AVIFAUNAL IMPACT ASSESSMENT REPORT

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED VELD PV NORTH SOLAR ENERGY FACILITY, GRID CONNECTION AND ASSOCIATED INFRASTRUCTURE IN THE NORTHERN CAPE PROVINCE

June 2019

AFRIMAGE Photography (Pty) Ltd t/a:

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EXECUTIVE SUMMARY

The Proponent proposes to develop a solar site on the farm Haramoep (Remainder of Farm no. 53) approximately 20 km north-west of Aggeneys in the Northern Cape. The solar farm would consist of a photovoltaic (PV) energy facility and associated infrastructure which would have a maximum generation capacity of up to 75 MW. The footprint of the PV facility will be approximately 200 hectares, within an assessment area of approximately 2 500 hectares. The proposed facility is located in the Haramoep and Black Mountain Mine (SA035) Important Bird Area (IBA).

It is estimated that a total of 64 bird species could potentially occur in the broader area – Appendix 2 provides a comprehensive list of all the species, including those recorded during the pre-construction monitoring. Of these, 20 species are classified as priority solar species, 13 as powerline priority species, and 20 as IBA trigger species.

No exclusion areas have been identified within the assessment area.

PV FACILITY

The proposed Veld PV North facility and the associated grid connection will have some pre-mitigation impacts on priority and/or IBA trigger species at a site and regional level, which will range from **Low to Very Low**.

The overall impact of the habitat transformation on priority and/or IBA trigger species in the PV footprint is limited by the already highly degraded state of the habitat in the assessment area. This existing impact has already had a significant negative impact on variety and abundance of priority species that could potentially have occurred there, if the habitat were in a less disturbed state. Within this context, the impact of displacement of priority and/or IBA trigger species due to habitat transformation associated with the operation of the plant and associated infrastructure is rated as **Low**. This impact can be partially reversed through mitigation, but it will remain at a **Low** level, after mitigation

The impact of displacement due to disturbance on priority and/or IBA trigger species in the PV footprint, during the construction phase, is rated as **Low** and will remain at a **Low** level after mitigation. It should be noted that the variety and abundance and variety of priority species have already been negatively affected by the existing impact of heavy grazing on the vegetation, resulting in depleted numbers of such species in the assessment area to start with.

The envisaged impacts of priority and/or IBA trigger species mortality due to collisions with the solar panels is rated as **Very Low**. No mitigation is suggested for the impact due to the low significance.

Entrapment of priority and/or IBA trigger species in the perimeter fences of the PV facility is rated as **Low** pre-mitigation and could be further reduced with appropriate mitigation to **Very Low**.

The cumulative impact of the proposed Veld PV North facility on priority and/or IBA trigger species is rated as **Low**, taking into account all planned and approved renewable energy facilities in a 35km radius around the proposed facility.

132kV GRID CONNECTION

The impact of displacement due to disturbance and habitat transformation associated with the construction of the proposed 132kV grid connection and substation on priority and/or IBA trigger species, is assessed to be **Low** and can be mitigated to a **Very Low** level.

The impact of collision related mortality on priority and/or some IBA trigger species with the 132kV grid connection is rated as **High** and could be reduced to **Low** with the application of mitigation measures.

The potential impact of electrocution related mortality on priority and/or some IBA trigger species is assessed to be **Low**, but it can be reduced to **Very Low** with appropriate mitigation.

The cumulative impact of the proposed grid connections on priority and/or IBA trigger species within a 35km radius around the proposed development is rated as **Moderate**, but it can be reduced to **Low** with the application of appropriate mitigation measures.

IMPACT STATEMENT

From an avifaunal impact perspective, there is no objection to the development of the proposed Veld PV North facility and associated grid connections, provided the proposed mitigation measures are strictly implemented.

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

Section in EIA Regulations 2014 (as amended)		**Clause**	**Section in Report**
Appendix 6	(1)	A specialist report prepared in terms of these Regulations must contain —	
	(a)	details of –	
		(i) the specialist who prepared the report; and	Pg. 7
		(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae.	Pg. 8 - 13
	(b)	A declaration that the person is independent in a form as may be specified by the competent authority;	Pg. 14 - 18
	(c)	An indication of the scope of, and the purpose for which, the report was prepared;	Section 2
	(cA)	An indication of the quality and age of base data used for the specialist report;	Section 3
	(cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Sections 6 and 7
	(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 3 and Appendix 1
	(e)	A description of the methodology adopted in preparing the report or carrying out the specialised process; inclusive of equipment and modelling used;	Appendix 1
	(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 7
	(g)	An indication of any areas to be avoided, including buffers;	Section 8
	(h)	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 8
	(i)	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4
	(j)	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities;	Sections 9 and 10
	(k)	Any mitigation measures for inclusion in the EMPr;	Section 7

	(l)	Any conditions for inclusion in the environmental authorization;	Section 7
	(m)	Any monitoring requirements for inclusion in the EMPr or environmental authorization;	N/A
	(n)	A reasoned opinion –	
		(i) as to whether the proposed activity, activities or portions thereof should be authorized;	Section 10
		(iA) regarding the acceptability of the proposed activity or activities; and	Section 10
		(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorized, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 7
	(o)	A description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 3
	(p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
	(q)	Any other information requested by the authority.	N/A
	(2)	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

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DETAILS OF THE SPECIALIST AND EXPERTISE TO COMPILE A SPECIALIST REPORT

Chris van Rooyen

Chris has 22 years' experience in the management of wildlife interactions with electricity infrastructure. He was head of the Eskom-Endangered Wildlife Trust (EWT) Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has worked in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. Chris also has extensive project management experience and has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author of 15 academic papers (some with co-authors), co-author of two book chapters and several research reports. He has been involved as ornithological consultant in numerous power line and wind generation projects. Chris is also co-author of the Best Practice for Avian Monitoring and Impact Mitigation at Wind Development Sites in Southern Africa, which is the industry standard. Chris also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Albert Froneman

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

SPECIALIST DECLARATION

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

Full Name: Chris van Rooyen

Position: Director

Curriculum vitae: Chris van Rooyen

Profession/Specialisation	:	Avifaunal Specialist
Highest Qualification	:	BA LLB
Nationality	:	South African
Years of experience	:	22 years

Key Experience

Chris van Rooyen has twenty-two years' experience in the assessment of avifaunal interactions with industrial infrastructure. He was employed by the Endangered Wildlife Trust as head of the Eskom-EWT Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has consulted in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. He also has extensive project management experience and he has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author and/or co-author of 17 conference papers, co-author of two book chapters, several research reports and the current best practice guidelines for avifaunal monitoring at wind farm sites. He has completed around 130 power line assessments; and has to date been employed as specialist avifaunal consultant on more than 50 renewable energy generation projects. He has also conducted numerous risk assessments on existing power lines infrastructure. He also works outside the electricity industry and he has done a wide range of bird impact assessment studies associated with various residential and industrial developments. He serves on the Birds and Wind Energy Specialist Group which was formed in 2011 to serve as a liaison body between the ornithological community and the wind industry.

Key Project Experience

Bird Impact Assessment Studies and avifaunal monitoring for wind-powered generation facilities:

1. Eskom Klipheuwel Experimental Wind Power Facility, Western Cape
2. Mainstream Wind Facility Jeffreys Bay, Eastern Cape (EIA and monitoring)
3. Biotherm, Swellendam, (Excelsior), Western Cape (EIA and monitoring)
4. Biotherm, Napier, (Matjieskloof), Western Cape (pre-feasibility)
5. Windcurrent SA, Jeffreys Bay, Eastern Cape (2 sites) (EIA and monitoring)
6. Caledon Wind, Caledon, Western Cape (EIA)
7. Innowind (4 sites), Western Cape (EIA)
8. Renewable Energy Systems (RES) Oyster Bay, Eastern Cape (EIA and monitoring)
9. Oelsner Group (Kerriefontein), Western Cape (EIA)
10. Oelsner Group (Langefontein), Western Cape (EIA)
11. InCa Energy, Vredendal Wind Energy Facility Western Cape (EIA)
12. Mainstream Loeriesfontein Wind Energy Facility (EIA and monitoring)
13. Mainstream Noupoort Wind Energy Facility (EIA and monitoring)
14. Biotherm Port Nolloth Wind Energy Facility (Monitoring)
15. Biotherm Laingsburg Wind Energy Facility (EIA and monitoring)
16. Langhoogte Wind Energy Facility (EIA)
17. Vleesbaai Wind Energy Facility (EIA and monitoring)
18. St. Helena Bay Wind Energy Facility (EIA and monitoring)
19. Electrawind, St Helena Bay Wind Energy Facility (EIA and monitoring)
20. Electrawind, Vredendal Wind Energy Facility (EIA)
21. SAGIT, Langhoogte and Wolseley Wind Energy facilities
22. Renosterberg Wind Energy Project – 12-month preconstruction avifaunal monitoring project
23. De Aar – North (Mulilo) Wind Energy Project – 12-month preconstruction avifaunal monitoring project
24. De Aar – South (Mulilo) Wind Energy Project – 12-month bird monitoring
25. Namies – Aggenys Wind Energy Project – 12-month bird monitoring
26. Pofadder - Wind Energy Project – 12-month bird monitoring
27. Dwarsrug Loeriesfontein - Wind Energy Project – 12-month bird monitoring
28. Waaihoek – Utrecht Wind Energy Project – 12-month bird monitoring
29. Amathole – Butterworth Utrecht Wind Energy Project – 12-month bird monitoring & EIA specialist
30. Phezukomoya and San Kraal Wind Energy Projects 12-month bird monitoring & EIA specialist study (Innowind)
31. Beaufort West Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mainstream)
32. Leeuwdraai Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mainstream)
33. Sutherland Wind Energy Facility 12-month bird monitoring (Mainstream)
34. Maralla Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
35. Esizayo Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
36. Humansdorp Wind Energy Facility 12-month bird monitoring & EIA specialist study (Cennergi)
37. Aletta Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
38. Eureka Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
39. Makambako Wind Energy Facility (Tanzania) 12-month bird monitoring & EIA specialist study (Windlab)
40. R355 Wind Energy Facility 12-month bird monitoring (Mainstream)
41. Groenekloof Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
42. Tsitsikamma Wind Energy Facility 24-months post-construction monitoring (Cennergi)
43. Noupoort Wind Energy Facility 24-months post-construction monitoring (Mainstream)
44. Kokerboom Wind Energy Facility 12-month bird monitoring & EIA specialist study (Business Venture Investments)
45. Kuruman Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
46. Dassieklip Wind Energy Facility 3 years post-construction monitoring (Biotherm)
47. Loeriesfontein 2 Wind Energy Facility 2 years post-construction monitoring (Mainstream)
48. Khobab Wind Energy Facility 2 years post-construction monitoring (Mainstream)
49. Excelsior Wind Energy Facility 18 months construction phase monitoring (Biotherm)
50. Boesmansberg Wind Energy Facility 12-months pre-construction bird monitoring (juwi)
51. Mañhica Wind Energy Facility, Mozambique, 12-months pre-construction monitoring (Windlab)

Bird Impact Assessment Studies for Solar Energy Plants:

1. Concentrated Solar Power Plant, Upington, Northern Cape.
2. Globeleq De Aar and Droogfontein Solar PV Pre- and Post-construction avifaunal monitoring
3. JUWI Kronos PV project, Copperton, Northern Cape
4. Sand Draai CSP project, Groblershoop, Northern Cape
5. Biotherm Helena PV Project, Copperton, Northern Cape
6. Biotherm Letsiao CSP Project, Aggeneys, Northern Cape
7. Biotherm Enamandla PV Project, Aggeneys, Northern Cape
8. Biotherm Sendawo PV Project, Vryburg, North-West
9. Biotherm Tlisitseng PV Project, Lichtenburg, North-West
10. JUWI Hotazel Solar Park Project, Hotazel, Northern Cape
11. Veld Solar One Project, Aggeneys, Northern Cape
12. Brypaal Solar Power Project, Kakamas, Northern Cape
13. ABO Vryburg 1,2,3 Solar PV Project, Vryburg, North-West
14. NamPower CSP Facility near Arandis, Namibia

Bird Impact Assessment Studies for the following overhead line projects:

1. Chobe 33kV Distribution line
2. Athene - Umfolozi 400kV
3. Beta-Delphi 400kV
4. Cape Strengthening Scheme 765kV
5. Flurian-Louis-Trichardt 132kV
6. Ghanzi 132kV (Botswana)
7. Ikaros 400kV
8. Matimba-Witkop 400kV
9. Naboomspruit 132kV
10. Tabor-Flurian 132kV
11. Windhoek - Walvisbaai 220 kV (Namibia)
12. Witkop-Overyssel 132kV
13. Breyten 88kV
14. Adis-Phoebus 400kV
15. Dhuva-Janus 400kV
16. Perseus-Mercury 400kV
17. Gravelotte 132kV
18. Ikaros 400 kV
19. Khanye 132kV (Botswana)
20. Moropule – Thamaga 220 kV (Botswana)
21. Parys 132kV
22. Simplon –Everest 132kV
23. Tutuka-Alpha 400kV
24. Simplon-Der Brochen 132kV
25. Big Tree 132kV
26. Mercury-Ferrum-Garona 400kV
27. Zeus-Perseus 765kV
28. Matimba B Integration Project
29. Caprivi 350kV DC (Namibia)
30. Gerus-Mururani Gate 350kV DC (Namibia)
31. Mmamabula 220kV (Botswana)
32. Steenberg-Der Brochen 132kV
33. Venetia-Paradise T 132kV
34. Burgersfort 132kV
35. Majuba-Umfolozi 765kV
36. Delta 765kV Substation
37. Braamhoek 22kV
38. Steelpoort Merensky 400kV
39. Mmamabula Delta 400kV
40. Delta Epsilon 765kV
41. Gerus-Zambezi 350kV DC Interconnector: Review of proposed avian mitigation measures for the Okavango and Kwando River crossings
42. Giyani 22kV Distribution line
43. Liqhobong-Kao 132/11kV distribution power line, Lesotho
44. 132kV Leslie – Wildebeest distribution line
45. A proposed new 50 kV Spoornet feeder line between Sishen and Saldanha
46. Cairns 132kv substation extension and associated power lines
47. Pimlico 132kv substation extension and associated power lines
48. Gyani 22kV
49. Matafin 132kV
50. Nkomazi_Fig Tree 132kV
51. Pebble Rock 132kV
52. Reddersburg 132kV
53. Thaba Combine 132kV
54. Nkomati 132kV
55. Louis Trichardt – Musina 132kV
56. Endicot 44kV
57. Apollo Lepini 400kV
58. Tarlton-Spring Farms 132kV
59. Kuschke 132kV substation
60. Bendstore 66kV Substation and associated lines

61. Kuiseb 400kV (Namibia)
62. Gyani-Malamulele 132kV
63. Watershed 132kV
64. Bakone 132kV substation
65. Eerstegoud 132kV LILO lines
66. Kumba Iron Ore: SWEP - Relocation of Infrastructure
67. Kudu Gas Power Station: Associated power lines
68. Steenberg Booysendal 132kV
69. Toulon Pumps 33kV
70. Thabatshipi 132kV
71. Witkop-Silica 132kV
72. Bakubung 132kV
73. Nelsriver 132kV
74. Rethabiseng 132kV
75. Tilburg 132kV
76. GaKgapane 66kV
77. Knobel Gilead 132kV
78. Bochum Knobel 132kV
79. Madibeng 132kV
80. Witbank Railway Line and associated infrastructure
81. Spencer NDP phase 2 (5 lines)
82. Akanani 132kV
83. Hermes-Dominion Reefs 132kV
84. Cape Pensinsula Strengthening Project 400kV
85. Magalakwena 132kV
86. Benficosa 132kV
87. Dithabaneng 132kV
88. Taunus Diepkloof 132kV
89. Taunus Doornkop 132kV
90. Tweedracht 132kV
91. Jane Furse 132kV
92. Majeje Sub 132kV
93. Tabor Louis Trichardt 132kV
94. Riversong 88kV
95. Mamatsekele 132kV
96. Kabokweni 132kV
97. MDPP 400kV Botswana
98. Marble Hall NDP 132kV
99. Bokmakiere 132kV Substation and LILO lines
100. Styldrift 132kV
101. Taunus – Diepkloof 132kV
102. Bighorn NDP 132kV
103. Waterkloof 88kV
104. Camden – Theta 765kV
105. Dhuva – Minerva 400kV Diversion
106. Lesedi –Grootpan 132kV
107. Waterberg NDP
108. Bulgerivier – Dorset 132kV
109. Bulgerivier – Toulon 132kV
110. Nokeng-Fluorspar 132kV
111. Mantsole 132kV
112. Tshilamba 132kV
113. Thabamoopo - Tshebela – Nhlovuko 132kV
114. Arthurseat 132kV
115. Borutho 132kV MTS
116. Volspruit - Potgietersrus 132kV
117. Neotel Optic Fibre Cable Installation Project: Western Cape
117. Matla-Glockner 400kV
118. Delmas North 44kV
119. Houwhoek 11kV Refurbishment
120. Clau-Clau 132kV
121. Ngwedi-Silwerkrans 134kV
122. Nieuwehoop 400kV walk-through
123. Booysendal 132kV Switching Station
124. Tarlton 132kV
125. Medupi - Witkop 400kV walk-through
126. Germiston Industries Substation
127. Sekgame 132kV
128. Botswana – South Africa 400kV Transfrontier Interconnector
129. Syferkuil – Rampheri 132kV
130. Queens Substation and associated 132kV powerlines
131. Oranjemond 400kV Transmission line
132. Aries – Helios – Juno walk-down
133. Kuruman Phase 1 and 2 Wind Energy facilities 132kV Grid connection
134. Transnet

Bird Impact Assessment Studies for the following residential and industrial developments:

1. Lizard Point Golf Estate

2. Lever Creek Estates
3. Leloko Lifestyle Estates
4. Vaaloewers Residential Development
5. Clearwater Estates Grass Owl Impact Study
6. Sommerset Ext. Grass Owl Study
7. Proposed Three Diamonds Trading Mining Project (Portion 9 and 15 of the Farm Blesbokfontein)
8. N17 Section: Springs To Leandra –"Borrow Pit 12 And Access Road On (Section 9, 6 And 28 Of The Farm Winterhoek 314 Ir)
9. South African Police Services Gauteng Radio Communication System: Portion 136 Of The Farm 528 Jq, Lindley.
10. Report for the proposed upgrade and extension of the Zeekoegat Wastewater Treatment Works, Gauteng.
11. Bird Impact Assessment for Portion 265 (a portion of Portion 163) of the farm Rietfontein 189-JR, Gauteng.
12. Bird Impact Assessment Study for Portions 54 and 55 of the Farm Zwartkop 525 JQ, Gauteng.
13. Bird Impact Assessment Study Portions 8 and 36 of the Farm Nooitgedacht 534 JQ, Gauteng.
14. Shumba's Rest Bird Impact Assessment Study
15. Randfontein Golf Estate Bird Impact Assessment Study
16. Zilkaatsnek Wildlife Estate
17. Regenstein Communications Tower (Namibia)
18. Avifaunal Input into Richards Bay Comparative Risk Assessment Study
19. Maquasa West Open Cast Coal Mine
20. Glen Erasmia Residential Development, Kempton Park, Gauteng
21. Bird Impact Assessment Study, Weltevreden Mine, Mpumalanga
22. Bird Impact Assessment Study, Olifantsvlei Cemetery, Johannesburg
23. Camden Ash Disposal Facility, Mpumalanga
24. Lindley Estate, Lanseria, Gauteng
25. Proposed open cast iron ore mine on the farm Lylyveld 545, Northern Cape
26. Avifaunal monitoring for the Sishen Mine in the Northern Cape as part of the EMPr requirements
27. Steelpoort CNC Bird Impact Assessment Study

Professional affiliations

I work under the supervision of and in association with Albert Froneman (MSc Conservation Biology) (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003.

Chris van Rooyen
02 July 2019

Curriculum vitae: Albert Froneman

Profession/Specialisation	:	Avifaunal Specialist
Highest Qualification	:	MSc (Conservation Biology)
Nationality	:	South African
Years of experience	:	18 years

Key Qualifications

Albert Froneman **(**Pr.Sci.Nat) has more than 18 years' experience in the management of avifaunal interactions with industrial infrastructure. He holds a M.Sc. degree in Conservation Biology from the University of Cape Town. He managed the Airports Company South Africa (ACSA) – Endangered Wildlife Trust Strategic Partnership from 1999 to 2008 which has been internationally recognized for its achievements in addressing airport wildlife hazards in an environmentally sensitive manner at ACSA's airports across South Africa. Albert is recognized worldwide as an expert in the field of bird hazard management on airports and has worked in South Africa, Swaziland, Botswana, Namibia, Kenya, Israel, and the USA. He has served as the vice chairman of the International Bird Strike Committee and has presented various papers at international conferences and workshops. At present he is consulting to ACSA with wildlife hazard management on all their airports. He also an accomplished specialist ornithological consultant outside the aviation industry and has completed a wide range of bird impact assessment studies. He has co-authored many avifaunal specialist studies and pre-construction monitoring reports for proposed renewable energy developments across South Africa. He also has vast experience in using Geographic Information Systems to analyse and interpret avifaunal data spatially and derive meaningful conclusions. Since 2009 Albert has been a registered Professional Natural Scientist (reg. nr 400177/09) with The South African Council for Natural Scientific Professions, specialising in Zoological Science.

Key Project Experience

Renewable Energy Facilities –avifaunal monitoring projects in association with Chris van Rooyen Consulting

1. Jeffrey's Bay Wind Farm – 12-months preconstruction avifaunal monitoring project
2. Oysterbay Wind Energy Project – 12-months preconstruction avifaunal monitoring project
3. Ubuntu Wind Energy Project near Jeffrey's Bay – 12-months preconstruction avifaunal monitoring project
4. Bana-ba-Pifu Wind Energy Project near Humansdorp – 12-months preconstruction avifaunal monitoring project
5. Excelsior Wind Energy Project near Caledon – 12-months preconstruction avifaunal monitoring project
6. Laingsburg Spitskopvlakte Wind Energy Project – 12-months preconstruction avifaunal monitoring project
7. Loeriesfontein Wind Energy Project Phase 1, 2 & 3 – 12-months preconstruction avifaunal monitoring project
8. Noupoort Wind Energy Project – 12-months preconstruction avifaunal monitoring project
9. Vleesbaai Wind Energy Project – 12-months preconstruction avifaunal monitoring project
10. Port Nolloth Wind Energy Project – 12-months preconstruction avifaunal monitoring project
11. Langhoogte Caledon Wind Energy Project – 12-months preconstruction avifaunal monitoring project
12. Lunsklip – Stilbaai Wind Energy Project – 12-months preconstruction avifaunal monitoring project
13. Indwe Wind Energy Project – 12-months preconstruction avifaunal monitoring project
14. Zeeland St Helena bay Wind Energy Project – 12-months preconstruction avifaunal monitoring project
15. Wolseley Wind Energy Project – 12-months preconstruction avifaunal monitoring project
16. Renosterberg Wind Energy Project – 12-months preconstruction avifaunal monitoring project
17. De Aar – North (Mulilo) Wind Energy Project – 12-months preconstruction avifaunal monitoring project (2014)
18. De Aar – South (Mulilo) Wind Energy Project – 12-months bird monitoring
19. Namies – Aggenys Wind Energy Project – 12-months bird monitoring
20. Pofadder - Wind Energy Project – 12-months bird monitoring
21. Dwarsrug Loeriesfontein - Wind Energy Project – 12-months bird monitoring
22. Waaihoek – Utrecht Wind Energy Project – 12-months bird monitoring
23. Amathole – Butterworth Utrecht Wind Energy Project – 12-months bird monitoring & EIA specialist study
24. De Aar and Droogfontein Solar PV Pre- and Post-construction avifaunal monitoring
25. Makambako Wind Energy Faclity (Tanzania) 12-month bird monitoring & EIA specialist study (Windlab)
26. R355 Wind Energy Facility 12-month bird monitoring (Mainstream)
27. Groenekloof Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
28. Tsitsikamma Wind Energy Facility 24-months post-construction monitoring (Cennergi)
29. Noupoort Wind Energy Facility 24-months post-construction monitoring (Mainstream)
30. Kokerboom Wind Energy Facility 12-month bird monitoring & EIA specialist study (Business Venture Investments)
31. Kuruman Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
32. Mañhica Wind Energy Facility 12-month bird monitoring & EIA specialist study (Windlab)

Bird Impact Assessment studies and / or GIS analysis:

1. Aviation Bird Hazard Assessment Study for the proposed Madiba Bay Leisure Park adjacent to Port Elizabeth Airport.
2. Extension of Runway and Provision of Parallel Taxiway at Sir Seretse Khama Airport, Botswana Bird / Wildlife Hazard Management Specialist Study
3. Maun Airport Improvements Bird / Wildlife Hazard Management Specialist Study
4. Bird Impact Assesment Study - Bird Helicopter Interaction – The Bitou River, Western Cape Province South Africa
5. Proposed La Mercy Airport – Bird Aircraft interaction specialists study using bird detection radar to assess swallow flocking behaviour
6. KwaZulu Natal Power Line Vulture Mitigation Project – GIS analysis
7. Perseus-Zeus Powerline EIA – GIS Analysis
8. Southern Region Pro-active GIS Blue Crane Collision Project.
9. Specialist advisor ~ Implementation of a bird detection radar system and development of an airport wildlife hazard management and operational environmental management plan for the King Shaka International Airport
10. Matsapha International Airport – bird hazard assessment study with management recommendations
11. Evaluation of aviation bird strike risk at candidate solid waste disposal sites in the Ekurhuleni Metropolitan Municipality
12. Gateway Airport Authority Limited – Gateway International Airport, Polokwane: Bird hazard assessment; Compile a bird hazard management plan for the airport
13. Bird Specialist Study - Evaluation of aviation bird strike risk at the Mwakirunge Landfill site near Mombasa Kenya
14. Bird Impact Assessment Study - Proposed Weltevreden Open Cast Coal Mine Belfast, Mpumalanga

15. Avian biodiversity assessment for the Mafube Colliery Coal mine near Middelburg Mpumalanga
16. Avifaunal Specialist Study - SRVM Volspruit Mining project – Mokopane Limpopo Province
17. Avifaunal Impact Assessment Study (with specific reference to African Grass Owls and other Red List species) Stone Rivers Arch
18. Airport bird and wildlife hazard management plan and training to Swaziland Civil Aviation Authority (SWACAA) for Matsapha and Sikhupe International Airports
19. Avifaunal Impact Scoping & EIA Study - Renosterberg Wind Farm and Solar PV site
20. Bird Impact Assessment Study - Proposed 60 year Ash Disposal Facility near to the Kusile Power Station
21. Avifaunal pre-feasibility assessment for the proposed Montrose dam, Mpumalanga
22. Bird Impact Assessment Study – Proposed ESKOM Phantom Substation near Knysna, Western Cape
23. Habitat sensitivity map for Denham's Bustard, Blue Crane and White-bellied Korhaan in the Kouga Municipal area of the Eastern Cape Province
24. Swaziland Civil Aviation Authority – Sikhuphe International Airport – Bird hazard management assessment
25. Avifaunal monitoring – extension of Specialist Study - SRVM Volspruit Mining project – Mokopane Limpopo Province
26. Avifaunal Specialist Study – Rooikat Hydro Electric Dam – Hope Town, Northern Cape
27. The Stewards Pan Reclamation Project – Bird Impact Assessment study
28. Airports Company South Africa – Avifaunal Specialist Consultant – Airport Bird and Wildlife Hazard Mitigation

Geographic Information System analysis & maps

1. ESKOM Power line Makgalakwena EIA – GIS specialist & map production
2. ESKOM Power line Benficosa EIA – GIS specialist & map production
3. ESKOM Power line Riversong EIA – GIS specialist & map production
4. ESKOM Power line Waterberg NDP EIA – GIS specialist & map production
5. ESKOM Power line Bulge Toulon EIA – GIS specialist & map production
6. ESKOM Power line Bulge DORSET EIA – GIS specialist & map production
7. ESKOM Power lines Marblehall EIA – GIS specialist & map production
8. ESKOM Power line Grootpan Lesedi EIA – GIS specialist & map production
9. ESKOM Power line Tanga EIA – GIS specialist & map production
10. ESKOM Power line Bokmakierie EIA – GIS specialist & map production
11. ESKOM Power line Rietfontein EIA – GIS specialist & map production
12. Power line Anglo Coal EIA – GIS specialist & map production
13. ESKOM Power line Camcoll Jericho EIA – GIS specialist & map production
14. Hartbeespoort Residential Development – GIS specialist & map production
15. ESKOM Power line Mantsole EIA – GIS specialist & map production
16. ESKOM Power line Nokeng Flourspar EIA – GIS specialist & map production
17. ESKOM Power line Greenview EIA – GIS specialist & map production
18. Derdepoort Residential Development – GIS specialist & map production
19. ESKOM Power line Boynton EIA – GIS specialist & map production
20. ESKOM Power line United EIA – GIS specialist & map production
21. ESKOM Power line Gutshwa & Malelane EIA – GIS specialist & map production
22. ESKOM Power line Origstad EIA – GIS specialist & map production
23. Zilkaatsnek Development Public Participation –map production
24. Belfast – Paarde Power line - GIS specialist & map production
25. Solar Park Solar Park Integration Project Bird Impact Assessment Study – avifaunal GIS analysis.
26. Kappa-Omega-Aurora 765kV Bird Impact Assessment Report – Avifaunal GIS analysis.
27. Gamma – Kappa 2nd 765kV – Bird Impact Assessment Report – Avifaunal GIS analysis.
28. ESKOM Power line Kudu-Dorstfontein Amendment EIA – GIS specialist & map production.
29. Proposed Heilbron filling station EIA – GIS specialist & map production
30. ESKOM Lebatlhane EIA – GIS specialist & map production
31. ESKOM Pienaars River CNC EIA – GIS specialist & map production
32. ESKOM Lemara Phiring Ohrigstad EIA – GIS specialist & map production
33. ESKOM Pelly-Warmbad EIA – GIS specialist & map production
34. ESKOM Rosco-Bracken EIA – GIS specialist & map production
35. ESKOM Ermelo-Uitkoms EIA – GIS specialist & map production
36. ESKOM Wisani bridge EIA – GIS specialist & map production
37. City of Tswane – New bulkfeeder pipeline projects x3 Map production
38. ESKOM Lebohang Substation and 132kV Distribution Power Line Project Amendment GIS specialist & map production
39. ESKOM Geluk Rural Powerline GIS & Mapping
40. Eskom Kimberley Strengthening Phase 4 Project GIS & Mapping
41. ESKOM Kwaggafontein - Amandla Amendment Project GIS & Mapping
42. ESKOM Lephalale CNC – GIS Specialist & Mapping
43. ESKOM Marken CNC – GIS Specialist & Mapping
44. ESKOM Lethabong substation and powerlines – GIS Specialist & Mapping
45. ESKOM Magopela- Pitsong 132kV line and new substation – GIS Specialist & Mapping

Professional affiliations

South African Council for Natural Scientific Professions (SACNASP) registered Professional Natural Scientist (reg. nr 400177/09) – specialist field: Zoological Science. Registered since 2009.

1 BACKGROUND

Aurecon has been appointed to conduct an Environmental Authorisation Application for the proposed Veld PV North Solar Energy Facility (SEF) and associated grid connection, near Aggeneys in the Northern Cape. Chris van Rooyen Consulting was in turn appointed by Aurecon to conduct an avifaunal impact study to assess the impact of the proposed SEF on avifauna.

The Proponent proposes to develop a solar site on the farm Haramoep (Remainder of Farm no. 53) approximately 20 km north-west of Aggeneys in the Northern Cape. The solar farm would consist of a photovoltaic (PV) energy facility and associated infrastructure which would have a maximum generation capacity of up to 75 MW. The footprint of the PV facility will be approximately 200 hectares, within an assessment area of approximately 2 500 hectares.

The proposed project will include the following components:

- Numerous arrays of PV solar panels;
- Internal access roads;
- An operations and maintenance building;
- A temporary laydown area;
- 100MW battery storage unit within a 2000m² area alongside the substation. The units will not exceed a height of 8m.
- An on-site substation including switching yard; internal cabling laid underground when feasible;
- Site access mostly via an existing road (widened to 6 m); and
- A 132kV sub-transmission line of approximately 25km in length which will connect the SEF to the national grid at the Aggeneys Substation.

The location and lay-out of the proposed project is shown in Figures 1 and 2.

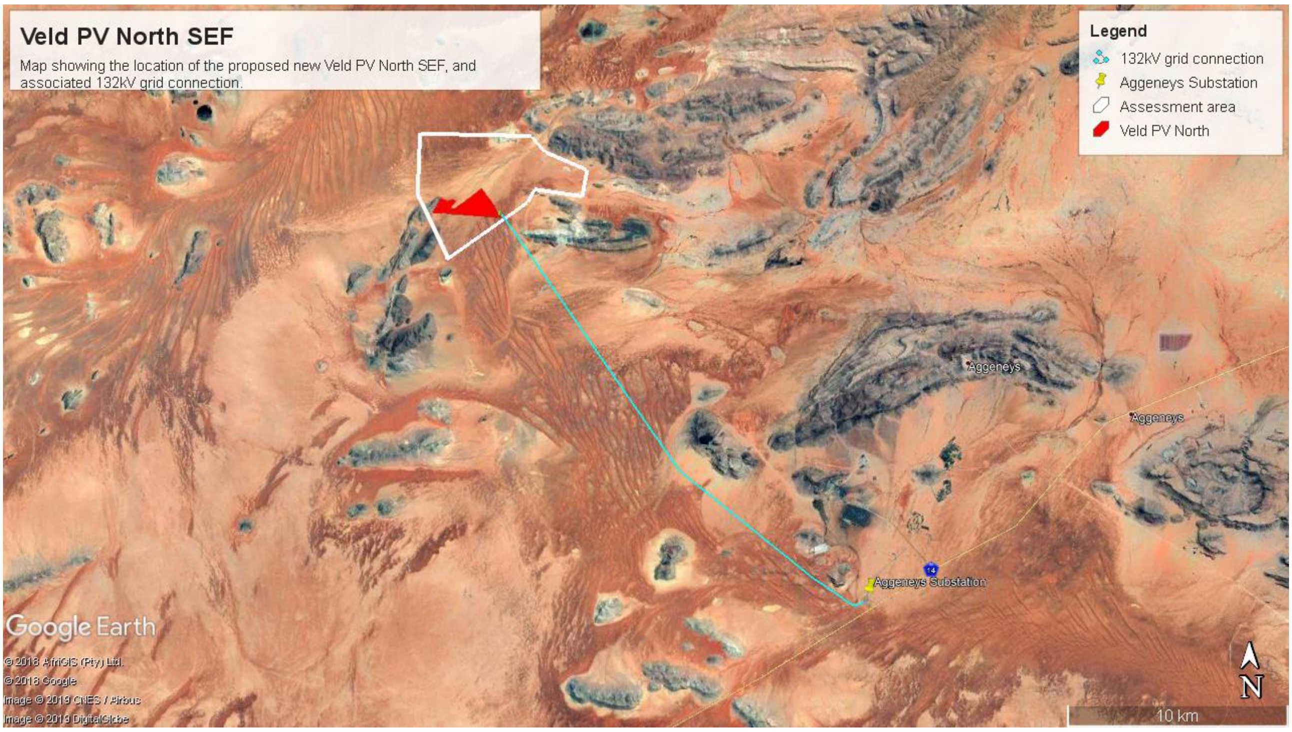

Figure 1: The location of the proposed Veld PV North solar energy facility.

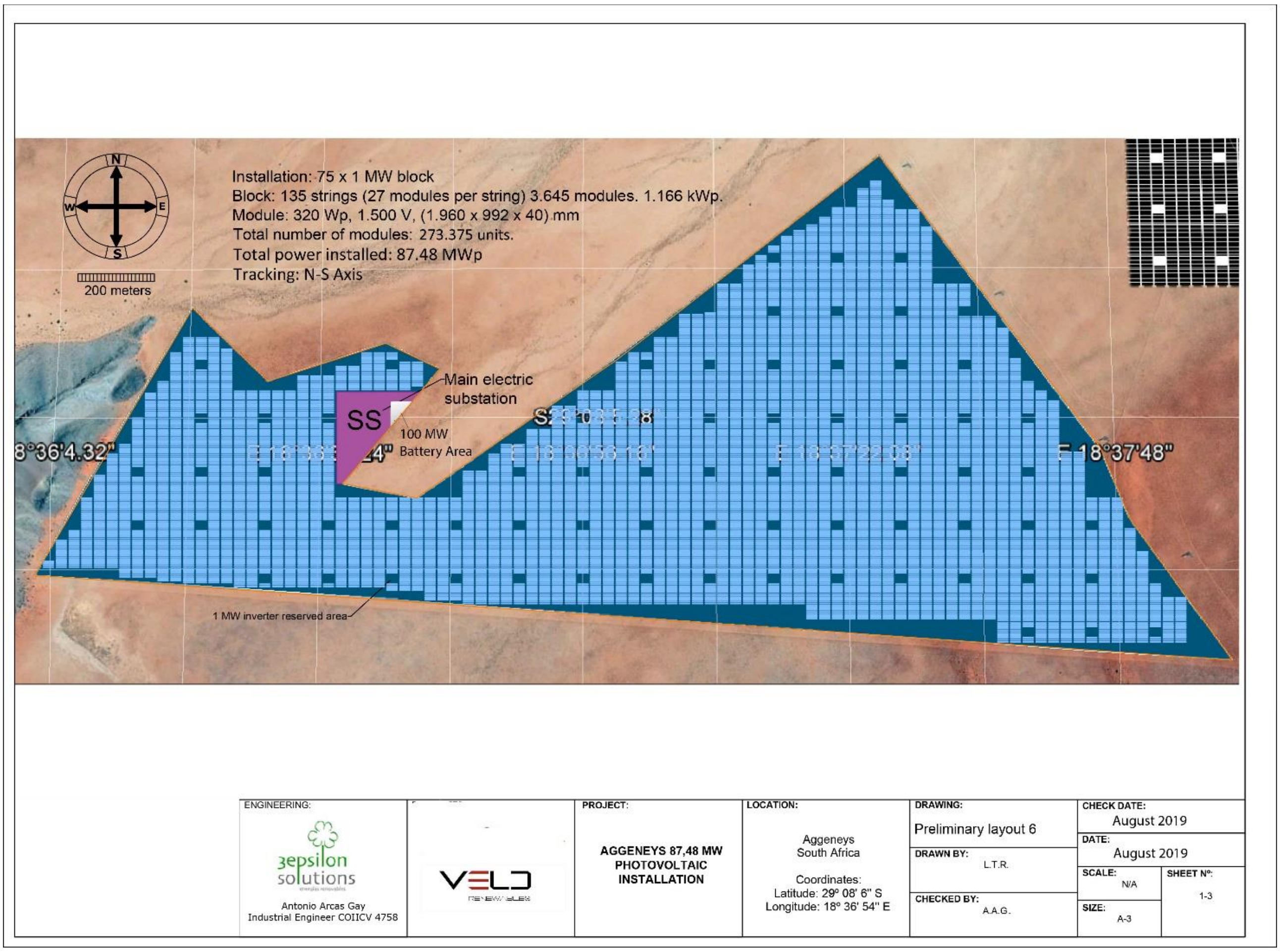

Figure 2: Veld PV North: Proposed preliminary layout for Veld PV North SEF (total footprint approximately 200 hectares).

2 PROJECT SCOPE

The terms of reference for this assessment report are as follows:

- Describe the affected environment from an avifaunal perspective;
- Discuss gaps in baseline data and other limitations;
- List and describe the expected impacts associated with the proposed SEF and associated infrastructure;
- Assess the potential impacts;
- Recommend mitigation measures to reduce the impact of the expected impacts.

3 OUTLINE OF METHODOLOGY AND INFORMATION REVIEWED

The following information sources were consulted in order to conduct this study:

- Bird distribution data from the Southern African Bird Atlas Project 2 (SABAP 2) was obtained (http://sabap2.adu.org.za/), in order to ascertain which species occur in the pentads where the proposed development areas are located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. In order to get a more representative impression of the birdlife, a consolidated data set was obtained for an area totalling 9 pentads, some of which intersect and others that are in the vicinity of the development, henceforth called the broader area (see Figure 3).
- A classification of the vegetation types in the development area was obtained from the Atlas of Southern African Birds 1 (SABAP1) and the National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006).
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa, Lesotho and Swaziland (Taylor *et al*. 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).

- The global threatened status of all priority species was determined by consulting the latest (2019.1) IUCN Red List of Threatened Species).
- The Important Bird and Biodiversity Areas of South Africa (Marnewick *et al.* 2015) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- Satellite imagery was used in order to view the broader area on a landscape level and to help identify bird habitat on the ground.
- A desktop investigation was conducted to source information on the impacts of solar facilities on avifauna.
- The results of habitat modelling conducted by BirdLife South Africa for the Red Lark was consulted to establish the potential suitability of the assessment area for Red Larks (BLSA 2019).
- An initial visit to the site and general area was conducted on 24 January 2017. This was followed up by on-site surveys during the following periods:
  - 30 January - 04 February 2017
  - 27 March - 01 April 2017
  - 19 - 20 March 2019
  - 6-8 May 2019
  - 4-6 June 2019.
- Surveys were conducted according to the best practice guidelines for avifaunal impact studies at solar developments, compiled by BirdLife South Africa (BLSA) in 2017 (Jenkins *et al*. 2017). Please see Appendix 1 for the methodology used in conducting the surveys.

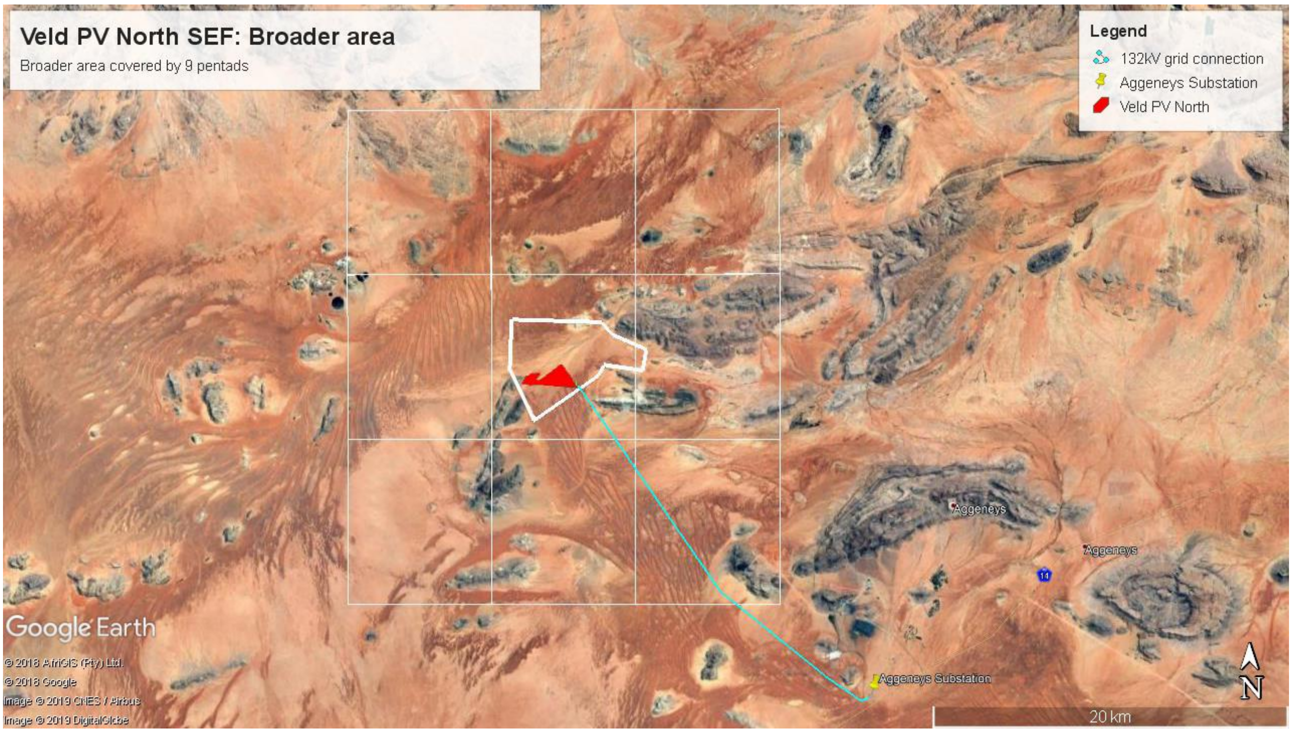

Figure 3: The broader area i.e. the area covered by the nine SABAP 2 pentads (white grid).

4 ASSUMPTIONS AND LIMITATIONS

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

- A total of only two SABAP2 full protocol lists has been completed to date for the broader area where the proposed project is located (i.e. bird listing surveys lasting a minimum of two hours each). No ad hoc protocol lists (i.e. bird listing surveys lasting less than two hours but still giving useful data) or incidental sightings were recorded. The SABAP2 data was therefore not regarded as a definitive indicator of the avifauna which could occur at the proposed development area; more emphasis was placed on the data collected during the on-site surveys. The list of species in the Haramoep and Black Mountain Mine Important Bird Area (IBA SA 035) was also consulted (Marnewick *et al.* 2015).

- The focus of the study is primarily on the potential impacts on priority solar and powerline species.
- Priority solar species were defined as follows:
  - South African Red Data species;
  - South African endemics and near-endemics;
  - Raptors
  - Waterbirds
- Priority powerline species were defined as those species which could potentially be impacted by powerline collisions or electrocutions, based on morphology and/or behaviour.
- The impact of solar installations on avifauna is a new field of study, with only one published scientific study on the impact of PV facilities on avifauna in South Africa (Visser *et al*. 2019). Strong reliance was therefore placed on expert opinion and data from existing monitoring programmes at solar facilities in the USA where monitoring has been ongoing since 2013. The pre-cautionary principle was applied throughout as the full extent of impacts on avifauna at solar facilities is not presently known.
- The assessment of impacts is based on the baseline environment as it currently exists at the proposed development area.
- Cumulative impacts include all proposed and existing renewable energy projects within a 35km radius around the proposed development areas.
- Conclusions in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will be valid under all circumstances.
- The **broader area** is defined as the area encompassed by the 9 pentads where the project is located (see Figure 4). The **assessment area** is an area of approximately 2 500 hectares (see Figure 4). The **development footprint** is defined as the combined area covered by the solar fields and on-site substation, and comes to about 200 hectares (see Figure 2).

5 LEGISLATIVE CONTEXT

There is no specific legislation pertaining specifically to the impact of solar facilities on avifauna. Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa (Jenkins *et al.* 2017), compiled by BirdLife South Africa, was followed in the compilation of this report.

5.1 AGREEMENTS AND CONVENTIONS

Table 1 below lists agreements and conventions which South Africa is party to and which is relevant to the conservation of avifauna (BirdLife International 2019).

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

Convention name	Description	Geographic scope
African-Eurasian Waterbird Agreement (AEWA)	The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) is an intergovernmental treaty dedicated to the conservation of migratory waterbirds and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland and the Canadian Archipelago. Developed under the framework of the Convention on Migratory Species (CMS) and administered by the United Nations Environment Programme (UNEP), AEWA brings together countries and the wider international conservation community in an effort to establish coordinated conservation and management of migratory waterbirds throughout their entire migratory range.	Regional
Convention on Biological Diversity (CBD), Nairobi, 1992	The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has 3 main objectives: The conservation of biological diversity The sustainable use of the components of biological diversity	Global

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

5.2 NATIONAL LEGISLATION

5.2.1 Constitution of the Republic of South Africa, 1996

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

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

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

- (i) prevent pollution and ecological degradation;
- (ii) promote conservation; and
- (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

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

The National Environmental Management Act 107 of 1998 (NEMA) creates the legislative framework for environmental protection in South Africa and is aimed at giving effect to the environmental right in the Constitution. It sets out a number of guiding principles that apply to the actions of all organs of state that may significantly affect the environment. Sustainable development (socially, environmentally and economically) is one of the key principles, and internationally accepted principles of environmental management, such as the precautionary principle and the polluter pays principle, are also incorporated.

NEMA also provides that a wide variety of listed developmental activities, which may significantly affect the environment, may be performed only after an environmental impact assessment has been done and authorization has been obtained from the relevant authority. Many of these listed activities can potentially have negative impacts on bird populations in a variety of ways. The clearance of natural vegetation, for instance, can lead to a loss of habitat and may depress prey populations, while erecting structures needed for generating and distributing energy, communication, and so forth can cause mortalities by collision or electrocution.

5.2.3 The National Environmental Management: Biodiversity Act 10 of 2004 (NEMBA) and the Threatened or Protected Species Regulations, February 2007 (TOPS Regulations)

The most prominent statute containing provisions directly aimed at the conservation of birds is the National Environmental Management: Biodiversity Act 10 of 2004 read with the Threatened or Protected Species Regulations, February 2007 (TOPS Regulations). Chapter 1 sets out the objectives of the Act, and they are aligned with the objectives of the Convention on Biological Diversity, which are the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of the benefits of the use of genetic resources. The Act also gives effect to CITES, the Ramsar Convention, and the Bonn Convention on Migratory Species of Wild Animals. The State is endowed with the trusteeship of biodiversity and has the responsibility to manage, conserve and sustain the biodiversity of South Africa.

6 BASELINE ASSESSMENT

6.1 IMPORTANT BIRD AREAS

The development is situated in the Haramoep and Black Mountain Mine (SA035) Important Bird Area (IBA) (see Figure 4**)**.

Situated near Aggeneys, this IBA is characterised by an arid landscape of extensive sandy and gravel plains with sparse vegetation scattered between bare sand patches. Inselbergs form islands of rocky habitat in a sea of red sand. Large sand dunes fill the fossil course of the Koa River. The gravel plains are covered by sparse dwarf shrubs and short Bushman grasses and they hide dwarf succulents. The dry riverbeds support taller woody vegetation, including *Boscia* species. Although much of the land area remains natural, large areas are overgrazed and degraded. Approximately 90% of the land is natural and utilised for ranching. The rest has been transformed by agriculture, mining activities, homesteads, settlements, erosion, roads and power-line servitudes (Marnewick *et al*. 2015).

This IBA is one of only a few sites protecting the globally threatened Red Lark, which inhabits the red sand dunes and sandy plains with a mixed grassy dwarf shrub cover; and the near-threatened Sclater's Lark, on the barren stony plains. It also holds 16 of the 23 Namib-Karoo biome-restricted assemblage species as well as a host of other arid-zone birds. Ludwig's Bustard and Kori Bustard are regularly seen. Martial Eagle, Secretarybird, Verreaux’s' Eagle, Booted Eagle, Cape Eagle-Owl and Spotted Eagle-Owl are present (Marnewick *et al*. 2015).

The following species are classified as trigger species for the IBA:

Globally threatened species	Regionally threatened species	Range-restricted and biome-restricted species
• Red Lark • Sclater's Lark • Martial Eagle • Kori Bustard • Ludwig's Bustard • Secretarybird.	• Karoo Korhaan • Verreaux’s' Eagle	• Stark's Lark • Karoo Long-billed Lark • Black-eared Sparrow-lark • Tractrac Chat • Sickle-winged Chat • Karoo Chat • Sociable Weaver • Pale-winged Starling • Black-headed Canary • Karoo Eremomela • Layard's Tit-Babbler • Cinnamon-breasted Warbler • Namaqua Warbler

See **Error! Reference source not found.**4 for a map of the assessment area relative to the Haramoep and Black Mountain Mine (SA035) Important Bird Area.

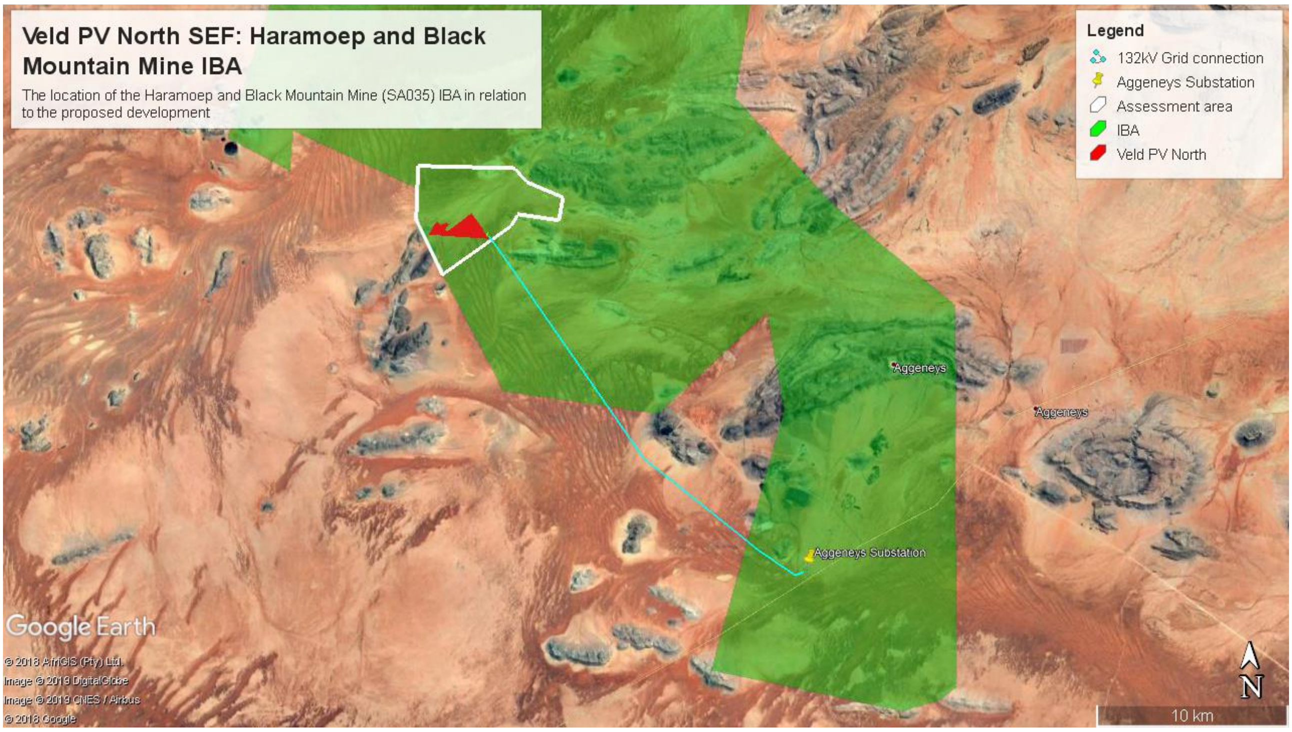

Figure 4: The location of the Haramoep and Black Mountain Mine (SA035) Important Bird Area relative to the study area.

6.2 BIRD HABITAT, CLIMATE AND RAINFALL

The assessment area is situated in the ecotone between the Desert and Nama Karoo biomes (Mucina & Rutherford 2006), approximately 20km north of the town of Aggeneys, in the Khai-Ma Local Municipality of the Northern Cape Province. It is surrounded by rocky hills to the west (Lemoenpoortberg), south (Witberg) and east (Haramoep Mountains. Peak rainfall in the Aggeneys area occurs mainly in summer and averages around 71mm per year (see Figure 55), which makes it an extremely arid area. Average daily temperatures range between 29 C° in January and 14C° in July. However, summer maximum temperatures can rise sharply and are often higher than 40°C (Mucina & Rutherford 2006).

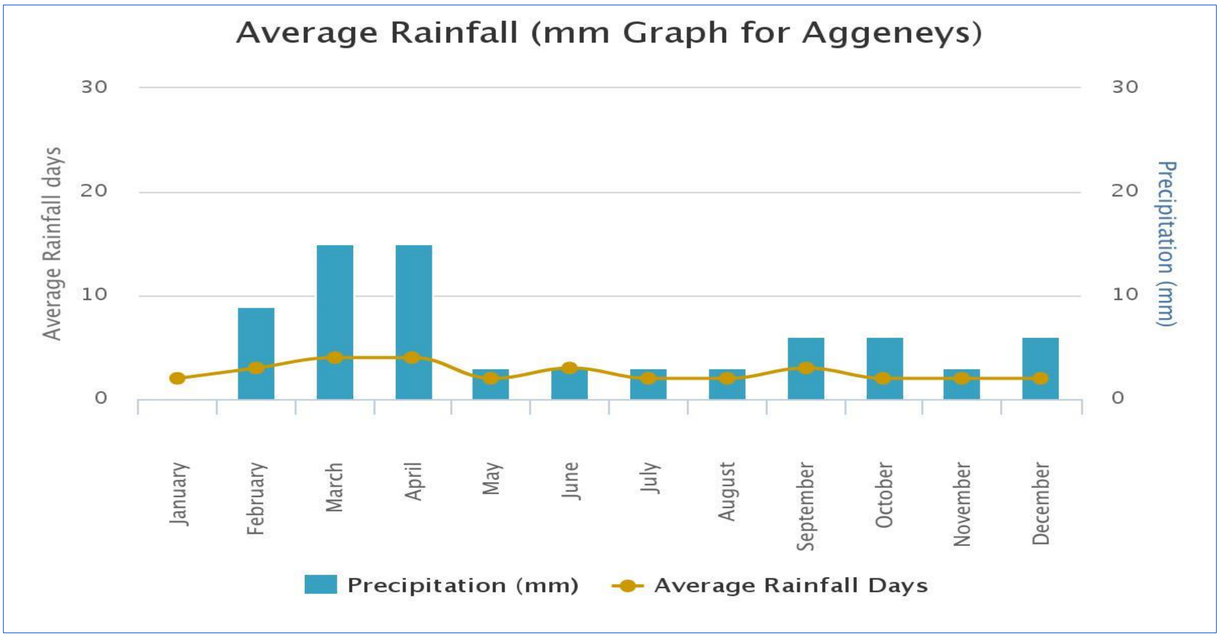

Figure 5: Average rainfall in the Aggeneys area (www.worldweatheronline.com)

Vegetation structure, rather than the actual plant species, is more significant for bird species distribution and abundance (Harrison *et al.* 1997). The description of the vegetation types occurring in the study area largely follows the classification system presented in the Atlas of southern African birds (SABAP1) (Harrison *et al.*

1997). The criteria used to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations. It is important to note that no new vegetation unit boundaries were created, with use being made only of previously published data. The description of vegetation presented in this study therefore concentrates on factors relevant to the bird species present and is not an exhaustive list of plant species present.

Whilst the distribution and abundance of the priority bird species in the study area are closely tied to natural features e.g. vegetation structure and topography/relief, it is also necessary to examine external modifications to the environment that might have relevance for priority species. Examples of anthropogenic avifaunal-relevant habitat modifications which could potentially influence the avifaunal community that were recorded in or close to the assessment area are water reservoirs, high voltage transmission lines, and agricultural activity, specifically intensive grazing.

The solar priority species, powerline priority species and IBA trigger species associated with each habitat class are listed in Tables 2, 3 and 4. The habitat classes which are present in the assessment area are discussed in more detail below.

6.2.1 Sandy plains and dunes

The assessment area consists primarily of sandy plains with a few dunes present in the extreme south. The main vegetation type at the assessment area is Bushmanland Arid Grassland which in a pristine state is dominated by white grasses (*Stipagrostis* species) giving this vegetation the character of semi-desert “steppe” (Mucina & Rutherford 2006). However, the vegetation in the assessment area is severely degraded by grazing pressure, resulting in large areas completely devoid of grass. The overall impression of the assessment area is that of sparse vegetation scattered between bare sand patches, and a complete absence of grass. The priority avifauna which could potentially be utilising this habitat in the assessment area are listed below (see also Tables 2, 3 and 4 for the likelihood of a species occurring in the assessment area):

Solar priority species	IBA trigger species	Powerline sensitive species
• Black-eared Sparrowlark • Karoo Korhaan • Kori Bustard • Layard's Tit-Babbler • Martial Eagle • Namaqua Warbler • Red Lark • Secretarybird • Greater Kestrel • Lanner Falcon • Pygmy Falcon • Southern Double-collared Sunbird • Spotted Eagle-Owl • Ludwig’s Bustard	• Karoo Korhaan • Martial Eagle • Kori Bustard • Ludwig's Bustard • Secretarybird • Black-eared Sparrowlark • Layard's Tit-Babbler • Black-headed Canary • Karoo Eremomela • Namaqua Warbler • Red Lark • Sociable Weaver • Tractrac Chat	• Karoo Korhaan • Kori Bustard • Martial Eagle • Secretarybird • Verreaux's Eagle • Cape Eagle-Owl • Greater Kestrel • Lanner Falcon • Spotted Eagle-Owl • Ludwig's Bustard • Namaqua Sandgrouse • Pied Crow • Southern Pale Chanting Goshawk

Figure 6: An example of sandy plains and dunes in the assessment area, which is the area to the left of the fence line. Note the severely degraded overgrazed state of the vegetation.

6.2.2 Surface water

The land use in the assessment area is mostly sheep farming, with some game and cattle also present. The land is divided into fenced off grazing camps, with a few boreholes with associated water reservoirs and drinking troughs. These troughs and reservoirs are a big draw card for several bird species. The priority avifauna which could potentially be utilising this habitat in the assessment area are listed below (see also Tables 2, 3 and 4 for the likelihood of a species occurring in the assessment area):

Solar priority species	IBA trigger species	Powerline sensitive species
• Kori Bustard • Martial Eagle • Greater Kestrel • Lanner Falcon • Sclater's Lark • Verreaux's Eagle • Rock Kestrel • Ludwig’s Bustard	• Kori Bustard • Martial Eagle • Verreaux's Eagle • Ludwig's Bustard • Sclater's Lark • Black-headed Canary • Pale-winged Starling • Sociable Weaver	• Kori Bustard • Martial Eagle • Verreaux's Eagle • Greater Kestrel • Lanner Falcon • Ludwig's Bustard

Figure 7: A water reservoir in the assessment area

6.2.3 Inselbergs

The assessment area is surrounded by several inselbergs which form islands of rocky habitat in a sea of red sand. The assessment area generally excludes these inselbergs, but some of the species using this habitat might occur marginally in the fringes of the assessment area. The priority avifauna which could potentially be utilising this habitat in the assessment area are listed below (see also Tables 2, 3 and 4 for the likelihood of a species occurring in the assessment area):

Solar priority species	IBA trigger species	Powerline sensitive species
• Martial Eagle • Greater Kestrel • Lanner Falcon • Verreaux's Eagle • Rock Kestrel • Layard's Tit-Babbler • Southern Double-collared Sunbird • Spotted Eagle-Owl • Cinnamon-breasted Warbler • Sickle-winged Chat • Cape Eagle-Owl	• Martial Eagle • Verreaux's Eagle • Black-headed Canary • Pale-winged Starling • Cinnamon-breasted Warbler • Layard's Tit-Babbler • Sickle-winged Chat • Karoo Chat • Karoo Eremomela • Karoo Long-billed Lark	• Martial Eagle • Verreaux's Eagle • Greater Kestrel • Lanner Falcon • Cape Eagle-Owl • Spotted Eagle-Owl

Figure 8**: An inselberg on the edge of the assessment area.**

6.2.4 High voltage lines

High voltage lines are an important roosting and breeding substrate for large raptors in the treeless Karoo habitat (Jenkins *et al.* 2006). The Aggeneys - Harib 220kV transmission line runs through the assessment area (see Figure 9 below). Martial Eagle was regularly recorded perching on the transmission line in the assessment area, which indicates that they must be breeding somewhere on the line, outside the assessment area. Two pairs of Lanner Falcons were also recorded breeding on the powerline in the assessment area, at -29.131797 18.626915 and -29.119246 and 18.617137.

Solar priority species	IBA trigger species	Powerline sensitive species
• Martial Eagle • Greater Kestrel • Lanner Falcon • Verreaux's Eagle • Rock Kestrel • Spotted Eagle-Owl	• Martial Eagle • Verreaux's Eagle • Sociable Weaver	• Martial Eagle • Verreaux's Eagle • Greater Kestrel • Lanner Falcon • Spotted Eagle-Owl


Figure 9: The Aggeneys - Harib 220kV transmission line runs through the assessment area.

6.3 AVIFAUNA

It is estimated that a total of 64 bird species could potentially occur in the broader area – Appendix 2 provides a comprehensive list of all the species, including those recorded during the pre-construction monitoring. Of these, 20 species are classified as priority solar species, 13 as powerline priority species, and 20 as IBA trigger species (see Section 4 for the definition of a priority species). The probability of a priority species occurring in the assessment area is indicated in Tables 2, 3 and 4.

Table 2 below lists all the solar priority species and the possible impact on the respective species by the proposed solar energy infrastructure. Table 3 does the same for powerline sensitive species, and Table 4 for IBA trigger species. The following abbreviations and acronyms are used:

- EN = Endangered
- VU = Vulnerable
- NT = Near-threatened
- LC = least concern

6.3.1 Pre-construction surveys

An initial visit to the assessment area and broader area was conducted on 24 January 2017. This was followed up by on-site surveys during the following periods:

- 30 January - 04 February 2017
- 27 March - 01 April 2017
- 19 - 20 March 2019
- 6-8 May 2019
- 4-6 June 2019.

Surveys were conducted according to the best practice guidelines for avifaunal impact studies at solar developments, compiled by BirdLife South Africa (BLSA) in 2017 (Jenkins *et al.* 2017). Please see Appendix 1 for the methodology used in the surveys.

6.3.1.1 Priority species abundance

The abundance of solar priority species (birds/km) recorded during the pre-construction surveys in the assessment area is displayed in Figures 10 and 11 below.

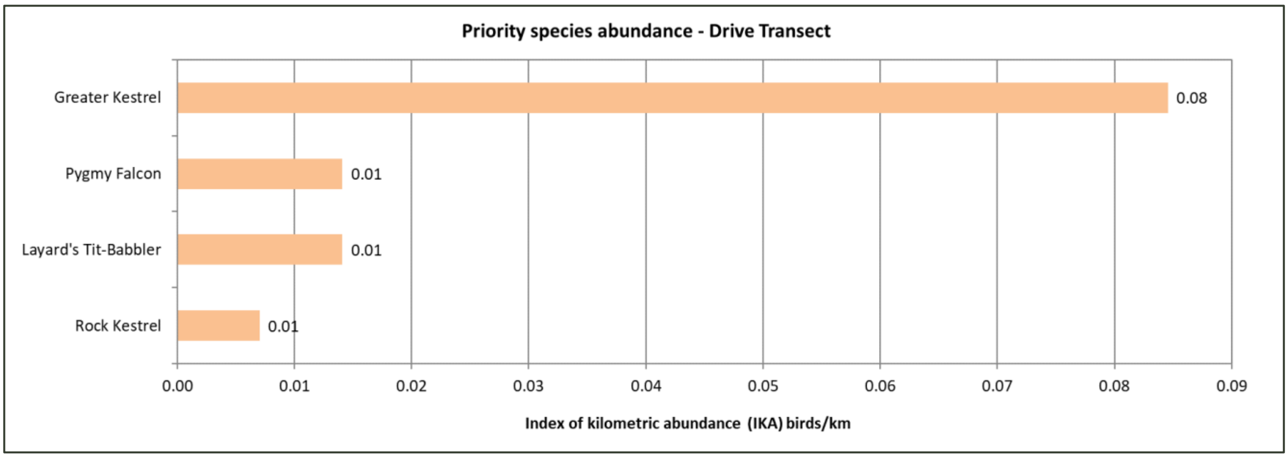

Figure 10: The abundance of solar priority species recorded during drive transects

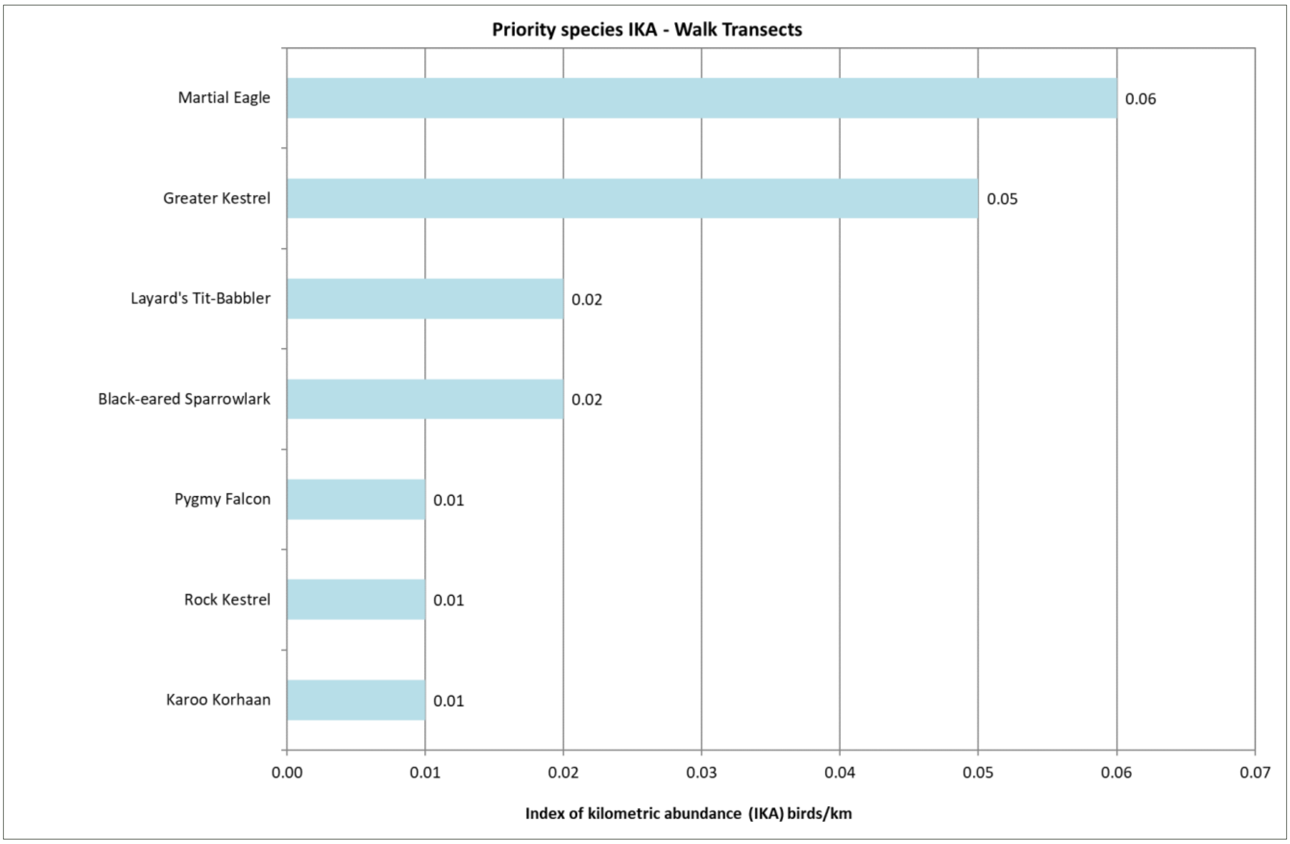

Figure 11: The abundance of solar priority species recorded during walk transects

The average IKA for solar priority species recorded during both drive and walk transects was 0.05 birds/km. For all birds, the average IKA for drive transects was 0.56 birds/km, and for walk transects it was 0.35 birds/km.

Table 2: Solar priority species potentially occurring at the assessment site.

Species	Taxonomic name	Status		Endemic - South Africa	Endemic - Southern Africa	IBA trigger species	Solar priority species	Powerline priority species	Possibility of occurrence in assessment area	Recorded during surveys	Habitat					Potential impacts		
		Global status	Regional status								Sandy dunes and plains	Gravel plains	Inselbergs	Surface water	Powerlines	Displacement: disturbance and habitat transformation	Collisions with the PV panels	Entrapment in perimeter fences
Martial Eagle	*Polemaetus bellicosus*	VU	EN			x	x	x	High	x	x	x	x	x	x			
Greater Kestrel	*Falco rupicoloides*						x	x	High	x	x	x	x	x	x			
Lanner Falcon	*Falco biarmicus*	LC	VU				x	x	High	x	x	x	x	x	x		x	
Verreaux's Eagle	*Aquila verreauxii*	LC	VU			x	x	x	High	x			x	x	x			
Rock Kestrel	*Falco rupicolus*						x		High	x			x	x	x			
Spotted Eagle-Owl	*Bubo africanus*						x	x	High	x	x	x	x		x		x	
Layard's Tit-Babbler	*Parisoma layardi*			Near endemic	Endemic	x	x		High	x	x	x	x					
Southern Double-collared Sunbird	*Cinnyris chalybeus*			Near endemic	Endemic		x		High	x	x	x	x					
Cinnamon-breasted Warbler	*Euryptila subcinnamomea*			Near endemic	Endemic	x	x		High	x			x					
Sickle-winged Chat	*Cercomela sinuata*			Near endemic	Endemic	x	x		Medium			x	x			x	x	
Cape Eagle-Owl	*Bubo capensis*						x	x	High	x			x					
Kori Bustard	*Ardeotis kori*	NT	NT			x	x	x	Medium		x	x		x		x		x
Sclater's Lark	*Spizocorys sclateri*	NT	NT	Near endemic	Endemic	x	x		Low			x		x		x	x	
Black-eared Sparrowlark	*Eremopterix australis*			Near endemic	Endemic	x	x		High	x	x	x				x	x	
Karoo Korhaan	*Eupodotis vigorsii*	LC	NT		Endemic	x	x	x	High	x	x	x				x		x
Namaqua Warbler	*Phragmacia substriata*			Near endemic	Endemic	x	x		Medium		x					x	x	
Red Lark	*Calendulauda burra*	VU	VU	Endemic	Endemic	x	x		Low		x					x	x	
Secretarybird	*Sagittarius serpentarius*	VU	VU			x	x	x	Low		x					x		x
Pygmy Falcon	*Polihierax semitorquatus*						x		High	x	x	x					x	
Ludwig's Bustard	*Neotis ludwigii*	EN	EN		Near endemic	x		x	High		x	x		x		x		x

Table 3: IBA priority species potentially occurring at the assessment site

		Status									Habitat					Potential impacts					
Species	Taxonomic name	Global status	Regional status	Endemic - South Africa	Endemic - Southern Africa	IBA trigger species	Solar priority species	Powerline priority species	Possibility of occurrence in assessment area	Recorded during surveys	Sandy dunes and plains	Gravel plains	Inselbergs	Surface water	Powerlines	Displacement: disturbance and habitat transformation	Collisions with the PV panels	Entrapment in perimeter fences	Powerline collisions	Electrocutions: Substation	Displacement due to construction of powerline & substation
Black-eared Sparrowlark	*Eremopterix australis*			Near endemic	Endemic	x	x		High	x	x	x				x	x				
Black-headed Canary	*Serinus alario*			Near endemic	Endemic	x			High		x	x	x	x		x					
Cinnamon-breasted Warbler	*Euryptila subcinnamomea*			Near endemic	Endemic	x	x		High	x			x								
Karoo Chat	*Cercomela schlegelii*				Near-endemic	x			High	x		x	x			x	x				
Karoo Eremomela	*Eremomela gregalis*			Near endemic	Endemic	x			Medium		x	x	x			x	x				
Karoo Korhaan	*Eupodotis vigorsii*	LC	NT		Endemic	x	x	x	High	x	x	x				x		x	x		
Karoo Long-billed Lark	*Certhilauda subcoronata*				Endemic	x			High	x		x	x			x	x				
Kori Bustard	*Ardeotis kori*	NT	NT			x	x	x	Medium		x	x		x		x		x	x		
Layard's Tit-Babbler	*Parisoma layardi*			Near endemic	Endemic	x	x		High	x	x	x	x								
Ludwig's Bustard	*Neotis ludwigii*	EN	EN		Near endemic	x		x	High		x	x		x		x		x	x		
Martial Eagle	*Polemaetus bellicosus*	VU	EN			x	x	x	High	x	x	x	x	x	x				x		x
Namaqua Warbler	*Phragmacia substriata*			Near endemic	Endemic	x	x		Medium		x					x	x				
Pale-winged Starling	*Onychognathus nabouroup*				Near-endemic	x			High	x			x	x							
Red Lark	*Calendulauda burra*	VU	VU	Endemic	Endemic	x	x		Low		x					x	x				
Sclater's Lark	*Spizocorys sclateri*	NT	NT	Near endemic	Endemic	x	x		Low			x		x		x	x				
Secretarybird	*Sagittarius serpentarius*	VU	VU			x	x	x	Low		x					x		x	x		
Sickle-winged Chat	*Cercomela sinuata*			Near endemic	Endemic	x	x		Medium			x	x			x	x				
Sociable Weaver	*Philetairus socius*				Endemic	x			High	x	x	x		x	x	x	x				
Tractrac Chat	*Cercomela tractrac*				Near-endemic	x			High	x	x	x				x	x				
Verreaux's Eagle	*Aquila verreauxii*	LC	VU			x	x	x	High	x			x	x	x				x		

Table 4: Powerline priority species potentially occurring at the assessment site

		Status									Habitat					Potential impacts					
Species	Taxonomic name	Global status	Regional status	Endemic - South Africa	Endemic - Southern Africa	IBA trigger species	Solar priority species	Powerline priority species	Possibility of occurrence in assessment area	Recorded during surveys	Sandy dunes and plains	Gravel plains	Inselbergs	Surface water	Powerlines	Displacement: disturbance and habitat transformation	Collisions with the PV panels	Entrapment in perimeter fences	Powerline collisions	Electrocutions: Substation	Displacement due to construction of powerline & substation
Cape Eagle-Owl	*Bubo capensis*						x	x	High	x			x							x	
Greater Kestrel	*Falco rupicoloides*						x	x	High	x	x	x	x	x	x					x	x
Karoo Korhaan	*Eupodotis vigorsii*	LC	NT		Endemic	x	x	x	High	x	x	x				x		x	x		
Kori Bustard	*Ardeotis kori*	NT	NT			x	x	x	Medium		x	x		x		x		x	x		
Lanner Falcon	*Falco biarmicus*	LC	VU				x	x	High	x	x	x	x	x	x		x		x	x	x
Ludwig's Bustard	*Neotis ludwigii*	EN	EN		Near endemic	x		x	High		x	x		x		x		x	x		
Martial Eagle	*Polemaetus bellicosus*	VU	EN			x	x	x	High	x	x	x	x	x	x				x		x
Namaqua Sandgrouse	*Pterocles namaqua*				Near-endemic			x	High	x											
Pied Crow	*Corvus albus*							x	High	x										x	
Secretarybird	*Sagittarius serpentarius*	VU	VU			x	x	x	Low		x					x		x	x		
Southern Pale Chanting Goshawk	*Melierax canorus*				Near-endemic			x	High												
Spotted Eagle-Owl	*Bubo africanus*						x	x	High	x	x	x	x		x		x			x	
Verreaux's Eagle	*Aquila verreauxii*	LC	VU			x	x	x	High	x			x	x	x				x		

6.3.1.2 Discussion

The overall abundance of avifauna at the site was very low high during the periods when the surveys were conducted. Interestingly, no Red Larks were recorded during five surveys, spanning two years. The SABP data for the greater area likewise do not contain any Red Lark records, despite the BLSA habitat model predicting high numbers of the species. The most likely explanation for the absence of the species in the assessment area, and the general low numbers of birds recorded during the surveys, is the degraded state of the vegetation. Red Larks require multi-layered vegetation, with scattered emergent bushes to provide perches and shade, and perennial large seeded grasses (Hockey *et al*. (2005). In the case of the assessment area, the virtual absence of grass (and the sparse vegetation in general) is striking, indicating long term sustained grazing pressure.

6.4 IMPACTS OF SOLAR PV FACILITIES AND ASSOCIATED INFRASTRUCTURE ON AVIFAUNA

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

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

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

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

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

South Africa is among the world's top 10 developing countries required to significantly reduce their carbon emissions (Seymore *et al.* 2014), and the introduction of low-carbon technologies into the country's compliment of power generation will greatly assist with achieving this important objective (Walwyn & Brent 2015). Given that South Africa receives among the highest levels of solar radiation on earth (Fluri 2009; Munzhedi *et al*. 2009), it is clear that solar power generation should feature prominently in future efforts to convert to a more sustainable energy mix in order to combat climate change, also from an avifaunal impact perspective. However, while the expansion of solar power generation is undoubtedly a positive development for avifauna in the longer term in that it will help reduce the effect of climate change and thus habitat transformation, it must also be acknowledged that renewable energy facilities, including solar PV facilities, in themselves have some potential for negative impacts on avifauna.

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

In summary, the potential impacts of PV plants on avifauna which have emerged so far include the following:

- Displacement due to disturbance and habitat transformation associated with the construction of the solar PV plant and associated infrastructure;
- Collisions with the solar panels;
- Entrapment in perimeter fences;
- Collisions with the associated power lines; and
- Electrocutions on the associated power lines.

6.4.1 Impacts associated with PV plants

6.4.1.1 Impact trauma (collisions)

This impact refers to collision-related fatality i.e. fatality resulting from the direct contact of the bird with a project structure(s). This type of fatality has been occasionally documented at solar projects of all technology types (McCrary *et al.* 1986; Hernandez *et al*. 2014; Kagan *et al*. 2014). In some instances, the bird is not killed outright by the collision impact, but succumbs to predation later, as it cannot avoid predators due to its injured state.

Sheet glass used in commercial and residential buildings has been well established as a hazard for birds. When the sky is reflected in the sheet glass, birds fail to see the building as an obstacle and attempt to fly through the glass, mistaking it for empty space (Loss *et al*. 2014). Although very few cases have been reported it is possible that the reflective surfaces of solar panels could constitute a similar risk to avifauna.

An extremely rare but potentially related problem is the so-called “lake effect” i.e. it seems possible that reflections from solar facilities' infrastructure, particularly large sheets of dark blue photovoltaic panels, may attract birds in flight across the open desert, who mistake the broad reflective surfaces for water (Kagan *et al.* 2014)[1]. The unusually high percentage of waterbird mortalities at the Desert Sunlight PV facility (44%) may support the “lake effect” hypothesis (West 2014). Although in the case of Desert Sunlight, the proximity of evaporation ponds may act as an additional risk increasing factor, in that birds are both attracted to the water feature and habituated to the presence of an accessible aquatic environment in the area. This may translate into the misinterpretation of diffusely reflected sky or horizontal polarised light source as a body of water. However, due to limited data it would be premature to make any general conclusions about the influence of the lake effect or other factors that contribute to fatality of water-dependent birds. The activity and abundance of water-dependent species near solar facilities may depend on other site-specific or regional factors, such as the surrounding landscape (Walston *et al*. 2015). However, until such time that enough scientific evidence has been collected to discount the “lake effect” hypothesis, it must be considered as a potential source of impacts.

Weekly mortality searches at 20% coverage were conducted at the 250MW, 1300ha California Valley Solar Ranch PV site (Harvey & Associates 2014a and 2014b). According to the information that could be sourced from the internet (two quarterly reports), 152 avian mortalities were reported for the period 16 November

[1] This could either result in birds colliding directly with the solar panels or getting stranded and unable to take off again because many aquatic bird species find it very difficult and sometimes impossible to take off from dry land e.g. grebes and cormorants. This exposes them to predation, even if they do not get injured through direct collisions with the panels.

2013 – 15 February 2014, and 54 for the period 16 February 2014 – 15 May 2014, of which approximately 90% were based on feathers spots which precluded a finding on the cause of death. These figures give an estimated unadjusted 1 030 mortalities per year, which is obviously an underestimate as it does not include adjustments for carcasses removed by scavengers and missed by searchers. The authors stated clearly that these quarterly reports do not include the results of searcher efficiency trials, carcass removal trials, or data analyses, nor does it include detailed discussions.

In a report by the National Fish and Wildlife Forensic Laboratory (Kagan *et al.* 2014), the cause of avian mortalities was estimated based on opportunistic avian carcass collections at several solar facilities, including the 550MW, 1 600ha Desert Sunlight PV plant. Impact trauma emerged as the highest identifiable cause of avian mortality, but most mortality could not be traced to an identifiable cause.

Walston *et al*. (2015) conducted a comprehensive review of avian fatality data from large scale solar facilities (all technology types) in the USA. Collision as cause of death (19 birds) ranked second at Desert Sunlight PV plant and California Valley Solar Ranch (CVSR) PV plant, after unknown causes. Cause of death could not be determined for over 50% of the fatality observations and many carcasses included in these analyses consisted only of feather spots (feathers concentrated together in a small area) or partial carcasses, thus making determination of cause of death difficult. It is anticipated that some unknown fatalities were caused by predation or some other factor unrelated to the solar project. However, they found that the lack of systematic data collection and standardization was a major impediment in establishing the actual extent and causes of fatalities across all projects.

The only scientific investigation of potential avifaunal impacts that has been performed at a South African PV facility was completed in 2016 at the 96MW Jasper PV solar facility (28°17′53″S, 23°21′56″E) which is located on the Humansrus Farm, approximately 4 km south-east of Groenwater and 30km east of Postmasburg in the Northern Cape Province (Visser *et al*. 2019). The Jasper PV facility contains 325 360 solar panels over a footprint of 180 hectares with the capacity to deliver 180 000 MWh of renewable electricity annually. The solar panels face north at a fixed 20° angle, reaching a height of approximately 1.86 m relative to ground level with a distance of 3.11 m between successive rows of panels. Mortality surveys were conducted from the 14th of September 2015 until the 6th of December 2015, with a total of seven mortalities recorded among the solar panels which gives an average rate of 0.003 birds per hectare surveyed per month. All fatalities were inferred from feather spots. Extrapolated bird mortality within the solar field at the Jasper PV facility was 435 birds/yr (95% CI 133 - 805). The broad confidence intervals result from the small number of birds detected. The mortality estimate is likely conservative because detection probabilities were based on intact birds, and probably decrease for older carcasses and feather spots. The study concluded inter alia that the short study period, and lack of comparable results from other sources made it difficult to provide a meaningful assessment of avian mortality at PV facilities. It further stated that despite these limitations, the few bird fatalities that were recorded might suggest that there is no significant collision-related mortality at the study site. The conclusion was that to fully understand the risk of solar energy development on birds, further collation and analysis of data from solar energy facilities across spatial and temporal scales, based on scientifically rigorous research designs, is required (Visser *et al*. 2019).

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

6.4.1.2 Entrapment in perimeter fences

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

6.4.1.3 Displacement due to disturbance and habitat transformation associated with the construction of the solar PV facility

Ground-disturbing activities affect a variety of processes in arid areas, including soil density, water infiltration rate, vulnerability to erosion, secondary plant succession, invasion by exotic plant species, and stability of cryptobiotic soil crusts. These processes have the ability – individually and together – to alter habitat quality, often to the detriment of wildlife, including avifauna. Any disturbance and alteration to the desert landscape, including the construction and decommissioning of utility-scale solar energy facilities, has the potential to increase soil erosion. Erosion can physically and physiologically affect plant species and can thus adversely influence primary production and food availability for wildlife (Lovich & Ennen 2011).

Solar energy facilities require substantial site preparation (including the removal of vegetation) that alters topography and, thus, drainage patterns to divert the surface flow associated with rainfall away from facility infrastructure. Channelling runoff away from plant communities can have dramatic negative effects on water availability and habitat quality in arid areas. Areas deprived of runoff from sheet flow support less biomass of perennial and annual plants relative to adjacent areas with uninterrupted water-flow patterns (Lovich & Ennen 2011).

The activities listed below are typically associated with the construction and operation of solar facilities and could have direct impacts on avifauna (County of Merced 2014):

- Preparation of solar panel areas for installation, including vegetation clearing, grading, cut and fill;
- Excavation/trenching for water pipelines, cables, fibre-optic lines, and the septic system;
- Construction of piers and building foundations;
- Construction of new dirt or gravel roads and improvement of existing roads;
- Temporary stockpiling and side-casting of soil, construction materials, or other construction wastes;
- Soil compaction, dust, and water runoff from construction sites;
- Increased vehicle traffic;
- Short-term construction-related noise (from equipment) and visual disturbance;
- Degradation of water quality in drainages and other water bodies resulting from project runoff;
- Maintenance of fire breaks and roads; and
- Weed removal, brush clearing, and similar land management activities related to the ongoing operation of the project.

These activities could have an impact on birds breeding, foraging and roosting in or in close proximity through disturbance and transformation of habitat, which could result in temporary or permanent displacement.

In a study comparing the avifaunal habitat use in PV arrays with adjoining managed grassland at airports in the USA, DeVault *et al.* (2014) found that species diversity in PV arrays was reduced compared to the grasslands (37 vs 46), supporting the view that solar development is generally detrimental to wildlife on a local scale.

In order to identify functional and structural changes in bird communities in and around the development footprint, Visser *et al.* (2019) gathered bird transect data at the 180 hectares, 96MW Jasper PV solar facility in the Northern Cape, representing the solar development, boundary, and untransformed landscape. The study found both bird density and diversity per unit area was higher in the boundary and untransformed landscape, however, the extent therefore was not considered to be statistically significant. This indicates that the PV facility matrix is permeable to most species. However, key environmental features, including available habitat and vegetation quality are most likely the overriding factors influencing species' occurrence and their relative density within the development footprint. Her most significant finding was that the distribution of birds in the landscape changed, from a shrubland to open country and grassland bird community, in response to changes in the distribution and abundance of habitat resources such as food, water and nesting sites. These changes in resource availability patterns were detrimental to some bird species and beneficial to others. Shrubland specialists appeared to be negatively affected by the presence of the PV facility. In contrast, open country/grassland and generalist species, were favoured by its development (Visser *et al.* 2019).

It is highly likely that the same pattern of reduced avifaunal densities and possible changes in densities and composition favouring grassland species will manifest itself at the proposed Veld PV North SEF.

6.4.2 Impacts associated with powerlines

Negative impacts on birds by electricity infrastructure generally take two principal forms, namely electrocution and collisions (Ledger & Annegarn 1981; Ledger 1983; Ledger 1984; Hobbs and Ledger 1986a; Hobbs & Ledger 1986b; Ledger, Hobbs & Smith, 1992; Verdoorn 1996; Kruger & Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000; Van Rooyen 2004; Jenkins *et al.* 2010). Birds also impact on the infrastructure through nesting and streamers, which can cause interruptions in the electricity supply (Van Rooyen *et al.* 2002). During the construction phase of power lines and substations, displacement of birds can also happen due to disturbance and habitat transformation.

6.4.2.1 Electrocutions

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004). The electrocution risk is largely determined by the design of the electrical hardware.

6.4.2.2 Collisions

Collision mortality is the biggest threat posed by transmission lines to birds in southern Africa (Van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with transmission lines (Van Rooyen 2004, Anderson 2001). In her PhD study, Shaw (2013) provides a concise summary of the phenomenon of avian collisions with transmission lines:

"The collision risk posed by power lines is complex and problems are often localised. While any bird flying near a power line is at risk of collision, this risk varies greatly between different groups of birds, and depends on the interplay of a wide range of factors (APLIC 1994). Bevanger (1994) described these factors in four main groups – biological, topographical, meteorological and technical. Birds at highest risk are those that are both susceptible to collisions and frequently exposed to power lines, with waterbirds, gamebirds, rails, cranes and bustards usually the most numerous reported victims (Bevanger 1998, Rubolini et al. 2005, Jenkins et al. 2010).

The proliferation of man-made structures in the landscape is relatively recent, and birds are not evolved to avoid them. Body size and morphology are key predictive factors of collision risk, with large-bodied birds with high wing loadings (the ratio of body weight to wing area) most at risk (Bevanger 1998, Janss 2000). These birds must fly fast to remain airborne, and do not have sufficient manoeuvrability to avoid unexpected obstacles. Vision is another key biological factor, with many collision-prone birds principally using lateral vision to navigate in flight, when it is the lower-resolution, and often restricted, forward vision that is useful to detect obstacles (Martin & Shaw 2010, Martin 2011, Martin et al. 2012). Behaviour is important, with birds flying in flocks, at low levels and in crepuscular or nocturnal conditions at higher risk of collision (Bevanger 1994). Experience affects risk, with migratory and nomadic species that spend much of their time in unfamiliar locations also expected to collide more often (Anderson 1978, Anderson 2002). Juvenile birds have often been reported as being more collision-prone than adults (e.g. Brown et al. 1987, Henderson et al. 1996).

Topography and weather conditions affect how birds use the landscape. Power lines in sensitive bird areas (e.g. those that separate feeding and roosting areas, or cross flyways) can be very dangerous (APLIC 1994, Bevanger 1994). Lines crossing the prevailing wind conditions can pose a problem for large birds that use the wind to aid take-off and landing (Bevanger 1994). Inclement weather can disorient birds and reduce their flight altitude, and strong winds can result in birds colliding with power lines that they can see but do not have enough flight control to avoid (Brown et al. 1987, APLIC 2012).

The technical aspects of power line design and siting also play a big part in collision risk. Grouping similar power lines on a common servitude, or locating them along other features such as tree lines, are both approaches thought to reduce risk (Bevanger 1994). In general, low lines with short span lengths (i.e. the distance between two adjacent pylons) and flat conductor configurations are thought to be the least dangerous (Bevanger 1994, Jenkins et al. 2010). On many higher voltage lines, there is a thin earth (or ground) wire above the conductors, protecting the system from lightning strikes. Earth wires are widely accepted to cause the majority of collisions on power lines with this configuration because they are difficult to see, and birds flaring to avoid hitting the conductors often put themselves directly in the path of these wires (Brown et al. 1987, Faanes 1987, Alonso et al. 1994a, Bevanger 1994)."

From incidental record keeping by the Endangered Wildlife Trust, it is possible to give a measure of what species are generally susceptible to power line collisions in South Africa (see **Figure 12** below – EWT unpublished data).

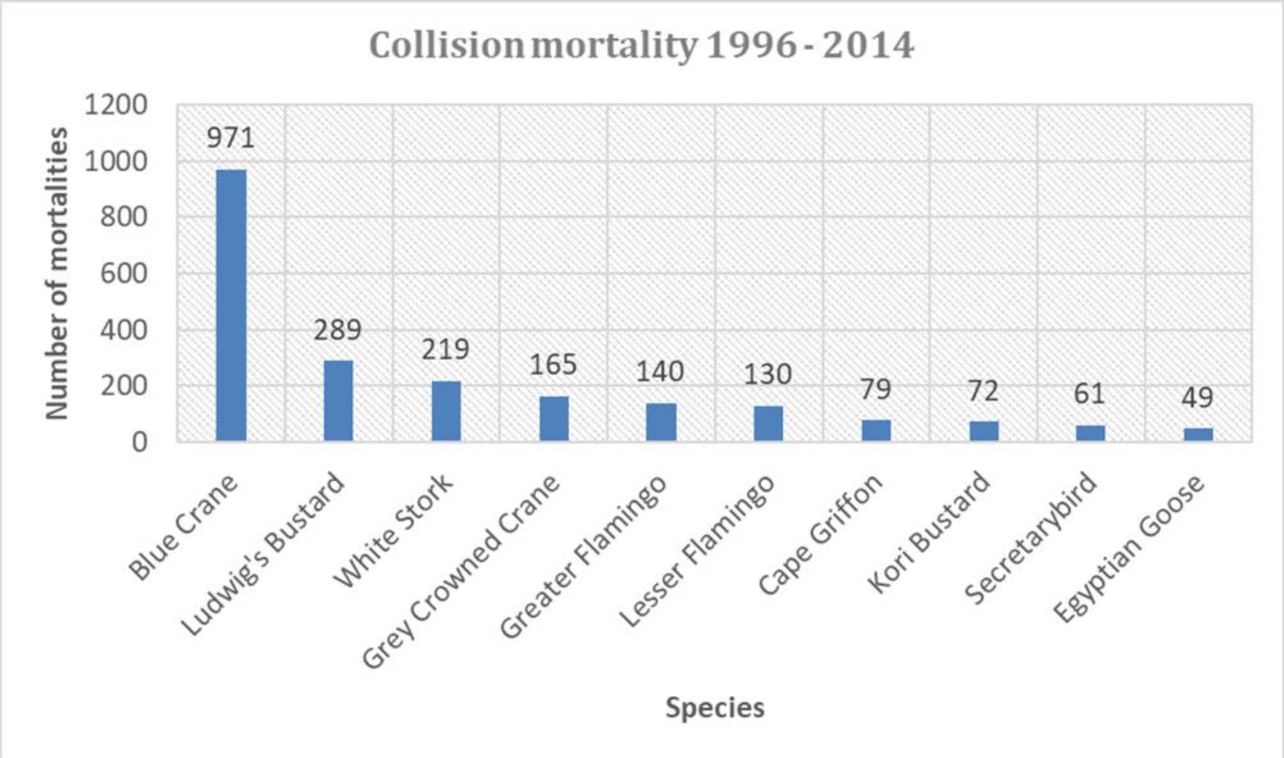

Figure 12: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom-EWT Strategic Partnership central incident register 1996 - 2014 (EWT unpublished data).

Power line collisions are generally accepted as a key threat to bustards (Raab *et al.* 2009; Raab *et al.* 2010; Jenkins & Smallie 2009; Barrientos *et al.* 2012, Shaw 2013). In a comprehensive study, carcass surveys were performed under high voltage transmission lines in the Karoo for two years, and low voltage distribution lines for one year (Shaw 2013). Ludwig's Bustard was the most common collision victim (69% of carcasses), with bustards generally comprising 87% of mortalities recovered. Total annual mortality was estimated at 41% of the Ludwig's Bustard population, with Kori Bustards also dying in large numbers (at least 14% of the South African population killed in the Karoo alone). Karoo Korhaan was also recorded, but to a much lesser extent than Ludwig's Bustard. The reasons for the relatively low collision risk of this species probably include their smaller size (and hence greater agility in flight) as well as their more sedentary lifestyles, as local birds are familiar with their territory and are less likely to collide with power lines (Shaw 2013).

Several factors are thought to influence avian collisions, including the manoeuvrability of the bird, topography, weather conditions and power line configuration. An important additional factor that previously has received little attention is the visual capacity of birds; i.e. whether they are able to see obstacles such as power lines, and whether they are looking ahead to see obstacles with enough time to avoid a collision. In addition to helping explain the susceptibility of some species to collision, this factor is key to planning effective mitigation measures. Recent research provides the first evidence that birds can render themselves blind in the direction of travel during flight through voluntary head movements (Martin & Shaw 2010). Visual fields were determined in three bird species representative of families known to be subject to high levels of mortality associated with power lines i.e. Kori Bustards, Blue Cranes *Anthropoides paradiseus* and White Storks *Ciconia ciconia*. In all species the frontal visual fields showed narrow and vertically long binocular fields typical of birds that take food items directly in the bill under visual guidance. However, these species differed markedly in the vertical extent of their binocular fields and in the extent of the blind areas which project above and below the binocular fields in the forward-facing hemisphere. The importance of these blind areas is that when in flight, head movements in the vertical plane (pitching the head to look downwards) will render the bird blind in the direction of travel. Such movements may frequently occur when birds are scanning below them (for foraging or roost sites, or for conspecifics). In bustards and cranes pitch movements of only 25° and 35°, respectively, are sufficient to render the birds blind in the direction of travel; in storks, head movements of 55° are necessary. That flying birds can render themselves blind in the direction of travel has not been previously recognised and has important implications for the effective mitigation of collisions with human artefacts including wind turbines and power lines. These findings have applicability to species outside of these families especially raptors (Accipitridae) which are known to have small binocular fields and large blind areas similar to those of bustards and cranes, and are also known to be vulnerable to power line collisions.

Despite doubts about the efficacy of line marking to reduce the collision risk for bustards (Jenkins *et al.* 2010; Martin *et al.* 2010), there are numerous studies which prove that marking a line with PVC spiral type Bird Flight Diverters (BFDs) generally reduce mortality rates (e.g. Bernardino *et al*. 2019; Sporer *et al.* 2013; Barrientos *et al.* 2011; Jenkins *et al.* 2010; Alonso & Alonso 1999; Koops & De Jong 1982), including to some extent for bustards (Barrientos *et al.* 2012; Hoogstad 2018 pers.comm). Beaulaurier (1981) summarised the results of 17 studies that involved the marking of earth wires and found an average reduction in mortality of 45%. Barrientos *et al.* (2011) reviewed the results of 15 wire marking experiments in which transmission or distribution wires were marked to examine the effectiveness of flight diverters in reducing bird mortality. The presence of flight diverters was associated with a decrease of 55–94% in bird mortalities. Koops and De Jong (1982) found that the spacing of the BFDs was critical in reducing the mortality rates - mortality rates are reduced up to 86% with a spacing of 5m, whereas using the same devices at 10m intervals only reduces the mortality by 57%. Barrientos *et al.* (2012) found that larger BFDs were more effective in reducing Great Bustard collisions than smaller ones. Line markers should be as large as possible, and highly contrasting with the background. Colour is probably less important as during the day the background will be brighter than the obstacle with the reverse true at lower light levels (e.g. at twilight, or during overcast conditions). Black and white interspersed patterns are likely to maximise the probability of detection (Martin *et al.* 2010).

6.4.2.3 Displacement due to habitat destruction and disturbance associated with the construction of the powerlines and substation

During the construction phase and maintenance of power lines and substations, some habitat destruction and transformation inevitably takes place. This happens with the construction of access roads, the clearing of servitudes and the levelling of substation yards. These activities have an impact on birds breeding, foraging and roosting in or in close proximity of the substation and power line servitudes through transformation of habitat, which could result in temporary or permanent displacement.

Apart from direct habitat destruction, the above-mentioned construction and maintenance activities also impact on birds through disturbance; this could lead to breeding failure if the disturbance happens during a critical part of the breeding cycle. Construction activities in close proximity to breeding locations could be a source of disturbance and could lead to temporary breeding failure or even permanent abandonment of nests.

7 DISCUSSION OF IMPACTS: VELD PV NORTH PV FACILITY AND GRID CONNECTION

The section below provides an overview of the envisaged impacts of the proposed Veld PV North facilities and grid connections on solar and powerline priority species, and IBA trigger species. Separate impact tables are provided which summarises the impacts and proposed mitigation on an individual basis for each PV facility and grid connection.

7.1 PV FACILITIES

7.1.1 Displacement due to disturbance associated with the construction and de-commissioning of the PV plants and associated infrastructure (construction and de-commissioning)

The construction of the PV plants and associated infrastructure will result in a significant amount of movement and noise, which will lead to displacement of avifauna from the development footprints. It is highly likely that most priority and IBA trigger species potentially occurring on the site will vacate the development footprints for the duration of these activities. However, it should be noted that the variety and abundance and variety of the aforementioned species have been negatively affected by the existing impact of heavy grazing on the vegetation, resulting in very low numbers of such species in the assessment area to start with.

7.1.2 Displacement due to habitat transformation associated with the PV plant and associated infrastructure (operation)

The overall impact of the habitat transformation on priority and IBA trigger species is limited by the already highly degraded state of the habitat in the assessment area. This existing impact has already had a significant negative impact on variety and abundance of priority and IBA trigger species that could potentially have occurred there, if the habitat were in a less disturbed state. The construction of the PV plant and associated infrastructure will result in a further transformation of the existing natural habitat. The remaining vegetation in the PV footprint will be cleared prior to construction commencing. Once operational, less sunlight will reach the vegetation below the solar panels, which is likely to result in stunted vegetation growth and possibly complete eradication of some plant species. The natural vegetation is likely to persist in the rows between the solar panels, although as has already been pointed out, this has already been heavily impacted by sustained intense grazing.

Small to medium-sized birds are often capable of surviving in small pockets of suitable habitat and populations are therefore generally less affected by habitat fragmentation than larger species. It is, therefore, possible that the smaller and medium-sized species (e.g. passerines) recorded at the site will continue to use the habitat available within the PV footprint, albeit at reduced densities for some, especially as far as shrubland specialists are concerned e.g. Rufous-eared Warbler *Malcorus pectoralis*. Priority and/or IBA trigger species which are likely to continue to use the habitat within the footprint are Black-eared Sparrowlark, Sickle-winged Chat, Karoo Chat, Karoo Long-billed Lark, Sociable Weaver, Tractrac Chat, and Black-headed Canary.

Larger priority species which require contiguous, un-fragmented tracts of suitable habitat (e.g. large raptors, korhaans and bustards) are likely to occur at significantly reduced densities in the proposed facility footprint or may even be totally displaced. The only larger terrestrial priority and IBA trigger species which was recorded during surveys at the site, was the Karoo Korhaan. According to Taylor *et al.* (2015) the South African population of the species is estimated to be around 250 000 birds, but possibly decreasing. The displacement impact on the regional population, should it occur, should therefore be low. The other large terrestrial priority and IBA trigger species which could potentially occur in the assessment area, are Ludwig's Bustard, Kori Bustard and Secretarybird. None of these wide ranging species is likely to be severely impacted on a regional level by the potential displacement resulting from the transformation of 200ha of already degraded sandy plains and dune habitat.

In the case of some priority and/or IBA trigger raptor species (e.g. Southern Pale Chanting Goshawk, Lanner Falcon and Pygmy Falcon) the potential availability of carcasses or injured birds due to collisions with the solar panels, and enhanced prey visibility (e.g. insects, reptiles and rodents) in the short grassland between the solar panels may attract them to the area. Jeal (2017) recorded large numbers of Barn Owls at the Bokpoort parabolic trough CSP facility near Groblershoop in the Northern Cape, roosting in the 'torque tubes' that support the parabolic mirrors – while this influx of owls may have been because of a lack of suitable roosting substrate in the surrounding range land, the enhanced prey visibility due to the sparse vegetation cover in the plant itself may also have played a role in attracting the owls. Greater Kestrel, Spotted Eagle-Owl, Cape Eagle-Owl and Rock Kestrel could also be attracted to the solar panels as perches from where to hunt for rodent and insect prey. Martial Eagle was regularly recorded in the assessment area but should not be significantly affected by the habitat transformation in the PV footprint, given the small size of the footprint and the large territory size of this species (Hockey *et al*. 2005).

Cape Sparrows *Passer melanurus*, Cape Turtle Doves *Streptopelia capicola* and other small birds will very likely attempt to nest underneath the solar panels to take advantage of the shade, but this should not adversely affect the operation of the equipment.

The complete absence of Red Larks, the key trigger species in the Haramoep and Black Mountain Mine IBA, in the assessment area, most likely due to habitat degradation, rules out any impact on the species in the PV footprint given the current status of the vegetation. Unless the vegetation is given the opportunity to recover, it is unlikely that the species will return to the assessment area in the foreseeable future.

Tables 2 and 3 lists the solar priority and IBA species that could potentially be displaced due to habitat transformation[2].

7.1.3 Collisions with the solar panels (operation)

The solar priority and IBA trigger species that may possibly occur in the assessment area which could potentially be exposed to collision risk are listed in Tables 2 and 3. In addition, the so-called "lake effect" could act as a potential attraction to waterbirds. It is not possible to tell whether this will happen until post-construction monitoring reveals actual mortality at the site, but the lack of permanent waterbodies with large waterbird populations in close vicinity to the proposed development area decreases the probability of the lake effect being a source of mortality.

7.1.4 Entrapment in perimeter fences (operational)

Solar priority and IBA trigger species such as Karoo Korhaan, Ludwig's Bustard and Kori Bustard may be vulnerable to entrapment between double perimeter fences. The possibility of using a single perimeter fence should be investigated. Alternatively, the two fences should be placed far enough apart for birds to able to take off if they somehow end up between the two fences. In addition, staff should be sensitised to not panic birds when they discover them trapped between the fences but to approach them with caution to give them time to escape by taking off in a lengthwise direction.

7.1.5 Impact on the solar infrastructure (operational)

An impact that could potentially materialise is the pollution of the solar panels by faecal deposits of large birds, particularly Pied Crows and raptors, if they regularly perch on the panels. It is expected that the regular cleaning and maintenance activities should prevent this from becoming a problem.

7.2 GRID CONNECTION

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[2] In some instances, the displacement will not be complete, but will result in lower densities.

7.2.1 Electrocutions (operational)

The tower/pole design of the proposed 132kV grid connection has not been finalised. However, irrespective of which design is used, the clearance should be sufficient to reduce the risk of phase – phase/ phase-earth electrocutions of priority and IBA trigger species potentially occurring at the assessment area to virtually zero.

Electrocutions within the proposed substation yards are possible, but should not affect any of the powerline sensitive Red Data and IBA trigger species as these species are unlikely to use the infrastructure within the substation yards for perching or roosting. Non-Red data powerline sensitive species which could be at risk are Spotted Eagle-Owl, Rock Kestrel and Greater Kestrel.

7.2.2 Collisions (operational)

See Table 3 for potential candidates for collision mortality caused by the proposed grid connection power line. The powerline sensitive priority and IBA trigger species most at risk will be Ludwig's Bustard, Secretarybird and Karoo Korhaan. The placing of the grid connection powerline line next to the existing Aggeneys - Harib 220kV transmission line will help to reduce the collisions on both lines, especially if the structures of the new line are located mid-span of the transmission line, making both lines more visible and thereby reducing the overall collision risk. Because the 132kV will have shorter spans than the adjacent 220kV line, it is likely that the majority of poles will not be directly opposite the 220kV towers, which is a positive development from a collision perspective.

7.2.3 Displacement due to disturbance and habitat transformation associated with the construction of the powerline and substation (construction)

In the present instance, the impact of permanent displacement of priority and/or IBA trigger species due to habitat transformation in the footprint of the proposed substations and powerline servitudes is likely to be very limited given the small size of the footprint. The displacement is likely to only affect small, locally common species and should have a negligible impact on local populations.

Temporary displacement of powerline sensitive and/or IBA trigger raptor species, particularly Martial Eagles and Lanner Falcons, breeding on the existing Aggeneys - Harib 220kV transmission line may happen if the construction activities on the new line disturb the breeding pairs. However, the long term reduction in the collision risk brought about by the construction of the lines next to each other should outweigh the temporary disruption of the raptors' breeding cycle.

7.3 IMPACT RATING CRITERIA

The impact criteria used to assess the potential impacts are set-out in detail in Appendix 3.

7.3.1 Assessment of impacts for the PV facilities

The impacts of the proposed PV facilities are detailed below separately for each potential impact.

IMPACT DESCRIPTION: Displacement of priority avifauna due to habitat transformation associated with the construction of the PV facility and associated infrastructure				
Predicted for project phase:	Pre-construction	Construction	Operation	No-Go
Dimension	**Rating**	**Motivation**		
PRE-MITIGATION				
Duration	Permanent	More than 10 years (after construction)	Consequence: Moderately detrimental	Significance: Low - negative
Extent	Site-specific	On site or within the boundaries of the property		
Magnitude	Medium - negative	Natural and/ or social functions and/ or processes are notably altered		
Probability	Very likely	Estimated 50 to 95% chance of the impact occurring		
MITIGATION The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of transformed areas is concerned.				
POST-MITIGATION				
Duration	Permanent	More than 10 years (after construction)	Consequence: Moderately detrimental	Significance: Low - negative
Extent	Site-specific	On site or within the boundaries of the property		
Magnitude	Medium - negative	Natural and/ or social functions and/ or processes are notably altered		
Probability	Very likely	Estimated 50 to 95% chance of the impact occurring		
BROADER CONSIDERATIONS				
Confidence	Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.		
Reversibility	Irreversible	The activity will lead to an impact that is permanent.		
Irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere		

<table>
<tr><th colspan="5">IMPACT DESCRIPTION: Collisions of priority avifauna with the solar panels resulting in the mortality of priority species.</th></tr>
<tr><td>Predicted for project phase:</td><td>Pre-construction</td><td>Construction</td><td>Operation</td><td>No-Go</td></tr>
<tr><td>Dimension</td><td>Rating</td><td colspan="3">Motivation</td></tr>
<tr><td colspan="5">PRE-MITIGATION</td></tr>
<tr><td>Duration</td><td>Permanent</td><td>More than 10 years (after construction)</td><td rowspan="3">Consequence:
Slightly detrimental</td><td rowspan="4">Significance:
Very low - negative</td></tr>
<tr><td>Extent</td><td>Site-specific</td><td>On site or within the boundaries of the property</td></tr>
<tr><td>Magnitude</td><td>Very Low - negative</td><td>Natural and/ or social functions and/ or processes are negligibly altered</td></tr>
<tr><td>Probability</td><td>Fairly likely</td><td colspan="2">Estimated 5 to 50 % chance of the impact occurring.</td></tr>
<tr><td colspan="5">MITIGATION: No mitgation is required due to the negligible significance of the impact</td></tr>
<tr><td colspan="5">POST-MITIGATION</td></tr>
<tr><td>Duration</td><td>Permanent</td><td>More than 10 years (after construction)</td><td rowspan="3">Consequence:
Slightly detrimental</td><td rowspan="4">Significance:
Very low - negative</td></tr>
<tr><td>Extent</td><td>Site-specific</td><td>On site or within the boundaries of the property</td></tr>
<tr><td>Magnitude</td><td>Very Low - negative</td><td>Natural and/ or social functions and/ or processes are negligibly altered</td></tr>
<tr><td>Probability</td><td>Fairly likely</td><td colspan="2">Estimated 5 to 50 % chance of the impact occurring.</td></tr>
<tr><td colspan="5">BROADER CONSIDERATIONS</td></tr>
<tr><td>Confidence</td><td>Unsure</td><td colspan="3">Limited useful information on and understanding of the environmental factors potentially influencing this impact.</td></tr>
<tr><td>Reversibility</td><td>Irreversible</td><td colspan="3">The activity will lead to an impact that is permanent.</td></tr>
<tr><td>Irreplaceability</td><td>Low</td><td colspan="3">The resource is not damaged irreparably or is not scarce</td></tr>
</table>

IMPACT DESCRIPTION: Entrapment in perimeter fences resulting in the mortality of priority species.				
Predicted for project phase:	Pre-construction	Construction	Operation	No-Go
Dimension	**Rating**	**Motivation**		
PRE-MITIGATION				
Duration	Permanent	More than 10 years (after construction)	Consequence: Moderately detrimental	Significance: Low - negative
Extent	Site-specific	On site or within the boundaries of the property		
Magnitude	Medium - negative	Natural and/ or social functions and/ or processes are notably altered		
Probability	Fairly likely	Estimated 5 to 50 % chance of the impact occurring.		
MITIGATION A single perimeter fence should be used. Alternatively, the two fences should be at least 4 metres apart to allow medium to large birds enough space to take off.				
POST-MITIGATION				
Duration	Permanent	More than 10 years (after construction)	Consequence: Moderately detrimental	Significance: Very low - negative
Extent	Site-specific	On site or within the boundaries of the property		
Magnitude	Low - negative	Natural and/ or social functions and/ or processes are slightly altered (negatively)		
Probability	Unlikely	Estimated less than 5 % chance of the impact occurring.		
BROADER CONSIDERATIONS				
Confidence	Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.		
Reversibility	Reversible	The impact is reversible, within a period of 10 years.		
Irreplaceability	Low	The resource is not damaged irreparably or is not scarce		

7.3.2 Assessment of impacts for the grid connections

The impacts of the proposed grid connections are detailed below separately for each impact.

IMPACT DESCRIPTION: Displacement of of priority species due to disturbance associated with the construction of the grid connection and the substation				
Predicted for project phase:	Pre-construction	Construction	Operation	No-Go
Dimension	**Rating**	**Motivation**		
PRE-MITIGATION				
Duration	Short-term	Up to 18 months	Consequence: Moderately detrimental	Significance: Low - negative
Extent	Regional	Within a 20 km radius of the site		
Magnitude	High - negative	Natural and/ or social functions and/ or processes are severely altered (negatively)		
Probability	Very likely	Estimated 50 to 95% chance of the impact occurring		
MITIGATION •Activity should be restricted to the immediate footprint of the infrastructure. •Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of avifauna. Measures to control noise should be applied according to current best practice in the industry. •Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. •The recommendations of the ecological and botanical specialist studies must be strictly implemented. •A walk-through must be conducted by the avifaunal specialist to assess whether there are any Red Data species, and/or large raptors breeding in the vicinity of the powerline, which could be displaced by the dismantling activities. Should this be the case, appropriate measures must be put in place to prevent the displacement of the breeding birds, through the timing of construction activities.				
POST-MITIGATION				
Duration	Short-term	Up to 18 months	Consequence: Moderately detrimental	Significance: Very low - negative
Extent	Regional	Within a 20 km radius of the site		
Magnitude	High - negative	Natural and/ or social functions and/ or processes are severely altered (negatively)		
Probability	Unlikely	Estimated less than 5 % chance of the impact occurring.		
BROADER CONSIDERATIONS				
Confidence	Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.		
Reversibility	Reversible	The impact is reversible, within a period of 10 years.		
Irreplaceability	Low	The resource is not damaged irreparably or is not scarce		

<table>
<tr><th colspan="5">IMPACT DESCRIPTION: Electrocutions of priority avifauna on the proposed 132kV powerline and in the substations</th></tr>
<tr><td>Predicted for project phase:</td><td>Pre-construction</td><td>Construction</td><td>Operation</td><td>No-Go</td></tr>
<tr><td>Dimension</td><td>Rating</td><td colspan="3">Motivation</td></tr>
<tr><td colspan="5">PRE-MITIGATION</td></tr>
<tr><td>Duration</td><td>Permanent</td><td>More than 10 years (after construction)</td><td rowspan="3">Consequence:
Highly detrimental</td><td rowspan="4">Significance:
Low - negative</td></tr>
<tr><td>Extent</td><td>Site-specific</td><td>On site or within the boundaries of the property</td></tr>
<tr><td>Magnitude</td><td>High - negative</td><td>Natural and/ or social functions and/ or processes are severely altered (negatively)</td></tr>
<tr><td>Probability</td><td>Fairly likely</td><td colspan="2">Estimated 5 to 50 % chance of the impact occurring.</td></tr>
<tr><td colspan="5">MITIGATION
•The final pole design must be signed off by the bird specialist to ensure that no electrocution risk will be present for priority species.
•With regards to the infrastructure within the substation yard, the hardware is too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if any impacts are recorded once operational, site specific mitigation be applied reactively.</td></tr>
<tr><td colspan="5">POST-MITIGATION</td></tr>
<tr><td>Duration</td><td>Permanent</td><td>More than 10 years (after construction)</td><td rowspan="3">Consequence:
Highly detrimental</td><td rowspan="4">Significance:
Very low - negative</td></tr>
<tr><td>Extent</td><td>Site-specific</td><td>On site or within the boundaries of the property</td></tr>
<tr><td>Magnitude</td><td>High - negative</td><td>Natural and/ or social functions and/ or processes are severely altered (negatively)</td></tr>
<tr><td>Probability</td><td>Unlikely</td><td colspan="2">Estimated less than 5 % chance of the impact occurring.</td></tr>
<tr><td colspan="5">BROADER CONSIDERATIONS</td></tr>
<tr><td>Confidence</td><td>Unsure</td><td colspan="3">Limited useful information on and understanding of the environmental factors potentially influencing this impact.</td></tr>
<tr><td>Reversibility</td><td>Reversible</td><td colspan="3">The impact is reversible, within a period of 10 years.</td></tr>
<tr><td>Irreplaceability</td><td>Low</td><td colspan="3">The resource is not damaged irreparably or is not scarce</td></tr>
</table>

IMPACT DESCRIPTION: Collisions of priority species with the earthwire of the proposed 132kV grid connection.				
Predicted for project phase:	Pre-construction	Construction	Operation	No-Go
Dimension	**Rating**	**Motivation**		
PRE-MITIGATION				
Duration	Permanent	More than 10 years (after construction)	Consequence: Extremely detrimental	Significance: High - negative
Extent	Regional	Within a 20 km radius of the site		
Magnitude	High - negative	Natural and/ or social functions and/ or processes are severely altered (negatively)		
Probability	Definite	Estimated greater than 95 % chance of the impact occurring.		
MITIGATION: A walk-through must be conducted once the final pole positions have been pegged to demarcate the sections requiring marking with Bird Flight Diverters.				
POST-MITIGATION				
Duration	Permanent	More than 10 years (after construction)	Consequence: Extremely detrimental	Significance: Low - negative
Extent	Regional	Within a 20 km radius of the site		
Magnitude	High - negative	Natural and/ or social functions and/ or processes are severely altered (negatively)		
Probability	Fairly likely	Estimated 5 to 50 % chance of the impact occurring.		
BROADER CONSIDERATIONS				
Confidence	Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.		
Reversibility	Irreversible	The activity will lead to an impact that is permanent.		
Irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere		

7.4 CUMULATIVE IMPACTS

Cumulative effects are commonly understood to be impacts from different developments that combine to result in significant change, which could be larger than the sum of all the individual impacts. The assessment of cumulative effects therefore needs to consider all renewable energy developments within at least a 35km radius of the proposed site. The six renewable projects, all solar PV project, which are planned or authorised are displayed in Figure 13. Appendix 4 lists the projects together with the relevant recommended mitigation measures pertaining to birds[3].

7.4.1 PV site

In the case of solar projects, the potentially most significant impact from an avifaunal perspective is the transformation of the natural habitat. The total land parcel area taken up by the six proposed and planned solar energy projects are approximately 45 000ha. The Veld PV North SEF assessment area will add another approximately 2 500ha to these. The total area of the 35km radius around the proposed projects equates to about 392 000ha. The total combined size of the land parcels taken up by SEFs, including the assessment area of the Veld PV North project, equates to about 47 500ha, which is just over 12% of the available land in the 35km radius. However, the actual footprint of the solar facilities is typically much smaller that the land parcel area. The total area to be taken up by renewable energy developments will therefore most likely comprise less than 10% of the land surface within the 35km radius around the proposed Veld PV North project. The cumulative impact of the habitat transformation which will come about as a result of the proposed Veld PV North project should therefore be L**ow**.

7.4.2 Grid connection

In the case of the grid connections, the existing high voltage grid in the 35km radius around the proposed Veld PV North SEF comes to about 112km. The Veld PV North SEF will add another approximately 25km of sub-transmission line to this total. This translates into an 18% increase in the length of existing high voltage line within the 35km radius around the proposed Veld PV North project. The most significant potential impact of high voltage lines within the aforesaid 35km radius is bird collisions with the earth wires of the lines. An 18% increase in line length should represent a **Moderate** increase in cumulative risk, which could be mitigated to a L**ow** level with the application of appropriate mitigation measures i.e. the fitting of Bird Flight Diverters.

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[3] Unfortunately, the impact assessment reports of several of the projects are not readily available on the internet, therefore not all the relevant mitigation measures could be sourced.

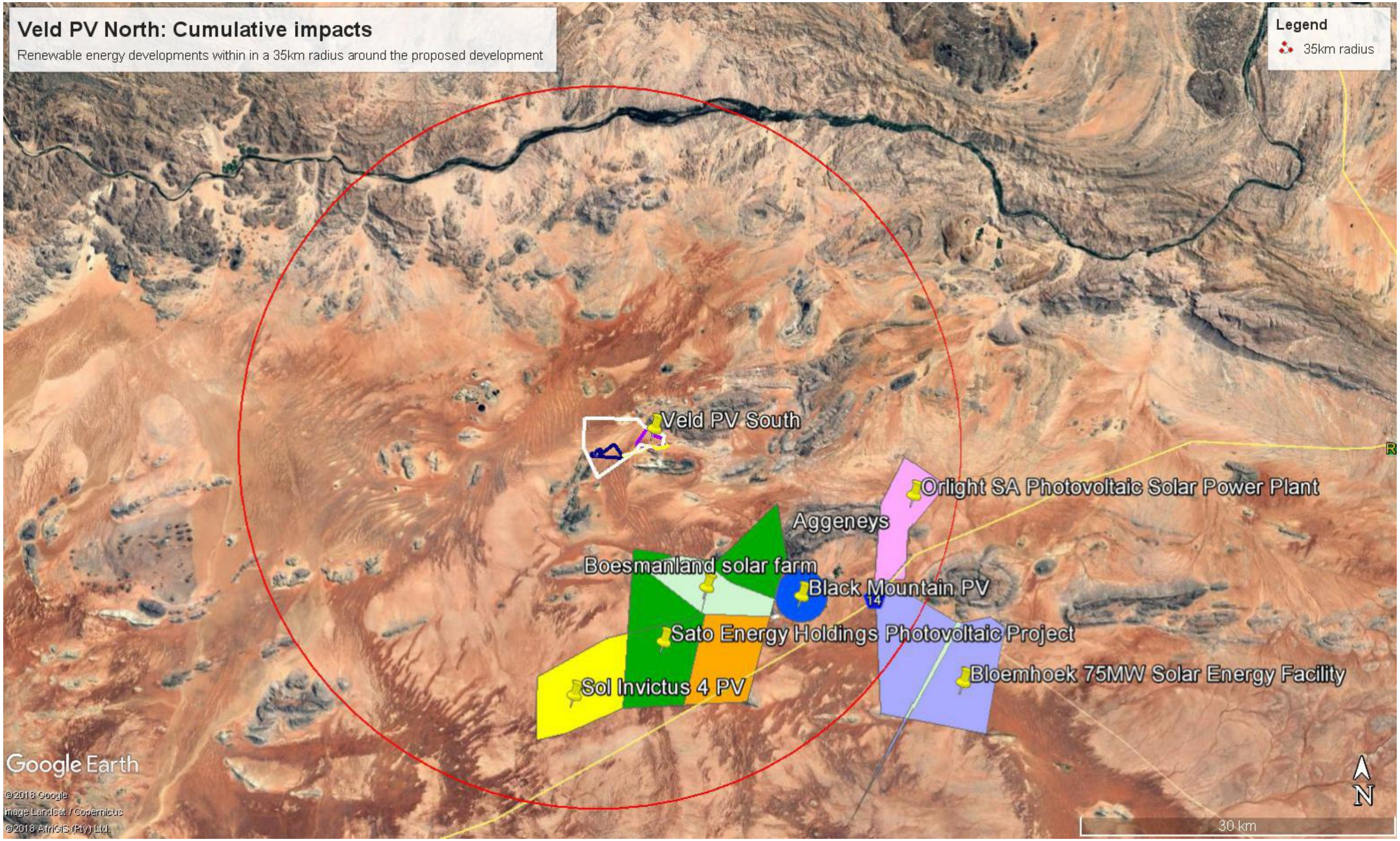

Figure 13: The locality of planned and authorised renewable energy projects within a 35km radius around the proposed Veld PV North SEF.

7.5 NO-GO ALTERNATIVE

The no-go alternative will result in the current status quo being maintained as far as the avifauna is concerned. The low human population in the area is definitely advantageous to avifauna. The no-go option would therefore eliminate any additional impact on the ecological integrity of the proposed development area as far as avifauna is concerned.

8 NO-GO AREAS

No exclusion areas have been identified within the assessment area.

9 CONCLUSIONS

9.1 PV FACILITY

The proposed Veld PV North facility and the associated grid connection will have some pre-mitigation impacts on priority and/or IBA trigger species at a site and regional level, which will range from **Low to Very Low**.

The overall impact of the habitat transformation on priority and/or IBA trigger species in the PV footprint is limited by the already highly degraded state of the habitat in the assessment area. This existing impact has already had a significant negative impact on variety and abundance of priority species that could potentially have occurred there, if the habitat were in a less disturbed state. Within this context, the impact of displacement of priority and/or IBA trigger species due to habitat transformation associated with the operation of the plant and associated infrastructure is rated as **Low**. This impact can be partially reversed through mitigation, but it will remain at a **Low** level, after mitigation

The impact of displacement due to disturbance on priority and/or IBA trigger species in the PV footprint, during the construction phase, is rated as **Low** and will remain at a **Low** level after mitigation. It should be noted that the variety and abundance and variety of priority species have already been negatively affected by the existing impact of heavy grazing on the vegetation, resulting in depleted numbers of such species in the assessment area to start with.

The envisaged impacts of priority and/or IBA trigger species mortality due to collisions with the solar panels is rated as **Very Low**. No mitigation is suggested for the impact due to the low significance.

Entrapment of priority and/or IBA trigger species in the perimeter fences of the PV facility is rated as **Low** pre-mitigation and could be further reduced with appropriate mitigation to **Very Low**.

The cumulative impact of the proposed Veld PV North facility on priority and/or IBA trigger species is rated as **Low**, taking into account all planned and approved renewable energy facilities in a 35km radius around the proposed facility.

9.2 132kV GRID CONNECTION

The impact of displacement due to disturbance and habitat transformation associated with the construction of the proposed 132kV grid connection and substation on priority and/or IBA trigger species, is assessed to be **Low** and can be mitigated to a **Very Low** level.

The impact of collision related mortality on priority and/or some IBA trigger species with the 132kV grid connection is rated as **High** and could be reduced to **Low** with the application of mitigation measures.

The potential impact of electrocution related mortality on priority and/or some IBA trigger species is assessed to be **Low**, but it can be reduced to **Very Low** with appropriate mitigation.

The cumulative impact of the proposed grid connections on priority and/or IBA trigger species within a 35km radius around the proposed development is rated as **Moderate**, but it can be reduced to **Low** with the application of appropriate mitigation measures.

10 IMPACT STATEMENT

From an avifaunal impact perspective, there is no objection to the development of the proposed Veld PV North facility and associated grid connections, provided the proposed mitigation measures are strictly implemented.

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APPENDIX 1: PRE-CONSTRUCTION MONITORING METHODOLOGY

An initial visit to the site and general area was conducted on 24 January 2017. This was followed up by on-site surveys during the following periods:

- 30 January - 04 February 2017
- 27 March - 01 April 2017
- 19 - 20 March 2019
- 6-8 May 2019
- 4-6 June 2019.

Monitoring was conducted in the following manner:

- One drive transect totalling 12.9km was identified in the study area.
- Two monitors travelling slowly (± 10km/h) in a vehicle recorded all birds on both sides of the transect. The observers stopped at regular intervals (every 500m) to scan the environment with binoculars. Drive transects were counted three times per survey.
- In addition, 5 walk transects of 1km each were identified in the study area and are counted 4 times per survey. All birds were recorded during walk transects.
- The following variables were recorded:
    - Species;
    - Number of birds;
    - Date;
    - Start time and end time;
    - Estimated distance from transect;
    - Wind direction;
    - Wind strength (estimated Beaufort scale);
    - Weather (sunny; cloudy; partly cloudy; rain; mist);
    - Temperature (cold; mild; warm; hot);
    - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground); and
    - Co-ordinates (priority species only).

The aim with drive transects was primarily to record large species, while walk transects were primarily aimed at recording small passerines.

A total of two potential focal points (FPs) of bird activity were identified and monitored. These were the following:

- FP1: Water trough
- FP2: Water trough

Figure 1 below indicates the study area where monitoring was implemented.

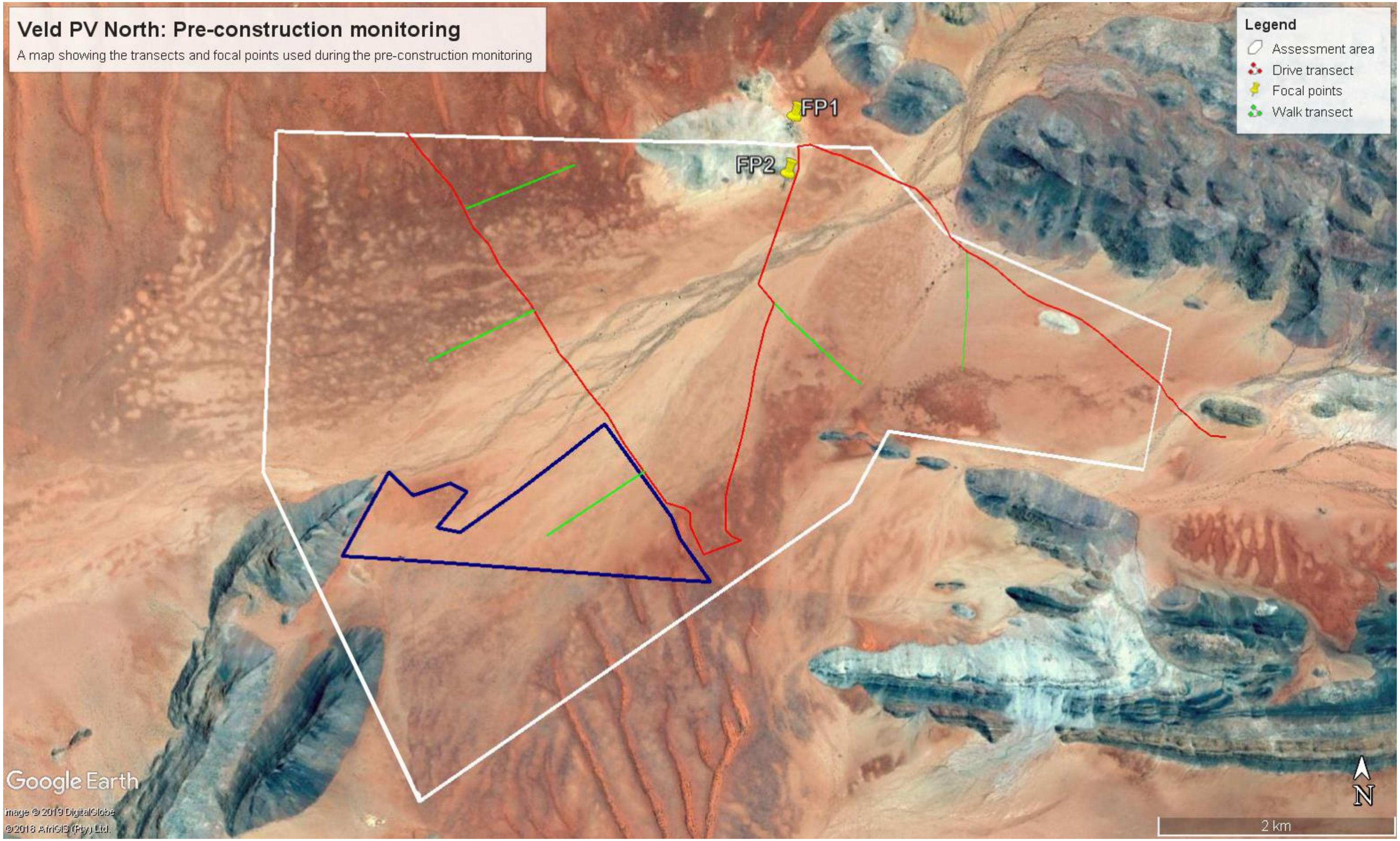

Figure 1: Transects used during pre-construction field surveys.

APPENDIX 2: AVIFAUNA IN THE BROADER AREA

LC = Least Concern, NT = Near threatened, V = Vulnerable, EN = Endangered

Species	Taxonomic name	RD Global	RD Regional	Endemic - South Africa	Endemic - Southern Africa	IBA trigger species	Solar priority species	Powerline priority species
Acacia Pied Barbet	*Tricholaema leucomelas*				Near-endemic			
African Red-eyed Bulbul	*Pycnonotus nigricans*				Near-endemic			
Anteating Chat	*Myrmecocichla formicivora*				Endemic			
Black-chested Prinia	*Prinia flavicans*				Near-endemic			
Black-eared Sparrowlark	***Eremopterix australis***			**Near endemic**	**Endemic**	**x**	**x**	
Black-headed Canary	***Serinus alario***			**Near endemic**	**Endemic**	**x**		
Bokmakierie	*Telophorus zeylonus*				Near-endemic			
Bradfield's Swift	*Apus bradfieldi*				Near-endemic			
Cape Bunting	*Emberiza capensis*				Near-endemic			
Cape Eagle-Owl	***Bubo capensis***						**x**	**x**
Cape Sparrow	*Passer melanurus*				Near-endemic			
Cape Turtle-Dove	*Streptopelia capicola*							
Chat Flycatcher	*Bradornis infuscatus*				Near-endemic			
Cinnamon-breasted Warbler	***Euryptila subcinnamomea***			**Near endemic**	**Endemic**	**x**	**x**	
Common Fiscal	*Lanius collaris*							
Dusky Sunbird	*Cinnyris fuscus*				Near-endemic			
Familiar Chat	*Cercomela familiaris*							
Greater Kestrel	***Falco rupicoloides***						**x**	**x**
Grey-backed Cisticola	*Cisticola subruficapilla*				Near-endemic			
Grey-backed Sparrowlark	*Eremopterix verticalis*				Near-endemic			
Karoo Chat	***Cercomela schlegelii***				**Near-endemic**	**x**		
Karoo Eremomela	***Eremomela gregalis***			**Near endemic**	**Endemic**	**x**		
Karoo Korhaan	***Eupodotis vigorsii***	**LC**	**NT**		**Endemic**	**x**	**x**	**x**
Karoo Long-billed Lark	***Certhilauda subcoronata***				**Endemic**	**x**		
Karoo Scrub-Robin	*Cercotrichas coryphoeus*				Endemic			
Kori Bustard	***Ardeotis kori***	**NT**	**NT**			**x**	**x**	**x**
Lanner Falcon	***Falco biarmicus***	**LC**	**VU**				**x**	**x**
Lark-like Bunting	*Emberiza impetuani*				Near-endemic			
Layard's Tit-Babbler	***Parisoma layardi***			**Near endemic**	**Endemic**	**x**	**x**	
Little Swift	*Apus affinis*							
Long-billed Crombec	*Sylvietta rufescens*							
Ludwig's Bustard	***Neotis ludwigii***	**EN**	**EN**		**Near endemic**	**x**	**x**	**x**

Species	Taxonomic name	RD Global	RD Regional	Endemic - South Africa	Endemic - Southern Africa	IBA trigger species	Solar priority species	Powerline priority species
Martial Eagle	***Polemaetus bellicosus***	**VU**	**EN**			**x**	**x**	**x**
Mountain Wheatear	*Oenanthe monticola*				Near-endemic			
Namaqua Sandgrouse	***Pterocles namaqua***				**Near-endemic**			**x**
Namaqua Warbler	***Phragmacia substriata***			**Near endemic**	**Endemic**	**x**	**x**	
Pale-winged Starling	***Onychognathus nabouroup***				**Near-endemic**	**x**		
Pied Crow	***Corvus albus***							**x**
Pink-billed Lark	*Spizocorys conirostris*				Near-endemic			
Pririt Batis	*Batis pririt*				Near-endemic			
Pygmy Falcon	***Polihierax semitorquatus***						**x**	
Red Lark	***Calendulauda burra***	**VU**	**VU**	**Endemic**	**Endemic**	**x**	**x**	
Red-headed Finch	*Amadina erythrocephala*				Near-endemic			
Rock Kestrel	***Falco rupicolus***						**x**	
Rock Martin	*Hirundo fuligula*							
Rufous-eared Warbler	*Malcorus pectoralis*				Endemic			
Sabota Lark	*Calendulauda sabota*				Near-endemic			
Scaly-feathered Finch	*Sporopipes squamifrons*				Near-endemic			
Sclater's Lark	***Spizocorys sclateri***	**NT**	**NT**	**Near endemic**	**Endemic**	**x**	**x**	
Secretarybird	***Sagittarius serpentarius***	**VU**	**VU**			**x**	**x**	**x**
Sickle-winged Chat	***Cercomela sinuata***			**Near endemic**	**Endemic**	**x**	**x**	
Sociable Weaver	***Philetairus socius***				**Endemic**	**x**		
Southern Double-collared Sunbird	***Cinnyris chalybeus***			**Near endemic**	**Endemic**		**x**	
Southern Masked-Weaver	*Ploceus velatus*							
Southern Pale Chanting Goshawk	***Melierax canorus***				**Near-endemic**			**x**
Speckled Pigeon	*Columba guinea*							
Spike-heeled Lark	*Chersomanes albofasciata*				Near-endemic			
Spotted Eagle-Owl	***Bubo africanus***						**x**	**x**
Stark's Lark	*Spizocorys starki*				Near-endemic			
Tractrac Chat	***Cercomela tractrac***				**Near-endemic**	**x**		
Verreaux's Eagle	***Aquila verreauxii***	**LC**	**VU**			**x**	**x**	**x**
White-backed Mousebird	*Colius colius*				Endemic			
White-throated Canary	*Crithagra albogularis*				Near-endemic			
Yellow Canary	*Crithagra flaviventris*				Near-endemic			

APPENDIX 3: ASSESSMENT METHODOLOGY

IMPACT ASSESSMENT METHODOLOGY

The assessment of the significance of impacts for a proposed development is by its nature, a matter of judgement. To deal with the uncertainty associated with judgement and ensure repeatable results, Aurecon rates impacts using a standardised and internationally recognised methodology adhering to ISO 14001 and World Bank/IFC requirements.

For each predicted impact, criteria are applied to establish the **significance** of the impact based on likelihood and consequence, both without mitigation being applied and with the most effective mitigation measure(s) in place.

The criteria that contribute to the **consequence** of the impact are **intensity** (at the indicated spatial scale), which also includes the **type** of impact (being either a positive or negative impact); the **duration** (length of time that the impact will continue); and the **extent** (spatial scale) of the impact. The sensitivity of the receiving environment and/or sensitive receptors is incorporated into the consideration of consequence by appropriately adjusting the thresholds or scales of the intensity, duration and extent criteria, based on expert knowledge. For each impact, the specialist applies professional judgement to ascribe a numerical rating for each criterion according to the examples provided in **Error! Reference source not found.**. The consequence is then established using the formula:

Consequence = type x (intensity + duration + extent).

Depending on the numerical result, the impact's **consequence** would be defined as either extremely, highly, moderately or slightly detrimental; or neutral; or slightly, moderately, highly or extremely beneficial. These categories are provided in **Error! Reference source not found.**.

To determine the significance of an impact, the **probability** (or likelihood) of that impact occurring is also taken into account. In assigning probability the specialist takes into account the likelihood of occurrence but also takes cognisance of uncertainty and detectability of the impact. The most suitable numerical rating for probability is selected from **Error! Reference source not found.** below and applied with the consequence according to the following equation:

Significance = consequence x probability

When assigning **probability** to an impact, it is vitally important to distinguish this from the concepts of **frequency <u>and</u> confidence,** with which it is sometimes confused.

- **Probability** refers to the likelihood that an impact will occur.
- **Frequency** refers to the regularity with which an impact occurs. To illustrate the difference between frequency and probability, it must be considered that something that happens infrequently may still be a certainty (i.e. have a high probability). For instance, Halley's Comet only comes close to the sun every 75 to 76 years (i.e. it has a very low frequency), but it is still a certainty.
- **Confidence** (see **Error! Reference source not found.**) refers to the degree of certainty of a prediction. Confidence may be related to any of the impact assessment criteria (extent, intensity, duration or probability) and is not necessarily only related to probability. Confidence may be influenced by any factors that introduce uncertainty into a prediction.

Depending on the numerical result of this calculation, the impact would fall into a **significance category of very low, low, moderate or high**, and the type would be either positive or negative. Examples of these categories are provided in **Error! Reference source not found.**.

Once the significance of an impact occurring without mitigation has been established, the specialist must apply his/her professional judgement to assign ratings for the same impact after the proposed mitigation has been implemented.

Lastly, a further point is important when applying these criteria to impacts:

- Specialists need to assess the impact, **not** the source or origin of the impact (i.e. the activity that causes the impact). For instance, although the activity that causes a specific impact may take place over a long period of time, this does not necessarily imply that the impact itself will persist for the same length of time. The assessment must focus on the impact (the change in the environment) rather than on the activity that causes an impact.

The tables on the following pages show the scales used to classify the above variables, and define each of the rating categories.

Table 5: Definition of extent, intensity, duration (Consequence criteria)

Criteria	Category	Description	Rank
Extent or spatial influence of impact	**National**	Beyond a 20km radius of the site	4
	Regional	Within a 20 km radius of the site	3
	Local	Within a 2 km radius of the centre of the site	2
	Site specific	On site or within the boundaries of the property	1
	None	None	0
Intensity of impact (at the indicated spatial scale) Note: this incorporates whether the type of impact is negative (-1) or positive (+1)	**High**	Natural and/ or social functions and/ or processes are *severely* altered	4 or -4
	Medium	Natural and/ or social functions and/ or processes are *notably* altered	3 or -3
	Low	Natural and/ or social functions and/ or processes are *slightly* altered	2 or -2
	Very Low	Natural and/ or social functions and/ or processes are *negligibly* altered	1 or -1
	None	Natural and/ or social functions and/ or processes remain *unaltered*	0
Duration of impact	**Permanent**	More than 10 years (after operation)	4
	Long Term	5- 10 years (after operation)	3
	Medium Term	0-5 years (after operation)	2
	Short Term	Up to 18 months	1
	None	Zero time	0

Table 6: Definition of probability criteria

Criteria	Category	Description	Rank
Probability	**Definite**	Estimated greater than 95 % chance of the impact occurring.	4
	Very likely	Estimated 50 to 95% chance of the impact occurring	3
	Fairly likely	Estimated 5 to 50 % chance of the impact occurring.	2
	Unlikely	Estimated less than 5 % chance of the impact occurring.	1
	None	Definitely no chance of occurrence	0

Table 7: Application of consequence ratings

Range		Consequence Rating
-12	-11	**Extremely detrimental**
-10	-9	**Highly detrimental**
-8	-7	**Moderately detrimental**
-6	-5	**Slightly detrimental**
-4	4	**Negligible**
5	6	**Slightly beneficial**
7	8	**Moderately beneficial**
9	10	**Highly beneficial**
11	12	**Extremely beneficial**

Table 8: Application of significance ratings

Range		Significance Rating
-48	-37	**High – negative**
-36	-25	**Moderate - negative**
-24	-13	**Low – negative**
-12	-3	**Very low – negative**
-2	2	**Neutral**
3	12	**Very Low - positive**
13	24	**Low – positive**
25	36	**Moderate – positive**
37	48	**High – positive**

Despite attempts at ensuring objectivity and impartiality, environmental assessment remains an act of judgement and can never escape the subjectivity inherent in attempting to define significance. The determination of the significance of an impact depends on context (spatial and temporal) and intensity of that impact. Since the rationalisation of context and intensity will ultimately be prejudiced by the observer, there can be no wholly objective measure by which to judge the components of significance, let alone how they are integrated into a single comparable measure.

This notwithstanding, in order to facilitate informed decision-making, environmental assessments must endeavour to come to terms with the significance of the environmental impacts. Recognising this, Aurecon has attempted to address potential subjectivity in the current Basic Assessment process as follows:

- Being explicit about the difficulty of being completely objective in the determination of significance, as outlined above;
- Developing an explicit methodology for assigning significance to impacts and outlining this methodology in detail. Having an explicit methodology not only forces the specialist to come to terms with the various facets that contribute to significance (thereby avoiding arbitrary assessment), but also provides the reader with a clear summary of how the specialist derived the significance; and
- Utilising a team approach and internal review of the assessment to facilitate a rigorous and defendable system.

Although these measures may not totally eliminate subjectivity, they provide an explicit context within which to review the assessment of impacts.

The specialists appointed to contribute to this impact assessment have empirical knowledge of their respective fields and are thus able to **comment on the confidence** they have in their findings based on the availability of data and the certainty of their findings (example provided in Table 9).

During the assessments specialists are requested to note the **Reversibility** of the impacts and **Irreplaceability** of the resource being assessed (refer to Table 10 and Table 11, respectively).

Table 9: Definition of confidence ratings

Rating	Criteria
Certain	Wealth of information on and sound understanding of the environmental factors potentially influencing the impact.
Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.
Unsure	Limited useful information on and understanding of the environmental factors potentially influencing this impact.

Table 10: Definition of reversibility ratings

Rating	Criteria
Irreversible	The activity will lead to an impact that is permanent.
Reversible	The impact is reversible, within a period of 10 years.

Table 11: Definition of irreplaceability ratings

Rating	Criteria
Low	The resource is not damaged irreparably or is not scarce
Medium	The resource is damaged irreparably but is represented elsewhere
High	The resource is irreparably damaged and is not represented elsewhere

Definition of reversibility ratings

Rating	Descriptor
Low	The affected environment will not be able to recover from the impact - permanently modified
Medium	The affected environment will only recover from the impact with significant intervention
High	The affected environmental will be able to recover from the impact

Definition of irreplaceability ratings

Rating	Descriptor
Low	The resource is not damaged irreparably or is not scarce
Medium	The resource is damaged irreparably but is represented elsewhere
High	The resource is irreparably damaged and is not represented elsewhere

APPENDIX 4: LIST OF EXISTING AND PROPOSED RENEWABLE ENERGY PROJECTS

Project	DEA Reference No	Technology	Capacity	Status of Application / Development	Avifaunal specialist study conducted	Recommendations pertaining to avifauna
Sol Invictus 4 PV solar facility	14/12/16/3/3/2/871	PV	150MW	Approved	Yes	Key finding: Construction activities must be timed to avoid the main breeding season of Karoo Korhaan, Burchell's Courser and Ludwig's Bustard
Sato Energy Holdings Photovoltaic Project	12/12/20/2334/7	PV	500MW	Lapsed?	No	The main conservation objectives for birds on Portion 3 of the farm Zuurwater 63 are to retain untransformed the mountains and their gravel skirts, the deep red sands and dunes, and as much as possible of the Koa River washes and pans, together with whatever of the adjacent grassy plains is not transformed by the proposed solar PV electricity generation facility. The mountains, pans and dunes should be designated sensitive areas and excluded from any development, apart from low densities of livestock grazing.
Boesmanland solar farm portion 6 (A portion of portion 2) Farm 62 Zuurwater, Aggeneys, Northern Cape	14/12/16/3/3/2/222	PV	75MW	Approved	?	Could not source any relevant documentations on the internet
Proposed 70MW Orlight SA Photovoltaic Solar Power Plant on Portion 1 of the Farm Aroams 57 RD near Aggeneys	12/12/20/2630/	PV	70MW	Approved	?	Could not source any relevant documentations on the internet
Bloemhoek 75MW Solar Energy Facility	14/12/16/3/3/2/448/9	PV	75MW	Approved	?	Could not source any relevant documentations on the internet
Veld PV South	?	PV	75MW	Pending	Yes	Construction activity should be restricted to the immediate footprint of the infrastructure. Measures to control noise and dust should be applied according to current best practice in the industry. Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned. The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of transform A single perimeter fence should be used. Alternatively, the two fences should be at least 4 metres apart to allow medium to large birds enough space to take off. ed areas is concerned. The final pole design must be signed off by the bird specialist to ensure that no electrocution risk will be present for priority species. With regards to the infrastructure within the substation yard, the hardware is too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if any impacts are recorded once operational, site specific mitigation be applied reactively. A walk-through must be conducted once the final pole positions have been pegged to demarcate the sections requiring marking with Bird Flight Diverters.