AVIFAUNAL IMPACT ASSESSMENT: SCOPING

Camden 1 Wind Energy Facility, Mpumalanga Province

Up to 400kV Grid connection components

November 2021

AFRIMAGE Photography (Pty) Ltd t/a:
Chris van Rooyen Consulting
VAT#: 4580238113
email: vanrooyen.chris@gmail.com
Tel: +27 (0)82 4549570 cell

EXECUTIVE SUMMARY

Enertrag South Africa is proposing to develop the Camden Renewable Energy Complex in Mpumalanga, South Africa. The Complex is being developed in the context of the Department of Mineral Resources and Energy's (DMRE) Integrated Resource Plan, and the Renewable Energy Independent Power Producer Procurement Programme (REIPPP) or similar programmes under the IRP. In addition, private off-take agreements are considered where possible.

The Cluster comprises eight (8) distinct projects, namely:

i. Camden I Wind Energy Facility (up to 210MW).
ii. Camden I Wind Grid Connection (up to 132kV).
iii. Camden up to 400kV Gid Connection and Collector substation.
iv. Camden I Solar (up to 100MW).
v. Camden I Solar up to 132kV Gid Connection.
vi. Camden Green Hydrogen and Ammonia Facility, including grid connection infrastructure.
vii. Camden II Wind Energy Facility (up to 210MW).
viii. Camden II Wind Energy Facility up to 132kV Gid Connection.

This report deals with the Camden 1 Wind Energy Facility up to up to 400kV Grid Connection and Collector substation. infrastructure considered as part of this application includes the Collector substation including 132kV/400kV step-up, a small control area and a workshop area, as well as the overhead up to 400kV export powerline to Camden Power Station. Direct connection to the Camden Power Station was assessed as well as the alternative of a Loop-In-Loop-Out connection onto the existing Eskom Camden – Incandu 400kV powerline running adjacent the site. In addition, the expansion of the Camden Power Station substation complex may be required.

IMPACT RATING

The below is a summarised scoping level assessment of the anticipated impacts.

Summarised scoping level assessment of the anticipated impacts

Impact	Nature of Impact	Extent of Impact	Significance (pre-mitigation)	Preferred alternative	No-Go Areas	Mitigation measures
Construction: Displacement due to habitat transformation associated with the construction of the switching station and grid connection power line.	Construction activities could impact on birds breeding, foraging, and roosting in or in close proximity of the proposed switching station through transformation of habitat, which could result in temporary or permanent displacement. Unfortunately, very little mitigation can be applied to reduce the significance of this impact as the total permanent transformation of the natural habitat within the construction footprint of the switching station yard is unavoidable. The loss of habitat for priority species due to direct habitat transformation associated with the construction of the proposed switching station and up to 400kV overhead power line is likely to be moderate due to the small size of the footprint, but ideally high quality grassland should be avoided if possible. The priority species which are potentially vulnerable to this impact are the following: Secretarybird, Black-bellied Bustard, Denham's Bustard, White-bellied Bustard, Blue Crane, Grey Crowned Crane, Spotted Eagle-Owl, Blue Korhaan, Northern Black Korhaan, African Grass Owl, Marsh Owl.	Local	Medium	• Option 2 of the switching station is preferred, as it is located in agricultural habitat and will not impact on high quality grassland. • Option 1 of the switching station is not preferred as it is partially located in high quality grassland.	No exclusion areas have been identified.	• Vegetation clearance should be limited to what is necessary. • The mitigation measures proposed by the biodiversity specialist must be strictly enforced.
Construction: Displacement due to disturbance associated with the construction of the switching station and grid connection power line.	Construction activities also impact on birds through disturbance; this could lead to breeding failure if the disturbance happens during a critical part of the breeding cycle. Construction activities near breeding locations could be a source of disturbance and could lead to temporary breeding failure	Local	Medium	• Option 2 of the switching station is preferred, as it is located in	No exclusion areas have been identified.	• Conduct a pre-construction inspection to identify Red List species that may be breeding within the project footprint to ensure that the impacts to breeding species

	or even permanent abandonment of nests. A potential mitigation measure is the timeous identification of nests and the timing of the construction activities to avoid disturbance during a critical phase of the breeding cycle, although in practice that can admittedly be very challenging to implement. Terrestrial species and owls are most likely to be affected by displacement due to disturbance in the study area. The priority species which are potentially vulnerable to this impact are the following: Secretarybird, Black-bellied Bustard, Denham's Bustard, White-bellied Bustard, Blue Crane, Grey Crowned Crane, Spotted Eagle-Owl, Blue Korhaan, Northern Black Korhaan, African Grass Owl, Marsh Owl.			agricultural habitat and will not impact on high quality grassland. • Option 1 of the switching station is not preferred as it is partially located in high quality grassland.		(if any) are adequately managed. • Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Measures to control noise and dust should be applied according to current best practice in the industry.
Operations: Mortality of priority species due to collisions with the up to 400kV grid connection power line.	Collisions are the biggest threat posed by transmission lines to birds in southern Africa (Van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes, and various species of waterbirds, and to a lesser extent, vultures. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with transmission lines. The priority species which are potentially vulnerable to this impact are the following: Hamerkop, Mallard, Secretarybird, Black-bellied Bustard, Denham's Bustard, White-bellied Bustard, Red-knobbed Coot, Reed Cormorant, White-breasted Cormorant, Blue Crane, Grey Crowned Crane, Wattled Crane, African Darter, African Black Duck, Fulvous Whistling Duck, White-backed Duck, White-faced Whistling Duck, Yellow-billed Duck, Spotted Eagle-Owl, Great Egret,	Regional	High	• Option 2 of the grid connection is preferred, as it is located mostly in agricultural habitat, and it is the shortest option. • Option 1 of the grid connection is not preferred as it is partially located in	A 1km buffer should be implemented around large pans at 26°40'24.53"S 30° 1'31.18"E and, 26°42'4.56"S 30° 1'58.46"E	The authorised alignment must be inspected by an avifaunal specialist by means of a “walk-through” inspection i.e., through a combination of satellite imagery supplemented with in situ inspections by vehicle and where necessary, on foot, once the pole positions have been finalised. The objective would be to demarcate the sections of the powerline crossing wetland and high sensitivity grassland habitat that need to be fitted with Bird Flight Diverters. Once the relevant spans have been identified, Eskom approved Bird flight diverters should be installed for the full span length on the earthwire (according to Eskom guidelines – five metres apart). Light and dark colour

	Intermediate Egret, Little Egret, Western Cattle Egret, Greater Flamingo, Lesser Flamingo, Egyptian Goose, Spur-winged Goose, Black-necked Grebe, Little Grebe, Black Heron, Black-crowned Night Heron, Black-headed Heron, Goliath Heron, Grey Heron, Purple Heron, Squacco Heron, African Sacred Ibis, Glossy Ibis, Hadada Ibis, Southern Bald Ibis, Blue Korhaan, Northern Black Korhaan, African Grass Owl, Marsh Owl, Western Barn Owl, Southern Pochard, South African Shelduck, Cape Shoveler, African Spoonbill, White Stork, Blue-billed Teal, Cape Teal, Red-billed Teal and Cape Vulture.			high quality grassland, and it is longer than Option 2.		devices must be alternated to provide contrast against both dark and light backgrounds respectively.
Operations: Mortality of priority species due to electrocutions within the switching station	Electrocutions within the proposed on-site substation yards are possible but should not affect the more sensitive Red List bird species, as these species are unlikely to use the infrastructure within the substation yard for perching or roosting. Species that are more vulnerable to this impact are corvids, owls and certain species of waterbirds. The priority species which are potentially vulnerable to electrocution impact are the following: Common Buzzard, Jackal Buzzard, Cape Crow, Pied Crow, African Fish Eagle, Black-chested Snake Eagle, Brown Snake Eagle, Long-crested Eagle, Martial Eagle, Spotted Eagle-Owl, Amur Falcon, Lanner Falcon, Peregrine Falcon, Helmeted Guineafowl, Black-headed Heron, Hadada Ibis, Southern Bald Ibis, Black-winged Kite, Yellow-billed Kite, Western Osprey. African Grass Owl, Marsh Owl, Western Barn Owl, Black Sparrowhawk and Cape Vulture.	Regional	Medium	n/a	No exclusion areas have been identified.	The hardware within the proposed substation yard is too complex to warrant any mitigation for electrocution at this stage. It is recommended that if on-going impacts are recorded once operational, site specific mitigation (insulation) be applied reactively. This is an acceptable approach because Red List priority species are unlikely to frequent the substation.

ENVIRONMENTAL SENSITIVITIES

The following specific environmental sensitivities were identified from an avifaunal perspective:

- **Drainage lines and associated wetlands.** Wetlands are important breeding, roosting and foraging habitat for a variety of Red List priority species, most notably for African Grass Owl (SA status Vulnerable), Grey Crowned Crane (SA status Endangered) and African Marsh Harrier (SA status Endangered). Sections of line that traverse this habitat need to be marked with Bird Flight Diverters.
- **Large pans**. The most significant landscape features from a collision risk perspective are the large pans. Pans attract many birds, including Red List species such as Greater Flamingo (SA status Near-threatened), Lesser Flamingo (SA status near-threatened), Martial Eagle (SA Status Endangered), Cape Vulture (SA Status Endangered) and Secretarybird (SA status Vulnerable A 1km buffer should be implemented around large pans at 26°40'24.53"S 30° 1'31.18"E and 26°42'4.56"S 30° 1'58.46"E.
- **High sensitivity grassland - Limited infrastructure zone**. The grassland is vital breeding, roosting and foraging habitat for a variety of Red List priority species. These include Blue Crane (SA status near-threatened), Blue Korhaan (Global status near -threatened), White-bellied Bustard (SA Status Vulnerable), Denham's Bustard (SA Status Vulnerable). Sections of line that traverse this habitat need to be marked with Bird Flight Diverters.

See Figure below for the avifaunal sensitivities identified from a powerline perspective.

Proposed avifaunal high sensitivity and No-Go zones at the Camden 1 Wind Energy Facility for the up to 400kV grid connection including Collector substation.

PRELIMINARY CONCLUSIONS

According to the DFFE national screening tool, the habitat within the development site is classified as **Medium and High** sensitivity for birds according to the Animal Species theme (see Figure 4). This classification is accurate as far as the impact of the proposed WEF is concerned, based on actual conditions recorded on the ground during the 12

months of pre-construction monitoring. The classification of High is justified due to the recorded presence of Red List priority species in the WEF development area, namely Secretarybird (Globally Endangered, Locally Vulnerable) White-bellied Bustard (Locally Vulnerable), Blue Crane (Globally Vulnerable, Locally Near-threatened), Grey Crowned Crane (Globally and Locally Endangered), Martial Eagle (Globally and Locally Endangered), Lanner Falcon (Locally Vulnerable), Greater Flamingo (Locally Near-threatened), Lesser Flamingo (Globally and Locally Near-threatened), Black Harrier (Locally and Globally Endangered), Southern Bald Ibis (Locally and Globally Vulnerable), Blue Korhaan (Globally Near-threatened), African Grass Owl (Locally Vulnerable) and Cape Vulture (Globally and Locally Endangered).

The proposed Camden 1 up to 400kV grid connection and Collector substation will have an anticipated medium to high pre-mitigation negative impact on priority avifauna, which is expected to be reduced to medium and low with appropriate mitigation.

CONTENTS

DETAILS OF THE SPECIALIST

Chris van Rooyen (Bird Specialist)

Chris has 25 years' experience in the management of wildlife interactions with electricity infrastructure. He was head of the Eskom-Endangered Wildlife Trust (EWT) Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has worked in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico, and Florida. Chris also has extensive project management experience and has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author of 15 academic papers (some with co-authors), co-author of two book chapters and several research reports. He has been involved as ornithological consultant in numerous power line and wind generation projects. Chris is also co-author of the Best Practice for Avian Monitoring and Impact Mitigation at Wind Development Sites in Southern Africa, which is currently (2016) accepted as the industry standard. Chris also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Albert Froneman (Bird and GIS Specialist)

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

1. INTRODUCTION

Enertrag South Africa is proposing to develop the Camden Renewable Energy Complex in Mpumalanga, South Africa. The Complex is being developed in the context of the Department of Mineral Resources and Energy's (DMRE) Integrated Resource Plan, and the Renewable Energy Independent Power Producer Procurement Programme (REIPPP), or similar programmes under the IRP. In addition, private off-take agreements are considered where possible.

The Cluster comprises eight (8) distinct projects, namely:

i. Camden I Wind Energy Facility (up to 210MW).
ii. Camden I Wind Grid Connection (up to 132kV).
iii. Camden up to 400kV Gid Connection and Collector substation.
iv. Camden I Solar (up to 100MW).
v. Camden I Solar up to 132kV Gid Connection.
vi. Camden Green Hydrogen and Ammonia Facility, including grid connection infrastructure.
vii. Camden II Wind Energy Facility (up to 210MW).
viii. Camden II Wind Energy Facility up to 132kV Gid Connection.

This report deals with the Camden 1 Wind Energy Facility up to up to 400kV Gid Connection. Infrastructure considered as part of this application includes the Collector substation including 132kV/400kV step-up, a small control area and a workshop area, as well as the overhead up to 400kV export powerline to Camden Power Station. Direct connection to the Camden Power Station was assessed as well as the alternative of a Loop-In-Loop-Out connection onto the existing Eskom Camden – Incandu 400kV powerline running adjacent the site. In addition, the expansion of the Camden Power Station substation complex may be required.

It is proposed that Camden I Wind Energy Facility will connect to the nearby Camden Power Station substation (Camden substation and Uitkoms substation) through an up to 400kV powerline (either single or double circuit). The onsite Collector substation will consist of high voltage substation yard to allow for multiple (up to) up to 400kV feeder bays and transformers, control building, telecommunication infrastructure, access roads, etc. In addition, the expansion of the Camden Power Station substation complex may be required. The area for the onsite substation will be up to 5ha and up to 1ha for the Camden Power Station substation complex expansion (if required). The up to up to 400kV powerline and substation will have a 250m corridor. Two alternative new powerline routes are being investigated. A third option is a LILO connection into the existing Camden – Incandu 400kV, which is currently the technically preferred option for connection to Camden PS.

See Figures 1 and 2 for a map indicating the proposed alternatives.

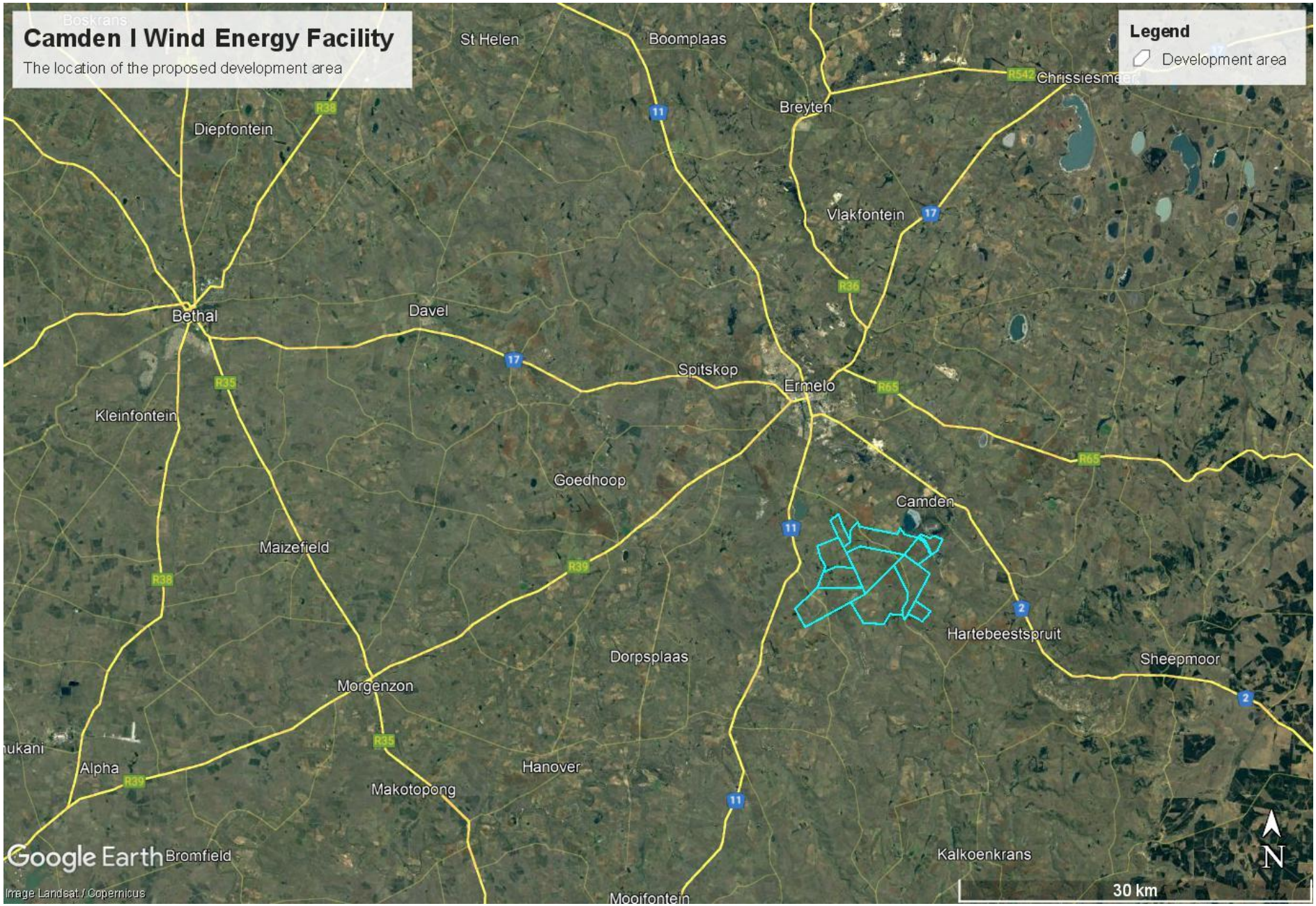

Figure 1: Locality map of the development area of the proposed Camden 1 Wind Energy Facility

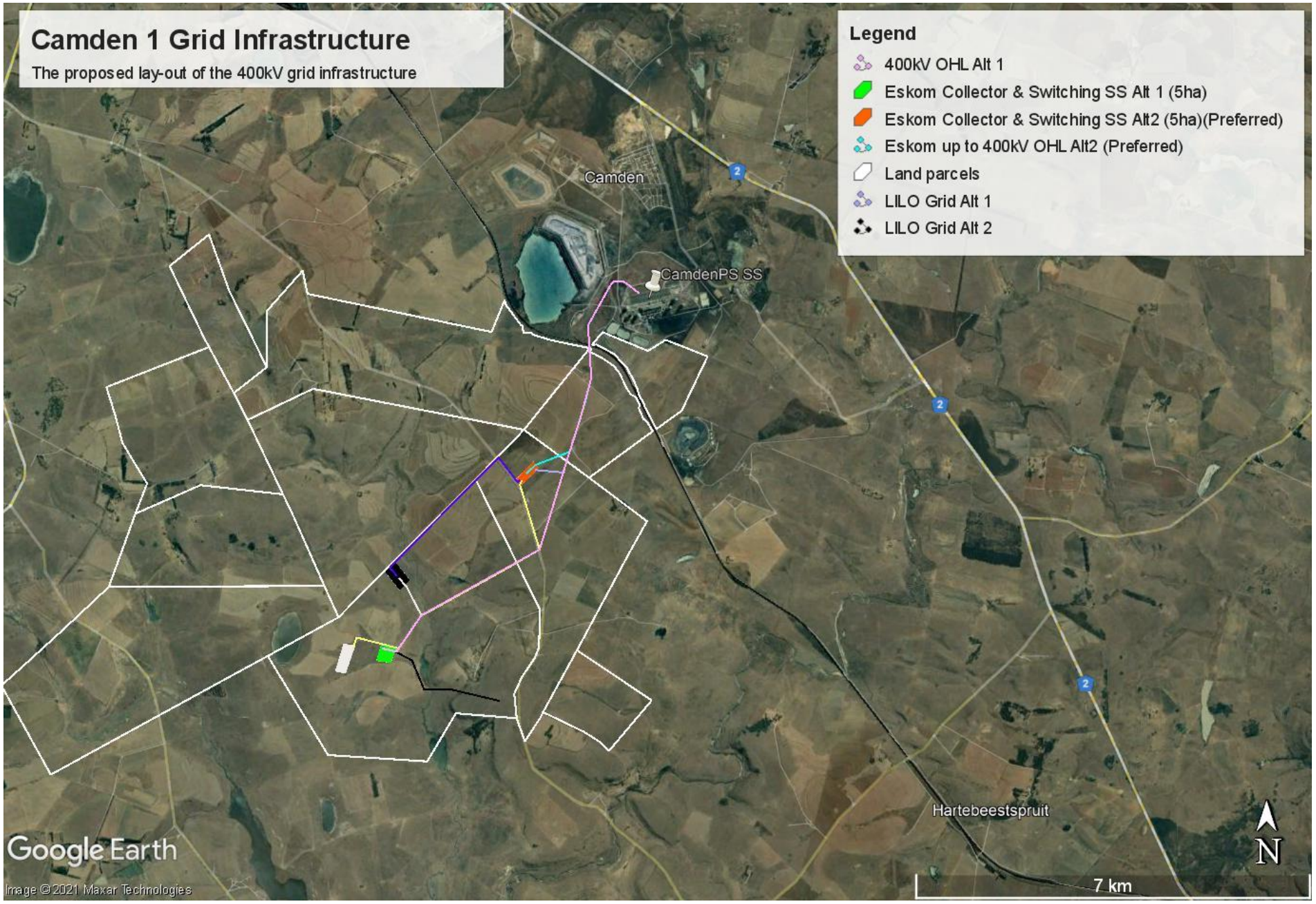

Figure 2: Conceptual lay-out of the proposed Camden 1 Wind Energy Facility grid connection (up to 400kV powerline and collector substation) assessed in this report.

2. TERMS OF REFERENCE

The purpose of the scoping phase report is to determine the main issues and potential impacts of the proposed project/s based on existing information and field assessments. The terms of reference are as follows:

- Describe the affected environment from an avifaunal perspective.
- Discuss gaps in baseline data and other limitations and describe the expected impacts associated with the wind farm and associated infrastructure.
- Identify potential sensitive environments and receptors that may be impacted on by the proposed grid connection and the types of impacts (i.e., direct, indirect and cumulative) that are most likely to occur.
- Determine the nature and extent of potential impacts during the construction and operational phases.
- Identify 'No-Go' areas, where applicable.
- Summarise the potential impacts that will be considered further in the EIA Phase through specialist assessments.
- Recommend mitigation measures to reduce the impact of the expected impacts.

3. OUTLINE OF METHODOLOGY AND INFORMATION REVIEWED

The following information sources were consulted to conduct this study:

- Bird distribution data from the Southern African Bird Atlas Project 2 (SABAP 2) was obtained (http://sabap2.adu.org.za/), in order to ascertain which species, occur in the pentads where the proposed development is located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5' × 5'). Each pentad is approximately 8 × 7.6 km. To get a more representative impression of the birdlife, a consolidated data set was obtained for a total of 16 pentads some of which intersect and others that are near the development area, henceforth referred to as "the broader area" (see Figure 3). The decision to include multiple pentads around the development area was to get a more representative picture of the bird abundance and variety in the region. The additional pentads and their data augment the bird distribution data. A total of 165 full protocol lists (i.e. bird listing surveys lasting a minimum of two hours each) and 227 ad hoc protocol lists (surveys lasting less than two hours but still yielding valuable data) have been completed to date for the 16 pentads where the development area is located. The SABAP2 data was therefore regarded as a reliable reflection of the avifauna which occurs in the area, but the data was also supplemented by data collected during the site surveys and general knowledge of the area.
- A classification of the vegetation types in the development area was obtained from the Atlas of Southern African Birds 1 (SABAP1) and the National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006).
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red List Book of Birds of South Africa, Lesotho, and Swaziland (Taylor *et al.* 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the latest (2021.2) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- The Important Bird and Biodiversity Areas of South Africa (Marnewick *et al.* 2015; http://www.birdlife.org.za/conservation/important-bird-areas) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- An intensive internet search was conducted to source information on the impacts of wind energy facilities on avifauna.
- Satellite imagery (Google Earth © 2021) was used to view the broader area on a landscape level and to help identify bird habitat on the ground.
- The South African National Biodiversity BGIS map viewer was used to determine the locality of the development area relative to National Protected Areas.
- The DFFE National Screening Tool was used to determine the assigned avian sensitivity of the development area.

- The following sources were consulted to determine the investigation protocol that is required for the site:
    - Procedures for the Assessment and Minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of NEMA when applying for Environmental Authorisation (Gazetted October 2020). The Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Animal Species was published on 30 October 2020. This protocol applies also for the assessment of impacts caused by power lines on avifauna.
- The main source of information on the avifaunal diversity and abundance at the study area and development area is an integrated pre-construction monitoring programme which was implemented at the study area, covering all eight proposed sub projects of the Camden Renewable Energy Complex (See Appendix 3).

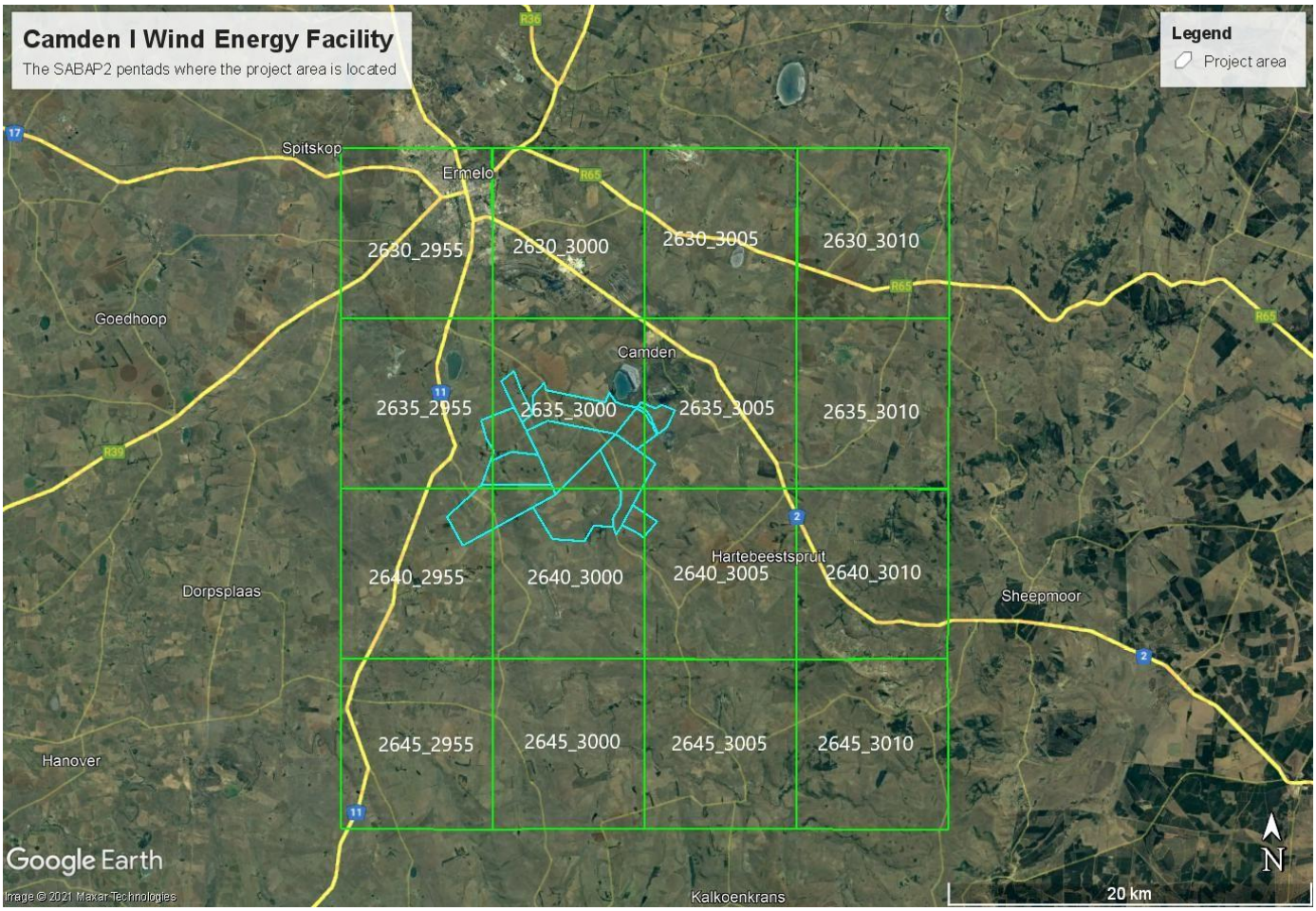

Figure 3: Area covered by the sixteen SABAP2 pentads.

4. ASSUMPTIONS AND LIMITATIONS

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

- The focus of the study was primarily on the potential impacts of the proposed substations (on-site collector and Eskom Camden substation upgrades) and up to up to 400kV overhead power line on priority species. Priority species were defined as species which could potentially be impacted by power line collisions or electrocutions, based on specific morphological and/or behavioural characteristics.
- The assessment of impacts is based on the baseline environment as it currently exists in the study area.
- Conclusions in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will be valid under all circumstances.
- The study area was defined as a 2km zone around the proposed on-site substation and up to up to 400kV overhead power line, inclusive of the Eskom Camden substation upgrades as needed.

5. LEGISLATIVE CONTEXT

5.1 Agreements and conventions

Table 1 below lists agreements and conventions which South Africa is party to, and which are relevant to the conservation of avifauna[1].

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

Convention name	Description	Geographic scope
African-Eurasian Waterbird Agreement (AEWA)	The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) is an intergovernmental treaty dedicated to the conservation of migratory waterbirds and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland and the Canadian Archipelago. Developed under the framework of the Convention on Migratory Species (CMS) and administered by the United Nations Environment Programme (UNEP), AEWA brings together countries and the wider international conservation community in an effort to establish coordinated conservation and management of migratory waterbirds throughout their entire migratory range.	Regional
Convention on Biological Diversity (CBD), Nairobi, 1992	The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has 3 main objectives: The conservation of biological diversity The sustainable use of the components of biological diversity The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.	Global
Convention on the Conservation of Migratory Species of Wild Animals, (CMS), Bonn, 1979	As an environmental treaty under the aegis of the United Nations Environment Programme, CMS provides a global platform for the conservation and sustainable use of migratory animals and their habitats. CMS brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.	Global
Convention on the International Trade in Endangered Species of Wild Flora and Fauna, (CITES), Washington DC, 1973	CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	Global
Ramsar Convention on Wetlands of International Importance, Ramsar, 1971	The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.	Global
Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia	The Signatories will aim to take co-ordinated measures to achieve and maintain the favourable conservation status of birds of prey throughout their range and to reverse their decline when and where appropriate.	Regional

5.2 National legislation

5.2.1 Constitution of the Republic of South Africa, 1996

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

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

[1] (BirdLife International (2021) Country profile: South Africa. Available from: http://www.birdlife.org/datazone/country/south_africa. Checked: 2021-09-20).

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

(i) prevent pollution and ecological degradation;

(ii) promote conservation; and

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

5.3 The National Environmental Management Act 107 of 1998 (NEMA)

The National Environmental Management Act 107 of 1998 (NEMA) creates the legislative framework for environmental protection in South Africa and is aimed at giving effect to the environmental right in the Constitution. It sets out several guiding principles that apply to the actions of all organs of state that may significantly affect the environment. Sustainable development (socially, environmentally, and economically) is one of the key principles, and internationally accepted principles of environmental management, such as the precautionary principle and the polluter pays principle, are also incorporated. NEMA also provides that a wide variety of listed developmental activities, which may significantly affect the environment, may be performed only after an environmental impact assessment has been done and authorization has been obtained from the relevant authority. Many of these listed activities can potentially have negative impacts on bird populations in a variety of ways. The clearance of natural vegetation, for instance, can lead to a loss of habitat and may depress prey populations, while erecting structures needed for generating and distributing energy, communication, and so forth can cause mortalities by collision or electrocution.

Procedures for the Assessment and Minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of NEMA when applying for Environmental Authorisation (Gazetted October 2020). The Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Animal Species was published on 30 October 2020. This protocol applies also for the assessment of impacts caused by power lines on avifauna.

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

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

5.5 Provincial Legislation

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

6. BASELINE ASSESSMENT

6.1 Important Bird Areas

The study area is not located in an Important Bird Area (IBA), but it is located between three IBAs. The closest IBA to the study area is the Amersfoort-Bethal-Carolina IBA SA018, which is located within 5km from the site to the west. The Grasslands IBA SA020 is located 6-7km to the east of the site. The Chrissies Pans IBA SA019 is located 16-17km to the north-east of the site. Due to the close proximity of the site to the IBAs, it is possible that some highly mobile priority species which are also IBA trigger species, and which occur either permanently or sporadically in the IBAs, might be impacted by the project when they leave to forage or breed beyond the borders of the IBA. Species that were recorded in the broader areas and fall within this category are the following:

- Secretarybird
- Denham's Bustard
- Blue Crane
- Grey Crowned Crane
- Wattled Crane
- White-backed Duck
- Yellow-billed Duck
- Martial Eagle
- Lanner Falcon
- Greater Flamingo
- Lesser Flamingo
- Black-necked Grebe
- Little Grebe
- African Marsh Harrier
- Black Harrier
- Southern Bald Ibis
- African Grass Owl
- Southern Pochard
- Cape Shoveler

6.2 DFFE National Screening Tool

According to the DFFE national screening tool, the habitat within the development site is classified as **Medium and High** sensitivity for birds according to the Animal Species theme (see Figure 4). This classification is accurate as far as the impact of the proposed WEF is concerned, based on actual conditions recorded on the ground during the 12 months of pre-construction monitoring. The classification of **High** is justified due to the recorded presence of Red List priority species in the WEF development area, namely Secretarybird (Globally Endangered, Locally Vulnerable) White-bellied Bustard (Locally Vulnerable), Blue Crane (Globally Vulnerable, Locally Near-threatened), Grey Crowned Crane (Globally and Locally Endangered), Martial Eagle (Globally and Locally Endangered), Lanner Falcon (Locally Vulnerable), Greater Flamingo (Locally Near-threatened), Lesser Flamingo (Globally and Locally Near-threatened), Black Harrier (Locally and Globally Endangered), Southern Bald Ibis (Locally and Globally Vulnerable), Blue Korhaan (Globally Near-threatened), African Grass Owl (Locally Vulnerable) and Cape Vulture (Globally and Locally Endangered).

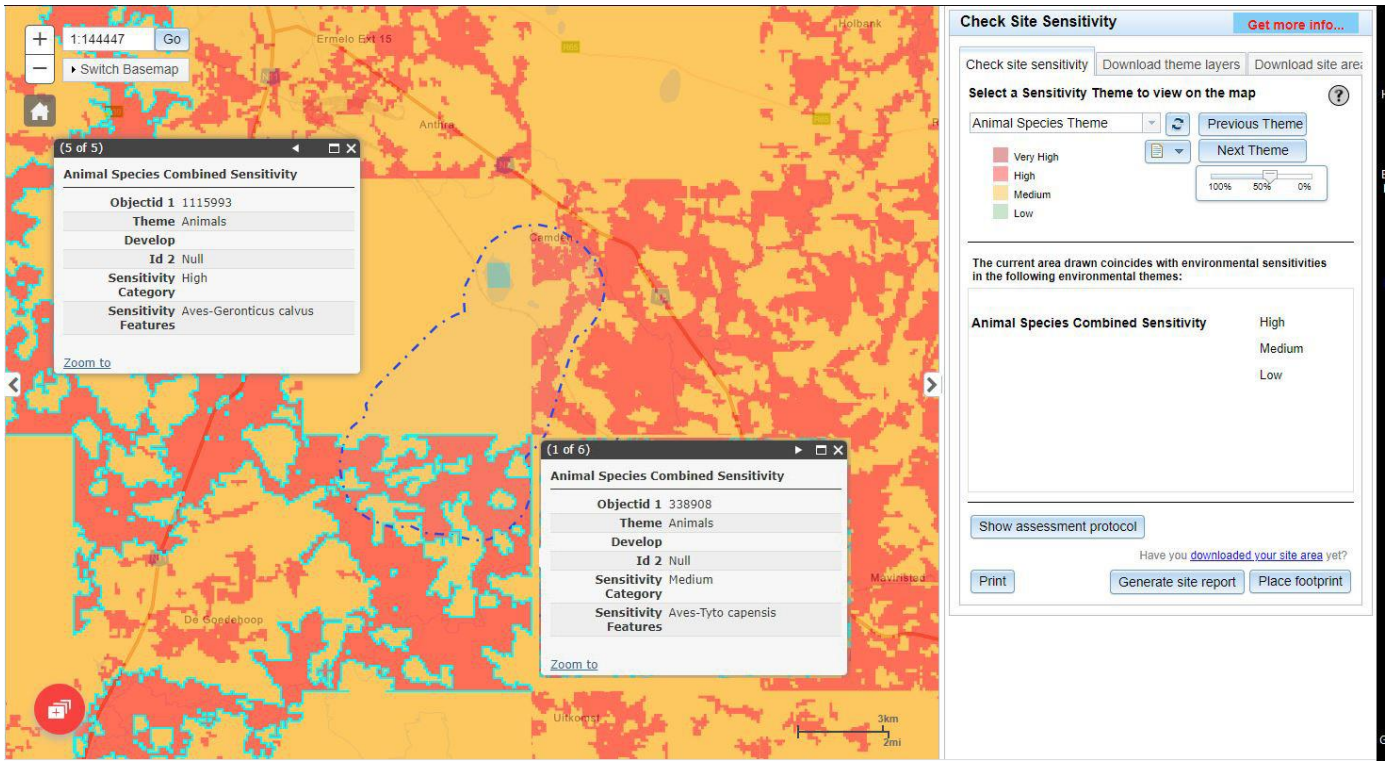

Figure 4: The National Web-Based Environmental Screening Tool map of the study area, indicating sensitivities for the Animal Species theme. The High sensitivity classification is linked to the presence of African Grass Owl and Southern Bald Ibis.

6.3 Protected Areas

According to the South African Protected Areas database (SAPAD), part of the site overlaps with the Langcarel Private Nature Reserve. No further information could be obtained about the nature reserve. However, from an avifaunal perspective the state of the habitat and land use at the project site is more important than the legal status, which has been surveyed and assessed for this assessment. The results provided are therefore applicable regardless of the legal status of the land parcels considered.

6.4 Biomes and vegetation types

The study area is situated in the Grassland Biome, in the Mesic Highveld Grassland Bioregion (Muchina & Rutherford 2006). Vegetation on site consists predominantly Amersfoort Highveld Clay Grassland and Eastern Highveld Grassland, which is comprised of undulating grassland plains, with small, scattered patches of dolerite outcrops in areas, low hills and pan depressions. The vegetation is comprised of a short, closed grassland cover, largely dominated by a dense *Themeda triandra* sward, often severely grazed to form a short lawn (Mucina & Rutherford 2006).

Ermelo has a temperate climate. January is the warmest month with a maximum temperature of 24.4 C°. June and July are the coldest months, with a minimum temperature of 0.2 C°. The driest month is June with an average of 3 mm of precipitation. Most of the precipitation falls in December, averaging 151 mm. The average annual precipitation is around 756 mm (Climate – data.org 2021).

The topography in the application site is characterised by gentle undulating plains. The predominant land use for this area is livestock grazing with some crop farming, mostly maize, soya beans and pastures. The livestock in the study area is a combination of mostly sheep and cattle, with a few horses.

6.5 Bird habitat

Whilst much of the distribution and abundance of the bird species in the study area can be explained by the dominant biomes and vegetation types, it is also important to examine the modifications which have changed the natural landscape, and which may influence the distribution of avifauna. These are sometimes evident at a much smaller spatial scale than the biome or vegetation types and are determined by a host of factors such as topography, land use and man-made infrastructure.

The following bird habitat classes were identified in the study area (see Appendix 2 for examples of the habitat classes):

6.5.1 Grassland

A large part of the habitat in the study area comprises grassland. The grassland varies from dense stands of relatively high grass to areas of heavily grazed short grass. The priority species which could potentially use the natural grassland in the study area on a regular basis are the following:

- Secretarybird
- White-bellied Bustard
- Common Buzzard
- Jackal Buzzard
- Blue Crane
- Grey Crowned Crane
- Cape Crow
- Pied Crow
- Black-chested Snake Eagle
- Long-crested Eagle
- Spotted Eagle-Owl
- Western Cattle Egret
- Amur Falcon
- Lanner Falcon
- Helmeted Guineafowl
- African Harrier-Hawk
- Black-headed Heron
- Hadada Ibis
- Southern Bald Ibis
- Black-winged Kite
- Blue Korhaan
- African Grass Owl
- Marsh Owl
- Western Barn Owl
- White Stork

The priority species which could occasionally use the grassland in the study area are the following:

- Black-bellied Bustard
- Denham's Bustard
- Brown Snake Eagle
- Martial Eagle
- Peregrine Falcon
- Black Harrier
- Montagu's Harrier
- Yellow-billed Kite
- Northern Black Korhaan
- Cape Vulture

6.5.2 Drainage lines and wetlands

There are a number of wetlands in the study area, most of which are associated with drainage lines. The priority species which could potentially use the wetlands in the study area on a regular basis are the following:

- Blue Crane
- Grey Crowned Crane
- Hadada Ibis
- African Grass Owl
- Marsh Owl

The priority species which could occasionally use the wetlands in the study area are the following:

- African Marsh Harrier
- Wattled Crane

6.5.3 Agricultural lands

The study area contains a patchwork of agricultural fields, where maize, soya beans and pastures are cultivated. Some fields are lying fallow or are in the process of being re-vegetated by grass. The priority species which could potentially use the agricultural fields in the study area on a regular basis are the following:

- Blue Crane
- Egyptian Goose
- Spur-winged Goose
- Helmeted Guineafowl
- Southern Bald Ibis

The priority species which could occasionally use the agricultural lands in the study area are the following:

- Amur Falcon
- Lanner Falcon
- Grey Crowned Crane

6.5.4 Alien trees

The study area contains few trees. Most trees are alien species, particularly Eucalyptus, Australian Acacia (Wattle), and Salix (Willow) species. Trees are often planted as wind breaks next to agricultural lands and around homesteads. Some of the drainage lines also have trees growing in them. The priority species which could potentially use the alien trees in the study area on a regular basis are the following:

- Secretarybird
- Common Buzzard
- Jackal Buzzard
- Reed Cormorant
- White-breasted Cormorant
- Cape Crow
- Pied Crow
- African Darter
- African Fish Eagle
- Black-chested Snake Eagle
- Long-crested Eagle
- Spotted Eagle-Owl
- Western Cattle Egret
- Amur Falcon
- Lanner Falcon
- Helmeted Guineafowl
- African Harrier-Hawk
- African Sacred Ibis
- Hadada Ibis
- Southern Bald Ibis
- Rock Kestrel
- Black-winged Kite
- Western Barn Owl
- Black Sparrowhawk

The priority species which could occasionally use the alien trees in the study area are the following:

- Peregrine Falcon
- Brown Snake Eagle
- Martial Eagle
- Cape Vulture
- Grey Crowned Crane
- Western Osprey

6.5.5 Dams

There are numerous ground dams at the study area, located in drainage lines. The priority species which could potentially use the dams in the study area on a regular basis are the following:

- Hamerkop
- Red-knobbed Coot
- Reed Cormorant
- White-breasted Cormorant
- African Darter
- Great Egret
- Intermediate Egret
- Little Egret
- Egyptian Goose

- Spur-winged Goose
- Little Grebe
- Grey Heron
- Purple Heron
- African Sacred Ibis
- Common Moorhen
- Southern Pochard
- South African Shelduck
- White Stork
- African Swamphen
- Red-billed Teal

The priority species which could occasionally use the dams in the study area are the following:

- Mallard
- Black-necked Grebe
- Black Heron
- Black-crowned Night Heron
- Goliath Heron
- Squacco Heron
- Western Osprey
- Blue-billed Teal
- Cape Teal

6.5.6 Pans

The study area contains one large pan, and another large pan is located on the southern edge of the study area. These pans are a potential drawcard for many priority species. Lesser and Greater Flamingos could use these pans for foraging and roosting. Large raptors and vultures could use the pans for bathing and drinking, and Blue Cranes could roost there on occasion. The priority species which could potentially use the pans in the study area on a regular basis are the following:

- Hamerkop
- Secretarybird
- Red-knobbed Coot
- Blue Crane
- Grey Crowned Crane
- Black-chested Snake Eagle
- Lanner Falcon
- Greater Flamingo
- Lesser Flamingo
- Egyptian Goose
- South African Shelduck

The priority species which could occasionally use the pans in the study area are the following:

- Mallard
- Brown Snake Eagle
- Martial Eagle
- Peregrine Falcon

- Yellow-billed Kite
- Cape Teal
- Cape Vulture

6.5.7 High voltage lines

Eskom power line pylons/towers are regularly used as roosting, hunting and/or nesting habitat by certain species, especially raptors and crows. Southern Bald Ibis is also known to roost on transmission towers in large numbers. The priority species which could potentially use the high voltage lines in the study area on a regular basis are the following:

- Common Buzzard
- Jackal Buzzard
- Cape Crow
- Pied Crow
- Black-chested Snake Eagle
- Long-crested Eagle
- Amur Falcon
- Lanner Falcon
- Southern Bald Ibis
- Rock Kestrel
- Black-winged Kite

The priority species which could occasionally use the high voltage lines in the study area are the following:

- Brown Snake Eagle
- Martial Eagle
- Peregrine Falcon
- Western Osprey
- Cape Vulture

See Appendix 2 for photographic record of habitat features in the study area and immediate surroundings.

6.6 AVIFAUNA

6.6.1 South African Bird Atlas Project 2

The SABAP2 data indicates that a total of 234 bird species could potentially occur within the broader area – Appendix 1 provides a comprehensive list of all the species. Of these, 78 species are classified as priority species (see definition of priority species in section 4) and 15 of these are South African Red List species. Of the priority species, 55 are likely to occur regularly in the development area (see Table 2 below).

Table 3 below lists all the priority species that are likely to occur regularly and the possible impact on the respective species by the proposed up to 400kV grid connection and collector substation. The following abbreviations and acronyms are used:

- NT = Near threatened
- VU = Vulnerable
- EN = Endangered

Table 2: Priority species potentially occurring at the development area (Red List species are shaded).

Species name	Scientific name	SABAp2 full protocol reporting rate	SABAp2 Ad hoc protocol reporting rate	Global status	Regional status	Powerline priority	Recorded during surveys	Likelihood of regular occurrence	Grassland	Drainage lines and wetlands	Dams	Pans	Alien trees	HV lines	Agriculture	Powerline - Collision	Displacement: Disturbance	Displacement: Habitat transformation	Electrocutions: Substation
Hamerkop	*Scopus umbretta*	12	0	-	-	x	x	H		x	x	x				x			
Mallard	*Anas platyrhynchos*	0.6	0.4	-	-	x		L			x	x				x			
Secretarybird	*Sagittarius serpentarius*	13	0	EN	VU	x	x	H	x			x	x			x	x	x	
Black-bellied Bustard	*Lissotis melanogaster*	0.6	0	-	-	x		L	x							x	x	x	
Denham's Bustard	*Neotis denhami*	1.8	0	NT	VU	x		L	x							x	x	x	
White-bellied Bustard	*Eupodotis senegalensis*	7.9	0	-	VU	x	x	M	x							x	x	x	
Common Buzzard	*Buteo buteo*	28	9.3	-	-	x	x	H	x				x	x					x
Jackal Buzzard	*Buteo rufofuscus*	19	2.2	-	-	x	x	H	x				x	x					x
Red-knobbed Coot	*Fulica cristata*	58	4.8	-	-	x	x	H			x	x				x			
Reed Cormorant	*Microcarbo africanus*	64	4.8	-	-	x	x	H			x		x			x			
White-breasted Cormorant	*Phalacrocorax lucidus*	12	0.9	-	-	x	x	H			x		x			x			
Blue Crane	*Grus paradisea*	12	0.4	VU	NT	x	x	H	x	x		x			x	x	x	x	
Grey Crowned Crane	*Balearica regulorum*	5.5	0	EN	EN	x	x	M	x	x		x	x		x	x	x	x	
Wattled Crane	*Grus carunculata*	0.6	0	VU	CR	x		L		x						x			
Cape Crow	*Corvus capensis*	18	0.4	-	-	x	x	H	x				x	x					x
Pied Crow	*Corvus albus*	12	3.5	-	-	x	x	H	x				x	x					x
African Darter	*Anhinga rufa*	16	2.2	-	-	x	x	H			x		x			x			
African Black Duck	*Anas sparsa*	11	0	-	-	x	x	H		x						x			
Fulvous Whistling Duck	*Dendrocygna bicolor*	0	0.4	-	-	x		L								x			
White-backed Duck	*Thalassornis leuconotus*	6.7	0	-	-	x	x	M								x			
White-faced Whistling Duck	*Dendrocygna viduata*	0.6	0	-	-	x		L								x			
Yellow-billed Duck	*Anas undulata*	62	4.4	-	-	x	x	H								x			
African Fish Eagle	*Haliaeetus vocifer*	12	0.9	-	-	x	x	H					x						x
Black-chested Snake Eagle	*Circaetus pectoralis*	3	0.4	-	-	x	x	M	x			x	x	x					x
Brown Snake Eagle	*Circaetus cinereus*	1.8	0	-	-	x		L	x			x	x	x					x
Long-crested Eagle	*Lophaetus occipitalis*	6.7	9.3	-	-	x	x	M	x				x	x					x
Martial Eagle	*Polemaetus bellicosus*	2.4	0	EN	EN	x	x	L	x			x	x	x					x
Spotted Eagle-Owl	*Bubo africanus*	9.1	0.9	-	-	x	x	M	x				x			x	x	x	x

Species name	Scientific name	SABAp2 full protocol reporting rate	SABAp2 Ad hoc protocol reporting rate	Global status	Regional status	Powerline priority	Recorded during surveys	Likelihood of regular occurrence	Grassland	Drainage lines and wetlands	Dams	Pans	Alien trees	HV lines	Agriculture	Powerline - Collision	Displacement: Disturbance	Displacement: Habitat transformation	Electrocutions: Substation
Great Egret	*Ardea alba*	7.9	1.3	-	-	x		M		x	x					x			
Intermediate Egret	*Ardea intermedia*	14	1.8	-	-	x	x	H		x	x					x			
Little Egret	*Egretta garzetta*	4.2	1.3	-	-	x		H		x	x					x			
Western Cattle Egret	*Bubulcus ibis*	45	12	-	-	x	x	H	x				x			x			
Amur Falcon	*Falco amurensis*	29	6.6	-	-	x	x	H	x				x	x	x				x
Lanner Falcon	*Falco biarmicus*	7.3	0	-	VU	x	x	M	x			x	x	x	x				x
Peregrine Falcon	*Falco peregrinus*	1.2	0	-	-	x	x	L	x			x	x	x					x
Greater Flamingo	*Phoenicopterus roseus*	3.6	4.4	-	NT	x	x	M				x				x			
Lesser Flamingo	*Phoeniconaias minor*	3.6	1.3	NT	NT	x	x	M				x				x			
Egyptian Goose	*Alopochen aegyptiaca*	78	6.2	-	-	x	x	H			x	x			x	x			
Spur-winged Goose	*Plectropterus gambensis*	44	1.8	-	-	x	x	H			x				x	x			
Black-necked Grebe	*Podiceps nigricollis*	0.6	0.4	-	-	x		L			x					x			
Little Grebe	*Tachybaptus ruficollis*	39	3.1	-	-	x	x	H			x					x			
Helmeted Guineafowl	*Numida meleagris*	49	3.1	-	-	x	x	H	x				x		x		x	x	x
African Marsh Harrier	*Circus ranivorus*	0.6	0	-	EN	x		L		x									
Black Harrier	*Circus maurus*	0	0.9	EN	EN	x		L	x										
Montagu's Harrier	*Circus pygargus*	1.2	0	-	-	x		L	x										
African Harrier-Hawk	*Polyboroides typus*	12	1.8	-	-	x	x	M	x				x						
Black Heron	*Egretta ardesiaca*	0.6	0	-	-	x		L			x					x			
Black-crowned Night Heron	*Nycticorax nycticorax*	0.6	0	-	-	x		L			x					x			
Black-headed Heron	*Ardea melanocephala*	52	4	-	-	x	x	H	x							x			x
Goliath Heron	*Ardea goliath*	2.4	0	-	-	x		L			x					x			
Grey Heron	*Ardea cinerea*	25	3.5	-	-	x	x	H			x					x			
Purple Heron	*Ardea purpurea*	4.2	0	-	-	x		M			x					x			
Squacco Heron	*Ardeola ralloides*	1.2	0	-	-	x		L			x					x			
African Sacred Ibis	*Threskiornis aethiopicus*	48	6.2	-	-	x	x	H			x		x			x			
Glossy Ibis	*Plegadis falcinellus*	4.2	1.8	-	-	x		M		x						x			
Hadada Ibis	*Bostrychia hagedash*	90	14	-	-	x	x	H	x	x			x			x			x
Southern Bald Ibis	*Geronticus calvus*	23	3.1	VU	VU	x	x	H	x				x	x	x	x			x
Rock Kestrel	*Falco rupicolus*	5.5	0.9	-	-	x	x	M					x	x					
Black-winged Kite	*Elanus caeruleus*	61	13	-	-	x	x	H	x				x	x					x
Yellow-billed Kite	*Milvus aegyptius*	2.4	0	-	-	x	x	L	x			x	x						x

Species name	Scientific name	SABAp2 full protocol reporting rate	SABAp2 Ad hoc protocol reporting rate	Global status	Regional status	Powerline priority	Recorded during surveys	Likelihood of regular occurrence	Grassland	Drainage lines and wetlands	Dams	Pans	Alien trees	HV lines	Agriculture	Powerline - Collision	Displacement: Disturbance	Displacement: Habitat transformation	Electrocutions: Substation
Blue Korhaan	*Eupodotis caerulescens*	6.1	0	NT	LC	x	x	H	x							x	x	x	
Northern Black Korhaan	*Afrotis afraoides*	0.6	0	-	-	x		L	x							x	x	x	
Common Moorhen	*Gallinula chloropus*	33	1.8	-	-	x	x	H			x								
Western Osprey	*Pandion haliaetus*	0.6	0	-	-	x		L			x		x	x					x
African Grass Owl	*Tyto capensis*	2.4	0	-	VU	x	x	M	x	x						x	x	x	x
Marsh Owl	*Asio capensis*	5.5	0.4	-	-	x	x	M	x	x						x	x	x	x
Western Barn Owl	*Tyto alba*	3	0.4	-	-	x		M	x				x			x			x
Southern Pochard	*Netta erythrophthalma*	9.1	0	-	-	x	x	M			x					x			
South African Shelduck	*Tadorna cana*	30	3.5	-	-	x	x	H			x	x				x			
Cape Shoveler	*Spatula smithii*	19	0	-	-	x	x	H								x			
Black Sparrowhawk	*Accipiter melanoleucus*	12	0.9	-	-	x	x	H					x						x
African Spoonbill	*Platalea alba*	16	2.2	-	-	x	x	H								x			
White Stork	*Ciconia ciconia*	7.3	1.3	-	-	x	x	M	x		x					x			
African Swamphen	*Porphyrio madagascariensis*	6.1	2.2	-	-	x	x	M			x								
Blue-billed Teal	*Spatula hottentota*	1.2	0	-	-	x		L			x					x			
Cape Teal	*Anas capensis*	3	0	-	-	x	x	L			x	x				x			
Red-billed Teal	*Anas erythrorhyncha*	17	1.3	-	-	x	x	H			x					x			
Cape Vulture	*Gyps coprotheres*	0	0	EN	EN	x	x	L	x			x	x	x		x			x

7 IMPACT ASSESSMENT

7.1 General

Negative impacts on avifauna by electricity infrastructure generally take two main forms namely electrocution and collisions (Ledger & Annegarn 1981; Ledger 1983; Ledger 1984; Hobbs and Ledger 1986a; Hobbs & Ledger 1986b; Ledger, Hobbs & Smith, 1992; Verdoorn 1996; Kruger & Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000; Van Rooyen 2004; Jenkins *et al*. 2010). Displacement due to habitat destruction and disturbance associated with the construction of the electricity infrastructure is another impact that could potentially impact on avifauna.

7.2 Electrocutions

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (Van Rooyen 2004). The electrocution risk is largely determined by the pole/tower design. In the case of the proposed up to 400kV grid connection, the electrocution risk is envisaged to be negligible because the proposed design of the up to 400kV line because of the clearance distances between the live and earthed components. The up to 400kV grid connection power line should not pose an electrocution threat to the priority species which are likely to occur in the study area and immediate surrounding environment.

Electrocutions within the proposed substation yards are possible but should not affect the more sensitive Red List bird species, as these species are unlikely to use the infrastructure within the substation yard for perching or roosting. Species that are more vulnerable to this impact are corvids, owls, and certain species of waterbirds.

The priority species which are potentially vulnerable to electrocution impact are listed in Table 3, and below:

- Common Buzzard
- Jackal Buzzard
- Cape Crow
- Pied Crow
- African Fish Eagle
- Black-chested Snake Eagle
- Brown Snake Eagle
- Long-crested Eagle
- Martial Eagle
- Spotted Eagle-Owl
- Amur Falcon
- Lanner Falcon
- Peregrine Falcon
- Helmeted Guineafowl
- Black-headed Heron
- Hadada Ibis
- Southern Bald Ibis
- Black-winged Kite
- Yellow-billed Kite
- Western Osprey

- African Grass Owl
- Marsh Owl
- Western Barn Owl
- Black Sparrowhawk
- Cape Vulture

7.3 Collisions

Collisions are the biggest threat posed by transmission lines to birds in southern Africa (Van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds, and to a lesser extent, vultures. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with transmission lines (Van Rooyen 2004, Anderson 2001). In a PhD study, Shaw (2013) provides a concise summary of the phenomenon of avian collisions with transmission lines:

"The collision risk posed by power lines is complex and problems are often localised. While any bird flying near a power line is at risk of collision, this risk varies greatly between different groups of birds, and depends on the interplay of a wide range of factors (APLIC 1994). Bevanger (1994) described these factors in four main groups – biological, topographical, meteorological, and technical. Birds at highest risk are those that are both susceptible to collisions and frequently exposed to power lines, with waterbirds, gamebirds, rails, cranes and bustards usually the most numerous reported victims (Bevanger 1998, Rubolini et al. 2005, Jenkins et al. 2010).

The proliferation of man-made structures in the landscape is relatively recent, and birds are not evolved to avoid them. Body size and morphology are key predictive factors of collision risk, with large-bodied birds with high wing loadings (the ratio of body weight to wing area) most at risk (Bevanger 1998, Janss 2000). These birds must fly fast to remain airborne, and do not have sufficient manoeuvrability to avoid unexpected obstacles. Vision is another key biological factor, with many collision-prone birds principally using lateral vision to navigate in flight, when it is the lower-resolution, and often restricted, forward vision that is useful to detect obstacles (Martin & Shaw 2010, Martin 2011, Martin et al. 2012). Behaviour is important, with birds flying in flocks, at low levels and in crepuscular or nocturnal conditions at higher risk of collision (Bevanger 1994). Experience affects risk, with migratory and nomadic species that spend much of their time in unfamiliar locations also expected to collide more often (Anderson 1978, Anderson 2002). Juvenile birds have often been reported as being more collision-prone than adults (e.g. Brown et al. 1987, Henderson et al. 1996).

Topography and weather conditions affect how birds use the landscape. Power lines in sensitive bird areas (e.g. those that separate feeding and roosting areas, or cross flyways) can be very dangerous (APLIC 1994, Bevanger 1994). Lines crossing the prevailing wind conditions can pose a problem for large birds that use the wind to aid take-off and landing (Bevanger 1994). Inclement weather can disorient birds and reduce their flight altitude, and strong winds can result in birds colliding with power lines that they can see but do not have enough flight control to avoid (Brown et al. 1987, APLIC 2012).

The technical aspects of power line design and siting also play a big part in collision risk. Grouping similar power lines on a common servitude or locating them along other features such as tree lines, are both approaches thought to reduce risk (Bevanger 1994). In general, low lines with short span lengths (i.e. the distance between two adjacent pylons) and flat conductor configurations are thought to be the least dangerous (Bevanger 1994, Jenkins et al. 2010). On many higher voltage lines, there is a thin earth (or ground) wire above the conductors, protecting the system from lightning strikes. Earth wires are widely accepted to cause

most collisions on power lines with this configuration because they are difficult to see, and birds flaring to avoid hitting the conductors often put themselves directly in the path of these wires (Brown et al. 1987, Faanes 1987, Alonso et al. 1994a, Bevanger 1994)."

From national incidental record keeping by the Endangered Wildlife Trust, it is possible to give a measure of what species are generally susceptible to power line collisions in South Africa (Figure 6).

Power line collisions are generally accepted as a key threat to bustards (Raab *et al*. 2009; Raab *et al*. 2010; Jenkins & Smallie 2009; Barrientos *et al*. 2012, Shaw 2013). In a recent study, carcass surveys were performed under high voltage transmission lines in the Karoo for two years, and low voltage distribution lines for one year (Shaw 2013). Ludwig's Bustard was the most common collision victim (69% of carcasses), with bustards generally comprising 87% of mortalities recovered. Total annual mortality was estimated at 41% of the Ludwig's Bustard population, with Kori Bustards also dying in large numbers (at least 14% of the South African population killed in the Karoo alone). Karoo Korhaan was also recorded, but to a much lesser extent than Ludwig's Bustard. The reasons for the relatively low collision risk of this species probably include their smaller size (and hence greater agility in flight) as well as their more sedentary lifestyles, as local birds are familiar with their territory and are less likely to collide with power lines (Shaw 2013).

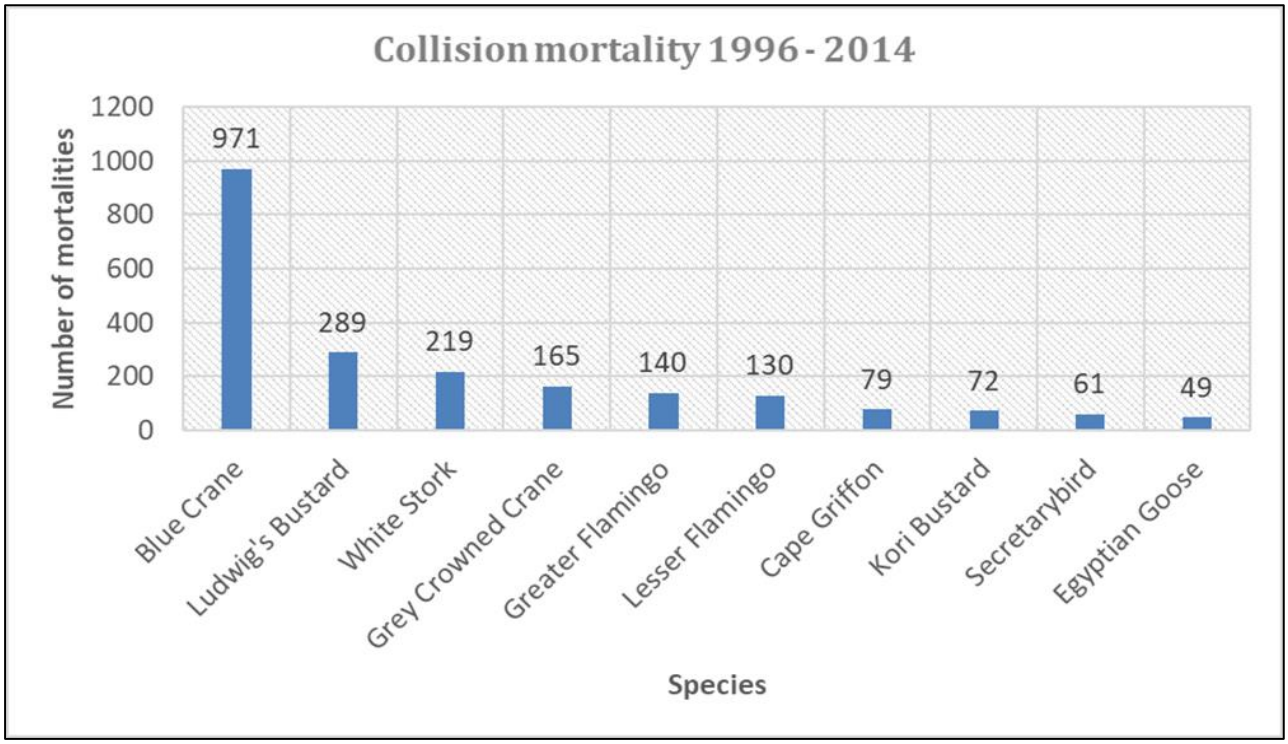

Figure 5: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/Endangered Wildlife Trust Strategic Partnership central incident register 1996 - 2014 (EWT unpublished data)

Several factors are thought to influence avian collisions, including the manoeuvrability of the bird, topography, weather conditions and power line configuration. An important additional factor that previously has received little attention is the visual capacity of birds, i.e., whether they are able to see obstacles such as power lines, and whether they are looking ahead to see obstacles with enough time to avoid a collision. In addition to helping explain the susceptibility of some species to collision, this factor is key to planning effective mitigation measures. Recent research provides the first evidence that birds can render themselves blind in the direction of travel during flight through voluntary head movements (Martin & Shaw 2010). Visual fields were determined

in three bird species representatives of families known to be subject to high levels of mortality associated with power lines i.e. Kori Bustards *Ardeotis kori*, Blue Cranes and White Storks. In all species the frontal visual fields showed narrow and vertically long binocular fields typical of birds that take food items directly in the bill under visual guidance. However, these species differed markedly in the vertical extent of their binocular fields and in the extent of the blind areas which project above and below the binocular fields in the forward-facing hemisphere. The importance of these blind areas is that when in flight, head movements in the vertical plane (pitching the head to look downwards) will render the bird blind in the direction of travel. Such movements may frequently occur when birds are scanning below them (for foraging or roost sites, or for conspecifics). In bustards and cranes pitch movements of only 25° and 35°, respectively, are sufficient to render the birds blind in the direction of travel; in storks, head movements of 55° are necessary. That flying birds can render themselves blind in the direction of travel has not been previously recognised and has important implications for the effective mitigation of collisions with human artefacts including wind turbines and power lines. These findings have applicability to species outside of these families especially raptors (A*ccipitridae*) which are known to have small binocular fields and large blind areas similar to those of bustards and cranes and are also known to be vulnerable to power line collisions.

Despite doubts about the efficacy of line marking to reduce the collision risk for bustards (Jenkins *et al*. 2010; Martin *et al.* 2010), there are numerous studies which prove that marking a line with PVC spiral type Bird Flight Diverters (BFDs) generally reduce mortality rates (e.g. Bernardino *et al.* 2018; Sporer *et al.* 2013, Barrientos *et al*. 2011; Jenkins *et al*. 2010; Alonso & Alonso 1999; Koops & De Jong 1982), including to some extent for bustards (Barrientos *et al*. 2012; Hoogstad 2015 pers.comm). Beaulaurier (1981) summarised the results of 17 studies that involved the marking of earth wires and found an average reduction in mortality of 45%. Barrientos *et al.* (2011) reviewed the results of 15 wire marking experiments in which transmission or distribution wires were marked to examine the effectiveness of flight diverters in reducing bird mortality. The presence of flight diverters was associated with a decrease of 55–94% in bird mortalities. Koops and De Jong (1982) found that the spacing of the BFDs was critical in reducing the mortality rates - mortality rates are reduced up to 86% with a spacing of 5m, whereas using the same devices at 10m intervals only reduces the mortality by 57%. Barrientos *et al*. (2012) found that larger BFDs were more effective in reducing Great Bustard collisions than smaller ones. Line markers should be as large as possible, and highly contrasting with the background. Colour is probably less important as during the day the background will be brighter than the obstacle with the reverse true at lower light levels (e.g. at twilight, or during overcast conditions). Black and white interspersed patterns are likely to maximise the probability of detection (Martin *et al*. 2010).

Using a controlled experiment spanning a period of nearly eight years (2008 to 2016), the Endangered Wildlife Trust (EWT) and Eskom tested the effectiveness of two types of line markers in reducing power line collision mortalities of large birds on three up to 400kV transmission lines near Hydra substation in the Karoo. Marking was highly effective for Blue Cranes, with a 92% reduction in mortality, and large birds in general with a 56% reduction in mortality, but not for bustards, including the endangered Ludwig's Bustard. The two different marking devices were approximately equally effective, namely spirals and bird flappers, they found no evidence supporting the preferential use of one type of marker over the other (Shaw *et al*. 2017).

The priority species which are potentially vulnerable to this impact are listed in Table 2, and below:

- Hamerkop
- Mallard
- Secretarybird
- Black-bellied Bustard
- Denham's Bustard

- White-bellied Bustard
- Red-knobbed Coot
- Reed Cormorant
- White-breasted Cormorant
- Blue Crane
- Grey Crowned Crane
- Wattled Crane
- African Darter
- African Black Duck
- Fulvous Whistling Duck
- White-backed Duck
- White-faced Whistling Duck
- Yellow-billed Duck
- Spotted Eagle-Owl
- Great Egret
- Intermediate Egret
- Little Egret
- Western Cattle Egret
- Greater Flamingo
- Lesser Flamingo
- Egyptian Goose
- Spur-winged Goose
- Black-necked Grebe
- Little Grebe
- Black Heron
- Black-crowned Night Heron
- Black-headed Heron
- Goliath Heron
- Grey Heron
- Purple Heron
- Squacco Heron
- African Sacred Ibis
- Glossy Ibis
- Hadada Ibis
- Southern Bald Ibis
- Blue Korhaan
- Northern Black Korhaan
- African Grass Owl
- Marsh Owl
- Western Barn Owl
- Southern Pochard
- South African Shelduck
- Cape Shoveler
- African Spoonbill
- White Stork
- Blue-billed Teal

- Cape Teal
- Red-billed Teal
- Cape Vulture

7.4 Displacement due to habitat destruction and disturbance

During the construction of power lines, service roads (jeep tracks) and substations, habitat destruction/transformation inevitably takes place. The construction activities will constitute the following:

- Site clearance and preparation;
- Construction of the infrastructure (i.e., the on-site substation and overhead power line);
- Transportation of personnel, construction material and equipment to the site, and personnel away from the site;
- Removal of vegetation for the proposed on-site substation and overhead power line, stockpiling of topsoil and cleared vegetation;
- Excavations for infrastructure;

These activities could impact on birds breeding, foraging, and roosting in or in close proximity of the proposed switching station through **transformation of habitat**, which could result in temporary or permanent displacement. Unfortunately, very little mitigation can be applied to reduce the significance of this impact as the total permanent transformation of the natural habitat within the construction footprint of the switching station yard is unavoidable. The loss of habitat for priority species due to direct habitat transformation associated with the construction of the proposed switching station and up to 400kV overhead power line is likely to be moderate due to the small size of the footprint, but ideally high quality grassland should be avoided if possible.

Apart from direct habitat destruction, the above-mentioned activities also impact on birds through **disturbance**; this could lead to breeding failure if the disturbance happens during a critical part of the breeding cycle. Construction activities near breeding locations could be a source of disturbance and could lead to temporary breeding failure or even permanent abandonment of nests. A potential mitigation measure is the timeous identification of nests and the timing of the construction activities to avoid disturbance during a critical phase of the breeding cycle, although in practice that can admittedly be very challenging to implement. Terrestrial species and owls are most likely to be affected by displacement due to disturbance in the study area.

The priority species which are potentially vulnerable to this impact are listed in Table 2, and below:

- Secretarybird
- Black-bellied Bustard
- Denham's Bustard
- White-bellied Bustard
- Blue Crane
- Grey Crowned Crane
- Spotted Eagle-Owl
- Blue Korhaan
- Northern Black Korhaan
- African Grass Owl
- Marsh Owl

8 IMPACT RATING AND MANAGEMENT ACTIONS

8.1 Potential impacts

The following potential impacts have been identified:

8.1.1 Construction Phase

- Displacement due to disturbance associated with the construction of the switching station and grid connection power line.
- Displacement due to habitat transformation associated with the construction of the switching station and grid connection power line.

8.1.2 Operational Phase

- Collisions with the up to 400kV grid connection power line.
- Electrocutions within the switching station.

8.1.3 Decommissioning Phase

- Displacement due to disturbance associated with the decommissioning of the switching station and grid connection power line.

8.1.4 Cumulative Impacts

- Displacement due to disturbance associated with the construction and decommissioning of the switching station and grid connection power line.
- Displacement due to habitat transformation associated with the switching station and grid connection power line.
- Collisions with the overhead power line.
- Electrocutions within the switching station.

9 IMPACT RATING

Table 4 below is a summarised scoping level assessment of the anticipated impacts.

Table 3: Summarised scoping level assessment of the anticipated impacts

Impact	Nature of Impact	Extent of Impact	Significance (pre-mitigation)	Preferred alternative	No-Go Areas	Mitigation measures
Construction: Displacement due to habitat transformation associated with the construction of the switching station and grid connection power line.	Construction activities could impact on birds breeding, foraging, and roosting in or in close proximity of the proposed switching station through transformation of habitat, which could result in temporary or permanent displacement. Unfortunately, very little mitigation can be applied to reduce the significance of this impact as the total permanent transformation of the natural habitat within the construction footprint of the switching station yard is unavoidable. The loss of habitat for priority species due to direct habitat transformation associated with the construction of the proposed switching station and up to 400kV overhead power line is likely to be moderate due to the small size of the footprint, but ideally high quality grassland should be avoided if possible. The priority species which are potentially vulnerable to this impact are the following: Secretarybird, Black-bellied Bustard, Denham's Bustard, White-bellied Bustard, Blue Crane, Grey Crowned Crane, Spotted Eagle-Owl, Blue Korhaan, Northern Black Korhaan, African Grass Owl, Marsh Owl.	Local	Medium	• Option 2 of the switching station is preferred, as it is located in agricultural habitat and will not impact on high quality grassland. • Option 1 of the switching station is not preferred as it is partially located in high quality grassland.	No exclusion areas have been identified.	• Vegetation clearance should be limited to what is necessary. • The mitigation measures proposed by the biodiversity specialist must be strictly enforced.
Construction: Displacement due to disturbance associated with the construction of the switching station and grid connection power line.	Construction activities also impact on birds through disturbance; this could lead to breeding failure if the disturbance happens during a critical part of the breeding cycle. Construction activities near breeding locations could be a source of disturbance and could lead to temporary breeding failure	Local	Medium	• Option 2 of the switching station is preferred, as it is located in	No exclusion areas have been identified.	• Conduct a pre-construction inspection to identify Red List species that may be breeding within the project footprint to ensure that the impacts to breeding species

	or even permanent abandonment of nests. A potential mitigation measure is the timeous identification of nests and the timing of the construction activities to avoid disturbance during a critical phase of the breeding cycle, although in practice that can admittedly be very challenging to implement. Terrestrial species and owls are most likely to be affected by displacement due to disturbance in the study area. The priority species which are potentially vulnerable to this impact are the following: Secretarybird, Black-bellied Bustard, Denham's Bustard, White-bellied Bustard, Blue Crane, Grey Crowned Crane, Spotted Eagle-Owl, Blue Korhaan, Northern Black Korhaan, African Grass Owl, Marsh Owl.			agricultural habitat and will not impact on high quality grassland. • Option 1 of the switching station is not preferred as it is partially located in high quality grassland.		(if any) are adequately managed. • Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Measures to control noise and dust should be applied according to current best practice in the industry.
Operations: Mortality of priority species due to collisions with the up to 400kV grid connection power line.	Collisions are the biggest threat posed by transmission lines to birds in southern Africa (Van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes, and various species of waterbirds, and to a lesser extent, vultures. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with transmission lines. The priority species which are potentially vulnerable to this impact are the following: Hamerkop, Mallard, Secretarybird, Black-bellied Bustard, Denham's Bustard, White-bellied Bustard, Red-knobbed Coot, Reed Cormorant, White-breasted Cormorant, Blue Crane, Grey Crowned Crane, Wattled Crane, African Darter, African Black Duck, Fulvous Whistling Duck, White-backed Duck, White-faced Whistling Duck, Yellow-billed Duck, Spotted Eagle-Owl, Great Egret,	Regional	High	• Option 2 of the grid connection is preferred, as it is located mostly in agricultural habitat, and it is the shortest option. • Option 1 of the grid connection is not preferred as it is partially located in	A 1km buffer should be implemented around large pans at 26°40'24.53"S 30° 1'31.18"E and, 26°42'4.56"S 30° 1'58.46"E	The authorised alignment must be inspected by an avifaunal specialist by means of a “walk-through” inspection i.e., through a combination of satellite imagery supplemented with in situ inspections by vehicle and where necessary, on foot, once the pole positions have been finalised. The objective would be to demarcate the sections of the powerline crossing wetland and high sensitivity grassland habitat that need to be fitted with Bird Flight Diverters. Once the relevant spans have been identified, Eskom approved Bird flight diverters should be installed for the full span length on the earthwire (according to Eskom guidelines – five metres apart). Light and dark colour

	Intermediate Egret, Little Egret, Western Cattle Egret, Greater Flamingo, Lesser Flamingo, Egyptian Goose, Spur-winged Goose, Black-necked Grebe, Little Grebe, Black Heron, Black-crowned Night Heron, Black-headed Heron, Goliath Heron, Grey Heron, Purple Heron, Squacco Heron, African Sacred Ibis, Glossy Ibis, Hadada Ibis, Southern Bald Ibis, Blue Korhaan, Northern Black Korhaan, African Grass Owl, Marsh Owl, Western Barn Owl, Southern Pochard, South African Shelduck, Cape Shoveler, African Spoonbill, White Stork, Blue-billed Teal, Cape Teal, Red-billed Teal and Cape Vulture.			high quality grassland, and it is longer than Option 2.		devices must be alternated to provide contrast against both dark and light backgrounds respectively.
Operations: Mortality of priority species due to electrocutions within the switching station	Electrocutions within the proposed on-site substation yards are possible but should not affect the more sensitive Red List bird species, as these species are unlikely to use the infrastructure within the substation yard for perching or roosting. Species that are more vulnerable to this impact are corvids, owls and certain species of waterbirds. The priority species which are potentially vulnerable to electrocution impact are the following: Common Buzzard, Jackal Buzzard, Cape Crow, Pied Crow, African Fish Eagle, Black-chested Snake Eagle, Brown Snake Eagle, Long-crested Eagle, Martial Eagle, Spotted Eagle-Owl, Amur Falcon, Lanner Falcon, Peregrine Falcon, Helmeted Guineafowl, Black-headed Heron, Hadada Ibis, Southern Bald Ibis, Black-winged Kite, Yellow-billed Kite, Western Osprey. African Grass Owl, Marsh Owl, Western Barn Owl, Black Sparrowhawk and Cape Vulture.	Regional	Medium	n/a	No exclusion areas have been identified.	The hardware within the proposed substation yard is too complex to warrant any mitigation for electrocution at this stage. It is recommended that if on-going impacts are recorded once operational, site specific mitigation (insulation) be applied reactively. This is an acceptable approach because Red List priority species are unlikely to frequent the substation.

10 ENVIRONMENTAL SENSITIVITIES

The following specific environmental sensitivities were identified from an avifaunal perspective:

- **Drainage lines and associated wetlands.** Wetlands are important breeding, roosting and foraging habitat for a variety of Red List priority species, most notably for African Grass Owl (SA status Vulnerable), Grey Crowned Crane (SA status Endangered) and African Marsh Harrier (SA status Endangered). Sections of line that traverse this habitat need to be marked with Bird Flight Diverters.
- **Large pans**. The most significant landscape features from a collision risk perspective are the large pans. Pans attract many birds, including Red List species such as Greater Flamingo (SA status Near-threatened), Lesser Flamingo (SA status near-threatened), Martial Eagle (SA Status Endangered), Cape Vulture (SA Status Endangered) and Secretarybird (SA status Vulnerable A 1km buffer should be implemented around large pans at 26°40'24.53"S 30° 1'31.18"E and 26°42'4.56"S 30° 1'58.46"E.
- **High sensitivity grassland - Limited infrastructure zone**. The grassland is vital breeding, roosting and foraging habitat for a variety of Red List priority species. These include Blue Crane (SA status near-threatened), Blue Korhaan (Global status near -threatened), White-bellied Bustard (SA Status Vulnerable), Denham's Bustard (SA Status Vulnerable). Sections of line that traverse this habitat need to be marked with Bird Flight Diverters.

See Figure 6 for the avifaunal sensitivities identified from a powerline perspective.

Figure 6: Proposed avifaunal high sensitivity and No Go zones at the Camden 1 Wind Energy Facility for the up to 400kV grid connection.

11 EIA PHASE

11.1 Plan of study

The following are proposed for the EIA Phase:

- The implementation of four avifaunal surveys, utilising transects, vantage point watches, focal points and incidental counts, to inform the assessment of the potential impacts of the planned infrastructure within the development footprint (see Appendix 3)[2]. The monitoring protocol is guided by the following:
    - Procedures for the Assessment and Minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of NEMA when applying for Environmental Authorisation (Gazetted October 2020)
    - Protocol for the specialist assessment and minimum report content requirements for environmental impacts om avifaunal species by onshore wind energy generation facilities where the electricity output is 20MW or more (Government Gazette No. 43110 – 20 March 2020).
    - Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2015. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. Produced by the Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa. Hereafter referred to as the wind guidelines.
    - Procedures for the Assessment and Minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of NEMA when applying for Environmental Authorisation (Gazetted October 2020). The Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Animal Species was published on 30 October 2020. This protocol applies also for the assessment of impacts caused by power lines on avifauna.

- The avifaunal specialists report will be structured around the following terms of reference:
    - Description of the affected environment from an avifaunal perspective.
    - Discussion of gaps in baseline data and other limitations.
    - Description of the methodology that was used for the field surveys.
    - Comparison of the site sensitivity recorded in the field with the sensitivity classification in the DFFE National Screening Tool and adjustment if necessary.
    - Provision of an overview of all applicable legislation.
    - Provision of an overview of assessment methodology.
    - Identification and assessment of the potential impacts of the proposed development on avifauna including cumulative impacts.
    - Provision of sufficient mitigation measures to include in the Environmental Management Programme (EMPr).
    - Conclusion with an impact statement whether the project is fatally flawed or may be authorised.

[2] This has been completed.

11.2 Environmental Management Programme

For each anticipated impact, management recommendations for the design, construction, and operational phase (where appropriate) will be drafted for inclusion in the project EMPRs.

12 PRELIMINARY CONCLUSIONS

According to the DFFE national screening tool, the habitat within the development site is classified as **Medium and High** sensitivity for birds according to the Animal Species theme (see Figure 4). This classification is accurate as far as the impact of the proposed WEF is concerned, based on actual conditions recorded on the ground during the 12 months of pre-construction monitoring. The classification of **High** is justified due to the recorded presence of Red List priority species in the WEF development area, namely Secretarybird (Globally Endangered, Locally Vulnerable) White-bellied Bustard (Locally Vulnerable), Blue Crane (Globally Vulnerable, Locally Near-threatened), Grey Crowned Crane (Globally and Locally Endangered), Martial Eagle (Globally and Locally Endangered), Lanner Falcon (Locally Vulnerable), Greater Flamingo (Locally Near-threatened), Lesser Flamingo (Globally and Locally Near-threatened), Black Harrier (Locally and Globally Endangered), Southern Bald Ibis (Locally and Globally Vulnerable), Blue Korhaan (Globally Near-threatened), African Grass Owl (Locally Vulnerable) and Cape Vulture (Globally and Locally Endangered).

The proposed Camden 1 up to 400kV grid connection and collector substation will have an anticipated medium to high pre-mitigation negative impact on priority avifauna, which is expected to be reduced to medium and low with appropriate mitigation.

13 REFERENCES

- ALONSO, J. A. AND ALONSO, J. C. 1999 Collision of birds with overhead transmission lines in Spain. Pp. 57–82 in Ferrer, M. and Janss, G. F. E., eds. Birds and power lines: Collision, electrocution and breeding. Madrid, Spain: Quercus.Google Scholar
- ANIMAL DEMOGRAPHY UNIT. 2021. The southern African Bird Atlas Project 2. University of Cape Town. http://sabap2.adu.org.za.
- AVIAN POWER LINE INTERACTION COMMITTEE (APLIC). 2012. Mitigating Bird Collisions with Power Lines: The State of the Art in 2012. Edison Electric Institute. Washington D.C.
- BARRIENTOS R, PONCE C, PALACIN C, MARTÍN CA, MARTÍN B, ET AL. 2012. Wire marking results in a small but significant reduction in avian mortality at power lines: A BACI Designed Study. PLoS ONE 7(3): e32569. doi:10.1371/journal.pone.0032569.
- BARRIENTOS, R., ALONSO, J.C., PONCE, C., PALACÍN, C. 2011. Meta-Analysis of the effectiveness of marked wire in reducing avian collisions with power lines. Conservation Biology 25: 893-903.
- BEAULAURIER, D.L. 1981. Mitigation of bird collisions with transmission lines. Bonneville Power Administration. U.S. Dept. of Energy.
- BERNARDINO, J., BEVANGER, K., BARRIENTOS, R., DWYER, J.F. MARQUES, A.T., MARTINS, R.C., SHAW, J.M., SILVA, J.P., MOREIRA, F. 2018. Bird collisions with power lines: State of the art and priority areas for research. https://doi.org/10.1016/j.biocon.2018.02.029. Biological Conservation 222 (2018) 1 – 13.
- ENDANGERED WILDLIFE TRUST. 2014. Central incident register for powerline incidents. Unpublished data.
- HARRISON, J.A., ALLAN, D.G., UNDERHILL, L.G., HERREMANS, M., TREE, A.J., PARKER, V & BROWN, C.J. (eds). 1997. The atlas of southern African birds. Vol 1 & 2. BirdLife South Africa, Johannesburg.
- HOBBS, J.C.A. & LEDGER J.A. 1986a. The Environmental Impact of Linear Developments; Power lines and Avifauna. Proceedings of the Third International Conference on Environmental Quality and Ecosystem Stability. Israel, June 1986.
- HOBBS, J.C.A. & LEDGER J.A. 1986b. Power lines, Birdlife and the Golden Mean. Fauna and Flora, 44:23-27.
- HOCKEY P.A.R., DEAN W.R.J., AND RYAN P.G. 2005. Robert's Birds of Southern Africa, seventh edition. Trustees of the John Voelcker Bird Book Fund, Cape Town.
- JENKINS, A. & SMALLIE, J. 2009. Terminal velocity: the end of the line for Ludwig's Bustard? Africa Birds and Birding. Vol 14, No 2.
- JENKINS, A., DE GOEDE, J.H. & VAN ROOYEN, C.S. 2006. Improving the products of the Eskom Electric Eagle Project. Unpublished report to Eskom. Endangered Wildife Trust.
- JENKINS, A.R., DE GOEDE, J.H., SEBELE, L. & DIAMOND, M. 2013. Brokering a settlement between eagles and industry: sustainable management of large raptors nesting on power infrastructure. Bird Conservation International 23: 232-246.
- JENKINS, A.R., SMALLIE, J.J. & DIAMOND, M. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. Bird Conservation International 20: 263-278.
- KOOPS, F.B.J. & DE JONG, J. 1982. Vermindering van draadslachtoffers door markering van hoogspanningsleidingen in de omgeving van Heerenveen. Electrotechniek 60 (12): 641 – 646.

- KRUGER, R. & VAN ROOYEN, C.S. 1998. Evaluating the risk that existing power lines pose to large raptors by using risk assessment methodology: The Molopo Case Study. Proceedings of the 5th World Conference on Birds of Prey and Owls. August 4-8,1998. Midrand, South Africa.
- KRUGER, R. 1999. Towards solving raptor electrocutions on Eskom Distribution Structures in South Africa. Bloemfontein (South Africa): University of the Orange Free State. (M. Phil. Mini-thesis)
- LEDGER, J. 1983. Guidelines for Dealing with Bird Problems of Transmission Lines and Towers. Eskom Test and Research Division. (Technical Note TRR/N83/005).
- LEDGER, J.A. & ANNEGARN H.J. 1981. Electrocution Hazards to the Cape Vulture (Gyps coprotheres) in South Africa. Biological Conservation 20:15-24.
- LEDGER, J.A. 1984. Engineering Solutions to the Problem of Vulture Electrocutions on Electricity Towers. The Certificated Engineer, 57:92-95.
- LEDGER, J.A., J.C.A. HOBBS & SMITH T.V. 1992. Avian Interactions with Utility Structures: Southern African Experiences. Proceedings of the International Workshop on Avian Interactions with Utility Structures. Miami (Florida), Sept. 13-15, 1992. Electric Power Research Institute.
- MARNEWICK, M.D., RETIEF E.F., THERON N.T., WRIGHT D.R., ANDERSON T.A. 2015. Important Bird and Biodiversity Areas of South Africa. Johannesburg: Birdlife South Africa.
- MARTIN, G., SHAW, J., SMALLIE J. & DIAMOND, M. 2010. Bird's eye view – How birds see is key to avoiding power line collisions. Eskom Research Report. Report Nr: RES/RR/09/31613.
- MUCINA. L. & RUTHERFORD, M.C. (Eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.
- SHAW, J.M. 2013. Power line collisions in the Karoo: Conserving Ludwig's Bustard. Unpublished PhD thesis. Percy FitzPatrick Institute of African Ornithology, Department of Biological Sciences, Faculty of Science University of Cape Town May 2013.
- SHAW, J.M., PRETORIUS, M.D., GIBBONS, B., MOHALE, O., VISAGIE, R., LEEUWNER, J.L.& RYAN, P.G. 2017. The effectiveness of line markers in reducing power line collisions of large terrestrial birds at De Aar, Northern Cape. Eskom Research, Testing and Development. Research Report. RES/RR/17/1939422.
- SPORER, M.K., DWYER, J.F., GERBER, B.D, HARNESS, R.E, PANDEY, A.K. 2013. Marking Power Lines to Reduce Avian Collisions Near the Audubon National Wildlife Refuge, North Dakota. Wildlife Society Bulletin 37(4):796–804; 2013; DOI: 10.1002/wsb.329
- TAYLOR, M.R., PEACOCK F, & WANLESS R.W (eds.) 2015. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg, South Africa.
- VAN ROOYEN, C.S. & LEDGER, J.A. 1999. Birds and utility structures: Developments in southern Africa. Pp 205-230, in Ferrer, M. & G.F.M. Janns. (eds.). Birds and Power lines. Quercus, Madrid (Spain). Pp 238.
- VAN ROOYEN, C.S. & TAYLOR, P.V. 1999. Bird Streamers as probable cause of electrocutions in South Africa. EPRI Workshop on Avian Interactions with Utility Structures 2-3 December 1999. Charleston, South Carolina.
- VAN ROOYEN, C.S. 1998. Raptor mortality on power lines in South Africa. Proceedings of the 5th World Conference on Birds of Prey and Owls. Midrand (South Africa), Aug.4 – 8, 1998.
- VAN ROOYEN, C.S. 1999. An overview of the Eskom-EWT Strategic Partnership in South Africa. EPRI Workshop on Avian Interactions with Utility Structures Charleston (South Carolina), Dec. 2-3 1999.
- VAN ROOYEN, C.S. 2000. An overview of Vulture Electrocutions in South Africa. Vulture News, 43: 5-22. (Vulture Study Group, Johannesburg, South Africa).

- VAN ROOYEN, C.S. 2004. The Management of Wildlife Interactions with overhead lines. In: The fundamentals and practice of Overhead Line Maintenance (132kV and above), pp217-245. Eskom Technology, Services International, Johannesburg.
- VAN ROOYEN, C.S. 2007. Eskom-EWT Strategic Partnership: Progress Report April-September 2007. Endangered Wildlife Trust, Johannesburg.
- VAN ROOYEN, C.S. VOSLOO, H.F. & R.E. HARNESS. 2002. Eliminating bird streamers as a cause of faulting on transmission lines in South Africa. Proceedings of the IEEE 46th Rural Electric Power Conference. Colorado Springs (Colorado), May. 2002.
- VERDOORN, G.H. 1996. Mortality of Cape Griffons Gyps coprotheres and African Whitebacked Vultures *Pseudogyps africanus* on 88kV and 132kV power lines in Western Transvaal, South Africa, and mitigation measures to prevent future problems. Proceedings of the 2nd International Conference on Raptors: Urbino (Italy), Oct. 2-5, 1996.

APPENDIX 1: SABAP 2 SPECIES LIST FOR THE BROADER AREA

Species name	Scientific name	Full protocol reporting rate	Ad hoc protocol reporting rate
Bokmakierie	*Telophorus zeylonus*	64.85	4.41
Hamerkop	*Scopus umbretta*	11.52	0.00
Mallard	*Anas platyrhynchos*	0.61	0.44
Neddicky	*Cisticola fulvicapilla*	7.88	0.00
Quailfinch	*Ortygospiza atricollis*	47.88	1.76
Ruff	*Calidris pugnax*	1.82	0.44
Secretarybird	*Sagittarius serpentarius*	13.33	0.00
Bar-throated Apalis	*Apalis thoracica*	5.45	0.00
Pied Avocet	*Recurvirostra avosetta*	4.85	0.00
Black-collared Barbet	*Lybius torquatus*	28.48	0.88
Crested Barbet	*Trachyphonus vaillantii*	3.03	0.00
Cape Batis	*Batis capensis*	0.61	0.00
European Bee-eater	*Merops apiaster*	0.61	0.00
Southern Red Bishop	*Euplectes orix*	84.24	12.33
Yellow-crowned Bishop	*Euplectes afer*	34.55	3.96
Southern Boubou	*Laniarius ferrugineus*	15.15	0.88
Dark-capped Bulbul	*Pycnonotus tricolor*	50.30	3.96
Cape Bunting	*Emberiza capensis*	13.94	0.44
Cinnamon-breasted Bunting	*Emberiza tahapisi*	1.82	0.00
Golden-breasted Bunting	*Emberiza flaviventris*	5.45	0.44
Black-bellied Bustard	*Lissotis melanogaster*	0.61	0.00
Denham's Bustard	*Neotis denhami*	1.82	0.00
White-bellied Bustard	*Eupodotis senegalensis*	7.88	0.00
Common Buttonquail	*Turnix sylvaticus*	0.61	0.00
Common Buzzard	*Buteo buteo*	27.88	9.25
Jackal Buzzard	*Buteo rufofuscus*	19.39	2.20
Black-throated Canary	*Crithagra atrogularis*	67.88	2.20
Cape Canary	*Serinus canicollis*	75.15	7.05
Yellow Canary	*Crithagra flaviventris*	15.76	0.44
Yellow-fronted Canary	*Crithagra mozambica*	9.09	0.88
Ant-eating Chat	*Myrmecocichla formicivora*	89.70	12.33
Buff-streaked Chat	*Campicoloides bifasciatus*	5.45	0.44
Familiar Chat	*Oenanthe familiaris*	0.61	0.00
Cloud Cisticola	*Cisticola textrix*	7.88	0.88
Lazy Cisticola	*Cisticola aberrans*	4.85	0.00
Levaillant's Cisticola	*Cisticola tinniens*	73.94	5.73
Pale-crowned Cisticola	*Cisticola cinnamomeus*	21.21	0.00
Wailing Cisticola	*Cisticola lais*	9.09	0.00
Wing-snapping Cisticola	*Cisticola ayresii*	45.45	6.17
Zitting Cisticola	*Cisticola juncidis*	41.21	2.64
Red-knobbed Coot	*Fulica cristata*	58.18	4.85

Species name	Scientific name	Full protocol reporting rate	Ad hoc protocol reporting rate
Reed Cormorant	*Microcarbo africanus*	63.64	4.85
White-breasted Cormorant	*Phalacrocorax lucidus*	11.52	0.88
Temminck's Courser	*Cursorius temminckii*	1.82	0.00
Black Crake	*Zapornia flavirostra*	9.09	0.00
Blue Crane	*Grus paradisea*	11.52	0.44
Grey Crowned Crane	*Balearica regulorum*	5.45	0.00
Wattled Crane	*Grus carunculata*	0.61	0.00
Cape Crow	*Corvus capensis*	17.58	0.44
Pied Crow	*Corvus albus*	11.52	3.52
Diederik Cuckoo	*Chrysococcyx caprius*	24.24	0.88
Red-chested Cuckoo	*Cuculus solitarius*	4.85	0.44
African Darter	*Anhinga rufa*	16.36	2.20
Cape Turtle Dove	*Streptopelia capicola*	92.12	23.79
Laughing Dove	*Spilopelia senegalensis*	45.45	7.49
Namaqua Dove	*Oena capensis*	1.82	0.00
Red-eyed Dove	*Streptopelia semitorquata*	64.24	12.33
Rock Dove	*Columba livia*	6.06	4.41
Fork-tailed Drongo	*Dicrurus adsimilis*	10.30	0.44
African Black Duck	*Anas sparsa*	10.91	0.00
Domestic Duck	*Anas platyrhynchos domestica*	0.61	0.00
Fulvous Whistling Duck	*Dendrocygna bicolor*	0.00	0.44
White-backed Duck	*Thalassornis leuconotus*	6.67	0.00
White-faced Whistling Duck	*Dendrocygna viduata*	0.61	0.00
Yellow-billed Duck	*Anas undulata*	61.82	4.41
African Fish Eagle	*Haliaeetus vocifer*	12.12	0.88
Black-chested Snake Eagle	*Circaetus pectoralis*	3.03	0.44
Brown Snake Eagle	*Circaetus cinereus*	1.82	0.00
Long-crested Eagle	*Lophaetus occipitalis*	6.67	9.25
Martial Eagle	*Polemaetus bellicosus*	2.42	0.00
Spotted Eagle-Owl	*Bubo africanus*	9.09	0.88
Great Egret	*Ardea alba*	7.88	1.32
Intermediate Egret	*Ardea intermedia*	13.94	1.76
Little Egret	*Egretta garzetta*	4.24	1.32
Western Cattle Egret	*Bubulcus ibis*	44.85	12.33
Amur Falcon	*Falco amurensis*	29.09	6.61
Lanner Falcon	*Falco biarmicus*	7.27	0.00
Peregrine Falcon	*Falco peregrinus*	1.21	0.00
Cuckoo Finch	*Anomalospiza imberbis*	1.21	0.00
Red-headed Finch	*Amadina erythrocephala*	1.82	0.00
Southern Fiscal	*Lanius collaris*	92.12	15.42
Greater Flamingo	*Phoenicopterus roseus*	3.64	4.41
Lesser Flamingo	*Phoeniconaias minor*	3.64	1.32
Red-chested Flufftail	*Sarothrura rufa*	0.61	0.00
African Paradise Flycatcher	*Terpsiphone viridis*	4.85	0.00
Fiscal Flycatcher	*Melaenornis silens*	16.97	0.88
Spotted Flycatcher	*Muscicapa striata*	4.24	0.44

Species name	Scientific name	Full protocol reporting rate	Ad hoc protocol reporting rate
Grey-winged Francolin	*Scleroptila afra*	27.27	2.20
Red-winged Francolin	*Scleroptila levaillantii*	24.85	1.32
Egyptian Goose	*Alopochen aegyptiaca*	78.18	6.17
Spur-winged Goose	*Plectropterus gambensis*	44.24	1.76
Cape Grassbird	*Sphenoeacus afer*	24.85	0.88
Black-necked Grebe	*Podiceps nigricollis*	0.61	0.44
Little Grebe	*Tachybaptus ruficollis*	38.79	3.08
Common Greenshank	*Tringa nebularia*	5.45	0.00
Helmeted Guineafowl	*Numida meleagris*	49.09	3.08
Grey-headed Gull	*Chroicocephalus cirrocephalus*	3.64	0.44
African Marsh Harrier	*Circus ranivorus*	0.61	0.00
Black Harrier	*Circus maurus*	0.00	0.88
Montagu's Harrier	*Circus pygargus*	1.21	0.00
African Harrier-Hawk	*Polyboroides typus*	11.52	1.76
Black Heron	*Egretta ardesiaca*	0.61	0.00
Black-crowned Night Heron	*Nycticorax nycticorax*	0.61	0.00
Black-headed Heron	*Ardea melanocephala*	52.12	3.96
Goliath Heron	*Ardea goliath*	2.42	0.00
Grey Heron	*Ardea cinerea*	24.85	3.52
Purple Heron	*Ardea purpurea*	4.24	0.00
Squacco Heron	*Ardeola ralloides*	1.21	0.00
Lesser Honeyguide	*Indicator minor*	0.61	0.00
African Hoopoe	*Upupa africana*	12.73	0.88
African Sacred Ibis	*Threskiornis aethiopicus*	47.88	6.17
Glossy Ibis	*Plegadis falcinellus*	4.24	1.76
Hadada Ibis	*Bostrychia hagedash*	89.70	13.66
Southern Bald Ibis	*Geronticus calvus*	23.03	3.08
African Jacana	*Actophilornis africanus*	1.82	1.32
Rock Kestrel	*Falco rupicolus*	5.45	0.88
Giant Kingfisher	*Megaceryle maxima*	4.85	0.00
Malachite Kingfisher	*Corythornis cristatus*	7.27	0.00
Pied Kingfisher	*Ceryle rudis*	12.73	0.44
Black-winged Kite	*Elanus caeruleus*	60.61	12.78
Yellow-billed Kite	*Milvus aegyptius*	2.42	0.00
Blue Korhaan	*Eupodotis caerulescens*	6.06	0.00
Northern Black Korhaan	*Afrotis afraoides*	0.61	0.00
African Wattled Lapwing	*Vanellus senegallus*	23.03	0.44
Black-winged Lapwing	*Vanellus melanopterus*	14.55	0.00
Blacksmith Lapwing	*Vanellus armatus*	67.88	7.05
Crowned Lapwing	*Vanellus coronatus*	61.21	3.08
Eastern Clapper Lark	*Mirafra fasciolata*	6.67	0.00
Eastern Long-billed Lark	*Certhilauda semitorquata*	4.85	0.00
Red-capped Lark	*Calandrella cinerea*	56.36	2.20
Rufous-naped Lark	*Mirafra africana*	1.21	0.88
Spike-heeled Lark	*Chersomanes albofasciata*	48.48	1.32

Species name	Scientific name	Full protocol reporting rate	Ad hoc protocol reporting rate
Cape Longclaw	*Macronyx capensis*	86.67	10.13
Banded Martin	*Riparia cincta*	42.42	3.08
Brown-throated Martin	*Riparia paludicola*	46.67	3.96
Common House Martin	*Delichon urbicum*	6.06	0.00
Rock Martin	*Ptyonoprogne fuligula*	13.94	1.76
Sand Martin	*Riparia riparia*	1.21	0.44
Common Moorhen	*Gallinula chloropus*	32.73	1.76
Lesser Moorhen	*Paragallinula angulata*	0.61	0.44
Red-faced Mousebird	*Urocolius indicus*	4.24	0.44
Speckled Mousebird	*Colius striatus*	25.45	0.88
Common Myna	*Acridotheres tristis*	21.21	10.13
Black-headed Oriole	*Oriolus larvatus*	13.94	1.76
Western Osprey	*Pandion haliaetus*	0.61	0.00
Common Ostrich	*Struthio camelus*	21.82	1.32
African Grass Owl	*Tyto capensis*	2.42	0.00
Marsh Owl	*Asio capensis*	5.45	0.44
Western Barn Owl	*Tyto alba*	3.03	0.44
Speckled Pigeon	*Columba guinea*	67.27	13.22
African Pipit	*Anthus cinnamomeus*	74.55	8.37
Nicholson's Pipit	*Anthus nicholsoni*	1.82	0.44
Plain-backed Pipit	*Anthus leucophrys*	1.21	0.00
Kittlitz's Plover	*Charadrius pecuarius*	7.27	0.44
Three-banded Plover	*Charadrius tricollaris*	35.15	0.88
Southern Pochard	*Netta erythrophthalma*	9.09	0.00
Black-chested Prinia	*Prinia flavicans*	16.36	0.00
Drakensberg Prinia	*Prinia hypoxantha*	18.79	0.00
Tawny-flanked Prinia	*Prinia subflava*	0.61	0.44
Common Quail	*Coturnix coturnix*	29.09	0.44
Red-billed Quelea	*Quelea quelea*	38.79	1.76
African Rail	*Rallus caerulescens*	5.45	0.00
Cape Robin-Chat	*Cossypha caffra*	60.00	3.52
Chorister Robin-Chat Robin-Chat	*Cossypha dichroa*	1.21	0.00
Common Sandpiper	*Actitis hypoleucos*	1.21	0.00
Wood Sandpiper	*Tringa glareola*	6.06	0.00
Streaky-headed Seedeater	*Crithagra gularis*	9.09	0.44
South African Shelduck	*Tadorna cana*	30.30	3.52
Cape Shoveler	*Spatula smithii*	18.79	0.00
Lesser Grey Shrike	*Lanius minor*	0.61	0.00
Red-backed Shrike	*Lanius collurio*	0.61	0.00
African Snipe	*Gallinago nigripennis*	20.00	0.88
Cape Sparrow	*Passer melanurus*	81.82	6.61
House Sparrow	*Passer domesticus*	20.00	9.25
Southern Grey-headed Sparrow	*Passer diffusus*	57.58	4.41
Black Sparrowhawk	*Accipiter melanoleucus*	12.12	0.88

Species name	Scientific name	Full protocol reporting rate	Ad hoc protocol reporting rate
African Spoonbill	*Platalea alba*	16.36	2.20
Swainson's Spurfowl	*Pternistis swainsonii*	61.21	2.64
Cape Starling	*Lamprotornis nitens*	6.06	0.00
Pied Starling	*Lamprotornis bicolor*	55.15	11.45
Red-winged Starling	*Onychognathus morio*	8.48	3.08
Wattled Starling	*Creatophora cinerea*	0.61	0.00
Black-winged Stilt	*Himantopus himantopus*	9.09	0.00
Little Stint	*Calidris minuta*	1.82	0.00
African Stonechat	*Saxicola torquatus*	87.88	10.57
White Stork	*Ciconia ciconia*	7.27	1.32
Amethyst Sunbird	*Chalcomitra amethystina*	11.52	0.44
Malachite Sunbird	*Nectarinia famosa*	11.52	0.44
Barn Swallow	*Hirundo rustica*	41.82	7.93
Greater Striped Swallow	*Cecropis cucullata*	55.76	7.93
Lesser Striped Swallow	*Cecropis abyssinica*	0.61	1.32
South African Cliff Swallow	*Petrochelidon spilodera*	38.18	3.52
White-throated Swallow	*Hirundo albigularis*	37.58	1.76
African Swamphen	*Porphyrio madagascariensis*	6.06	2.20
African Black Swift	*Apus barbatus*	3.03	0.44
African Palm Swift	*Cypsiurus parvus*	1.21	1.32
Horus Swift	*Apus horus*	1.21	0.00
Little Swift	*Apus affinis*	16.36	4.85
White-rumped Swift	*Apus caffer*	30.30	3.96
Blue-billed Teal	*Spatula hottentota*	1.21	0.00
Cape Teal	*Anas capensis*	3.03	0.00
Red-billed Teal	*Anas erythrorhyncha*	16.97	1.32
Whiskered Tern	*Chlidonias hybrida*	12.12	5.29
White-winged Tern	*Chlidonias leucopterus*	3.64	0.88
Spotted Thick-knee	*Burhinus capensis*	9.09	0.00
Groundscraper Thrush	*Turdus litsitsirupa*	0.61	0.00
Karoo Thrush	*Turdus smithi*	5.45	0.00
Kurrichane Thrush	*Turdus libonyana*	8.48	0.44
Olive Thrush	*Turdus olivaceus*	6.06	0.44
Sentinel Rock Thrush	*Monticola explorator*	2.42	0.00
Cape Wagtail	*Motacilla capensis*	78.18	3.52
African Reed Warbler	*Acrocephalus baeticatus*	3.03	0.44
African Yellow Warbler	*Iduna natalensis*	3.03	0.00
Lesser Swamp Warbler	*Acrocephalus gracilirostris*	12.73	0.44
Little Rush Warbler	*Bradypterus baboecala*	6.67	0.88
Sedge Warbler	*Acrocephalus schoenobaenus*	0.61	0.00
Willow Warbler	*Phylloscopus trochilus*	4.24	0.00
Common Waxbill	*Estrilda astrild*	52.73	3.52
Orange-breasted Waxbill	*Amandava subflava*	9.70	0.00
Cape Weaver	*Ploceus capensis*	33.94	2.20

Species name	Scientific name	Full protocol reporting rate	Ad hoc protocol reporting rate
Southern Masked Weaver	*Ploceus velatus*	90.91	9.69
Village Weaver	*Ploceus cucullatus*	4.24	0.00
Capped Wheatear	*Oenanthe pileata*	10.30	0.00
Mountain Wheatear	*Myrmecocichla monticola*	4.85	0.88
Cape White-eye	*Zosterops virens*	35.15	1.32
Pin-tailed Whydah	*Vidua macroura*	44.85	2.64
Fan-tailed Widowbird	*Euplectes axillaris*	39.39	3.08
Long-tailed Widowbird	*Euplectes progne*	84.85	15.42
Red-collared Widowbird	*Euplectes ardens*	12.12	1.32
Green Wood Hoopoe	*Phoeniculus purpureus*	7.88	0.44
Cardinal Woodpecker	*Dendropicos fuscescens*	9.09	1.32
Olive Woodpecker	*Dendropicos griseocephalus*	3.03	0.00
Red-throated Wryneck	*Jynx ruficollis*	29.70	2.20
Cape Vulture	*Gyps coprotheres*	0.00	0.00

APPENDIX 2: HABITAT FEATURES AT THE STUDY AREA

Figure 1: High sensitivity natural grassland

Figure 2: A large pan

Figure 3: An example of an earth dam

Figure 4: Agriculture

Figure 5: Drainage line and associated wetland

Figure 6: Alien trees

APPENDIX 3: PRE-CONSTRUCTION MONITORING

Monitoring was conducted in the following manner:

- One drive transect was identified totalling 10.2km on the development site and one drive transect in the control site with a total length of 10.5km.
- One monitor travelling slowly (± 10km/h) in a vehicle recorded all birds on both sides of the transect. The observer stopped at regular intervals (every 500m) to scan the environment with binoculars. Drive transects were counted three times per sampling session.
- In addition, 4 walk transects of 1km each were identified at the development site, and two at the control site, and counted 4 times per sampling season. All birds were recorded during walk transects.
- The following variables were recorded:
    - Species
    - Number of birds
    - Date
    - Start time and end time
    - Estimated distance from transect
    - Wind direction
    - Wind strength (estimated Beaufort scale)
    - Weather (sunny; cloudy; partly cloudy; rain; mist)
    - Temperature (cold; mild; warm; hot)
    - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground) and
    - Co-ordinates (priority species only)

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

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

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

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

- FP1: A farm dam in a drainage line in the application site
- FP2: A large salt pan in the application site
- FP3: A large pan situated approximately 3.6km north-west of the application site on the farm Rietspruit 437 IS.

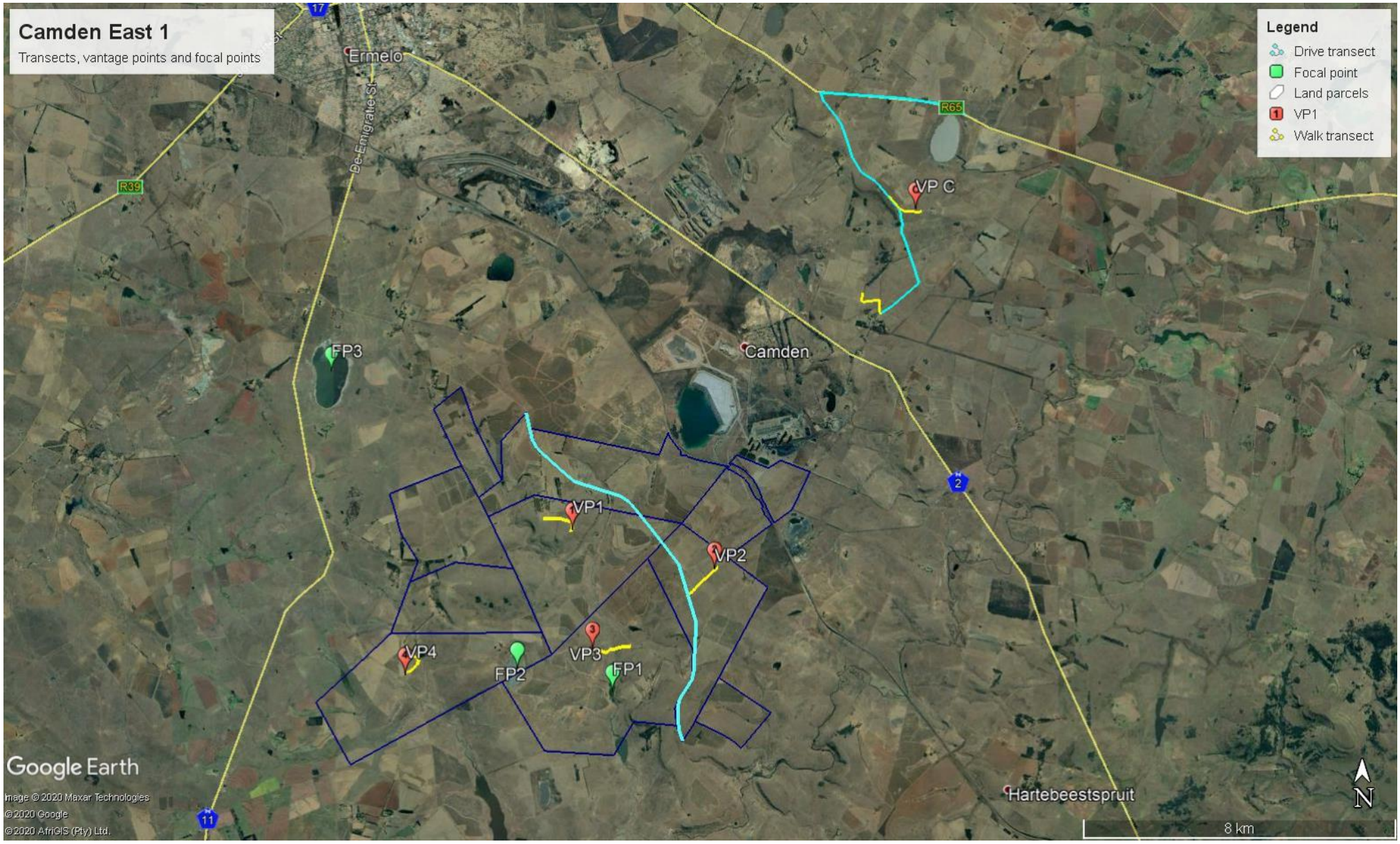

Figure 1: Area where monitoring is taking place, with position of VPs, focal points, drive transects, walk transects and land parcels (dark blue polygon). The area to the north-east of the land parcels is the control area.