AVIFAUNAL IMPACT ASSESSMENT: SCOPING

Proposed construction and operation of the 100 MW Vrede Photovoltaic Solar Energy Facility, Battery Energy Storage System (BESS) and associated infrastructure located near Kroonstad in the Free State Province

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EXECUTIVE SUMMARY

South Africa Mainstream Renewable Power Developments (Pty) Ltd is proposing the construction and operation of the 100 MW Vrede Solar Photovoltaic (PV) Facility and Battery Energy Storage System (BESS), near the town of Kroonstad in the Moqhaka Local Municipality (Fezile Dabi District) of the Free State Province of South Africa.

The proposed PV facility will be connecting to the grid via a 132kV grid connection, which is the subject of a separate EA. This bird scoping assessment report deals only with the proposed 100 MW Vrede Solar Photovoltaic (PV) Facility and the associated infrastructure thereof.

1. Impacts

The anticipated impacts were summarized, and a comparison made between pre-and post-mitigation phases as shown in the Table below. The rating of environmental issues associated with different parameters prior to and post mitigation of a proposed activity was averaged. A comparison was then made to determine the effectiveness of the proposed mitigation measures. The comparison identified critical issues related to the environmental parameters.

Environmental parameter	**Issues**	**Anticipated rating prior to mitigation**	**Anticipated rating post mitigation**
Avifauna	*Displacement of priority species due to disturbance associated with construction of the PV plant and associated infrastructure.*	40 medium	30 medium
	Displacement of priority species due to habitat transformation associated with construction of the PV plant and associated infrastructure.	52 medium	44 medium
	Mortality of priority species due to collisions with solar panels	21 low	21 low
	Entrapment of large-bodied birds in the double perimeter fence	21 low	7 low
	Mortality of priority species due to electrocution on the 33kV internal reticulation network	56 medium	11 low

	Cumulative impact of displacement due to construction and habitat transformation, collisions with solar panels and entrapment in fences	44 medium	28 low
	Average	**39 medium**	**20 low**

2. Environmental sensitivities

The following environmental sensitivities were identified from an avifaunal perspective:

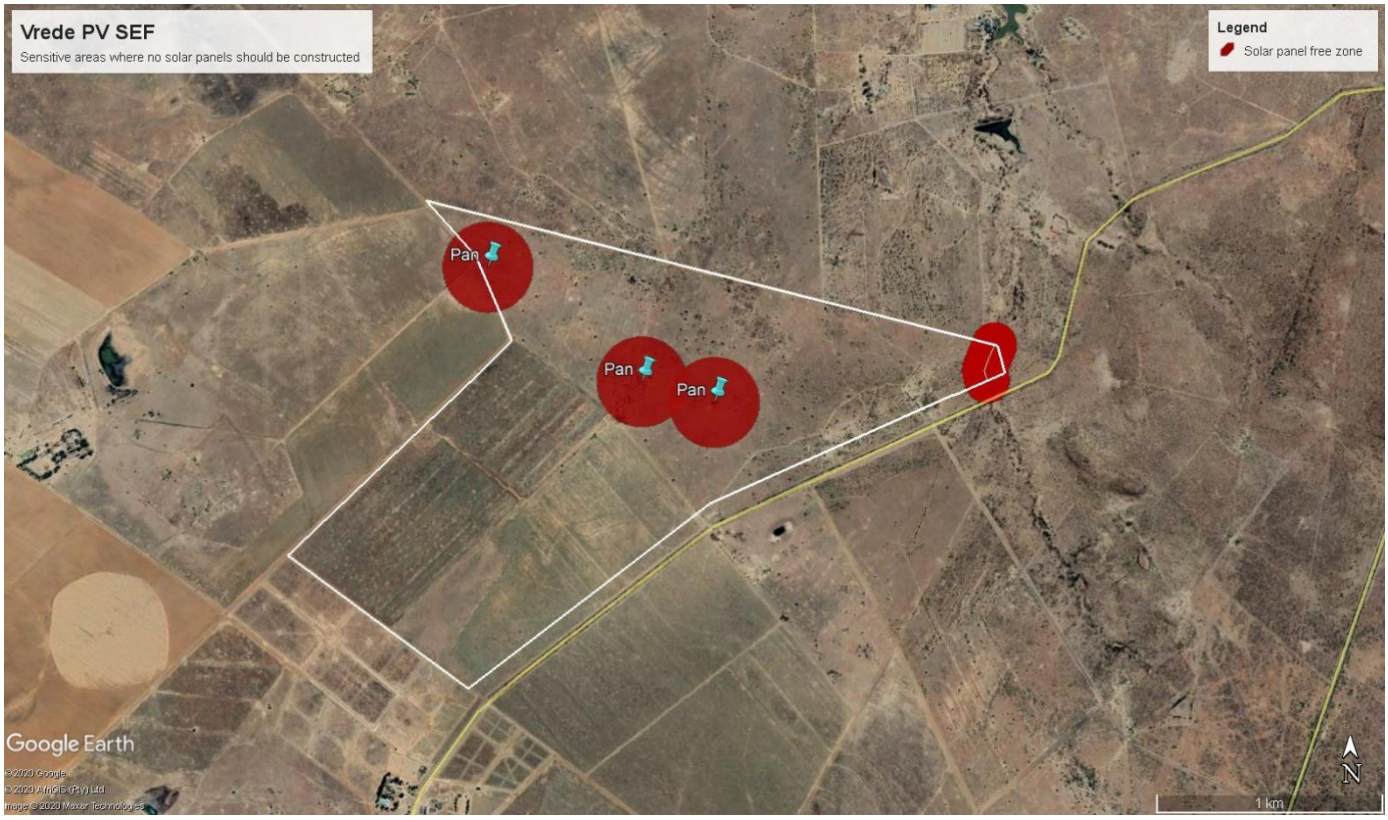
- **Surface water: Very High sensitivity (No solar panels – other infrastructure allowed)**

  Included are areas within 200m of the pans on the development area. It is important to leave open space for birds to access and leave the surface water area unhindered. Surface water is also important area for raptors to hunt birds which congregate around water troughs, and they should have enough space for fast aerial pursuit.

- **Drainage line woodland: Very High sensitivity (No solar panels – other infrastructure allowed)**

  Drainage lines are corridors of woodland which provide nesting and foraging opportunities for woodland species which are dependent on this habitat for their survival. The majority of thew woodland and trees at the development area is concentrated around the drainage line. A 100m buffer zone should be implemented on both side of the drainage channel.

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



3. Conclusions

The proposed 100 MW Vrede Photovoltaic (PV) Solar Energy Facility will have an anticipated medium negative impact on priority avifauna, which is expected to be reduced to low with appropriate mitigation. No fatal flaws are expected to manifest in the course of the investigations.

The cumulative impact of the facility on priority avifauna within a 30km radius around the proposed development is also anticipated to be low, mainly due to the small size of the proposed development, and the small number of additional renewable energy projects.

CONTENTS

DETAILS OF THE SPECIALIST AND EXPERTISE TO COMPILE A SPECIALIST REPORT

Chris van Rooyen (Bird Specialist)

Chris has 22 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.

Jason Boyce (Field Monitor)

Jason is the owner of Jason Boyce Birding, a company specialising in custom made birding tours. He has a BSc Environmental Management from (Zoology) from UNISA. Prior to starting his own company in 2019, he was a senior tour leader and bird guide with Birding Ecotours for 7 years, working in Africa, Asia and Europe.

SPECIALIST DECLARATION

I, Chris van Rooyen as duly authorised representative of Chris van Rooyen Consulting, and working under the supervision of and in association with Albert Froneman (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003, hereby confirm my independence (as well as that of Chris van Rooyen Consulting) as a specialist and declare that neither I nor Chris van Rooyen Consulting have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Savannah Environmental was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Basic Assessment for the proposed Leeuwbosch PV Facility.

Full Name: Chris van Rooyen

Position: Director

National Environmental Management Act, 1998 (Act No. 107 of 1998) and Environmental Impact Regulations 2014 (as amended) Requirements for Specialist Reports (Appendix 6)

Section in EIA Regulations 2014 (as amended)		Clause	Section in Report
Appendix 6	(1)	A specialist report prepared in terms of these Regulations must contain —	
	(a)	details of –	
		(i) the specialist who prepared the report; and	Pg.5
		(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae.	Pg.5
	(b)	A declaration that the person is independent in a form as may be specified by the competent authority;	Pg.5
	(c)	An indication of the scope of, and the purpose for which, the report was prepared;	Section 2
	(cA)	An indication of the quality and age of base data used for the specialist report;	Section 3
	(cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 8
	(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 7
	(e)	A description of the methodology adopted in preparing the report or carrying out the specialised process; inclusive of equipment and modelling used;	Section 3
	(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Sections 6 - 9
	(g)	An indication of any areas to be avoided, including buffers;	Not applicable
	(h)	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Not applicable
	(i)	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4
	(j)	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities;	Sections 9 and 10
	(k)	Any mitigation measures for inclusion in the EMPr;	Section 9
	(l)	Any conditions for inclusion in the environmental authorization;	Section 9
	(m)	Any monitoring requirements for inclusion in the EMPr or environmental authorization;	Not applicable
	(n)	A reasoned opinion –	

		(i) as to whether the proposed activity, activities or portions thereof should be authorized;	Sections 9 -10
		(iA) regarding the acceptability of the proposed activity or activities; and	Sections 9 -10
		(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorized, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 10
	(o)	A description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 3
	(p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	No comments received
	(q)	Any other information requested by the authority.	Not applicable
	(2)	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Not applicable

1. INTRODUCTION

South Africa Mainstream Renewable Power Developments (Pty) Ltd is proposing the construction and operation of the 100 MW Vrede Solar Photovoltaic (PV) Facility and Battery Energy Storage System (BESS), near the town of Kroonstad in the Moqhaka Local Municipality (Fezile Dabi District) of the Free State Province of South Africa. The proposed development traverses two (2) farm parcels namely:

- Farm Vrede, No. 1152, Remaining Extent;
- Farm Uitval, No 1104, portion 1;

The proposed PV facility will be connecting to the grid via a 132kV grid connection which is the subject of a separate EA. This bird impact assessment report deals only with the proposed 100 MW Vrede Photovoltaic (PV) Solar PV Facility, and the associated infrastructure thereof.

1.1 Project details

The proposed project will consist of the following components include:

Solar Field:

- Solar Arrays:
  - Solar Panel Technology - Mono and Bifacial Photovoltaic (PV) Modules;
  - Mounting System Technology – single axis tracking, dual axis tracking or fixed axis tracking PV;
  - Underground cabling (up to 33kV)
  - Centralised inverter stations or string inverters;
  - Power Transformers;
- Building Infrastructure
  - Offices;
  - Operational control centre;
  - Operation and Maintenance Area / Warehouse / workshop;
  - Ablution facilities;
  - Battery Energy Storage Facility;
  - Substation building.
- Electrical Infrastructure
  - 33/132kV onsite substation including associated equipment and infrastructure
  - Underground cabling and overhead power lines (up to 33kV)
- Associated Infrastructure:
  - Access roads and Internal gravel roads;
  - Fencing and lighting;
  - Lightning protection
  - Permanent laydown area;
  - Temporary construction camp and laydown area;
  - Telecommunication infrastructure
  - Stormwater channels; and water pipelines

The size of the land parcels is 538 ha and the development footprint will be approximately 195ha (subject to change depending on the final layout however). An alternative site was also identified, however, it is used as game camp and is not the landowner’s preference.

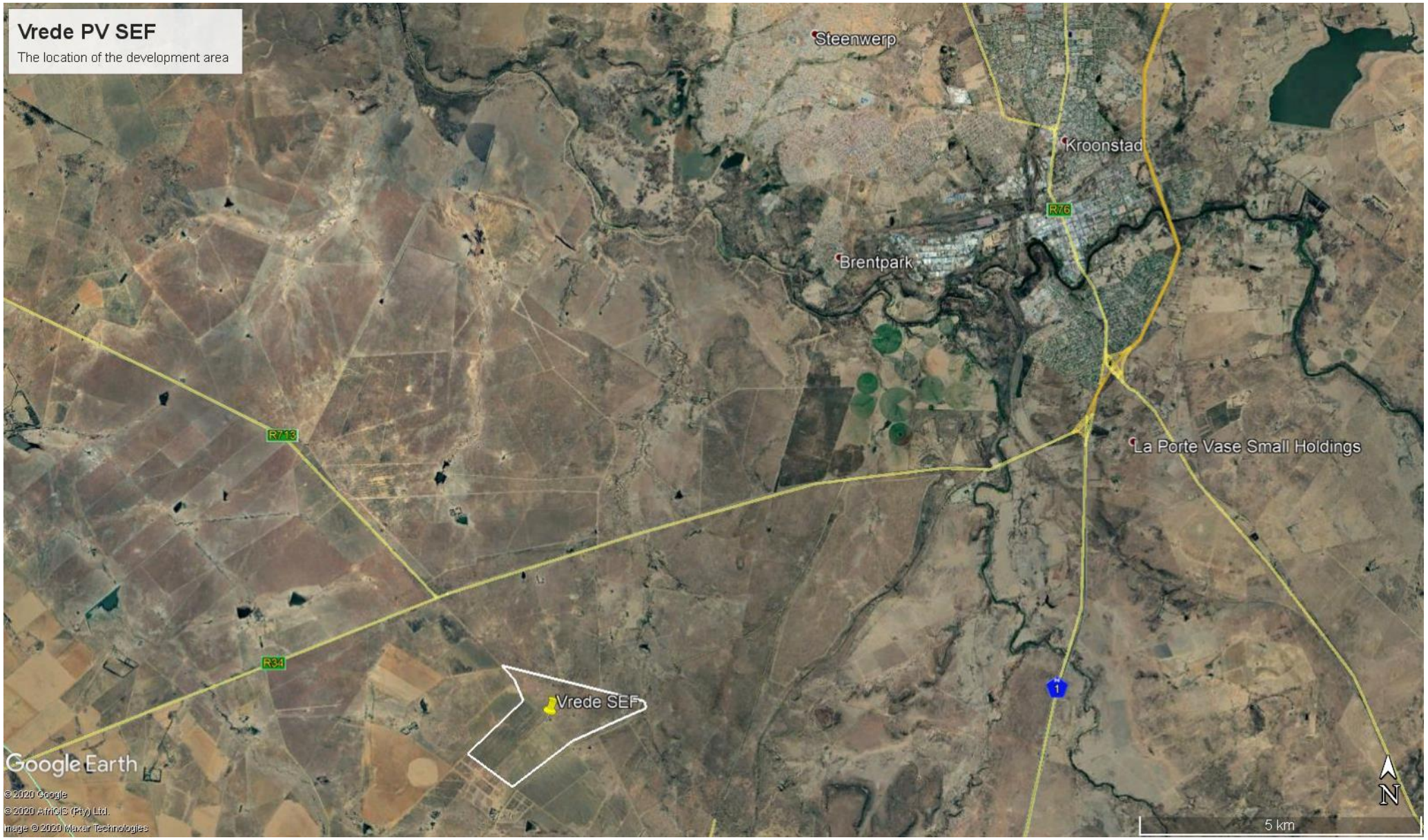


Figure 1: Locality map of the development area of the proposed 100 MW Vrede Solar Photovoltaic (PV) Facility

Figure 2: Close-up of proposed 100 MW Vrede Solar Photovoltaic (PV) Facility development area.

2 PROJECT SCOPE

The purpose of the Scoping Report is to determine the main issues and potential impacts of the proposed project/s during the scoping phase at a desktop level based on existing information, or field assessments as required:

- Describe the affected environment from an avifaunal perspective
- Discuss gaps in baseline data and other limitations
- List 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 and operational phases.
- Identify 'No-Go' areas, where applicable.
- Summarise the potential impacts that will be considered further in the EIA Phase through specialist assessments.
- Recommend mitigation measures to reduce the impact of the expected impacts.

3 OUTLINE OF METHODOLOGY AND INFORMATION REVIEWED

The following information sources were consulted to conduct this study:

- Bird distribution data from the Southern African Bird Atlas Project 2 (SABAP 2) was obtained (http://sabap2.adu.org.za/), in order to ascertain which species occur in the pentads where the proposed development is located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5' × 5'). Each pentad is approximately 8 × 7.6 km. To get a more representative impression of the birdlife, a consolidated data set was obtained for a total of 6 pentads some of which intersect and others that are near the development area. The decision to include multiple pentads around the development are was influenced by the fact that many of the pentads in the area have few completed full protocol surveys. The additional pentads and their data augment the bird distribution data. The 6 pentad grid cells are the following: 2735_2705, 2735-_710, 2740_2705, 2740_2710, 2745_2705, AND 2745_2710 (see Figure 33). A total of 57 full protocol lists (i.e. bird listing surveys lasting a minimum of two hours each) and 63 ad hoc protocol lists (surveys lasting less than two hours but still yielding valuable data) have been completed to date for the 6 pentads where the development area is located. The SABAP2 data was therefore regarded as a reliable reflection of the avifauna which occurs in the area, but the data was also supplemented by data collected during the site surveys and general knowledge of the area.
- A classification of the vegetation types in the development area was obtained from the Atlas of Southern African Birds 1 (SABAP1) and the National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006).
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa, Lesotho and Swaziland (Taylor *et al.* 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the latest (2020.2) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- The Important Bird and Biodiversity Areas of South Africa (Marnewick *et al.* 2015; http://www.birdlife.org.za/conservation/important-bird-areas) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- An intensive internet search was conducted to source information on the impacts of solar facilities on avifauna.
- Satellite imagery (Google Earth © 2020) was used in order to view the broader area on a landscape level and to help identify bird habitat on the ground.
- The South African National Biodiversity BGIS map viewer was used to determine the locality of the development area relative to National Protected Areas, National Protected Areas Expansion Strategy (NPEAS) focus areas and Critical Biodiversity Areas in the North-West Province.

- The DEFF National Screening Tool was used to determine the assigned avian sensitivity of the development area.
- The BirdLife South Africa (BLSA) Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa. BirdLife South Africa by Jenkins, A.R., Ralston-Patton, Smit- Robinson, A.H. 2017 (hereafter referred to as the Solar Guidelines) were consulted to determine the level of survey effort that is required.
- A one-day site visit was conducted on 17 July 2020 and again from 20 – 22 July 2020. During the latter, data was collected by means of transect and incidental counts.

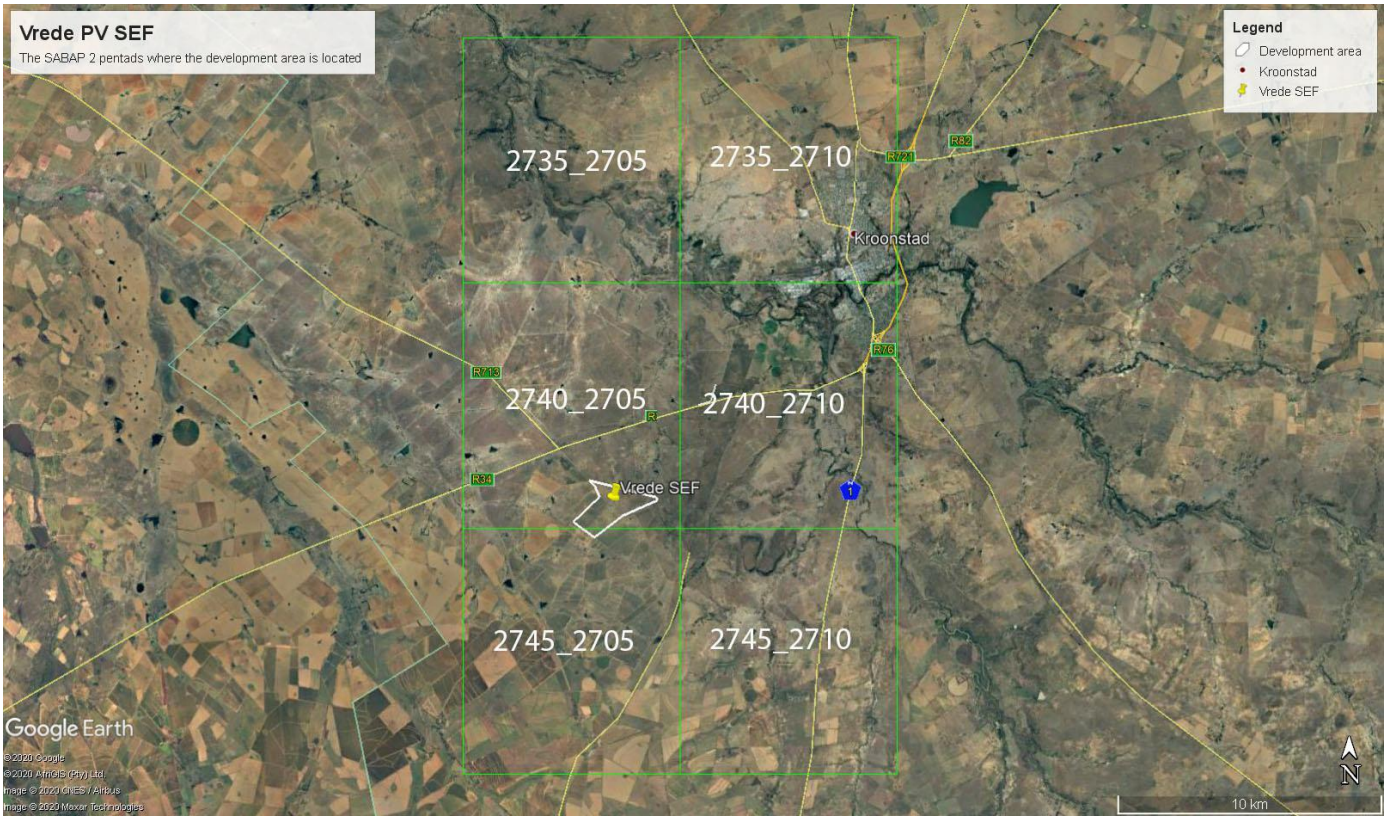


Figure 3: Area covered by the six SABAP2 pentads.

4 ASSUMPTIONS AND LIMITATIONS

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

- The focus of the study is primarily on the potential impacts on priority species which were defined as follows:
  - South African Red Data species;
  - South African endemics and near-endemics;
  - Waterbirds; and
  - Raptors
- The impact of solar installations on avifauna is a new field of study, with only one published scientific study on the impact of PV facilities on avifauna in South Africa (Visser et al. 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.
- The assessment of impacts is based on the baseline environment as it currently exists in the development area.
- Cumulative impacts include all solar PV projects within a 30km radius that currently have open applications or have been approved by the Competent Authority as per the 2020 Q2 database from the DEFF.
- Conclusions in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will be valid under all circumstances.

- The site was classified as a Low Sensitivity site as defined in the Solar Guidelines, requiring a Regime 1 protocol to be followed for data collection i.e. a minimum of one site visit of 1 to 5 days in duration.
- The project site is defined as the remaining extent of the farm Vrede No. 1152 and Portion 1 of the farm Uitval No. 1104, which combined have the extent of ~ 538ha.
- The development area is that identified area (located within the project site) where the Vrede Solar PV Facility is planned to be located. This area has been selected as a practicable option for the facility, considering technical preference and constraints. The development area is ~279ha in extent.
- The development footprint is the defined area (located within the development area) where the PV panel array and other associated infrastructure for the Vrede PV facility is planned to be constructed. This is the anticipated actual footprint of the facility, and the area which would be disturbed. The exact size of this area is subject to finalisation of the layout, however is anticipated to be 195ha.

5 LEGISLATIVE CONTEXT

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

5.1 Agreements and conventions

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

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

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

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

	international cooperation for the conservation and wise use of wetlands and their resources.	
Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia	The Signatories will aim to take co-ordinated measures to achieve and maintain the favourable conservation status of birds of prey throughout their range and to reverse their decline when and where appropriate.	Regional

5.2 National legislation

5.2.1 Constitution of the Republic of South Africa, 1996

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

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

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

  (i) prevent pollution and ecological degradation;

  (ii) promote conservation; and

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

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

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

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 Free State Province is the Nature Conservation Ordinance 8 of 1969. There are no specific regulations pertaining to the conservation of avifauna, except to classify all birds as wild animals with the exception of a list of species in Schedule 1, which is exempted from a general hunting ban.

6 BASELINE ASSESSMENT

6.1 Important Bird Areas

There are no Important Bird Areas (IBA) within a 60km radius around the proposed Vrede SEF. It is therefore highly unlikely that the proposed development will have a negative impact on any IBA.

6.2 Critical Biodiversity Areas (CBAs)

The part of the northern section of the development area is classified as a CBA, but the majority is classified as degraded.

6.3 DEFF National Screening Tool

The DEFF National Screening Tool classifies parts of the development area as highly sensitive from an avifaunal perspective, due to the presence of wetlands. However, when the classification is further interrogated, it seems to be applicable to bats and not birds. The site investigations revealed that the development area is not highly sensitive from an avifaunal perspective, with the exception of three small natural pans.

6.4 National Protected Areas Expansion Strategy (NPEAS) focus areas

The development area does not form part of a NPEAS focus area.

6.5 Biomes and vegetation types

The development area is situated approximately 12-13km south-west of the town of Kroonstad, in the Free State Province, and is located in the grassland biome, in the Dry Highveld Grassland Bioregion (Mucina & Rutherford 2006). Two vegetation types occur in the development area, namely Central Free State Grassland, and Vaal-Vet Sandy Grassland (Mucina & Rutherford 2006). Central Free State Grassland occurs on undulating plains supporting short grassland, in natural condition dominated by *Themeda triandra* while *Eragrostis curvula* and *E. chloromelas* become dominant in degraded habitats. Dwarf karoo bushes establish in severely degraded clayey bottomlands. Overgrazed and trampled low-lying areas with heavy clayey soils are prone to *Vachellia karroo* encroachment. Vaal-Vet Sandy Grassland consists mainly of low-tussock grasslands with an abundant karroid element. Dominance of *Themeda triandra* is an important feature of this vegetation unit. Locally low cover of *T. triandra* and the associated increase in *Elionurus muticus*, *Cymbopogon pospischilii* and *Aristida congesta* is attributed to heavy grazing and/or erratic rainfall. These vegetation types occur in the summer-rainfall seasonal precipitation region, with a mean annual precipitation of 530 - 560 mm. Much of the rainfall is of convectional origin and peaks in December to January. Incidence of frost relatively high (37 - 43 days on average) (Mucina & Rutherford 2006). January is the warmest month of the year. The temperature in January averages 22.4 °C. The lowest average temperatures in the year occur in June, when it is around 8.8 °C[2].

Whilst the distribution and abundance of the bird species in the development area are typical of the broad vegetation type, it is also necessary to examine bird habitats in more detail as it may influence the distribution and behaviour of priority species. These are discussed in more detail below. The priority species most likely associated with the various bird habitats are listed in Table 2.

6.6 Bird habitats

[2] https://en.climate-data.org/

6.6.1 Grassland

The development area consists mainly of medium-tall, dense, grassland with scattered clumps of *Vachellia* sp. trees and shrubs. The southern section of the development area consists of old lands with severely degraded grassland cover.

6.6.2 Woodland

The development area contains scattered areas of thorny shrubs and trees. One small ephemeral drainage line bisects the north-eastern corner of the development area, with a length of approximately 150m situated within the development area. Drainage lines are important corridors for woodland species because the woodland along the banks is a refuge for woodland species. The largest concentration of shrubs and a few small trees in the development area is found along the banks of the drainage line.

6.6.3 Pans

The development area contains three small pans. When the pans hold water (which is only likely after sustained rainfall events), it may temporarily attract a variety of waterbirds, as well as other birds which use them to drink and bath. Sources of surface water are major attractants to birds.

6.6.4 Fences

The development area contains a number of fences. Farm fences provide important perching substrate for a wide range of birds, as a staging post for territorial displays by small birds and also for perch hunting by some raptors.

See Appendix 2 for photographic record of the habitat in the development area.

7 AVIFAUNA IN THE DEVELOPMENT AREA

7.1 South African Bird Atlas Project 2

The SABAP2 data indicates that a total of 192 bird species could potentially occur within the development area and immediate surroundings – Appendix 1 provides a comprehensive list of all the species. Of these, 67 species are classified as priority species (see definition of priority species in section 4) and 2 of these are South African Red Data species. Of the priority species, 11 are likely to occur regularly at the development area, and another 17 could occur sporadically.

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

- NT = Near threatened
- End = South African Endemic
- N-End = South African near endemic
- H = High
- M = Medium
- L = Low

Priority species with a high likelihood of occurrence on site included the Amur Falcon (Falco amurensis), Black-winged Kite (Elanus caeruleus), Lesser Kestrel (Falco naumanni), Black-headed Heron (Ardea melanocephala), Blacksmith Lapwing (Vanellus armatus), Cape White-eye (Zosterops virens), Egyptian Goose (Alopochen aegyptiacus), Fiscal Flycatcher (Sigelus silens), Hadeda Ibis (Bostrychia hagedash), Three-banded Plover (Charadrius tricollaris), and the Western Cattle Egret (Bubulcus ibis). Only these, only the Western Cattle Egret (Bubulcus ibis), Fiscal Flycatcher

(Sigelus silens), Egyptian Goose (Alopochen aegyptiacus) and the Blacksmith Lapwing (Vanellus armatus) were actually observed during the avifaunal field assessment.

Of the priority species with moderate likelihood of occurrence on site, only the Pale Chanting Goshawk (Melierax canorus), Fairy Flycatcher (Stenostira scita) and South African Shelduck (Tadorna cana) where observed during the avifaunal field assessment.

A strong preference for surface water habitats are shown across the priority species, with roughly equal utilisation of the grassland and woodland habitats (Table 2).

The species of greatest abundance as determined by on site observations, was that of the Egyptian Goose, followed by the Fiscal Flycatcher, following which the South African Shelduck and the Fairy Flycatcher shared equal abundance values. Furthermore, the Egyptian Goose and Fiscal Flycatcher distribution was fairly widespread across the development area. Transect counts recorded the greatest number of Egyptian Goose individuals on site, as compared to all other priority species, which was therefore the most abundant priority species on site. Incidental counts indicated 25 counts of Greater Flamingo in the broader project area, however these were not observed within the development area.

Table 2: Priority species potentially occurring at the site and immediate surroundings.

Species	Taxonomic name	Full protocol	Ad hoc protocol	Solar priority species	Red Data status: International	Red Data status: Regional	Endemic/near endemic - South Africa	Raptor	Waterbird	Possibility of regular occurrence	Recorded during surveys: Vrede	Grassland	Woodland	Surface water	Fences	PV panel collisions	Displacement - disturbance	Displacement - habitat loss	Entrapment in fences	Electrocution on 33kV OHL
Amur Falcon	*Falco amurensis*	28.07	4.76	x				x		H		x			x	x		x		
Black-winged Kite	*Elanus caeruleus*	45.61	9.52	x				x		H		x			x	x		x		
Lesser Kestrel	*Falco naumanni*	35.09	1.59	x			x	x		H		x			x	x		x		
Black-headed Heron	*Ardea melanocephala*	47.37	6.35	x					x	H		x		x					x	x
Blacksmith Lapwing	*Vanellus armatus*	87.72	11.11	x					x	H	x			x						
Cape White-eye	*Zosterops virens*	35.09	1.59	x			x			H			x			x	x	x		
Egyptian Goose	*Alopochen aegyptiacus*	49.12	1.59	x					x	H	x			x						x
Fiscal Flycatcher	*Sigelus silens*	42.11	0.00	x			x			H	x		x		x	x	x	x		
Hadeda Ibis	*Bostrychia hagedash*	84.21	11.11	x					x	H				x						x
Three-banded Plover	*Charadrius tricollaris*	26.32	0.00	x					x	H				x						
Western Cattle Egret	*Bubulcus ibis*	77.19	19.05	x					x	H	x	x		x						x
African Fish-eagle	*Haliaeetus vocifer*	1.75	0.00	x				x	x	L				x						x
African Harrier-Hawk	*Polyboroides typus*	3.51	0.00	x				x		L			x		x	x				x
Black Sparrowhawk	*Accipiter melanoleucus*	1.75	0.00	x				x		L			x					x		x
Gabar Goshawk	*Melierax gabar*	1.75	0.00	x				x		L			x			x		x		
Red-footed Falcon	*Falco vespertinus*	1.75	0.00	x				x		L		x			x	x		x		
African Black Duck	*Anas sparsa*	1.75	0.00	x					x	L				x						
African Darter	*Anhinga rufa*	10.53	0.00	x					x	L				x						
African Openbill	*Anastomus lamelligerus*	1.75	0.00	x					x	L				x						
African Snipe	*Gallinago nigripennis*	7.02	0.00	x					x	L				x						
African Spoonbill	*Platalea alba*	7.02	0.00	x					x	L				x						
Black-necked Grebe	*Podiceps nigricollis*	1.75	0.00	x					x	L				x						
Black-winged Stilt	*Himantopus himantopus*	12.28	0.00	x					x	L				x						
Blue Korhaan	*Eupodotis caerulescens*	1.75	1.59	x	NT	LC	x			L		x					x		x	
Cape Shoveler	*Anas smithii*	8.77	0.00	x					x	L				x						
Cape Teal	*Anas capensis*	1.75	0.00	x					x	L				x						
Cape Weaver	*Ploceus capensis*	1.75	0.00	x			x			L			x			x	x	x		
Common Greenshank	*Tringa nebularia*	1.75	0.00	x					x	L				x						
Common Moorhen	*Gallinula chloropus*	22.81	0.00	x					x	L				x						
Common Sandpiper	*Actitis hypoleucos*	1.75	0.00	x					x	L				x						
Fulvous Duck	*Dendrocygna bicolor*	10.53	0.00	x					x	L				x						
Glossy Ibis	*Plegadis falcinellus*	12.28	0.00	x					x	L				x						

Species	Taxonomic name	Full protocol	Ad hoc protocol	Solar priority species	Red Data status: International	Red Data status: Regional	Endemic/near endemic - South Africa	Raptor	Waterbird	Possibility of regular occurrence	Recorded during surveys: Vrede	Grassland	Woodland	Surface water	Fences	PV panel collisions	Displacement - disturbance	Displacement - habitat loss	Entrapment in fences	Electrocution on 33kV OHL
Goliath Heron	*Ardea goliath*	1.75	0.00	x					x	L				x						
Greater Flamingo	*Phoenicopterus ruber*	1.75	1.59	x	LC	NT			x	L				x						
Kittlitz's Plover	*Charadrius pecuarius*	3.51	0.00	x					x	L				x						
Lesser Flamingo	*Phoenicopterus minor*	1.75	0.00	x	NT	NT			x	L				x						
Little Stint	*Calidris minuta*	3.51	0.00	x					x	L				x						
Maccoa Duck	*Oxyura maccoa*	1.75	0.00	x					x	L				x						
Malachite Kingfisher	*Alcedo cristata*	15.79	0.00	x					x	L				x						
Marsh Sandpiper	*Tringa stagnatilis*	1.75	0.00	x					x	L				x						
Melodious Lark	*Mirafra cheniana*	1.75	0.00	x			x			L		x			x	x	x			
Pied Avocet	*Recurvirostra avosetta*	1.75	0.00	x					x	L				x						
Pied Kingfisher	*Ceryle rudis*	1.75	0.00	x					x	L				x						
Purple Heron	*Ardea purpurea*	8.77	0.00	x					x	L				x						
Reed Cormorant	*Phalacrocorax africanus*	43.86	3.17	x					x	L				x						
Southern Pochard	*Netta erythrophthalma*	10.53	0.00	x					x	L				x						
Whiskered Tern	*Chlidonias hybrida*	3.51	0.00	x					x	L				x						
White Stork	*Ciconia ciconia*	1.75	0.00	x					x	L		x		x					x	x
White-breasted Cormorant	*Phalacrocorax carbo*	28.07	1.59	x					x	L				x						
Common Buzzard	*Buteo vulpinus*	7.02	0.00	x			x	x		M		x			x	x		x		x
Greater Kestrel	*Falco rupicoloides*	3.51	0.00	x				x		M		x			x	x		x		x
Marsh Owl	*Asio capensis*	7.02	0.00	x				x		M		x			x	x	x	x		x
Pale Chanting Goshawk	*Melierax canorus*	5.26	0.00	x				x		M	x	x	x		x	x	x	x		x
African Sacred Ibis	*Threskiornis aethiopicus*	26.32	0.00	x					x	M				x						
Fairy Flycatcher	*Stenostira scita*	5.26	0.00	x			x			M	x		x			x	x	x		
Grey Heron	*Ardea cinerea*	14.04	1.59	x					x	M				x						x
Little Egret	*Egretta garzetta*	12.28	0.00	x					x	M				x						
Little Grebe	*Tachybaptus ruficollis*	38.60	1.59	x					x	M				x						
Pied Starling	*Spreo bicolor*	5.26	1.59	x			x			M		x			x	x				
Red-billed Teal	*Anas erythrorhyncha*	28.07	0.00	x					x	M				x						
Red-knobbed Coot	*Fulica cristata*	59.65	7.94	x					x	M				x						
South African Cliff-swallow	*Hirundo spilodera*	26.32	6.35	x			x			M		x				x				
South African Shelduck	*Tadorna cana*	7.02	0.00	x			x		x	M	x			x						
Spur-winged Goose	*Plectropterus gambensis*	24.56	3.17	x					x	M				x						x
White-faced Duck	*Dendrocygna viduata*	33.33	0.00	x					x	M				x						
Yellow-billed Duck	*Anas undulata*	68.42	1.59	x					x	M				x						

7.2 On-site surveys

On-site surveys were conducted from 20 - 22 July 2020 by means of transect counts. The methodology which was followed to record the avifauna is explained in Appendix 3.

The abundance of avifauna recorded during the transect and incidental counts are displayed in Figures 4 to 6. The location of all recorded priority species is displayed in Figure 7.

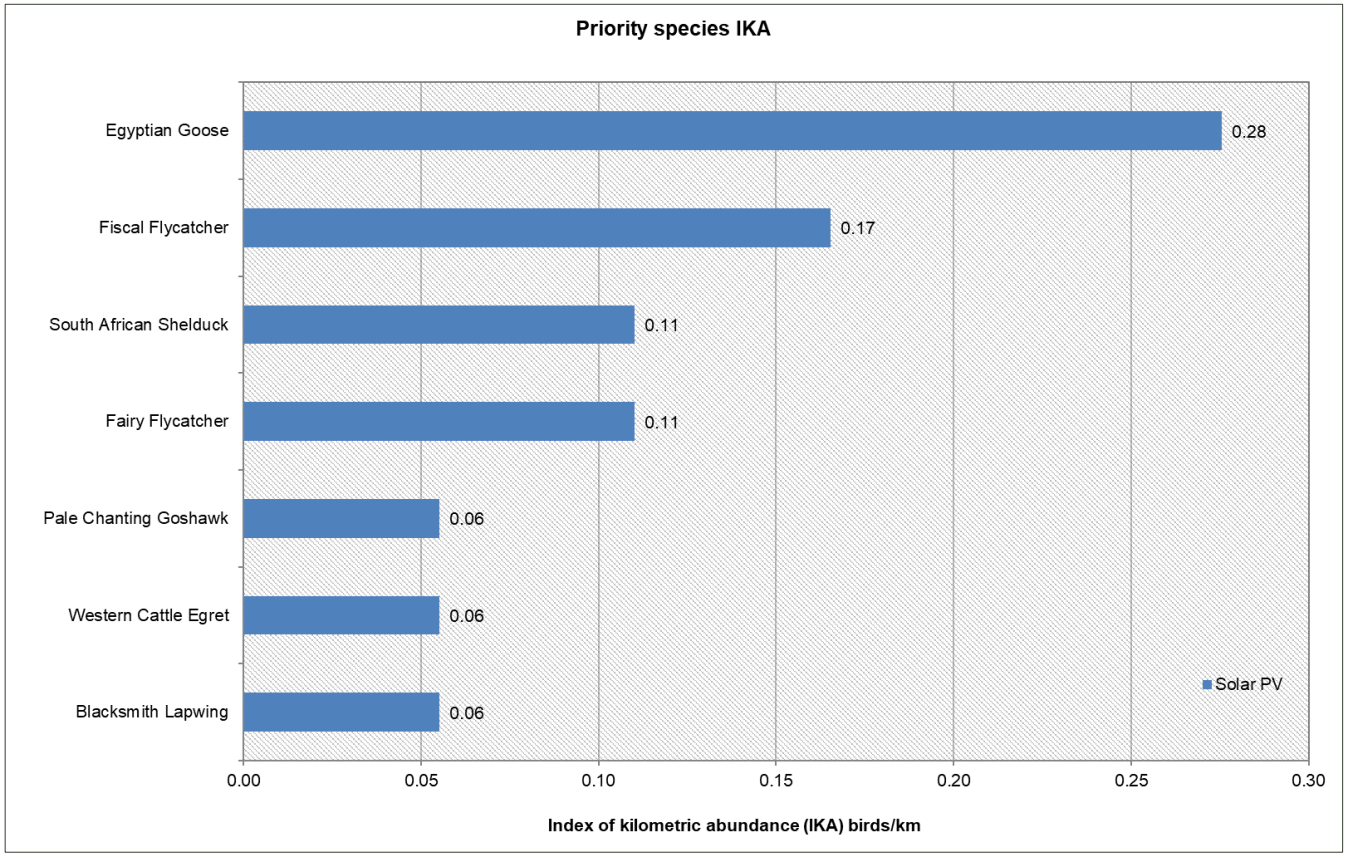


Figure 4: Index of kilometric abundance (IKA) for all priority species recorded by means of transect counts during the surveys in the study area, conducted in July 2020.

The number of incidental records of priority species within a 10km radius around the development area is listed in Figure 5 below.

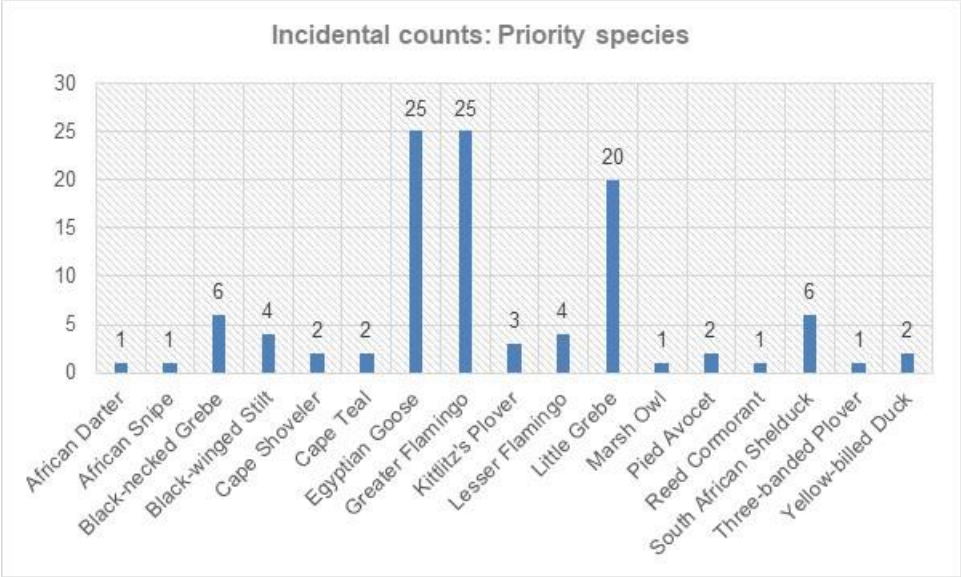


Figure 5: Incidental counts of priority species within a 10km radius around the development area.

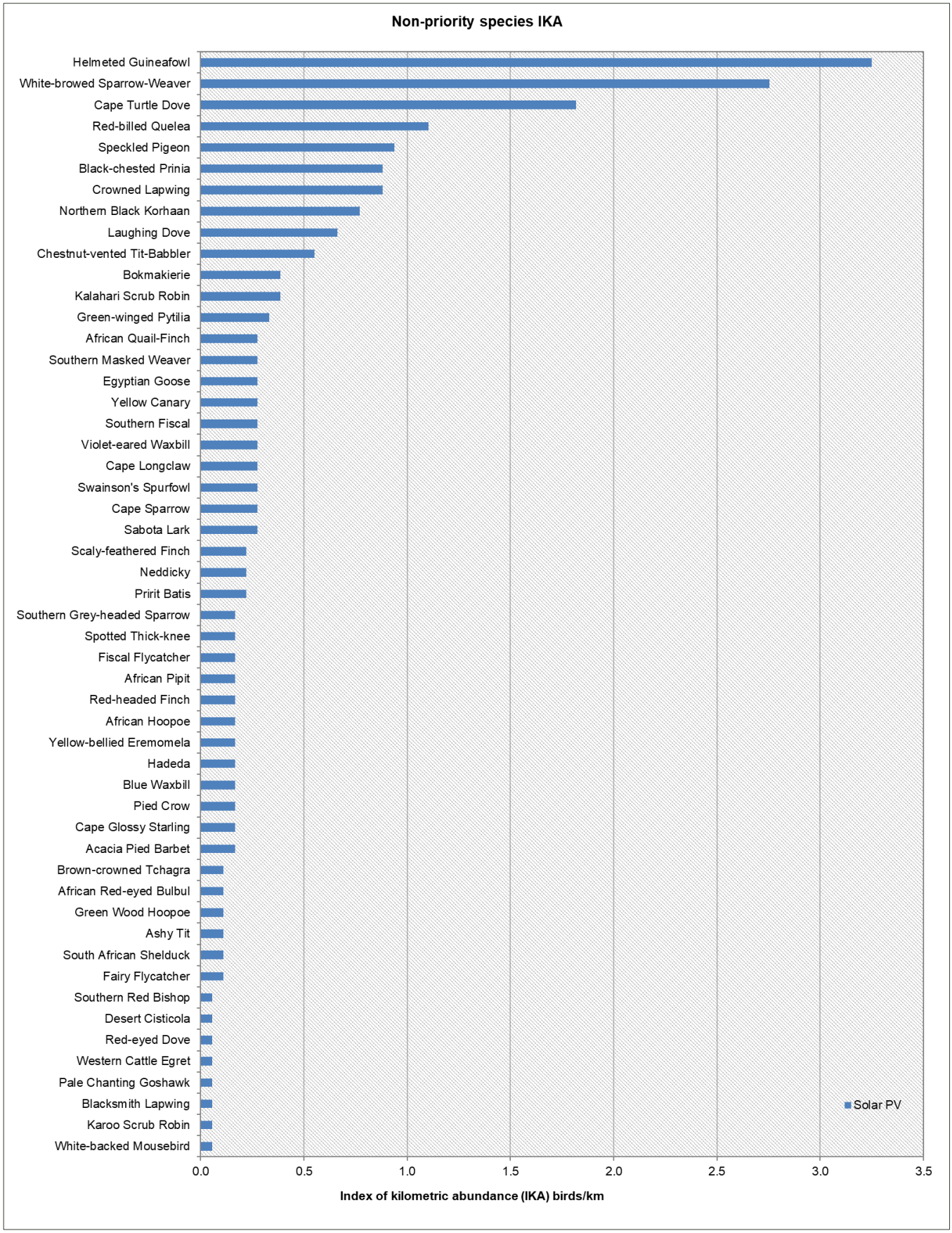


Figure 6: Index of kilometric abundance (IKA) for all non-priority species recorded by means of transect counts during the surveys, conducted in July 2020.

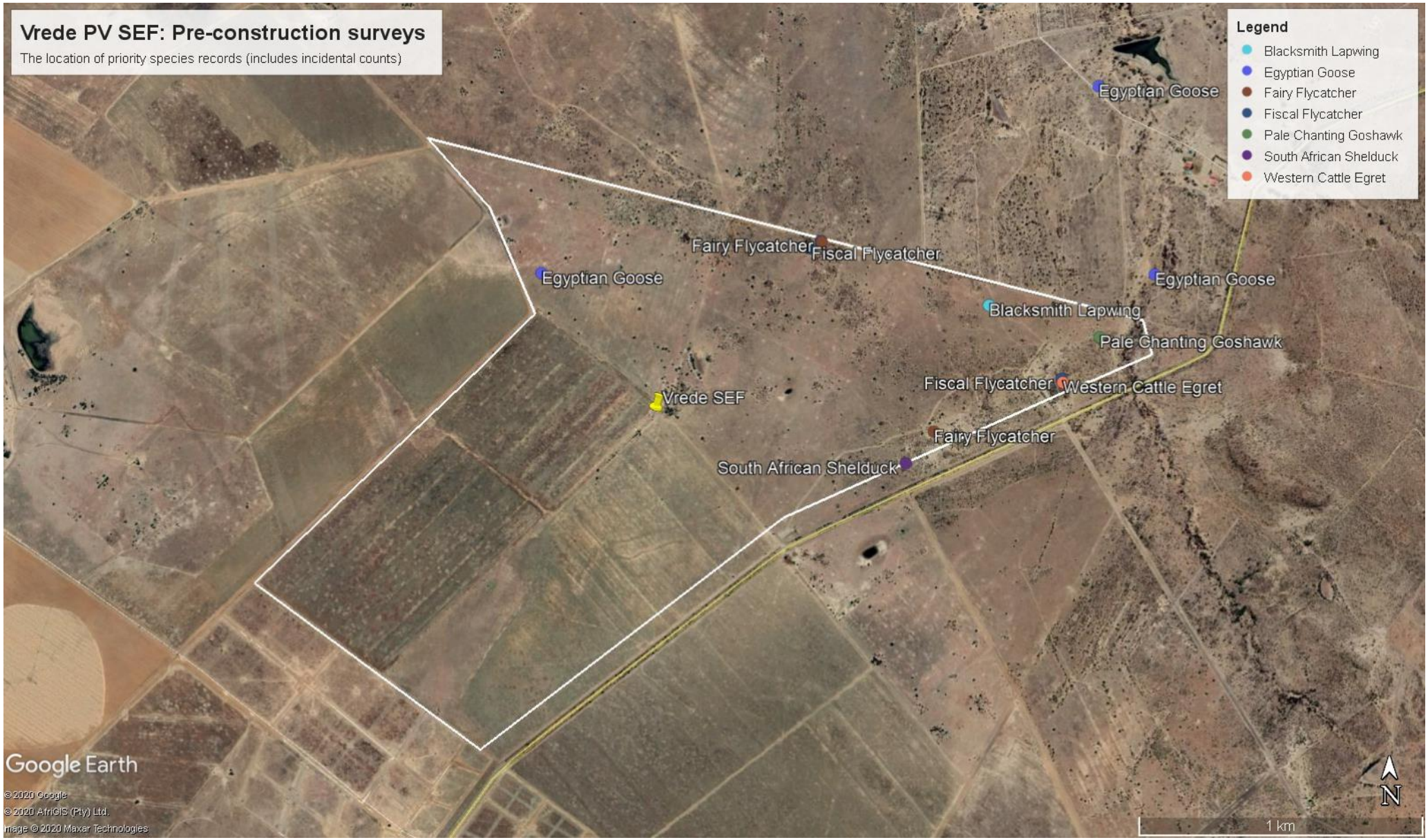


Figure 7: The location of priority species recorded during transect and incident counts.

8 IMPACT ASSESSMENT

A literature review reveals a scarcity of published, scientifically examined information regarding large-scale PV plants and birds. The reason for this is mainly that large-scale PV plants is a relatively recent phenomenon. The main source of information for these types of impacts are from compliance reports and a few government-sponsored studies relating to recently constructed solar plants in the south-west United States. In South Africa, one published scientific study has been completed on the impacts of PV plants in a South African context (Visser 2016).

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

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

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

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

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

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

South Africa is among the world's top 10 developing countries required to significantly reduce their carbon emissions (Seymore *et al.* 2014), and the introduction of low-carbon technologies into the country's compliment of power generation will greatly assist with achieving this important objective (Walwyn & Brent 2015). Given that South Africa receives among the highest levels of solar radiation on earth (Fluri 2009; Munzhedi *et al.* 2009), it is clear that solar power generation should feature prominently in future efforts to convert to a more sustainable energy mix in order to

combat climate change, also from an avifaunal impact perspective. However, while the expansion of solar power generation is undoubtedly a positive development for avifauna in the longer term in that it will help reduce the effect of climate change and thus habitat transformation, it must also be acknowledged that renewable energy facilities, including solar PV facilities, in themselves have some potential for negative impacts on avifauna.

A literature review reveals a scarcity of published, scientifically examined information regarding large-scale PV plants and birds. The reason for this is mainly that large-scale PV plants are a relatively recent phenomenon. The main source of information for these types of impacts are from compliance reports and a few government-sponsored studies relating to recently constructed solar plants in the south-west United States. In South Africa, only one published scientific study has been completed on the impacts of PV plants in a South African context (Visser *et al.* 2019).

8.2 Impacts associated with PV plants

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)[3]. 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 evaporation ponds may act as an additional risk increasing factor, in that birds are both attracted to the water feature and habituated to the presence of an accessible aquatic environment in the area. This may translate into the misinterpretation of diffusely reflected sky or horizontal polarised light source as a body of water. However, due to limited data it would be premature to make any general conclusions about the influence of the lake effect or other factors that contribute to fatality of water-dependent birds. The activity and abundance of water-dependent species near solar facilities may depend on other site-specific or regional factors, such as the surrounding landscape (Walston *et al.* 2015). However, until such time that enough scientific evidence has been collected to discount the “lake effect” hypothesis, it must be considered as a potential source of impacts.

Weekly mortality searches at 20% coverage were conducted at the 250MW, 1300ha California Valley Solar Ranch PV site (Harvey & Associates 2014a and 2014b). According to the information that could be sourced from the internet (two quarterly reports), 152 avian mortalities were reported for the period 16 November 2013 – 15 February 2014, and 54 for the period 16 February 2014 – 15 May 2014, of which approximately 90% were based on feather spots which precluded a finding on the cause of death. These figures give an estimated unadjusted 1 030 mortalities per year, which is obviously an underestimate as it does not include adjustments for carcasses removed by scavengers and

[3] 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.

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.* 2019).

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

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

Priority species which could potentially be impacted due to collisions with the solar panels are listed in Table 2.

8.2.2 Entrapment in perimeter fences

Visser *et al.* (2019) recorded a fence-line fatality (Orange River Francolin *Scleroptila gutturalis*) resulting from the bird being trapped between the inner and outer perimeter fence of the facility. This was further supported by observations of large-bodied birds unable to escape from between the two fences (e.g. Red-crested Korhaan *Lophotis ruficrista*) (Visser *et al.* 2019). Considering that one would expect the birds to be able to take off in the lengthwise direction (parallel to the fences), it seems possible that the birds panicked when they were approached by observers and thus flew into the fence.

It is not foreseen that entrapment of priority species in perimeter fences will be a significant impact. The priority species which could potentially be affected by this impact are most likely medium to large terrestrial species. Priority species which could potentially be impacted due entrapment are listed in Table 2.

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.* (2019) 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.* 2019).

As far as displacement, either completely or partially (reduced densities) due to habitat loss is concerned, it is highly likely that the same pattern of reduced avifaunal densities and possible changes in densities and composition favouring grassland species will manifest itself at the proposed PV facility. In addition, raptors are also likely to be impacted by the habitat transformation, as it will result in reduced prey availability and accessibility. Species that could be negatively affected by displacement due to habitat loss are listed in Table 2.

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. The priority species which would be most severely affected would be ground nesting birds or those that utilise low shrubs for nesting, which are listed in Table 2.

8.2.5 Electrocution of priority species on the internal 33kV reticulation network

While the intention to place the 33kV reticulation network underground next to the access roads where possible, there are areas were the lines might have to run above ground. In these instances, the 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.

9 IMPACT RATING

Please see Appendix 4 for a preliminary impact assessment, subject to further refinement in the EIA phase.

Table 3 below is a summarised scoping level assessment of the anticipated impacts.

Table 3: Summarised scoping level assessment of the anticipated impacts

Issue	Nature of Impact	Extent of Impact	No-Go Areas
During construction: Displacement of priority species due to disturbance associated with construction of the PV plant and associated infrastructure.	As far as disturbance is concerned, it is likely that all the avifauna, including all the priority species, will be temporarily displaced in the development footprint, either completely or more likely partially (reduced densities) during the	Local	No avifaunal no-go areas were determined necessary for the mitigation of this anticipated impact.

	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. The priority species which would be most severely affected would be ground nesting birds or those that utilise low shrubs for nesting.		
During construction: Displacement of priority species due to habitat transformation associated with construction of the PV plant and associated infrastructure.	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. 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.	Local	A 200m solar panel free buffer zone must be implemented around the pans (-27.736377° 27.134694°, -27.740910° 27.141575°, -27.741723° 27.144815°) to provide avifauna with unhindered access to the water. A 100m solar panel free buffer zone must be implemented on both sides of the drainage line on the development area, to maintain a corridor of woodland.
During operation: Mortality of priority species due to collisions with solar panels	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.	Local	No avifaunal no-go areas were determined necessary for the mitigation of this anticipated impact.
During operation: Entrapment of large-bodied birds in the double perimeter fence	Visser et al. (2019) recorded a fence-line fatality (Orange River Francolin Scleroptila gutturalis) resulting from the bird being trapped between the inner and outer perimeter fence of the development area. This was further supported by observations of large-bodied birds unable to escape from between the two fences (e.g. Red-crested Korhaan Lophotis ruficrista) (Visser et al. 2019). It is not foreseen that entrapment of priority species in perimeter fences will be a significant impact. The priority species which could potentially be affected by this impact are most likely medium to large terrestrial species.	Local	No avifaunal no-go areas were determined necessary for the mitigation of this anticipated impact.
During operation: Mortality of priority species due to electrocution on the 33kV internal reticulation network	While the intention is to place the 33kV reticulation network underground next to the access roads where possible, there are areas were the lines might have to run above ground. In these instances, the 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	Local	No avifaunal no-go areas were determined necessary for the mitigation of this anticipated impact.

	and earthed components (van Rooyen 2000). The electrocution risk is largely determined by the design of the electrical hardware.		
During construction and operation: Cumulative impact of displacement due to construction and habitat transformation, collisions with solar panels and entrapment in fences	Mortality and displacement of priority avifauna due to the construction of the PV facility and associated infrastructure and similar construction of other facilities in the broader Kroonstad region.	Local	A 200m solar panel free buffer zone must be implemented around the pans (-27.736377° 27.134694°, -27.740910° 27.141575°, -27.741723° 27.144815°) to provide avifauna with unhindered access to the water. A 100m solar panel free buffer zone must be implemented on both sides of the drainage line on the development area, to maintain a corridor of woodland.

9.1 Cumulative impacts

"Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities .

The role of the cumulative assessment is to test if such impacts are relevant to the proposed project in the proposed location (i.e. whether the addition of the proposed project in the area will increase the impact). This section addresses whether the construction of the proposed development will result in:

- Unacceptable risk
- Unacceptable loss
- Complete or whole-scale changes to the environment
- Unacceptable increase in impact

According to the official database of DEFF, there were no registered applications for renewable energy projects falling entirely within a 30km radius around the proposed development at the end of the second quarter of 2020. The only other planned facility falling entirely within the 30km radius is the 100 MW Rondavel Solar Photovoltaic (PV) Facility and Battery Energy Storage System (BESS) (see Figure 8)

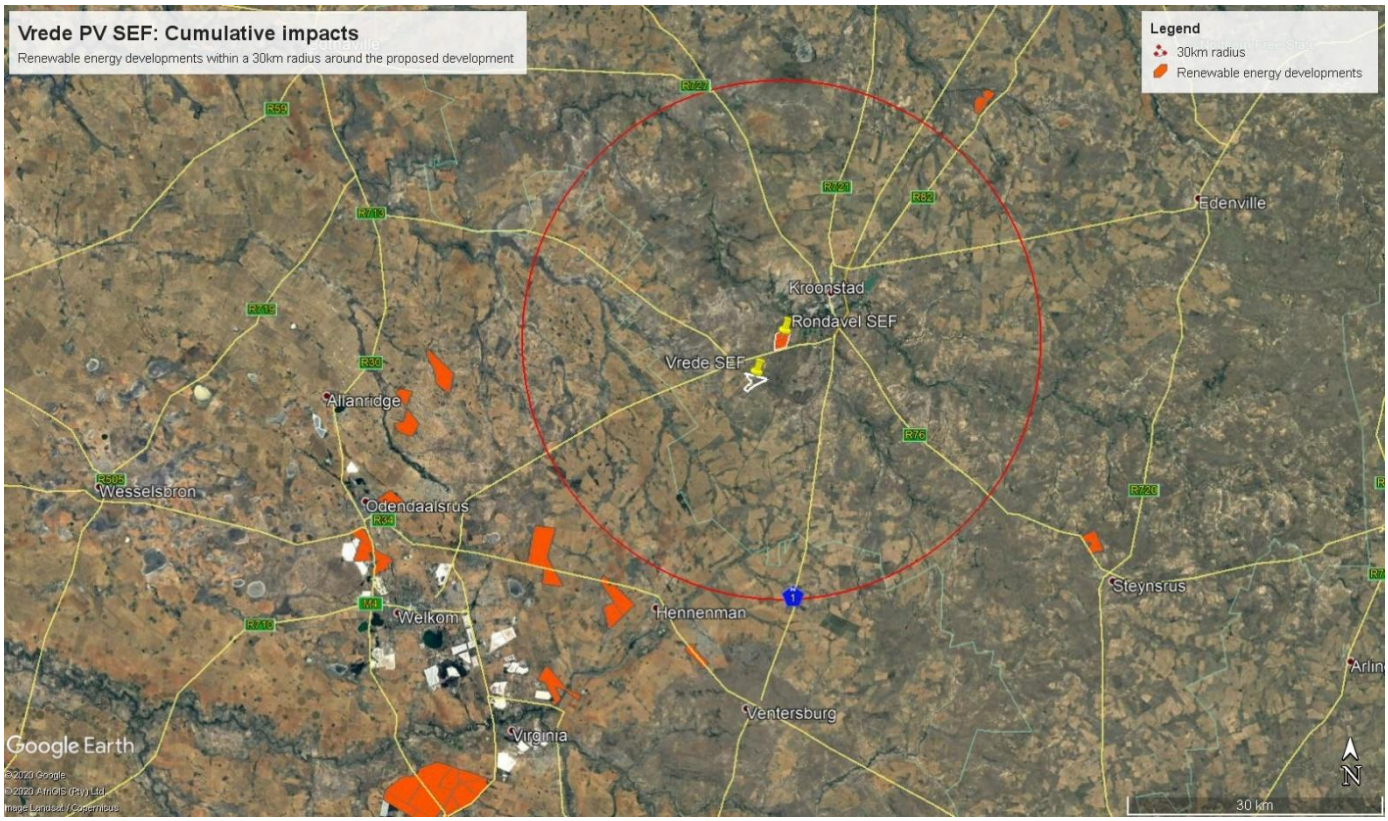


Figure 8: Renewable energy applications within 30km of the proposed Vrede SEF

9.2 No-Go Alternative

The no-go alternative will result in the current status quo being maintained at the proposed development site as far as the avifauna is concerned. The development site itself consist mostly of natural grassland. The no-go option would maintain the natural grassland which would be beneficial to the avifauna currently occurring there.

9.3 Environmental sensitivities

The following environmental sensitivities were identified from an avifaunal perspective:

- **Very High sensitivity (No solar panels – other infrastructure allowed): Surface water**

  Included are areas within 200m of the pans on the development area. It is important to leave open space for birds to access and leave the surface water area unhindered. Surface water is also important area for raptors to hunt birds which congregate around water troughs, and they should have enough space for fast aerial pursuit.

- **Very High sensitivity (No solar panels – other infrastructure allowed): Drainage line woodland**

  Drainage lines are corridors of woodland which provide nesting and foraging opportunities for woodland species which are dependent on this habitat for their survival. The highest density of woodland and trees at the development area is concentrated around the drainage line. A 100m buffer zone should be implemented on both side of the drainage channel.

See Figure 9 for the avifaunal sensitivities identified from a PV solar perspective.

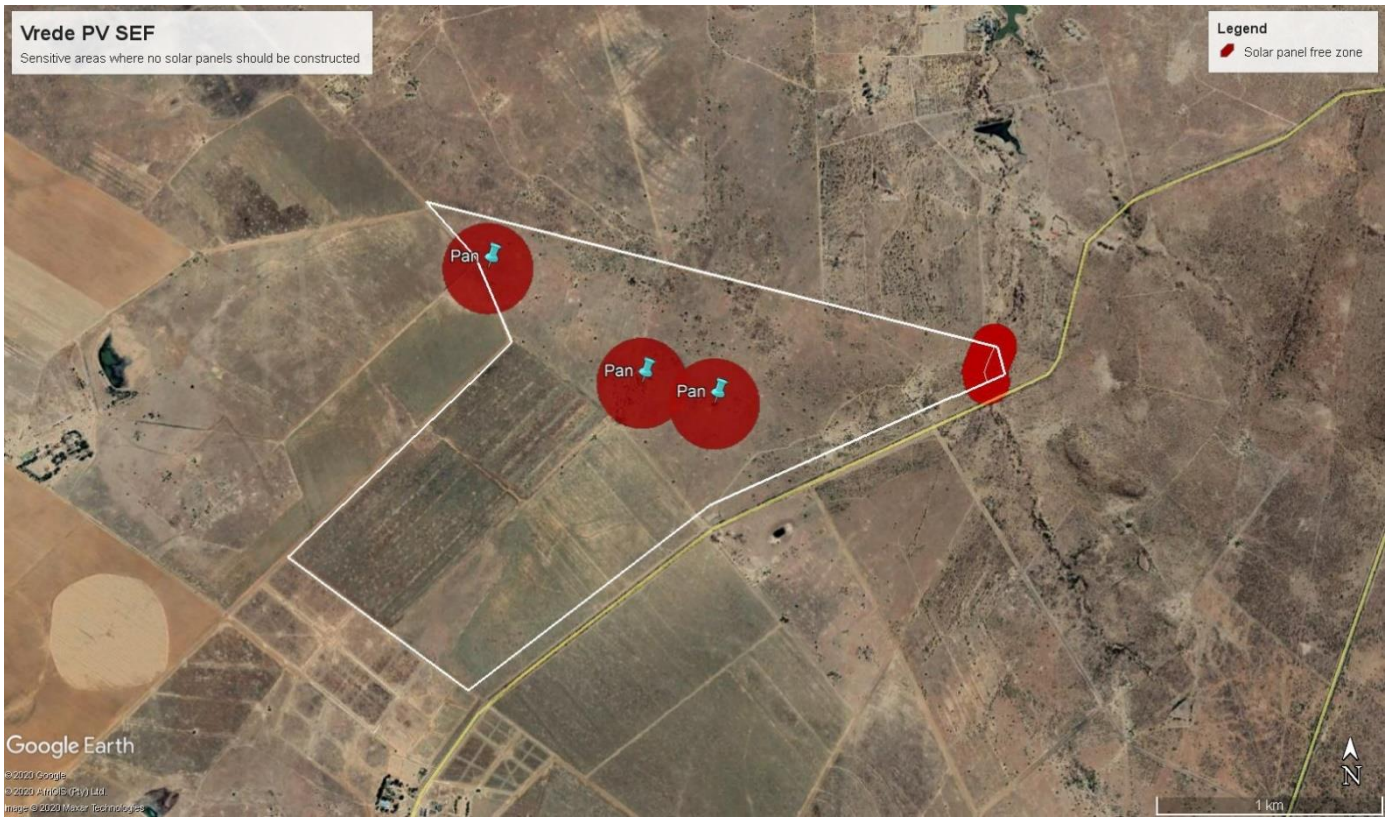


Figure 9: Avifaunal sensitivities (PV solar) at the Vrede Solar PV facility and associated infrastructure.

10 PLAN OF STUDY

The following Plan of Study is proposed for assessment of the avifaunal impacts:

10.1 Sensitivity Analysis and EIA assessment

The following activities are proposed during the EIA Phase:

- Consider the findings of a summer-season avifaunal survey utilising transects and incidental counts, in accordance with the sensitivity regime determine for the site and the latest BirdLife SA monitoring survey guideline , against the planned infrastructure within the development footprint.
- Provide an assessment of cumulative impacts associated with the development of the project site. Including an assessment of the extent of habitat lost to solar energy development in the area to date, and the likely future potential loss from the current as well as other proposed developments in the area.
- Evaluate, based on the site attributes and final layout of the proposed development, what the most applicable mitigation measures to reduce the impact of the proposed development on the project site would be, and if there are any areas where specific pre-cautions or mitigation measures should be implemented. Particular attention will be paid to potential impacts on important landscape features in the vicinity of the site or where sensitive avifaunal species may nest or roost.
- Identifying the species or habitat features that are ‘key ecosystem providers’ and complete sensitivity mapping.
- Sensitivity ratings assigned and reasoning will be clearly defined.
- Assessment of Impacts for the EIA
- This methodology described above assists in the evaluation of the overall effect of a proposed activity on the environment. It includes an assessment of the significant direct, indirect, and cumulative impacts. The significance of environmental impacts is to be assessed by means of criteria including extent (scale), duration, magnitude (severity), probability (certainty) and direction (negative, neutral or positive).

- The nature of the impact will be defined and described. It will refer to the causes of the effect, what will be affected, and how it will be affected. For each anticipated impact, recommendations will be made for desirable mitigation measures.

10.2 Environmental Management Programme

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

11 PRELIMINARY CONCLUSIONS

The proposed 100 MW Vrede Photovoltaic (PV) Solar Energy Facility will have an anticipated medium negative impact on priority avifauna, which is expected to be reduced to low with appropriate mitigation. No fatal flaws are expected to be discovered in the course of the investigations.

The cumulative impact of the facility on priority avifauna within a 30km radius around the proposed development is also anticipated to be low, mainly due to the small size of the proposed development, and the small number of additional renewable energy projects

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APPENDIX 1: SABAP 2 SPECIES LIST FOR THE DEVELOPMENT AREAAND SURROUNDINGS

Species	Taxonomic name	Full protocol	Ad hoc protocol	Solar priority species	Red Data status: International	Red Data status: Regional
Acacia Pied Barbet	*Tricholaema leucomelas*	61.40	0.00			
African Black Duck	*Anas sparsa*	1.75	0.00	x		
African Darter	*Anhinga rufa*	10.53	0.00	x		
African Fish-eagle	*Haliaeetus vocifer*	1.75	0.00	x		
African Harrier-Hawk	*Polyboroides typus*	3.51	0.00	x		
African Hoopoe	*Upupa africana*	54.39	3.17			
African Openbill	*Anastomus lamelligerus*	1.75	0.00	x		
African Palm-swift	*Cypsiurus parvus*	19.30	4.76			
African Paradise-flycatcher	*Terpsiphone viridis*	3.51	0.00			
African Pipit	*Anthus cinnamomeus*	33.33	1.59			
African Quailfinch	*Ortygospiza atricollis*	7.02	0.00			
African Red-eyed Bulbul	*Pycnonotus nigricans*	77.19	0.00			
African Reed-warbler	*Acrocephalus baeticatus*	3.51	0.00			
African Sacred Ibis	*Threskiornis aethiopicus*	26.32	0.00	x		
African Snipe	*Gallinago nigripennis*	7.02	0.00	x		
African Spoonbill	*Platalea alba*	7.02	0.00	x		
African Stonechat	*Saxicola torquatus*	61.40	3.17			
Amethyst Sunbird	*Chalcomitra amethystina*	12.28	0.00			
Amur Falcon	*Falco amurensis*	28.07	4.76	x		
Anteating Chat	*Myrmecocichla formicivora*	29.82	12.70			
Ashy Tit	*Parus cinerascens*	3.51	0.00			
Barn Swallow	*Hirundo rustica*	17.54	0.00			
Black Sparrowhawk	*Accipiter melanoleucus*	1.75	0.00	x		
Black-chested Prinia	*Prinia flavicans*	66.67	0.00			
Black-collared Barbet	*Lybius torquatus*	40.35	1.59			
Black-faced Waxbill	*Estrilda erythronotos*	3.51	0.00			
Black-headed Heron	*Ardea melanocephala*	47.37	6.35	x		
Black-necked Grebe	*Podiceps nigricollis*	1.75	0.00	x		
Black-shouldered Kite	*Elanus caeruleus*	45.61	9.52	x		
Blacksmith Lapwing	*Vanellus armatus*	87.72	11.11	x		
Black-throated Canary	*Crithagra atrogularis*	54.39	3.17			
Black-winged Stilt	*Himantopus himantopus*	12.28	0.00	x		
Blue Korhaan	*Eupodotis caerulescens*	1.75	1.59	x	NT	LC
Blue Waxbill	*Uraeginthus angolensis*	10.53	0.00			
Bokmakierie	*Telophorus zeylonus*	38.60	0.00			
Brown-crowned Tchagra	*Tchagra australis*	8.77	0.00			
Brown-hooded Kingfisher	*Halcyon albiventris*	1.75	0.00			
Brown-throated Martin	*Riparia paludicola*	10.53	1.59			
Buffy Pipit	*Anthus vaalensis*	3.51	0.00			
Burchell's Coucal	*Centropus burchellii*	5.26	0.00			
Cape Glossy Starling	*Lamprotornis nitens*	17.54	0.00			
Cape Longclaw	*Macronyx capensis*	45.61	0.00			
Cape Robin-chat	*Cossypha caffra*	61.40	1.59			
Cape Shoveler	*Anas smithii*	8.77	0.00	x		
Cape Sparrow	*Passer melanurus*	92.98	11.11			
Cape Teal	*Anas capensis*	1.75	0.00	x		
Cape Turtle-dove	*Streptopelia capicola*	94.74	12.70			
Cape Wagtail	*Motacilla capensis*	63.16	1.59			
Cape Weaver	*Ploceus capensis*	1.75	0.00	x		
Cape White-eye	*Zosterops virens*	35.09	1.59	x		
Cardinal Woodpecker	*Dendropicos fuscescens*	1.75	0.00			
Cattle Egret	*Bubulcus ibis*	77.19	19.05	x		
Chestnut-backed Sparrowlark	*Eremopterix leucotis*	5.26	0.00			
Chestnut-vented Tit-babbler	*Parisoma subcaeruleum*	43.86	0.00			
Cinnamon-breasted Bunting	*Emberiza tahapisi*	5.26	0.00			
Cloud Cisticola	*Cisticola textrix*	5.26	0.00			
Common (Southern) Fiscal	*Lanius collaris*	91.23	22.22			

Species	Taxonomic name	Full protocol	Ad hoc protocol	Solar priority species	Red Data status: International	Red Data status: Regional
Common Buzzard	*Buteo vulpinus*	7.02	0.00	x		
Common Greenshank	*Tringa nebularia*	1.75	0.00	x		
Common House-martin	*Delichon urbicum*	1.75	0.00			
Common Moorhen	*Gallinula chloropus*	22.81	0.00	x		
Common Myna	*Acridotheres tristis*	78.95	9.52			
Common Ostrich	*Struthio camelus*	12.28	1.59			
Common Sandpiper	*Actitis hypoleucos*	1.75	0.00	x		
Common Scimitarbill	*Rhinopomastus cyanomelas*	8.77	0.00			
Crested Barbet	*Trachyphonus vaillantii*	77.19	1.59			
Crowned Lapwing	*Vanellus coronatus*	96.49	7.94			
Desert Cisticola	*Cisticola aridulus*	10.53	0.00			
Diderick Cuckoo	*Chrysococcyx caprius*	40.35	1.59			
Double-banded Courser	*Rhinoptilus africanus*	5.26	0.00			
Eastern Clapper Lark	*Mirafra fasciolata*	17.54	0.00			
Egyptian Goose	*Alopochen aegyptiacus*	49.12	1.59	x		
Fairy Flycatcher	*Stenostira scita*	5.26	0.00	x		
Familiar Chat	*Cercomela familiaris*	1.75	0.00			
Fiscal Flycatcher	*Sigelus silens*	42.11	0.00	x		
Fulvous Duck	*Dendrocygna bicolor*	10.53	0.00	x		
Gabar Goshawk	*Melierax gabar*	1.75	0.00	x		
Giant Kingfisher	*Megaceryle maximus*	3.51	0.00			
Glossy Ibis	*Plegadis falcinellus*	12.28	0.00	x		
Goliath Heron	*Ardea goliath*	1.75	0.00	x		
Greater Flamingo	*Phoenicopterus ruber*	1.75	1.59	x	LC	NT
Greater Honeyguide	*Indicator indicator*	1.75	0.00			
Greater Kestrel	*Falco rupicoloides*	3.51	0.00	x		
Greater Striped Swallow	*Hirundo cucullata*	59.65	3.17			
Green Wood-hoopoe	*Phoeniculus purpureus*	45.61	3.17			
Green-winged Pytilia	*Pytilia melba*	5.26	0.00			
Grey Heron	*Ardea cinerea*	14.04	1.59	x		
Hadeda Ibis	*Bostrychia hagedash*	84.21	11.11	x		
Hamerkop	*Scopus umbretta*	5.26	1.59			
Helmeted Guineafowl	*Numida meleagris*	66.67	3.17			
Horus Swift	*Apus horus*	1.75	0.00			
House Sparrow	*Passer domesticus*	64.91	3.17			
Jacobin Cuckoo	*Clamator jacobinus*	3.51	0.00			
Jameson's Firefinch	*Lagonosticta rhodopareia*	1.75	0.00			
Kalahari Scrub-robin	*Cercotrichas paena*	28.07	0.00			
Karoo Scrub-robin	*Cercotrichas coryphoeus*	3.51	0.00			
Karoo Thrush	*Turdus smithi*	70.18	3.17			
Kittlitz's Plover	*Charadrius pecuarius*	3.51	0.00	x		
Kurrichane Buttonquail	*Turnix sylvaticus*	1.75	0.00			
Laughing Dove	*Streptopelia senegalensis*	92.98	19.05			
Lesser Flamingo	*Phoenicopterus minor*	1.75	0.00	x	NT	NT
Lesser Grey Shrike	*Lanius minor*	5.26	0.00			
Lesser Honeyguide	*Indicator minor*	1.75	0.00			
Lesser Kestrel	*Falco naumanni*	35.09	1.59	x		
Lesser Swamp-warbler	*Acrocephalus gracilirostris*	5.26	1.59			
Levaillant's Cisticola	*Cisticola tinniens*	19.30	0.00			
Lilac-breasted Roller	*Coracias caudatus*	5.26	0.00			
Little Bee-eater	*Merops pusillus*	1.75	0.00			
Little Egret	*Egretta garzetta*	12.28	0.00	x		
Little Grebe	*Tachybaptus ruficollis*	38.60	1.59	x		
Little Stint	*Calidris minuta*	3.51	0.00	x		
Little Swift	*Apus affinis*	71.93	15.87			
Long-tailed Paradise-whydah	*Vidua paradisaea*	5.26	0.00			
Long-tailed Widowbird	*Euplectes progne*	57.89	4.76			
Maccoa Duck	*Oxyura maccoa*	1.75	0.00	x		
Malachite Kingfisher	*Alcedo cristata*	15.79	0.00	x		

Species	Taxonomic name	Full protocol	Ad hoc protocol	Solar priority species	Red Data status: International	Red Data status: Regional
Marsh Owl	*Asio capensis*	7.02	0.00	x		
Marsh Sandpiper	*Tringa stagnatilis*	1.75	0.00	x		
Melodious Lark	*Mirafra cheniana*	1.75	0.00	x		
Namaqua Dove	*Oena capensis*	29.82	1.59			
Namaqua Sandgrouse	*Pterocles namaqua*	1.75	0.00			
Natal Spurfowl	*Pternistis natalensis*	3.51	0.00			
Neddicky	*Cisticola fulvicapilla*	21.05	0.00			
Nicholson's Pipit	*Anthus nicholsoni*	1.75	0.00			
Northern Black Korhaan	*Afrotis afraoides*	82.46	12.70			
Orange River Francolin	*Scleroptila levaillantoides*	5.26	0.00			
Orange River White-eye	*Zosterops pallidus*	29.82	1.59			
Pied Avocet	*Recurvirostra avosetta*	1.75	0.00	x		
Pied Crow	*Corvus albus*	7.02	0.00			
Pied Kingfisher	*Ceryle rudis*	1.75	0.00	x		
Pied Starling	*Spreo bicolor*	5.26	1.59	x		
Pink-billed Lark	*Spizocorys conirostris*	1.75	0.00			
Pin-tailed Whydah	*Vidua macroura*	19.30	0.00			
Pririt Batis	*Batis pririt*	1.75	0.00			
Purple Heron	*Ardea purpurea*	8.77	0.00	x		
Red-backed Shrike	*Lanius collurio*	7.02	0.00			
Red-billed Firefinch	*Lagonosticta senegala*	8.77	0.00			
Red-billed Quelea	*Quelea quelea*	43.86	0.00			
Red-billed Teal	*Anas erythrorhyncha*	28.07	0.00	x		
Red-breasted Swallow	*Hirundo semirufa*	3.51	0.00			
Red-capped Lark	*Calandrella cinerea*	14.04	0.00			
Red-chested Cuckoo	*Cuculus solitarius*	14.04	0.00			
Red-eyed Dove	*Streptopelia semitorquata*	82.46	4.76			
Red-faced Mousebird	*Urocolius indicus*	56.14	0.00			
Red-footed Falcon	*Falco vespertinus*	1.75	0.00	x		
Red-headed Finch	*Amadina erythrocephala*	47.37	0.00			
Red-knobbed Coot	*Fulica cristata*	59.65	7.94	x		
Red-throated Wryneck	*Jynx ruficollis*	8.77	0.00			
Red-winged Starling	*Onychognathus morio*	1.75	0.00			
Reed Cormorant	*Phalacrocorax africanus*	43.86	3.17	x		
Rock Dove	*Columba livia*	26.32	3.17			
Rock Martin	*Hirundo fuligula*	3.51	1.59			
Ruff	*Philomachus pugnax*	3.51	0.00			
Rufous-naped Lark	*Mirafra africana*	40.35	1.59			
Sabota Lark	*Calendulauda sabota*	3.51	0.00			
Scaly-feathered Finch	*Sporopipes squamifrons*	7.02	0.00			
Shaft-tailed Whydah	*Vidua regia*	1.75	0.00			
South African Cliff-swallow	*Hirundo spilodera*	26.32	6.35	x		
South African Shelduck	*Tadorna cana*	7.02	0.00	x		
Southern Grey-headed Sparrow	*Passer diffusus*	26.32	1.59			
Southern Masked-weaver	*Ploceus velatus*	96.49	7.94			
Pale Chanting Goshawk	*Melierax canorus*	5.26	0.00	x		
Southern Pochard	*Netta erythrophthalma*	10.53	0.00	x		
Southern Red Bishop	*Euplectes orix*	59.65	6.35			
Speckled Mousebird	*Colius striatus*	45.61	1.59			
Speckled Pigeon	*Columba guinea*	84.21	12.70			
Spike-heeled Lark	*Chersomanes albofasciata*	5.26	0.00			
Spotted Thick-knee	*Burhinus capensis*	19.30	1.59			
Spur-winged Goose	*Plectropterus gambensis*	24.56	3.17	x		
Swainson's Spurfowl	*Pternistis swainsonii*	61.40	3.17			
Three-banded Plover	*Charadrius tricollaris*	26.32	0.00	x		
Village Indigobird	*Vidua chalybeata*	1.75	0.00			
Violet-eared Waxbill	*Granatina granatina*	3.51	0.00			
Wattled Starling	*Creatophora cinerea*	36.84	1.59			
Whiskered Tern	*Chlidonias hybrida*	3.51	0.00	x		
White Stork	*Ciconia ciconia*	1.75	0.00	x		

Species	Taxonomic name	Full protocol	Ad hoc protocol	Solar priority species	Red Data status: International	Red Data status: Regional
White-backed Mousebird	*Colius colius*	35.09	0.00			
White-bellied Sunbird	*Cinnyris talatala*	8.77	0.00			
White-breasted Cormorant	*Phalacrocorax carbo*	28.07	1.59	x		
White-browed Sparrow-weaver	*Plocepasser mahali*	77.19	9.52			
White-faced Duck	*Dendrocygna viduata*	33.33	0.00	x		
White-fronted Bee-eater	*Merops bullockoides*	12.28	0.00			
White-rumped Swift	*Apus caffer*	36.84	4.76			
White-throated Swallow	*Hirundo albigularis*	26.32	1.59			
White-winged Widowbird	*Euplectes albonotatus*	5.26	1.59			
Willow Warbler	Phylloscopus trochilus	7.02	0.00			
Yellow Canary	*Crithagra flaviventris*	70.18	1.59			
Yellow-bellied Eremomela	*Eremomela icteropygialis*	5.26	0.00			
Yellow-billed Duck	*Anas undulata*	68.42	1.59	x		
Yellow-crowned Bishop	*Euplectes afer*	21.05	4.76			
Zitting Cisticola	*Cisticola juncidis*	15.79	0.00			

APPENDIX 2: HABITAT AT THE DEVELOPMENT AREA

Figure 1: Typical grassland habitat at the development area.

Figure 2: A fence in the development area.

Figure 3: Woodland at the development area

Figure 4: A pan at the development area

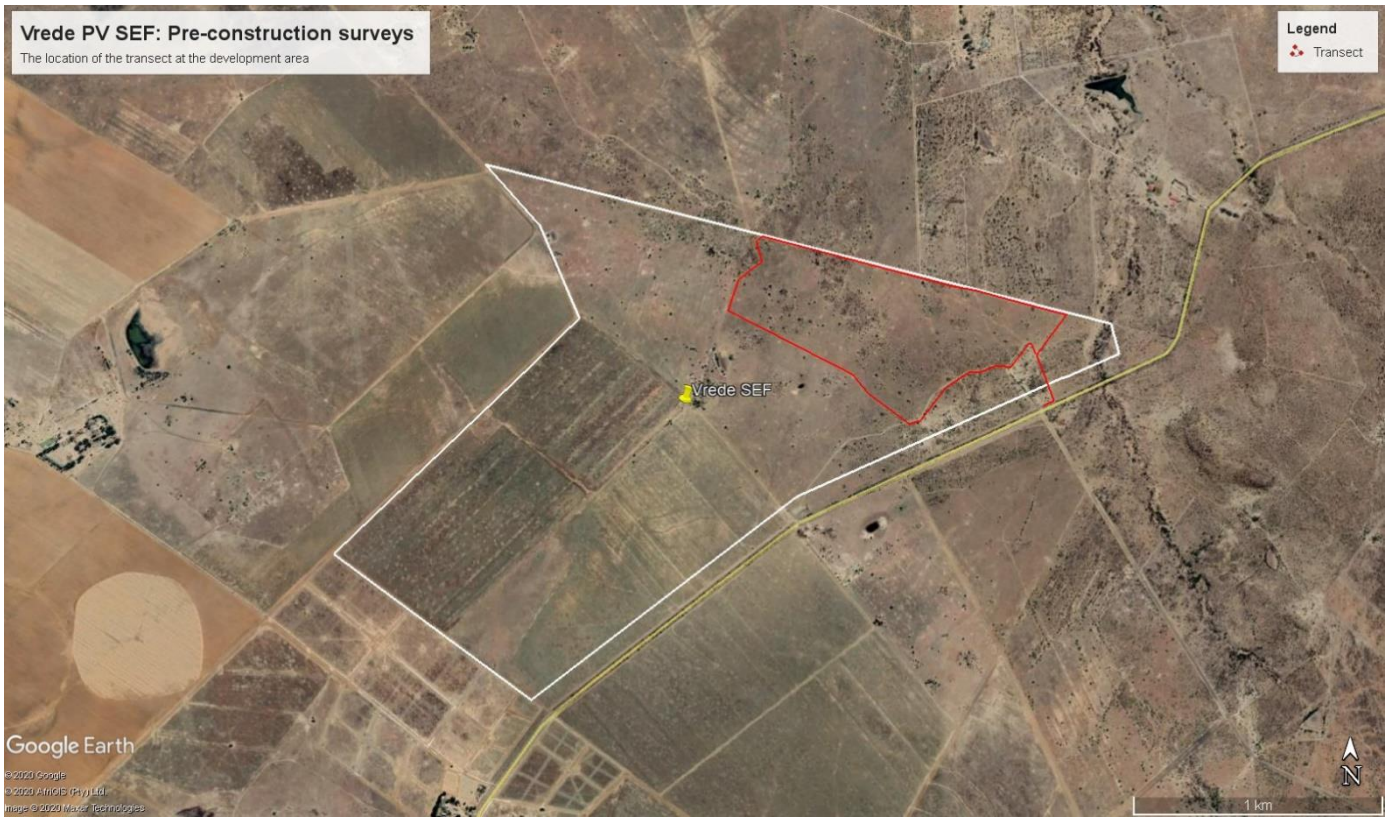
APPENDIX 3: PRE-CONSTRUCTION MONITORING

Methodology

Monitoring was conducted in the following manner:

- On site surveys were implemented on 17 July 2020 and again from 20 – 22 July 2020.
- One transect of 5km was identified and counted 5 times over a period of 3 days. The observer drove slowly and stopped at regular intervals to scan the environment with binoculars. All species were recorded.
- The following variables were recorded:
  - Species;
  - Number of birds;
  - Date;
  - Start time and end time;
  - Estimated distance from transect (m);
  - Wind direction;
  - Wind strength (estimated Beaufort scale 1 - 7);
  - 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.
- All incidental sightings of priority species were recorded.

The map below indicates the location of the transect used for counting the birds at the development area.



APPENDIX 4: PRELIMINARY IMPACT ASSESSMENT

The EIA Methodology assists in evaluating the overall effect of a proposed activity on the environment. The determination of the effect of an environmental impact on an environmental parameter is determined through a systematic analysis of the various components of the impact. This is undertaken using information that is available to the environmental practitioner through the process of the environmental impact assessment. A preliminary impact evaluation of predicted impacts was undertaken through an assessment of the significance of the impacts.

12.1 Determination of Significance of Impacts

Direct, indirect and cumulative impacts of the issues identified through the EIA process, as well as all other issues identified due to the amendment 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 local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The duration, wherein is indicated whether:
    - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1
    - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2
    - medium-term (5–15 years) – assigned a score of 3
    - long term (> 15 years) - assigned a score of 4 or
    - permanent - assigned a score of 5
- The consequences (magnitude), quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The probability of occurrence, which describes the likelihood of the impact actually occurring. Probability is estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- The significance, which is determined through a synthesis of the characteristics described above and is assessed as low, medium or high; and
- 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).

12.2 Anticipated Impact Assessments

The anticipated impacts are summarised in the tables below.

Nature: Displacement of priority species due to disturbance associated with construction of the PV plant and associated infrastructure		
	Without mitigation	**With mitigation**
Extent	1 local	1 local
Duration	1 very short	1 very short
Magnitude	8 high	8 high
Probability	4 highly probable	3 probable
Significance	**40 medium**	**30 medium**
Status (positive or negative)	negative	negative
Reversibility	low	low
Irreplaceable loss of resources?	yes	yes
Can impacts be mitigated?	To a limited extent	To a limited extent
Mitigation: • Construction activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.		
Cumulative impacts: The cumulative impact of this impact on avifauna is assessed to be low, based on the small size of the footprint (195ha) and the fact that there are only one planned renewable energy facility falling in totality within a 30km radius around the proposed development.		
Residual Risks: The residual risk of displacement will remain at a medium level after mitigation, due to the fact that limited mitigation is available to reduce the impact.		

Nature: Displacement of priority species due to habitat transformation associated with construction of the PV plant and associated infrastructure.		
	Without mitigation	**With mitigation**
Extent	1 local	1 local
Duration	4 long term	4 long term
Magnitude	8 high	6 high
Probability	4 highly probable	4 highly probable
Significance	**52 medium**	**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	To a limited extent

Mitigation:

- Construction activity should be restricted to the immediate footprint of the infrastructure.
- Access to the remainder of the site should be strictly controlled to prevent unnecessary degradation of habitat.
- Maximum use 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 vegetation specialist must be strictly enforced.
- A 200m solar panel free buffer zone must be implemented around the pans (-27.736377° 27.134694°, -27.740910° 27.141575°, -27.741723° 27.144815°) to provide avifauna with unhindered access to the water.
- A 100m solar panel free buffer zone must be implemented on both sides of the drainage line on the development area, to maintain a corridor of woodland.

Cumulative impacts:

The cumulative impact of this impact on avifauna is assessed to be low, based on the small size of the footprint (195ha) and the fact that there are only one planned renewable energy facility falling in totality within a 30km radius around the proposed development.

Residual Risks:

The residual risk of displacement will remain at a medium level after mitigation, due to the fact that limited mitigation is available to reduce the impact.

Nature: Mortality of priority species due to collisions with the solar panels		
	Without mitigation	**With mitigation**
Extent	1 local	1 local
Duration	4 long term	4 long term
Magnitude	2 minor	2 minor
Probability	3 probable	3 probable
Significance	**21 low**	**21 low**
Status (positive or negative)	negative	negative
Reversibility	high	high
Irreplaceable loss of resources?	yes	yes
Can impacts be mitigated?	To a limited extent	To a limited extent

Mitigation:

- No mitigation is required due to the low significance of this impact.

Cumulative impacts:

The cumulative impact of this impact on avifauna is assessed to be low, based on the small size of the footprint (195ha) and the fact that there are only one planned renewable energy facility falling in totality within a 30km radius around the proposed development.

Residual Risks:

There will be an ongoing residual risk of collisions with the solar panels, but due to the low significance of this impact, it should not be biologically significant.

Nature: Entrapment of large-bodied birds in the double perimeter fence		
	Without mitigation	**With mitigation**
Extent	1 local	1 local
Duration	4 long term	4 long term
Magnitude	2 minor	2 minor
Probability	3 probable	1 very improbable
Significance	**21 low**	**7 low**
Status (positive or negative)	negative	negative
Reversibility	high	high
Irreplaceable loss of resources?	yes	yes
Can impacts be mitigated?	yes	yes
Mitigation: • It is recommended that a single perimeter fence is used.		
Cumulative impacts: The cumulative impact of this impact on avifauna is assessed to be low, based on the small size of the footprint (195ha) and the fact that there are only one planned renewable energy facility falling in totality within a 30km radius around the proposed development.		
Residual Risks: None		

Nature: Electrocution of priority species on the internal 33kV reticulation network.		
	Without mitigation	**With mitigation**
Extent	2 local	1 local
Duration	4 long term	4 long term
Magnitude	8 high	6 high
Probability	4 highly probable	1 very improbable
Significance	**56 medium**	**11 low**
Status (positive or negative)	negative	negative
Reversibility	high	high
Irreplaceable loss of resources?	yes	yes
Can impacts be mitigated?	yes	yes

Mitigation:

- A bird-friendly pole design must be implemented. The pole design must be submitted to the avifaunal specialist for approval.

Cumulative impacts:

The cumulative impact of this impact on avifauna is assessed to be low, based on the small size of the footprint (195ha) and the fact that there are only one planned renewable energy facility falling in totality within a 30km radius around the proposed development.

Residual Risks:

The residual risk of electrocution will be negligible if a bird-friendly pole design is implemented.

Nature: Mortality and displacement of priority avifauna due to the construction of the PV facility and associated infrastructure		
	Overall impact of the proposed project considered in isolation (post mitigation)	**Cumulative impact of the project and other projects in the area (post mitigation)**
Extent	1 local	1 local
Duration	4 long term	4 long term
Magnitude	6 moderate	2 low
Probability	4 highly probable	4 highly probable
Significance	**44 moderate**	**28 low**
Status (positive/negative)	Negative	Negative
Reversibility	High	High
Loss of resources?	yes	yes
Can impacts be mitigated?	Yes, but only to some extent	Yes, but only to some extent
Confidence in findings: Medium.		
Mitigation: • Construction activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary degradation of habitat. • Maximum use 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 vegetation specialist must be strictly enforced. • A 200m solar panel free buffer zone must be implemented around the pans (-27.736377° 27.134694°, -27.740910° 27.141575°, -27.741723° 27.144815°) to provide avifauna with unhindered access to the water. • A 100m solar panel free buffer zone must be implemented on both sides of the drainage line on the development area, to maintain a corridor of woodland. • It is recommended that a single perimeter fence is used. • A bird-friendly pole design must be implemented. The pole design must be submitted to the avifaunal specialist for approval.		

The anticipated impacts were summarized, and a comparison made between pre-and post-mitigation phases as shown in the table below. The rating of environmental issues associated with different parameters prior to and post mitigation of a proposed activity was averaged. A comparison was then made to determine the anticipated effectiveness of the proposed mitigation measures. The comparison identified critical issues related to the environmental parameters.

Environmental parameter	Issues	Anticipated rating prior to mitigation	Anticipated rating post mitigation
Avifauna	*Displacement of priority species due to disturbance associated with construction of the PV plant and associated infrastructure.*	40 medium	30 medium
	Displacement of priority species due to habitat transformation associated with construction of the PV plant and associated infrastructure.	52 medium	44 medium
	Mortality of priority species due to collisions with solar panels	21 low	21 low
	Entrapment of large-bodied birds in the double perimeter fence	21 low	7 low
	Mortality of priority species due to electrocution on the 33kV internal reticulation network	56 medium	11 low
	Cumulative impact of displacement due to construction and habitat transformation, collisions with solar panels and entrapment in fences	44 medium	28 low
	Average	**39 medium**	**20 low**