# Avian Baseline Monitoring Programme for the Witberg Renewable Energy Facility

# Pre-construction Monitoring Report

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ANCHOR
environmental

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# List of acronyms and abbreviations

| | |
|---|---|
| AIA | Avifaunal Impact Assessment |
| BAWESG | Birds and Wind Energy Study Group |
| EIA | Environmental Impact Assessment |
| EWT | Endangered Wildlife Trust |
| masl | Metres above sea level |
| SD | Standard deviation |
| SE | Standard error |
| WEF | Wind energy facility |
| NEMA | National Environmental Management Act |
| NSBA | National Spatial Biodiversity Assessment |
| NBSAP | National Biodiversity Strategic Action Plan |

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# 1 INTRODUCTION

G7 Renewable Energies ("G7")[1] has proposed the development of a Wind Energy Facility on a ridge of the Witteberg mountains, directly south of the N1 highway, 4km west of Matjiesfontein and approximately 40km east of Touwsrivier in the Western Cape Province. The proposed Wind Energy Facility (WEF) would be spread over distance of about 13km along the main "Witberg ridge".

The proposed project has an operational lifespan of 20 – 25 years (S. Hirschman, G7, pers. comm.). A potential replacement of turbines - including change of turbine hub height, rotor diameter, turbine position, foundations substations, roads etc. – thereafter, may require a new environmental impact assessment (EIA).

An Avian Impact Assessment (AIA) was carried out for the study area by Avisense (2010) as part of the overall Environmental Impact Assessment (EIA) for the proposed development. Recommendations of the AIA report included that pre- and post-construction monitoring of birds should be carried out at the site, following the guidelines published by the Birds and Wind Energy Specialist Group (BAWESG) of the Endangered Wildlife Trust (Jenkins et al. 2011), and that the outcome of the monitoring studies should be used to update the recommendations in the AIA for the mitigation of potential negative impacts of the WEF on avifauna. Anchor Environmental Consultants was contracted by G7 to undertake the pre-construction avifaunal monitoring for the proposed WEF site.

The primary aims of the baseline monitoring as taken from the best practise guidelines for avian monitoring at proposed wind energy development sites (Jenkins *et al*. 2011) include:

- Determining the densities of birds regularly present or resident within the impact area of the WEF (and a control site) before the construction phase.
- Documenting the patterns and movements of birds in the vicinity of the proposed WEF before its construction.
- Monitoring the patterns and movements of birds in the WEF vicinity in relation to weather conditions, time of day and season for at least a year.
- Establishing a pre-impact baseline for bird numbers, distributions and movements.
- Informing final design, construction and management strategy of development with a view to mitigating potential impacts.

Five pre-construction monitoring trips have been undertaken to survey the avifauna in the vicinity of the proposed WEF. More than 200 hours have been spent recording the bird activity of the area and a valuable data set has been collated. This report provides

[1] The development will be undertaken by Witberg Wind Power (Pty) Ltd, which has been established subsequently.

the overall results of all the bird monitoring undertaken and updates the recommendations made in the AIA. These updated recommendations are required by the Environmental Management Plan that has been prepared for the site, as well as in terms of the Environmental Authorisation that has been granted by the national Department of Environmental Affairs for the listed activities that comprise the proposed development.

# 2 STUDY AREA

The proposed Witberg WEF will be located on a number of immovable properties immediately south of the N1 highway 4km west of Matjiesfontein in the Western Cape Province. The farms include Jantjesfontein, Besten Weg, Tweedside, and Elandskrag (Avisense 2011). Up to 40 wind turbines were initially included in the proposed layout at the start of the monitoring study (Figure 1). By the end of this study this number had been reduced to 26 turbines (see Discussion). The WEF site is centred on 13km of the main Witberg ridgeline, which runs east-west between Laingsburg and Matjiesfontein. The terrain is rocky and mountainous along the ridge (Avisense 2011).

The proposed WEF is located at the interface of the Fynbos and Succulent Karoo biomes (Avisense 2011). The natural vegetation is dominated by Matjiesfontein Shale Renosterveld in the valleys and Matjiesfontein Quartzite Fynbos on the ridges (Avisense 2011). The vegetation and habitats in the study area are described in detail in the AIA (Avisense 2011). The lowlands are mainly used for stock farming (cattle and sheep) as well as for cereal crops. The ridge itself is relatively pristine, except for the road access to the top from the north-east, and the large communications tower situated on the crest (Avisense 2011).

The prevailing winds are from the north-west in winter and the south-east and north-east in summer, with the north-west winds being the dominant wind in terms of strength.


**Figure 1: Site map of the Witberg Wind Farm in the Western Cape Province. The authorised turbine layout is shown in red with alternatives in white.**

# 3 MONITORING METHODS

## 3.1 INTRODUCTION

Monitoring data needs to be collected from both the impact zone of the proposed Witberg WEF as well as a control site. By doing so, data can be compared between the two sites from pre- and post- construction and actual impacts associated with the WEF can be accurately quantified (Jenkins *et al*. 2011). Suitable control sites should match the habitats, land-use and topography of the proposed WEF site, host a similar mix of bird species to those found in the WEF, be at least half the size of the WEF, be situated as close as possible to the WEF but simultaneously far enough to ensure that the resident bird species are not directly affected by the wind farm activities or operations (Jenkins *et al.* 2011). This study attempted to meet these conditions as far as was practically possible within time and other constraints such as land accessibility. The control site was considered to be very satisfactory.

Monitoring of the proposed WEF site and of the control site was conducted during five sampling trips over a twelve-month period, to be representative of the full environmental conditions likely to occur at these specific sites (Jenkins *et al.* 2011). At least two off-road vehicles and four observers were used on each trip of four to five days. The activities carried out during monitoring are detailed below. The study team included two professional ornithologists and the remaining observers were ecologists and professional birdwatchers.

Prior to the monitoring study, data provided by Avisense (2011) in the AIA included the extraction of all bird atlas records for the study area, as well as a bird list compiled from three days in the study area and its immediate surrounds. In addition, the cliffs of the study area were searched for raptor nesting sites and the locations of those nests were mapped. This study builds on the findings of the AIA, and where appropriate, the results of the AIA are included and/or compared with the results of the monitoring trips.

## 3.2 PRESENCE AND ABUNDANCE OF BIRDS

All species present on and around the site were noted on each visit. Densities of birds were measured using 1 km-long walked transects. Six transects were established along the ridge at the WEF site, and three were sited along the ridge at the control site (Figure 2, Table 1). All transects were in the same vegetation type and within a narrow altitudinal band between 1200 and 1500 metres above sea level (masl). The density sampling was carried out in the early to mid-morning, recording species, number and distance from the transect line or central point of all birds seen.

Since the above method is more suited to smaller passerine species, populations of large terrestrial birds and raptors, with emphasis on the priority species listed in the AIA, were also estimated on the basis of observations made during the course of the field visits, particularly in the course of travelling the length of the site *en route* to vantage points.


FIGURE 2. GOOGLE EARTH IMAGE OF THE STUDY AREA SHOWING TURBINE LAYOUT (GREEN), AND POSITION OF VANTAGE POINTS AND TRANSECTS ON THE WEF SITE AND THE CONTROL SITE TO THE EAST. SCALE: ROUGHLY 24 KM FROM MOST WESTERLY TURBINE TO OUTER LIMIT OF TRANSECTS ON CONTROL SITE.

TABLE 1. GPS CO-ORDINATES OF VANTAGE POINTS AND TRANSECTS ON THE WEF AND CONTROL SITES

| **WEF site** | Lat | Long | **Control site** | Lat | Long |
|---|---|---|---|---|---|
| Vantage E | 33°16'49.27"S | 20°30'16.11"E | Vantage | 33°16'57.86"S | 20°36'16.88"E |
| Vantage Mid | 33°16'53.85"S | 20°26'38.27"E | | | |
| Vantage W | 33°17'27.29"S | 20°23'48.73"E | | | |
| **Transects** | | | **Transects** | | |
| T1 start | 33°16'47.55"S | 20°31'23.09"E | T1 start | 33°17'5.61"S | 20°35'27.39"E |
| T1 end | 33°16'53.22"S | 20°30'45.02"E | T1 end | 33°17'8.45"S | 20°34'48.76"E |
| T2 start | 33°16'48.88"S | 20°30'12.52"E | T2 start | 33°17'5.96"S | 20°35'32.61"E |
| T2 end | 33°16'50.28"S | 20°29'34.29"E | T2 end | 33°16'57.43"S | 20°36'10.23"E |
| T3 start | 33°17'01.01"S | 20°27'38.47"E | T3 start | 33°17'0.23"S | 20°36'17.93"E |
| T3 end | 33°16'56.93"S | 20°27'00.21"E | T3 end | 33°17'3.98"S | 20°36'56.48"E |
| T4 start | 33°17'04.18"S | 20°26'55.03"E | | | |
| T4 end | 33°17'07.17"S | 20°26'16.77"E | | | |
| T5 start | 33°16'54.05"S | 20°29'15.09"E | | | |
| T5 end | 33°17'1.76"S | 20°28'37.28"E | | | |
| T6 start | 33°17'5.64"S | 20°28'8.49"E | | | |
| T6 end | 33°17'11.16"S | 20°27'30.46"E | | | |

## 3.3 Breeding activity of key raptor species

Areas deemed suitable for nesting of key raptor species, particularly the raptor nesting sites identified in the area during the AIA study, were checked for activity during the breeding period.

## 3.4 Movements of priority species

Movements of priority species plus any other large bird species over and around the WEF site and control site were recorded from suitable vantage points at the sites. Bird movements were simultaneously monitored by four observers stationed at three vantage points at the WEF site and one at the control site, located about 7.5 km to the east of the WEF site (Figure 2). GPS positions of the vantage points are provided in Table 1.

The vantage points are higher than the surrounding landscape and were strategically chosen to achieve maximum coverage of the study area. There was little overlap between the view sheds of each vantage point. Observers were stationed at the vantage points over a three day period, and observations were made for blocks of time within the day (typically midday to sunset). Observations involved continuous slow scanning of a 360° area, alternately with telescopes and binoculars. Once a large bird was spotted, it was followed till out of sight and its flight path recorded on a 1: 50 000 topographic map in addition to height and behavioural data. For each sighting, the following information was recorded as far as possible:

- Time
- Updated weather conditions
- Species and number
- Mode of flight (gliding, flapping, soaring)
- Flight activity (commuting, hunting)
- Vertical zoning relative to the proposed turbines (low/below turbines, medium/within turbine zone, high/above turbines)
- Horizontal distance and bearing from the observer at start and end of observation.
- Direction of flight, or flight path plotted on map.

These data were then mapped digitally in ArcView and passage rates calculated.

# 4 RESULTS

## 4.1 SPECIES RICHNESS AND ENDEMISM

A total of 220 bird species have been recorded in the bird atlassing squares of the South African Bird Atlas Project (round two) that overlap and immediately surround the original study area. These include 13 South African red-listed species, 69 endemics or near endemics, and three red-listed endemics (Avisense 2011).

Within the study area itself, a total of 49 species were recorded during the initial site visit undertaken as part of the AIA (Avisense 2011). During the pre-construction monitoring study, efforts were concentrated on the ridge. A total of 47 – 57 species was seen on each trip, and the overall list of bird species was expanded to a total of 108 species. A complete list of birds recorded, their scientific names, conservation status, endemicity and local status is provided in Appendix 1. The species-effort curve suggests that the number of species recorded is close to the maximum number of bird species that can be expected to be recorded on the site (Figure 3).

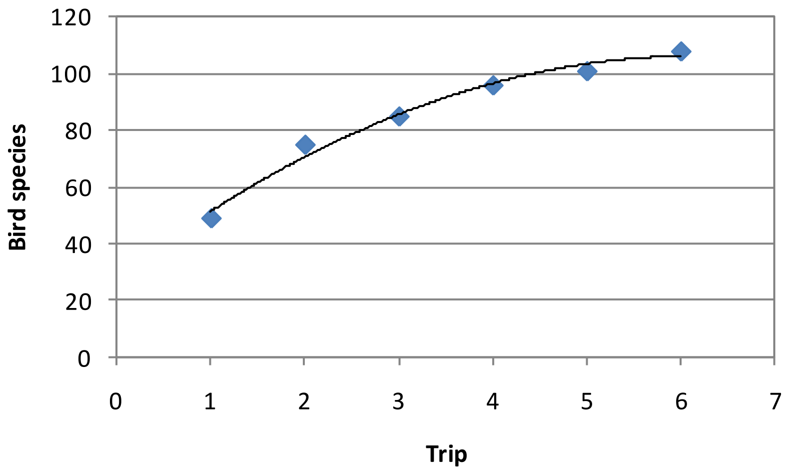


FIGURE 3. CUMULATIVE TOTAL NUMBER OF SPECIES SEEN AFTER EACH 3-4 DAY TRIP, STARTING WITH THE AIA FIELD WORK.

The avifauna recorded at the site has an extremely high level of endemism. The birds recorded in the area included 31 endemic and 13 near-endemic species whose distributions are confined or largely confined to southern Africa (Table 2), four of which are also Priority Species (discussed in more detail below). Most of these were present on ridges of the WEF site, but a few (e.g. Blue Crane) were only seen in the valleys.

Several endemic resident species were present on the WEF site year-round, and seen on most or all visits. These included species that are uncommon or rare in South Africa, due to having very narrow habitat requirements, such as Cape Rockjumpers, Ground Woodpecker (Figure 4), African Rock Pipit and Cape Sugarbird. The birds found year–round on the site are likely to breed there. Only one, the Lark-like Bunting, was a seasonal non-breeding visitor, seen only in summer.

**TABLE 2. SPECIES ENDEMIC TO SOUTHERN AFRICA THAT WERE RECORDED AT THE WEF SITE. E = ENDEMIC, N = NEAR-ENDEMIC. PRIORITY ENDEMIC SPECIES ARE INDICATED WITH AN ASTERISK.**

| Species | | Local status | Species | | Local status |
|---|---|---|---|---|---|
| Cape Spurfowl | E | Common resident | Pied Starling | E | Common resident |
| Grey-winged Francolin | E | Uncommon resident | Orange-breasted Sunbird | E | Common resident |
| South African Shelduck | E | Common resident | Southern Double-collared Sunbird | E | Common resident |
| Ground Woodpecker | E | Uncommon resident | Cape Sugarbird | E | Uncommon resident |
| White-backed Mousebird | E | Common migrant | Cape Weaver | E | Common resident |
| Blue Crane (V)* | E | Uncommon resident | African Rock Pipit* | E | Uncommon resident |
| Black Harrier (NT)* | E | Uncommon resident | Cape Canary | E | Common resident |
| Jackal Buzzard | E | Common resident | Black-headed Canary | E | Uncommon resident |
| Cape Rock-jumper* | E | Rare resident | Cape Siskin | E | Uncommon resident |
| Cape Bulbul | E | Common resident | Southern Pale Chanting Goshawk | N | Uncommon resident |
| Layard's Tit-Babbler | E | Uncommon resident | Bokmakierie | N | Common resident |
| Karoo Prinia | E | Common resident | Pririt Batis | N | Uncommon resident |
| Rufous-eared Warbler | E | Common resident | Chestnut-vented Tit-Babbler | N | Uncommon resident |
| Cape Clapper Lark | E | Uncommon resident | Grey-backed Cisticola | N | Common resident |
| Karoo Lark | E | Uncommon resident | Mountain Wheatear | N | Common resident |
| Karoo Long-billed Lark | E | Uncommon resident | Cape Sparrow | N | Common resident |
| Large-billed Lark | E | Common resident | Yellow Canary | N | Common resident |
| Cape Rock Thrush | E | Common resident | White-throated Canary | N | Common resident |
| Sentinel Rock Thrush | E | Uncommon resident | Lark-like Bunting | N | Common visitor |
| Karoo Scrub-Robin | E | Common resident | Cape Bunting | N | Common resident |
| Ant-eating Chat | E | Common resident | Protea Seedeater | E | Uncommon resident |
| Karoo Chat | N | Common resident | | | |
| Pale-winged Starling | N | Common resident | | | |

**FIGURE 4. GROUND WOODPECKERS SEEN AROUND THE EAST VANTAGE POINT.**

## 4.2 Densities of small birds

Small passerine densities were determined from the 1km transects at both the proposed WEF and Control sites. Average ± SD species diversity per sampling period was relatively low ranging from 3.7 ± 2.1 to 10.0 ± 4.8 species per kilometre at the proposed WEF. Overall average ± SE species diversity was 7.1 ± 1.1 for the five independent sampling periods (Table 3).

Table 3. Numbers of passerine species and bird abundance per kilometre for the Witberg WEF and Control sites based on four independent surveys

| Survey Period | Proposed WEF Site | | Control Site | |
|---|---|---|---|---|
| | Species/km ± SD | Frequency/km ± SD | Species/km ± SD | Frequency/km ± SD |
| 18-21 Jun 2011 | 3.7 ± 2.1 | 9.3 ± 6.3 | 4.7 ± 1.5 | 14.7 ± 6.0 |
| 28-30 Aug 2011 | 5.5 ± 3.9 | 12.8 ± 14.8 | 5.0 ± 1.7 | 13.7 ± 3.5 |
| 1-4 Nov 2011 | 7.5 ± 2.0 | 19.2 ± 10.0 | 7.0 ± 4.0 | 13.0 ± 7.9 |
| 8-10 Jan 2012 | 10.0 ± 4.8 | 131.0 ± 109.1 | 6.7 ± 4.6 | 39.7 ± 56.6 |
| 19-20 Apr 2012 | 8.8 ± 3.7 | 23.7 ± 7.8 | 5.0 ± 2.6 | 24.0 ± 20.3 |
| **Summary** | | | | |
| **Min** | 3.7 ± 2.1 | 9.3 ± 6.3 | 4.7 ± 1.5 | 13.0 ± 7.9 |
| **Max** | 10 ± 4.8 | 131 ± 109.1 | 7.0 ± 4.0 | 39.7 ± 56.6 |
| **Median** | 7.5 | 19.2 | 5.0 | 14.7 |
| **Average ± SE** | 7.1 ± 1.1 | 39.2 ± 23.1 | 5.7 ± 0.5 | 21.0 ± 5.1 |

A similar average ± SE species diversity of 5.7 ± 0.5 was recorded at the adjacent Control Site. In terms of passerine abundances, these varied considerably between the five periods sampled, and were influenced by weather conditions (low numbers recorded in very windy conditions). Average abundance ± SD per period ranged from 9.3 ± 6.3 to 131 ± 109.1 at the proposed WEF with a median value of 19.2. A similar median abundance of 14.7 was recorded at the Control Site. These data can be analysed more rigorously when used for comparative analysis with the post-construction data.

## 4.3 Priority species

Eight out of 12 Priority Bird species from the region were recorded in the immediate vicinity of the proposed WEF (Table 4), and a ninth (Blue Crane), was recorded in the cultivated lands below. Those not recorded were Ludwig's Bustard, Black Stork and Peregrine Falcon. The most consistently-present species were the Verreaux's Eagle and Cape Rock-Jumper as they were seen every day on all visits. Booted Eagle and African Rock Pipit were also regularly seen. It is highly likely that all of the eight species occurring on the ridge were breeding in the vicinity of the WEF site, and this was confirmed for the eagle species. Some pertinent facts about the priority species found on the ridge are given below (based on Hockey et al. 2005). Red data status is taken from the Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland (Barnes 2000).

TABLE 4. PRIORITY SPECIES SEEN DURING THE AIA AND MONITORING VISITS TO THE WITBERG WEF.

| Species | Oct 2010 | Jun 2011 | Aug 2011 | Nov 2011 | Jan 2012 | Apr 2012 |
|---|---|---|---|---|---|---|
| African Rock Pipit | x | | x | x | x | x |
| Blue Crane | x | x | | | | |
| Cape Rock-Jumper | x | x | x | x | x | x |
| Cape Eagle-Owl | | | x | | | |
| Black Harrier | x | | | x | | |
| Verreaux's Eagle | x | x | x | x | x | x |
| Booted Eagle | x | x | x | x | | x |
| Martial Eagle | x | x | x | | | |
| Lanner Falcon | | x | | | | |

**African Rock Pipit** (range-restricted endemic) occurs along the southern Cape fold mountains and highlands of the southern Nama Karoo and Drakensberg, and has a total breeding population of about 5-10 000 birds, entirely within South Africa and Lesotho. It is territorial and spends most of the time on the ground moving among vegetation and rocks. This species was fairly common on the WEF site.

**Cape Rock Jumper** (range-restricted endemic) has a very limited distribution range largely within the fynbos biome, but is not threatened because most of its habitat is still largely intact. If forages on the ground among bushes and rocks. Pairs or small groups maintain territories year round. There were several groups present on the WEF site.

**Cape Eagle Owl** occurs throughout much of southern and eastern Africa, but is generally uncommon, and should be considered for Red-listing (Avisense 2011). It tends to be associated with rocky outcrops and cliffs, and feeds mainly on small mammals. Its movements are unknown, but may be nomadic. This species was not found during the day, but was recorded on the single occasion that the study area was visited at night.

**Black Harrier** (Near Threatened) is restricted to South Africa and Namibia, and is uncommon, with a total of only 500 -1000 breeding pairs. It is territorial, nesting on or near the ground. It feeds aerially, being particularly active on windy days. Its main concentrations are associated with coastal lowlands and mountains and high altitude grasslands. Black Harrier was seen several times on the WEF site, as well as in the valleys below, where some breeding behaviour was also observed.

**Verreaux's Eagle** (important apex predator) occurs throughout Africa and into the Middle East, and is fairly common in South Africa. Within southern Africa, the density of Verreaux's Eagles is highest in a band from the south-western Cape to KwaZulu-Natal, incorporating the study area. There are an estimated 400 – 2000 pairs in the old Cape Province (Northern Cape, the Eastern Cape and the western edge of the North West Province; Boshoff & Vernon 1980, Hockey et al. 2005). Of these there are probably a maximum of 800 pairs in the Western Cape (L. Rodriguez, pers. comm.). Densities of 1 pair per $24km^2$ have been recorded in the Karoo (Davies 1994, Hockey et al. 2005).

Verreaux's Eagles are found in mountainous and rocky areas with cliffs, and because of this their populations have remained relatively secure in the past. Verreaux's Eagles are monogamous and defend territories year round, the pairs staying together most of the day. Most territories contain multiple nest sites (up to 5), although one nest might be favoured for several years in a row. Verreaux's Eagles tend to hunt by soaring along ridges and their diet is dominated by mammals, particularly hyrax. They tend to rest during the middle of the day. Verreaux's Eagles were present in high densities in the study area, where they nested on cliffs just below the ridge top, and hunted mainly along the ridges and slopes.

**Booted Eagle** (important apex predator) is found throughout much of Africa and Eurasia, but their world population is less than 100 000 birds. Within southern Africa, they are most common in the south and south west part, which includes the study area. An estimated 700 breeding pairs occur in the 'Cape' area, breeding mainly in mountainous areas, where they nest on cliffs. The Palaearctic breeders migrate to southern Africa spending November to March here. The population resident in southern Africa move into the south-western areas to breed during July-August, remaining until March. This population is a separate subspecies to the Palearctic migrants, but they are not considered threatened. In southern Africa, Booted Eagles are monogamous, and while they are territorial, they are often known to have nest sites in close proximity to their neighbours (e.g. less than 300m), as was the case in the study area. Booted Eagles are agile aerial foragers, and their diet is dominated by birds. At least two pairs of Booted Eagles nested on the cliffs at the WEF site and foraged over the ridges.

**Martial Eagle** (Vulnerable) is widespread throughout Africa, but occurs only sparsely within southern Africa, and is more common in flat country than in mountainous areas. In the study area, their nests are on pylons at the base of the Witberg mountains (north of the proposed turbine ridge), but they forage over the ridges as well as over the lower hills and valleys in the surrounding areas. Martial Eagles tend to be resident, with a monogamous pair defending a territory for several seasons. Although the majority of pairs have one nest site (typically on a pylon or tree fork), multiple nest sites (up to 4) are not uncommon. They defend large territories of at least 280 $km^2$ in the Nama Karoo

(Simmons 2005). While hunting, they often soar at high altitudes, and their diet is dominated by small mammals. Martial Eagles foraged over the WEF site and were frequently seen in the surrounding hill areas as well.

**Lanner Falcon** (Near-Threatened) occurs through much of Africa and Eurasia, and is fairly common. It favours sites where there are cliffs available for nesting and roosting. It feeds from a perch or on the wing, catching mainly birds. It is a partial and facultative migrant in South Africa. This species was only seen on one occasion at the WEF site, in an aggressive interaction with Verreaux's Eagles near their nest site. It was not seen foraging over the WEF site.

## 4.4 Breeding activity of eagles

In the AIA, Avisense (2011) recorded four Verreaux's Eagle nests and two Martial Eagle nests within 5km of the turbine layout. After the AIA was carried out, the proposed turbine layout was revised to avoid the Martial Eagle nests (based on a 2.5km buffer suggested by Avisense 2011). This was done prior to the Environmental Authorisation being granted.

During the pre-construction monitoring additional Verreaux's Eagle nests were found within this area, bringing the total of Verreaux's Eagle nests to seven, as well as two Booted Eagle nests (see Figure 5). Four Verreaux's Eagle nests (M1, M2, E2, E3) and two Booted Eagle nests are in very close proximity to the current proposed line of turbines along the main ridge (Figure 8). The most recent nest (M2) was discovered during the April 2012 trip and is located approximately 2.5km south of the WEF (see Figure 6 and Figure 7). Although eagles can have multiple nest sites, sightings of pairs interacting suggested that each nest on the northern ridge belonged to a different eagle pair. The two nests to the south of the ridge (M2 and E2) were found in two different seasons and could have belonged to the same pair of birds, but this is unlikely. All of the eagle pairs close to the WEF were observed to be engaged in one or more breeding activities during the course of the monitoring period, including mating, displaying, attendance of nests and feeding chicks. The WEF ridge was also frequented by several other raptor species likely to breed, including Jackal Buzzard [endemic], Cape Eagle Owl [endemic subspecies] and Rock Kestrel.

**Figure 5. Prime nesting habitat for many species of raptors, including Priority Species, is found along the Witberg range. The top photograph shows a Verreaux's Eagle at the nest.**

Several more pairs of Verreaux's Eagles were also sighted in the areas further from the turbines, suggesting that their nesting density is high throughout the Witteberge range. This is a cause for concern regarding the development of Wind Energy Facilities in the area.


**FIGURE 6. VERREAUX'S EAGLE NEST M2. THE GOOGLE EARTH IMAGE SHOWS THE POSITION OF THE NEXT IN RELATION TO THE ROW OF TURBINES ON THE RIDGE.**

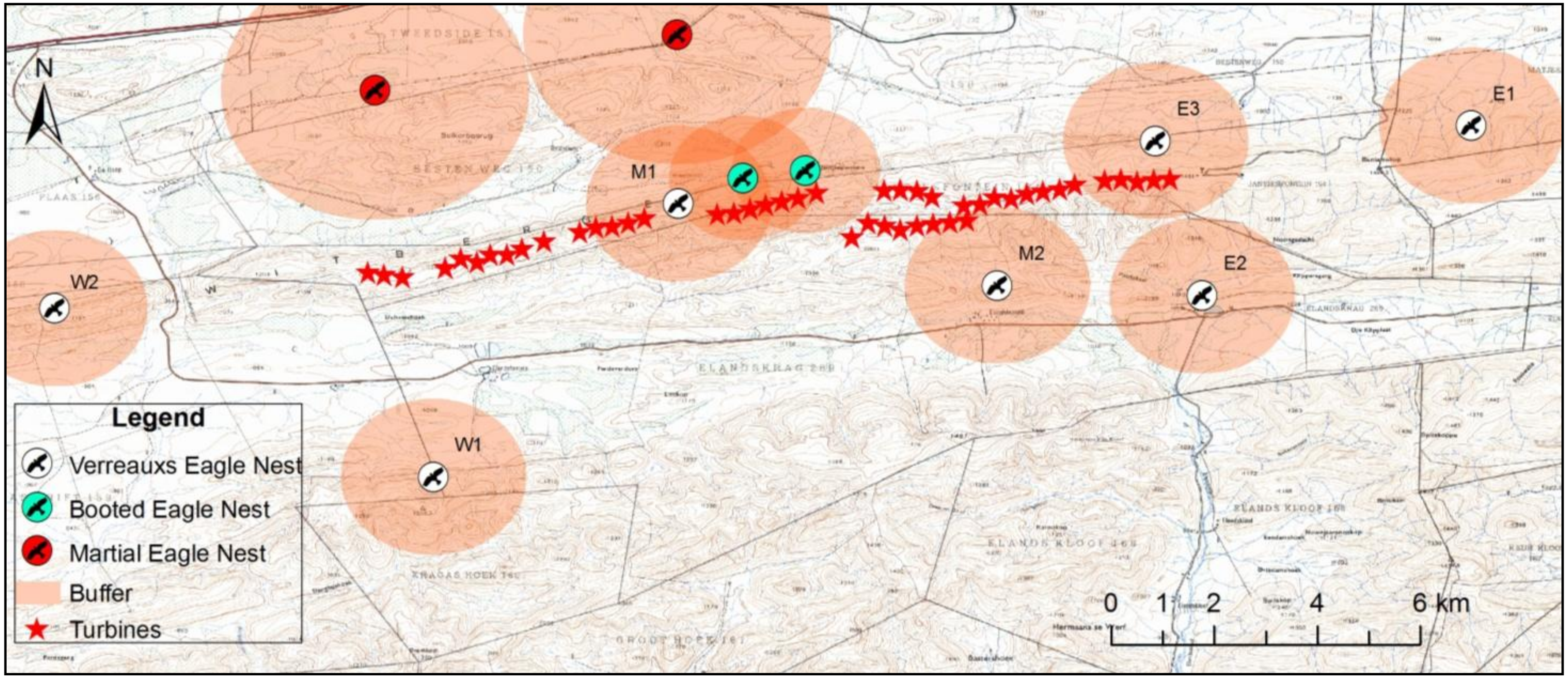


**Figure 7. Position of raptor nests showing buffer areas of 2.5km diameter for Martial Eagle, 1.5km for Verreaux's Eagle and 1.2km for Booted Eagle. Proposed turbine positions (as at start of monitoring study) are indicated by red stars**

## 4.5 FLIGHT ACTIVITY OF LARGE BIRDS

During the observations from vantage points, movements of all large birds were recorded, including crows and ravens and smaller raptors such as kestrels. In fact most of the movements recorded were undertaken by raptors (mainly eagles). No flights by cranes, bustards, storks or waterbirds were seen, and crows and ravens were uncommonly seen. Commuting flights by smaller birds such as doves were also fairly uncommon. Raptor flight paths recorded during more than 200 hrs of observations are shown in relation to the turbines of the proposed Witberg WEF (Figure 8). Flight paths observed from the Control Site vantage point are shown in Figure 9.

During the five 3-day periods flights paths were recorded, passage rates at the proposed WEF ranged from 1.2 to 6.9 large birds per hour with an average ± SD of 2.4 ± 2.5 (Table 5**Error! Reference source not found.**). The passage rates of the Priority Species alone were 1.4 ± 1.3 birds per hour with the lowest passage rate of 0.5 birds per hour being recorded in January 2012. At the Control Site similar rates to the proposed WEF were recorded with 1.2 ± 0.7 Priority Species being recorded per hour on average and never less than 0.4 Priority Species per hour. These rates are very high and a cause for concern. The data collected on passage rates are designed for comparison with similar data to be collected during the post-construction monitoring.

TABLE 5. HOURS SURVEYED, NUMBER OF SPECIES AND PASSAGE RATES RECORDED DURING FOUR PERIODS OF OBSERVATION AT THE WITBERG WEF AND CONTROL SITES.

| Survey Period | WEF Site | | | | Control Site | | | |
|---|---|---|---|---|---|---|---|---|
| | Hours surveyed | Species | Passage rate (large birds/hr) | Passage rate (priority species/hr) | Hours surveyed | Species | Passage rate (large birds/hr) | Passage rate (priority species/hr) |
| Jun 2011 | 18.1 | 8 | 6.9 | 3.7 | 14.5 | 5 | 5.2 | 2.3 |
| Aug 2011 | 33.5 | 7 | 1.2 | 0.7 | 19.3 | 5 | 2.6 | 1.2 |
| Nov 2011 | 57.9 | 9 | 1.2 | 0.8 | 18.6 | 5 | 0.8 | 0.4 |
| Jan 2012 | 52.8 | 4 | 1.2 | 0.5 | 13.2 | 5 | 2.0 | 0.6 |
| Apr 2012 | 50.9 | 6 | 1.6 | 1.1 | 16.8 | 4 | 4.9 | 1.3 |
| **Min** | 18.1 | 4 | 1.2 | 0.5 | 13.2 | 5 | 0.8 | 0.4 |
| **Max** | 57.9 | 9 | 6.9 | 3.7 | 19.3 | 5 | 5.2 | 2.3 |
| **Average ± SD** | 42.6 ± 16.5 | 6.8 ± 1.9 | 2.4 ± 2.5 | 1.4 ± 1.3 | 16.5 ± 2.6 | 4.8 ± 0.4 | 3.1 ± 1.9 | 1.2 ± 0.7 |
| **Total** | 213.2 | 13 | | | 82.4 | 8 | | |

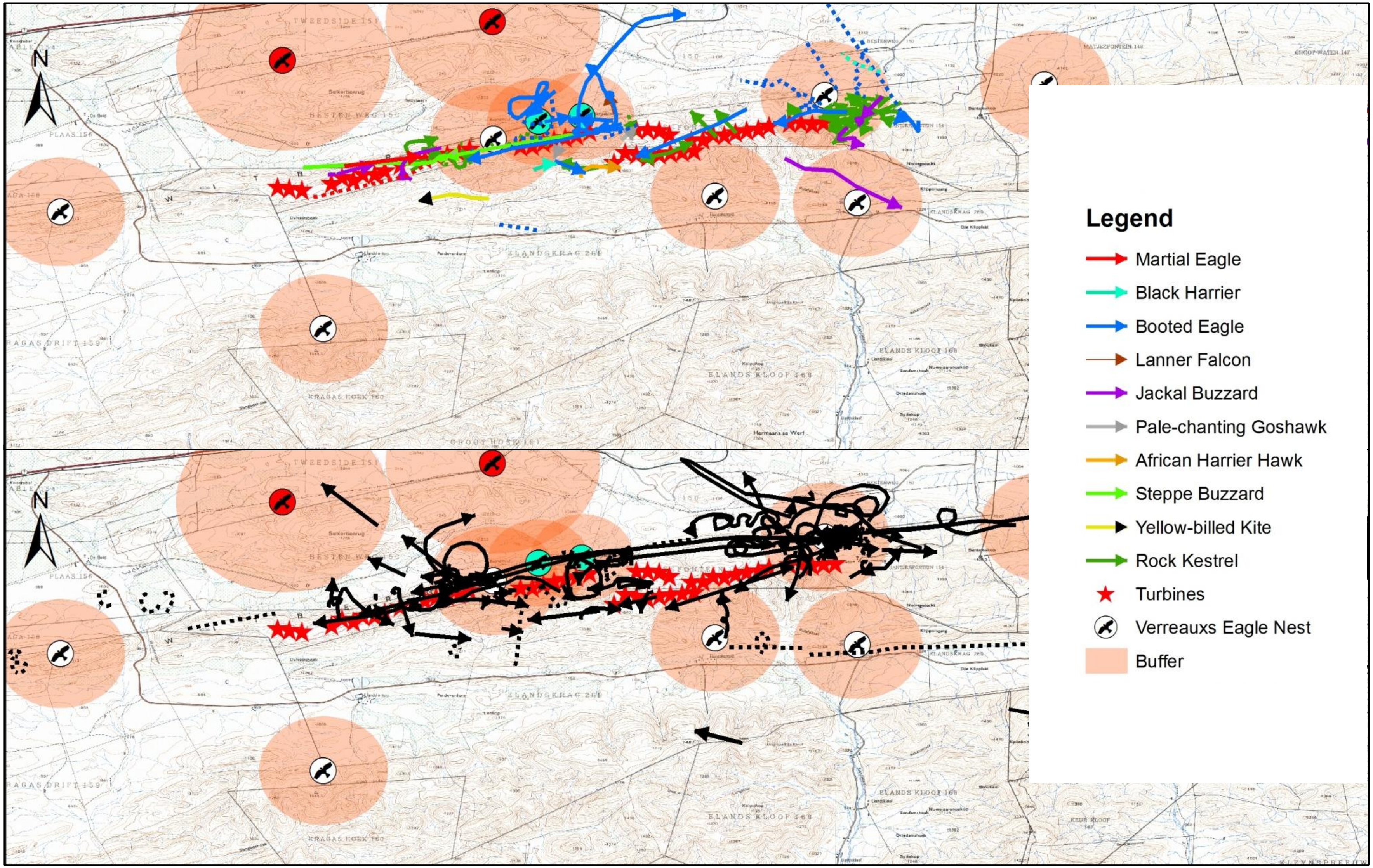


FIGURE 8. RAPTOR FLIGHT PATHS RECORDED AT THE WEF SITE DURING THE STUDY. PROPOSED TURBINE POSITIONS (AS AT START OF MONITORING STUDY) ARE INDICATED BY RED STARS. VERREAUX'S EAGLE FLIGHT PATHS ARE SHOWN SEPARATELY FROM OTHER SPECIES ON THE LOWER MAP.

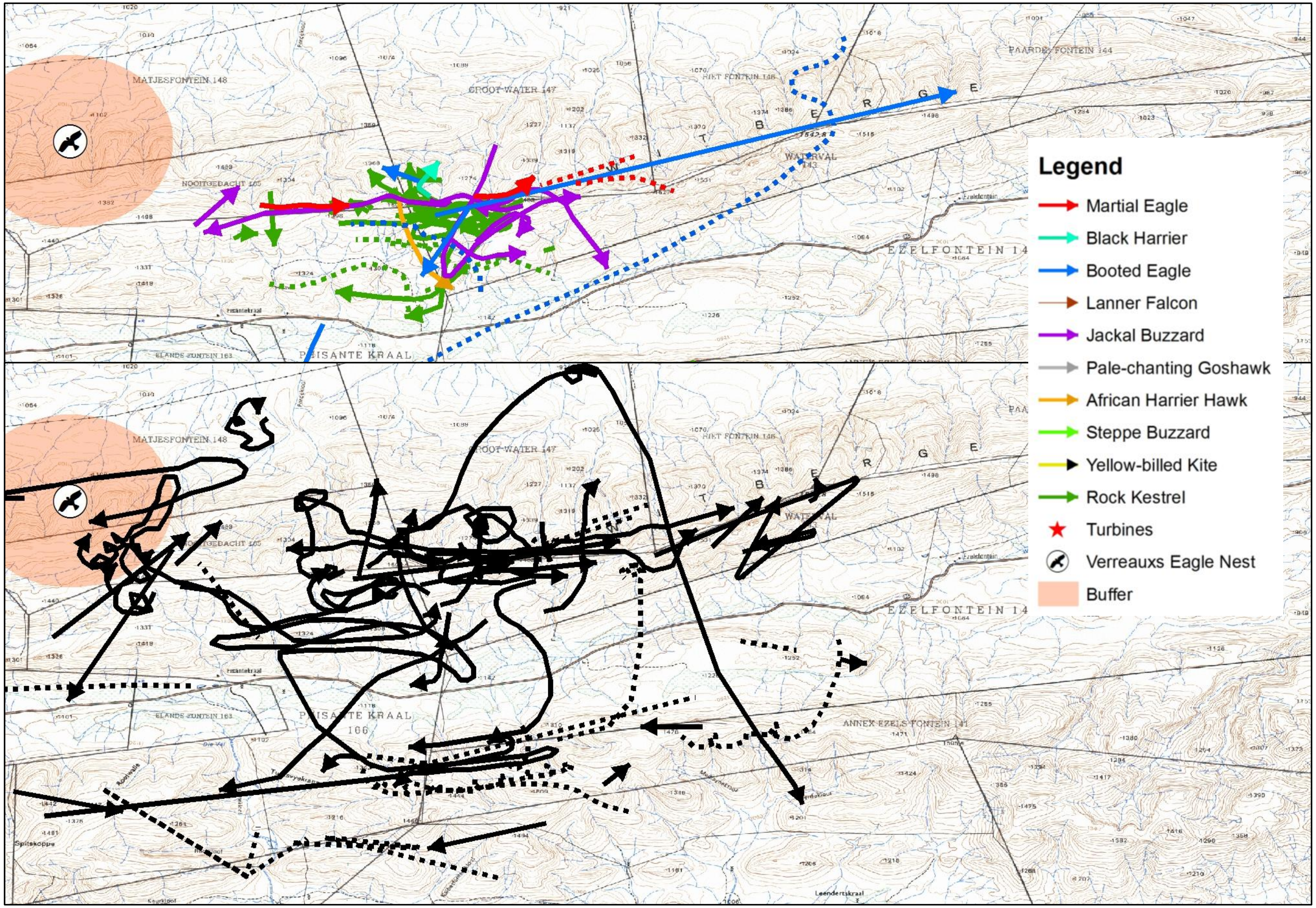


FIGURE 9. RAPTOR FLIGHT PATHS RECORDED FROM THE CONTROL SITE VANTAGE POINT DURING THE STUDY. VERREAUX'S EAGLE FLIGHT PATHS ARE SHOWN SEPARATELY FROM OTHER SPECIES ON THE LOWER MAP.

Of the eagles, flight activity was mainly by Verreaux's Eagle, and most flight activity occurred along the sides and tops of the ridges (Figure 8). This was generally soaring flight, but typically fast, covering long distances in a short period. There were also many instances of birds traversing the ridge, usually commuting at high speed, and heading over the adjacent valleys. Aerial activity of Verreaux's Eagles was highest during the breeding season, especially the laying period, when several interactions between neighbouring pairs were observed. Vertical zones utilised by eagles at the WEF were mainly at medium heights (40-120m; 45%) followed closely by low (<40m; 34%) and high zones (120<150m; 18%). In other words, the birds fly mostly in the vertical zone corresponding to the turbine blade zone, which puts them at a significant risk of collision. A similar pattern was observed at the Control Site..

Booted Eagles were active in the area all year. Although they were not recorded specifically from the WEF in January, they were recorded at the control site. Booted Eagles also appeared to hunt over the lower slopes and valleys as well as on the ridge. They utilised all vertical zones, but were recorded to fly within the medium vertical zone (40-120m) most frequently on 33% of occasions putting them at high risk of collision (Table 6).

Martial Eagle activity on the ridge was not as common as other eagle species. They were seen during the winter months on the first field trip in June and again in August. This species is very wide-ranging and would have been hunting over the valleys and other ridges and hills in the area as well. Flight zones utilised varied considerably and there was no evidence of a preference a particular height to fly at (Table 6).

Other commonly observed raptor species worthy of mention include the Rock Kestrel and Jackal Buzzard. Rock Kestrel were often seen gliding along the ridge which they regularly traversed, and during times of north-easterly winds were found to hover facing into the wind on the north facing slopes at the proposed WEF. They utilised the low (58%) and medium (29%) flight zones at the proposed WEF extensively and are therefore at high risk of collision.

Jackal Buzzards also utilised the low and medium flight zones more extensively than other zones at both the proposed WEF and the Control Site (Table 6). They were seen making use of the ridge at the proposed WEF, either flying along it or crossing it over saddles. In addition they were seen to hunt over undulating hills adjacent to the ridge at moderately lower altitudes.

The Cape Eagle owl was not recorded via a flight-path record but rather from a call on the proposed WEF ridge. Two unconfirmed sightings were also made at and near the Control Site. The habitat at Witberg is ideal for Cape Eagle owl, which favours rocky outcrops, cliffs and gorges with scrub in the vicinity (Martin & Pepler 1977). The Cape Eagle Owl is known to roost in rock or shrub during the day and then move to a prominent perch at dusk (Kemp, A.C, *unpublished data*). In the Karoo, the owl mainly feeds on small prey such as rodents and other birds (Steyn & Myburgh 1983). Due to its rather sedentary habits of swooping on prey from perches, it is not likely to prominently fly higher than 40m above the ridge. The Cape Eagle Owl is therefore not likely to be at major risk of collision. It is more likely however to be affected by the construction of the WEF due to disturbance (noise and light) and habit destruction imposed by the WEF footprint.

Generally, raptors appeared on slopes facing the prevailing wind, probably due to the updrafts experienced here and the turbulence on the leeward slopes. The ridges above the north-facing slopes had a higher level of activity than the south side of the ridges. Raptors were found to generally fly along and periodically across the WEF ridge or hover above the faces of the north-facing slopes during north-easterly winds.

More than two-thirds (73%) of raptor flight paths recorded at the proposed WEF were within low to medium vertical zones, with the latter being in the range of the turbine blades (i.e. 40-120m; Table 6). At the WEF site most raptors utilised the low vertical zone (37%) closely followed by the medium vertical zone (36%) and high vertical zone (16%; Table 6). A similar trend was observed at the Control Site.

At the study area, the cloud ceiling is frequently low and can envelope the top of the mountains. During these conditions we noticed that the raptors tended to fly below the cloud ceiling, at much lower altitudes than on other days. In very low cloud they remained perched, and during calm conditions there was less activity. Verreaux's Eagles are known for their ability to forage in very strong winds, and this was observed to a degree.

**Table 6. Proportion (%) of vertical height zones utilised by raptors at the proposed WEF, Control and combined sites. L = Low Vertical Zone (i.e. <40m); M = Medium Vertical Zone (40-120m); H = High Vertical Zone (120-150m); VH = Very High Vertical Zone (>150m). Values in brackets after the species name give the number of flight paths used to calculate the percentages for the proposed WEF Site followed by the control site.**

| Species | Proposed WEF Site | | | | Control Site | | | | Combined Sites | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | M | H | VH | L | M | H | VH | L | M | H | VH |
| African Harrier Hawk (2,2) | 50 | 50 | 0 | 0 | 50 | 50 | 0 | 0 | 50 | 50 | 0 | 0 |
| Black Harrier (2,2) | 50 | 0 | 50 | 0 | 50 | 50 | 0 | 0 | 50 | 25 | 25 | 0 |
| Booted Eagle (33,6) | 18 | 33 | 21 | 27 | 33 | 33 | 0 | 33 | 21 | 33 | 18 | 28 |
| Greater Kestrel (0,1) | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 0 |
| Jackal Buzzard (7,8) | 43 | 43 | 14 | 0 | 13 | 75 | 13 | 0 | 27 | 60 | 13 | 0 |
| Lanner Falcon (1,0) | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 |
| Martial Eagle (2,5) | 0 | 50 | 0 | 50 | 60 | 0 | 0 | 40 | 43 | 14 | 0 | 43 |
| Pale-chanting Goshawk (3,0) | 67 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 67 | 33 | 0 | 0 |
| Rock Kestrel (48,37) | 58 | 29 | 10 | 2 | 46 | 32 | 11 | 5 | 54 | 31 | 11 | 4 |
| Steppe Buzzard (2,0) | 50 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 50 | 0 | 0 |
| Yellow-billed Kite (1,0) | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 |
| Verreaux's Eagle (77,90) | 34 | 45 | 18 | 13 | 27 | 50 | 13 | 10 | 37 | 57 | 19 | 14 |
| **Combined Species per Site** | 37 | 36 | 16 | 11 | 36 | 41 | 12 | 11 | | | | |
| **Combined Species & Sites** | | | | | | | | | 37 | 38 | 14 | 11 |

# 5 IMPACTS AND RECOMMENDATIONS

## 5.1 IMPACTS

The AIA described the WEF as being medium-sized with a moderate to high degree of avian sensitivity with respect to birds (Avisense 2011). The AIA states that there are no regionally- or nationally-critical populations of impact-susceptible species within or near to the development area, and the proposed WEF site does not impinge on any known major avian fly-ways or migration routes (Avisense 2011). However, the AIA also recognised that the WEF would seriously impinge on the Witberg ridge, which is an important landscape feature, and may have a significant negative effect on the avifauna of this ridge (including breeding pairs of large eagles and concentrations of localised endemic species) in both the construction and operational phases of the development (Avisense 2011). The AIA concluded that the proposed WEF "could have a significant, long-term impact on the avifauna of the area" as a result of disturbance, displacement and/or collision mortality, mainly affecting raptors, endemic passerines, large terrestrial birds commuting over the area, and flocks of waterbirds moving over the area. The AIA listed the expected impacts as likely to include:

1. "Disturbance and displacement of **resident/breeding raptors** (especially Verreaux's Eagle, Martial Eagle, Booted Eagle, Black Harrier, Cape Eagle Owl) from nesting and/or foraging areas by construction and/or operation of the facility, and /or mortality of these species in collisions with the turbine blades or associated new power lines while slope-soaring along the high-lying ridges or hunting in the valleys, or by electrocution when perched on power infrastructure.
2. Disturbance and displacement of **resident/breeding Fynbos/montane endemics** on the high-lying ridges central to the study area by construction and/or operation of the facility.
3. Disturbance and displacement of **resident/breeding large terrestrial birds** (especially Blue Crane and possibly Ludwig's Bustard) from nesting and/or foraging areas by construction and/or operation of the facility, and /or mortality of these species in collisions with the turbine blades or associated new power lines while commuting between resource areas (croplands, nest sites, roost sites/wetlands).
4. Disturbance and displacement of **resident/breeding wetland birds** from nesting and/or foraging areas by construction and/or operation of the facility, and /or mortality of these species in collisions with the turbine blades or associated new power lines while commuting between resource areas (croplands, wetlands)." (Avisense 2011).

The pre-construction monitoring study confirmed that the proposed development site is rich in birdlife, and has an extremely high level of activity by priority species, including species that are range restricted and of particular conservation concern in southern Africa. The focus of the pre-construction monitoring study was slightly narrower than that of the AIA, because of the change in turbine layout, which was reduced to being on the main Witberg ridge. The potential impacts listed above remain accurate, although this study has shown that the first two appear to be more serious than originally thought, while the last two impacts are somewhat diminished, due to the absence of large terrestrial birds such as cranes and bustards, and the absence of waterbirds commuting over the ridge.

The monitoring study confirms that a high density of raptors is resident in the area, but also found that there are at least five eagle nests close to the proposed line of turbines, a situation more serious than originally thought. Mating behaviour and breeding was observed in all three pairs of Verreaux's Eagles and both pairs of Booted Eagles in closest proximity to the turbine line.

High levels of activity and passage rates were recorded throughout the area that could be monitored from the vantage points. Many of the eagles observed ranged long distances from their home bases during the course of a day, much further than the range of the buffer zones mapped in the AIA report (1.5km for Verreaux's Eagle). Flights of up to 9km long were recorded.

Birds of prey worked the ridges throughout the study area, usually soaring along the ridges at medium altitude (within the turbine blade zone), but also commuting at higher altitudes both along and across the ridge and occasionally spending time foraging over the valleys. High rates of passage occurred over the whole ridge, but particularly on the northern edge of the ridge, probably because of the direction of prevailing winds. Both Verreaux's Eagle and Booted Eagle also alighted on the WEF ridge, and mating also occurred on the ridge (as opposed to the cliffs below). Booted, Verreaux's and Martial Eagles and several other raptor species were observed to move through the turbine blade zone.

The high density and passage rates of raptors within the proposed development footprint suggests that there is a high likelihood of impacts of the proposed WEF on these species in the form of the loss of habitat, obstruction of foraging paths, and collision with turbines. Furthermore, the danger exists that the mortality caused will create a vacuum in these strongly territorial species. This could bring in other adult eagles to take their place and create a "sink" effect into which other adult eagles seeking vacant nesting sites will be drawn. This can happen in a matter of hours or days of a nest site being vacated (R. Simmons, pers. obs.). This could lead to further mortality, affecting the population over a much broader area. It is also possible that the area may be abandoned by some species. In the case of the endemic passerine species of concern, such as Cape Rock Jumper, their numbers are likely to be reduced as a result of loss of habitat, and they may be further deterred by human activity, vibration and noise disturbance during the operational phase. Although little is known about the impacts of wind turbines on birds in South Africa, studies from elsewhere in the world have shown that these impacts can be major (Drewitt & Langston 2006).

## 5.2 Mitigation

Recommendations in the AIA regarding mitigation measures to be undertaken, are as follows, in brief (for details, see Avisense 2011):

1. 'No-go' areas to minimise disturbance during construction;
2. Minimising construction footprint and noise disturbance during construction;
3. Minimizing disturbance during operation;
4. Excluding development from near large eagle nest sites and a locally important wetland (1.5km from Verreaux's Eagle nests, 2.5km from Martial Eagle nests and 1.5km from the large waterbody near the site;
5. Painting one blade of each turbine black[2];
6. Ensuring that lighting is kept to a minimum, is coloured (red or green) and intermittent;
7. Ensuring that all new power infrastructure is bird-friendly;
8. Minimising the length of any new power lines installed;
9. Routing power lines underground as far as possible; and
10. Monitoring, including radar tracking systems.

These recommendations were based on a comprehensive review of the literature as well as specialist opinion. It is also stated in both the AIA and the EMP that these recommendations should be updated following the pre-construction monitoring study.

The developer has queried whether mitigation could be achieved by relocating the affected breeding eagle pairs away from the site. Unfortunately, this is not a feasible option. Practiced in the past to deal with 'problem' Verreaux's Eagles, this has resulted in the birds either returning to their capture site or dying (Simmons 2005).

Another desirable form of mitigation would be to stop the movement of the rotors during parts of the day when activity is highest, particularly during the months of peak activity by eagles. However, the developer has stated this is not a feasible option given the available technology.

The most controversial of the above recommendations (from the developer's perspective) was the exclusion of development from within a radius of eagle nests and wetlands. The buffer areas around the eagle nests were decided on the basis of

[2] Not allowed by Civil Aviation, we suggest UV paint seen well by birds but not humans

estimated territory radius and the assumption that the core activity areas would be contained within about half of the full extent (citing Walker *et al.* 2005, Martínez *et al.* 2010, Boshoff 1993, Machange *et al.* 2005). Observations suggested that this was not the case for the Verreaux's Eagle pairs nesting close to the proposed turbine layout. These birds moved great distances along the ridges, and were frequently seen several kilometres from the nest. Interactions between neighbouring pairs were also not uncommon[3], suggesting that the area was quite fully utilised, as opposed to being largely restricted to core areas around the nest. It is thus doubtful that a 1.5km radius would provide sufficient protection for Verreaux's Eagle. There are four eagle nests which are within a few hundred metres of the original turbine layout. If buffer areas are applied for each of these, then three of the buffer areas would be overlapping, thus fortunately extending the effective buffered zone for each. A further concern is that having a limited buffer around a current nest site does not adequately deal with the fact that the birds may have multiple nesting sites.

Based on flight activity patterns, even if buffer zones are implemented there would be a high probability of residual impacts in the remaining turbine layout, particularly along the ridge to the west of the M1 nest site (Figure 8). It is unknown to what extent the eagles would be able to avoid collision with the remaining turbines, or to what extent their foraging requirements could be met in other parts of their territories. Studies from elsewhere show that eagles can suffer heavy mortality with similar turbines (e.g. White-tailed Eagles on the island of Smola in Norway). In addition, the habitat in the vicinity of the proposed WEF is ideal breeding habitat for many raptor species as there is an abundance of rocky ridges and cliffs. It is therefore likely that other raptors recorded in the area which nest in such habitat are also breeding in the vicinity, in particular Rock Kestrel, Jackal Buzzard, Cape Eagle Owl and Lanner Falcons.

The bottom line is that it is unlikely that the buffer areas proposed in the AIA would adequately mitigate the potentially high impacts of the proposed development. Unfortunately the effectiveness of such buffers has simply not been tested in this situation. Thus we would suggest that, in addition to buffer zones around the eagle nests, development is avoided in areas where a high level of raptor activity was recorded during the monitoring study, notably along the northern edge of the ridge on the western half of the proposed layout (Figure 8), and that the developer offsets the residual impacts of the development through conservation action elsewhere. The latter is discussed in more detail below.

## 5.3 BIODIVERSITY OFFSET

As long as there is any development of turbines along the Witberg ridge, there are likely to be residual impacts, as the turbines would fall within the foraging range of several

[3] On more than one occasion, as many as five adult Verreaux's Eagles were seen interacting above the ridge.

important species. Thus the only other option available, short of stopping the development in its entirety, is to create a biodiversity offset that more than makes up for the residual loss of biodiversity that is likely to occur at the WEF site. Since the development has already been authorised, this will be a necessary option. The notion of biodiversity offsets has become popular during recent years, and offsets have been implemented around the globe. In the Western Cape, guidelines have been developed for the establishment of biodiversity offsets (Brownlie *et al.* 2007), although these have not yet been finalised. Biodiversity offsets are also being considered in the context of WEF developments elsewhere in the world (e.g. New Zealand).

In South Africa, biodiversity offsets are supported by a number of laws, policies and plans. The Constitution of the Republic of South Africa (Act 108 of 1996), the NEMA (National Environmental Management Act (Act No. 107 of 1998) and the National Environmental Management Biodiversity Act (Act No. 10 of 2004) provide the groundwork, mandating the protection of the natural environment, while offsets are more directly provided for by the Western Cape Spatial Development Framework and the National Biodiversity Strategy Action Plan (NBSAP), which highlights the need for biodiversity offsets.

The draft Western Cape guidelines suggest that biodiversity offsets must be identified in the decision-making process for a proposed development. Furthermore, they state that the purpose of biodiversity offsets is to ensure compensation for residual impacts on biodiversity and ecosystem services that are not so great as to constitute a fatal flaw, nor so small as to be of low significance, ensuring that ecological integrity is maintained and development is sustainable. The guidelines highlight that biodiversity offsets are a 'last resort', to be implemented only once all other mitigatory options have been employed, in order to offset whatever 'residual impacts' remain. Only residual impacts on biodiversity which are of medium to high significance should be explored, as impacts which are greater cannot be compensated for through offsets, and impacts which are lesser do not warrant offsets. In the case of the Witberg WEF, residual impacts on birds are likely to fall within this middle range.

The significance of residual impacts is influenced heavily by the characteristics of the environment they fall within. Of the four characteristics identified in the guidelines, the area under consideration could potentially be classified as "a threatened ecosystem, habitat containing threatened species, special habitats or an ecological corridor". The guidelines at this stage are very much geared towards the assessments that have been done for the National Spatial Biodiversity Assessments, which are focused on vegetation types, wetland types and marine ecozones. None of these analyses suit the perspective of this situation, and thus a suitable logic for this kind of case will need to be devised.

The draft provincial guidelines suggest that offsets should be located within a core biodiversity area, or priority area identified in bioregional or biodiversity plans.

Furthermore, it should be stressed that in order for the offsets to fulfil the role of continued protection of the species threatened by the development, they would need to conserve a similar habitat to that which is being developed, i.e. like for like. The ecosystem component under consideration in the present instance is relatively high altitude (1200 - 1500m) rocky fynbos ridges with cliffs within the Nama Karoo biome, and can be considered as a special habitat (having high densities of eagles and other birds of prey) as well as habitat containing threatened and endemic species. The main direct threats to this habitat and associated fauna are overgrazing, off-road vehicle trails and the development of wind energy facilities, with the latter two only having come to the fore as a significant threat in the last few years. As such, the habitat in question may also become a threatened ecosystem.

In Figure 10, the Witteberge range more or less corresponds with the area above 950m in north of the Anysberg, which traverses the southern part of the Anysberg Nature Reserve. The area shown to be above 1200m, within which the proposed development is sited, clearly shows that the main ridge stands out as a 34km-long unbroken ridge within the Witteberge range which accounts for almost half of this habitat in the Witteberge. South of this ridge, the area above 1200m is a bit more fragmented but is still prime habitat. These areas, both on the main ridge and to the south, provide opportunities for offsetting the potential residual impacts of the development.

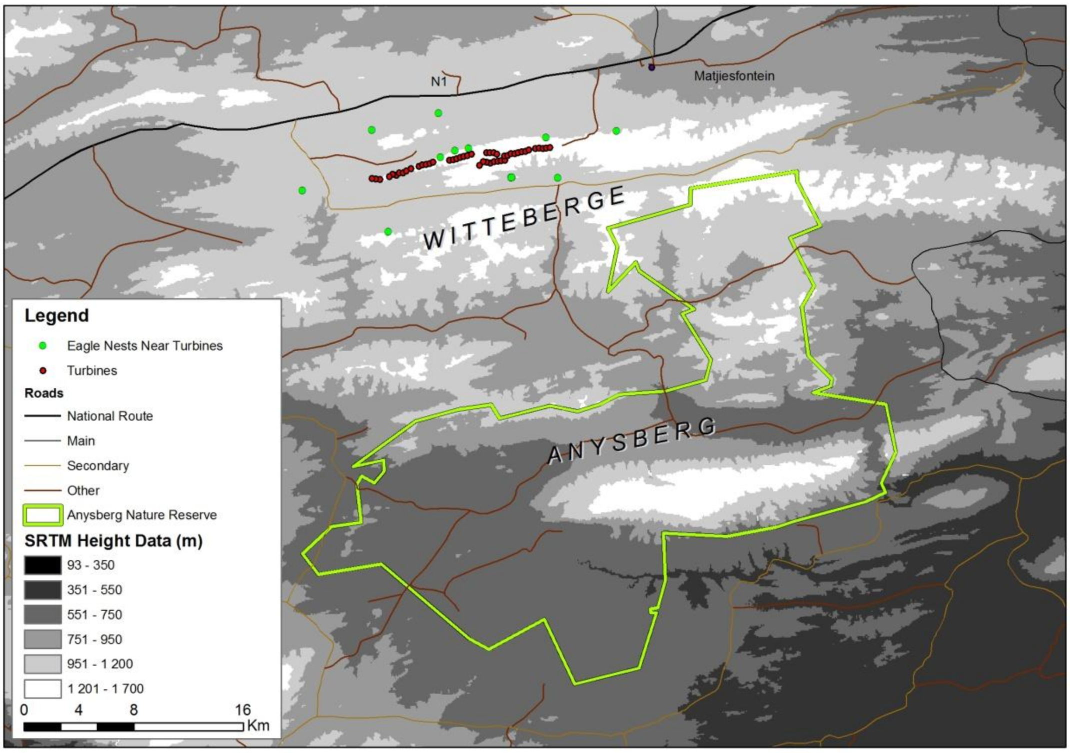


**FIGURE 10. MAP OF THE WITTEBERGE AND THE ANYSBERG (TO THE SOUTH), SHOWING THE LAYOUT OF THE PROPOSED WIND ENERGY FACILITY ON THE MAIN WITBERG RIDGE, THE LOCATION OF EAGLE NESTS NEAR THE TURBINES, AND THE BOUNDARIES OF THE ANYSBERG NATURE RESERVE. LOCATION OF ROADS ARE ALSO SHOWN FOR REFERENCE.**

In terrestrial systems, conservation status has only been evaluated for vegetation types, no such analysis has been done in terms of holistic analysis of ecosystems which includes avifauna. Some of the study area falls within the boundaries of the Gouritz Initiative, but even the detailed conservation assessment in this case was based only on vegetation parameters (Lombard & Wolf 2004). At this stage, if an offset were deemed feasible, the size and location of the area required would have to be based on expert opinion and where possible, analysis, in order to meet agreed criteria.

Guidelines further state that when a biodiversity offset option is pursued, an additional specialist study must be conducted. An offset report must be prepared which details the information gathering and matters relating to offset design and management mechanisms – including an offset management plan and a means through which to guarantee the long term security of the offset.

While there is no precedent for offsets in the context of wind energy developments in South Africa, and this process is still fairly new on a global scale, this would provide an interesting test case for South Africa, would allow detailed study of the impacts of turbines in this kind of habitat, and would potentially render the development biodiversity-friendly on balance.

## 5.4 Recommendations

In view of the above, and in addition to the recommendations made by Avisense (2011), it is our recommendation that the development is not allowed to proceed unless (a) **buffers** are established around all known eagle nests in the vicinity of the development, with a diameter of 2.5km for Martial Eagle, 1.5km for Verreaux's Eagle and 1.2km for Booted Eagle, as well as any other nests of priority species that may yet come to light, (b) outside of these buffers, the layout of turbines should **avoid the areas of high raptor flight activity** along the northern edge of the ridge as far as possible, and (c) a suitable **offset** area is purchased that mitigates the residual impacts of the development.

Given the indications of what is possible regarding recommendation (b), the development will still carry significant risk to the priority species in the study area. We thus recommend that an offset study is conducted which investigates how the developer can contribute to securing equivalent populations elsewhere, following international best practice and involving adequate stakeholder participation.

At the minimum, the offset should remove the risk of habitat loss or degradation (e.g. due to developments and grazing) from a land area that would be able to support populations of the priority bird species as found on the WEF site. Verreaux's Eagle can be used as an 'umbrella species' in this regard in that meeting their range requirements will likely take care of the other species. Given that there are four pairs of Verreaux's

Eagle at high risk, and working with the offset principle that the conservation area should be scaled up, this probably requires securing a land area of about 20 - 30 000 ha of similar habitat. The area and spatial possibilities would have to be investigated in a more thorough analysis which takes eagle densities, land use and threats into account. Securing conservation areas might take the form of acquiring land to be added to the existing Anysberg Nature Reserve, which is desirable under the National Protected Areas Expansion Plan, or paying farmers to incorporate title deed restrictions on appropriate parcels of land. The fact that some land parcels in the area are already being managed as private nature reserves could be advantageous, as consolidation of these areas would also be possible.

In response to these recommendations, the developer has proposed a new layout of 26 turbines which was devised using optimisation software within the constraint of the developable footprint (Figure 11). This layout was constrained by the eagle buffer zones (apart from M2 – discussed below) as well as a 50m buffer of the northern ridge east of the 60m western mast. Turbine positions are given in Table 7. Details of the changes to the layout are shown in Appendix 2.

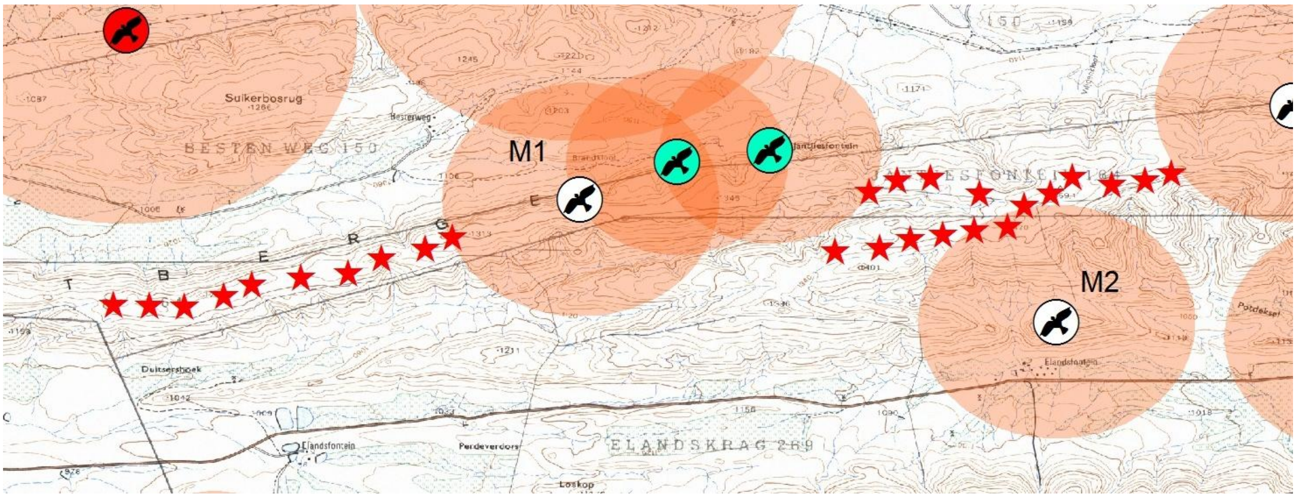


FIGURE 11. TURBINE LAYOUT PROPOSED BY G7 AS AT APRIL 2012.

The proposed layout has the caveat that 20m shifts must be allowed for each turbine subject to micrositing, and for turbines west of the western mast, shifts of turbines of up to 100m are possible.

The layout in Figure 11 was devised before the use of nest site M2 was discovered, and falls within the edge of the 1500m buffer zone for this nest, however, moving the turbine that falls just inside the buffer zone would probably not appreciably lower the risk of collision for that pair. This layout and associated caveats will be acceptable on condition that it is established in conjunction with an offset arrangement that significantly improves the conservation status of 20 – 30 000 ha of similar habitat in the Witteberg Range, preferably adjacent to the Anysberg Nature Reserve.

**Table 7. Positions of the turbines shown in Figure 11.**

| Turbine ID | Eastings (m) | Northings (m) | Turbine ID | Eastings (m) | Northings (m) |
|---|---|---|---|---|---|
| 1 | 451852 | 6317234 | 14 | 450512 | 6316950 |
| 2 | 451538 | 6317109 | 15 | 450224 | 6316794 |
| 3 | 451175 | 6317069 | 16 | 448983 | 6316339 |
| 4 | 450742 | 6317176 | 17 | 440320 | 6315449 |
| 5 | 449683 | 6316472 | 18 | 440703 | 6315441 |
| 6 | 449200 | 6317149 | 19 | 441085 | 6315441 |
| 7 | 449340 | 6316398 | 20 | 441519 | 6315571 |
| 8 | 448835 | 6317118 | 21 | 442357 | 6315819 |
| 9 | 448170 | 6316171 | 22 | 442867 | 6315880 |
| 10 | 444001 | 6316350 | 23 | 443138 | 6316061 |
| 11 | 450039 | 6316524 | 24 | 441818 | 6315726 |
| 12 | 448650 | 6316241 | 25 | 448532 | 6316965 |
| 13 | 449739 | 6316944 | 26 | 443704 | 6316204 |

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# 8 APPENDIX 1. BIRD SPECIES RECORDED AT THE SITE

South African Red Data status: V = vulnerable, NT = near-threatened; E = endemism: E = endemic, N= near endemic; Local status: C = common, UnC= uncommon, R = Rare; R = resident, M = migrant, V = visitor; Risk: H = high, M = moderate

| | | | | | | Recorded | | | | | | Risk | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Name** | **Scientific name** | **Red data status** | **Endemism** | **Local status** | **Oct-10** | **Jun-11** | **Aug-11** | **Nov-11** | **Jan-12** | **Apr 12** | **Overall** | **Clision** | **Electrocution** | **Hab loss** |
| Cape Spurfowl | *Pternistis capensis* | - | E | CR | | 1 | 1 | 1 | | | 1 | M | - | H |
| Grey-winged Francolin | *Scleroptila africanus* | - | E | | | | | | 1 | 1 | 1 | M | - | H |
| Helmeted Guineafowl | *Numida meleagris* | - | - | CR | | 1 | | | | | 1 | M | - | H |
| Egyptian Goose | *Alopochen aegyptiaca* | - | - | CR | 1 | 1 | 1 | 1 | 1 | | 1 | H | H | - |
| South African Shelduck | *Tadorna cana* | - | E | CR | 1 | 1 | 1 | | 1 | 1 | 1 | H | - | - |
| Spur-winged Goose | *Plectropterus gambensis* | - | - | CR | | 1 | | | 1 | | 1 | H | M | - |
| African Black Duck | *Anas sparsa* | - | - | UnCR | | 1 | | | | | 1 | M | - | - |
| Yellow-billed Duck | *Anas undulata* | - | - | CR | 1 | 1 | | | 1 | | 1 | M | - | - |
| Ground Woodpecker | *Geocalaptes olivaceus* | - | E | UnCR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | M |
| White-backed Mousebird | *Colius colius* | - | E | CM | 1 | | | | | | 1 | - | - | M |
| Alpine Swift | *Tachymarptis melba* | - | - | CR | | | | 1 | 1 | 1 | 1 | M | - | - |
| Common Swift | *Apus apus* | - | - | UnCM | | | | | 1 | 1 | 1 | M | - | - |
| African Black Swift | *Apus barbatus* | - | - | CR | | | 1 | | 1 | | 1 | M | - | - |
| Little Swift | *Apus affinis* | - | - | CR | | | | 1 | 1 | | 1 | M - | - | - |
| White-rumped Swift | *Apus caffer* | - | - | CV | 1 | | 1 | 1 | 1 | 1 | 1 | M | - | - |
| Cape Eagle-Owl | *Bubo capensis* | - | - | UnCR | | | 1 | | | | 1 | - | H | M |
| Spotted Eagle-Owl | *Bubo africanus* | - | - | CR | | | 1 | | 1 | | 1 | - | H | M |
| Rock Dove | *Columba livia* | - | - | CV | | 1 | 1 | 1 | | | 1 | - | - | M |
| Speckled Pigeon | *Columba guinea* | - | - | CR | 1 | 1 | 1 | | 1 | 1 | 1 | - | - | M |
| Cape Turtle-Dove | *Streptopelia capicola* | - | - | CR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Namaqua Dove | *Oena capensis* | - | - | CR | | | | 1 | 1 | | 1 | - | - | M |
| Blue Crane | *Anthropoides paradiseus* | V | E | UnCR | 1 | 1 | | | | | 1 | H | - | M |
| Red-knobbed Coot | *Fulica cristata* | - | - | CR | | 1 | | | | | 1 | M - | - | - |
| Pied Avocet | *Recurvirostra avosetta* | - | - | CR | 1 | | | | | | 1 | M | - | - |
| Blacksmith Lapwing | *Vanellus armatus* | - | - | CR | | 1 | | | | | 1 | M | - | - |
| Yellow-billed Kite | *Milvus migrans* | - | - | UnCM | | | | 1 | | | 1 | - | - | - |
| African Fish-Eagle | *Haliaeetus vocifer* | - | - | UnCR | 1 | | | | | | 1 | - | H | - |
| Black Harrier | *Circus maurus* | NT | E | UnCR | 1 | 1 | | 1 | 1 | | 1 | M | - | M |
| African Harrier-Hawk | *Polyboroides typus* | - | - | UnCV | | | | 1 | 1 | | 1 | - | - | M |
| Southern Pale Chanting Goshawk | *Melierax canorus* | - | N | UnCR | 1 | 1 | | 1 | 1 | 1 | 1 | - | M | M |
| Gabar Goshawk | *Melierax gabar* | - | - | UnCR | | 1 | | | | | 1 | - | - | M |
| Steppe Buzzard | *Buteo vulpinus* | - | - | CM | | | | 1 | | | 1 | - | M | M |
| Jackal Buzzard | *Buteo rufofuscus* | - | E | CR | | 1 | 1 | 1 | 1 | 1 | 1 | - | M | M |
| Verreaux's Eagle | *Aquila verreauxii* | - | - | UnCR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | M | H | M |
| Booted Eagle | *Aquila pennatus* | - | - | UnCR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Martial Eagle | *Polemaetus bellicosus* | V | - | UnCR | 1 | 1 | | | | | 1 | M | H | M |
| Rock Kestrel | *Falco rupicolus* | - | - | CR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Greater Kestrel | *Falco rupicoloides* | - | - | UnCV | | 1 | | | | | 1 | - | - | M |
| Lanner Falcon | *Falco biarmicus* | NT | - | UnCV | | 1 | | | | | 1 | H | M | - |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Little Grebe | *Tachybaptus ruficollis* | - | - | CR | | 1 | | | | | 1 | - | - | - |
| Reed Cormorant | *Phalacrocorax africanus* | - | - | CV | 1 | 1 | | | | | 1 | - | - | - |
| Grey Heron | *Ardea cinerea* | - | - | CV | 1 | | | | | | 1 | M | M | - |
| Hadeda Ibis | *Bostrychia hagedash* | - | - | CR | 1 | 1 | | | | | 1 | M | - | - |
| African Spoonbill | *Platalea alba* | - | - | CV | 1 | | | | | | 1 | M | - | - |
| Bokmakierie | *Telophorus zeylonus* | - | N | CR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Pririt Batis | *Batis pririt* | - | N | UnCR | | | 1 | | | | 1 | - | - | M |
| Cape Crow | *Corvus capensis* | - | - | CR | | 1 | | | | | 1 | - | - | M |
| Pied Crow | *Corvus albus* | - | - | CR | 1 | 1 | 1 | 1 | | | 1 | - | - | M |
| White-necked Raven | *Corvus albicollis* | - | - | CR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Common Fiscal | *Lanius collaris* | - | - | CR | | 1 | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Cape Rock-jumper | *Chaetops frenatus* | - | E | RR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Brown-throated Martin | *Riparia paludicola* | - | - | CR | | | | 1 | 1 | | 1 | - | - | M |
| Barn Swallow | *Hirundo rustica* | - | - | CM | 1 | | | | 1 | | 1 | - | - | M |
| White-throated Swallow | *Hirundo albigularis* | - | - | CR | | | | | 1 | | 1 | - | - | M |
| Greater Striped Swallow | *Hirundo cucullata* | - | - | CM | 1 | | | 1 | 1 | 1 | 1 | - | - | M |
| Rock Martin | *Hirundo fuligula* | - | - | CR | 1 | | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Cape Bulbul | *Pycnonotus capensis* | - | E | CR | 1 | 1 | 1 | | | 1 | 1 | - | - | M |
| Layard's Tit-Babbler | *Parisoma layardi* | - | E | UnCR | | 1 | | 1 | | | 1 | - | - | M |
| Chestnut-vented Tit-Babbler | *Parisoma subcaeruleum* | - | N | UnCR | | | | 1 | | | 1 | - | - | M |
| Grey-backed Cisticola | *Cisticola subruficapilla* | - | N | CR | | | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Karoo Prinia | *Prinia maculosa* | - | E | CR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Rufous-eared Warbler | *Malcorus pectoralis* | - | E | CR | | 1 | 1 | | | | 1 | - | - | M |
| Cape Clapper Lark | *Mirafra apiata* | - | E | UnCR | | | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Karoo Lark | *Calendulauda albescens* | - | E | UnCR | | | 1 | | 1 | 1 | 1 | - | - | M |
| Karoo Long-billed Lark | *Certhilauda subcoronata* | - | E | UnCR | 1 | | 1 | 1 | | | 1 | - | - | M |
| Red-capped Lark | *Calandrella cinerea* | - | - | CR | | | | 1 | | | 1 | - | - | M |
| Large-billed Lark | *Galerida magnirostris* | - | E | CR | 1 | | 1 | 1 | | | 1 | - | - | M |
| Cape Rock Thrush | *Monticola rupestris* | - | E | CR | | 1 | | 1 | | | 1 | - | - | M |
| Sentinel Rock Thrush | *Monticola explorator* | - | E | UnCR | 1 | | | | | | 1 | - | - | M |
| Karoo Scrub-Robin | *Cercotrichas coryphoeus* | - | E | CR | 1 | | 1 | 1 | | 1 | 1 | - | - | M |
| African Stonechat | *Saxicola torquatus* | - | - | CR | | 1 | 1 | | | | 1 | - | - | M |
| Mountain Wheatear | *Oenanthe monticola* | - | N | CR | 1 | | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Familiar Chat | *Cercomela familiaris* | - | - | CR | 1 | 1 | 1 | 1 | 1 | | 1 | - | - | M |
| Ant-eating Chat | *Myrmecocichla formicivora* | - | E | CR | | 1 | | | | | 1 | - | - | M |
| Red-winged Starling | *Onychognathus morio* | - | - | CR | 1 | 1 | | 1 | 1 | 1 | 1 | - | - | M |
| Pied Starling | *Spreo bicolor* | - | E | CR | 1 | 1 | 1 | 1 | 1 | | 1 | - | - | M |
| Orange-breasted Sunbird | *Anthobaphes violacea* | - | E | CR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Malachite Sunbird | *Nectarinia famosa* | - | - | CR | | 1 | 1 | 1 | | 1 | 1 | - | - | M |
| Southern Double-collared Sunbird | *Cinnyris chalybeus* | - | E | CR | 1 | 1 | 1 | 1 | | 1 | 1 | - | - | M |
| Cape Sugarbird | *Promerops cafer* | - | E | UnCR | | 1 | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Cape Weaver | *Ploceus capensis* | - | E | CR | | 1 | | | | | 1 | - | - | M |
| Southern Masked-Weaver | *Ploceus velatus* | - | - | CR | 1 | | | 1 | | | 1 | - | - | M |
| Southern Red Bishop | *Euplectes orix* | - | - | CR | | | | 1 | | | 1 | - | - | M |
| Yellow Bishop | *Euplectes capensis* | - | - | CR | | | 1 | 1 | | 1 | 1 | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Common Waxbill | *Estrilda astrild* | - | - | CR | 1 | | | 1 | | | 1 | - | - | M |
| House Sparrow | *Passer domesticus* | - | - | CR | | 1 | | | | | 1 | - | - | M |
| Cape Sparrow | *Passer melanurus* | - | N | CR | 1 | 1 | 1 | 1 | | | 1 | - | - | M |
| Cape Wagtail | *Motacilla capensis* | - | - | CR | | 1 | 1 | 1 | | | 1 | - | - | M |
| African Rock Pipit | *Anthus cinnamomeus* | - | E | UnCR | 1 | | 1 | 1 | 1 | 1 | 1 | - | - | M |
| African Pipit | *Anthus cinnamomeus* | - | - | CR | | | 1 | | | | 1 | - | - | M |
| Long-billed Pipit | *Anthus similis* | - | - | UnCR | 1 | | 1 | | | | 1 | - | - | M |
| Cape Canary | *Serinus canicollis* | - | E | CR | | 1 | | 1 | | | 1 | - | - | M |
| Black-headed Canary | *Serinus alario* | - | E | UnCR | | | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Yellow Canary | *Crithagra flaviventris* | - | N | CR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Brimstone Canary | *Crithagra sulphuratus* | - | - | UnCR | | 1 | | | | | 1 | - | - | M |
| White-throated Canary | *Crithagra albogularis* | - | N | CR | 1 | 1 | 1 | 1 | | | 1 | - | - | M |
| Cape Siskin | *Crithagra totta* | - | E | UnCR | | | | 1 | | 1 | 1 | - | - | M |
| Lark-like Bunting | *Emberiza impetuani* | - | N | CV | | | | | 1 | 1 | 1 | - | - | M |
| Cape Bunting | *Emberiza capensis* | - | N | CR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | M |
| Protea seedeater | *Crithagra leucoptera* | - | E | UnCR | | | | | | 1 | 1 | | | H |
| Pale-winged Starling | *Onychognathus nabouroup* | - | E | CR | | | | | | 1 | 1 | | | M |

# 9 APPENDIX 2. DETAILS OF THE LAYOUT CHANGES PROPOSED BY DEVELOPER