Heron		1	5		1	1	1	1	2	4	1	1	2	2	2	**24**
Blacksmith Lapwing	1	2				2	16				7					**28**
Black-throated Canary					4	1			2	4	14	24				**49**
Black-winged Kite		1				2		1	4	2	4	6			1	**21**
Blue Crane	1	2				2										**5**
Blue Korhaan	3	5	2	15		3	5	2	3		3			1	3	**45**
Bokmakierie													1			**1**
Cape Canary			4								1		2			**7**
Cape Crow				2					1			2				**5**
Cape Long-billed Lark															1	**1**
Cape Longclaw	12	16	2	19	3	14	13	17	19	5	21	5	19	19	9	**193**
Cape Sparrow			39	2	15	17	5		6	17	4	22		3	1	**131**
Cape Turtle Dove												1				**1**
Capped Wheatear			2													**2**
Cloud Cisticola	5	7		9	1	5	6	15	3		1		9	7	11	**79**
Common Buzzard				1			1							1		**3**
Common Greenshank							1									**1**

Species	Walk Transect															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Common Quail	13	6	6	14	1	3	1	14	6	15	7	4	2	11	6	**109**
Common Swift									2							**2**
Common Waxbill			4		27	2			3		10	11				**57**
Crowned Lapwing	4	1	1	17		1	9		10	17	3	5	2	10	2	**82**
Diederik Cuckoo		2							1							**3**
Eastern Clapper Lark						1							6			**7**
Egyptian Goose	457	14	19	17	1	10	8	5	6	8	7	1	1	7	14	**575**
Fan-tailed Widowbird		3	1			2				1	14					**21**
Greater Striped Swallow	2		1	6					8		12					**29**
Grey Heron															1	**1**
Grey Plover						1										**1**
Grey-winged Francolin	11	1							3		2		1			**18**
Hadada Ibis	10	2	1	2	11	9	1	4	13	4	13	1	1		3	**75**
Helmeted Guineafowl		1			1		2			3		22				**29**
Helmeted Guineafowl										1		4				**5**
Kittlitz's Plover							3									**3**
Lanner Falcon		1														**1**
Laughing Dove					1											**1**
Levaillant's Cisticola			3		13	5			3		8	1				**33**
Levaillant's Cuckoo					1											**1**
Long-tailed Widowbird	3	15	1	13	7	12	1	21	41	33	27		13	17	15	**219**
Marsh Owl		1														**1**
Montagu's Harrier			1					1								**2**
Mosque Swallow						1										**1**
Namaqua Dove					2											**2**
Orange-breasted Waxbill					14											**14**
Pale-crowned Cisticola	1	2									7			3	3	**16**
Pallid Harrier								1							1	**2**
Pied Starling											2					**2**
Pink-billed Lark	3	1		1	1		2						1			**9**
Pin-tailed Whydah			1		3				4		10	2				**20**
Quailfinch	1		2		3	1		4	6		6	1			2	**26**
Red-billed Quelea			82	4	45	74		20	240	79	115	52				**711**
Red-billed Teal															3	**3**
Red-capped Lark	24	4	15	11	11	1	62	1		38	1	20	1	10	4	**203**

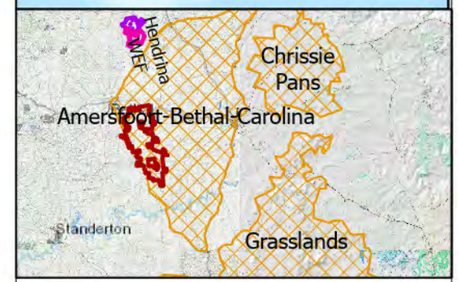
Species	Walk Transect															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Red-eyed Dove				1	1	3			2		1					**8**
Red-headed Finch				2												**2**
Red-knobbed Coot	6							2								**8**
Red-throated Wryneck						1										**1**
Reed Cormorant								1	1		5				3	**10**
Ring-necked Dove	3	2	3	4	7	13	4	1	4	8	5	8	4	2	9	**77**
Rock Kestrel											1	2				**3**
Rufous-naped Lark			1													**1**
Secretarybird											1			1	1	**3**
Sentinel Rock Thrush											1					**1**
South African Cliff Swallow	23		6	63			10	18	26	2	18	3	34		2	**205**
South African Shelduck	4			7		2										**13**
Southern Bald Ibis	127			7				10				2				**146**
Southern Fiscal					1	2	1			1	3	4		3	2	**17**
Southern Grey-headed Sparrow			1													**1**
Southern Masked Weaver			22		31	7	30		8	4	49	40			14	**205**
Southern Red Bishop	7	10	93	6	61	17	1	12	16	197	123	59		1	4	**607**
Speckled Pigeon	31		9	62	2		60		5		1	67		16	48	**301**
Spike-heeled Lark	3	2		17		1	9						6	2		**40**
Spotted Thick-knee		2		4						2						**8**
Spur-winged Goose	18	2		4		3			1	1		2		1	3	**35**
Square-tailed Nightjar										1						**1**
Swainson's Spurfowl		1	3	2	3	4	2		6	12	2	11	3	2	3	**54**
Temminck's Courser			1													**1**
Three Banded Plover													1			**1**
Three-banded Plover						2										**2**
Unidentified	7	9	7	5	11	7	8	5	4	14	6	10	14	15	14	**136**
Western Cattle Egret	2		1	7		19	2	3	12	6	4	1		1	1	**59**
White Stork			12											1		**13**
White-breasted Cormorant		1							1							**2**
White-rumped Swift		1		3		17					10					**31**
Wing-snapping Cisticola	10	2		6		5	7	2	7		2			2		**43**

Species	Walk Transect															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Yellow Canary					6							8				**14**
Yellow-billed Duck	7	4		2		1	1	3			1	3	2		7	**31**
Yellow-crowned Bishop	1	2	71	3	26				7	4	70	4		1	3	**192**
Zitting Cisticola	2	6	3	7	5	4	4	6	10	1	13	1	1	10	7	**80**
Total	**818**	**139**	**448**	**421**	**332**	**322**	**314**	**208**	**600**	**510**	**750**	**433**	**142**	**155**	**213**	**5805**



ARCUS

- Project Boundary
- Pentads
- Vantage Point
- CWAC Site
- Walked Transect
- Drive Transect
- CAR Route



1:300,000 Scale @ A3

0 6 12 km

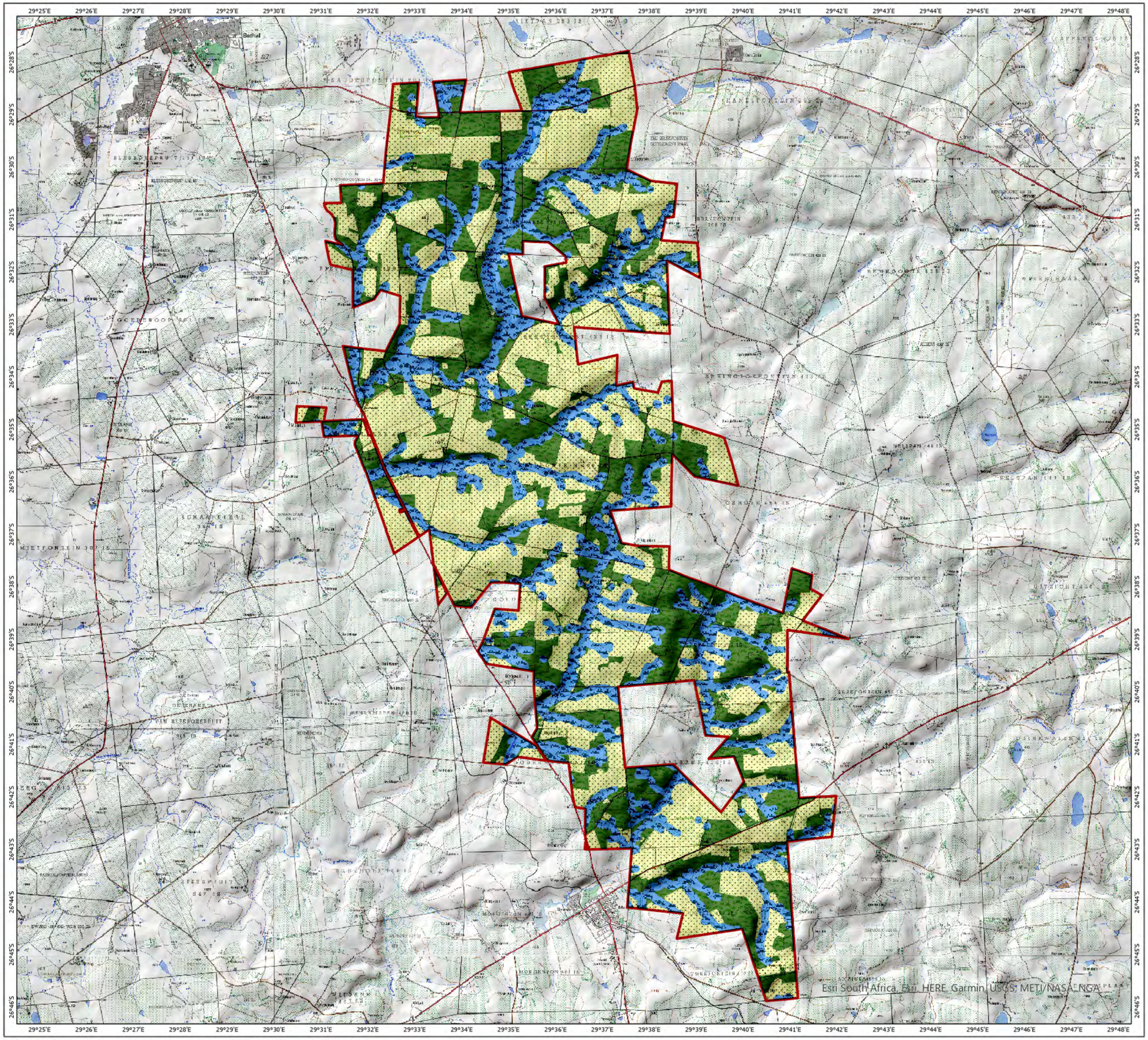
NORTH

Produced By: OD	Ref: 4307-ASR-0001
Checked By: AdVH	Date: 9/1/2022

Location and Vegetation
Figure 1

Ummbila Emoyeni Avifaunal Specialist Assessment Report

G:\Projects\4307 Ummbila Emoyeni WEF\4307 Ummbila Emoyeni WEF3.aprx\4307 - UmmE - Fig 1- Locations



ARCUS

- Project Area Of Influence (PAOI)
- Wetland and Aquatic Habitat
- Natural or Near-natural Grassland
- Agricultural Land (Highly Modified)

1:145,000 Scale @ A3

0 2.5 5 km

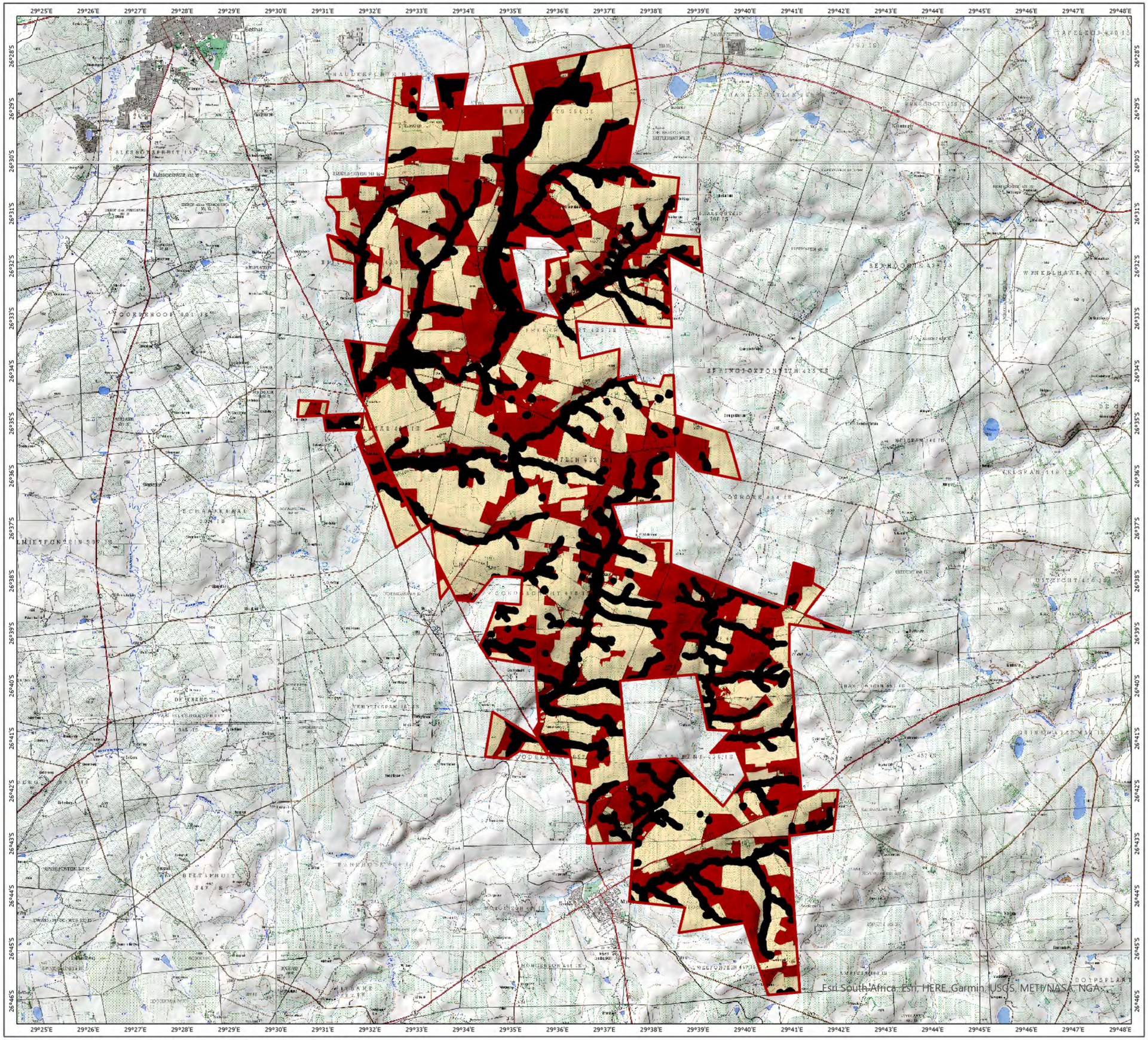
NORTH

Produced By: OD	Ref: 4307-ASR-0002
Checked By: AvDH	Date: 8/13/2022

Land Cover
Figure 2

Ummbila Emoyeni
Avifaunal Specialist Assessment Report

G:\Projects\4307 Ummbila Emoyeni WEF\4307 Ummbila Emoyeni WEF3.aprx\4307 - UmmE - Fig 2 - Landcover



ARCUS

- Project Area of Influence (PAOI)
- Very High Avifaunal SEI
- High Avifaunal SEI
- Very Low Avifaunal SEI (Preferred Development Areas)

1:145,000 Scale @ A3

0 2.5 5 km

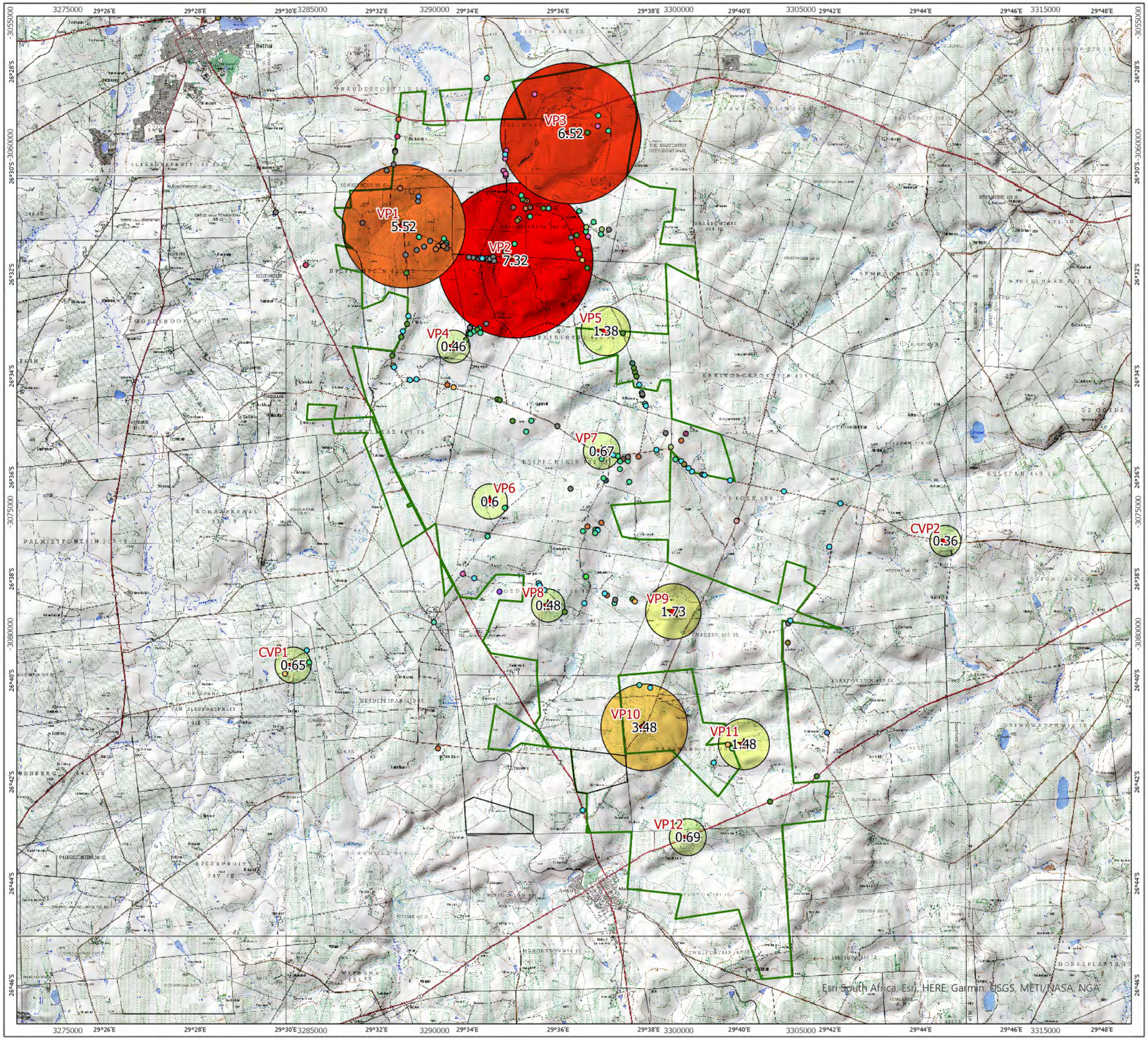
NORTH

Produced By: OD	Ref: 4307-ASR-0003
Checked By: AdVH	Date: 8/13/2022

Avifaunal Site Ecological Importance
Figure 3

Ummbila Emoyeni Avifaunal Specialist Assessment Report

G:\Projects\4307 Ummbila Emoyeni WEF\4307 Ummbila Emoyeni WEF3.aprx\4307 - UmmE- Fig 3 - SEI



ARCUS

- Vantage Point
- Preferred Site
- African Barred Owlet
- African Cuckoo-Hawk
- African Fish Eagle
- African Harrier-Hawk
- Amur Falcon
- Black Sparrowhawk
- Black-chested Snake Eagle
- Black-winged Kite
- Black-winged Pratincole
- Blue Crane
- Blue Korhaan
- Brown Snake Eagle
- Common Buzzard
- Denham's Bustard
- Greater Kestrel
- Grey-winged Francolin
- Lanner Falcon
- Marsh Owl
- Montagu's Harrier
- Pallid Harrier
- Rock Kestrel
- Secretarybird
- Southern Bald Ibis
- White Stork

1:150,000 Scale @ A3

0 3 6 km

NORTH

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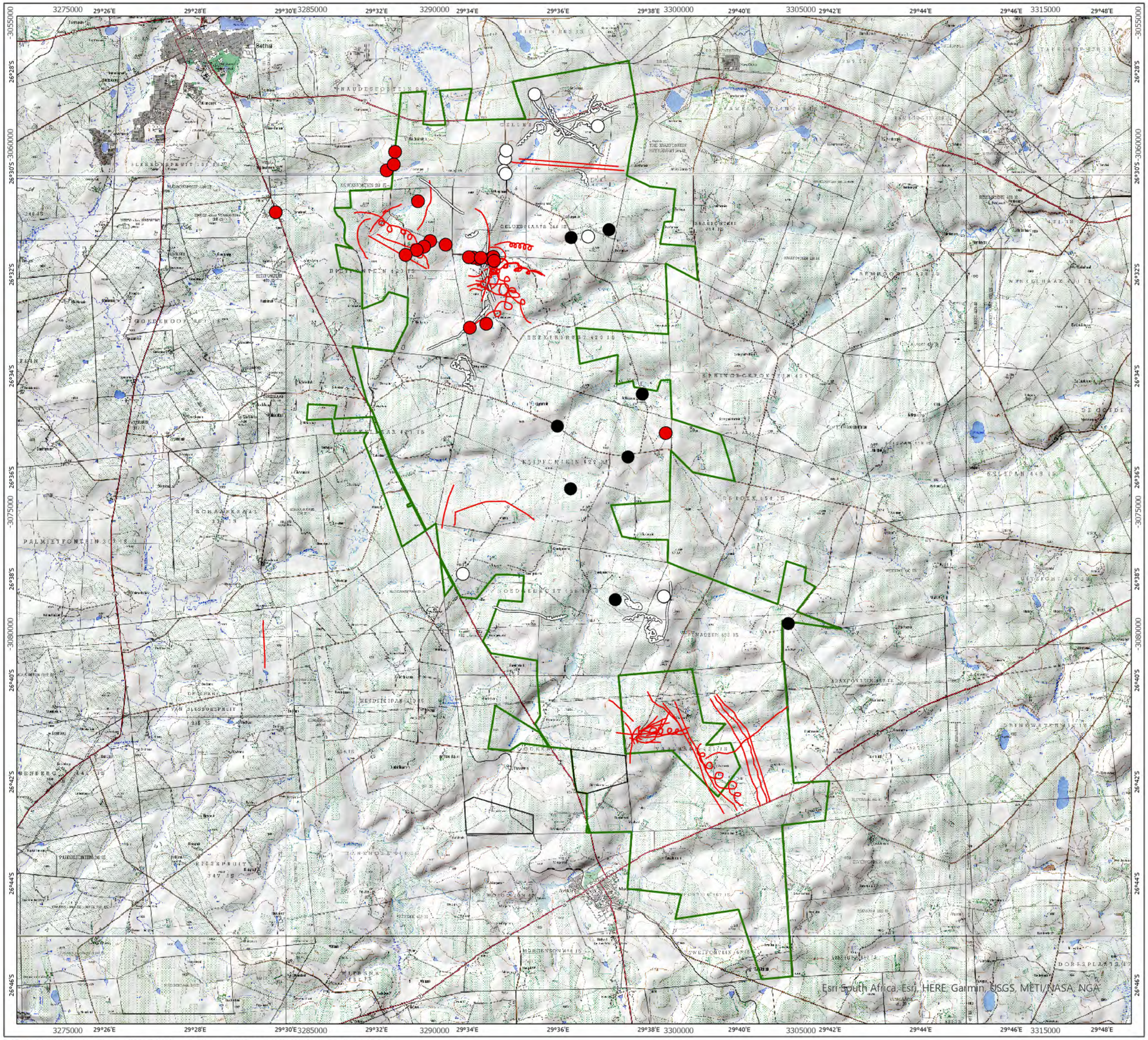
Checked By: AvDH	Date: 8/13/2022

Average Passage Rates and Transect Target Species
Figure 4

Ummbila Emoyeni Avifaunal Specialist Assessment Report

G:\Projects\4307 Ummbila Emoyeni WEF\4307 Ummbila Emoyeni WEF3.aprx\4307-ASR-0004 Fig 4 - Passage Rate



ARCUS

- Preferred Site
- Secretarybird
- Southern Bald Ibis
- White Stork
- Southern Bald Ibis
- White Stork

1:150,000 Scale @ A3

0 3 6 km

NORTH

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Flight Path and Foraging Records for Southern Bald Ibis and White Stork
Figure 5

Ummbila Emoyeni Avifaunal Specialist Assessment Report

G:\Projects\4307 Ummbila Emoyeni WEF\4307 Ummbila Emoyeni WEF3.aprx\4307-ASR-0005 - Fig 5 - Flight Paths

ARCUS

- Indicative WTG Position
- Solar PV Area
- MTS Property

Avifaunal Sensitivity

- Low Avifaunal Sensitivity
- Medium Avifaunal Sensitivity
- High Avifaunal Sensitivity (WTG Acceptable With Mitigation)
- Very High Avifaunal Sensitivity (WTG No-Go)

1:150,000 Scale @ A3

0 3 6 km

NORTH

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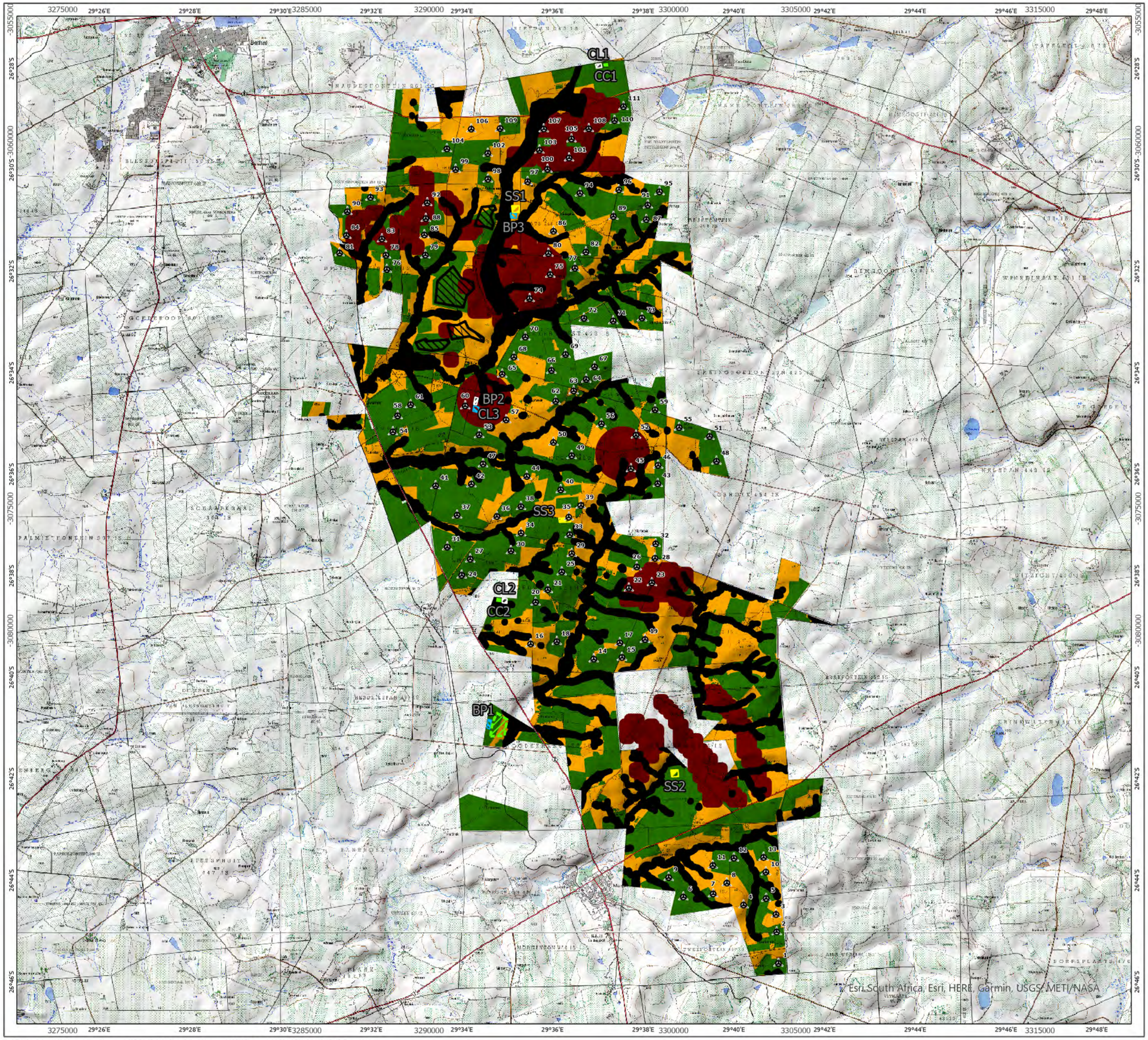
Avifaunal Sensitivity and Indicative Layout
Figure 6

Ummbila Emoyeni Avifaunal Specialist Assessment Report

Esri South Africa, Esri, HERE, Garmin, USGS, METI/NASA, NGA

G:\Projects\4307 Ummbila Emoyeni WEF\4307 Ummbila Emoyeni WEF3.aprx\4307-ASR-0006 - Fig 6 - Sensitivity



ARCUS

- Optimised WTG Position
- Construction Compound
- Construction Laydown Area
- Batching Plant
- Substation
- MTS Area
- Solar PV Area
- Low Avifaunal Sensitivity
- Medium Avifaunal Sensitivity
- High Avifaunal Sensitivity (WTG Acceptable With Mitigation)
- Very High Avifaunal Sensitivity (WTG No-Go)

1:150,000 Scale @ A3

0 3 6 km

NORTH

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Avifaunal Sensitivity and Optimised Layout
Figure 7

Ummbila Emoyeni Avifaunal Specialist Assessment Report

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SACNASP

South African Council for Natural Scientific Professions

herewith certifies that

Owen Rhys Davies

Registration Number: 117555

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following fields(s) of practice (Schedule 1 of the Act)

Ecological Science (Professional Natural Scientist)

Effective **19 July 2017** Expires **31 March 2023**

Chairperson

Chief Executive Officer

To verify this certificate scan this code

CURRICULUM VITAE

Dr Owen Davies Pr. Sci. Nat. (Ecology)

Senior Ecologist – Avifaunal Specialist

Email:OwenD@arcusconsulting.co.za

Specialisms

- Avifaunal surveys
- Ecological surveys
- Field research
- Data analysis and assessment of ecological data

Summary of Experience

Owen is a Professional Natural Scientist registered with the South African Council for Natural Scientific Professions (SACNASP) and obtained his doctoral degree from the Percy FitzPatrick Institute of African Ornithology, a DST-NRF Centre of Excellence at the University of Cape Town. Owen has been involved in avifaunal monitoring activities for renewable energy projects since 2013. Extensive field research has given Owen experience in the techniques required for conducting biological surveys on a variety of taxa including observations, physical trapping and identification of small terrestrial birds, raptors, bats, small mammals, rodents, snakes, reptiles, scorpions and fish. He is also qualified to conduct observations and acoustic monitoring of marine mammals in the offshore environment. Data collection in a diversity of habitats and ecosystems, combined with formal training in field skills such as off-road driving, enables Owen to conduct ecological surveys across southern Africa. In addition, his skills in data analysis and scientific writing at the PhD level enable him to produce high quality assessments and reports.

Qualifications and Professional Interests

- **University of Cape Town, Percy FitzPatrick Institute of African Ornithology, 2010 to 2015**
  PhD Zoology
- **University of Cape Town, Percy FitzPatrick Institute of African Ornithology, 2008 to 2010**
  MSc Zoology (upgraded to PhD)
- **University of Cape Town, 2007**
  BSc Zoology (Hons)
- **University of Cape Town, 2003 to 2006**
  BSc Zoology
  BSc Botany

Professional History

2019 to present - Avifaunal Specialist, Ecologist, field team leader, Arcus Consultancy Services South Africa (Pty) Ltd, Cape Town
2015 to 2017 - Ecologist, Avifaunal Field Team Leader, Arcus Consultancy Services
2014 to 2015 - Bat monitoring field assistant, Arcus Consultancy Services
2013 to 2015 - Avifaunal observer, Arcus Consultancy Services
2009 to 2013 - Research Assistant (birds) to Dr J. Fuchs (Curator of Birds at the Muséum national d'Histoire naturelle, Paris), throughout South Africa
2007 to 2013 - Research Assistant (birds) to Prof T. M. Crowe (Percy FitzPatrick Institute of African Ornithology, Department of Zoology, University of Cape Town), throughout South Africa
2011 - Research Assistant (birds) to Dr I. Little, Endangered Wildlife Trust, Uganda
2010 - Research Assistant (bats) to Asst. Prof Hassan Salata, Department of Wildlife (South Sudan), Northern Cape
2010 to 2011 - Research Assistant (small mammals) to Dr B. Smit, University of Pretoria, Northern Cape
2010 - Research Assistant to Dr H. Smit-Robinson, Birdlife SA, Western and Northern Cape

CURRICULUM VITAE

Project Experience

- Confidential WEF near Beaufort West, Western Cape Province (Avifaunal monitoring, data analysis and reporting)
- Confidential WEF near Lutzville, Western Cape Province (Ecological assessment and reporting)
- Umsinde Emoyeni WEF (Avifaunal assessment, data analysis and reporting)
- Confidential WEF near Molteno, Northern Cape Province (Avifaunal monitoring data analysis and reporting)
- Confidential Battery Energy Storage System (BESS) near De Aar, Northern Cape Province (Avifaunal assessment, Ecological Assessment, site-walkthrough and reporting)
- Confidential Grid Connection near De Aar, Northern Cape Province (Avifaunal assessment, Ecological assessment, site-walkthrough, data analysis and reporting)
- Confidential WEF near Yzerfontein, Western Cape Province (Avifaunal assessment, Ecological assessment, site-walkthrough, data analysis and reporting)
- Confidential WEF near Kuruman, Northern Cape Province (Ecological Assessment and reporting)
- Confidential WEF near Pofadder, Northern Cape Province (Avifaunal assessment and reporting)
- Confidential WEF near Nelspoort, Western Cape Province (Avifaunal assessment and reporting)
- Metsimatala Solar (Field team leader, bird observations, data analysis and reporting in collaboration with specialists)
- Kolkies WEF (Field team leader, bird observations, bat mast commission, data analysis and reporting in collaboration with specialists)
- Karee WEF (Field team leader, bird observations, bat mast commission, data analysis and reporting in collaboration with specialists)
- Gouda WEF (Field team leader, bird observations – post construction)
- Hopefield WEF (Field team leader, bird observations, data analysis and reporting in collaboration with specialists – post construction)
- Spitzkop West WEF (Bird observations, bat mast commission)
- Pofadder WEF (Bat mast commission)
- Cookhouse WEF (Bat mast commission and decommission)
- Komsberg WEF (Field team leader, bird observations, bat mast commission, data analysis and reporting in collaboration with specialists)
- Bokpoort Solar (Avifaunal assessment, bird observations, data analysis and reporting)

Publications

FJELDSÅ, J., DINESEN, L., DAVIES, O.R., IRESTEDT, M., KRABBE, N.K., HANSEN, L.A. AND BOWIE, R.C. 2021. Description of two new Cisticola species endemic to the marshes of the Kilombero floodplain of southwestern Tanzania. Ibis. https://doi.org/10.1111/ibi.12971

JUNKER, K., SPICKETT, A., DAVIES, O.R., JANSEN, R., KRASNOV, B. R. 2021. Gastrointestinal nematodes in two galliform birds from South Africa: patterns associated with host sex and age. Parasitology Research. https://doi.org/10.1007/s00436-021-07254-0

DAVIES, O.R, JUNKER, K, JANSEN, R, CROWE, T.M. & BOOMKER, J. 2008. Age- and sex-based variation in helminth infection of Helmeted Guineafowl (*Numida meleagris*) with comments on Swainson's Spurfowl (*Pternistis swainsonii*) and Orange River Francolin (*Scleroptila levaillantoides*). South African Journal of Wildlife Research 38 (2): 163-170.

JUNKER, K., DAVIES, O.R., JANSEN, R., CROWE, T.M. & BOOMKER, J. 2008. Nematodes of Swainson's Spurfowl *Pternistis swainsonii* and Orange River Francolin *Scleroptila levaillantoides* from the Free State province, South Africa, with a description of *Tetrameres swainsonii*, sp. nov. (Nematoda: Tetrameridae). Journal of Helminthology 82: 365-371.

University of Cape Town • iYunivesithi yaseKapa • Universiteit van Kaapstad

SPES BONA

We certify that

Owen Rhys Davies

was admitted to the degree of

Doctor of Philosophy

on 11 June 2015

for a thesis entitled: "Taxonomy, phylogeny and biogeography of cisticolas (Cisticola spp.)"

Vice-Chancellor

UNIVERSITY OF CAPE TOWN MDCCCXXIX

Registrar