AVIFAUNAL IMPACT ASSESSMENT REPORT FOR THE PROPOSED SUN GARDEN PV FACILITY NEAR COOKHOUSE, EASTERN CAPE PROVINCE

For

Sun Garden (Pty) Ltd

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EXECUTIVE SUMMARY

- The proposed development relates to a Solar Photovoltaic (PV) Facility and associated infrastructure, including (but not limited to) a 132 kV overhead powerline grid connection;
- Data used to inform the impact assessment were extensive and included both monitoring of the broader area associated with proposed Wind Energy Facilities nearby as well as focussed surveys with the proposed development site;
- Nine avifaunal Species of Conservation Concern (SCCs) were identified to be the most relevant receptors of the potential impacts associated with the development and were the primary focus of the assessment;
- These SCCs were not the only impact receptors considered for the assessment and many act as surrogates for determining potential impacts on other species (e.g. mitigation measures for Blue Crane will also be applicable to Grey Crowned Crane);
- Given the nature of the potential impacts, the proposed development site location and habitats present, the available avifauna data, the SCCs identified and their utilisation of the area (both observed and predicted) the Site Ecological Importance of the proposed development area of impact was determined to be low to very low;
- Potential collisions with overhead powerlines was assessed to be the most significant impact (assessed as Medium significance) associated with the proposed development (particularly for bustards), however mitigation measures such as staggering pylon positions between those of parallel overhead powerlines is likely to mitigate this impact;
- Overhead powerline pylon positions are to be staggered relative to existing or other novel overhead powerline pylons associated with other proposed developments nearby;
- Bird Flight Diverters (BFDs) are to be installed and maintained along the whole length of novel overhead powerlines constructed to reduce collision risk, particularly for cranes;
- The proposed development is unlikely to jeopardize the long-term persistence and viability of SCC populations in the area following the implementation of mitigation measures when assessed both alone and cumulatively with other nearby infrastructure;
- The 'No-Go' Alternative is not considered to be the preferred action as the proposed development site appears to be well suited to the development of a solar PV facility as assessed; therefore
- The proposed development is acceptable and can be approved from an avifaunal perspective.

1 INTRODUCTION

1.1 Background

Sun Garden (Pty) Ltd is proposing the development of a commercial solar PV facility and associated infrastructure on a site located approximately 36 km south-east of Somerset East and 28 km south-west of Cookhouse within the Blue Crane Route Local Municipality and the Sarah Baartman District Municipality in the Eastern Cape Province. The entire extent of the site falls within the Cookhouse Renewable Energy Development Zone (REDZ) and within the Eastern Corridor of the Strategic Transmission Corridors. The facility is known as the Sun Garden PV Facility.

A preferred project site with an extent of ~4037 ha has been identified by Sun Garden (Pty) Ltd as a technically suitable area for the development of the Sun Garden PV Facility. The project site consists of four affected properties:

- Portion 9 of the farm Britzkraal No 253, Division of Somerset East;
- Portion 8 (a Portion of Portion 7) of the farm Britzkraal No 253, Division of Somerset East;
- Portion 7 of the farm Britzkraal No 253, Division of Somerset East; and
- Portion 1 of farm Bothas Hoop 358.

A development envelope for the placement of the solar facility infrastructure (i.e. development footprint) has been identified within the project site and assessed as part of the Basic Assessment (BA) process. The development envelope is ~500 ha in extent and the much smaller development footprint of ~350 ha will be placed and sited within the development envelope. The development footprint will contain the following infrastructure to enable the solar facility to generate up to 400 MW:

- Solar PV array comprising PV modules and mounting structures;
- Inverters and transformers;
- Cabling between the project components, lain underground where practical;
- A 132/33 kV on-site collector substation to be connected to a proposed 400 kV Main Transmission Substation (MTS) located to the south of the site via a new 132 kV overhead power line (twin turn dual circuit line). The development of the proposed 400 kV Main Transmission Substation will be assessed as part of the separate BA process in order to obtain Environmental Authorisation;
- Site offices and maintenance buildings, including workshop areas for maintenance and storage;
- Water supply pipelines from onsite boreholes;
- Temporary laydown areas;
- Access roads to the site and between project components with a width of approximately 4.5 m. The main access points will be 8 m wide;
- A temporary concrete batching plant;
- Staff accommodation (temporary); and
- Operation and Maintenance buildings including a gate house, security building, control centre, offices, warehouses, a workshop and visitor's centre.

The new 132 kV overhead power line to connect the development to the proposed 400kV Main Transmission Substation will follow a route east of the project site to complete the connection. The power line will therefore cross properties located to the south of the project site. The majority of these properties form part of the project sites of the adjacent proposed wind farms which forms part of the cluster of renewable energy facilities proposed. The power line is being assessed within a 300 m grid connection corridor which will provide for the avoidance of sensitive environment areas and features and allow for the micro-siting of the power line within the corridor. It is understood that the new 132 kV overhead power line will be approximately 11.2 km in length and follow existing transmission infrastructure

for approximately 1.5 km at the crossing of the Kleinvisrivier. It is proposed that the servitude assessed will include grid connection infrastructure for the proposed Sun Garden PV Facility, Solaris Fields Solar PV Facility and Redding Wind Energy Facility (WEF) running in parallel along the corridor.

1.2 Terms of Reference

The terms of reference for this report are to:

- Determine the baseline avifaunal community of the receiving environment;
- Provide baseline avifaunal abundance data against which post-construction impacts can be measured;
- Determine the avifaunal species of conservation concern (SCCs) most at risk of potential impact by the proposed development;
- Identify and assess the potential impact of the proposed development on the avifaunal community of the receiving environment, particularly as they relate to SCCs;
- Determine appropriate measures (if any) for inclusion into the Environmental Management Programme (EMPr) to mitigate the potential impacts of the proposed development on the avifaunal community of the receiving environment, particularly as they relate to SCCs; and
- Provide a statement regarding the environmental suitability of the proposed development from an avifaunal perspective.

2 METHODS

The avifaunal surveys conducted for this assessment were commissioned and completed prior to the publication of Government Gazette 43855 (Published in Government Notice No. 1150) of 30 October 2020: "Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Animal Species". The general assessment report layout nevertheless follows those outlined in the Species Environmental Assessment Guideline[1] prescribed therein to facilitate the decision making process by the competent authority.

The Birds and Solar Energy Best Practice Guidelines[2] recommends different avifaunal assessment regimes depending on the overall size of the proposed development and the expected avifaunal sensitivity of the receiving environment. The avifaunal sensitivity is based on the number of priority species present, or potentially present, the regional, national or global importance of the affected area for these species, and the perceived susceptibility of these species to the anticipated impacts of the development. As no avifaunal habitats, populations of priority species, movement corridors or biodiversity areas of particular national or regional significance occur within the broader impact zone the avifaunal sensitivity of the receiving environment is not considered to be high. However, given the potential presence of SCCs and the relatively large size of the proposed development, 'Regime 2' levels of avifaunal monitoring would have been appropriate. This would have included two to three site visits conducted over a period of six months, including the likely peak in avifaunal abundance.

Baseline avifaunal data used to inform this assessment were collected by East Cape Diverse Consultants who conducted extensive pre-construction avifaunal surveys across the broader surrounding area (between June 2019 to August 2020) as well as surveys in and around the proposed solar PV development footprint itself (twice-monthly between June

[1] South African National Biodiversity Institute (SANBI). 2020. Species Environmental Assessment Guideline. Guidelines for the implementation of the Terrestrial Fauna and Terrestrial Flora Species Protocols for environmental impact assessments in South Africa. South African National Biodiversity Institute, Pretoria. Version 1.2020.

[2] Jenkins, A.R., Ralston-Paton, S., and Smit-Robinson, H.A. 2017. Birds & Solar Energy Best Practice Guidelines. Guidelines for Assessing and Monitoring the Impact of Solar Power Generating Facilities on Birds in Southern Africa. BirdLife South Africa.

2020 to October 2020). Data collected for multiple nearby proposed wind energy facilities (Rippon, Hamlett, Redding and Aeolus WEFs, Figures 1, 2 and 3) were incorporated into the assessment of the solar PV facility as data collection methods for WEFs often exceed those generally employed for solar PV facilities for 'Regime 2' sites (e.g. the inclusion of long-term VP monitoring) and therefore provide a more complete understanding of the baseline avifaunal community of the receiving environment.

Data collection was conducted by East Cape Diverse Consultants CC and primary data analyses (e.g. passage rates, abundance and spatial modelling) were conducted by Ecology Consulting, who also provided input into the report. The sensitivity analyses and avifaunal impact assessments were conducted by Arcus Consultancy Services South Africa (Pty) Ltd.

2.1 Desk-top Study

The following data sources were consulted during the formulation of the monitoring surveys and/or impact assessment:

- Strategic Environmental Assessment (SEA, Cookhouse Focus Area) 2015[3];
- Bird distribution data of the Southern African Bird Atlas Project 2 (SABAP2) obtained from the Avian Demography Unit of the University of Cape Town[4];
- Co-ordinated Avifaunal Road Count (CAR) project[5];
- Co-ordinated Water-bird Count (CWAC) project[6];
- The Important Bird Areas of southern Africa (IBA) project[7];
- The National Web-based Screening Tool[8];
- Habitat suitability models produced by BirdLife South Africa[9];
- Publically available satellite imagery; and
- The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland[10].

2.2 Pre-construction Avifaunal Monitoring Surveys

2.2.1 Vantage Point Monitoring

While the VP surveys were designed primarily to obtain to enable collision risk for the four nearby WEFs to be calculated, these data also provide relevant long-term baseline data (i.e. including a range of seasonal variation) on key species flight activity in/around the proposed solar PV facility. A total of 39 VPs across the broader area were monitored monthly by a single observer (180° viewshed) for a minimum of 48 hours each (up to 73 hours) over 15 months between June 2019 and August 2020[11] (Figure 3). Two of these VPs were located within 2 km of the proposed solar PV facility, each surveyed for 56 hours. Species recorded during these surveys included raptors, cranes and bustards, large flocks (> 100 individuals) of other species and any other notable observations.

[3] Department of Environmental Affairs, 2015. Strategic Environmental Assessment for wind and solar photovoltaic energy in South Africa. CSIR Report Number: CSIR/CAS/EMS/ER/2015/0001/B. Stellenbosch. https://egis.environment.gov.za/redz

[4] http://sabap2.birdmap.africa/

[5] Young, D.J., Harrison, J.A, Navarro, R.A., Anderson, M.A., & Colahan, B.D. (Eds). 2003. Big birds on farms: Mazda CAR Report 1993-2001. Avian Demography Unit: Cape Town.

[6] Taylor, P.B., Navarro, R.A., Wren-Sargent, M., Harrison, J.A. & Kieswetter, S.L. 1999. Coordinated waterbird Counts in South Africa, 1992-1997. Avian Demography Unit, Cape Town.

[7] Marnewick MD, Retief EF, Theron NT, Wright DR, Anderson TA. 2015. Important Bird and Biodiversity Areas of South Africa. Johannesburg: BirdLife South Africa.

[8] https://screening.environment.gov.za/

[9] Black Harrier Breeding Habitat, Black Harrier Foraging Habitat and Verreaux's Eagle Habitat models.

[10] Taylor, M.R., Peacock, F., and Wanless, R.M. 2015. Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland.

[11] No surveys were conducted during April 2020 due to a national lock-down.

2.2.2 Breeding Raptor Surveys

Breeding raptor surveys were carried out between June 2019 and August 2020, where all known and other possible raptor nest sites within a 5 km buffer of the nearby WEFs were checked for breeding activity. The survey area included the proposed solar PV site considered in this assessment. These surveys included 'mini-VP' surveys (i.e. VP-type monitoring but for a shorter duration) and walkover surveys focussing on likely habitat/nesting sites (initially identified from the initial site visit and from inspection of aerial photographs of the area). Surveys included searches for all key raptors potentially utilising the survey area, but had a particular focus on detecting Verreaux's *(Aquila verreauxii)* and Martial Eagle *(Polemaetus bellicosus)* and included periods of peak breeding activity for those species.

2.2.3 Wetland Surveys

While there are no CWAC sites within 35 km of the proposed solar PV facility, there are several areas of wetland habitat present in the broader area surveyed for the WEFs (predominantly around reservoirs for agricultural irrigation, along river corridors). Each wetland site was visited at least once each month to undertake a count of all of the waterbirds present. As well as the wetland areas, it became apparent during the initial surveys that many of the irrigated agricultural area ('pivots') also supported a range of larger terrestrial bird species, so these were also included in the surveys. While none of these features are present in the vicinity of the proposed solar PV facility the data collected was considered during the assessment of the potential impacts of the development in the context of the broader local avifaunal community.

2.2.4 Drive Transects

Vehicle-based drive transects (approx. 150 km) were conducted over two days each month (totalling 12 surveys) across the surrounding area (Figure 3), where observers would stop at regular intervals to scan open habitats to record observations on raptors, bustards, storks and cranes. These broader road transect surveys were supplemented by further vehicle transect surveys undertaken within the proposed solar PV site. These more focussed transects covered all the tracks (approx. 35 km) within the site and were carried out on a more frequent basis (twice per month) but over a shorter period of time between May 2020 and October 2020 (totalling 12 surveys over 6 months).

Data from both broader and focussed drive transects were considered during the assessment of the proposed solar PV facility.

2.2.5 Walk Transects

Walking transects were undertaken at a series of locations within the proposed solar farm site (nine locations in total) to provide sample data on the abundance of small terrestrial birds within the proposed solar PV development footprint. Transects were walked for 20 minutes at a rate of 5 minutes per 100m at each location each month, to provide an index of small bird abundance across the survey area. This gave a total of 18.4 km of walking transects. Surveys were carried out twice-monthly between June 2020 and October 2020 (inclusive).

2.3 Spatial Modelling

Spatial modelling was undertaken to predict flight activity of certain avifaunal species across the broader area as part of the impact assessment for the proposed WEFs, enabling estimates to be made of flight density in areas that fell outside the VP survey area. This provided insight into the potential utilisation of the area by species such as Martial Eagle,

including the proposed solar PV development site. More specific detail of the modelling process is provided in Appendix A.

2.4 Impact Assessment

All predicted impacts were rated for significance as per a standard set of criteria supplied by Savannah Environmental (Pty) Ltd (detailed in Appendix B). The impact receptors were identified at multiple spatial scales depending on the nature of the impact assessed, for example:

- Direct habitat loss – The avifaunal community potentially utilising the immediate development footprint of solar PV facility and associated infrastructure;
- Disturbance and displacement – The avifaunal community potentially utilising the immediate development footprint plus a 500 m buffer;
- Direct fatalities – Both the immediate and broader local avifaunal community of the area.

2.5 Assumptions and Limitations

Data collection methods and analyses were not conducted under the direct supervision of the avifaunal specialist conducting this impact assessment and pre-date the publication of GN 1150. This limitation is not considered to jeopardise the integrity or validity of the assessment as the available data used to inform the assessment were extensive and the avifaunal specialist has experience with the avifaunal community in the area and is well acquainted with the impact assessments conducted for the nearby WEFs.

Some of the data included during the assessment process was collected primarily for the purpose of assessing the impacts of WEFs (e.g. spatial and collision risk modelling). The assumptions included in those models likely do not translate directly into determining the collision risk associated with overhead power lines for example. This is nevertheless not considered to be a significant limitation as the inclusion of these data provide a more complete understanding of the avifaunal community in the area and therefore the advantages of including these data outweigh the disadvantages as the limitations were considered when interpreting the model outputs.

3 RESULTS

3.1 Regional Context

The proposed development site is located towards the southern extent of the Nama-Karoo Biome[12] near its interface with Albany Thicket. The Nama-Karoo interface with Albany Thicket does not follow strict substrate lines where Thicket can occur on any substrate, it is thought that the boundary between the two biomes may involve a competitive element where Thicket can be driven forward or backward repeatedly depending on the disturbance regime[13]. This indicates that the suite of avifaunal species associated with each biome may have been in a state of flux within a historically dynamic landscape depending on the availability and persistence of preferred habitats.

The broader area receives relatively high rainfall for the Nama-Karoo, with a bimodal pattern of rainfall peaking in spring (October/November) and late summer/early autumn (February/March)[13]. The area is therefore an interesting mix of vegetation types including Albany Broken Veld (NKl4), Albany Valley Thicket (AT18) and patches of Saltaire Karroid Thicket (AT47)[13]. While vegetation type isn't necessarily a predictor of avifaunal species

[12] Low, A. B. & Rebelo, A. G. 1996. Vegetation of South Africa, Lesotho and Swaziland. Department of Environmental Affairs and Tourism, Pretoria.

[13] Mucina, L. and Rutherford, M.C. (eds) 2006. The vegetation of South Africa, Lesotho and Swaziland, in Strelitzia 19. South African National Biodiversity Institute, Pretoria.

composition, differences in structural complexity and temporal resource stability between these vegetation types provides variation in avifaunal habitat availability, species diversity and abundance. In more stable Thicket vegetation types, species composition is likely to be skewed towards smaller, resident avifaunal species while larger[14] and nomadic species are likely to utilise open areas, particularly during times of increased primary productivity following rainfall events[15].

3.2 Local Context

The proposed development site is located to the south of the Brakrivier and west of its confluence with the Klein-Visrivier between the towns of Bracefield to the south and Somerset East to the north (Figure 1). The local area is characterised by relatively low density sheep farming within the natural vegetation with additional areas of highly modified irrigated agriculture along the river banks (Figure 2). The development footprint falls wholly within the Albany Broken Veld vegetation type characterised by low mountain ridges and hills with an open grassy karroid dwarf shrubland with scattered low trees[13]. This vegetation type is offered protection within the Greater Addo Elephant National Park as well as on private reserves (Kuzuko Game Reserve, Frontier Safaris Game Farm, Aylesbury Nature Reserve, Rockdale Game Ranch and Woodlands Game Reserve)[13].

The more natural vegetation provides habitat for a variety of avifaunal species such as Ludwig's Bustard *(Neotis ludwigii)*, Denham's Bustard *(Neotis denhami)*, Southern Black Korhaan *(Afrotis afra)* and Secretarybird *(Sagittarius serpentarius)* while the irrigated agricultural areas and associated farm dams provide foraging and roosting opportunities for Blue Crane *(Anthropoides paradiseus)*.

3.2.1 Survey Effort and General Sampling Conditions

Focussed avifaunal surveys of the proposed solar PV development site included the dry period as well as the onset of the spring rainfall period and increase in primary productivity associated with the dominant vegetation type present. Avifaunal surveys of the broader area were longer-term and included a wide range of seasonal variation due to the monthly sampling regime employed.

The sampling in and around the proposed development site nevertheless included the variation in conditions over 17 months (June 2019 to October 2020) and this is considered to be as representative as can be expected and exceeds the variation in conditions generally used to inform an impact assessment for this kind of development.

3.2.2 Expected Species

No CWAC sites or IBAs occur in proximity to the proposed development site. Black Stork *(Ciconia nigra)* was recorded in the area by a CAR transect (ES05).

The proposed development site falls wholly within a single pentad (3305_2540), with 110 species recorded in this pentad by SABAP2 to date, however only 5 cards have been submitted, with the number of cards providing an indication of the sampling effort. The SABAP2 data search area was therefore increased to include six pentads[16] with 75 cards submitted. A total of 222 species of birds have been recorded by SABAP2 in the six pentads in and around the proposed development site.

[14] D. M. Parker. 2019. The elephant in the 'room': determinants of songbird assemblages in the Thicket Biome, South Africa, Emu - Austral Ornithology, 119:2, 157-165.

[15] Dean, WRJ. 2000. Factors affecting bird diversity patterns in the Karoo, South Africa. South African Journal of Science. 96. 609-616.

[16] Pentads 3300_2535, 3300_2540, 3300_2545, 3305_2535, 3305_2540 and 3305_2545

The SEA for the Cookhouse Focus Area notes that the Focus Area (FA) is not located close to any recognised national IBAs, but that it does support a diverse avifauna. It identified at least 283 bird species that could regularly occur in the FA. This includes 19 red-listed species, six of which are endemic; Ludwig's Bustard, Blue Crane, Cape Vulture *(Gyps coprotheres)*, Black Harrier *(Circus maurus)*, Melodious Lark *(Mirafra cheniana)* and African Rock Pipit *(Anthus crenatus)*. The Cookhouse FA considered by the SEA is significantly larger than the impact area of influence of the development, these species (Table 1) were nevertheless considered during the impact assessment.

Table 1: Threat status, endemism, reporting rate and predicted susceptibility of key avifaunal species to solar developments within the Cookhouse Focus Area as considered by the Strategic Environmental Assessment

Species	Threat status		South African Endemism	SABAP2 Reporting Rate (%)	FA-specific Predicted Susceptibility to Solar Developments
	Regional[10]	Global[17]			
Denham's Bustard	VU	NT	-	1.89	Moderate
Ludwig's Bustard	EN	EN	Near-endemic	2.83	Moderate
Kori Bustard (*Ardeotis kori*)	NT	NT	-	1.65	Moderate
Southern Black Korhaan	VU	VU	Endemic	8.96	Moderate
White-bellied Korhaan (*Eupodotis senegalensis*)	VU	LC	-	3.77	Moderate
Blue Crane	NT	VU	Near-endemic	9.91	Moderate
African Fish-Eagle (*Haliaeetus vocifer*)	LC	LC	-	12.5	Low
Cape Vulture	EN	VU	Near-endemic	0.94	Low
Black Harrier	EN	VU	Near-endemic	6.37	Moderate
Jackal Buzzard (*Buteo rufofuscus*)	LC	LC	Near-endemic	26.18	Low
Verreaux's Eagle (*Aquila verreauxii*)	VU	LC	-	3.3	Low
Booted Eagle (*Hieraaetus pennatus*)	LC	LC	-	5.19	Low
Martial Eagle (*Polemaetus bellicosus*)	EN	VU	-	4.72	Moderate

[17] The IUCN Red List of Threatened Species 2020 (IUCN) https://www.iucnredlist.org/

Species	Threat status		South African Endemism	SABAP2 Reporting Rate (%)	FA-specific Predicted Susceptibility to Solar Developments
	Regional[10]	Global[17]			
African Crowned Eagle (*Stephanoaetus coronatus*)	VU	NT	-	4.25	Low
Secretarybird	VU	EN	-	5.42	Moderate
Lesser Kestrel (*Falco naumanni*)	LC	LC	-	0.47	Moderate
Amur Falcon (*Falco amurensis*)	LC	LC	-	2.59	Moderate
Lanner Falcon (*Falco biarmicus*)	VU	LC	-	2.59	Low
Melodious Lark	LC	NT	Near-endemic	1.42	High

The SEA sensitivity mapping was based on the data available at the time on these species' distributions, and on habitat features associated with these species, including high voltage (>132 kV) power lines (which could be used for roosting sites by Cape Vultures and nesting large eagles, buzzards and falcons), larger river corridors (potential bird flyway and waterbird communities), wetlands, and an historic migratory kestrel roost site. The proposed development area lies outside the key constraint areas identified in the Focus Area SEA.

The National Web-based Screening Tool was run prior to the impact assessment[18], the output identified parts of the proposed development footprint to be of High Sensitivity in the Relative Animal Species Theme due to the presence of Ludwig's Bustard. The remainder of the site was identified as being of Low sensitivity and Medium Sensitivity due to the potential presence of Black Harrier and Denham's Bustard.

3.2.3 Observed Species

3.2.3.1 Breeding Raptor Surveys

Three Martial Eagle and three Verreaux's Eagle territories were confirmed in the broader area during the raptor surveys conducted for the WEFs. Breeding was confirmed in all three Martial Eagle ranges, with females seen incubating. The 'potential' Martial Eagle nest location indicated in proximity to the proposed development site (Figure 4) does not likely represent an active nesting site given the relatively low flight activity of this species recorded from VPs (VPs 2 and 3) positioned near this location during the long-term monitoring conducted for the Redding WEF (Figure 3). A fledged sub-adult recorded in this vicinity may rather represent the previous offspring of the breeding pair located further to the east of the site in the process of leaving the core territory as the next breeding cycle commences. Breeding was also confirmed and nest sites located at all three Verreaux's Eagle sites in 2019 (though only two of these sites were active in 2020, with the third occupied by a pair of Lanner Falcons). Other breeding locations identified included four Secretarybird nests, a Grey Crowned Crane nest and two Jackal Buzzard nests. However,

[18] Accessed 2021/10/13.

none of the nests located are in proximity to the proposed solar PV development (Figure 4).

3.2.3.2 Vantage Point Surveys

The VP surveys closest to the proposed solar PV site recorded a relatively low number of flights (Appendix C), notable species observed include Blue Crane, Ludwig's Bustard, Southern Black Korhaan, Martial Eagle and Lanner Falcon (Figures 5 and 6).

3.2.3.3 Drive Transects

The results of the longer-term drive transect survey of the WEFs are summarised in Appendix D. Ten species of particular interest were noted in this area: Blue Crane, Ludwig's Bustard, Denham's Bustard, Kori Bustard, Karoo Korhaan, Southern Black Korhaan, Caspian Tern, Martial Eagle, Black Harrier and Lanner Falcon.

The results of the drive transect surveys in and around the proposed development site are summarised in Appendix E. Notable records included: Blue Crane, Ludwig's Bustard, Denham's Bustard, Kori Bustard, Karoo Bustard, Southern Black Bustard, Secretarybird and Martial Eagle.

Blue Crane (Figure 7) were abundant, with largest numbers recorded approximately 2 to 3 km to the north-west of the proposed development site, with relatively few records within the site itself.

Ludwig's Bustard (Figure 8) and Southern Black Korhaan (Figure 9) were both widely distributed over the whole surveys area, including the proposed development site, though the numbers there were typical of the wider area.

While Denham's Bustard, Karoo Korhaan and Kori Bustard were widely distributed over the whole of the survey area, only a single Denham's Bustard, four Kori Bustard and no Karoo Korhaan were recorded in the proposed solar PV development site (Figure 10).

The other two key species, namely Martial Eagle and Secretarybird, (Figure 11) were widely scattered with few records from within the proposed solar PV development site.

3.2.3.4 Walk Transects

The results of the walking transect surveys within the proposed solar PV development site are summarised in Appendix F. Generally only low numbers of birds were recorded during these surveys. These surveys did record a high diversity of small terrestrial species, but the only two notable species were recorded, namely Ludwig's Bustard and Southern Black Korhaan. No Melodious Lark were recorded.

3.2.4 Spatial Modelling

The proposed development site is located outside of predicted core areas utilised by Martial Eagle (Figure 12) and Verreaux's Eagle (Figure 13) and loss of habitat resulting from vegetation clearing is unlikely to have a significant effect on these species. Similarly the proposed development is unlikely to have a significant negative effect on Cape Vulture (Figure 14) and is outside of high predicted habitat suitability for breeding or foraging Black Harrier, which corresponds to the low number of observations made during the baseline surveys.

The baseline avifaunal data summarised above were used to assess the utilisation of the impact area of the proposed solar PV site by the expected SCCs determined during the desktop exercise, resulting in a list of potential avifaunal SCC impact receptors for the development (Table 3).

Table 3: Identification of potential avifaunal SCCs most likely to be impact receptors of the solar PV development and associated infrastructure as inferred by baseline data

Species	IUCN Threat Status	Regional Red Data Status	Observed Utilisation of Potential Impact Area	Potential Solar PV Impact Receptor	Potential Grid Connection Impact Receptor
Greater Flamingo	LC	NT	Not recorded using the solar PV site during any of the baseline surveys.	×	×
Grey Crowned Crane	EN	EN	Not recorded using the solar PV site during any of the baseline surveys.	×	×
Blue Crane	VU	NT	Regularly recorded during the solar PV baseline surveys.	✓	✓
Ludwig's Bustard	EN	EN	Regularly recorded during the solar PV baseline surveys.	✓	✓
Denham's Bustard	NT	VU	Occasionally recorded during the solar PV baseline surveys.	✓	✓
Kori Bustard	NT	NT	Regularly recorded during the solar PV baseline surveys.	✓	✓
Karoo Korhaan	LC	NT	Occasionally recorded during the solar PV baseline surveys.	✓	✓
Southern Black Korhaan	VU	VU	Regularly recorded during the solar PV baseline surveys.	✓	✓
Black Stork	LC	VU	Not recorded using the solar PV site during any of the baseline surveys.	×	×
Caspian Tern (*Hydroprogne caspia*)	LC	VU	Only a single record of a bird over-flying during the baseline surveys.	×	×
Secretarybird	EN	VU	Occasionally recorded during the solar PV baseline surveys.	✓	✓
Cape Vulture	EN	VU	Not recorded using the solar PV site during any of the baseline surveys.	×	✓
African Marsh-harrier	LC	EN	Not recorded using the solar PV site during any of the baseline surveys.	×	×
Black Harrier	EN	EN	Not recorded using the solar PV site during any of the baseline surveys.	×	×

Species	IUCN Threat Status	Regional Red Data Status	Observed Utilisation of Potential Impact Area	Potential Solar PV Impact Receptor	Potential Grid Connection Impact Receptor
Pallid Harrier	NT	NT	Not recorded using the solar PV site during any of the baseline surveys.	×	×
Martial Eagle	EN	EN	Closest nest 13km, outside core range, low use of site.	×	✓
Verreaux's Eagle	LC	VU	Closest nest 15km, outside core range, not recorded during any solar PV baseline surveys.	×	×
Lanner Falcon	LC	VU	Closest nest 13km, outside core range, low use of site (single record).	×	×
African Rock pipit	LC	NT	Not recorded using the solar PV site during any of the baseline surveys. Prefers rocky slopes.	×	×
Melodious Lark	LC	LC	Not recorded using the solar PV site during any of the baseline surveys.	×	×

3.3 Current Impacts

The proposed development site is in a near-natural state and the primary current impact across the site relates to low-level livestock farming. A stretch of existing transmission line exists parallel to the proposed overhead powerline corridor near the crossing of the Kleinvisrivier.

3.4 Site Ecological Importance (SEI)

SEI is considered to be a function of the biodiversity importance (BI) of the receiving environment (e.g. species of conservation concern and the habitat type present on the site) and its resilience to impacts (i.e. receptor resilience [RR]). The BI of the receiving environment is in turn a function of the conservation importance (CI) and the functional integrity (FI) of the receiving environment[1].

3.4.1 Conservation Importance (CI)

Conservation importance is defined as:

"*The importance of a site for supporting biodiversity features of conservation concern present, e.g. populations of IUCN threatened and Near Threatened species (CR, EN, VU and NT), rare species, range-restricted species, globally significant populations of congregatory species, and areas of threatened ecosystem types, through predominantly natural processes.*"

The conservation importance of the project site for each potential SCC impact receptor has been determined separately and listed in Table 4 below.

Table 4: Conservation importance of the project site for Species of Conservation Concern

Common Name	Conservation Importance	Motivation
Blue Crane	Medium	Confirmed or highly likely occurrence of populations of VU species listed under Criterion A only and which have more than 10 locations or more than 10 000 mature individuals.
Ludwig's Bustard	Medium	Confirmed or highly likely occurrence of EN species listed under Criterion A only and which have more than 10 locations or more than 10 000 mature individuals.
Denham's Bustard	Medium	Confirmed or highly likely occurrence of populations of NT species listed under Criterion A only and which have more than 10 locations or more than 10 000 mature individuals.
Kori Bustard	Medium	Confirmed or highly likely occurrence of populations of NT species listed under Criterion A only and which have more than 10 locations or more than 10 000 mature individuals.
Karoo Korhaan	Medium	Confirmed or highly likely occurrence of populations of NT species listed under Criterion A only and which have more than 10 locations or more than 10 000 mature individuals.
Southern Black Korhaan	Medium	Confirmed or highly likely occurrence of populations of VU species listed under Criterion A only and which have more than 10 locations or more than 10 000 mature individuals.
Secretarybird	Medium	Confirmed or highly likely occurrence of EN species listed under Criterion A only and which have more than 10 locations or more than 10 000 mature individuals.
Cape Vulture	Medium	Confirmed or highly likely occurrence of EN species listed under Criterion A only and which have more than 10 locations or more than 10 000 mature individuals.
Martial Eagle	High	Confirmed or highly likely occurrence of EN species that have a global EOO of > 10 km^2. IUCN threatened species (EN) listed under any criterion other than A (Regionally C1[10]). Regional population estimates are c. 800 pairs with population trend calculated to be in significant decline.

3.4.2 Functional Integrity (FI)

Functional integrity of the receiving environment/habitats is defined as its current ability to maintain the structure and functions that define it, compared to its known or predicted state under ideal conditions, i.e. a measure of the ecological condition of the receiving environment as determined by its remaining intact and functional area, its connectivity to other natural areas and the degree of current persistent ecological impacts.

The site experiences mostly minor current negative ecological impacts related to relatively low density livestock farming and therefore the functional integrity of the site can be considered to be high.

3.4.3 Biodiversity Importance (BI)

As biodiversity importance is a function of conservation importance and the functional integrity, the biodiversity importance can be determined. With a high functional integrity both high and medium conservation importance scores result in high and medium biodiversity importance scores respectively.

3.4.4 Receptor Resilience (RR)

Receptor resilience is the intrinsic capacity of the receptor to resist major damage from disturbance and/or to recover to its original state with limited or no human intervention.

Resilience of avifaunal receptors will often be linked to a particular disturbance or impact and time of year. For example large birds of prey have different levels of resilience to noise disturbance depending on whether they are breeding or not; these species would have low resilience to noise disturbance such as construction of a road adjacent to a nest site during the breeding season than outside of the breeding season.

All species listed in Table 4 are considered to have a high receptor resilience to the potential impacts of the development in the local context as while a certain amount of habitat destruction is inevitable for solar PV facilities, these species have a high likelihood of returning to the site once the impact has been removed. Similarly, the habitats present on the site and immediate surrounds are not unique to the site and are relatively widespread and contiguous in the area so any displacement from the immediate vicinity that may occur will unlikely incur a high energetic cost as suitable habitat is widely available nearby. Blue Crane become habituated to disturbance quite readily and along with other ground-nesting birds such as the korhaans and bustards do not appear to have limited suitable nesting site available, as may be the case with species such as Martial Eagle. No Martial Eagle nests have been located in proximity to the proposed solar PV development and therefore receptor reliance is likely to be considerably higher than if the site was closer to an active territory as the species has a very high likelihood of remaining in the area despite the presence of impacts associated with the proposed development. Receptor Resilience for bustards is reduced related to potential collision impacts with overhead powerlines, however the placement of the proposed line, habitat suitability and monitoring data regarding their utilisation of the site have been considered to inform the assessment.

The Site Ecological Importance has been determined for each SCC and listed in Table 5 below and mapped in Figure 15.

Table 5: Site Ecological Importance per Species of Conservation Concern.

Common Name	Biodiversity Importance	Receptor Resilience	Site Ecological Importance
Blue Crane	Medium	High	Low
Ludwig's Bustard	Medium	High	Low
Denham's bustard	Medium	High	Low
Kori Bustard	Medium	High	Low
Karoo Korhaan	Medium	High	Low
Southern Black Korhaan	Medium	High	Low
Secretarybird	Medium	High	Low
Cape Vulture	Medium	High	Low
Martial Eagle	High	Very High	Low

The interpretation guideline of the SEI for the 'Low' category as detailed in the Species Assessment Guideline states that development activities of medium to high impact are acceptable following the implementation of appropriate minimisation and restoration mitigation measures.

4 IMPACT ASSESSMENT

4.1 Identification of Potential Impacts

The following key potential impacts on avifauna, arising from the proposed development have been identified for assessment:

- Construction Phase:

- Direct Habitat Destruction – modification, removal and clearing of vegetation for development of infrastructure such as temporary laydown areas, site buildings, solar PV array footprint, access roads and servitudes;
- Disturbance/Displacement – indirect habitat loss and/or reduced breeding success due to displacement by noise and activity associated with machinery and construction activity; and
- Direct Mortality – fatalities of avifauna due to vehicle collision, entrapment, entanglement or collision with temporary infrastructure (e.g. fencing), entrapment in uncovered excavations and increased predation pressure.

- Operational Phase:
  - Disturbance/Displacement – indirect habitat loss, reduced breeding success, obstruction of movement corridors due to displacement by infrastructure and noise/activity associated with ongoing, routine operational tasks/maintenance activity; and
  - Direct Mortality – fatalities of avifauna due to vehicle collision, collision or entrapment with perimeter fencing, collision with solar PV arrays, collision with overhead powerlines, electrocution from electrical components and increased predation pressure.
- Decommissioning Phase:
  - Disturbance/Displacement – indirect habitat loss and/or reduced breeding success due to displacement by noise/activity associated with decommission activity; and
  - Direct Mortality due to vehicle collisions and increased predation pressure.

4.2 Construction Phase

4.2.1 Direct Habitat Destruction

The removal and/or destruction and/or alteration of habitat during the construction phase is potentially the most significant impact associated with solar PV developments as the vegetation within the development footprint is cleared for the installation of the solar PV arrays. This results in the permanent exclusion of several species from the development footprint.

This impact is largely unavoidable, resulting in numerous birds being displaced from the projects site needing to find suitable available habitat elsewhere. The reduction in habitat has the potential to impact on the foraging and/or breeding success of certain species. Habitat loss may particularly affect larger terrestrial species such as korhaans and bustards as well as coursers and small passerine species. Raptors (e.g. Martial Eagle) may also be affected (though to a lesser degree) through the loss of potential foraging habitat.

The habitats present in the proposed development footprint for the solar PV arrays are not unique to the site and are relatively widespread and contiguous in the area. The loss of habitat associated with clearing will not likely have a significant negative impact on the long-term viability or persistence of avifaunal species populations in the area.

The proposed development site is considered to have a low ecological importance for potential SCC receptors of this impact and therefore the impact will not likely have a significant negative impact on these species.

Impact phase: Construction
Nature: Habitat destruction due to clearing of vegetation in the development footprint for the construction of infrastructure such as solar PV arrays, temporary laydown areas, site buildings, transmission line pylon bases, servitudes and access roads. This results in loss of area available to avifaunal species for foraging and breeding.

	Without mitigation	With mitigation
Extent	Footprint (1)	Footprint (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Minor (2)	Minor (2)
Probability	Definite (5)	Definite (5)
Significance	**Medium (35)**	**Medium (35)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Partially	

Mitigation:

- A site specific environmental management programme (EMPr) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat (e.g. no open fires outside of designated areas);
- All contractors are to adhere to the EMPr and should apply good environmental practice during construction;
- Existing roads and farm tracks should be used where possible;
- The minimum footprint areas of infrastructure should be used wherever possible, including road widths and lengths;
- No off-road driving should be permitted in areas not identified for clearing;
- An Environmental Site Officer (ESO) must form part of the on-site team to ensure that the EMPr is implemented and enforced and an Environmental Control Officer (ECO) must be appointed to oversee the implementation activities and monitor compliance for the duration of the construction phase; and
- Following construction, rehabilitation of areas disturbed by temporary laydown areas and facilities must be undertaken.

Residual Impacts:

Habitat cleared for the construction of permanent facilities will not be available for use by many avifaunal species during the operational lifespan of the development. No long-term residual impacts to SCCs are likely following decommission and rehabilitation given the low SEI of the site.

4.2.2 Disturbance and Displacement

Indirect loss of habitat from disturbance during the construction phase is temporary in nature and is expected to result largely from the presence of heavy machinery and increased activity of construction personnel. This impact may extend beyond the immediate development footprint and result in the temporary exclusion of species from adjacent areas.

The habitats present in vicinity of the proposed development are not unique to the site and are relatively widespread and contiguous in the area so any displacement from the immediate vicinity that may occur will unlikely incur a high energetic cost as suitable habitat is widely available nearby. The proximity of nearby suitable habitat makes it likely that species will return to areas that have not been physically altered by the proposed development once construction activity ceases.

There are no known active nest locations in proximity to the proposed development site where breeding success is likely to be negatively impacted upon through disturbance or displacement.

Impact phase: Construction

Nature: Disturbance or displacement of birds due to increased noise and activity levels associated with construction machinery and personnel resulting in an indirect loss of habitat available for foraging and breeding.

	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Very Short-term (1)	Very Short-term (1)
Magnitude	Minor (2)	Minor (2)
Probability	Distinct Possibility (3)	Distinct Possibility (3)
Significance	**Low (15)**	**Low (15)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	Unlikely	Unlikely
Can impacts be mitigated?	Yes	

Mitigation:

- A site specific EMPr must be implemented, which gives appropriate and detailed description of how construction activities must be conducted;
- All contractors are to adhere to the EMPr and should apply good environmental practice during construction;
- Environmental Officer to oversee activities and ensure that the site specific EMPr is implemented and enforced;
- Maximum use of existing access road and servitudes;
- No off-road driving in undesignated areas;
- Speed limits (30 km/h) should be strictly enforced on site to reduce unnecessary noise;
- Construction camps should be lit with as little light as practically possible, with the lights directed downwards where appropriate;
- The movement of construction personnel should be restricted to the construction areas on the project site;
- No dogs or cats other than those of the landowners should be allowed on site;
- The appointed Environmental Officer must be trained to identify the potential Red Data species as well as the signs that indicate possible breeding by these species;
- The Environmental Officer must then, during audits/site visits, make a concerted effort to look out for such breeding activities of Red Data species, and such efforts may include the training of construction staff (e.g. in Toolbox talks) to identify Red Data species, followed by regular questioning of staff as to the regular whereabouts on site of these species;
- If any of the Red Data species are confirmed to be breeding (e.g. if a nest site is found), construction activities within 500 m of the breeding site must cease, and an avifaunal specialist is to be contacted immediately for further assessment of the situation and instruction on how to proceed;
- Prior to construction, an avifaunal specialist should conduct a site walkthrough, covering the final road and power line routes as well as temporary laydown areas and facilities, to identify any nests/breeding/roosting activity of sensitive species;
- The results of which may inform the final construction schedule in close proximity to that specific area, including abbreviating construction time, scheduling activities around breeding activity, and lowering levels of associated noise.

Residual Impacts:

None.

4.2.3 Direct Mortality

Fatalities of avifaunal species can occur through collision with vehicles as traffic in the area increases due to construction activity. Large-bodied and ground dwelling species (e.g. korhaans and bustards) are at increased risk, but this impact can be effectively mitigated against. Temporary fencing can result in collisions, entrapment or entanglement if not suitably installed. Similarly ground dwelling avifauna (particularly chicks) can fall into uncovered excavations and become entrapped. Increased traffic and personnel activity associated with the construction phase can result in the attraction of species such as crows to a development site if there is an increased abundance of foraging opportunities from roadkill mortalities or organic waste. An increased abundance of crows can increase the predation pressure on SCCs as it increases the probability that crows may locate nests of these species. Domestic cats and dogs may also be attracted to an area and increase the predation pressure on ground dwelling species.

Impact phase: Construction		
Nature: Avifaunal fatalities caused by construction activity including vehicle collision (i.e. roadkill), entrapment within security fencing or uncovered excavations and increased predation pressure through the increased attraction of crows, cats and dogs to the site.		
	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Very Short-term (1)	Very Short-term (1)
Magnitude	Minor (2)	Minor (2)
Probability	Distinct Possibility (3)	Low Likelihood (2)
Significance	**Low (15)**	**Low (10)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation: • Maximum use of existing access road and servitudes; • No off-road driving in undesignated areas; • Speed limits (30 km/h) should be strictly enforced on site to reduce probability of vehicle collisions; • The movement of construction personnel should be restricted to the construction areas on the project site; • No dogs or cats other than those of the landowners should be allowed on site; • Any holes dug e.g. for foundations of pylons should not be left open for extended periods of time to prevent entrapment by ground dwelling avifauna or their young and only be dug when required and filled in soon thereafter; • Temporary fencing must be suitably constructed, e.g. if double layers of fencing are required for security purposes they should be positioned at least 2 m apart to reduce the probability of entrapment by larger bodied species that may find themselves between the two fences; • Roadkill is to be reported to the ECO and removed as soon as possible to reduce the attraction of the site to crows and other scavengers; • Organic waste is to be disposed of in an appropriate manner to reduce the attraction of the site to crows and other scavengers.		
Residual Impacts: Without mitigation predatory species such as crows, cats or dogs may become established at the site increasing the residual threat to local SCCs such as ground dwelling birds (cranes, bustards, korhaans etc.) once construction activities have ceased. However, this can be effectively mitigated against.		

4.3 Operational Phase

4.3.1 Disturbance and Displacement

Indirect loss of habitat from disturbance during the operational phase is associated with ongoing operational activity as well as more discrete periods of routine maintenance tasks. Many species (e.g. Blue Crane) are likely to become habituated to these activities and persist in the immediate surrounds of the proposed development. Maintenance tasks including aerial surveys of overhead powerlines (e.g. with helicopters) may pose a higher intensity of disturbance to avifaunal species than more general operational activity, however these events are temporally discrete in time and duration and the impact can be mitigated against should the need arise. For example, aerial surveys can be scheduled to occur outside of the breeding period of SCCs where possible should a Martial Eagle nest be constructed on transmission infrastructure.

Utility scale solar energy facilities may form a physical barrier or distraction to movement of avifauna across the landscape, and this may alter migration routes and increase distances travelled and energy expenditure or block movement to important areas such as hunting and foraging areas. This potential impact is not yet well understood, is likely to be more significant as a cumulative impact with surrounding developments, is difficult to measure and assess, and therefore mitigation measures are difficult to identify. Mitigation measures have nevertheless been prescribed to reduce this impact.

Impact phase: Operational		
Nature: Disturbance or displacement of avifaunal SCCs due to ongoing routine daily operational tasks and maintenance activity. This can result in reduced areas available for foraging and breeding and reduce breeding success if e.g. helicopter assisted line surveys are frequently conducted near nesting locations during the breeding season. Facility may impede movement across the landscape by acting as a physical barrier or a distraction to certain species.		
	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Low Likelihood (2)	Very Improbable (1)
Significance	**Low (20)**	**Low (10)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation: • Aerial assessment or maintenance of the powerline (e.g. by helicopter) should not be conducted within 1 000 m of any located SCC nest (e.g. a newly constructed Martial Eagle nest on the transmission infrastructure) during the relevant breeding season where possible; • All vehicles should adhere to clearly defined and demarcated roads, no off-road driving should be allowed; • Speed limits (30 km/h) should be strictly enforced to reduce unnecessary noise; • The movement of personnel should be restricted to the servitudes and access roads on the project site; • No dogs or cats other than those of the landowners should be allowed on site; and • Any No-go areas identified should be adhered to.		

Residual Impacts: None.

4.3.2 Direct Mortality

4.3.2.1 Collision with Infrastructure (Excluding Overhead Powerlines)

Smaller passerine (songbird) species seem to account for the majority records of fatality due to collision with solar arrays[19]. This is not entirely unexpected as they are often the most abundant species, however larger ground dwelling birds such as francolin appear to be overly represented in the fatality records in relation to their abundance[19]. This may be due to an increased risk of collision mortality if panicked by a predator while feeding under the solar arrays[19].

Bustards and korhaans are unlikely to enter the solar PV arrays due to operational activity. It is unlikely that collisions with infrastructure such as solar arrays will have a significant negative impact on local populations of avifaunal SCCs at the proposed development site.

Impact phase: Operational		
Nature: Avifaunal fatalities of SCCs resulting in collisions with solar PV arrays.		
	Without mitigation	With mitigation
Extent	Footprint (1)	Footprint (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Minor (2)	Minor (2)
Probability	Very Improbable (1)	Very Improbable (1)
Significance	**Low (7)**	**Low (7)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Partially	
Mitigation: • Lighting should be kept to a minimum to avoid attracting insects and birds, light sensors/switches should be utilised to keep lights off when not required; and • Lighting fixtures should be hooded and directed downward where possible, to minimize the skyward and horizontal illumination, lighting should be motion activated where possible.		
Residual Impacts: None.		

[19] Visser, E., Perlod, V., Ralston-Paton, S., Cardenal, A.C., Ryan, P.G. 2019. Assessing the impacts of a utility-scale photovoltaic solar energy facility on birds in the Northern Cape, South Africa. Renewable Energy. 2019; 133: 1285–1294. https://doi.org/10.1016/j.renene.2018.08.106

4.3.2.2 Collision with Overhead Powerlines

Collisions with large (132 kV or above) power lines are a well-documented threat to birds in southern Africa[20,21] while smaller lines pose a higher threat of electrocution but can still be responsible for collision. Collisions with overhead power lines occur when a flying bird does not see the cables, or is unable to take effective evasive action, and is killed by the impact or impact with the ground. Especially heavy-bodies birds such as bustards, cranes and waterbirds, with limited manoeuvrability are susceptible to this impact[20]. Many of the collision sensitive species are also considered threatened in southern Africa. A recent large-scale study[22] on avifaunal collisions with overhead powerlines in the eastern karoo of South Africa concluded that line-marking devices such as bird flight diverters (BFDs) line reduced collision rates for Blue Cranes by 92% (95% confidence interval [CI]: 77–97%) and all large birds by 51% (95% CI: 23–68%), but had no effect on bustards. The same study reported that five bustard species were in the top 10 list of most frequently found carcasses, and highlighted the relatively high collision rates of Ludwig's Bustards (0.68 birds/km/yr.).

There is currently no widely accepted effective mitigation for reducing the collisions of bustards with overhead powerlines, however there is some indication that bustards collide more often with mid-span areas (89%) than they do nearer the supporting pylons (11%) suggesting that they see the pylons and take avoiding action[23]. The staggering of pylons for novel transmission infrastructure between (rather than next to, i.e. in the mid-span) pylons of adjacent transmission lines may reduce bustard collisions by ~45%[23].

The proposed overhead powerline corridor is mostly positioned alongside hills and slopes, away from the flatter areas generally preferred by bustards (Figure 15), this is likely to reduce the probability of collisions by these species simply due to the proposed position on the landscape. This follows the mitigation hierarchy philosophy through the avoidance of placing infrastructure in particularly sensitive areas.

The relatively short length of the proposed overhead powerline, combined with its position on the landscape and potential for running alongside other transmission infrastructure makes it unlikely that the development will have a significant negative impact on the long-term viability or persistence of avifaunal SCCs in the area following the implementation if mitigation measures.

Impact phase: Operational		
Nature: Fatalities of SCCs from collision with overhead powerlines. Cranes, bustards and korhaans are particularly susceptible to colliding with powerlines, unmarked earth wires when positioned above transmission cables pose an increased risk to cranes. If excessive fatalities of SCCs occurred this could potentially impact the population viability of species at the intermediate scale.		
	Without mitigation	With mitigation
Extent	Intermediate (3)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (52)**	**Medium (30)**

[20]van Rooyen, C.S. 2004. The Management of Wildlife Interactions with over-headlines. In The fundamentals and practice of Over-head Line Maintenance (132kV and above), pp217-245. Eskom Technology, Services International, Johannesburg.

[21]Shaw, J.M, Jenkins, A.R., Smallie, J.J & Ryan, P.G. 2010. Modelling power-line collision risk for the Blue Crane *Anthropoids paradiseus* in South Africa. Ibis 152: 590-599

[22] Shaw, J.M., Reid, T.A., Gibbons, B.K., Pretorius, M., Jenkins, A.R., Visage, R., Michael, M.D., Ryan, P.G. 2021. A large-scale experiment demonstrates that line marking reduces power line collision mortality for large terrestrial birds, but not bustards, in the Karoo, South Africa, Ornithological Applications, Volume 123, Issue 1, 1 February 2021, duaa067, https://doi.org/10.1093/ornithapp/duaa067

[23] Simmons, R.E., Pallett, J. & Brown, C.J. In prep.

Status (positive or negative)	Negative	Negative
Reversibility	Unlikely	Unlikely
Irreplaceable loss of resources?	Potentially	Unlikely
Can impacts be mitigated?	Yes	
Mitigation: • Where practical, powerlines/cables on the project site should be underground; • Where practical, grid connection infrastructure should follow existing servitudes such as existing powerlines, roads and fences; • Pylon positions should be placed in a staggered manner in relation to adjacent parallel transmission lines to increase the overall visibility of transmission infrastructure to avifauna such as bustards; • Appropriate bird flight diverters (BFDs) to be installed on all lengths of new overhead powerlines; • The operational monitoring programme for the overhead powerline route must be implemented to locate potential collision (and electrocution) fatalities; and • Any fatalities located should be reported to Birdlife South Africa (BLSA) and the Endangered Wildlife Trust (EWT).		
Residual Impacts: Current mitigation measures, while effective, are not capable of completely preventing collisions and some residual impact will remain. It is unlikely that the proposed development will have a significantly negative impact on the long-term viability and persistence of SCCs in the area considering the relatively short length of overhead powerline proposed as well as the proposed position on the landscape, low SEI and potential for multiple powerlines running in parallel increasing overall visibility to avifauna.		

4.3.2.3 Electrocution

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components[20]. With regard to the grid connection infrastructure, overhead power line infrastructure with a capacity of 132 kV or more do not generally pose a risk of electrocution due to the large size of the clearances between the electrical infrastructure components. Electrocutions are therefore more likely for larger species whose wingspan is able to bridge the gap such as eagles or vultures. Mitigation measures nevertheless remain effective at reducing the potential risk of electrocution.

Impact phase: Operational		
Nature: Avifaunal fatalities caused by electrocution from energized infrastructure. Modern pylon designs generally installed greatly reduce the probability of this impact.		
	Without mitigation	With mitigation
Extent	Local (2)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Minor (2)	Small (0)
Probability	Low Likelihood (2)	Improbable (1)
Significance	**Low (16)**	**Low (6)**
Status (positive or negative)	Negative	Negative
Reversibility	Yes	Yes
Irreplaceable loss of resources?	No	No

Can impacts be mitigated?	Yes
Mitigation: • All new overhead powerline pylons must be of a design that minimizes electrocution risk by using adequately insulated 'bird friendly' structures, with sufficient clearances between live components to reduce the risk of electrocution for large species such as vultures and Martial Eagle.	
Residual Impacts: None.	

4.4 Decommissioning Phase

The impacts of the decommissioning phase are similar to those of the construction phase, with the exception of a reduced impact of habitat destruction. Temporary disassembly and storage areas associated with the decommission phase are to be positioned on the same sites as those used for temporary laydown areas during the construction phase where possible to reduce the incidence of novel habitat destruction.

4.5 Cumulative Impact

The proposed development site falls within the Cookhouse Renewable Energy Development Zone (REDZ) and within the Eastern Corridor of the Strategic Transmission Corridors, an area that is therefore the focus of multiple proposed renewable energy developments. The proposed development of a complex of four WEFs (up to 170 wind turbine generators) in the vicinity (Figure 1) are of particular relevance. The Sun Garden PV Facility lies adjacent to the proposed Redding WEF (64 turbines).

In addition to these, the following operational or approved WEFs are located within approximately 50 km:

- Cookhouse (66 turbines);
- Nojoli (44 turbines);
- Nxuba (47 turbines);
- Golden Valley (48 turbines);
- Amakhala Emoyeni (56 turbines); and
- Highlands (49 turbines).

The Solaris Fields Solar PV Facility is proposed for development directly adjacent to the Sun Garden PV Facility. The Solaris Fields Solar PV Facility is of similar design and capacity to the Sun Garden PV Facility and is likely to have the same individual contribution to potential impacts as the proposed development assessed above.

Impact phase: Cumulative		
Nature: The contribution of the proposed development to the cumulative post-mitigation impact of multiple developments in an area and their combined impacts on the regional populations of avifaunal SCCs over the long-term.		
	Sun Garden PV Facility Alone	Cumulative Impact
Extent	Intermediate (3)	Regional (5)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (33)**	**Medium (39)**

Status (positive or negative)	Negative	Negative
Reversibility	Possible	Possible
Irreplaceable loss of resources?	Unlikely	Unlikely
Can impacts be mitigated?	Yes	
Mitigation: • Implement the mitigation measures listed above.		
Residual Impacts: Residual impacts associated with habitat loss and collisions with overhead powerlines would remain, however these would be at acceptable levels after the implementation of mitigation measures.		

The Species Assessment Guideline states that in areas identified to be of low SEI (as is the case at the proposed development site), development activities of medium to high impact are acceptable following the implementation of appropriate minimisation and restoration mitigation measures.

It is therefore unlikely that the Sun Garden PV Facility and associated infrastructure will significantly contribute to the cumulative impact on avifaunal species in the area, even when considered together with the proposed Solaris Fields Solar PV Facility.

4.6 'No-Go' Alternative

The 'No-Go' alternative considers that the proposed development is not constructed. Most of the potential impacts associated with the development itself and assessed above would therefore not be imposed on the avifaunal community of the receiving environment.

However the 'No-Go' alternative reduces the opportunity to progress the de-carbonisation transition of the economy and achieve various climate change mitigation targets outlined by the South Africa's Low Emission Development Strategy, The National Development Plan, The National Climate Change Response Policy, Integrated Resource Plan, the National Climate Change Adaptation Strategy (amongst others) and ultimately South Africa's commitment to the Paris Agreement. The proposed development site appears to be well suited for the development of renewable energy facilities as proposed.

Furthermore, opportunity exists to reduce the potential impact of collisions with overhead powerlines for species such as Ludwig's Bustard that may occur along the stretch of existing transmission infrastructure in the areas where the proposed overhead powerline runs adjacent to it through considered pylon positioning (i.e. the staggering of novel pylons between the pylon positions of the existing transmission line). Similarly, should the proposed Solaris Fields Solar PV Facility and Redding WEF be constructed, the construction of the Sun Garden PV Facility and associated overhead powerline may increase the visibility of the transmission line infrastructure of those facilities in the same manner and reduce the likelihood of avifaunal collisions.

5 ADDITIONAL REQUIREMENTS

In addition to the mitigation measures outlined for each potential impact, the requirement for post-construction/operational phase monitoring is to be included in the Environmental Management Programme (EMPr). This is necessary to determine the actual impacts of the proposed development, determine if additional mitigation is required and learn about impacts and improve future assessments[2].

Construction Phase monitoring is not considered to be necessary for this development as despite this period potentially being the most intense period in terms of disturbance and

displacement of avifauna, no focal sites of particular concern (e.g. nearby SCC nests) have been identified in proximity to the proposed development site.

Post-construction monitoring should be started as soon as possible once the facility becomes operational. As the effects of the proposed development may change over time both activity and fatality monitoring should be conducted during the first two years of operation and then repeated every fifth year. Fatality monitoring is to be conducted both systematically and on a continuous ad-hoc basis. Systematic fatality monitoring must be conducted at least once per season and include an estimation of searcher efficiency and carcass persistence rates (determined experimentally), carcass searches, and appropriate data analyses to determine estimated mortality rates. This process is to be conducted under the direction of an avifaunal specialist. The duration and scope of post-construction monitoring should be informed by the outcomes of the previous year's monitoring, and should be reviewed annually, however a minimum of 20 % of the solar hardware is to be methodically searched for fatalities, with a search interval informed by carcass persistence trials. Systematic fatality surveys are to include the full length of the proposed overhead powerline. Ad-hoc fatality monitoring is to be conducted continuously throughout the lifespan of the project and all carcasses and feather spots found during routine operational activity by on-site personnel are to be recorded and made available for an avifaunal specialist for inclusion into subsequent reports.

The activity monitoring methods and data collection should replicate those employed during pre-construction monitoring as closely as possible in terms of effort and timing and should follow any additional recommendations of the latest best-practice guidelines available at the time.

6 CONCLUSION

The impacts of solar PV facilities on avifauna are not well understood, particularly in the South African context. Nevertheless the low and very low classification of the site ecological importance for avifaunal SCCs as assessed reduces the overall risk of significant impacts to the local avifaunal community by the proposed development, despite any gaps that may exist in our current understanding of potential impacts.

As the Species Assessment Guideline states that in areas identified to be of low SEI development activities of medium to high impact are acceptable following the implementation of appropriate minimisation and restoration mitigation measures.

7 AVIFAUNAL SPECIALIST IMPACT STATEMENT

Based on the impact assessment conducted for the Sun Garden PV Facility (including cumulative impacts) it is the avifaunal specialist's informed opinion that the proposed development will not have a significant negative impact on the viability or persistence of SCC populations in the area following the implementation of mitigation measures.

The proposed Sun Garden PV Facility is therefore acceptable and can be approved from an avifaunal perspective.

APPENDIX A: SPATIAL MODELLING METHODOLOGY

Flight activity data from the vantage point surveys conducted for the nearby WEFs were analysed using a 200 x 200m grid overlaid onto the survey area, to determine a flight activity index (measured as the total observed track length per unit observation time, using ArcGIS) of each key species in each grid square, and this value was used as the response variable in the further analysis. The grid square flight densities were analysed in relation to the following explanatory variables:

- Distance from nest site (Martial Eagle and Verreaux's Eagle);
- Distance from roost site (Cape Vulture) - roost site locations were identified during road transect and additional focal roost surveys;
- Habitat type (derived from South African National Land Cover 2018 survey;
- Altitude (derived from NASA Shuttle Radar Topographic Mission (SRTM) digital elevation data);
- Distance from nearest ridge line, calculated using SRTM data in Global Mapper software to identify ridge lines, using those at higher altitude (>600 m); and
- Slope (maximum within grid square, derived from SRTM data).

Other measures of local terrain variability were also investigated, including standard deviation of altitude with each grid square, terrain ruggedness index[24] and mean slope, but as they were strongly correlated with each other only one (maximum slope) was selected for inclusion in the modelling (as the one that gave the strongest relationship with flight activity).

Similarly, alternative measures of topographic measures were considered, including topographic position index[25] and mean slope, but these did not give as high a correlation with flight activity as maximum slope and were highly inter-correlated, so only maximum slope was taken forward for the modelling. Habitat was initially included in the analysis but was dropped from the final models as it did not improve the precision of those models.

Spatial Autoregressive Modelling (StataCorp 2019) was used to analyse these data to test whether each species' abundance was statistically significantly related to these explanatory variables. This enabled the latitude and longitude of the central point of each grid square to be included in the modelling to account for spatial autocorrelation in the data.

[24] Riley, S.J., De Gloria, S.D. and Elliot, R. 1999. A Terrain Ruggedness Index that Quantifies Topographic Heterogeneity. Intermountain Journal of sciences, 5: 23-27.

[25] Guisan, A., Weiss, S.B. and Weiss, A.D. 1999. GLM versus CCA spatial modelling of plant species distribution. Plant Ecology 143: 107-122.

APPENDIX B: IMPACT ASSESSMENT SCORING METHODOLOGY

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

The **significance** is calculated by combining the criteria in the following formula:

$S = (E + D + M) * P$

where:

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

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

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

APPENDIX C: PASSAGE RATES OF AVIFAUNAL SPECIES RECORDED AT VPS WITHIN 2 KM OF THE PROPOSED SOLAR PV SITE (BIRDS/HOUR)

Species (n)	2019							2020						
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	May	Jun	Jul	Aug
Egyptian Goose (2)	-	-	-	-	-	-	-	0.25	-	-	-	-	-	-
Blue Crane (9)	-	-	0.25	-	-	-	-	0.88	-	-	-	-	-	-
Ludwig's Bustard (34)	0.13	3.38	0.13	-	-	-	-	-	-	-	0.63	-	-	-
Southern Black Korhaan (17)	0.38	0.63	0.38	0.25	0.13	0.13	-	-	-	-	0.25	-	-	-
Black-winged Kite (2)	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-
African Harrier-hawk (2)	-	-	0.13	-	-	-	0.13	-	-	-	-	-	-	-
Martial Eagle (16)	0.13	0.25	0.13	-	-	0.13	-	0.25	0.13	-	1.0	-	-	-
Booted Eagle (7)	-	-	-	0.63	-	-	-	0.25	-	-	-	-	-	-
Pale Chanting-goshawk (61)	-	0.88	0.88	0.5	0.63	0.13	0.25	0.13	0.5	0.38	2.25	0.13	0.5	0.5
Jackal Buzzard (18)	-	-	-	0.13	0.13	0.13	0.13	-	1.0	0.5	0.13	-	0.13	-
Common (Steppe) Buzzard (4)	-	-	-	-	-	0.13	-	0.13	0.25	-	-	-	-	-
Rock Kestrel (8)	-	-	-	-	-	-	-	-	-	-	0.75	-	0.25	-
Lanner Falcon (1)	-	0.13	-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX D: ROAD TRANSECT SURVEY COUNTS (BIRDS/KM) BY MONTH AS RECORDED FOR THE NEARBY WEFS, JUNE 2019-AUGUST 2020.

Species	2019							2020						
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	May	Jun	Jul	Aug
Helmeted Guineafowl	-	-	-	0.49	-	-	-	-	-	-	-	-	-	-
Egyptian Goose	0.16	-	-	1.23	-	-	-	0.16	0.16	0.9	5.16	-	12.3	0.16
South African Shelduck	-	-	-	-	-	0.08	-	-	-	-	0.82	-	0.33	-
Spur-winged Goose	-	-	-	-	-	-	-	0.74	0.08	0.16	0.16	-	-	-
Blue Crane	4.43	-	0.16	3.11	4.84	0.41	3.52	-	-	-	21.15	4.02	6.64	5
Ludwig's Bustard	-	-	-	0.08	0.82	0.08	0.33	-	0.16	0.33	3.77	1.31	0.57	1.72
Denham's Bustard	-	-	-	-	-	-	-	-	-	-	-	0.08	-	0.16
Kori Bustard	-	-	-	-	-	-	-	-	-	-	0.33	0.25	0.49	0.33
Karoo Korhaan	-	-	0.08	-	-	-	-	-	-	-	0.33	-	-	-
Southern Black Korhaan	-	-	0.33	0.08	-	0.08	-	-	-	-	0.66	-	-	0.25
White Stork	-	-	-	-	-	-	-	0.33	-	-	-	-	-	-
African Sacred Ibis	0.33	-	-	-	-	1.07	-	-	-	-	-	-	1.15	0.25
Hadeda Ibis	-	-	-	0.41	-	-	-	-	1.07	0.16	0.74	-	-	0.49
Cattle Egret	0.16	-	-	-	-	-	-	-	-	-	-	-	0.98	-
Black-headed Heron	0.08	-	-	-	-	-	-	-	-	-	0.49	-	-	-
Hamerkop	-	-	-	-	-	-	-	-	-	-	-	-	-	0.16
Black-winged Stilt	-	-	-	0.16	-	-	-	-	-	-	-	-	-	-
Crowned Lapwing	0.66	-	-	0.16	-	-	-	-	-	0.49	-	-	-	-
Caspian Tern	-	-	-	0.16	-	-	-	-	-	-	-	-	-	-
Martial Eagle	-	-	-	-	-	-	-	-	-	-	-	-	0.08	-
Pale Chanting-goshawk	-	-	-	0.08	0.25	-	-	-	0.08	-	1.07	-	-	0.08
Black Harrier	-	-	-	-	-	-	-	-	-	-	0.08	-	-	-
Jackal Buzzard	-	-	-	-	-	-	-	0.08	-	-	-	-	-	-
Rock Kestrel	0.08	-	-	0.9	-	-	-	0.08	-	-	0.16	-	0.25	-
Lanner Falcon	-	-	-	-	-	-	-	-	-	-	0.16	-	-	-

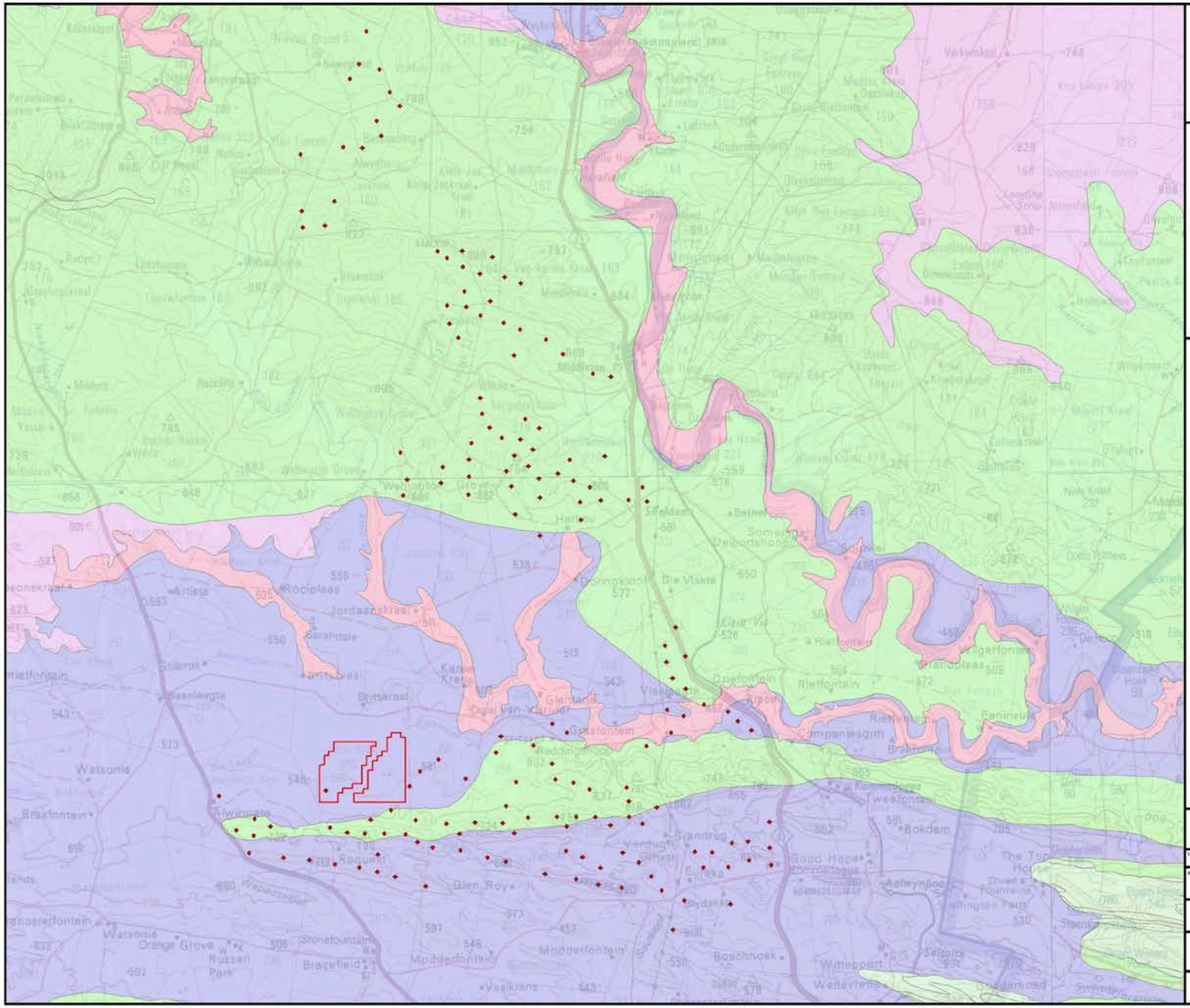
APPENDIX E: ROAD TRANSECT SURVEY COUNTS (BIRDS/KM) BY MONTH AS RECORDED FOR THE SOLAR PV FACILITY, MAY 2020 - OCTOBER 2020.

Species	17-May	25-May	11-Jun	12-Jun	02-Jul	10-Jul	03-Aug	10-Aug	17-Sep	19-Sep	13-Oct	15-Oct
Helmeted Guineafowl	0.86	-	-	-	-	-	-	-	-	-	-	-
Blue Crane	0.69	1.56	7.67	7.55	5.56	3.46	0.81	1.61	3.98	2.02	0.26	0.29
Ludwig's Bustard	0.32	0.72	0.78	0.2	1.7	2.39	1.5	1.12	1.41	0.2	0.06	0.35
Denham's Bustard	-	-	-	-	-	-	-	-	-	-	-	0.03
Kori Bustard	0.06	0.26	-	-	0.2	0.17	0.14	0.32	0.17	0.12	-	0.06
Karoo Korhaan	-	-	-	-	-	-	-	-	0.06	-	0.03	-
Southern Black Korhaan	0.12	0.29	0.03	-	0.78	1.21	0.98	1.04	0.32	0.46	0.32	0.29
Kittlitz's Plover	-	-	-	0.52	-	-	-	-	-	-	-	-
Double-banded Courser	-	-	-	-	-	-	-	-	0.06	-	-	-
Secretarybird	0.03	-	-	-	-	-	-	0.06	-	-	-	0.03
Martial Eagle	-	-	-	-	-	-	0.03	-	0.03	0.03	0.03	-
Booted Eagle	-	-	-	-	-	-	-	0.03	-	-	-	-
Pale Chanting-goshawk	0.06	0.09	0.06	0.06	0.12	0.14	0.23	0.12	0.09	0.17	0.12	0.06
Rock Kestrel	-	-	-	-	0.03	0.03	0.06	0.03	-	0.03	-	-

APPENDIX F: WALK TRANSECT SURVEY COUNTS (BIRDS/KM) BY MONTH AS RECORDED FOR THE SOLAR PV FACILITY, MAY 2020 - OCTOBER 2020.

Species	11-Jun	12-Jun	02-Jul	10-Jul	03-Aug	10-Aug	17-Sep	19-Sep	13-Oct	15-Oct
Namaqua Dove	-	1.67	1.25	-	-	-	0.83	0.83	-	-
Namaqua Sandgrouse	-	1.67	-	-	-	5	2.5	-	1.25	2.5
Ludwig's Bustard	-	-	-	3.33	2.5	-	-	-	-	-
Southern Black Korhaan	-	-	-	10.83	-	2	-	-	-	0.83
Caspian Plover	-	-	-	-	-	-	-	1.25	-	1.25
Crowned Lapwing	-	-	-	-	-	-	0.83	-	-	-
Pale Chanting-goshawk	-	-	-	-	1.25	-	-	-	-	-
Acacia Pied Barbet	-	-	-	-	-	-	-	0.83	-	-
Cardinal Woodpecker	-	-	-	-	-	-	0.42	-	-	-
Rock Kestrel	-	-	-	-	-	0.5	-	-	-	0.42
Chinspot Batis	-	-	-	-	-	0.5	-	-	-	-
Pririt Batis	-	-	-	-	-	-	1.25	0.83	-	-
Fork-tailed Drongo	-	-	-	-	-	0.5	-	-	-	-
Common Fiscal	-	-	-	-	0.63	-	-	-	-	-
Cape Crow	-	-	-	2.5	-	-	-	2.92	-	-
Pied Crow	-	-	-	-	-	-	-	0.83	-	-
Cape Penduline-tit	-	-	-	-	-	2	-	-	-	-
Spike-heeled Lark	5.83	1.0	11.25	14.17	8.13	16.5	4.17	8.75	7.08	10.42
Grey-backed Sparrow-lark	-	-	1.88	-	-	-	2.5	-	-	-
Sabota Lark	-	0.83	-	-	-	-	0.83	-	-	-
Eastern Clapper-lark	-	-	-	-	-	-	0.83	0.83	0.42	-
Rufous-naped Lark	-	0.83	-	-	-	-	-	0.83	-	-
Large-billed Lark	-	-	1.25	4.17	0.63	-	-	-	0.42	0.42
Yellow-bellied Eremomela	-	-	2.5	1.67	0.63	-	-	0.42	0.42	-
Rufous-eared Warbler	-	-	2.5	10.83	3.13	1.5	-	4.58	3.33	1.67
Grey-backed Cisticola	-	-	-	-	-	0.5	-	-	-	-
Neddicky	0.83	-	-	0.83	-	-	-	-	-	-
Lesser Striped Swallow	-	-	-	-	-	-	-	-	0.42	-
Pearl-breasted Swallow	-	-	-	-	-	-	0.42	-	-	-
Chestnut-vented Warbler	-	-	-	-	-	-	-	0.42	0.42	-
Wattled Starling	-	-	-	-	-	-	-	-	2.08	-
African Pied Starling	-	-	-	-	-	-	9.58	-	-	-
Cape Starling	-	-	-	-	-	1.5	0.83	1.25	-	-
Karoo Scrub-robin	-	-	-	-	-	-	-	0.42	-	0.42
Common Stonechat	-	1.67	-	-	-	-	-	-	-	-
Karoo Chat	0.83	-	-	-	-	-	0.42	-	-	-
Sickle-winged Chat	-	-	2.5	5.83	6.25	3.5	1.67	0.83	2.5	0.83

Species	11-Jun	12-Jun	02-Jul	10-Jul	03-Aug	10-Aug	17-Sep	19-Sep	13-Oct	15-Oct
Southern Anteater-chat	2.5	1.67	3.13	-	-	1	2.08	0.83	1.25	0.83
Capped Wheatear	1.67	0.83	-	-	-	-	-	-	-	-
Familiar Chat	-	1.67	-	-	-	-	-	-	-	-
Southern Double-collared Sunbird	-	-	-	-	1.25	-	-	-	-	-
Cape Weaver	-	-	-	-	-	1	-	0.42	-	-
Yellow-throated Bush-sparrow	-	-	-	-	-	-	0.42	-	-	-
African Pipit	0.83	-	3.75	6.67	3.75	4.5	1.25	4.17	1.67	2.08
Yellow-fronted Canary	-	-	-	-	-	-	-	-	2.08	-



WIND RELIC
RENEWABLES

FIGURE 1

Current Site Layout and Mucina & Rutherford (2006) Biomes

KEY:

- Solar farm
- Choje West turbines EIA

BIOME

- Albany Thicket Biome
- Azonal Vegetation
- Desert Biome
- Forests
- Fynbos Biome
- Grassland Biome
- Indian Ocean Coastal Belt
- Nama-Karoo Biome
- Savanna Biome
- Succulent Karoo Biome
- Waterbodies

Ecology Consulting

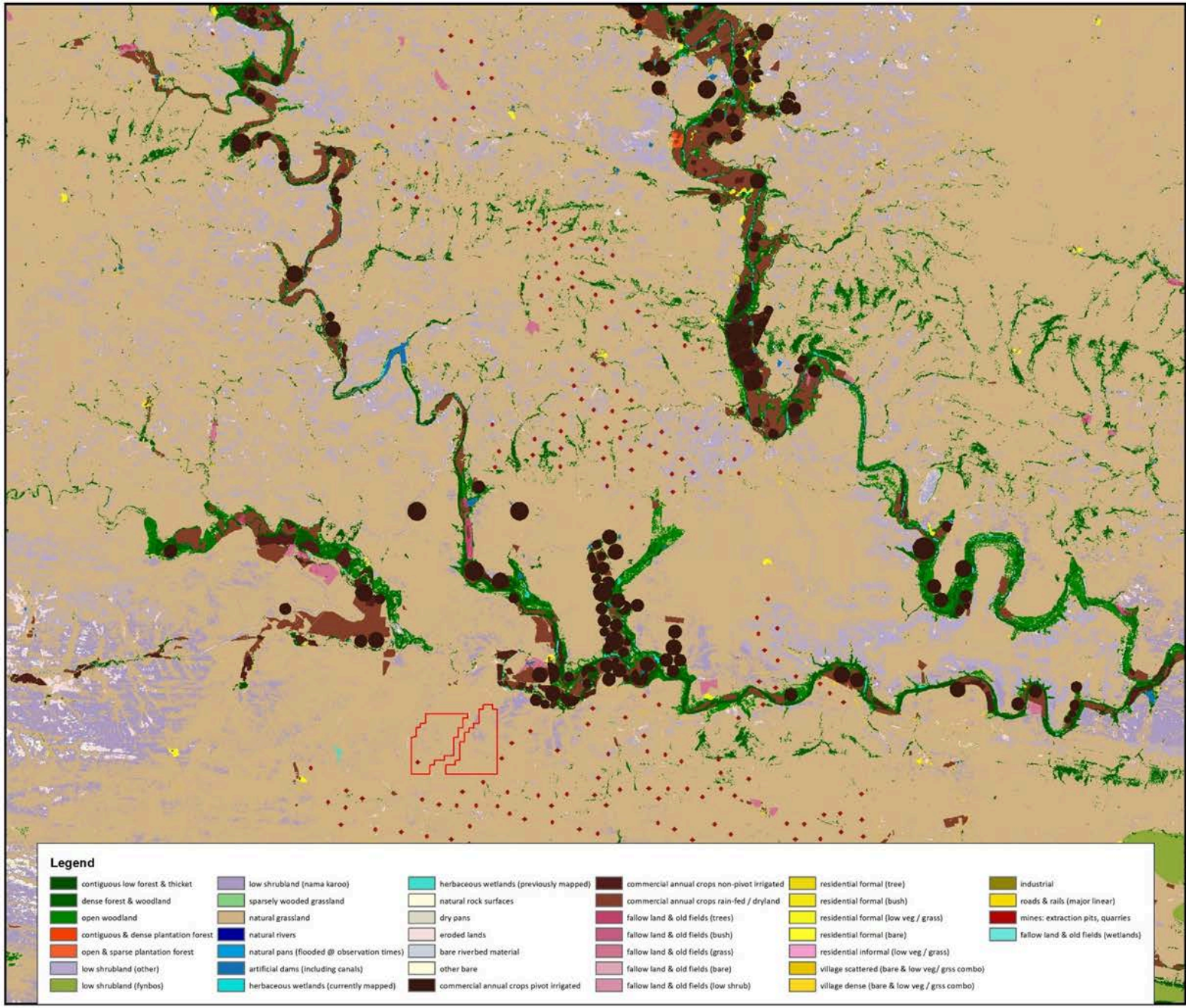
N

0 0.75 1.5 3 4.5 6 Kilometres

N/A	N/A

EC-2020-1

SCALE - 1:150,000 @ A3



WIND RELIC RENEWABLES

FIGURE 2

Current Site Layout and Land Cover (2018) Classes

KEY:

- Solar farm
- Choje West turbines EIA

Ecology Consulting

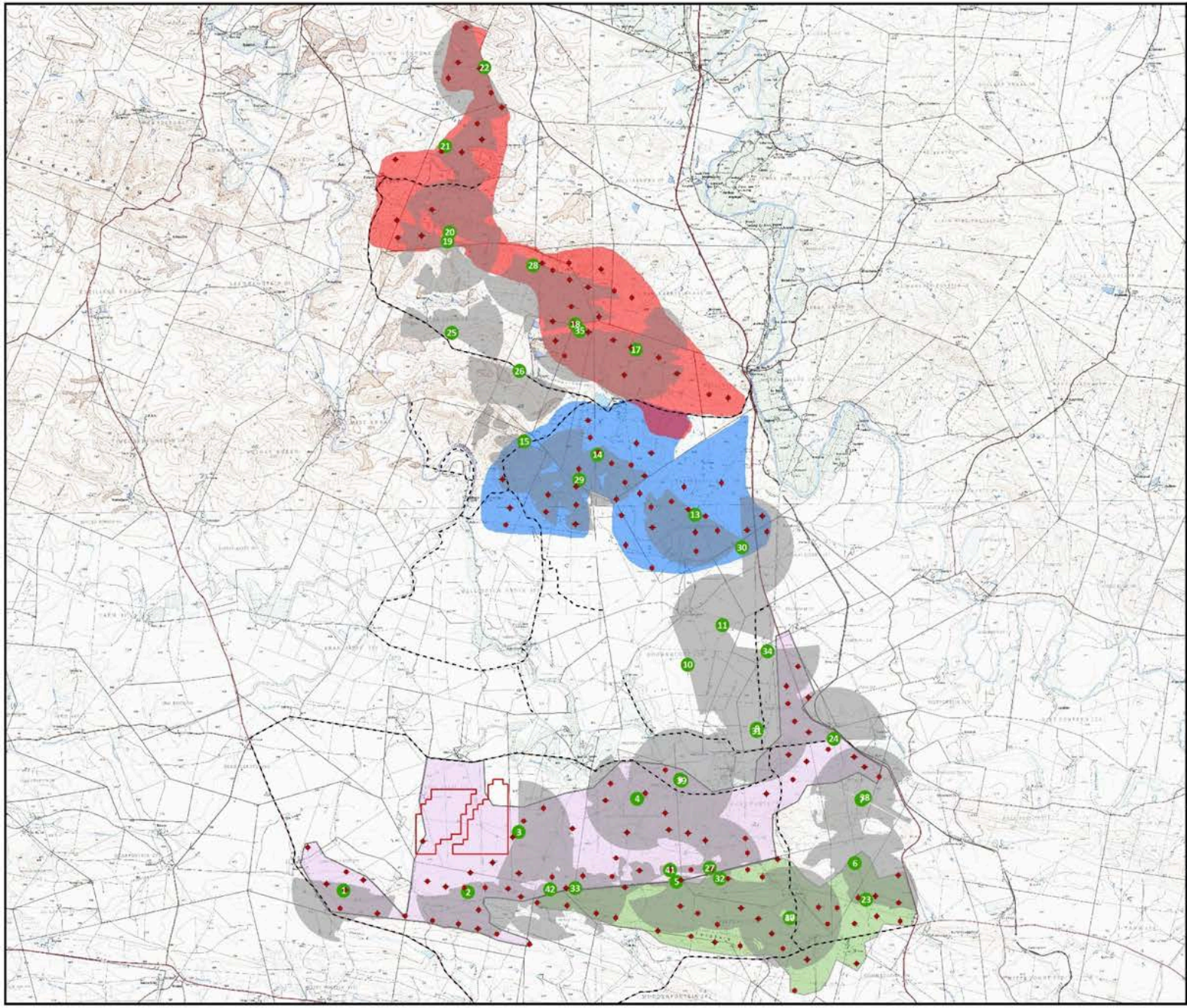
N

0 0.75 1.5 3 4.5 6 Kilometres

N/A	N/A

EC-2020-1

SCALE - 1:150,000 @ A3



WIND RELIC RENEWABLES

FIGURE 3

Western Block: proposed layout, VP locations and road transects

KEY:

- Solar farm
- Choje West turbines EIA
- Choje West VP locations
- Choje West Road Transects
- Rippon Site Boundary
- Hamlett Site Boundary
- Redding Site Boundary
- Aeolus Site Boundary
- Choje West Viewsheds

Ecology Consulting

N

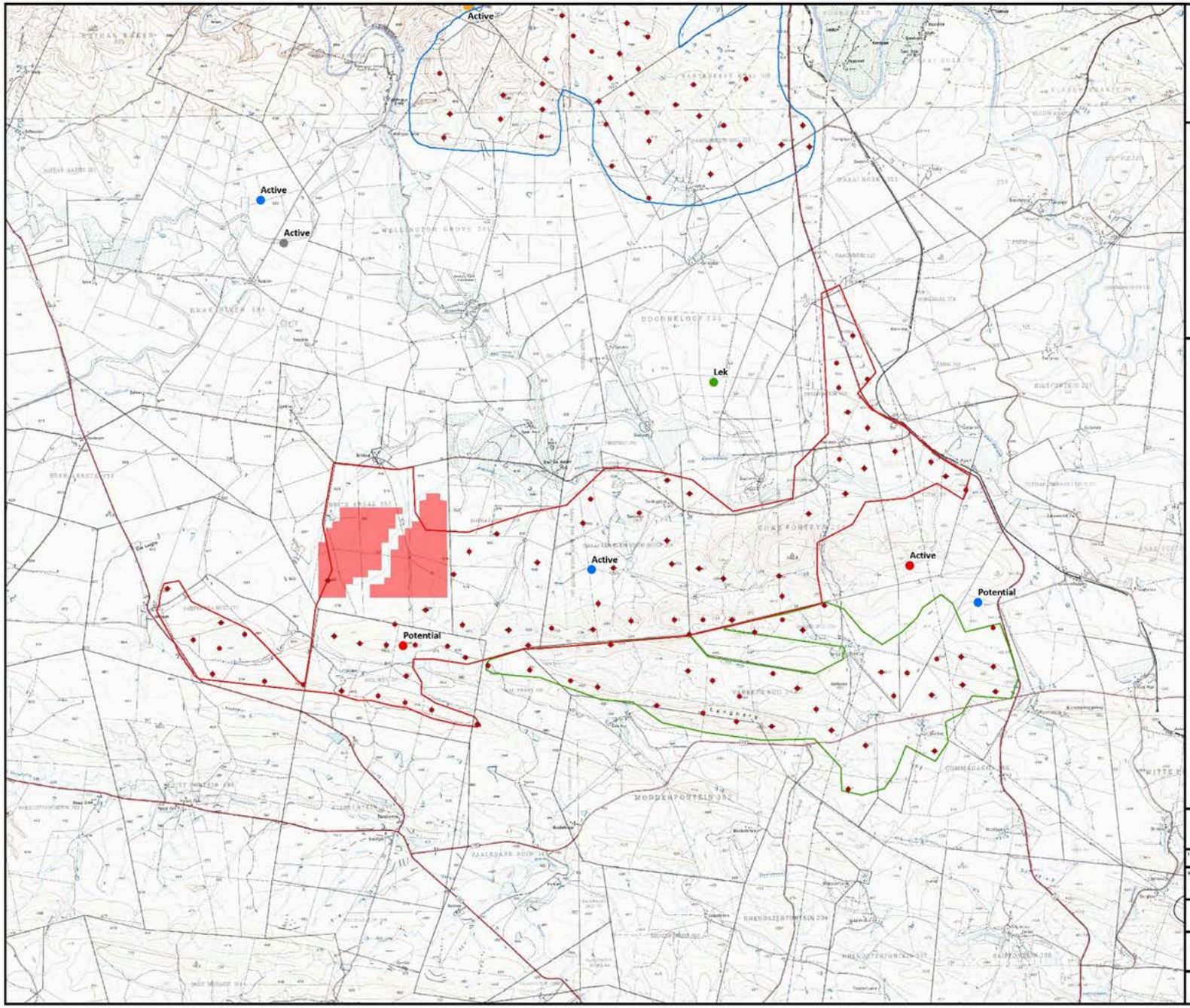
0 0.75 1.5 3 4.5 6 Kilometres

N/A	N/A

EC-2020-1

SCALE - 1:140,000 @ A3

Viewshed: 2km cut-off, 1.7m viewing height to 40m above ground level



WIND RELIC RENEWABLES

FIGURE 4

Rapter and other key species breeding locations 2019-20

KEY:

- Choje West turbines EIA

Species

- Grey Crowned-crane
- Jackal Buzzard
- Lanner Falcon
- Ludwig's Bustard
- Martial Eagle
- Secretarybird
- Verreaux's Eagle
- Solar farm
- Redding Site Boundary
- Aeolus Site Boundary
- Rippon Site Boundary

Ecology Consulting

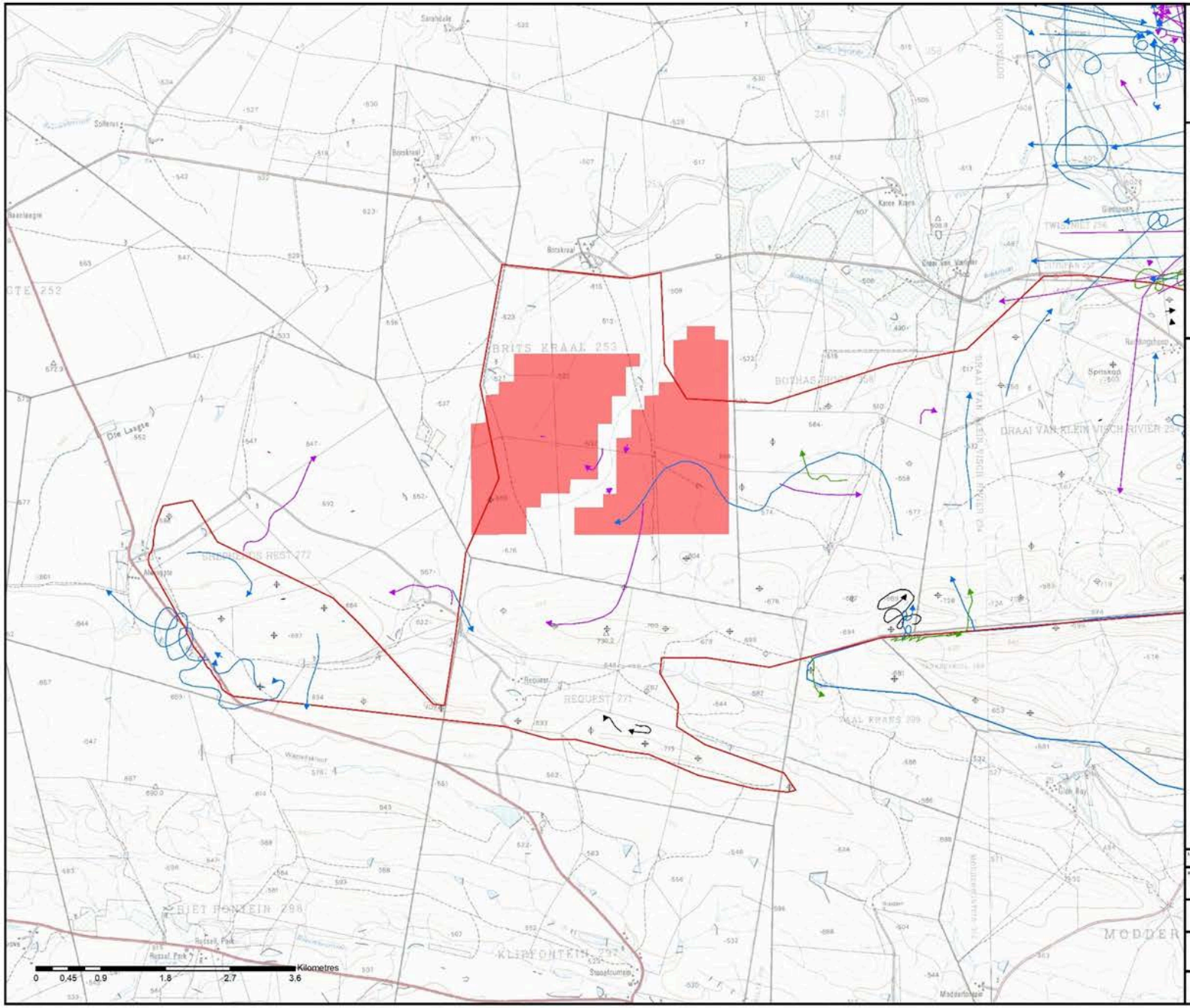
N

0 0.5 1 2 3 4 Kilometres

N/A	N/A

EC-2020-1

SCALE - 1:100,000 @ A3



WIND RELIC RENEWABLES

FIGURE 5

VP survey Flight Lines Jun 2019 - Aug 2020: Blue Crane and other key species

KEY:

- Solar farm
- Choje West turbines EIA
- Redding Site Boundary
- Rippon Site Boundary
- Aeolus Site Boundary

Species

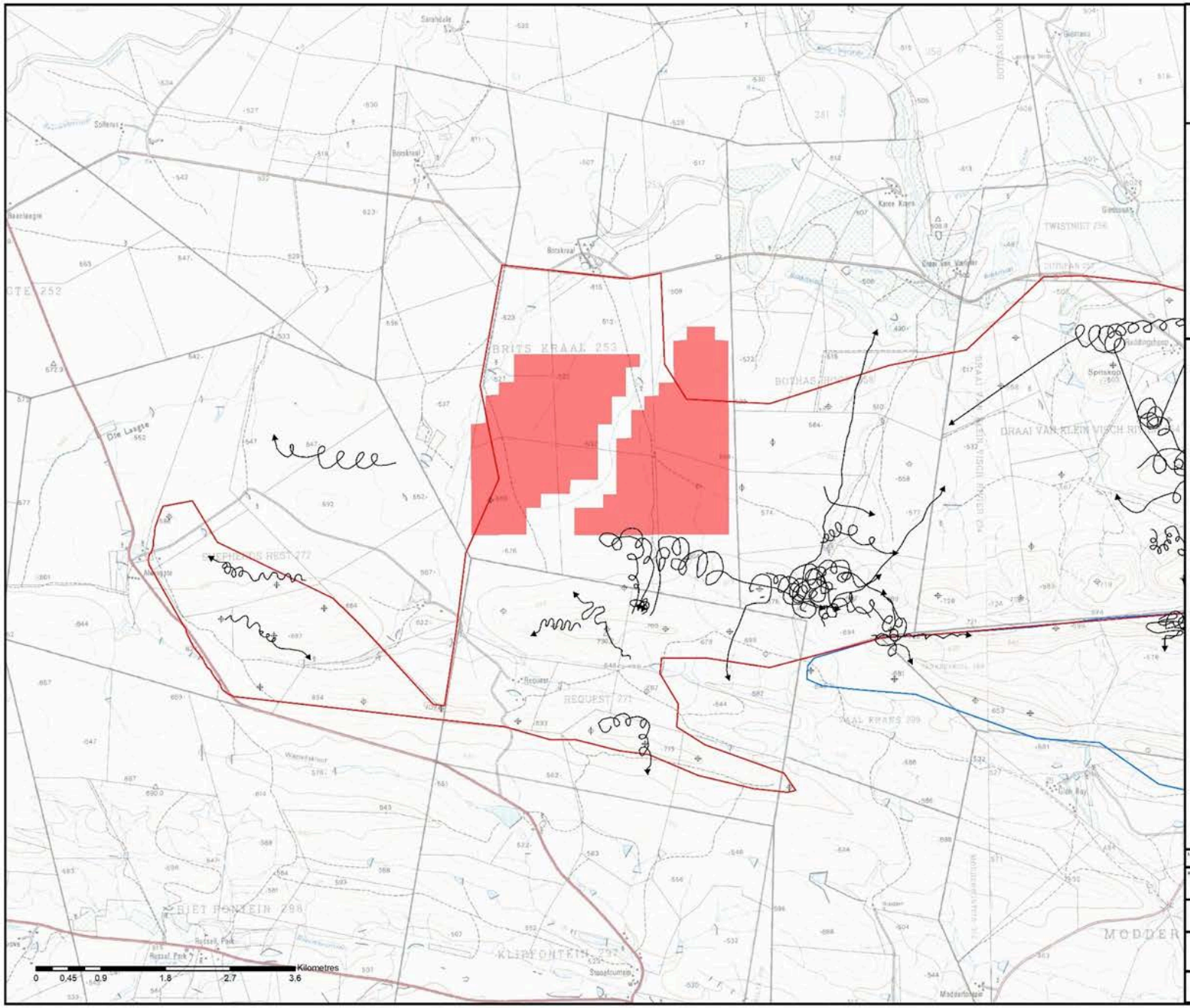
- Blue crane
- Lanner falcon
- Ludwig's bustard
- Secretarybird

Ecology Consulting

N

N/A	N/A
EC-2020-1	

SCALE - 1:50,000 @ A3



WIND RELIC RENEWABLES

FIGURE 6

VP survey Flight Lines Jun 2019 - Aug 2020: Martial Eagle

KEY:

- Solar farm
- Choje West turbines EIA
- Redding Site Boundary
- Rippon Site Boundary
- Aeolus Site Boundary
- Flight lines Jun 2019-Aug 2020

Ecology Consulting

N

N/A	N/A
EC-2020-1	

SCALE - 1:50,000 @ A3

WIND RELIC RENEWABLES

FIGURE 7

Vehicle Transect Surveys May-October 2020: Blue Crane

KEY:

- Solar farm
- Solar farm 500m buffer
- Vehicle transects (solar farm)
- Choje West turbines EIA

Count

- 1
- 10
- 100

Ecology Consulting

N

0 0.225 0.45 0.9 1.35 1.8 Kilometres

N/A	N/A

EC-2020-1

SCALE - 1:35,000 @ A3

ROAD TRANSECT SURVEY

WIND RELIC RENEWABLES

FIGURE 8

Vehicle Transect Surveys May-October 2020: Ludwig's Bustard

KEY:

- Solar farm
- Solar farm 500m buffer
- Vehicle transects (solar farm)
- Choje West turbines EIA

Count

- 1
- 5
- 10

Ecology Consulting

N

0 0.225 0.45 0.9 1.35 1.8 Kilometres

N/A	N/A
EC-2020-1	

SCALE - 1:35,000 @ A3

ROAD TRANSECT SURVEY

WIND RELIC RENEWABLES

FIGURE 9

Vehicle Transect Surveys May-October 2020:

Southern Black Korhaan

KEY:

- Solar farm
- Solar farm 500m buffer
- Vehicle transects (solar farm)
- Choje West turbines EIA

Count

- 1
- 5
- 10

Ecology Consulting

N

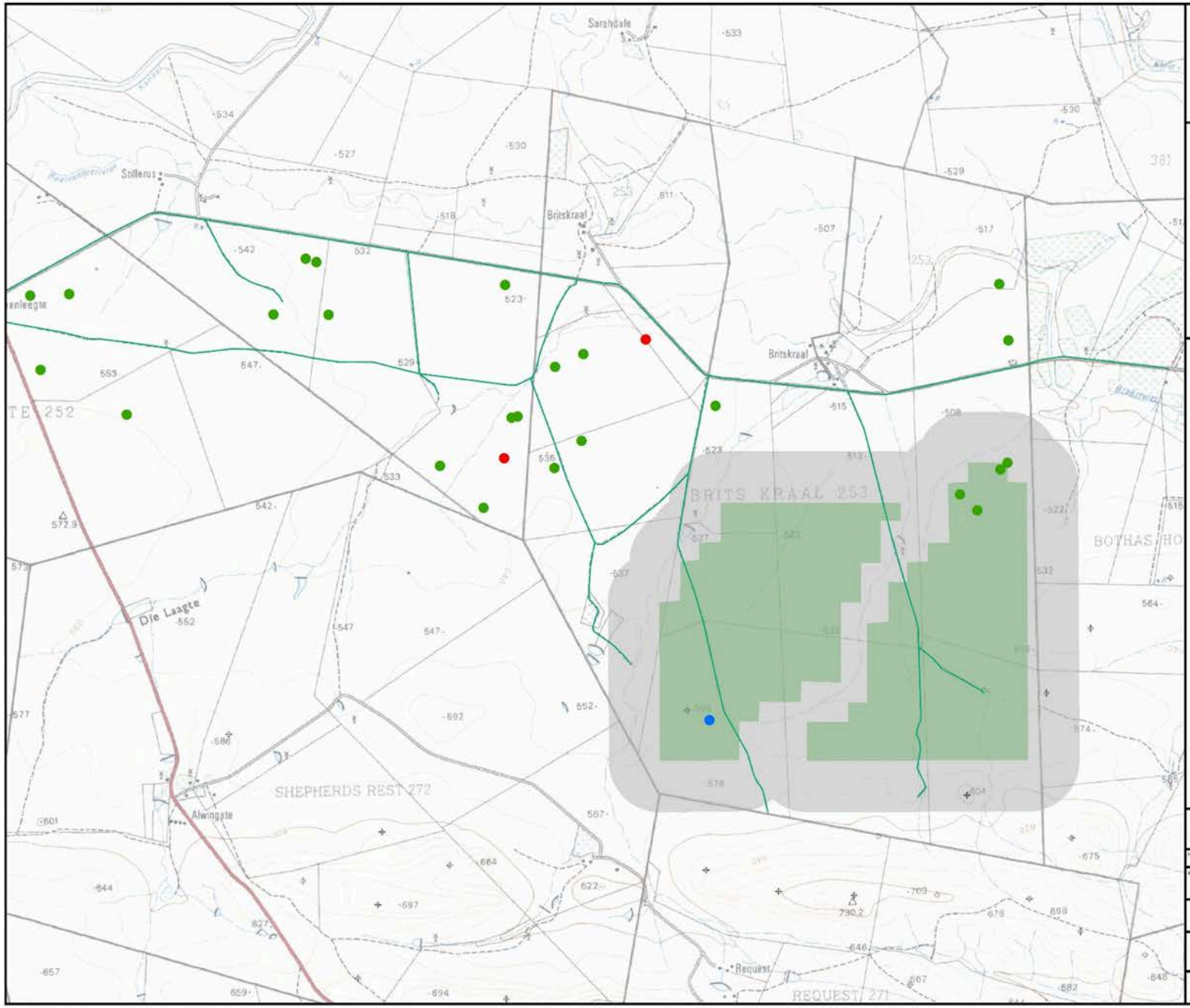
0 0.225 0.45 0.9 1.35 1.8 Kilometres

N/A	N/A

EC-2020-1

SCALE - 1:35,000 @ A3

ROAD TRANSECT SURVEY



WIND RELIC
RENEWABLES

FIGURE 10

Vehicle Transect Surveys May-October 2020: Other Bustards

KEY:

- Solar farm
- Solar farm 500m buffer
- Vehicle transects (solar farm)
- Choje West turbines EIA

Species

- Denham's bustard
- Karoo bustard
- Kori bustard

Ecology Consulting

N

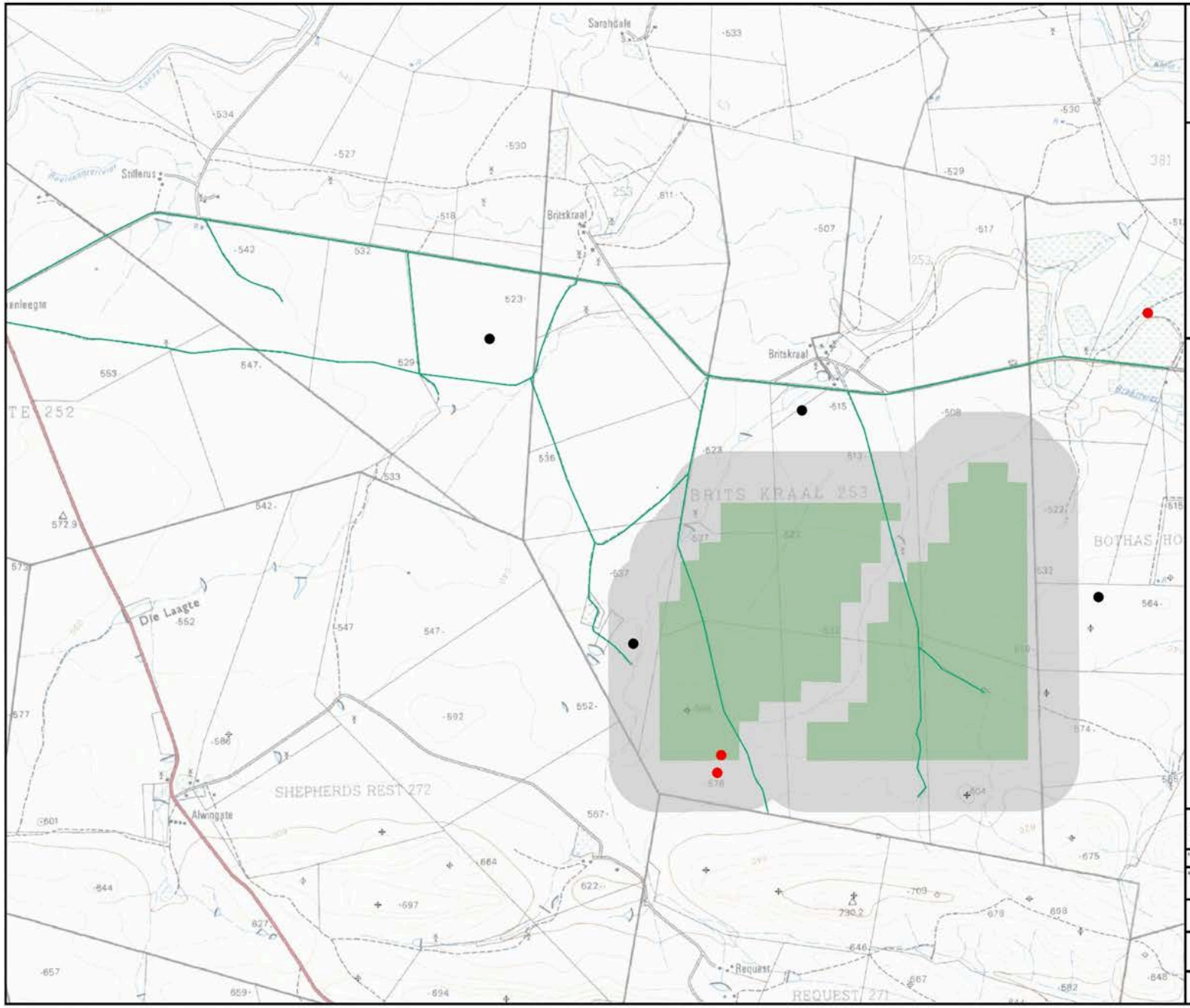
0 0.225 0.45 0.9 1.35 1.8 Kilometres

LAYOUT DWG	N/A	T-LAYOUT NO.	N/A

DRAWING NUMBER: EC-2020-1

SCALE - 1:35,000 @ A3

ROAD TRANSECT SURVEY



WIND RELIC RENEWABLES

FIGURE 11

Vehicle Transect Surveys May-October 2020: Other Key Species

KEY:

- Solar farm
- Solar farm 500m buffer
- Vehicle transects (solar farm)
- Choje West turbines EIA

Species

- Martial eagle
- Secretarybird

Ecology Consulting

N

0 0.225 0.45 0.9 1.35 1.8 Kilometres

LAYOUT DWG	N/A	T-LAYOUT NO.	N/A

DRAWING NUMBER: EC-2020-1

SCALE - 1:35,000 @ A3

ROAD TRANSECT SURVEY

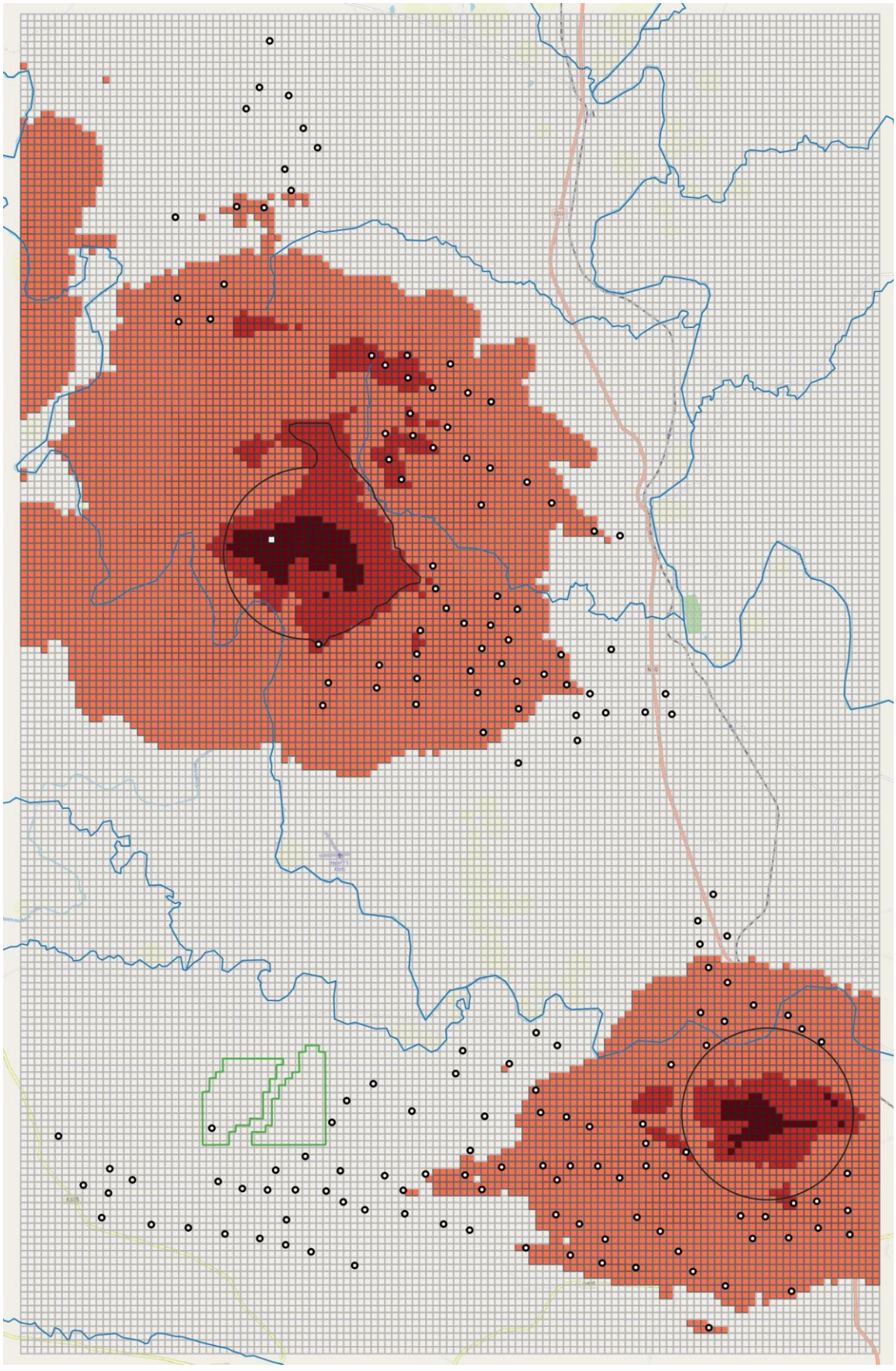


Figure 12: Predicted Martial Eagle distribution. Darker shading indicates higher predicted use, with the solar PV (green) site boundary and proposed positions of wind turbine generators (dots) associated with wind energy facilities proposed nearby.

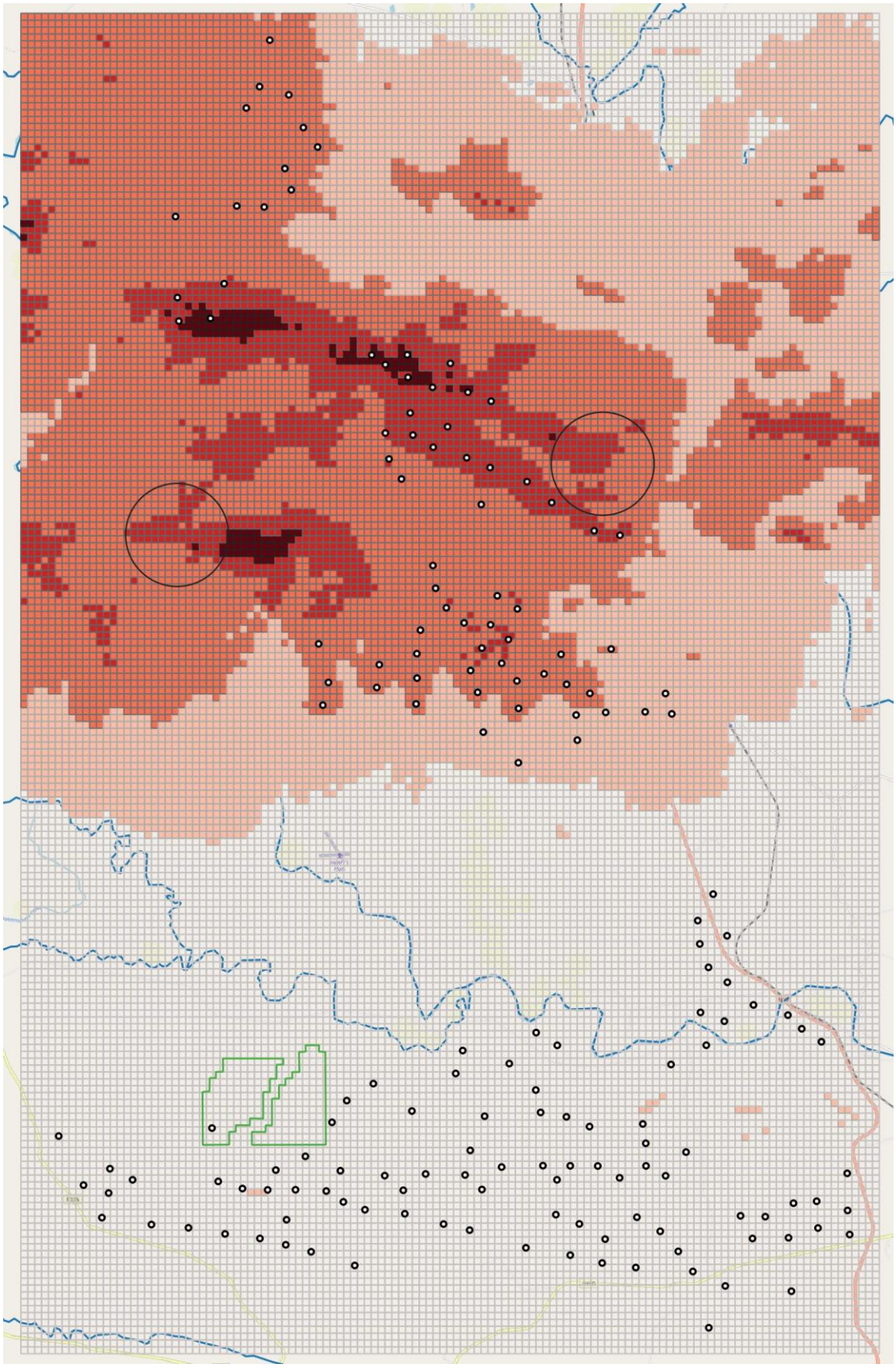


Figure 13: Predicted Verreaux's Eagle distribution. Darker shading indicates higher predicted use, with the solar PV (green) site boundary and proposed positions of wind turbine generators (dots) associated with wind energy facilities proposed nearby.

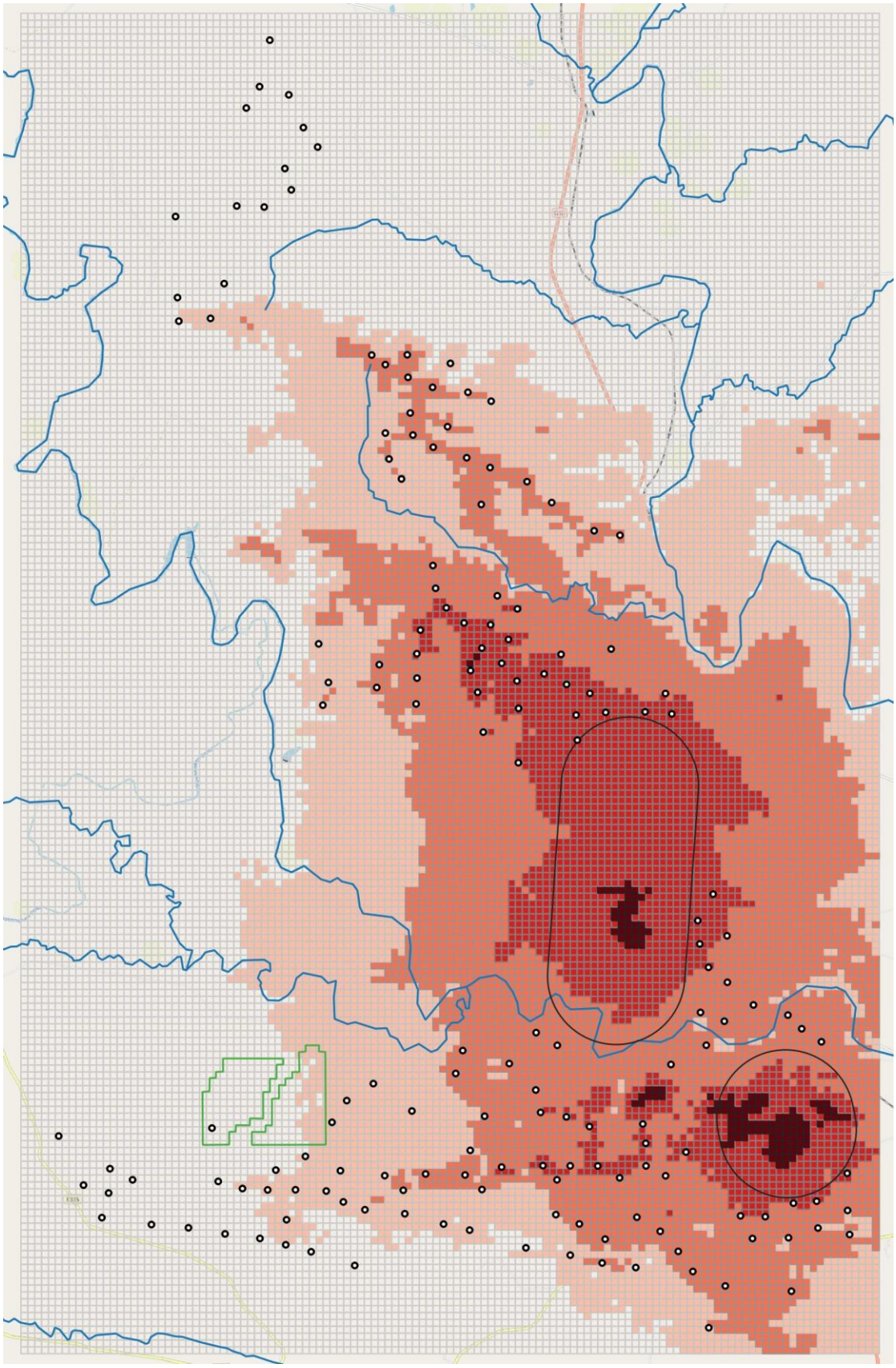


Figure 14: Predicted Cape Vulture distribution. Darker shading indicates higher predicted use, with the solar PV (green) site boundary and proposed positions of wind turbine generators (dots) associated with wind energy facilities proposed nearby.

ARCUS

Solar PV Facility

BoP Area

132 kV Overhead Powerline

Avifaunal SEI

Low

Very Low

1:60 000 Scale @ A3

0 1 2 km

NORTH

Produced By: OD	Ref: 3065-REP-0002
Checked By: AB	Date: 2021/10/20

Avifaunal
Site Ecological Importance
Figure 15

Sun Garden PV Facility
Avifaunal Impact Assessment Report

S:\GIS\Projects\3065 Solaris Fields\3065 Solaris Fields.aprx\Figure15_Solaris_SEI