THE PROPOSED DEVELOPMENT OF THE MURA ELECTRICAL GRID INFRASTRUCTURE

Avifaunal Impact Assessment

October 2022

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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, Mura 1 (Pty) Ltd, Mura 2 (Pty) Ltd, Mura 3 (Pty) Ltd, and Mura 4 (Pty) Ltd, 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 sites will be accessed via the R381, DR02317 and existing roads.

Each solar facility will connect to the Eskom grid via new 132 kV overhead lines (which are the subject of this current report) connecting the two on-site solar substations via adjacent Eskom switching stations to the approved Nuweveld Collector substation.

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 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 four priority bird species to be at High or Medium risk (pre-mitigation) if the proposed projects proceed. Ludwig's Bustard (Endangered), Karoo Korhaan (Near-threatened), and Blue Crane (Near-threatened) are at High risk, whilst Verreaux's Eagle is at Medium risk. These species are primarily at risk of collision with the overhead lines. Electrocution of large eagles, such as Verreaux's Eagle, perched on pylons is also a risk, although can be comprehensively mitigated as described below.

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

Phase	Impact	Significance before mitigation	Significance after mitigation
	Disturbance of birds	Low Negative	Low Negative
Operational	Collision of birds with overhead lines	High Negative	Moderate Negative
	Electrocution of birds on pylons	High Negative	Low Negative
Decommissioning	Disturbance of birds	Low Negative	Low Negative
Cumulative impacts	Cumulative impacts through collision of birds with overhead lines	High Negative	Moderate Negative
	Cumulative impacts through habitat destruction	Moderate Negative	Moderate Negative

Mitigation for inclusion in the EMPr

The following mitigation measures are recommended:

- The identified No-Go areas on site should be avoided by the proposed infrastructure. The identified High sensitivity areas should also be avoided as far as possible. One exception is applicable at a small dam in the far west of the EGI corridor (west of Mura 1 and 2) where it has been agreed between specialist and applicant that the EGI corridor may infringe on the buffer area.

- A pre-construction avifaunal walk down should be conducted to confirm final layout and identify any sensitivities that may arise between the conclusion of the Environmental Authorisation process and construction.

- 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.

- Overhead conductors or earth wires should be fitted with the best available Eskom approved anti bird collision line marking device available at the time of construction. Should new more effective bird flight diverters (BFDS) come available the developer needs to ensure that Eskom procures and fits these.

- The proposed pylon designs should all provide for sufficient clearance between phase and phase, and phase and earthed components, to mitigate the risk of eagle electrocution. In addition, we recommend the use of a monopole structure with the standard Eskom Bird Perch on all pole tops to further provide safe perching substrate well above the dangerous hardware. Any deviation from these approved structures should be cleared with an avifaunal specialist.

- The cumulative impacts of overhead power lines on birds in the study area will need to be carefully mitigated by each project using the above mitigation measures for bird collision and electrocution, repeated here for clarity:

- Overhead conductors or earth wires should be fitted with the best available Eskom approved anti bird collision line marking device available at the time of construction. Should new more effective BFD's come available the developer needs to be ready to procure and fit these.
- The proposed pylon designs all provide for sufficient clearance between phase and phase, and phase and earthed components, to mitigate the risk of eagle electrocution. In addition, we recommend the use of the standard Eskom Bird Perch on all pole tops to further provide safe perching substrate well above the dangerous hardware. Any deviation from these approved structures should be cleared with an avifaunal specialist.

- The new power lines should be monitored as part of the solar PV facility monitoring that will be required. This should include at least two line surveys per year to survey for power line bird fatalities, bird nests, and the working order of the line marking devices. New large eagle nests built on the new power lines closer to the Nuweveld Wind Farm turbines (if built) or any other operational wind turbines should immediately be reported to an avifaunal specialist for case specific recommendations. Such nesting could increase the risk of turbine collision and be an indirect impact of the projects under assessment by this study. We strongly recommend against the use of steel lattice towers on the proposed power lines as they provide much more suitable perching substrate for eagles than monopoles.

- 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.

- All decommissioning activities should be strictly managed according to generally accepted environmental best practice standards, so as to avoid any unnecessary impact on the receiving environment.

Environmental impact statement

The construction of the proposed power lines and switching stations will transform some natural habitat, and will also pose a bird collision risk (in the case of the overhead lines). The impacts of the proposed project are all rated as Moderate Negative or even Low Negative significance after mitigation. We recommend that the project be authorised, provided that the recommendations of this report are implemented.

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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 energy 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 sites will be accessed via the R381, DR02317 and existing roads.

The four solar facilities will be assessed within a separate combined specialist report. **This current specialist report deals with the Electrical Grid Infrastructure component of the projects (Table 1).** Each solar facility will connect to the Eskom grid via new 132 kV overhead lines connecting the two on-site solar substations via adjacent Eskom switching stations to the approved Nuweveld Collector substation.

For the grid connection, an Electrical Grid Infrastructure (EGI) Corridor is proposed. The grid corridor includes multiple connection routes of up to two 132 kV overhead lines running in parallel and switching stations to enable the connection of Mura Solar Developments to the approved Nuweveld Collector Substation. The Corridor includes a "collector ring line". This implies that it is a circular grid line and not just a single line between the Nuweveld Collector Substation. The use of a circular "collector ring line" is an approach used by Eskom and others to improve the grid stability and to ensure that if the grid line is damaged on one side of the "collector ring line", that the solar facilities can still export their energy along the other side of the ring line while the fault is repaired. This allows these facilities to be better integrated into the national grid and to better reduce risks of downtime which enables these solar facility projects to be better adapted to potential amendments to future bidding requirements or to potentially give them a competitive advantage over other similar projects.

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.

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 **Electrical Grid Infrastructure** components are as follows:

- Eight Eskom Switching stations:
  - Located adjacent to the solar farm substations within the solar area footprint;
  - Maximum height of 12m;
  - Footprint of up to 150 m x 75 m each.
- Four additional up to 150 m x 75 m switching stations located within the corridor;
- Approximately 70 km of overhead 132 kV lines (~40 km will be single overhead 132 kV lines and ~30 km will be up to two overhead 132 kV lines running in parallel running between the switching stations supported by monopole pylons with a max height 38m); and
- Access tracks.

The pylon structure options are shown in Appendix 7.

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

Table 1. Project specific information (Electrical Grid Infrastructure).

(EGI) Project Components	**Description**	**Disturbance footprint (Ha)**
Switching stations	There will be up to two Eskom switching stations on each solar farm with a footprint of approximately 150 x 75 m (11,250 m2). The switching station area will include all the standard switching station electrical equipment/components, such as bus bars, metering equipment, switchgear, and will also house control, operational, workshop and storage buildings/areas. Additional switching stations are also proposed outside of the solar farm footprint.	13
Overhead lines and pylons	~70 km of overhead 132 kV lines (~40 km will be single overhead 132 kV lines and ~30 km will be up to two overhead 132 kV lines running in parallel running between the switching stations supported by monopole pylons with a max height 38m. The spans	2,5

(EGI) Project Components	Description	Disturbance footprint (Ha)
	(distance between pylons) on the monopole pylons (without stays) are on average 260 m.	
Access roads and tracks	Existing access roads and tracks (upgraded to ± 2-4 m wide where needed) will be used as far as possible and new access tracks would be created where needed (±2-4 m wide). These are required for all project phases.	32
Temporary areas	Temporary laydown areas will be identified along the alignment, with the main equipment and construction yards being located along the alignment or based at the solar site camp. It is anticipated that the total area required for the temporary laydown areas is up to 5 ha and two will be required.	10
Total disturbance footprint: Temporary		10
Total disturbance footprint: Permanent		48
TOTAL		58

Project Name	Affected Farm portions
Mura EGI Corridor	Leeuwkloof Farm 43 Bultfontein Farm 13 Portion 4 of Duiker Kranse Farm 45 Portion 3 of Duiker Kranse Farm 45 Portion 12 of Bultfontein Farm 387 Aangrensend Abramskraal Farm 11 RE of Abrams Kraal Farm 206 Sneeuwkraal Farm 46 RE of Duiker Kranse Farm 45 Portion 2 of Paardeberg Farm 49

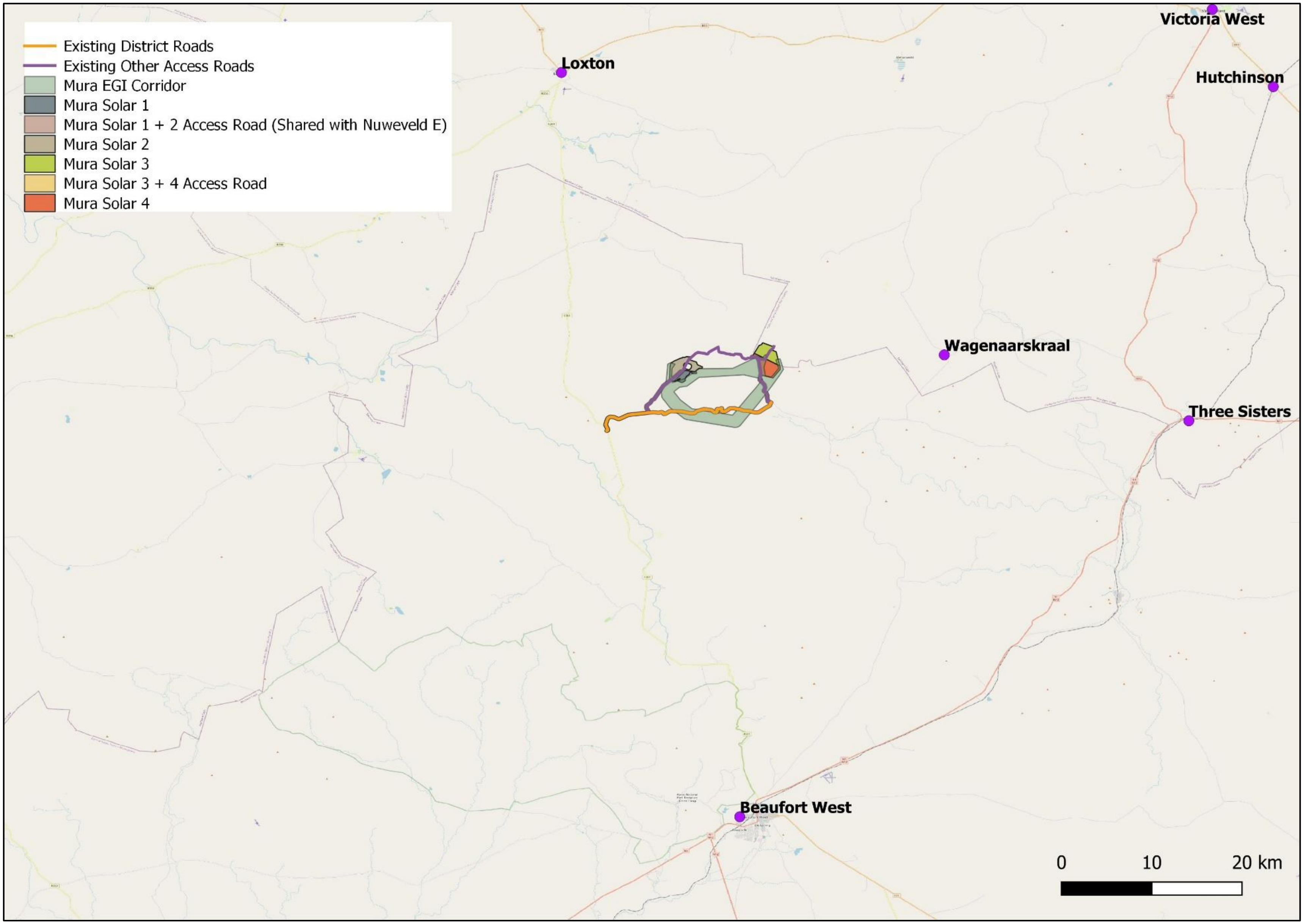

Figure 1. The location of the proposed project and associated solar facilities.

Figure 2. The detailed layout of the proposed project.

1.4. Background to bird interactions with overhead power lines

1.4.1. Habitat destruction during construction

During the construction phase of power lines and switching/sub stations, a certain amount of habitat destruction and alteration takes place on the site. This happens with the construction of access roads along sections of the line, where existing roads are not available, the clearing of the pylon sites and any associated infrastructure. The destruction or alteration of natural habitat may impact birds breeding, foraging and roosting in close proximity to the site.

1.4.2. Disturbance during construction

Similarly, the above-mentioned construction and maintenance activities impact on birds through disturbance, particularly during breeding activities. The potential exists for the impact of disturbance to influence a greater area than the site itself. This corridor has sections that are relatively un-disturbed by other infrastructure, but generally there are roads/ tracks criss-crossing most of the corridor.

1.4.3. Electrocution of birds on tower structures

Electrocution refers to the scenario whereby a bird bridges the gap between two phases or a phase and an earthed component thereby causing an electrical short circuit. The larger bird species such as vultures and eagles are particularly vulnerable to this impact, as obviously the larger the wingspan and other dimensions of a bird, the greater the likelihood of it being able to bridge the gap between hardware. On the 132kV power lines, if the design is not correct, electrocution of large eagles could be possible. It is essential that the pylon design is eagle friendly. Eagles are very susceptible to electrocution on pylons, particularly in a treeless landscape such as the proposed site where they will certainly perch on pylons if available. The Eskom-EWT data set records 22 electrocution fatalities for each of Verreaux's *Aquila verreauxii* and Martial Eagles *Polemaetus bellicosus*. However, electrocutions can be easily mitigated through designing the pylons to have sufficient clearance between phases (i.e. individual lines) and between phases and earthed components so that birds cannot bridge these gaps. This is already adopted in the current design being assessed for this project.

1.4.4. Bird collision with overhead power lines

Collision with power lines is a well-known conservation problem for many birds and for some species it can be a significant source of mortality (Bevanger 1998, Erickson *et al.* 2005, Drewitt & Langston 2008, Shaw *et al.* 2010, Jenkins *et al.* 2011). The reasons for collisions are complex, with each case involving a variety of biological, topographical, meteorological and technical factors (Bevanger 1994). Although all birds have the potential to be affected by collisions, those most heavily impacted are generally large, flocking species which fly often, with waterfowl, gamebirds, cranes, bustards and storks usually among the most frequently reported casualties (Bevanger 1998, Janss 2000, Jenkins *et al.* 2010). The large body size of such species mean that they have limited manoeuvrability in the air and are less able to take necessary evasive action to avoid colliding with power lines (Bevanger 1998).

In South Africa, incidentally, discovered mortality incidents reported by Eskom staff, conservationists and the general public are collated in the Central Incident Register, which is maintained by the Eskom-Endangered Wildlife Trust Strategic Partnership (Eskom-EWT). These data, together with those from more systematic power line surveys near De Aar (Anderson 2001), in the Overberg (Shaw *et al.* 2010) and across the Karoo (Jenkins *et al.* 2011, Shaw 2013, Shaw *et al*, 2017) highlight the high levels of large terrestrial bird mortality caused by existing power lines in this country. Particularly affected are Red-listed birds including cranes, bustards, storks, Secretarybird *Sagittarius serpentarius*, flamingos and vultures, which are generally long-lived and slow to reproduce (Shaw 2013). These species have not evolved to cope with high adult mortality, with the result that consistent mortality in this age group over an extended period could seriously affect a population's ability to sustain itself in the long or even medium term. The cumulative effects of collisions together with other anthropogenic threats to these species (e.g., habitat destruction, disturbance) are unknown over the long term. Mitigating bird collisions with power lines typically involves the installation of line marking devices on the cables in order to make them more visible to approaching birds. Worldwide, a variety of marking devices are used, but very few have been adequately field-tested (Jenkins *et al.* 2010). Great uncertainty remains about which are best, as they vary in effectiveness between species and in different conditions (van Rooyen & Ledger 1999, Anderson 2002). Generally, though, marking seems to be fairly effective, with a recent meta-analysis showing a 78% decrease in mortality rates on marked lines (Barrientos *et al.* 2011). A more recent trial of line marking devices conducted by Shaw *et al* (2017) is described later in this section.

While collisions generally occur in localised hot-spots (i.e., many collisions, sometimes of multiple species in small areas) and are not spread evenly across the landscape, the factors describing these locations are still very difficult to understand. Landscape level GIS studies on Blue Cranes *Grus paradisea* and Ludwig's Bustard *Neotis ludwigii* in South Africa have failed to find useful contributory factors (Shaw *et al.* 2010, Shaw 2013). Some locations are clearly high risk for resident birds with predictable movement patterns, such as lines in close proximity to roosting dams for cranes.

A long term monitoring study conducted on sample sections of 400kV power line in the Karoo (near De Aar) (Shaw *et al*, 2017) provides the most relevant data for our assessment at the proposed site. The study was conducted along three 400 kV transmission lines radiating from the Hydra substation. The landscape is covered by gently-undulating plains dotted with inselbergs and dolerite hills. The primary land use is livestock farming (mostly wool and mutton production), with a few landowners also stocking cattle and game. The site falls within the Platberg-Karoo Conservancy, which is listed as an Important Bird Area due to its contribution to the conservation of globally and regionally threatened large terrestrial birds and raptors (Marnewick *et al.,* 2015). These include the Blue Crane, Ludwig's Bustard, Kori Bustard *Ardeotis kori*, Secretarybird, Martial Eagle, Blue Korhaan *Eupodotis caerulescens*, Black Harrier *Circus maurus*, Denham's Bustard *Neotis denhamii*, Black Stork *Ciconia nigra*, Lanner Falcon *Falco biarmicus*, Tawny Eagle *Aquila rapax*, Karoo Korhaan *Eupodotis vigorsii* and Verreaux's Eagle. The long-term monitoring site included 46 km of the Hydra-Poseidon 1 and 2 and 63 km of the Droërivier-Hydra 1 and 2 400 kV transmission lines, totalling 109 km. Although these were 400kV lines, the findings are still applicable to the 132kV lines proposed at the Mura EGI project. Between May 2008 and January 2011 these two sections of line were surveyed approximately every three months. Overall, at least 32 species were recovered as collision victims (see Figure 3). In common with other power lines surveyed for avian collisions in the Karoo (Shaw *et al.,* 2017), Ludwig's Bustard was the most heavily impacted species at De Aar. The power lines were then marked with anti-collision line marking devices as a trial of these devices. The marking devices showed a significant reduction in collisions of all the relevant species, except for Ludwig's Bustard. The Eskom-EWT Strategic Partnership is currently researching line marking devices for this species specifically (Leeuwner pers comm).

The reason for this apparently low efficacy is likely to be a result of the visual capacity of bustards. A South African study on Kori Bustards, Blue Cranes, and White Storks *Ciconia ciconia* demonstrated that these birds have a narrow field of frontal vision, so when in flight, head movements in the vertical plane (pitching the head to look downwards, perhaps to look for other birds or foraging patches) will render the bird blind in the direction of travel and they will not see the power line at all (Martin & Shaw 2010). Similar visual constraints were subsequently found in *Gyps* vultures, including White-backed Vultures *Gyps africanus* (Martin *et al.* 2012). Development of additional mitigation to draw the bird's attention to the marked line (which must still be marked, because the bird will see the markers if it is looking at the line) is a priority for future research for these groups of birds.

A Verreaux's Eagle nest exists close to the Mura EGI corridor. This means that these birds may be at risk of collision with any new power lines constructed. Our experience is that eagles have fairly low susceptibility to power line collision (based on our experience working on and managing the Eskom –EWT Strategic Partnership between 1998 and 2011). It is advised that the new power lines are routed as far as possible from the nest. This is discussed in more detail in Section 6.

Table 3-1: Number of new (recovered on cleared lines) and total (includes historic carcasses and those found on clearing surveys) bird collision carcasses found on all De Aar site power lines by species (May 2008-October 2016).

Species	New	Total
Ludwig's Bustard	412	536
Blue Crane	303	414
Northern Black Korhaan	36	40
White Stork	20	20
Secretarybird	10	13
Karoo Korhaan	11	12
Pied Crow	10	12
Blue Korhaan	9	9
Kori Bustard	4	8
Spur-winged Goose	7	7
Greater Flamingo	5	5
Jackal Buzzard	5	5
Tawny Eagle	5	5
Black-headed Heron	3	3
Egyptian Goose	3	3
Feral Pigeon	3	3
Hadeda Ibis	3	3
Helmeted Guineafowl	2	3
Greater Kestrel	2	2
Sacred Ibis	1	2
South African Shelduck	2	2
Speckled Pigeon	2	2
Double-banded Courser	1	1
Duck spp.	1	1
Goose spp.	0	1
Grey-backed Sparrowlark	1	1
Gymnogene	1	1
Kestrel spp.	1	1
Korhaan spp.	1	1
Racing pigeon	1	1
Red-billed Teal	1	1
Red-knobbed Coot	1	1
Spotted Dikkop (Thick-knee)	1	1
Steppe Buzzard	1	1
Verreaux's Eagle	1	1
White-necked Raven	1	1
Unidentified	6	30
TOTAL	**877**	**1153**

Figure 3. Summary of Karoo long term monitoring results (from Shaw *et al*, 2017).

1.4.5. Nesting on power lines

Raptors, large eagles, crows, Hadeda Ibises *Bostrychia hagedash* and Egyptian Goose *Alopochen aegyptiaca* have learnt to nest on transmission towers, and this has allowed them to breed in areas of the country where breeding would not previously have been possible due to limited nesting substrates (van Rooyen & Ledger 1999; Jenkins *et al* 2007). This has probably resulted in a range expansion for some of these species, and large eagles such as Tawny, Martial and Verreaux's are now quite common inhabitants of transmission towers in the Karoo. In August 2006 Jenkins *et al* (2007) surveyed approximately 1 400 km of transmission line in the Karoo by helicopter. A total of 132 eagle nests were identified, of three large eagle species (Martial Eagle, Verreaux's Eagle, and Tawny

Eagle). These nest structures were thought to represent a minimum of 90 eagle pairs/territories, and of these, 44 eagle pairs were actively breeding at the time of the survey (nests contained either eggs or young or showed obvious signs of having recently contained large young). An updated survey was conducted more recently, but the report is not yet available.

At face value this nesting appears a positive contribution that power lines can make to these species. However, the situation is more complex in that this is creating artificial nesting sites for birds that may not have nested in such areas. This could be argued to upset the natural balance or could be seen as helping spread the range of the birds. Furthermore, nesting on the tower places the adults and young at much greater risk of collision with the overhead cables than would otherwise be the case (although as shown above the number of incidents of collision do not seem significant). Due to the electrical faulting that these birds can cause on transmission towers, Eskom also sometimes wishes to remove nests in order to manage the risk of faulting, with negative effects for the birds if not correctly handled.

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. Electrical faulting due to birds

Birds are able to cause electrical faults on transmission power lines through their faeces and/or nest material. Large birds perching above live conductors can cause flashovers when they produce long continuous 'streamers' of excrement which bridges the critical air gap, or through build-up of faeces on insulators to the point where the insulation is compromised and a fault occurs. Material used to build nests on towers can also intrude into the air gap and cause short circuits. Fortunately, bird related electrical faulting is not common on 132kV power lines due to the lower voltage than on transmission lines >132kV.

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 powerlines, 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).Although the current application is for overhead power lines, these power lines are to serve four solar PV facilities, and the overall study area was assessed according to these best practice guidelines.

- 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 is a key point:

- 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 EGI corridor. The closest IBA is the Karoo National Park IBA approximately 31km south of the site.
- The Coordinated Avifaunal Roadcount project was consulted (Young *et al,* 2003). One routes exists approximately 47km south of the projects.
- 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 project. 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. Although the project currently assessed is an Electrical Grid Infrastructure Corridor, the grid is needed because of the development of solar PV facilities, so these guidelines are relevant. Also – the EGI corridor has been studied as part of a holistic bird monitoring programme at the overall site.
- The Nuweveld Wind Farms and grid connection avifaunal studies and data were considered.
- 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.

The EGI Corridor was studied pre-construction as part of the overall studies for the four Mura PV facilities. As such the below description of the monitoring as per the best practice guidelines has relevance. Since birds are mobile, each sub component of the overall project benefits from drawing from bird data for a larger area.

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 4)

Season 2 (spring-summer):

- Identical methods to the above
- Conducted in September 2022
- Covering only Area 2 and 5 (Figure 4)

Figure 4 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 4, 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 this 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 screening. At Area 2 the walked transects shown in Figure 4 were moved into the proposed PV area to get better representation.

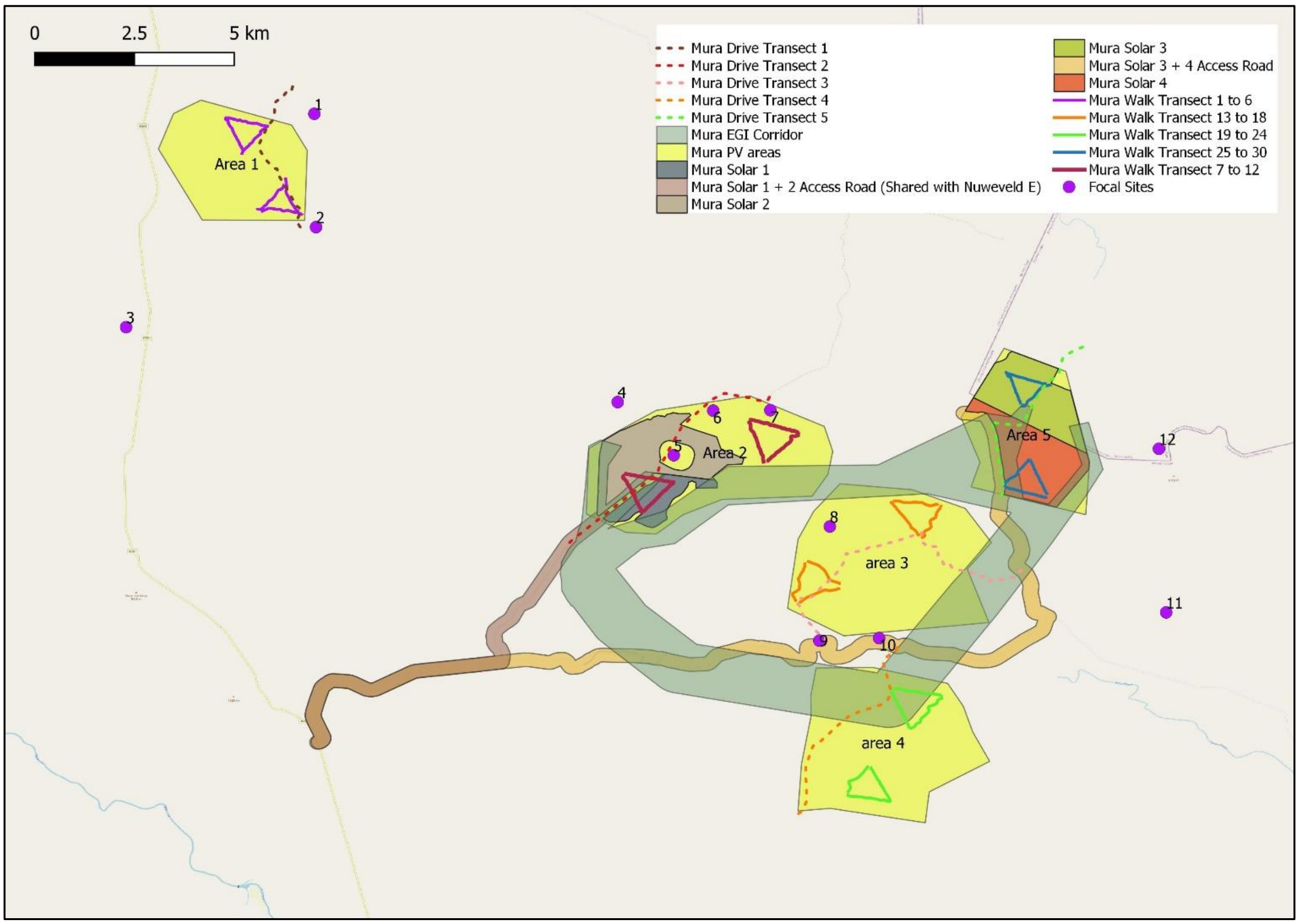

Figure 4. Layout of pre-construction bird monitoring activities on site.

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 DFFE Screening Tool classifies the proposed project sites as follows:

Mura EGI Corridor (Figure 5)

- Animal Theme rated as High sensitivity, with Ludwig's Bustard *Neotis ludwigii* and Verreaux's Eagle *Aquila verreauxii* listed.
- Avian Theme was not rated.
- Terrestrial Biodiversity Theme was rated as Very High sensitivity, based on the presence of CBA and ESA areas on site.

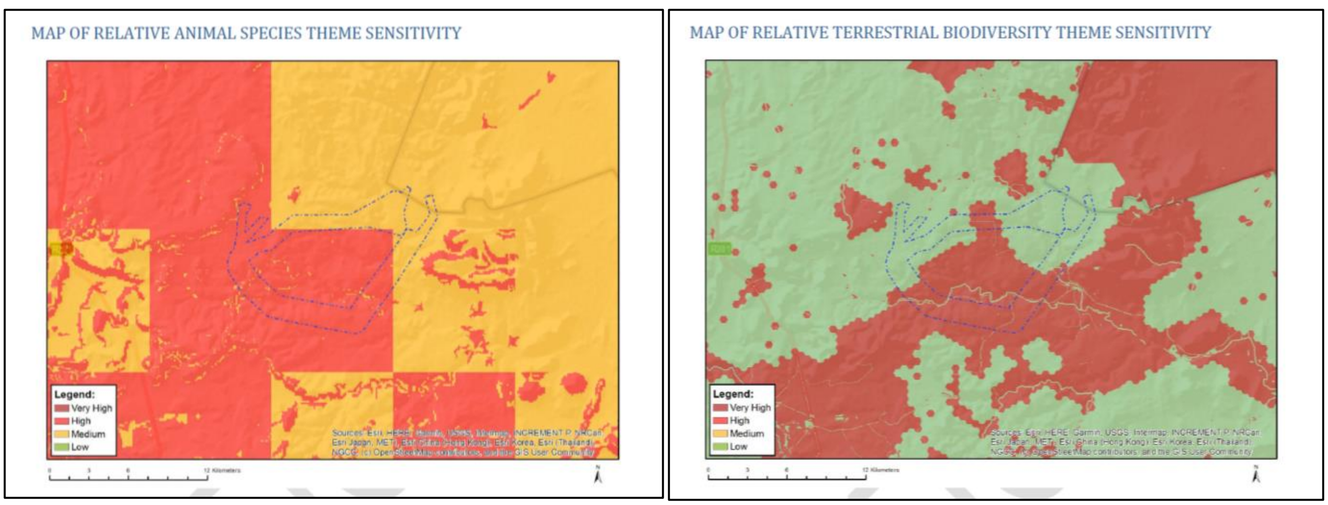

Figure 5. The relevant screening tool outputs for the Mura EGI Corridor.

The screening tool findings are summarised in Table 2.

Table 2. Summary of screening tool ratings.

Theme	**Grid Corridor**
Animal species	High Birds - *Neotis ludwigii* and *Aquila verreauxii*
Avian	Not rated
Terrestrial Biodiversity	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 and Hoogland 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 730m north of the EGI corridor edge, and an alternate nest approximately 400m north of the edge (see Section 6).

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 project is 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 6.

Figure 6. 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 in the Mura EGI corridor 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

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

The corridors were studied as part of the overall solar PV sites pre-construction bird monitoring. A very strong data set of which bird species occurs in the area is therefore available. Since birds are mobile, in most cases the data set is applied to the full project including the corridors. Where specific exceptions exist and data applies only to a particular portion of this proposed project, these have been highlighted.

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 4 presents a summary (6 month monitoring 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 5 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 6)(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 were a Martial Eagle nest and a Verreaux's Eagle nest. The Martial Eagle nest is now some distance from the proposed EGI corridor now that certain areas have been screened out (PV Area 1 was screened out), and no longer considered relevant. The Verreaux's Eagle nest remains relevant and 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 7.

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 31 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 47km 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 7summarises these data.

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

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

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.

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

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	Collision with overhead lines, Habitat destruction, Disturbance	High
Verreaux's Eagle	*Aquila verreauxii*	VU, LC	Confirmed, resident several kilometres off site and likely forages on site occasionally	High	Collision with overhead lines, Electrocution on pylons, Habitat destruction, Disturbance	Medium
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC	Confirmed, multiple pairs resident on site	Medium	Collision with overhead lines, Habitat destruction, Disturbance	High
Sclater's Lark	*Spizocorys sclateri*	NT, NT, E	Confirmed, one pair seen on site, likely occasional visitor	Medium	Habitat destruction, Disturbance	Low
Blue Crane	*Grus paradisea*	NT, VU, E	Confirmed, likely resident in broader area	Low	Collision with overhead lines, Habitat destruction, Disturbance	Medium

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 Endangered by Taylor *et al* (2015). This physically large species is highly vulnerable to collision with overhead power lines, and is also likely to be affected to a lesser extent 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.

We recorded Ludwig's Bustard on site on all site visits. We believe that small influxes of Ludwig's Bustards onto site could occur at times when conditions are right on site. This would result in temporary high risk of collision of the species with power lines. Based on the species' conservation status, the importance of this site as habitat, and its susceptibility to collision with overhead power lines, 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 that is). 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 (2010) 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 site we have recorded a Verreaux's Eagle nest approximately 730m north of the edge of the EGI corridor (with an alternate nest approximately 400m from the corridor). We categorised a 2km radius around this nest as No-Go for solar PV development. This resulted in the impact avoidance measures taken by the developer in excluding the closest PV area from development. This in turn influenced where the EGI corridor needed to be to reach the PV areas. For the EGI corridor specifically, we categorised a 1km circular buffer around the nest (and the alternate) as No-Go for overhead lines.

This species is likely to be susceptible to four possible impacts: collision with overhead lines, electrocution on pylons, habitat destruction, and disturbance. Based on our data collected on site to date, we conclude that this species is at Medium risk.

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 an overhead power line or switching station: habitat destruction, and collision with the overhead lines. We have recorded this species consistently on site 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 collision with overhead lines, and to a lesser extent habitat destruction and disturbance.

Sclater's Lark (Low 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. These records were made within a few hundred metres of the EGI corridor, and we consider this species highly likely to occur in the corridor itself. This species could be susceptible to habitat destruction, and disturbance.

Blue Crane (High 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. This species is highly susceptible to collision with overhead power lines. At the proposed broader site (including within the EGI corridor) we have recorded the species infrequently and in low abundance to date. We do however expect to record a higher abundance at times and have judged the species to be at Medium risk on a precautionary basis.

5. Evaluation of Impacts

The various potential impacts that could occur as a result of the proposed project 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 project will consist of three phases: construction; operation; and decommissioning.

5.1. Construction phase

5.1.1. Habitat destruction associated with the construction of the project

During the construction phase of this project, a certain amount of habitat destruction and alteration will take place. The amount of habitat that will be affected by the project will be 58 hectares (Section 1.3).

We have judged the significance of this impact for the project to be of Moderate Negative Significance pre-mitigation. Since this habitat destruction is inevitable the significance will remain at Moderate Negative post mitigation.

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 identified one Verreaux's Eagle breeding within the EGI corridor to be relevant. The risk at this receptor has been largely avoided through the classification of a 1km No-Go buffer around the nest (and its' alternate) (Section 6). We conclude the significance of this impact to be of Low Negative Significance both with and without mitigation.

5.2. Operational phase

5.2.1. Collision of birds with overhead lines

Overhead power lines pose a collision risk to large terrestrial species such as bustards, cranes and korhaans in particular. The significance of bird collision with overhead power lines has been rated as High Negative significance and can be reduced to Medium Negative significance through the application of the mitigation below. Unfortunately the line marking devices currently available have proven less effective for Ludwig's Bustards (present in the study area) and so the significance of this impact cannot be reduced below Medium at this time. Research into more effective devices is ongoing and it is conceivable that a more effective device will be available for use on this project by the time of construction. Overhead conductors or earth wires should be fitted with the best available Eskom approved anti bird collision line marking device available at the time of construction. Should new more effective BFDS come available they should be procured and fit.

5.2.2. Electrocution of birds on pylons

Large eagles would typically be at risk of electrocution on pylons in this largely treeless landscape, where they will almost certainly perch frequently on any available pylons. The proposed pylon designs all provide for sufficient clearance between phase and phase, and phase and earthed components, to mitigate the risk of eagle electrocution. We have rated the impact as High Negative significance pre-mitigation, and Low Negative significance after the use of these bird friendly designs. In addition, we recommend the use of a monopole structure with the standard Eskom Bird Perch on all pole tops to further provide safe perching substrate well above the dangerous hardware.

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 identified one Verreaux's Eagle breeding within the EGI corridor to be relevant. The risk at this receptor has been largely avoided through the classification of a 1km No-Go buffer around the nest (and its' alternate) (Section 6). We conclude the significance of this impact to be of Low Negative Significance both with and without mitigation.

5.4. Cumulative effects of development on avifauna in this area

Red Cap provided a map of renewable energy projects within 30km of the proposed site (Figure 7). Five wind farm complexes (mostly consisting of more than one wind farm each) exist within this area.

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

The two cumulative impacts that are of most concern are: collision of birds with overhead lines; and habitat destruction. The impact of bird collision with overhead lines is rated as High negative pre-mitigation, and Moderate Negative post mitigation. This is due in particular to the challenges of mitigating collision of Ludwig's Bustard, one of the priority species on site. 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.

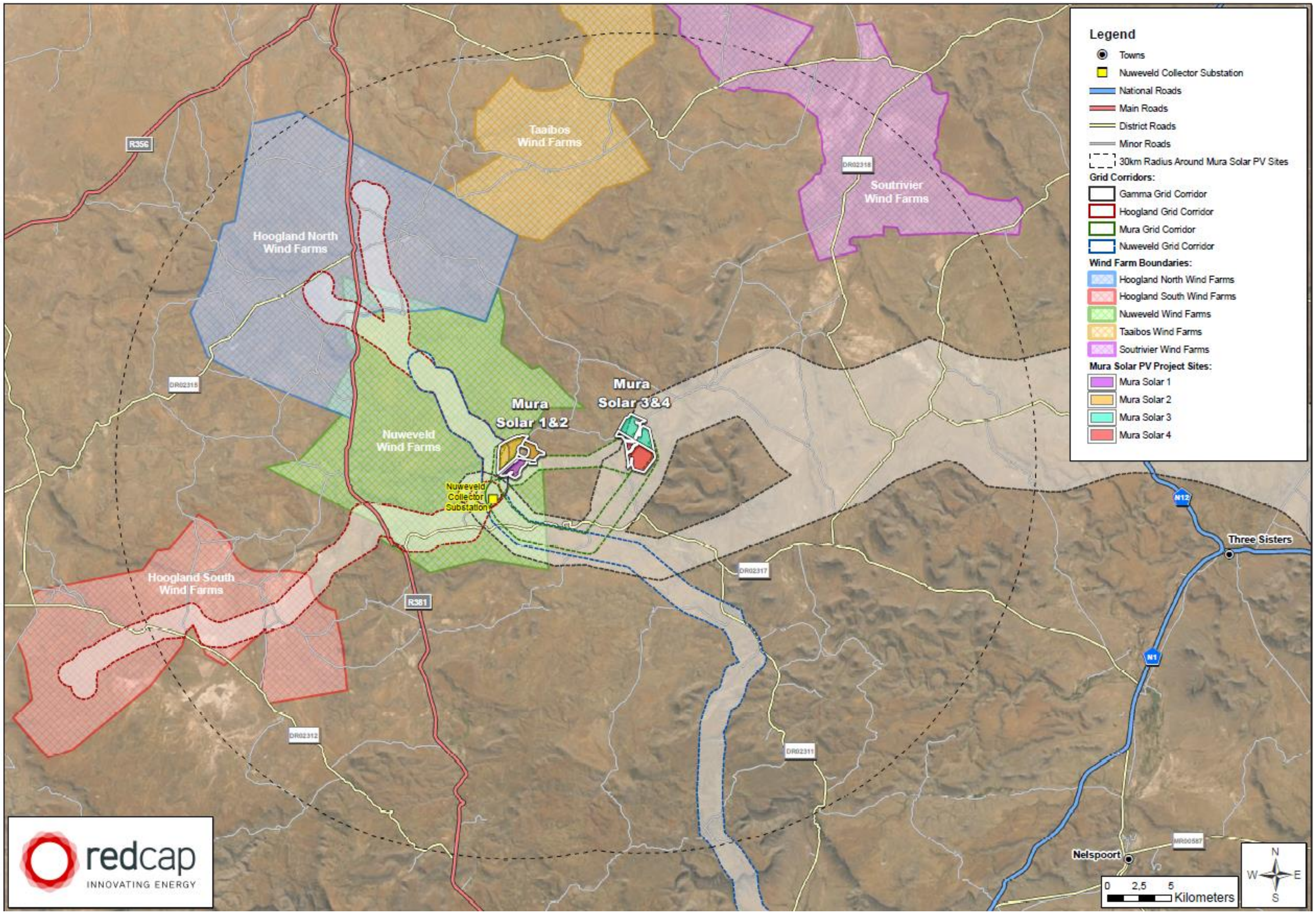

Figure 7. Summary of renewable projects within 30km of the proposed gridline corridor (supplied by Red Cap).

Table 9. Impact assessment scoring details.

Impact number	Aspect	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation						
CONSTRUCTION																			
Impact number	**Aspect**	**Description**	**Stage**	**Charac ter**	**Ease of 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	3	1	3	4	5	**55**	**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**	**Charac ter**	**Ease of Mitigation**	**Pre-Mitigation**							**Post-Mitigation**						
						(M+	**E+**	**R+**	**D)x**	**P=**	**S**		**(M+**	**E+**	**R+**	**D)x**	**P=**	**S**	
Impact 1:	Collision of birds with overhead lines	Birds in flight collide with the lines and are killed either by the impact or by the subsequent impact with the ground	Operational	Negative	Medium	4	3	5	4	4	**64**	**N4**	2	3	5	4	3	**42**	**N3**
					Significance	**N4 - High**							**N3 - Moderate**						
Impact 2:	Electrocution of birds	Birds perched on pylons are electrocuted when they bridge critical clearances	Operational	Negative	High	4	3	5	4	4	**64**	**N4**	1	3	5	4	2	**26**	**N2**
					Significance	**N4 - High**							**N2 - Low**						
DECOMISSIONING																			
Impact number	**Receptor**	**Description**	**Stage**	**Charac ter**	**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:	Collision of birds with overhead lines	Birds in flight collide with the lines and are killed either by the impact or by the subsequent impact with the ground	Cumulative	Cumulative	Medium	4	3	5	4	4	**64**	**P4**	2	3	5	4	3	**42**	**P3**
					Significance	**P4 - High**							**P3 - Moderate**						
Impact 2:	Destruction of habitat	Habitat destroyed or altered in such a way as to render it unavailable to birds	Construction	Cumulative	Low	3	1	3	4	5	**55**	**P3**	3	1	3	4	5	**55**	**P3**
					Significance	**P3 - Moderate**							**P3 - Moderate**						

5.6. Summary of impacts

Table 10 summarises the above impact assessment.

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
Operational	Collision of birds with overhead lines	High Negative	Moderate Negative
	Electrocution of birds on pylons	High Negative	Low Negative
Decommissioning	Disturbance of birds	Low Negative	Low Negative
Cumulative impacts	Cumulative impacts through collision of birds with overhead lines	High Negative	Moderate Negative
	Cumulative impacts through habitat destruction	Moderate Negative	Moderate Negative

6. 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 categories" No-Go; and High were identified on the site. The input features for these categories are described below, and the categories and mapping presented in Table 11 and Figure 8. Avifaunal constraints are presented in Figure 8 for the full corridor.

The input avifaunal feature data is as follows:

- Bird nests. We have assigned a No-Go buffer for new infrastructure of 1km to the two Verreaux's Eagle nests (see Table 11). No new overhead power line may be built within this area.

- Dams. A buffer of 250m has been applied to the dams identified on site and the resulting areas are classified as High sensitivity for new infrastructure (see Table 11). One exception is applicable at a small dam in the far west of the EGI corridor (west of Mura 1 and 2) where it has been agreed between specialist and applicant that the EGI corridor may infringe on the buffer area.

Table 11. Avifaunal sensitivity features for EGI areas.

Category	Feature
No Go	Verreaux's Eagle nest plus 1 000m buffer
High	Dams plus 250m buffer
Medium	
Low	

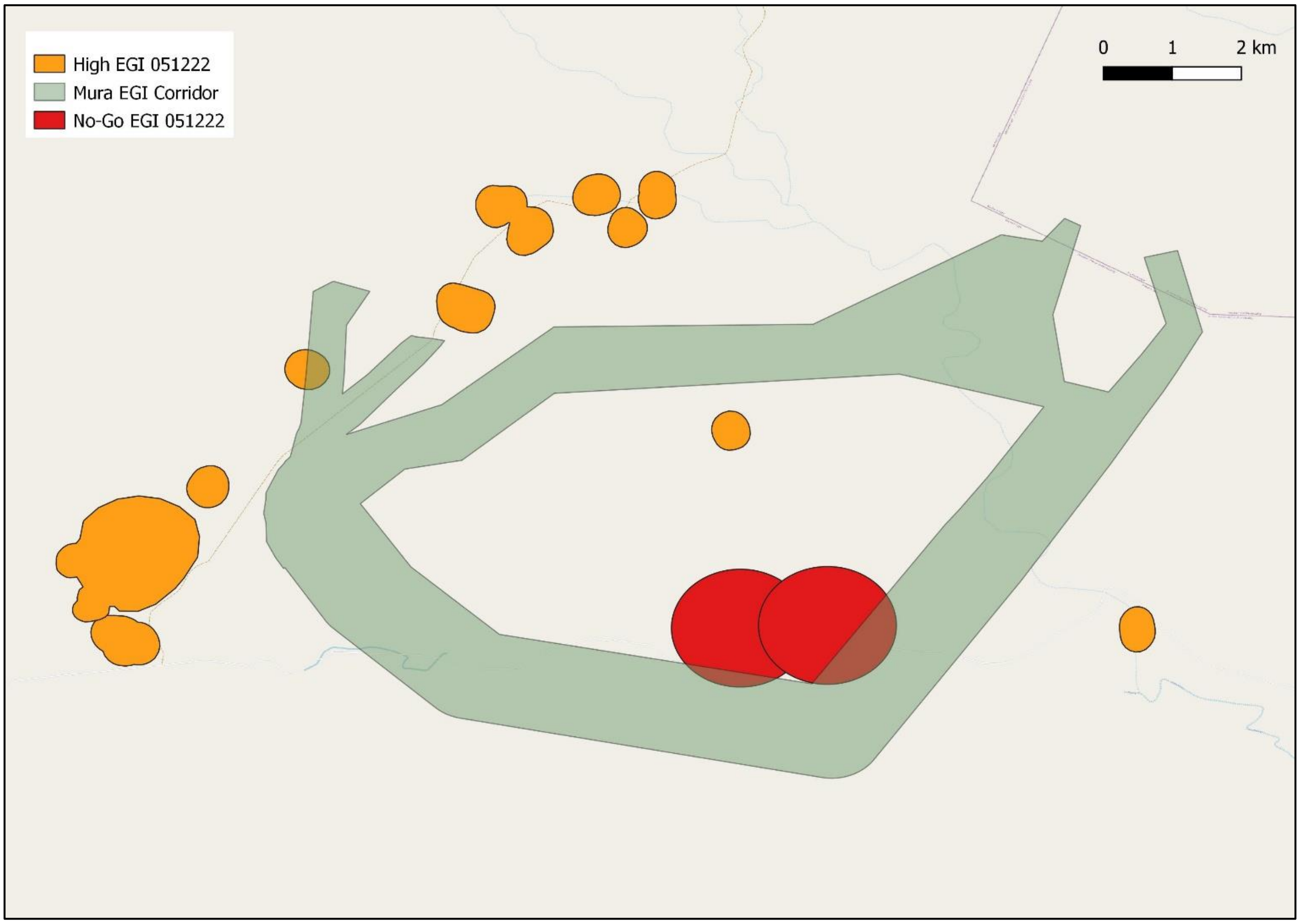

Figure 8. Avifaunal sensitivity of the overall site.

7. Operational phase monitoring framework

The new power lines should be monitored as part of the solar PV facility monitoring that will be required. This should include at least two line surveys per year. These surveys should check for: power line bird fatalities; bird nests; and monitor the working order of the line marking devices (which must be replaced if they fail).

8. Comparison of alternatives

The proposed development is described in Section 1.3. No alternatives have been provided for this assessment. However, an iterative design approach has been adopted for this project, whereby the EGI corridor has been refined following the screening input received from specialists. The alignment and placement of infrastructure will be guided by the sensitivity mapping received from the specialists as well as considering technical constraints.

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).

9. Mitigation measures summary (to include in the EMPr)

The following mitigation measures are recommended for the project and must be included in the EMPr.

- The identified No-Go areas on site should be avoided by the proposed infrastructure. The identified High sensitivity areas should also be avoided as far as possible. One exception in High sensitivity areas is applicable at a small dam in the far west of the EGI corridor (west of Mura 1 and 2) where it has been agreed between specialist and applicant that the EGI corridor may infringe on the buffer area.

- A pre-construction avifaunal walk down should be conducted to confirm final layout and identify any sensitivities that may arise between the conclusion of the Environmental Authorisation process and construction.

- 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.

- Overhead conductors or earth wires should be fitted with the best available Eskom approved anti bird collision line marking device available at the time of construction. Should new more effective BFDS come available the developer needs to be ready to procure and fit these.

- The proposed pylon designs all provide for sufficient clearance between phase and phase, and phase and earthed components, to mitigate the risk of eagle electrocution. In addition, we recommend the use of a monopole structure with the standard Eskom Bird Perch on all pole tops to further provide safe perching substrate well above the dangerous hardware. Any deviation from these approved structures should be cleared with an avifaunal specialist.

- The cumulative impacts of overhead power lines on birds in the study area will need to be carefully mitigated by each project using the above mitigation measures for bird collision and electrocution, repeated here for clarity:
    - Overhead conductors or earth wires should be fitted with the best available Eskom approved anti bird collision line marking device available at the time of construction. Should new more effective BFDS come available the developer needs to be ready to procure and fit these.
    - The proposed pylon designs all provide for sufficient clearance between phase and phase, and phase and earthed components, to mitigate the risk of eagle electrocution. In addition, we recommend the use of the standard Eskom Bird Perch on all pole tops to further provide safe perching substrate well above the dangerous hardware. Any deviation from these approved structures should be cleared with an avifaunal specialist.

- The new power lines should be monitored as part of the solar PV facility monitoring that will be required. This should include at least two line surveys per year to survey for power line bird fatalities, bird nests, and the working order of the line marking devices. New large eagle nests built on the new power lines closer to the Nuweveld Wind Farm turbines (if built) or any other operational wind turbines should immediately be reported to an avifaunal specialist for case specific recommendations. Such nesting could increase the risk of turbine collision and be an indirect impact of the projects under assessment by this study. We strongly recommend against the use of steel lattice towers on the proposed power lines as they provide much more suitable perching substrate for eagles than monopoles.

- 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.

- All decommissioning activities should be strictly managed according to generally accepted environmental best practice standards, so as to avoid any unnecessary impact on the receiving environment.

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 four priority bird species to be at High or Medium risk (pre-mitigation) if the proposed projects proceed. Ludwig's Bustard (Endangered), Karoo Korhaan (Near-threatened), and Blue Crane (Near-threatened) are at High risk, whilst Verreaux's Eagle is at Medium risk. These species are primarily at risk of collision with the overhead lines. Electrocution of large eagles, such as Verreaux's Eagle, perched on pylons is also a risk, although can be comprehensively mitigated.

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
Operational	Collision of birds with overhead lines	High Negative	Moderate Negative
	Electrocution of birds on pylons	High Negative	Low Negative
Decommissioning	Disturbance of birds	Low Negative	Low Negative
Cumulative impacts	Cumulative impacts through collision of birds with overhead lines	High Negative	Moderate Negative
	Cumulative impacts through habitat destruction	Moderate Negative	Moderate Negative

The mitigation measures for the management of these identified impacts have been detailed in Section 9.

Environmental impact statement

The construction of the proposed power lines and switching stations will transform some natural habitat, and will also pose a bird collision risk (in the case of the overhead lines). The impacts of the proposed project are all rated as Moderate Negative or even Low Negative significance after mitigation. We recommend that the project be authorised, provided that the recommendations of this report are implemented.

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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 thos 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				
				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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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.

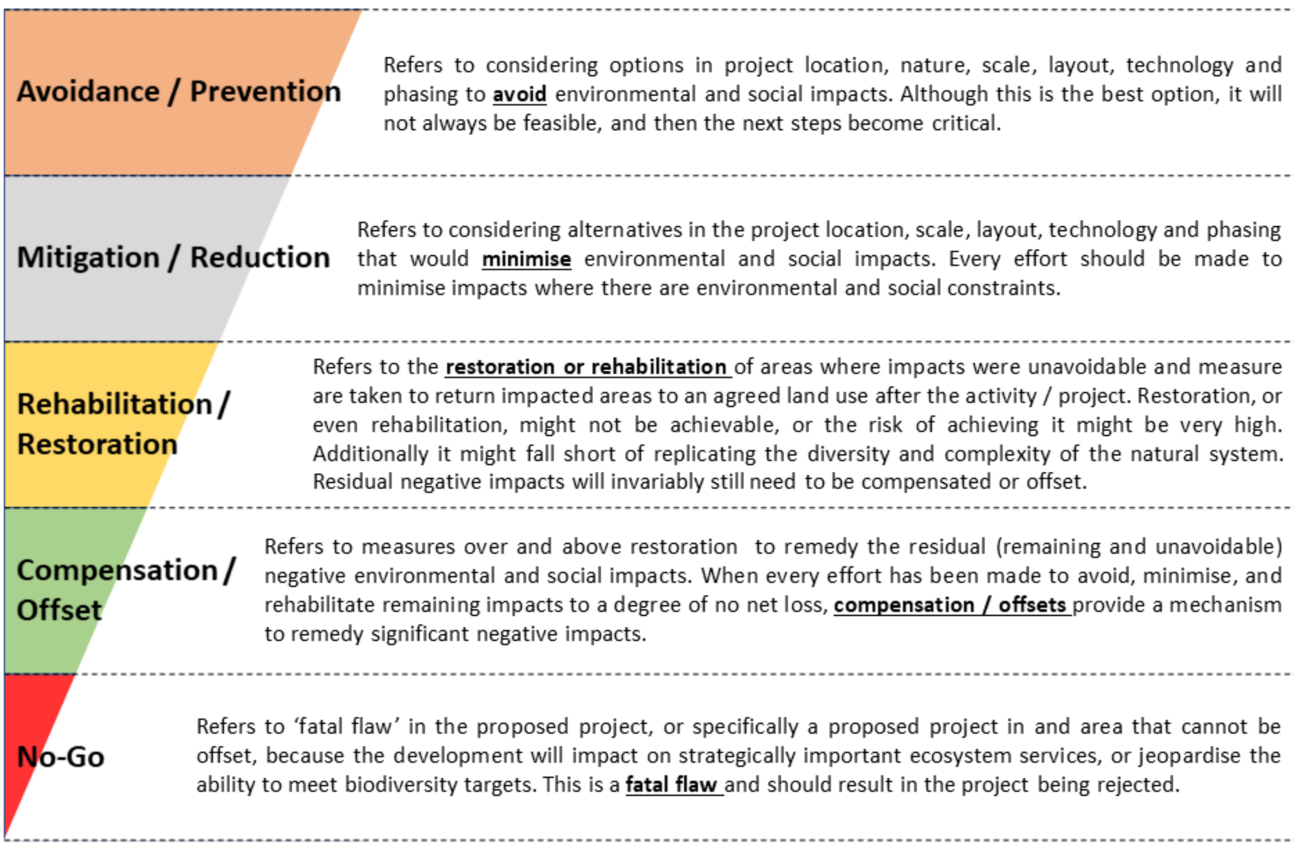
	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite 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

<u>Ascribing Significance for Decision-Making</u>

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.

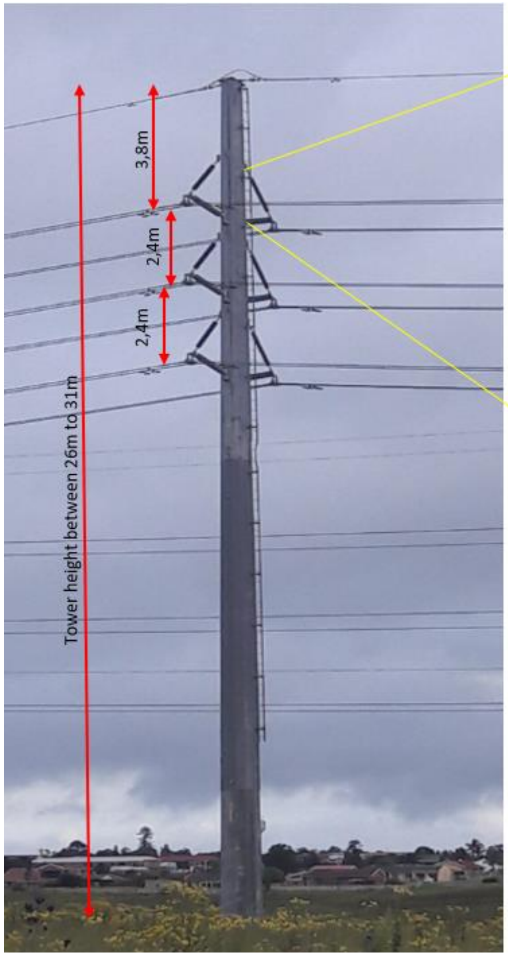
Residual Risk Categories

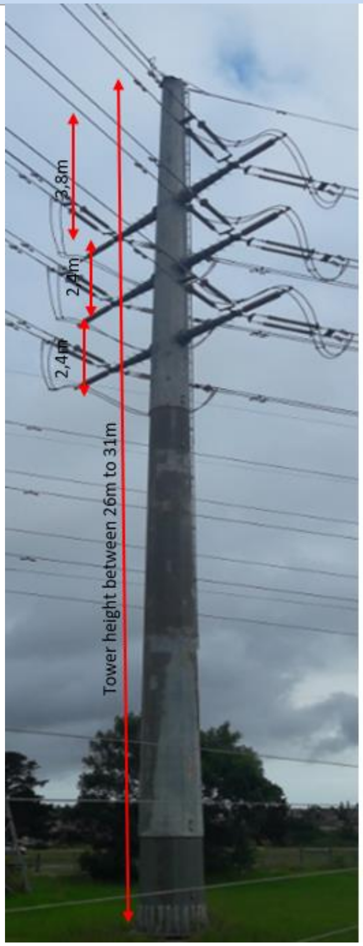
Consequence	High	Moderate	High	High	Fatally flawed	
	Moderate – high	Low	Moderate	High	High	High
	Moderate	Low	Moderate	Moderate	Moderate	Moderate
	Moderate – low	Low	Low	Low	Low	Moderate
	Low	Low	Low	Low	Low	Low
		Highly unlikely	Unlikely but possible	Likely	Highly likely	Definite
		Likelihood				

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

Appendix 7. Grid connection structure types.

Tower Type	Description and purpose	Illustration
132kV Intermediate **Self-Supporting Double Circuit** Monopole.	Self-supporting galvanised steel Monopole Intermediate or Suspension structure with no stays/anchors. The monopole is designed to support a double electrical circuit with a twin conductor arrangement, This structure will be used as intermediate structures between inline strain or angle strain points. This structure will also be the most common structure used at an estimated 60% to 80% of the total number of structures. The structure is design to support the conductor weight as well as the wind loading specifications. Monopole Height: Between 26m and 32m. Pole top diameter: 380mm to 450mm Pole Base diameter: 1.2m to 1.5m	**Front View of the tower with typical foundation size:** 
132kV Inline or Angle Strain	Self-supporting galvanised steel Monopole Inline or Angle Strain structure with no stays/anchors. The monopole is designed to	**Front View of the tower:**

Tower Type	Description and purpose	Illustration
Self-Supporting Double Circuit Monopole.	support a double electrical circuit with a twin conductor arrangement, This structure will be used as the strain structure and will be positioned at the angle points along the line or as an inline position where a strain point is required due to the ground elevation. The number of inline or angle strain points estimated in the order of 20% to 40% of the total number of structures. The monopole is design to support the conductor tensions associated with the conductor weight and span lengths as well as the wind loading specifications. Monopole Height: Between 26m and 32m. Pole top diameter: 380mm to 450mm Pole Base diameter: 1.8m to 2.5m	

Tower Type	Description and purpose	Illustration
132kV Inline or Angle Strain **Guyed Double Circuit** Monopole.	Galvanised steel Monopole Inline or Angle Strain structure with anchors/stays for additional structure support. This monopole is similar to the self-supporting monopole but with additional anchor support for conditions where longer span lengths is required with higher conductor tensions. The monopole with anchors is design to support the conductor tensions associated with the conductor weight and longer span lengths. Monopole Height: Between 26m and 32m. Pole top diameter: 380mm to 450mm Pole Base diameter: 1.8m to 2.5m Anchors/Stays: Depending on the angle strain point up to 4 x anchors.	**Front View of the tower:**  Dimensions (dashed line =NGL)
132kV Suspension **Self-Supporting Single** Circuit Monopole with **single** conductor.	Self-supporting galvanised steel Monopole Suspension structure with no stays/anchors. The monopole is designed to support a single electrical circuit with a single conductor arrangement. This structure will be used as an intermediate structure between inline strain or angle strain points and if used will only be used for the collector powerlines on the wind farm sites between the collector switching/ substation and the wind farm switching stations. The structure is designed to support the conductor weight as well as the wind loading specifications.	**Front View of the tower with typical foundation size:**

Tower Type	Description and purpose	Illustration
	Monopole Height: Between 22m and 26m. Pole top diameter: 230mm Pole Base diameter: 650mm The structure will be planted at the following depths: 22m — 2.8m 24m — 3.0m 26m — 3.2m	
132kV Inline or Angle Strain **Self-Supporting Single** Circuit Monopole with **single** conductor	Self-supporting galvanised steel Monopole Inline or Angle Strain structure with no stays/anchors. The monopole is designed to support a single electrical circuit with a single conductor arrangement, This structure will be used as a strain structure and will be positioned at the angle points along the line or as an inline position where a strain point is required due to the ground elevation. If used this structure will only be used for the collector powerlines on the	**Front View of the tower:**

22m	2.8m
24m	3.0m
26m	3.2m

Tower Type	Description and purpose	Illustration
	wind farm sites between the collector switching/ substation and the wind farm switching stations. The monopole is designed to support the conductor tensions associated with the conductor weight and span lengths as well as the wind loading specifications. Monopole Height: Between 24m and 26m. Pole top diameter: 380mm Pole Base diameter: 1m to 1.2m The foundation will consists of a typical pad foundation with bolts inside the concrete foundation.	

Tower Type	Description and purpose	Illustration
Triple pole structure. 2 x Single circuit with Twin Tern Conductor	For long spans (>350m to 500m) across valleys and rivers. Strain structure with three single monopoles per circuit. 5-9 stays per triple pole structure depending on angle configuration. Typical 18 to 16m in length. In a double circuit configuration it will be a triple pole structure per circuit place at 10m-15m apart	
Triple pole structure 1 x Single circuit with up to Twin Tern Conductor	For long spans (>350 m to 500 m) across valleys and rivers. Strain structure with three single monopoles. 5-9 stays per triple pole structure depending on angle configuration. Height: Typically 18 to 16 m.	

Tower Type	Description and purpose	Illustration
132kV Inline or Angle Strain **Lattice** Steel Tower for double circuit line	Galvanised steel inline or angle strain lattice tower for conditions where longer span lengths across valley in exceptional cases is required with higher conductor tensions. (500 m to 800 m spans) Tower Height: Between 31 m and 38 m. Foundations: 4 x concrete foundations for 4 x legs of the tower. Base of the tower with 4 legs in general 15 m x 15 m area.