Pre-construction Avian Basic Assessment for the proposed NAMAS Wind Farm, Kleinsee, Northern Cape

Prepared for:

A JOINT VENTURE BETWEEN

genesis eco-energy DEVELOPMENTS

ATLANTIC ENERGY PARTNERS

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1 SUMMARY

Genesis Namas Wind (Pty) Limited have proposed the development of a wind energy facility (WEF) in the Renewable Energy Zone (REDZ 8) near Kleinsee, South Africa in the arid Namaqualand Strandveld. Monitoring of potential threats to the priority avifauna covered 12 months as dictated by the DEA and Birds and Renewable Energy Specialist Group (BARESG) guidelines. Kleinsee lies in the Succulent Karoo Biome of the Northern Cape and this report details the number of priority species (including all threatened and collision-prone birds) and their Passage Rates through the 28-km^2 area, proposed for development, in spring, summer, autumn and winter seasons. We then quantify and predict possible threats and impacts, and map high-risk and medium-risk areas to reduce future impacts.

The possible impacts for any wind farm include:

- Displacement and avoidance of nationally important species by the turbines;
- Loss of habitat for such species due to direct habitat destruction under the turbines;
- Disturbance during construction;
- Mortality arising from birds impacting the moving turbine blades or associated infrastructure.

The impact zone of the proposed WEF site lies within the coastal area of the Succulent Karoo biome. Dry and uniform grazed habitats within this undulating area allows a small suite of arid-adapted and nomadic species to exist. Up-to-date (SABAP2) bird atlas data of the broader region indicates that the area proposed for the development supports a low diversity of 48 bird species. Our own records, focussed on the wind farm site in a particularly dry period, found only 46 species in 12 months of monitoring. More birds (29 per kilometre) and more species (21) were present in summer (December) than in any other month. This included 8 collision-prone species of which 3 were red-listed: Ludwig's Bustard *Neotis ludwigii* (ranked 10th in the top 100), Secretarybird *Sagittarius serpentarius* (12th) and Lanner Falcon *Falco biarmicus* (ranked 22nd).

Given that 8 collision-prone species were recorded on bird atlas cards from the general area around the proposed WEF area, the farm may impact these birds negatively. Turbines that kill, on average, 4.1 birds per turbine per year in South Africa, particularly raptors (Ralston-Paton et al. 2017) may, therefore, impact the eagles and falcons that frequent the site. Fortunately, both the annual passage rate of the collision-prone species on the WEF (0.13 birds per hour), and the Red Data birds alone (0.01 birds per hour) was so low, that the probability of impacts and avoidance are also likely to be low.

Few birds on site flew at blade-swept heights (i.e. 55 to 205m) of the proposed turbines (130-m hub height, 75-

m blades). Neither Secretarybird (0%) nor the Ludwig's Bustards (0%) – both Red Data species – flew at these rotor-swept heights.

One area of potential high-sensitivity was found on the proposed wind farm in the central section of the site near the wind mast where an inactive Secretarybird nest site was located. This nest site should be protected with a 1-km precautionary buffer in which no disturbance or development should take place. There were no medium-risk areas identified on the site. Therefore, the majority of the 28 km^2 site is available for development from an avian-risk assessment. We recommend that:

- construction and post-construction monitoring takes place for 12 months to ensure that any wind-farm-related avian fatalities are documented and addressed immediately.

The cumulative impacts of 3 other proposed renewable energy facilities within 30-km of the Namas Wind Farm were assessed, and a maximum of 1384 bird fatalities are estimated annually from the three developments. Approximately 100 of these are estimated to be priority collision-prone Red Data raptors per year. However, given the very low occurrence and Passage Rates this is likely to be an over-estimate. It is also unlikely for all the proposed facilities to be developed, further reducing the likely cumulative impacts.

Because this is a relatively low impact site for birds we recommend that, with the mitigations above considered, development be allowed to proceed with a full 12-24 months' post-construction monitoring programme in place. This should be undertaken by competent ornithologists familiar with the area's threatened species to monitor fatalities or problems in the construction and post-construction phases. Solutions and alternatives can then be suggested and implemented if challenges arise.

1.1 Consultant's Declaration of Independence

Birds & Bats Unlimited are independent consultants to Genesis Namas Wind (Pty) Limited. They have no business interest - financial, personal or other - in the activity, application or appeal other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of the specialists performing such work.

1.2 Qualifications of Specialist Consultant

Birds & Bats Unlimited (www.birds-and-bats-unlimited.com/) were approached to undertake the specialist avifaunal assessment for the pre-construction phase of the proposed Namas Wind Farm near Kleinsee. Dr Rob Simmons is an ornithologist, with 35 years' experience in avian research and impact assessment work. He has published over 100 peer-reviewed papers and 2 books, (see www.fitzpatrick.uct.ac.za/fitz/staff/research/simmons for details). More than 64 projects and assessments over 23 habitats have been undertaken throughout Namibia, where he was the State Ornithologist for 14 years, Angola, Lesotho and South Africa. He also undertakes long-term research on threatened species (raptors, vultures, flamingos and terns) and the impacts of predatory domestic cats on biodiversity at the FitzPatrick Institute, UCT, where he is an Honorary Research Associate.

Marlei Martins, co-director of Birds & Bats Unlimited, has over 7 years' consultancy experience in avian wind farm impacts as well as 20 years in environmental issues and rehabilitation. She has been employed by several consultancy companies throughout South Africa because of her expertise in this field. She has published papers on her observations, including a new species of raptor to South Africa (http://www.birds-and-bats-unlimited.com/).

2 TERMS OF REFERENCE

The terms of reference for the final Pre-construction Avian Assessment Report, based on the EIA regulations, are as follows:

- To provide a list of the occurrence and passage rates of priority species, particularly the priority Red Data and collision-prone species [CPS], at the proposed Namas Wind Farm;
- To estimate the density of smaller passerine species in the WEF and compare that with those found in the Control area;
- To provide an overview of any medium- and high-risk avian areas within the WEF, based on the occurrence of priority species found throughout the year;
- To provide a semi-quantitative assessment of impacts, before and after the proposed mitigations
- To provide recommendations for mitigating the possible impacts identified;
- To provide an assessment of the Cumulative Impacts for other authorised renewable energy facilities with a current Environmental Authorization within 30-km to determine possible wide-scale mortalities or displacement;
- To provide an Environmental Management Plan to implement during-construction and post-construction monitoring and to ensure that the recommended mitigations are implemented to reduce potential impacts to the priority avifauna of the area.

2.1 Need for Proposed Avian Assessment

Birds are known to be impacted directly and indirectly by wind farms world-wide, both onshore and offshore (Langston 2006), and the Department of Environmental Affairs (DEA) mandates that all proposed wind farms require 12-months of avian pre-construction monitoring to determine the abundance and diversity of collision-prone species, particularly threatened red data species, and which are most at risk. Mitigations and alternatives must be provided at the conclusion of such reports, and they are guided in these recommendations by the Birds and Renewable Energy Specialist Group (BARESG). This advisory group was formed between the Endangered Wildlife Trust (EWT) and Birdlife South Africa and has produced monitoring guidelines for birds and wind farms (Jenkins et al. 2014). This study arises from this need for 12-months' monitoring, and we follow the BARESG guidelines throughout.

3 BACKGROUND

Genesis Namas Wind (Pty) Limited have proposed a wind energy facility (WEF) in the Renewable Energy Zone (REDZ 8) near Kleinsee, South Africa in the arid Namaqualand Strandveld. The wind farm will be sited on slightly raised ground on Portion 3 and portion 4 of the Farm Zonnekwa No. 328, Remainder of the Farm Rooivlei No. 327, Portion 3 of the Farm Rooivlei No. 327, 22.5-km south-east of Kleinsee. The central wind mast is situated at S 29°50'49" E 17°11'39" in heavily grazed sand substrate.

The wind farm was designed to generate 140MW of power, initially, from 70, 2.5MW turbines of 80-m hub height. However, in March 2018 new technology allowed the possibility of fewer turbines with the following combinations:

- 47 turbines, of 3.0MW each;
- 36 turbines of 4MW each; or
- 34 turbines of 4.2MW each (D Peinke pers comm).

All designs have hub heights of up to 130-m, with blades (rotors) of 75-m giving a rotor diameter of 150-m. These are important considerations for birds as taller turbines are predicted to cause a greater impact to birds than shorter turbines (see details below). This may be offset by having fewer turbines.

Pre-construction monitoring was undertaken following the international best-practice guidelines of the Birds and Renewable Energy Specialist Group (BARESG) (Jenkins et al. 2014). These call for four seasons' monitoring over 12-months across the proposed site and a Control site to be simultaneously monitored over the same period. This allows us to determine the effect that turbines may have on birds after construction, independent of natural fluctuations due to other causes. Passage rates (number of collision-prone birds [CPB] per hour) through both areas are highlighted to determine the risk to CPB.

4 STUDY METHODOLOGY

The avian monitoring reported here covered 12-months as dictated by the DEA and Birdlife South Africa. Priority species, defined as the top 100 collision-prone species (CPS) and red-listed species that pass through the 28-km^2 area, were documented in winter (June 2017), spring (September 2017), summer (December 2017) and autumn (March 2018), to help quantify, predict and reduce future impacts. This covers all the bird-active months for migrants and residents. The study area was originally larger at 50 km^2, but the avian component was directed to cover only 28 km^2 of this by the client. We report on (i) the density of smaller resident species in the wind farm site; (ii) the presence and passage rates of all larger CPS passing through the wind farm site (and the Control area) from Vantage Point (VP) surveys; and (iii) breeding species throughout the area. We conclude by identifying high- and medium-risk sensitivity areas within the WEF, based on the presence and number of CPS using the area. The possible Cumulative impacts are then provided, as required by the DEA.

All bird transects took place in the morning (bird-active) hours. Each 1-km transect was walked slowly over a 25- to 50-minute duration, depending on terrain and number of birds present. One survey was walked in each of the areas proposed for turbines (i.e. WEF areas) in each season, with another 1-km transect in the Control area south of the WEF. These transects cover the main habitat type present (e.g. heavily grazed Succulent Karoo and Nama Karoo scrub), including ridges and valleys. All VPs and transects are shown in Figure 1. All species were identified where possible, and the number of individual birds and the perpendicular distance to them recorded with a Leica Laser Rangemaster 1600. This allows an estimate of the density (birds per unit area and kilometre) and the species richness in each area. We, simultaneously, recorded all large birds (mainly raptors and bustards) and noted and recorded the position of any large active nests found in the study area.

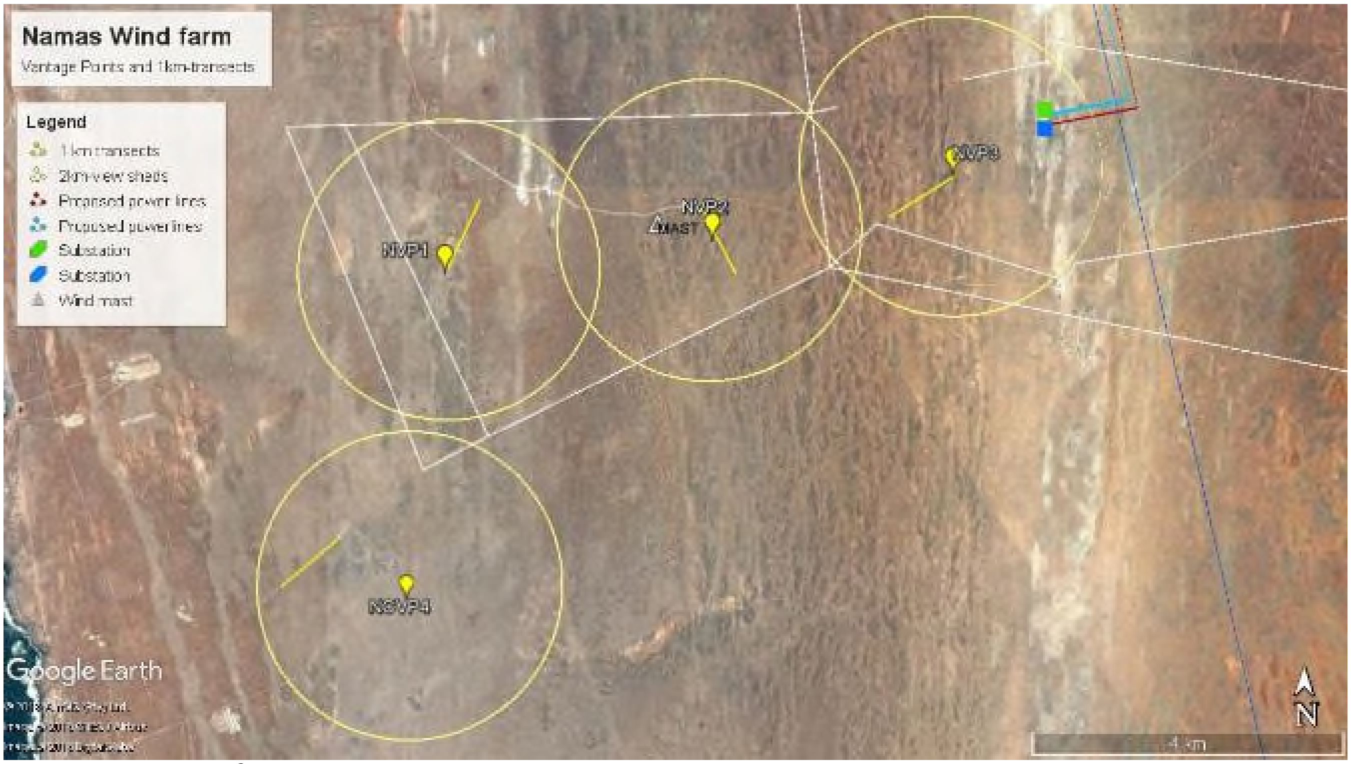

Figure 1: The 28-km^2 extent of the proposed Namas wind farm showing the boundary of the site (white polygon), the VP viewsheds of 2-km radius (yellow circles) and the 1-km transects in the WEF (yellow lines). A Control area with equivalent habitat and land-use was chosen to the south-west and surveyed simultaneously (NQVP4).

Vantage Point (VP) monitoring is the most important aspect of such site surveys (BARESG 2015). They comprised 6-hours observations for each VP on two separate days, for a total of 12-hours to record passage rates of the larger CPB (i.e. large raptors and bustards) from equally-spaced vantage points throughout the WEF and Control areas. These were undertaken from hills and other raised points, and allowed uninterrupted views of about 2-km. At 2-km it becomes more difficult to identify each species and their positions, but the presence and identity of larger birds is still possible over these distances with 8.5x or 10x Swarovski binoculars. The VPs were sited to cover the entire study area equally. For areas where the viewshed was obstructed we undertook additional observations from a second VP in those obstructed areas. For identified birds, their flight height and behaviour were estimated every 15-seconds and recorded directly onto laminated Google Earth maps in the field, and then transferred to a digital Google Earth image of the area. These are combined and presented here for June 2017 to March 2018 (Figures 5-8). Flight height is a difficult parameter to measure, but the presence of the 99-m wind mast and smaller power poles was utilised to increase our accuracy. Below we present a test of our abilities using a drone in another site.

4.1 Data Sources Used

The following data sources and reports were consulted in the compilation of this report:

- Data on the biology (Hockey et al 2005), distribution (Harrison et al. 1997) and conservation status (Taylor et al. 2015) of South African birds was consulted. Up-to-date data were extracted from the Southern African Bird Atlas Projects (SABAP) which were obtained from the Animal Demography Unit website (http://sabap2.adu.org.za/index.php for the relevant "pentads" of 5' x 5' (from SABAP 2: Appendix 1). From these data, we compiled a list of the avifauna likely to occur within the impact zone of the proposed WEF. These data were augmented and constantly updated from our four visits over the period of June 2017 to March 2018;
- The ranking of collision-prone species (CPS) is drawn from the updated BARESG tabulation of 2014. We consider only the top 100 collision-prone species as priority species. This reduces the spurious introduction of species that may be influenced by the wind farm but have a low conservation status. This was sourced from the Birdlife South Africa website at www.birdlife.org.za/conservation/terrestrial-bird-conservation/birds-and-renewable-energy;
- Among these CPS are Red Data species that require special attention;
- Red Data species conservation status, and the Red Data classification in South Africa, was sourced from Taylor et al. (2015);
- Important Bird Area (IBA) data were collated from Barnes (1998) and Marnewick et al. 2015) and the updated layers provided by D Marnewick (Birdlife SA) and available at http://www.birdlife.org.za/conservation/important-bird-areas/documents-and-downloads.

4.2 Limitations and Assumptions

Inaccuracies in the above sources of information can limit this study. The SABAP1 national dataset is now over 20-years old (Harrison et al. 1997) and it is likely that bird distributions have since altered under the effects of climate change in South Africa (Simmons et al. 2004). Therefore, we have used only the more recent SABAP2 data set. This has a higher spatial resolution and is up to date (2007 to 2017). There were 37 full-protocol cards in the pentads that cover the wind farm site and together they help to give a picture of the overall species richness, that single site visits would not achieve.

Any site visits to record birds, even over a 12-month period, may not provide a complete picture of all species likely to occur in an arid region. Rainfall is the chief limiting factor as it dictates if birds occur, and when, and if they breed (Lloyd 1999, Dean 2004). Rainfall was scarce throughout most visits to the site, and this may reduce the overall numbers of birds occurring. However, our knowledge of the area and species (such as bustards) that may occur after rains is taken into account in all assessments of impacts below.

5 BRIEF REVIEW OF AVIAN-WIND FARM IMPACTS

Birds are known to be impacted directly and indirectly by wind farms, both onshore and offshore worldwide. But which birds are susceptible and why? And what mitigation measures have been tried to reduce the impacts?

5.1 Interactions between birds and wind farms

The main avian impacts, according to a position paper on the subject by Birdlife SA (http://www.birdlife.org.za/conservation/terrestrial-bird-conservation/birds-and-renewable-energy), are:

- displacement of nationally important species from their habitats,
- loss of habitats for such species,
- disturbance during construction and operation of the facility,
- collision with the turbine blades or associated infrastructure.

Several literature reviews (www.nrel.gov, Kingsley & Whittam 2005, Drewitt & Langston 2006, Kuvlevsky et al. 2007, Stewart et al. 2007, Drewitt & Langston 2008, Loss et al. 2013) have summarised all sources of information in the field of wind energy facilities. The number of longer-term analyses of the effects of wind energy facilities on birds is increasing, but most research in this field rarely sees the light of day (Madders & Whitfield 2006, Stewart et al. 2007). Available information originates from short-term studies from the United Kingdom, the United States of America and, more recently, longer-term studies from Spain, where wind power generation is well established.

Concern about the impacts of wind facilities on birds arose in the 1980s when numerous raptor mortalities were detected in California (Altamont Pass, USA) and at Tarifa (Spain). Mortalities at these sites focused attention on the impact of wind energy facilities on birds, and subsequently much monitoring has been done at a wide variety of wind energy facility sites. More recently, there has been additional concern about the degree to which birds avoid, or are excluded from, the areas occupied by wind energy facilities - either because of the action of the turbine blades or because of the noise they generate - and hence, suffer a loss of habitat (Larsen & Guillemette 2007, Stewart et al. 2007, Devereaux et al. 2008. Pearce-Higgins et al. 2009).

With a few exceptions, most studies suggest low numbers of bird fatalities at wind energy facilities numbering tens to hundreds of birds per year (Kingsley & Whittam 2005). The observed mortality caused by wind energy facilities is also very low compared to other existing sources of anthropogenic avian mortality (Crockford 1992, Colson & associates 1995, Gill et al. 1996, and Erickson et al. 2001, Sovacool 2009, 2013). For example, population declines due to climate change and fossil fuels is estimated at 14.5 million birds annually, whereas wind energy facilities killed about 234 000 birds annually in the USA (Sovacool 2013). See Benefits of Wind farms (5.2) below. In South Africa, with 22 operational wind farms by the end of 2017, and an average of 36.8 turbines per farm at an average fatality rate of 4.1 birds/turbine/yr (Ralston et al. 2017), the projected mortality is much lower at an estimated 3310 birds annually.

5.1.1 Collisions with turbines

COLLISION RATES

Avian mortality rates at wind energy facilities are compared in terms of a common unit: mortalities/turbine/year, or mortalities/MW/year (Smallwood & Thelander 2008). Wherever possible, measured collision rates should allow for

- the proportion of actual casualties detected (and missed) by observers (searcher efficiency); and
- the rate at which carcasses are removed by scavengers (scavenger removal rate, important in an African landscape).
- Cumulative effects over time, especially when applied to large, long-lived, slow-reproducing and/or threatened species (many of which are collision-prone) may be of considerable conservation significance.

The most pertinent results include:

- Loss et al. (2013) estimated that 5.25 (95% Cl: 3.15-7.35) birds are killed per turbine per year across the contiguous United States from a meta-analysis of 53 studies (corrected for searcher efficiency and scavenger rates);
- A peak in California was due to high fatalities at Altamont pass – a migration corridor – where casualties of >1000 raptors, and nearly 3000 birds are killed in turbine collisions annually (Smallwood & Thelander 2008) or 2-4 mortalities per MW per year ;
- 13% of the >5000 turbines at Altamont Pass, California, were responsible for all Golden Eagle *Aquila chrysaetos* and Red-tailed Hawk *Buteo jamaicensis* collisions (Curry & Kerlinger 2000);
- Similar figures are known from Jeffreys Bay wind farm, South Africa where 22% of the turbines caused 69% of all fatalities (Simmons & Martins 2017a);
- In the Straits of Gibraltar, southern Spain, about 0.04-0.08 birds are killed/turbine/year (Janss 2000a, de Lucas et al. 2008), with relatively high collision rates for threatened Griffon Vultures *Gyps fulvus*,;
- A review of South African fatalities over two years at eight of the first operational wind farms in South Africa indicates that about 4.1 birds per turbine per year are killed (Ralston-Paton et al. 2017).

CAUSES OF COLLISION

Multiple factors influence the number of birds killed at wind energy facilities. These can be classified into three broad groupings:

- avian variables (some birds, especially raptors are more prone to collision than others);
- location variables (wind farms placed on migration routes, in pristine vegetation or near roosts or nests will attract more fatalities than others);
- facility-related variables (farms with more turbines, more lighting, or lattice towers may attract more fatalities).

Two studies have shown a direct relationship between the abundance of birds in an area and the number of collisions (Everaert 2003, Smallwood et al 2009), but de Lucas et al. (2007) questioned this from studies in Spain. However, a positive relationship between seasonal Passage Rates of Priority Species and the number of fatalities was found in South Africa over three years (Figure 2). Thus, logically, the more birds flying through an array of turbines, the higher the chances of a collision. The identity of the species present in the area is also important as some birds are more vulnerable to collision than others, featuring disproportionately frequently in collision surveys (Drewitt & Langston 2006, 2008, de Lucas et al. 2008).

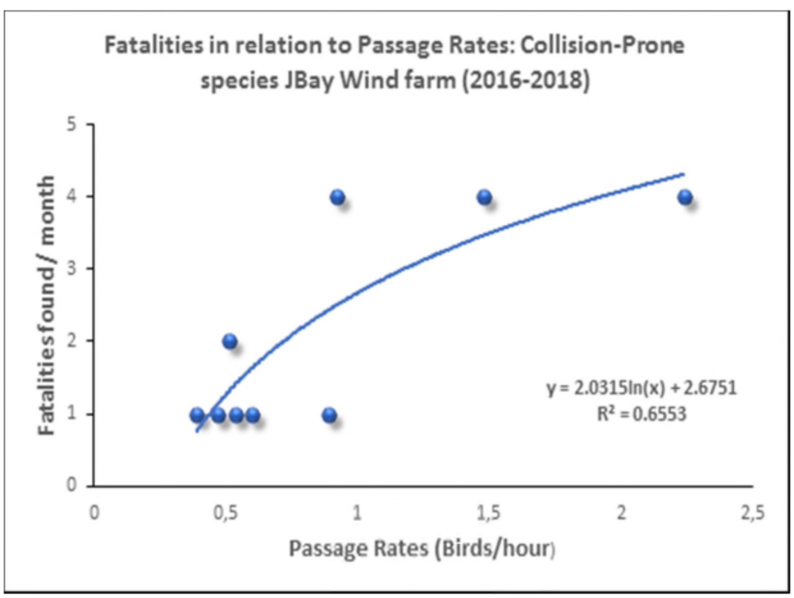

Figure 2: Raptor fatalities in relation to the Passage Rates (bird flights/hour) of all raptors in 2-month sampling periods in a South African wind farm over two years (Simmons, Martins, Smallie and MacEwan unpubl data).

Species-specific variation in behaviour, such as foraging, commuting or courting, also affect susceptibility to collision (Barrios & Rodríguez 2004, Smallwood et al. 2009). There may also be seasonal and temporal differences in behaviour, for example breeding males displaying or food-carrying may be particularly at risk (Simmons 2011, Simmons & Martins 2017).

In 2016, observations on a wind farm in the Eastern Cape indicated that breeding males are particularly susceptible to impacts. This includes both Martial Eagles and Black Harriers flying frequently at rotor-swept height. Given that these birds were providing food for females and young at the time, there are clearly hidden costs to the fatalities beyond the loss of the individual birds – i.e. the loss of the next generation because breeding females cannot rear a brood alone, as evidenced there (Simmons & Martins 2017).

Landscape features often channel birds towards a certain area and, in the case of raptors, influence their flight and foraging behaviour. Ridges and steep slopes are important factors in determining the extent to which an area is used by gliding and soaring birds (Barrios & Rodríguez 2004). Golden Eagles *Aquila chrysaetos* fly higher (> 250-m) over flat terrain and low hills where thermals occur, than over steep slopes (~150-m) where orographic winds give them lift (Katzner et al. 2012). Migratory eagles tended to fly higher overall land forms (135-341-m) than resident birds (63-83-m). This suggests that wind farms placed on top of steep slopes are more likely to impact eagles than those on flat terrain, and resident birds are more likely to be impacted (flying within the rotor-swept area) than migrants.

High densities of prey will attract raptors, increasing the time spent hunting, and reducing vigilance. Poor weather affects visibility, with birds flying lower during strong headwinds (Hanowski & Hawrot 2000, Richardson 2000) so when the turbines are functioning at maximum speed, birds are likely to be flying at their lowest – increasing collision risk (Drewitt & Langston 2006, 2008).

Larger wind energy facilities, with more than 100 turbines, are almost, by definition, more likely to incur increased bird casualties (Kingsley & Whittam 2005), and turbine size may be proportional to collision risk – with taller turbines associated with higher mortality rates in some instances (e.g. de Lucas et al. 2009, Loss et al. 2013). However, this has been questioned by Howell (1995), Erickson et al. (1999), and Barclay et al. (2007).

With newer technology, fewer, larger turbines are needed to generate the same amount of power, which may result in fewer collisions per Megawatt produced (Erickson et al. 1999). Certain tower structures, and particularly the old-fashioned lattice designs, present many potential perches for birds, increasing the likelihood of collisions as birds land or leave these sites. This problem has, largely, been solved with more modern, tubular tower designs (Drewitt & Langston 2006, 2008).

However, Loss et al. (2013) undertook a meta-analysis of all wind farms and associated fatalities in the USA and found a strong correlation of increasing hub height or blade length with increased impacts to birds. Thus, taller turbines appear to be more risky for birds. We have taken that data set and added eight studies from South Africa and found that the relationship still holds (Figure 3).

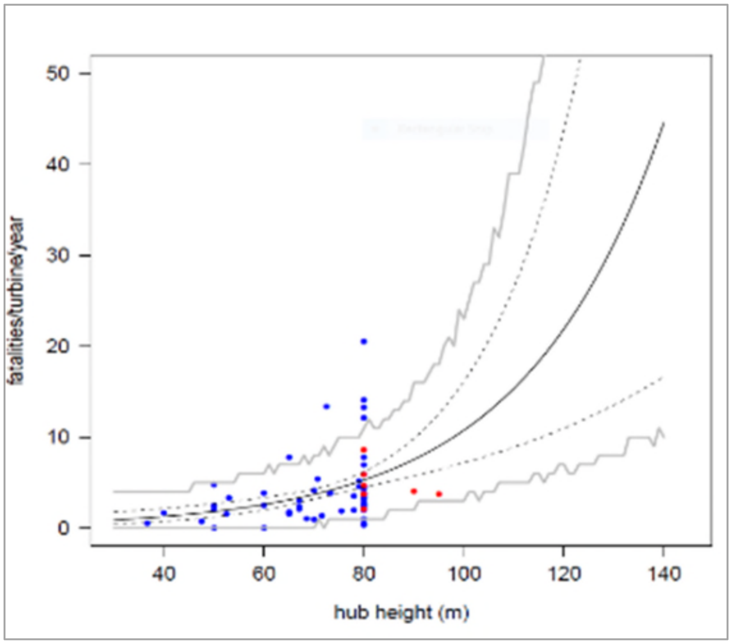

Figure 3: Modelled data combining avian fatalities from the USA (Loss et al. 2013) and from South Africa (Ralston-Paton et al. 2017) and their relationship with hub height. The South African data (n=7 farms, red dots) include two farms with hub heights of 90-m and 95-m. The combined data and 95% confidence limits predict that 16 birds (95% CI = 9, 28) will be killed on average per year for 120-m-high turbines and 28 (95% CI = 12, 65) birds on average for 140-m-high turbines. Given that the average number of birds killed for the typical 80-m turbines was 5.40 and it increased to 16 fatalities at 120-m, the increase in fatalities is forecast to be 2.9-fold if turbines are increased from 80 to 120-m. Note that this is a statistical forecast and is not based on empirical data. From Simmons, Cervantes-Peralta, Erni, Martins & Loss (2017).

Illumination of turbines and other infrastructure often increases collision risk (Winkelman 1995, Erickson et al. 2001), either because birds move long distances at night and navigate using the stars, mistaking lights for stars (Kemper 1964), or because lights attract insects, which in turn attract foraging birds. Changing constant lighting to flashing lighting has been shown to reduce nocturnal collision rates (Richardson 2000, APLIC 1994, Jaroslow 1979, Weir 1976) and changing flood-lighting from white to red (or green) can affect an 80% reduction in mortality rates (Weir 1976).

Spacing between turbines at a wind facility can also affect the number of collisions. Some authors have suggested that paths need to be left between turbines so that birds can move through unscathed. Alternatively, those turbines known to kill more birds can be temporarily taken out of service (e.g. during migration or breeding). For optimal wind generation, relatively large spaces are required between turbines to avoid wake and turbulence effects.

Collision prone birds

Collision prone birds (CPBs) generally include:

- large species, or those with high wing-loading (i.e. the ratio of body weight to wing surface area), and with low manoeuvrability (cranes, bustards, vultures, gamebirds, waterfowl, falcons);
- species which fly at high speed (gamebirds, pigeons and sandgrouse, swifts, falcons);
- species which are distracted in flight – predators, or species with aerial displays (many raptors, aerial insectivores, some open country passerines);
- species which habitually fly in low light conditions (flamingos);

- species with narrow field, or no binocular vision (cranes and bustards) (Drewitt & Langston 2006, 2008, Jenkins et al. 2010, Martin & Shaw 2010).

To these we can add those species that more frequently fly at rotor swept height (e.g. buzzards and eagles) and are more likely to impact turbines (Simmons & Martins unpubl data).

Recent studies by Martin & Shaw (2010) indicate that, particularly, collision-prone species such as bustards and cranes do not see ahead of them due to skull morphology and have a blind region that prevents them from seeing directly ahead. This is one reason why they hit overhead lines so regularly (Shaw et al. 2015).

These traits confer high levels of susceptibility, which may be compounded by high levels of exposure to man-made obstacles such as wind turbine areas (Jenkins et al. 2010). Exposure is greatest in (i) highly aerial species; (ii) species that make regular and/or long-distance movements (migrants or any species with widely-separated resources – food, water, roost and nest sites); and (iii) species that fly in flocks (increasing the chances of incurring multiple fatalities in single collision incidents). Soaring species may be particularly prone to colliding with turbines where this infrastructure is placed along ridges, because the turbines exploit the same updrafts favoured by such birds – vultures, storks, cranes, and most raptors (Erickson et al. 2001, Kerlinger & Dowdell 2003, Drewitt & Langston 2006, 2008, Jenkins et al. 2010, Katzner et al. 2012).

Mitigating collision risk

One direct way to reduce the risk of birds colliding with turbine blades is to render the blades more conspicuous.

- Blade conspicuousness is compromised by a phenomenon known as 'motion smear' or retinal blur, in which rapidly moving objects become less visible the closer they are to the eye (McIsaac 2001, Hodos 2002). The retinal image can only be processed up to a certain speed, after which the image cannot be perceived. This effect is magnified in low light conditions, so slow blade rotation may be difficult for birds to see.

Laboratory-based studies of visual acuity in raptors have determined that:

- visual acuity in kestrels is superior when objects are viewed at a distance, suggesting that the birds may view nearby objects with one visual field, and objects further away with another;
- moderate motion of the object ahead significantly influences acuity, and kestrels may be unable to resolve all portions of rotating turbine blade because of motion smear, especially in low light;
- this can be addressed by patterning the blade surface to maximize the time between successive stimulations of the same retinal region; and

- the cheapest and most visible, blade pattern for this purpose, effective across several backgrounds, is a single black blade in amongst white blades (McIsaac 2001, Hodos 2002).

This was tested in Norway where high mortality rates of White-tailed Eagles Haliaetus albicilla occurred on the island of Smøla. Eagle fatalities were reduced 100% over a 2-year experiment (Stokke et al. 2017). Hence marking blades is an important means to reduce collision rates by making them more conspicuous. While CAA regulations currently disallow marking of turbine blades, Birds & Bats Unlimited and BLSA are negotiating to have this temporarily lifted to test it in South Africa. This can be avoided by using UV paint that is visible to birds but not to pilots. In the only experimental test of the effectiveness of UV paint in deterring birds Young et al. (2003) found no difference in fatalities at UV-painted turbines. However, their results were compromised because they painted all three blades (rather than just one) and thus probably did not reduce the problems associated with "motion-smear".

Figure 4: A single black-painted blade on turbines on the island of Smøla, Norway. This simple mitigation reduced eagle fatalities by 100% relative to unpainted controls. Civil Aviation Authorities in Norway permitted this new mitigation technique, setting a precedent for other aviation authorities in the world (from Stokke et al. 2017).

Other mitigations to reduce fatalities include (from Langston 2011, de Lucas et al. 2012; Jenkins et al. 2014, Ralston et al. 2017):

- siting farms and individual turbines away from concentrations of birds or regular commuting/migrating or slope-soaring regions;
- buffering sensitive habitats (pans, breeding cliffs, roosting area) with appropriate-size buffers;
- using low-risk turbine designs and configurations;
- allowing sufficient space for commuting birds to fly through the turbine strings; and
- systematically monitoring collision incidence and being prepared to shut-down problem turbines at particular times or under particular conditions (e.g. breeding, or increased migration activity.
- A recently tested suggestion is to use short bursts of intense short-wave light to approaching raptors at banding station (Foss et al. 2017). In experiments, the number of hawks approaching a lure with pulsed lights was 5-fold less than at a control area with no lights indicating some success.

5.1.2 Habitat loss – destruction, disturbance and displacement

While the final footprint of most wind farms is likely to be relatively small, the construction phase of development incurs quite extensive temporary or permanent destruction of habitat. This may be of lasting significance where wind energy facility sites coincide with critical areas for restricted range, endemic and/or threatened species. Similarly, construction, and maintenance activities are likely to cause some disturbance to birds in the general surrounds, and especially of shy and/or ground-nesting species resident in the area. Mitigation of such effects requires that best-practice principles be rigorously applied – that sites are selected to avoid the destruction of key habitats, and construction and final footprints, as well as sources of disturbance of key species, must be minimised.

Some studies have shown significant decreases in the numbers of birds in areas where wind energy facilities occur, as a result of avoidance due to noise or movement of the turbines (e.g. Larsen & Guillemette 2007). Others have shown decreases attributed to a combination of collision casualties and avoidance, or exclusion from the impact zone of the facility in question (Stewart et al. 2007). Such displacement effects are probably more relevant in situations where wind energy facilities are built in natural habitat (Pearce-Higgins et al. 2009, Madders & Whitfield 2006) than in modified environments such as farmland (Devereaux et al. 2008).

5.1.3 Impacts of associated infrastructure

Infrastructure commonly associated with wind farms can often be more detrimental to birds than the turbines themselves. The construction and maintenance of substations, servitudes and roadways cause both temporary and permanent habitat destruction and disturbance.

We note that in our discussions with Birdlife South Africa staff familiar with Secretarybirds (recorded on this site) they pointed out that Secretarybirds are more likely to be killed on farm fences (flying into them or walking over them) than they are on other structures. Thus, new road ways and fences should be carefully planned around roosts/nest of susceptible species.

Habitat destruction during construction and maintenance of road ways

Some habitat destruction and alteration inevitably takes place during the construction of substations and associated roadways. These activities have an impact on birds breeding, foraging and roosting in or close to the servitude, and retention of cleared servitudes can have the effect of altering bird community structure along the length of any road way (e.g. King & Byers 2002).

5.2 Benefits of wind farms

While this study focuses on the impacts of wind farming, and reducing those impacts to birds, we must also give the positive side of such energy production. As a green, sustainable form of energy production, with no green-house gas emissions, wind farms have many benefits over traditional fossil-fuel or nuclear energy production. At present over 80% of South Africa's energy is derived from coal, oil or gas that increases South Africa's carbon-footprint. From an environmental point of view, wind farms use sustainable energy, do not emit green-house gases, and can be built on otherwise productive land without altering the land use practises. They are one of the most cost-effective sources of energy and provide energy at night when other renewable energy sources are dormant (https://energy.gov/eere/wind/advantages-and-challenges-wind-energy).The impacts to the environment, while highlighted by environmentalists, are relatively negligible when compared with other forms of energy that we take for granted in our homes. Most of South Africa's energy is produced by coal-fired power stations (69%), crude oil (15%) or natural gas (~3%). Renewables accounted for ~0.2% of all energy production in 2012 (www.zapmeta.co.za/wiki/page/Energy_in_South_Africa). This will have increased since 2012 when these statistics where compiled.

An attempt was made to determine the impact on birds of these various forms of energy production to contextualize the impacts reported from wind farms (Sovacool 2009). His paper summarised the impacts as follows:

"For wind turbines, the risk appears to be greatest to birds striking towers or turbine blades and for bats suffering barotrauma. For fossil-fuelled power stations, the most significant fatalities come from climate change, which is altering weather patterns and destroying habitats that birds depend on. For nuclear power plants, the risk is almost equally spread across hazardous pollution at uranium mine sites and collisions with draft cooling structures. Yet, taken together, fossil-fuelled facilities are about 17 times more dangerous to birds on a per GWh basis than wind and nuclear power stations. In absolute terms, wind turbines may have killed about 20 000 birds [in the USA: Sovacool 2013] in 2006 but fossil-fuelled stations killed 14.5 million and nuclear power plants 327,000 birds." (Sovacool 2009, p2246).

Sovacools' (2013) revised data of 20 000 birds killed annually at wind farms in the USA were revised again by Loss et al. (2013), to 234 000 birds killed annually by American wind farms by non-lattice tower turbines. This revised estimate is still 62-fold lower than the estimated 14.5 million fatalities caused by fossil-fuel powered energy. In a southern African or African context, this means that moving away from our heavy reliance on coal, to one based on renewable energies, could reduce the impact on birds at least 60-fold. If even a small proportion of these birds in southern Africa are threatened red-listed species (and climate change may be affecting these red-listed species more than other – more common – species: Simmons et al. 2004), then the threats to these species are likely to be reduced. Thus, while this report details the negative impacts to birds at wind farm sites, the goal of turning away from fossil-fuel dependence through wind (and solar) energy is a positive move for South Africa, which lies 19th in the world of CO^2 producers (Olivier et al. 2014) and should be encouraged.

6 STUDY AREA AND HABITAT

The 28-km^2 site proposed for development of the wind farm, occurs on the Portion 3 and 4 of the Farm Zonnekwa No. 328, Remainder of the Farm Rooivlei No. 327, and Portion 3 of the Farm Rooivlei No. 327, all within the Nama Karoo. The centre of the site is located at S 29°50'49" E 17°11'39". The land falls from a high point of 240-m asl in the east to about 150-m asl in the west and is primarily deep sand with some calcrete outcrops in some areas. The land-use is predominantly for sheep grazing with at least one farmhouse centrally located in the east of the affected properties.

6.1 Vegetation of the study area

The study area occurs at the north-west end of the Nama Karoo biome (Mucina and Rutherford 2006, p264) and is designated as Namaqualand Strandveld. It is dominated by low species-rich shrubland (Photos 1-2) of erect and creeping succulents on nutrient-poor sand and heavily grazed in places. The sheep are moved off the land in the summer when temperatures increase, and rainfall decreases.

The study area experiences winter rainfall averaging a low 112-mm per annum, with high variability. Most falls in June-July-August (winter). In our 12-month visit little rain had fallen and by the summer and autumn visits the veld was dry and mainly moribund. From our experience in the area at times of more average rainfall we are able to extrapolate to what species may occur and their likely abundance when typical rainfall occurs.

Maximum day time temperatures average about 10-20°C from winter to summer. Minimum temperatures average ~7-15oC. Minimum night-time temperatures rarely dip below zero for the winter months (Mucina & Rutherford 2006).

Photos 1-2: Coastal shrubs and succulent plants found on the Namas site.

6.2 Avian microhabitats

Bird habitat in the region consists of uniform vegetation type of coastal shrubs and succulent plants (Photos 1-2). The vegetation includes succulent shrubs such as *Tertragonia, Cephalophyllum* and *Didelta* and non-succulents such as *Eriocephalus, Pteronia* and *Salvia*. There are a few alien trees on site (Eucalyptus), and farm dams and water points for sheep. Few grasses are found, making the lark species diversity rather slim within the site. One Eskom reticulation line with monopoles is found within the site, providing some perch sites for raptors but no nesting sites.

 

Photos 3-4: Raptors were the main species seen on site, including this Red Data Secretarybird *Sagittarius serpentarius* (left) and the Least Concern Black-chested Snake-Eagle *Circaetus cinerescens* (right). The latter occurred mainly on the Eskom reticulation lines that run adjacent to the study site.

7 RESULTS

7.1 Species diversity

Over the course of 12-months we recorded only 46 avian species in the WEF site in our four equally-spaced site visits. This is a very low total compared with other arid areas in the Northern and Western Capes that we have sampled. Species richness varied over the seasons with higher totals recorded in summer (38 species) and the lowest in spring and autumn (21 and 22 respectively: Table 1). All were typical residents of the arid Karoo landscape including Chats, Prinias, Titbabbler, Flycatchers, Karoo Larks and Grey Tit *Parus afer*. (photos 5-6).

Small aerial species which may be affected by a new wind farm included the occasional hirundines such as Rock Martin *Ptyonoprogne fuligula* and groups of up to 90 swifts including Alpine *Tachymarptis melba*, Little *Apus affinis* and Common Swifts *A. apus* were recorded foraging over the east end of the study site.


Photos 5-6: Clockwise from left - Grey Tit, and Malachite Sunbird photographed on site.

The average number of species per kilometre was slightly lower in the WEF site (9.7 species per km) than in the Control site (10.5 species per km) (Table 1). Similarly, the average number of individual birds per kilometre found in the WEF site (29.6 birds per km) was higher than in the Control (26.3 birds per km). Bird abundance indices were higher in the spring (September) than any other month (Table 1). Bird species richness on site stayed relatively constant throughout the year, with summer showing the highest numbers. This is not typical for arid areas, where spring is often the most species-rich season following winter rains. We can also expect these totals to be lower in terms of diversity and numbers than in a typical year, and more raptors are likely to be present.

Table 1: Summary of bird species richness and number of birds/km recorded in 1 km transects in the proposed WEF and Control areas, from June 2017 through March 2018. Overall means are given in bold.

1-km Transects in WEF Site (region of the WEF)	SPECIES per km					BIRDS per km				
	Jun	Sep	Dec	Mar	MEAN	Jun	Sep	Dec	Mar	MEAN
Transect NT1 (centrally placed at VP1)	13	10	13	7	10.8	65	43	38	21	41.8
Transect NT2 (centrally placed at VP2)	9	10	12	11	10.5	17	29	32	30	27.0
Transect NT3 (centrally placed at VP3)	7	10	6	8	7.8	16	31	16	17	20.0
Means	**9.7**	**10.0**	**10.3**	**8.7**	**9.7 Species/km**	**32.7**	**34.3**	**28.7**	**22.7**	**29.6 birds/km**
Seasonal occurrence of all species:	**28**	**21**	**36**	**22**						
Overall totals	**46 Species in WEF**									

1-km Transects in CONTROL Site	SPECIES per km					BIRDS per km				
	Jun	Sep	Dec	Mar	MEAN	Jun	Sep	Dec	Mar	MEAN
Transect NT1 (centrally placed at VP1)	11	12	10	9	10.5	24	30	36	15	26.3
Means					**10.5 Species/km**					**26.3 birds/km**
Seasonal occurrence of all species:	**13**	**15**	**12**	**11**						
Overall totals	**24 Species in Control**									

7.2 Collision-prone and red-listed species

Among the 48-species recorded on the 37 SABAP2 bird atlas cards for this region (June 2013-March 2018) were 8 priority collision-prone species (CPS). Five of the eight species were recorded from our Vantage Point surveys in the proposed wind farm over the course of the year (Table 2). These included two Red Data species (Secretarybird and Ludwig's Bustard *Neotis ludwigii*). The Ludwig's Bustards were recorded twice, and the Secretarybirds just once in November 2017; a pair, however, was observed in flight together on the adjacent farm Zonnequa in August 2017.

An inactive Secretarybird nest site was discovered on the Namas Wind Farm site (Photo 7) and this was used as a roost by the territorial bird. This suggests a pair could occur more often when conditions are less arid.

Photo 7. A single adult Secretarybird was recorded roosting and displaying on an inactive nest near the wind mast in November 2017 at S29°50'41.8" E17°11'41.69" See also Figure 10.

Table 2. Red-listed bird species (in red) and collision-prone species recorded on 37 cards by SABAP2 in the four pentads that cover the Namas WEF site (see Appendix 2). Those species shaded were recorded over the WEF site during our four site visits (total 20 field-days) from June 2017 to March 2018. Reporting Rate from SABAP2 is given in brackets.

				Susceptibility to:	
Common Name	**Scientific Name**	**Red-list status**	**Reporting Rate ***	**Collision (Rank **)**	**Disturbance**
Ludwig's Bustard	*Neotis ludwigii*	**Endangered**	**2/20 = 10% (11%)**	**10**	**Medium**

Secretarybird	*Sagittarius serpentarius*	**Vulnerable**	**1/20 = 5% (5%)**	**12**	**High**
Lanner Falcon	*Falco biarmicus*	**Vulnerable**	**0/20 = 0% (3%)**	**22**	**Medium**
Southern Black Korhaan	*Afrotis afra*	-	**6/20 = 30% (8%)**	**35**	**Low**
Booted Eagle	*Aquila pennatus*	-	**0/20 = 0% (11%)**	**55**	**Medium**
Black-chested Snake Eagle	*Circaetus cinerescens*	-	**0/20 = 0% (8%)**	**56**	**Medium**
Pale Chanting Goshawk	*Melierax canorus*	-	**6/20 = 30% (22%)**	**73**	**Low**
Greater Kestrel	*Falco rupicolloides*	-	**3/20 = 25% (16%)**	**97**	**low**

* Reporting rate is a measure of the likelihood of occurrence and is based on the number of times seen in 20 days field work over 4 seasons. We compare this with the number of times it was recorded in 37 atlas cards (on SABAP2 cards)

** Collision rank derived from the BAWSESG 2014 guidelines. Smaller numbers denote higher collision-risk.

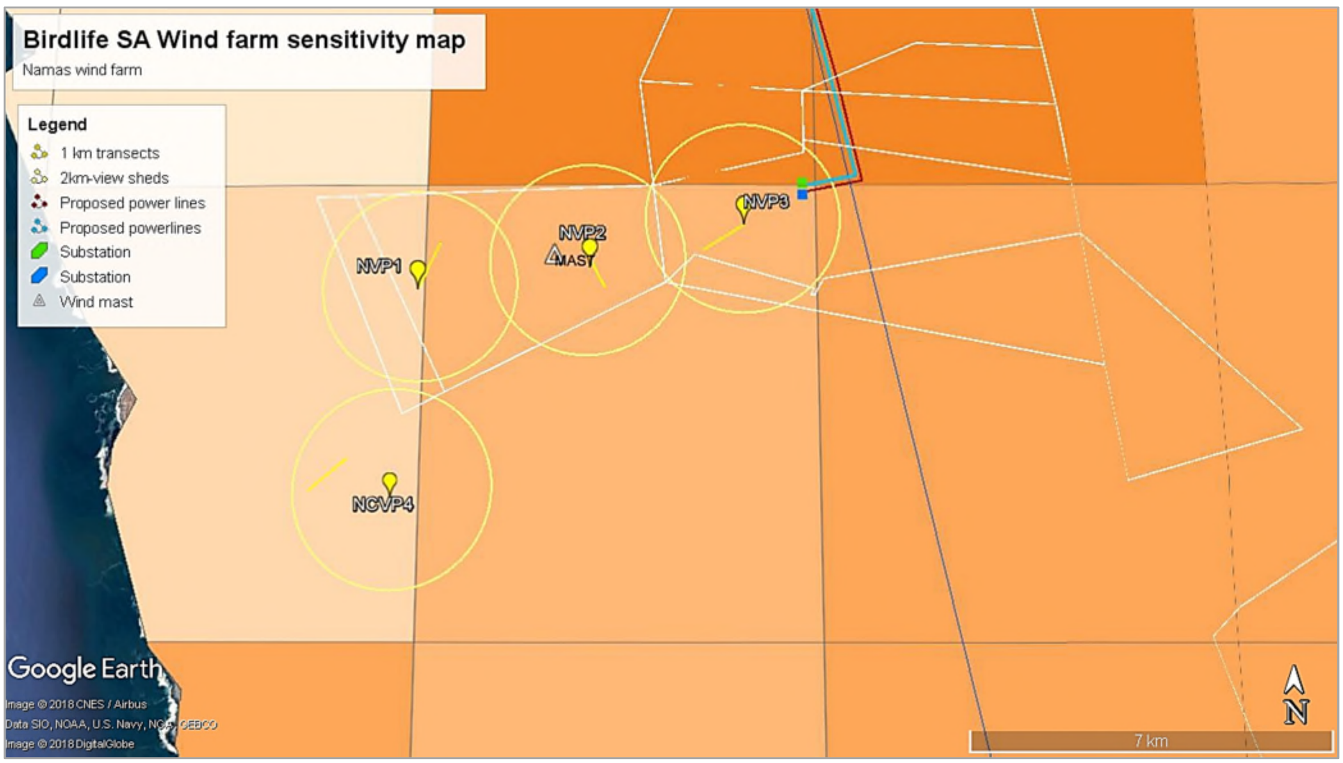

Figure 5: The Namas WEF site in relation to the national bird sensitivity map of Birdlife South Africa. Light squares depict low-bird sensitivity (score ~ 50-100) and darker squares higher bird sensitivity (scores 800-1000). The majority of the Namas WEF site lies in an area of medium-low bird sensitivity (scored 112 and 341). See: http://www.birdlife.org.za/conservation/terrestrial-bird-conservation/birds-and-renewable-energy/wind-farm-map

7.2.1 Passage Rates of collision-prone species (CPSs)

By observing from three Vantage Points (VPs) over the airspace above the proposed WEF (Figure 1), we calculated the frequency with which the 5 collision-prone species on site (Table 1) traversed the wind farm in 143.5-hours of field observations. We recorded only 19 individual flights of the five species of CPB in the 143.5-hours over one year, giving a very low Passage Rate of 0.13 birds per hour (Table 3).

Table 3. Passage Rates of all (5) collision-prone species recorded in the WEF site over all seasons in 2017-2018. Red Data species (2) are included and their combined passage rate was very low at 0.13 birds per hour.

Summary of Passage Rates for all seasons and all collision-prone birds at Namas WEF							
Passage rate:						Season	Collision-prone species
WEF	36.00	Hr	2 birds	0.06	birds / hr	March 2018	Korhaans
WEF	36.00	Hr	8 birds	0.22	birds / hr	December 2017	Pale Chanting Goshawk, Secretarybird
WEF	36.00	Hr	7 birds	0.19	birds / hr	September 2017	Ludwig's PCG, GK
WEF	35.50	Hr	2 birds	0.06	birds / hr	June 2017	(Korhaans)
Summary	**143.5 hours**		**19 birds**	**0.13**	**birds / hr**	**4 seasons**	**Korhaans, Chanting Goshawk, Secretarybird, Bustard, Kestrel**

In the Control area, we recorded only 16 flights of 4 species of CPBs in 48-hours over the year, giving a similarly low Passage Rate of 0.33 birds per hour (Table 4).

Table 4. Passage Rates of all (5) collision-prone species recorded in the Control site over all seasons in 2017-2018. Red Data species (2) are included and their combined passage rate was also low at 0.33 birds per hour.

Summary of Passage Rates for all seasons and all collision-prone birds at Namas Control Site							
Passage rate:						Season	Collision-prone species
Control	12.00	Hr	0 birds	0.00	birds / hr	March 2018	None
Control	12.00	Hr	7 birds	0.58	birds / hr	December 2017	Ludwig's Bustard Pale Chanting Goshawk, Greater Kestrel
Control	12.00	Hr	7 birds	0.58	birds / hr	September 2017	Ludwig's Bustard Pale Chanting Goshawk, Greater Kestrel
Control	12.00	Hr	2 birds	0.17	birds / hr	June 2017	S.B. Korhaan, Pale Chanting Goshawk
Summary	**48 hours**		**16 birds**	**0.33**	**birds / hr**	**4 seasons**	**Korhaans, Chanting Goshawk, Ludwig's Bustard, Kestrel**

For the priority Red Data species alone (comprising the Secretarybird and the Ludwig's Bustard) the Passage Rates were very low, averaging just 0.01 birds per hour in the WEF site and 0.19 birds per hour in the Control site. Thus, while two Red Data species were present on site, their Passage Rates (Table 3) and their likelihood of occurrence (Table 1) were both low, making risk of collision unlikely. These data were collected at a time of drought and these are likely to be lower than normal. This is taken into account in the scoring of impacts below.

Table 5. Passage Rates of the three Red Data collision-prone species recorded in the WEF site over all seasons in 2017-2018. The Red Data species combined passage rate was very low at 0.01 birds per hour.

WEF site - Month	Hours	No. of Collision-prone Red Data birds	Passage Rate (birds/h) Red Data birds	Season
June 2017	36.0	0	0.00	Spring
September 2017	36.0	1	0.03	Summer
December 2017	36.0	2	0.06	Autumn
March 2018	35.5	0	0.00	Winter

TOTALS	**143.5**	**3**	**0.01**	**All seasons**
Control site - Month	**Hours**	**No. of Collision-prone Red Data birds**	**Passage Rate (birds/h) Red Data birds**	**Season**
June 2017	12.0	0	0.00	Spring
September 2017	12.0	3	0.25	Summer
December 2017	12.0	2	0.17	Autumn
March 2018	12.0	0	0.00	Winter
TOTALS	**48.0**	**5**	**0.10**	**All seasons**

7.2.2 Flying heights and risk

Flying heights are possibly a better estimate than Passage Rate of the risk that the collision-prone species face on site (Whitfield & Madders 2006, Band et al. 2007). This arises because any species spending large proportions of time at rotor-swept heights of 55-205-m (130-m hub height with 75-m blades) is more likely to be at risk of being hit by turbine blades, than if it is simply passing through the site at low (or high) altitudes (Smallwood et al. 2009). By recording flight height every 15-seconds for focal birds, we assessed the proportion of time spent in the rotor-swept zone by all Red Data species, as a gauge of risk.

Table 6: Flying heights of the two collision-prone Red Data species seen in and around the proposed Namas Wind Farm site recorded every fifteen seconds. Data were collected throughout the year – June, September, December 2017 and March 2018 from focal birds. Total observed flying time covered only 4 minutes for both Red Data species.

Species	Flight heights	Number of observations	Proportion of observations in blade-swept area
Ludwig's Bustard	1-55 m	14	100%
N= 14	55-205 m [blade-swept zone]	0	0%
	205 +m	0	0%
Secretarybird	1-55 m	2	100%
N= 2	55-205 m [blade-swept zone]	0	0%
	205+ m	0	0%

The flight heights recorded (Table 6) indicate that if Ludwig's Bustards occurred in the wind farm site they would be the least at-risk species with 0% of their flights recorded within the rotor-swept area. Only one bustard is known to have been killed by turbines in South Africa at an Eastern Cape wind farm (J Smallie pers comm). At first sight, Secretarybirds appear to be at risk 0% of the time on the Namas Wind Farm site. However, Secretarybirds do undertake soaring flights (Dean & Simmons 2005, Allan 2005). For example, at an Eastern Cape wind farm Secretarybirds were recorded at similar Rotor Swept Height (58-203 m) 85% of the time when in flight despite their terrestrial life style (Martins & Simmons unpubl data).

All flight tracks of all collision-prone species in the proposed Namas WEF site are shown in Figure 6-9. Areas where two or more of the Red Data species overlap are designated as medium- or high-risk areas where turbine development is not recommended. Locations of the nests of Red data species are also to be avoided.

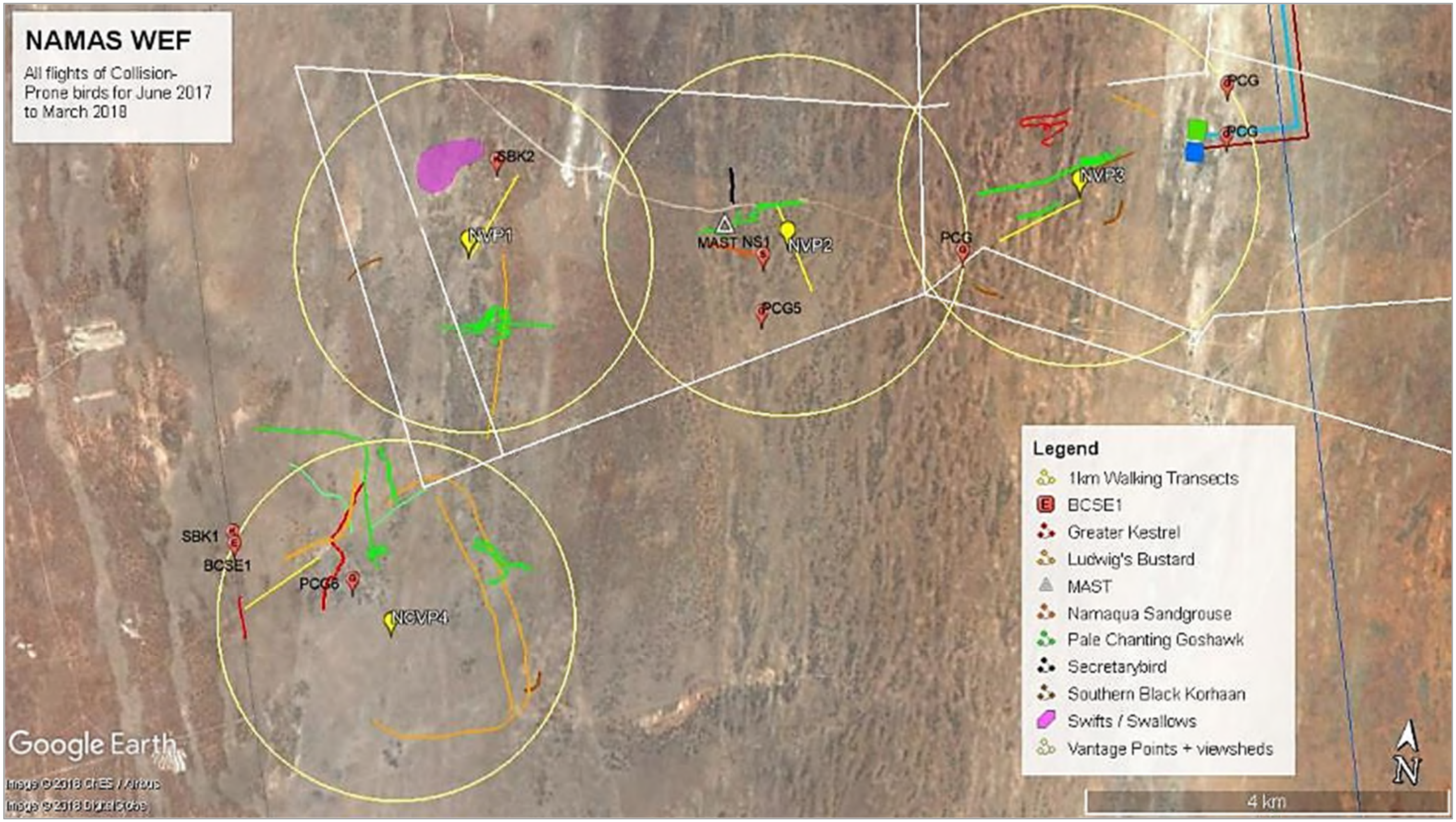

Figure 6: All flights of collision-prone birds across all VPs on the proposed Namas Wind Farm site from June 2017 to March 2018. Our VPs (=yellow pins) and their 2-km viewsheds (=yellow circles) are shown. Two Red Data species - Secretarybird (=black line) and Ludwig's Bustards (=light orange lines) were found on site, and several Pale Chanting Goshawks (=PCG, green lines), Greater Kestrels (=red lines), Southern Black Korhaan (=brown lines), Namaqua Sandgrouse (=dark orange line), Black-chested Snake Eagle and Swifts (=pink polygon) were apparent across the site.

Figure 7: Flight paths of all collision-prone species passing through VP1 (=yellow pin) during our monitoring from June 2017 – March 2018. A Red Data Ludwig's Bustard (=orange line), a pair of Pale Chanting Goshawks (=green+ yellow lines) and a Southern Black Korhaan (=brown line) were three collision-prone species found here, as well as a flock of Swifts and Swallows (=pink polygon) hunting on the wing.

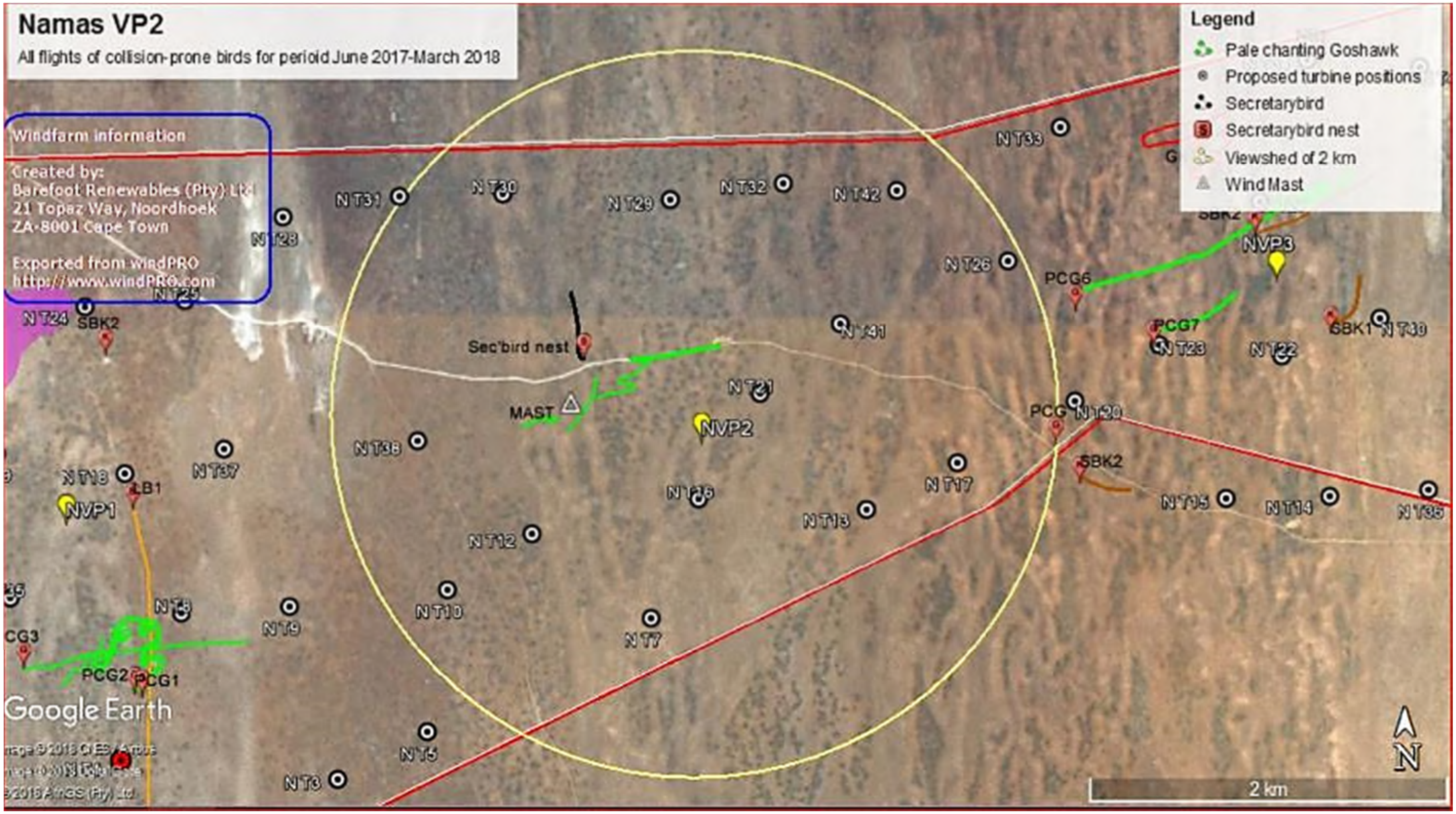

Figure 8: Flight paths of all collision-prone species passing through VP2 (=yellow pin) during our monitoring from June 2017 – March 2018. A Red Data Secretarybird (=black line) at a nest/roost (Red "S" pin) occurred near the Wind Mast, Pale Chanting Goshawks (=green lines) and a Namaqua Sandgrouse (=orange line) were the three collision-prone species found here. The proposed turbine positions are shown (NT and circles).

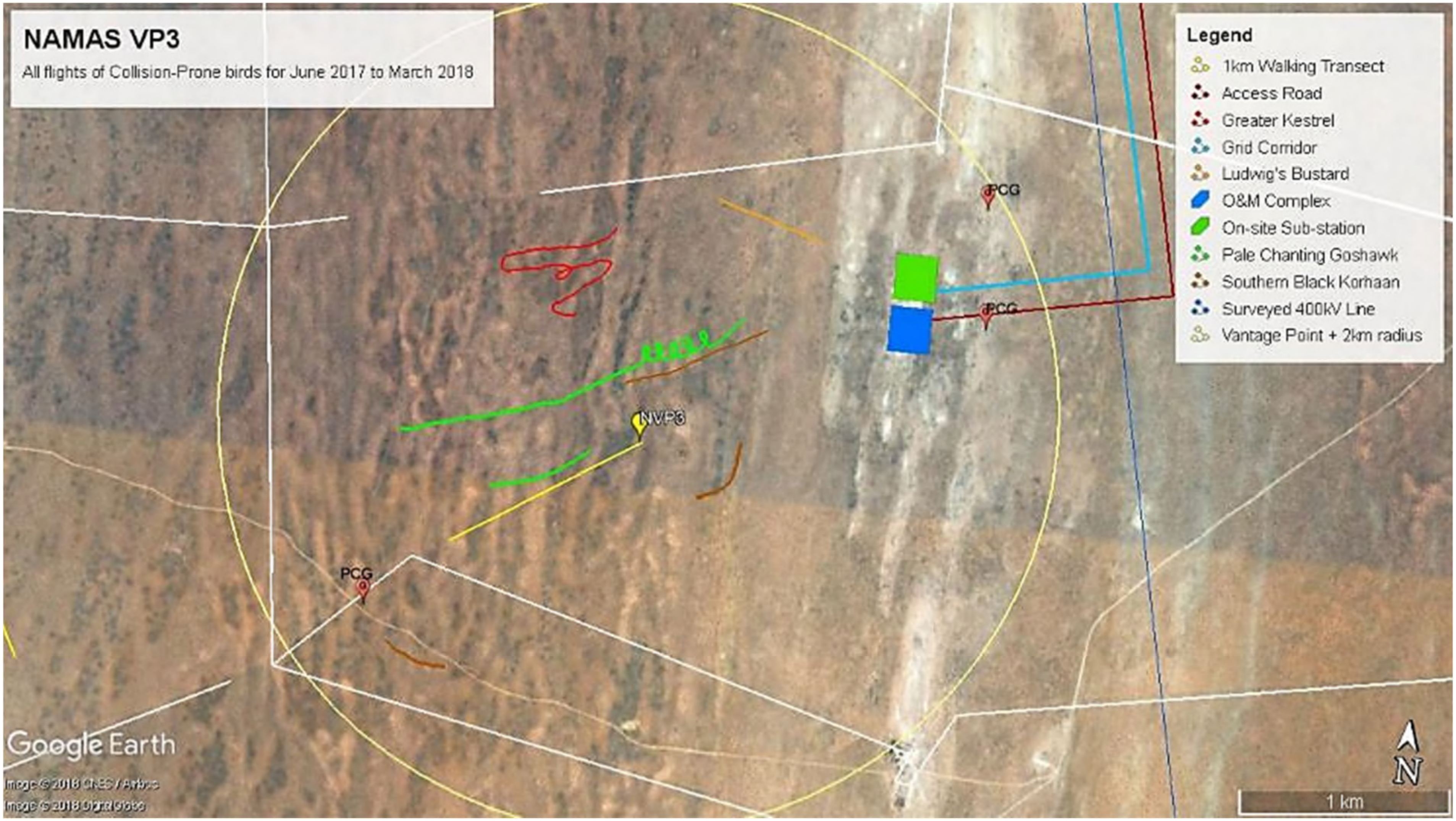

Figure 9: Flight paths of all collision-prone species passing through VP3 (=yellow pin) during our monitoring from June 2017 – March 2018. Pale Chanting Goshawks (=green lines), Southern Black Korhaan (=brown lines), Namaqua Sandgrouse (=orange line) and a Greater Kestrel (=red line) were four collision-prone species found here.

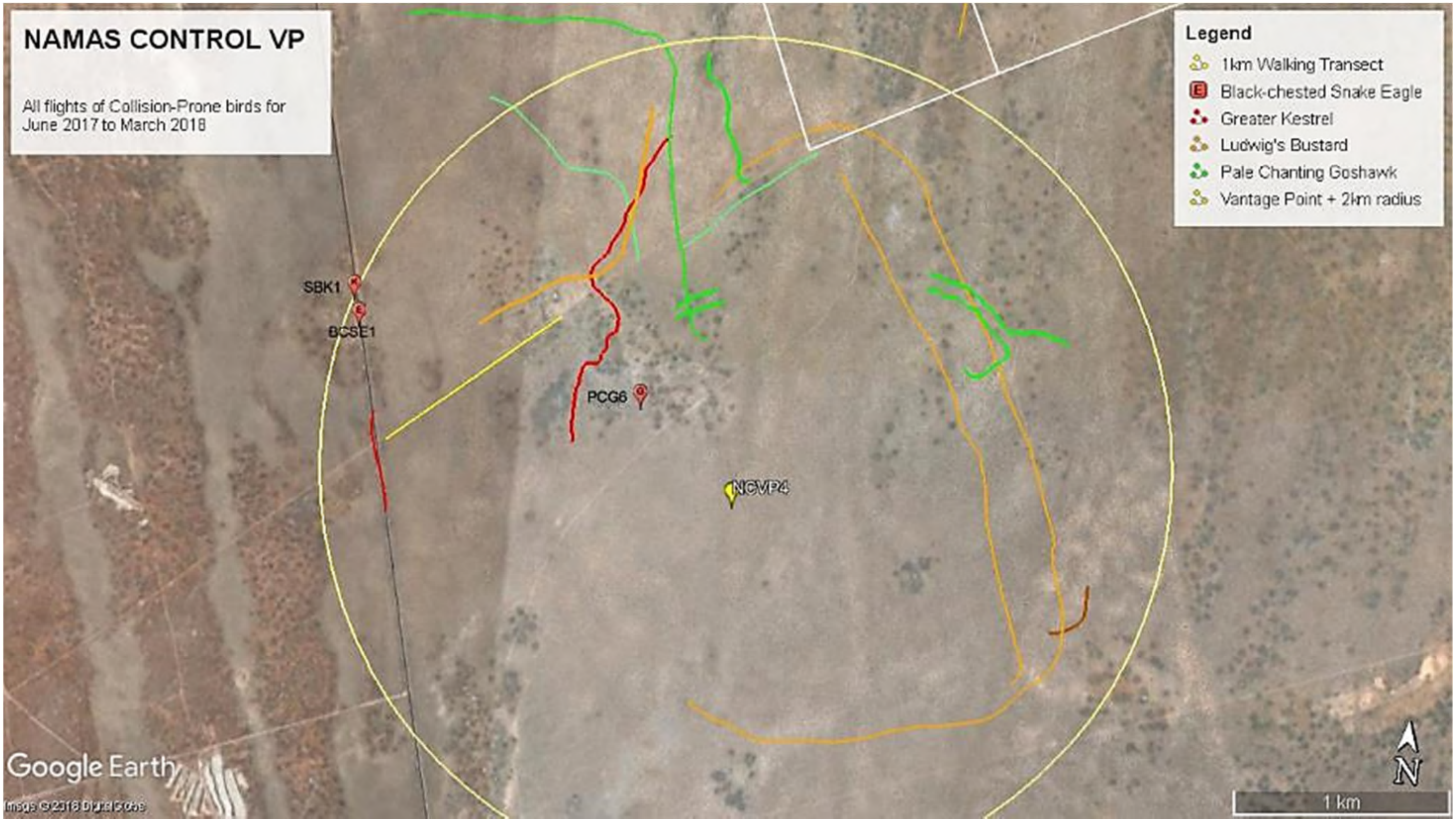

Figure 10: Flight paths of all collision-prone species passing through the Control site (=yellow pin) south of the WEF, during our monitoring from June 2017 – March 2018. A Red Data Ludwig's Bustards (=orange lines), Pale Chanting Goshawks (=all green lines). Southern Black Korhaan (=brown lines and SBK1), a Greater Kestrel (=red line), and a Black-chested Snake Eagle (=BCSE) were the five collision-prone species found here.

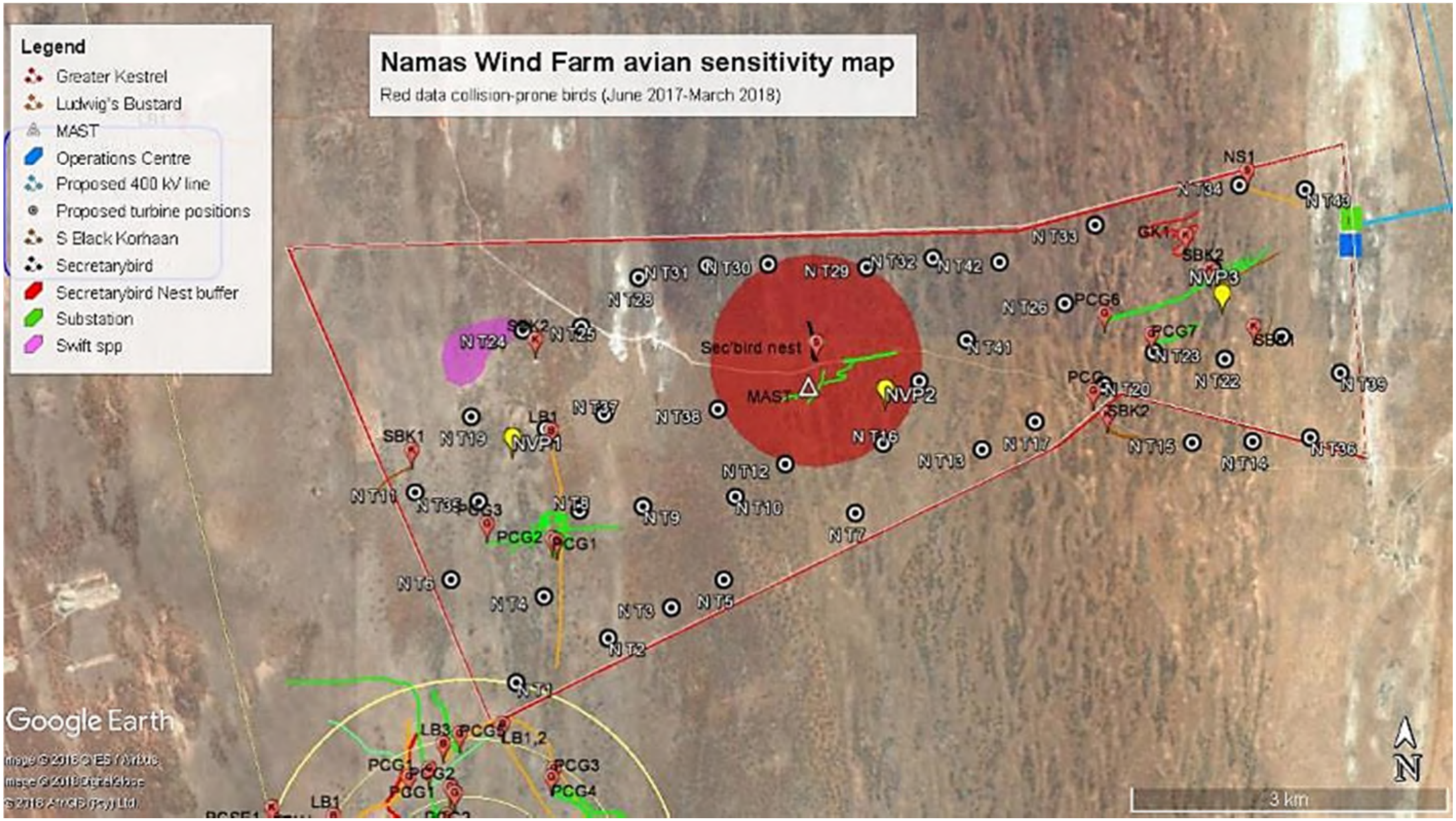

Figure 11: High-risk bird areas identified in the Namas Wind farm site. The red circle indicates the only high-risk area identified – an inactive Secretarybird nest/roost with a 1-km buffer around it. This is to reduce disturbance and reduce the likelihood of collision with nearby turbines if it is ever used. This nest may be the alternative site to a new but inactive nest found on Zonnequa in December 2017.

The risk areas identified on Figure 11 encompassed just one area:

- **High risk** (red) – Secretarybird inactive nest just north of the wind mast at S29°50'41.8" E17°11'41.69 (with a 1-km buffer).

No other areas hold more than one Red data species and no areas overlap for other collision prone species. The 1-km precautionary buffer around the known but inactive Secretarybird nest is designed to reduce the possibility of disturbance by construction or operation for this Vulnerable red data species (Taylor et al. 2015), if it is ever used. This is also designed to reduce the possibility of direct impacts for these species.

Justification for 1-km buffer around the Secretarybird nest

There are no Birdlife South Africa guidelines for Secretarybirds (as there are for Verreaux's Eagles and vultures) so expert opinion was sought to inform us of appropriate mitigation for the nest structure found on the proposed Namas wind farm (front cover photo). The following is based on email discussions with Dr A Kemp ex-Transvaal Museum), E Retief and S Ralston (BLSA), Dr C. Whittington-Jones (Ornithologist, Gauteng Department of Agriculture & Rural Development), including satellite tagging studies of juvenile birds (E Retief unpubl), as well as published work (Steyn 1982, Dean and Simmons 2005).

We recommend a precautionary 1-km buffer for the Namas Secretarybird for the following reasons:

- The Namas nest is not an active breeding site (the farmers report that is has not been used successfully) and thus the 1-km buffer is proposed as a precautionary measure;
- The Secretarybird is a very terrestrial species and rarely takes flight (Steyn 1982, Dean and Simmons 2005);
- "2500m is considered a sensitive area around a Secretarybird nest" (C. Whittington-Jones pers. comm.);
- There is only one recorded death of a Secretarybird in over 200 raptor deaths as a result of wind farm collisions across South Africa (S. Ralston pers comm). There are more deaths due to fences than there are from wind farms (E Retief pers. comm);
- For satellite-tagged young birds the ranges were not as large as expected. Tagged juveniles rarely ranged beyond 1.3 km from the nest (E. Retief pers comm). Retief further suggested that habitat (grassland of < 0.5 m tall) may be a good predictor of habitat use. He does not favour buffers because the movements can be so skewed in one direction or the other;

- There is no published usage data (i.e. 90% kernel assessments) to show what size and where the high use areas are for SBs. However, unpublished data provided by M Whitecross (BLSA) from satellite-tagged juveniles showed that home ranges averaged 1.2$\pm$ 1.4 km^2.
- Our data for a breeding pair of Secretarybirds at an Eastern Cape wind farm indicates that breeding adult and juvenile Secretarybirds flew for just 36 minutes in 321 hours when at least one SB was on site. Thus, for only ~0.19% of the time.
- From 169 records of focal birds in flight over the same time period, 85% of all flights occurred in the Blade-swept Area [BSA] between 58 and 205-m (the blade heights of 130-m hub height with 75-m blades).

Thus, **we conclude that** the rarity of flight in this species (< 0.2% of 321 hours) and the death of only 1 Secretarybird in over 200 recorded raptor fatalities at South African wind farms, suggests that the risk of collision for this species is very low. Thus, because the Namas nest site is not an active site we recommend that a 1-km precautionary buffer will be sufficient to avoid disturbance.

These data were presented to BLSA (S Ralston-Paton) on 14th August in a joint meeting with the EAP (Savannah Environmental) and developer (Atlantic Energy partners), and this size precautionary buffer was deemed acceptable by BLSA given that the nest was inactive.

The level of risk for this red data species will be related to (i) their presence on the site (they are not seen on every site visit) and (ii) more so if they breed (because they will then probably perform display flights within the BSA.) Because another new, but inactive nest was found on the Zonnequa site (where two birds were briefly seen), and only one bird was ever seen on Namas, it may be that this nest is an alternative site and may be used very rarely. If birds are killed, despite the 1 km buffer for this inactive nest, then additional mitigations, particularly the black-blade mitigation or similar (UV-reflective paint) detailed above will have to be implemented. Further details are given below.

8 QUANTIFYING THE IMPACTS

Below, we semi-quantify the impacts and evaluate the advantages of various forms of mitigation to reduce expected impacts.

Nature: The impact of the proposed WEF area will generally be negative for birds given the certainty that: (i) ~28-km^2 of habitat will be transformed and the associated habitat potentially fragmented; and (ii) birds may be killed directly if they fly into the wind turbines. Some displacement may also occur.

The Extent (E, from 1-5) of the impact will be local within the 28-km^2 area = (1).

The Duration (D, from 1-5) will be long-term (4) for the lifetime of the WEF. This is so for all collision-prone species.

The Magnitude (M, from 0-10) of the WEF area is expected to cause a low impact (1) for the raptors.

The Probability of occurrence (P, from 1-5) of the raptors (Secretarybird) and bustards having some sort of interaction with the WEF site is ranked as medium (2) because of their low passage rates and occurrence on the proposed wind farm identified in this assessment. This does not mean there is no risk as Secretarybirds do fly at such heights as recorded in our unpublished studies (above).

The Significance S, [calculated as S = (E+D+M)P], is as follows (Table 7) for the species identified as at risk in the (i) wind farm site.

The scale varies from:

- 0 (no significance), to
- $\leq$30 Low (this impact would not have a direct influence on the decision to develop in the area), to
- 30-60 (the impact could influence the decision to develop in the area unless it is effectively mitigated), to
- >60 (the impact must have an influence on the decision process to develop in the area).

Table 7. A quantification of impacts to the three, main, collision-prone Red Data species likely to be impacted by the **proposed Namas WEF.**

<u>WEF development site</u>

Nature: Negative due to direct impact fatalities, disturbance and loss of foraging habitat around the WEF site for the Red-listed bird groups identified as at risk above.

- The Secretarybird (= **SB**), and possibly the Lanner Falcon (= **LF**) recorded on site as an incidental , are the only raptors species likely to be impacted as well as the nomadic Ludwig's Bustard (= **LB**).

	Without mitigation		**With mitigation**
Extent	**1**		**1**
Duration	**4**		**4**
Magnitude	**5 (SB) 1(LF), 4 (LB)**		**3 (SB) 1(LF), 3 (LB)**
Probability	**3 (SB) 2(LF), 2 (LB)**		**2 (SB LF), 2 (LB)**
Significance (E+D+M)P	**30 (SB) (medium)**	**12(LF), 18 (LB) (low) (low)**	**16 (SB) 12 (LF), 16 (LB) (low) (low)**
Status (+ve or –ve)	Negative		Negative

Reversibility	Yes, if turbines avoid areas identified as high-risk	Yes, if turbines avoid areas identified as high-risk
Irreplaceable loss of species?	No, Secretarybirds populations are relatively low here (not core habitat). Ludwig's Bustards are nomadic visitors to this area.	
Can impacts be mitigated?	Yes. If the areas identified as high-risk are avoided for development	Yes. If all areas identified as high-risk are avoided for development

Mitigation for WEF site:

The mitigation for birds around the Namas WEF site are as follows:

- position the turbines away from risk areas of high aerial traffic or nests of collision-prone species; this applies to the Secretarybird nest on site via the 1 km buffer;
- if birds impact the turbines then paint a single blade black (or with UV-paint) for those select turbines known to kill most birds to reduce impacts for eagles and other raptors (Stokke et al. 2017);
- selective feathering or stopping of turbines can be implemented during high-use seasons or times in the day for turbines that continue to kill unsustainable numbers of raptors
- if raptors continue to be attracted into the site then habitat can be manipulated to reduce the attractiveness (from a prey point of view) for the raptors. Reducing the attractiveness from a food resources point of view will reduce raptor use of the area. This can be achieved by increasing the stocking density of sheep or goats on the farm;

One of the mitigations above (black-blade mitigations) is dependent upon knowing which turbines are responsible for most deaths. Thus, we recommended that: Genesis Namas Wind (Pty) Ltd implement 12-24 months post-construction monitoring to assess the mortality of birds in the wind farm, through direct observation and carcass searches. This will assist in determining where individual turbine-specific mitigation measures are required to be implemented.

Residual impacts:

After mitigation, direct mortality through collision, or area avoidance, by the species identified above may still occur and further research and mitigation measures should be suggested. This can only be undertaken in conjunction with a systematic monitoring programme.

8.1 Cumulative Impacts

Cumulative impacts are defined as "impacts that result from incremental changes caused by either past, present or reasonably foreseeable actions together with the project" (Hyder, 1999, in Masden et al. 2010).

Thus, in this context, cumulative impacts are those that will impact the general avian communities in and around the Namas Wind Farm development, mainly by other wind and solar farms and associated infrastructure in the Nama Karoo. This will happen via the same factors identified here viz: collision, avoidance and displacement. As a starting point, the number of renewable energy developments within a 30-km radius of the site needs to be determined and secondly, to know their impact on avifauna.

Given the general assumption that footprint size and bird impacts are linearly related for wind farms, a starting point in determining cumulative impacts is to determine:

- the number of birds displaced per unit area, by habitat destruction, or disturbed or displaced by human activity;
- the number of birds killed by collision with the turbines on site; and
- the number of birds killed by collision with infrastructure leading away from the site.

Three renewable energy developments are currently on record with the DEA (Table 9), and all are wind farms (Figure 12). The combined energy output of the five sites is projected to be 645MW.

Table 9: All renewable energy projects within a 30-km radius of the Namas WEF, and their approval status with the DEA. Source: Savannah Environmental updated from http://egis.environment.gov.za/frontpage. aspx?m=27 DEA last quarter 2017.

	Project Title	Distance from NAMAS	Technology	Megawatts	Current Status
1	Genesis Zonnequa Wind Farm	3.0 km	Wind	140 MW	In Process
2	Eskom Kleinsee K300	7.0 km	Wind	300 MW	Approved
3	Juwi Kap Vley wind farm	10.0 km	Wind	300 MW	In process
Totals: 3 farms			All wind	740 MW	

We searched for data to populate the Cumulative Impacts table from published and unpublished studies and theses. We sourced data from (i) post-construction wind farm data from avian assessments summarised by Birdlife South Africa from 1-2 years' post-construction monitoring (Ralston et al. 2017) (Table 10).

The national review of post-construction data (Table 10), including data from West Coast wind farms indicates that South African wind farms kill about 4.1 birds per turbine per year, similar to the international mean of about 5.25 birds per turbine per year (see Review (Point 5) above). Of concern is that 36% of the fatalities recorded are raptors (Table 10). The equivalent number of fatalities per Megawatt lies between 1.87 and 5.5 birds per MW per year (Ralston et al. 2017). Using a median value of 3.7 bird fatalities per MW per year we can calculate the number of birds likely to be killed per megawatt. Note that this may be a slightly inflated figure because many early wind farms in South Africa did not have stringent mitigation measures, appropriate buffers and sensitive siting of turbines. However, given that it is similar to internationally-derived mortality rates (Loss et al. 2013, Sovacool 2013) it is probably a robust estimate.

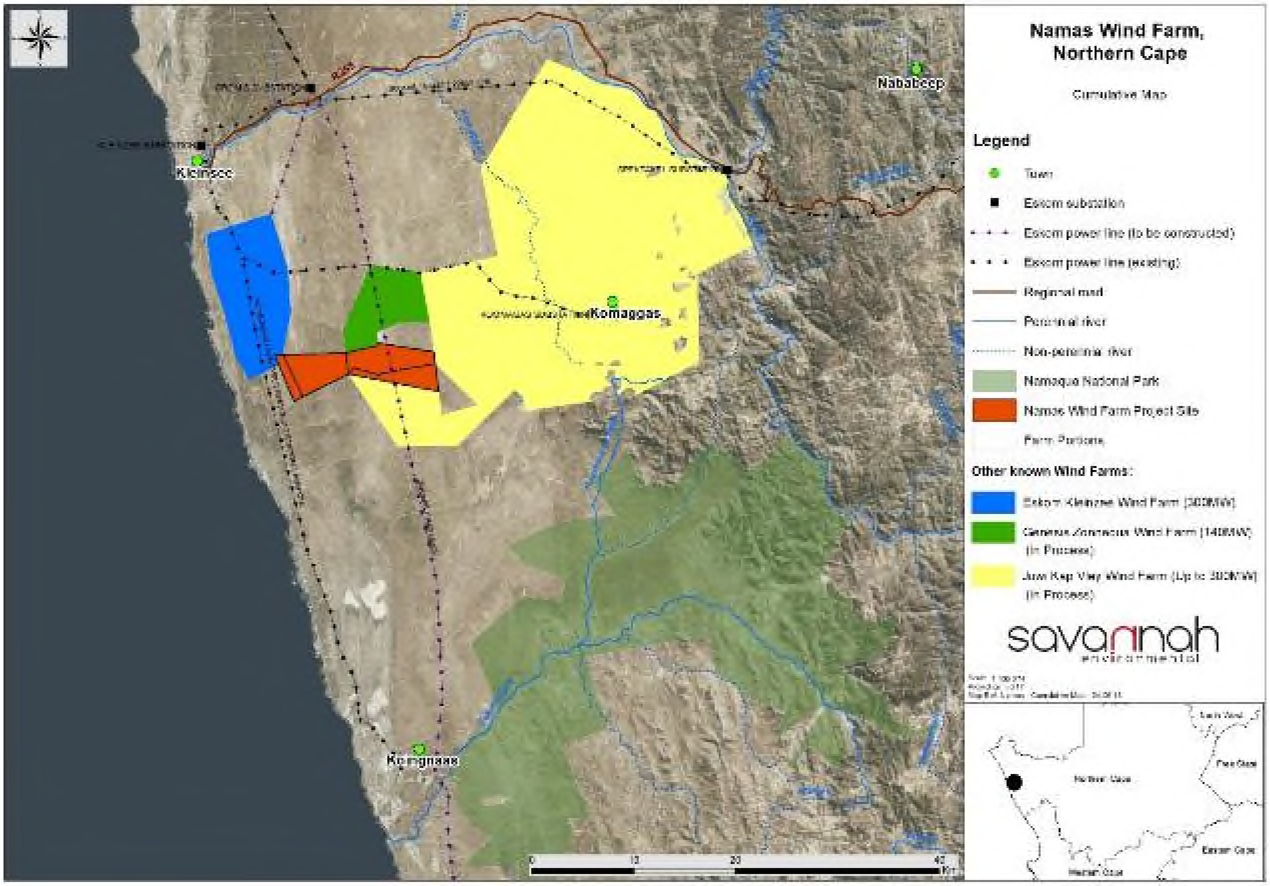

Figure 12: All proposed renewable energy (RE) developments within a 30-km radius of the Namas wind farm. Three proposed RE sites are shown within 30-km – the Eskom Kleinsee 300 site (blue), the Genesis Zonnequa site (green) and the Juwi Kap Vley wind farm (yellow).

We can estimate the potential cumulative number of fatalities using the known fatalities from Ralston et al. (2017). The total power output of all proposed wind farms within 30 km is 740 MW.

The potential number of fatalities expected therefore is:

- 740MW x 1.87 fatalities per MW per year = 1384 birds per year (wind)
- If 36% of these are likely to be raptors (Table 10), then 498 raptor fatalities are predicted per year.
- If ~20% of these raptors are Red Data species (Ralston et al. 2017) then the cumulative impact is estimated to be 100 threatened raptors killed annually by the three wind farms within 30-km.

Note that these are likely to be liberal estimates for the possible fatalities. First, the Passage Rates for raptors and bustards through this area when typically dry conditions occur is very low. Second, the fatality rates derived from Ralston et al (2017) were from areas with higher raptor concentrations (Eastern Cape, wet Western Cape sites) than here in the arid far-west. Thus, they may over-estimate the possible fatalities.

High (99%) avoidance rates are known for raptors around wind farms (Madders & Whitfield 2006). Thus, it is likely these figures are inflated fatality estimates.

Table 10: Summary of all birds and Red Data raptors killed at six wind farms in South Africa from 2014–2016. From Birdlife South Africa (Ralston et al. 2017). The identity of the wind farms was kept anonymous as a condition for the use of the data.

Wind farms	Turbines	Months monitored	Avian fatalities	Adjusted mortality rate*
6	46, 9, 41, 40, 60, 32	69	309	4.1 birds.turbine^{-1}year^{-1}
Main groups		Proportion of all avian fatalities		Ranking
Raptors (small-medium)		33%		1
Others/unknown		16%		2
Swifts, swallow and martins		14%		3
Passerine (small perching birds)		14%		3
Waders and wetland birds		10%		5
Raptors (eagles)		3%		6
Red Data raptors as a proportion of all raptors killed		12/61 = 19.7%		

Table 11: Cumulative impacts of the Namas Wind Farm in the Nama Karoo, relative to 3 other wind farms within 30-km of the site.

Nature: The impact of the wind energy facilities proposed in the coastal Nama Karoo is expected to be negative and arise from disturbance, displacement and collision for birds around the wind turbines.

The direct potential impact of the 3 wind farms (Table 7) was gauged using data released in 2017 by Birdlife South Africa for fatalities at 8 wind farms in South Africa (Ralston et al. 2017).

About 4.1 birds per turbine per year, or ~3.7 birds per MW per year are killed annually. We have used the lower mortality rate of 1.87 birds/MW/yr because dry areas will have lower species richness and abundance than more mesic areas.

If a total of 740MW (wind) is generated per year from all wind farms within 30 km, we estimate a maximum of 1384 birds could be killed annually, of which 36% (498) are likely to be raptors. Since about 20% of these raptors are threatened Red Data species, about 100 are estimated to be killed (above). These estimates are likely over-estimates given the very low passage rates recorded in this study area, and it is expected that probably 10% of this figure to be closer to reality in dry periods. Thus, the likely impact varies from medium without mitigation. Careful mitigation can reduce this to low levels.

	Contribution of Proposed Namas wind farm project*	**Cumulative Impact Of all projects within 30 km**
Extent	Local (1)	Regional (3)

Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Moderate (7)
Probability	Probable (3)	Probable (3)
Significance (E+D+M]P	**Medium (33)**	**Medium (42)**
Status (positive/negative)	Negative	Negative
Reversibility	Medium	Medium
Loss of resources/species?	Likely	Likely
Can impacts be mitigated?	Probably, Yes	Yes

Confidence in findings:

Medium-Low: the mortality data released by Birdlife South Africa allows for the estimation of the probable mortality, but they may over-estimate avian mortality rates in the dry conditions typical in the western part of South Africa. Passage Rates and occurrence of Collision-prone species are typically low when annual rainfall is low, and mortality is thus expected to be minimal at such times. The mitigation measures suggested to avoid major raptor fatalities is unknown for each wind farm. Without mitigation measures (i.e. the avoidance of high-use and high-risk areas) the chances of mortality will increase greatly.

Mitigation:

Reducing avian impacts at wind energy facilities is in its infancy in South Africa. Recommended measures include:

- avoiding all migration routes and major flyways in the placement of such facilities;
- avoiding all nest areas and foraging/roosting areas of Red Data species in the siting of said facilities;
- employ radar or video detection of collision-prone birds and audible or visual deterrence to deter birds from approaching close to the turbines (both are quite expensive);
- painting one turbine blade black (or equivalent such as UV) and selective stopping of turbines should both be tested for efficacy;
- introduce livestock into the area to reduce the attractiveness of the habitat to raptors through increased grazing pressure, thereby reducing prey populations.

****With mitigation***

9 ENVIRONMENTAL MANAGEMENT PLAN

Given the possible impact of the proposed Namas Wind farm development, the overall impact on avifaunal species requires systematic monitoring at both the construction and post-construction phases. This is a recommendation of the BARESG guidelines (Jenkins et al. 2015).

The guidelines suggest an adaptive and systematic monitoring of bird displacement (comparing avian densities before and after construction, particularly for priority collision-prone and red data species) and particularly the monitoring of all turbine-related fatalities. The latter must take account of biases introduced by scavengers removing carcasses and observers failing to detect bird remains below the turbines.

The monitoring should include the following (as per BARESG guidelines):

- Post-construction monitoring should be started as the facility becomes operational, bearing in mind that the effects of the WEF facility may change over time;
- Post-construction monitoring can be divided into two categories: a) quantifying bird numbers and movements (replicating baseline data collection), and b) estimating bird mortalities;
- Carcass monitoring should be undertaken by trained observers, willing to cover 4-5 turbines per day in all weathers and over-seen by an ornithologist competent to determine species identification and a manager to collate and analyse each year's data;
- Estimating bird fatality rates includes: a) estimation of searcher efficiency and scavenger removal rates, b) carcass searches, and c) data analysis incorporating systematically collected data from (a) and (b); These biases should then allowed for in estimating fatality rates;
- A minimum of 30-40% of the wind farm footprint should be methodically searched for fatalities, throughout the year, with a search interval informed by scavenger removal trials and objective monitoring. Any evidence of mortalities or injuries within the remaining area should be recorded and included in reports as incidental finds;
- The search area should be defined and consistently applied throughout monitoring;
- The duration and scope of post-construction monitoring should be informed by the outcomes of the previous year's monitoring, and reviewed annually;
- Post-construction monitoring of bird abundance and movements and fatality surveys should span 2-3 years to take inter-annual variation into account; and
- If significant problems are found or suspected, the post-construction monitoring should continue in conjunction with adaptive management and mitigations, taking into account the risks related to the particular site and species involved.

An assessment guided by these principles is required not only to enact and experiment with different mitigation measures where significant mortality occurs, but allow data to be collected that will benefit the welfare of avifauna at other renewable energy farms. This is also important for a study of cumulative avian impacts for the increasing number of wind farms planned for South Africa.

Management interventions: Where avian fatalities are found to occur (i) to red-data species, or (ii) at unacceptably high levels, to priority species, then the mitigation measures detailed above, should be brought into play. Thus, experiments for example with bird deterrent techniques such as black-painted (or UV-painted) blade mitigation should be undertaken without delay to reduce fatality rates. The results of these experiments should also be publicized so that other wind farms, with similar issues, can be informed.

We would encourage the developers to release the results of the annual monitoring to Birdlife South Africa such that South Africa-wide fatality and displacement results to be collated and assessed. Only in this way will the cumulative impacts assessments, currently crudely estimated, be refined, region by region.

10 CONCLUSIONS AND RECOMMENDATIONS

This year-long survey provides a comprehensive understanding of the avian species present in the Namas Wind Farm prior to construction. The presence of some Red Data species (Ludwig's Bustard, Secretarybird, and Lanner Falcon) means the site is low to medium-rich in threatened species. Despite this, the Passage Rates were very low: for the Red Data species on the WEF site they were 0.01 bird per hour and were low for all the collision-prone species combined (0.13 birds per hour). This suggests a relatively low risk to any birds on site. We also believe that this may have arisen from the very dry conditions present in western South Africa in 2017-2018. However, this may become the norm under climate change as it is part of a long-term decline in rainfall apparent since the 1940s. This amounts to a decline of 17mm per year every decade (www.news24.com/SouthAfrica/News/how-severe-is-cape-towns-drought-a-detailed-look-at-the-data-20180123) While avian passage rates are expected to be higher during more typical rainfall, research in arid areas indicates that avian populations decline with a decline in mean annual rainfall over large areas (Seymour et al. 2015).

One area of high-risk was identified on the proposed site, because of an (inactive) nest and roost site of a single resident Red Data Secretarybird. If a pair occurs and breeds they may be impacted if turbines are constructed. A pair were seen once on the adjacent Zonnequa wind farm and a new nest structure was built not far from the Namas site. Because only one pair (or one bird) was ever seen in the back-to-back monitoring at these two adjacent sites over 12 months, we infer that these nests and pairs are the same birds. Thus, a 1-km precautionary buffer is recommended around the inactive nest in which no development (roads or turbines or fences) should occur. Because the Namas nest was the most used (for roosting) we recommend a 1-km buffer around it and that that development avoids this area. We note that it is very rare for Secretarybirds to be killed by wind farms, (1 death in > 200 wind farm raptor fatalities) and few flights in the blade swept area are taken by this largely terrestrial species. By implementing these measures to mitigate possible impacts for these collision-prone Red Data species, risks and mortality can be reduced to very low and acceptable levels. No areas of medium-risk were identified.

We define **acceptable levels** as less than one raptor fatality every 2 month across the entire wind farm site. Or not more than one red data raptor per year across the wind farm. If more than these levels are found, with the current level of mitigation implemented, then additional mitigation measures as itemised in Table 7 must be implemented.

Cumulative impacts are greater for the 3 proposed wind farms within 30-km of the Namas Wind Farm site, and we estimate that in high rainfall years thousands of fatalities (all bird species) may occur annually based on average South African fatality rates. The proportion of red listed species is estimated at 100 red data raptors (Table 11) cumulatively killed annually in high rainfall years. Low Passage Rates of raptors in normally dry conditions and in this over-grazed landscape suggests that this figure is over-inflated and that fatalities may be only 10% of this figure. That is, 10-20 red data raptors for all 3 wind farms if all gain Environmental Authorization. At present, only one wind farm has actually gained authorization (Eskom's Kleinsee 300).

In our view, and from research on bird populations in arid areas (Seymour et al. 2015), low rainfall sites will have fewer species and a lower abundance of those species. Given the relatively rapid decline in rainfall over the last 80 years and the expected negative effect on South African bird populations (Simmons et al. 2004), the Passage Rates recorded here are, on average, unlikely to be much higher than recorded in 2017-2018, and the impact on the avifauna of the area will be at acceptable levels to allow development to proceed with the recommended mitigations.

We also suggest that further reducing the attractiveness of the site for raptors through the continued intense livestock farming, will assist in reducing future impacts. At present the land-owners here farm with sheep year-round, supplementing in the dry months, while other more affluent farmers move their sheep away in hot dry summer months. We recommend this land use be continued.

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Appendix 1

All Bird species recorded on SABAP2 bird atlas cards in the pentads (2945_1710, 2950_1710, 2945_1715, 2950_1715) N = 37 cards from June 2013 to March 2018 for the WEF and control sites.

SABAP species 37 cards	**Full protocol**	
June 2013 - March 2018	Rep Rate (%)	n
Scrub-robin, Karoo	37.8	14
Prinia, Karoo	35.1	13
Lark, Karoo	32.4	12
Flycatcher, Chat	29.7	11
Crow, Pied	27.0	10
Crow, Cape	27.0	10
Cisticola, Grey-backed	27.0	10
Lark, Karoo Long-billed	24.3	9
Sunbird, Southern Double-collared	24.3	9
Goshawk, Southern Pale Chanting	21.6	8
Warbler, Rufous-eared	21.6	8
Canary, Yellow	18.9	7
Martin, Rock	18.9	7
Kestrel, Greater	16.2	6
Bokmakierie,	13.5	5
Crombec, Long-billed	13.5	5
Bustard, Ludwig's	10.8	4
Tit-babbler, Layard's	10.8	4
Lark, Spike-heeled	10.8	4
Swift, Little	10.8	4
Eagle, Booted	10.8	4
Swallow, Barn	10.8	4
Sparrow, Cape	10.8	4
Swift, Alpine	8.1	3
Sunbird, Malachite	8.1	3
Korhaan, Southern Black	8.1	3
Penduline-tit, Cape	8.1	3
Snake-eagle, Black-chested	8.1	3
Secretarybird	5.4	2
Wheatear, Capped	5.4	2
Fiscal, Common (Southern)	5.4	2
Bee-eater, European	5.4	2
Canary, White-throated	5.4	2
Chat, Familiar	5.4	2
Lark, Cape Long-billed	5.4	2
Chat, Anteating	5.4	2
Sandgrouse, Namaqua	5.4	2
Falcon, Lanner	2.7	1
Swift, Common	2.7	1

Thick-knee, Spotted	2.7	1
Turtle-dove, Cape	2.7	1
Tit, Grey	2.7	1
Lark, Red-capped	2.7	1
Bulbul, Cape	2.7	1
Kestrel, Rock	2.7	1
Swallow, White-throated	2.7	1
Stonechat, African	2.7	1
Lapwing, Crowned	2.7	1
48 species recorded		
8 Collision-prone species		
3 Red data species		

APPENDIX 2

ALL COLLISION-PRONE BIRD SPECIES RECORDED IN THE PROPOSED NAMAS WIND FARM JUNE 2017-MARCH 2018.

NAMAS WEF Passage Rates -June 2017

Date	Time	Obs period	Hrs	VP	No	Species	Height	Secs	Ref on Map
04/06/2017	11h59	08h00-14h00	6.00	**NVP1**	25	Swifts spp	20m-30m		SW1-25
06/06/2017		11h40-17h40	6.00	**NVP1**		No Birds			
03/06/2017		8h00-14h00	6.00	**NVP2**		No Birds			
05/06/2017		12h00-18h00	6.00	**NVP2**		No Birds			
03/06/2017	8h27	07h50-13h50	6.00	**NVP3**	1	**Southern Black Korhaan**	5,5m	15	SBK1
05/06/2017	12h25	12h25-17h55	5.50	**NVP3**	1	**Southern Black Korhaan**	5,5,7m	30	SBK2
WEF	**Passage rate:**		**35.50**	**Hr**	**2**	**0.06**	**Birds / hr**		

NAMAS WEF Passage Rates - September

Date	Time	Obs period	Hrs	VP	No	Species	Height	Sec	Ref on Map
3/9/2017		7h00-13h00	6.00	**NVP1**		No Birds			-
4/9/2017	8:25	6h50-12h50	6.00	**NVP1**	1	**Ludwig's Bustard**	7,7,8,10,10,15,15,15,15,12,13 ,10,7,7	195	LB1
1/9/2017	7:10	7h10-13h10	6.00	**NVP2**	1	Pale Chanting Goshawk	5,5,8,10,10	60	PCG1
	9:02				1	Pale Chanting Goshawk	On nest - then flies 2,6,8	35	PCG2
	10:59				1	Pale Chanting Goshawk	30,30,30,2,0	66	PCG3
	11:16				2	Pale Chanting Goshawk	0,5	5	PCG4,5
2/9/2017		7h50-13h50	6.00	**NVP2**		No Birds			-
1/9/2017	12:30	7h20-13h20	6.00	**NVP3**	1	Greater Kestrel	10,15,15,20,29,15,6,7,20,25,2 5,7,5,10,17,15,20	240	GK1
2/9/2017		8h15-14h15	6.00	**NVP3**		No Birds			-
WEF	**Passage rate:**		**36.0**	**Hr**	**7**	**0.19**	**Birds / hr (3 Species)**		

NAMAS WEF Passage Rates – December 2017

Date	Time	Obs period	Hrs	VP	No	Species	Age	Sex	Height	Seconds	Ref on Map
30/11/2017	11:58	8h30-14h30	6.00	**NVP1**	1	Pale Chanting Goshawk	Ad	U	80,50,20,50, 40,30	61	PCG1
	11:58				1	Pale Chanting Goshawk	Ad	U	80,50,20,50, 20	57	PCG2
	13:19				1	Pale Chanting Goshawk	Ad	U	10,20,40,70, 90	52	PCG3
1/12/2017		8:00-14:00	6.00	**NVP1**		**No Birds**	**-**			-	
28/11/2017	7:30	7h30-13h30	6.00	**NVP2**	1	Pale Chanting Goshawk	Ad	U	25,25,30,30, 30,30	75	PCG4
29/11/2017	7:30	6:50-12:50	6.00	**NVP2**	1	**Secretarybird**	Ad	U	Perched, preening on nest-bush	-	SEC1
	7:40				1	**Secretarybird**	Ad	U	5,5	15	SEC1
28/11/2017	11:10	7h00-12h00	6.00	**NVP3**	1	Pale Chanting Goshawk	Ad	U	10,10,20,25, 40,45,70,100	105	PCG6
	11:16				1	Pale Chanting Goshawk	Ad	U	5,5	15	PCG7
29/11/2017		7h00-12h00	6.00	**NVP3**		**No Birds**				-	
WEF	**Passage rate:**		**36.0**	**Hr**	**8**	**0.22**			**Birds / hr**	**(2 Species)**	

NAMAS WEF Passage Rates – March 2018

Date	Time	Obs period	Hrs	VP	No	Species	Age	Sex	Height	Seconds
2018/03/04		7h30-13h30	6.00	**NVP1**		No birds			-	
2018/03/05	8:55	7h20-13h20	6.00	**NVP1**	1	**Southern Black Korhaan**	**A**	**M**	7;7m	20
2018/03/02		7h00-14h00	7.00	**NVP2**		No birds			-	
2018/03/03		7h10-12h10	5.00	**NVP2**		No birds			-	
2018/03/02	7:30	7h05-14h05	7.00	**NVP3**	1	**Southern Black Korhaan**	U	U	20;25;20;15;20;25	75
2018/03/03		7h05-12h05	5.00	**NVP3**		No birds			-	
WEF	**Passage rate:**		**36.0**	**Hr**	**2**	**0.06**		**Birds / hr**	**(1 Species)**	

Summary: All Passage Rates	Hours	Birds	Passage Rate Birds / hour	Season
All Birds	**36.00**	**2**	**0.06**	**Autumn - March 2018**
Red Data Birds	**36.00**	**0**	**0.00**	**Autumn - March 2018**
All Birds	**36.00**	**8**	**0.22**	**Summer - December 2017**
Red Data Birds	**36.00**	**2**	**0.06**	**Summer - December 2017**
All Birds	**36.00**	**7**	**0.19**	**Spring - September 2017**
Red Data Birds	**36.00**	**1**	**0.03**	**Spring - September 2017**
All Birds	**35.50**	**2**	**0.06**	**Winter - June 2017**
Red Data Birds	**35.50**	**0**	**0.00**	**Winter - June 2017**
All Collision-prone Birds	**143.50**	**19**	**0.08 Birds / hr**	
Red Data Birds	**143.50**	**3**	**0.01 Birds / hr**	