The potential impacts on birds resulting from the establishment of the Roggeveld Wind Farm include impacts associated with mortality through collision with turbines, habitat loss and disturbance or displacement from foraging or nesting areas. ERM appointed Avisense Consulting to undertake the required specialist study on birds for the proposed development, which is appended to this report as *Annex F*. This section examines the potential impacts and mitigation measures to reduce the impacts.

Table 8.1 Impact characteristics: Roggeveld WEF – Birds

Summary	Construction	Operation
Project Aspect/ activity	(i) Disturbance associated with noise and movement. (ii) Loss of vegetation and avian habitat through site clearance, road upgrade and establishment of the camp, lay-down and assembly areas.	(i) Disturbance and/or displacement from foraging or nesting area by movement and/or noise of rotating turbine blades. (ii) Mortality in collisions with turbine blades and/or power lines, or by electrocution on new power infrastructure.
Impact Type	Direct	Direct
Receptors Affected	(i) All birds on site; key species Verreaux's Eagle, Martial Eagle, Black Harrier, Cape Eagle-Owl, Ludwig's Bustard. (ii) Ludwig's Bustard, Martial Eagle, Black Harrier, Cape Eagle-Owl.	(i) All birds on site; key species: Verreaux's Eagle, Martial Eagle, Black Harrier, Ludwig's Bustard, Cape Eagle-Owl. (ii) All birds on site; key species Verreaux's Eagle, Martial Eagle, Black Harrier, Ludwig's Bustard, Cape Eagle-Owl.

8.1 HABITAT LOSS – DESTRUCTION, DISTURBANCE AND DISPLACEMENT

Construction Impact

Although the final, destructive footprint of most wind energy facilities is likely to be relatively small, the construction phase of development inevitably incurs quite extensive temporary damage or permanent destruction of habitat, which may be of lasting significance in cases where wind energy facility sites coincide with critical areas for restricted range, endemic and/or threatened

species. Similarly, construction, and to a lesser extent ongoing maintenance activities, are likely to cause some disturbance of birds in the general surrounds, and especially of shy and/or ground-nesting species resident in the area. Mitigation of such effects requires that generic best-practice principles be rigorously applied - 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 kept to an absolute minimum.

Some studies have shown significant decreases in the numbers of certain birds in areas where wind energy facilities are operational as a direct result of avoidance of the noise or movement of the turbines (e.g. Larsen & Guillemette 2007, Farfán *et al.* 2009, Table 1), while others have shown decreases which may be 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 more modified environments such as farmland (Devereaux *et al.* 2008), and are highly species-specific.

8.1.2 Construction and maintenance of power lines and substations

Some habitat destruction and alteration inevitably takes place during the construction of power lines, substations and associated roadways. Also, power line service roads or servitudes have to be cleared of excess vegetation at regular intervals in order to allow access to the line for maintenance, and to prevent vegetation from intruding into the legally prescribed clearance gaps between the ground and the conductors. These activities have an impact on birds breeding, foraging and roosting in or in close proximity to the servitude, and retention of cleared servitudes can have the effect of altering bird community structure along the length of any given power line (e.g. King & Byers 2002).

Box 8.1 Habitat loss

Nature: Construction activities would result in a negative direct impact on the avifauna of the WEF site.
Impact Magnitude – Medium

- Extent: The extent of the impact is local.
- Duration: The duration would be medium-term as the ecology of the area would be altered beyond the completion of the project.
- Intensity: Loss of habitat for priority species will be considerable, so the magnitude of the change will be medium.

Likelihood – There is a high likelihood that areas of habitat will be lost.
IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM-HIGH
Degree of Confidence: The degree of confidence is high.

Box 8.2 *Disturbance*

Nature: Construction activities would result in a negative direct impact on the avifauna of the WEF site.
Impact Magnitude – Medium
- Extent: The extent of the impact is local.
- Duration: The duration would be short-term as this effect will not extend beyond the life of the project.
- Intensity: Some biome/range restricted and/or threatened species will severely disturbed, so the magnitude of the change will be medium.

Likelihood – There is a high likelihood that birds will be disturbed.
IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM-HIGH
Degree of Confidence: The degree of confidence is high.

Box 8.3 *Disturbance and displacement*

Nature: Operational activities would result in a negative direct impact on the avifauna of the WEF site.
Impact Magnitude – Medium
- Extent: The extent of the impact is local.
- Duration: The duration would be long-term as the ecology of the area would be affected until the project stops operating.
- Intensity: Some priority species may be displaced for the duration of the project, and there will be some loss of habitat, so the magnitude of the change will be medium.

Likelihood – There is a medium likelihood that some priority species will be disturbed/displaced.
IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM
Degree of Confidence: The degree of confidence is medium.

8.2 IMPACTS OF ASSOCIATED INFRASTRUCTURE

Operation

Infrastructure commonly associated with wind energy facilities may also have detrimental effects on birds. The construction and maintenance of substations, power lines, servitudes and roadways causes both temporary and permanent habitat destruction and disturbance, and overhead power lines pose a collision and possibly an electrocution threat to certain species (Van Rooyen 2004a, Lehman *et al.* 2007, Jenkins *et al.* 2010).

Box 8.4 **Mortality**

Nature: Operational activities would result in a negative direct impact on the avifauna of the WEF site.
Impact Magnitude – Medium

- Extent: The extent of the impact is local.
- Duration: The duration would be long-term as the ecology of the area would be affected at least until the project stops operating.
- Intensity: Some of individuals of threatened species may be killed in collision/electrocution incidents, so change will be medium.

Likelihood – There is a medium likelihood that some individuals of priority species will be killed.
IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM
Degree of Confidence: The degree of confidence is medium

Mitigation

Mitigation of these impacts will be best achieved in the following ways:

(i) On-site demarcation of 'no-go' areas identified during pre-construction monitoring (see below) to minimise disturbance impacts associated with the construction of the facility.

(ii) Excluding turbines from:

(a) Within 500 m from the edge of the ridge slope of the most prominent ridge-lines within the development area to reduce collision risk for slope soaring raptors.

(b) Within 1500 m of any Verreaux's Eagle nest sites located within the development area (at least one site is directly affected to reduce disturbance and collision risk for this species.

(c) Within 2500 m of any Martial Eagle nest sites located within the development area (at least one site is directly affected) to reduce disturbance and collision risk for this species.

(d) Within 1000 m of the outer perimeter of the wetland/watercourse designated as a Black Harrier nesting area to reduce disturbance and collision risk for this species.

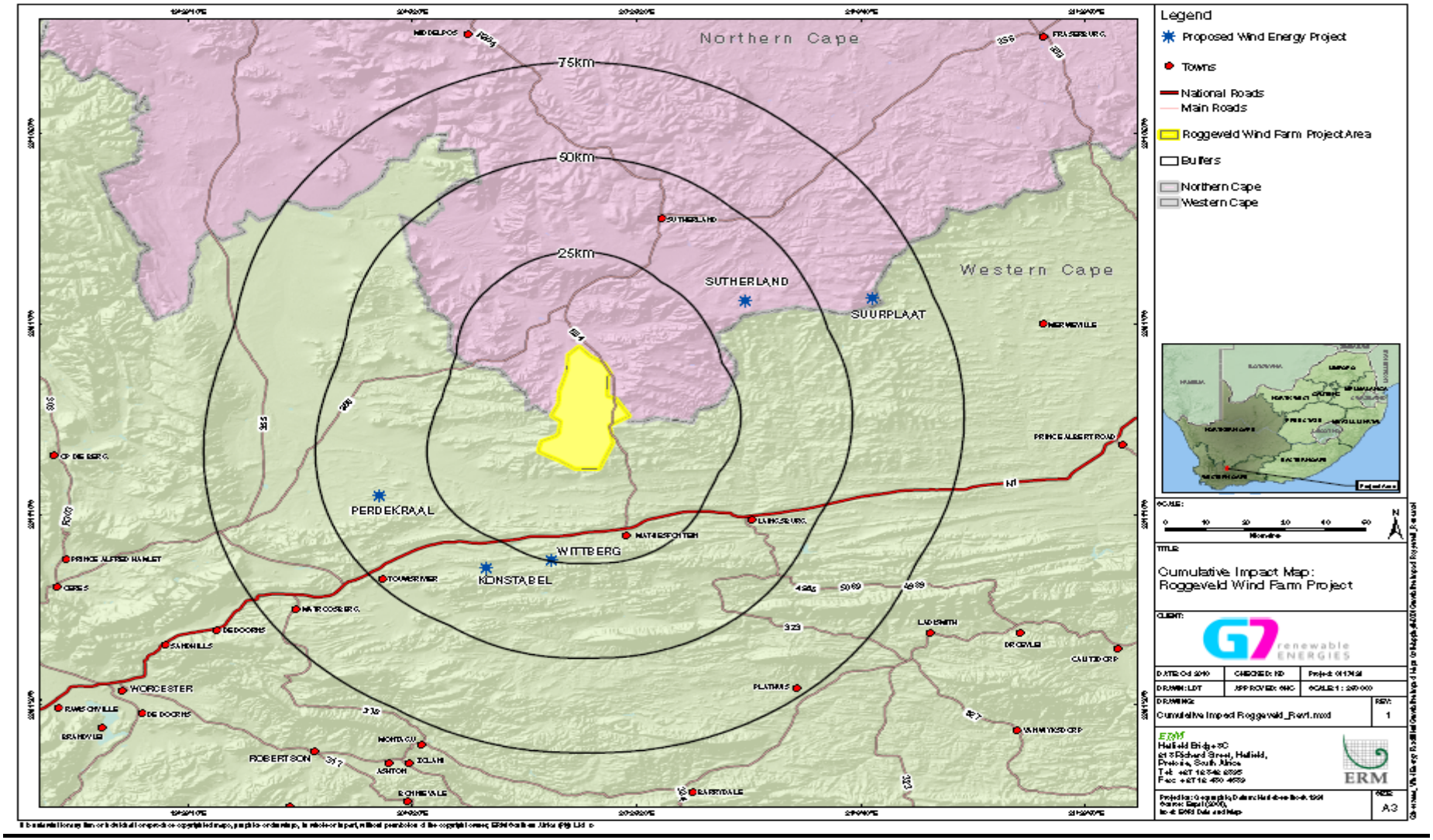
(iii) Painting one blade of each turbine black to maximize conspicuousness to oncoming birds. The evidence for this as an effective mitigation measure is not conclusive, but it is suggestive. It might be best to adopt an experimental approach to blade marking, identifying a sample of pairs of potentially high risk turbines in pre-construction monitoring, and marking the blades on one of each pair. Post-construction monitoring should allow empirical testing of efficacy, which would inform subsequent decisions about the need to mark blades more widely

in this and other WEFs. However, the possibility of painting the blades is limited due to Civil Aviation requirements.

(iv) Minimizing the length of any new power lines installed, and ensuring that all new lines are marked with bird flight diverters (Jenkins *et al.* 2010), and that all new power infrastructure is adequately insulated and bird friendly in configuration (Lehman *et al.* 2007). Note that current understanding of power line collision risk in birds precludes any guarantee of successfully distinguishing high risk from medium or low risk sections of a new line (Jenkins *et al.* 2010). The relatively low cost of marking the entire length of a new line during construction, especially quite a short length of line in an area frequented by collision prone birds, more than offsets the risk of not marking the correct sections, causing unnecessary mortality of birds, and then incurring the much greater cost of retro-fitting the line post-construction. In situations where new lines run in parallel with existing, unmarked power lines, this approach has the added benefit of reducing the collision risk posed by the older line.

(v) Carefully monitoring the local avifauna pre- and post-construction (see below), and implementing appropriate additional mitigation as and when significant changes are recorded in the number, distribution or breeding behaviour of any of the priority species listed in this report, or when collision or electrocution mortalities are recorded for any of the priority species listed in this report. Radar tracking systems, however expensive, may be the best and most practical solution to this problem.

Figure 8.1 *Roggeveld WEF site in the context of other WEF developments planned within a 75 km radius. Note that there are five such projects at present.*



(vi) Ensuring that the results of pre-construction monitoring are applied to project-specific impact mitigation in a way that allows for the potential cumulative effects on the local/regional avifauna of any other wind energy projects proposed for this area (of which there are five with a 75 km radius, including the Sutherland Renewable Energy Facility and the Suurplaat Wind Farm, both proposed for properties along the Klein Roggeveld escarpment to the north-east, and the G7 Witberg project, some 20 km to the south. Viewed in isolation, each of these projects may pose only a limited threat to the avifauna of the area. However, in combination they may result in the formation of significant barriers to energy-efficient travel between resource areas for regionally important bird populations, and/or significant levels of mortality in these populations in collisions with what may become a substantial array of many 100s of turbines (Masden *et al.* 2010). The construction of all planned wind farms may be unlikely as the planned farm compete for use of grid connection via power lines in the area.

(vii) Additional mitigation, subject to feasibility, might include re-scheduling construction or maintenance activities on site, shutting down problem turbines either permanently or at certain times of year or in certain conditions, or installing a 'DeTect' or similar radar tracking system to monitor bird movements and institute temporary shut-downs as and when required.

8.3 COLLISION OF BIRDS WITH WIND TURBINES AND DISPLACEMENT

8.3.1 Impact Description and Assessment

Collision monitoring should have two components: (i) experimental assessment of search efficiency and scavenging rates of bird carcasses on the site, and (ii) regular searches of the vicinity of the wind farm for collision casualties.

8.3.2 Mitigation

- Minimizing the disturbance impacts associated with the operation of the facility by scheduling maintenance activities to avoid disturbances in sensitive areas (identified through operational monitoring).
- Ensuring that lighting on the turbines is kept to a minimum, and is coloured (red or green) and intermittent, rather than permanent and white, to reduce confusion effects for nocturnal migrants.

8.3.3 Residual Impact

The implementation of the above mitigation measures, including the revision of the layout from Layout Alternative 1 to Layout Alternative 2 following recommendation from the specialists and wind monitoring results obtained by

G7, would contribute towards ensuring the significance is reduced from minor to negligible during the construction phase and moderate to minor/moderate during the operational phase. The pre- and post-mitigation impacts are compared in Table 8.2.

Table 8.2 Pre- and Post- Mitigation Significance: Roggeveld WEF - Birds

Phase	Pre-mitigation Significance	Residual Impact Significance
Construction		
Habitat loss	**MEDIUM-HIGH**	**MEDIUM**
Disturbance	**MEDIUM-HIGH**	**MEDIUM**
Operation		
Displacement	**MEDIUM**	**LOW-MEDIUM**
Mortality	**MEDIUM**	**LOW-MEDIUM**

8.4 MONITORING REQUIREMENTS

8.4.1 Monitoring protocols

Avian densities before and after

A set of at least 10 walk-transect routes, each of at least 1000 m in length, should be established in areas representative of all the avian habitats present within a 10 km radius of the centre of the WEF development site. Each of these should be walked at least once every two months over the six months preceding construction, and at least once every two months over the same calendar period, at least 6-12 months after the WEF is commissioned. The transects should be walked after 06h00 and before 09h00, and the species, number and perpendicular distance from the transect line of all birds seen should be recorded for subsequent analysis and comparison.
In addition, the cliff-lines and/or power lines within the development area should be surveyed for nesting raptors at least every 6-12 months using documented protocols (Malan 2009), and all sightings of key species (Table 6.1) on site should carefully plotted and documented, and the major waterbodies on and close to the development area should be surveyed for wetland species on each visit to the study area, using the standard protocols set out by the CWAC initiative (Taylor *et al.* 1999).

8.4.2 Bird activity monitoring

Monitoring of bird activity in the vicinity of the WEF should be done over a 2-3 day period at least every two months for the 6-12 months preceding construction, and at least once per quarter for a full calendar year starting at

least 6-12 months after the WEF is commissioned. Each monitoring day should involve:

(i) Half-day counts of all priority species flying over or past the WEF impact area (see passage rates below)

(ii) Opportunistic surveys of bustards, cranes and raptors seen when travelling around the WEF site.

8.4.3 Passage rates of priority bird species

Counts of bird traffic over and around the proposed/operational WEF should be conducted from suitable vantage points (and a number of these should be selected and used to provide coverage of avian flights in relation to all areas of the WEF), and extend alternately from dawn to midday, or from midday to dusk, so that the equivalent of four full days of counts is completed each count period. This should provide an adequate (if minimal) sample of bird movements around the facility in relation to a representative cross-section of conditions and times of day, for all seasons of the year.

8.4.4 Additional mitigation based on monitoring data

Additional mitigation might include re-scheduling construction or maintenance activities on site, shutting down problem turbines either permanently or at certain times of year or in certain conditions, or installing a DeTect or similar radar tracking system to monitor bird movements and institute temporary shut-downs as and when required.

The primary aims of a long-term monitoring programme would be to:

- Determine the densities of birds resident within the impact area of the WEF before construction of the facility, and afterwards, once the facility, or phases of the facility, become operational.
- Document patterns of bird activity and movements in the vicinity of the proposed WEF before construction, and afterwards, once the facility is operational.
- Monitor patterns of bird activity and movement in relation to weather conditions, time of day and season for at least a full calendar year after the WEF is commissioned.
- Register and as far as possible document the circumstances surrounding all avian collisions with the WEF turbines for at least a full calendar year after the facility becomes operational.

Pre-construction monitoring would determine the need for any additional mitigations requirements to be implemented during the construction or operational phases of the development.