AVIFAUNAL IMPACT ASSESSMENT

Proposed Development of Pixley Park Solar PV Facilities

De Aar, Northern Cape Province

July 2022

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EXECUTIVE SUMMARY

A cluster of renewable energy facilities to be known as Pixley Park Renewable Energy Project, which will include three Solar PV Facilities of up to 120MW each and one solar PV facility of up to 200 MW (i.e., a total of up to 560MW combined) and its associated grid connection infrastructure, is proposed by various Special Purpose Vehicles (SPVs) on the following farms:

- Portion 3 of Farm Carolus Poort No. 3
- Portion 4 of Farm Riet Fountain No. 6
- Portion 1 of Farm Riet Fountain No. 6
- Remainder Extent of the Farm Wagt en Bittje No. 5

The Project Site is located approximately 10km east of De Aar within the Emthanjeni Local Municipality the Pixley ka Seme District Municipality, Northern Cape Province. The four Development Areas within the Project Site will be known as Carolus Solar PV1, Fountain Solar PV1, Riet Fountain Solar PV1 and Wagt Solar PV1 respectively. The four development areas will all connect to the new Vetlaagte Main Transmission Substation (MTS) or the new Wag 'n Bietjie MTS.

The SABAP2 data indicates that a total of 162 species could potentially occur within the broader area where the project is located (see Appendix 1). Of these, 76 are classified as priority species for solar developments. Of the 76 priority species, 45 have a medium to high probability of occurring regularly in the Project Site, and 21 of the priority species were recorded during the field monitoring. Five Red Data species were recorded during the site surveys, namely Cape Vulture (Globally and Regionally Endangered), Lanner Falcon (Regionally Vulnerable), Martial Eagle (Globally and Regionally Endangered), Secretarybird (Globally Endangered, Regionally Vulnerable), and Tawny Eagle (Globally Vulnerable, Regionally Endangered).

The table below is a table with a summarised assessment of the anticipated impacts.

Summarised assessment of the anticipated impacts

Environmental Parameter	Nature of the Impact	Rating prior to mitigation	Rating post mitigation
Avifauna	Displacement of priority species due to disturbance associated with construction of the PV plant and associated infrastructure.	55 MEDIUM	45 MEDIUM
	Displacement of priority species due to habitat transformation associated with construction of the PV plant 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 medium voltage internal reticulation network	42 MEDIUM	10 LOW

Environmental Parameter	Nature of the Impact	Rating prior to mitigation	Rating post mitigation
	Mortality of priority species due to collisions with the medium voltage internal reticulation network	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**

ENVIRONMENTAL SENSITIVITIES

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

- **All infrastructure exclusion zones**

Jackal Buzzard nests: A 750m all infrastructure exclusion zone is recommended to prevent the displacement of the breeding pair during the construction phase due to disturbance. In addition, the buffer area will reduce the risk of injury to the juvenile bird due to collision with the solar panels, when it starts flying and practicing its hunting technique around the nest.

- **Solar panel exclusion zones (other infrastructure allowed)**

Riverine and wetland habitat: A 200m solar panel free buffer zone must be implemented around riverine areas, wetlands, and dams to provide unhindered access to the surface water for a variety of priority species. Surface water in this semi-arid habitat is crucially important for priority avifauna and many non-priority species. It is important to leave open space with no solar panels for birds to access and leave the surface water area unhindered. Surface water is also an important area for raptors to hunt birds which congregate around surface water, and they should have enough space for fast aerial pursuit. This will also benefit species like Blue Cranes which prefer to breed close to water bodies.

- **High sensitivity zones**

The entire Project Site is a high sensitivity zone due to the potential presence of several Species of Conservation Concern (SCC) including African Rock Pipit, Black Stork, Blue Crane, Cape Vulture, Greater Flamingo, Karoo Korhaan, Lanner Falcon, Ludwig's Bustard, Martial Eagle, Secretarybird, Tawny Eagle, and Verreaux's Eagle which could utilise the whole Project Site for foraging. However, these species do not require specific avoidance measures at this stage because there is still adequate habitat available outside the Project Site.

See Figure 1 below for the avifaunal sensitivities identified from a PV solar perspective.

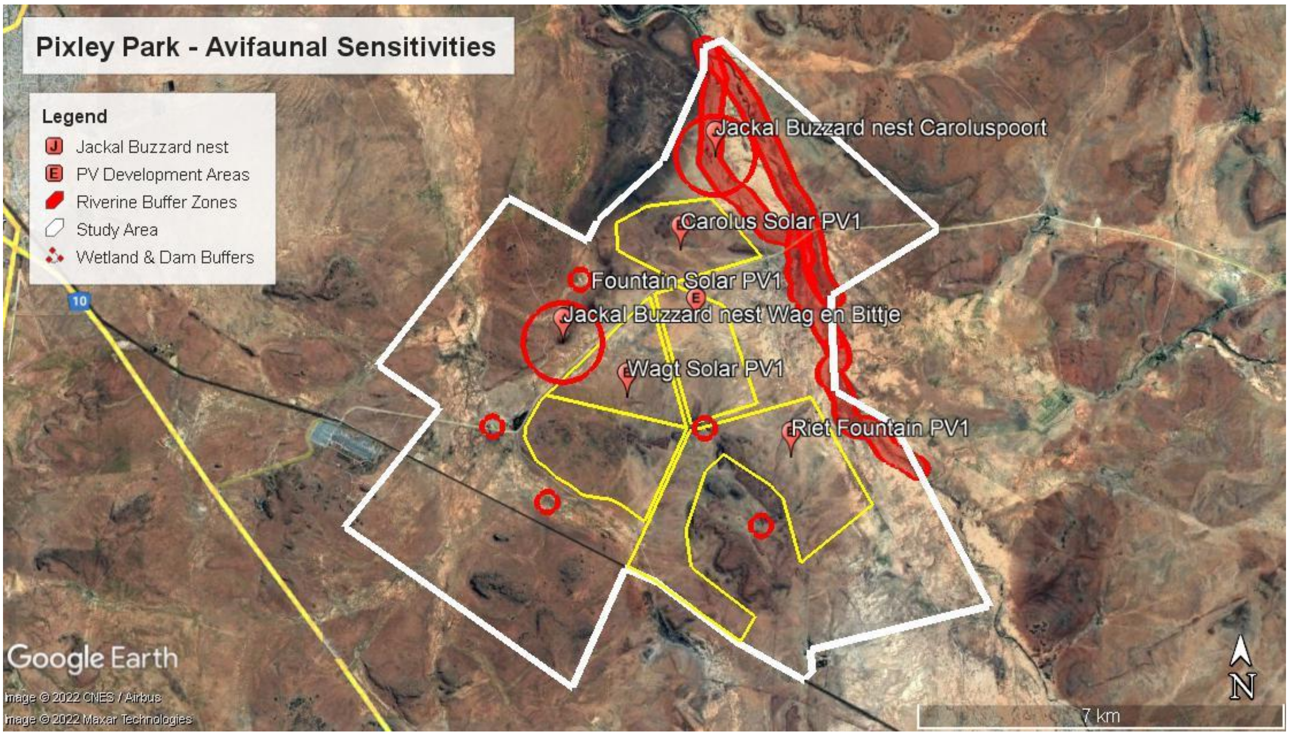

Figure 1: Avifaunal sensitivity zones (in red) within the Project Site. Development Areas outlined in yellow.

CUMULATIVE IMPACTS

Cumulative effects are commonly understood to be impacts from different projects that combine to 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 an EA at the time of starting the environmental impact process, as well as the proposed Pixley Park Renewable Energy Project. There are currently 14 renewable energy projects authorised, operational or in process within a 30 km radius around the cluster of four proposed Solar PV Development Areas of the proposed Pixley Park Renewable Energy Project.

The total affected land parcel area taken up by authorised and planned renewable energy projects within the 30 km radius is approximately 1 316 km². The total affected land parcel area affected by the Pixley Solar Renewable Energy Cluster equates to approximately 83.2km². The combined land parcel area affected by authorised renewable energy developments within the 30 km radius around the proposed Pixley Park Renewable Energy Project, including the latter, thus equals approximately 1 399 km². Of this, the proposed Pixley Park Renewable Energy Project land parcel areas constitute ~5.8%. The cumulative impact of the proposed Pixley Park Renewable Energy Project is thus anticipated to be **low** after mitigation.

The total area within the 30km radius around the proposed projects equates to about 4 053 km² of similar habitat (excluding developed areas). The total combined size of the land parcels potentially affected by renewable energy projects will equate to ~34.5% of the available untransformed habitat in the 30km radius. Assuming that all the projects are actually constructed, the cumulative impact of all the proposed renewable energy projects is estimated to be **medium**. However, the actual physical footprint of the renewable energy facilities will 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.

CONCLUSIONS

The proposed Pixley Park Renewable Energy Project will have a range of potential pre-mitigation impacts on priority avifauna ranging from low to high, which is expected to be reduced to medium and low with the appropriate mitigation. No fatal flaws were discovered during the investigations.

CONTENTS

DETAILS OF THE SPECIALIST

Chris van Rooyen (Bird Specialist)

Chris has 26 years' experience in the management of wildlife interactions with electricity infrastructure. He was head of the Eskom-Endangered Wildlife Trust (EWT) Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has worked in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. Chris also has extensive project management experience and has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author of 15 academic papers (some with co-authors), co-author of two book chapters and several research reports. He has been involved as ornithological consultant in numerous power line and wind generation projects. Chris is also co-author of the Best Practice for Avian Monitoring and Impact Mitigation at Wind Development Sites in Southern Africa, which is currently (2016) accepted as the industry standard. Chris also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Albert Froneman (Bird and GIS Specialist)

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

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

A cluster of renewable energy facilities to be known as Pixley Park Renewable Energy Project, which will include three Solar PV Facilities of up to 120MW each and one solar PV facility of up to 200 MW (i.e., a total of up to 560MW combined) and its associated grid connection infrastructure, is proposed by various Special Purpose Vehicles (SPVs) on the following farms:

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A development footprint of approximately 2,100ha has been identified within the Project Site (approximately 8,200ha in extent) for the development of the Pixley Park Solar PV Facilities. The development areas are

- Riet Fountain PV1 - 781 ha
- Wagt Solar PV1 - 300 ha (plus Wagt Solar PV1 Extension - 434 ha)
- Fountain Solar PV1 - 300 ha
- Carolus Solar PV1 - 285 ha

The infrastructure associated with each of the four solar PV Facilities will include the following:

- Solar PV array comprising PV modules (potentially bifacial) and mounting structures, using single axis tracking technology
- Inverters and transformers
- Cabling between the panels
- Battery Energy Storage System (BESS)
- Laydown areas, construction camps, site offices
- 12m wide Access Road and entrance gate to the project site and switching station
- 6m wide internal distribution roads
- Operations and Maintenance Building, Site Offices, Ablutions with conservancy tanks, Storage Warehouse, workshop, Guard House
- Onsite 132kV IPP Collector Substation including the HV Step up transformer, MV Interconnection building.

The Pixley Park Renewable Energy Project 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 developers' intention to bid the proposed projects under the Department of Mineral Resources and Energy's (DMRE's) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme (or similar programme), or to make the projects available to private off-takers (e.g., mines) with the aim of evacuating the generated power into the national grid. 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 Pixley Park set to inject up to 560MW into the national grid.

Please see Figures 1 and 2 for a map of the proposed Project Site and Development Areas.

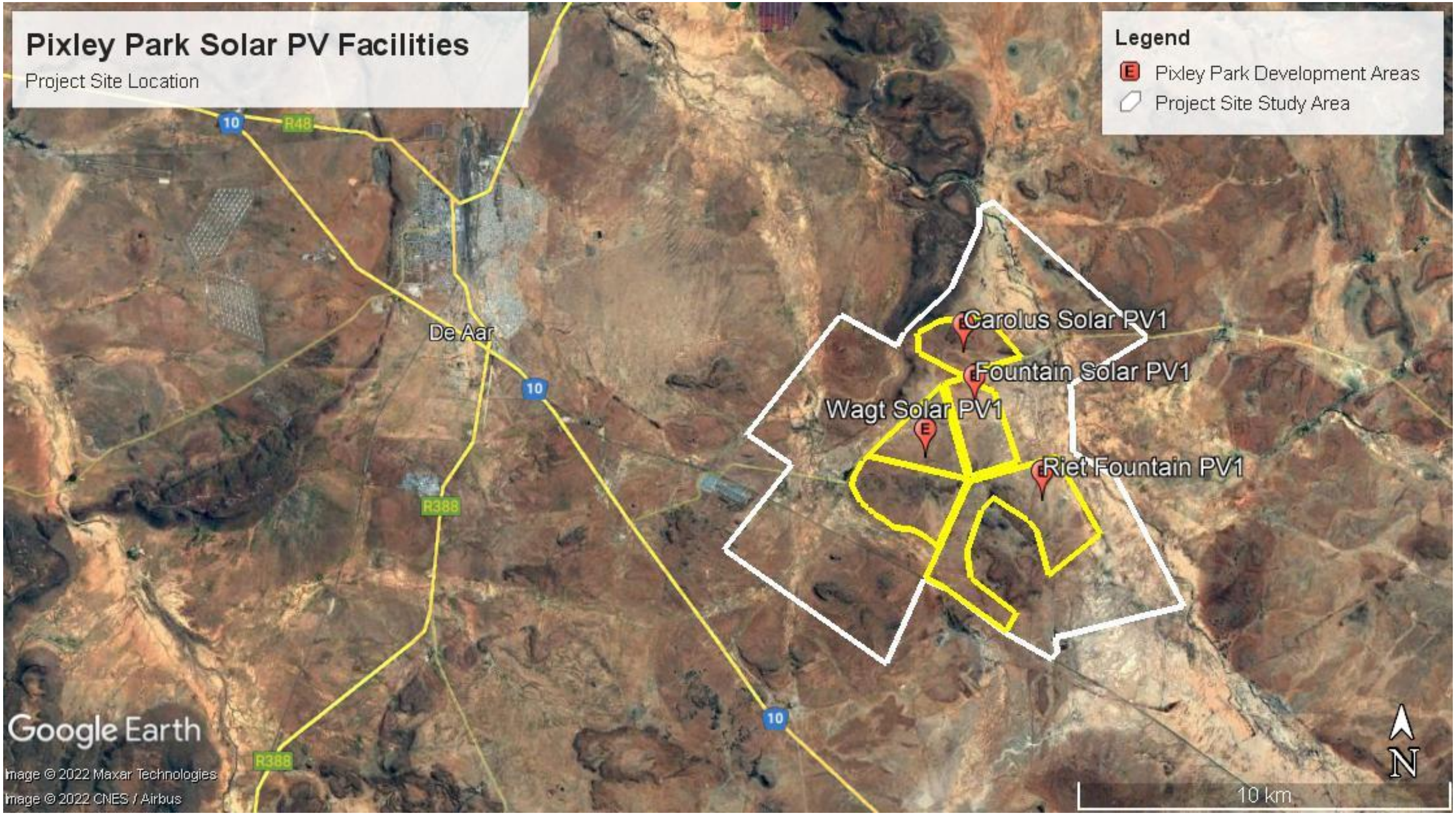


Figure 2: Locality map of the Project Site (in white) and the Development Areas (in yellow) for the proposed Pixley Park Solar PV Facilities

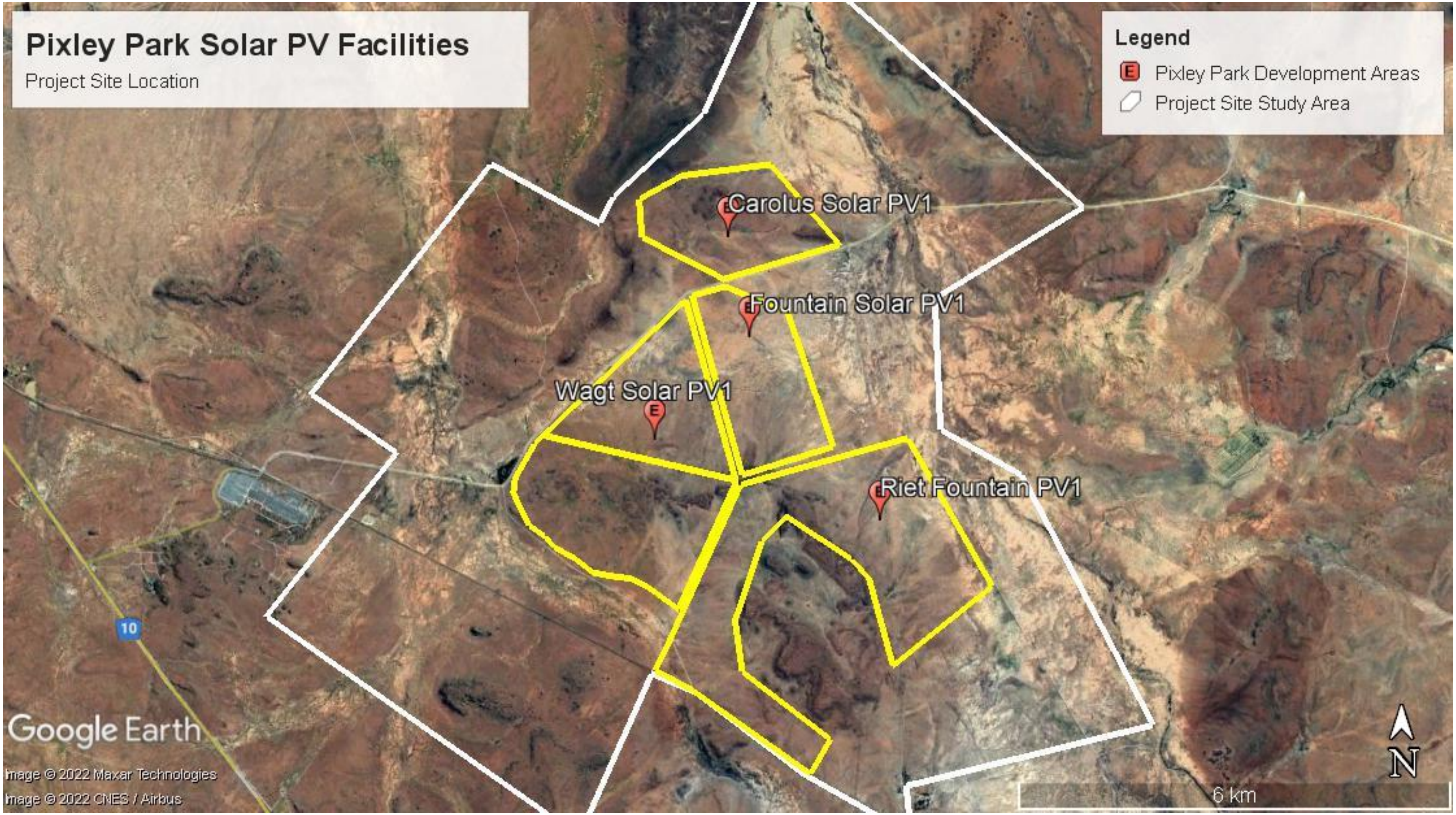


Figure 3: Close-up view of the Project Site (in white) and Development Areas (in yellow) for the proposed Pixley Park Solar PV Facilities.

2 PROJECT SCOPE

The purpose of the specialist study is to determine the main issues and potential impacts of the proposed project/s on existing information and field assessments:

- 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 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 of the South African Bird Atlas 2 (SABAP 2) was obtained from the University of Cape Town, to ascertain which species occur within the broader area i.e., within a block consisting of 9 pentad grid cells within which the proposed project site is situated (Figure 4). A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. From 2007 to date, a total of 20 full protocol lists (i.e., surveys lasting a minimum of two hours each) have been completed for this area. In addition, 29 ad hoc protocol lists (i.e., surveys lasting less than two hours but still yielding valuable data) have been completed.
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa (Taylor *et al.* 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the (2021.3) International Union for Conservation of Nature (IUCN) Red List of Threatened Species (http://www.iucnredlist.org/).
- A classification of the habitat in the Project Site was obtained from the Atlas of Southern African Birds 1 (SABAP 1) (Harrison *et al.* 1997) and the National Vegetation Map (2012 beta2) from the South African National Biodiversity Institute (SANBI) website (Mucina & Rutherford 2006 & http://bgisviewer.sanbi.org). The Project Site is the area covered by the land parcels where Project will be located.
- The Important Bird Areas of Southern Africa (Marnewick *et al.* 2015) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- Satellite imagery (Google Earth ©2022) was used to view the Project Site on a landscape level and to help identify sensitive bird habitat.
- Priority species were defined as follows:
  - South African Red Data species: High conservation significance
  - South African endemics and near-endemics: High conservation significance
  - Raptors: High conservation significance. Raptors are at the top of the food chain and play a key role in their ecosystems. When populations of birds of prey go down, then the numbers of their prey species go up, creating an imbalance in the ecosystem.
  - Waterbirds: Evidence indicate that waterbirds may be particularly susceptible to collisions with solar arrays due to the so-called lake effect, caused by the reflection of the sun of the smooth surface of solar panels.
- The SANBI BGIS map viewer was used to determine the locality of the proposed site relative to National Protected Areas and National Protected Areas Expansion Strategy (NPAES) focus areas.
- The Department of Forestry, Fisheries and the Environment (DFFE) National Screening Tool was used to determine the assigned avian sensitivity of the Project Site.

- Data collected during recent site visits (including powerline inspections) to the broader area was also considered as far as habitat classes and the occurrence of priority species are concerned.
- The following sources were used 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 & Terrestrial Fauna Species Protocols for EIAs in South Africa produced by the SANBI on behalf of the Department of Environment, Forestry and Fisheries (2020); and
    - 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).
- The main source of information on the avifaunal diversity and abundance at the Project Site came from the integrated pre-construction monitoring programme implemented at the Project Site, covering the 4 proposed Pixley Renewable Energy Project's development areas (Survey 01 was conducted from 03 to 05 February 2022 and Survey 02 from 04 to 08 April 2022).The pre-construction avifaunal monitoring programme followed an adapted Regime 2 protocol as defined in the Solar Guidelines (Jenkins *et al.* 2017) which require a minimum of two surveys over a six month period.

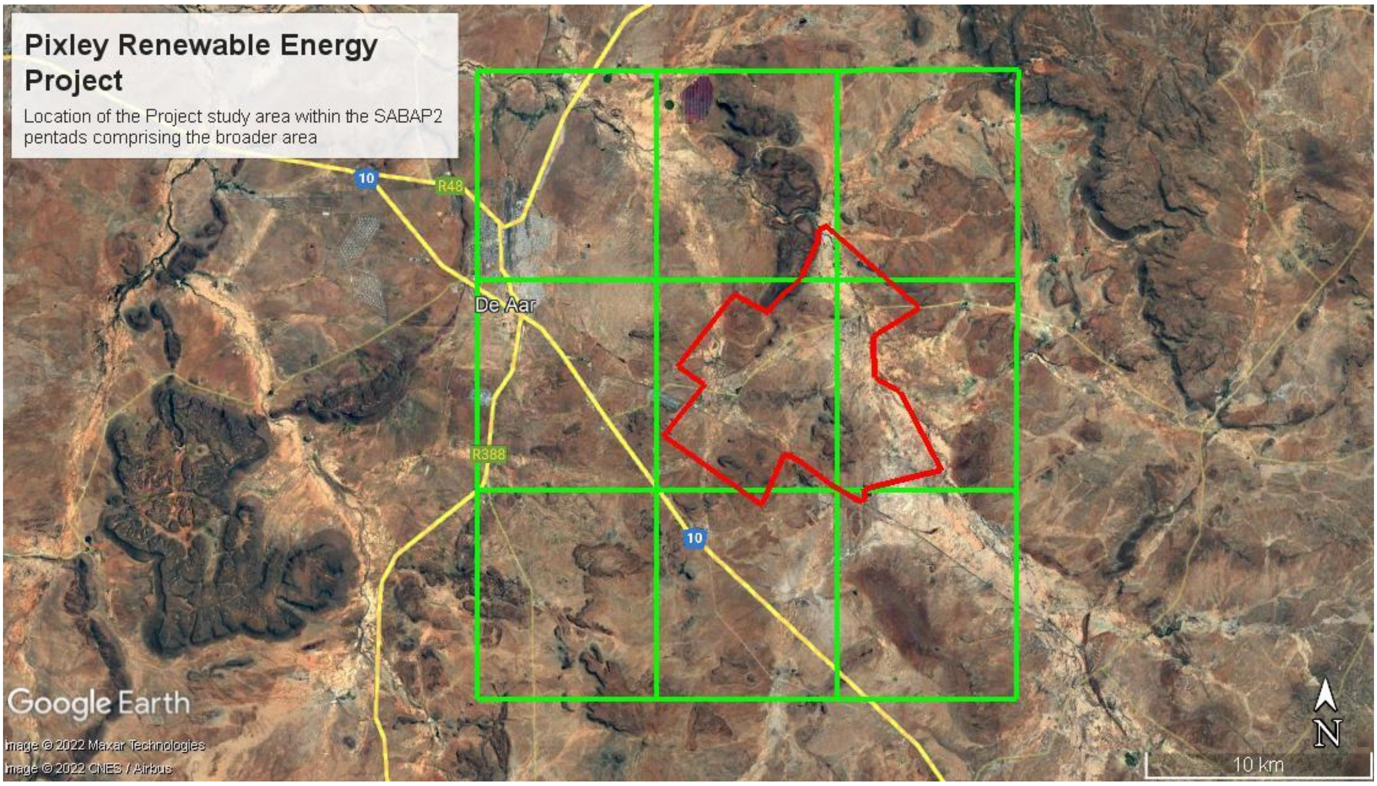


Figure 4: Area covered by the nine SABAP2 pentads outlined in green (i.e., the broader area).

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 SABAP2 data is not regarded as an adequate indicator of the avifauna which could occur at the Project Site, and it was therefore further supplemented by data collected during the on-site surveys to date.
- The focus of the study is primarily on the potential impacts 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 two published scientific study on the impact of PV facilities on avifauna in South Africa (Rudman *et al.*, 2017; Visser *et al.*, 2019); and one related study on the impacts of concentrated solar power facilities on wildlife in South Africa (Jeal *et al.*, 2019). 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.
- Conclusions drawn in this study are based on experience of the specialist on the species found on site and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will be valid under all circumstances.
- The **broader area** is defined as the area covered by the nine (9) SABAP2 pentads where the project is located (see Figure 6 above). The **Project Site** is defined as the area covered by the land parcels/farm portions where Carolus Solar PV1, Fountain Solar PV1, Riet Fountain Solar PV1 and Wagt Solar PV1 are proposed to be located. The **Development Areas** are the areas, within the Project Site, where the proposed developments will be located, i.e., the footprints containing the PV solar arrays and associated infrastructure of the four proposed Pixley Park Solar PV Facilities.
- The assessment of impacts is based on the baseline environment as it currently exists at the Project Site.

5 LEGISLATIVE CONTEXT

There is no legislation pertaining specifically to the impact of solar facilities and associated electrical infrastructure on avifauna. Below is a summary pertaining to the conservation of avifauna in general.

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	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	Global

[1] (BirdLife International (2016) Country profile: South Africa. Available from: http://www.birdlife.org/datazone/country/south_africa. Checked: 2016-04-02).

Convention name	Description	Geographic scope
Species of Wild Animals, (CMS), Bonn, 1979	States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.	
Convention on the International Trade in Endangered Species of Wild Flora and Fauna, (CITES), Washington DC, 1973	CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	Global
Ramsar Convention on Wetlands of International Importance, Ramsar, 1971	The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.	Global
Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia	The Signatories will aim to take co-ordinated measures to achieve and maintain the favourable conservation status of birds of prey throughout their range and to reverse their decline when and where appropriate.	Regional

5.2 National legislation

5.2.1 Constitution of the Republic of South Africa, 1996

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

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

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

NEMA makes provision for the prescription of procedures for the assessment and minimum criteria for reporting on identified environmental themes (Sections 24(5)(a) and (h) and 44) when applying for environmental authorisation. The Protocol for the specialist assessment and minimum report content requirements 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 the Northern Cape is the Northern Cape Nature Conservation Act No 9 of 2009. It provides for the sustainable utilisation of wild animals, aquatic biota and plants; the implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora; describes offences and penalties for contravention of the Act; provides for the appointment of nature conservators to implement the provisions of the Act; provides for the issuing of permits and other authorisations; and provides for matters connected therewith.

6 BASELINE ASSESSMENT

6.1 Important Bird Areas

The Project Site falls within the Platberg-Karoo Conservancy Important Bird Area (Marnewick *et al.* 2015). The Platberg–Karoo Conservancy IBA covers the entire districts of De Aar, Philipstown and Hanover, including suburban towns. The landscape consists of extensive flat to gently undulating plains that are broken by dolerite hills and flat-topped inselbergs. The ephemeral Brak River flows in an arc from south-east to north-west, eventually feeding into the Orange River basin. Other ephemeral rivers include the Hondeblaf, Seekoei, Elandsfontein and Ongers rivers with a network of tributaries. Vanderkloof Dam is on the north-eastern boundary (Marnewick *et al.* 2015). This IBA is in the Nama Karoo and Grassland Biomes. The eastern Nama Karoo has the highest rainfall of all the Nama Karoo vegetation types and is thus ecotonal to grassland, with a complex mix of grass- and shrub-dominated vegetation types (Marnewick *et al.* 2015).

The land is used primarily for livestock grazing and agriculture. Commercial livestock farming is mostly extensive wool and mutton production, with some cattle and game farming. Less than 5% of this IBA is cultivated under dry-land or irrigated conditions and includes lucerne and prickly pear *Opuntia ficus-indica* orchards (Marnewick *et al.* 2015).

This IBA contributes significantly to the conservation of large terrestrial birds and raptors. These include Blue Crane *Anthropoides paradiseus*, Ludwig's Bustard *Neotis ludwigii*, Kori Bustard *Ardeotis kori*, Blue Korhaan *Eupodotis caerulescens*, Black Stork *Ciconia nigra*, Secretarybird *Sagittarius serpentarius*, Martial Eagle *Polemaetus bellicosus*, Verreauxs' Eagle *Aquila verreauxii* and Tawny Eagle *Aquila rapax*.

A total of 289 bird species are known to occur in the IBA. IBA trigger species that could potentially occur in the Project Site are the following:

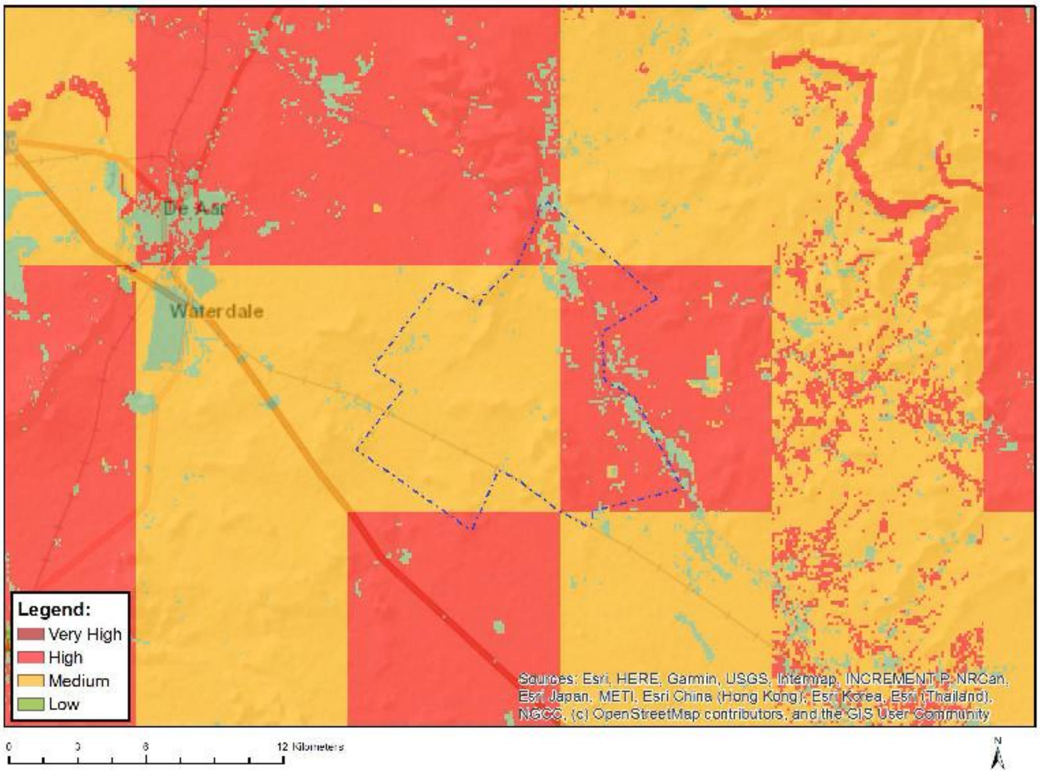
- Blue Crane (Globally Vulnerable, Regionally Near-threatened)
- Blue Korhaan (Globally Near-threatened)
- Martial Eagle (Globally and regionally Endangered)

- Verreaux's Eagle (Regionally Vulnerable)
- Ludwig's Bustard (Globally and Regionally Endangered)
- Secretarybird (Globally Endangered, Regionally Vulnerable)

6.2 DFFE National Screening Tool

The Project Site and immediate environment is classified as **Medium** and **High** sensitivity for terrestrial animals according to the Terrestrial Animal Species Theme (Figure 7). The four (4) development areas specifically are all classified as **Medium to High**. The High and Medium sensitivity classifications are linked to Ludwig's Bustard *Neotis ludwigii*, Lanner Falcon *Falco biarmicus*, Verreaux's Eagle *Aquila verreauxii*, Caspian Tern *Hydroprogne caspia* and Tawny Eagle *Aquila rapax*. The Project Site contains confirmed habitat for species of conservation concern (SCC) 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 occurrence of SCC was confirmed during the surveys so far i.e. Martial Eagle *Polemaetus bellicosus* (Globally and Regionally Endangered), Secretarybird *Sagittarius serpentarius* (Globally and Regionally Endangered), Cape Vulture *Gyps coprotheres* (Globally Vulnerable and Regionally Endangered), Lanner Falcon (Regionally Vulnerable), and Tawny Eagle (Globally Vulnerable and Regionally Endangered). Habitat for Ludwig's Bustard was also observed.

Based on the available SABAP2 data and the Site Sensitivity Verification (Appendix 5) survey conducted on 21 April 2022, the classification of **High** sensitivity for avifauna in the screening tool is therefore confirmed for all four development areas. None of the development areas has a specific habitat feature that distinguishes it from the other development areas which would justify a lesser rating (Figure 5).



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

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Aves-Neotis ludwigii
High	Aves-Falco biarmicus
Low	Subject to confirmation
Medium	Aves-Hydroprogne caspia
Medium	Aves-Neotis ludwigii
Medium	Aves-Aquila rapax
Medium	Aves-Aquila verreauxii

Figure 5: The National Web-Based Environmental Screening Tool map of the Project Site, indicating sensitivities for the Terrestrial Animal Species theme. The High and Medium sensitivity classifications are linked to Ludwig's Bustard *Neotis ludwigii*, Lanner Falcon *Falco biarmicus*, Verreaux's Eagle *Aquila verreauxii*, Caspian Tern *Hydroprogne caspia* and Tawny Eagle *Aquila rapax.*

6.3 Protected Areas

The Project Site does not fall within a protected area or a National Protected Areas Expansion Strategy (NPAES) focus area.

6.4 Biomes and vegetation types

The Project Site is situated on a vast grassy Karoo plain, with its centre approximately 14 km south-east of the town of De Aar in the Northern Cape Province. The Project Site falls within the Nama Karoo Biome, in the Upper Karoo Bioregion, with some patches that are classified as Dry Highveld Grassland Bioregion (Mucina & Rutherford 2006).

The habitat in the Project Site is highly homogenous and consist of extensive plains with low shrubs and a prominent grassy component. Mucina & Rutherford (2006) classify the vegetation in the Project Site as Northern Upper Karoo on the plains, with Besemkaree Koppies Shrubland on the ridges. Northern Upper Karoo consist of shrubland dominated by dwarf microphyllous shrubs, with 'white' grasses of the genera *Aristida* and *Eragrostis* (these become prominent especially in the early autumn months after good summer rains, as is the case currently in the Project Site). Besemkaree Koppies Shrubland consist of two-layered karroid shrubland. The lower (closed-canopy) layer is dominated by dwarf small-leaved shrubs and, especially in precipitation-rich years, also by abundant grasses, while the upper (loose canopy) layer is dominated by tall shrubs (Mucina & Rutherford). There is one prominent drainage line in the north-eastern corner of the Project Site.

SABAP1 recognises six primary vegetation divisions (biomes) within South Africa, namely (1) Fynbos (2) Succulent Karoo (3) Nama Karoo (4) Grassland (5) Savanna and (6) Forest (Harrison *et al.* 1997). The criteria used by the authors to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations. 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 Project Site is classified as Grassy Karoo, a sub-category of the Nama Karoo biome. Grassy Karoo can be viewed as a transitional zone between the Nama Karoo and grassland biomes, although also primarily a dwarf shrub habitat, it shows a higher proportion of grass cover (Harrison *et al*. 1997).

The De Aar has a semi-arid climate with hot summers and cold winters. The average temperature during summer is 24.3 °C (January) and 9.1 °C during winter (June) (SA Atlas of Climatology and Agrohydrology, Schulze, 2009). The average annual precipitation is about 280 mm, with most rainfall occurring during summer and autumn. De Aar experiences frost during the winter with 25.4 frost days per year on average (SA Atlas of Climatology and Agrohydrology, Schulze, 2009).

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

6.5 Bird habitat

6.5.1 Nama Karoo Shrubland

The main vegetation type within the development areas consists of Karoo shrubland with a strong grassy component.

6.5.2 Drainage Lines and Wetlands

There is a large riverine and wetland system in the north/north-eastern corner of the Project Site. This habitat feature is most likely very important feeding, breeding, and nesting habitat for several priority and non-priority species, especially waterbirds. It should be noted that this riverine system falls outside of the proposed Development Areas.

6.5.3 Water Reservoirs and Dams

Surface water is of specific importance to avifauna in this arid Project Site. The Project Site contains man-made dams (earthen dams) and water reservoirs. Boreholes with open water troughs are important sources of surface water for priority avifauna for drinking and bathing.

6.5.4 Alien Trees

The Project Site is generally devoid of trees, except for isolated clumps of trees at homesteads and boreholes, where a mixture of alien and indigenous trees is growing. The trees could attract a variety of bird species for the purposes of nesting and roosting.

6.5.5 High Voltage Lines

High voltage lines are an important potential roosting and breeding substrate for large raptors in the Karoo (Jenkins *et al*. 2013). A high voltage line bisects the Project Site. There is increasing evidence that vultures are using high voltage lines in the Karoo (personal observation), mostly in the non-breeding season (January to March), and that they could be encountered anywhere in the broader area.

6.5.6 Rocky Ridges

The Project Site contains one prominent ridge (koppie) known as Rietfontein in the south-eastern corner of the Project Site, which rises to a height of 1352 m/asl. There is also a prominent ridgeline in the north-west of the Project Site (Wachteenbeetje 1466 m/asl). There are a number of other ridges in the broader area too. Ridges provide important habitat for several bird species, especially certain raptors, who use these areas for foraging.

See Appendix 2 for photographic records of habitat features in the development area and immediate surroundings.

7 AVIFAUNA IN THE DEVELOPMENT AREA

7.1 South African Bird Atlas Project 2

The SABAP2 data indicates that a total of 162 species could potentially occur within the broader area where the project is located (see Appendix 1). Of these, 76 are classified as priority species for solar developments. Of the 76 priority species, 45 have a medium to high probability of occurring regularly in the Project Site, and 21 of the priority species were recorded during the field monitoring surveys. Five Red Data species were recorded during the site surveys, namely Cape Vulture (Globally and Regionally Endangered), Lanner Falcon (Regionally Vulnerable), Martial Eagle (Globally and Regionally Endangered), Secretarybird (Globally Endangered, Regionally Vulnerable), and Tawny Eagle (Globally Vulnerable, Regionally Endangered).

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

Red List species are highlighted.

Table 2: Priority species with a medium to high likelihood of occurring in the Project Site.

Species name	Scientific name	SABAP2 Reporting Rate (%)		Global Conservation Status	Regional Conservation Status	Endemic (SA)	Recorded during monitoring	Likelihood of regular occurrence in Project Site	Nama Karoo shrub	Drainage lines and wetlands	Water reservoirs and dams	High voltage lines	Alien trees	Rocky ridges	Solar - Collisions with solar panels	Solar - Displacement: Disturbance (breeding)	Solar - Displacement: Habitat transformation	Solar - Entanglement in fences	Substations - Electrocution	Powerline - Collision
		Full protocol	Ad hoc protocol																	
African Sacred Ibis	*Threskiornis aethiopicus*	55,0	3,4	-	-			H		x	x									x
Amur Falcon	*Falco amurensis*	15,0	6,9	-	-		x	M	x			x	x	x			x		x	
Black Stork	*Ciconia nigra*	10,0	0,0	-	VU			M		x	x			x						x
Black-chested Snake Eagle	*Circaetus pectoralis*	5,0	0,0	-	-			M	x			x	x				x		x	
Black-headed Heron	*Ardea melanocephala*	20,0	0,0	-	-			M		x	x		x				x		x	x
Blacksmith Lapwing	*Vanellus armatus*	55,0	3,4	-	-			H		x	x				x					
Black-winged Kite	*Elanus caeruleus*	10,0	0,0	-	-			M	x			x	x	x			x		x	
Black-winged Stilt	*Himantopus himantopus*	35,0	6,9	-	-			M		x	x				x					
Blue Crane	*Grus paradisea*	45,0	6,9	VU	NT			H	x	x						x	x	x		x
Blue Korhaan	*Eupodotis caerulescens*	15,0	6,9	NT	LC	x		M	x						x	x	x	x		x
Booted Eagle	*Hieraaetus pennatus*	15,0	3,4	-	-		x	M	x			x	x	x			x		x	
Cape Teal	*Anas capensis*	15,0	0,0	-	-			M		x	x				x					x
Cape Vulture	*Gyps coprotheres*	5,0	0,0	EN	EN		x	M	x		x	x		x		x	x		x	x
Cape White-eye	*Zosterops virens*	20,0	0,0	-	-	x		M					x							
Common Buzzard	*Buteo buteo*	10,0	6,9	-	-			M	x		x	x	x	x		x	x		x	
Common Greenshank	*Tringa nebularia*	15,0	0,0	-	-			M		x	x				x					
Common Moorhen	*Gallinula chloropus*	25,0	0,0	-	-			M		x	x				x					
Egyptian Goose	*Alopochen aegyptiaca*	60,0	13,8	-	-		x	H		x	x	x	x		x		x		x	x
Fiscal Flycatcher	*Melaenornis silens*	15,0	6,9	-	-	x		M					x							
Glossy Ibis	*Plegadis falcinellus*	30,0	0,0	-	-			M		x	x				x					x
Greater Kestrel	*Falco rupicoloides*	10,0	17,2	-	-		x	M	x			x	x	x		x	x		x	
Grey Heron	*Ardea cinerea*	20,0	0,0	-	-			M		x	x				x					x

Jackal Buzzard	*Buteo rufofuscus*	10,0	10,3	-	-	x	x	H	x			x	x	x		x	x		x	
Karoo Lark	*Calendulauda albescens*	10,0	0,0	-	-	x		M	x						x	x	x			
Karoo Prinia	*Prinia maculosa*	25,0	3,4	-	-	x	x	M	x	x					x	x	x			
Karoo Thrush	*Turdus smithi*	50,0	3,4	-	-	x		M					x				x			
Lanner Falcon	*Falco biarmicus*	10,0	3,4	-	VU		x	M	x		x	x	x	x		x	x		x	
Large-billed Lark	*Galerida magnirostris*	30,0	13,8	-	-	x	x	H	x						x	x	x			
Lesser Kestrel	*Falco naumanni*	55,0	6,9	-	-		x	H	x			x	x	x			x		x	
Little Stint	*Calidris minuta*	10,0	0,0	-	-			M		x	x				x					
Ludwig's Bustard	*Neotis ludwigii*	25,0	0,0	EN	EN			M	x							x	x	x		x
Martial Eagle	*Polemaetus bellicosus*	5,0	3,4	EN	EN		x	M	x		x	x	x	x			x		x	
Pale Chanting Goshawk	*Melierax canorus*	50,0	13,8	-	-		x	H	x			x	x	x			x		x	
Pied Avocet	*Recurvirostra avosetta*	20,0	0,0	-	-			M		x	x				x					
Pied Starling	*Lamprotornis bicolor*	40,0	6,9	-	-	x		H	x		x		x		x	x	x			
Rock Kestrel	*Falco rupicolus*	20,0	3,4	-	-			M	x					x		x	x		x	
Ruff	*Calidris pugnax*	15,0	0,0	-	-			M		x	x				x					
Secretarybird	*Sagittarius serpentarius*	5,0	10,3	EN	VU		x	M	x		x					x	x	x		x
Sickle-winged Chat	*Emarginata sinuata*	10,0	6,9	-	-	x	x	M	x						x	x	x			
South African Cliff Swallow	*Petrochelidon spilodera*	40,0	0,0	-	-	x		H	x								x			
South African Shelduck	*Tadorna cana*	30,0	6,9	-	-			H		x	x				x					x
Spotted Eagle-Owl	*Bubo africanus*	5,0	0,0	-	-			M		x			x	x	x	x	x	x	x	
Spur-winged Goose	*Plectropterus gambensis*	35,0	3,4	-	-		x	M		x	x				x		x			x
Three-banded Plover	*Charadrius tricollaris*	45,0	6,9	-	-			H		x	x				x					
Yellow-billed Duck	*Anas undulata*	20,0	3,4	-	-		x	M		x	x				x					x

7.1 Pre-construction surveys

Pre-construction avifaunal surveys were undertaken at the project site during the following time envelopes:

- 03 to 05 February 2022 (Survey 1)
- 04 to 08 April 2022 (Survey 2)

Surveys were conducted according to an adapted Regime 2 site as defined in the Solar Guidelines (Jenkins *et al.* 2017) i.e., a minimum of two surveys conducted over 6 months.

The abundance of priority species (Index of kilometric abundance (IKA) = birds/km) recorded during the transect counts are displayed in Figure 6.

See Appendix 3 for a description of the pre-construction monitoring for the Pixley Park Solar PV Project.

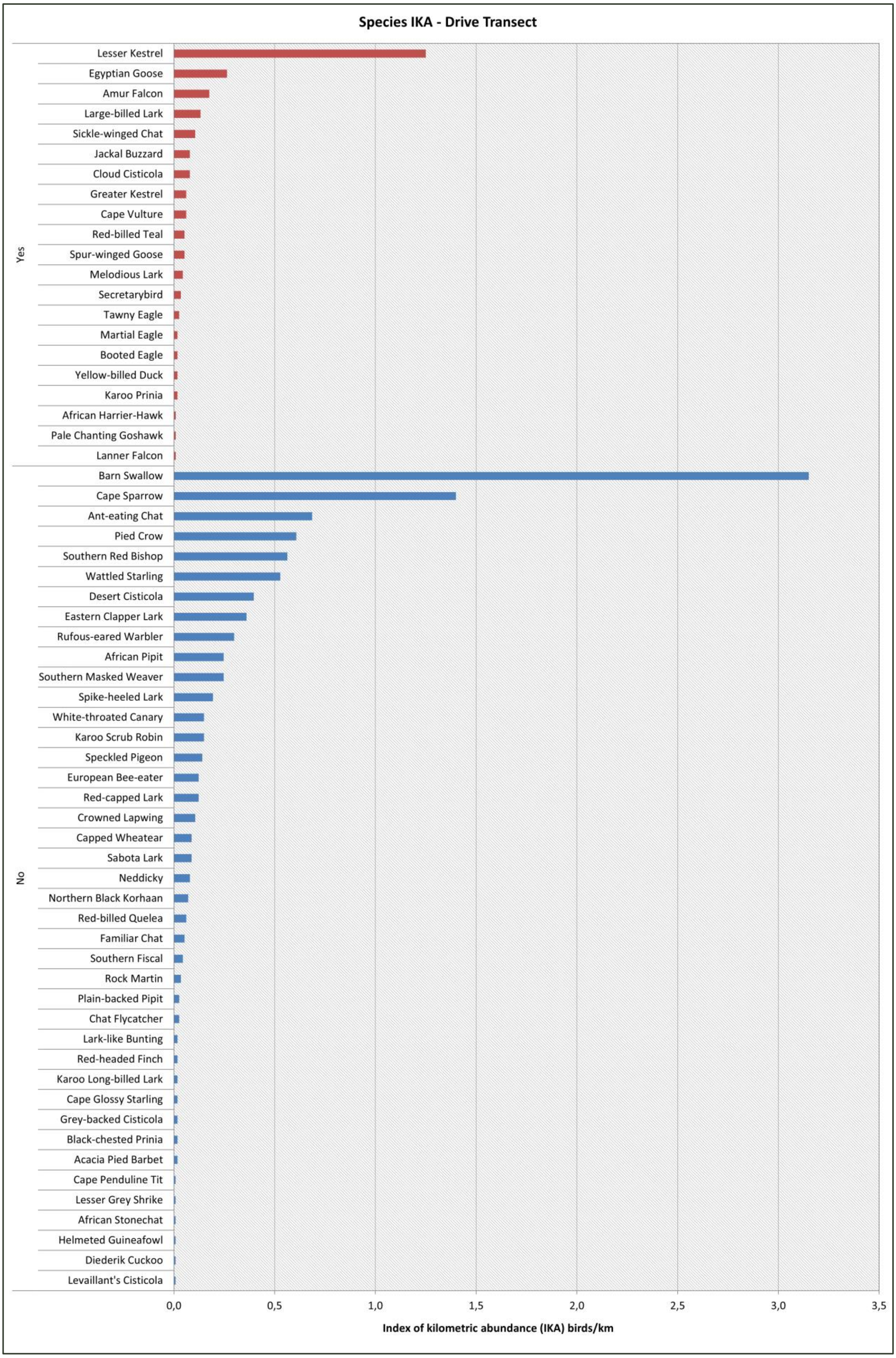


Figure 6: IKA for drive transect solar priority & non-priority species at the project site recorded during two surveys over six months.

The overall abundance of priority species at the project site was moderate to high, with an average of 2.52 birds/km recorded during the drive transect counts. For all bird species combined (i.e., priority and non-priority species), the average IKA for the drive transect counts was 12.74 birds/km.

8 IMPACT ASSESSMENT

Due to the similarity in habitat, the impacts for all four (4) PV projects are expected to be identical in nature and extent.

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-western United States. In South Africa, only two published scientific studies been conducted on the environmental impacts of PV plants in a South African context (Rudman *et al.*, 2017; Visser *et al.*, 2019). A related scientific study has also been conducted upon the effects of concentrated solar power facilities on wildlife in South Africa (Jeal *et al.*, 2019).

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

8.1 Introduction

Anthropogenic climate change poses a global conservation concern and is predicted to drive rapid redistribution of plant and animal species (National Audubon Society, 2015). Such redistribution events include large-scale population displacements alongside species range reductions and fragmentation, alongside population displacements (Ehrlén & Morris, 2015; Pecl *et al.*, 2017), and changes to the timing interactions (Kharouba *et al.*, 2018). Collectively, these anthropogenically-induced changes pose the risk of extinction event occurring at unprecedented rates compared to natural long-term climate (Urban, 2015) – which is itself a fundamental driver behind species distributions. In 2006, WWF Australia produced a report on the envisaged impact of climate change on birds worldwide (Wormworth & Mallon, 2006). The report found that:

- Anthropogenic 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, range loss is predicted to occur without accompanying range expansion.
- For 188 species, predicted range 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-emitting technologies into the country's compliment of power generation will greatly facilitate achieving this important objective (Walwyn & Brent, 2015). Given that South Africa receives among the highest levels of solar radiation on earth (Fluri, 2009; Munzhedzi & Sebitosi, 2009), it is clear that solar power generation should feature prominently in future national efforts to convert to a more sustainable energy suite of energy productions to combat human-induced climate change.

From an avifaunal perspective, solar power generation undoubtedly presents a long-term benefit to species viability, given that solar power generation is anticipated to mitigate the environmental threats posed by anthropogenic climate change (i.e. rapid species redistribution and broad-scale habitat transformation). However, renewable energy facilities – including solar PV facilities – themselves can impede the viability of bird species populations. The environmental risks associated with solar PV facilities need to be recognised and addressed to minimise the negate impacts such facilities may have of bird species populations.

8.2 Impacts associated with PV plant

8.2.1 Impact trauma (collisions)

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%) may support the "lake effect" hypothesis (West 2014). Although in the case of Desert Sunlight, the proximity of

[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.

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). Koskiuch *et al.* (2020) found that water-obligate birds, which rely on water for take-off and landing, occurred at 90% (9/10) of site-years at 7 sites in the Sonoran and Mojave Deserts Bird Conservation Region in the USA from January 2013 to September 2018. However, they stressed that their statements should not be interpreted as evidence there will be water-obligate bird mortality at PV facilities developed in areas with concentrations of migrating or overwintering water obligates because the causal mechanism for fatality risk is unknown. 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 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).

The results of the available literature lack compelling evidence of collisions as a cause of large-scale mortality among birds at PV facilities. Kosciuch *et al*. (2020) synthesized results from fatality monitoring studies at 10 photovoltaic solar facilities across 13 site years in California and Nevada in the USA. Annual fatality rates never exceeded 2.99 fatalities/MW/year (1.03 fatalities/hectare/year), and 3 of the four top species detected were ground-dwelling species.

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, ground-dwelling birds which forage between the solar panels, and possibly raptors which prey on them.

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 solar priority species which would most likely be potentially affected by this impact include small terrestrial birds which forage between the solar panels, and raptors which predate these small birds or forage for insects and other animals between the PV panels, e.g., Greater Kestrels (i.e., if they are not completely displaced due to the habitat transformation).

Solar priority species which could potentially be impacted due to collisions with the solar panels are the following: African Black Duck, African Rock Pipit, Black Crake, Blacksmith Lapwing, Black-winged Stilt, Blue Korhaan, Cape Shoveler, Cape Teal, Cape Weaver, Cloud Cisticola, Common Greenshank, Common Moorhen, Common Sandpiper, Curlew Sandpiper, Egyptian Goose, Gabar Goshawk, Glossy Ibis, Greater Flamingo, Grey Heron, Grey Tit, Hamerkop, Karoo Lark, Karoo Prinia, Kittlitz's Plover, Large-billed Lark, Layard's Warbler, Little Egret, Little Grebe, Little Stint, Melodious Lark, Pied Avocet, Pied Starling, Red-billed Teal, Red-knobbed Coot, Ruff, Sickle-winged Chat, South African Shelduck, Spotted Eagle-Owl, Spur-winged Goose, Three-banded Plover, Western Cattle Egret ,White-breasted Cormorant, White-faced Whistling Duck, Wood Sandpiper, Yellow-billed Duck.

8.2.2 Entrapment in perimeter fences

Visser *et al.* (2019) recorded a fence-line fatality of an Orange River Francolin *Scleroptila gutturalis* resulting being trapped between the inner and outer perimeter fence of the facility; additionally, three Red-crested Korhaans were claimed to be unable to escape between these two fences without intervention from facility personnel. 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. Potentially, too-close a parallel configuration of double-fenced perimeters can cause fatalities, particularly of larger terrestrial birds, by way of entrapment, and especially if disturbed by people. This risk remains low, however, with Visser *et al.* (2019) tentatively presenting a fatality rate of 0.002 birds per km per month from this risk factor, although qualifying that the single documented fatality was inadequate for robust extrapolations. Owls are also prone to getting entangled in barbed wire fences (personal observation).

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

Solar priority species which could potentially be impacted due to entrapment are the following: Blue Crane, Blue Korhaan, Karoo Korhaan, Ludwig's Bustard, Secretarybird, Spotted Eagle-Owl.

8.2.3 Displacement due to habitat transformation associated with the construction of the solar PV facility

Ground-disturbing activities affect a variety of processes in arid areas, 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.

In order 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 a pattern of reduced avifaunal densities will manifest itself at the proposed PV facilities. Ground nesting species, shrubland specialists and some raptors are likely to be impacted most by the habitat transformation, raptors particularly as a result in reduced prey availability and accessibility.

Solar priority species that could be negatively affected by displacement due to habitat loss are the following: African Harrier-Hawk, Amur Falcon, Black-chested Snake Eagle, Black-headed Heron, Black-winged Kite, Blue Crane, Blue Korhaan, Booted Eagle, Cape Vulture, Common Buzzard, Egyptian Goose, Greater Kestrel, Grey-winged Francolin, Jackal Buzzard, Karoo Korhaan, Karoo Lark, Karoo Prinia, Karoo Thrush, Lanner Falcon, Large-billed Lark, Layard's Warbler, Lesser Kestrel, Ludwig's Bustard, Martial Eagle, Pale Chanting Goshawk, Pied Starling, Rock Kestrel, Secretarybird, Sickle-winged Chat, South African Cliff Swallow, Spotted Eagle-Owl, Spur-winged Goose, Tawny Eagle, Verreaux's Eagle.

8.2.4 Displacement due to disturbance associated with the construction of the solar PV facility

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 facilities, the solar priority species which would be most severely affected by disturbance would be ground dwelling species, those that utilise low shrubs for nesting, and raptors which predate these bird species, and on other ground/shrub-dwelling fauna.

Solar priority species that could be negatively affected by disturbance associated with the construction of the solar PV facilities are the following: African Harrier-Hawk, African Rock Pipit, Blue Crane, Blue Korhaan, Cape Vulture, Cloud Cisticola, Common Buzzard, Gabar Goshawk, Greater Kestrel, Grey-winged Francolin, Jackal Buzzard, Karoo Korhaan, Karoo Lark, Karoo Prinia, Lanner Falcon, Large-billed Lark, Layard's Warbler, Ludwig's Bustard, Melodious Lark, Pied Starling, Rock Kestrel, Secretarybird, Sickle-winged Chat, Spotted Eagle-Owl, Tawny Eagle, Verreaux's Eagle.

8.3 Impacts associated with the medium voltage network

8.3.1 Electrocution of priority species on the internal medium voltage reticulation network

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.

While the intention is to place the majority of the medium voltage reticulation network underground at the PV facility, there are areas where the lines will run above ground. Electrocutions at the on-site substations are also a probability.

Solar priority and powerline sensitive species which could be at risk of electrocution on the medium voltage powerlines are the following: Amur Falcon, Black-chested Snake Eagle, Black-headed Heron, Black-winged Kite, Booted Eagle, Cape Vulture, Common Buzzard, Egyptian Goose, Greater Kestrel, Jackal Buzzard, Lanner Falcon, Lesser Kestrel, Martial Eagle, Pale Chanting Goshawk, Rock Kestrel, Spotted Eagle-Owl

8.3.2 Collisions with the internal medium voltage overhead lines

Collisions might be 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 (see Figure 7 below).

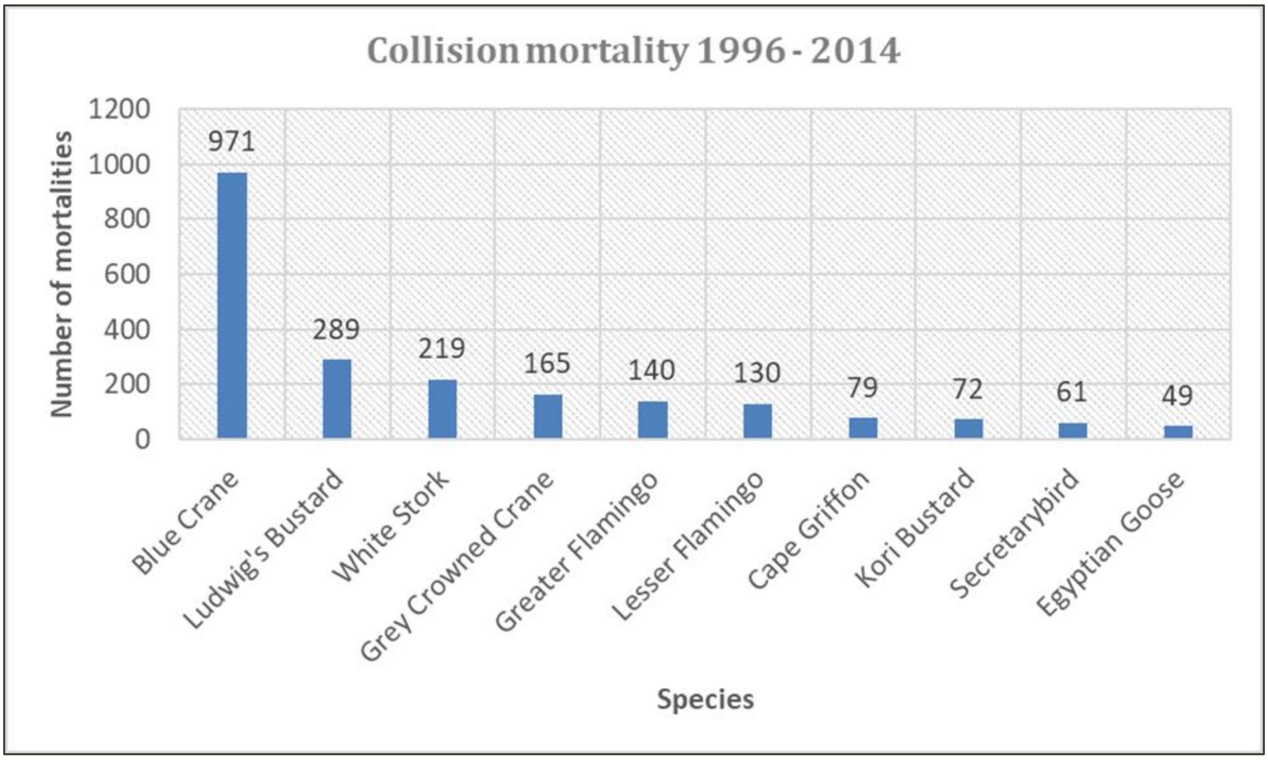


Figure 7: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/Endangered Wildlife Trust Strategic Partnership central incident register 1996 - 2014 (EWT unpublished data)

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. Total annual mortality was estimated at 41% of the Ludwig's Bustard population, with Kori Bustards *Ardeotis kori* also dying in large numbers (at least 14% of the South African population killed in the Karoo alone). Karoo Korhaan was also recorded, but to a much lesser extent than Ludwig's Bustard. The reasons for the relatively low collision risk of this species probably include their smaller size (and hence greater agility in flight) as well as their more sedentary lifestyles, as local birds are familiar with their territory and are less likely to collide with power lines (Shaw 2013).

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 the majority of the medium voltage reticulation network underground at the PV facility, there are areas where the lines will run above ground. Solar priority and powerline sensitive species which are most at risk of collisions with the medium voltage powerlines are the following: African Sacred Ibis, Black Stork, Black-headed Heron, Blue Crane, Blue Korhaan, Cape Teal, Cape Vulture, Egyptian Goose, Glossy Ibis, Grey Heron, Ludwig's Bustard, Secretarybird, South African Shelduck, Spur-winged Goose and Yellow-billed Duck.

9 IMPACT RATING

9.1 Determination of Significance of Impacts

Direct, indirect and cumulative impacts of the issues identified through the EIA process were assessed in terms of the following criteria:

- The nature, which includes a description of what causes the effect, what will be affected and how it will be affected.

- The extent, wherein it is indicated whether the impact will be
  - 1 = site only
  - 2 = local
  - 3 = regional
  - 4 = national
  - 5 = international

- The duration, wherein is indicated whether:
  - 1 = the lifetime of the impact will be of a very short duration (0–1 years)
  - 2 = the lifetime of the impact will be of a short duration (2-5 years)
  - 3 = medium-term (5–15 years)
  - 4 = long term (> 15 years)
  - 5 = permanent

- The consequences (magnitude), quantified on a scale from 0-10, where:
  - 0 = small and will have no effect on the environment
  - 2 = minor and will not result in an impact on processes
  - 4 = low and will cause a slight impact on processes
  - 6 = moderate and will result in processes continuing but in a modified way
  - 8 = high (processes are altered to the extent that they temporarily cease)
  - 10 = very high and results in complete destruction of patterns and permanent cessation of processes.

- The probability of occurrence, which describes the likelihood of the impact actually occurring. Probability is estimated on a scale of 1–5, where:
  - 1 = very improbable (probably will not happen)
  - 2 = improbable (some possibility, but low likelihood)
  - 3 = probable (distinct possibility)
  - 4 = highly probable (most likely)
  - 5 is definite (impact will occur regardless of any prevention measures)

- The significance, which is determined through a synthesis of the characteristics described above and is assessed as low, medium, or high

- The status, which is 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

The impact assessments are summarised in the tables below.

9.2.1 Construction Phase

Nature: Displacement of priority species due to disturbance associated with construction of the Pixley Park PV plants 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.		

- 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.
- A 750m all infrastructure exclusion zone must be implemented around the Jackal Buzzard nest Caroluspoort at 30°39'54.80"S 24° 9'37.22"E and Jackal Buzzard nest Wag ten Bittje at 30°41'50.20"S 24° 7'47.94"E

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: During construction: Displacement of priority species due to habitat transformation associated with construction of the Pixley Park PV plants 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:

- A 200m solar panel free buffer zone must be implemented around dams, wetlands, and drainage lines.
- 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 Pixley Park PV plants.		
	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 electrocution will be low once mitigation is implemented.		

Nature: Mortality of priority species due to electrocution on the medium voltage internal reticulation networks		
	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.		
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 Pixley Park PV plants 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.

The impacts are summarized, and a comparison made between pre-and post-mitigation phases as shown in Table 3 below. The rating of environmental issues associated with different parameters prior to, and post mitigation of a proposed activity was averaged.

Table 3: Comparison of summarised impacts on environmental parameters

Environmental Parameter	Nature of the Impact	Rating prior to mitigation	Rating post mitigation
Avifauna	Displacement of priority species due to disturbance associated with construction of the PV plant and associated infrastructure.	55 MEDIUM	45 MEDIUM
	Displacement of priority species due to habitat transformation associated with construction of the PV plant 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

Environmental Parameter	Nature of the Impact	Rating prior to mitigation	Rating post mitigation
	Mortality of priority species due to electrocution on the medium voltage internal reticulation network	42 MEDIUM	10 LOW
	Mortality of priority species due to collisions with the medium voltage internal reticulation network	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**

10 ENVIRONMENTAL SENSITIVITIES

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

- **All infrastructure exclusion zones**

Jackal Buzzard nests: A 750m all infrastructure exclusion zone is recommended to prevent the displacement of the breeding pair during the construction phase due to disturbance. In addition, the buffer area will reduce the risk of injury to the juvenile bird due to collision with the solar panels, when it starts flying and practicing its hunting technique around the nest.

- **Solar panel exclusion zones (other infrastructure allowed)**

Riverine and wetland habitat: A 200m solar panel free buffer zone must be implemented around riverine areas, wetlands, and dams to provide unhindered access to the surface water for a variety of priority species. Surface water in this semi-arid habitat is crucially important for priority avifauna and many non-priority species. It is important to leave open space with no solar panels for birds to access and leave the surface water area unhindered. Surface water is also an important area for raptors to hunt birds which congregate around surface water, and they should have enough space for fast aerial pursuit. This will also benefit species like Blue Cranes which prefer to breed close to water bodies.

- **High sensitivity zones**

The entire Project Site is a high sensitivity zone due to the potential presence of several SCC including African Rock Pipit, Black Stork, Blue Crane, Cape Vulture, Greater Flamingo, Karoo Korhaan, Lanner Falcon, Ludwig's Bustard, Martial Eagle, Secretarybird, Tawny Eagle, and Verreaux's Eagle which could utilise the whole Project Site for foraging. However, these species do not require specific avoidance measures at this stage because there is still adequate habitat available outside the Project Site.

See Figure 8 for the avifaunal sensitivities identified from a PV solar perspective.

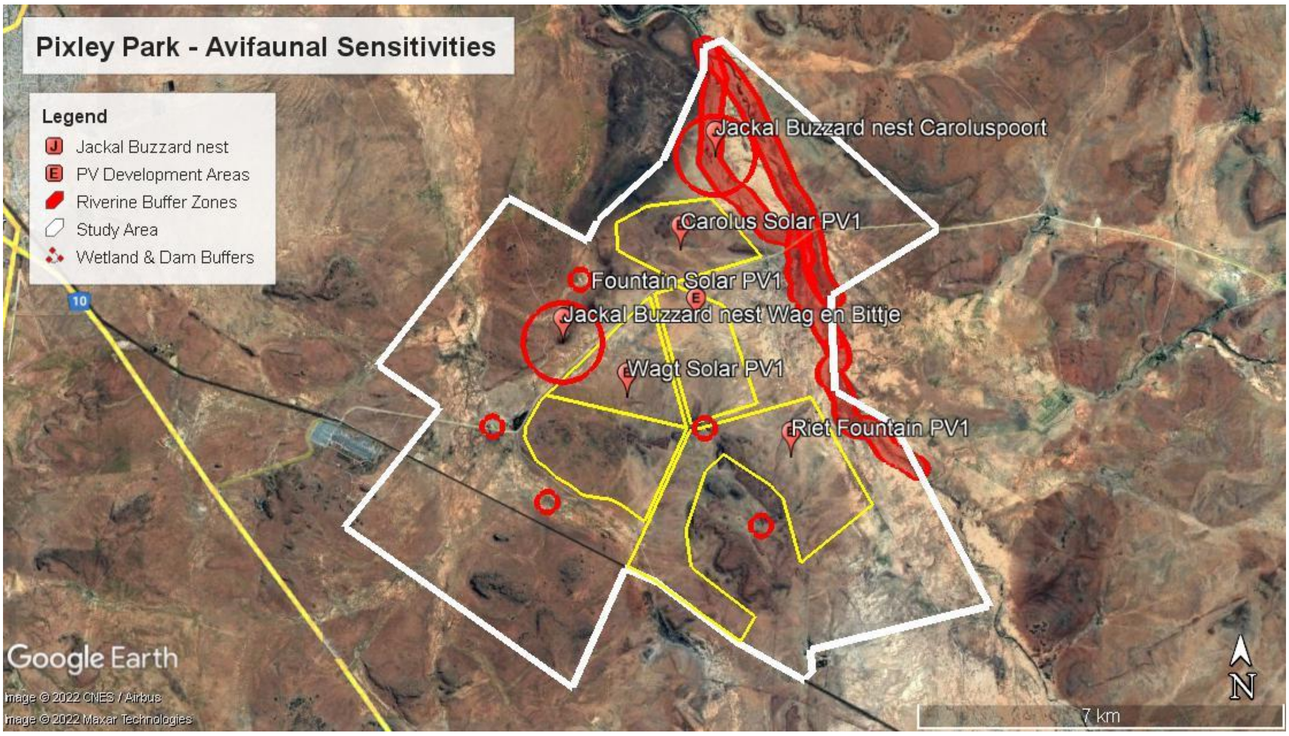


Figure 8: Avifaunal sensitivity zones (in red) within the Project Site. Development Areas are outlined in yellow.

11 CUMULATIVE IMPACTS

Cumulative effects are commonly understood to be impacts from different projects that combine to 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 an EA at the time of starting the environmental impact process, as well as the proposed Pixley Park Renewable Energy Project. There are currently 14 renewable energy projects authorised, operational or in process within a 30 km radius around the cluster of four proposed Solar PV Development Areas of the proposed Pixley Park Renewable Energy Project (**Figure 9**).

The total affected land parcel area taken up by authorised and planned renewable energy projects within the 30 km radius is approximately 1 316 km². The total affected land parcel area affected by the Pixley Solar Renewable Energy Cluster equates to approximately 83.2km². The combined land parcel area affected by authorised renewable energy developments within the 30 km radius around the proposed Pixley Park Renewable Energy Project, including the latter, thus equals approximately 1 399 km². Of this, the proposed Pixley Park Renewable Energy Project land parcel areas constitute ~5.8%. The cumulative impact of the proposed Pixley Park Renewable Energy Project is thus anticipated to be **low** after mitigation.

The total area within the 30km radius around the proposed projects equates to about 4 053 km² of similar habitat (excluding developed areas). The total combined size of the land parcels potentially affected by renewable energy projects will equate to ~34.5% of the available untransformed habitat in the 30km radius. Assuming that all the projects are actually constructed, the cumulative impact of all the proposed renewable energy projects is estimated to be **medium**. However, the actual physical footprint of the renewable energy facilities will 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.

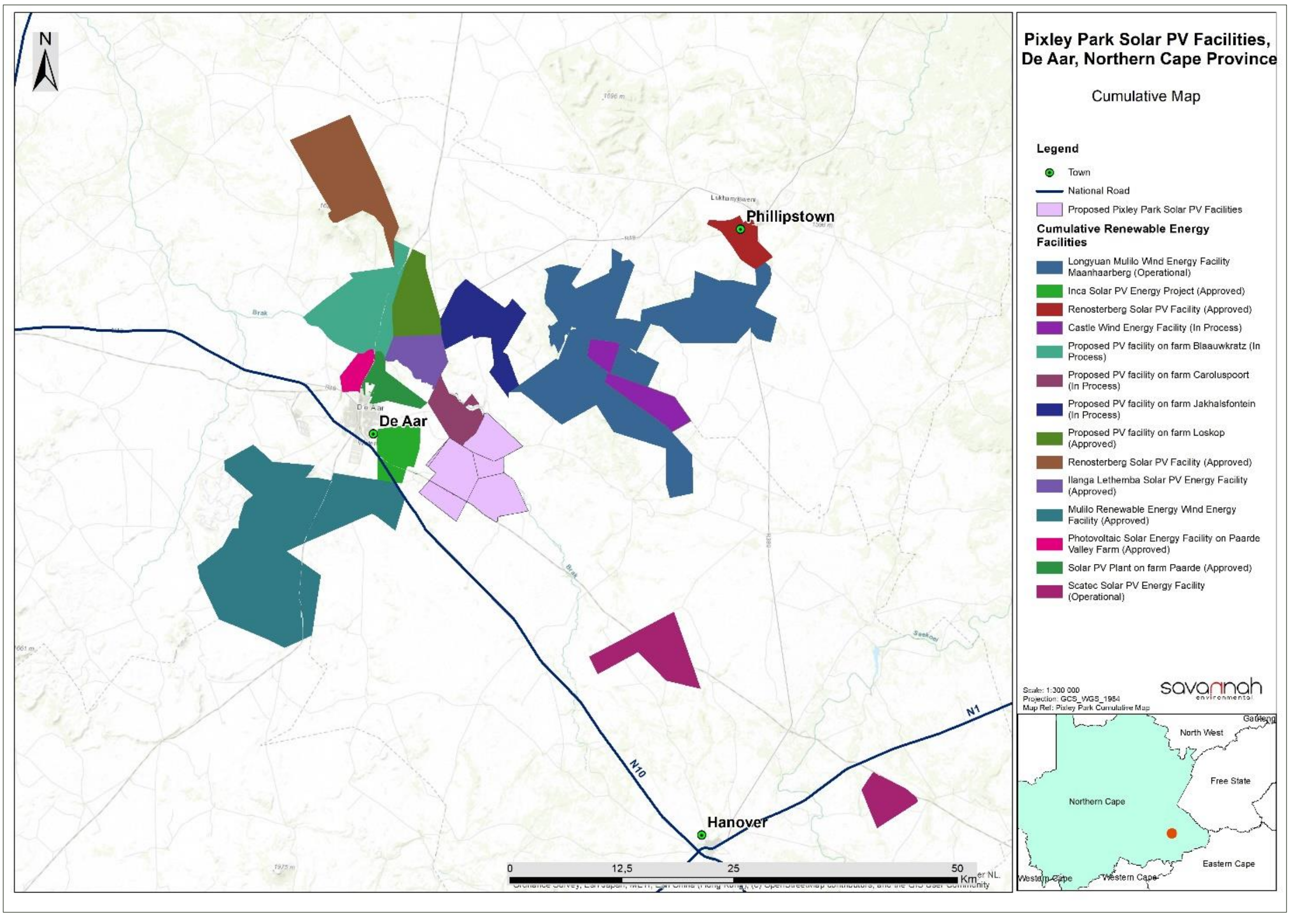


Figure 9: South Africa Renewable Energy EIA Applications Map for the area near De Aar, Northern Cape (Department of Forestry, Fisheries, and the Environment (DFFE), 2021).

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 Pixley Park Renewable Energy Project within a 30km radius (post mitigation).	**Cumulative impact of 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	6 moderate
Probability	3 probable	4 highly probable

Significance	**27 LOW**	**52 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 Pixley Park Renewable Energy Project and all mitigation measures relevant to avifauna listed in the various specialist reports for the other planned projects within a 30km radius of the Pixley Park Renewable Energy Project should be followed.		

12 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).

13 CONCLUSIONS

The proposed Pixley Park Renewable Energy Project will have a range of potential pre-mitigation impacts on priority avifauna ranging from low to high, which is expected to be reduced to medium and low with the appropriate mitigation. No fatal flaws were discovered during the investigations.

14 REFERENCES

- ALONSO, J. A. AND ALONSO, J. C. 1999 Collision of birds with overhead transmission lines in Spain. Pp. 57–82 in Ferrer, M. and Janss, G. F. E., eds. Birds and power lines: Collision, electrocution and breeding. Madrid, Spain: Quercus.Google Scholar
- ANIMAL DEMOGRAPHY UNIT. 2021. The southern African Bird Atlas Project 2. University of Cape Town. http://sabap2.adu.org.za.
- BARRIENTOS R, PONCE C, PALACIN C, MARTÍN CA, MARTÍN B, ET AL. 2012. Wire marking results in a small but significant reduction in avian mortality at power lines: A BACI Designed Study. PLoS ONE 7(3): e32569. doi:10.1371/journal.pone.0032569.
- BARRIENTOS, R., ALONSO, J.C., PONCE, C., PALACÍN, C. 2011. Meta-Analysis of the effectiveness of marked wire in reducing avian collisions with power lines. Conservation Biology 25: 893-903.
- COUNTY OF MERCED. 2014. Draft Environmental Impact Report for the Wright Solar Park Conditional Use Permit Application CUP12-017. Public Draft. July. (ICF 00552.13.) Merced, CA. Prepared by ICF International, Sacramento, CA.
- ENDANGERED WILDLIFE TRUST. 2014. Central incident register for powerline incidents. Unpublished data.
- FLURI, T.P. 2009. The potential of concentrating solar power in South Africa. Energy Policy 37: 5075-5080.

- H. T. HARVEY & ASSOCIATES. 2014a. California Valley Solar Ranch Project Avian and Bat Protection Plan Sixth Quarterly Post construction Fatality Report 16 November 2013 - 15 February 2014.
- H. T. HARVEY & ASSOCIATES. 2014b. California Valley Solar Ranch Project Avian and Bat Protection Plan Sixth Quarterly Post construction Fatality Report 16 February 2014 - 15 May 2014.
- HARRISON, J.A., ALLAN, D.G., UNDERHILL, L.G., HERREMANS, M., TREE, A.J., PARKER, V & BROWN, C.J. (eds). 1997. The atlas of southern African birds. Vol 1 & 2. BirdLife South Africa, Johannesburg.
- HERNANDEZ, R.R., et al., 2014, “Environmental Impacts of Utility-Scale Solar Energy,” Renewable and Sustainable Energy Reviews 29: 766–779.
- HOCKEY P.A.R., DEAN W.R.J., AND RYAN P.G. 2005. Robert’s Birds of Southern Africa, seventh edition. Trustees of the John Voelcker Bird Book Fund, Cape Town.
- JEAL. C. 2017. The impact of a ‘trough’ Concentrated Solar Power facility on birds and other animals in the Northern Cape, South Africa. Minor Dissertation presented in partial fulfilment of the requirements for the degree of Master of Science in Conservation Biology. University of Cape Town.
- JENKINS, A. & SMALLIE, J. 2009. Terminal velocity: the end of the line for Ludwig’s Bustard? Africa Birds and Birding. Vol 14, No 2.
- JENKINS, A., DE GOEDE, J.H. & VAN ROOYEN, C.S. 2006. Improving the products of the Eskom Electric Eagle Project. Unpublished report to Eskom. Endangered Wildife Trust.
- JENKINS, A.R., DE GOEDE, J.H., SEBELE, L. & DIAMOND, M. 2013. Brokering a settlement between eagles and industry: sustainable management of large raptors nesting on power infrastructure. Bird Conservation International 23: 232-246.
- JENKINS, A.R., RALSTON-PATTON, SMIT- ROBINSON, A.H. 2017. Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa. BirdLife South Africa.
- JENKINS, A.R., SMALLIE, J.J. & DIAMOND, M. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. Bird Conservation International 20: 263-278.
- KAGAN, R. A., T. C. VINER, P. W. TRAIL, AND E. O. ESPINOZA. 2014. Avian Mortality at Solar Energy Facilities in Southern California: A Preliminary Analysis. National Fish and Wildlife Forensics Laboratory.
- LOSS, S.R., WILL, T., LOSS, S.S., & MARRA, P.P. 2014. Bird–building collisions in the United States: Estimates of annual mortality and species vulnerability. The Condor 116(1):8-23. 2014.
- LOVICH, J.E. and ENNEN, J.R. 2011, Wildlife Conservation and Solar Energy Development in the Desert Southwest, United States, BioScience 61:982–992.
- MARNEWICK, M.D., RETIEF E.F., THERON N.T., WRIGHT D.R., ANDERSON T.A. 2015. Important Bird and Biodiversity Areas of South Africa. Johannesburg: Birdlife South Africa.
- MARTIN, G., SHAW, J., SMALLIE J. & DIAMOND, M. 2010. Bird’s eye view – How birds see is key to avoiding power line collisions. Eskom Research Report. Report Nr: RES/RR/09/31613.
- MCCRARY, M. D., R. L. MCKERNAN, R. W. SCHREIBER, W. D. WAGNER, AND T. C. SCIARROTTA. 1986. Avian mortality at a solar energy plant. J. Field Ornithology 57:135-141.
- MUCINA. L. & RUTHERFORD, M.C. (Eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.
- MUNZHEDI, R. & SEBITOSI, A.B. 2009. Re-drawing the solar map of South Africa for photovoltaic applications. Renewable Energy 34: 165-169.

- NATIONAL AUDUBON SOCIETY. 2015. Audubon's Birds and Climate Change Report: A Primer for Practitioners. National Audubon Society, New York. Contributors: Gary Langham, Justin Schuetz, Candan Soykan, Chad Wilsey, Tom Auer, Geoff LeBaron, Connie Sanchez, Trish Distler. Version 1.3.
- RAAB, R., SPAKOVSZKY, P., JULIUS, E., SCHÜTZ, C. & SCHULZE, C. 2010. Effects of powerlines on flight behaviour of the West-Pannonian Great Bustard *Otis tarda* population. Bird Conservation International. Birdlife International.

- RAAB, R., SPAKOVSZKY, P., JULIUS, E., SCHÜTZ, C. & SCHULZE, C. 2010. Effects of powerlines on flight behaviour of the West-Pannonian Great Bustard *Otis tarda* population. Bird Conservation International. Birdlife International.

- RUDMAN, J., GAUCHÉ, P., & ESLER, K. J. (2017). Direct environmental impacts of solar power in two arid biomes: An initial investigation. South African Journal of Science, 113(11–12). https://doi.org/10.17159/sajs.2017/20170113
- SEYMORE, R., INGLESI-LOTZ, R. & BLIGNAUT, J. 2014. A greenhouse gas emissions inventory for South Africa: a comparative analysis. Renewable & Sustainable Energy Reviews 34: 371-379.
- SHAW, J.M. 2013. Power line collisions in the Karoo: Conserving Ludwig's Bustard. Unpublished PhD thesis. Percy FitzPatrick Institute of African Ornithology, Department of Biological Sciences, Faculty of Science University of Cape Town May 2013.
- SHAW, J.M., PRETORIUS, M.D., GIBBONS, B., MOHALE, O., VISAGIE, R., LEEUWNER, J.L.& RYAN, P.G. 2017. The effectiveness of line markers in reducing power line collisions of large terrestrial birds at De Aar, Northern Cape. Eskom Research, Testing and Development. Research Report. RES/RR/17/1939422.
- VAN ROOYEN, C.S. 2000. An overview of Vulture Electrocutions in South Africa. Vulture News, 43: 5-22. (Vulture Study Group, Johannesburg, South Africa).
- VAN ROOYEN, C.S. 2004. The Management of Wildlife Interactions with overhead lines. In: The fundamentals and practice of Overhead Line Maintenance (132kV and above), pp217-245. Eskom Technology, Services International, Johannesburg.
- VISSER, E., PEROLD, V., RALSTON-PATON, S., CARDENAL, A. C., & RYAN, P. G. (2019). Assessing the impacts of a utility-scale photovoltaic solar energy facility on birds in the Northern Cape, South Africa. Renewable Energy, 133, 1285–1294. https://doi.org/10.1016/j.renene.2018.08.106
- WALSTON, L.J. ROLLINS, K.E. SMITH, K.P. LAGORY, K.E. SINCLAIR, K. TURCHI, C. WENDELIN, T. & SOUDER, H. A Review of Avian Monitoring and Mitigation Information at Existing Utility-Scale Solar Facilities. U.S. Department of Energy, SunShot Initiative and Office of Energy Efficiency & Renewable Energy. April 2015.
- WALWYN, D.R., BRENT A.C. 2015. Renewable energy gathers steam in South Africa. Renewable and Sustainable Energy 41: 390-401.
- WEST (Western EcoSystems Technology, Inc.), 2014, Sources of Avian Mortality and Risk Factors Based on Empirical Data from Three Photovoltaic Solar Facilities, prepared by Western EcoSystems Technology, Inc., June 17.
- WORMWORTH, J. & MALLON, K. 2006. Bird Species and Climate Change. WWF – Australia. Sydney, NSW, Australia.

APPENDIX 1: SABAP 2 SPECIES LIST FOR THE BROADER AREA

Species name	Scientific name	SABAP2 Reporting Rate (%)	
		Full protocol	Ad hoc protocol
Acacia Pied Barbet	*Tricholaema leucomelas*	55,0	10,3
African Black Duck	*Anas sparsa*	5,0	0,0
African Harrier-Hawk	*Polyboroides typus*	5,0	3,4
African Hoopoe	*Upupa africana*	25,0	0,0
African Pipit	*Anthus cinnamomeus*	70,0	13,8
African Red-eyed Bulbul	*Pycnonotus nigricans*	60,0	3,4
African Reed Warbler	*Acrocephalus baeticatus*	30,0	3,4
African Rock Pipit	*Anthus crenatus*	0,0	3,4
African Sacred Ibis	*Threskiornis aethiopicus*	55,0	3,4
African Stonechat	*Saxicola torquatus*	35,0	6,9
Amur Falcon	*Falco amurensis*	15,0	6,9
Ant-eating Chat	*Myrmecocichla formicivora*	75,0	34,5
Barn Swallow	*Hirundo rustica*	65,0	17,2
Black Crake	*Zapornia flavirostra*	5,0	0,0
Black Stork	*Ciconia nigra*	10,0	0,0
Black-chested Prinia	*Prinia flavicans*	5,0	3,4
Black-chested Snake Eagle	*Circaetus pectoralis*	5,0	0,0
Black-headed Heron	*Ardea melanocephala*	20,0	0,0
Blacksmith Lapwing	*Vanellus armatus*	55,0	3,4
Black-throated Canary	*Crithagra atrogularis*	20,0	3,4
Black-winged Kite	*Elanus caeruleus*	10,0	0,0
Black-winged Stilt	*Himantopus himantopus*	35,0	6,9
Blue Crane	*Grus paradisea*	45,0	6,9
Blue Korhaan	*Eupodotis caerulescens*	15,0	6,9
Bokmakierie	*Telophorus zeylonus*	60,0	6,9
Booted Eagle	*Hieraaetus pennatus*	15,0	3,4
Brown-throated Martin	*Riparia paludicola*	10,0	0,0
Cape Bunting	*Emberiza capensis*	10,0	0,0
Cape Robin-Chat	*Cossypha caffra*	50,0	0,0
Cape Shoveler	*Spatula smithii*	5,0	0,0
Cape Sparrow	*Passer melanurus*	100,0	24,1
Cape Starling	*Lamprotornis nitens*	10,0	3,4
Cape Teal	*Anas capensis*	15,0	0,0
Cape Turtle Dove	*Streptopelia capicola*	75,0	17,2
Cape Vulture	*Gyps coprotheres*	5,0	0,0
Cape Wagtail	*Motacilla capensis*	60,0	3,4
Cape Weaver	*Ploceus capensis*	5,0	3,4

Species name	Scientific name	SABAP2 Reporting Rate (%)	
		Full protocol	Ad hoc protocol
Cape White-eye	*Zosterops virens*	20,0	0,0
Capped Wheatear	*Oenanthe pileata*	50,0	6,9
Chat Flycatcher	*Melaenornis infuscatus*	15,0	13,8
Chestnut-vented Warbler	*Curruca subcoerulea*	10,0	0,0
Cinnamon-breasted Bunting	*Emberiza tahapisi*	0,0	3,4
Cloud Cisticola	*Cisticola textrix*	0,0	0,0
Common Buzzard	*Buteo buteo*	10,0	6,9
Common Greenshank	*Tringa nebularia*	15,0	0,0
Common Moorhen	*Gallinula chloropus*	25,0	0,0
Common Ostrich	*Struthio camelus*	10,0	0,0
Common Quail	*Coturnix coturnix*	0,0	3,4
Common Sandpiper	*Actitis hypoleucos*	0,0	3,4
Common Starling	*Sturnus vulgaris*	25,0	0,0
Common Swift	*Apus apus*	5,0	0,0
Common Waxbill	*Estrilda astrild*	15,0	0,0
Crowned Lapwing	*Vanellus coronatus*	15,0	3,4
Curlew Sandpiper	*Calidris ferruginea*	5,0	0,0
Desert Cisticola	*Cisticola aridulus*	40,0	6,9
Diederik Cuckoo	*Chrysococcyx caprius*	25,0	3,4
Dusky Sunbird	*Cinnyris fuscus*	5,0	0,0
Eastern Clapper Lark	*Mirafra fasciolata*	65,0	13,8
Egyptian Goose	*Alopochen aegyptiaca*	60,0	13,8
European Bee-eater	*Merops apiaster*	45,0	13,8
Familiar Chat	*Oenanthe familiaris*	55,0	20,7
Fiscal Flycatcher	*Melaenornis silens*	15,0	6,9
Gabar Goshawk	*Micronisus gabar*	5,0	0,0
Glossy Ibis	*Plegadis falcinellus*	30,0	0,0
Greater Flamingo	*Phoenicopterus roseus*	15,0	0,0
Greater Kestrel	*Falco rupicoloides*	10,0	17,2
Greater Striped Swallow	*Cecropis cucullata*	60,0	3,4
Grey Heron	*Ardea cinerea*	20,0	0,0
Grey Tit	*Melaniparus afer*	5,0	0,0
Grey-backed Cisticola	*Cisticola subruficapilla*	30,0	3,4
Grey-backed Sparrow-Lark	*Eremopterix verticalis*	20,0	3,4
Grey-headed Gull	*Chroicocephalus cirrocephalus*	5,0	0,0
Grey-winged Francolin	*Scleroptila afra*	5,0	3,4
Hadada Ibis	*Bostrychia hagedash*	65,0	0,0
Hamerkop	*Scopus umbretta*	5,0	0,0
Helmeted Guineafowl	*Numida meleagris*	55,0	3,4

Species name	Scientific name	SABAP2 Reporting Rate (%)	
		Full protocol	Ad hoc protocol
House Sparrow	*Passer domesticus*	35,0	13,8
Jackal Buzzard	*Buteo rufofuscus*	10,0	10,3
Kalahari Scrub Robin	*Cercotrichas paena*	5,0	0,0
Karoo Chat	*Emarginata schlegelii*	10,0	0,0
Karoo Korhaan	*Eupodotis vigorsii*	5,0	0,0
Karoo Lark	*Calendulauda albescens*	10,0	0,0
Karoo Long-billed Lark	*Certhilauda subcoronata*	10,0	6,9
Karoo Prinia	*Prinia maculosa*	25,0	3,4
Karoo Scrub Robin	*Cercotrichas coryphoeus*	70,0	13,8
Karoo Thrush	*Turdus smithi*	50,0	3,4
Kittlitz's Plover	*Charadrius pecuarius*	10,0	0,0
Lanner Falcon	*Falco biarmicus*	10,0	3,4
Large-billed Lark	*Galerida magnirostris*	30,0	13,8
Lark-like Bunting	*Emberiza impetuani*	25,0	6,9
Laughing Dove	*Spilopelia senegalensis*	70,0	6,9
Layard's Warbler	*Curruca layardi*	5,0	0,0
Lesser Kestrel	*Falco naumanni*	55,0	6,9
Lesser Swamp Warbler	*Acrocephalus gracilirostris*	15,0	0,0
Levaillant's Cisticola	*Cisticola tinniens*	10,0	3,4
Little Egret	*Egretta garzetta*	5,0	0,0
Little Grebe	*Tachybaptus ruficollis*	5,0	0,0
Little Stint	*Calidris minuta*	10,0	0,0
Little Swift	*Apus affinis*	50,0	3,4
Ludwig's Bustard	*Neotis ludwigii*	25,0	0,0
Malachite Kingfisher	*Corythornis cristatus*	5,0	0,0
Martial Eagle	*Polemaetus bellicosus*	5,0	3,4
Melodious Lark	*Mirafra cheniana*	0,0	0,0
Mountain Wheatear	*Myrmecocichla monticola*	15,0	6,9
Namaqua Dove	*Oena capensis*	20,0	3,4
Namaqua Sandgrouse	*Pterocles namaqua*	5,0	0,0
Nicholson's Pipit	*Anthus nicholsoni*	5,0	0,0
Northern Black Korhaan	*Afrotis afraoides*	75,0	6,9
Orange River White-eye	*Zosterops pallidus*	20,0	3,4
Pale Chanting Goshawk	*Melierax canorus*	50,0	13,8
Pale-winged Starling	*Onychognathus nabouroup*	20,0	0,0
Pied Avocet	*Recurvirostra avosetta*	20,0	0,0
Pied Crow	*Corvus albus*	95,0	34,5
Pied Starling	*Lamprotornis bicolor*	40,0	6,9
Pink-billed Lark	*Spizocorys conirostris*	5,0	0,0

Species name	Scientific name	SABAP2 Reporting Rate (%)	
		Full protocol	Ad hoc protocol
Pin-tailed Whydah	*Vidua macroura*	15,0	0,0
Quailfinch	*Ortygospiza atricollis*	0,0	3,4
Red-billed Quelea	*Quelea quelea*	25,0	3,4
Red-billed Teal	*Anas erythrorhyncha*	10,0	0,0
Red-eyed Dove	*Streptopelia semitorquata*	35,0	3,4
Red-faced Mousebird	*Urocolius indicus*	30,0	0,0
Red-headed Finch	*Amadina erythrocephala*	20,0	3,4
Red-knobbed Coot	*Fulica cristata*	10,0	0,0
Rock Dove	*Columba livia*	15,0	0,0
Rock Kestrel	*Falco rupicolus*	20,0	3,4
Rock Martin	*Ptyonoprogne fuligula*	35,0	10,3
Ruff	*Calidris pugnax*	15,0	0,0
Rufous-eared Warbler	*Malcorus pectoralis*	90,0	17,2
Sabota Lark	*Calendulauda sabota*	50,0	6,9
Secretarybird	*Sagittarius serpentarius*	5,0	10,3
Short-toed Rock Thrush	*Monticola brevipes*	0,0	3,4
Sickle-winged Chat	*Emarginata sinuata*	10,0	6,9
South African Cliff Swallow	*Petrochelidon spilodera*	40,0	0,0
South African Shelduck	*Tadorna cana*	30,0	6,9
Southern Fiscal	*Lanius collaris*	70,0	10,3
Southern Grey-headed Sparrow	*Passer diffusus*	15,0	3,4
Southern Masked Weaver	*Ploceus velatus*	90,0	13,8
Southern Red Bishop	*Euplectes orix*	50,0	10,3
Speckled Pigeon	*Columba guinea*	60,0	13,8
Spike-heeled Lark	*Chersomanes albofasciata*	70,0	10,3
Spotted Eagle-Owl	*Bubo africanus*	5,0	0,0
Spotted Flycatcher	*Muscicapa striata*	15,0	0,0
Spotted Thick-knee	*Burhinus capensis*	10,0	0,0
Spur-winged Goose	*Plectropterus gambensis*	35,0	3,4
Tawny Eagle	*Aquila rapax*	5,0	3,4
Three-banded Plover	*Charadrius tricollaris*	45,0	6,9
Verreaux's Eagle	*Aquila verreauxii*	0,0	3,4
Wattled Starling	*Creatophora cinerea*	5,0	6,9
Western Cattle Egret	*Bubulcus ibis*	5,0	0,0
White Stork	*Ciconia ciconia*	5,0	0,0
White-backed Mousebird	*Colius colius*	55,0	0,0
White-breasted Cormorant	*Phalacrocorax lucidus*	5,0	0,0
White-browed Sparrow-Weaver	*Plocepasser mahali*	10,0	0,0
White-faced Whistling Duck	*Dendrocygna viduata*	5,0	0,0

Species name	Scientific name	SABAP2 Reporting Rate (%)	
		Full protocol	Ad hoc protocol
White-necked Raven	*Corvus albicollis*	5,0	0,0
White-rumped Swift	*Apus caffer*	35,0	0,0
White-throated Canary	*Crithagra albogularis*	40,0	10,3
White-throated Swallow	*Hirundo albigularis*	35,0	0,0
Wood Sandpiper	*Tringa glareola*	5,0	3,4
Yellow-bellied Eremomela	*Eremomela icteropygialis*	20,0	3,4
Yellow-billed Duck	*Anas undulata*	20,0	3,4
Zitting Cisticola	*Cisticola juncidis*	55,0	3,4

APPENDIX 2: HABITAT FEATURES AT THE DEVELOPMENT AREA

Figure 1: Strong grassy layer within the Project Site.

Figure 2: Typical Nama Karoo habitat in the project site.

Figure 3: Alien trees in the project site.

Figure 4: High voltage powerlines running through the Project Site.

APPENDIX 3: PRE-CONSTRUCTION MONITORING

Pre-construction avifaunal surveys were undertaken at the project site during the following time envelopes:

- 03 to 05 February 2022 (Survey 1)
- 04 to 08 April 2022 (Survey 2)

Surveys were conducted according to an adapted Regime 2 site as defined in the Solar Guidelines (Jenkins *et al.* 2017) i.e., a minimum of two surveys conducted over 6 months.

Monitoring for the Pixley Park Solar PV development areas was conducted in the following manner:

- Two drive transects of 4.9 and 9.3 km respectively were identified within the project site.
- One monitor travelling slowly (± 10km/h) in a vehicle recorded all birds on both sides of the transects. The observer stopped at regular intervals (every 500m) to scan the environment with binoculars. Drive transects were counted three times per sampling session. All birds were recorded during the surveys.
- 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

Figure 1 below indicates the location of the transects where monitoring was conducted.

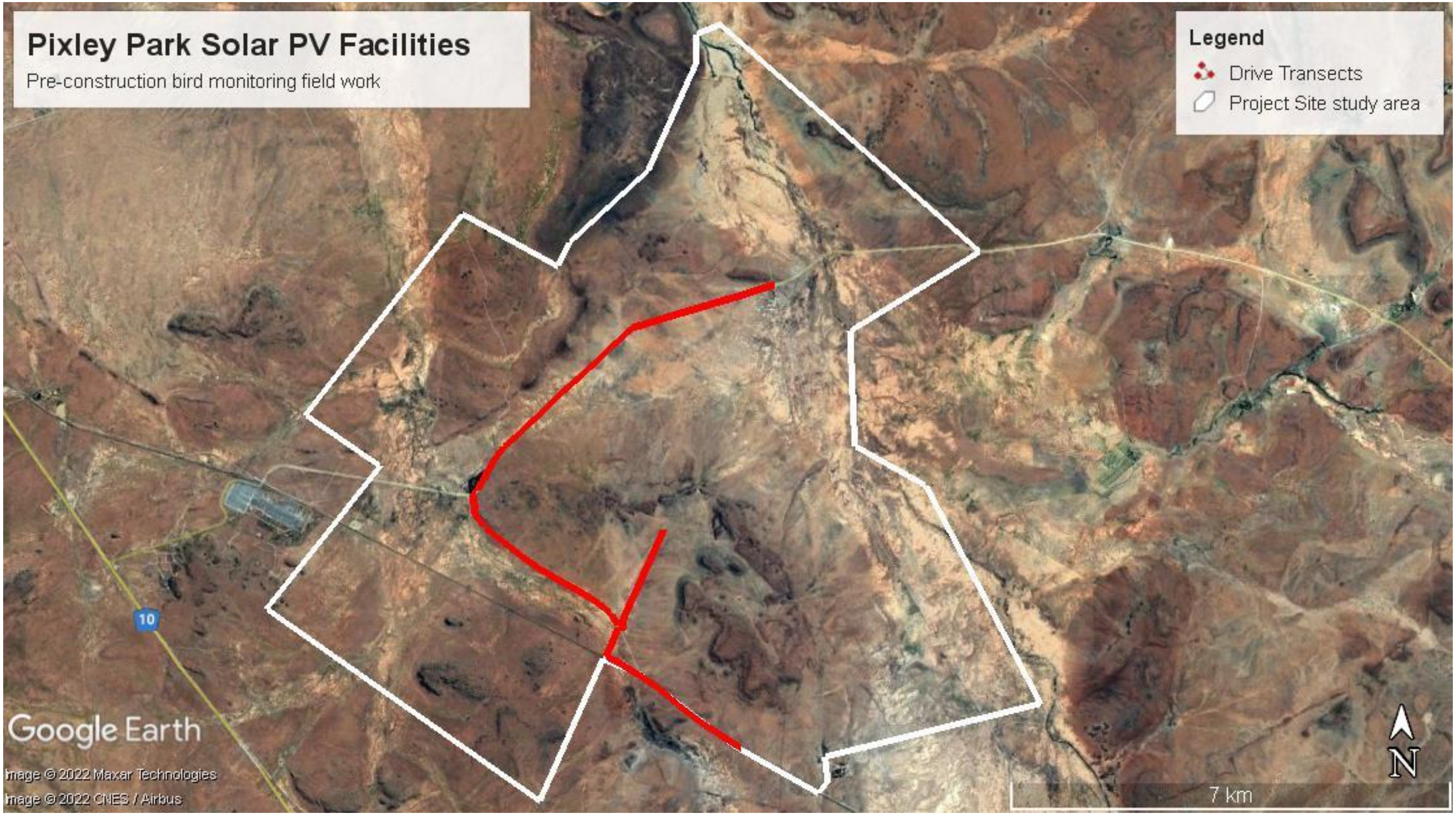


Figure 1: Area where bird monitoring was implemented, with the position of drive transects indicated in red within the Project Site.

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. A 750m all infrastructure exclusion zone is recommended to prevent the displacement of the Jackal Buzzard breeding pair during the construction phase due to disturbance. In addition, the buffer area will reduce the risk of injury to the juvenile bird due to collision with the solar panels, when it starts flying and practicing its hunting technique around the nest 2. A 200m solar panel free buffer zone must be implemented around dams, wetlands, and drainage lines.	Design the facility with a 750m all infrastructure exclusion zone around priority species nests and a 200m solar panel free buffer zone around dams, wetlands, and drainage lines.	Once-off during the planning phase.	Project Developer
Avifauna: Mortality due to electrocutions on the internal 33kV network					
Electrocution of priority species on the 33kV network .	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					
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 (SSV) are noted below:

Date of Site Visits	21 April 2022
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

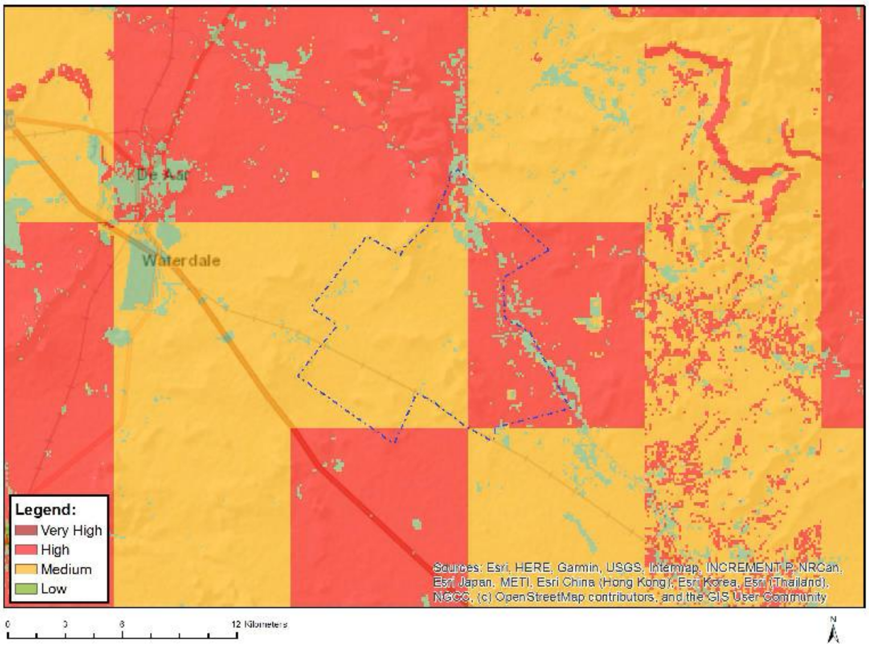
The following methods were used to compile the SSV report:

- Bird distribution data of the South African Bird Atlas 2 (SABAP 2) was obtained from the University of Cape Town, as a means to ascertain which species occur within the broader area i.e., within a block consisting of 9 pentad grid cells within which the proposed project is situated (see Figure 1). A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. From 2007 to date, a total of 20 full protocol lists (i.e., surveys lasting a minimum of two hours each) have been completed for this area. In addition, 29 ad hoc protocol lists (i.e., surveys lasting less than two hours but still yielding valuable data) have been completed.
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa (Taylor *et al.* 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the (2021.3) International Union for Conservation of Nature (IUCN) Red List of Threatened Species (http://www.iucnredlist.org/).
- A classification of the habitat in the Study Area was obtained from the Atlas of Southern African Birds 1 (SABAP 1) (Harrison *et al.* 1997) and the National Vegetation Map (2012 beta2) from the South African National Biodiversity Institute (SANBI) website (Mucina & Rutherford 2006 & http://bgisviewer.sanbi.org). Study Area is the area covered by the land parcels where PV1 – 15 will be located.
- The Important Bird Areas of Southern Africa (Marnewick *et al.* 2015) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- Satellite imagery (Google Earth ©2021) was used in order to view the Study Area on a landscape level and to help identify sensitive bird habitat.
- Priority species were defined as follows:
  - South African Red Data species: High conservation significance
  - South African endemics and near-endemics: High conservation significance
  - Raptors: High conservation significance. Raptors are at the top of the food chain and play a key role in their ecosystems. When populations of birds of prey go down, then the numbers of their prey species go up, creating an imbalance in the ecosystem.
  - Waterbirds: Evidence indicate that waterbirds may be particular susceptible to collisions with solar arrays due to the so-called lake effect, caused by the reflection of the sun of the smooth surface of solar panels.
- The SANBI BGIS map viewer was used to determine the locality of the Study Area relative to National Protected Areas and National Protected Areas Expansion Strategy (NPAES) focus areas.
- The Department of Forestry, Fisheries and the Environment (DFFE) National Screening Tool was used to determine the assigned avian sensitivity of the Study Area.

- Data collected during previous site visits to the broader area was also considered as far as habitat classes and the occurrence of priority species are concerned.
- A Site Sensitivity Verification site visit to the Project Site was conducted on 21 April 2022 during which time the habitat was classified, and all birds were recorded.

Results of site assessment

The Project Site and immediate environment is classified as **Medium** and **High** sensitivity for terrestrial animals according to the Terrestrial Animal Species Theme (Figure 7). The four (4) development areas specifically are all classified as **Medium to High**. The High and Medium sensitivity classifications are linked to Ludwig's Bustard *Neotis ludwigii*, Lanner Falcon *Falco biarmicus*, Verreaux's Eagle *Aquila verreauxii*, Caspian Tern *Hydroprogne caspia* and Tawny Eagle *Aquila rapax*. The Project Site contains confirmed habitat for species of conservation concern (SCC) 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 occurrence of SCC was confirmed during the surveys so far i.e. Martial Eagle *Polemaetus bellicosus* (Globally and Regionally Endangered), Secretarybird *Sagittarius serpentarius* (Globally and Regionally Endangered), Cape Vulture *Gyps coprotheres* (Globally Vulnerable and Regionally Endangered), Lanner Falcon (Regionally Vulnerable), and Tawny Eagle (Globally Vulnerable and Regionally Endangered). Habitat for Ludwig's Bustard was also observed.



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

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Aves-Neotis ludwigii
High	Aves-Falco biarmicus
Low	Subject to confirmation
Medium	Aves-Hydroprogne caspia
Medium	Aves-Neotis ludwigii
Medium	Aves-Aquila rapax
Medium	Aves-Aquila verreauxii

Figure 1: The National Web-Based Environmental Screening Tool map of the project site, indicating sensitivities for the Terrestrial Animal Species theme. The High and Medium sensitivity classifications are linked to Ludwig's Bustard (*Neotis ludwigii*), Lanner Falcon (*Falco biarmicus*), Verreaux's Eagle (*Aquila verreauxii*), Caspian tern (*Hydroprogne caspia*) and Tawny Eagle (Aquila rapax).

Avifauna

A total of 162 species could potentially occur within the broader area where the project is located (see Appendix E). Of these, 76 are classified as priority species for solar developments. Of the 76 priority species, 45 have a medium to high probability of occurring regularly in the Study Area, and 21 of the priority species were recorded during the monitoring thus far. Five Red Data species were recorded during the site surveys, namely Cape Vulture, Lanner Falcon, Martial Eagle, Secretarybird, and Tawny Eagle.

The species recorded during the SSV visit is listed in Table 1.

Table 1: Priority species recorded during the SSV site visit.

Common Name	Scientific Name	Species of Conservation Concern
African Harrier-Hawk	*Polyboroides typus*	-
Amur Falcon	*Falco amurensis*	-
Booted Eagle	*Hieraaetus pennatus*	-
Cape Vulture	*Gyps coprotheres*	EN
Cloud Cisticola	*Cisticola textrix*	-
Egyptian Goose	*Alopochen aegyptiaca*	-
Greater Kestrel	*Falco rupicoloides*	-
Jackal Buzzard	*Buteo rufofuscus*	-
Karoo Prinia	*Prinia maculosa*	-
Lanner Falcon	*Falco biarmicus*	VU
Large-billed Lark	*Galerida magnirostris*	-
Lesser Kestrel	*Falco naumanni*	-
Martial Eagle	*Polemaetus bellicosus*	EN
Melodious Lark	*Mirafra cheniana*	-
Pale Chanting Goshawk	*Melierax canorus*	-
Red-billed Teal	*Anas erythrorhyncha*	-
Secretarybird	*Sagittarius serpentarius*	VU
Sickle-winged Chat	*Emarginata sinuata*	-
Spur-winged Goose	*Plectropterus gambensis*	-
Tawny Eagle	*Aquila rapax*	EN
Yellow-billed Duck	*Anas undulata*	-

Bird Habitat

The following bird habitat features were recorded at and near the Study Area:

Biomes And Vegetation Types

The Study Area is situated on a vast grassy Karoo plain, with its centre approximately 14 km south-east of the town of De Aar in the Northern Cape Province. The Study Area is in the Nama Karoo Biome, in the Upper Karoo Bioregion, with some patches that are classified as Dry Highveld Grassland Bioregion (Mucina & Rutherford 2006). The habitat in the Study Area is highly homogenous and consists of extensive plains with low shrub and a very prominent grass component (see Figures 6 and 7). Mucina & Rutherford (2006) classify the vegetation in the Study Area as Northern Upper Karoo on the plains, with Besemkaree Koppies Shrubland on the ridges. Northern Upper Karoo consist of shrubland dominated by dwarf microphyllous shrubs, with 'white' grasses of the genera *Aristida* and *Eragrostis* (these become prominent especially in the early autumn months after good summer rains, as is the case currently in the Study Area). Besemkaree Koppies Shrubland consist of two-layered karroid shrubland. The lower (closed-canopy) layer is dominated by dwarf small-leaved shrubs and, especially in precipitation-rich years, also by abundant grasses, while the upper (loose canopy) layer is dominated by tall shrubs (Mucina & Rutherford). There are no prominent rivers or drainage lines in the Study Area.

SABAP1 recognises six primary vegetation divisions (biomes) within South Africa, namely (1) Fynbos (2) Succulent Karoo (3) Nama Karoo (4) Grassland (5) Savanna and (6) Forest (Harrison *et al.* 1997). The criteria used by the authors to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations. Using this classification system, the natural vegetation in the Study Area is classified as Grassy Karoo, a sub-category of the Nama Karoo biome. Grassy Karoo can be viewed as a transitional zone between the Nama Karoo and grassland biomes, although also primarily a dwarf shrub habitat, it shows a higher proportion of grass cover (Harrison *et al.* 1997).

The De Aar has an arid climate with hot summers and cold winters. The average temperature during summer is 24.3 °C (January) and 9.1 °C during winter (June) (SA Atlas of Climatology and Agrohydrology, Schulze, 2009). The average annual precipitation is about 280 mm, with most rainfall occurring during summer and autumn. De Aar experiences frost during the winter with 25.4 frost days per year on average (SA Atlas of Climatology and Agrohydrology, Schulze, 2009).

1) <u>Karoo Shrubland</u>

Figures 2 and 3 illustrate the typical grassy Karoo Shrubland habitat in the Study Area.

Figure 2: Typical Karoo shrubland on the plains in the Study Area.

Figure 3: Clumps of grass interspersed with low shrubs in the Study Area.

2) Drainage Lines and Wetlands

There is a large riverine and wetland system in the north/north-eastern corner of the Study Area (Figure 4). This habitat feature is most likely very important feeding, breeding, and nesting habitat for several priority and non-priority species, especially waterbirds.

Figure 4: Riverine and wetland habitat in the north of the Study Area. Study Area boundary indicated in white.

3) Water Reservoirs and Dams

Surface water is of specific importance to avifauna in this arid Study Area. The Study Area contains man-made dams (ground dams) and water reservoirs (Figure 5 and 6). Boreholes with open water troughs are important sources of surface water for priority avifauna for drinking and bathing.

Figure 5: One of the earthen dams in the Study Area.

Figure 6: One of several water reservoirs present in the Study Area.

4) Alien Trees

The Study Area is generally devoid of trees, except for isolated clumps of trees at homesteads and boreholes, where a mixture of alien and indigenous trees is growing (Figure 7). The trees could attract a variety of bird species for the purposes of nesting and roosting.

Figure 7: A stand of alien tree species at a farm homestead in the Study Area.

5) High voltage lines

High voltage lines are an important potential roosting and breeding substrate for large raptors in the Karoo (Jenkins *et al*. 2013). A high voltage line bisects the Study Area (Figure 8). There is increasing evidence that vultures are using high voltage lines in the Karoo (personal observation), mostly in the non-breeding season (January to March), and that they could be encountered anywhere in the broader area.

Figure 8: Jackal Buzzard nest on high voltage powerline pylon in the Study Area.

6) Rocky Ridges

The Study Area contains one prominent ridge (koppie) known as Rietfontein in the south-eastern corner of the Study Area, which rises to a height of 1352 m/asl. There is also a prominent ridgeline in the north-west of the Study Area (Wachteenbeetje 1466 m/asl). There are a number of other ridges in the broader area too. Ridges provide important habitat for several bird species, especially raptors, who use these areas for foraging (Figure 9).

Figure 9: Rocky ridges present in the Study Area.

<u>Conclusion</u>

Based on the available SABAP2 data and the Site Sensitivity Verification survey conducted on 21 April 2022, the classification of **High** sensitivity for avifauna in the screening tool is therefore confirmed for all four PV buildable areas. None of the Development Areas has a specific habitat feature that distinguishes it from the other Development Areas which would justify a lesser rating.