Appendix H.7

AVIFAUNAL IMPACT ASSESSMENT

THE PROPOSED DEVELOPMENT OF THE FOUR MURA SOLAR PV PROJECTS

Avifaunal Impact Assessment

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Submitted to:
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Executive Summary

Red Cap Energy (Pty) Ltd is proposing to develop four solar facilities and associated grid connections, on behalf of four separate Project Applicants, collectively known as the Mura PV projects between Loxton and Beaufort West in the Beaufort West Local Municipality and Ubuntu Local Municipality and the Central Karoo District Municipality and Pixley ka Sema District Municipality. The proposed Mura PV projects are located in close proximity to the approved Nuweveld Wind Farm Development. The four solar facilities, namely Mura 1 (Pty) Ltd, Mura 2 (Pty) Ltd, Mura 3 (Pty) Ltd, and Mura 4 (Pty) Ltd, will be assessed within a combined specialist report.

The sites will be accessed via the R381, DR02317 and existing access roads. Each solar facility will connect to the Eskom grid via new 132 kV overhead lines (assessed in separate processes to the PV facilities) connecting the two on-site solar substations via adjacent Eskom switching stations to the approved Nuweveld Collector substation.

Five initial areas were selected to be screened from an environmental and technical perspective. Areas 1, 3 and 4 have been screened out due to several constraints which has made development within these areas unfeasible.

For the assessment phase of the project, four sites, within two originally assessed areas of Areas 2 and 5, will be taken forward into the formal Assessment Phase of the development.

WSP has been appointed as the Environmental Assessment Practitioner (EAP) to manage the environmental impact assessment process for the proposed development. Since a project of this nature has the potential to impact on birds, WildSkies Ecological Services was appointed to conduct the specialist avifaunal assessment component of the basic assessment process. A screening site visit, and two pre-construction bird monitoring site visits were conducted on site.

Our work on site has made the following findings with respect to avifauna:

- A total of 88 bird species were recorded on site (Appendix 1) by all our pre-construction bird monitoring methods. Five of these 88 species are regionally Red Listed: Ludwig's Bustard is Endangered; Verreaux's Eagle is Vulnerable; and Karoo Korhaan, Blue Crane and Sclater's Lark are Near-threatened (Taylor *et al*, 2015).
- We judge Ludwig's Bustard and Karoo Korhaan to be at High risk if the proposed projects proceed, due to habitat destruction and disturbance. Verreaux's Eagle and Sclater's Lark are judged to be at Medium risk, and Blue Crane at Low risk.

Our assessment of the significance of the impacts on avifauna on site is as follows:

Phase	Impact	Significance before mitigation	Significance after mitigation
Construction	Destruction of habitat	Moderate Negative	Moderate Negative
	Disturbance of birds	Low Negative	Low Negative
Operations	Fatality of birds at facility	Moderate Negative	Low Negative
Decommissioning	Disturbance of birds	Low Negative	Low negative
Cumulative impacts	Cumulative impacts through habitat destruction	Moderate Negative	Moderate Negative

Mitigation for inclusion in the EMPr

The following mitigation measures are recommended:

- The risk of electrocution of large birds in the substations should be managed reactively. If any such electrocutions are recorded once operational this should be reported to an ornithologist for suitable case specific mitigation measures.
- The risk of bird collision/entanglement with facility fences must be mitigated by using a fence design which is either highly visible to birds or has a tight enough mesh to avoid entanglement.
- All staff, vehicle and machinery activities should be strictly controlled at all times so as to ensure that the absolute minimum of surface area is impacted.
- A strict speed limit is to be enforced on site to minimise the risk of road kill. Driving at night time should also be kept to an absolute minimum.
- Care should be taken not to introduce or propagate alien plant species/weeds during construction.
- A carefully considered surface water/drainage management plan must be developed for the site including attention to the use of environmentally friendly cleaning chemicals.
- It is strongly recommended that rodenticides not be used at the newly established Operation and Maintenance (O&M) buildings or around auxiliary infrastructure on the project site. While pest control of this nature may be effective, even so-called “environmentally friendly” rodenticides are toxic and pose significant secondary poisoning risk to predatory avifauna, especially owls.
- General good environmental practice should be implemented during construction in terms of control of vehicles, staff, minimising the impact on the receiving environment as much as possible.

- Once operational, if facility staff identify any bird fatalities this should be reported on fully through the sites incident reporting system. A suitably qualified ornithologist should be consulted for any case specific reactive mitigation measures.

- Operational phase bird monitoring should be conducted for at least one year as per the best practice guidelines – see Section 8.

- Once operational, if facility staff identify any bird nesting which interferes with operations this should be reported on fully through the sites incident reporting system. A suitably qualified ornithologist should be consulted for any case specific reactive mitigation measures. All nest management measures should only be undertaken in compliance with national and provincial environmental legislation in this regard.

Environmental impact statement

The construction of each of the proposed projects will transform a relatively large area of natural habitat. However, the avifaunal community using this habitat is not remarkable, nor is the habitat particularly unique or scarce. The impacts of the proposed project are all rated as Moderate Negative or even Low Negative significance after mitigation. We recommend that each of the projects be authorised, provided that the recommendations of this report are implemented.

Table of Contents

List of Figures

List of Tables

This report has been compiled in accordance with the EIA Regulations, 2014 (Government Notice (GN) R982). Note that there are no specific government protocols for assessment of impacts of solar PV development on avifauna, however the report complies with aspects of the protocols for assessment and minimum report content requirements for environmental impacts on bird species by solar generation facilities where the electricity output is 20 Megawatts or more, which are relevant to the proposed solar PV facilities, and with the BirdLife South Africa best practice guidelines for birds and solar energy (Jenkins *et al*, 2017). A summary of the report structure, and the specific sections that correspond to the applicable regulations, is provided in the table below.

Summary of report structure in compliance with above legislation.

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	**Section of Report**
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Section 1.7, Appendix 5
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Attached
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1
(cA) an indication of the quality and age of base data used for the specialist report;	Section 2
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 4 & 5
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 2
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 2
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;	Section7
g) an identification of any areas to be avoided, including buffers;	Section 7
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;	Section 7
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1
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;	Section 8
k) any mitigation measures for inclusion in the EMPr;	Section 9
l) any conditions for inclusion in the environmental authorisation;	Section 9,10

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	**Section of Report**
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 8
n) a reasoned opinion- i. (as to) whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, 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;	n/a
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	n/a
q) any other information requested by the competent authority.	n/a
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.	n/a

1. Introduction

1.1 Background to the current study

Red Cap Energy (Pty) Ltd is proposing to develop four solar facilities and associated grid connections, on behalf of four separate Project Applicants, collectively known as the Mura PV projects between Loxton and Beaufort West in the Beaufort West Local Municipality and Ubuntu Local Municipality and the Central Karoo District Municipality and Pixley ka Sema District Municipality. The proposed Mura PV projects are located in close proximity to the approved Nuweveld Wind Farm Development. The four solar facilities will be assessed within a combined specialist report.

The sites will be accessed via the R381, DR02317 and existing access roads. Each solar facility will connect to the Eskom grid via new 132 kV overhead lines (assessed in separate processes to the PV facilities) connecting the two on-site solar substations via adjacent Eskom switching stations to the approved Nuweveld Collector substation.

Five initial areas were selected to be screened from an environmental and technical perspective. Areas 1,3 and 4 have been screened out due to several constraints which has made development within these areas unfeasible.

For the assessment phase of the project, four sites, within two originally assessed areas of Areas 2 and 5, will be taken forward into the formal Assessment Phase of the development.

WSP has been appointed as the Environmental Assessment Practitioner (EAP) to manage the environmental impact assessment processes for the proposed development.

Since a project of this nature has the potential to impact on birds, WildSkies Ecological Services was appointed to conduct the specialist avifaunal assessment component of the basic assessment process. A screening site visit, and two pre-construction bird monitoring site visits were conducted on site.

1.2. Terms of reference

The typical terms of reference for a study of this nature are as follows:

- Provide status of bird habitats and identification of all ecologically sensitive areas;
- Identification of endangered species and their locations;
- Identify conservation worthy areas and how the proposed development can avoid them;

- Identify potential impacts and mitigation measures of the proposed infrastructure on the avifauna;
- Classification of each impact according to methods as outlined by WSP;
- Recommendation of the best management measures to mitigate any risk; and
- Identification of any monitoring required during operational phase.

1.3. Description of the proposed development

The following are proposed as part of each project. It should be noted that the areas under consideration for each solar project site should be assumed to be wholly transformed by the proposed projects and will contain the following:

A. Solar Field, comprising Solar Arrays:

- Maximum height of 6 m;
- PV Modules that are located on either single axis tracking structures or fixed tilt mounting structures or similar

B. Solar Farm Substation:

- Maximum height of 12m;
- Two up to 150 m x 75 m substation yards that will include:
- Substation building; and
- High voltage gantry.

C. Building Infrastructure:

- Maximum height of 8m;
- Offices;
- Operational and maintenance (O&M)/ control centre;
- Warehouse/workshop;
- Ablution facilities; and
- Converter/inverter stations.

D. Li-ion or similar solid state Battery Energy Storage System (BESS):

- Each solar farm will have up to a 4 ha area for a 240 MWac BESS;

- BESS substation (same specifications as the solar farm substations)
- Connected to the solar farm sub/switching stations via an underground high voltage cable.

E. Other Infrastructure located within the solar area footprint:

- Internal underground cables of up to 132 kV;
- Internal gravel roads;
- Fencing (between 2 – 3 m high) around the PV Facility;
- Panel maintenance and cleaning area;
- Storm water management system; and
- Construction site camps.

F. Associated Infrastructure (outside the solar area footprint but part of each solar project's application):

- Internal access gravel roads will have a 2-4 m wide driving surface and may require side drains on one or both sides. During construction the roads may be up to 12m wide but this will be a temporary impact and rehabilitated following the construction phase; and
- Up to two construction site camps located within the internal access road corridor.

Table 1 describes the details of each of the four solar projects. Figures 1 and 2 show the project layout.

Table 1. Project specific information (Solar)

Project Name	**Project Extent (full area to be transformed)**	**Road Access Area (existing roads to be upgraded including site camps)**	**Generation capacity**	**Affected Farm portions**
Mura Solar Project 1	176 ha	21 ha	Up to 150 MW	Leeuwkloof Farm 43 Portion 4 of Duiker Kranse Farm 45
Mura Solar Project 2	484 ha	21 ha	Up to 400 MW	Leeuwkloof Farm 43 Portion 4 of Duiker Kranse Farm 45 Bultfontein Farm 13
Mura Solar Project 3	395 ha	41 ha	Up to 320 MW	Leeuwkloof Farm 43 RE of Abrams Kraal Farm 206 Portion 4 of Duiker Kranse Farm 45 RE of Portion 3 of Duiker Kranse Farm 45 RE of Duiker Kranse Farm 45 Sneeuwkraal Farm 46 Aangrensend Abramskraal Farm 11

Mura Solar Project 4	425 ha	40 ha	Up to 360 MW	Leeuwkloof Farm 43 Aangrensend Abramskraal Farm 11 Portion 4 of Duiker Kranse Farm 45 RE of Portion 3 of Duiker Kranse Farm 45 RE of Duiker Kranse Farm 45 Sneeuwkraal Farm 46

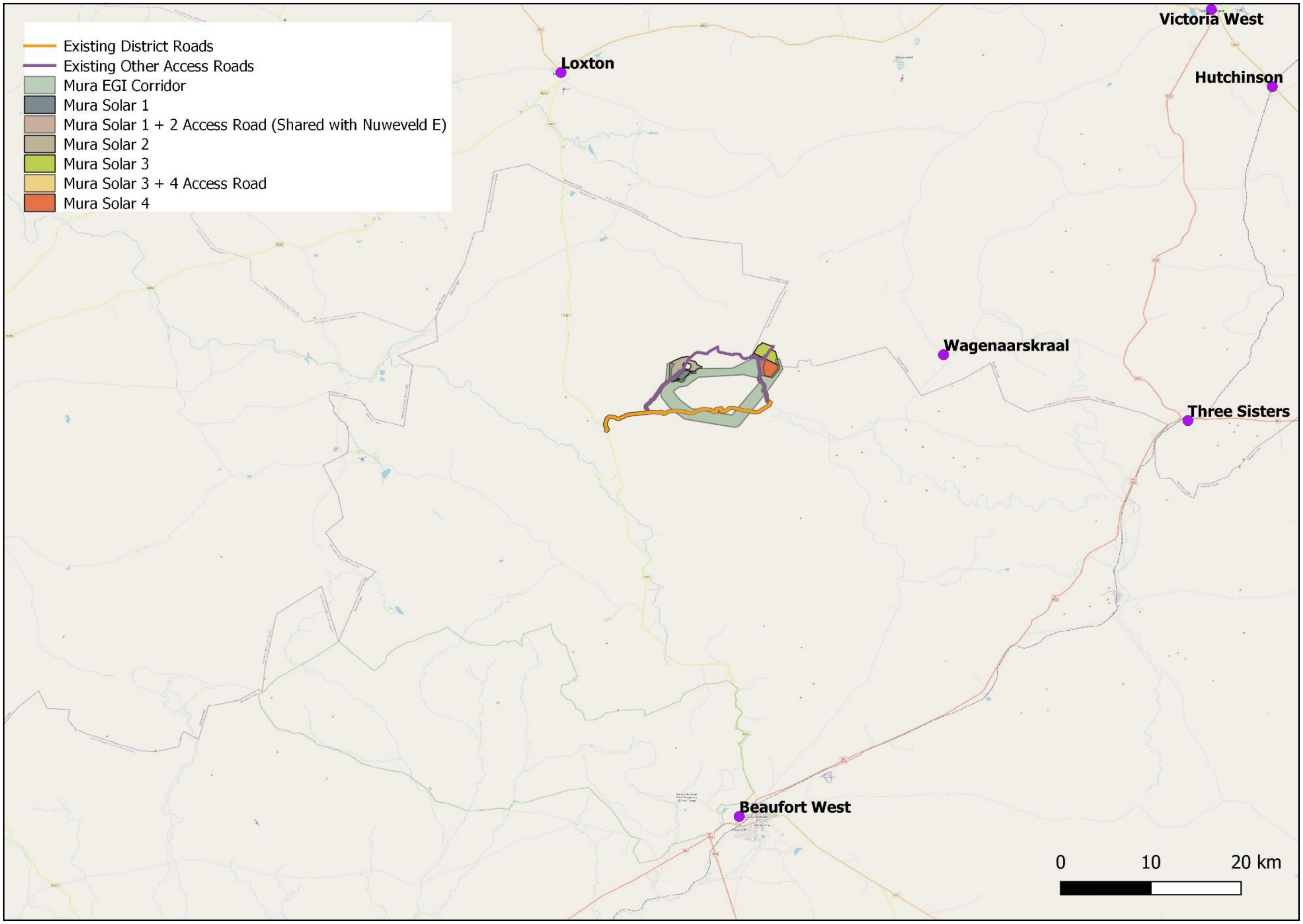

Figure 1. The location of the proposed project.

Figure 2. The layouts of the proposed projects.

1.4. Background to bird interactions with solar PV facilities

Photovoltaic technology uses cells to convert sunlight into electric current. Commercial scale facilities typically consist of the following components: PV modules; Inverters and power electronics; structural and wiring hardware; roads; fences; substations; and office buildings.

1.4.1 Habitat destruction

Due primarily to the surface area required for the PV modules or panels (typically approximately 2-5ha per MW – Ong *et al*, 2013; Hernandez *et al,* 2014 or 1.4 to 6.2 ha/MW according to US Department of Energy 2012) and the associated roads, substations, offices and its ancillary grid connection, solar PV facilities occupy a relatively large amount of land and therefore represent a significant anthropogenic land use in the environment (Walston *et al*, 2015). Lovich and Ennen (2011) and DeVault *et al* (2014) state that in 'many' cases vegetation removal is complete at PV facilities. Vegetation removal translates into habitat removal or destruction for bird species. Habitat removal is a consequence of almost any new form of development and is not particularly unique to solar PV energy. The significance of the habitat removal depends on factors such as: the amount of habitat affected; the uniqueness of the habitat; and the sensitivity and conservation status of the bird species utilizing that habitat.

1.4.2. Disturbance of birds & displacement effects

Construction of a facility of this nature requires a significant amount of machinery and labour to be present on site. For the more shy and sensitive bird species this could disturb them and displace them from the area at least for the duration of construction and possibly longer. In addition, species commuting around the area may avoid the site once operational (for approximately 20 years) and fly longer distances than usual as a result. For some species this may have critical energy implications. Disturbance of breeding birds is of particular concern since this could result in lower breeding productivity, total breeding failure, and/or temporary or permanent abandonment of the breeding site. All of these can have significant consequences for threatened bird species.

1.4.3. Bird fatality at PV facilities

Until recently very little information on bird fatality at PV facilities around the world was available. As a result, there was relatively low concern for this impact amongst ornithologists, certainly when compared to wind energy facilities for example. However, in the 2010 to 2015 period some data emerged from the USA which pointed towards the direct fatality impacts at PV facilities possibly being far greater than previously understood (Kagan *et al,* 2014; Walston *et al*, 2015). Bird fatalities were recorded in high numbers at at-least one site in the USA (Kagan *et al,* 2014; Walston *et al*, 2015; Walston *et al*, 2016).

Walston *et al* (2016) reviewed bird fatality information at Solar Energy Facilities (SEFs) across the USA (although finding that most information was available for a smaller area in California). They found that 3 facilities had systematically collected data on avian mortalities, one of which was a PV facility, the California Valley Solar Ranch project of 250MW. At this facility, a total mortality rate of 10.7birds/MW/year was recorded, consisting of

0.5birds/MW/year from known fatality causes (attributable to the facility) and 10.2birds/MW/year of unknown causes.

In addition to the above information, much has been written about the potential to attract certain bird guilds to a PV facility (Kagan *et al,* 2014). Glare and polarized light could attract insects and in turn foraging bird species (Horvάth *et al*, 2009). The PV panels provide shade for smaller species. The infrastructure can provide nesting substrate. The so called "lake effect" created by the reflective surfaces of the PV panels has been hypothesized to attract migrating waterfowl that then collide with the panels when they attempt to land (Kagan *et al*, 2014). To date no empirical research has been conducted on this "lake effect" (Walston *et al,* 2015) and it remains unproven. At the proposed facilities we do not identify any significant attractants. In particular, there will be no open water sources on site.

More locally, we are aware of one operational utility scale PV facility (the 96MW Jasper facility) which monitored impacts on birds and published the results (Visser, 2016, Visser *et al*, 2019). Seven bird mortalities were recorded during a 3 month period under the PV panels, although they could not all be attributed to a specific case of death since in almost all cases only feathers were found. An eighth bird fatality was found during the initial clearing of bird fatalities before the three months. Five bird species were killed during this study: Fiscal Flycatcher *Sigelus silens*; Eastern Clapper Lark *Mirafra apiata*; Orange River Francolin *Scleroptila levaillantoides*; Speckled Pigeon *Columba guinea*; and Red-eyed Bulbul *Pycnonotus nigricens*. Visser (2016) estimated the annual bird fatality rate at the site to be 4.5 fatalities per MW per year, although the confidence limits in this estimate were very high due to the low number of fatalities found. One fatality of a bird which became entangled in the perimeter fence was recorded (Orange River Francolin). Most fatality species showed an over representation on the facility when compared to the surrounds, indicating that they were possibly attracted to the facility. Bird species richness and diversity were found to be lower on the facility than on the border or off the facility. This indicates a possible displacement effect amongst certain bird groups, particularly those that favoured the woody vegetation previously present on the site.

It is important to understand that bird abundance and flight activity levels differ according to habitat availability, and other natural features. Therefore, the impact on birds through direct fatality is very site specific. The risk can be greatly reduced if the location of the project takes the following features relating to bird habitat into account: migratory flyways; wetlands; riparian vegetation; and availability of habitat amongst the arrays. Avoiding siting the solar project infrastructure in these sensitive areas can greatly reduce the impact on birds (Walston *et al*, 2015).

Birds can also be killed through collision with the overhead power line conductors/earth wires, electrocution on electrical infrastructure such as pole tops, substations and switching gear on site, in addition to entanglement in or collision with fences (this may be lessened by the use of mesh panel style fencing). Avian collision occurs when a bird physically strikes either the conductor or the earth (shield) wire of an overhead power line while in flight. Most heavily impacted upon are bustards, storks, cranes, and various species of water birds, owing to their morphology and propensity for low level flights. Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004). The larger bird species are most affected since they are most capable of bridging critical clearances on electrical hardware.

1.4.5. Nesting & other utilization of facility by birds

Various bird species are quick to seize a new opportunity for perching, roosting, or nesting, including on man-made structures (van Rooyen & Ledger 1999, de Goede 2011 and de Goede & Jenkins 2001). It is likely then that birds (particularly passerine and corvid species) could use certain parts of the proposed facility once commissioned (Visser *et al,* 2019). Whilst this nesting could be viewed as a positive impact for birds, it typically creates operational problems for the facility, which require management actions such as nest management in order to ensure that the nests don't interfere with operations or increase fire risk. Nest relocation or removal should be done only under permit from the provincial authority.

It is also likely that some small species will use the PV panels for shade and this will create a new microhabitat on the site. This should not adversely affect the operation of the equipment however and should also not lead to direct mortalities by these small species.

The impact of nesting of birds is of relatively low importance and is described only to be thorough. This impact will be managed reactively and has not been rated formally in Section 5.

1.4.6. Altered water runoff patterns

It is likely that altering the nature of the sites surface from natural vegetation to infrastructure, roads, gravel, and possible paving – will alter the way in which water moves on the site after rainfall and cleaning of infrastructure. If this is not carefully managed this could cause soil erosion and thereby alter more bird habitat than necessary by affecting off site areas. Increased runoff could also create moister conditions on or near the site thereby attracting more birds to the area and increasing the likelihood of other interactions with the facility.

This is a very minor impact and will be covered by general environmental good practice and will not be assessed formally in Section 5.

1.4.7. Chemical pollution associated with PV panel cleaning

It has been suggested (Jenkins *et al,* 2017) that pollution could occur if hazardous chemicals are used to clean PV panels once operational. This could have secondary effects on vegetation, invertebrate populations and in turn food availability and habitat for birds.

This is a very minor impact and will be covered by general environmental good practice, and will not be assessed formally in Section 5.

1.4.8. Contextualising solar energy avifaunal impacts

Walston *et al* (2015) stated that it is important to compare solar energy bird fatalities with bird fatalities from other anthropogenic sources. Several authors have done this already (including Erickson *et al*. 2005, 2014; Loss *et al*. 2013; Smallwood 2013; Sovacool 2013). Whilst such contextualization is important, care needs to be taken when using this approach as not all bird species are equally exposed to all of the sources of fatality, and not all comparisons are valid. Drawing comparisons between for example common passerines colliding in high numbers with high rise buildings in cities, and rare Red List bird species colliding with a PV facility in a rural landscape is not reasonable. Small numbers of fatalities of threatened species can far outweigh (in conservation importance) far greater numbers of fatalities of common bird species. Comparisons with other 'rurally' located developments such as wind energy may be far more valid. Importantly, any mortality associated with a new proposed development such as the proposed PV facilities is added to the existing mortality from all other sources for the species, they do not replace any of the other sources of mortality. For certain bird species, especially Red Listed species it is of critical importance than any new sources of anthropogenic impacts are avoided as far as possible, precisely because the existing other impacts are so difficult to mitigate reactively. Impacts of other forms of development on bird species should be used for context but cannot be used as justification for creating new impacts on those species in our opinion.

1.5. Relevant legislation

Various sets of legislation and policy frameworks are relevant to this specialist study and development, including the following:

- The Convention on Biological Diversity (CBD) is dedicated to promoting sustainable development. The Convention recognises that biological diversity is about more than plants, animals and micro-organisms and their ecosystems. It is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live. It is an international convention signed by 150 leaders at the Rio 1992 Earth Summit, and South Africa is a signatory.

- An important principle encompassed by the CBD is the precautionary principle, which essentially states that where serious threats to the environment exist, lack of full scientific certainty should not be used as a reason for delaying management of these risks. The burden of proof that the impact will not occur lies with the proponent of the activity posing the threat.

- The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or the Bonn Convention) aims to conserve terrestrial, aquatic and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nation's Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. Since the Convention's entry into force, its membership has grown steadily to include 117 (as of 1 June 2012) Parties from Africa, Central and South America, Asia, Europe and Oceania. South Africa is a signatory.

- The African-Eurasian Waterbird Agreement: the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) is the largest of its kind developed so far under the CMS. The AEWA covers 255 species of birds ecologically dependent on wetlands for at least part of their annual cycle, including many species of divers, grebes, pelicans, cormorants, herons, storks, rails, ibises, spoonbills, flamingos, ducks, swans, geese, cranes, waders, gulls, terns, tropic birds, auks, frigate birds and even the South African penguins. The agreement covers 119 countries from Europe, parts of Asia and Canada, the Middle East and Africa.

- National Environmental Management – Biodiversity Act - Threatened or Protected Species list (TOPS).

- The National Environmental Management Act 107 of 1998 (NEMA) Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Animal Species - This protocol replaces the requirements of Appendix 6 of the Environmental Impact Assessment Regulations and provides the criteria for the specialist assessment and minimum report content requirements for impacts on terrestrial animal species for activities requiring environmental authorisation. However there is no specific protocol for avifauna and solar facilities, so we have complied with the BirdLife South Africa best practice guidelines in this regard, as below.

- The "Best Practice Guidelines: Birds and Solar Energy: Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa." (Jenkins *et al,* 2017).

- The Species Environmental Assessment Guideline (SANBI, 2020) is applicable, this report adheres to the guideline.

1.6. Limitations & assumptions

Certain biases and challenges are inherent in the methods that have been employed to collect data in this programme. It is not possible to discuss all of them here, and some will only become evident with time and operational phase data, but the following are some of the key points:

- The presence of the ornithologist on site is certain to have an effect on the birds itself. For example during walked transects, certain bird species will flush more easily than others (and therefore be detected), certain species may sit undetected, certain species may flee, and yet others may be inquisitive and approach the observers.

1.7. The avifaunal specialist

The avifaunal specialist, Jon Smallie completed a BSC WILDLIFE SCIENCE (Hons) at the University of KwaZulu-Natal-Pietermaritzburg in 1998, and an MSC ENVIRONMENTAL SCIENCE at University of Witwatersrand in 2011. He has 20 years of experience working on bird conservation and impact assessment, in particular the interaction between birds and energy infrastructure. This includes 4 years managing the Eskom-Endangered Wildlife Trust Strategic Partnership. He is SACNASP registered (# 400020/06).

A full *curriculum vitae* can be seen in Appendix 2.

2. Study methods

The following information sources were consulted for this study:

- DFFE Online Screening Tool Report – drawn in September 2022;
- Bird distribution data from the South African Bird Atlas Projects 1 and 2 were obtained (October 2022) to ascertain which bird species occur in the study area (Harrison *et al.* 1997; www.sabap2.adu.org.za; www.mybirdpatch.adu.org.za);
- The conservation status of all bird species occurring in the study area was determined using The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland (Taylor, Peacock & Wanless, 2015) and the IUCN Red List version 2022.
- A description of the vegetation types occurring in the study area was obtained from The Vegetation of South Africa, Lesotho and Swaziland (Mucina & Rutherford 2018).
- The Important Bird & Biodiversity Areas programme of BirdLife South Africa was consulted (Marnewick, Retief, Theron, Wright, & Anderson, 2015). There are no IBBA's within close proximity to the proposed SEF. The closest IBA is the Karoo National Park IBA approximately 35km south of the site.
- The Coordinated Avifaunal Roadcount project was consulted (Young *et al,* 2003). One routes exists approximately 51km south of the projects.
- The avifaunal monitoring data and studies from the nearby Nuweveld Wind Farms and grid connection.

- Co-ordinated Waterbird Count Database (Taylor *et al,* 1999) was consulted determine if large concentrations of water birds, associated with South African wetlands, may occur within the study area. No sites exist within close proximity to the proposed projects. One site is approximately 16km north of the site.
- The recent "Best Practice Guidelines: Birds and Solar Energy: Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa. (Jenkins, Ralston-Paton & Smit-Robinson, 2017) was consulted for guidance on relevant aspects and for pre-construction bird monitoring requirements for the site.
- Primary species occurrence and abundance data were collected as per BirdLife guidelines (Regime 2: >150ha facility with medium avifaunal sensitivity) described in more detail below.
- At the time of writing no comment or input had been received from Interested & Affected Parties or stakeholders.

In accordance with the *BirdLife SA Birds & Solar Energy Best Practice Guidelines* (Jenkins *et al*, 2017) a site assessment (8 to 17 April 2022) and two pre-construction bird monitoring site visits (8 to 17 April 2022; 2 to 7 September 2022) were conducted on site. Pre-construction bird monitoring methods on site were as follows:

As per the BirdLife South Africa best practice guidelines, the site required 'Regime 2' monitoring since it is > 150 ha in size and Medium sensitivity as illustrated by the below extract from the guidelines:

Table 1. *Recommended avian assessment regimes in relation to proposed solar energy technology, project size, and known impact risks.*
Regime 1: One site visit (peak season); minimum 1-5 days.
Regime 2: Pre- and post-construction; minimum 2-3 x 3-5 days over 6 months (including peak season); carcass searches.
Regime 3: Pre- and post-construction; minimum 4-5 x 4-8 days over 12 months, carcass searches.

Type of technology[1]	Size[2]	Avifaunal Sensitivity[3]		
		Low	Medium	High
All except CSP power tower	Small (<30 ha)	Regime 1	Regime 1	Regime 2
	Medium (30-150 ha)	Regime 1	Regime 2	Regime 2
	Large (>150 ha)	Regime 2[4]	Regime 2	Regime 3
CSP power tower	All		Regime 3	

This means that two seasons of monitoring were required, one of which needed to be in peak season (wetter, warmer months). These are described below:

Season 1 (autumn):

- Conducted in April 2022.
- 10 days on site by one monitor.
- 5 Driven transects were conducted once on each site visit, to sample large terrestrials and raptors.
- 30 Walked transects were conducted to sample small passerine species (30 x 1 000m transects were done once each on each site visit).
- Focal sites. Any focal sites such as open water, pans etc. were identified on site and surveyed on each site visit. The existing power lines were surveyed for nests and priority bird species perching.
- All relevant Incidental observations during time on site were recorded.
- An overall species inventory was maintained for the site.
- Covering Areas 1 to 5 (Figure 3)

Season 2 (spring-summer):

- Identical methods to the above.
- Conducted in September 2022.
- Covering only Area 2 and 5 (Figure 3).

Figure 3 shows the layout of the above pre-construction bird monitoring activities. The Project Area of Influence (PAOI) was defined as the area shown as sampled in Figure 3, including driven transects which extend slightly off site. Data collection was conducted for the full site as a whole, although care was taken not to neglect any one of the individual areas. This means that a very strong data set covering a wider area, is applied to each project, in addition to having 'project specific' data where needed. Since birds are mobile it is always good to study a larger area than the actual proposed footprint to ensure that the understanding of the avifaunal community is complete.

The first season covered Areas 1 to 5, whilst the second season covered only Areas 2 and 5 as the others had been designed out through environmental and technical screening. At Area 2 the walked transects shown in Figure 3 were moved into the proposed PV area to get better representation.

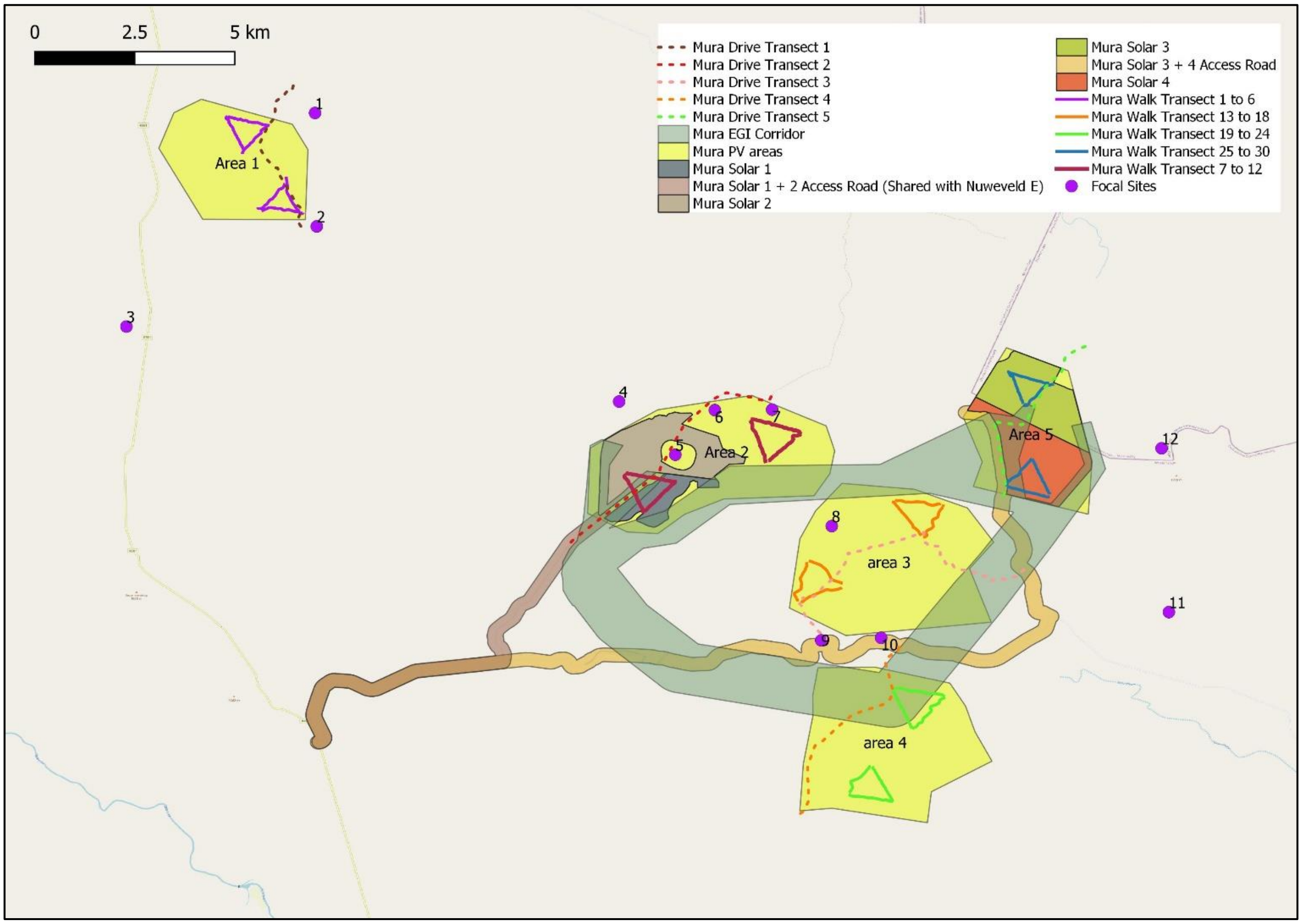

Figure 3. Layout of pre-construction bird monitoring activities on site.

3. Site sensitivity verification

In accordance with GN 320 and GN 1150 (20 March 2020) of the NEMA EIA Regulations of 2014 (as amended), prior to commencing with a specialist assessment, a site sensitivity verification must be undertaken to confirm the current land use and environmental sensitivity of the proposed project area as identified by the National Web-Based Environmental Screening Tool (i.e., Screening Tool).

The Screening Tool classifies the proposed project sites as follows:

Mura 1 (Figure 4)

- Animal Theme rated as High sensitivity, with Ludwig's Bustard *Neotis ludwigii* listed.
- Avian Theme rated as Low sensitivity
- Terrestrial Biodiversity Theme rated as Low sensitivity

Mura 2 (Figure 5)

- Animal Theme rated as High sensitivity, with Ludwig's Bustard listed.
- Avian Theme rated as Low sensitivity
- Terrestrial Biodiversity Theme rated as Very High sensitivity as the site intersects slightly with CBA1 areas.

Mura 3 (Figure 6)

- Animal Theme rated as Medium sensitivity, with Ludwig's Bustard listed.
- Avian Theme rated as Low sensitivity
- Terrestrial Biodiversity Theme rated as Low sensitivity

Mura 4 (Figure 7)

- Animal Theme rated as Medium sensitivity, with Ludwig's Bustard listed
- Avian Theme rated as Low sensitivity
- Terrestrial Biodiversity Theme rated as Low sensitivity

Mura 1 and 2 Access roads (Figure 8)

- Animal Theme rated as High sensitivity, with Ludwig's Bustard and Verreaux's Eagle *Aquila verreauxii* listed
- Terrestrial Biodiversity Theme rated as Vey High sensitivity due to some intersection with CBA 1 and ESA1 areas

Mura 3 and 4 Access roads (Figure 9)

- Animal Theme rated as High sensitivity, with Ludwig's Bustard and Verreaux's Eagle *Aquila verreauxii* listed
- Terrestrial Biodiversity Theme rated as Vey High sensitivity due to some intersection with CBA 1 and ESA1 areas

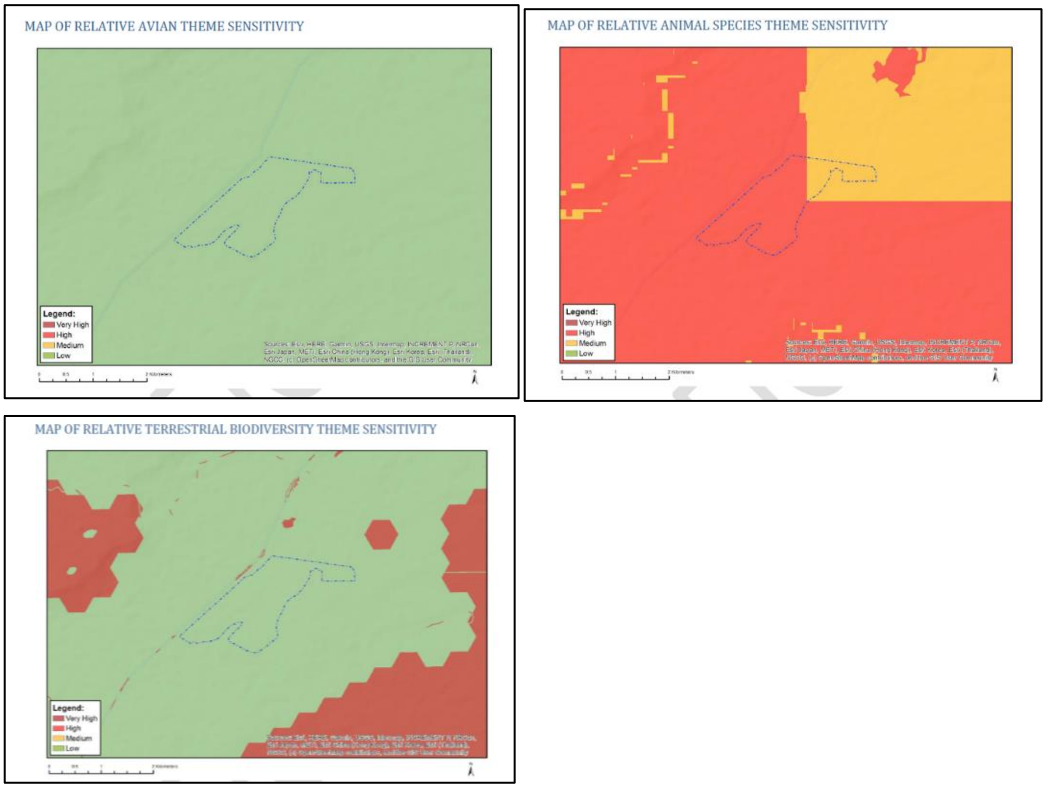

Figure 4. The screening tool outputs for Mura 1.

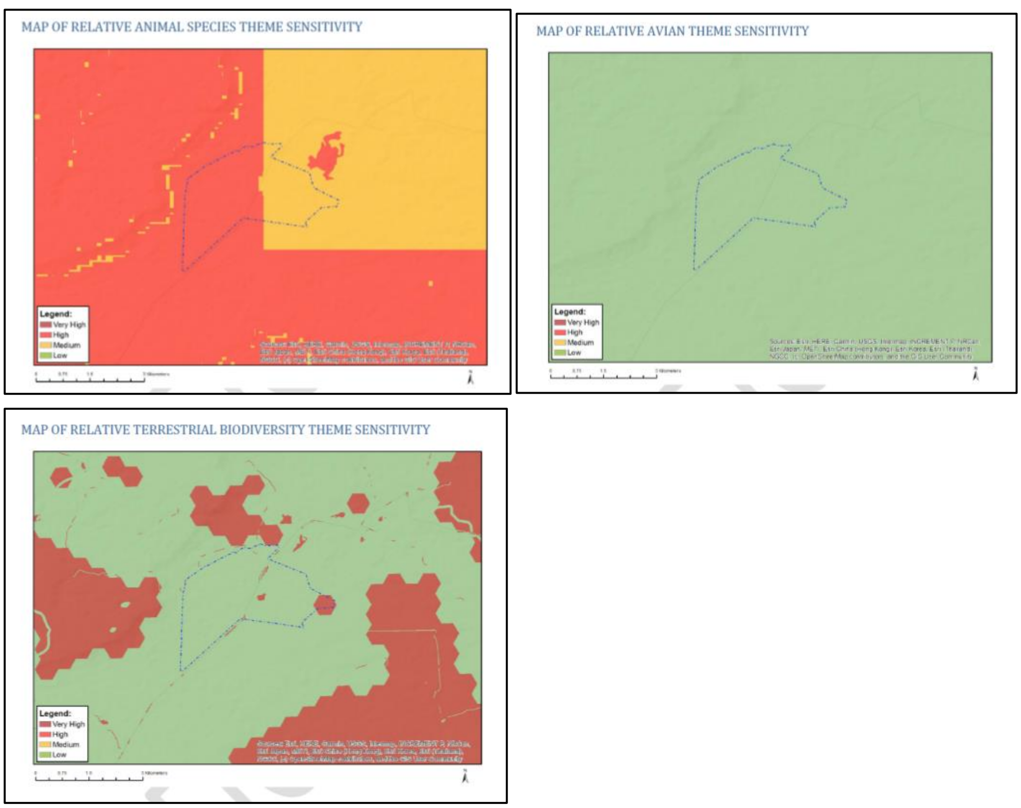

Figure 5. The screening tool outputs for Mura 2.

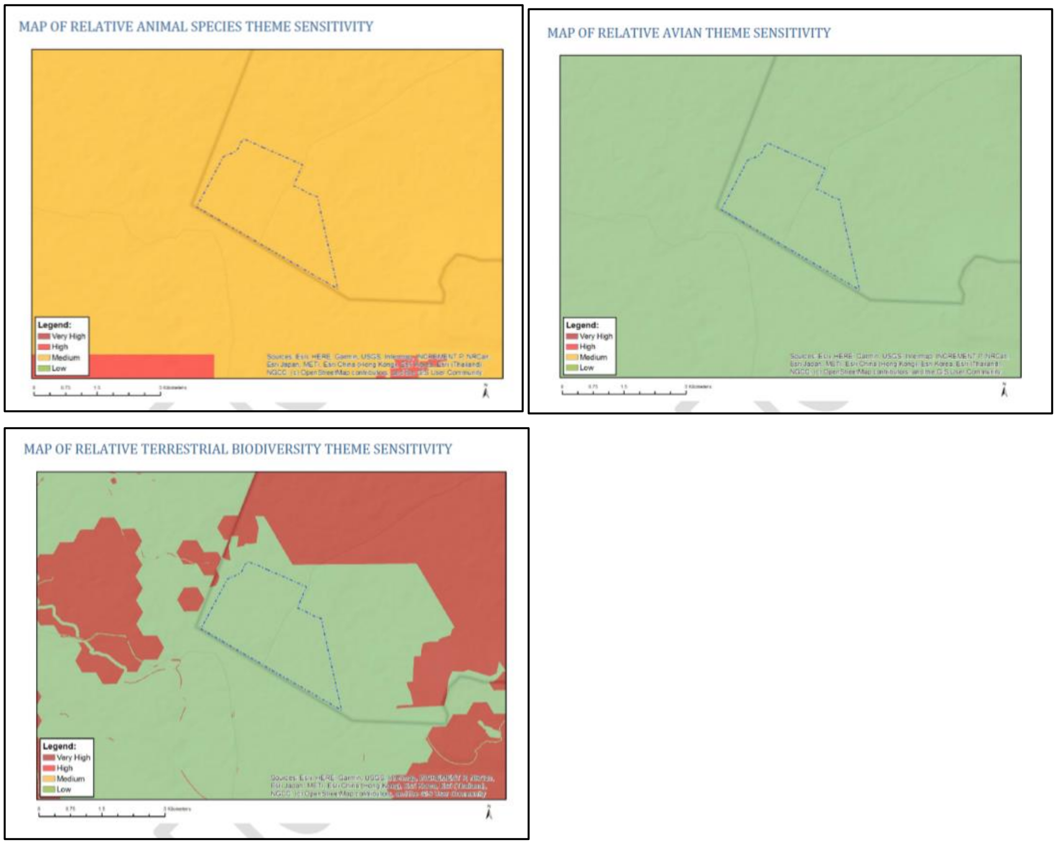

Figure 6. The screening tool output for Mura 3.

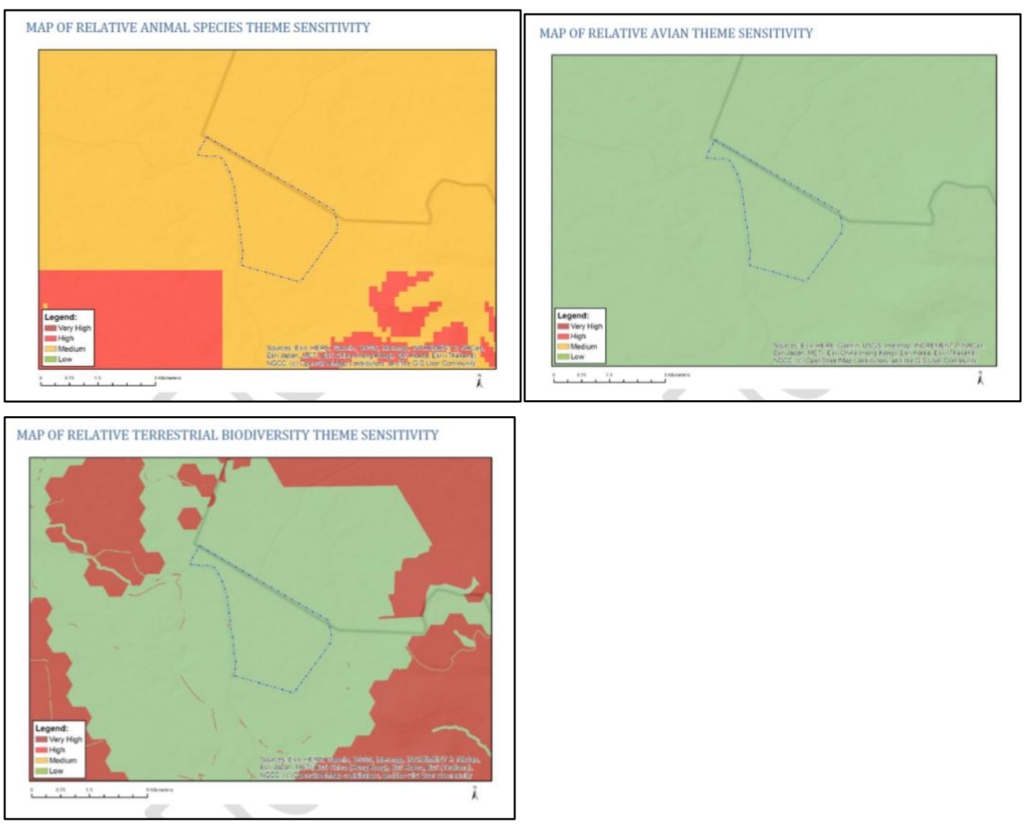

Figure 7. The screening tool output for Mura 4.

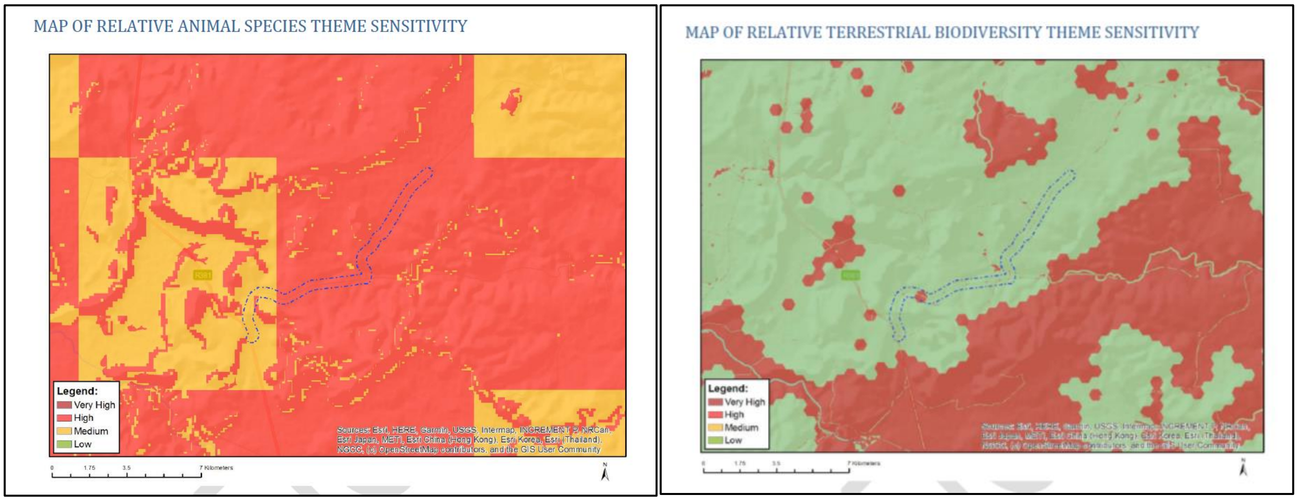

Figure 8. The screening tool output for Mura Access roads 1 and 2.

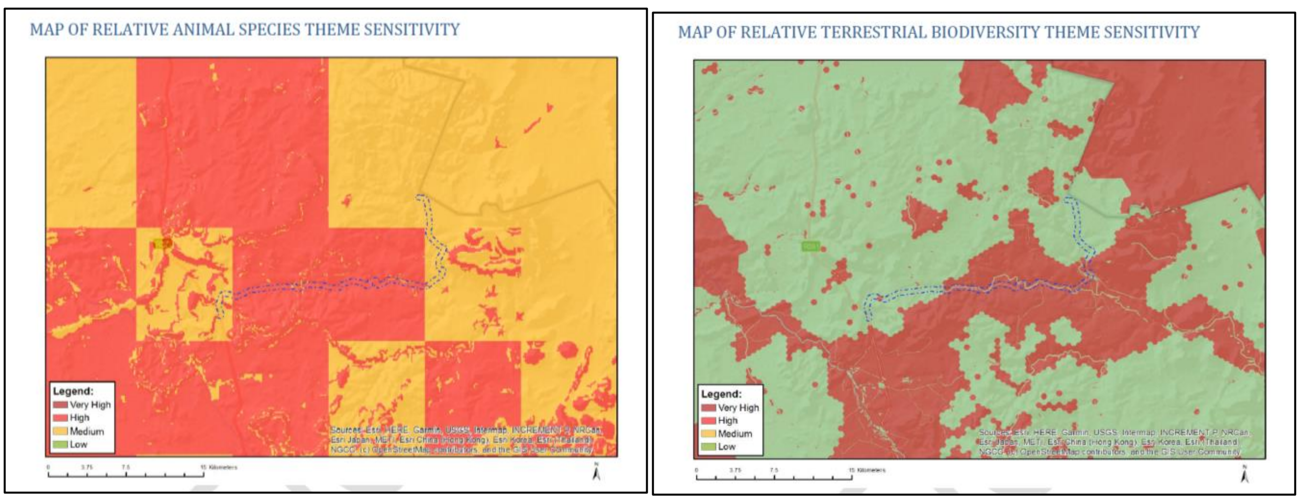

Figure 9. The screening tool output for Mura Access roads 3 and 4.

The screening tool findings are summarised in Table 2.

Table 2. Summary of screening tool ratings.

Theme	**MURA 1**	**MURA 2**	**MURA 3**	**MURA 4**	**MURA 1 and 2 Access Roads**	**MURA 3 and 4 Access Roads**
Animal species	High (Ludwig's Bustard)	High (Ludwig's Bustard)	Medium (Ludwig's Bustard)	Medium (Ludwig's Bustard)	High (Ludwig's Bustard & Verreaux's Eagle)	High (Ludwig's Bustard & Verreaux's Eagle)
Avian	Low	Low	Low	Low		
Terrestrial Biodiversity	Low	Very High	Low	Low	Very High	Very High

Based on a site verification survey, two seasons of pre-construction bird monitoring (in accordance with best practice), and extensive previous work in the area for the Nuweveld Wind Farms, we draw the following conclusions:

- The two listed species: Ludwig's Bustard; and Verreaux's Eagle do occur on the proposed site (see Section 4).
  - Ludwig's Bustard has been recorded as follows on site: twice on drive transects in spring (1 and 3 birds); four times as incidental records of single birds and pairs. The species can be expected to forage on site at times. However, no evidence of breeding was recorded.
  - Verreaux's Eagle has been recorded twice (both single birds) incidentally and has a nest approximately 5.2km south-west of south of Mura 3 and 4, which has been protected by a 2km No-Go buffer (see Section 7).

Based on our on-site work we confirm that the site is of Medium sensitivity for avifauna.

4. Description of baseline conditions

4.1 Vegetation description

According to Mucina and Rutherford (2018), the proposed projects are located entirely within “Eastern Upper Karoo” vegetation type. Flats and gently sloping plains are found within the Eastern Upper Karoo vegetation unit, which is ‘Least Threatened’ and has the largest mapped area of all units in the country. The entire site is comprised of this vegetation unit. Dwarf microphyllous shrubs dominate this landscape and ‘white’ grasses (*Aristida* and *Eragrostis* species) are prominent after good summer rains. Karoo scrub species of *Pentzia*, *Eriocephalus*, *Rosenia* and *Lycium* are important taxa (Mucina & Rutherford 2012). Beaufort Group sandstones and mudstones are common in this vegetation unit, and some Jurassic dolerites are also to be found. Mean annual precipitation ranges from 180 – 430mm per year (west to east), peaking in March, and frost incidence is relatively high (30 – 80 days per year).

Functionally in avifaunal terms, the site can be classified as Karoo shrubland. Often more important than vegetation type in determining avifaunal diversity and abundance, are the micro habitats available for birds. Micro habitats are determined by multiple factors, including but not limited to vegetation type. Anthropogenic factors such as land use, construction of dams etc. are a significant factor. At the proposed site the micro habitats available to birds are: dams, Karoo shrubland, exotic trees (mostly at homesteads), rivers, ridge/cliff lines. These micro habitats are pictured in Figure 10.

Figure 10. Photographs of micro habitats on and near site.

4.2. Avifaunal community on site

4.2.1. Southern African Bird Atlas Project data

Up to approximately 220 species were recorded in the broader area by the first and second Southern Africa Bird Atlas Projects (www.sabap2.adu.org.za). These birds were not necessarily recorded on the Mura site itself but are an indication of which species could occur on site if conditions and habitats are right. Of the 220 species approximately 71 were classified in the top 200 at risk species by Retief *et al* (2014). Four species are regionally Endangered (Ludwig's Bustard, Black Harrier *Circus maurus*, Martial Eagle *Polemaetus bellicosus* & Yellow-billed Stork *Mycteria ibis*), five are Vulnerable, and 6 are Near-threatened. Two species (Ground Woodpecker *Geocolaptes olivaceus* & Curlew Sandpiper *Calidris ferruginea*) are Least Concern regionally but Near-threatened globally (IUCN 2022).

4.2.2. Pre-construction bird monitoring data

Whereas the atlas data described above shows which species could occur on the site since they have been recorded in the broader area, our own monitoring data confirms those species definitely occurring on the site. The species diversity on the proposed site itself is lower, due to its smaller size and lower habitat diversity.

A total of 88 bird species were recorded on site by all our pre-construction bird monitoring methods (Appendix 1). Five of these 88 species are regionally Red Listed: Ludwig's Bustard is Endangered; Verreaux's Eagle is Vulnerable; and Karoo Korhaan *Eupodotis vigorsii*, Blue Crane *Grus paradisea* and Sclater's Lark *Spizocorys sclateri* are Near-threatened (Taylor *et al*, 2015).

Small Passerine Bird Data (walked transects)

Table 3 presents a summary (full programme of 6 months) results for those species for which > 10 individuals recorded) of the bird data collected by walked transects during the monitoring period (see Appendix 2 for the full dataset). A total of 37 bird species were recorded by this method. One of the 37 species is regionally Red Listed, the Sclater's Lark (Near-threatened, Taylor *et al*, 2015). One record of a pair of these larks was made in spring on Area 2 (Mura 1 and Mura 2). The most abundant species was Black-headed Canary *Serinus alario*, followed by Namaqua Sandgrouse *Pterocles Namaqua* and Sickle-winged Chat *Cercomela sinuata*. Overall, this is a rather unremarkable bird species diversity, reflecting the relatively uniform nature of the habitat on site.

Large terrestrial and raptor data (driven transects)

Table 4 summarises the findings from driven transects on site across the 6 months (the full dataset can be seen in Appendix 3). In total, 9 species were recorded in the period. Three regionally Red Listed species are included: Karoo Korhaan (Near-threatened), Blue Crane (Near-threatened) and Ludwig's Bustard (Endangered). The most abundant species was Karoo Korhaan, which was predominantly recorded in pairs.

Incidental observations

Incidental records of priority bird species were made during both site visits and comprised a total of 13 species (Table 5) (Appendix 4 shows the full dataset). Five of the recorded species are regionally Red Listed (Taylor *et al*, 2015): Ludwig's Bustard is Endangered; Verreaux's Eagle is Vulnerable; and Karoo Korhaan, Blue Crane and Sclater's Lark are Near-threatened. These incidental data are not used formally as they are not the product of systematic sampling. They do however assist in assessing how frequently various species are seen, and in what abundance.

Focal sites

The two most important Focal Sites monitored by this programme are a Martial Eagle nest and a Verreaux's Eagle nest (both some distance off the proposed project sites now that certain areas have been screened out). The Martial Eagle nest became irrelevant when PV Area 1 was dropped from the project design as it is too far from the proposed areas to be relevant. The Verreaux's Eagle nest also became less relevant to the study once the PV Areas 3 and 4 closest to it were excluded from the project. The nest was active in 2021 according to farm workers but does not seem to have had successful breeding in the 2022 breeding season. The results are summarised in Table 6.

Table 3. Summary data from walked transects on site.

Species	Birds	Records	Birds/km
Black-headed Canary	760	104	18.10
Namaqua Sandgrouse	209	46	4.98
Sickle-winged Chat	157	96	3.74
Lark-like Bunting	119	38	2.83
Spike-heeled Lark	98	27	2.33
Rufous-eared Warbler	70	43	1.67
Capped Wheatear	51	41	1.21
Karoo Eremomela	51	24	1.21
Grey-backed Sparrow-Lark	47	6	1.12
Large-billed Lark	44	28	1.05
White-necked Raven	40	16	0.95
Karoo Long-billed Lark	33	29	0.79
Bokmakierie	29	21	0.69
Karoo Chat	28	23	0.67
Speckled Pigeon	28	7	0.67
Red-capped Lark	27	11	0.64
Pied Crow	23	10	0.55
Cape Bunting	22	9	0.52
Cape Sparrow	22	7	0.52
Mountain Wheatear	20	14	0.48
South African Shelduck	18	9	0.43
African Pipit	17	12	0.40
Yellow-bellied Eremomela	17	9	0.40
Karoo Scrub Robin	16	9	0.38
White-throated Canary	16	11	0.38
Black-eared Sparrow-Lark	12	1	0.29
Cape Turtle Dove	11	8	0.26
Namaqua Dove	10	5	0.24

Table 4. Summary data from driven transects on site.

Transect length (km)	49		
	Birds	Records	Birds/km
Karoo Korhaan	30	12	0.61
Blue Crane	10	3	0.20
Double-banded Courser	6	3	0.12
Ludwig's Bustard	4	3	0.08
Jackal Buzzard	2	2	0.04
Pied Crow	2	2	0.04
Temminck's Courser	2	1	0.04
African Harrier-Hawk	1	1	0.02
Rock Kestrel	1	1	0.02

Table 5. Summary of incidental observations recorded on site.

# species	13	
Species	**Birds**	**Records**
Karoo Korhaan	104	46
Grey-winged Francolin	12	6
Ludwig's Bustard	12	10
Blue Crane	10	3
Double-banded Courser	6	3
Jackal Buzzard	3	3
Sclater's Lark	3	2
Verreaux's Eagle	2	2
Rock Kestrel	2	2
Spotted Eagle-Owl	1	1
Pale Chanting Goshawk	1	1
African Harrier-Hawk	1	1
Temminck's Courser	1	1

Table 6. Summary of Focal Site findings.

Focal site	Type	Season 1	Season 2
1	Dam	Nothing seen	n/a
2	Dam	Egyptian Goose, Blacksmith Lapwing	n/a
3	Martial Eagle nest	Nothing seen	No records
4	Medium size nests	Nothing seen	No records
5	Dam	Egyptian Goose, SA Shelduck	2 Pied Avocet
6	Dam	SA Shelduck	4 Pied Avocet, 4 SA Shelduck
7	Dam	Egyptian Goose, Blacksmith Lapwing, SA Shelduck	Cape Teal x 2
8	Dam	Nothing seen	Nothing, dam dry
9	Cliff	Verreaux's Eagle occupied nest, Hamerkop nest	Inactive
10	Cliff & river	SA Shelduck, African Spoonbill, Blacksmith Lapwing, Egyptian Goose, African Black Duck	Jackal Buzzard nest active
11	Cliff	Nothing seen	No records
12	Cliff	Nothing seen	No records

4.2.3 Important Bird & Biodiversity Area (IBA) data

The closest Important Bird and Biodiversity Area (IBA - Marnewick *et al*, 2015) is approximately 35 kilometres south of the study area at its closest point, the Karoo National Park IBA. Although this is geographically quite distant, the avifaunal community is believed to be fairly similar and is discussed further below.

The Karoo National Park is in the semi-arid central Karoo and is approximately 90 000 hectares in size. The IBA contains the Nuweveld escarpment with peaks over 1900 metres above sea level and plains at 900m.a.s.l. The climate is one of extremes, with very hot summers and very cold winters, particularly on top of the escarpment. Average annual rainfall is 260mm p.a. Up to 231 bird species have been recorded in the IBA, which is extremely important for Namib-Karoo biome restricted species such as Black-headed Canary, Swee Waxbill *Coccopygia melanotis*, Cape Rockjumper *Chaetops frenatus*, Protea Seedeater *Crithagra leucoptera*, Cape Siskin *Crithagra totta*, Victorin's Warbler *Cryptillas victorini* and Hottentot Buttonquail *Turnix hottentottus*. The plains are particularly good for Ludwig's Bustard, Karoo Korhaan, Spike-heeled Lark, Karoo Lark *Calendulauda albescens*, Grey-backed Sparrow-lark *Eremopterix verticalis*, Tractrac Chat *Emarginata tractrac*, Karoo Chat *Emarginata schlegelii*, Karoo Eremomela *Eremomela gregalis*, Rufous-eared Warbler *Malcorus pectoralis*, and Black-headed Canary. The riverine woodland along drainage lines holds Namaqua Warbler *Phragmacia substriata* and other species. The cliffs hold Verreaux's Eagle, Booted Eagle *Hieraaetus pennatus* and Black Stork *Ciconia nigra*.

IBA trigger species include: Martial Eagle, Blue Crane, Black Harrier, Secretarybird *Sagittarius serpentarius*, Kori Bustard *Ardeotis kori* and Ludwig's Bustard. Regionally threatened species are Verreaux's Eagle, Lanner Falcon *Falco biarmicus*, Black Stork, Karoo Korhaan and African Rock Pipit *Anthus crenatus*. Biome-restricted species that are common in the IBA include Karoo Long-billed Lark *Certhilauda semitorquata*, Karoo Chat, Namaqua Warbler, Pale-winged Starling *Onychognathus nabouroup*, Black-headed Canary, Layard's Tit-Babbler *Curruca layardi* and the locally common Karoo Korhaan. Uncommon species in this category include Ludwig's Bustard, Karoo Lark, Sclater's Lark, Black-eared Sparrow-lark *Eremopterix australis*, Tractrac Chat, Sickle-winged Chat, Karoo Eremomela and Cinnamon-breasted Warbler *Curruca subcoerulea*. The Beaufort West sewage works (within this IBA) is important for water birds particularly in dry times when little other surface water is present in the landscape. Greater Flamingo, Lesser Flamingo, South African Shelduck *Tadorna cana*, and Cape Shoveler *Spatula smithii* are regularly recorded here. Interestingly the town of Beaufort West itself is included in the IBA because there is a Lesser Kestrel *Falco naumanii* roost in trees in town.

4.2.4. Coordinated Avifaunal Roadcount (CAR) project

CAR counts are a census of birds (focussed on large terrestrial species) performed twice annually (in winter and summer) by volunteer birdwatchers driving set routes. The purpose is to provide population data for use in science, especially conservation biology, by determining findings about the natural habitats and the birds that use them. The closest CAR routes to the proposed site are approximately 51km south, below the escarpment. These data are too far from site to be of use.

4.2.5. Coordinated Waterbird Count (CWAC) project

There is one Coordinated Waterbird Count (CWAC) site approximately 16km north of the site (Slangfontein Dam) (Taylor *et al*, 1999). Bird species counted at this dam include all the usual waterfowl species such as Yellow-billed Duck *Anas undulata*, Egyptian Goose *Alopochen aegyptiaca*, South African Shelduck *Tadorna cana*, Cape Shoveler *Anas smithii*, and Red-billed Teal *Anas erythrorhyncha* (Table 7). None of these species were recorded in remarkable numbers. No flamingos were recorded at this dam to date, which is positive as flamingos would be susceptible to power line collision. Table 7 summarises these data.

Table 7. CWAC data from Slangfontein Dam (www.cwac.adu.org.za)

Common name	**Taxonomic name**	**Min**	**Avg**	**Max**
Duck, Yellow-billed	*Anas undulata*	44	44	44
Goose, Egyptian	*Alopochen aegyptiacus*	10	10	10
Greenshank, Common	*Tringa nebularia*	8	8	8
Heron, Black-headed	*Ardea melanocephala*	1	1	1
Heron, Grey	*Ardea cinerea*	1	1	1
Ibis, African Sacred	*Threskiornis aethiopicus*	10	10	10
Ibis, Hadeda	*Bostrychia hagedash*	1	1	1
Lapwing, Blacksmith	*Vanellus armatus*	9	9	9
Plover, Kittlitz's	*Charadrius pecuarius*	15	15	15
Plover, Three-banded	*Charadrius tricollaris*	3	3	3
Ruff, Ruff	*Philomachus pugnax*	8	8	8
Sandpiper, Curlew	*Calidris ferruginea*	14	14	14
Shelduck, South African	*Tadorna cana*	11	11	11
Shoveler, Cape	*Anas smithii*	2	2	2
Teal, Red-billed	*Anas erythrorhyncha*	55	55	55
Wagtail, Cape	*Motacilla capensis*	18	18	18

4.3 Description of Species of Conservation Concern for this site

Given the large number of species within the broader study area, it is necessary to prioritise the species most relevant to the proposed development to streamline the impact assessment process. Relevant to this study, Species of Conservation Concern (SCC) include regionally and globally Red Listed species (Taylor, 2015; IUCN, 2022) and endemic species, especially those that may be susceptible to solar energy impacts.

Taking the above data sources described in Section 4.2 into account, the SCC species were identified and are presented in Table 8. Table 8 provides an annotated list of the identified species. The likelihood of each of these species occurring on the proposed site, the likely importance of the site for each species, and potential impacts of the proposed facility were also rated in the table. The ratings are all the same for all four PV sites, since the species involved were recorded in the broader area and are mobile, so are considered to occur on all the sites.

Table 8. Identified Species of Conservation Concern (SCC) for the proposed projects.

Common name	Taxonomic name	Taylor *et al* 2015, IUCN 2022	Endemic /near	Likelihood of occurring on site	Relative importance of the site for species	Possible impacts	Overall risk
Ludwig's Bustard	*Neotis ludwigii*	EN, EN		Confirmed, likely forages on site frequently when conditions are right	Medium	Habitat destruction, Disturbance	High
Verreaux's Eagle	*Aquila verreauxii*	VU, LC		Confirmed, resident several kilometres off site and likely forages on site occasionally	High	Habitat destruction, Disturbance	Medium
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC		Confirmed, multiple pairs resident on site	Medium	Habitat destruction, Disturbance	High
Sclater's Lark	*Spizocorys sclateri*	NT, NT	1	Confirmed, one pair seen on site, likely occasional visitor	Medium	Habitat destruction, Disturbance	Medium
Blue Crane	*Grus paradisea*	NT, VU	1	Confirmed, likely resident in broader area	Low	Habitat destruction, Disturbance	Low

‘1’ denotes presence, not abundance; EN – Endangered; VU – Vulnerable; NT – Near-threatened; LC - Least Concern; RD (Regional, Global) – Regional Red List – Taylor *et al*, 2015; Global Red List – IUCN 2022.

Ludwig's Bustard (High risk)

The Ludwig's Bustard is classified as regionally Endangered by Taylor *et al* (2015). This physically large species is highly vulnerable to collision with overhead power (although not the scope of this report, still relevant as the proposed PV projects will give rise to new overhead power lines) and is also likely to be affected by disturbance and habitat destruction. This species was listed as globally Endangered in 2010 because of potentially unsustainable power line collision mortality, exacerbated by the current lack of proven mitigation and the rapidly expanding power grid (Jenkins *et al*. 2011). Ludwig's Bustard is a wide-ranging bird endemic to the south-western region of Africa (Hockey *et al*. 2005). Ludwig's Bustards are both partially nomadic and migratory (Allan 1994, Shaw 2013, Shaw *et al*, 2015), with a large proportion of the population moving west in the winter months to the Succulent Karoo. In the arid and semi-arid Karoo environment, bustards are also thought to move in response to rainfall, so the presence and abundance of bustards in any one area are not predictable.

Ludwig's Bustard is likely to be susceptible to two possible impacts associated with a solar PV facility: habitat destruction, and disturbance. We recorded Ludwig's Bustard on the proposed sites in both seasons. Most records were of 1 or 2 individual birds. We believe that small influxes of Ludwig's Bustards onto site could occur at times when conditions are right on site. Based on the species' conservation status, we consider this species to be at High risk at this site.

Verreaux's Eagle (Medium risk)

The Verreaux's Eagle has recently been up-listed in regional conservation status to Vulnerable (Taylor *et al.* 2015) in recognition of the threats it is facing. This species tends to occupy remote mountainous areas largely unaffected by development (until the advent of wind energy in SA). A pair can typically use several alternate nests in different seasons, varying from a few metres to 2.5km apart (in Steyn, 1989). Approximately 400 – 2 000 pairs exist in the Western and Northern Cape (Hockey *et al*. 2005). These eagles can exist at quite high density compared to other eagle species, with some territories as small as 10km² in the Karoo (Davies, 2010 – www.africanraptors.org – work done on Nuweveld Escarpment) and 10.3km² in the Matopos in Zimbabwe (Steyn, 1989). Davies found a range of territory size from 10 to 50km², with an average size of 24km² in the Karoo of South Africa, and nests were approximately 2 kilometres apart on average.

At the proposed sites we have recorded a Verreaux's Eagle nest within the broader area (5.2km south-west of Mura 4). We categorised a 2km radius around this nest as No-Go for new development. This resulted in the impact avoidance measures taken by the developer in excluding the closest PV area from development.

This species is likely to be susceptible to two possible impacts at a solar PV facility: habitat destruction, and disturbance. Based on our data collected on site to date, we conclude that this species is at Medium risk. This risk would have been High if avoidance had not already been applied through the application of the no-go buffers around the nest.

Karoo Korhaan (High risk)

Karoo Korhaan is classified as Near-threatened regionally (Taylor *et al*, 2015). This species is suspected to have undergone a reduction in population and range (Taylor *et al,* 2015). Karoo Korhaan could be susceptible to two possible impacts at a solar PV facility: habitat destruction, and disturbance. We have recorded this species consistently on the proposed sites through all site visits, mostly in pairs and small family units. Based on these data we judge the species to be at High risk at the proposed site, primarily through habitat destruction and disturbance.

Sclater's Lark (Medium risk)

The Sclater's Lark is Near Threatened regionally and globally (Taylor et al, 2015, IUCN, 2022). This is an uncommon, localised, species that is found in the Karoo. There is currently no population estimate for the species', mostly due to incomplete survey data due to its remote habitats and inconspicuous nature. We recorded a single pair of Sclater's Lark once on Mura PV 3 and 4 in spring through walked transects. Two incidental records of the species were also made on Mura PV 3 and 4 in spring, a single bird, and a pair. This species could be susceptible to habitat destruction, disturbance, and possibly direct mortality at solar PV facilities. Given our current understanding of direct mortality at PV facilities (and information from Visser *et al,* 2019) and the Sclater's Lark we believe that direct mortality is not likely to be significant.

Blue Crane (Low risk)

The Blue Crane is classed as Near-threatened regionally by Taylor *et al* (2015) and Vulnerable globally (IUCN, 2021). It is almost endemic to South Africa (a small population exists in Namibia) and is the South African national bird. It has the most restricted range of any of the 15 crane species worldwide. The population is estimated at a minimum of 25 000 birds (Taylor *et al*, 2015). The 2015 Red Data book on birds downgraded the species conservation status from Vulnerable (Barnes, 2000) to Near-threatened (Taylor *et al*, 2015). Globally the status remained the same at Vulnerable (IUCN, 2022). The species population is divided into three sub-populations: the eastern grasslands (2600 cranes), the Karoo (10 800 cranes) (within which the site is located); and the Western Cape (12 100 cranes). Of these the Western Cape population appears to have shown growth in recent decades, whilst the eastern grasslands population has declined or at best been stable, and the Karoo population has been stable.

At the proposed sites we have recorded the species several times, in pairs or small family units. Overall, we conclude that Blue Crane is at Low risk at the site, since no large flocks or congregation areas were recorded.

5. Evaluation of Impacts

The various potential impacts that could occur as a result of the proposed projects have been identified and discussed below and rated formally according to criteria supplied by WSP (Appendix 6). The ratings of impacts are summarised in Tables 9 and 10.

The proposed projects will consist of three phases: construction; operation; and decommissioning. The impact assessment findings below apply to all four Mura PV sites.

5.1. Construction phase

5.1.1. Habitat destruction associated with the construction of the facility

During the construction phase of this project, a certain amount of habitat destruction and alteration will take place. The nature of the proposed projects means that the majority of the development footprint (PV module) will be transformed from the current state to an industrial site. Most of this vegetation is currently in a fairly natural state. The amount of habitat that will be affected by each project (including the existing access roads that will be upgraded and site camps) is: Mura 1 – 198 ha; Mura 2 – 506 ha; Mura 3 – 436 ha; and Mura 4 – 466 ha.

We have judged the significance of this impact for each project to be of Moderate Negative Significance pre-mitigation. Since this habitat destruction is inevitable the significance will remain at Moderate Negative post mitigation. Although the Mura 1 project is much smaller in footprint than the other 3, this difference does not result in a difference in the categorical significance rating.

There is no specific mitigation required. Impact avoidance has already been implemented in the project design phase through the adherence to no-go buffers around sensitive receptors on site.

5.1.2. Disturbance of birds & displacement effects

Disturbance of avifauna during the construction of the projects is likely to occur. Disturbance of breeding birds is typically of greatest concern. In this regard any breeding sites of sensitive bird species would be the most important. We have not identified any such breeding sites at this stage, other than those identified during screening and where impacts have been avoided in the location of the proposed four solar projects. We conclude the significance of this impact to be of Low Negative Significance both with and without mitigation. There is no specific mitigation required.

5.2. Operational phase

5.2.1. Bird fatality at PV facility

Bird fatalities could occur at the site through a number of mechanisms, including collision with PV panels, entanglement in perimeter fence, electrocution in substations/electrical compounds, road kill and others. Based on results from operational PV facilities elsewhere in South Africa (Visser, 2016, Visser *et al*, 2019), we conclude that this impact will be of Moderate Negative Significance pre-mitigation. With mitigation, this impact can be reduced to Low Negative Significance. See Section 9 for mitigation measures.

5.3. Decommissioning phase

5.3.1. Disturbance of birds & displacement effects

Disturbance of avifauna during the decommissioning of the projects is likely to occur. Disturbance of breeding birds is typically of greatest concern. In this regard any breeding sites of sensitive bird species would be the most important. We have not identified any such breeding sites at this stage, other than those identified during screening and where impacts have been avoided in the project design. We conclude the significance of this impact to be of Low Negative Significance both with and without mitigation. There is no specific mitigation required.

5.4. Cumulative effects of development on avifauna in this area

Red Cap provided a map of renewable projects within 30km of the proposed site (Figure 11). Five wind farm complexes (mostly consisting of more than one wind farm each) exist within this area. In addition to the below listed projects, for each Mura PV project, the remaining three Mura projects should be considered as part of the cumulative impact.

- The three approved Nuweveld Wind Farm Projects
- The four approved Hoogland Wind Farm Projects
- The approved Nuweveld gridline
- The two approved gridline connections as part of the Hoogland Wind Farm Projects
- The proposed Gamma gridline project
- The proposed WKN Wind Farm Projects (Soutrivier and Taaibos)

The two cumulative impacts that are of most concern are: habitat destruction; and collision of birds with overhead lines. Since the power lines associated with the proposed Mura PV projects are assessed in a separate report, we will not discuss the cumulative power line impacts further in this report. We have rated habitat destruction as Moderate Negative pre mitigation. Habitat destruction remains at Moderate Negative significance even if all the projects in the area correctly mitigate, as the habitat destruction is inevitable.

The detailed impact assessment scoring (as per WSP methods) is presented in Table 9.

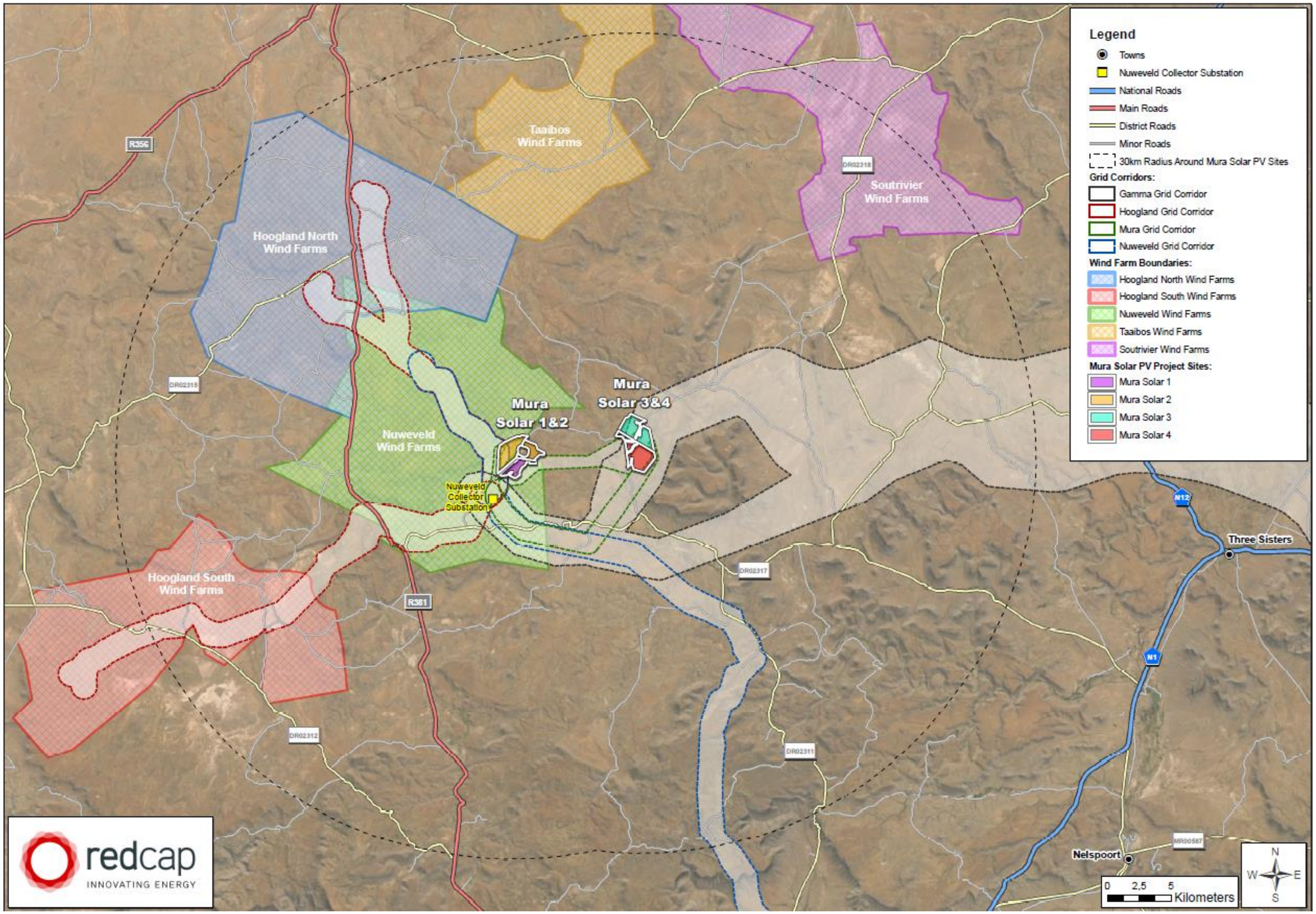

Figure 11. Summary of renewable projects within 30km of the site (supplied by Red Cap).

Table 9. Impact assessment scoring details.

CONSTRUCTION

Impact number	Aspect	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Impact 1:	Destruction of habitat	Habitat destroyed or altered in such a way as to render it unavailable to birds	Construction	Negative	Low	4	1	3	4	5	**60**	**N3**	4	1	3	4	5	**60**	**N3**
					Significance	**N3 - Moderate**							**N3 - Moderate**						
Impact 2:	Disturbance of birds	Birds are disturbed during construction impacting on breeding, foraging	Construction	Negative	Low	2	3	1	2	3	**24**	**N2**	2	3	1	2	3	**24**	**N2**
					Significance	**N2 - Low**							**N2 - Low**						

OPERATIONAL

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S		(M+	E+	R+	D)x	P=	S	
Impact 1:	Fatality of birds during operations	Birds killed through interaction with facility, collision with panels, fence entanglement	Operational	Negative	Low	2	3	5	4	3	**42**	**N3**	2	3	5	4	2	**28**	**N2**
					Significance	**N3 - Moderate**							**N2 - Low**						

DECOMISSIONING

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S		(M+	E+	R+	D)x	P=	S	
Impact 1:	Disturbance of birds	Birds are disturbed during decommissioning impacting on breeding, foraging	Decommissioning	Negative	Low	2	3	1	2	3	**24**	**N2**	2	3	1	2	3	**24**	**N2**
					Significance	**N2 - Low**							**N2 - Low**						

CUMULATIVE

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
						(M+	E+	R+	D)x	P=	S		(M+	E+	R+	D)x	P=	S	
Impact 1:	Destruction of habitat	Habitat destroyed or altered in such a way as to render it unavailable to birds	Cumulative	Negative	Low	4	3	3	4	4	**56**	**N3**	4	3	3	4	4	**56**	**N3**
					Significance	**N3 - Moderate**							**N3 - Moderate**						

5.6. Summary of impacts

Table 10 summarises the above impact assessment. It is noted that this applies to all four proposed Mura PV projects. All projects have the same ratings.

Table 10. Summary of assessment findings for all impacts

Phase	**Impact**	**Significance before mitigation**	**Significance after mitigation**
Construction	Destruction of habitat	Moderate Negative	Moderate Negative
	Disturbance of birds	Low Negative	Low Negative
Operations	Fatality of birds at facility	Moderate Negative	Low Negative
Decommissioning	Disturbance of birds	Low Negative	Low negative
Cumulative impacts	Cumulative impacts through habitat destruction	Moderate Negative	Moderate Negative

6. Comparison of alternatives

The proposed development is described in Section 1.3. No alternatives have been provided for the assessment. However extensive consideration of alternatives and avoidance of impacts took place in the screening/design phase. Initially five areas were considered for the PV projects, three of which were then excluded due to identified environmental sensitivities.

The No-go alternative has been assessed. The No-Go alternative or status quo would not impact on avifauna in any new way. Farming does have its' own impacts on birds, but they have evolved into co-existing for the large part, and most of the site is not intensively farmed (it being mostly livestock grazing).

7. Avifaunal sensitivity mapping

During the screening phase we identified sensitive areas on site for avifauna and delineated these and buffered them where necessary. Two sensitive avifaunal feature categories were identified on the site:

- Dams. Dams provide an open source of surface water and attract birds to drink, wash, feed and roost. These areas should be avoided by the proposed infrastructure. We used the SANFEPA and NBA2018 shape files to identify dams on site, of which there are relatively few. A buffer of 250m was applied to these dams and the resulting areas are classified as No-Go for new PV or overhead line infrastructure and roads (see Table 11). Use may be made of existing roads within these areas.

- Bird nests. Most of the sensitive nests in the broader area are sufficiently far from the proposed areas to be irrelevant to this phase of study. However, one Verreaux's Eagle nest was previously considered close enough to be relevant. An alternate nest for this pair of eagles also exists to the east. We have assigned a No-Go buffer for new infrastructure of 2km to these two nests (see Table 11). This buffer size is determined by our own judgement and is intended to provide protection against disturbance of the birds' breeding during construction and operations; and destruction of foraging habitat for the birds. This buffer size is less than half that required for wind farms, because direct mortality of eagles (through collision) is not likely on the PV facilities. This buffer area is considered a No-Go area for new PV infrastructure and new roads. Use may be made of existing roads (which may be widened) within this area.

Table 11. Avifaunal sensitivity features for solar areas.

Category	Feature
No Go	Dams plus 250m buffer Verreaux's Eagle nest x 2 (1 alternate) plus 2 000m buffer
High	
Medium	
Low	

Avifaunal constraints are presented in Figure 12 for the full site. There are no conflicts between the planned infrastructure and the No-Go areas.

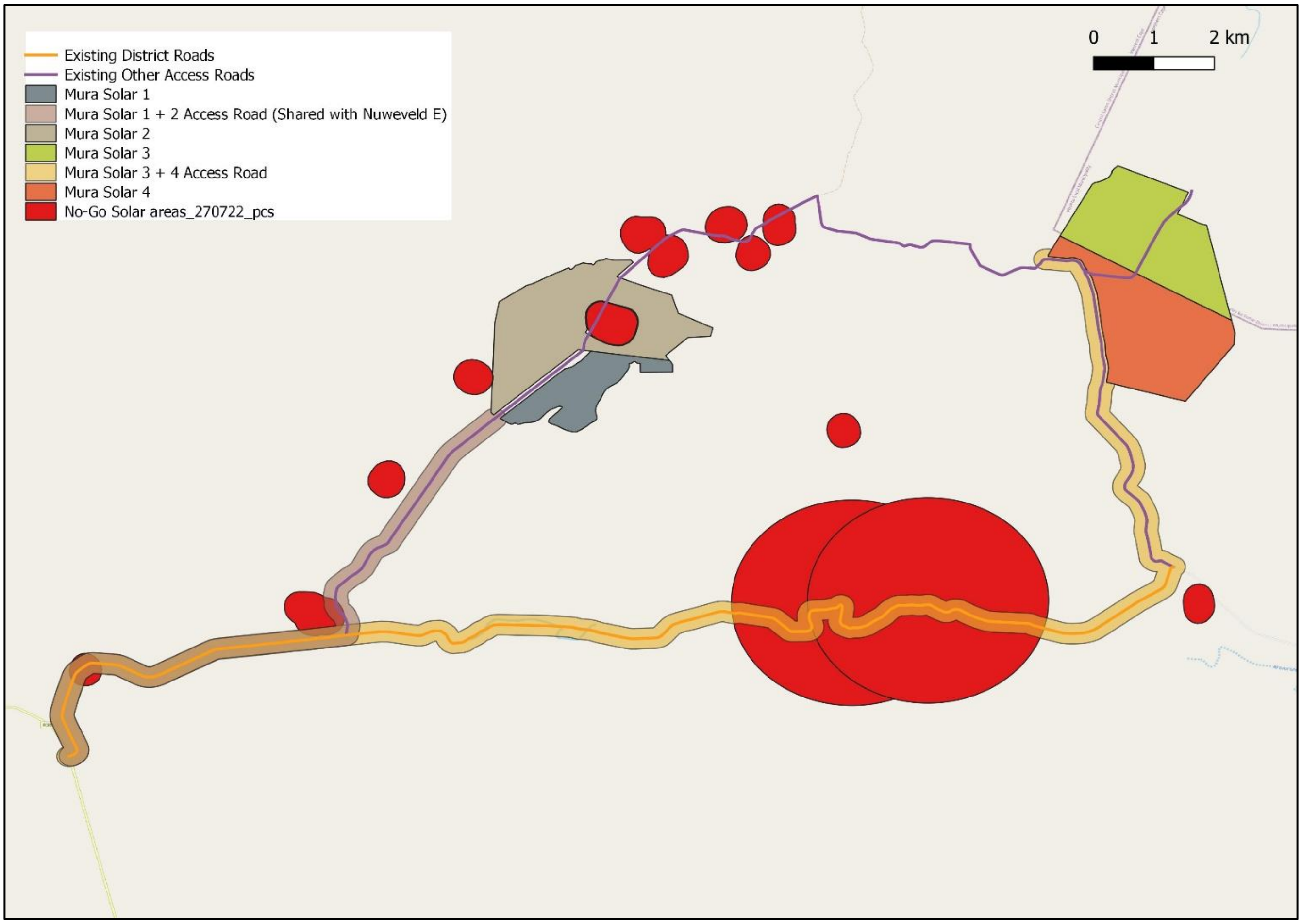

Figure 12. Avifaunal sensitivity of the overall PV site.

8. Operational phase monitoring framework

There are no avifaunal receptors which require 'during construction' phase monitoring.

Operational phase monitoring will however be required as stipulated in the best practice guidelines (Jenkins *et al*, 2017). This monitoring should be supervised by an independent avifaunal specialist. The fatality search component could possibly be done by facility staff under the specialist's supervision. The framework for such monitoring is as follows:

1. For Regime 2 projects (such as these proposed projects), post construction bird monitoring is necessary in order to:
    a. Determine the actual impacts of the facility
    b. Determine if additional mitigation is required
    c. Learn about impacts and improve future assessments

2. Post construction monitoring should be started as soon as the facility becomes operational
3. Post construction monitoring can be divided into three sections:
    a. Habitat classification (this is a once off exercise)
    b. Replicating pre-construction baseline monitoring (2 x site visits, one in peak season)
    c. Estimating bird mortalities. This will include: searching a minimum of 20% of the PV panel array for bird fatalities every 14 days for the full year; estimating searcher efficiency and carcass persistence through bias trials. Fences, electrical compounds, and other key infrastructure which may kill birds should also be searched.
4. Operational monitoring should be done for one year, and if significant impacts are recorded it can be extended to two years.
5. Quarterly reports summarising interim findings should be submitted to Birdlife South Africa and the DFFE.
6. Final year end reports with full results analysis should also be submitted to Birdlife South Africa and the DFFE.

9. Summary of Mitigation measures to be included in the EMPr

The following mitigation measures are recommended for these projects and must be included in each project's EMPr:

- The risk of electrocution of large birds in the substations should be managed reactively. If any such electrocutions are recorded once operational this should be reported to an ornithologist for suitable case specific mitigation measures.

- The risk of bird collision/entanglement with facility fences must be mitigated by using a fence design which is either highly visible to birds or has a tight enough mesh to avoid entanglement.

- All staff, vehicle and machinery activities should be strictly controlled at all times so as to ensure that the absolute minimum of surface area is impacted.

- A strict speed limit is to be enforced on site to minimise the risk of road kill. Driving at night time should also be kept to an absolute minimum.

- Care should be taken not to introduce or propagate alien plant species/weeds during construction.

- A carefully considered surface water/drainage management plan must be developed for the site including attention to the use of environmentally friendly cleaning chemicals.

- It is strongly recommended that rodenticides not be used at the newly established Operation and Maintenance (O&M) buildings or around auxiliary infrastructure on the project site. While pest control of this nature may be effective, even so-called “environmentally friendly” rodenticides are toxic and pose significant secondary poisoning risk to predatory avifauna, especially owls.

- General good environmental practice should be implemented during construction in terms of control of vehicles, staff, minimising the impact on the receiving environment as much as possible.

- Once operational, if facility staff identify any bird fatalities this should be reported on fully through the sites incident reporting system. A suitably qualified ornithologist should be consulted for any case specific reactive mitigation measures.

- Operational phase bird monitoring should be conducted for at least one year as per the best practice guidelines – see Section 8.

- Once operational, if facility staff identify any bird nesting which interferes with operations this should be reported on fully through the sites incident reporting system. A suitably qualified ornithologist should be consulted for any case specific reactive mitigation measures. All nest management measures should only be undertaken in compliance with national and provincial environmental legislation in this regard.

10. Conclusion

Our work on site has made the following findings with respect to avifauna:

- A total of 88 bird species were recorded on site by all our pre-construction bird monitoring methods. Five of these 88 species are regionally Red Listed: Ludwig’s Bustard is Endangered; Verreaux’s Eagle is Vulnerable; and Karoo Korhaan, Blue Crane and Sclater’s Lark are Near-threatened (Taylor *et al*, 2015).
- We judge Ludwig’s Bustard and Karoo Korhaan to be at High risk if the proposed projects proceed, due to habitat destruction and disturbance. Verreaux’s Eagle and Sclater’s Lark are judged to be at Medium risk, and Blue Crane at Low risk.

Our assessment of the significance of the impacts on avifauna on site is as follows:

Phase	Impact	Significance before mitigation	Significance after mitigation
Construction	Destruction of habitat	Moderate Negative	Moderate Negative
	Disturbance of birds	Low Negative	Low Negative
Operations	Fatality of birds at facility	Moderate Negative	Low Negative
Decommissioning	Disturbance of birds	Low Negative	Low negative
Cumulative impacts	Cumulative impacts through habitat destruction	Moderate Negative	Moderate Negative

The mitigation measures listed within Section 9 must be included in each project's EMPr.

Environmental impact statement

The construction of each of the proposed projects will transform a relatively large area of natural habitat. However, the avifaunal community using this habitat is not remarkable, nor is the habitat particularly unique or scarce. The impacts of the proposed project are all rated as Moderate Negative or even Low Negative significance after mitigation. We recommend that each of the projects be authorised, provided that the recommendations of this report are implemented.

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Walston L.J., Rollins K.E., Kirk E., LaGory K.E., Smith K.P. and Meyers S.P. 2016. A preliminary assessment of avian mortality at utility-scale solar energy facilities in the United States. Renewable Energy 92:405-414

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Appendix 1. Bird species data

‘1’ denotes presence, not abundance

CR - Critically Endangered; EN – Endangered; VU – Vulnerable; NT – Near-threatened; LC - Least Concern

RD (Regional, Global) – Regional Red List – Taylor *et al*, 2015; Global Red List – IUCN 2021

E – Endemic – E=Endemic, NE=Near-endemic, BSLS=Endemic to Botswana, South Africa Lesotho & Swaziland

Season 1, 2 – recorded in those seasons

Shaded columns are those areas which are now proposed to be developed, non-shaded columns are those areas which were designed out in order to avoid impacts.

					Season 1 (April 2022)					Season 2 (Sep 2022)	
Common name	**Taxonomic name**	**Taylor *et al* 2015**	**IUCN 2022**	**Endemic /near**	**Area 1**	**Area2**	**Area3**	**Area4**	**Area5**	**Area2**	**Area5**
Verreaux's Eagle	*Aquila verreauxii*	VU	LC			1	1		1		
Karoo Korhaan	*Eupodotis vigorsii*	NT	LC		1	1	1	1	1	1	1
Sclater's Lark	*Spizocorys sclateri*	NT	NT	1						1	1
Blue Crane	*Anthropoides paradiseus*	NT	VU	1			1			1	
Ludwig's Bustard	*Neotis ludwigii*	EN	EN			1		1	1	1	1
Double-banded Courser	*Rhinoptilus africanus*						1	1	1		
Large-billed Lark	*Galerida magnirostris*			1	1	1	1	1	1	1	1
Grey-winged Francolin	*Scleroptila africanus*			1	1		1				
Pied Starling	*Spreo bicolor*			1	1	1					
Fairy Flycatcher	*Stenostira scita*			1							1
Cape Weaver	*Ploceus capensis*			1			1				
Cape Turtle Dove	*Streptopelia capicola*				1	1	1	1	1	1	1
Spike-heeled Lark	*Chersomanes albofasciata*				1	1	1	1	1	1	1
Sickle-winged Chat	*Cercomela sinuata*			1	1	1	1	1	1	1	1
Karoo Eremomela	*Eremomela gregalis*			1	1	1	1	1	1	1	1

Rufous-eared Warbler	*Malcorus pectoralis*				1	1	1	1	1	1	1
Bokmakierie	*Telophorus zeylonus*				1	1	1	1	1	1	1
Black-headed Canary	*Serinus alario*			1	1	1	1	1	1	1	1
South African Shelduck	*Tadorna cana*				1	1	1	1		1	1
Namaqua Sandgrouse	*Pterocles namaqua*				1	1	1		1	1	1
Pied Crow	*Corvus albus*				1	1	1	1		1	1
White-necked Raven	*Corvus albicollis*				1	1	1		1	1	1
Capped Wheatear	*Oenanthe pileata*				1	1	1	1	1		1
Karoo Scrub Robin	*Cercotrichas coryphoeus*				1	1	1	1	1		1
Lark-like Bunting	*Emberiza impetuani*				1	1	1	1		1	1
Egyptian Goose	*Alopochen aegyptiaca*				1	1	1	1			1
Speckled Pigeon	*Columba guinea*				1	1	1		1		1
Rock Martin	*Hirundo fuligula*				1	1	1	1		1	
Mountain Wheatear	*Oenanthe monticola*				1	1	1		1		1
Karoo Chat	*Cercomela schlegelii*				1	1	1	1	1		
Yellow-bellied Eremomela	*Eremomela icteropygialis*				1			1	1	1	1
African Pipit	*Anthus cinnamomeus*				1	1	1	1	1		
Cape Sparrow	*Passer melanurus*				1	1	1	1		1	
Karoo Long-billed Lark	*Certhilauda subcoronata*				1	1	1	1	1		
Namaqua Dove	*Oena capensis*					1			1	1	1
Layard's Tit-Babbler	*Parisoma layardi*			1	1	1	1	1			
Hamerkop	*Scopus umbretta*					1	1	1			
African Sacred Ibis	*Threskiornis aethiopicus*					1	1	1			
Blacksmith Lapwing	*Vanellus armatus*				1	1	1				
Acacia Pied Barbet	*Tricholaema leucomelas*				1	1	1				
African Red-eyed Bulbul	*Pycnonotus nigricans*					1	1	1			
Desert Cisticola	*Cisticola aridulus*				1		1	1			
Cape Wagtail	*Motacilla capensis*					1	1			1	
Southern Fiscal	*Lanius collaris*					1	1	1			
House Sparrow	*Passer domesticus*				1	1			1		
Black-throated Canary	*Crithagra atrogularis*				1				1		1
Hadeda	*Bostrychia hagedash*						1	1			

Jackal Buzzard	*Buteo rufofuscus*				1	1					
Rock Kestrel	*Falco rupicolus*						1			1	
Common Quail	*Coturnix coturnix*									1	1
Crowned Lapwing	*Vanellus coronatus*					1		1			
Pied Avocet	*Recurvirostra avosetta*				1					1	
White-backed Mousebird	*Colius colius*							1	1		
Red-capped Lark	*Calandrella cinerea*									1	1
Grey-backed Sparrowlark	*Eremopterix verticalis*									1	1
Ant-eating Chat	*Myrmecocichla formicivora*				1				1		
Nicholson's Pipit	*Anthus similis*					1			1		
Pale-winged Starling	*Onychognathus nabouroup*						1	1			
Dusky Sunbird	*Cinnyris fuscus*						1		1		
White-throated Canary	*Crithagra albogularis*				1	1					
Cape Bunting	*Emberiza capensis*				1		1				
Damara Hornbill	*Tockus damarensis*									1	1
African Spoonbill	*Platalea alba*						1				
African Black Duck	*Anas sparsa*						1				
Cape Teal	*Anas capensis*									1	
Pale Chanting Goshawk	*Melierax canorus*					1					
African Harrier Hawk	*Polyboroides typus*						1				
Three-banded Plover	*Charadrius tricollaris*									1	
Black-winged Stilt	*Himantopus himantopus*				1						
Temminck's Courser	*Cursorius temminckii*										1
Rock Dove	*Columba livia*					1					
Red-eyed Dove	*Streptopelia semitorquata*								1		
Klaas's Cuckoo	*Chrysococcyx klaas*					1					
Spotted Eagle-Owl	*Bubo africanus*				1						
White-rumped Swift	*Apus caffer*				1						
Black-eared Sparrowlark	*Eremopterix australis*			1						1	
White-throated Swallow	*Hirundo albigularis*										1
South African Cliff Swallow	*Hirundo spilodera*								1		
Grey Tit	*Parus afer*			1			1				

Cape Robin-Chat	*Cossypha caffra*						1				
Chestnut-vented Tit-Babbler	*Parisoma subcaeruleum*						1				
Long-billed Crombec	*Sylvietta rufescens*							1			
Cloud Cisticola	*Cisticola textrix*								1		
Grey-backed Cisticola	*Cisticola subruficapilla*					1					
Karoo Prinia	*Prinia maculosa*			1					1		
Fiscal Flycatcher	*Sigelus silens*			1			1				
Southern Grey-headed Sparrow	*Passer diffusus*							1			
Red-billed Quelea	*Quelea quelea*						1				
Total birds per area				15	41	45	51	35	33	31	31

Appendix 2. Small passerine bird data (walked transect).

	Total			**Season 1 (April 2022)**															**Season 2 (Sep 2022)**					
				Area 1			Area 2			Area 3			Area 4			Area 5			Area 2			Area 5		
Transect length (km)	42			6			6			6			6			6			6			6		
# species	37			21			22			20			21			16			24			28		
Species	**Birds**	**Records**	**Birds/km**	**Birds**	**Records**	**Birds/km**	**Birds**	**Records**	**Birds/km**	**Birds**	**Records**	**Birds/km**	**Birds**	**Records**	**Birds/km**	**Birds**	**Records**	**Birds/km**	**Birds**	**Records**	**Birds/km**	**Birds**	**Records**	**Birds/km**
Black-headed Canary	760	104	18.10	11	2	1.83	186	11	31.00	78	10	13.00	62	12	10.33	139	16	23.17	184	33	30.67	100	20	16.67
Namaqua Sandgrouse	209	46	4.98	35	7	5.83	10	3	1.67	5	1	0.83				3	2	0.50	30	6	5.00	126	27	21.00
Sickle-winged Chat	157	96	3.74	16	12	2.67	24	14	4.00	24	15	4.00	31	16	5.17	12	8	2.00	24	13	4.00	26	18	4.33
Lark-like Bunting	119	38	2.83	10	4	1.67	5	2	0.83	6	2	1.00	2	1	0.33				61	19	10.17	35	10	5.83
Spike-heeled Lark	98	27	2.33	4	2	0.67	14	4	2.33	14	6	2.33	21	5	3.50	9	2	1.50	16	3	2.67	20	5	3.33
Rufous-eared Warbler	70	43	1.67	4	3	0.67	16	9	2.67	6	4	1.00	8	4	1.33	7	5	1.17	13	9	2.17	16	9	2.67
Capped Wheatear	51	41	1.21	1	1	0.17	20	16	3.33	11	10	1.83	16	11	2.67	1	1	0.17				2	2	0.33
Karoo Eremomela	51	24	1.21				8	3	1.33	2	1	0.33	4	2	0.67	7	4	1.17	19	9	3.17	11	5	1.83
Grey-backed Sparrow-Lark	47	6	1.12																35	5	5.83	12	1	2.00
Large-billed Lark	44	28	1.05	4	3	0.67	9	7	1.50	6	3	1.00	5	3	0.83	2	2	0.33	10	6	1.67	8	4	1.33
White-necked Raven	40	16	0.95	2	1	0.33	2	1	0.33	2	1	0.33				5	3	0.83	6	3	1.00	23	7	3.83
Karoo Long-billed Lark	33	29	0.79	3	2	0.50	3	3	0.50	8	7	1.33	7	6	1.17	2	2	0.33	4	4	0.67	6	5	1.00
Bokmakierie	29	21	0.69	4	2	0.67	2	1	0.33	8	6	1.33	6	5	1.00				8	6	1.33	1	1	0.17
Karoo Chat	28	23	0.67	9	6	1.50	6	5	1.00	6	6	1.00	3	3	0.50	4	3	0.67						
Speckled Pigeon	28	7	0.67																			28	7	4.67
Red-capped Lark	27	11	0.64																22	9	3.67	5	2	0.83
Pied Crow	23	10	0.55	2	1	0.33	5	2	0.83				3	2	0.50				5	2	0.83	8	3	1.33
Cape Bunting	22	9	0.52	22	9	3.67																		
Cape Sparrow	22	7	0.52	5	1	0.83	6	3	1.00	2	1	0.33	4	1	0.67				5	1	0.83			

Mountain Wheatear	20	14	0.48	9	5	1.50	6	5	1.00	1	1	0.17										4	3	0.67
South African Shelduck	18	9	0.43	4	2	0.67	4	2	0.67	2	1	0.33							6	3	1.00	2	1	0.33
African Pipit	17	12	0.40	4	3	0.67	5	4	0.83				5	3	0.83	3	2	0.50						
Yellow-bellied Eremomela	17	9	0.40										4	2	0.67	2	1	0.33	11	6	1.83			
Karoo Scrub Robin	16	9	0.38				5	3	0.83				7	4	1.17	2	1	0.33				2	1	0.33
White-throated Canary	16	11	0.38				3	1	0.50													13	10	2.17
Black-eared Sparrow-Lark	12	1	0.29																12	1	2.00			
Cape Turtle Dove	11	8	0.26				2	1	0.33	4	3	0.67				1	1	0.17	1	1	0.17	3	2	0.50
Namaqua Dove	10	5	0.24																9	4	1.50	1	1	0.17
Layard's Tit-Babbler	9	6	0.21	7	5	1.17							2	1	0.33									
Pale-winged Starling	8	2	0.19							5	1	0.83	3	1	0.50									
Rock Martin	7	2	0.17	2	1	0.33													5	1	0.83			
Crowned Lapwing	6	2	0.14										6	2	1.00									
Egyptian Goose	6	2	0.14				4	1	0.67													2	1	0.33
Common Quail	5	4	0.12																3	2	0.50	2	2	0.33
Ant-eating Chat	3	1	0.07													3	1	0.50						
Desert Cisticola	3	3	0.07	1	1	0.17				1	1	0.17	1	1	0.17									
Southern Fiscal	3	3	0.07							2	2	0.33	1	1	0.17									
Black-throated Canary	3	2	0.07													2	1	0.33				1	1	0.17
African Red-eyed Bulbul	2	1	0.05				2	1	0.33															
Cloud Cisticola	2	2	0.05													2	2	0.33						
Hadeda	2	1	0.05										2	1	0.33									
Karoo Prinia	2	1	0.05													2	1	0.33						
Long-billed Crombec	2	1	0.05										2	1	0.33									
Nicholson's Pipit	2	2	0.05				1	1	0.17							1	1	0.17						
Southern Grey-headed Sparrow	2	1	0.05										2	1	0.33									
Cape Wagtail	2	1	0.05																2	1	0.33			
Sclater's Lark	2	1	0.05																			2	1	0.33

Three-banded Plover	2	1	0.05																2	1	0.33			
Klaas's Cuckoo	1	1	0.02				1	1	0.17															
Fairy Flycatcher	1	1	0.02																			1	1	0.17
White-throated Swallow	1	1	0.02																			1	1	0.17

Appendix 3. Large terrestrial and raptor data (drive transects).

	Total			**Season 1 (April 2022)**															**Season 2 (Sep 2022)**					
				Area 1			Area 2			Area 3			Area 4			Area 5			Area 2			Area 5		
Transect length (km)	49			5			7			9			7			7			7			7		
	Birds	**Records**	**Birds/km**	**Birds**	**Records**	**Birds/km**	**Birds**	**Records**	**Birds/km**	**Birds**	**Records**	**Birds/km**	**Birds**	**Records**	**Birds/km**	**Birds**	**Records**	**Birds/km**	**Birds**	**Records**	**Birds/km**	**Birds**	**Records**	**Birds/km**
Karoo Korhaan	30	12	0.61	2	1	0.40	4	1	0.57	2	1	0.22				2	1	0.29	2	1	0.29	18	7	2.57
Blue Crane	10	3	0.20							4	1	0.44							6	2	0.86			
Double-banded Courser	6	3	0.12							3	1	0.33				3	2	0.43						
Ludwig's Bustard	4	3	0.08																3	2	0.43	1	1	0.14
Jackal Buzzard	2	2	0.04	1	1	0.20	1	1	0.14															
Pied Crow	2	2	0.04				1	1	0.14										1	1	0.14			
Temminck's Courser	2	1	0.04																			2	1	0.29
African Harrier-Hawk	1	1	0.02							1	1	0.11												
Rock Kestrel	1	1	0.02							1	1	0.11												

Appendix 4. Incidental observations of priority species.

			Season 1 (April 2022)										Season 2 (Sep 2022)			
	Total		Area 1		Area 2		Area 3		Area 4		Area 5		Area 2		Area 5	
# species	**13**		**4**		**5**		**6**		**3**		**3**		**5**		**3**	
Species	**Birds**	**Records**	**Birds**	**Records**	**Birds**	**Records**	**Birds**	**Records**	**Birds**	**Records**	**Birds**	**Records**	**Birds**	**Records**	**Birds**	**Records**
Karoo Korhaan	104	46	2	2	14	6	14	6	22	7	16	5	11	8	25	12
Grey-winged Francolin	12	6	7	3			5	3								
Ludwig's Bustard	12	10			1	1			1	1	1	1	9	7		
Blue Crane	10	3					4	1					6	2		
Double-banded Courser	6	3							2	1	4	2				
Jackal Buzzard	3	3	2	2	1	1										
Sclater's Lark	3	2											1	1	2	1
Verreaux's Eagle	2	2			1	1	1	1								
Rock Kestrel	2	2					1	1					1	1		
Spotted Eagle-Owl	1	1	1	1												
Pale Chanting Goshawk	1	1			1	1										
African Harrier-Hawk	1	1					1	1								
Temminck's Courser	1	1													1	1

Appendix 5. Specialist curriculum vitae

JONATHAN JAMES SMALLIE

WildSkies Ecological Services (2011/131435/07)

BACKGROUND

Date of birth:	20 October 1975
Qualifications:	BSC – Agriculture (Hons) (completed 1998)
	University of Natal – Pietermaritzburg
	MSC – Environmental Science (completed 2011)
	University of Witwatersrand
Occupation:	Specialist avifaunal consultant
Profession registration:	South African Council for Natural Scientific Professions

CONTACT DETAILS

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Email: jon@wildskies.co.za

Postal: 36 Utrecht Avenue, Bonnie Doon, East London, 5210

PROFESSIONAL EXPERIENCE

Consulting Projects:

Post construction bird monitoring for wind energy facilities:

Dassieklip (Caledon) –initiated in April 2014; Dorper Wind Farm (Molteno) – initiated in July 2014; Jeffreys Bay Wind Farm – initiated in August 2014; Kouga Wind Farm – started Feb 2015; Cookhouse West Wind Farm – started March 2015; Grassridge Wind Farm – initiated in April 2015; Chaba Wind Farm – initiated December 2015; Amakhala Emoyeni 01 Wind Farm initiated August 2016; Gibson Bay Wind Farm – initiated March 2017; Nojoli Wind Farm initiated March 2017.

Pre-construction bird monitoring & EIA for wind energy facilities:

Golden Valley; Middleton; Dorper; Qumbu; Ncora; Nqamakhwe; Ndakana; Thomas River; Peddie; Mossel Bay; Hluhluwe; Richards Bay; Garob; Outeniqua; Castle; Wolf; Inyanda-Roodeplaat; Dassiesridge; Great Kei; Bayview; Grahamstown; Bakenskop; Umsobomvu; Stormberg; Zingesele; Oasis; Gunstfontein; Naumanii; Golden Valley Phase 2; Ngxwabangu; Hlobo; Woodstock; and Impofu wind energy facilities.

Other Electricity Generation projects:

Port of Nqura Power Barge EIA; Bonnievale Solar Energy Facility; Dealesville Solar Energy Facility; Rooipunt Solar Energy Facility; De Aar Solar Energy Facility; Noupoort Solar Energy Facility, Aggeneys Solar Energy Facility; Tugela Hydro-Electric Scheme*;* Eskom Concentrated Solar Power Plant; Bronkhorstspruit Solar Photovoltaic Plant; De Aar Solar Energy Facility; Paulputs Solar Energy Facility; Kenhardt Solar Energy Facility.

Overhead transmission power lines (>132 000 kilovolts):

Oranjemund Gromis 220kv; Perseus Gamma 765kv; Aries Kronos 765kv; Aries Helios 765kv; Perseus Kronos 765kv; Helios Juno 765kv; Borutho Nzelele 400kv; Foskor Merensky 275kv; Kimberley Strengthening; Mercury Perseus 400kV; Eros Neptune Grassridge 400kV; Kudu Juno 400kV; Garona Aries 400kV; Perseus Hydra 765Kv; Tabor Witkop 275kV; Tabor Spencer 400kV; Moropule Orapa 220kV (Botswana); Coega Electrification; Majuba Venus 765kV; Gamma Grassridge 765kV; Gourikwa Proteus 400KV; Koeberg Strengthening 400kV; Ariadne Eros 400kV; Hydra Gamma 765kV; Zizabona transmission - Botswana

Overhead distribution power lines (<132 000 kilovolts):

Kanoneiland 22KV; Hydra Gamma 765kV; Komani Manzana 132kV; Rockdale Middelburg 132kV; Irenedale 132 kV; Zandfontein 132kV; Venulu Makonde 132 kV; Spencer Makonde 132 kV; Dalkeith Jackal Creek 132Kv; Glen Austin 88kV; Bulgerivier 132kV; Ottawa Tongaat 132kV; Disselfontein 132kV; Voorspoed Mine 132kV; Wonderfontein 132kV; Kabokweni Hlau Hlau 132kV; Hazyview Kiepersol 132kV; Mayfern Delta 132kV; VAAL Vresap 88kV; Arthursview Modderkuil 88kV; Orapa, AK6, Lethakane substations and 66kV lines (Botswana); Dagbreek Hermon 66kV; Uitkoms Majuba 88kV; Pilanesberg Spitskop 132kV; Qumbu PG Bison 132kV; Louis Trichardt Venetia 132kV; Rockdale Middelburg Ferrochrome 132kV; New Continental Cement 132KV; Hillside 88kV; Marathon Delta 132kV; Malelane Boulder 132kV; Nondela Strengthening 132kV; Spitskop Northern Plats 132kV; West Acres Mataffin 132kV; Westgate Tarlton Kromdraai 132kV; Sappi Elliot Ugie 132kV; Melkhout Thyspunt 132kV; St Francis Bay 66kv

Risk Assessments on existing power lines:

Hydra-Droerivier 1,2 & 3 400kV; Hydra-Poseidon 1,2 400kV; Butterworth Ncora 66kV; Nieu-Bethesda 22kV; Maclear 22kV (Joelshoek Valley Project); Wodehouse 22kV (Dordrecht district); Burgersdorp Aliwal North Jamestown 22kV; Cradock 22kV; Colesberg area 22kV; Loxton self build 6.6kV; Kanoneiland 22kV; Stutterheim Municipality 22kV; Majuba-Venus 400kV; Chivelston-Mersey 400kV; Marathon-Prairie 275kV; Delphi-Neptune 400kV; Ingagane – Bloukrans 275kV; Ingagane – Danskraal 275kV; Danskraal – Bloukrans 275kV

Avifaunal "walk through" (EMP's):

Kappa Omega 765kv; Rockdale Marble Hall 400kv*;* Beta Delphi 400kV; Mercury Perseus 765kV; Perseus 765kV Substation; Beta Turn 765kV in lines; Spencer Tabor 400kV line; Kabokweni Hlau Hlau 132kV; Mayfern Delta 132Kv; Eros Mtata 400kV; Cennergi Grid connect 132kV; Melkhout Thyspunt 132kv.

Strategic Environmental Assessments for Master Electrification Plans:

Northern Johannesburg area; Southern KZN and Northern Eastern Cape; Northern Pretoria; Western Cape Peninsula

Other specialist studies:

Bird Impact Assessment for Lizzard Point Golf Estate – Vaaldam; Bird Impact Assessment for Lever Creek Estates housing development; Investigation into rotating Bird Flapper saga – Aberdeen 22Kv; Investigation of in excess of 80 separate incidents of bird mortalities on power line networks from August 1999 to present; Investigation of bird mortalities at 3 substations; Special investigation into faulting on Ariadne-Eros 132kV; Special investigation into Bald Ibis faulting on Tutuka Pegasus 275kV; Special investigation into bird related faulting on 22kV Geluk Hendrina line; Special investigation into bird related faulting on Camden Chivelston 400kV line

Specialist risk assessments for wildlife airport hazards:

Kigali International Airport – Rwanda; Port Elizabeth Airport – specialist study as part of the EIA for the proposed Madiba Bay Leisure Park; Manzini International Airport (Swaziland); Polokwane International Airport; Mafekeng International Airport; Lanseria Airport

Positions held to date:

- ✓ August 1999 to May 2004: Eastern Cape field officer for the South African Crane Working Group of the Endangered Wildlife Trust
- ✓ May 2004 to November 2007: National Field officer for Eskom-EWT Strategic Partnership and Airports Company SA – EWT Strategic Partnership (both programmes of Endangered Wildlife Trust)
- ✓ November 2007 to August 2011: Programme Manager – Wildlife & Energy Programme – Endangered Wildlife Trust
- ✓ August 2011 to present: Independent avifaunal specialist – Director at WildSkies Ecological Sevices (Pty) Ltd

Relevant achievements:

- ✓ Recipient of BirdLife South Africa's Giant Eagle Owl in 2011 for outstanding contribution to bird conservation in SA
- ✓ Founded and chaired for first two years – the Birds and Wind Energy Specialist Group (BAWESG) of the Endangered Wildlife Trust & BirdLife South Africa.

Conferences attended and presented at:

- ✓ May 2011. Conference of Wind Energy and Wildlife, Trondheim, Norway.
- ✓ March 2011. Chair and facilitator at Endangered Wildlife Trust – Wildlife & Energy Programme – "2011 Wildlife & Energy Symposium", Howick, SA
- ✓ September 2010 – Raptor Research Foundation conference, Fort Collins, Colorado. Presented on the use of camera traps to investigate Cape Vulture roosting behaviour on transmission lines
- ✓ May 2010 - Wind Power Africa 2010. Presented on wind energy and birds
- ✓ October 2008. Session chair at Pan-African Ornithological Conference, Cape Town, South Africa

- ✓ March 27 – 30 2006: International Conference on Overhead Lines, Design, Construction, Inspection & Maintenance, Fort Collins Colorado USA. Presented a paper entitled "Assessing the power line network in the Kwa-Zulu Natal Province of South Africa from a vulture interaction perspective".
- ✓ June 2005: IASTED Conference at Benalmadena, Spain – presented a paper entitled "Impact of bird streamers on quality of supply on transmission lines: a case study"
- ✓ May 2005: International Bird Strike Committee 27th meeting – Athens, Greece. Presented a paper entitled Bird Strike Data analysis at SA airports 1999 to 2004.
- ✓ 2003: Presented a talk on "Birds & Power lines" at the 2003 AGM of the Amalgamated Municipal Electrical Unions – in Stutterheim - Eastern Cape
- ✓ September 2000: 5th World Conference on Birds of Prey in Seville, Spain.

Papers & publications:

- ✓ Prinsen, H.A.M., J.J. Smallie, G.C. Boere, & N. Pires. (compilers), 2011. Guidelines on how to avoid or mitigate impacts of electricity power grids on migratory birds in the African-Eurasian Region. CMS Technical Series Number XX. Bonn, Germany.
- ✓ Prinsen, H.A.M., J.J. Smallie, G.C. Boere, & N. Pires. (compilers), 2011. Review of the conflict between migratory birds and electricity power grids in the African-Eurasian region. CMS Technical Series Number XX, Bonn, Germany.
- ✓ Jenkins, A.R., van Rooyen, C.S, Smallie, J.J, Harrison, J.A., Diamond, M.D., Smit-Robinson, H.A & Ralston, S. 2014. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa
- ✓ Jenkins, A.R., Shaw, J.M., Smallie, J.J., Gibbons, B., Visagie, R. & Ryan, P.G. 2011. Estimating the impacts of power line collisions on Ludwig's Bustards Neotis ludwigii. Bird Conservation International.
- ✓ Jordan, M., & Smallie, J. 2010. A briefing document on best practice for pre-construction assessment of the impacts of onshore wind farms on birds. Endangered Wildlife Trust , Unpublished report
- ✓ Smallie, J., & Virani, M.Z. 2010. A preliminary assessment of the potential risks from electrical infrastructure to large birds in Kenya. Scopus 30: p32-39
- ✓ Shaw, J.M., Jenkins, A.R., Ryan, P.G., & Smallie, J.J. 2010. A preliminary survey of avian mortality on power lines in the Overberg, South Africa. Ostrich 2010. 81 (2) p109-113
- ✓ Jenkins, A.R., Smallie, J.J., & Diamond, M. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. Bird Conservation International 2010. 20: 263-278.
- ✓ Shaw, J.M., Jenkins, A.R., Ryan, P.G., & Smallie, J.J. 2010. Modelling power line collision risk for the Blue Crane *Anthropoides paradiseus* in South Africa. Ibis 2010 (152) p590-599.
- ✓ Jenkins, A.R., Allan, D.G., & Smallie, J.J. 2009. Does electrification of the Lesotho Highlands pose a threat to that countries unique montane raptor fauna? Dubious evidence from surveys of three existing power lines. Gabar 20 (2).
- ✓ Smallie, J.J., Diamond, M., & Jenkins, A.R. 2008. Lighting up the African continent – what does this mean for our birds? Pp 38-43. In Harebottle, D.M., Craig, A.J.F.K., Anderson, M.D., Rakotomanana, H., & Muchai. (eds). Proceedings of the 12th Pan-african Ornithological Congress. 2008. Cape Town. Animal Demography Unit. ISBN (978-0-7992-2361-3)
- ✓ Van Rooyen, C., & Smallie, J.J. 2006. The Eskom –EWT Strategic Partnership in South Africa: a brief summary. Nature & Faunae Vol 21: Issue 2, p25
- ✓ Smallie, J. & Froneman, A. 2005. Bird Strike data analysis at South African Airports 1999 to 2004. Proceedings of the 27th Conference of the International Bird Strike Committee, Athens Greece.
- ✓ Smallie, J. & Van Rooyen, C. 2005. Impact of bird streamers on quality of supply on transmission lines: a case study. Proceedings of the Fifth IASTED International Conference on Power and Energy Systems, Benalmadena, Spain.

- ✓ Smallie, J. & Van Rooyen, C. 2003. Risk assessment of bird interaction on the Hydra-Droërivier 1 and 2 400kV. Unpublished report to Eskom Transmission Group. Endangered Wildlife Trust. Johannesburg. South Africa
- ✓ Van Rooyen, C. Jenkins, A. De Goede, J. & Smallie J. 2003. Environmentally acceptable ways to minimise the incidence of power outages associated with large raptor nests on Eskom pylons in the Karoo: Lessons learnt to date. Project number 9RE-00005 / R1127 Technology Services International. Johannesburg. South Africa
- ✓ Smallie, J. J. & O'connor, T. G. (2000) Elephant utilization of *Colophospermum mopane*: possible benefits of hedging. African Journal of Ecology 38 (4), 352-359.

Courses & training:

- ✓ Successfully completed a 5 day course in High Voltage Regulations (modules 1 to 10) conducted by Eskom – Southern Region
- ✓ Successfully completed training on, and obtained authorization for, live line installation of Bird Flappers

Appendix 6. Impact Assessment Methodology (supplied by WSP)

Assessment of Impacts and Mitigation

The assessment of impacts and mitigation evaluates the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation.

The key objectives of the risk assessment methodology are to identify any additional potential environmental issues and associated impacts likely to arise from the proposed project, and to propose a significance ranking. Issues / aspects will be reviewed and ranked against a series of significance criteria to identify and record interactions between activities and aspects, and resources and receptors to provide a detailed discussion of impacts. The assessment considers direct[1], indirect[2], secondary[3] as well as cumulative[4] impacts.

A standard risk assessment methodology is used for the ranking of the identified environmental impacts pre-and post-mitigation (i.e. residual impact). The significance of environmental aspects is determined and ranked by considering the criteria[5] presented in the table below.

Impact Assessment Criteria and Scoring System

	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low: No impact on processes	Low: Slight impact on processes	Medium: Processes continue but in a modified way	High: Processes temporarily cease	Very High: Permanent cessation of processes
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries

[1] Impacts that arise directly from activities that form an integral part of the Project.

[2] Impacts that arise indirectly from activities not explicitly forming part of the Project.

[3] Secondary or induced impacts caused by a change in the Project environment.

[4] Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.

[5] The definitions given are for guidance only, and not all the definitions will apply to all the environmental receptors and resources being assessed. Impact significance was assessed with and without mitigation measures in place.

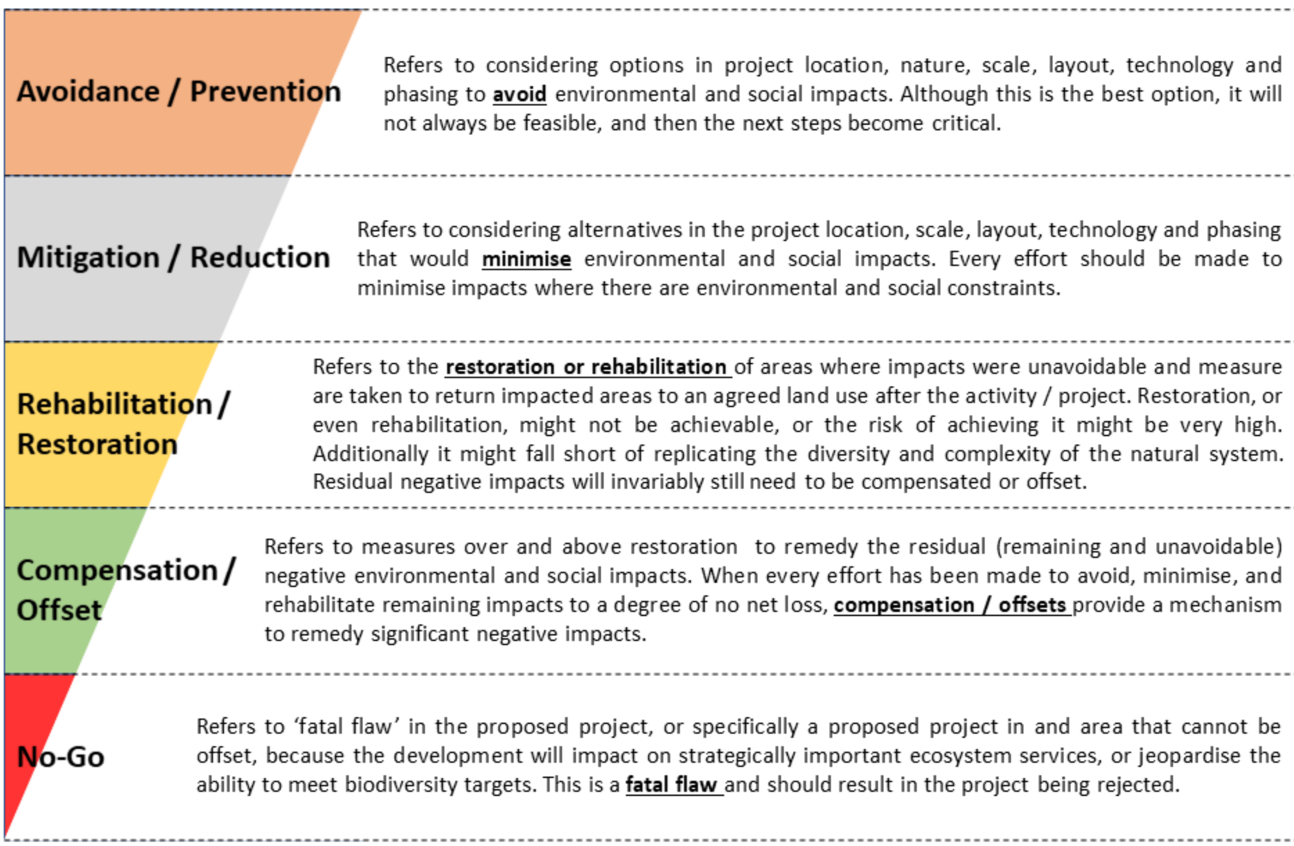
	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probability	Definite
Significance (S) is determined by combining the above criteria in the following formula:	$[S = (E + D + R + M) \times P]$ $Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$				
IMPACT SIGNIFICANCE RATING					
Total Score	**4 to 15**	**16 to 30**	**31 to 60**	**61 to 80**	**81 to 100**
Environmental Significance Rating (Negative (-))	**Very low**	**Low**	**Moderate**	**High**	**Very High**
Environmental Significance Rating (Positive (+))	**Very low**	**Low**	**Moderate**	**High**	**Very High**

Impact Mitigation

The impact significance without mitigation measures will be assessed with the design controls in place. Impacts without mitigation measures in place are not representative of the proposed development's actual extent of impact and are included to facilitate understanding of how and why mitigation measures were identified. The residual impact is what remains following the application of mitigation and management measures and is thus the final level of impact associated with the development. Residual impacts also serve as the focus of management and monitoring activities during Project implementation to verify that actual impacts are the same as those predicted in this report.

The mitigation measures chosen are based on the mitigation sequence/hierarchy which allows for consideration of five (5) different levels, which include avoid/prevent, minimise, rehabilitate/restore, offset and no-go in that order. The idea is that when project impacts are considered, the first option should be to avoid or prevent the impacts from occurring in the first place if possible, however, this is not always feasible. If this is not attainable, the impacts can be allowed, however they must be minimised as far as possible by considering reducing the footprint of the development for example so that little damage is encountered. If impacts are unavoidable, the next goal is to rehabilitate or restore the areas impacted back to their original form after project completion. Offsets are then considered if all the other measures described above fail to remedy high/significant residual negative impacts. If no offsets can be achieved on a potential impact, which results in full destruction of any ecosystem for example, the no-go option is considered so that another activity or location is considered in place of the original plan.

The mitigation sequence/hierarchy is shown in the figure below.



Mitigation Sequence/Hierarchy

Ascribing Significance for Decision-Making

The best way of expressing these cost benefit implications for decision-making is to present them as risks. Risk is defined as the consequence (implication) of an event multiplied by the probability (likelihood)[6] of that event.

[6] Because 'probability' has a specific mathematical/empirical connotation the term 'likelihood' is preferred in a qualitative application and is accordingly the term used in this document.

Many risks are accepted or tolerated on a daily basis because even if the consequence of the event is serious, the likelihood that the event will occur is low. A practical example is the consequence of a parachute not opening, is potentially death but the likelihood of such an event happening is so low that parachutists are prepared to take that risk and hurl themselves out of an airplane. The risk is low because the likelihood of the consequence is low even if the consequence is potentially severe.

It is also necessary to distinguish between the event itself (as the cause) and the consequence. Again using the parachute example, the consequence of concern in the event that the parachute does not open is serious injury or death, but it does not necessarily follow that if a parachute does not open that the parachutist will die.

Various contingencies are provided to minimise the likelihood of the consequence (serious injury or death) in the event of the parachute not opening, such as a reserve parachute. In risk terms this means distinguishing between the inherent risk (the risk that a parachutist will die if the parachute does not open) and the residual risk (the risk that the parachutist will die if the parachute does not open but with the contingency of a reserve parachute) i.e. the risk before and after mitigation.

<u>Consequence</u>

The ascription of significance for decision-making becomes then relatively simple. It requires the consequences to be ranked and likelihood to be defined of that consequence.

In the below table a scoring system for consequence ranking is shown. Two important features should be noted in the table, namely that the scoring doubles as the risk increases and that there is no equivalent 'high' score in respect of benefits as there is for the costs. This high negative score serves to give expression to the potential for a fatal flaw where a fatal flaw would be defined as an impact that cannot be mitigated effectively and where the associated risk is accordingly untenable. Stated differently, the high score on the costs, which is not matched on the benefits side, highlights that such a fatal flaw cannot be 'traded off' by a benefit and would render the proposed project to be unacceptable.

Ranking of Consequence

Environmental Cost	**Inherent risk**
Human health – morbidity/ mortality, loss of species	High
Material reductions in faunal populations, loss of livelihoods, individual economic loss	Moderate – High
Material reductions in environmental quality – air, soil, water. Loss of habitat, loss of heritage, amenity	Moderate
Nuisance	Moderate – Low
Negative change – with no other consequences	Low
Environmental Benefits	**Inherent benefit**

Net improvement in human health and welfare	Medium – High
Improved environmental quality – air, soil, water. Improved individual livelihoods	Moderate
Economic development	Moderate – Low
Positive change – with no other benefits	Low

Likelihood

Although the principle is one of probability, the term 'likelihood' is used to give expression to a qualitative rather than quantitative assessment, because the term 'probability' tends to denote a mathematical/empirical expression. A set of likelihood descriptors that can be used to characterise the likelihood of the costs and benefits occurring, is presented in the table below.

Likelihood Categories and Definitions

Likelihood Descriptors	Definitions
Highly unlikely	The possibility of the consequence occurring is negligible
Unlikely but possible	The possibility of the consequence occurring is low but cannot be discounted entirely
Likely	The consequence may not occur but a balance of probability suggests it will
Highly likely	The consequence may still not occur but it is most likely that it will
Definite	The consequence will definitely occur

It is very important to recognise that the likelihood question is asked twice. The first time the question is asked is the likelihood of the cause and the second as to the likelihood of the consequence. In the tables that follow the likelihood is presented of the cause and then the likelihood of the consequence is presented. A high likelihood of a cause does not necessarily translate into a high likelihood of the consequence. As such the likelihood of the consequence is not a mathematical or statistical 'average' of the causes but rather a qualitative estimate in its own right.

Residual Risk

The residual risk is then determined by the consequence and the likelihood of that consequence. The residual risk categories are shown below where consequence scoring is shown in the rows and likelihood in the columns. The implications for decision-making of the different residual risk categories are shown below.

Residual Risk Categories

Consequence	High	Moderate	High	High	Fatally flawed	
	Moderate – high	Low	Moderate	High	High	High
	Moderate	Low	Moderate	Moderate	Moderate	Moderate
	Moderate – low	Low	Low	Low	Low	Moderate
	Low	Low	Low	Low	Low	Low
		Highly unlikely	Unlikely but possible	Likely	Highly likely	Definite
		Likelihood				

Implications for Decision-Making of the different Residual Risk Categories

Rating	Nature of implication for Decision – Making
Low	Project can be authorised with low risk of environmental degradation
Moderate	Project can be authorised but with conditions and routine inspections
High	Project can be authorised but with strict conditions and high levels of compliance and enforcement
Fatally Flawed	The project cannot be authorised