AVIFAUNAL IMPACT ASSESSMENT

Quantum 1 Solar Energy Facility

Gauteng Province

July 2023

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EXECUTIVE SUMMARY

South Africa Mainstream Renewable Power Developments (Pty) Ltd is proposing the construction and operation of a solar photovoltaic (PV) facility and associated infrastructure on Portion 285 (a portion of portion 19) of the Farm Vlakplaats 160, located approximately 7.2km west of Krugersdorp, within the Mogale City Local Municipality in the West Rand District Municipality in the Gauteng Province. The facility will have a contracted capacity of up to 10MW and will be known as Quantum 1 Solar Energy Facility. A preferred Development Area with an extent of ~94.1479ha has been identified by South Africa Mainstream Renewable Power Developments (Pty) Ltd as technically suitable for the development of the Quantum 1 Solar Energy Facility (SEF).

The Quantum 1 SEF is proposed in response to the identified objectives of the national and provincial government and local and district municipalities to develop renewable energy facilities for power generation purposes. It is the developer's intention to submit a bid in terms of a regulated power purchase procurement process (e.g., REIPPPP) with the aim of evacuating the generated power into the national grid or obtaining a commercial PPA (Power Purchase Agreement). This will aid in the diversification and stabilisation of the country's electricity supply, in line with the objectives of the Integrated Resource Plan (IRP) with the Quantum 1 SEF set to inject up to 10MW (peak AC power) into the national grid.

From a regional perspective, the area within the West Rand District Municipality identified for the project is considered favourable for the development of a commercial PV facility due to the low environmental sensitivity of the identified site, excellent solar resource, and availability of land on which the development can take place. There is also potential for evacuating the power to the national grid via a direct grid connection at the Eskom Tarlton 132/44/11kV substation which is adjacent to the proposed site. The site is also in proximity to large electricity users which opens opportunities for commercial PPAs (Behind the meter connection Or Wheeling to a 3rd party off-taker).

AVIFAUNA

The SABAP2 data indicates that a total of 301 bird species could potentially occur within the Broader Area – **Appendix 1** provides a comprehensive bird species list. Of these, 105 species are classified as priority species for solar developments and 12 of these are South African Red List species (i.e., Species of Conservation Concern). Of the 105 priority species, 38 are likely to occur regularly in the Development Area.

The table below provides the summarised assessment of the anticipated impacts on avifauna due to the construction and operation of the proposed Quantum 1 SEF.

Summarised assessment of the anticipated impacts

Environmental Parameter	Nature of Impact	Rating prior to mitigation	Rating post mitigation
Avifauna	Displacement of priority species due to disturbance associated with construction of the SEF and associated infrastructure.	55 MEDIUM	45 MEDIUM
	Displacement of priority species due to habitat transformation associated with construction of the SEF and associated infrastructure.	65 HIGH	44 MEDIUM
	Mortality of priority species due to collisions with solar panels.	20 LOW	20 LOW
	Entrapment of large-bodied birds in the double perimeter fence.	36 MEDIUM	20 LOW
	Mortality of priority species due to electrocution on the internal medium voltage powerline.	42 MEDIUM	10 LOW
	Mortality of priority species due to collisions with the internal medium voltage powerline.	36 MEDIUM	20 LOW

Environmental Parameter	Nature of Impact	Rating prior to mitigation	Rating post mitigation
	Displacement of priority species due to disturbance associated with decommissioning of the PV plant and associated infrastructure.	55 MEDIUM	45 MEDIUM
	AVERAGE SIGNIFICANCE RATING	**44 MEDIUM**	**29 LOW**

ENVIRONMENTAL SENSITIVITIES

The Development Area and immediate environment is classified as **Medium** sensitivity for terrestrial animals according to the Terrestrial Animal Species Theme. The Medium sensitivity classification for avifauna is due to the possible occurrence of African Grass Owl *Tyto capensis* and White-bellied Bustard *Eupodotis senegalensis*.

The Development Area contains suitable habitat for avian species of conservation concern (SCC), namely African Grass Owl (Regionally Vulnerable), as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020). One SCC was also recorded during the field surveys, namely Cape Vulture *Gyps coprotheres* (Globally Vulnerable and Regionally Endangered). Based on the field surveys, the SABAP2 data, and African Grass Owl habitat modelling, a classification of **High** sensitivity for avifauna is suggested for the proposed Development Area.

The following specific environmental sensitivities have been identified from an avifaunal perspective:

- **African Grass Owl Habitat: Very High Sensitivity (All Infrastructure Exclusion Zone)**

  Included are areas that have been identified as suitable habitat for African Grass Owls (Regionally Vulnerable). Key wetlands used by African Grass Owl were identified from a presence locality dataset provided by Craig Whittington-Jones and supplemented with personal records of African Grass Owl breeding sites. Roadkill and marginal/stochastic sites were disregarded for this analysis, with an emphasis being placed on records noted as confirmed or suspected breeding sites, as well as sites noted to host the species consistently, but where breeding was unconfirmed. A systematic GIS grid was then used to generate positive training data samples from these sites representing suitable breeding wetlands for African Grass Owl. Please refer to **Appendix 6** for a full description of the habitat suitability modelling methodology.

- **Wetlands and Drainage Lines: High Sensitivity (Solar Panel Exclusion Zone)**

  The Development Area and the immediate environment contain several drainage lines and associated wetlands which are sources of surface water and habitat for a range of species. It is necessary to leave open space with no solar panels, for birds utilising this habitat. The buffer zones as recommended by the Freshwater Specialist should be followed as it will also benefit the avifauna that use this habitat.

See the figure below for the avifaunal sensitivities identified in and near the Development Area. The Development Footprint does not overlap with the identified avifaunal sensitivities.

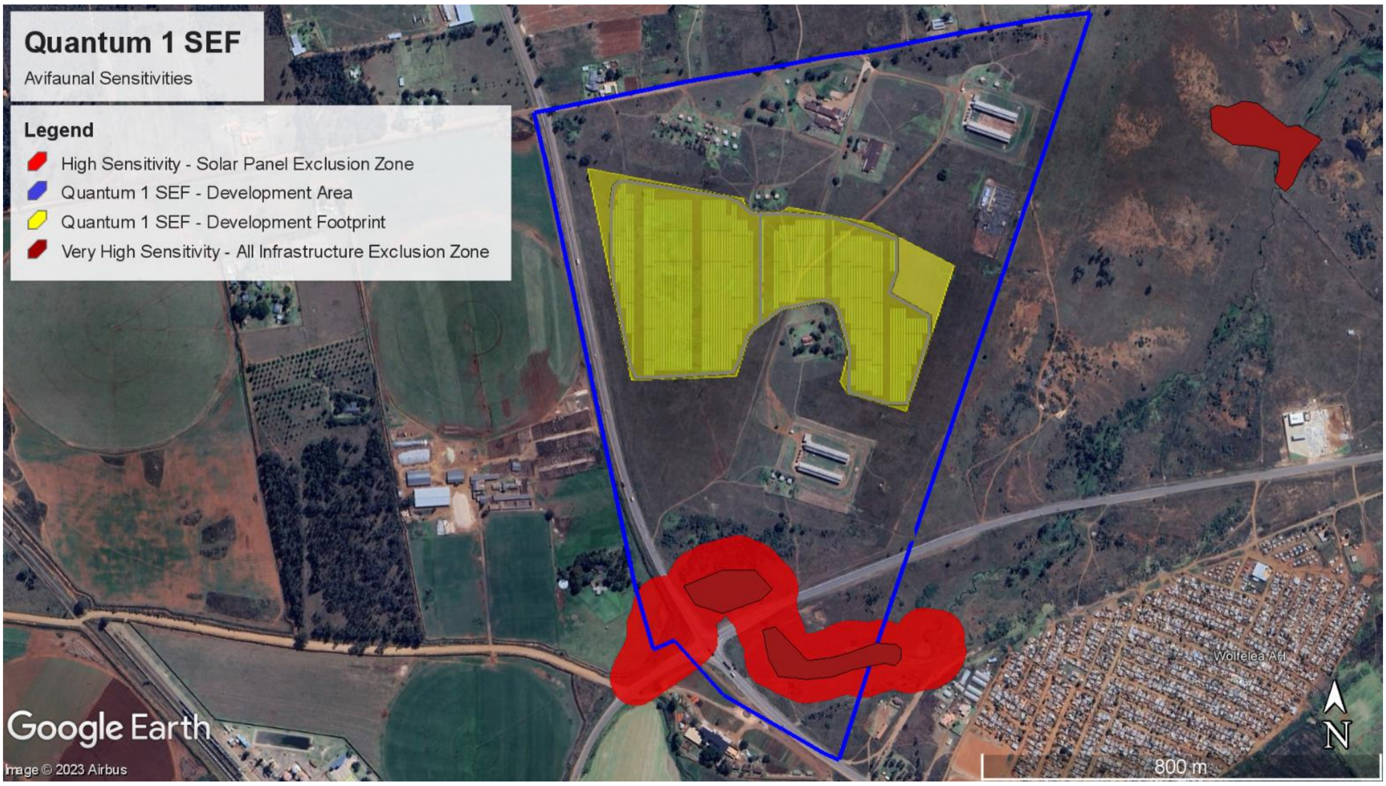

Figure 1: Avifaunal sensitivities identified at the Quantum 1 SEF Development Area.

CONCLUSION

The proposed 10 MW Quantum 1 SEF will have anticipated high, medium, and low negative impacts on priority avifauna, which is expected to be reduced to medium and low with appropriate mitigation. No fatal flaws were discovered during the on-site investigations. The development is supported provided the mitigation measures listed in this report are strictly implemented.

CONTENTS

DETAILS OF THE SPECIALISTS

Albert Froneman (Bird and GIS Specialist)

Albert is a registered Professional Natural Scientist with the South African Council of Natural Scientific Professionals (SACNASP) in the field of Zoology and has an M.Sc. in Conservation Biology from the University of Cape Town. He 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.

Megan Loftie-Eaton (Bird Specialist and Ecologist)

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

1. INTRODUCTION

South Africa Mainstream Renewable Power Developments (Pty) Ltd (Mainstream) is proposing the construction and operation of a solar photovoltaic (PV) facility and associated infrastructure on Portion 285 (a portion of portion 19) of the Farm Vlakplaats 160, located approximately 7.2km west of Krugersdorp, within the Mogale City Local Municipality in the West Rand District Municipality in the Gauteng Province. The facility will have a contracted capacity of up to 10MW and will be known as Quantum 1 Solar Energy Facility.

A preferred Development Area with an extent of ~94.15 ha has been identified by Mainstream as technically suitable for the development of the Quantum 1 Solar Energy Facility. The facility will comprise the following infrastructure:

- Solar PV array comprising solar modules.
- Mounting System Technology
- Inverters and transformers.
- Low voltage cabling between the PV modules to the inverters.
- Overhead power lines
- Onsite substation, switching substation, and laydown areas.
- Battery Energy Storage System (BESS) and associated infrastructure.
- Internal access roads.
- Fence around the project development areas.

The Quantum 1 SEF is proposed in response to the identified objectives of the national and provincial government and local and district municipalities to develop renewable energy facilities for power generation purposes. It is the developer's intention to submit a bid in terms of a regulated power purchase procurement process (e.g., REIPPPP) with the aim of evacuating the generated power into the national grid or obtaining a commercial PPA (Power Purchase Agreement). This will aid in the diversification and stabilisation of the country's electricity supply, in line with the objectives of the Integrated Resource Plan (IRP) with the Quantum 1 SEF set to inject up to 10MW (peak AC power) into the national grid.

From a regional perspective, the area within the West Rand District Municipality identified for the project is considered favourable for the development of a commercial PV facility due to the low environmental sensitivity of the identified site, excellent solar resource, and availability of land on which the development can take place. There is also potential for evacuating the power to the national grid via a direct grid connection at the Eskom Tarlton 132/44/11kV substation which is located within the proposed development area The development area is also in proximity to large electricity users which opens opportunities for commercial PPAs (Behind the meter connection Or Wheeling to a 3rd party off-taker

Please see **Figures 2 and 3** for a map of the proposed Development Area and Footprint.

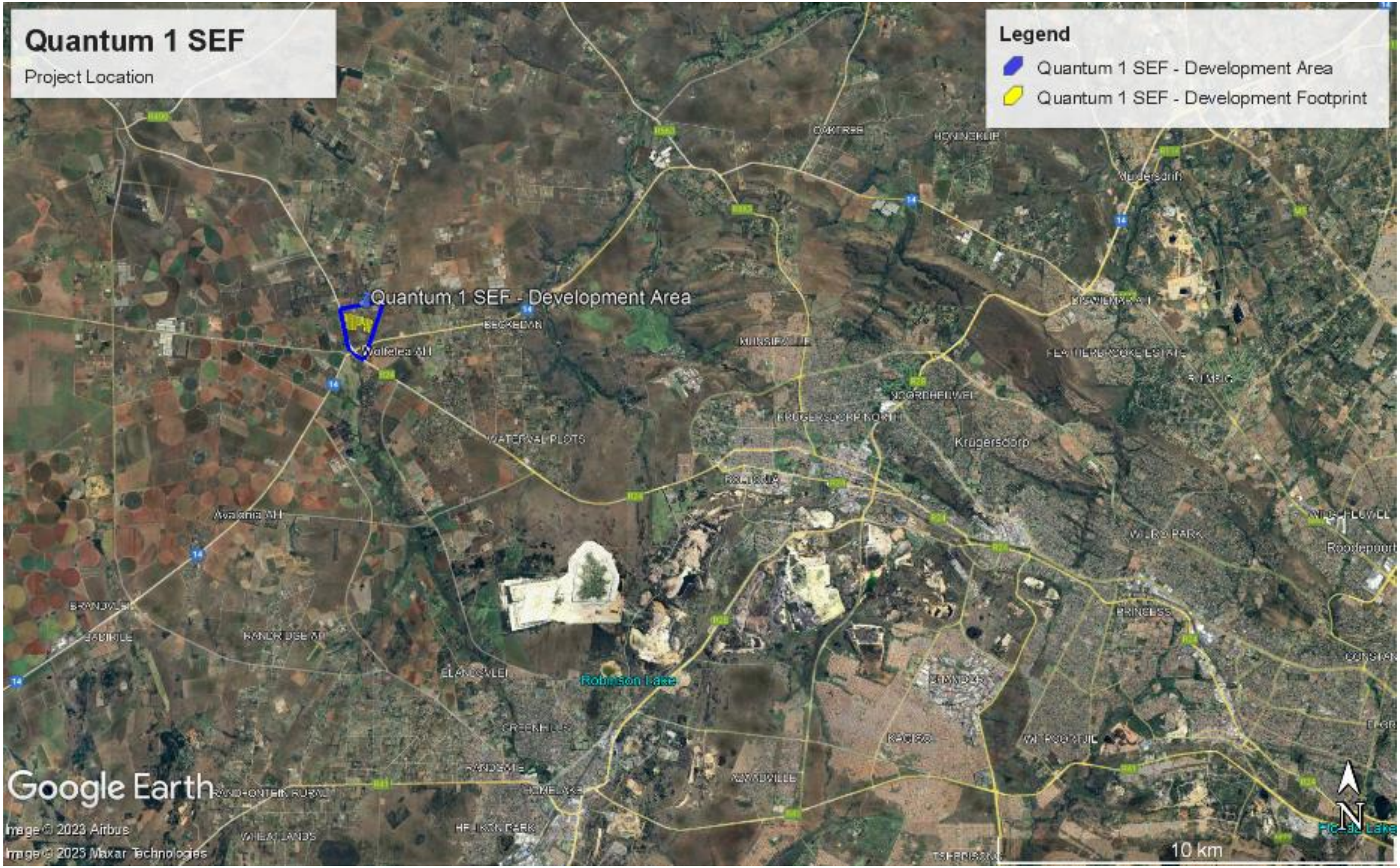

Figure 2: Locality map of the Development Area of the proposed 10 MW Quantum 1 SEF.

Figure 3: Close-up of proposed 10 MW Quantum 1 SEF Development Area and Footprint.

2 SCOPE OF STUDY

The purpose of the specialist study is to determine the main issues and potential impacts of the proposed project on avifauna based on existing information and field assessments. The scope of the study is 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 solar facilities and associated infrastructure.
- Identify potential sensitive environments and receptors that may be impacted on by the proposed facility 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, operational and decommissioning phases.
- Identify 'No-Go' areas, where applicable.
- Recommend mitigation measures to reduce the impact of the expected impacts to acceptable levels.
- Conclude with an impact statement on whether the PV facility is fatally flawed or may be authorised.

3 OUTLINE OF METHODOLOGY AND INFORMATION REVIEWED

The following information sources were consulted to conduct this study:

- Bird distribution data from the Second Southern African Bird Atlas Project (SABAP2) was obtained (https://sabap2.birdmap.africa/), to ascertain which species occur in the pentads where the proposed Project is located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5' × 5'). Each pentad is approximately 8 × 9 km. To get a more representative impression of the birdlife, a consolidated data set was obtained for a total of 4 pentads some of which intersect and others which are near the proposed Development Area, henceforth referred to as "the **Broader Area**". The 4 pentad grid cells are the following: 2600_2735, 2600_2740, 2605_2735, 2605_2740 (**Figure 44**). To date, a total of 391 full protocol checklists (i.e., intensive bird listing surveys lasting a at least two hours each) and 847 ad hoc protocol lists (surveys lasting less than two hours but still yielding valuable data) have been completed for the 4 pentads where the Project is located.
- The SABAP2 data was regarded as a reliable reflection of the avifauna which occur in the area, but the data was also supplemented by data collected during the on-site surveys and general knowledge of the area.
- A classification of the vegetation types in the project site was obtained from the First Atlas of Southern African Birds (SABAP1) and the 2018 National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006, SANBI 2018).
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red List Book of Birds of South Africa, Lesotho, and Swaziland (Taylor *et al.* 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the latest (2022.2) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- The Important Bird and Biodiversity Areas of South Africa (Marnewick *et al.* 2015; http://www.birdlife.org.za/conservation/important-bird-areas) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- An intensive internet search was conducted to source information on the impacts of solar facilities on avifauna.
- Satellite imagery (Google Earth © 2023) was used to view the Broader Area on a landscape level and to help identify bird habitat on the ground.
- The South African National Biodiversity BGIS map viewer was used to determine the locality of the project site relative to National Protected Areas.
- The DFFE National Screening Tool was used to determine the assigned avian sensitivity of the project site.
- The sources that 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)

- Guidelines for the Implementation of the Terrestrial Flora (3c) & Terrestrial Fauna (3d) Species Protocols for EIAs in South Africa produced by the South African National Biodiversity Institute on behalf of the Department of Environment, Forestry and Fisheries (2020).
- The BirdLife South Africa (BLSA) Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa. BirdLife South Africa by Jenkins, A.R., Ralston-Patton, Smit- Robinson, A.H. 2017 (hereafter referred to as the Solar Guidelines) were consulted to determine the level of survey effort that is required.

- The main source of information on the avifaunal diversity and abundance at the Development Area is a pre-construction monitoring programme conducted in April and June 2023, covering the Quantum 1 SEF Development Area and immediate surroundings.

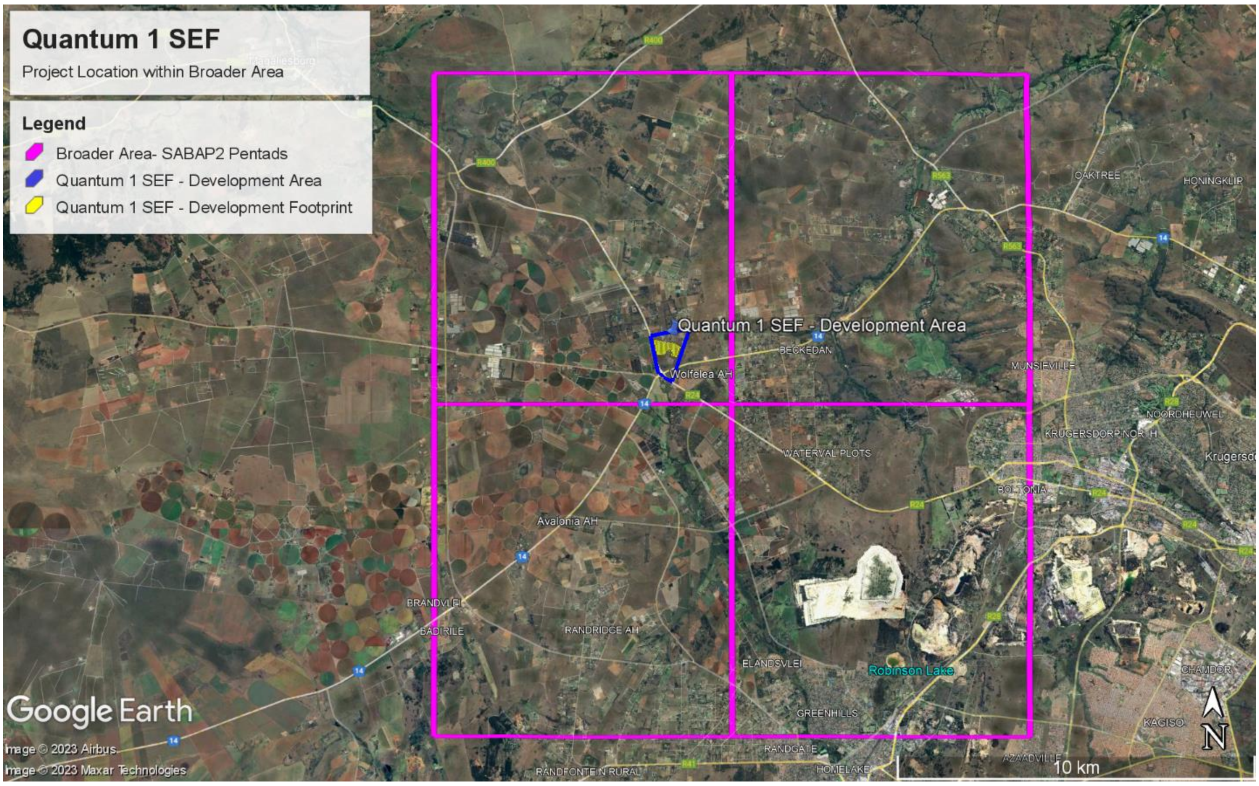

Figure 4: Area covered by the four SABAP2 pentads (outlined in pink), Development Area in blue.

4 ASSUMPTIONS AND LIMITATIONS

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

- The focus of the study is primarily on the potential impacts of the Project on solar priority species which were defined as follows:
  - South African Red List species
  - South African endemics and near-endemics
  - Waterbirds; and
  - Raptors
- The impact of solar installations on avifauna is a new field of study, with only one published scientific study on the impact of PV facilities on avifauna in South Africa (Visser *et al.* 2018). Strong reliance was therefore placed on expert opinion and data from existing monitoring programmes at solar facilities in the USA where monitoring has been ongoing since 2013. The pre-cautionary principle was applied throughout as the full extent of impacts on avifauna at solar facilities is not presently known.
- The assessment of impacts is based on the baseline environment as it currently exists in the project site.
- 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 **Project Site** is the area within which the Quantum 1 Solar PV Facility Development Footprint will be located.

- The **Development Area** is the identified area (located within the Project Site) of ~94.1479ha demarcated within the affected properties for consideration in the EIA process where the Quantum 1 Solar PV Facility and associated infrastructure is planned to be located.
- The **Development Footprint** is the defined area (located within the Development Area) where the PV array and other associated infrastructure for the Quantum 1 Solar PV Facility is planned to be constructed. This is the actual footprint of the facility, and the area which would be disturbed, and is 19.99ha in extent.
- The **Broader Area** refers to the area covered by the four (4) SABAP2 pentads (**Figure 4**).

5 LEGISLATIVE CONTEXT

There is no legislation pertaining specifically to the impact of solar facilities and associated electrical infrastructure on avifauna.

5.1 Agreements and Conventions

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

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

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

[1] (BirdLife International (2022) Country profile: South Africa. Available from: http://www.birdlife.org/datazone/country/south_africa. Checked: 2022-04-02).

Convention name	Description	Geographic scope
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

(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.

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

NEMA makes provision for the prescription of procedures for the assessment and minimum criteria for reporting on identified environmental themes (Sections 24(5)(a) and (h) and 44) when applying for environmental authorisation. The Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020 is applicable in the case of solar PV developments.

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

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

5.3 Provincial Legislation

The current legislation applicable to the conservation of fauna and flora in Gauteng Province is the Gauteng Nature Conservation Bill, 2014. It provides for the sustainable utilization and protection of biodiversity within Gauteng; to provide for the protection of wild and the management of alien animals; protected plants; aquatic biota and aquatic systems; to provide for the protection of invertebrates and the management of alien invertebrates; to provide for professional hunters, hunting outfitters and trainers; to provide for the preservation of caves, cave formations, cave biota and karst systems; to provide for the establishment of zoos; to provide for the powers and establishment of Nature Conservators; to provide for administrative matters and general powers; and to provide for matters connected therewith.

6 BASELINE ASSESSMENT

6.1 Important Bird Areas

The proposed Quantum 1 SEF Development Area is located within the Magaliesberg Important Bird Area (IBA) SA025. This IBA consists mainly of the Magaliesberg mountain range, which extends in an arc from just north-west of Rustenburg in the west to the N1 in the east near Pretoria. To the south, the Witwatersberg range runs parallel to the Magaliesberg, extending from the town of Magaliesburg in the west to Hartbeespoort Dam in the east.

Several large rivers have their headwaters in these mountains, including the Crocodile, Sterkstroom, Magalies and Skeerpoort. Three major impoundments have been built along the Magaliesberg: the massive Hartbeespoort Dam in the east, Buffelspoort Dam in the centre and Olifantsnek Dam about 7 km south of Rustenburg.

The most important trigger species in this IBA is the globally threatened Cape Vulture *Gyps coprotheres*. The number of breeding pairs in the Skeerpoort colony seems to be stable at 200–250. Secretarybird *Sagittarius serpentarius* is the other globally threatened species in the IBA. Regionally threatened species are Lanner Falcon *Falco biarmicus*, Half-collared Kingfisher *Alcedo semitorquata*, African Grass Owl *Tyto capensis*, African Finfoot *Podica senegalensis* and Verreaux's' Eagle *Aquila verreauxii*. Biome-restricted species include White-bellied Sunbird *Cinnyris talatala*, Kurrichane Thrush *Turdus libonyanus*, White-throated Robin-chat *Cossypha humeralis*, Kalahari Scrub Robin *Erythropygia paena* and Barred Wren-Warbler *Calamonastes fasciolatus*.

Red Listed species in this IBA, that could potentially utilize or pass through the Development Area from time to time include:

- Cape Vulture
- Lanner Falcon
- African Grass Owl
- Secretarybird

6.2 DFFE National Screening Tool

The Development Area and immediate environment is classified as **Medium** sensitivity for terrestrial animals according to the Terrestrial Animal Species Theme. The Medium sensitivity classification for avifauna is due to the possible occurrence of African Grass Owl *Tyto capensis* and White-bellied Bustard *Eupodotis senegalensis* (**Figure 5**).

The Development Area contains suitable habitat for avian species of conservation concern (SCC), namely African Grass Owl (Regionally Vulnerable), as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020). The habitat at the Development Area is not suitable for White-bellied Bustards and they were not recorded by SABAP2 in the broader area or during the two on-site surveys. One SCC, the Cape Vulture *Gyps coprotheres* (Globally Vulnerable and Regionally Endangered) was also recorded flying over the site during the field surveys.

Based on the field surveys, the SABAP2 data, and African Grass Owl habitat modelling, a classification of **High** sensitivity for avifauna is suggested for the proposed Development Area.

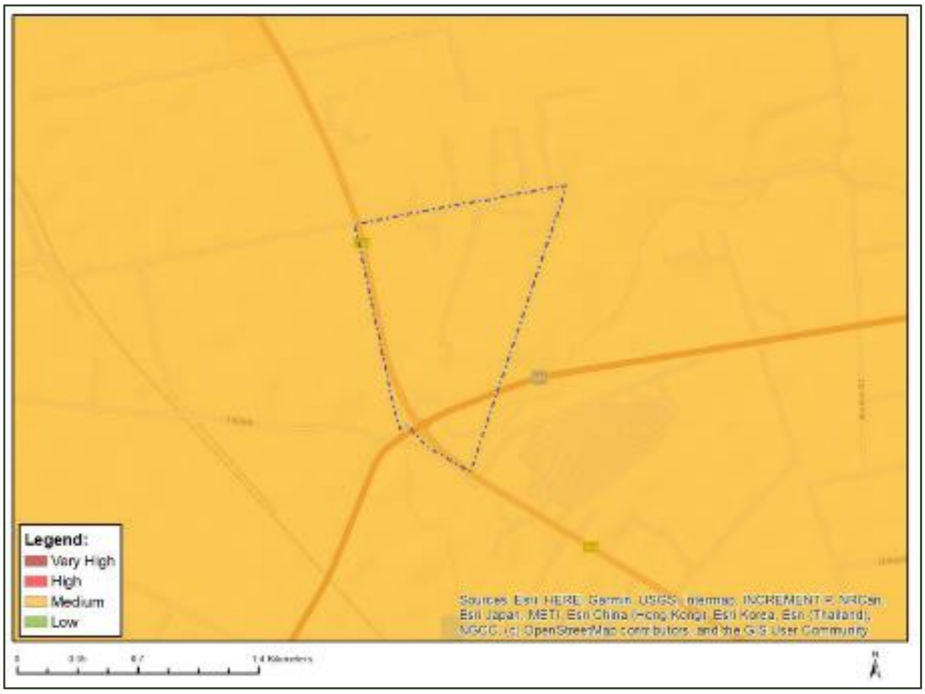

Figure 5: The National Web-Based Environmental Screening Tool map of the proposed Quantum 1 SEF Development Area, indicating sensitivities for the Terrestrial Animal Species theme. The Medium sensitivity classification for avifauna is linked to the possible occurrence of African Grass Owl and White-bellied Bustard.

6.3 Protected Areas

The project site does not fall within a formally protected area.

6.4 Biomes and Vegetation types

The proposed Project is located in the Grassland Biome, in the Dry Highveld Grassland Bioregion of South Africa. The Dry Highveld Grassland Bioregion is characterised by a mean annual precipitation above 650 mm and frost is common in the winter. A thick cover of sourveld grass species dominate in the summer, followed by a dormant winter period. The high diversity of forbs found in grasslands, is what makes grasslands an important biome for species richness. The main vegetation type in the Development Area is classified as Carletonville Dolomite Grassland.

SABAP1 recognises six primary vegetation divisions within South Africa, namely (1) Fynbos (2) Succulent Karoo (3) Nama Karoo (4) Grassland (5) Savanna and (6) Forest (Harrison *et al.* 1997). The criteria used by the authors to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations. It is important to note that no new vegetation unit boundaries were created, with use being made only of previously published data. Using this classification system, the natural vegetation in the Development Area is classified as Grassland.

The habitats across the proposed Development Area are a mixture of grassland with some scattered trees, clumps of alien trees, and wetlands with their associated drainage lines and streams. Whilst the distribution and abundance of the bird species in the project site are typical of the broad vegetation type, it is also necessary to examine bird habitats in more detail as it may influence the distribution and behaviour of priority species. These are discussed in more detail below.

The priority species most likely associated with the various bird habitat features are listed in **Table 2**.

6.5 Bird Habitat

6.5.1 Grassland

The natural vegetation in the Development Area is classified as Grassland. Grassland is dominated by grasses, with geophytes and herbs also well represented. Grasslands are maintained by a combination of relatively high summer rainfall, frequent fires, frost, and grazing, which prevent the presence of shrubs and trees. Grassland specialist species, as well as several ground nesting birds such as korhaan and guineafowl could use this habitat. Raptors will also use these areas for hunting.

6.5.2 Wetlands & Drainage Lines

Surface water is important to avifauna. Wetlands and drainage lines provide important habitat to waterbirds and several other non-priority species. Raptors will also use these areas to hunt other bird species. African Grass Owls (Regionally Vulnerable) could potentially utilize the wetland habitat in the Development Area.

6.5.3 Alien Trees

There are several patches of alien trees present within the Development Area. Alien trees often provide good nesting and roosting sites for birds. Raptor species also use alien trees as perches from which they can scan an area for prey.

6.5.4 Overhead Powerlines

There are some existing overhead powerlines in and near the Development Area. Birds, such as raptors and crows, often use powerlines as perches or even nesting sites.

See **Appendix 2 and 5** for photographic record of habitat features in the Development Area and immediate surroundings.

7 AVIFAUNA IN THE DEVELOPMENT AREA

7.1 Southern African Bird Atlas Project

The SABAP2 data indicates that a total of 301 bird species could potentially occur within the Broader Area – **Appendix 1** provides a comprehensive bird species list. Of these, 105 species are classified as priority species for solar developments and 12 of these are South African Red List species (i.e., Species of Conservation Concern). Of the 105 priority species, 38 are likely to occur regularly in the Development Area (**Table 2**).

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

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

Table 2: Priority species with a medium to high likelihood of regular occurrence in the Development Area.

Species Name	Scientific Name	SABAP2 Reporting Rate %		Global Conservation Status	Regional Conservation Status	Recorded during monitoring	Likelihood of Regular Occurrence	Grassland	Wetlands & Drainage Lines	Alien Trees	Overhead Powerlines	Solar - Collisions with solar panels	Solar - Displacement: Disturbance	Solar - Displacement: Habitat transformation	Solar - Entanglement in fences	Powerline - Electrocution MV	Powerline - Collision
		Full protocol	Ad hoc protocol														
Abdim's Stork	*Ciconia abdimii*	4,60	0,83	-	NT		M	x	x			x					x
African Black Duck	*Anas sparsa*	12,79	0,94	-	-		M		x			x					x
African Sacred Ibis	*Threskiornis aethiopicus*	61,64	25,15	-	-	x	H	x	x			x				x	x
Amur Falcon	*Falco amurensis*	11,51	5,19	-	-		M	x		x	x	x	x			x	
Black Crake	*Zapornia flavirostra*	5,12	0,12	-	-		M		x			x					
Black Sparrowhawk	*Accipiter melanoleucus*	11,51	8,85	-	-		M	x		x	x	x	x			x	
Black-chested Snake Eagle	*Circaetus pectoralis*	7,67	4,60	-	-		M	x		x	x		x	x		x	
Black-headed Heron	*Ardea melanocephala*	59,85	22,43	-	-	x	H	x	x	x	x	x				x	x
Blacksmith Lapwing	*Vanellus armatus*	84,40	40,97	-	-	x	H	x	x			x					
Black-winged Kite	*Elanus caeruleus*	52,94	18,30	-	-	x	H	x		x			x			x	
Black-winged Stilt	*Himantopus himantopus*	4,60	0,24	-	-		M		x			x					
Cape Grassbird	*Sphenoeacus afer*	4,60	0,35	-	-		M	x				x	x				
Cape Vulture	*Gyps coprotheres*	6,91	2,13	VU	EN	x	M	x			x					x	x
Cape Weaver	*Ploceus capensis*	4,35	0,35	-	-		M	x	x	x		x		x			
Cape White-eye	*Zosterops virens*	50,13	9,45	-	-	x	H		x	x		x	x	x			
Cloud Cisticola	*Cisticola textrix*	20,72	1,53	-	-		H	x				x	x				
Common Buzzard	*Buteo buteo*	8,95	3,31	-	-		M	x		x	x					x	
Common Moorhen	*Gallinula chloropus*	25,06	1,06	-	-		H		x			x					
Egyptian Goose	*Alopochen aegyptiaca*	55,50	20,78	-	-	x	H	x	x	x		x				x	x

Species Name	Scientific Name	SABAP2 Reporting Rate %		Global Conservation Status	Regional Conservation Status	Recorded during monitoring	Likelihood of Regular Occurrence	Grassland	Wetlands & Drainage Lines	Alien Trees	Overhead Powerlines	Solar - Collisions with solar panels	Solar - Displacement: Disturbance	Solar - Displacement: Habitat transformation	Solar - Entanglement in fences	Powerline - Electrocution MV	Powerline - Collision
		Full protocol	Ad hoc protocol														
Fiscal Flycatcher	*Melaenornis silens*	40,67	14,64	-	-	x	H	x	x			x	x	x			
Glossy Ibis	*Plegadis falcinellus*	28,13	13,58	-	-		H		x			x					x
Grey Heron	*Ardea cinerea*	12,28	3,31	-	-	x	M	x	x			x					x
Hamerkop	*Scopus umbretta*	5,88	1,65	-	-		M		x			x				x	x
Karoo Thrush	*Turdus smithi*	36,83	23,26	-	-	x	H		x	x		x	x	x			
Little Grebe	*Tachybaptus ruficollis*	12,02	1,30	-	-		M		x			x					x
Marsh Owl	*Asio capensis*	5,12	1,06	-	-	x	M	x	x			x	x	x	x	x	x
Pied Starling	*Lamprotornis bicolor*	20,46	1,65	-	-	x	H	x				x	x				
Red-billed Teal	*Anas erythrorhyncha*	7,93	1,18	-	-		M		x			x					x
Red-knobbed Coot	*Fulica cristata*	19,44	3,31	-	-		H		x			x					x
Reed Cormorant	*Microcarbo africanus*	19,18	4,60	-	-	x	H		x			x					x
Spotted Eagle-Owl	*Bubo africanus*	6,14	9,92	-	-		M	x		x		x	x		x	x	x
Spur-winged Goose	*Plectropterus gambensis*	7,42	1,30	-	-		M	x	x			x					x
Three-banded Plover	*Charadrius tricollaris*	11,51	0,71	-	-		M	x	x			x					
Western Barn Owl	*Tyto alba*	4,09	4,37	-	-		M	x		x						x	x
Western Cattle Egret	*Bubulcus ibis*	70,84	36,01	-	-	x	H	x	x			x				x	x
White-faced Whistling Duck	*Dendrocygna viduata*	4,35	0,35	-	-		M		x			x					x
Wood Sandpiper	*Tringa glareola*	7,16	0,24	-	-		M		x			x					
Yellow-billed Duck	*Anas undulata*	39,39	5,31	-	-		H		x			x					x

7.2 Pre-construction Surveys

Pre-construction avifaunal surveys were undertaken at the Development Area according to a Regime 2 monitoring protocol (i.e., a minimum of two surveys conducted over 6 months) in accordance with the BLSA guidelines for Solar PV developments on:

- 16 April 2023 (Survey 1)
- 03 June 2023 (Survey 2)

The abundance of priority species (Index of kilometric abundance (IKA) = birds/km) recorded during the transect counts at the Development Area is displayed in **Figure 6**. The locations of priority species recorded at the proposed Quantum 1 SEF site during transect counts and incidental sightings are displayed in **Figure 7**.

See **Appendix 3** for a description of the pre-construction monitoring that took place at the proposed Quantum 1 SEF Development Area.

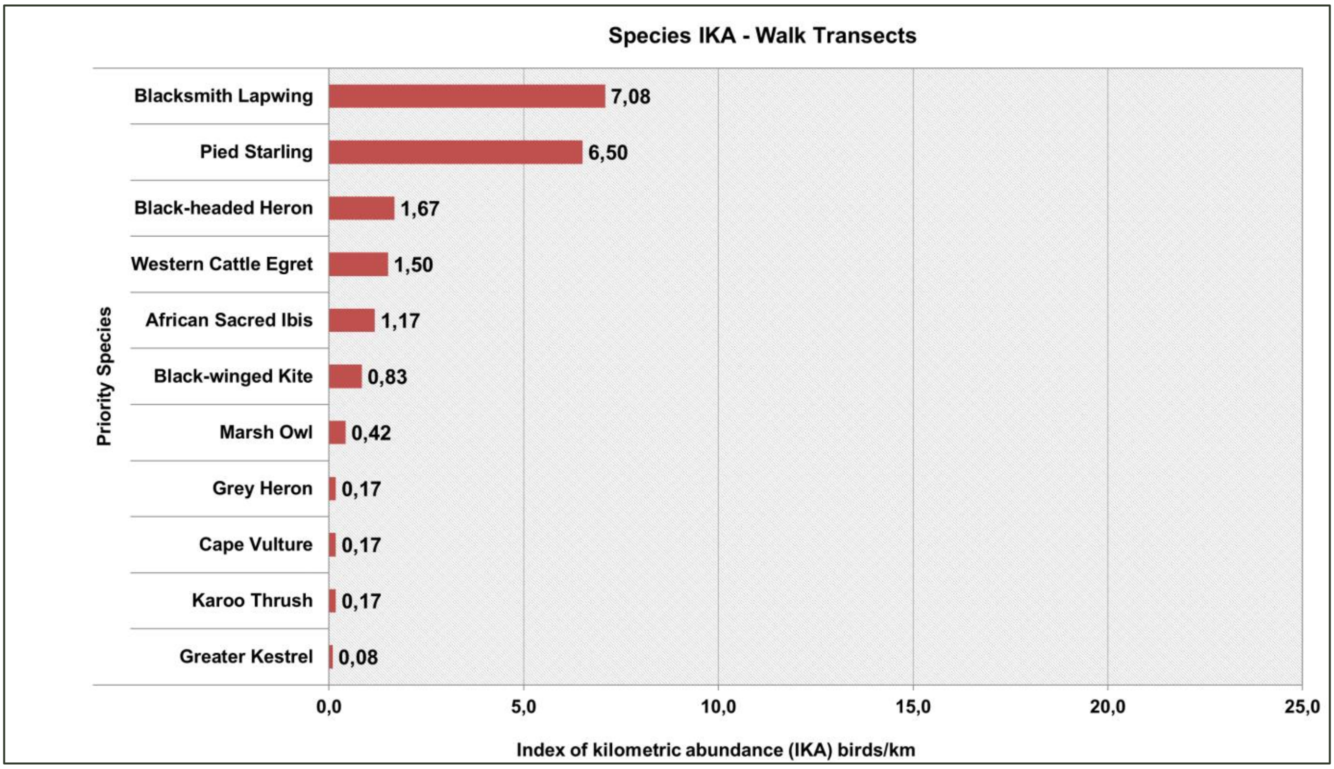

Figure 6: IKA for solar priority species recorded during walk transects at the Quantum 1 SEF site during two on-site surveys (April and June 2023).

Figure 7: The locations of priority species recorded at the proposed Quantum 1 SEF site during transect counts and incidental sightings.

8 IMPACT ASSESSMENT

A literature review reveals a scarcity of published, scientifically examined information regarding large-scale PV plants and birds. The reason for this is mainly that large-scale PV plants is a relatively recent phenomenon. The main source of information for these types of impacts are from compliance reports and a few government-sponsored studies relating to recently constructed solar plants in the south-west United States. In South Africa, one published scientific study has been completed on the impacts of PV plants in a South African context (Visser *et al.* 2018).

In summary, the main impacts of PV plants on avifauna which have emerged so far include the following:

- Displacement due to disturbance associated with the construction of the solar PV plant and associated infrastructure
- Displacement due to habitat transformation associated with the construction of the solar PV plant and associated infrastructure
- Collisions with the solar panels
- Entrapment in perimeter fences
- Collisions with and/or electrocutions on the medium voltage internal powerline network

8.1 Introduction

Increasingly, human-induced climate change is recognized as a fundamental driver of biological processes and patterns. Historic climate change is known to have caused shifts in the geographic ranges of many plants and animals, and future climate change is expected to result in even greater redistributions of species (National Audubon Society 2015). In 2006 WWF Australia produced a report on the envisaged impact of climate change on birds worldwide (Wormworth, J. & Mallon, K. 2006). The report found that:

- Climate change now affects bird species' behaviour, ranges and population dynamics;
- Some bird species are already experiencing strong negative impacts from climate change;
- In future, subject to greenhouse gas emissions levels and climatic response, climate change will put large numbers of bird species at risk of extinction, with estimates of extinction rates varying from 2 to 72%, depending on the region, climate scenario and potential for birds to shift to new habitat.

Using statistical models based on the North American Breeding Bird Survey and Audubon Christmas Bird Count datasets, the National Audubon Society assessed geographic range shifts through the end of the century for 588 North American bird species during both the summer and winter seasons under a range of future climate change scenarios (National Audubon Society 2015). Their analysis showed the following:

- 314 of 588 species modelled (53%) lose more than half of their current geographic range in all three modelled scenarios.
- For 126 species, loss occurs without accompanying range expansion.
- For 188 species, loss is coupled with the potential to colonize new areas.

Climate sensitivity is an important piece of information to incorporate into conservation planning and adaptive management strategies. The persistence of many birds will depend on their ability to colonize climatically suitable areas outside of current ranges and management actions that target climate change adaptation.

South Africa is among the world's top 10 developing countries required to significantly reduce their carbon emissions (Seymore *et al.* 2014), and the introduction of low-carbon technologies into the country's compliment of power generation will greatly assist with achieving this important objective (Walwyn & Brent 2015). Given that South Africa receives among the highest levels of solar radiation on earth (Fluri 2009; Munzhedi *et al.* 2009), it is clear that solar power generation should feature prominently in future efforts to convert to a more sustainable energy mix in order to combat climate change, also from an avifaunal impact perspective. However, while the expansion of solar power generation is undoubtedly a positive development for avifauna in the longer term in that it will help reduce the effect of climate change and thus habitat transformation, it must also be acknowledged that renewable energy facilities, including solar PV facilities, in themselves have some potential for negative impacts on avifauna.

A literature review reveals a scarcity of published, scientifically examined information regarding large-scale PV plants and birds. The reason for this is mainly that large-scale PV plants are a relatively recent phenomenon. The main source of information for these types of impacts are from compliance reports and a few government-sponsored studies relating to recently constructed solar plants in the south-west United States. In South Africa, only one published scientific study has been completed on the impacts of PV plants in a South African context (Visser *et al.* 2018).

8.2 Impacts Associated with the SEF

8.2.1 Impact Trauma (Collisions with Solar Panels)

This impact refers to collision-related fatality i.e., fatality resulting from the direct contact of the bird with a project structure(s). This type of fatality has been occasionally documented at solar projects of all technology types (McCrary *et al.* 1986; Hernandez *et al.* 2014; Kagan *et al.* 2014). In some instances, the bird is not killed outright by the collision impact, but succumbs to predation later, as it cannot avoid predators due to its injured state.
Sheet glass used in commercial and residential buildings has been well established as a hazard for birds. When the sky is reflected in the sheet glass, birds fail to see the building as an obstacle and attempt to fly through the glass, mistaking it for empty space (Loss *et al.* 2014). Although very few cases have been reported it is possible that the reflective surfaces of solar panels could constitute a similar risk to avifauna.

An extremely rare but potentially related problem is the so-called "lake effect" i.e., it seems possible that reflections from solar facilities' infrastructure, particularly large sheets of dark blue photovoltaic panels, may attract birds in flight across the open desert, who mistake the broad reflective surfaces for water (Kagan *et al.* 2014)[2]. The unusually high percentage of waterbird mortalities at the Desert Sunlight PV facility (44% of recorded mortalities) may support the "lake effect" hypothesis (West 2014). Although in the case of Desert Sunlight, the proximity of evaporation ponds may act as an additional risk increasing factor, in that birds are both attracted to the water feature and habituated to the presence of an accessible aquatic environment in the area. This may translate into the misinterpretation of diffusely reflected sky or horizontal polarised light source as a body of water. However, due to limited data it would be premature to make any general conclusions about the influence of the lake effect or other factors that contribute to fatality of water-dependent birds. The activity and abundance of water-dependent species near solar facilities may depend on other site-specific or regional factors, such as the surrounding landscape (Walston *et al.* 2015). However, until such time that enough scientific evidence has been collected to discount the "lake effect" hypothesis, it must be considered as a potential source of impacts.

Weekly mortality searches at 20% coverage were conducted at the 250MW, 1300ha California Valley Solar Ranch PV site (Harvey & Associates 2014a and 2014b). According to the information that could be sourced from the internet (two quarterly reports), 152 avian mortalities were reported for the period 16 November 2013 – 15 February 2014, and 54 for the period 16 February 2014 – 15 May 2014, of which approximately 90% were based on feather spots which precluded a finding on the cause of death. These figures give an estimated

[2] This could either result in birds colliding directly with the solar panels or getting stranded and unable to take off again because many aquatic bird species find it very difficult and sometimes impossible to take off from dry land e.g., grebes and cormorants. This exposes them to predation, even if they do not get injured through direct collisions with the panels.

unadjusted 1 030 mortalities per year, which is obviously an underestimate as it does not include adjustments for carcasses removed by scavengers and missed by searchers. The authors stated clearly that these quarterly reports do not include the results of searcher efficiency trials, carcass removal trials, or data analyses, nor does it include detailed discussions. In a report by the National Fish and Wildlife Forensic Laboratory (Kagan *et al.* 2014), the cause of avian mortalities was estimated based on opportunistic avian carcass collections at several solar facilities, including the 550MW, 1 600ha Desert Sunlight PV plant. Impact trauma emerged as the highest identifiable cause of avian mortality, but most mortality could not be traced to an identifiable cause.

Walston *et al.* (2015) conducted a comprehensive review of avian fatality data from large scale solar facilities (all technology types) in the USA. Collision as cause of death (19 birds) ranked second at Desert Sunlight PV plant and California Valley Solar Ranch (CVSR) PV plant, after unknown causes. Cause of death could not be determined for over 50% of the fatality observations and many carcasses included in these analyses consisted only of feather spots (feathers concentrated together in a small area) or partial carcasses, thus making determination of cause of death difficult. It is anticipated that some unknown fatalities were caused by predation or some other factor unrelated to the solar project. However, they found that the lack of systematic data collection and standardization was a major impediment in establishing the actual extent and causes of fatalities across all projects.

The only scientific investigation of potential avifaunal impacts that has been performed at a South African PV facility was completed in 2016 at the 96MW Jasper PV solar facility (28°17′53″S, 23°21′56″E) which is located on the Humansrus Farm, approximately 4 km south-east of Groenwater and 30km east of Postmasburg in the Northern Cape Province (Visser *et al.* 2019). The Jasper PV facility contains 325 360 solar panels over a footprint of 180 hectares with the capacity to deliver 180 000 MWh of renewable electricity annually. The solar panels face north at a fixed 20° angle, reaching a height of approximately 1.86 m relative to ground level with a distance of 3.11 m between successive rows of panels. Mortality surveys were conducted from the 14th of September 2015 until the 6th of December 2015, with a total of seven mortalities recorded among the solar panels which gives an average rate of 0.003 birds per hectare surveyed per month. All fatalities were inferred from feather spots. Extrapolated bird mortality within the solar field at the Jasper PV facility was 435 birds/yr (95% CI 133 - 805). The broad confidence intervals result from the small number of birds detected. The mortality estimate is likely conservative because detection probabilities were based on intact birds, and probably decrease for older carcasses and feather spots. The study concluded inter alia that the short study period, and lack of comparable results from other sources made it difficult to provide a meaningful assessment of avian mortality at PV facilities. It further stated that despite these limitations, the few bird fatalities that were recorded might suggest that there is no significant collision-related mortality at the study site. The conclusion was that to fully understand the risk of solar energy development on birds, further collation, and analysis of data from solar energy facilities across spatial and temporal scales, based on scientifically rigorous research designs, is required (Visser *et al.* 2018).

Kosciuch *et al.* (2020) analysed the results from fatality monitoring studies at 10 photovoltaic solar facilities across 13 site years in the Sonoran and Mojave Deserts Bird Conservation Region in California and Nevada in the USA. They found no evidence of mass mortality related to the lake effect despite the occurrence of water-obligate birds, which rely on water for take-off and landing, occurring at 90% (9/10) of site-years in the Sonoran and Mojave Deserts Bird Conservation Region. However, until such time that enough scientific evidence has been collected to discount the "lake effect" hypothesis completely, it must be considered as a potential source of impact.

The results of the available literature lack compelling evidence of collisions as a cause of large-scale mortality among birds at PV facilities. However, it is clear from this limited literature survey that the lack of systematic and standardised data collection is a major problem in the assessment of the causes and extent of avian mortality at all types of solar facilities, regardless of the technology employed. Until statistically tested results emerge from existing compliance programmes and more dedicated scientific research, conclusions will inevitably be largely speculative and based on professional opinion.

Based on the lack of evidence to the contrary, it is not foreseen that collisions with the solar panels at the PV facility will be a significant impact. The priority species which would most likely be potentially affected by this impact are mostly small birds which forage between the solar panels, and possibly raptors which prey on them, or forage for insects and reptiles between the PV panels, e.g., Amur Falcon (i.e., if they are not completely displaced due to the habitat transformation). Due to the absence of large permanent waterbodies at or close to the Development Area, it is unlikely that waterbirds will be attracted to the solar arrays due to the "lake effect".

Priority species with a medium to high probability of regular occurrence at the Development Area which could potentially be impacted due to collisions with the solar panels are the following:

Species name	***Scientific name***	**Full protocol**	**Ad hoc protocol**
Abdim's Stork	*Ciconia abdimii*	4,60	0,83
African Black Duck	*Anas sparsa*	12,79	0,94
African Sacred Ibis	*Threskiornis aethiopicus*	61,64	25,15
Amur Falcon	*Falco amurensis*	11,51	5,19
Black Crake	*Zapornia flavirostra*	5,12	0,12
Black Sparrowhawk	*Accipiter melanoleucus*	11,51	8,85
Black-headed Heron	*Ardea melanocephala*	59,85	22,43
Blacksmith Lapwing	*Vanellus armatus*	84,40	40,97
Black-winged Stilt	*Himantopus himantopus*	4,60	0,24
Cape Grassbird	*Sphenoeacus afer*	4,60	0,35
Cape Weaver	*Ploceus capensis*	4,35	0,35
Cape White-eye	*Zosterops virens*	50,13	9,45
Cloud Cisticola	*Cisticola textrix*	20,72	1,53
Common Moorhen	*Gallinula chloropus*	25,06	1,06
Egyptian Goose	*Alopochen aegyptiaca*	55,50	20,78
Fiscal Flycatcher	*Melaenornis silens*	40,67	14,64
Glossy Ibis	*Plegadis falcinellus*	28,13	13,58
Grey Heron	*Ardea cinerea*	12,28	3,31
Hamerkop	*Scopus umbretta*	5,88	1,65
Karoo Thrush	*Turdus smithi*	36,83	23,26
Little Grebe	*Tachybaptus ruficollis*	12,02	1,30
Marsh Owl	*Asio capensis*	5,12	1,06
Pied Starling	*Lamprotornis bicolor*	20,46	1,65
Red-billed Teal	*Anas erythrorhyncha*	7,93	1,18
Red-knobbed Coot	*Fulica cristata*	19,44	3,31
Reed Cormorant	*Microcarbo africanus*	19,18	4,60
Spotted Eagle-Owl	*Bubo africanus*	6,14	9,92
Spur-winged Goose	*Plectropterus gambensis*	7,42	1,30
Three-banded Plover	*Charadrius tricollaris*	11,51	0,71
Western Cattle Egret	*Bubulcus ibis*	70,84	36,01
White-faced Whistling Duck	*Dendrocygna viduata*	4,35	0,35
Wood Sandpiper	*Tringa glareola*	7,16	0,24
Yellow-billed Duck	*Anas undulata*	39,39	5,31

8.2.2 Etranglement In Fences

Visser *et al.* (2018) recorded a fence-line fatality (Orange River Francolin *Scleroptila gutturalis*) resulting from the bird being trapped between the inner and outer perimeter fence of the facility. This was further supported by observations of large-bodied birds unable to escape from between the two fences (e.g., Red-crested Korhaan *Lophotis ruficrista*) (Visser *et al.* 2018). Considering that one would expect the birds to be able to take off in the lengthwise direction (parallel to the fences), it seems possible that the birds panicked when they were approached by observers and thus flew into the fence.

It is not foreseen that entrapment of priority species in perimeter fences will be a significant impact at the PV facility. The priority species which could potentially be affected by this impact are most likely medium to large terrestrial species.

Priority species with a medium to high probability of regular occurrence at the Development Area which could potentially be impacted due entrapment are the following:

Species name	***Scientific name***	**Full protocol**	**Ad hoc protocol**
Black-headed Heron	*Ardea melanocephala*	59,85	22,43
Marsh Owl	*Asio capensis*	5,12	1,06
Spotted Eagle-Owl	*Bubo africanus*	6,14	9,92

8.2.3 Displacement Due to Habitat Transformation

Ground-disturbing activities affect a variety of processes, including soil density, water infiltration rate, vulnerability to erosion, secondary plant succession, invasion by exotic plant species, and stability of cryptobiotic soil crusts. These processes have the ability – individually and together – to alter habitat quality, often to the detriment of wildlife, including avifauna. Any disturbance and alteration to the desert landscape, including the construction and decommissioning of utility-scale solar energy facilities, has the potential to increase soil erosion. Erosion can physically and physiologically affect plant species and can thus adversely influence primary production and food availability for wildlife (Lovich & Ennen 2011).

Solar energy facilities require substantial site preparation (including the removal of vegetation) that alters topography and, thus, drainage patterns to divert the surface flow associated with rainfall away from facility infrastructure. Channelling runoff away from plant communities can have dramatic negative effects on water availability and habitat quality in arid areas. Areas deprived of runoff from sheet flow support less biomass of perennial and annual plants relative to adjacent areas with uninterrupted water-flow patterns (Lovich & Ennen 2011).

The activities listed below are typically associated with the construction and operation of solar facilities and could have direct impacts on avifauna through the transformation of habitat (County of Merced 2014):

- Preparation of solar panel areas for installation, including vegetation clearing, grading, cut and fill;
- Excavation/trenching for water pipelines, cables, fibre-optic lines, and the septic system;
- Construction of piers and building foundations;
- Construction of new dirt or gravel roads and improvement of existing roads;
- Temporary stockpiling and side-casting of soil, construction materials, or other construction wastes;
- Soil compaction, dust, and water runoff from construction sites;
- Degradation of water quality in drainages and other water bodies resulting from project runoff;
- Maintenance of fire breaks and roads; and

- Weed removal, brush clearing, and similar land management activities related to the ongoing operation of the project.

These activities could have an impact on birds breeding, foraging, and roosting in or in close proximity through transformation of habitat, which could result in temporary or permanent displacement.

In a study comparing the avifaunal habitat use in PV arrays with adjoining managed grassland at airports in the USA, DeVault *et al.* (2014) found that species diversity in PV arrays was reduced compared to the grasslands (37 vs 46), supporting the view that solar development is generally detrimental to wildlife on a local scale.

To identify functional and structural changes in bird communities in and around the development footprint, Visser *et al.* (2018) gathered bird transect data at the 180 hectares, 96MW Jasper PV solar facility in the Northern Cape, representing the solar development, boundary, and untransformed landscape. The study found both bird density and diversity per unit area was higher in the boundary and untransformed landscape, however, the extent therefore was not considered to be statistically significant. This indicates that the PV facility matrix is permeable to most species. However, key environmental features, including available habitat and vegetation quality are most likely the overriding factors influencing species' occurrence and their relative density within the development footprint. Her most significant finding was that the distribution of birds in the landscape changed, from a shrubland to open country and grassland bird community, in response to changes in the distribution and abundance of habitat resources such as food, water and nesting sites. These changes in resource availability patterns were detrimental to some bird species and beneficial to others. Shrubland specialists appeared to be negatively affected by the presence of the PV facility. In contrast, open country/grassland and generalist species, were favoured by its development (Visser *et al.* 2018).

As far as displacement, either completely or partially (reduced densities) due to habitat loss is concerned, it is highly likely that the same pattern of reduced avifaunal densities will manifest itself at the proposed PV facility. In addition, ground nesting species, those that utilise low shrubs for nesting, and some raptors are also likely to be impacted by the habitat transformation, as it will result in reduced prey availability and accessibility.

Priority species with a medium to high probability of regular occurrence at the Development Area which could be negatively affected by displacement due to habitat loss are the following:

Species name	***Scientific name***	**Full protocol**	**Ad hoc protocol**
Black-chested Snake Eagle	*Circaetus pectoralis*	7,67	4,60
Cape Weaver	*Ploceus capensis*	4,35	0,35
Cape White-eye	*Zosterops virens*	50,13	9,45
Fiscal Flycatcher	*Melaenornis silens*	40,67	14,64
Karoo Thrush	*Turdus smithi*	36,83	23,26
Marsh Owl	*Asio capensis*	5,12	1,06

8.2.4 Displacement Due to Disturbance

As far as disturbance is concerned, it is likely that all the avifauna, including all the priority species, will be temporarily displaced in the footprint area, either completely or more likely partially (reduced densities) during the construction phase, due to the disturbance associated with the construction activities e.g., increased vehicle traffic, and short-term construction-related noise (from equipment) and visual disturbance.

At the PV facility, the priority species which would be most severely affected by disturbance would be raptors, ground nesting species, and those that utilise low shrubs for nesting.

Priority species with a medium to high probability of regular occurrence at the Development Area which could be negatively affected due to disturbance associated with the PV Facility include:

Species name	***Scientific name***	**Full protocol**	**Ad hoc protocol**
Amur Falcon	*Falco amurensis*	11,51	5,19
Black Sparrowhawk	*Accipiter melanoleucus*	11,51	8,85
Black-chested Snake Eagle	*Circaetus pectoralis*	7,67	4,60
Black-winged Kite	*Elanus caeruleus*	52,94	18,30
Cape Grassbird	*Sphenoeacus afer*	4,60	0,35
Cape White-eye	*Zosterops virens*	50,13	9,45
Cloud Cisticola	*Cisticola textrix*	20,72	1,53
Fiscal Flycatcher	*Melaenornis silens*	40,67	14,64
Karoo Thrush	*Turdus smithi*	36,83	23,26
Marsh Owl	*Asio capensis*	5,12	1,06
Pied Starling	*Lamprotornis bicolor*	20,46	1,65
Spotted Eagle-Owl	*Bubo africanus*	6,14	9,92

8.3 Impacts Associated with the On-site Substation & Internal Medium Voltage Network

8.3.1 Electrocution of priority species in the substation and on the MV powerlines

Medium voltage electricity poles could potentially pose an electrocution risk to raptors. Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2000). The electrocution risk is largely determined by the design of the electrical hardware.

Electrocutions within the proposed substations are possible, however, the likelihood of this impact on the more sensitive Red List priority species is remote, as these species are unlikely to regularly utilise the infrastructure within the substation yard for perching or roosting. 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 and be electrocuted.

While the intention is to place most of the medium voltage reticulation network underground at the PV facility, there are areas where the lines could run above ground.

Priority species with a medium to high probability of regular occurrence at the Development Area which could be at risk of electrocution are the following:

Species name	***Scientific name***	**Full protocol**	**Ad hoc protocol**
African Sacred Ibis	*Threskiornis aethiopicus*	61,64	25,15
Amur Falcon	*Falco amurensis*	11,51	5,19
Black Sparrowhawk	*Accipiter melanoleucus*	11,51	8,85
Black-chested Snake Eagle	*Circaetus pectoralis*	7,67	4,60
Black-headed Heron	*Ardea melanocephala*	59,85	22,43
Black-winged Kite	*Elanus caeruleus*	52,94	18,30
Cape Vulture	*Gyps coprotheres*	6,91	2,13

Species name	*Scientific name*	Full protocol	Ad hoc protocol
Common Buzzard	*Buteo buteo*	8,95	3,31
Egyptian Goose	*Alopochen aegyptiaca*	55,50	20,78
Hamerkop	*Scopus umbretta*	5,88	1,65
Marsh Owl	*Asio capensis*	5,12	1,06
Spotted Eagle-Owl	*Bubo africanus*	6,14	9,92
Western Barn Owl	*Tyto alba*	4,09	4,37
Western Cattle Egret	*Bubulcus ibis*	70,84	36,01

8.3.2 Collisions with the MV Powerlines

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).

From incidental record keeping by the Endangered Wildlife Trust, it is possible to give a measure of what species are generally susceptible to power line collisions in South Africa (**Figure 8**). There are many 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). 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).

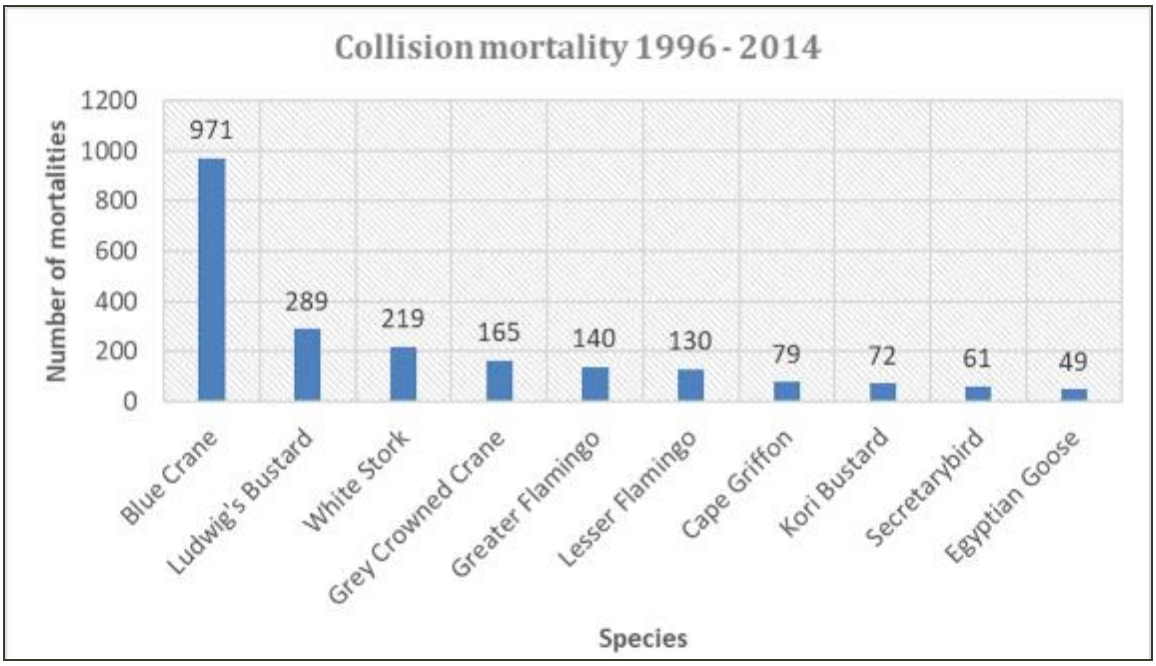

Figure 8: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/Endangered Wildlife Trust Strategic Partnership central incident register 1996 - 2014 (EWT unpublished data)

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

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

While the intention is to place most of the medium voltage reticulation network underground at the PV facility, there are areas where the lines could run above ground.

Priority species with a medium to high probability of regular occurrence at the Development Area which are most at risk of collisions with the medium voltage powerlines are the following:

Species name	***Scientific name***	**Full protocol**	**Ad hoc protocol**
Abdim's Stork	*Ciconia abdimii*	4,60	0,83
African Black Duck	*Anas sparsa*	12,79	0,94
African Sacred Ibis	*Threskiornis aethiopicus*	61,64	25,15

Species name	*Scientific name*	Full protocol	Ad hoc protocol
Black-headed Heron	*Ardea melanocephala*	59,85	22,43
Cape Vulture	*Gyps coprotheres*	6,91	2,13
Egyptian Goose	*Alopochen aegyptiaca*	55,50	20,78
Glossy Ibis	*Plegadis falcinellus*	28,13	13,58
Grey Heron	*Ardea cinerea*	12,28	3,31
Hamerkop	*Scopus umbretta*	5,88	1,65
Little Grebe	*Tachybaptus ruficollis*	12,02	1,30
Marsh Owl	*Asio capensis*	5,12	1,06
Red-billed Teal	*Anas erythrorhyncha*	7,93	1,18
Red-knobbed Coot	*Fulica cristata*	19,44	3,31
Reed Cormorant	*Microcarbo africanus*	19,18	4,60
Spotted Eagle-Owl	*Bubo africanus*	6,14	9,92
Spur-winged Goose	*Plectropterus gambensis*	7,42	1,30
Western Barn Owl	*Tyto alba*	4,09	4,37
Western Cattle Egret	*Bubulcus ibis*	70,84	36,01
White-faced Whistling Duck	*Dendrocygna viduata*	4,35	0,35
Yellow-billed Duck	*Anas undulata*	39,39	5,31

9 IMPACT RATING

9.1 Impact Assessment Methodology

Assessment of Impacts

Direct, indirect, and cumulative impacts of the issues identified through the scoping study, as well as all other issues identified in the EIA phase must be assessed in terms of the following criteria:

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

» the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
» the **status**, which will be described as either positive, negative or neutral.
» the degree to which the impact can be reversed.
» the degree to which the impact may cause irreplaceable loss of resources.
» the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:
S=(E+D+M)P
S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

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

» < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
» 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
» > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

9.2 Impact Assessment Ratings

9.2.1 Construction Phase

Nature: Displacement of priority species due to disturbance associated with construction of the Quantum 1 SEF and associated infrastructure.		
	Without mitigation	**With mitigation**
Extent	2 local	2 local
Duration	1 very short	1 very short
Magnitude	8 high	6 moderate
Probability	5 definite	5 definite
Significance	**55 MEDIUM**	**45 MEDIUM**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, but to a limited extent	

Mitigation:
- 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 solar priority species.
- The African Grass Owl habitat buffers as indicated in the Avifaunal Sensitivities Map should be maintained (Section 9.3).
- Measures to control noise and dust should be applied according to current best practice in the industry.

• Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint is concerned.
Residual Risks: The residual risk of displacement will be reduced but remain at a medium level after mitigation, if the proposed mitigation is implemented.

Nature: Displacement of priority species due to habitat transformation associated with construction of the Quantum 1 SEF and associated infrastructure.		
	Without mitigation	**With mitigation**
Extent	1 site only	1 site only
Duration	4 long term	4 long term
Magnitude	8 high	6 moderate
Probability	5 definite	4 improbable
Significance	**65 HIGH**	**44 MEDIUM**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To a limited extent	
Mitigation: • The African Grass Owl habitat buffers as indicated in the Avifaunal Sensitivities Map should be maintained (Section 9.3). • Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum. • The mitigation measures proposed by the biodiversity and vegetation specialists must be strictly implemented.		
Residual Risks: The residual risk of displacement will be reduced after mitigation but will remain for some species due to the change in habitat.		

9.2.2 Operational Phase

Nature: Mortality of priority species due to collisions with solar panels.		
	Without mitigation	**With mitigation**
Extent	2 local	2 local
Duration	4 long term	4 long term
Magnitude	4 low	4 low
Probability	2 probable	2 probable
Significance	**20 LOW**	**20 LOW**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No

Can impacts be mitigated?	No mitigation required

Mitigation:

- Due to the expected low significance of this impact, no mitigation measures are recommended.

Residual Risks:

Not applicable

Nature: Entrapment of large-bodied birds in the double perimeter fence lines of the Quantum 1 SEF.		
	Without mitigation	**With mitigation**
Extent	2 local	2 local
Duration	4 long term	4 long term
Magnitude	6 moderate	4 low
Probability	3 possible	2 improbable
Significance	**36 MEDIUM**	**20 LOW**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation:

- It is recommended that a single perimeter fence is used.
- Increasing the spacing between at least the top two wires (to a minimum of 30cm) and ensuring they are correctly tensioned will reduce the snaring risk for owls.

Residual Risks: The residual risk of entrapment will be low once mitigation is implemented.

Nature: Mortality of priority species due to electrocution on the medium voltage internal reticulation networks and substation		
	Without mitigation	**With mitigation**
Extent	2 local	2 local
Duration	4 long term	4 long term
Magnitude	8 high	4 low
Probability	3 possible	1 very improbable
Significance	**42 MEDIUM**	**10 LOW**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation: • Use underground cables as much as possible. • A raptor-friendly pole design must be used, and the pole design must be approved by the avifaunal specialist. • The hardware within the proposed substation yards 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 and be electrocuted.
Residual Risks: The residual risk of electrocution will be low once mitigation is implemented.

Nature: Mortality of priority species due to collisions with the medium voltage internal reticulation networks		
	Without mitigation	**With mitigation**
Extent	2 local	2 local
Duration	4 long term	4 long term
Magnitude	6 medium	4 low
Probability	3 possible	2 improbable
Significance	**36 MEDIUM**	**20 LOW**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation: • Use underground cables as much as possible. • All internal medium voltage lines must be marked with Eskom approved Bird Flight Diverters according to the latest official Eskom Engineering Instruction.		
Residual Risks: The residual risk of collision will still be present for Ludwig's Bustard, but significantly reduced for other species.		

9.2.3 Decommissioning Phase

Nature: Displacement of priority species due to disturbance associated with decommissioning of the Quantum 1 SEF and associated infrastructure.		
	Without mitigation	**With mitigation**
Extent	2 local	2 local
Duration	1 very short	1 very short
Magnitude	8 high	6 moderate
Probability	5 definite	5 definite
Significance	**55 MEDIUM**	**45 MEDIUM**
Status (positive or negative)	Negative	Negative
Reversibility	High	High

Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, but to a limited extent	

Mitigation:

- Activity should be restricted to the footprint of the infrastructure as far as possible.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical.
- Access to the rest of the property must be restricted.
- The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint is concerned.

Residual Risks: The residual risk of displacement will be reduced but remain at a medium level after mitigation, if the proposed mitigation is implemented.

9.2.4 Summary

The methodology explained above was used to obtain the summarised assessment of the anticipated impacts on avifauna in **Table 3** below.

Table 3: Summarised Assessment of The Anticipated Impacts

Environmental Parameter	Nature of Impact	Rating prior to mitigation	Rating post mitigation
Avifauna	Displacement of priority species due to disturbance associated with construction of the SEF and associated infrastructure.	55 MEDIUM	45 MEDIUM
	Displacement of priority species due to habitat transformation associated with construction of the SEF and associated infrastructure.	65 HIGH	44 MEDIUM
	Mortality of priority species due to collisions with solar panels.	20 LOW	20 LOW
	Entrapment of large-bodied birds in the double perimeter fence.	36 MEDIUM	20 LOW
	Mortality of priority species due to electrocution on the internal medium voltage powerline.	42 MEDIUM	10 LOW
	Mortality of priority species due to collisions with the internal medium voltage powerline.	36 MEDIUM	20 LOW
	Displacement of priority species due to disturbance associated with decommissioning of the PV plant and associated infrastructure.	55 MEDIUM	45 MEDIUM
	AVERAGE SIGNIFICANCE RATING	**44 MEDIUM**	**29 LOW**

9.3 Environmental Sensitivities

The Development Area and immediate environment is classified as **Medium** sensitivity for terrestrial animals according to the Terrestrial Animal Species Theme. The Medium sensitivity classification for avifauna is due to the possible occurrence of African Grass Owl *Tyto capensis* and White-bellied Bustard *Eupodotis senegalensis*.

The Development Area contains suitable habitat for avian species of conservation concern (SCC), namely African Grass Owl (Regionally Vulnerable), as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020). The habitat at the Development Area is not suitable for White-bellied

Bustards and they were not recorded by SABAP2 in the broader area or during the two on-site surveys. One SCC, the Cape Vulture *Gyps coprotheres* (Globally Vulnerable and Regionally Endangered) was recorded flying over the area during the field surveys. Based on the field surveys, the SABAP2 data, and African Grass Owl habitat modelling, a classification of **High** sensitivity for avifauna is suggested for the proposed Development Area.

The following specific environmental sensitivities have been identified from an avifaunal perspective:

- **African Grass Owl Habitat: Very High Sensitivity (All Infrastructure Exclusion Zone)**

  Habitat suitability modelling indicates small areas of suitable breeding habitat for African Grass Owls (Regionally Vulnerable) in the proposed Development Area. The model was informed by known African Grassland Owl localities and breeding sites. Key wetland habitats that could potentially be used by African Grass Owl were identified from a presence locality dataset provided by Craig Whittington-Jones (GDARD Ornithologist) and supplemented with other known records of African Grass Owl breeding sites. Roadkill and marginal/stochastic sites were disregarded for this analysis, the emphasis was placed on records noted as confirmed or suspected breeding sites, as well as sites noted to host the species consistently, but where breeding was unconfirmed. A systematic GIS grid was then used to generate positive training data samples from these sites representing suitable breeding wetlands for African Grass Owl. Please refer to **Appendix 6** for a full description of the habitat suitability modelling methodology.

  Despite the model indicating potential suitable breeding habitat for African Grass Owls, the identified wetland areas are small and are further impacted by high levels of anthropogenic disturbance (adjacent roads N14/R24 intersection and associated pedestrian traffic). Within the broader area, the model identified larger and more continuous patches of suitable African Grass Owl habitat further afield from the Development Area (See **Figure 9** below).

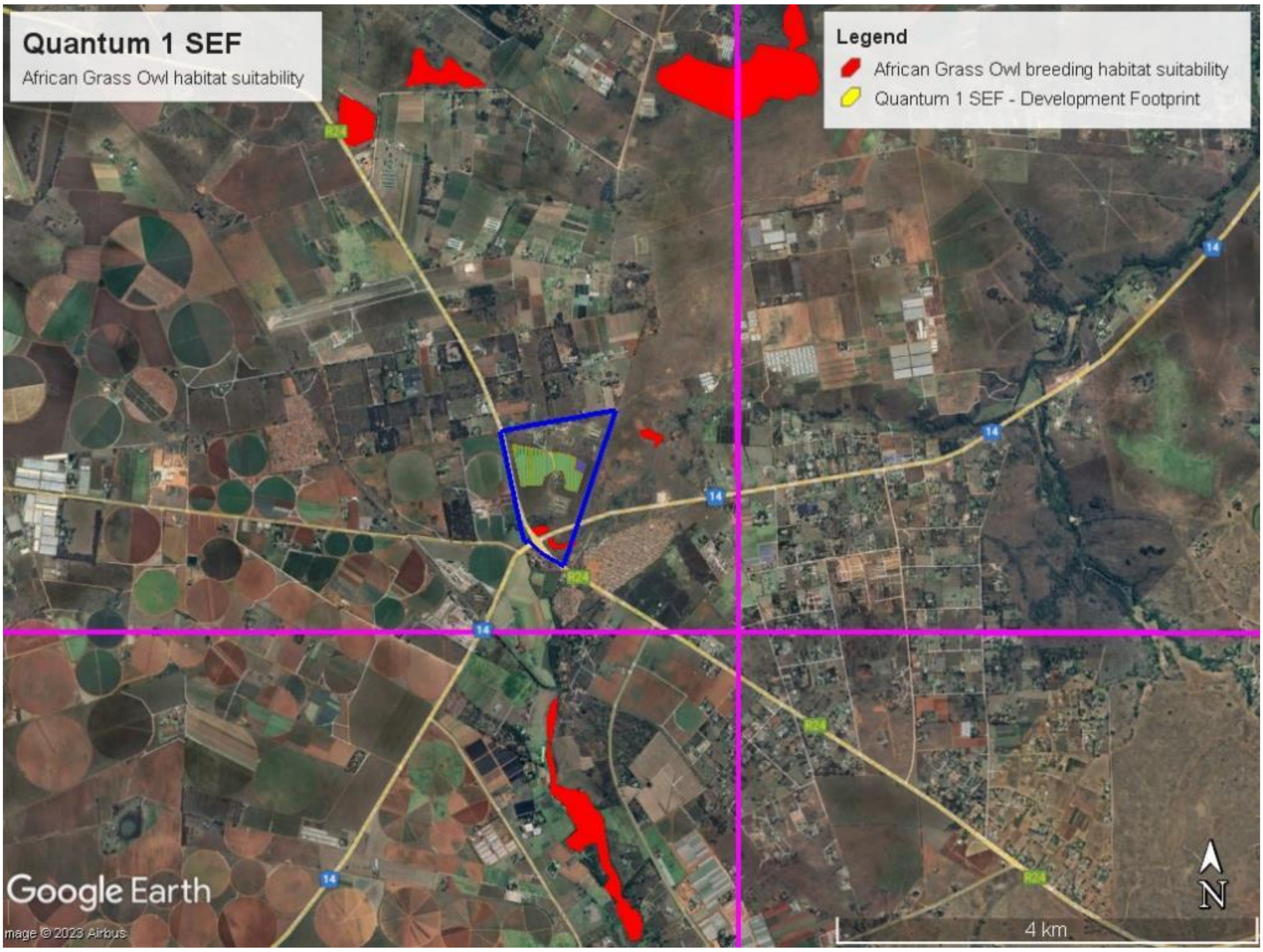

Figure 9: African Grass Owl breeding habitat suitability model output in the Broader Area.

- **Wetlands and Drainage Lines: High Sensitivity (Solar Panel Exclusion Zone)**

  The Development Area and the immediate environment contain several drainage lines and associated wetlands which are sources of surface water and habitat for a range of species. It is necessary to leave open space with no solar panels, for birds utilising this habitat. <u>The buffer zones as recommended by the Freshwater Specialist should be followed as it will also benefit the avifauna that use this habitat</u>.

See the **Figure 10** below for the avifaunal sensitivities identified in and near the Development Area. <u>The Development Footprint does not overlap with the identified avifaunal sensitivities</u>.

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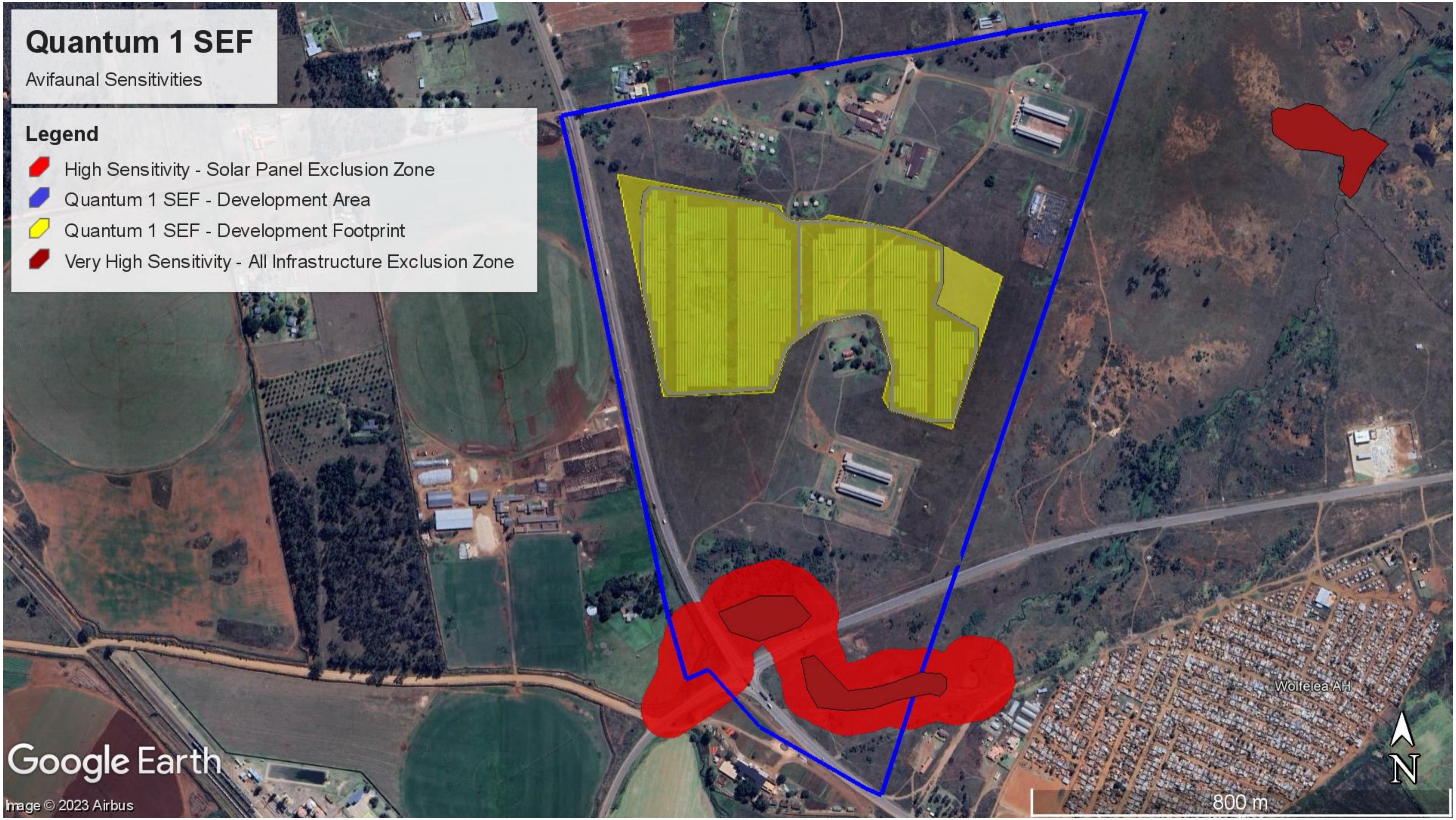

Figure 10: Avifaunal sensitivities identified at the Quantum 1 SEF Development Area.

10 CUMULATIVE IMPACTS

Cumulative effects are commonly understood to be the combined impacts from different projects that result in significant change in an area, which could be larger than the sum of all the individual impacts. The assessment of cumulative effects therefore needs to consider all renewable energy projects within a 30 km radius that have received or is in the process of receiving an Environmental Authorisation at the time of starting the EIA process for the proposed Quantum 1 SEF. There are currently two (2) renewable energy projects authorised, operational, or in process, within a 30 km radius of the proposed Quantum 1 SEF (**Figure 10 and Table 5**).

The total affected land parcel area taken up by authorised and/or planned renewable energy projects within the 30 km radius is approximately 34 km² (3400 ha). The total affected land parcel area affected by the Quantum 1 SEF equates to approximately 0.94 km² (94 ha). The combined land parcel area affected by authorised renewable energy developments within the 30 km radius, including the proposed Quantum 1 SEF, thus equals approximately 35 km² (3500 ha). The proposed Quantum 1 SEF land parcel area thus constitute ~2.7%. The contribution of the proposed Quantum 1 SEF to the cumulative impact is thus anticipated to be **low** after mitigation.

The total area within the 30 km radius around the proposed project equates to about 2475 km² (247 500 ha) of similar habitat (i.e., a mixture of agriculture, grassland, and some urban settlements). The total combined size of the land parcels potentially affected by renewable energy projects will equate to ~1.4 % of the available similar habitat in the 30 km radius. Assuming that all the projects are constructed, the cumulative impact of all the proposed renewable energy projects is estimated to be **low to medium**. The actual physical footprint of the renewable energy facilities will also be much smaller than the land parcel areas themselves. Furthermore, several of these projects must still be subject to a competitive bidding process where only the most competitive projects will win a power purchase agreement required for the project to proceed to construction.

Table 4: List of other renewable energy projects within a 30km radius of the proposed Quantum 1 SEF

Project	DFFE Reference No	Technology	Capacity	Land parcel area (km²)	Status
70mw Photovoltaic Power Plant On Portion 57 Of The Farm Waterval 174	12/12/20/2539/AM1	Solar	70 MW	32.4	Approved
Photovoltaic Solar Panels On Portion 3 Of The Farm Rietpoort 395	12/12/20/2330	Solar	15 MW	1.5	Approved

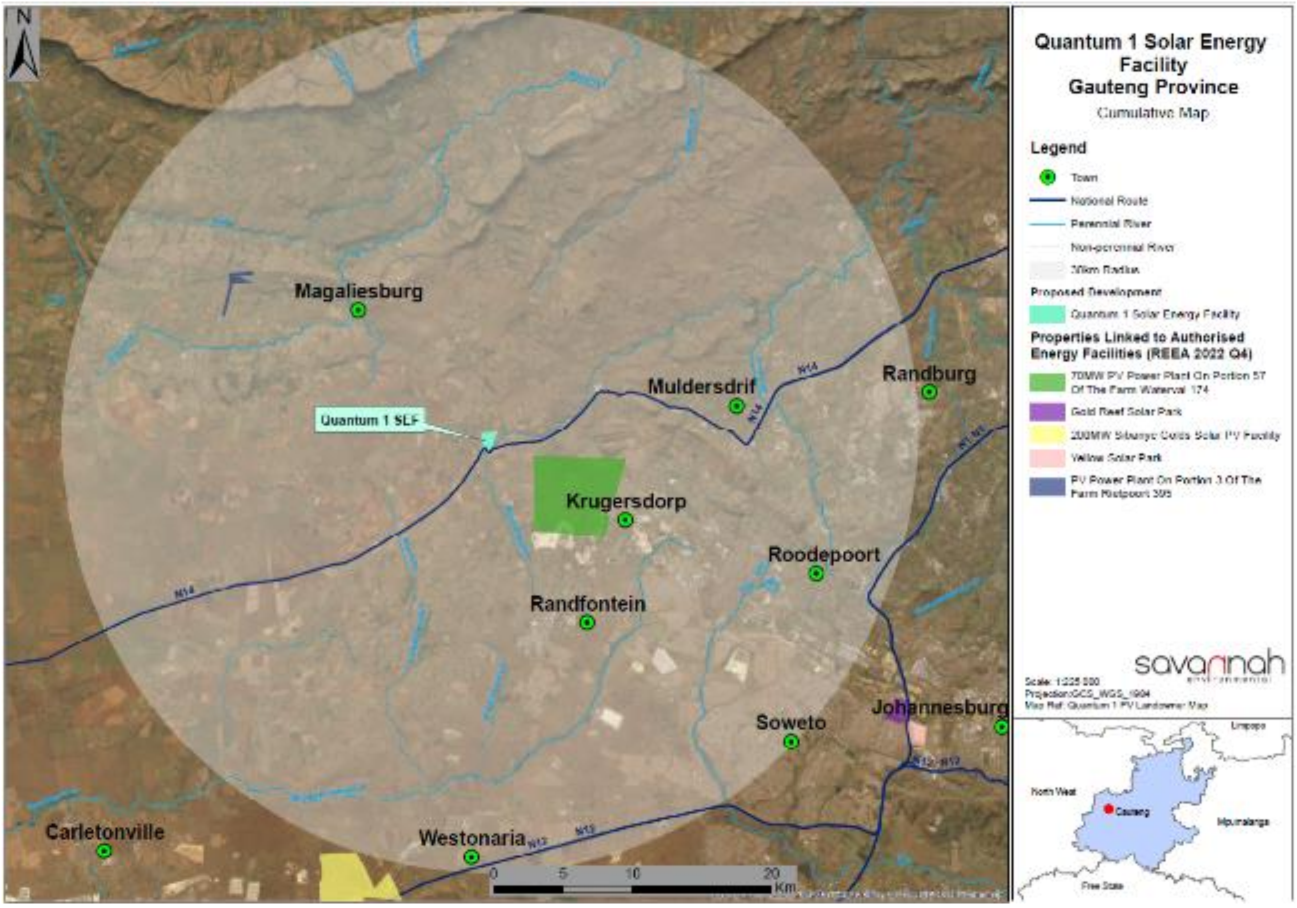

Figure 11: Other renewable energy projects within a 30km radius of the proposed Quantum 1 SEF.

Nature: *Cumulative impacts associated with renewable energy facilities*

- *Displacement due to disturbance associated with the construction of the renewable energy facility and associated infrastructure*
- *Displacement due to habitat transformation associated with the construction and operation of the renewable energy facility and associated infrastructure*
- *Collisions with the solar panels*
- *Collison with wind turbines*
- *Entrapment in perimeter fences*
- *Displacement due to disturbance associated with the decommissioning of the renewable energy facilities and associated infrastructure*
- *Mortality of priority species due to electrocution on the medium voltage internal reticulation networks*
- *Mortality of priority species due to collisions with the medium voltage internal reticulation networks*

	Cumulative impact of the proposed Quantum 1 SEF within a 30km radius (post mitigation).	**Cumulative impact of all other renewable energy projects within a 30km radius (post mitigation)**
Extent	3 regional	3 regional
Duration	4 long term	4 long term
Magnitude	2 minor	2 minor
Probability	3 probable	4 highly probable
Significance	**27 LOW**	**36 MEDIUM**
Status (positive/negative)	Negative	Negative
Reversibility	High	High

Loss of resources?	No	Yes
Can impacts be mitigated?	Yes	
Confidence in findings: Medium.		
Mitigation: • All mitigation measures listed in this report for the Quantum 1 SEF and all mitigation measures relevant to avifauna listed in the various specialist reports for the other planned projects within a 30km radius of Quantum 1 SEF should be followed.		

11 ENVIRONMENTAL MANAGEMENT PROGRAMME

For each anticipated impact, management recommendations for the design, construction, and operational phase (where appropriate) are included in the project EMPr (see **Appendix 4**).

12 CONCLUSION

The proposed 10 MW Quantum 1 SEF will have anticipated high, medium, and low negative impacts on priority avifauna, which is expected to be reduced to medium and low with appropriate mitigation. No fatal flaws were discovered during the on-site investigations. <u>The development is supported provided the mitigation measures listed in this report are strictly implemented</u>.

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APPENDIX 1: SABAP2 SPECIES LIST FOR THE BROADER AREA

Species name	Scientific name	SABAP2 Reporting Rate %	
		Full protocol	Ad hoc protocol
Abdim's Stork	Ciconia abdimii	4,60	0,83
Acacia Pied Barbet	Tricholaema leucomelas	3,07	0,35
African Black Duck	Anas sparsa	12,79	0,94
African Black Swift	Apus barbatus	1,53	0,12
African Crake	Crecopsis egregia	0,00	0,12
African Cuckoo-Hawk	Aviceda cuculoides	0,26	0,00
African Darter	Anhinga rufa	2,05	0,12
African Firefinch	Lagonosticta rubricata	1,02	0,00
African Fish Eagle	Haliaeetus vocifer	0,51	0,00
African Grey Hornbill	Lophoceros nasutus	11,00	2,36
African Harrier-Hawk	Polyboroides typus	1,02	1,65
African Hoopoe	Upupa africana	16,88	5,67
African Marsh Harrier	Circus ranivorus	0,26	0,00
African Olive Pigeon	Columba arquatrix	3,84	0,59
African Palm Swift	Cypsiurus parvus	46,29	16,53
African Paradise Flycatcher	Terpsiphone viridis	4,60	0,83
African Pipit	Anthus cinnamomeus	62,40	21,96
African Rail	Rallus caerulescens	3,58	0,24
African Red-eyed Bulbul	Pycnonotus nigricans	0,51	0,12
African Reed Warbler	Acrocephalus baeticatus	6,65	0,35
African Sacred Ibis	Threskiornis aethiopicus	61,64	25,15
African Snipe	Gallinago nigripennis	2,56	0,12
African Spoonbill	Platalea alba	1,02	0,47
African Stonechat	Saxicola torquatus	60,87	8,03
African Swamphen	Porphyrio madagascariensis	1,79	0,00
African Wattled Lapwing	Vanellus senegallus	49,62	5,31
Alpine Swift	Tachymarptis melba	0,51	0,12
Amethyst Sunbird	Chalcomitra amethystina	35,29	21,02
Amur Falcon	Falco amurensis	11,51	5,19
Ant-eating Chat	Myrmecocichla formicivora	9,46	0,59
Arrow-marked Babbler	Turdoides jardineii	12,28	2,01
Baillon's Crake	Zapornia pusilla	0,26	0,00
Banded Martin	Riparia cincta	8,70	0,24
Barn Swallow	Hirundo rustica	46,55	22,31
Bar-throated Apalis	Apalis thoracica	10,74	0,47
Bearded Woodpecker	Chloropicus namaquus	0,00	0,12

Species name	Scientific name	SABAP2 Reporting Rate %	
		Full protocol	Ad hoc protocol
Black Crake	Zapornia flavirostra	5,12	0,12
Black Cuckoo	Cuculus clamosus	2,30	0,12
Black Cuckooshrike	Campephaga flava	0,26	0,00
Black Heron	Egretta ardesiaca	0,26	0,00
Black Kite	Milvus migrans	0,26	0,00
Black Sparrowhawk	Accipiter melanoleucus	11,51	8,85
Black-backed Puffback	Dryoscopus cubla	5,63	0,24
Black-chested Prinia	Prinia flavicans	31,20	8,38
Black-chested Snake Eagle	Circaetus pectoralis	7,67	4,60
Black-collared Barbet	Lybius torquatus	35,29	12,16
Black-crowned Tchagra	Tchagra senegalus	7,16	0,47
Black-headed Heron	Ardea melanocephala	59,85	22,43
Black-headed Oriole	Oriolus larvatus	12,53	9,92
Blacksmith Lapwing	Vanellus armatus	84,40	40,97
Black-throated Canary	Crithagra atrogularis	42,97	9,45
Black-winged Kite	Elanus caeruleus	52,94	18,30
Black-winged Stilt	Himantopus himantopus	4,60	0,24
Blue Waxbill	Uraeginthus angolensis	3,32	1,65
Blue-billed Teal	Spatula hottentota	0,26	0,12
Bokmakierie	Telophorus zeylonus	46,29	7,91
Bronze Mannikin	Spermestes cucullata	2,05	0,24
Brown Snake Eagle	Circaetus cinereus	1,28	0,12
Brown-backed Honeybird	Prodotiscus regulus	1,02	0,00
Brown-crowned Tchagra	Tchagra australis	2,56	0,47
Brown-hooded Kingfisher	Halcyon albiventris	6,91	0,47
Brown-throated Martin	Riparia paludicola	13,81	2,13
Brubru	Nilaus afer	0,26	0,00
Buffy Pipit	Anthus vaalensis	3,84	0,00
Burchell's Coucal	Centropus burchellii	6,14	0,35
Cape Bunting	Emberiza capensis	0,26	0,00
Cape Grassbird	Sphenoeacus afer	4,60	0,35
Cape Longclaw	Macronyx capensis	57,54	6,85
Cape Robin-Chat	Cossypha caffra	54,48	12,40
Cape Rock Thrush	Monticola rupestris	1,53	0,12
Cape Shoveler	Spatula smithii	0,26	0,12
Cape Sparrow	Passer melanurus	83,38	32,11
Cape Starling	Lamprotornis nitens	71,87	36,01
Cape Turtle Dove	Streptopelia capicola	63,94	9,45

Species name	Scientific name	SABAP2 Reporting Rate %	
		Full protocol	Ad hoc protocol
Cape Vulture	Gyps coprotheres	6,91	2,13
Cape Wagtail	Motacilla capensis	51,66	28,10
Cape Weaver	Ploceus capensis	4,35	0,35
Cape White-eye	Zosterops virens	50,13	9,45
Capped Wheatear	Oenanthe pileata	21,48	3,78
Cardinal Woodpecker	Dendropicos fuscescens	5,12	0,94
Chestnut-backed Sparrow-Lark	Eremopterix leucotis	0,51	0,24
Chestnut-vented Warbler	Curruca subcoerulea	3,84	0,35
Chinspot Batis	Batis molitor	5,37	0,12
Cinnamon-breasted Bunting	Emberiza tahapisi	8,44	2,13
Cloud Cisticola	Cisticola textrix	20,72	1,53
Common Buzzard	Buteo buteo	8,95	3,31
Common Greenshank	Tringa nebularia	0,77	0,12
Common House Martin	Delichon urbicum	0,51	0,00
Common Moorhen	Gallinula chloropus	25,06	1,06
Common Myna	Acridotheres tristis	82,10	38,72
Common Ostrich	Struthio camelus	16,62	1,77
Common Quail	Coturnix coturnix	1,28	0,00
Common Scimitarbill	Rhinopomastus cyanomelas	0,51	0,00
Common Swift	Apus apus	1,79	0,00
Common Waxbill	Estrilda astrild	13,04	1,30
Coqui Francolin	Peliperdix coqui	8,44	1,06
Crested Barbet	Trachyphonus vaillantii	60,36	7,91
Crested Francolin	Dendroperdix sephaena	1,79	1,65
Crimson-breasted Shrike	Laniarius atrococcineus	0,26	0,12
Crowned Lapwing	Vanellus coronatus	87,47	38,13
Cut-throat Finch	Amadina fasciata	0,00	0,24
Dark-capped Bulbul	Pycnonotus tricolor	85,42	34,59
Desert Cisticola	Cisticola aridulus	9,97	0,83
Diederik Cuckoo	Chrysococcyx caprius	19,44	4,01
Domestic Goose	Anser anser domesticus	1,02	0,12
Eastern Clapper Lark	Mirafra fasciolata	5,63	0,24
Eastern Long-billed Lark	Certhilauda semitorquata	1,28	0,12
Egyptian Goose	Alopochen aegyptiaca	55,50	20,78
European Bee-eater	Merops apiaster	15,35	2,01
European Honey-buzzard	Pernis apivorus	1,28	0,00
European Roller	Coracias garrulus	0,00	0,24
Fairy Flycatcher	Stenostira scita	1,79	0,83

Species name	Scientific name	SABAP2 Reporting Rate %	
		Full protocol	Ad hoc protocol
Familiar Chat	Oenanthe familiaris	10,74	18,30
Fiery-necked Nightjar	Caprimulgus pectoralis	2,05	2,13
Fiscal Flycatcher	Melaenornis silens	40,67	14,64
Fork-tailed Drongo	Dicrurus adsimilis	11,00	0,12
Fulvous Whistling Duck	Dendrocygna bicolor	0,26	0,00
Gabar Goshawk	Micronisus gabar	1,02	0,24
Garden Warbler	Sylvia borin	0,26	0,00
Giant Kingfisher	Megaceryle maxima	0,26	0,12
Glossy Ibis	Plegadis falcinellus	28,13	13,58
Golden-breasted Bunting	Emberiza flaviventris	0,77	0,00
Golden-tailed Woodpecker	Campethera abingoni	2,30	0,00
Goliath Heron	Ardea goliath	0,26	0,00
Great Egret	Ardea alba	0,51	0,00
Great Reed Warbler	Acrocephalus arundinaceus	0,77	0,24
Great Spotted Cuckoo	Clamator glandarius	0,77	0,00
Greater Double-collared Sunbird	Cinnyris afer	0,77	0,12
Greater Flamingo	Phoenicopterus roseus	0,26	0,00
Greater Honeyguide	Indicator indicator	2,05	0,59
Greater Kestrel	Falco rupicoloides	3,07	1,77
Greater Painted-snipe	Rostratula benghalensis	0,26	0,12
Greater Striped Swallow	Cecropis cucullata	53,45	21,84
Green Wood Hoopoe	Phoeniculus purpureus	21,74	8,15
Grey Go-away-bird	Crinifer concolor	27,37	7,56
Grey Heron	Ardea cinerea	12,28	3,31
Grey-backed Camaroptera	Camaroptera brevicaudata	0,26	0,00
Grey-headed Bushshrike	Malaconotus blanchoti	1,02	0,24
Grey-headed Gull	Chroicocephalus cirrocephalus	3,58	0,12
Groundscraper Thrush	Turdus litsitsirupa	13,56	2,48
Hadada Ibis	Bostrychia hagedash	85,68	38,84
Hamerkop	Scopus umbretta	5,88	1,65
Helmeted Guineafowl	Numida meleagris	79,80	39,43
Horus Swift	Apus horus	0,77	0,12
House Sparrow	Passer domesticus	44,25	32,11
Hybrid Mallard	Anas hybrid	0,26	0,00
Indian Peafowl	Pavo cristatus	2,56	6,49
Intermediate Egret	Ardea intermedia	0,77	0,00
Jackal Buzzard	Buteo rufofuscus	0,26	0,00
Jacobin Cuckoo	Clamator jacobinus	0,26	0,00

Species name	Scientific name	SABAP2 Reporting Rate %	
		Full protocol	Ad hoc protocol
Jameson's Firefinch	Lagonosticta rhodopareia	2,81	0,24
Kalahari Scrub Robin	Cercotrichas paena	0,26	0,00
Karoo Thrush	Turdus smithi	36,83	23,26
Klaas's Cuckoo	Chrysococcyx klaas	0,26	0,00
Kurrichane Thrush	Turdus libonyana	5,37	0,59
Lanner Falcon	Falco biarmicus	0,51	0,12
Laughing Dove	Spilopelia senegalensis	89,00	51,95
Lazy Cisticola	Cisticola aberrans	0,77	0,12
Lesser Grey Shrike	Lanius minor	2,81	0,35
Lesser Honeyguide	Indicator minor	1,79	0,12
Lesser Kestrel	Falco naumanni	0,26	0,12
Lesser Masked-weaver	Ploceus intermedius	0,51	0,00
Lesser Striped Swallow	Cecropis abyssinica	8,95	0,83
Lesser Swamp Warbler	Acrocephalus gracilirostris	20,46	0,71
Levaillant's Cisticola	Cisticola tinniens	46,29	2,48
Levaillant's Cuckoo	Clamator levaillantii	0,26	0,00
Lilac-breasted Roller	Coracias caudatus	0,51	0,00
Little Bee-eater	Merops pusillus	1,53	1,18
Little Bittern	Ixobrychus minutus	0,26	0,00
Little Egret	Egretta garzetta	3,58	0,47
Little Grebe	Tachybaptus ruficollis	12,02	1,30
Little Rush Warbler	Bradypterus baboecala	11,76	0,59
Little Sparrowhawk	Accipiter minullus	3,32	0,83
Little Stint	Calidris minuta	0,26	0,00
Little Swift	Apus affinis	14,32	1,42
Long-billed Crombec	Sylvietta rufescens	0,77	0,00
Long-crested Eagle	Lophaetus occipitalis	0,51	0,12
Long-tailed Paradise Whydah	Vidua paradisaea	0,26	0,00
Long-tailed Widowbird	Euplectes progne	48,59	11,22
Malachite Kingfisher	Corythornis cristatus	1,53	0,47
Malachite Sunbird	Nectarinia famosa	0,51	0,00
Mallard	Anas platyrhynchos	1,28	0,12
Marabou Stork	Leptoptilos crumenifer	0,51	0,00
Marico Flycatcher	Melaenornis mariquensis	0,51	0,00
Marico Sunbird	Cinnyris mariquensis	0,26	0,00
Marsh Owl	Asio capensis	5,12	1,06
Marsh Warbler	Acrocephalus palustris	1,79	0,12
Melodious Lark	Mirafra cheniana	1,02	0,00

Species name	Scientific name	SABAP2 Reporting Rate %	
		Full protocol	Ad hoc protocol
Mocking Cliff Chat	Thamnolaea cinnamomeiventris	10,23	0,47
Mountain Wheatear	Myrmecocichla monticola	14,32	11,22
Namaqua Dove	Oena capensis	4,35	0,94
Natal Spurfowl	Pternistis natalensis	1,28	0,00
Neddicky	Cisticola fulvicapilla	37,08	3,78
Nicholson's Pipit	Anthus nicholsoni	2,81	0,00
Northern Black Korhaan	Afrotis afraoides	28,39	1,77
Orange River Francolin	Scleroptila gutturalis	14,83	1,18
Orange-breasted Bushshrike	Chlorophoneus sulfureopectus	0,77	0,00
Orange-breasted Waxbill	Amandava subflava	3,84	0,59
Ovambo Sparrowhawk	Accipiter ovampensis	2,56	0,47
Pearl-breasted Swallow	Hirundo dimidiata	6,91	0,35
Peregrine Falcon	Falco peregrinus	0,51	0,00
Pied Avocet	Recurvirostra avosetta	0,26	0,00
Pied Crow	Corvus albus	56,78	23,61
Pied Kingfisher	Ceryle rudis	1,02	0,00
Pied Starling	Lamprotornis bicolor	20,46	1,65
Pin-tailed Whydah	Vidua macroura	28,39	8,15
Plain-backed Pipit	Anthus leucophrys	3,84	0,12
Purple Heron	Ardea purpurea	2,81	0,24
Purple Indigobird	Vidua purpurascens	0,26	0,35
Quailfinch	Ortygospiza atricollis	29,67	2,60
Rattling Cisticola	Cisticola chiniana	0,26	0,24
Red-backed Shrike	Lanius collurio	4,35	0,47
Red-billed Firefinch	Lagonosticta senegala	2,05	0,71
Red-billed Quelea	Quelea quelea	26,60	6,14
Red-billed Teal	Anas erythrorhyncha	7,93	1,18
Red-breasted Swallow	Cecropis semirufa	1,79	0,24
Red-capped Lark	Calandrella cinerea	5,63	0,47
Red-chested Cuckoo	Cuculus solitarius	13,81	4,96
Red-chested Flufftail	Sarothrura rufa	1,28	0,12
Red-collared Widowbird	Euplectes ardens	24,55	4,60
Red-eyed Dove	Streptopelia semitorquata	68,80	28,93
Red-faced Mousebird	Urocolius indicus	47,06	8,03
Red-footed Falcon	Falco vespertinus	0,00	0,24
Red-headed Finch	Amadina erythrocephala	13,30	2,72
Red-knobbed Coot	Fulica cristata	19,44	3,31
Red-throated Wryneck	Jynx ruficollis	15,86	2,48

Species name	Scientific name	SABAP2 Reporting Rate %	
		Full protocol	Ad hoc protocol
Red-winged Francolin	Scleroptila levaillantii	2,05	0,12
Red-winged Starling	Onychognathus morio	19,44	1,06
Reed Cormorant	Microcarbo africanus	19,18	4,60
Rock Dove	Columba livia	24,04	3,31
Rock Kestrel	Falco rupicolus	0,51	0,35
Rock Martin	Ptyonoprogne fuligula	11,76	0,83
Rose-ringed Parakeet	Psittacula krameri	0,51	0,00
Ruff	Calidris pugnax	1,79	0,00
Rufous-cheeked Nightjar	Caprimulgus rufigena	2,56	3,78
Rufous-naped Lark	Mirafra africana	55,50	10,04
Sabota Lark	Calendulauda sabota	0,77	0,00
Secretarybird	Sagittarius serpentarius	1,79	0,59
Shikra	Accipiter badius	0,00	0,12
Short-toed Rock Thrush	Monticola brevipes	0,26	0,00
South African Cliff Swallow	Petrochelidon spilodera	1,02	0,00
South African Shelduck	Tadorna cana	1,28	0,00
Southern Black Flycatcher	Melaenornis pammelaina	0,51	0,59
Southern Boubou	Laniarius ferrugineus	25,83	2,24
Southern Fiscal	Lanius collaris	90,54	37,90
Southern Grey-headed Sparrow	Passer diffusus	51,92	23,02
Southern Masked Weaver	Ploceus velatus	93,09	47,82
Southern Pochard	Netta erythrophthalma	1,28	0,00
Southern Red Bishop	Euplectes orix	67,52	22,08
Speckled Mousebird	Colius striatus	34,78	4,13
Speckled Pigeon	Columba guinea	67,01	26,45
Spike-heeled Lark	Chersomanes albofasciata	5,37	0,12
Spotted Eagle-Owl	Bubo africanus	6,14	9,92
Spotted Flycatcher	Muscicapa striata	5,63	2,48
Spotted Thick-knee	Burhinus capensis	23,02	8,85
Spur-winged Goose	Plectropterus gambensis	7,42	1,30
Streaky-headed Seedeater	Crithagra gularis	16,62	1,06
Striated Heron	Butorides striata	0,26	0,00
Striped Pipit	Anthus lineiventris	5,12	0,00
Swainson's Spurfowl	Pternistis swainsonii	38,11	10,04
Swallow-tailed Bee-eater	Merops hirundineus	0,77	1,06
Tawny-flanked Prinia	Prinia subflava	41,94	1,77
Temminck's Courser	Cursorius temminckii	2,56	0,35
Thick-billed Weaver	Amblyospiza albifrons	14,07	0,59

Species name	Scientific name	SABAP2 Reporting Rate %	
		Full protocol	Ad hoc protocol
Three-banded Plover	Charadrius tricollaris	11,51	0,71
Verreaux's Eagle	Aquila verreauxii	3,32	0,12
Village Indigobird	Vidua chalybeata	0,51	0,00
Village Weaver	Ploceus cucullatus	1,02	0,12
Violet-backed Starling	Cinnyricinclus leucogaster	0,26	0,00
Wailing Cisticola	Cisticola lais	4,09	0,12
Wattled Starling	Creatophora cinerea	2,30	0,47
Western Barn Owl	Tyto alba	4,09	4,37
Western Cattle Egret	Bubulcus ibis	70,84	36,01
Western Yellow Wagtail	Motacilla flava	0,26	0,12
Whiskered Tern	Chlidonias hybrida	1,28	0,59
White Stork	Ciconia ciconia	1,79	1,18
White-backed Duck	Thalassornis leuconotus	0,51	0,00
White-backed Mousebird	Colius colius	0,77	0,12
White-backed Vulture	Gyps africanus	0,26	0,00
White-bellied Sunbird	Cinnyris talatala	28,13	2,48
White-breasted Cormorant	Phalacrocorax lucidus	2,05	0,12
White-browed Scrub Robin	Cercotrichas leucophrys	0,51	0,00
White-browed Sparrow-Weaver	Plocepasser mahali	61,89	23,85
White-faced Whistling Duck	Dendrocygna viduata	4,35	0,35
White-fronted Bee-eater	Merops bullockoides	5,63	1,53
White-rumped Swift	Apus caffer	31,20	10,74
White-throated Swallow	Hirundo albigularis	28,64	4,84
White-winged Tern	Chlidonias leucopterus	0,51	0,00
White-winged Widowbird	Euplectes albonotatus	29,92	5,08
Willow Warbler	Phylloscopus trochilus	5,12	0,94
Wing-snapping Cisticola	Cisticola ayresii	14,07	0,71
Wood Sandpiper	Tringa glareola	7,16	0,24
Woodland Kingfisher	Halcyon senegalensis	0,77	0,00
Yellow Canary	Crithagra flaviventris	0,77	0,24
Yellow-billed Duck	Anas undulata	39,39	5,31
Yellow-billed Kite	Milvus aegyptius	1,28	1,06
Yellow-crowned Bishop	Euplectes afer	14,32	3,66
Yellow-fronted Canary	Crithagra mozambica	6,65	0,59
Yellow-fronted Tinkerbird	Pogoniulus chrysoconus	1,79	0,24
Yellow-throated Bush Sparrow	Gymnoris superciliaris	0,26	0,00
Zitting Cisticola	Cisticola juncidis	40,92	10,15

APPENDIX 2: HABITAT FEATURES AT THE PROJECT SITE

Figure 1: Grassland habitat in the Development Area.

Figure 2: Drainage line and wetland habitat in the Development Area.

Figure 3: Overhead powerlines in the Development Area.

Figure 3: Alien trees in the Development Area.

APPENDIX 3: PRE-CONSTRUCTION MONITORING

Pre-construction monitoring was implemented at the Quantum 1 SEF Development Area on 16 April 2023 and 03 June 2023.

Monitoring was conducted in the following manner:

- One walk transects was identified totalling 2km in the Development Area.
- Two monitors recorded all birds on both sides of the transect. The observers stopped at regular intervals to scan the environment with binoculars. The walk transect was surveyed three times per sampling session.
- 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)

- One focal point (FP) of bird activity was identified – a drainage line and associated wetland in the south of the Development Area.

Figure 1 below indicates the location of the walk transect and focal point where monitoring took place.

Figure 1: Area where monitoring took place, indicating the location of the walk transect and focal point in the Development Area.

APPENDIX 4: ENVIRONMENTAL MANAGEMENT PROGRAMME

Management Plan for the Planning and Design Phase

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
AVIFAUNA: ENTRAPMENT					
Entrapment of medium and large terrestrial birds between the perimeter fences, leading to mortality.	Prevent mortality of avifauna	1. A single perimeter fence should be used[3].	Design the facility with a single perimeter fence.	Once-off during the planning phase.	Project Developer
AVIFAUNA: DISPLACEMENT					
Displacement of avifauna due to disturbance during construction activities.	Prevent displacement of avifauna	1. Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible. 2. Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of solar priority species. 3. Measures to control noise and dust should be applied according to current best practice in the industry. 4. Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical	As indicated	Once-off during the planning phase.	Project Developer
AVIFAUNA: MORTALITY DUE TO ELECTROCUTIONS ON THE MV POWERLINES AND SUBSTATION					
Electrocution of priority species on MV powerlines and substation	Prevention of electrocution mortality	1. Design the facility with underground cables as much as possible. 2. A raptor -friendly pole design must be used, and the pole design must be approved by the avifaunal specialist.	Design the facility with underground cabling and where impractical, use a bird friendly pole design approved by the avifaunal specialist.	Once-off during the planning phase.	Project Developer

[3] If a fence is used consisting of an outer diamond mesh fence and inner electric fence with a separation distance of approximately 100 mm or less, it should not pose any risk of entrapment for large terrestrial species and can be considered a single fence.

Management Plan for the Construction Phase

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
AVIFAUNA: DISTURBANCE					
The noise and movement associated with the construction activities at the development footprint will be a source of disturbance which would lead to the displacement of avifauna from the area	Prevent unnecessary displacement of avifauna by ensuring that contractors are aware of the requirements of the Construction Environmental Management Programme (CEMPr.)	A site-specific CEMPr must be implemented, which gives appropriate and detailed description of how construction activities must be conducted. All contractors are to adhere to the CEMPr and should apply good environmental practice during construction. The CEMPr must specifically include the following: 1. No off-road driving; 2. Maximum use of existing roads, where possible; 3. Measures to control noise and dust according to latest best practice; 4. Restricted access to the rest of the property; 5. Strict application of all recommendations in the botanical specialist report pertaining to the limitation of the footprint.	1. Implementation of the CEMPr. Oversee activities to ensure that the CEMPr is implemented and enforced via site audits and inspections. Report and record any non-compliance. 2. Ensure that construction personnel are made aware of the impacts relating to off-road driving. 3. Construction access roads must be demarcated clearly. Undertake site inspections to verify. 4. Monitor the implementation of noise control mechanisms via site inspections and record and report non-compliance. 5. Ensure that the construction area is demarcated clearly and that construction personnel are made aware of these demarcations. Monitor via site inspections and report non-compliance.	1. On a daily basis 2. Monthly 3. Monthly 4. Monthly 5. Monthly	1. Contractor and ECO 2. Contractor and ECO 3. Contractor and ECO 4. Contractor and ECO 5. Contractor and ECO
Mortality of priority species due to collisions with the medium voltage internal reticulation network	Prevention of powerline collision mortality	Eskom approved bird flight diverters should be installed on the full span length of all 33kV overhead lines according to the applicable Eskom Engineering Instruction. These devices must be installed as soon as the conductors are strung.	Bird Flight Diverters must be installed as soon as the conductors are strung.	1. Once-off	1. Contractor and ECO

Management Plan for the Operational Phase

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

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
Total or partial displacement of avifauna due to habitat transformation associated with the vegetation clearance and the presence of the solar PV plants and associated infrastructure.	Prevent unnecessary displacement of avifauna by ensuring that the rehabilitation of transformed areas is implemented by an appropriately qualified rehabilitation specialist, according to the recommendations of the botanical specialist study.	1. Develop a Habitat Restoration Plan (HRP). 2. Monitor rehabilitation via site audits and site inspections to ensure compliance. 3. Record and report any non-compliance.	1. Appointment of rehabilitation specialist to develop HRP. 2. Site inspections to monitor progress of HRP. 3. Adaptive management to ensure HRP goals are met.	1. Once-off 2. Once a year 3. As and when required	1. Project Developer 2. Facility Environmental Manager 3. Project Developer and Facility Operational Manager

APPENDIX 5: SITE SENSITIVITY VERIFICATION

Prior to commencing with the specialist assessment in accordance with Appendix 6 of the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) Environmental Impact Assessment (EIA) Regulations of 2014, a site sensitivity verification was undertaken in order to confirm the current land use and environmental sensitivity of the proposed project area as identified by the National Web-Based Environmental Screening Tool (Screening Tool). NEMA makes provision for the prescription of procedures for the assessment and minimum criteria for reporting on identified environmental themes (Sections 24(5)(a) and (h) and 44) when applying for environmental authorisation. The Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020 is applicable in the case of solar PV developments.

The details of the site sensitivity verification are noted below:

Date of Site Visit	01 April 2023
Supervising Specialist Name	Albert Froneman
Professional Registration Number	MSc Conservation Biology (SACNASP Zoological Science Registration number 400177/09)
Specialist Affiliation / Company	Chris van Rooyen Consulting

METHODOLOGY

The following methods were used to compile the SSV report:

- Bird distribution data from the Second Southern African Bird Atlas Project (SABAP2) was obtained (https://sabap2.birdmap.africa/), to ascertain which species occur in the pentads where the proposed Project is located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5' × 5'). Each pentad is approximately 8 × 9 km. To get a more representative impression of the birdlife, a consolidated data set was obtained for a total of 4 pentads some of which intersect and others which are near the proposed Development Area, henceforth referred to as “the **Broader Area**”. The 4 pentad grid cells are the following: 2600_2735, 2600_2740, 2605_2735, 2605_2740 (**Figure 44**). To date, a total of 391 full protocol checklists (i.e., intensive bird listing surveys lasting a at least two hours each) and 847 ad hoc protocol lists (surveys lasting less than two hours but still yielding valuable data) have been completed for the 4 pentads where the Project is located.
- The SABAP2 data was regarded as a reliable reflection of the avifauna which occur in the area, but the data was also supplemented by data collected during the on-site surveys and general knowledge of the area.
- A classification of the vegetation types in the project site was obtained from the First Atlas of Southern African Birds (SABAP1) and the 2018 National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006, SANBI 2018).
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red List Book of Birds of South Africa, Lesotho, and Swaziland (Taylor *et al.* 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the latest (2022.2) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- The Important Bird and Biodiversity Areas of South Africa (Marnewick *et al.* 2015; http://www.birdlife.org.za/conservation/important-bird-areas) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- An intensive internet search was conducted to source information on the impacts of solar facilities on avifauna.
- Satellite imagery (Google Earth © 2023) was used to view the Broader Area on a landscape level and to help identify bird habitat on the ground.
- The South African National Biodiversity BGIS map viewer was used to determine the locality of the project site relative to National Protected Areas.
- The DFFE National Screening Tool was used to determine the assigned avian sensitivity of the project site.
- The sources that 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)
- Guidelines for the Implementation of the Terrestrial Flora (3c) & Terrestrial Fauna (3d) Species Protocols for EIAs in South Africa produced by the South African National Biodiversity Institute on behalf of the Department of Environment, Forestry and Fisheries (2020).
- The BirdLife South Africa (BLSA) Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa. BirdLife South Africa by Jenkins, A.R., Ralston-Patton, Smit- Robinson, A.H. 2017 (hereafter referred to as the Solar Guidelines) were consulted to determine the level of survey effort that is required.

- An SSV survey conducted on 01 April 2023. The Development Area was inspected with a 4x4 vehicle and on foot. All birds were recorded.
- Priority species were defined as follows:
  - South African Red Data species.
  - South African endemics and near-endemics.
  - Raptors
  - Waterbirds

RESULTS OF SITE ASSESSMENT

The Development Area and immediate environment is classified as **Medium** sensitivity for terrestrial animals according to the Terrestrial Animal Species Theme. The Medium sensitivity classification for avifauna is due to the possible occurrence of African Grass Owl *Tyto capensis* and White-bellied Bustard *Eupodotis senegalensis* (**Figure 5**).

The Development Area contains suitable habitat for avian species of conservation concern (SCC), namely African Grass Owl (Regionally Vulnerable), as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020). The habitat at the Development Area is not suitable for White-bellied Bustards and they were not recorded by SABAP2 in the broader area or during the two on-site surveys. One SCC, the Cape Vulture *Gyps coprotheres* (Globally Vulnerable and Regionally Endangered), was also recorded flying over the area during the field surveys, namely.

Based on the field surveys, the SABAP2 data, and African Grass Owl habitat modelling, a classification of **High** sensitivity for avifauna is suggested for the proposed Development Area.

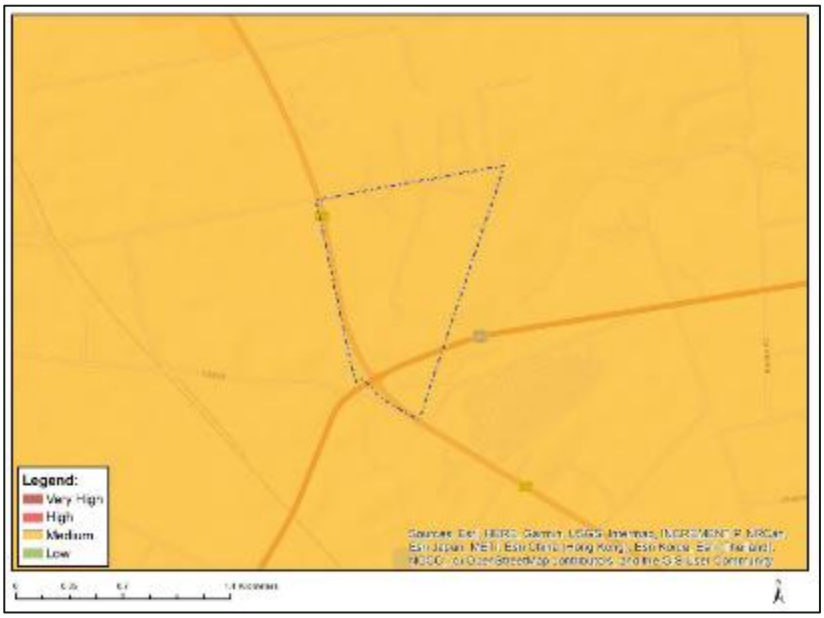

Figure 1: The National Web-Based Environmental Screening Tool map of the proposed Quantum 1 SEF Development Area, indicating sensitivities for the Terrestrial Animal Species theme. The Medium sensitivity classification for avifauna is linked to the possible occurrence of African Grass Owl and White-bellied Bustard.

AVIFAUNA

The SABAP2 data indicates that a total of 301 bird species could potentially occur within the Broader Area – **Appendix 1** provides a comprehensive bird species list. Of these, 105 species are classified as priority species for solar developments and 12 of these are South African Red List species (i.e., Species of Conservation Concern). Of the 105 priority species, 38 are likely to occur regularly in the Development Area.

- **Receiving Environment**

The proposed Project is located in the Grassland Biome, in the Dry Highveld Grassland Bioregion of South Africa. The Dry Highveld Grassland Bioregion is characterised by a mean annual precipitation above 650 mm and frost is common in the winter. A thick cover of sourveld grass species dominate in the summer, followed by a dormant winter period. The high diversity of forbs found in grasslands, is what makes grasslands an important biome for species richness. The main vegetation type in the Development Area is classified as Carletonville Dolomite Grassland.

SABAP1 recognises six primary vegetation divisions within South Africa, namely (1) Fynbos (2) Succulent Karoo (3) Nama Karoo (4) Grassland (5) Savanna and (6) Forest (Harrison et al. 1997). The criteria used by the authors to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations. It is important to note that no new vegetation unit boundaries were created, with use being made only of previously published data. Using this classification system, the natural vegetation in the Development Area is classified as Grassland.

The habitats across the proposed Development Area are a mixture of grassland with some scattered trees, clumps of alien trees, and wetlands with their associated drainage lines and streams. Whilst the distribution and abundance of the bird species in the project site are typical of the broad vegetation type, it is also necessary to examine bird habitats in more detail as it may influence the distribution and behaviour of priority species. These are discussed in more detail below. The following distinct habitat features from an avifaunal perspective are present in the Development Area:

- Grassland
- Wetlands & Drainage Lines
- Alien Trees
- Overhead Powerlines

- **Grassland**

The natural vegetation in the Development Area is classified as Grassland. Grassland is dominated by grasses, with geophytes and herbs also well represented. Grasslands are maintained by a combination of relatively high summer rainfall, frequent fires, frost, and grazing, which prevent the presence of shrubs and trees. Grassland specialist species, as well as several ground nesting birds such as korhaan and guineafowl could use this habitat. Raptors will also use these areas for hunting.

Figure 2: Grassland habitat in the Development Area.

The following priority species with a high or medium likelihood of regular occurrence could use grassland habitat in the Development Area:

- Abdim's Stork
- African Sacred Ibis
- Amur Falcon
- Black Sparrowhawk
- Black-chested Snake Eagle
- Black-headed Heron
- Blacksmith Lapwing
- Black-winged Kite
- Cape Grassbird
- Cape Vulture
- Cape Weaver
- Cloud Cisticola
- Common Buzzard
- Egyptian Goose
- Fiscal Flycatcher
- Grey Heron
- Marsh Owl
- Pied Starling
- Spotted Eagle-Owl
- Spur-winged Goose
- Three-banded Plover
- Western Barn Owl
- Western Cattle Egret

➢ **Wetlands & Drainage Lines**

Surface water is important to avifauna. Wetlands and drainage lines provide important habitat to waterbirds and several other non-priority species. Raptors will also use these areas to hunt other bird species. African Grass Owls (Regionally Vulnerable) could potentially utilize the wetland habitat in the Development Area.

Figure 3: Wetland and drainage line habitat in the Development Area.

The following priority species with a high or medium likelihood of regular occurrence could use wetland habitat in the Development Area:

- Abdim's Stork
- African Black Duck
- African Sacred Ibis
- Black Crake

- Black-headed Heron
- Blacksmith Lapwing
- Black-winged Stilt
- Cape Weaver
- Cape White-eye
- Common Moorhen
- Egyptian Goose
- Fiscal Flycatcher
- Glossy Ibis
- Grey Heron
- Hamerkop
- Karoo Thrush
- Little Grebe
- Marsh Owl
- Red-billed Teal
- Red-knobbed Coot
- Reed Cormorant
- Spur-winged Goose
- Three-banded Plover
- Western Cattle Egret
- White-faced Whistling Duck
- Wood Sandpiper
- Yellow-billed Duck

➢ **Alien Trees**

There are several patches of alien trees present within the Development Area. Alien trees often provide good nesting and roosting sites for birds. Raptor species also use alien trees as perches from which they can scan an area for prey.

The following priority species with a high or medium likelihood of occurrence could use alien trees in the Development Area:

- Amur Falcon
- Black Sparrowhawk
- Black-chested Snake Eagle
- Black-headed Heron
- Black-winged Kite
- Cape Weaver
- Cape White-eye
- Common Buzzard
- Egyptian Goose
- Karoo Thrush
- Spotted Eagle-Owl
- Western Barn Owl

➢ **Overhead Powerlines**

There are some existing overhead powerlines in and near the Development Area. Birds, such as raptors and crows, often use powerlines as perches or even nesting sites.


Figure 3: Overhead powerlines in the Development Area.

The following priority species with a high or medium likelihood of regular occurrence could utilize overhead powerlines in the Development Areas:

- Amur Falcon
- Black Sparrowhawk
- Black-chested Snake Eagle
- Black-headed Heron
- Cape Vulture
- Common Buzzard

CONCLUSIONS

The Development Area and immediate environment is classified as **Medium** sensitivity for terrestrial animals according to the Terrestrial Animal Species Theme. The Medium sensitivity classification for avifauna is due to the possible occurrence of African Grass Owl *Tyto capensis* and White-bellied Bustard *Eupodotis senegalensis* (**Figure 5**).

The Development Area contains suitable habitat for avian species of conservation concern (SCC), namely African Grass Owl (Regionally Vulnerable), as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020). The habitat at the Development Area is not suitable for White-bellied Bustards and they were not recorded by SABAP2 in the broader area or during the two on-site surveys. One SCC, the Cape Vulture *Gyps coprotheres* (Globally Vulnerable and Regionally Endangered) was also recorded flying over the area during the field surveys. .

Based on the field surveys, the SABAP2 data, and African Grass Owl habitat modelling, a classification of **High** sensitivity for avifauna is suggested for the proposed Development Area.

APPENDIX 6: AFRICAN GRASS OWL HABITAT SUITABILITY MODELLING

DATA ANALYSIS

We scripted and used an R workflow to prepare, pre-process and analyse remote sensing data acquired by the Sentinel 2 satellite platform (Copernicus 2023). A classification modelling framework, which included the use of an ensemble model, was used to assess habitat suitability for target species. An ensemble modelling approach incorporates the use of more than one classification algorithm, drawing on the strengths of each and resisting any inherent bias that could be present in a single model. This general modelling process has been previously used in multiple peer-reviewed avian habitat suitability studies (Colyn et al. 2020a; Colyn et al. 2020b; Colyn et al. 2020c). We used a stepwise variable selection technique to conduct a data driven process of variable selection. Variable selection includes the removal of highly correlated variables, thereby preventing autocorrelation and improving the interpretation of final model results (Vignali et al. 2020).

Key wetlands used by African Grass Owl were identified from a presence locality dataset provided by Craig Whittington-Jones and supplemented with personal records of African Grass Owl breeding sites. Roadkill and marginal/stochastic sites were disregarded for this analysis, with an emphasis being placed on records noted as confirmed or suspected breeding sites, as well as sites noted to host the species consistently, but where breeding was unconfirmed. A systematic GIS grid was then used to generate positive training data samples from these sites representing suitable breeding wetlands for African Grass Owl.

The modelling workflow included data partitioning, model training, variable selection, model testing, model optimization through hyperparameter tuning and final model predictions. The occurrence data largely included presence data with absence data being limited geographically to certain areas of greater survey coverage. Subsequently, to supplement existing absence data additional pseudo-absence data was generated across the area of interest using the Dismo R package (Hijmans et al. 2022). We partitioned the overall occurrence and pseudo-absence dataset into training (80%) and testing (20%) subsets. Subsequently, we trained the primary models using the MaxEnt, Random Forest and ANN algorithms, followed by hyperparameter tuning and model optimization using the genetic algorithm (Vignali et al. 2020). Variable importance and partial dependence plots were generated for the final set of variables selected following initial model training and optimization. A final global model was trained using the entire training occurrence dataset for each species, and this model was then used to make predictions of habitat suitability within the local area of interest (i.e. proposed development footprint).

Model performance was assessed using the Receiver-operating characteristic (ROC) and associated area under the curve (AUC-ROC) value (Freeman and Moisen 2008). ROC plots compare the true positive and false positive rates and are commonly used as a metric of model performance in classification studies (Jimenez-Valverde 2012; Sofaer et al. 2018). I used the package PresenceAbsence (Freeman and Moisen 2008) to create ROC-AUC plots and generate threshold selection statistics. Threshold selection assesses the relationship between the predicted and observed values to generate thresholds that can be used to convert model outputs from a continuous format to a binary one.

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