PORT ELIZABETH WIND ENERGY FACILITY AVIFAUNAL AND BAT IMPACT ASSESSMENT

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EXECUTIVE SUMMARY

The proposed wind farm will consist of ten wind turbines (with a power generation potential of 2.3MW each), appropriately spaced over the site, as well as the associated infrastructure for connection onto the existing power grid, and access for maintenance purposes, as required for the particular site selected. Each turbine will have a tower height of 80 meters, and a rotor diameter of 85 meters (total height is therefore 122.5 meters). Phase 1 of the proposed development will have a total power generation potential of 20MW, with possible future expansion to 40MW (by the addition of more turbines), depending on the area limitations of the site.

The three site alternatives (Figure 5) have been selected for their suitability with regard to wind, topography and conservation status, and will be examined in more detail in this report.

The proposed development falls within three quarter degree squares, namely 3325CC, 3325CD and 3325DC and the number of bird species recorded in these squares by the South African Bird Atlas Project (SABAP) range from 272 to 325 species. Of these species 36 are Red List species, with two classified as Endangered, 10 classified as Vulnerable and 24 classified as Near threatened. One bird species is protected internationally under the Bonn Convention.

The proposed development can be built with acceptable impact on avifauna should the recommendations regarding site selection in this report be followed.

The Bushy Park site is the most preferred site alternative from an avifaunal perspective and the Driftsands site is least preferred. The Driftsands site should be discarded as an alternative from an avifaunal perspective.

With regards to bats, the Van Staden site is the most preferred site alternative with Bushy Park and Driftsands being least preferred.

In particular the following important points must be stressed:

1: A Site specific EMP is strongly recommended to site the turbines correctly as well as to deal with the details of the associated infrastructure that was not provided at this stage of the process.

2: A monitoring program is seen as critical in extending our knowledge of wind energy and avifaunal and bat interactions. Since this could be the first commercial wind energy facility in South Africa, it is recommended that a monitoring program be planned to collect data on a host of environmental factors, including avifaunal collisions and bat fatalities.

3: Turbines must be painted as detailed in this report to mitigate for collision of bird species.

4: If possible the wind turbines must be shut down in extreme wind and extreme low visibility events such as thick cloud or mist.

5: If possible the wind turbines should be shut down in low-wind conditions at night when the bats are foraging.

6: The wind energy facility should not be lit, if this is not feasible the lights must only be red strobe lights and lights that do not attract insects.

7: The use of a radar to alert bats to the presence of wind turbines is strongly encouraged.

It must also be stressed that with wind energy and avifaunal interactions the cumulative impacts of multiple developments could be important. It is recommended that a national or at least municipal strategic study be undertaken to address this issue.

DECLARATION OF CONSULTANTS' INDEPENDENCE & QUALIFICATIONS

J. Smallie and L. Strugnell (Avifaunal Specialists – Endangered Wildlife Trust) are independent consultants to SRK consulting. They have no business, financial, personal or other interest in the activity, application or appeal in respect of which they were appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of these specialists performing such work.

C. Patterson (Bat Specialists – Endangered Wildlife Trust) are independent consultants to SRK consulting. She has no business, financial, personal or other interest in the activity, application or appeal in respect of which they were appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of this specialist performing such work.

Mr. Smallie and Mr. Strugnell are registered with The South African Council for Natural Scientific Professionals. They have more than ten years of experience in the field of bird interactions with electrical infrastructure and have, relevant to this study, conducted avifaunal impact assessments for two Wind Energy projects. The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information.

1. INTRODUCTION

The proposed wind farm will consist of ten wind turbines (with a power generation potential of 2.3MW each), appropriately spaced over the site, as well as the associated infrastructure for connection onto the existing power grid, and access for maintenance purposes, as required for the particular site selected. Each turbine will have a tower height of 80 meters, and a rotor diameter of 85 meters (total height is therefore 122.5 meters). Phase 1 of the proposed development will have a total power generation potential of 20MW, with possible future expansion to 40MW (by the addition of more turbines), depending on the area limitations of the site.

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The proposed development falls within three quarter degree squares, namely 3325CC, 3325CD and 3325DC and the number of bird species recorded in these squares by the South African Bird Atlas Project (SABAP) range from 272 to 325 species. Of these species 36 are Red List species, with two classified as Endangered, 10 classified as Vulnerable and 24 classified as Near threatened. One bird species is protected internationally under the Bonn Convention. In addition, eleven bat species are likely to be found in the area, one of which is classified as Lower Risk (Near Threatened) and one as Vulnerable as it is a South African endemic (Taylor 2000).

A site visit was conducted on 29 September to 1 October 2009 to assess the site alternatives as well as get a first hand perspective on the area and any potential attractive micro-habitats for avifauna.

This report will review the impacts of wind energy facilities on avifauna and bats (both nationally and internationally) as well as discuss the various site alternatives and impacts expected with this project. These impacts will be fully assessed and rated and the alternatives will be ranked in terms of preference for avifauna and bats, i.e. the site with the least impact will be the most favorable.

2. TERMS OF REFERENCE

The following are the terms of reference for the project:

- Review the existing knowledge in terms of avifauna and bats and wind energy facilities.
- Describe the environment that may be affected by the activity and the manner in which the environment may be affected by the proposed project.

- Describe and evaluate environmental issues and potential impacts (including direct, indirect and cumulative impacts) that have been identified.
- Direct, indirect and cumulative aspects of the identified aspects must be evaluated within the report in terms of the following criteria:
    - The nature of the impact.
    - The extent of the impact.
    - Duration of the impact.
    - Magnitude of the impact.
    - The probability of occurrence of the impact.
    - Significance of the impact.
    - Cumulative impact

- Provide a comparative evaluation of any feasible alternatives.

3 STUDY METHODOLOGY

3.1. Approach

This study followed the following steps:

- An extensive review of available international literature, pertaining to bird and bat interactions with wind energy facilities was undertaken in order to fully understand the issues involved and the current level of knowledge in this field. Care was taken to adapt the international knowledge to local conditions and species wherever necessary.
- The various data sets listed below were obtained and examined.
- The potential impacts of the proposed facility were described and evaluated.
- Sensitive areas within the proposed site were identified using various GIS layers and Google Earth.
- Site visits were conducted over a three day period with a heterodyne bat detector being used to determine bat presence and call frequency (recorded as kHz).

3.2. Data sources used

The following data sources and reports were used in varying levels of detail for this study:

- The Southern African Bird Atlas Project data (Harrison *et al.* 1997) for the quarter degree squares covering the three sites.
- The Important Bird Areas report (Barnes 1998) was consulted for data on the area.
- Conservation status of bird species occurring in the study areas was determined using Barnes (2000).

- Presence and conservation status of bat species likely to occur in the study area was determined using Taylor (2000).
- The bird specialist report for the original Klipheuwel demonstration facility (van Rooyen 2001).
- The report to Eskom Peaking Generation on the monitoring of bird mortalities at the demonstration facility at Klipheuwel (Kuyler 2004 – obtained from Eskom Peaking Generation).
- International literature on avian interactions with wind energy facilities.
- Coordinated Waterbird Counts in South Africa (CWAC) (Taylor *et al.* 1999).
- Vegetation cover (Mucina & Rutherford 2006).
- Land cover data (CSIR).
- Paul Martin and BirdLife Eastern Cape were consulted for local knowledge of the area.

3.3. Limitations & assumptions

- Any inaccuracies in the above sources of information could limit this study. In particular, the Bird Atlas data is now ten years old (Harrison *et al.* 1997), but no reliable more recent data on bird species presence and abundance in the study area exists.
- Similarly, little work has been done in South Africa regarding the distribution and abundance of bats. The information available in Taylor (2000) is dated but no more recent and reliable data exists for the *Chiroptera* order as a whole.
- This study relies entirely upon secondary data sources such as the Atlas of Southern African Birds (Harrison *et al.* 1997) and Taylor (2000). The scope of this project did not allow for any significant primary data collection by the EWT on the proposed site.
- The associated infrastructure for this project (power line and substations) has not been decided upon by the developer and thus could not be fully assessed in this report as exact technical specifications were not available.

4. BACKGROUND TO THE STUDY

4.1 Background to interactions between wind energy facilities and birds

The following section provides a background to avifauna - wind energy facility interactions. It is critical to understand the various issues and factors at play, before an accurate assessment of the impacts of the proposed wind energy facility on the birds of the area can be conducted. By necessity, the following description is based almost entirely on international literature, primarily from the United States of America (USA). In reality the South African experience of wind energy generation has been extremely limited to date. Most of the principles that have been learnt internationally can, to a certain extent, be applied locally. However, care needs to be taken to adapt existing international knowledge to local bird species and conditions. Much of the work cited below has also been published in proceedings of meetings and conferences, not in formal peer reviewed journals. The information therefore needs to be used with some degree of caution, particularly when drawing comparisons, as the methodologies used were not always as scientific as desired. This section focuses largely on the impact of bird collisions with wind turbines. Wind energy facilities also impact on birds through disturbance and habitat destruction, and by means of their associated infrastructure. These disturbances on birds have received less attention in the literature, probably because they are less direct (and less emotive) impacts. In spite of the focus of this section on turbine collisions, this study will assess all possible interactions between avifauna and the proposed facility.

A relatively recent summary of the available literature entitled "Wind Turbines and Birds, a background review for environmental assessment" by Kingsley & Whittam (2005) and the Avian Literature Database of the National Renewable Energy Laboratory (www.nrel.gov) have been used extensively in the discussion below.

Concern for the avian impacts of wind energy facilities first arose in the 1980's when raptor mortalities were detected in California (Altamont Pass - USA) and at Tarifa (Spain). The Altamont Pass and Tarifa locations were the site of some extremely high levels of bird mortalities. These mortalities focused attention on the impact of wind energy on birds, and subsequently a large amount of monitoring at various sites has been undertaken. Naturally, as more monitoring was conducted at different sites, a need arose for a standard means of expressing the levels of bird mortalities – in this case, number of mortalities per turbine per year. Table 1 presents a brief summary of some data that has emerged internationally. It is important to note that searcher efficiency (and independence) and scavenger removal rates need to be accounted for. Searcher efficiency refers to the percentage of bird mortalities that are detected by searchers, searcher independence refers to whether the person monitoring has certain objectives of their own which may influence the results of monitoring. Additionally, although the rates may appear relatively low – it is important to note that it is the cumulative effect of a wind farm that is really important. In other words, the absolute number of birds killed by a wind farm in a year is far more meaningful than an average per turbine. In addition, for some species, even a minute increase in mortality rates could be significant (long lived, slow reproducing species such as many of the South African Red List species).

Table 1- Summary of wind energy and bird collision rates from various international countries

Country	Organisation	Collision Rate (Birds/turbine/year)	Comment
USA	National Wind Co-ordinating Committee	2.3(Range of 0.63 to 10)	Curry & Kerlinger (2000) found that 13% of turbines at Altamont Pass, California were responsible for all Golden Eagle and Red-tailed Hawk collisions
Australia	Australian Wind Energy Association	0.23 to 2.7	Monitoring site for this data consisted of only three wind turbines and one wind mast, so the results must be viewed with caution.
New Zealand	New Zealand Wind Energy Association	No reports	Wind power in New Zealand is relatively new
Spain	Janss(2000)	0.03	A study by Acha (1997) found that 28 of the 190 turbines killed 57% of vultures at Tarifa
Germany	German Wind Energy Association	0.5	Collated information from 127 case studies and concluded that only 269 birds were found to be killed by turbines across Germany since 1989

South Africa

To date, only three wind turbines have been constructed at a demonstration facility at Klipheuwel in the Western Cape, in 2002 and 2003. (Although four turbines have been constructed privately at a site near Darling, access to these for the purpose of monitoring bird impacts has been restricted). A monitoring program, conducted by Jacque Kuyler (2004), was put in place once the Klipheuwel turbines were operational. This report was obtained from Eskom Peaking Generation. The monitoring involved site visits twice a month to monitor birds flying in the vicinity of the site, and detect bird mortalities. Important findings of this monitoring conducted from June 2003 to January 2004 are as follows:

- Between 9 and 57% of birds observed within 500m of the turbines were at blade height – there was great variation between months.
- Between 0 and 32% of birds sighted were close to the turbines defined as "between turbines or within outer router arc" and again showed great variation between months.
- Five bird carcasses were found on the site during this eight month period. Two of these, a Helmeted Guineafowl and a Spotted Dikkop were determined to be killed by predators. A Horus Swift and a Thick-billed Lark were determined to have been killed by collision with turbine blades. A Cattle Egret was found with no visible injuries and was allocated to natural causes.
- If these two mortalities in eight months are expressed as number of mortalities/turbine/year (using the three turbines at Klipheuwel), the result is 1.00 mortalities per turbine per year.
- Experimental assessment of the searcher efficiency revealed that seven out of nine (77%) carcasses placed in the study area were detected by the searcher.

- These nine carcasses were scavenged at between 12 and 117 days after their placement.

4.1.1. Factors influencing bird collisions with turbines

A number of factors influence the number of birds killed at wind farms. These can be classified into three broad groupings: bird related information; site related information and facility related information.

Bird related information

Although only one study has so far shown a direct relationship between numbers of birds present in an area and number of collisions (Everaert 2003) it stands to reason that the more birds flying through the area of the turbines, the more chance of collisions occurring. The particular bird species present in the area is also very important as some species are more vulnerable to collision with turbines than others. This is examined further below. Bird behaviour and activity differs between species – with certain hunting behaviours rendering certain species more vulnerable. For example a falcon stooping after prey is too focused to notice other infrastructure. There may also be seasonal and temporal differences in behaviour, for example breeding males displaying may be particularly at risk. These factors can all influence the birds' vulnerability.

A controlled experiment with homing pigeons was undertaken by Cade (1994) to examine their flight behaviour in the proximity of turbines. Pigeons released near turbines clearly recognised the turbines and adjusted their flight as required. Of about 2270 pigeon flights near turbines, three collisions occurred. In a radar study of the movement of ducks and geese in the vicinity of an off-shore wind facility in Denmark, less than 1% of bird flights were close enough to the turbines to be at risk. This is graphically shown in Figure 1, where black lines represent bird flights, and red dots represent the position of turbines. It is clear that the birds avoided the turbines effectively (Desholm & Kahlert 2005).

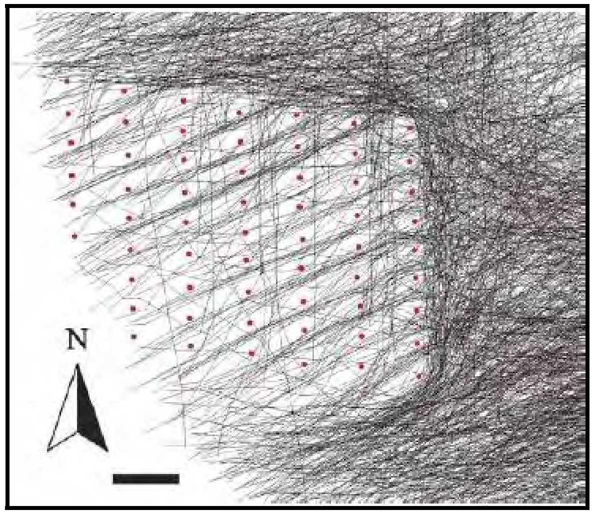

Figure 1 - Radar tracked movement of ducks and geese relative to an offshore wind facility in Denmark (Scale bar = 1000m (Desholm & Kahlert 2005))

Site information

Landscape features can potentially channel or funnel birds towards a certain area, and in the case of raptors, influence their flight and foraging behaviour. Elevation, ridges and slopes are all important factors in determining the extent to which an area is used by birds in flight. High levels of prey will attract raptors, increasing the time spent hunting, and as a result reducing the time spent being observant. At Mountaineer Wind Energy Centre in Tucker County (USA), 30 songbirds collided unexpectedly with a turbine during thick fog conditions in May 2003 (Cumberland Times). Very few collisions had been recorded prior to this weather incident. Birds fly lower during strong headwinds (Hanowski & Hawrot 2000; Richardson 2000; pers. obs.). This means that, when the turbines are functioning at their maximum speed, birds are likely to be flying at their lowest – a perilous combination.

Facility information

According to Kingsley & Whittam (2005), “More turbines will result in more collisions”. Although only two mortalities have been recorded at Klipheuwel, the difference between the three turbines at Klipheuwel and a potential 10 turbines at the proposed wind energy facility is substantial. Larger facilities also have greater potential for disturbance and habitat destruction.

To date it has been shown that large turbines kill the same number of birds as smaller ones (Howell 1995; Erickson *et al.* 1999). With newer technology and larger turbines, fewer turbines are needed for the same quantity of power generation, possibly resulting in less mortalities per KW of power produced (Erickson *et al.* 1999). Figure 2 below shows the development of turbine size over the years.

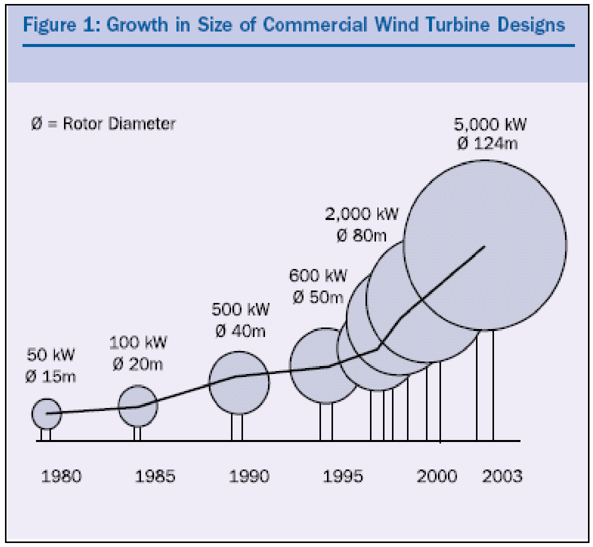

Figure 2 - The development of turbine size since the 1980's – European Wind Energy Association (EWEA)

Certain turbine tower structures may provide suitable perching space to certain bird species, thereby increasing the chances of collisions as birds leave or enter the perch. It is anticipated that tubular towers will be used for the proposed Port Elizabeth wind energy facility. Tubular towers will not provide very desirable perching space as they are relatively smooth and rounded.

Lighting of turbines and other infrastructure has the potential to attract birds, thereby increasing the risk of collisions with turbines. In Sweden a large number of collisions were recorded with one turbine in one night. The turbine was not operational, but was lit (Karlsson 1983: in Winkelman 1995). At the Mountaineer site mentioned above, all collisions occurred on the three turbines closest to the substation (which was lit with a solid white light). No collisions occurred on any of the other 12 turbines which were lit with red strobe lights. The theory behind the relationship between lights and the number of collisions is that nocturnal migrants navigate using stars, and mistake lights for stars (Kemper 1964). Another partial explanation may be that lights attract insects which in turn attract birds. Changing constant lighting to intermittent lighting has been shown to reduce attraction (Richardson 2000) and mortality (APLIC 1994; Jaroslow 1979; Weir 1976) and changing white flood light to red flood light resulted in an 80% reduction in mortality (Weir 1976). Erickson *et al.* (2001) suggest that lighting is the single most critical attractant leading to collisions with tall structures.

One of the reasons suggested for bird collisions with turbine blades is 'motion smear' or retinal blur, terms used to describe the phenomenon whereby rapidly moving objects become less visible the closer the eye is to them. The retinal image can only be processed up to a certain speed, after which the image cannot be perceived. It stands to reason then that the slower the blades move, the less motion smear – and this should translate into less collisions.

Interestingly, it is believed that at night there is no difference between a moving blade and a stationary one in terms of number of collisions (Kingsley & Whittam 2005).

Infrastructure associated with the facility often also impacts on birds. Overhead power lines pose a collision and possibly an electrocution threat to certain bird species. Furthermore, the construction and maintenance of the power lines will result in some disturbance and habitat destruction. New access roads constructed will also have a disturbance and habitat destruction impact.

Collisions are one of the biggest single threats posed by overhead power lines to birds in southern Africa (van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds. These species are mostly heavy-bodied birds with limited maneuverability, which makes it difficult for them to take the necessary evasive action to avoid colliding with power lines (Anderson 2001; van Rooyen 2004). Unfortunately, many of the collision sensitive species are considered threatened in southern Africa. The Red List species vulnerable to power line collisions are generally long living, slow reproducing species under natural conditions. Some require very specific conditions for breeding, resulting in very few successful breeding attempts, or breeding might be restricted to very small areas. These species have not evolved to cope with high adult mortality, with the result that consistent high adult mortality over an extensive period could have a serious effect on a population's ability to sustain itself in the long or even medium term.

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004). The electrocution risk of the proposed 132kV line can only be assessed once the tower structure to be used is known. Species that could be impacted upon include herons and some large eagles (non Red List species).

During the construction phase and maintenance of power lines and substations, some habitat destruction and alteration inevitably takes place. This happens with the construction of access roads, the clearing of servitudes and the leveling of substation yards. Servitudes have to be cleared of excess vegetation at regular intervals in order to allow access to the line for maintenance, to prevent vegetation from intruding into the legally prescribed clearance gap between the ground and the conductors and to minimise the risk of fire under the line which can result in electrical flashovers. These activities have an impact on birds breeding, foraging and roosting in or in close proximity to the servitude, through the modification of habitat.

During the construction and maintenance of electrical infrastructure, a certain amount of disturbance results. For shy, sensitive species this can impact on their usual daily activities, particularly whilst breeding.

Spacing between turbines at a wind facility can have an effect on the number of collisions. Some authors have suggested that paths need to be left between turbines so that birds can move along these paths. For optimal wind generation, relatively large spaces are generally required between turbines in order to avoid wake and turbulence effects.

Extending the literature review to look at the international experience in terms of the different broad groupings of species, and their vulnerability, reveals that very few collisions have been recorded relating to water birds, water fowl, owls and shorebirds. The majority of bird mortalities at Altamont Pass were raptors, however, in the USA outside of California raptors only accounted for 2.7% of mortalities (Erickson *et al.* 2001; Kerlinger 2001). Songbirds comprise 78% of fatalities in the USA (Erickson *et al.* 2001). A group of species particularly at risk is grassland species with aerial courtship displays – such as the Horned Lark in the USA (Kerlinger & Dowdell 2003). Interestingly, at the Klipheuwel demonstration facility, a pair of Blue Cranes was recorded to breed within close proximity (400m) of the facility in 2003 (Ian Smit, pers. comm.; Kuyler 2004).

4.1.2. Potential explanations for collisions of birds with turbines:

The three main hypotheses proposed for birds not seeing turbine blades are as follows (Hodos 2002):

- An inability to divide attention between prey and obstacles. This seems an unlikely explanation as birds have been found to maintain good acuity in the peripheral vision, have different foveal regions in the eye for frontal and ground vision and they have various other optical methods for keeping objects at different distances simultaneously in focus.
- The phenomenon of motion smear or retinal blur, explained earlier in this report.
- The angle of approach. If a bird approaches from side on to the turbine, the blades present a very small profile and are even more difficult to detect.

Mitigation measures should therefore focus on solving the problem of motion smear both from front and side angles.

4.1.3. Mitigation measures

Whilst bird mortalities have been comprehensively documented at numerous sites world-wide, very little has been written about the potential methods of reducing the level of mortalities. The following is a brief discussion of several forms of mitigation that have been either tested or merely suggested:

Turbine design

Several different turbine designs exist, apart from the conventional three blade design, and are potentially of less threat to avifauna. These turbines turn in the wind on the same plane as the tower as opposed to the three bladed design which turns at right angles to the tower. Another important aspect is that some of these designs are a solid mass and thus not having the gaps between the blades should be more visible to birds and hence result in fewer collisions.

Example of a potentially safe design can be seen in Figures 3 and 4 below:

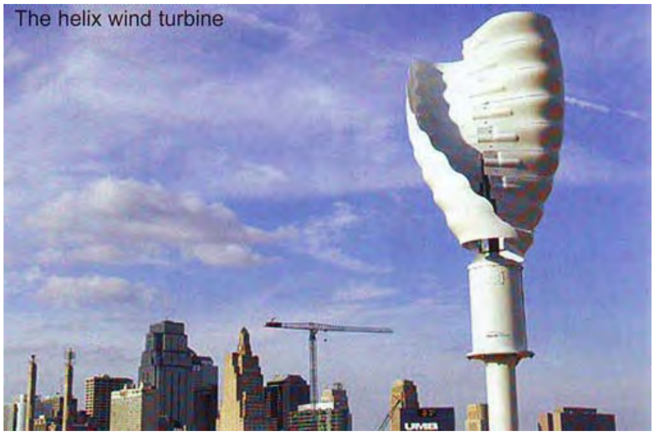

Figure 3 - The bird friendly Helix wind turbine

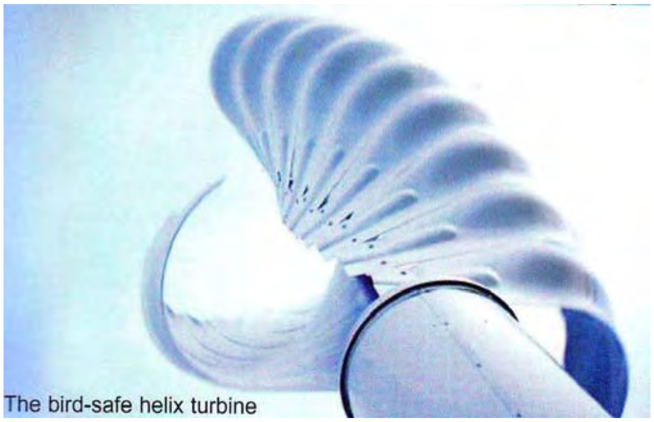

Figure 4 - Close up view of the bird friendly Helix wind *turbine*

Painting turbines

Dr Hugh McIsaac and colleagues studied visual acuity in raptors (American Kestrels) using laboratory based behavioural testing methods (McIsaac 2001). Key findings from their studies include the following:

- Acuity of kestrels appears 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 stimulus significantly influences kestrel acuity. Kestrels may be unable to resolve all portions of turbine blades under some conditions such as blade rotation, low contrast of blade with background and dim illumination.
- Results suggest that careful selection of blade pattern will increase conspicuity. Blade patterns that were proven to be conspicuous to humans also proved to be conspicuous to kestrels. Patterns across the blade produce better conspicuity in humans and kestrels than patterns down the length of blades. These authors recommend a pattern of square wave black and white components that run across the blade width.

Hodos (2002) also studied acuity in American Kestrels in laboratory conditions using electrode implants in the retinas of the birds to record the pattern electroretinogram (Hodos 2002):

- A solution to motion smear, is to maximise the time between successive stimulation of the same retinal region. Applying the same pattern to each blade does not achieve this. Each blade should have a different pattern so that a pattern on one blade is not repeated in the same position on another blade. This would have the effect of almost tripling the time between stimulations of the same retinal region.
- Various laboratory-based testing of seven blade patterns led to the conclusion that the most visible blade pattern across the widest variety of backgrounds were the single black blade pattern and the black thin stripe pattern staggered across the three blades. Since the single black blade pattern has the advantage of being easier and cheaper to implement, it is recommended for use by Hodos (2002).

Unfortunately these tests (and the above by McIsaac) confirm only that the blades will be more visible if painted. They do not test what the psychological response of birds to the blades will be. Birds may be scared and repelled from the blades, or may be curious and be attracted closer. Only field testing can confirm these responses. To date these issues have not been tested in the field to the knowledge of this author.

Anti perching devices

Perching on turbines has been implicated in increasing collision rates, although this may have been predominantly on lattice type towers and not tubular towers.

Construction of pylons:

It has been suggested (but not tested) that building pylons around the line of turbines would reduce the number of collisions as birds would be forced around the turbines. In other words a line of pylons could serve as a shield to the turbines. This is not considered a realistic option and is not discussed further.

Summary of the main points from the above literature review:

- With a few exceptions (such as at Altamont Pass and Tarifa), studies have found low numbers of bird mortalities at wind facilities.
- There is a huge variance in mortality between sites, and even between individual turbines within sites.
- The majority of collisions seem to involve raptors and/or songbirds.
- At the Klipheuwel site, monitoring for eight months revealed two mortalities, a Horus Swift and a Thick-billed Lark (now named Large-billed Lark). The lark mortality is in accordance with literature which states that grassland species with aerial courtship displays (such as larks, many of which perform aerial displays) are particularly vulnerable to collisions.
- Factors affecting the number of mortalities at a facility include: bird species present, prey abundance, landscape features, weather, number of turbines, turbine size, turbine spacing and facility lighting.
- Associated infrastructure such as power lines etc. also impact on birds.
- It appears that intermittent lighting may be less attractive than continuous lighting, and that possibly red light is less attractive than white light.
- The primary explanation for collisions appears to be the phenomenon of motion smear or retinal blur. Mitigation measures should therefore focus on reducing motion smear effects.
- In laboratory testing, two studies have found that painting turbine blades increases their visibility to American Kestrels. The most visible patterns appear to be black stripes across the blade, in different positions on each blade so as to reduce retinal blur or motion smear or more simply a single solid black blade with two solid white blades. Unfortunately these tests confirm only that the blades will be more visible if painted. They do not test what the psychological response of birds to the blades will be. Birds may be scared and repelled from the blades, or may be curious and be attracted closer. Only field testing can confirm these responses. We are not aware of any field testing of these blades to date.

4.2 Background to interactions between wind energy facilities and bats

The following section provides a background to bat - wind energy facility interactions. It is critical to understand the various issues and factors at play, before an accurate assessment of the impacts of the proposed wind energy facility on the bats of the area can be conducted. By necessity, the following description is based almost entirely on international literature, primarily from the United States of America (USA), Canada and Europe. In reality the South African experience of wind energy generation has been extremely limited to date. Most of the principles that have been learnt internationally can, to a certain extent, be applied locally. However, care needs to be taken to adapt existing international knowledge to local bat species and conditions.

The issue of bats and wind turbines has been widely covered in the media, with most articles referencing a few groundbreaking studies. It is recommended that, due to the studies being carried out in countries other than South Africa, the information should be used with some degree of caution.

This section focuses largely on the impact of wind turbines on bats, particularly with regards to barotrauma (defined by Wikipedia as *the physical damage to body tissues caused by a difference in pressure between an airspace inside or beside the body and the surrounding fluid*), and echolocation.

Concern for the impacts of wind energy facilities on bats has only been recognised as a concern in recent years. Most research has focused on bird mortalities but according to Baerwald *et al*. (2009), investigations revealed that bat fatalities outnumber those of birds. This discovery led to research programmes being conducted into the cause of death, what was attracting the bats to the sites, species concerned, and environmental factors associated with the presence of bats (e.g. pressure, time of year, time of night, wind speed, wind direction and temperature).

Although bats are true mammals, they show a number of unique characteristics when it comes to breeding, and are the slowest reproducing mammal for their size. Many of these are associated with the demands of hibernation which can cause disruptions in the reproductive process. The gestation period of bats found in the southern African region varies from 60 days to about eight months in those species exhibiting delays in the development of the embryo. The females of most bat species give birth to only one young at a time, although twins and occasionally triplets have occasionally been recorded. Females may be at least two to three years old before they begin breeding. The slow reproductive rate of bats, coupled with high infant mortality (around 70% of young bats die in their first year) makes any mortality an issue of concern as the bats will be slow to recover from such losses (Taylor 2000).

The mortality rates recorded at wind farms include the studies as presented in Table 2.

Table 2 – Mortality rates recorded at wind farms

Region	Bat mortality per year
Castle River, AB	1.6 in 2003
McBride Lake, AB	0.9 in 2004
Summerview, AB	9.2 in 2005
Buffalo Ridge, MN	0.3 in Phase I, 2.7 in Phase II
Top of Iowa	7.1 in 2003, 10.2 in 2004
Foote Ck. Rim, WY	2.0
Pacific Northwest	1.7
Buffalo Mt., TN	42.4 (0.66MW turbines) and 38.7 (1.8MW turbines)
Meyersdale	15.3 in 6 weeks
Mountaineer	32 in 2003; 25.3 in 6 weeks in 2004

Source: Arnett (2006)

4.1.1. Factors influencing bat collisions with turbines

A number of factors influence the number of bats killed at wind farms. These can be classified into three broad groupings: bat related information; site related information and facility related information.

Bat related information

Nearly every wind facility in North America have recorded bat deaths, some reporting thousands of deaths per year (Cryan undated). The most well known study was carried out by Baerwald and colleagues who reported that only approximately half the dead bats found near the wind turbines in Alberta, Canada showed any physical evidence of being hit by a blade. Of these 90% showed signs of internal hemorrhaging (Handwerk 2008). A study in Pennsylvania and West Virginia, USA, in 2004 showed the death of 1764 and 2900 bats respectively (Choi 2009).

Wind turbines cause local changes in air pressure. While bats are able to detect the relatively slow pressure changes caused by approaching storms, they are not able to detect the sudden drops in pressure caused by wind turbines. These sudden pressure changes cause the rapid expansion of the lungs and the bursting of the fine capillaries around the edges of the lungs, leading to the death of the bat, a process known as 'barotrauma' (Handwerk 2008).

The US National Research Council published the results of a study in May 2007 which revealed that two species of bats accounted for 60% of the winged animals found dead at wind farms. These two species of bats are both migratory species and tree roosting species (Brahic 2008). In addition, most of the deaths were recorded during the autumn migration period and when mating takes place (Cryan undated). An additional theory states that during the migration and mating period, when the bats are not feeding, they may turn off their echolocation systems in order to conserve energy resources (Sagrillo 2003).

Site information

Landscape features can potentially channel or funnel bats towards a certain area. The majority of bats found in the area feed along the coast or forest edges, not on ridge tops. Studies conducted in Indiana, USA, revealed that during the summer, bats forage in riparian areas, bottomlands, old fields and pastures with scattered trees. Winter roosts, often used for hibernation, may take bats closer to wind farms as their movement patterns change. Bats are known to use topographical features such as ridges to navigate during their migrations. In addition, they may use these features as temporary roosts, foraging areas and shortcuts (Anon. undated).

Facility information

According to Professor Barclay of the University of Calgary, Canada, studies are needed regarding the suitability of different wind turbine styles in terms of reducing bat deaths (Anon. 2009).

4.1.2. Potential explanations for bat mortalities resulting from wind farms:

The three main hypotheses proposed for bat mortalities associated with wind farms are as follows:

- Barotrauma – the sudden drop in air pressure at wind farms causes a bats' lungs to expand and the death of the bat (Handwerk 2008).
- Changes in flight patterns – these may be caused by the use of topographical features to migrate, mating behaviour, and the turning off of echolocation systems (Cryan undated).
- Collision – a small percentage of the dead bats found show signs of physical injury resulting from collision from the blades of wind turbines (Handwerk 2008).

Mitigation measures should therefore focus on preventing barotraumas, and siting the turbines correctly.

4.1.3. Mitigation measures

Wind energy is considered to be a form of green energy. As such it relies on its reputation as a source of energy with a low environmental impact and the loss of bats can negate this advantage (Anon. undated). As barotrauma is the number one cause of death of bats at wind farms, mitigation measures must be aimed at reducing the possibility of bats experiencing sudden drops in wind pressure.

Turbine operation

Research has shown that most of the bat deaths occur during periods of low wind speeds (Baerwald *et al*. 2009). Tests have been conducted regarding raising the minimum wind speed needed to operate the wind turbines and results are indicating that this may be a promising solution. By not operating the wind turbines at low wind speeds the number of bat deaths has decreased by as much as 60% (Baerwald *et al*. 2009; Brahic 2008). Reduction in bat presence by 53-87% have been reported using this technique (Anon. 2008). Bats generally feed during periods of low wind, preferring not to fly during high wind which is when the wind turbines are most effective in generating power.

The loss in revenue as the 15 turbines at the TransAlta facility in Canada was reported to be between $3,000 and $4,000 over the one-month study period (Baerwald *et al*. 2009). Similar tests have been carried out at other facilities in Canada but cost-benefit tests are still being looked at (Baerwald *et al*. 2009).

Noise generators

In an attempt to keep bats away from wind farms, experiments with white noise generators known as ‘acoustic scarecrows’ have been tested. Results have not proved promising and it has been thought that this is related to the fact that sound systems are not strong enough to influence the bats over the entire area covered by the wind farm (Choi 2009).

Studies carried out over ponds have shown that ultrasound does deter bats. While bats were shown to not become habituated to the ultrasound, the trials did reveal that the bats may learn from the experience and avoid wind turbines that do not emit ultrasound. This remains unproven though. One of the big disadvantages of this technique is that the range of emission from an ultrasound device is limited (the device used in trials was limited to 12-15 m) (Szewczak & Arnett 2008).

Wind turbines emit acoustics that are both below and above the human auditory range of a 20 kHz maximum. Tests carried out on the effects of ultrasound noise on bats have revealed that wind turbines do emit sounds at the 20, 30 and 40 kHz range – all of which fall within the range of calls made by bats found in the area. This test was only conducted on the 1.5 MW NEG Micron turbines and results could be different on other turbines (Szewczak & Arnett 2006).

Radar systems

Bats have been noted to avoid radar installations and for this reason the use of radars at wind farms was tested as a bat deterring device. Bats are well known for their ability to echolocate when feeding and navigating – a system which makes use of sound waves. Radars, however, use radio waves, a form of light. Researchers from the University of Aberdeen tested the use of radars at 20 bat foraging sites in Scotland along woodlands and riverbank areas where insect densities are high. The results of the study showed that radars reduced bat activity by 30-40% but did not affect the presence of insects. It is thought that the radars work by emitting small but rapid spikes of heat in the head that generate sound waves. In turn, these stimulate the ears. As bat hearing is more sensitive than human, even a tiny amount of sound will affect the presence of bats (Choi 2009).

4.3. Description of the proposed wind energy facility

The proposed activity is the establishment of a wind energy facility and associated infrastructure consisting of the following:

- 10 x Wind Turbines
- Power line to link the facility into the existing network (no details on size available).
- Possible substation on the wind farm site (no details on size available).

The locations of these sites are shown in Figure 5.

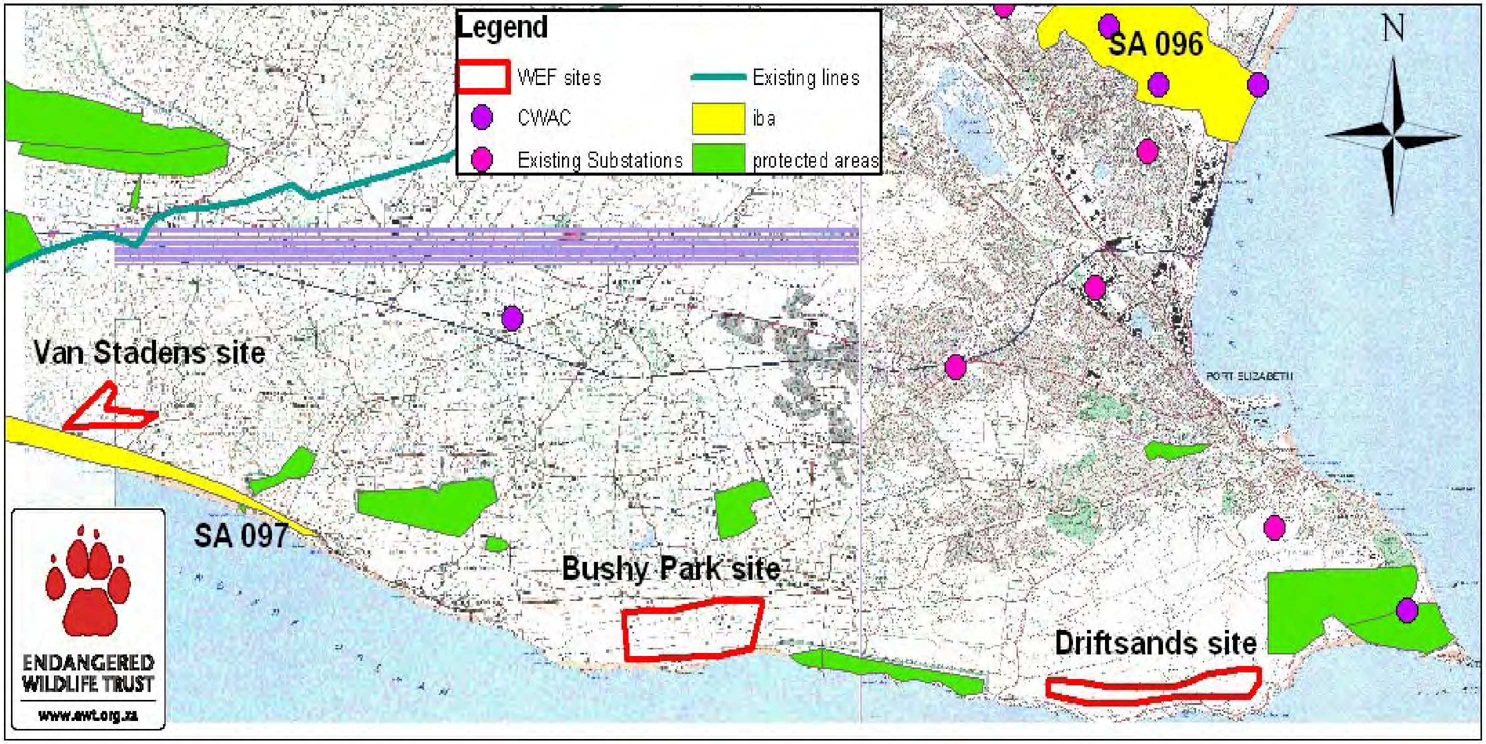

Figure 5 - Layout of the study area showing the three proposed sites for the wind farm as well as existing infrastructure and important areas for avifauna. (CWAC= Co-ordinated Water bird Avifaunal Count; IBA= Important Bird Area)

5. DESCRIPTION OF AFFECTED ENVIRONMENT

5.1 Land cover and vegetation of the study area

The area was assessed using CSIR's land cover data to determine what land cover and land covers were present in and around the three alternative sites. Land cover is seen as more valuable to avifaunal and bat assessments than vegetation type as birds and bats are mobile and the land cover data allows an assessment of the presence or absence of various land cover types that may attract birds and bats. These are further discussed under micro habitats below but can be seen at a broader scale on the following map (Figure 6).

The vegetation of the area was also assessed and used to determine the presence or absence of suitable habitat for the bird species recorded by the SABAP and the bat species likely to occur in the area. Table 3 in the report gives the most preferred habitat of each species and this has been assessed on the vegetation map to determine the likelihood of occurrence (last column in table). The vegetation map can be seen below (Figure 7).

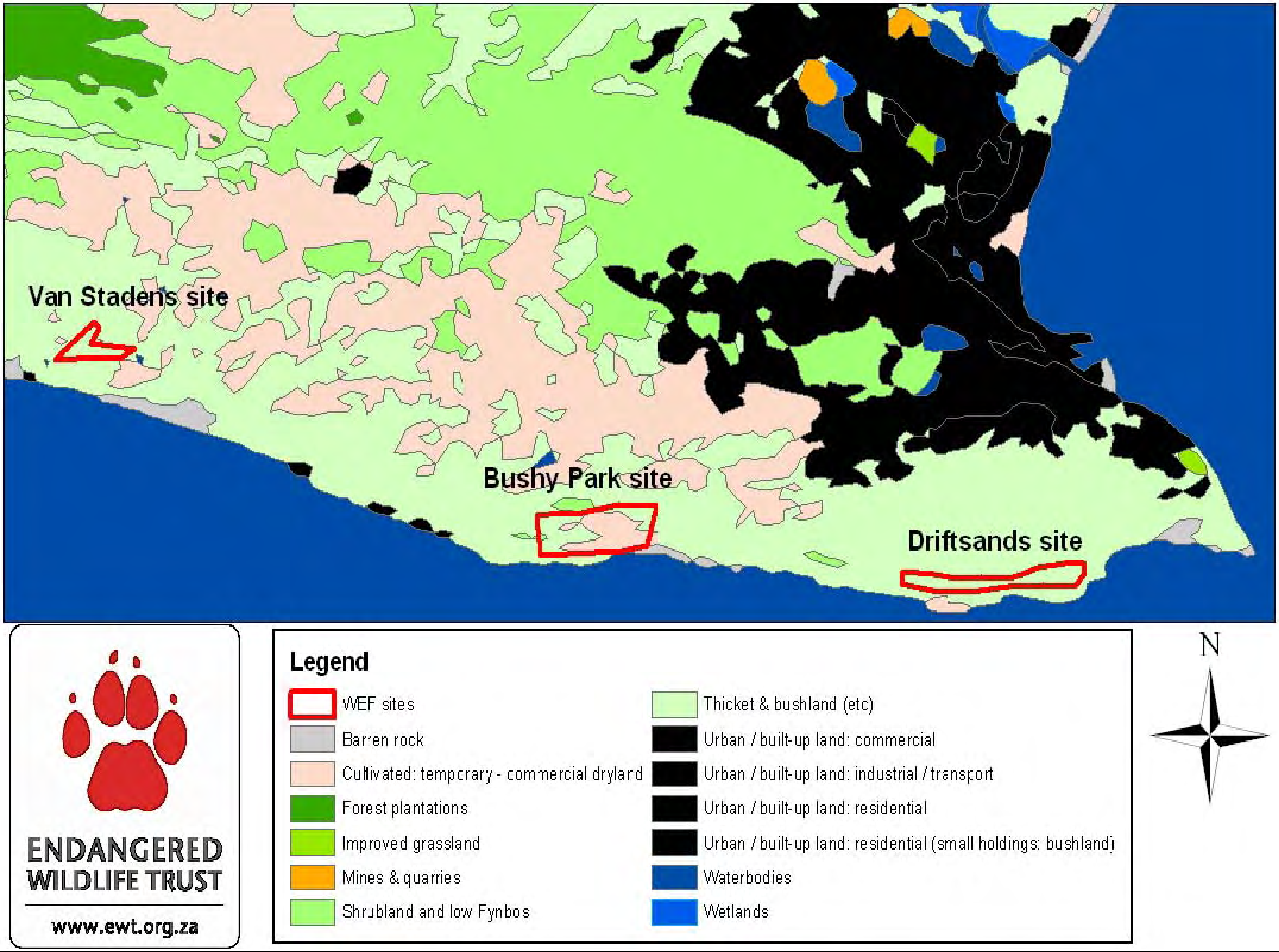

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Figure 6 - Land cover data for the study area (CSIR)

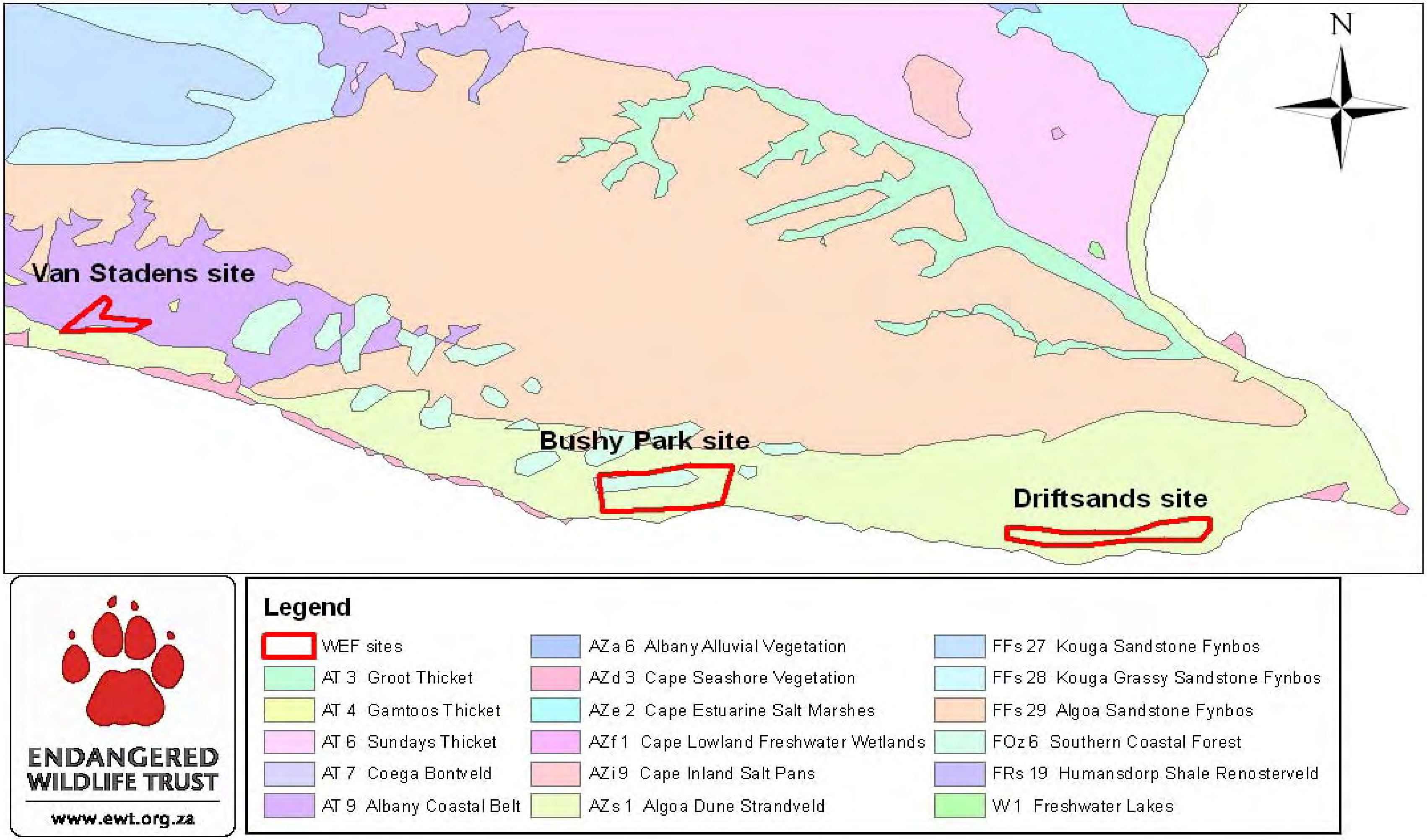

Figure 7 - Vegetation classification and the three alternative sites (Mucina and Rutherford, 2006)

The majority of the affected farms occur in thicket and bushland as well as cultivated-temporary commercial dryland, shrubland and low fynbos. From a vegetation classification the majority of the land is Algoa Dune Strandveld, Southern Coastal forest, Albany Coastal belt, Algoa Sandstone Fynbos and Cape Seashore vegetation. This data has been used to assess the likelihood of occurrence of the various species in Table 3.

5.2 Bird micro habitats

The above vegetation description partially helps describe the species likely to occur in the study area. However, more detail is required in order to understand exactly where within the study area certain species will occur. These “micro” habitats are formed by a combination of factors such as vegetation, land cover, and others. These micro habitats will be critically important in siting the proposed turbines within the affected farms. The following micro habitats are evident:

Wetland: Wetlands are characterized by slow flowing water and tall emergent vegetation, and provide habitat for many water birds. The conservation status of many of the bird species that are dependant on wetlands reflects the critical status of wetlands nationally, with many having already been destroyed. There is evidence of at least one wetland in and around the Driftsands site.

Dams: Many thousands of earthen and other dams exist in the southern African landscape. Whilst dams have altered flow patterns of streams and rivers, and affected many bird species detrimentally, a number of species have benefited from their construction. The construction of these dams has probably resulted in a range expansion for many water bird species that were formerly restricted to areas of higher rainfall. These include the pelicans, darters and cormorants. Many species from these families occur in this study area. Dams may be used as roost sites by flocks of Blue Cranes and other species. This has serious implications for Blue Crane interaction with vertical structures such as wind turbines, as they leave the roost in the early morning during low light conditions, and arrive at the roost in the late evening, again during low light conditions. The dam pictured below is found approximately two kilometres north of the Bushy Park site.

Rivers: Rivers can be very important micro habitats for birds as well as important flight paths, with many bird species flying along the river course. In this study area two rivers exist and these are the Van Stadens river, which is found in close proximity to the most western wind farm alternative (Van Stadens site); and the Maitland river, which is found in between the Van Stadens site and the Bushy Park site.

Arable or cultivated land: These areas represent significant feeding areas for many bird species in any landscape for the following reasons: through opening up the soil surface, land preparation makes many insects, seeds, bulbs and other food sources suddenly accessible to birds and other predators; the crop or pasture plants cultivated are often eaten themselves by birds, or attract insects which are in turn eaten by birds; during the dry season arable lands often represent the only green or attractive food sources in an otherwise dry landscape. In this study area arable lands take the form of pastures for grazing of dairy cows (commercially and part time). This attracts certain species as shown in Table 3. In particular the White Stork has a high affinity with arable lands, with 86% of sightings in South Africa recorded on arable lands (Allan 1985; Allan 1989; Allan 1997 in Hockey *et al*. 2005).

Rubbish dumping site: The Arlington waste disposal site is located in close proximity to the Driftsands site and can be seen below. While this is a very disturbed and degraded area, as can be expected, it does attract certain bird species that would thus be at risk of collision with the wind turbines. These species include herons, ibises, and some other non red data list species.

Thicket: Various sites have thicket vegetation and the important areas are where this thicket vegetation meets open grassland and pastures. This is evident on both the Bushy Park site and the Van Stadens site. These areas would be important for large terrestrial bird species as the thickets are difficult to move through and so these species will move along the edges of this vegetation.

Exotic Species: Certain areas in the area are heavily infested with exotic vegetation, for example Port Jackson. While normally of little conservation concern this vegetation can provide habitat for certain bird species and thus can be important for these species.

Coastal zone: The coastal zone is another very important area and attracts a great number of species not found inland. These species include the terns, Cape Gannets, Great White Pelican, Cape Cormorant and African Black Oystercatcher. Cape Recife is an important area for these species and the bird species found here can be seen in the Appendix 1 from the CWAC counts.

Bats are broadly divided into two groups, insect- and fruit-eating bats. Fruit-eating bats are generally found in the warmer, eastern parts of the country where fruit trees, often of a commercial nature, are commonly found. Insect-eating bats, however, are found across the entire country, including the study site. It stands to reason then that anything that attracts insects is likely to attract bats in turn. Wetlands, pans, rivers, dumping sites, and animals such as cows and horses are all likely to attract both insects and bats and the presence of these features should be taken into account when considering the siting of wind turbines.

5.3 Bird and bat presence in the study area

5.3.1 Southern African Bird Atlas Project

Table 3 lists the Red List bird species recorded in the three quarter degree squares covering the study area (Figure 8 below) by the Southern African Bird Atlas Project (Harrison *et al.* 1997), i.e. 3325CC, 3325CD and 3325DC.

Report rates are essentially percentages of the number of times a species was recorded in the square, divided by the number of times that square was counted. It is important to note that these species were recorded in the entire quarter degree square in each case, and may not actually have been recorded on the proposed site for this study.

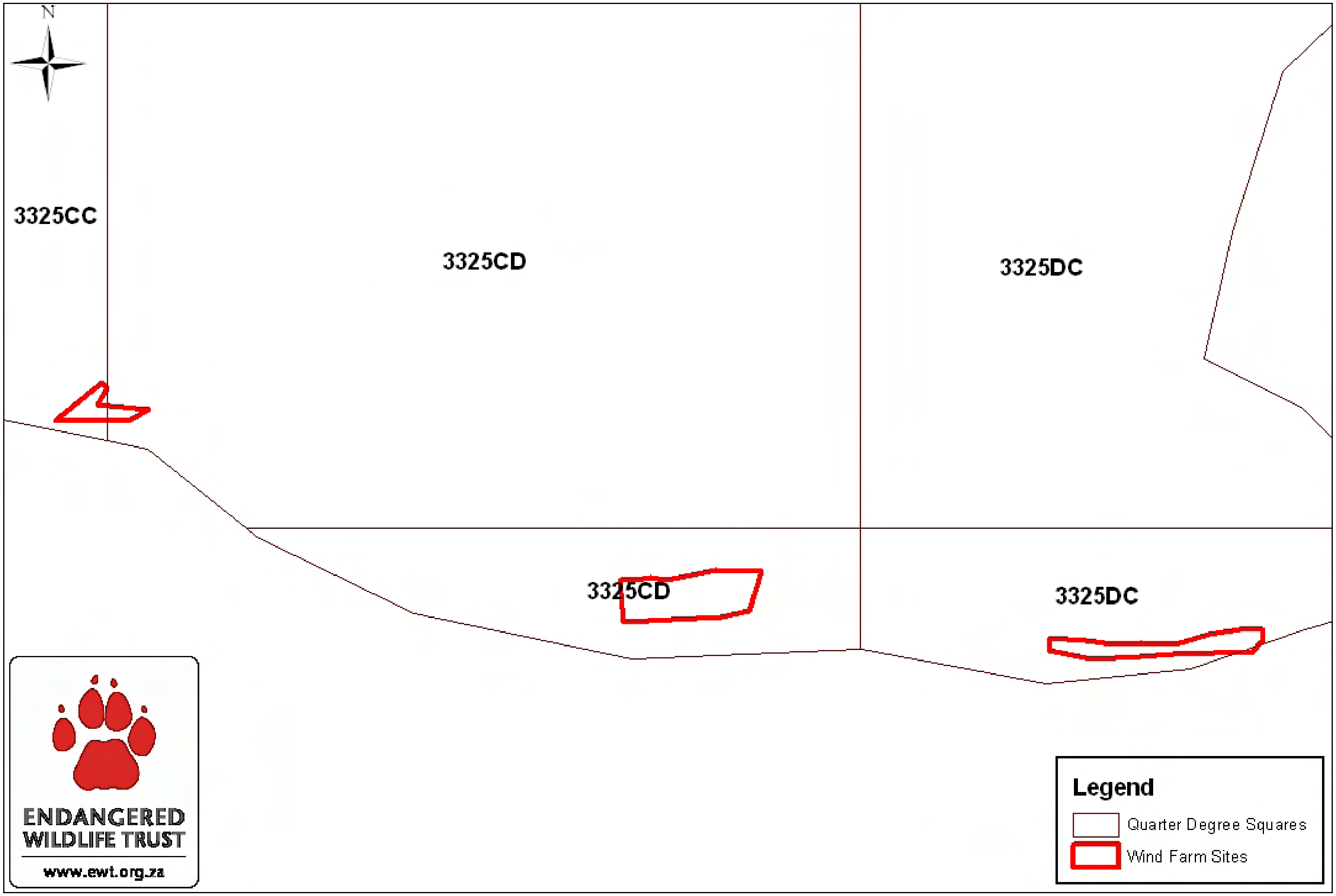

Figure 8- Relevant Quarter Degree Squares and the wind farm sites.

Table 3 – Red Data species recorded in the two quarter degree squares covering the study area (Harrison *et al.* 1997)

Total Cards		350	843	238		
Total Species		291	325	272		
Total Breeding Species		93	133	64		
Name	**Conservation status**	**3325CD**	**3325DC**	**3325CC**	**Habitat**	**Likelihood of occurrence**
Roseate Tern	EN	1	3	1	Coastal waters and offshore islands	Unlikely
Damara Tern	EN		1		Sandy marine shores, sheltered bays, lagoons, estuaries, open sandy flats inland from beach.	Unlikely
African Penguin	VU	0	5	0	Marine.	Unlikely
Shy Mollymawk	VU		0		Open ocean.	Unlikely
Cape Gannet	VU	13	18	3	Gregarious, plunging for fish in large flocks usually within sight of land. Hundreds of birds follow "sardine run" up KwaZulu-Natal coast in June and July each year. Roosts at sea or on breeding islands at night.	Possible
Cape Vulture	VU		0		Mostly mountainous country, or open country with inselbergs and escarpments; less commonly in savanna or desert	Unlikely
Martial Eagle	VU	0	0	4	Woodland, savanna or grassland with clumps of large trees or power pylons for nest sites.	Unlikely
African Marsh-Harrier	VU	4	2	1	Marsh, vlei, grassland (usually near water); may hunt over grassland, cultivated lands and open savanna	Possible
Lesser Kestrel	VU		0		Open grassveld, mainly on highveld, usually near towns or farms	Unlikely
Blue Crane	VU	1	2	0	Midland and highland grassveld, edge of karoo, cultivated land, edges of vleis.	Possible
Denham's Bustard	VU	3		2	Montane and highland grassveld, savanna, karoo scrub	Possible
Knysna Warbler	VU	2		1	Lowland and coastal evergreen forest with dense tangled undergrowth; also thickets in gullies and in riverine forest	Possible
Black-browed Mollymawk	NT		0		Open ocean.	Unlikely
Northern Giant Petrel	NT		0		Open ocean, sometimes inshore around harbours	Unlikely
White-chinned Petrel	NT		2		Open ocean and offshore waters	Unlikely
Great White Pelican	NT		0		Coastal bays, estuaries, lakes, larger pans and dams.	Unlikely
Cape Cormorant	NT	13	26	3	Coastal waters usually within 10 km of shore; also brackish estuaries.	Possible

Black Stork	NT	1	8	3	Feeds in or around marshes, dams, rivers and estuaries; breeds in mountainous regions	Possible
Yellow-billed Stork	NT		2		Mainly inland waters; rivers, dams, pans, floodplains, marshes; less often estuaries.	Unlikely
Greater Flamingo	NT	0	22		Large bodies of shallow water, both inland and coastal; saline and brackish waters preferred.	Possible
Lesser Flamingo	NT		14		Larger brackish or saline inland and coastal waters.	Possible
Secretarybird	NT	2	0	2	Semidesert, grassland, savanna, open woodland, farmland, mountain slopes	Unlikely
African Crowned Eagle	NT	1		21	Dense indigenous forest, including riverine gallery forest; may range far from forest to hunt	Possible
Pallid Harrier	NT	0			Open grassveld, cultivated fields; less commonly in open to semi-arid savanna (but more likely in arid areas than Montagu's Harrier).	Unlikely
Black Harrier	NT	3	1	5	Grassveld, karoo scrub, mountain fynbos, cultivated lands, subalpine vegetation, semidesert.	Possible
Peregrine Falcon	NT	0	2	3	Cliffs, mountains, steep gorges; may hunt over open grassland, farmland and forests; rarely enters cities to hunt pigeons	Unlikely
Lanner Falcon	NT	1	9	1	Mountains or open country from semidesert to woodland and agricultural land; also cities	Possible
Greater Painted-snipe	NT		0		Marshes, swamps, edges of lakes, dams, ponds and streams, with marginal vegetation	Unlikely
African Black Oystercatcher	NT	22	29	14	Rocky and sandy shores of mainland and coastal islands; less often coastal vleis and lagoons	Likely
Chestnut-banded Plover	NT		0	0	Saline lagoons, saline and brackish pans, saltworks; occasionally estuaries and sandy lagoons.	Unlikely
Black-winged Lapwing	NT	3	0	0	Open short grassland, fallow lands, pastures, airfields, playing fields, race courses	Possible
Black-tailed Godwit	NT		0		Dams, pans, marshes, tidal mudflats, larger rivers (Zambezi, Olifants).	Unlikely
Caspian Tern	NT	5	19	3	Estuaries, marine shores, larger inland dams and pans	Possible
Half-collared Kingfisher	NT	1	5	8	Fast-flowing perennial streams, rivers and estuaries, usually with dense marginal vegetation	Unlikely
Knysna Woodpecker	NT	2	5	5	Coastal and riverine bush, evergreen forest, denser thornveld, *Euphorbia* scrub	Possible
Bush Blackcap	NT		0		Evergreen mistbelt and montane forest and adjacent scrubby hillsides, especially with *Leucosidea* .	Unlikely
White Stork	Bonn	5	2	11	Highveld grasslands, mountain meadows, cultivated lands, marshes, karoo	Possible

EN=Endangered; NT=Near Threatened; VU=Vulnerable; Bonn=Protected under the Bonn Convention on Migratory Species.

5.3.2 Important Bird Areas (IBA's)

Two IBA's exist relevant to this study area, these are the SA097 Maitland-Gamtoos Coast IBA and the SA096 Swartkops Estuary, Redhouse and Chatty Saltpans IBA. These will be discussed further below:

SA097 Maitland-Gamtoos Coast- This IBA is a stretch of coastal dunefield 23 km in length and 0.75 km wide running from the Gamtoos River mouth to the Maitland River mouth.

This IBA holds approximately 4% of the global African Black Oystercatcher breeding population and is furthermore important breeding habitat for Damara Tern. The surrounding valley bushveld holds Southern Tchagara and Southern Grey Tit.

Importantly this IBA is situated approximately 200 meters from the Van Stadens Site.

SA096 Swartkops Estuary, Redhouse and Chatty Saltpans IBA- The Swartkops Estuary is located on the outskirts of Port Elizabeth, 15 km north of the harbor.

This IBA is an important area for water birds and on average hold 14 500 birds per year. There are up to 70 water bird species recorded on the site including the African Black Oystercatcher. Caspian Tern, Roseate Tern, Lesser Flamingo, Knysna Woodpecker, Black Stork, Greater Flamingo and Chestnut-banded Plover are other important species occurring on this site.

This IBA is north of all three sites but does represent a sensitive avifaunal area for the relevant species.

5.3.3 CWAC counts

CWAC counts are available for the following sites and are shown visually in Figure 5. These data can be found in Appendix 1.

- Fairview Racecourse
- Cape Recife
- Zwartkops River Estuary
- Chatty Saltpans

These data were used to confirm species presence and absence as well as to get an idea of the numbers of these water birds in the area. Cape Recife in particular is very important for water birds and is found in close proximity to the Driftsands site.

5.3.4 Protected areas

A number of protected areas exist in and around the proposed sites. These have all been identified and discussed in the discussion on the alternatives below. Generically these protected areas are sensitive bird areas as they provide suitable habitat and a protected environment for many species. An important factor to consider is birds flying between these protected areas and this has been taken into account when choosing the preferred site alternative.

5.3.5 Bat presence

According to Taylor (2000) the species of bats as presented in Table 4 are likely to be found in the area of the three proposed sites for the wind farm. Table 4 also provides details of the frequencies at which bat calls were recorded during the site visit, as well as which species these call frequencies could indicate as being present. Table 5 provides details of the habitat, feeding and roosting preferences of these species.

Table 4 – Bat species likely to be present at the study site as well as the call frequencies recorded during the site visit

Species	Scientific Name	Call Frequency (kHz)	Dominant Frequency (kHz)	Frequencies Recorded at Driftsands	Frequencies Recorded at Bushy Park (kHz)						Frequencies Recorded at Van Stadens
				(none)	**28**	**32**	**36**	**38**	**43**	**45**	**(none)**
Mauritian Tomb Bat	*Taphozous mauritianus*	10-16	13	X	X	X	X	X	X	X	X
Egyptian Free-tailed Bat	*Tadarida aegyptiaca*	20-27	22-24	X	✓	X	X	X	X	X	X
Schreiber's Long-fingered Bat	*Miniopterus schreibersii*	28-80	38-40	X	✓	✓	✓	✓	✓	✓	X
Long-tailed Greater Serotine Bat	*Eptesicus hottentotus*	20-54	28-32	X	✓	✓	✓	✓	✓	✓	X
Temminck's Hairy Bat	*Myotis tricolor*	33-86	50	X	X	X	✓	✓	✓	✓	X
Cape Serotine	*Pipistrellus capensis*	33-80	38-41	X	X	X	✓	✓	✓	✓	X
Yellow House Bat	*Scotophilus dinganii*	29-54	35	X	X	X	✓	✓	✓	✓	X
Lesser Woolly Bat	*Kerivoula lanosa*	(unknown)	(unknown)								
Common Slit-faced Bat	*Nycteris thebaica*	20-90	22, 44, 66	X	✓	✓	✓	✓	✓	✓	X
Cape Horseshoe Bat	*Rhinolophus capensis*	88-90		X	X	X	✓	X	X	✓	X
Geoffroy's Horseshoe	*Rhinolophus clivosus*	74-94		X	X	X	X	X	X	X	X

Table 5 – Bat species likely to be found at the three proposed sites with their preferred habitat, roost and food preferences

Species	Scientific Name	Conservation Status	Habitat	Roost	Food
Mauritian Tomb Bat	*Taphozous mauritianus*		Open savanna and forest edges in the wetter northern and eastern parts of the subcontinent	On outer bark of trees, under covering vegetation; under the eaves on the outer house walls	Feed in open spaces; Moth specialists with termites and butterflies occurring in their diet at lower frequency
Egyptian Free-tailed Bat	*Tadarida aegyptiaca*		All vegetation associations except forest, favours open country	Rock, tree and building crevices, behind the bark of dead trees	High aerial feeders; beetles and moths
Schreiber's Long-fingered Bat	*Miniopterus schreibersii*	Lower Risk (Near Threatened) Its survival depends on the availability of underground sites having a suitable warm moist microclimate for maternity colonies	Wide range of vegetation types, mostly restricted to lower-lying bushveld and coastal regions	Hollow-roosting: caves, disused water and railway tunnels and mine shafts, substantial cavities in rocks, bridges, dams walls and trees; cave-dwelling maternity colonies; may migrate distances of up to 260 km between roosts; use open outbuildings, garages and verandahs for temporary feeding shelters	Moths, flies and buds (De Hoop Cave, SA)
Long-tailed Greater Serotine Bat	*Eptesicus hottentotus*		Poorly known; often collected in mountainous or hilly areas, but also in savanna woodland and semi-arid	Caves, rocky crevices and mine tunnels	

Species	Scientific Name	Conservation Status	Habitat	Roost	Food
			conditions		
Temminck's Hairy Bat	*Myotis tricolor*		Savanna woodland, extending into more arid areas as well as mountainous areas in the Drakensberg	Caves, tunnels; often with Schreibers Long-fingered Bat; may migrate hundreds of kilometers between summer maternity caves and winter hibernating caves	
Cape Serotine	*Pipistrellus capensis*		Broad habitat tolerance from forest to deserts	Crevices in rocks, under the bark of trees, at the base of aloe leaves, frequently in roofs	Aerial 'woodland edge' feeders: beetles, lacewings, moths, bugs and flies
Yellow House Bat	*Scotophilus dinganii*		Savanna woodland and coastal forests, often associated with houses	Roofs of houses – between brickwork and rafters	Aerial 'intermediate clutter' feeder: Medium-sized beetles, bugs, flies, termites, moths and lacewings
Lesser Woolly Bat	*Kerivoula lanosa*		Riverine habitat in savanna woodland	Disused nests of Masked Weavers and a Scarlet-chested Sunbird	Slow fluttering flight, close to ground
Common Slit-faced Bat	*Nycteris thebaica*		Open savanna woodland, dense coastal forest	Hollow roosting: caves, mine adits, road culverts, tree hollows, aardvark holes; thatches hides and rondavels, open buildings	Forage close to the ground and in dense vegetation: predominantly gleaners but may feed aerially; non-flying arthropods, crickets and other noise-

Species	Scientific Name	Conservation Status	Habitat	Roost	Food
					producing insects; orthopteran insects (katydids, crickets, grasshoppers), spiders, beetles, cockroaches, moths and lacewings
Cape Horseshoe Bat	*Rhinolophus capensis*	Vulnerable (endemic to South Africa)	Coastal caves along the Eastern Cape and Western Cape	May roost with Geoffroy's Horseshoe Bat (separate clusters); small-scale migrations of 10 km have been noted; Caves and disused mines	Slow aerial 'clutter forager', 'perch-hunting', gleaning insects; beetles
Geoffroy's Horseshoe	*Rhinolophus clivosus*		Savanna woodland, deserts; Drakensberg grasslands when suitable rocky areas exist for roosting	Caves, disused mines and similar cavities during the day; trees, eaves and verandahs of buildings at night	Slow aerial 'clutter foragers' and 'perch hunters', possibly gleaners; beetles

6. ASSESSMENT OF IMPACTS OF PROPOSED FACILITY

6.1. Description and assessment of interactions between avifauna, bats and the proposed development

6.1.1. Wind energy facility

These have largely been summarized and discussed generically in Section 4.1 and 4.2 above. Each impact has been assessed in Tables 6 to 14 below

Table 6 - Collision of birds and bats with Wind Turbines at Driftsands site

Birds

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	3	3	7	Probable	High	-ve	Medium
With Mitigation	1	2	3	6	Probable	Medium	-ve	Medium

Bats

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	2	3	6	Probable	Medium	-ve	Low
With Mitigation	1	2	3	6	Probable	Medium	-ve	Low

Table 7 - Habitat destruction

Birds

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	2	2	5	Probable	Low	-ve	High
With Mitigation	1	1	2	4	Probable	Very Low	-ve	High

Bats

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	2	3	6	Probable	Medium	-ve	Low
With Mitigation	1	2	3	6	Probable	Medium	-ve	Low

Table 8 - Disturbance of birds and bats

Birds

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	1	3	5	Probable	Low	-ve	Medium
With Mitigation	1	1	3	5	Probable	Low	-ve	Medium

Bats

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	2	3	6	Probable	Medium	-ve	Medium
With Mitigation	1	2	3	6	Probable	Medium	-ve	Medium

Table 9 - Collision of birds and bats with Wind Turbines at Bushy Park site

Birds

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	2	3	6	Probable	Medium	-ve	Medium
With Mitigation	1	1	3	5	Possible	Very Low	-ve	Medium

Bats

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	2	3	6	Probable	Medium	-ve	High
With Mitigation	1	2	3	6	Probable	Medium	-ve	High

Table 10 - Habitat destruction

Birds

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	2	2	5	Probable	Low	-ve	High
With Mitigation	1	1	2	4	Probable	Very Low	-ve	High

Bats

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	2	3	6	Probable	Medium	-ve	Medium
With Mitigation	1	2	3	6	Probable	Medium	-ve	Medium

Table 11 - Disturbance of birds and bats

Birds

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	1	3	5	Probable	Low	-ve	Medium
With Mitigation	1	1	3	5	Probable	Low	-ve	Medium

Bats

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	2	3	6	Probable	Medium	-ve	Medium
With Mitigation	1	2	3	6	Probable	Medium	-ve	Medium

Table 12 - Collision of birds and bats with Wind Turbines at Van Staadens site

Birds

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	2	3	6	Probable	Medium	-ve	Medium
With Mitigation	1	1	3	5	Possible	Very Low	-ve	Medium

Bats

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	2	3	6	Probable	Medium	-ve	Low
With Mitigation	1	2	3	6	Probable	Medium	-ve	Low

Table 13 - Habitat destruction

Birds

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	2	2	5	Probable	Low	-ve	High
With Mitigation	1	1	2	4	Probable	Very Low	-ve	High

Bats

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	2	3	6	Probable	Medium	-ve	Low
With Mitigation	1	2	3	6	Probable	Medium	-ve	Low

Table 14 - Disturbance of birds and bats

Birds

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	1	3	5	Probable	Low	-ve	Medium
With Mitigation	1	1	3	5	Probable	Low	-ve	Medium

Bats

	Spatial Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without Mitigation	1	2	3	6	Probable	Medium	-ve	Low
With Mitigation	1	2	3	6	Probable	Medium	-ve	Low

Collisions with Turbines

As can be seen above, collisions have been rated as high significance without mitigation. This is mainly due to the presence of IBA's, the coastline, the protected areas and the birds that occur in these areas. One area of particular concern is the Driftsands site where birds may be crossing the peninsular in the Cape Recife area and thus come in close proximity to the turbines should they be positioned on this site. For this reason this site is the least preferred and should be discarded.

Standard mitigation measures should be put in place and this should decrease the significance of collision to low. These include painting the blades of the turbines as detailed in 4.1.3 above. The turbines should also not be lit if at all possible as this has been shown to attract birds to the area. If lights must be added these must only be red strobe lights.

One concerning factor is bad weather and should it be feasible the wind turbines should be stopped during severe wind conditions (this is often in the technical best interest as well and must be confirmed by the developer) as well as severe mist and cloud cover, where the visibility is severely restricted.

The importance of this risk has been rated as low for bats but it must be remembered that there is little to no experience to draw on with regards to studies conducted in South Africa. Insects, the primary food of bats, are generally attracted to lights and if lights are used at the facility, they should be of a colour and nature that does not attract insects.

One important factor to note is that these recommendations have been put forward from very limited experience (since South Africa does not have any operational commercial wind energy facilities) and it is **strongly advised that a monitoring program be put together once the site has been commissioned to monitor the impact of collision of bird and bat species**. This can be done in conjunction with the Nelson Mandela Metropolitan University (NMMU) and as such would be a good capacity building exercise.

Habitat Destruction

A project of this magnitude will have a certain amount of habitat destruction, even though the footprint of the turbines is relatively small. The expected impacts will come about from the building of access roads, the turbines themselves as well as the associated infrastructure.

The impact has been rated as low since the sites are mainly on transformed habitat and as long as environmental best practices are followed this impact is seen as acceptable. Wherever possible natural vegetation should be left intact and not cleared.

Although ranked as low, a reduction in habitat may mean a reduction in food supply for the bats and for this reason, careful consideration needs to be given to the siting of the wind turbines. Where whole patches of forest or shrub vegetation need to be removed, it should be taken into account that the bats which normally fed from those patches will have to move to other patches. In addition, species may start moving from one patch to another, possibly across open areas where the wind turbines are located, thus increasing their risk of collision with blades and their exposure to the drop in air pressure which may result in barotrauma. As many bat species feed long the edges of forest and shrub patches, these should be kept as contiguous as possible.

Disturbance of birds and bats

Again on a project such as this a certain amount of disturbance is expected during the construction and maintenance of the turbines and the associated infrastructure. If environmental best practices are followed and disturbance is kept to a minimum this will be an acceptable impact on the avifauna of the area.

This impact is ranked as medium for bats. Without appropriate mitigation measures, the likelihood of bats experiencing barotraumas is high. Every effort should be made to ensure that the wind turbines are not operational during night-time periods of low wind when the bats are most active.

6.1.2 Associated infrastructure

It is assumed for this project that in addition to the wind turbines a small substation as well as a power line would be required in order to link the turbines to the existing network. The exact nature of each of these however has not been provided. The impact of these has thus been discussed generically at this stage and is a limitation to this study.

Collision

Overhead power lines can have a huge impact on birds and thus collisions on additional power line could be a significant impact of this project. It is recommended that where possible the shortest line routing be used and in addition that any additional line be placed next to existing lines. Wetlands, dams, centre pivot irrigation, etc. must be avoided with the routing of the power line.

It is further suggested that a site specific EMP be done to further advise on the line routing once the site alternative has been chosen. In this way the impact can be managed and would be acceptable.

Electrocution

Electrocution may be possible on the power lines that link the turbines to the existing network as well as in the substation should one be required. The technical details of these have not been provided and thus an evaluation on electrocution could not be completed. This again could be looked at in the site specific EMP and the impacts mitigated as to make this impact acceptable.

Habitat Destruction

Habitat destruction is likely with the building of the new power lines as well as the substation. Should the route/site be carefully chosen however this is not seen as a significant impact. This can be further analysed during the EMP.

Disturbance

Disturbance would increase with the additional line and substation, however in the greater scheme of things this increase is likely to be minimal compared to the turbine building and maintenance and is thus seen as insignificant.

6.2. Comparison of Site Alternatives

There are three site alternatives for this project, Driftsands, Bushy Park and Van Stadens. These will be discussed further below and the evaluated in Table 15 with preference scores for each site.

Driftsands

- This is the most easterly alternative site and is situated just north of Marine Drive and just east of Victoria drive.
- The site is approximately 6.49 km long and 0.82 km wide at the widest point.
- The site is located in close proximity to Cape Recife and this is negative for avifauna as Cape Recife attracts many bird species putting them at risk of collision with the turbines.
- The site is situated close to the peninsular and this is negative for avifauna as coastal birds could be flying over the peninsular and would thus be at high risk of collision with the turbines.
- This site is situated between three protected areas, Cape Recife, NMMU nature reserve and Sardinia Bay nature reserve. This is negative for avifauna as these areas could provide refuge for a variety of bird species and as these species fly between the sites, they would be in the direct flight path of the wind turbines.
- During the site visit a wetland was observed in the middle of the Driftsands site, this is negative for avifauna as it would attract certain species, for example Yellow-billed Ducks, putting these species at risk of collision with the turbines.
- Although no bats were recorded at this site during the site visit, Taylor (2000) indicates that a number of bat species that favour low-lying bushveld and coastal regions occur in the area. This is a negative for the site being so close to the coast and so low in altitude.
- There are two caves nearby this site which are reported to have bats present in them. It was not possible to visit these sites during the site visit but such close proximity of roosting habitat is a negative for this site.

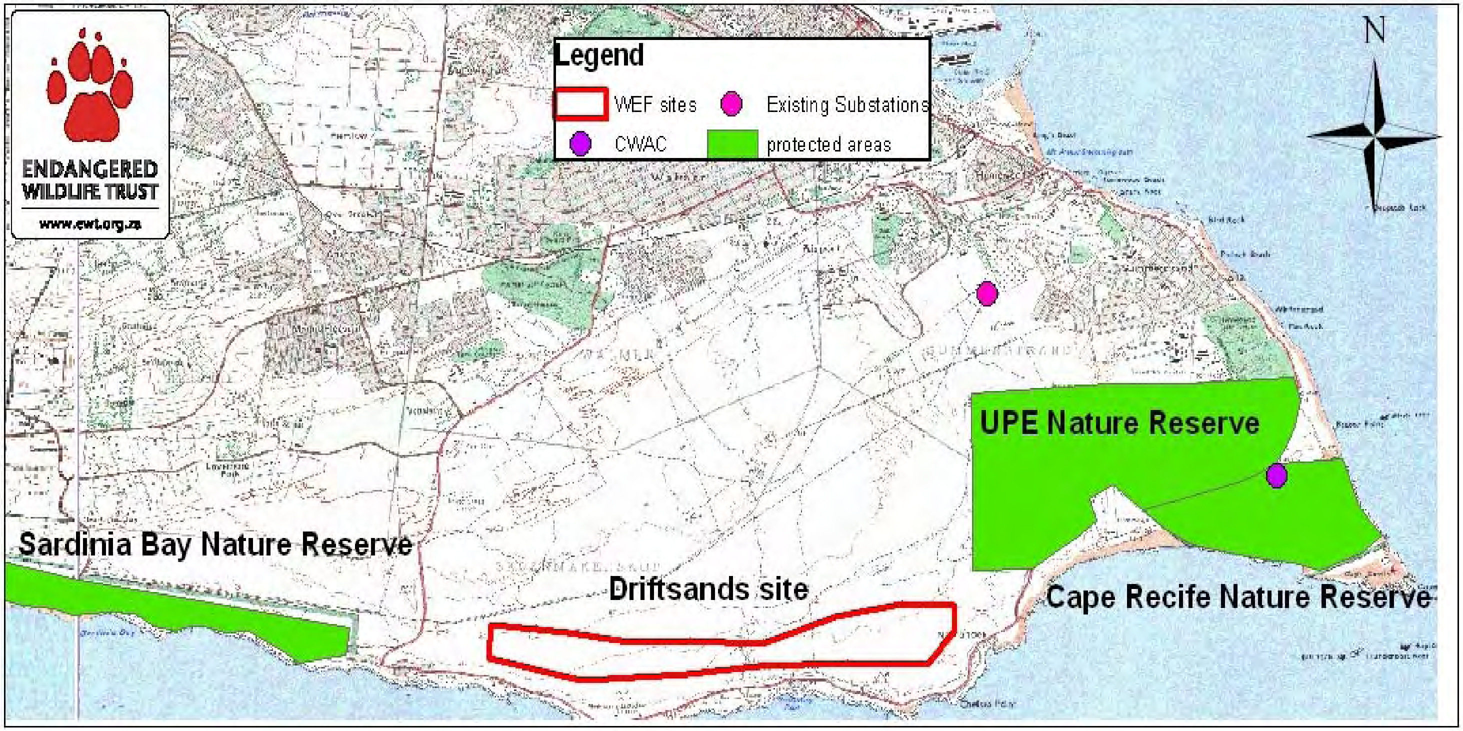

Figure 9 - Driftsands site showing various protected areas

Bushy Park

- This is the middle site alternative situated approximately 15 km south west of the Port Elizabeth CBD.
- The site is approximately 4 km long by 1.7 wide.
- The site is a commercial dairy farm and is transformed into pastures in the valleys. These pastures would attract certain species for example White Stork placing these birds at risk of collision with the turbines.
- This site is located between three protected areas, the Sardinia Bay nature reserve, Kragga Kama game park and Sea View game park. The Island nature reserve also exists on the western side of Sea View game park. All of these protected areas could be refuges for certain bird species, however only the Sardinia Bay nature reserve and The Island nature reserve would result in a flight path that could pose a risk for birds.
- The area is comprised of hill tops and valleys and specific turbine location would be important, a further reason for a site specific EMP.
- The frequency of bat calls recorded at this site during the field visit indicate that any of up to eight species may have been present at the site. Such biodiversity is a negative for the site.
- With its mosaic of habitat in terms of valleys, open grassland, and small forest patches indicates that this site provides the best foraging sites for the bat species likely to occur in the area. Furthermore, this site offers a range of suitable roosting sites including buildings, a nearby town with flowering trees and plants, and trees suitable for roosting in.

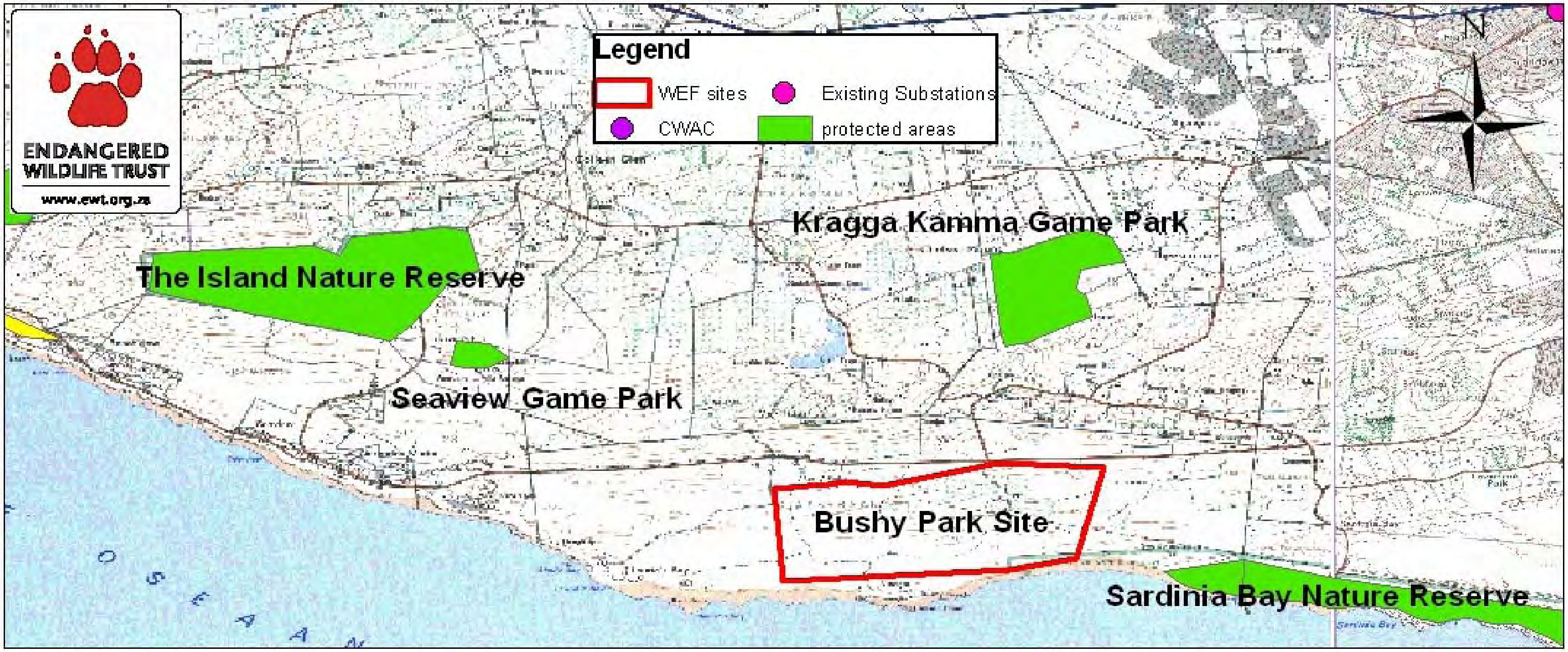

Figure 10 - Bushy Park site showing various protected areas

Van Stadens

- This is the most westerly site and is located approximately 30 km west south west of Port Elizabeth CBD.
- The site is an arrow head shape and is approximately 2.8 km long and 1.7 km wide.
- This site is located on the edge of the SA 097 IBA, which is negative for avifauna.
- This site would require a substantially longer power line (exact details are not yet available in terms of routing and power line type), this would be negative for avifauna as the longer line would pose additional risk to birds.
- Near to the Van Stadens river, this is negative for avifauna as many bird species may be attract to the river placing them at risk of collision with the wind turbines.
- The site is located west of three protected areas, Maitland nature reserve, The Island nature reserve and Seaview game reserve. This is negative for avifauna, however it is not envisaged that birds will fly from these sites near to the proposed development.
- No bats were recorded at this site during the site visit but this could be due to the inclement weather present at the time. Although no evidence indicating bat presence was found in the two buildings close to the proposed site of the wind turbines, this is still a negative for this site as these buildings could provide roosting habitat for bats.
- Although the proposed site is an open grassland, it is surrounded by forest patches. Bats feed along the edges of forest patches making their presence at the site feasible.

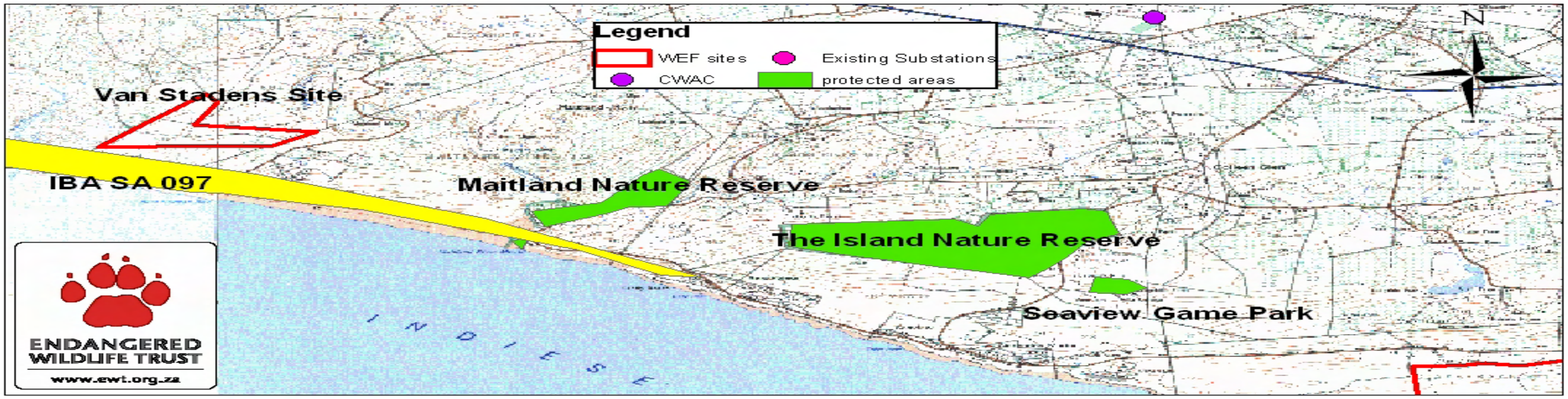

Figure 11 - Van Stadens site showing the location of the IBA and other protected areas

In order to rank these three sites a scale was used between 1 and 5, with 5 being the most highly preferred option and 1 being unacceptable.

Table 15 – Site preference for the proposed wind farm development

Alternative	Birds	Bats
	Preference rating	Preference rating
Driftsands	1	2
Bushy Park	4	2
Van Stadens	2	4

It is thus clear that the Bushy Park site is the most highly preferred site alternative from an avifaunal perspective and that the Driftsands site is unacceptable. The Driftsands site should be discarded as an alternative.

With regards to bats, the Van Staden site is the most preferred site alternative with Bushy Park and Driftsands being least preferred.

7. CONCLUSION

In conclusion the proposed development can be built with acceptable impact on avifauna and bats should the recommendations in this report be followed. In particular the following important points must be stressed:

1: A Site specific EMP is strongly recommended to site the turbines correctly as well as to deal with the details of the associated infrastructure that was not provided at this stage of the process.

2: A monitoring program is seen as critical in extending our knowledge of wind energy and avifaunal and bat interactions. Since this could be the first commercial wind energy facility in South Africa, it is recommended that a monitoring program be planned to collect data on a host of environmental factors, including avifaunal collisions and bat fatalities.

3: Turbines must be painted as detailed in this report to mitigate for collision of bird species.

4: If possible the wind turbines must be shut down in extreme wind and extreme low visibility events such as thick cloud or mist.

5: If possible the wind turbines should be shut down in low-wind conditions at night when the bats are foraging.

6: The wind energy facility should not be lit, if this is not feasible the lights must only be red strobe lights and lights that do not attract insects.

7: The use of a radar to alert bats to the presence of wind turbines is strongly encouraged.

It must also be stressed that with wind energy and avifaunal and bat interactions, the cumulative impacts of multiple developments could be important. It is recommended that a national or at least municipal strategic study be undertaken to address this issue.

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APPENDIX 1- CWAC DATA

Species Summary
S : Subregional IBA level passed for species
G : Global IBA level passed for species
R : Ramsar level passed for species

Ref	Species Name (**IUCN Status**)	Summer				Winter				All				Bred	S	G	R
		Min	Avg	Max	f	Min	Avg	Max	f	Min	Avg	Max	f	in past			
6	Little Grebe *Tachybaptus ruficollis*	9	9.0	9	1		0.0		0	9	9.0	9	1	No data			
50	Reed Cormorant *Phalacrocorax africanus*	2	2.0	2	1		0.0		0	2	2.0	2	1	No data			
54	Grey Heron *Ardea cinerea*	1	1.0	1	1		0.0		0	1	1.0	1	1	No data			
55	Black-headed Heron *Ardea melanocephala*	1	1.0	1	1		0.0		0	1	1.0	1	1	No data			
61	Cattle Egret *Bubulcus ibis*	254	254.0	254	1		0.0		0	254	254.0	254	1	No data			
69	Black-crowned Night-Heron *Nycticorax nycticorax*	5	5.0	5	1		0.0		0	5	5.0	5	1	No data			
88	Spur-winged Goose *Plectropterus gambensis*	5	5.0	5	1		0.0		0	5	5.0	5	1	No data			
94	Cape Shoveler *Anas smithii*	2	2.0	2	1		0.0		0	2	2.0	2	1	No data			
96	Yellow-billed Duck *Anas undulata*	35	35.0	35	1		0.0		0	35	35.0	35	1	No data			
97	Red-billed Teal *Anas erythrorhyncha*	14	14.0	14	1		0.0		0	14	14.0	14	1	No data			
203	Black Crake *Amaurornis flavirostris*	3	3.0	3	1		0.0		0	3	3.0	3	1	No data			
208	African Purple Swamphen *Porphyrio madagascariensis*	2	2.0	2	1		0.0		0	2	2.0	2	1	No data			
210	Common Moorhen *Gallinula chloropus*	1	1.0	1	1		0.0		0	1	1.0	1	1	No data			
212	Red-knobbed Coot *Fulica cristata*	20	20.0	20	1		0.0		0	20	20.0	20	1	Probably			
238	Three-banded Plover *Charadrius tricollaris*	4	4.0	4	1		0.0		0	4	4.0	4	1	No data			
245	Blacksmith Lapwing *Vanellus armatus*	8	8.0	8	1		0.0		0	8	8.0	8	1	No data			
250	African Snipe *Gallinago nigripennis*	12	12.0	12	1		0.0		0	12	12.0	12	1	No data			
256	Ruff *Philomachus pugnax*	3	3.0	3	1		0.0		0	3	3.0	3	1	No data			
264	Wood Sandpiper *Tringa glareola*	3	3.0	3	1		0.0		0	3	3.0	3	1	No data			
305	Whiskered Tern *Chlidonias hybridus*	1	1.0	1	1		0.0		0	1	1.0	1	1	No data			

Fairview Racecourse