Great Karoo Wind Energy Facility: Updated Bird Impact Assessment

On behalf of

Savannah Environmental (Pty) Ltd

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1 INTRODUCTION

1.1 Background

It is understood that Great Karoo Wind Farm (Pty) Ltd ('the Developer') received environmental authorisation (EA) for the construction of the Great Karoo Wind Energy Facility (WEF), near Sutherland, Northern Cape Province (previously part of the larger Hidden Valley WEF).

Savannah Environmental Pty Ltd (Savannah) conducted the Environmental Impact Assessment (EIA) study, and had previously appointed the Endangered Wildlife Trust (EWT) to conduct the specialist avifaunal assessment. The Avifaunal Impact Assessment report (EWT, 2012) was submitted with Final Environmental Impact Report (FEIR). Following submission of the Final Environmental Impact Report (FEIR) to the Department of Environmental Affairs (DEA) in 2012, it was requested by DEA that 4 seasons of site specific bird monitoring be conducted prior to Environmental Authorisation (EA) being issued, and for the baseline data to inform the final preconstruction monitoring report containing the updated assessment. The EWT was subsequently appointed to develop and implement such a monitoring programme and produced an updated avifaunal impact assessment, informed by 12 months of monitoring, as part of their final monitoring report (EWT, 2014).

The original authorised layout (and the one which EWT (2014) based their assessment) consisted of 56 wind turbines each with a 120 m rotor diameter and a hub height of up to 120 m. In 2016 Arcus produced an updated avifaunal impact assessment (Arcus, 2016) based on a proposed change in turbine numbers to 52 and rotor diameter up to 140 m and hub height up to 120 m. That amendment was approved, as well as a validity extension of the EA until 12 August 2019.

The Developer is proposing to amend the EA as follows:

- Increase hub height to up to 150m;
- Increase rotor diameter to up to 180m;
- Decreased number of turbines to 42;
- Increase rated power of turbines to up to 6.5MW per WTG;
- Potential increase to WTG foundation area and laydown area;
- Update the layout as required; and
- Extend the validity period by an additional 5 years.

1.2 Terms of Reference

Arcus were appointed by Savannah to review the applicable bird information relating to the assessment of impacts for the Great Karoo WEF, and then to re-assess the impacts based on a change in rotor diameter and turbine layout. The reduced number of turbines in the layout, is an indirect result of the increased rated power, as this would allow more advanced and higher generating turbines to be used, requiring less turbines for the same MW output previously authorised. More specifically the report must reflect:

- An assessment of all impacts related to the proposed change and based on current information and understanding of WEF impacts in South Africa;
- Advantages and disadvantages associated with the proposed change; and
- Mitigation measures to ensure avoidance, management and mitigation of impacts.

2 METHODOLOGY

2.1 Document and Data Review

In order to understand the baseline avifauna environment as well as avifaunal issues relating to the project, Arcus reviewed the following documents, data and sources of information applicable to the Great Karoo WEF:

- Endangered Wildlife Trust (EWT), 2012. Hidden Valley Wind Energy Facility, Northern Cape. Avifaunal Impact Assessment EIA Report: February 2012
- EWT, 2014. Three Phased Hidden Valley Wind Energy Facility. Pre-construction Bird Monitoring Report and Updated Avifaunal Assessment. April, 2014.
- Arcus, 2016. Great Karoo Wind Energy Facility: Updated Bird Impact Assessment. Version 1: March 2016.
- The most recent data available online from the South African Bird Atlas Project 2 (SABAP2) of the Animal Demography Unit (ADU), University of Cape Town (UCT). These data were examined to identify if any additional relevant priority species[1] and/or raptors have been recorded in the area covering and surrounding the project site, following the completion of the abovementioned studies.

2.2 Literature Review

In order to understand the mechanism resulting in bird collisions with wind turbines, and a resultant potential change with an increased rotor diameter and increased hub height and a reduced number of turbines, a brief literature review on this topic was conducted.

2.3 Site Visit

Considering that the last site work was conducted by EWT in 2014 and to further advise the updated impact assessment, the specialist and an assistant visited the site over four days (05-08 February 2019).

The aim of the site visit was to conduct a nest search for raptor nests, with a focus cliff nest sites of Verreaux's Eagle, although other cliff nesting raptors (e.g. Jackal Buzzard, Booted Eagle and Lanner falcon) would be recorded if found. A number of potential cliff sites were first identified using Google Earth, and were then visited using a 4 x 4 vehicle and traversing on foot (where possible) and surveyed accordingly. Relevant electricity pylons and stands of alien trees were also surveyed on an ad hoc basis

If nests are found, the specialist attempted to determine the species utilising the site and status of the nest (active or inactive), however no long term observations of located nests will be conducted as visiting the most prominent cliffs/ridges to locate nests was the main aim (as opposed to determining the current status of a nest once located).

2.4 Impact Assessment

The applicable bird impacts, as identified and rated by Arcus (2016), were evaluated and where applicable were re-rated using the same criteria used in the original assessment. The re-rating was done by considering all applicable information which included: i) a literature review; ii) review of applicable documents; iii) the latest available information on WEF impacts on birds in South Africa; iv) the specialists experience of monitoring at various

[1] Species with a priority score of 170 or more, as calculated by Birdlife SA in the 2014 update: Retief, E.F, Diamond, M., Anderson, M.D., Smit, Dr. H.A., Jenkins Dr. A. & Brooks, M. 2011, updated 2014. Avian Wind Farm Sensitivity Map for South Africa: Criteria and Procedures Used.

operational WEFs) the proposed changes to the Great Karoo WEF layout and turbine specifications.

3 REVIEW RESULTS

3.1 Original Avifaunal Impact Assessment for the Hidden Valley WEF (EWT, 2012).

The original assessment was done in February 2012, and was based on a detailed desk-based analysis of available data, as well as a site visit by the specialist over four days in August 2011. The key findings of this study can be summarised as follows:

- Identified avifaunal micro-habitats are cultivated lands, shrublands, dams, rivers, streams, drainage lines, hills, ridges and thickets.
- SABAP1 Data considered recorded Martial Eagle, Ludwig's Bustard, Black Stork, Greater Flamingo and Black Harrier. The former two species were relatively regularly recorded and abundant in this data set.
- 39 species were recorded during the site visit including the following priority species and/or raptors: Black Stork, Black-shouldered Kite, Jackal Buzzard, Pale Chanting Goshawk, Rock Kestrel, and Southern Black Korhaan.
- A list of 'target species' was identified as being "*the most important species to be considered (for assessment)*" and these were: Ludwig's Bustard, Black Stork, Southern Black Korhaan, Martial Eagle, Jackal Buzzard, Greater Flamingo, Lesser Kestrel, and assorted waterfowl and waders.
- In general, the site was found to be moderately sensitive in terms of avifauna.
- The most important potential impacts of the proposed development will be collision of certain bird species with the turbine blades, and collision of birds with the associated power lines.
- It was concluded by EWT (2012) that "*the proposed facility has the potential to significantly impact on avifauna in the area, although our confidence in this assessment is low due to the lack of operation experience of commercial scale wind farms in South Africa. There are no fatal flaws associated with the site, and the project should proceed subject to the mitigations, recommendations and conditions contained in this report*".
- One of the main recommendations was to implement a one year pre-construction monitoring programme to advise the final turbine layout.

3.2 Pre-construction Bird Monitoring Report and Updated Avifaunal Assessment for the Three Phased Hidden Valley Wind Energy Facility (EWT, 2014).

This study was conducted by the Endangered Wildlife Trust (EWT, 2014) on the Hidden Valley Wind Energy Facility site, which subsequently has been re-named according to its various phases, one of which is the Great Karoo WEF. When interpreting this data, in the context of the current updated assessment specific only to the Great Karoo WEF, it is important to note that this study was conducted over a larger area comprising the three-phased Hidden Valley WEF. The data was not broken down in to the different phases, and therefore it can't be determined which data (if any) is only applicable and/or not applicable to the Great Karoo WEF.

The study was completed in autumn 2014 and was conducted in line with the applicable monitoring guidelines at the time. It consisted of various sampling methods including walked transects, vehicle transects, vantage points and focal sites, and included four seasonal surveys across a 12 month period.

3.2.1 General

Appendix B of the EWT (2014) report included 149[2] species, including 20 priority species (Retief, *et.al.* 2011) and 9 Regional Red Data species (Barnes, 2000).

Of the priority species recorded, nine (five of which have Red Data Status-Taylor, 2015) were not recorded in the updated SABAP2 data examined (Section 3.3 of this report), namely Black Harrier (*Endangered*), Black Stork (*Vulnerable*) Blue Crane (*Near-threatened*), Black-shouldered Kite, Lanner Falcon (*Vulnerable*), African Harrier-hawk, Cape Eagle-Owl, African Rock Pipit (*Near-threatened*), and Black Sparrowhawk. Additional non-priority species raptors recorded were Western Barn Owl, and Gabar Goshawk.

Monitors identified no less than five separate individual Martial Eagles across the entire site, including an unusual observation of four individual adults soaring in one location, and one juvenile in another location which allows 100% certainty of five Martial Eagles. It was suspected that Martial Eagle are breeding within the greater Hidden Valley WEF, however a nest location could not be confirmed. There were at least three Verreaux's Eagles, two adults and a juvenile utilizing the study site, although a nest site could not be located. It was noted that no specific 'specialist nest survey' was conducted, specifically attempting to locate nests of these species.

3.2.2 Walked Transect Data Summary

Species that were recorded in abundance by walked transect surveys included: Blacksmith Lapwing, Cape Wagtail, Cape Sparrow, Egyptian Goose, South African Shelduck, Spur-winged Goose, Ant-eating Chat, Bokmakierie, Cape Clapper Lark, Cape Bunting, Cape Weaver, Grey-backed Cisticola, Karoo Prinia, Large-billed Lark, Karoo Scrub-robin, White-throated Canary and Yellow Canary. The small terrestrial species that were recorded during the walk transects, were generally not threatened or restricted in range. The study found "*a low IKA* (Index of Kilometric Abundance) *of 1.23 priority species per kilometre observed on site"*. It stated the "*abundance of non-priority species on site is 88.73 birds per kilometre indicating a significantly larger abundance in comparison to priority species observed on walk transects".*

3.2.3 Vehicle Transect Data Summary

Pale Chanting Goshawk, Southern Black Korhaan, Rock Kestrel and Jackal Buzzard were the most abundant species observed on vehicle transects, and the report stated "*As a result of the low number of bird individuals recorded in the drive transects and the length of the total transects required on this large site, the IKA's for priority species are considered to be low with the total abundance being 0.19 birds per km*".

3.2.4 Flight Activity Summary

Flight activity data reported that there were 600 flights of priority species, representing 13 species[3], recorded of which 268 were within the potential rotor swept height (RSH).

The total flight duration of all priority species flights was 22 hours, of which 11 hours and 53 minutes was deemed to be at potential RSH. The average duration of flights was 2.6 ± 3 minutes, which is long in the experience of the specialist.

The species most regularly recorded flying from VP watches was Rock Kestrel (38 % of flights) followed by Verreaux's Eagle (19%), Jackal Buzzard (16%) and Martial Eagle 7%).

[2] Arcus assumes that one of these species, the Red-winged Warbler, was a misidentification or typing error and therefore the actual number recorded is 148.

[3] As defined by EWT, 2014, and Including Gabar Goshawk and Rock Kestrel.

These four priority species with the highest number of individual flights also had more than 50% of their flights at potential RSH as does the Ludwig's Bustard. The Booted Eagle had 100% of its recorded flights (five in total) observed at RSH. The report therefore stated that "*These species are considered to be at high risk with turbine collision should turbines be placed in their preferred flight paths*."

It is noted that the study based RSH upon outdated turbine specifications, and therefore flight height information (and conclusions based upon such information) is not relevant to the current proposed turbine specifications and should be interpreted with caution.

An analysis of flight activity data against environmental factors concluded that "*flights are affected by temperature, no significant relationship was determined on the site for wind speed and wind direction*".

3.2.5 Sensitive Zones and Exclusion Zones

Based on flight activity and landscape features, the study identified sensitivity zones as follows:

- High sensitivity: The high sensitivity zones include the Rivers and Streams in the study area buffered by 150 m on either side. These areas also include high sensitivity areas based on flight activity, and were called 'Exclusion Zones', it was stated that "*These areas have been considered in the final layout of the facility when positioning the wind turbines. The developer has complied with the EWTs recommendation that turbines positioned within these zones be moved, especially those along ridge edges, which should be moved 100m (or more) back from the ridge edge*."
- Medium Sensitivity: The medium sensitivity zones identified are farm dams as well as certain low risk ridges. EWT stated "*These dams and ridges were primarily identified at a desk top level while the presence were confirmed during the site visit as being potentially important to avifauna. However, construction of infrastructure is possible, with caution, in these areas with medium likelihood*."
- Low Sensitivity: These are the remaining areas where no obvious avifaunal features or patterns could be identified during the study. EWT stated that "*some areas could be designated as Medium in the future upon availability of new data and/or after additional site analysis or pre-construction monitoring*" and that "*there is no proven reason that infrastructure should not be built in these areas. Therefore, these Low sensitivity areas are preferred for construction*".

The study then summarised the sensitivity for each phase. It must be noted that the following comment was made regarding two ridges in the north east of the Great Karoo site: "*Limited bird flight data was collected in this area (i*.e. two parallel ridges running south-west to north-east*) due to access and limited viewshed, but it is predicted to be a potentially higher risk area from the model due to its suitable habitat*".

3.3 South African Bird Atlas Project Data

South African Bird Atlas Project Data (SABAP2) data[4] were examined by Arcus to identify recent reporting rates for priority species and raptors recorded in five Pentads (Figure 1); one containing proposed turbine locations (3245_2040) and four from surrounding pentads (3240_2040; 3240_2045; 3250_2035; and 3240_2050).

A total of 15 priority species or raptors were recorded by the SABAP2 data considered, of which one species (Rock Kestrel) is not a priority species (Table 1). Five regional Red Data (Taylor, 2015) priority species or raptors were recorded, including two classified as *Endangered*: Ludwig's Bustard and Martial Eagle. Priority species or raptors with relatively high reporting rates and/or recorded across three or more pentads considered were the

[4] http://sabap2.adu.org.za/ (Accessed 21/01/2019)

Grey-winged Francolin, Jackal Buzzard, Karoo Korhaan, Southern Black Korhaan, Martial Eagle, Verreaux's Eagle, Spotted Eagle-owl, Pale Chanting Goshawk and Rock Kestrel. Of the species identified in Table 1, Black-chested Snake-eagle, Booted Eagle, Grey-winged Francolin, Rufous-breasted Sparrowhawk, Southern Black Korhaan and Verreaux's Eagle were not listed in the SABAP1 or SABAP2 data provided by EWT, 2012.

Table 1: Priority Species and Raptors Recorded in the SABAP2 Pentad Squares (accessed 21/01/2019)

Species	Priority Species Score	Regional Red Data Status	Pentad Report Rate (%)				
			3245_2040*	3240_2040	3240_2045	3250_2035	3240_2050
Total Species			53	83	88	79	50
Number of Cards Submitted[5]			2	10	15	9	3
Black-chested Snake-eagle	230	-	-	20	-	-	-
Booted Eagle	230	-	50	-	-	-	-
Grey-winged Francolin	190	-	50	-	73.3	-	-
Jackal Buzzard	250	-	50	70	66.7	55.6	100
Karoo Korhaan	240	NT	-	-	26.7	11.1	33.3
Lesser Kestrel	214	-	-	20	-	-	-
Ludwig's Bustard	320	EN	-	-	13.3	-	-
Martial Eagle	350	EN	-	30	20	22.2	-
Pale Chanting Goshawk	200	-	-	20	46.7	22.2	Ad hoc
Rock Kestrel	-	-	50	40	53.3	55.6	66.7
Rufous-breasted Sparrowhawk	170	-	-	20	-	22.2	-
Spotted Eagle-owl	170	-	-	-	6.7	100	-
Southern Black Korhaan	270	VU	50	50	40	-	-
Steppe Buzzard	210	-	-	30	13.3	-	-
Verreaux's Eagle	360	VU	50	20	6.7	-	66.7

** Pentads containing proposed Great Karoo WEF turbines. EN=Endangered; VU=Vulnerable; NT=Near-threatened*

3.4 Site Visit Findings (2019)

While access to some of the ridges and valleys in the north east of the WEF was challenging, the specialist was able to survey the majority of identified cliffs and is satisfied with the search effort completed. Three nests (N1-N3) were identified within or in the near vicinity of the Great Karoo Wind Farm, two on cliffs and one in a stand of trees. These are described in more detail below and their locations are shown in Figure 1.

[5] Each time that birds in a pentad have been counted by a citizen scientist registered with the ADU, a pentad 'card' is submitted online to the ADU. The number of cards therefore indicate the number of times a pentad has been counted.

- **N1**: A medium sized stick nest in a sheltered corner/crevice of a cliff. Access was difficult and this nest site was viewed from distance (i.e. approximately 750 m away in the valley below). It is highly likely a raptor nest, and there is a possibility that it is a Verreaux's Eagle nest site. A single adult Verreaux's Eagle was seen flying within 1 km of this site, but no birds were seen on or near the nest. It is noted though that is could also possibly be used by White-necked Ravens and a pair of this species was observed in the vicinity.
- **N2:** A small/medium stick nest. Viewed at a distance of approximately 300 m in poor light conditions. It is likely a raptor nest (possibly Booted Eagle or Jackal Buzzard). It was grey and dry, with no evidence of recent use.
- **N3:** A medium stick nest in a large stand of Poplar trees. No birds seen on or near nest. Nest had some evidence (e.g. feathers on nests and white-wash below) of recent use although species could not be confirmed with certainty. It possibly could be nest of a Martial Eagle, although Jackal Buzzard or Black Sparrowhawk could not be discounted.

A total of 64 species were recorded during the site visit and incidental and ad-hoc observations of priority species or raptors on the WEF site included: Ludwig's Bustard (one sighting of one adult); Verreaux's Eagle (one sighting of one adult); Jackal Buzzard (three sightings of at least two different adults); Steppe Buzzard (one sighting of one adult); Booted Eagle (two sightings of two different adults); Rufous-breasted Sparrowhawk (two sightings of two different adults); Martial Eagle (one sighting of one juvenile); Grey-winged Francolin (numerous sightings of a number of flocks); Greater Kestrel (one sighting of one adult) and Rock Kestrel (numerous sightings of at least five different adults). The juvenile Martial Eagle was seen approximately 1.5 km south east of nest site N3, indicating (but not confirming) the possibility of the nest being used by this species.

3.5 Literature Review

Large turbines are more efficient, therefore most modern wind developments for a given number of megawatts have fewer turbines with wider spacing. However, wider and longer blades produce greater vortices and turbulence in their wake as they rotate, posing a potential problem for bats (and some birds). Larger turbines have fewer rotations per minute but have similar blade tip speeds compared to the smaller turbines commonly used in older wind facilities (NWCC 2010). It is believed this difference may be partly responsible for the lower raptor collision rates observed at most wind facilities where larger turbines have been installed, but that the main reason is because fewer larger turbines are needed to produce the same energy as smaller turbines. NWCC (2010) does note though that because the transition to larger turbines has largely coincided with a number of other transitions in turbine technology and siting practice, it is difficult to separate the individual effects and thereby determine the degree to which turbine size affects raptor collision rates.

It is likely that the level of bird use and their behaviour at the site, as well as elevation and topography are more important factors to consider than turbine size and rotation speed when assessing potential collision risk (Watson *et al*. 2018).

In Spain taller and higher elevation turbines were more likely to kill soaring birds than shorter turbines at lower elevations. In the US repowering with fewer, taller, slower-moving turbines reduced collisions. Other studies (Barrios & Rodriguez, 2004; Stewart *et al.* 2007) also found that the size and alignment of turbines and rotor speed are likely to influence collision risk; however, physical structure is probably only significant in combination with other factors, especially wind speed, with moderate winds resulting in the highest risk. In fact, Barrios & Rodriguez (2004) found tower structure to have no effect on mortality, and that mortality may be directly related to abundance for certain species (e.g. Common Kestrel). They concluded that physical structures had little effect on bird mortality unless in combination with other factors. Somewhat conversely, De Lucas *et al*. 2008 found that

turbine height and higher elevations may heighten the risk (taller/higher = higher risk), but that abundance was not directly related to collision risk, at least for Eurasian Griffon Vulture. De Lucas et al. 2008 stated "*All else being equal, more lift is required by a griffon vulture over a taller turbine at a higher elevation and we found that such turbines killed more vultures compared to shorter turbines at lower elevations*".

Howell *et al.*, 1997 found that the evidence to date from the Altamont Pass did not support the hypothesis that the larger rotor swept area (RSA) results in more mortalities. On the contrary it was found that the ratio of smaller to larger turbines rather than RSA was consistent with the mortality ratio, and that it appeared that the mortality occurred on a per-turbine basis, i.e. that each turbine simply presented an obstacle.

Barclay *et al.* 2007 reviewed data from North American wind energy facilities and found that diameter of turbine rotor did not influence the rate of bird or bat fatality. The height of the tower had no effect on bird fatalities per turbine, but bat fatalities increased exponentially with tower height.

Krijgsveld *et al.* 2009 found that collision risk of birds with larger multi-MW wind turbines is similar to that with smaller earlier-generation turbines, and much lower than expected based on the large rotor surface and high altitude-range of modern turbines. Smallwood *et al.* 2013 found that Red-tailed hawk and all raptor fatality rates correlated inversely with increasing wind-turbine size.

Everaert, 2014 states *"Combined with the mortality rates of several wind farms in the Netherlands (in similar European lowland conditions near wetlands or other areas with water), no significant relationship could be found between the number of collision fatalities and the rotor swept area of the turbines. In contrast to more common landscapes, Hötker (2006) also found no significant relationship between mortality rate and the size of wind turbines near wetlands and mountain ridges."*

One would initially assume that a larger RSA would mean an increase in the risk of collision. In the case of Great Karoo WEF 56 turbines with a rotor diameter of 120 m would have a combined RSA of approximately 633,343.2 m^2 (or ~63.33 ha), 52 turbines with a rotor diameter of 140 m would have a combined RSA of ~80.05 ha, while 42 turbines with a rotor diameter of 140 m have a combined RSA of approximately 1,068,768.9 m^2 (or ~106.8 ha). Although there are ten less turbines in the proposed amendment compared to the current approved layout, there is an increase in total RSA of approximately 26.7 ha. However, as can be seen from the above literature survey, most published findings indicate that rotor swept area is not a key factor in the collision risk. Turbine dimensions seem to play an insignificant role in the magnitude of the collision risk in general, relative to other factors such as topography, turbine location, turbine numbers, species abundance, morphology and a species' inherent ability to avoid the turbines, and may only be relevant in combination with other factors, particularly wind strength and topography. The reduction in turbine numbers is likely to be a more critical factor in the overall significance of the collision risk of a project.

4 IMPACT ASSESSMENT

EWT (2014) updated the avifaunal impact assessment done by EWT (2012), based on the findings of their pre-construction surveys for the following impacts:

- Construction Phase: Disturbance of birds and Habitat destruction.
- Operational Phase: Collision with turbines; Collision with associated overhead power lines; Electrocution on associated overhead power lines; Disturbance during operation and maintenance; and Disruption in local bird movement patterns.

Arcus (2016) then updated the assessment applicable to the Great Karoo WEF. This report (Arcus, 2019) now presents updated ratings of the impacts presented by Arcus (2016).

The evaluation and re-rerating was done in order to determine if the proposed change in rotor diameter (and related reduction in the number of proposed turbines from 52 to 42) will have any impact on the significance of the findings previously identified by Arcus, 2016. Impacts were re-rated for both 'Without Mitigation' and 'With Mitigation' scenarios and in specific relation to the revised 42 turbine layout, after examining this layout against the exclusion zones and sensitivities defined by EWT (2014). All mitigations given in Tables 2-8 in the Arcus 2016 report remain relevant and must be implemented. Additional mitigation recommendations based upon the findings of this updated assessment are given in Section 5 below.

Table 2 shows a summary of the bird impacts as rated by Arcus (2016) for the currently authorised layout and project description (i.e. the 52 turbine layout). Arcus determined whether the significance of each impact (as authorised) would change due to the proposed amendment, and this is shown in the last column in Table 2 below. This determination of a change in significance was made by considering all applicable information which included: i) a literature review; ii) review of applicable documents; iii) the latest available information on WEF impacts on birds in South Africa; iv) the specialists experience of monitoring at various operational WEFs and V) the proposed changes to the Great Karoo WEF layout and turbine specifications.

Table 2: Summary of the Avifauna Impact Assessment from Arcus, 2016

Phase	Impact	Significance Without-Mitigation	Significance With-Mitigation	Significance[6] will change due to Proposed Amendment (Y/N)
Construction	Disturbance	Medium	Low	N
	Habitat Destruction	Medium	Medium	Y
Operational	Collision with turbines	Medium	Medium	N
	Collision with associated overhead power lines	Medium	Medium	N
	Electrocution with associated overhead power lines	Medium	Low	N
	Disturbance during operation and maintenance	Medium	Low	N
	Disruption of local bird movement patterns	Medium	Low	N
N/A	Cumulative Impacts on Birds	High	High	N

It was determined that the significance scores of all impacts except one, are likely to remain unchanged. The significance score for the impact of habitat destruction during construction is reduced (Table 3 below). This is primarily because the amended layout will have 10 less turbines and associated platforms, roads, foundations etc.

[6] Refers to the actual numerical significance score, and not necessarily the significance category of Low/Medium/High

Table 3: Updated Impact Table for Habitat Destruction

Nature: Destruction of habitat used by birds				
	Authorised		**Proposed Amendment**	
	Without mitigation	**With mitigation**	**Without mitigation**	**With mitigation**
Extent	2 (local)	1 (local)	2 (local)	1 (local)
Duration	4 (long term)	4 (long term)	4 (long term)	4 (long term)
Magnitude	4 (low)	3 (minor-low)	3 (minor-low)	1 (minor)
Probability	5 (definite)	5 (definite)	5 (definite)	5 (definite)
Significance	**50 (Medium)**	**40 (Medium)**	**45 (Medium)**	**30 (Medium)**
Status (positive or negative)	Negative	Negative	Negative	Negative
Reversibility	Medium	Medium	Medium	Medium
Irreplaceable loss of resources?	No	No	No	No
Can impacts be mitigated?	Partially	Partially	Partially	Partially
Mitigation: • Strict control over contractors, to ensure only the minimum required areas is cleared. • No off-road driving. • Minimize footprint areas, road lengths, road widths, wherever possible during the final layout design. • Where possible existing roads must be used and batching plants, labour camps, equipment storage, etc. should be situated in areas that are already disturbed. • A full site specific EMP must also be compiled to specify all of the impacts and mitigation measures and provide a step by step programme to follow for the ECO on site. • Construction of infrastructure must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible. • Prior to construction, an avifaunal specialist should conduct a site walkthrough, covering the final road and power line routes as well as the final turbine positions, to identify any nests/breeding activity of sensitive species, as well as any additional sensitive habitats within which construction activities may need to be excluded. • Any clearing of stands of alien trees on site should be approved first by an avifaunal specialist. • Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and to this end a habitat restoration plan is to be developed by a specialist and included within EMP.				
Cumulative impacts: Multiple WEFs may result in a larger habitat destruction impact on birds, which could potentially be Medium significance after mitigation is applied at all facilities.				
Residual Risks: Residual impacts will be medium in the long term -Habitat destruction will be long-term for the operational life of the facility, with little options to mitigate. Over the very long term, the residual impacts could be low if the facility is decommissioned, infrastructure removed and habitat is re-habilitated				

It was found that the new layout predominantly adheres to the recommendations and exclusion areas given by EWT (2014). Therefore, as was done by EWT (2014) this 'embedded design mitigation' was already considered in the 'Without Mitigation' rating. Figure 1 shows that four turbines in the new proposed layout (i.e. GK23, GK32, GK34 and GK39) are situated within exclusion zones. Three of these (i.e. GK23, GK32 and GK34) are very close to the edges of the zones, and will be moved outside of these zones. Considering the resolution and coarseness of the spatial slope and aspect data used by EWT in their modelling, the fact that the number of turbines in now reduced to 42, and the fact that the site in the most part has low levels of priority species flight activity and no eagle nest have been confirmed on or near the site, it is acceptable to the specialist that one turbine (GK39) remains within the current exclusion zone. This is unlikely to result in a significant increase in the overall collision impact rating of the site.

South Africa has experienced an increase in the number of wind energy developments (both in terms of applications and those that are operational) in the past six years, but still lacks some information about the effects that these developments have on certain aspects of the environment. In South Africa, while post-construction monitoring is being conducted on the majority of operational sites, publically available data and information of operational results is limited and restricted to information supplied to BirdLife SA and made available by them to the public in the form of a report (Ralston Paton et al. 2017), and a public presentation (BLSA 2017a).

International experience, and results from South Africa have shown that birds can be impacted negatively by wind farms and that the severity of these impacts can differ drastically from site to site (Bose *et al.* 2018; Grünkorn *et al.* 2017; Ralston-Paton *et al.* 2017; Thaxter *et al*. 2017). Overall, it appears that severe impacts, such as the high mortality numbers of Golden Eagle observed at Altamont Pass in California (Hunt *et al.* 1998; Orloff & Flannery 1992) seem to be the exception rather than the rule, with the majority of facilities recording relatively low mortalities (Watson *et al.* 2018, Strickland *et al.* 2011; de Lucas *et al.* 2008; Erickson *et al.* 2001). The effects of one poorly placed facility, or some poorly sited turbines within a facility, can however affect the population of certain species at a regional, national or even global level (Bellebaum *et al*. 2013; Dahl *et al.* 2012; Carrete 2009). Hence, it is important to assess the impacts of wind energy facilities, and to base this assessment on a thorough investigation of the local avifauna prior to construction, which is being done for the proposed development.

4.1.1 Cumulative Impacts

Approximately 17 wind energy applications have been made within 50 km of the Great Karoo WEF, in various stages of application or development. Included in these are two projects that already have preferred bidder status in the department of Energy's Renewable Energy Independent Power Producers Procurement Programme (REIPPPP), and are due for imminent construction, namely Roggeveld Wind Farm (140 MW) and Karusa Wind Farm (140 MW), the latter of which was part of the originally proposed Hidden Valley WEF, and borders on Great Karoo WEF. Arcus (2016) have conducted a high level re-assessment of the cumulative impacts (identified by EWT (2014)), and concluded that the cumulative impacts ratings for birds with mitigation was as follows:

- Cumulative Impact Rating for Collision with Turbines: **High**
- Cumulative Impact Rating for Impacts with Overhead Power Lines: **Medium**
- Cumulative Impact Rating for Disruption in Local Bird Movement Patterns: **Medium**

The proposed amendment does not result in any new cumulative impacts or in any changes to the cumulative impact ratings as rated by Arcus in 2016.

Although the cumulative impact of collision is rated at a high level, this is done with moderate-low confidence because a detailed (and highly confident) significance rating of these cumulative impacts would depend largely on knowledge unavailable at the time of writing such as:

- The final turbine layouts of all facilities;
- If turbine placement was informed by adequate pre-construction monitoring and nest surveys (in line with applicable guidelines) on these facilities, and to what extent these layouts were in line with specialist recommendations;
- The density of the key species (e.g. Verreaux's Eagle, Martial Eagle, Ludwig's Bustard, Black Stork) populations on the facilities (i.e. the regional population of these species), and there behaviour on the different sites.
- The species richness, abundance and behaviour of the avifaunal community within and around the various WEFs;

- Whether or not mitigation measures were recommended and implemented and are successful.

Conducting such a detailed cumulative impact assessment of all of these facilities together on a regional scale is beyond the scope of this specialist study and would need the input of all proponents and specialists working on the above mentioned projects. Such an assessment is best undertaken and commissioned by an appropriate regional or national agency/agencies in the context of strategic planning, but is not required in the context of assessing this proposal. In the scope of this study it is therefore difficult to say with confidence at this stage what the cumulative impact of all the proposed developments will be on birds because there is no cumulative baseline to measure against. The extent of actual impacts on the region's avifauna will only become known once a few wind farms are developed in the Sutherland area and operational data becomes available, and regional population viability analysis have been conducted for key species. If all proposed projects that are built implement appropriate mitigation measures as well as post-construction monitoring programmes (in line with applicable guidelines) and share the information gained from these, then the overall significance of cumulative impacts may be reduced.

5 ADDITIONAL MITIGATION MEASURES

- The current best practise guidelines for pre-construction monitoring (Jenkins et al., 2015) indicate that additional monitoring may be advisable if there is a significant gap between the original assessment and the commencement of construction, to assess whether there have been any changes in species abundance, movements and/or habitat use in the interim. As the pre-construction monitoring data (EWT, 2014) is now over four years old, we recommend that additional pre-construction monitoring must be conducted. This monitoring can be refined, and focussed on the Great Karoo WEF, and it is not necessary to repeat the full protocol conducted by EWT (2014). The monitoring data collected will update the avifaunal baseline for the site, to allow for meaningful comparison with operational monitoring data, and it must also be used to inform the final micro-siting of the WEF where applicable. The additional pre-construction monitoring can take place after the current amendment decision, but must be done prior to construction, in sufficient time so as to allow the results to inform the micro-siting of the WEF site prior to any construction taking place.
- The nests sites, N1-N3, must be revisited by an avifaunal specialist during the eagle breeding season (e.g. approximately June-September) to confirm the activity of these sites and the species utilising these sites (if active). Once the above has been completed, the specialist must advise any additional recommendations and/or mitigations, which may result in a need to update the EMPr for the project and/or refine the final layout of the turbines. If any active nest sites of eagles are confirmed, these nests sites must be re-visited and regularly surveyed to determine the breeding success of eagles. Monitoring of any such active eagle nest sites should continue in to the construction phase of the project, and throughout the operational lifespan of the project, in accordance with the applicable guidelines in effect at the time.

6 CONCLUSION AND RECOMMENDATIONS

The proposed amendment will result in no change to the significance rating of the impacts of disturbance, turbine collisions, bird mortality through collision/electrocution with power lines, disruption of movement patterns, and cumulative impacts, as they have been rated previously.

The impact of bird mortalities from turbine collisions is unlikely to change because any increased risk due to an increased RSA per turbine may be offset by a reduction in the number of turbines built. The only impact rating that changes, because of a reduce number

of turbines, is that of habitat destruction which now has a lower significance score (30) with mitigation, but remains within the **Medium** category.

The additional fieldwork conducted for this assessment revealed the location of three nest sites, potentially used by raptors and possibly eagles. It is important that fieldwork be done in the eagle breeding season to determine the activity status and species utilising these sites, the results of which must inform possible additional mitigation measures and the final layout. Furthermore, all mitigation measures given previously (i.e. in Arcus, 2016) must be incorporated into the updated EMPr and implemented. This includes a thorough operational phase bird monitoring programme (in line with the guidelines applicable at the start of the operational phase) that must be implemented, and should start no later than the commercial operation date of the facility. This programme should feed back into an adaptive management strategy, which could include the need to shut down or curtail certain turbines should unacceptably high impacts be found.

Cumulative impacts remain a concern for the broader Sutherland area, with several proposed WEF projects in the region. If a number of these projects are built, it is likely that the cumulative impact of turbine collision will be high, particularly on red data eagle species such as Verreaux's Eagle and Martial Eagle, and possibly also on Ludwig's Bustard. However, the extent of actual cumulative impacts on the region's avifauna will only become known once a few wind farms are developed in the Sutherland area and operational data becomes available, and regional population viability analysis have been conducted for key species.

It is the opinion of the specialist that the above amendments can be authorised, subject to implementation of all mitigation measures.

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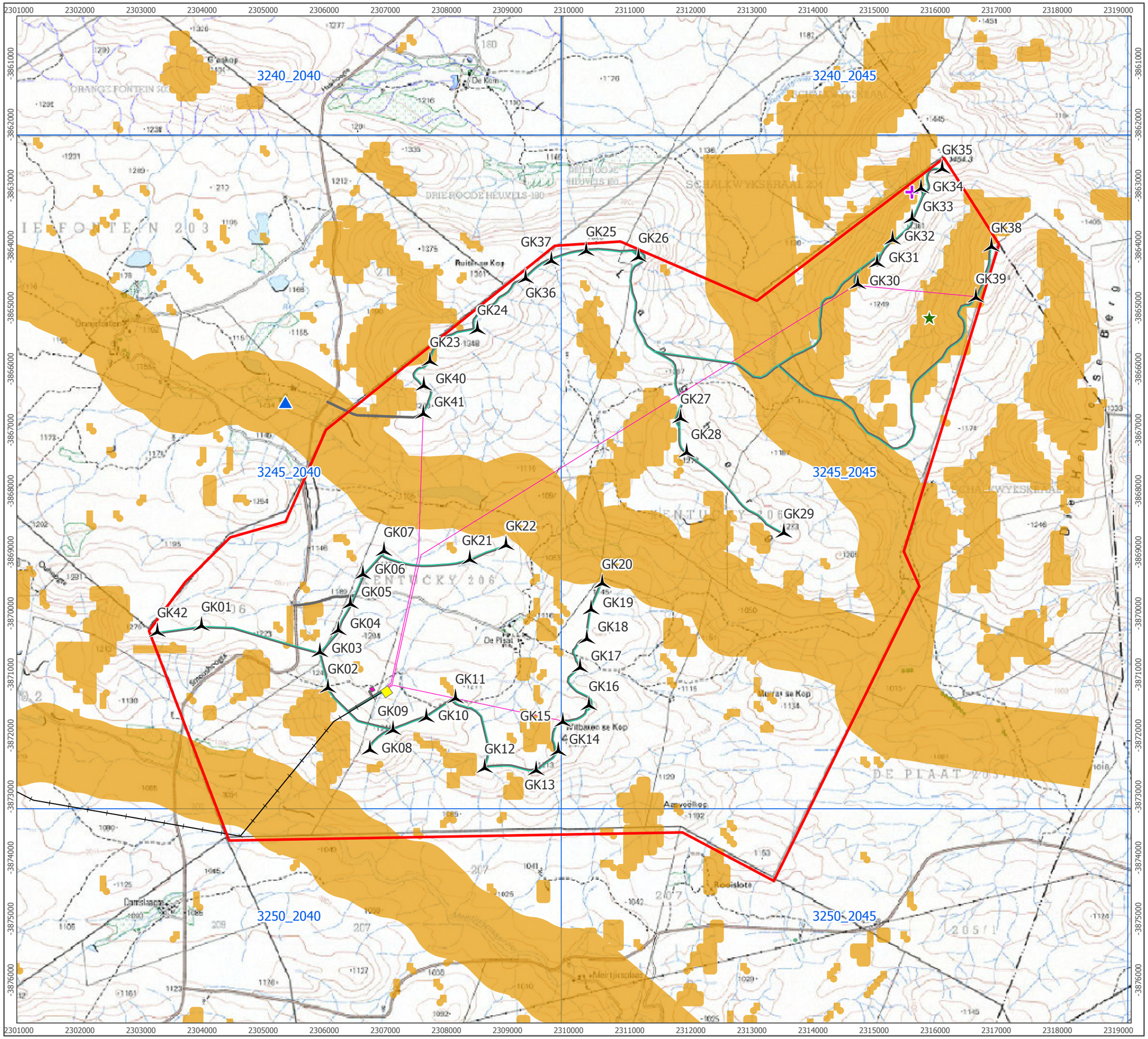

ARCUS

- Site Boundary
- SABAP2 Pentads
- Layout Being Applied For
- HV Transmission (Existing)
- MV Overhead
- MV Reticulation
- Roads (New)
- O&M Building
- Substation
- Exclusion zones

Nest Sites

- N1
- N2
- N3

1:60,000 Scale @ A3

0 1 2 km

NORTH

Produced By: MB	Ref: 2319-REP-002
Checked By: JA	Date: 26/02/2019

Proposed Turbine Layout, Exclusion Zones and SABAP2 Grid Squares
Figure 1

Great Karoo WEF
Updated Bird Impact Assessment

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