APPENDIX C ORIGINAL SPECIALIST STUDIES

RHEBOKSFONTEIN WIND ENERGY FACILITY

Avian impact assessment

AVISENSE CONSULTING

EXECUTIVE SUMMARY

This study contains an extensive review of relevant literature on wind energy impacts on avifauna, and identifies potential impacts of the proposed Rheboksfontein Wind Energy Facility on the avifauna of the area. These expected impacts are: habitat destruction by construction of the facility itself and any associated power lines or substation/s, disturbance by both activities and possible displacement or disturbance of sensitive species by the operation of the facility, collision with blades of the wind turbines and other associated infrastructure.

The impact zone of the proposed wind energy facility features degraded and natural Fynbos and Renosterveld vegetation. The area is likely to support over 200 bird species, including 14 red-listed species, 44 endemics, and two red-listed endemics. Commuting wetland species, large terrestrial species, and various raptors are probably the avian groups most likely to be impacted by the wind energy facility, both in terms of the collision and disturbance impacts of the facility itself, and the disturbance and mortality risks posed by its peripheral infrastructure.

The proposed facility is likely to have a moderate to high, long-term impact on the avifauna of the area, and may negatively affect key rare, red-listed and/or endemic species. The most important negative impacts are likely to be on Great White Pelican *Pelecanus onocrotalus*, Blue Crane *Anthropoides paradiseus*, Black Harrier *Circus maurus*, and Greater Flamingo *Phoenicopterus ruber*. These birds (and other priority species) may be disturbed by construction of the facility, and/or lose foraging habitat to the construction footprint and/or be displaced from the area by the operating turbines (bustards and cranes) and/or may suffer mortalities in collisions with the turbine blades and ancillary power lines. Such effects can probably be reduced to acceptable and sustainable levels by adherence to a proposed mitigation scheme, mainly involving careful and responsible development and management of the facility, with sensitivity to potential, negative impacts and a preparedness to adjust operating procedures in a sincere effort to mitigate such impacts. A comprehensive programme to fully monitor the actual impacts of the facility on the broader avifauna of the area is recommended and outlined, from pre-construction and into the operational phase of the project.

It is imperative that the impacts of this project be viewed in the context of cumulative effects generated by multiple wind energy facility proposals for this general area (including one small facility which is already operational), and that mitigation of these cumulative impacts be managed accordingly.

CONSULTANT'S DECLARATION OF INDEPENDENCE

Andrew Jenkins (*AVISENSE* Consulting) is an independent consultant to Savannah Environmental Pty (Ltd) and Moyeng Energy (Pty) Ltd. He 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.

1. INTRODUCTION

Moyeng Energy (Pty) Ltd is planning to construct a wind energy facility (project name 'Rheboksfontein Wind Energy Facility') on a site located near Darling, Western Cape Province. Savannah Environmental Pty (Ltd) were appointed to do the Environmental Impact Assessment study, and subsequently appointed *AVISENSE* Consulting to conduct the specialist avifaunal assessment. The study was conducted by Dr Andrew Jenkins, an ornithologist with over 20 years of experience in avian research and impact assessment work. He has been involved in the design and/or execution of many of the completed EIA and EMP studies for wind energy facilities in South Africa to date, including two of the three operational facilities, at Darling and Klipheuwel, Western Cape Province.

2. TERMS OF REFERENCE

The terms of reference for this environmental impact study, as supplied by Savannah Environmental Pty (Ltd), were to provide:

- An indication of the methods used in determining the significance of potential impacts.
- A description of all the environmental issues (pertaining to birds) identified during the EIA process.
- An assessment of the significance of each of the identified direct, indirect and cumulative impacts, in terms of the expected nature, extent, duration, probability and severity of each, as well as in terms of the reversibility of impacts, and the degree to which each can be mitigated.
- A description and comparative assessment of alternatives in the development plan.
- Recommendations on practical mitigation of potentially significant negative impacts for inclusion in the Environmental Management Plan, with an indication of the expected efficacy of such mitigation measures.
- A description of any assumptions, uncertainties or knowledge gaps affecting this assessment.
- An environmental impact statement with a summary of key findings, an assessment of positive and negative implications of the proposed development, and a comparative assessment of identified alternatives.

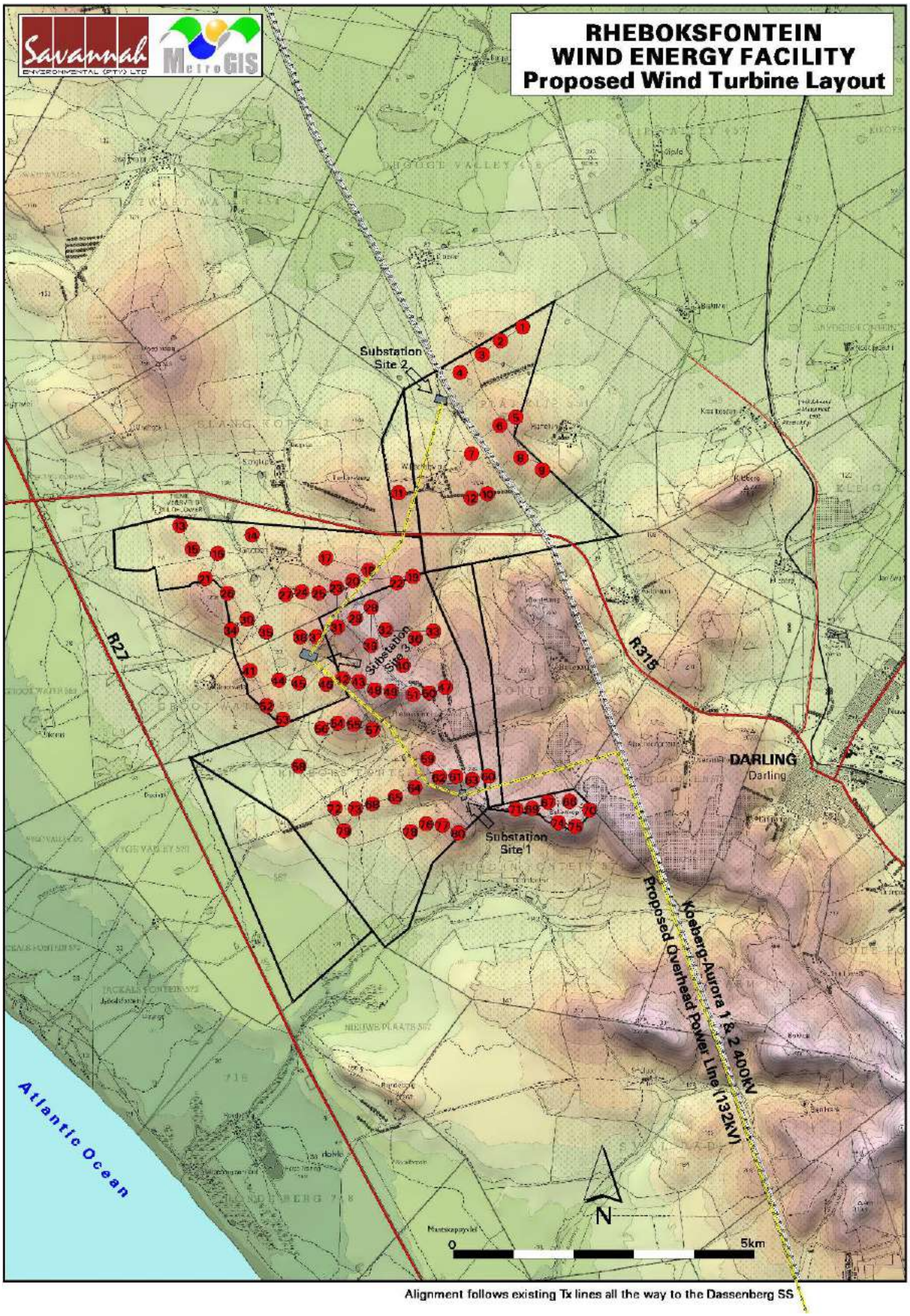


FIGURE 1. General location and layout of the proposed Rheboksfontein Wind Energy Facility.

3. STUDY METHODS

3.1. Approach

The initial scoping study, which forms the background to this report, included the following steps:

- A review of available published and unpublished literature pertaining to bird interactions with wind energy facilities is provided summarising the issues involved and the current level of knowledge in this field. Various information sources (listed below), including data on the birdlife of the area and previous studies of bird interactions with wind energy facility and electricity infrastructure, were examined.
- An inclusive, annotated list of the avifauna likely to occur within the impact zone of the proposed wind energy facility was compiled using a combination of the existing distributional data and previous experience/knowledge of the avifauna of the general area.
- A short-list of priority bird species (defined in terms of conservation status and endemicity) which could possibly be impacted by the proposed wind energy facility was extracted from the total bird list. These species were subsequently considered as adequate surrogates for the local avifauna generally, and mitigation of impacts on these species was considered likely to accommodate any less important bird populations that may also potentially be affected.
- A summary of more likely and significant impacts of the wind energy facility on the local avifauna was drawn up, and a brief methodology was devised for the EIA phase for confirming these impacts and developing an effective mitigation strategy.

The present EIA report builds on the scoping study, with emphasis on the outcome of a site visit, made on 12-13 August 2010. While the scoping phase identified potential avifaunal issues associated with the proposed wind energy facility and its possible associated infrastructure, the EIA investigates these issues in more detail and includes:

- Field surveys of large terrestrial species, raptors and endemic passerines within the study area to determine the relative importance of local populations of these key taxa.
- Refinement of the expected species and priority species lists based on (i), and compilation of SABAP 2 atlas lists for the pentads visited during the site visit.
- Estimates of the extent and direction of possible movements of these species within/through the anticipated impact zone of the wind energy facility, in relation to the distribution of available resources – nesting or roosting sites (wetlands, stands of trees, existing power lines), foraging areas (croplands, wetlands), sources of list for slope soaring birds (ridge lines).

- Identification of any sensitive/high risk areas to locate wind turbines or associated infrastructure within the broader study area, in terms of (i) to (iii) above.
- Recommendations on mitigation where necessary (particularly with reference to the siting of turbines and power line alignments).
- A comprehensive, long-term programme for monitoring actual impacts from pre- to post-construction phases of the development, and improving our understanding of the long-term effects of wind energy developments on South African avifauna.

3.2. Data sources used

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

- Bird distribution data of the Southern African Bird Atlas Project (SABAP – Harrison *et al.* 1997) were obtained from the Animal Demography Unit website (http://sabap2.adu.org.za/index.php) for the relevant quarter-degree squares (SABAP 1: 3318AC Yzerfontein – 233 cards submitted over the atlas period, 222 species recorded, and 3318AD Darling – 164 cards, 198 species) or pentads (SABAP 2: 3320_1815, 3320_1820, 3315_1815 – 29 cards submitted so far for all three pentads combined). A composite list of species likely to occur in the impact zone of the wind energy facility was drawn up as a combination of these data, refined by a more specific assessment of the actual habitats affected, based on general knowledge of the avifauna of the region (APPENDIX 1).
- Conservation status and endemicity of all species considered likely to occur in the area was determined as per the most recent iteration of the national Red-list for birds (Barnes 2000), informed by a more recent revision for raptors (Jenkins 2008a), the most recent iteration of the global list of threatened species (http://www.iucnredlist.org), and the most recent and comprehensive summary of southern African bird biology (Hockey *et al.* 2005).
- Data from the Animal Demography Unit's Coordinated Avifaunal Roadcount project (CAR: http://car.adu.org.za/, Young *et al.* 2003), and Coordinated Waterbird Counts (CWAC: http://cwac.adu.org.za/, Taylor *et al.* 1999).
- Data from the Endangered Wildlife Trust's (EWT) Migrating Kestrel Project, with summer roost counts for Lesser Kestrel *Falco naumanni*, Amur Falcon *Falco amurensis*, and Red-footed Falcon *Falco vespertinus* for much of southern Africa (http://www.kestreling.com/).
- Data from the Animal Demography Unit's Coordinated Avifaunal Roadcount project (CAR: http://car.adu.org.za/, Young *et al.* 2003).
- Data from the EIA report and subsequent monitoring study associated with the nearby Darling Wind Farm (Jenkins 2001, 2003), which has been operational on

the property immediately north of the Rheboksfontein study area for at least 2-3 years.

- EIA reports and any subsequent monitoring reports on the potential impacts on birds of other proposed and/or constructed and operational wind energy facilities in South Africa (e.g. van Rooyen 2001a, Küyler 2004, Jenkins 2008b, 2009).

3.3. Limitations & assumptions

Any inaccuracies in the above sources of information could limit this study. The SABAP 1 data accumulated for this area were comprehensive originally (397 cards submitted for both quarter-degree squares combined) but are now >15 years old (Harrison *et al.* 1997). Some recent SABAP 2 data are available by way of an update on the earlier project, but probably not sufficient to pronounce conclusively on the birdlife present. This deficiency was partially addressed by the short visit to the site.

Given that there are currently only three, very small wind energy facilities operational in South Africa (totalling only 8 turbines between them), practical experience of the environmental effects of wind energy facilities in this country is extremely limited, and we must base our estimates of the possible impacts of new facilities largely on lessons learnt internationally. While many of the established, general principles can probably be usefully applied here, care should be taken in adapting international knowledge and experience to uniquely South African birds and conditions.

The Rheboksfontein project is unique in a South African context, as the only commercial wind energy facility proposal to have any substantial avian monitoring data available to the EIA process. More than 80 hours of monitoring of bird movements, and regular counts of large terrestrial, wetland and raptorial birds in the area, were completed over a calendar year on the Darling Wind Farm site, only 6-7 km north of the centre of the proposed Rheboksfontein facility. However, note that these data are now nearly eight years old, and their value has been compromised by the lack of follow-up monitoring, which should have been done for at least a year after construction and commissioning of the Darling site.

4. BACKGROUND TO THE STUDY

4.1 Interactions between wind energy facilities and birds

Recent literature reviews (www.nrel.gov, Kingsley & Whittam 2005, Drewitt & Langston 2006, Kuvlevsky *et al.* 2007, Stewart *et al.* 2007, Drewitt & Langston 2008, Krijgsveld *et al.* 2009, Sovacool 2009) are essential summaries and sources of information in this field. While the number of comprehensive, longer-term analyses of the effects of wind energy facilities on birds is increasing, and the body of empirical data describing these effects is rapidly growing, scientific research in this field is still in its infancy (Madders & Whitfield 2006, Stewart *et al.* 2007), and much of the available information originates from short-term, unpublished, descriptive studies, most of which have been carried out in the United States, and more recently across western Europe, where wind power generation is a more established and developed industry.

Concern about the impacts of wind facilities on birds first arose in the 1980s when numerous raptor mortalities were detected at facilities at Altamont Pass Wind Resource Area (California, USA) and Tarifa (southern Spain). More recently, there has been additional concern about the degree to which birds avoid or are excluded from the areas occupied by wind energy facilities – either because of the visible action of the turbine blades or because of the noise they generate - and hence suffer a loss of habitat (Larsen & Guillemette 2007, Stewart *et al.* 2007, Devereaux *et al.* 2008. Pearce-Higgins *et al.* 2009). With a few important exceptions, most studies completed to date suggest low absolute numbers of bird fatalities at wind energy facilities (Kingsley & Whittam 2005), and low casualty rates relative to other existing sources of anthropogenic avian mortality on a per structure basis (Crockford 1992, Colson & associates 1995, Gill *et al.* 1996, and Erickson *et al*. 2001).

4.1.1 Collisions with turbines

Collision rates

As more monitoring has been conducted at a growing number of sites, some generic standards and common units have been established, with bird collisions with turbine blades generally measured in mortalities/turbine/year, mortalities/Mega-Watt/year, or mortalities /Giga-Watt Hour (Smallwood & Thelander 2008, Sovacool 2009). Wherever possible, measured collision rates should allow for (i) casualty remains which are not detected by observers (searcher efficiency - Newton & Little 2009), and (ii) casualties which are removed by scavengers before detection, and the rate at which this occurs (scavenger removal rate). Also, although collision rates may appear relatively low in many instances, cumulative effects over time, especially when applied to large, long lived, slow reproducing and/or threatened species (many of which are collision-prone), may be of considerable conservation significance.

The National Wind Co-ordinating Committee (2004) estimates that 2.3 birds are killed per turbine per year in the US outside of California – correcting for searcher efficiency and scavenger rates. However, this index ranges from as low as 0.63 mortalities/turbine/year in Oregon, to as high as 10 mortalities/turbine/year in Tennessee (NWCC 2004), illustrating the wide variance in mortality rates between sites. Curry & Kerlinger (2000) found that only 13% of the >5000 turbines at Altamont Pass, California were responsible for all Golden Eagle *Aquila chrysaetos* and Red-tailed Hawk *Buteo jamaicensis* collisions, but the most recent aggregate casualty estimates for Altamont run to >1000 raptor mortalities/turbine/year, and nearly 3000 mortalities/turbine/year overall (Smallwood & Thelander 2008), including >60 Golden Eagles, and at a mean rate of about 2-4 mortalities/MW/year.

At the Tarifa and Navarre wind energy facilities on the Straits of Gibraltar, southern Spain, about 0.04-0.08 birds are killed per turbine/year (Janss 2000a, de Lucas *et al.* 2008), with relatively high collision rates for threatened raptors such as Griffon Vulture *Gyps fulvus*, of particular concern (Table 1). At the same sites, collisions have also been found to be non-randomly distributed between turbines, with >50% of the vulture casualties recorded at Tarifa being killed by only 15% of the turbine array at the facility (Acha 1997). Collision rates from other European sites are equally variable, with certain locations sporadically problematic (Everaert 2003, Newton & Little 2009, Table 1).

To date, only eight wind turbines have been constructed in South Africa at two pilot wind energy facilities at Klipheuwel and Darling in the Western Cape (van Rooyen 2001, Jenkins 2001, 2003) and, more recently, in the first phase of a bigger development at Coega in the Eastern Cape. An avian mortality monitoring program was established at the Klipheuwel facility once the turbines were operational, involving regular site visits to monitor both bird traffic through the area and detect bird mortalities (Küyler 2004). This study found that (i) 9-57% of birds observed within 500m of the turbines were flying at blade height, and (ii) 0-32% of birds sighted were flying either between the turbines or within the arc of the rotors of the outermost turbines. Five bird carcasses were found on the three-turbine site during the 8-month monitoring period, of which two, a Horus Swift *Apus horus* and a Large-billed Lark *Galerida magnirostris*, were thought to have been killed by collision with turbine blades, indicating a net collision rate for birds of about 1.00 mortality/turbine/year.

It is important to note here that simple estimates of aggregate collision rates for birds are not an adequate expression of biodiversity impact. Rather, consideration must be given to the conservation status of the species affected or potentially affected, and the possibility that even relatively low collision rates for some threatened birds may not be sustainable in the long term.

Causes of collision

Multiple factors influence the number of birds killed at wind energy facilities. These can be classified into three broad groupings: (i) avian variables, (ii) location variables, and (iii) facility-related variables. Although only one study has so far shown a direct relationship between the abundance of birds in an area and the number of collisions (Everaert 2003), it would seem logical to assume that the more birds there are flying through an array of turbines, the higher the chances of a collision occurring. The nature of the birds present in the area is also very important as some species are more vulnerable to collision with turbines than others, and feature disproportionately frequently in collision surveys (Drewitt & Langston 2006, 2008, de Lucas *et al.* 2008). Species-specific variation in behaviour, from general levels of activity to particular foraging or commuting strategies, also affect susceptibility to collision (Barrios & Rodríguez 2004, Smallwood *et al.* 2009). There may also be seasonal and temporal differences in behaviour, for example breeding males displaying may be particularly at risk.

Landscape features can potentially channel birds towards a certain area, and in the case of raptors, influence their flight and foraging behaviour. Ridges and steep slopes are important factors in determining the extent to which an area is used by gliding and soaring birds (Barrios & Rodríguez 2004). High densities of prey will attract raptors, increasing the time spent hunting, and as a result reducing the time spent being observant. Poor weather affects visibility. Birds fly lower during strong headwinds (Hanowski & Hawrot 2000, Richardson 2000), so when the turbines are functioning at their maximum speed, birds are likely to be flying at their lowest, exponentially increasing collision risk (Drewitt & Langston 2006, 2008).

Larger wind energy facilities, with more turbines, are almost by definition more likely to incur significant numbers of bird casualties (Kingsley & Whittam 2005), and turbine size may be proportional to collision risk, with taller turbines associated with higher mortality rates in some instances (e.g. de Lucas *et al.* 2009, but see Howell 1995, Erickson *et al.* 1999, Barclay *et al.* 2007), although with newer technology, fewer, larger turbines are needed to generate equivalent or even greater quantities of power, possibly resulting in fewer collisions per Megawatt of power produced (Erickson *et al.* 1999). Certain turbine tower structures, and particularly the old-fashioned lattice designs, present many potential perches for birds, increasing the likelihood of collisions occurring as birds land at or leave these perch or roost sites. This generally is not a problem associated with more modern, tubular tower designs (Drewitt & Langston 2006, 2008), such as those proposed for this project.

Table 1. Results of recent published studies of the effects of wind energy facilities on local avifauna.

Location	***n* wind farm/s assessed**	**Turbine hub height (m)**	***n* turbines**	**Habitat**	**Bird groups assessed**	**Evidence of displacement?**	**Collision rate (birds/turbine/year)**	**Reference**
Tarifa, Southern Spain	2	18-36	66-190	Hilly woodland	Raptors	N/A	Raptors = 0.27, Griffon Vultures = 0.12	Barrios & Rodríguez 2004
Tarifa, Southern Spain	2	28-36	66-190	Hilly woodland	Raptors	N/A	0.04-0.07, mostly Griffon Vultures	de Lucas *et al.* 2008
East Anglia, UK	2	60	8	Croplands	Gamebirds, corvids, larks and see-eaters	Minimal, only gamebirds significantly affected	N/A	Devereaux *et al.* 2008
Altamont Pass, California	1	14-43	5400	Hilly grassland	Various	N/A	4.67 , raptors = 1.94	Smallwood & Thelander 2008
Southern Spain	1	44	16	Hilly woodland	Various	Yes, >75% reduction in raptor sightings	0.03	Farfán *et al.* 2009
Netherlands	3	67-78	7-10	Farmland	Various	N/A	27.0-39.0	Krijgsveld *et al.* 2009
Northumberland, UK	1	30	9	Coastal	Seabirds	N/A	16.5-21.5, mostly large gulls	Newton & Little 2009
N England & Scotland	12	30-70	14-42	Moorland	Gamebirds, shorebirds, raptors, passerines	Yes, 53% reduction in Hen Harrier *Circus cyaneus* sightings, other species also decreased	N/A	Pearce-Higgins *et al.* 2009

Illumination of turbines and other infrastructure is often associated with increased collision risk (Winkelman 1995, Erickson *et al.* 2001), either because birds moving long distances at night do so by celestial navigation, and may confuse lights for stars (Kemper 1964), or because lights attract insects, which in turn attract birds. Changing constant lighting to intermittent lighting has been shown to reduce nocturnal collision rates (Richardson 2000, APLIC 1994, Jaroslow 1979, Weir 1976) and changing flood-lighting from white to red can reduce mortality rates by up to 80% (Weir 1976).

Spacing between turbines at a wind facility can have an effect on the number of collisions. Some authors have suggested that paths should be left between turbines to allow free passage through the turbine strings (Drewitt & Langston 2006, Kuvlevsky *et al.* 2007, Drewitt & Langston 2008). This approach tallies well with wind energy generation principles, which require relatively large spaces between turbines in order to avoid wake and turbulence effects. An alternative perspective suggests that all attempts by birds to fly through wind energy facilities, rather than over or around them, should be discouraged to minimise collision risk (Drewitt & Langston 2006, Kuvlevsky *et al.* 2007, Drewitt & Langston 2008). This approach effectively renders the entire footprint of the facility as lost habitat (see below).

Collision prone birds

Collision prone birds are generally either (i) large species and/or species with high ratios of body weight to wing surface area (wing loading), which confers low maneuverability (cranes, bustards, vultures, gamebirds, waterfowl, falcons), (ii) species which fly at high speeds (gamebirds, pigeons and sandgrouse, swifts, falcons), (iii) species which are distracted in flight - predators or species with aerial displays (many raptors, aerial insectivores, some open country passerines), (iv) species which habitually fly in low light conditions, and (v) species with narrow fields of forward binocular vision (Drewitt & Langston 2006, 2008, Jenkins *et al.* 2010, Noguera *et al.* 2010). These traits confer high levels of *susceptibility*, which may be compounded by high levels of *exposure* to man-made obstacles such as overhead power lines and wind turbine areas (Jenkins *et al.* 2010). Exposure is greatest in (i) very aerial species, (ii) species inclined to make regular and/or long distance movements (migrants, any species with widely separated resource areas - food, water, roost and nest sites), (iii) species that regularly fly in flocks (increasing the chances of incurring multiple fatalities in single collision incidents).

Soaring species may be particularly prone to colliding with wind turbines where the latter are placed along ridges to exploit the same updrafts favoured by such birds - vultures, storks, cranes, and most raptors - for cross-country flying (Erickson et al. 2001, Kerlinger & Dowdell 2003, Drewitt & Langston 2006, 2008, Jenkins *et al.* 2010, Noguera *et al.* 2010). Large soaring birds – for example, many raptors and storks - depend heavily on external sources of energy for sustainable flight (Pennycuick 1989). In terrestrial situations, this generally requires that they locate and exploit pockets or waves of rising air, either in the form of bubbles of vertically rising, differentially heated air –

thermal soaring - or in the form of wind forced up over rises in the landscape, creating waves of rising turbulence – slope soaring.

Certain species are morphologically specialised for flying in open landscapes with high relief and strong prevailing winds, and are particularly dependent on slope soaring opportunities for efficient aerial foraging and travel. South African examples might include Bearded *Gypaetus barbatus* and Cape Vulture *Gyps coprotheres*, Verreaux's Eagle *Aquila verreauxii*, Jackal Buzzard *Buteo rufofuscus*, Rock Kestrel *Falco rupicolus*, Peregrine Falcon *Falco peregrinus*, Lanner Falcon *Falco biarmicus* and Black Stork *Ciconia nigra* and, to a lesser extent, most other open-country raptors. Such species are potentially threatened by wind energy developments where turbines are situated to exploit the wind shear created by hills and ridge-lines. In these situations, birds and industry are competing for the same wind resource, and the risk that slope soaring birds will collide with the turbine blades, or else be prevented from using foraging habitat critical for their survival, is greatly increased. Evidence of these effects has been obtained from several operational wind energy facilities in other parts of the world – for example relatively high mortality rates of large eagles, buzzards and kestrels at Altamont Pass, California (>1100 raptors killed annually or 1.9 raptor casualties/MW/year, Smallwood & Thelander 2008), and of vultures and kestrels at Tarifa, Spain (0.15-0.19 casualties/turbine/year, Barrios & Rodríguez 2004, de Lucas *et al.* 2008, Table 1), and displacement of raptors generally in southern Spain (Farfán *et al.* 2009) and of large eagles in Scotland (Walker *et al.* 2005) – and one study has shown that the additive impact of wind farm mortality on an already threatened raptor could theoretically cause its localised extinction (Carrete *et al.* 2009).

Mitigating collision risk

The only direct way to reduce the risk of birds colliding with turbine blades is to make the blades more conspicuous and hence easier to avoid. Blade conspicuity is compromised by a phenomenon known as 'motion smear' or retinal blur, in which rapidly moving objects become less visible the closer they are to the eye (McIsaac 2001, Hodos 2002). The retinal image can only be processed up to a certain speed, after which the image cannot be perceived. This effect is magnified in low light conditions, so that even slow blade rotation can be difficult for birds to see.

Laboratory-based studies of visual acuity in raptors have determined that (i) visual acuity 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, (ii) moderate motion of the visual stimulus significantly influences acuity, and kestrels may be unable to resolve all portions of an object such as a rotating turbine blade because of motion smear, especially under low contrast or dim lighting conditions, (iii) this deficiency can be addressed by patterning the blade surface in a way which maximises the time between successive stimulations of the same retinal region, and (v) the easiest, cheapest and most visible blade pattern for this purpose, effective across the widest variety of backgrounds, is a single black blade in an array of white blades (McIsaac 2001, Hodos 2002). Hence blade marking may be an important means to reduce collision rates by making the rotating turbine blades as conspicuous as possible under the least favourable visual conditions, particularly at facilities where raptors are known or likely to be frequent collision casualties.

Even if the turbine rotors are marked in this way, many species may still be susceptible to colliding with them, especially during strong winds (when the rotor speed is high and birds tend to fly low and with less control) and when visibility is poor (at night or in thick mist). All other collision mitigation options operate indirectly, by reducing the frequency with which collision prone species are exposed to collision risk. This is achieved mainly by (i) siting farms and individual turbines away from areas of high avifaunal density or aggregation, regular commute routes or hazardous flight behavior, (ii) using low risk turbine designs and configurations, which discourage birds from perching on turbine towers or blades, and allow sufficient space for commuting birds to fly safely through the turbine strings, and (iii) carefully monitoring collision incidence, and being prepared to shut-down problem turbines at particular times or under particular conditions.

Effective mitigation can only be achieved with a commitment to rigorous pre- and post-construction monitoring (see below), ideally using a combination of occasional, direct observation of birds commuting or foraging through and around the wind energy facility, coupled with constant, remote tracking of avian traffic using specialised radar equipment (e.g. see http://www.detect-inc.com/wind.html). Such systems can be programmed to set the relevant turbines to idle as birds enter a pre-determined danger zone around the turbine array, and to re-engage those turbines once the birds have safely passed.

4.1.2 Habitat loss – destruction, disturbance and displacement

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 in operation.

4.1.3 Impacts of associated infrastructure

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).

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).

Collision with power lines
Power lines pose at least an equally significant collision risk to wind turbines, probably affecting the same suite of collision prone species (Bevanger 1994, 1995, 1998, Janss 2000b, Anderson 2001, van Rooyen 2004a, Drewitt & Langston 2008, Jenkins *et al.* 2010). Mitigation of this risk involves the informed selection of low impact alignments for new power lines relative to movements and concentrations of high risk species, and the use of either static or dynamic marking devices to make the lines, and in particular the earthwires, more conspicuous. While various marking devices have been used globally, many remain largely untested in terms of their efficacy in reducing collision incidence, and those that have been fully assessed have all been found to be only partially effective (Drewitt & Langston 2008, Jenkins *et al.* 2010).

Electrocution on power infrastructure
Avian electrocutions occur when a bird perches or attempts to perch on an 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 2004b, Lehman *et al.* 2007). Electrocution risk is strongly influenced by the voltage and design of the power lines erected (generally occurring on lower voltage infrastructure where air gaps are relatively small), and mainly affects larger, perching species, such as vultures, eagles and storks, easily capable of spanning the spaces between energised components.

Mitigation of electrocution risk involves the use of bird-safe structures (ideally with critical air gaps >2 m), the physical exclusion of birds from high risk areas of live infrastructure, and comprehensive insulation of such areas (van Rooyen 2004b, Lehman *et al.* 2007).

4.2. Description of the proposed wind energy facility

The proposed wind energy facility will be located on portions of the farms Platklip, Slangkop, Bonteberg, Nieuweplaats, Doornfontein and Rheboksfontein, located just south of the intersection of the R27 and the R315, about 6 km northwest of Darling, Western Cape Province, South Africa (Fig. 1), and will be contained within an area of about 39 km^2. The facility will comprise up to 80 wind turbines, each of which will be 80-100 m in height (at the hub), and with rotor diameters of up to 110 m. The facility will include a network of access and service roads, and three substations, connected within the development area by three lengths of 132 kV overhead power line, of 3-5 km in length. Power will be supplied to the Eskom grid by means of a dedicated 132 kV power line, running from the facility to the Dassenburg substation in Atlantis, ~30 km to the south of the site. This new power line is proposed to run parallel with the existing Aurora-Koeberg 400 kV transmission line (Fig. 1).

5. DESCRIPTION OF THE AFFECTED ENVIRONMENT

5.1 Vegetation of the study area

The study area falls within the Fynbos Biome, and the Southwest Fynbos Bioregion at its junction with the West Strandveld Bioregions (Mucina & Rutherford 2006). The natural vegetation of the study area comprises mainly Hopefield Sand Fynbos (tallish, ericoid shrubland, with proteoid elements along watercourses - Mucina & Rutherford 2006) on the top of the ridge that bisects the site and its western slopes, with Swartland Granite Renosterveld (a grass/herb mosaic with renosterbos dominated shrublands – Mucina & Rutherford 2006) on the eastern crest of the ridge and on slopes to the east.

FIGURE 2a. Natural vegetation along the crest of the central ridge which runs the length of the Rheboksfontein Wind Energy site, with a matrix of cereal croplands on either side.

FIGURE 2b. Rolling wheatfields with the Aurora-Koeberg transmission line in the background, on the farm Wildschutsvlei.

FIGURE 2c. Droëvlei, just to the north of the study area, which supports 1000s of flamingo and many other wetland birds.

5.2 Avian microhabitats

The area features open, hilly heathland, heavily modified by agriculture in most areas. The site is situated 3-4 km from the Atlantic coastline. The local climate is temperate, featuring warm, dry, windy summers, and wetter, cooler winters. The area receives about 150-200 mm of rain per annum, with mean temperatures ranging from about 5-10ºC on winter nights, to 25-30ºC during the day in summer. Altitude averages about 160 m above sea level, rising to just over 300 m a.s.l. at Bakenkop in the south-eastern corner of the site. Land use is mainly cereal crop (wheat) farming, with dairy operations at both Rheboksfontein and Wildschutskraal, some small-stock (sheep) farming at Wildschutskraal, and some vineyards on the eastern slopes of the ridge at Rheboksfontein. There are three main farm houses (with associated outhouses) within the development area, Wildschutsvlei in the north, Grootberg in the west, and Rheboksfontein in the south. The area is bordered by the R27 West Coast Rd to the west, crossed by the R315 between Yzerfontein and Darling (Fig. 1), and is criss-crossed by a network of lesser, gravel roads and farm tracks. The Aurora-Koeberg 400 kV transmission line runs north-south through the eastern sector of the development area.

Avian habitats within the impact zone comprise (i) tracts of degraded **natural vegetation** on the hill tops and on the granite koppies (Fig. 2a), surrounded by (ii) modified pastures and cereal **croplands** in the flatter areas (Fig. 2b), (iii) a network of **wetlands**, including the Dwarsrivier to the south, various other vleis, drainage lines and artificial impoundments within the study area, and extended to include Droëvlei and other salt pans to the north, which hold large numbers of flamingo and other wetland birds (Fig. 2c), and (iv) scattered stands of **alien trees** (*Acacias*, eucalypts and pines).

5.3 Avifauna of the impact area

The proposed Rheboksfontein Wind Energy Facility lies about 20-25 km south of the West Coast National Park and Saldanha Bay Islands (WCNPSBI) Important Bird Area (Barnes 1998) (Fig. 3). The site provides a limited diversity of habitats for birds. It is almost completely covered by wheatfields, fallow lands or associated pastures. The seasonal life of these highly modified areas simulates open grassland, and attracts some significant birdlife, most importantly the threatened endemic Blue Crane *Anthropoides paradiseus*, but including a community of endemic lark species. The farm dams support limited wetland birds, particularly in winter when water levels are highest. Vestigial areas of uncultivated land, which mostly lie along the crest and the western slopes of the ridge in the centre of the study site, have retained the natural Fynbos and/or Renosterveld vegetation. These areas still support healthy Fynos bird communities, including some woodland species associated with alien tree infestation.

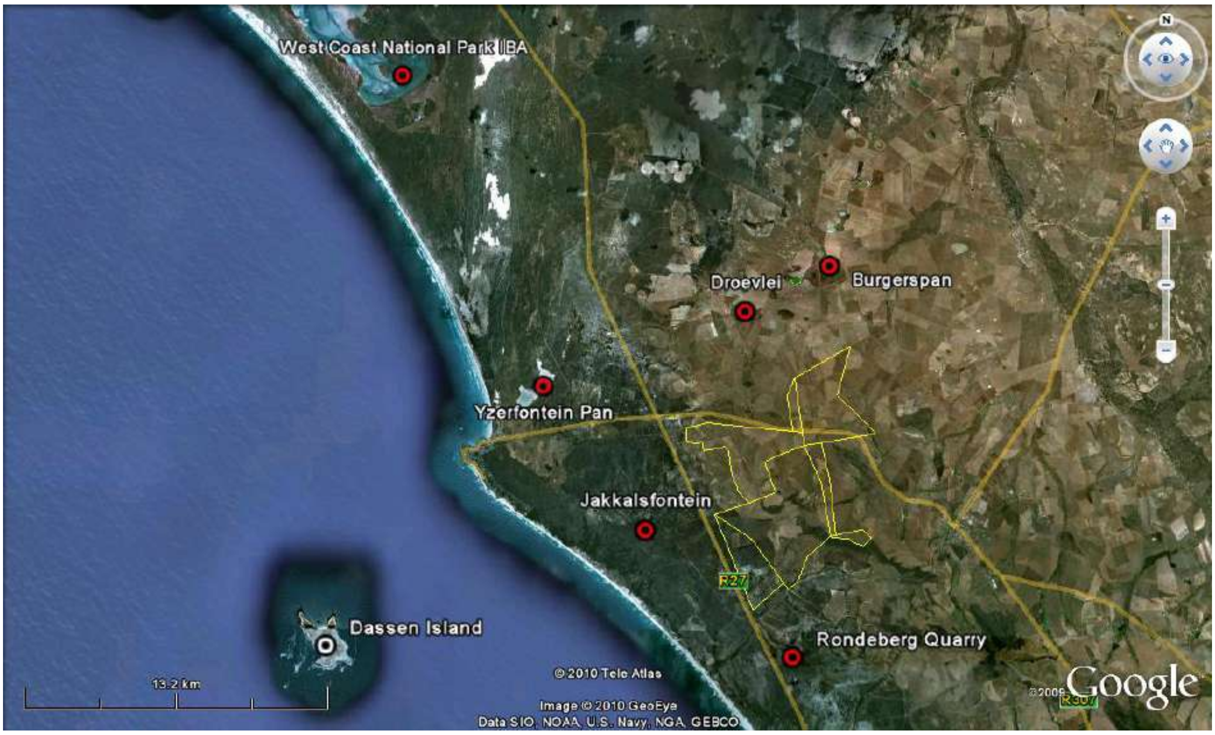


FIGURE 3. Location of the proposed Rheboksfontein Wind Energy Facility in relation to potentially affected Important Bird Areas (Barnes 1998).

At least 200 bird species are considered likely to occur with some regularity within the anticipated impact zone of the wind energy facility (Appendix 1), including 44 endemic or near-endemic species, 14 red-listed species, and two species – Blue Crane *Anthropoides paradiseus*, and Black Harrier *Circus maurus* – which are both endemic and red-listed (Barnes 1998, 2000, Table 1). Sixty-three species were seen during a site visit on August 12-13 2010 (Appendix 1). The area was adequately covered by vehicle and on foot (Fig. 4), and SABAP 2 atlas cards were completed for the pentads 3315_1815 (48 spp.) and 3320_1815 (47 spp.). Significant information gathered during the site visit included:

(i) Sightings of Great White Pelican *Pelecanus onocrotalus* at two locations within the proposed development area: a single grounded bird near the Rheboksfontein farm house, and two flocks of four and 30+ seen commuting along the ridge from north to south. The smaller flock routed directly through the impact area at about turbine height (Fig. 4).

(ii) Counts of >1000 Greater Flamingo *Phoenicopterus ruber* and >350 Lesser Flamingo *Phoenicopterus minor* at Droëvlei, <2 km to the north of the study site (Fig. 2c, Fig. 4).

(iii) Sightings of pairs of Blue Crane near Droëvlei, and within the study area at Grootberg (Fig. 4).

(iv) A sighting of African Marsh Harrier *Circus ranivorus* quartering the ridge near Rheboksfontein (Fig. 4).

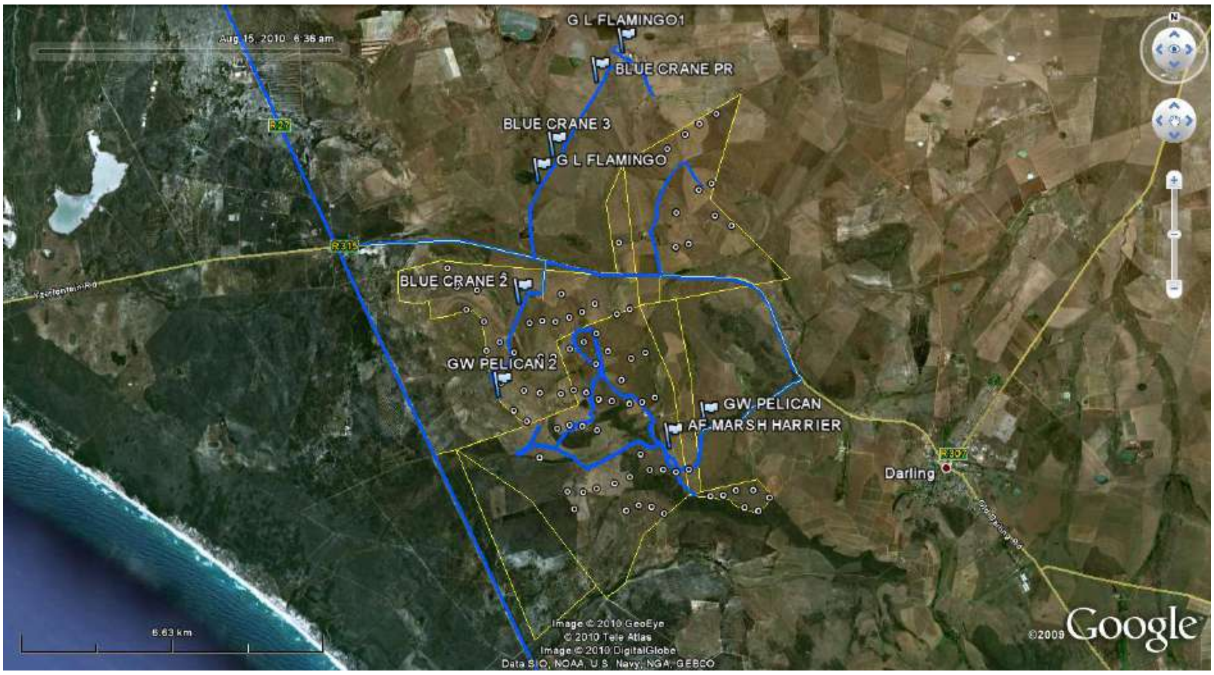
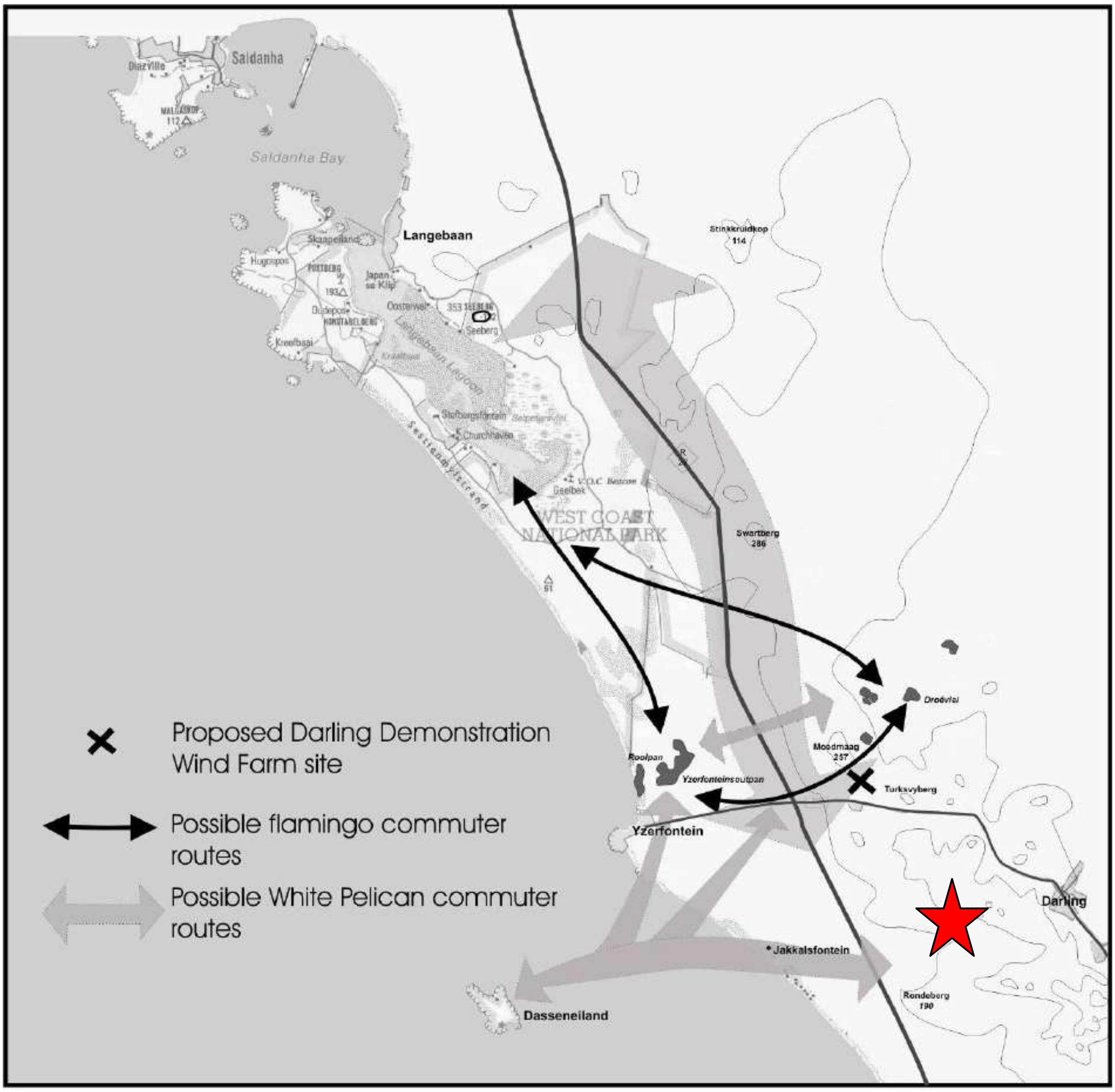


FIGURE 4. Area covered (blue lines) and locations of the most significant bird sightings recorded during the site visit in August 2010, in relation to the proposed location and turbine layout (white circles) of the Rheboksfontein Wind Energy Facility.

On the basis of these on-site observations, and in combination with the available SABAP atlas data for the general area and the data collected during the Darling Wind Farm EIA and pre-construction monitoring study (Jenkins 2001, 2003), 10 priority species are recognised as key in the assessment of avian impacts of the proposed Rheboksfontein Wind Energy Facility (Table 2), and as suitable surrogates for impacts on other species. These are mostly nationally and/or globally threatened species which are known to occur, or could occur in relatively high numbers in the development area and which are likely to be, or could be, negatively affected by the wind energy project.

Table 2. Priority bird species considered central to the avian impact assessment process for the Rheboksfontein Wind Energy Facility, selected on the basis of South African (Barnes 2000) or global conservation status (www.iucnredlist.org or http://www.birdlife.org/datazone/species/), level of endemicity, relative abundance on site (SABAP reporting rates, direct observation), and estimated conservation or ecological significance of the local population. Red-listed endemic species are shaded in grey.

Common name	Scientific name	SA conservation status/ (Global conservation status)	Regional endemicity	Average SABAP reporting rate (*N* = 426 cards)	Estimated importance of local population	Preferred habitat	Risk posed by		
							Collision	Electro-cution	Disturbance / habitat loss
Blue Crane	*Anthropoides paradiseus*	Vulnerable (Vulnerable)	Endemic	5.4	Moderate	Croplands, wetlands	High	-	High
African Marsh Harrier	*Circus ranivorus*	Vulnerable	-	8.0	High	Croplands, wetlands	Moderate	-	High
Black Harrier	*Circus maurus*	Near-threatened (Vulnerable)	Endemic	15.3	High	Wetlands, Fynbos, croplands	Moderate	-	High
Martial Eagle	*Polemaetus bellicosus*	Vulnerable (Near-threatened)	-	0.2	Moderate	Fynbos, croplands	High	High	Moderate
Secretarybird	*Sagittarius serpentarius*	Near-threatened	-	0.9	Moderate	Croplands	High	-	Moderate
Lanner Falcon	*Falco biarmicus*	Near-threatened	-	6.1	Moderate	Croplands, ridges	High	Moderate	High
Peregrine Falcon	*Falco peregrinus*	Near-threatened	-	0.2	Moderate	Croplands, ridges	High	Moderate	High
Greater Flamingo	*Phoenicopterus ruber*	Near-threatened	-	12.4	Moderate	Wetlands, flying through	High	-	Moderate
Lesser Flamingo	*Phoenicopterus minor*	Near-threatened	-	3.8	Moderate	Wetlands, flying through	High	-	Moderate
Great White Pelican	*Pelecanus onocrotalus*	Near-threatened	-	27.2	High	Wetlands, flying through	High	-	High



<u>FIGURE 5. Location of the Darling Wind Farm in relation to bird resource areas and estimated commuter routes (from Jenkins 2001), later largely confirmed by direct observation (Jenkins 2003). The red star denotes the approximate location of the proposed Rheboksfontein Wind Energy Facility.</u>

In summary, the birds of greatest potential relevance and importance in terms of the possible impacts of the proposed wind energy facility are likely to be:

(i) Flocks of Great White Pelicans commuting up and down the coast between Dassen Island and resource areas to the south, and routing through the development area. The site is situated about 15 km east of Dassen Island, which lies about 8 km off the coast at Yzerfontein, and supports the entire Western Cape breeding population of Great White Pelican *Pelecanus onocrotalus* (>550 pairs - Crawford *et al.* 1995, Crawford & Taylor 2000). In an assessment of possible impacts of the Darling Wind Farm, situated just northwest of the proposed Rheboksfontein site (Fig. 3), pre-construction monitoring showed that Great White Pelicans travelling from Dassen Island made regular use of the ridge now occupied by this small wind farm to travel both north and (mainly) south to distant foraging areas (Jenkins 2003, Fig 5). The higher lying parts of the Rheboksfontein site are a southerly continuation of this ridge. Fly-through passage rates for Great White Pelican on the Darling site in 2002/2003 averaged 0.27 birds per hour over the year's monitoring, peaking in mid-winter (Jenkins 2003). At the time, it was noted that the passage rate at the Darling site was low relative to the numbers of birds seen tracking to the south to pick up the north-south running ridge at Rheboksfontein, or north-bound birds seen leaving the ridge at Rheboksfontein to cross the coastal plain *en route* to the coast. These heavy, slope-soaring birds evidently still use this ridge to travel north/south to and from wetlands around Cape Town, and the levels of exposure to collision risk with turbines is likely to be demonstrably higher for Rheboksfontein than was the perceived risk for the Darling facility.

Note: the lack of systematic post-construction monitoring data for the Darling Wind Farm since its inception, both in terms of the presence and movements of Great White Pelicans (and other key species) and surveys for collision victims, was a significant omission, and compromises the efforts of this report to predict the scale, severity and significance of bird impacts at the neighbouring Rheboksfontein site. This mistake should NOT be repeated on this project should it be implemented.

(ii) Breeding pairs and/or flocks of non-breeding Blue Crane. This is a Red-listed, highly collision prone (Jenkins *et al.* 2010, Shaw *et al.* 2010 a & b) and possibly displacement prone species. Blue Cranes can reach densities in this general area of >100 birds per 100 km in road surveys (Young *et al.* 2003), particularly in winter when non-breeding birds may form large flocks. Blue Crane counts in the same area during the Darling Wind Farm site monitoring project showed numbers over the year peaking in March/April at >80 birds (Jenkins 2003), and an average of 0.1 Blue Cranes per hour were seen flying through the development area of this wind farm over 12 months of monitoring.

(iii) A range of locally resident or visiting raptors (particularly including Black Harrier, Martial Eagle, Secretarybird *Sagitarrius serpentarius*, Peregrine Falcon *Falco peregrinus* and Lanner Falcon *F. biarmicus*) foraging in or moving through the area. These are all collision prone and possibly displacement prone species, likely to use ridges occupied by wind turbines as sources of slope lift, bringing them into direct conflict with the development (see 4.1.1. above).

The wetlands of the lower reaches of the Dwarsrivier, just south-west of the study area, as well as the small pans scattered across the open Strandveld of Jakkalsfontein, about 2-3 km to the west, hold several breeding pairs of Black Harrier, and some of African Marsh Harrier (Curtis *et al.* 2004, Pers. obs, R. E. Simmons pers. comm.). Passage rates for Black Harrier at the Darling Wind Farm site averaged 0.01 birds per hour (Jenkins 2003). Black Harrier could even breed within the development area in wet years (Curtis *et al.* 2004).

Also note that the Rondeberg stone quarry which lies some 3 km south of the southern extreme of the study site supports a breeding pair of Peregrine Falcon *Falco peregrinus* and up to 12 pairs of Rock Kestrel *Falco rupicolus* (Pers. obs, A.J. van Zyl, Unpublished data), and that Lanner Falcon *Falco biarmicus* (0.28 birds per hour), Peregrine Falcon (0.06 birds per hour), Martial Eagle *Polemaetus bellicosus* (0.05 birds per hour) and Secretarybird *Sagittarius serpentarius* (0.04 birds per hour) were all quite regular commuters through the impact zone of the Darling Wind Farm in pre-construction monitoring (Jenkins 2003). Some of these birds, and large numbers of more common species – Jackal Buzzard *Buteo rufofuscus*, Steppe Buzzard *Buteo vulpinus* and Black Kite *Milvus migrans* (and/or Yellow-billed Kite *Milvus aegyptius*) – are drawn into the area in late summer/early winter to forage on rodents exposed by ploughing of wheat fields and/or burning off of stubble (Van Zyl *et al.* 1994).

(iv) Flocks of Greater and Lesser Flamingo commuting between resource areas and routing through the development area. The site lies just south-east of a network of dams and salt pans, stretching from Yzerfontein Pan in the west to Burgerspan in the east, which attracts large numbers of both Flamingo species, as well as a variety of other wetland species (Jenkins 2001, 2003). Flamingo counts at these same wetlands during the Darling Wind Farm site monitoring project showed flamingo numbers over the year peaking in late winter at >3500 birds (Jenkins 2003). Both these species are Red-listed, both are highly collision prone, and both are inclined to make distance flights at night, when visibility is poor and collision risk highest.

6. IMPACT ASSESSMENT

Impacts of the proposed Wind Energy Facility are most likely to be manifest in the following ways:

(i) Mortality of Great White Pelicans commuting through the area, using ridge lines targeted by the development for turbine placements as sources of slope lift, and colliding with the turbine blades or any new power lines associated with the facility. It is also possible that the turbine arrays may form a barrier to direct ravel for these birds, forcing them to take a different, more energetically expensive route to and from key resource areas.

(ii) Disturbance and displacement of resident/breeding or non-breeding flocks of Blue Crane from nesting and/or foraging areas by construction and/or operation of the facility, and/or mortality of these birds in collisions with the turbine blades or associated new power lines while commuting between resource areas (croplands, nest sites, roost sites/wetlands).

(iii) Displacement of resident/visiting raptors (especially Black Harrier, Martial Eagle, Secretarybird, Peregrine Falcon and Lanner Falcon) from foraging areas by construction and/or operation of the facility, and/or mortality of these species in collisions with the turbine blades or associated new power lines while slope-soaring along the high-lying ridges or hunting, or by electrocution when perched on power infrastructure.

(iv) Mortality of Greater and Lesser Flamingo commuting through the area in collisions with the turbine blades or any new power lines associated with the facility. It is also possible that the turbine arrays may form a barrier to direct ravel for these birds, forcing them to take a different, more energetically expensive route to and from key resource areas.

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

(i) Minimising the disturbance impacts associated with the construction of the facility, by abbreviating construction time, scheduling activities around avian breeding and/or movement schedules (actual timing to be refined by the results of pre-construction monitoring), and lowering levels of associated noise.

(ii) Minimising habitat destruction caused by the construction of the facility by keeping the lay-down areas as small as possible, building as few temporary roads as possible, and reducing the final extent of developed area to a minimum.

(iii) Minimising the disturbance impacts associated with the operation of the facility, by abbreviating maintenance times, scheduling activities in relation to avian breeding and/or movement schedules (actual timing to be refined by the results of pre- and post-construction monitoring), and lowering levels of associated noise.

(iv) Possibly excluding development from certain high-lying areas where Great White Pelicans and slope-soaring raptors are most likely to fly. A decision on if and where to delineate exclusion zones along the central ridge cannot be made at this stage, in the absence of adequate information on how often, when, under what conditions, and expressly where pelicans and raptors use the ridge for cross-country flying. This information will require additional observations to be done at the site (e.g. see pre-construction monitoring below).

(v) Either changing the primary land use on the site, or else shutting down key turbines during late summer (January-March) when the wheat stubble is burned, fields are ploughed for seeding, gerbils and other rodents are exposed to predation, and associated numbers of raptors are at their peak. Again, decisions on which turbine locations might be implicated here can only be determined with additional, pre-construction monitoring.

(vi) Painting one blade of each turbine black to maximise conspicuousness to oncoming birds.

(vii) 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.

(viii) Minimising the length of any new power lines installed, ensuring that all new lines are marked with bird flight diverters (Jenkins *et al.* 2010) along their entire length, and that all new power line 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.

(ix) Carefully monitoring the local avifauna both 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. Note that the use of a radar system to provide accurate, round-the-clock measures of the nature, extent and frequency of bird traffic passing over the site, in all weather conditions, is considered essential for pre-construction monitoring on this project. An essential weakness of the EIA process here is the dearth of knowledge about the actual movements of key species through the impact area on a seasonal basis. Such knowledge, which could not be gathered as part of the EIA study because of the time constraints imposed, must be generated as quickly and as accurately as possible in order for this and other wind energy proposals in the area to proceed in an environmentally sustainable way. Radar tracking systems, however expensive, are the only practical solution to this problem.

(x) Ensuring that the results of pre-construction monitoring are applied to project-specific impact mitigation in a way that allows for the potentially considerable cumulative effects on the local/regional avifauna of any other wind energy projects proposed for this area. There are immediate plans to expand the Darling Wind Farm, and to develop a new facility on the property immediately to the north. Viewed in isolation, each of these projects may pose only a limited threat to the wetland/coastal bird populations of the Darling/Yzerfontein area (and more broadly). However, collectively 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 extensive arrays of 100s of turbines across regular flight paths (Masden *et al.* 2010).

(xi) 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.

Table 3. Assessment tables for construction impacts of the proposed Rheboksfontein Wind Energy Facility on the local avifauna.

(A) Disturbance

Nature: Noise, movement and temporary occupation of habitat during the building process. Likely to impact all birds in the area to some extent, but sensitive, sedentary and/or habitat specific species will most adversely affected.

	Without mitigation	**With mitigation**
Extent	Low-Medium (2)	Low-Medium (2)
Duration	Short (1)	Short (1)
Magnitude	High (7)	Medium (5)
Probability	Definite (5)	Definite (5)
Significance	50 (Medium)	40 (Medium)
Status	Negative	Negative
Reversibility	Medium	High
Irreplaceable loss?	Possible	Probably not
Can impacts be mitigated?	Yes	

Mitigation: Abbreviating construction time, scheduling activities around avian breeding and/or movement schedules, lowering levels of associated noise, and reducing the size of the inclusive development footprint.

Cumulative impacts: Considerable if, as seems likely, other wind energy developments are under construction nearby at the same time.

Residual impacts: Some priority species may move away regardless of mitigation.

(B) Habitat loss

Nature: Destruction of habitat for priority species, either temporary – resulting from construction activities peripheral to the built area, or permanent - the area occupied by the completed development.

	Without mitigation	**With mitigation**
Extent	Low (1)	Low (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low-Medium (4)	Low (3)
Probability	Definite (5)	Definite (5)
Significance	50 (Medium)	45 (Medium)
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss?	Possible	Probably not
Can impacts be mitigated?	Yes	

Mitigation: Minimising habitat destruction caused by the construction of the facility by keeping the lay-down areas as small as possible, building as few temporary roads as possible, and reducing the final extent of developed area to a minimum. Much of the habitat on site is heavily modified anyway.

Cumulative impacts: Yes, more wind energy developments in the area will increase habitat losses exponentially.

Residual impacts: Some species may be permanently lost to the area regardless of mitigation.

Table 4. Assessment tables for operational impacts of the proposed Rheboksfontein Wind Energy Facility on the local avifauna.

(A) Disturbance

Nature: Noise and movement generated by operating turbines and maintenance activities is sufficient to disturb priority species, causing displacement from the area, adjustments to commute routes with energetic costs, or otherwise affecting nesting success or foraging efficiency.

	Without mitigation	**With mitigation**
Extent	Low-Medium (2)	Low-Medium (2)
Duration	Lifetime of the facility (4)	Lifetime of the facility (4)
Magnitude	Moderate (7)	Moderate (6)
Probability	Highly probable (4)	Highly probable (4)
Significance	52 (Medium-High)	48 (Medium)
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss?	Possible	Possible
Can impacts be mitigated?	Slightly	

Mitigation: Abbreviating maintenance times, scheduling activities in relation to avian breeding and/or movement schedules, and lowering levels of associated noise.

Cumulative impacts: Considerable. Any additional wind energy facilities proposed for the same general area will substantially raise disturbance levels, and extend the displacement or barrier effect across a broader front.

Residual impacts: Some priority species may be permanently lost from the area.

(B) Mortality

Nature: Collision of priority species with the wind turbine blades and/or any new power lines, or electrocution of the same on new power line infrastructure.

	Without mitigation	**With mitigation**
Extent	Medium (3)	Low-Medium (2)
Duration	Lifetime of the facility (4)	Lifetime of the facility (4)
Magnitude	High (8)	Low (4)
Probability	Highly probable (4)	Probable (3)
Significance	60 (Medium-High)	30 (Medium)
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss?	Yes	Possibly not
Can impacts be mitigated?	Yes	

Mitigation: Careful siting of turbines, painting turbine blades, marking power lines, bird friendly power hardware, monitoring priority bird movements and collisions, turbine management sensitive to these data – radar assisted if necessary.

Cumulative impacts: Yes, if more turbines are built in the same general area, more collision hot-spots are likely, and mortality rates may increase exponentially.

Residual impacts: Some casualties may be incurred regardless of mitigation.

IMPACT STATEMENT

This is a medium-large wind energy project, proposed for a site with a number of conflicting issues in terms of its avifauna. The development area does not impinge significantly on any unique landscape features, but it does affect a known bird fly-way, and it will potentially affect populations of regionally or nationally threatened (and impact susceptible) bird species likely to occur within or close to the proposed turbine arrays. The facility will have a detrimental impact on these birds, particularly during its operational phase, unless significant commitment is made to mitigating these effects. Careful and responsible implementation of the required mitigation measures should reduce construction and operational phase impacts to tolerable and sustainable levels, especially if every effort is made to monitor impacts throughout and to learn as much as possible about the effects of wind energy developments on South Africa avifauna. The impacts of this development must be viewed in the context of the potentially substantial cumulative effects generated by multiple wind energy projects proposed for the immediate vicinity.

7. MONITORING PROGRAMME

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

(i) Determine the densities of birds resident within the impact area of the wind energy facility before construction of the facility, and afterwards, once the facility, or phases of the facility, become operational.

(ii) Document patterns of bird activity and movements in the vicinity of the proposed wind energy facility before construction, and afterwards, once the facility is operational.

(iii) 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 facility is commissioned.

(iv) Register and as far as possible document the circumstances surrounding all avian collisions with the turbines for at least a full calendar year after the facility becomes operational.

Bird density and activity monitoring should focus on rare and/or endemic, potentially disturbance or collision prone species, which occur with some regularity in the area (Table 2, Appendix 1). Ultimately, the study should provide much needed quantitative information on the effects of the facility on the distribution and abundance of birds, and the actual risk it poses to the local avifauna, and serve to inform and improve mitigation measures to reduce this risk. It will also establish a precedent and a template for research and monitoring of avian impacts at possible, future wind energy sites in the region. This programme outline is informed by monitoring studies established in other countries (e.g. Erickson *et al.* 1999, Scottish National Heritage 2005), but is based substantially on those developed for both the Darling and the Klipheuwel wind power demonstration facilities in South Africa (Jenkins 2003, Küyler 2004). The bulk of the work involved should be done by an expert ornithologist or under the supervision of such.

7.1 Monitoring protocols

7.1.1 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 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 six months after the facility 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, any cliff-lines or quarry faces within the broader development area should surveyed for cliff-nesting raptors at least once every six months using documented protocols (Malan 2009), all sightings of key species (Table 2) 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).

7.1.2 Bird activity monitoring

Monitoring of bird activity in the vicinity of the facility should be done over a 2-3 day period at least every two months for the six months preceding construction, and at least once per quarter for a full calendar year starting at least six months after the facility is commissioned. Each monitoring day should involve:

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

(ii) Opportunistic surveys of large terrestrial species and raptors seen when travelling around the site.

7.1.3 Passage rates of priority bird species

Counts of bird traffic over and around the proposed/operational facility 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 site), 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.

Once in position at the selected count station, the observer should record (preferably on a specially designed data sheet) the date, count number, start-time and conditions at start - extent of cloud cover, temperature, wind velocity and visibility – and proceed with the count. The counts should detail all individuals or flocks of the stipulated priority bird species, all raptors, and any additional species of particular interest or conservation concern, seen flying within 500 m of the envisaged or actual periphery of the facility. Each record should include the following data: time, updated weather assessment, species, number, mode of flight (flapping, gliding, soaring), flight activity (commuting, hunting other), direction of flight, vertical zoning relative to the envisaged or actual turbine string (low – below or within the rotor arc, medium – within *c.*100 m of the upper rotor arc, high – >100 m above the upper rotor arc), and horizontal zoning relative to the envisaged or actual turbine string (near – through the turbine string or within the outer rotor arc, middle – within *c.*100 m of the outer rotor arc, distant - >100 m beyond the outer rotor arc) and, for post construction monitoring, notes on any obvious evasive behaviour or flight path changes observed in response to the wind energy facility. The time and weather conditions should again be noted at the end of each count.

7.1.4 Lift potential of key slopes

One way to fast track an understanding of the location of important areas for slope soaring birds is to use the flight performance of remote controlled model gliders as surrogates for these birds. These models could be flown by experienced pilots along ridges targeted for turbine placement, and used to identify the main areas of slope lift generation under prevailing wind and weather conditions. This knowledge would then inform decisions about turbine placement in the final layout. Lift potential maps for identified problem slopes or ridges could be generated after 2-4 hours of glider flight per 500 m of ridge line, under each of the commonly occurring wind condition regimes.

7.2 Avian collisions

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.

7.2.1 Assessing search efficiency and scavenging rates

The value of surveying the area for collision victims only holds if some measure of the accuracy of the survey method is developed (Morrison 2002). To do this, a sample of suitable bird carcasses (of similar size and colour to the priority species – e.g. Egyptian Goose *Alopochen aegyptiacus*, domestic waterfowl and pigeons) should be obtained and distributed randomly around the site without the knowledge of the surveyor, some time before the site is surveyed. This process should be repeated opportunistically (as and when suitable bird carcasses become available) for the first two months of the monitoring period, with the total number of carcasses not less than 20. The proportion of the carcasses located in surveys will indicate the relative efficiency of the survey method.

Simultaneous to this process, the condition and presence of all the carcasses positioned on the site should be monitored throughout the initial two-month period, to determine the rates at which carcassess are scavenged from the area, or decay to the point that they are no longer obvious to the surveyor. This should provide an indication of scavenge rate that should inform subsequent survey work for collision victims, particularly in terms of the frequency of surveys required to maximise survey efficiency and/or the extent to which estimates of collision frequency should be adjusted to account for scavenge rate (Osborn *et al.* 2000, Morrison 2002). Scavenger numbers and activity in the area may vary seasonally so, ideally, scavenge and decomposition rates should be measured twice during the monitoring year, once in winter and once in summer.

7.2.2 Collision victim surveys

The area within a radius of at least 50 m of each of the turbines at the facility should be checked regularly for bird casualties (Anderson *et al.* 1999, Morrison 2002). The frequency of these surveys should be informed by assessments of scavenge and decomposition rates conducted in the initial stages of the monitoring period (see above), but they should be done at least weekly for the first two months of the study. The area around each turbine, or a larger area encompassing the entire facility, should be divided into quadrants, and each should be carefully and methodically searched for any sign of a bird collision incident (carcasses, dismembered body parts, scattered feathers, injured birds). All suspected collision incidents should be comprehensively documented, detailing the precise location (preferably a GPS reading), date and time at which the evidence was found, and the site of the find should be photographed with all the evidence *in situ*. All physical evidence should then be collected, bagged and carefully labeled, and refrigerated or frozen to await further examination. If any injured birds are recovered, each should be contained in a suitably-sized cardboard box. The local conservation authority should be notified and requested to transport casualties to the nearest reputable veterinary clinic or wild animal/bird rehabilitation centre. In such cases, the immediate area of the recovery should be searched for evidence of impact with the turbine blades, and any such evidence should be fully documented (as above).

In tandem with surveys of the wind farm for collision casualties, sample sections of any new lengths of power line associated with the development should also be surveyed for collision victims using established protocols (see Jenkins *et al.* 2009, Jenkins *et al.* 2010, Shaw *et al.* 2010 a & b).

8. INPUTS TO THE ENVIRONMENTAL MANAGEMENT PLAN

OBJECTIVE:	A wind energy facility that is sustainable in terms of its impacts on local avifauna
Project components	Conducting comprehensive pre- and post-construction monitoring of local avifauna (as per 7. Above) Getting the monitoring protocols right Securing the strategic use of radar Selecting and training a good monitoring team Selecting a remote controlled glider expert for produce a map/s of slope lift potential on key slopes or ridges where turbine placement and habitat use by soaring birds are expected to be in conflict Collecting and collating sufficient accurate survey data pre-construction Analysing the the pre-construction survey data to inform the final layout and the construction schedule Collecting and collating sufficient accurate survey data post-construction Analysing the post-construction survey data to inform the sustainable management of the facility
Activity / risk source	Starting pre-construction monitoring too late Appointment of unqualified personnel to do the monitoring Use of radar as a monitoring tool is not approved by the client Results of pre-construction monitoring not integrated into the final layout and/or the mitigation scheme Lack of clear communication between the scientist analysing the monitoring data and the client Misinterpetation of either the pre- or post-construction monitoring data

Mitigation: Target / Objective	The delivery of an effective impact mitigation scheme for the facility, informed initially by influence of pre-construction monitoring on final construction plans, and refined by post-construction monitoring of actual impacts, and resulting adjustments in management practices and mitigation measures applied

Mitigation: Action / control	**Responsibility**	**Timeframe**
Appoint advising scientist and agency to conduct pre- and post-construction monitoring	Client	As soon as possible / practical
Refine monitoring protocol and determine the extent of radar deployment required	Advising scientist, in negotiation with the client	As soon as possible / practical
Appoint radar technologists to service the project, and acquire/hire hardware, software and relevant expertise, IF radar use is approved	Advising scientist, in negotiation with the client	As soon as possible / practical
Develop maps of slope soaring potential for any slopes or ridges where birds and turbines may be in competition for the wind resource	Advising scientist, in collaboration with remote controlled glider pilot	As soon as possible / practical
Start pre-construction monitoring	Monitoring agency	1 year before construction is due to start
Periodically collate an analyse pre-construction monitoring data	Advising scientist and radar specialist (if applicable)	Every 3 months of monitoring
Review report on the full year of pre-constrcution monitoring, and integrate findings into construction EMP and broader mitigation scheme	Advising scientist, monitoring agency and radar specialist (if applicable), in negotiation with the client	After a year of pre-construction monitoring
Ensure construction EMP is applied	Relevant Environmental Control Officer	During construction
Refine post-construction monitoring protocol in terms of results pre-construction, and determine the extent of radar deployment required	Advising scientist, monitoring agency and radar specialist (if applicable), in negotiation with the client	As soon as possible / practical after construction completed
Start post-construction monitoring	Monitoring agency	6 months after construction is completed
Periodically collate an analyse post-construction monitoring data	Advising scientist and radar specialist (if applicable)	Every 3 months of monitoring
Review report on the full year of post-constrcution monitoring, and integrate findings into operational EMP and broader mitigation scheme	Advising scientist, monitoring agency and radar specialist (if applicable), in negotiation with the client	1 year post-construction

Review the need for further post-construction monitoring	Advising scientist, monitoring agency and radar specialist (if applicable), in negotiation with the client	1 year post-construction

Performance indicator	Regular provision of clearly worded, logical and objective information on the interface between the local avifauna and the proposed/operating wind energy facility Clear and logical recommendations on why, how and when to institute mitigation measures to reduce avian impacts of the development, from pre-construction to operational phase Quantifiable reductions in avian impacts once the facility is operational
Monitoring	Report on slope lift patterns on key ridges and implications for turbine placements 3-monthly and annual reports produced by the scientist advising the monitoring project

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Appendix 1. Annotated list of the bird species considered likely to occur within the impact zone of the proposed Rheboksfontein Wind Energy Facility. Species seen during the July site visit appear in **bold**.

SPECIES	SCIENTIFIC NAME	CONSERVATION STATUS	ENDEMICITY	HABITAT			
				Natural vegetation fragments	Grain croplands or pasture	Alien trees	Wetlands
Grey-winged Francolin	*Francolinus africanus*	-	Endemic	X	X		
Cape Spurfowl	***Pternistis capensis***	**-**	**Endemic**	**X**			
Common Quail	***Coturnix coturnix***	**-**	**-**	**X**	**X**		
Helmeted Guineafowl	***Numida meleagris***	**-**	**-**	**X**	**X**		
Egyptian Goose	***Alopochen aegyptiaca***	**-**	**-**		**X**		**X**
South African Shelduck	*Tadorna cana*	-	Endemic		X		X
Spur-winged Goose	***Plectropterus gambensis***	**-**	**-**		**X**		
Cape Teal	***Anas capensis***	**-**	**-**				**X**
Yellow-billed Duck	***Anas undulata***	**-**	**-**		**X**		**X**
Cape Shoveler	***Anas smithii***	**-**	**-**				**X**
Red-billed Teal	***Anas erythrorhyncha***	**-**	**-**		**X**		**X**
Greater Honeyguide	*Indicator indicator*	-	-	X		X	
Ground Woodpecker	*Geocalaptes olivaceus*	-	Endemic	X			
Acacia Pied Barbet	*Tricholaema leucomelas*	-	Near-endemic	X		X	
African Hoopoe	*Upupa africana*	-	-	X		X	
Giant Kingfisher	*Megaceryle maximus*	-	-				X
Pied Kingfisher	*Ceryle rudis*	-	-				X
European Bee-eater	*Merops apiaster*	-	-				
White-backed Mousebird	***Colius colius***	**-**	**Endemic**	**X**			
Speckled Mousebird	*Colius striatus*	-	-	X			
Red-faced Mousebird	*Urocolius indicus*	-	-	X			
Klaas's Cuckoo	*Chrysococcyx klaas*	-	-	X		X	
Diderick Cuckoo	*Chrysococcyx caprius*	-	-	X		X	
Burchell's Coucal	*Centropus burchelli*	-	-	X			
Alpine Swift	*Tachymarptus melba*	-	-	X	X		X
Common Swift	*Apus apus*	-	-	X	X		X
African Black Swift	*Apus barbatus*	-	-	X	X		X

SPECIES	SCIENTIFIC NAME	CONSERVATION STATUS	ENDEMICITY	HABITAT			
				Natural vegetation fragments	Grain croplands or pasture	Alien trees	Wetlands
Little Swift	*Apus affinis*	-	-	X	X		X
Horus Swift	*Apus horus*	-	-	X	X		X
White-rumped Swift	*Apus caffer*	-	-	X	X		X
Barn Owl	*Tyto alba*	-	-	X	X	X	
Cape Eagle-Owl	*Bubo capensis*	-	-	X			
Spotted Eagle-Owl	*Bubo africanus*	-	-	X	X	X	
Fiery-necked Nightjar	*Caprimulgus pectoralis*	-	-	X		X	
Freckled Nightjar	*Caprimulgus tristigma*	-	-	X			
Rock Dove	***Columba livia***	**-**	**-**		**X**		
Speckled Pigeon	***Columba guinea***	**-**	**-**		**X**		
Laughing Dove	***Streptopelia senegalensis***	**-**	**-**		**X**		
Cape Turtle-Dove	***Streptopelia capicola***	**-**	**-**	**X**	**X**		
Red-eyed Dove	***Streptopelia semitorquata***	**-**	**-**		**X**	**X**	
Namaqua Dove	*Oena capensis*	-	-		X		
Southern Black Korhaan	*Afrotis afra*	-	Endemic	X	X		X
Blue Crane	***Anthropoides paradiseus***	**Vulnerable**	**Endemic**		**X**		**X**
Black Crake	*Amourornis flavirostris*	-	-				X
African Purple Swamphen	*Porphyrio madagascariensis*	-	-				X
Common Moorhen	*Gallinula chloropus*	-	-				X
Red-knobbed Coot	***Fulica cristata***	**-**	**-**				**X**
Namaqua Sandgrouse	*Pterocles namaqua*	-	-		X		
African Snipe	*Gallinago nigripennis*	-	-				X
Common Whimbrel	*Numenius phaeops*	-	-				X
Marsh Sandpiper	*Tringa stagnatilus*	-	-				X
Common Greenshank	*Tringa nebularia*	-	-				X
Common Sandpiper	*Actitis hypoleucos*	-	-				X
Ruddy Turnstone	*Arenaria interpres*	-	-				X
Red Knot	*Calidris canutus*	-	-				X
Sanderling	*Calidris alba*	-	-				X
Little Stint	*Calidris minuta*	-	-				X

SPECIES	SCIENTIFIC NAME	CONSERVATION STATUS	ENDEMICITY	HABITAT			
				Natural vegetation fragments	Grain croplands or pasture	Alien trees	Wetlands
Curlew Sanpiper	*Calidris ferruginea*	-	-				X
Ruff	*Philomachus pugnax*	-	-				X
Water Thick-knee	*Burhinus vermiculatus*				X		X
Spotted Thick-knee	***Burhinus capensis***	**-**	**-**		**X**		
Black-winged Stilt	***Himantopus himantopus***	**-**	**-**		**X**		**X**
Pied Avocet	***Recurvirostra avosetta***	**-**	**-**				**X**
Grey Plover	*Pluvialis squaterola*	-	-				X
Common Ringed Plover	*Charadrius hiaticula*	-	-				X
Kittlitz's Plover	*Charadrius pecuarius*	-	-				X
Three-banded Plover	*Charadrius tricollaris*	-	-				X
Chestnut-banded Plover	*Charadrius pallidus*	Near-threatened	-				X
White-fronted Plover	*Charadrius marginatus*	-	-				X
Blacksmith Lapwing	***Vanellus armatus***	**-**	**-**		**X**		**X**
Crowned Lapwing	***Vanellus coronatus***	**-**	**-**		**X**		**X**
Kelp Gull	*Larus dominicanus*	-	-		X		X
Grey-headed Gull	*Larus cirrocephalus*	-	-				X
Hartlaub’s Gull	*Larus hartlaubii*	-	Endemic				X
Caspian Tern	*Sterna caspia*	Near-threatened	-				X
Swift Tern	*Sterna bergii*	-	-				X
Sandwich Tern	*Sterna sandvicensis*	-	-				X
Common Tern	*Sterna hirundo*	-	-				X
Arctic Tern	*Sterna paradisaea*	-	-				X
Antarctic Tern	*Sterna vittata*	-	-				X
Little Tern	*Sternaalbifrons*	-	-				X
Black-shouldered Kite	***Elanus caeruleus***	**-**	**-**		**X**	**X**	
Black Kite	*Milvus migrans*	-	-			X	
African Fish-Eagle	*Haliaeetus vocifer*	-	-		X	X	X
Black-chested Snake-Eagle	*Circaetus pectoralis*	-	-	X	X		
African Marsh-Harrier	***Circus ranivorus***	**Vulnerable**	**-**	**X**	**X**		**X**
Black Harrier	*Circus maurus*	Near-threatened	Endemic	X	X		

SPECIES	SCIENTIFIC NAME	CONSERVATION STATUS	ENDEMICITY	HABITAT			
				Natural vegetation fragments	Grain croplands or pasture	Alien trees	Wetlands
Rufous-chested Sparrowhawk	*Accipiter rufiventris*	-	-			X	
Black Sparrowhawk	*Accipiter melanoleucus*	-	-		X	X	
Steppe Buzzard	*Buteo vulpinus*	-	-	X	X	X	
Jackal Buzzard	***Buteo rufofuscus***	**-**	**Endemic**	**X**	**X**	**X**	
Verreauxs' Eagle	*Aquila verreauxii*	-	-	X			
Booted Eagle	*Aquila pennatus*	-	-	X	X		
Martial Eagle	*Polemaetus bellicosus*	Vulnerable	-	X	X	X	
Secretarybird	*Sagittarius serpentarius*	Near-threatened	-	X	X		
Lesser Kestrel	*Falco naumanni*	Vulnerable	-	X	X	X	
Rock Kestrel	***Falco rupicolus***	**-**	**-**	**X**	**X**		
Lanner Falcon	*Falco biarmicus*	Near-threatened	-	X	X		
Peregrine Falcon	*Falco peregrinus*	Near-threatened	-	X	X		
Little Grebe	***Tachybaptus ruficollis***	**-**	**-**				**X**
Great Crested Grebe	*Podiceps cristatus*	-	-				X
Black-necked Grebe	***Podiceps nigricollis***	**-**	**-**				**X**
African Darter	*Anhinga rufa*	-	-				X
Reed Cormorant	***Phalacrocorax africanus***	**-**	**-**				**X**
White-breasted Cormorant	*Phalacrocorax lucidus*	-	-				X
Little Egret	*Egretta garzetta*	-	-		X		X
Yellow-billed Egret	*Egretta intermedia*	-	-				X
Grey Heron	***Ardea cinerea***	**-**	**-**			**X**	**X**
Black-headed Heron	***Ardea melanocephala***	**-**	**-**		**X**	**X**	**X**
Cattle Egret	***Bubulcus ibis***	**-**	**-**		**X**	**X**	**X**
Hamerkop	*Scopus umbretta*	-	-		X	X	X
Greater Flamingo	***Phoenicopterus ruber***	**Near-threatened**	**-**				**X**
Lesser Flamingo	***Phoenicopterus minor***	**Near-threatened**	**-**				**X**
Glossy Ibis	*Plegadis falcinellus*	-	-				X
Hadeda Ibis	***Bostrychia hagedash***	**-**	**-**		**X**	**X**	**X**
African Sacred Ibis	***Threskiornis aethiopicus***	**-**	**-**		**X**		**X**

SPECIES	SCIENTIFIC NAME	CONSERVATION STATUS	ENDEMICITY	HABITAT			
				Natural vegetation fragments	Grain croplands or pasture	Alien trees	Wetlands
African Spoonbill	*Platalea alba*	-	-				X
Great White Pelican	***Pelecanus onocrolatus***	**Near-threatened**	**-**				**X**
Black Stork	*Ciconia nigra*	Near-threatened	-				X
White Stork	*Ciconia ciconia*	-	-		X		
Southern Boubou	*Laniarius ferrugineus*	-	Endemic	X			
Bokmakierie	***Telophorus zeylonus***	**-**	**Near-endemic**	**X**			
Cape Crow	*Corvus capensis*	-	-		X	X	
Pied Crow	***Corvus albus***	**-**	**-**		**X**	**X**	
White-necked Raven	*Corvus albicollis*	-	-	X	X		
Common Fiscal	***Lanius collaris***	**-**	**-**	**X**			
Cape Penduline Tit	*Anthroscopus minutus*	-	Near-endemic	X			
Grey Tit	*Parus afer*	-	Endemic	X			
Brown-throated Martin	***Riparia paludicola***	**-**	**-**	**X**	**X**		**X**
Banded Martin	*Riparia cincta*	-	-	X	X		X
Barn Swallow	*Hirundo rustica*	-	-	X	X		X
White-throated Swallow	*Hirundo albigularis*	-	-	X	X		X
Pearl-breasted Swallow	*Hirundo dimidiata*	-	-	X	X		X
Greater Striped Swallow	*Hirundo cucullata*	-	-	X	X		X
Rock Martin	*Hirundo fuligula*	-	-	X	X		X
Common House-Martin	*Delichon urbicum*	-	-	X	X		X
Cape Bulbul	***Pycnonotus capensis***	**-**	**Endemic**	**X**			
Cape Grassbird	*Sphenoeacus afer*	-	Endemic	X			
Long-billed Crombec	*Sylvietta rufescens*	-	-	X			
Yellow-bellied Eremomela	*Eremomela icteropygialis*	-	-	X			
Little Rush Warbler	*Bradypterus baboecala*	-	-				X
African Reed Warbler	*Acrocephalus baeticatus*	-	-				X
Lesser Swamp Warbler	*Acrocephalus gracilirostris*	-	-				X
Layard's Tit-Babbler	*Parisoma layardi*	-	Endemic	X			
Chestnut-vented Tit-Babbler	*Parisoma subcaeruleum*	-	-	X			

SPECIES	SCIENTIFIC NAME	CONSERVATION STATUS	ENDEMICITY	HABITAT			
				Natural vegetation fragments	Grain croplands or pasture	Alien trees	Wetlands
Cape White-eye	*Zosterops virens*	-	Endemic	X		X	
Grey-backed Cisticola	*Cisticola subruficapilla*	-	-	X			
Levaillant's Cisticola	*Cisticola tinniens*	-	-	X			
Neddicky	*Cisticola fulvicapilla*	-	-	X			
Zitting Cisticola	*Cisticola juncidis*	-	-		X		
Cloud Cisticola	*Cisticola textrix*	-	Near-endemic		X		
Karoo Prinia	***Prinia maculosa***	**-**	**Endemic**	**X**	**X**		
Bar-throated Apalis	*Apalis thoracica*	-	-	X			
Cape Clapper Lark	*Mirafra apiata*	-	Endemic	X	X		
Karoo Lark	*Calendulauda albescens*	-	Endemic	X	X		
Cape Long-billed Lark	*Certhilauda curvirostris*	-	Endemic	X	X		
Grey-backed Sparrowlark	*Eremopterix verticalis*	-	-	X	X		
Red-capped Lark	***Calandrella cinerea***	**-**	**-**		**X**		
Large-billed Lark	***Galerida magnirostris***	**-**	**Endemic**		**X**		
Cape Rock Thrush	*Monticola rupestris*	-	Endemic	X			
Fiscal Flycatcher	*Sigelus silens*	-	Endemic			X	
Cape Robin-Chat	***Cossypha caffra***	**-**	**-**	**X**		**X**	
Karoo Scrub-Robin	***Cercotrichas coryphoeus***	**-**	**Endemic**	**X**			
African Stonechat	***Saxicola torquatus***	**-**	**-**	**X**	**X**		
Mountain Wheatear	*Oenanthe monticola*	-	Near-endemic	X	X		
Capped Wheatear	***Oenanthe pileata***	**-**	**-**		**X**		
Sickle-winged Chat	*Cercomela sinuata*	-	Endemic	X	X		
Familiar Chat	*Cercomela familiaris*	-	-	X	X		
Ant-eating Chat	***Myrmecocichla formicivora***	**-**	**Endemic**	**X**	**X**		
Red-winged Starling	*Onychognathus morio*	-	-				
Pied Starling	***Spreo bicolor***	**-**	**Endemic**		**X**		
Wattled Starling	***Creatophora cinerea***	**-**	**-**		**X**		
Common Starling	***Sturnus vulgaris***	**-**	**-**		**X**	**X**	
Orange-breasted Sunbird	*Anthobaphes violacea*	-	Endemic	X			
Malachite Sunbird	*Nectarinia famosa*	-	-	X			

SPECIES	SCIENTIFIC NAME	CONSERVATION STATUS	ENDEMICITY	HABITAT			
				Natural vegetation fragments	Grain croplands or pasture	Alien trees	Wetlands
Southern Double-collared Sunbird	***Cinnyris chalybeus***	**-**	**Endemic**	**X**		**X**	
Cape Sugarbird	*Promerops cafer*	-	Endemic	X			
Dusky Sunbird	*Cinnyris fuscus*	-	Near-endemic	X			
Cape Weaver	***Ploceus capensis***	**-**	**Endemic**	**X**	**X**	**X**	**X**
Southern Masked-Weaver	*Ploceus velatus*	-	-	X	X	X	X
Red-billed Quelea	*Quelea quelea*	-	-		X		
Yellow Bishop	***Euplectes capensis***	**-**	**-**	**X**	**X**		
Southern Red Bishop	***Euplectes orix***	**-**	**-**	**X**	**X**		
African Quailfinch	*Ortygospiza atricollis*	-	-		X		
Common Waxbill	*Estrilda astrild*	-	-		X		
Pin-tailed Whydah	*Vidua macroura*	-	-		X		
House Sparrow	***Passer domesticus***	**-**	**-**		**X**	**X**	
Cape Sparrow	***Passer melanurus***	**-**	**Near-endemic**	**X**	**X**	**X**	
Cape Wagtail	***Motacilla capensis***	**-**	**-**				**X**
Cape Longclaw	***Macronyx capensis***	**-**	**Endemic**	**X**			
African Pipit	***Anthus cinnamomeus***	**-**	**-**	**X**	**X**		
Plain-backed Pipit	*Anthus leucophrys*	-	-	X	X		
Cape Canary	***Serinus canicollis***	**-**	**Endemic**	**X**	**X**	**X**	
Black-headed Canary	*Serinis alario*	-	Endemic	X	X		
Yellow Canary	*Crithagra flaviventris*	-	Near-endemic	X	X		
Brimstone Canary	*Crithagra sulphuratus*	-	-	X		X	
White-throated Canary	*Crithagra albogularis*	-	Near-endemic		X		
Streaky-headed Seedeater	*Crithagra gularis*	-	-		X		
Lark-like Bunting	*Emberiza impetuani*	-	-		X		
Cape Bunting	*Emberiza capensis*	-	Near-endemic	X			

ENVIRONMENTAL IMPACT REPORT:

Specialist ecological study on the potential impacts of the proposed Rheboksfontein Wind Energy Facility Project, Darling, Western Cape

Prepared by

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for

Savannah Environmental (Pty) Ltd
Eglin Office Park, 14 Eglin Road
PO Box 148,
Sunninghill,
2197

on behalf of
Moyeng Energy (Pty) Ltd

20 September 2010

FINAL EIA REPORT

David Hoare Consulting cc

Biodiversity Assessments, Vegetation Description / Mapping, Species Surveys

CONTROL SHEET FOR SPECIALIST REPORT

The table below lists the specific requirements for specialist studies, according to Regulation 33 of Government Notice No. R385 of 1996 EIA Regulations.

Activity	Yes	No	**Comment**
Details of: 1. the person who prepared the report; and	√		
2. the expertise of that person to carry out the specialist study or specialised process	√		
A declaration that the person is independent in a form as may be specified by the competent authority	√		
An indication of the scope of, and the purpose for which, the report was prepared	√		
A description of the methodology adopted in preparing the report or carrying out the specialised process	√		
A description of any assumptions made and any uncertainties or gaps in knowledge	√		
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	√		
Recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority	√		
A description of any consultation process that was undertaken during the course of carrying out the study	√		
A summary and copies of any comments that were received during any consultation process	√		
Any other information requested by the competent authority	√		

REGULATIONS GOVERNING THIS REPORT

This report has been prepared in terms the EIA Regulations promulgated under the *National Environmental Management Act* No. 107 of 1998 (NEMA) and is compliant with Regulation 385 Section 33 - Specialist reports and reports on specialized processes under the Act. Relevant clauses of the above regulation are quoted below and reflect the required information in the "Control sheet for specialist report" given above.

Regulation 33. (1): An applicant or the EAP managing an application may appoint a person who is independent to carry out a specialist study or specialized process.

Regulation 33. (2): A specialist report or a report on a specialized process prepared in terms of these Regulations must contain:
(a) details of (i) the person who prepared the report, and
(ii) the expertise of that person to carry out the specialist study or specialized process;
(b) declaration that the person is independent in a form as may be specified by the competent authority;
(c) indication of the scope of, and the purpose for which, the report was prepared;
(d) description of the methodology adopted in preparing the report or carrying out the specialized process;
(e) description of any assumptions made and any uncertainties or gaps in knowledge;
(f) description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment;
(g) recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority;
(h) description of any consultation process that was undertaken during the course of carrying out the study;
(i) summary and copies of any comments that were received during any consultation process;
(j) any other information requested by the competent authority.

Appointment of specialist

Dr David Hoare of David Hoare Consulting cc was commissioned by Savannah Environmental (Pty) Ltd to provide specialist consulting services for the Environmental Impact Assessment for the proposed Rheboksfontein Wind Energy Facility Project near Darling in the Western Province. The consulting services comprise an assessment of potential impacts on the fauna in the study area by the proposed project.

Details of specialist

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Summary of expertise

Dr David Hoare:

- Registered professional member of The South African Council for Natural Scientific Professions (Ecological Science, Botanical Science), registration number 400221/05.
- Founded David Hoare Consulting cc, an independent consultancy, in 2001.
- Ecological consultant since 1995.
- Conducted, or co-conducted, over 200 specialist ecological surveys as an ecological consultant.
- Published six technical scientific reports, 15 scientific conference presentations, seven book chapters and eight refereed scientific papers.
- Attended 15 national and international congresses & 5 expert workshops, lectured vegetation science / ecology at 2 universities and referee for 2 international journals.

Independence

David Hoare Consulting cc and its Directors have no connection with Moyeng Energy (Pty) Ltd. David Hoare Consulting cc is not a subsidiary, legally or financially, of the proponent. Remuneration for services by the proponent in relation to this project is not linked to approval by decision-making authorities responsible for authorising this proposed project and the consultancy has no interest in secondary or downstream developments as a result of the authorisation of this project. David Hoare is an independent consultant to Savannah Environmental (Pty) Ltd and has no business, financial, personal or other interest in the activity, application or appeal in respect of which he was 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. The percentage work received directly or indirectly from the proponent in the last twelve months is approximately 0% of turnover.

Scope and purpose of report

The scope and purpose of the report are reflected in the "Terms of reference" section of this report

Conditions relating to this report

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. David Hoare Consulting cc and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

This report must not be altered or added to without the prior written consent of the author. This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

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INTRODUCTION

Terms of reference and approach

Savannah Environmental (Pty) Ltd. was appointed by Moyeng Energy (Pty) Ltd to undertake an application for environmental authorisation through an Environmental Impact Assessment (EIA) for the proposed "Rheboksfontein Wind Energy Facility Project." The project involves the establishment of a wind energy facility and associated infrastructure, including wind turbines, undergound cables between turbines, a sub-station and internal access roads. The purpose of the EIA is to identify environmental impacts associated with the project.

In February 2010 David Hoare Consulting cc was appointed by Savannah Environmental (Pty) Ltd to undertake a fauna assessment of the study area. The specific terms of reference for the ecological study include:

- an indication of the methodology used in determining the significance of potential environmental impacts;
- a description of the environmental issues that were identified during the environmental impact assessment process;
- an assessment of the significance of direct, indirect and cumulative impacts in terms of standard criteria;
- a description and comparative assessment of all alternatives identified during the environmental impact assessment process;
- recommendations regarding practical mitigation measures for potentially significant impacts, for inclusion in the Environmental Management Plan;
- an indication of the extent to which the issue could be addressed by the adoption of achievable mitigation measures;
- a description of any assumptions, uncertainties and gaps in knowledge;
- an environmental impact statement which contains
- a summary of the key findings of the environmental impact assessment,
- an assessment of the positive and negative implications of the proposed activity,
- a comparative assessment of the positive and negative implications of the distribution line alternatives,
- a comparative assessment of the postivie and negative implications of the access road alternatives.

This report provides details of the results of the EIA phase. The findings of the study are based on a combination of a desktop assessment of the study area and fieldwork undertaken on site

Study area

At a regional level the study area falls within the Western Province to the north of the town of Darling. A more detailed description of the study area is provided in a section below.

METHODOLOGY

The project was to be undertaken in two phases, a Scoping phase and an Environmental Impact Assessment phase. The objective of the EIA phase study was to assess the significance of potential impacts on fauna and flora patterns within the study area. This report contains all the descriptive information on flora and fauna that were presented in the Scoping report as well as a comprehensive assessment of potential impacts. The results of the EIA phase study are provided in this report.

Assessment philosophy

Many parts of South Africa contain high levels of biodiversity at species and ecosystem level. At any single site there may be large numbers of species or high ecological complexity. Sites also vary in their natural character and uniqueness and the level to which they have been previously disturbed. Assessing the potential impacts of a proposed development often requires evaluating the conservation value of a site relative to other natural areas and relative to the national importance of the site in terms of biodiversity conservation. A simple approach to evaluating the relative importance of a site includes assessing the following:

- Is the site unique in terms of natural or biodiversity features?
- Is the protection of biodiversity features on site of national/provincial importance?
- Would development of the site lead to contravention of any international, national or provincial legislation, policy, convention or regulation?

Thus, the general approach adopted for this type of study is to identify any critical biodiversity issues that may lead to the decision that the proposed project cannot take place, i.e. to specifically focus on red flags and/or potential fatal flaws. Biodiversity issues are assessed by documenting whether any important biodiversity features occur on site, including species, ecosystems or processes that maintain ecosystems and/or species. These can be organised in a hierarchical fashion, as follows:

Species

- threatened animal species

Ecosystems

- critical biodiversity areas
- areas of high biodiversity
- centres of endemism

Processes

- corridors
- mega-conservancy networks

It is not the intention to provide comprehensive lists of all species that occur on site, since most of the species on these lists are usually common or widespread species. Rare, threatened, protected and conservation-worthy species and habitats are considered to be the highest priority, the presence of which are most likely to result in significant negative impacts on the ecological environment. The focus on national and provincial priorities and critical biodiversity issues is in line with National legislation protecting environmental and biodiversity resources, including, but not limited to the following which ensure protection of ecological processes, natural systems and natural beauty as well as the preservation of biotic diversity in the natural environment:

- Environment Conservation Act (Act 73 of 1989)
- National Environmental Management Act, 1998 (NEMA) (Act 107 of 1998)
- National Environmental Management Biodiversity Act, 2004. (Act 10 0f 2004)

Animal species of concern

The purpose of listing Red Data animal species was to provide information on the potential occurrence of species of special concern in the study area that may be affected by the proposed infrastructure. Species appearing on these lists could then be assessed in terms of their habitat requirements in order to determine whether any of them have a likelihood of occurring in habitats that may be affected by the proposed infrastructure.

Lists were compiled specifically for any species of conservation concern previously recorded in the area and any other species with potential conservation value. Lists of threatened animal and bird species that have a geographical range that includes the study area were obtained from literature sources (e.g. Barnes 2000, Branch 1988, 2001, Friedmann & Daly 2004, Mills & Hes 1997). The likelihood of any of them occurring was evaluated on the basis of habitat preference and habitats available at each of the proposed sites. The three parameters used to assess the probability of occurrence for each species were as follows:

- *Habitat requirements*: most Red Data animals have very specific habitat requirements and the presence of these habitat characteristics within the study area were assessed;
- *Habitat status*: in the event that available habitat is considered suitable for these species, the status or ecological condition was assessed. Often, a high level of degradation of a specific habitat type will negate the potential presence of Red Data species (especially wetland-related habitats where water-quality plays a major role); and
- *Habitat linkage*: movement between areas used for breeding and feeding purposes forms an essential part of ecological existence of many species. The connectivity of the study area to these surrounding habitats and adequacy of these linkages are assessed for the ecological functioning Red Data species within the study area.

For all threatened fauna that occur in the general geographical area of the site, a rating of the likelihood of it occurring on site is given as follows:

- LOW: no suitable habitats occur on site / habitats on site do not match habitat description for species;
- MEDIUM: habitats on site match general habitat description for species (e.g. fynbos), but detailed microhabitat requirements (e.g. mountain fynbos on shallow soils overlying Table Mountain sandstone) are absent on the site or are unknown from the descriptions given in the literature or from the authorities;
- HIGH: habitats found on site match very strongly the general and microhabitat description for the species (e.g. mountain fynbos on shallow soils overlying Table Mountain sandstone);
- DEFINITE: species found in habitats on site.

Sensitivity assessment

The study site was evaluated in terms of the potential for containing habitat for animal species of conservation concern. Any habitat considered important for species of concern was considered to be sensitive whereas habitat not important for species of conservation concern was considered t be not sensitive.

Table 1: Sensitivity analysis

Sensitivity class	Description
Low Sensitivity	Habitat with no breeding, inhabiting or foraging importance for animal species of conservation concern
Medium Sensitivity	Habitat with breeding, inhabiting or foraging importance for animal species of low conservation concern (Near Threatened, Declining, Rare or Restricted)
High Sensitivity	Habitat with breeding, inhabiting or foraging importance for animal species of high conservation concern (Critically Endangered, Endangered or Vulnerable)

Assessment of impacts

Direct, indirect and cumulative impacts of the issues identified through the scoping study, as well as all other issues identified in the EIA phase were assessed in terms of the following criteria:

- » The **nature**, which includes a description of what causes the effect, what will be affected and how it will be affected.
- » The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 was assigned as appropriate (with 1 being low and 5 being high):
- » The **duration**, wherein it was indicated whether:
  - ∗ the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - ∗ the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - ∗ medium-term (5–15 years) – assigned a score of 3;
  - ∗ long term (> 15 years) - assigned a score of 4; or
  - ∗ permanent - assigned a score of 5;
- » The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- » The **probability** *of occurrence*, which describes the likelihood of the impact actually occurring. Probability was estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- » the **significance**, was determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- » the **status**, which was described as either positive, negative or neutral.
- » the degree to which the impact can be reversed.
- » the degree to which the impact may cause irreplaceable loss of resources.
- » the degree to which the impact can be mitigated.

The **significance** was calculated by combining the criteria in the following formula:

S=(E+D+M)P

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

» < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
» 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
» > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

Limitations

- Red List species are, by their nature, usually very rare and difficult to locate. Compiling the list of species that could potentially occur in an area is limited by the paucity of collection records that make it difficult to predict whether a species may occur in an area or not. The methodology used in this assessment is designed to reduce the risks of ommitting any species, but it is always possible that a species that does not occur on a list may be located in an area where it was not previously known to exist.

DESCRIPTION OF STUDY AREA

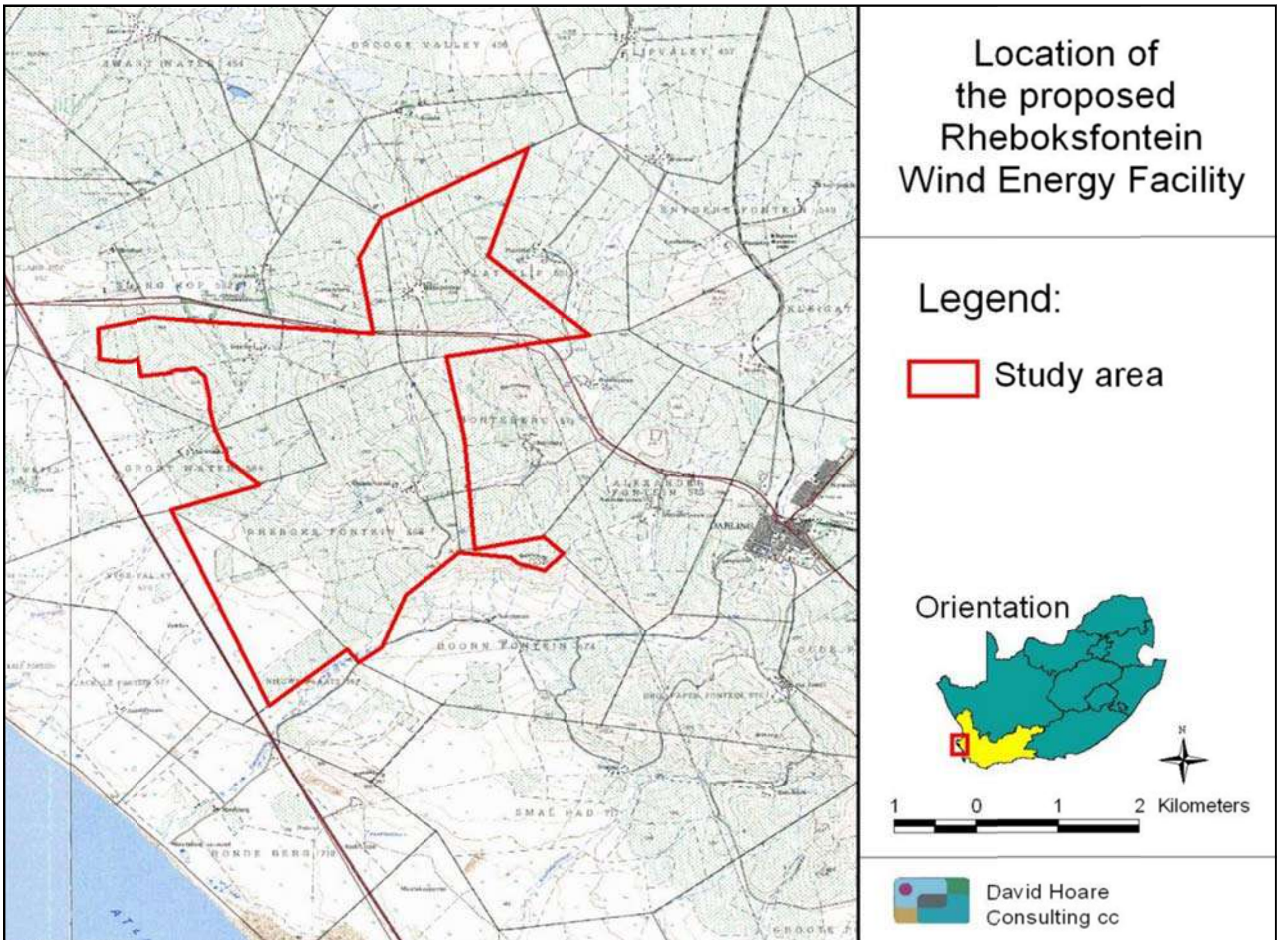
Location

The study site is situated west of Darling in the Western Cape Province and falls within the quarter degree grid 3318AD (Figure 1). The farm portions on which the proposed wind energy facility would occur include the following: Remaining extent of Farm 568 (Rheboksfontein), Farm 567 (Nieuwe Plaats), Remaining extent of Farm 571 (Bonteberg), Portion 1 of Farm 574 (Doornfontein), Portion 1 of Farm 551 (Plat Klip), Farm 1199 (Groot Berg) and Portion 2 of Farm 552 (Slang Kop). No alternative site is currently being considered for the proposed wind energy facility.

The study area is to the east of the R27 coastal road from the Cape (Melkbossttrand) to Velddrift. The R315 from Darling to Yzerfontein passes through the site. The site is therefore well-connected to regional routes.

Landuse / landcover and vegetation

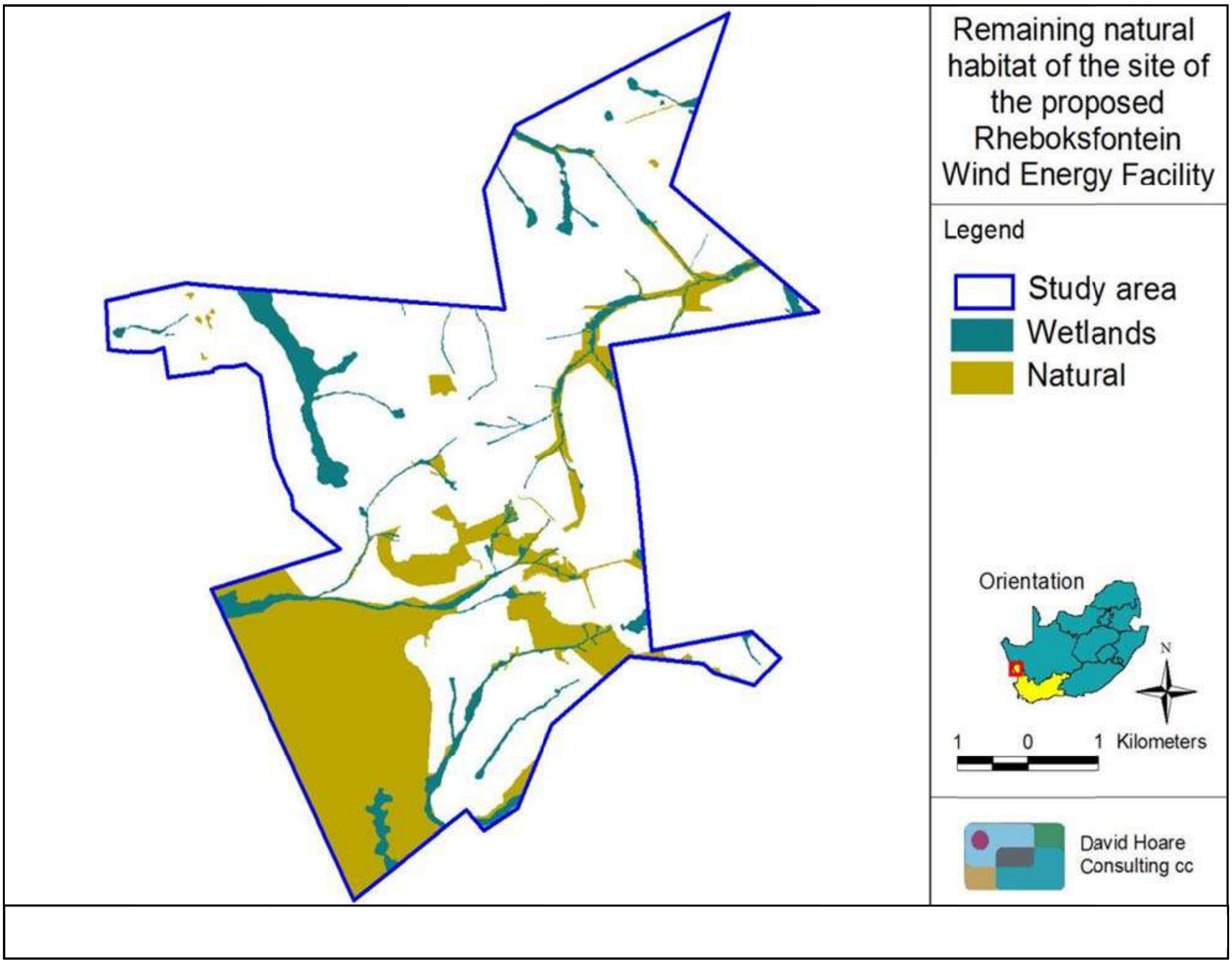
A landcover map of the study area (Fairbanks *et al*. 2000) indicates that a large proportion of the site consists of cultivation, degraded shrubland / low fynbos and grassland (both considered to be secondary vegetation on old lands) with a few small patches of shrubland / low fynbos (natural). The Surveyor General's 1:50 000 topocadastral maps for the study area



supports this observation and indicates that cultivation has taken place across most of the site. The field assessment confirmed these patterns. Large parts of the site were found to be cultivated and remaining areas of natural habitat were often not in pristine condition. There are, however, areas that could potentially support unique populations of animals, depending on their habitat requirements. The extent of these remaining areas of habitat is shown in Figure 2. This figure can also be considered to be a sensitivity map for fauna for the study area.

The study site is located within the Cape Floristic Region (CFR), which is recognised as one of the principal centres of diversity and endemism in Africa. Fynbos and Renosterveld are considered to be the main vegetation types in the CFR. Fynbos is very species rich, but has been transformed or degraded to a high degree and is therefore considered to be of high conservation value.

The site occurs within two vegetation types: Swartland Granite Renosterveld, classified as Critically Endangered, and Hopefield Sand Fynbos, classified as Endangered (Mucina *et al*. 2005, Mucina & Rutherford 2006). The vegetation-type descriptions provide an indication that vegetation on site consists primarily of fynbos and renosterveld. There are, however, also strips of thicket along drainage lines in the areas of steeper topography and wetland vegetation within the drainage lines. Areas closer to the coast have large proportions of sandy substrates or mobile sand. Despite high levels of transformation on site, there are a number of different habitat types that may provide suitable habitat for a variety of faunal species.



Red List animal species of the study area

All vertebrates (mammals, birds, reptiles, amphibians) of conservation concern that have a geographical distribution that includes the study area are listed in Appendix 1[1]. Based on habitat requirements, there are a number of threatened or near threatened species that were considered to have a possibility of occurring on site or making use of habitats available on site. These are the following:

- White-tailed Rat (EN)
- Cape Caco (VU)
- Namaqua Plated Lizard (NT)
- Fisk's House Snake (VU)
- Yellow-bellied House Snake (NT)
- Gronovi's Dwarf Burrowing Skink (NT)
- Kasner's Dwarf Burrowing Skink (VU)

There were also two threatened bat species that have a geographical distribution that includes the site and there is some possibility that they may be encountered on site, either foraging, nesting or roosting. These include the following:

- Lesueur's Wing-gland bat (NT)
- Schreiber's long-fingered bat (NT)

None of these species are protected according to section 56(1) of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004).

The remaining species with a geographical range that includes the site were assessed as having a low chance of occurring in available habitats in the study area or the study site is at the margin of their distribution range.

[1] The IUCN conservation status of some species has been updated since the Scoping Report was written. Appendix 1 contains fewer species than in the Scoping Report.

RELEVANT LEGISLATIVE AND PERMIT REQUIREMENTS

Relevant legislation is provided in this section to provide a description of the key legal considerations of importance to the proposed project. The applicable legislation is listed below.

Legislation

National Environmental Management Act, Act No. 107 of 1998 (NEMA)

NEMA requires, inter alia, that:

- "development must be socially, environmentally, and economically sustainable",
- "disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied." ,
- "a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions",

NEMA states that "the environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage."

Environment Conservation Act No 73 of 1989 Amendment Notice No R1183 of 1997

The ECA states that:

- Development must be environmentally, socially and economically sustainable. Sustainable development requires the consideration of inter alia the following factors:
- that pollution and degradation of the environment is avoided, or, where they cannot be altogether avoided, are minimised and remedied;
- that the use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource;
- that the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised; and
- that negative impacts on the environment and on peoples' environmental rights be anticipated and prevented, and where they cannot be altogether prevented are minimised and remedied.
- The developer is required to undertake Environmental Impact Assessments (EIA) for all projects listed as a Schedule 1 activity in the EIA regulations in order to control activities which might have a detrimental effect on the environment. Such activities will only be permitted with written authorisation from a competent authority.

National Environmental Management: Biodiversity Act (Act No 10 of 2004)

In terms of the Biodiversity Act, the developer has a responsibility for:

- The conservation of endangered ecosystems and restriction of activities according to the categorisation of the area (not just by listed activity as specified in the EIA regulations).
- Promote the application of appropriate environmental management tools in order to ensure integrated environmental management of activities thereby ensuring that all development within the area are in line with ecological sustainable development and protection of biodiversity.
- Limit further loss of biodiversity and conserve endangered ecosystems.

The Nature and Environmental Conservation Ordinance, 1974 (Ordinance 19 of 1974)

Provides for protection of fauna and flora in the Western Cape Province.

The Western Cape Nature Conservation Laws Amendment Act, 2000 (Ordinance 3 of 2000)

Provides for the amendment of various laws on nature conservation in order to transfer the administration of the provisions of those laws to the Western Cape Nature Conservation Board. Also provides updated lists of endangered and protected fauna and flora for the Province.

National Water Act

Wetlands, riparian zones and watercourses are defined in the Water Act as a water resource and any activities that are contemplated that could affect the wetlands requires authorisation (Section 21 of the National Water Act of 1998). A "watercourse" in terms of the National Water Act (act 36 of 1998) means:

- River or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and

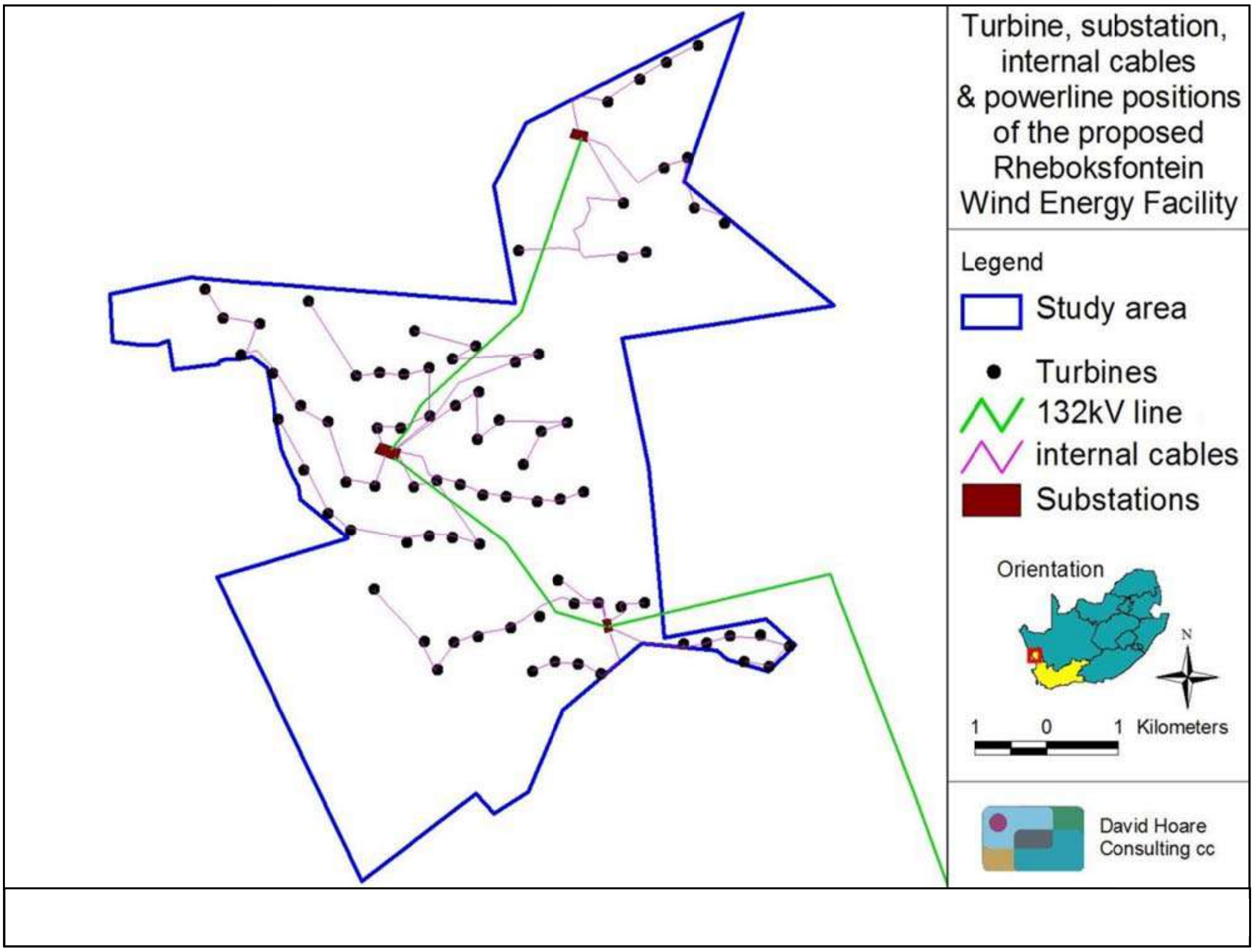
Any collection of water which the Minister may, by notice in the gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

DESCRIPTION OF INFRASTRUCTURE

A total of 80 turbines have been proposed for the site. Each turbine will have a relatively small footprint (i.e. 15 m x 15m). There will be disturbance beyond this during the construction phase since a lay-down area is required prior to raising the turbine to it's final position.

The power line from the wind energy facility to the substation and to the grid will be a 132kV line. The substation will be 80 m x 90 m in extent. There are 3 internal substations, internal cables for connecting turbines to one another and internal access roads to turbines. It is proposed that the internal access roads and the internal cables linking turbines will follow the same routes.

The position of the turbines, substations, internal underground cables and overhead power line in the study area is indicated in Figure 3.



IDENTIFICATION OF RISKS AND POTENTIAL IMPACTS

Potential issues relevant to potential impacts on the fauna of the study area include the following:

- Impacts on biodiversity: this includes any impacts on populations of individual species of concern.
- Impacts on sensitive habitats: this includes impacts on any habitats that are important for threatened fauna.
- Impacts on ecosystem function: this includes impacts on any processes or factors that maintain ecosystem health and character, including the following:
    - disruption to nutrient-flow dynamics;
    - impedance of movement of material or water;
    - habitat fragmentation;
    - changes to abiotic environmental conditions;
    - changes to disturbance regimes, e.g. increased or decreased incidence of fire;
    - changes to successional processes;
    - effects on pollinators;
    - increased invasion by alien plants.

  Changes to factors such as these may lead to a reduction in the resilience of habitats and ecosystems or loss or change in ecosystem function.

- Secondary and cumulative impacts on fauna: this includes an assessment of the impacts of the proposed project taken in combination with the impacts of other known projects for the area or secondary impacts that may arise from changes in the social, economic or ecological environment.

A number of direct risks to ecosystems would result from construction of the proposed WEF, as follows:

- Clearing of land for construction.
- Construction of access roads.
- Placement of underground cables linking turbines.
- Chemical contamination of the soil by construction vehicles and machinery.
- Storage of materials required for construction.

There are also risks associated with operation of the proposed WEF, as follows:

- Collisions with flying animals (bats and birds). This may have local impacts on populations as well as cumulative effects on species over wider areas.
- Maintenance of surrounding vegetation as part of management of WEF.

Description of potential impacts

Major potential impacts are described briefly below. These are compiled from a generic list of possible impacts derived from previous projects of this nature and from a literature review of the potential impacts of wind energy facilities on the ecological environment. There are two major ways that wind-energy development may influence ecosystem structure and functioning—through direct impacts on individual organisms and through impacts on habitat structure and functioning. The most important potential negative ecological impacts of a WEF are related to bird and bat mortality and loss of habitat.

Impact 1: Impacts on threatened animals

Nature: Threatened animal species are affected primarily by the overall loss of habitat, since direct construction impacts can often be avoided due to movement of individuals from the path of construction. Construction of turbines, access roads, transmission lines and other infrastructure associated with the wind energy facility will lead to direct loss of habitat. There are some small patches of natural habitat remaining on site. This vegetation potentially provides habitat for a number of threatened or near threatened species (threatened species include those classified as critically endangered, endangered or vulnerable), including the following: White-tailed Rat (EN), Cape Caco (VU), Namaqua Plated Lizard (NT), Fisk's House Snake (VU), Yellow-bellied House Snake (NT), Gronovi's Dwarf Burrowing Skink (NT) and Kasner's Dwarf Burrowing Skink (VU). The potential value of this natural habitat for these species of conservation concern is affected by the particular requirements of each species and the availability of habitat on site.

For threatened animal species, loss of a population or individuals could lead to:

- fragmentation of populations of affected species;
- reduction in area of occupancy of affected species; and
- loss of genetic variation within affected species.

These may all lead to a negative change in conservation status of the affected species, which implies a reduction in the chances of the species overall survival chances.

Impact 2: Impacts on bats

Nature: Bird and bat deaths are one of the most controversial biological issues related to wind turbines. The deaths of birds and bats at wind farm sites have raised concerns by conservation agencies internationally. In order to address this issue in South Africa, the Endangered Wildlife Trust (EWT) and BirdLife South Africa (BLSA) have combined efforts to lobby for the appropriate consideration of the potential negative effects of wind energy production. Impacts on birds as a result of the proposed WEF are assessed in a separate report.

Bats have been found to be particularly vulnerable to being killed by wind turbines. It has long been a mystery why they should be so badly affected since bat echo-location allows them to detect moving objects very well. A recent study in America has found that the primary cause for mortality is a combination of direct strikes and barotrauma (bats are killed when suddenly passing through a low air pressure region surrounding the turbine blade tips causing low pressure damage the bat's lungs, Baerwald *et al*. 2008). The relative importance of this impact on bat populations depends on which species are likely to be affected, the importance of the site for those species and whether the site is within a migration corridor for particular bat species.

The most vulnerable species are those that are already classified as threatened species, including those classified as critically endangered, endangered or vulnerable. For any other species a loss of individuals or localized populations is unlikely to lead to a change in the conservation status of the species unless the impact occurs across a wide area that co-incides with their overall distribution range. Loss of a population or individuals could lead to a direct change in the conservation status of the species. This may arise if the proposed infrastructure is located where it will impact on such individuals or populations or the habitat that they depend on. Consequences may include:

- fragmentation of populations of affected species;
- reduction in area of occupancy of affected species; and
- loss of genetic variation within affected species.

These may all lead to a negative change in conservation status of the affected species, which implies a reduction in the chances of the species overall survival chances.

It has been evaluated that there are two near threatened bat species that could potentially be affected by the proposed wind energy facility. These are Lesueur's Wing-gland bat (NT) and Schreiber's long-fingered bat (NT).

Impact 3: Impacts on watercourses and wetlands

Construction may lead to some direct or indirect loss of or damage to seasonal marsh wetlands or drainage lines or impacts that affect the catchment of these wetlands. This will lead to localised loss of wetland habitat and may lead to downstream impacts that affect a greater extent of wetlands or impact on wetland function. Where these habitats are already stressed due to degradation and transformation, the loss may lead to increased vulnerability (susceptibility to future damage) of the habitat. Physical alteration to wetlands can have an impact on the functioning of those wetlands. Consequences may include:

1. increased loss of soil;
2. loss of or disturbance to indigenous wetland vegetation;
3. loss of sensitive wetland habitats;
4. loss or disturbance to individuals of rare, endangered, endemic and/or protected species that occur in wetlands;
5. fragmentation of sensitive habitats;
6. impairment of wetland function;
7. change in channel morphology in downstream wetlands, potentially leading to further loss of wetland vegetation; and
8. reduction in water quality in wetlands downstream of road.

The site contains a number of non-perennial streams, drainage lines and wetlands. These are mapped on Figure 2.

ASSESSMENT OF IMPACTS

Impacts are assessed for each component of infrastructure for the proposed wind energy facility, as follows:

- wind turbines;
- substations;
- overhead power line (132kV);
- underground cables between turbines and linking turbines to internal substations in combination with internal access roads.

Wind turbines

Impact 1: Impacts on threatened animals

It has been evaluated that there are four threatened and two near threatened animal species that could potentially be affected by the proposed wind energy facility. These are White-tailed Rat (EN), Cape Caco (VU), Namaqua Plated Lizard (NT), Fisk's House Snake (VU), Yellow-bellied House Snake (NT), Gronovi's Dwarf Burrowing Skink (NT) and Kasner's Dwarf Burrowing Skink (VU). These species are most likely to be affected by the construction of the wind energy facility to a greater extent than the operation of the wind energy facility.

Extent: The impact will occur at the site of the proposed WEF, specifically at the scale of the individual infrastructure within the site. At it's greatest extent this may affect the entire site, but according to the proposed layout is likely to only affect a small proportion of suitable habitat on site. Only one turbine is within untransformed habitat (number 57) and is close to the edge of such habitat. The impact will occur at the site of the turbine.

Duration: The impact will either be of short-term duration (construction phase only) or of permanent duration if it leads to loss of critical habitat for species.

Magnitude: The scale of the impact is very small (one turbine). The habitat at this point is slightly disturbed and is also not ideal habitat for any of the species of conservation concern. The potential magnitude of the impact could therefore be very low, due to the fact that only one turbine affects these areas and its footprint is relatively small.

Probability: Because of the fact that only one turbine infringes on natural habitat, the probability of the impact occurring is therefore relatively low and is scored as improbable.

Potential significance: The overall significance of the impact is rated as low.

Mitigation measures: Move turbine number 57 to the north-east by about 40 m.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	permanent (5)	permanent (5)
Magnitude	low (2)	low (1)
Probability	improbable (2)	Highly improbable (1)
Significance	**low (16)**	**low (7)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible

Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) Move one turbine slightly to avoid natural habitat.		
Cumulative impacts: Any other infrastructure could cause similar impacts.		
Residual Impacts: None.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 2: Impacts on bats

It has been evaluated that there are two near threatened bat species that could potentially be affected by the proposed wind energy facility. These are Lesueur's Wing-gland bat (NT) and Schreiber's long-fingered bat (NT). These species are most likely to be affected by the operation of the WEF to a greater extent than the construction of the WEF.

Extent: The impact will occur at the site of the proposed WEF, but will have an impact at a more regional level, since it affects entire populations of affected species and may affect migration routes of species.

Duration: The impact will be of long-term duration, because it will occur for the entire duration of the operation of the wind energy facility.

Magnitude: If any populations of either species occur in the area, the potential magnitude of the impact could be moderate.

Probability: No known populations of either bat species occur in the grid in which the site is located. The probability of the impact occurring is therefore relatively low and is scored as improbable.

Potential significance: The overall significance of the impact is rated as low.

Mitigation measures: A monitoring programme should be implemented to document the effect of the WEF operation on bats. This should take place before construction (to provide a benchmark), and during operation. If the turbines are found to have a significant negative impact on bats then further measures will need to be implemented to control the impact, for example, halting operation during low wind conditions when bats are most active.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	regional (3)	regional (3)
Duration	long-term (4)	long-term (4)
Magnitude	medium (5)	Medium low (4)
Probability	improbable (2)	improbable (2)
Significance	**low (24)**	**low (22)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	

Mitigation: (2) A monitoring programme should be implemented to document the effect of wind turbines on bat species.	
Cumulative impacts: Any other infrastructure could cause similar impacts.	
Residual Impacts: None.	

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 3: Impacts on watercourses

There are a number of watercourses and wetlands on site that could potentially be affected by the proposed construction of turbines. Some of the turbines are currently positioned within or immediately adjacent to mapped wetland areas (turbine numbers 3, 32, 35 and 66). These are all disturbed wetlands in previously cultivated areas.

<u>Extent</u>: The impact will be local and surrounding areas, although downstream areas could be affected.

<u>Duration</u>: The impact will be of medium-term duration (until a perennial cover of vegetation becomes re-established in disturbed areas).

<u>Magnitude</u>: The scale of the impact is very small (four turbines). The potential magnitude of the impact could therefore be low to medium, depending on the degree to which impacts are managed at each turbine site.

<u>Probability</u>: According to the current position of the turbines, it is highly probable that the impact will occur.

<u>Mitigation measures</u>: Stormwater and runoff water must be controlled and managed to avoid impacts on watercourses. A permit from DWA is required if there are expected to be any impacts on any wetland or water resources.

Nature: Damage to wetland areas resulting in hydrological impacts		
	Without mitigation	**With mitigation**
Extent	local and surroundings (2)	local and surroundings (2)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Medium (4)	Low (3)
Probability	highly probable (4)	probable (3)
Significance	**medium (36)**	**low (24)**
Status (positive or negative)	negative	negative
Reversibility	Reversible with effective rehabilitation	Reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) Avoid unnecessary impacts on wetland areas. Impacts should be contained, as much as possible, within the footprint of the turbine and lay-down area. (2) obtain a permit from DWA to impact on any wetland or water resource. (3) rehabilitate any disturbed areas immediately to stabilise landscapes		
Cumulative impacts:		

None.
Residual Impacts: Despite proposed mitigation measures, it is expected that this impact will still occur to some degree.

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Substations

Impact 1: Impacts on threatened animals

It has been evaluated that there are four threatened and two near threatened animal species that could potentially be affected by the proposed wind energy facility. These are White-tailed Rat (EN), Cape Caco (VU), Namaqua Plated Lizard (NT), Fisk's House Snake (VU), Yellow-bellied House Snake (NT), Gronovi's Dwarf Burrowing Skink (NT) and Kasner's Dwarf Burrowing Skink (VU). These species are most likely to be affected by the construction of the wind energy facility and associated infrastructure to a greater extent than the operation of the wind energy facility.

Extent: The impact will occur at the site of the proposed WEF, specifically at the scale of the individual infrastructure within the site. At it's greatest extent this may affect the entire site, but according to the proposed layout is likely to only affect a small proportion of suitable habitat on site. Substation 1 is in the centre of an area of untransformed habitat and includes some wetlands habitat. The impact will occur at the site of the substation.

Duration: The impact will either be of short-term duration (construction phase only) or of permanent duration if it leads to loss of critical habitat for species.

Magnitude: The scale of the impact is very small (one substation). The habitat at this point is in relatively good condition and includes variable sub-habitats. It is potentially suitable habitat for some of the species of conservation concern. The potential magnitude of the impact could therefore be medium.

Probability: Because of the fact that the substation infringes squarely on natural habitat, the probability of the impact occurring is relatively high and is scored as probable.

Potential significance: The overall significance of the impact is rated as medium.

Mitigation measures: Move substation 1 eastwards by about 400 m onto the summit of the hill where it is cultivated.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	permanent (5)	permanent (5)
Magnitude	medium (5)	low (1)
Probability	probable (3)	Highly improbable (1)
Significance	**medium (33)**	**low (7)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	

Mitigation: (1) Move substation 1 eastwards by about 400 m onto the summit of the hill where it is cultivated.to avoid natural habitat.
Cumulative impacts: Any other infrastructure could cause similar impacts.
Residual Impacts: None.

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 2: Impacts on bats

It has been evaluated that there are two near threatened bat species that could potentially be affected by the proposed wind energy facility. These are Lesueur's Wing-gland bat (NT) and Schreiber's long-fingered bat (NT). These species are not likely to be affected by the construction or operation of the substations.

Extent: The impact will occur at the site of the proposed substations.

Duration: The impact will be of long-term duration, because it will occur for the entire duration of the operation of the wind energy facility.

Magnitude: If any populations of either species occur in the area, the potential magnitude of the impact could be very low.

Probability: No known populations of either bat species occur in the grid in which the site is located. The probability of the impact occurring is therefore relatively low. It is also very unlikely that the substation will have any effect on bats. The probability is therefore scored as highly improbable.

Potential significance: The overall significance of the impact is rated as low.

Mitigation measures: None required.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	long-term (4)	long-term (4)
Magnitude	Very low (1)	very low (1)
Probability	Highly improbable (1)	Highly improbable (1)
Significance	**low (6)**	**low (6)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) None required		
Cumulative impacts: No other impacts are likely to cause similar effects on bats.		
Residual Impacts: None.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 3: Impacts on watercourses

Substation 1 is positioned directly across a small watercourse. The other two substations are further than 50 m away from the edge of any watercourse. The watercourse affected by substation 1 is in an undisturbed part of the landscape.

Extent: The impact will be local and surrounding areas, although downstream areas could be affected.

Duration: The impact will be of permanent duration, because the vegetation will be permanently cleared in order to construct the substation.

Magnitude: The potential magnitude of the impact could be medium to high at a local scale, due to the steepness of the slope and the complete clearing of vegetation required.

Probability: According to the current position of the substation, it is definite that the impact will occur.

Mitigation measures: Stormwater and runoff water must be controlled and managed to avoid impacts on watercourses. A permit from DWA is required if there are expected to be any impacts on any wetland or water resources. The substation position should be moved approximately 400 m to the east, where it will not affect the wetland and will be positioned on flatter terrain.

Nature: Damage to wetland areas resulting in hydrological impacts		
	Without mitigation	**With mitigation**
Extent	local and surroundings (2)	local and surroundings (2)
Duration	Permanent (5)	Medium-term (3)
Magnitude	Medium (6)	Low (1)
Probability	definite (5)	improbable (2)
Significance	**high (65)**	**low (12)**
Status (positive or negative)	negative	negative
Reversibility	Reversible with effective rehabilitation	Reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) Move substation 1 position by 400 m to the east. (2) Avoid unnecessary impacts on wetland areas. Impacts should be contained, as much as possible, within the footprint of the substation. (3) obtain a permit from DWA to impact on any wetland or water resource. (4) rehabilitate any disturbed areas immediately to stabilise landscapes		
Cumulative impacts: None.		
Residual Impacts: Despite proposed mitigation measures, it is expected that this impact will still occur to some degree.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Overhead power line

Impact 1: Impacts on threatened animals

It has been evaluated that there are four threatened and two near threatened animal species that could potentially be affected by the proposed wind energy facility. These are White-tailed Rat (EN), Cape Caco (VU), Namaqua Plated Lizard (NT), Fisk's House Snake (VU), Yellow-bellied House Snake (NT), Gronovi's Dwarf Burrowing Skink (NT) and Kasner's Dwarf Burrowing Skink (VU). These species are most likely to be affected by the construction of the wind energy facility and associated infrastructure to a greater extent than the operation of the wind energy facility.

Extent: The impact will occur at the site of the proposed power line, specifically at the scale of the individual towers. Part of the power line (near substation 1) is within untransformed habitat. The impact will occur at the site of this section of power line. There are also patches of untransformed habitat along the remainder of the alignment to the Dassenburg substation. This part of the power line is adjacent to two existing powerlines. The assumption is made that the towers will be placed next to or close to existing towers. There are therefore a number of places where existing twoers are within untransformed habitat.

Duration: The impact will either be of permanent duration if it leads to loss of habitat for species.

Magnitude: The scale of the impact is small (one section of power line on site and some areas along the remainder of the existing power line route to Dassenburg). The habitat on site at this point is in relatively good condition and includes variable sub-habitats. It is potentially suitable habitat for some of the species of conservation concern. Along the existing servitude and alignment to Dassenburg, the potential impact is ameliorated by the fact that two power lines already exist, access is therefore alrteady in place and there are existing disturbances at the existing towers. The potential magnitude of the impact could therefore be medium.

Probability: Because of the fact that this section of the power line infringes squarely on natural habitat, the probability of the impact occurring is relatively high and is scored as highly probable.

Potential significance: The overall significance of the impact is rated as medium.

Mitigation measures: Move power line east by about 400 m. For the power line from the site to the Dassenburg substation, towers must be placed as close to the existing towers on the existing power lines parallel to the proposed alignment.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	permanent (5)	permanent (5)
Magnitude	medium (4)	low (1)
Probability	Highly probable (4)	Highly probable (4)
Significance	**medium (40)**	**low (28)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes

Can impacts be mitigated?	To some degree	
Mitigation: (1) Move power line eastwards to avoid natural habitat. (2) Place towers next to / near to existing towers along the route to Dassenburg (off-site)		
Cumulative impacts: Any other infrastructure could cause similar impacts.		
Residual Impacts: None.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 2: Impacts on bats

It has been evaluated that there are two near threatened bat species that could potentially be affected by the proposed wind energy facility. These are Lesueur's Wing-gland bat (NT) and Schreiber's long-fingered bat (NT). These species are not likely to be affected by the construction or operation of the overhead power line. At worst, there may be some collisions with cables, but due to the echolocation abilities of bats, is unlikely to occur very often. Bats do, however, occasionally turn off their echolocation and can run into things, but this is very unlikely to cause more than a small number of mortalities for the proposed project.

Extent: The impact will occur at the site of the proposed power line.

Duration: The impact will be of long-term duration, because it will occur for the entire duration of the operation of the wind energy facility.

Magnitude: If any populations of either species occur in the area, the potential magnitude of the impact could be low.

Probability: No known populations of either bat species occur in the grid in which the site is located. The probability of the impact occurring is therefore relatively low. It is also very unlikely that the power line will have any effect on bats. The probability is therefore scored as highly improbable.

Potential significance: The overall significance of the impact is rated as low.

Mitigation measures: None required.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	long-term (4)	long-term (4)
Magnitude	Very low (1)	very low (1)
Probability	Highly improbable (1)	Highly improbable (1)
Significance	**low (6)**	**low (6)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) None required		
Cumulative impacts:		

Any other infrastructure could cause similar impacts.
Residual Impacts: None.

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 3: Impacts on watercourses

The 132kV power line crosses wetlands and watercourses in various places, although it is unlikely that power line towers will be positioned within wetlands. The impact is assessed assuming that towers may be positioned in watercourses, thereby indicating the worst-case scenario. The assessment includes the entire length of the power line to the Dassenburg substation. This latter section of the power line includes a tower that will be placed very close to the permanent wetland part of a small pan between Saxonsea and Mamre.

Extent: The impact will be local and surrounding areas, although downstream areas could be affected.

Duration: The impact will be of permanent duration, because the vegetation will be permanently cleared in order to erect the tower.

Magnitude: The potential magnitude of the impact could be medium at a local scale.

Probability: According to the current position of the power line, it is probable that the impact will occur.

Mitigation measures: Stormwater and runoff water must be controlled and managed to avoid impacts on watercourses. A permit from DWA is required if there are expected to be any impacts on any wetland or water resources. Power line towers must not be positioned in watercourses.

Nature: Damage to wetland areas resulting in hydrological impacts		
	Without mitigation	**With mitigation**
Extent	local and surroundings (2)	local and surroundings (2)
Duration	Permanent (5)	Medium-term (3)
Magnitude	Medium (4)	Low (1)
Probability	probable (3)	improbable (2)
Significance	**medium (33)**	**low (12)**
Status (positive or negative)	negative	negative
Reversibility	Reversible with effective rehabilitation	Reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) Ensure towers are not positioned in watercourses. (2) Avoid unnecessary impacts on wetland areas. Impacts should be contained, as much as possible, within the power line servitude. (3) obtain a permit from DWA to impact on any wetland or water resource. (4) rehabilitate any disturbed areas immediately to stabilise landscapes		
Cumulative impacts: None.		
Residual Impacts:		

Despite proposed mitigation measures, it is expected that this impact will still occur to some degree.

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Internal cables and access roads

Impact 1: Impacts on threatened animals

It has been evaluated that there are four threatened and two near threatened animal species that could potentially be affected by the proposed wind energy facility. These are White-tailed Rat (EN), Cape Caco (VU), Namaqua Plated Lizard (NT), Fisk's House Snake (VU), Yellow-bellied House Snake (NT), Gronovi's Dwarf Burrowing Skink (NT) and Kasner's Dwarf Burrowing Skink (VU). These species are most likely to be affected by the construction of the wind energy facility and associated infrastrucrure to a greater extent than the operation of the wind energy facility.

There are a number of places where internal access roads and underground cables are proposed to cross untransformed natural habitats. This includes the following: between turbines 55 and 57, between turbines 53 and 56, between turbines 57 and 42, between turbines 62 and 64, between turbine 80 and substation 1.

Extent: The impact will occur at the site of the proposed WEF, specifically at the scale of the individual infrastructure within the site. At it's greatest extent this may affect the entire site, but according to the proposed layout is likely to only affect a relatively moderate proportion of suitable habitat on site. The impact will occur along the alignments within natural habitat.

Duration: The impact will be of permanent duration if it leads to loss of habitat for species.

Magnitude: The scale of the impact is moderately small, but may be significant in terms of preserving habitat integrity on site. The potential magnitude of the impact could therefore be moderate to high.

Probability: Based on the current alignment of internal access roads and underground cables, the probability of the impact occurring is definite.

Potential significance: The overall significance of the impact is rated as medium.

Mitigation measures: Re-align the proposed alignments to follow contours, avoid drainage lines and untransformed natural habitat and follow existing disturbances on site. Suggestions are as follows: between turbines 55 and 57, the alignment should be shifted so that it runs from turbine 57 first towards turbine 42 along an exisitng dirt track and then back towards turbine 55; between turbines 53 and 56, the alignment should be moved northwards from turbine 56 to the edge of the existing cultivated land and then towards turbine 53; between turbines 57 and 42, the alignment should follow the existing track going northwards from turbine 57 then swing about 200 m eastwards of its existing alignment and follow the contour around the hill back to turbine 42; between turbines 62 and 64, the alignment should go north-westwards from turbine 62, past turbine 59 and then down the hill along the existing gravel road; between turbine 80 and substation 1, the substation needs to be moved 400 m eastwards and the underground cable between the substation and turbine 80 needs to follow the existing track up the hill that runs more-or-less where the cable will then go.

Nature: Impacts on individuals of threatened bat species

	Without mitigation	With mitigation
Extent	local (1)	local (1)
Duration	permanent (5)	permanent (5)
Magnitude	Medium high (6)	low (1)
Probability	definite (5)	improbable (2)
Significance	**medium (60)**	**low (14)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) Move alignments slightly that currently affect wetlands / watercourses and untransformed natural habitats.		
Cumulative impacts: Any other infrastructure could cause similar impacts.		
Residual Impacts: None.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 2: Impacts on bats

It has been evaluated that there are two near threatened bat species that could potentially be affected by the proposed wind energy facility. These are Lesueur's Wing-gland bat (NT) and Schreiber's long-fingered bat (NT). These species are not likely to be affected by the construction or operation of underground cables or access roads, except for a small loss of habitat.

Extent: The impact will occur at the site of the proposed wind energy facility.

Duration: The impact will be of long-term duration, because it will occur for the entire duration of the operation of the wind energy facility.

Magnitude: If any populations of either species occur in the area, the potential magnitude of the impact could be very low.

Probability: No known populations of either bat species occur in the grid in which the site is located. The probability of the impact occurring is therefore relatively low. It is also very unlikely that the infrastructure will have any effect on bats. The probability is therefore scored as highly improbable.

Potential significance: The overall significance of the impact is rated as low.

Mitigation measures: None required.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	long-term (4)	long-term (4)
Magnitude	Very low (1)	very low (1)
Probability	Highly improbable (1)	Highly improbable (1)
Significance	**low (6)**	**low (6)**

Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) None required		
Cumulative impacts: Any other infrastructure could cause similar impacts.		
Residual Impacts: None.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 3: Impacts on watercourses

There are a number of watercourses on site that could potentially be affected by the proposed construction of underground cables and internal access roads. Access to turbines and thus construction of roads will probably require disturbance to a number of watercourses. It is considered likely that watercourses are highly likely to be affected by construction of internal access roads and underground cables.

Extent: The impact will be local and surrounding areas, although downstream areas could be affected.

Duration: The impact will be of permanent duration, because the vegetation will be permanently cleared in order to construct the infrastructure.

Magnitude: The potential magnitude of the impact could be medium to high at a local scale, due to the complete clearing of vegetation required.

Probability: According to the current position of the underground cables and internal access roads, it is definite that the impact will occur.

Mitigation measures: Stormwater and runoff water must be controlled and managed to avoid impacts on watercourses. A permit from DWA is required if there are expected to be any impacts on any wetland or water resources. Some alignments must be adjusted to co-incide with existing disturbances on site and, in some cases, to go around the top of a wetland rather than through the middle near the top. Turbine 58 should be moved to the south-eastern side of the watercourse next to which it stands in order to avoid impacts from underground cables and access roads.

Nature: Damage to wetland areas.		
	Without mitigation	**With mitigation**
Extent	local and surroundings (2)	local and surroundings (2)
Duration	Permanent (5)	Medium-term (3)
Magnitude	Medium (5)	Low (3)
Probability	definite (5)	probable (3)
Significance	**medium (60)**	**low (24)**
Status (positive or negative)	negative	negative
Reversibility	Reversible with effective rehabilitation	Reversible

Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) Align the cable alignment as much as possible along existing linear disturbances, e.g. roads on site. (2) Cross wetlands perpendicularly. (3) Avoid unnecessary impacts on natural vegetation. Impacts should be contained, as much as possible, within the footprint of the proposed cable alignment. (4) obtain a permit from DWA to impact on any wetland or water resource. (5) rehabilitate any disturbed areas immediately to stabilise landscapes (6) Proper culvert and bridge structures are required for permanent roads.		
Cumulative impacts: None.		
Residual Impacts: Despite proposed mitigation measures, it is expected that this impact will still occur to some degree.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

DISCUSSION AND CONCLUSIONS

A large proportion of the study area is in a transformed state and consists primarily of agricultural lands. There are, however, areas of remaining natural vegetation as well as areas within cultivated lands that may provide habitat for threatened fauna. The current layout of infrastructure avoids remaining natural habitat to a large degree.

There are a number of animal species of conservation concern that may occur in habitats within the study area. Those of concern are the following:

- Lesueur's Wing-gland bat (NT)
- Schreiber's long-fingered bat (NT)
- White-tailed Rat (EN)
- Cape Caco (VU)
- Namaqua Plated Lizard (NT)
- Fisk's House Snake (VU)
- Yellow-bellied House Snake (NT)
- Gronovi's Dwarf Burrowing Skink (NT)
- Kasner's Dwarf Burrowing Skink (VU)

A risk assessment was undertaken which identified three main potential negative impacts on fauna, as follows:

- Impacts on habitats of non-flying threatened fauna;
- Impacts due to collision of bats with infrastructure (primarily turbine blades);
- Impacts of construction on wetlands / watercourses.

Impacts were assessed and it emerged that substation 1 is currently positioned within an untransformed area of habitat and could potentially have impacts of high significance on wetlands and watercourses and of medium significance on habitat for threatened animal species. Similar impacts may occur due to construction of internal access roads and underground cables. Impacts on wetlands may occur due to construction of some wind turbines. All impacts can be reduced to having low significance by adjusting the position of components of the infrastructure.

Recommendations

The following recommendations are made to reduce impacts or provide additional information that can lead to reduction or control of impacts:

- A monitoring programme should be implemented to document the effect of the WEF operation on bats. This should take place before construction (to provide a benchmark), during construction and during operation. This will provide information to quantify the impacts of the present project.
- Final planning of infrastructure position needs to take some factors into account with respect to existing disturbance on site. Existing road infrastructure should be used as far as possible for providing access to proposed turbine positions. Where no road infrastructure exists, new roads should be placed within existing disturbed areas or environmental conditions must be taken into account to ensure the minimum amount of damage is caused to natural habitats. Road infrastructure and underground cable alignments should co-incide. One turbine (number 57), substation 1 and part of the overhead powerline needs to be moved in order to avoid impacts on untransformed habitats or watercourses on site. The underground cables and internal access roads need to be re-aligned to avoid wetlands and watercourses, where possible.

Conclusions

The overall impacts of the proposed project have been assessed as largely being of medium to low significance (see Table 3 below). If mitigation measures are put in place to manage impacts, then all potential impacts can be reduced to having low significance. The proposed project is therefore considered to be acceptable in terms of potential impacts on fauna and wetlands / watercourses and it is recommended that it should be permitted to go ahead.

Table 3: Summary of the significance of impacts for different infrastructure components before and after mitigation.

	Wind turbines		**Substations**		**Overhead powerline**		**Internal cables & access roads**	
Impacts on:	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation
1. threatened animals	low (16)	low (7)	medium (33)	low (7)	medium (40)	low (28)	medium (60)	low (14)
2. bats	low (24)	low (22)	low (6)	low (6)	low (6)	low (6)	low (6)	low (6)
3. watercourses & wetlands	medium (36)	low (24)	high (65)	low (12)	medium (33)	low (12)	medium (60)	low (24)

MANAGEMENT PLAN

Control measures are only proposed for those impacts where mitigation measures are proposed to reduce the significance of impacts, i.e. some impacts are of low significance and thus no mitigation measures are proposed or no mitigation measures are possible or required.

OBJECTIVE: Monitor impacts on bats due to turbine blade collisions

Project component/s	Turbines
Potential Impact	Loss of individuals of the threatened bat species
Activity/risk source	Operation
Mitigation: Target/Objective	Target: low mortalities within project control area Time period: implement pre-construction; continue throughout operation

Mitigation: Action/control	Responsibility	Timeframe
(1) establish an ongoing monitoring programme to detect and quantify any mortalities of individuals of threatened bat species	Management (environmental officer),	Estabish and implement pre-construction; continue throughout operation

Performance Indicator	Number of individuals killed by turbine blades within project area
Monitoring	• Determine densities of affected bat species within the area occupied by the wind energy facility before and after construction. • Document patterns of bat movement in the vicinity of the wind energy facility before and after construction. • Record bat mortalities and, as far as possible, the circumstances surrounding collisions. Standard protocols should be used when undertaking such surveys.

OBJECTIVE: Limit impacts on untransformed habitat due to construction of infrastructure

Project component/s	Substation 1, some turbines and some internal access road / underground cable alignments
Potential Impact	Loss of untransformed natural habitat
Activity/risk source	Planning / construction
Mitigation: Target/Objective	Target: no loss of natural habitat within project control area Time period: planning , construction

Mitigation: Action/control	Responsibility	Timeframe
(1) Move some infrastructure and adjust some alignments, as per mitigation measures given in sections of this report.	Management (environmental officer),	Planning, construction

Performance Indicator	Area of untrasnformed natural habitat lost within project area
Monitoring	• Determine area of natural habitat remaining before and after construction.

OBJECTIVE: Limit damage to watercourses / wetlands

Project component/s	Any infrastructure or activity that will result in disturbance to watercourses
Potential Impact	Damage to wetland areas by any means that will result in hydrological changes (includes erosion, siltation, dust, direct removal of soil of vegetation, dumping of material within wetlands). The focus should be on the functioning of the watercourse as a natural system
Activity/risk source	Construction, operation
Mitigation: Target/Objective	Target: no damage to watercourses within project area Time period: construction, operation

Mitigation: Action/control	Responsibility	Timeframe
(1) align underground cables and internal access roads as much as possible along existing infrastructure. (2) for any new construction, cross watercourses perpendicularly to minimise disturbance footprints (3) rehabilitate any disturbed areas as quickly as possible (4) control stormwater and runoff water (5) appoint an independent environmental control officer during construction and an environmental manager during operation whose duty it will be to minimise impacts on surrounding sensitive habitats (6) obtain a permit from DWA to impact on any wetland or water resource.	Planning team; construction team, management, environmental control officer	Planning, construction, operation

Performance Indicator	No impacts on water quality, water quantity, wetland vegetation, natural status of watercourses
Monitoring	• Water quality monitoring to take place on a regular basis. This should include the water quality and quantity leaving the project area through the watercourses (should be monitored within main drainage systems that exit site). • Habitat loss in watercourses should be monitored before and after construction. • The environmental manager should be responsible for driving this process. • Reporting frequency depends on legal compliance framework.

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Appendix 1: Threatened vertebrate species with a geographical distribution that includes the current study area.

MAMMALS

Common name	Taxon	Habitat	Status[2]	Likelihood of occurrence
Lesueur's Wing-gland bat	Cistugo lisueuri	Rock crevices in fynbos.	NT (Friedmann & Daly 2004, no record at www.iucnredlist.org)	**MEDIUM**, not previously recorded in grids, but overall geographical distribution includes this area; no suitable roosting habitat on site, but there may be nearby
Schreiber's long-fingered bat	Miniopterus schreibersii	Caves and sub-terranean habitats in Fynbos, savanna, woodland, succulent and Nama Karoo, grassland; cave-dwelling aerial insectivore.	NT	**MEDIUM**, not previously recorded in grids, but overall geographical distribution includes this area; no suitable roosting habitat on site, but there may be nearby
White-tailed rat	Mystromus albicaudatus	Highveld and montane grassland, requires sandy soils with good cover. Found throughout South Africa except Northern Cape and Limpopo	EN (Friedmann & Daly 2004, no record at www.iucnredlist.org)	**HIGH**, previously recorded in neighbouring grid, presence of suitable substrate (sandy soils present)
Grant's golden mole	Eremitalpa granti	Strandveld Succulent Karoo, Namib Desert, in subterranean habitats in shifting sands	LC Listed as VU in Friedmann & Daly 2004	**HIGH**, previously recorded in neighbouring grid, substrate properties on site are suitable for this species.

[1]Distribution according to Friedmann & Daly 2004.

[2]Status according to IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. (www.iucnredlist.org). Downloaded on 09 September 2010.

AMPHIBIANS

Common name	Species	Habitat	Status[2]	Likelihood of occurrence
Cape Caco	Cacosternum capense	Lowlands west of the Cape Fold mountains, from the Cape Flats northwards to Graafwater. Vredenburg (3217DD) is at the western limit of its distribution range. Inhabits flat or gently undulating low-lying areas with poorly drained loamy to clay soil, where it breeds in shallow, temporary, rain-filled pools and pans that form during the winter months. Also occurs in more sandy habitats. About 90% of recorded breeding sites occur in modified habitat, particularly agricultural lands.	VU	**HIGH**, previously recorded in grid and suitable habitat available on site.

[2]Status according to Minter et al. 2004 and IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. (www.iucnredlist.org). Downloaded on 09 September 2010..

REPTILES

Common name	Species	Habitat	Status[3]	Likelihood of occurrence
Cape sand snake	Psammophis leightoni leightoni	Coastal renosterveld, coastal fynbos and transitional strandveld in the extreme south-western Cape.	VU[4] (no record at www.iucnredlist.org)	**LOW**, just outside known distribution range, but suitable habitat on site.
Armadillo girdled lizard	Cordylus cataphractus	Rock cracks and crevices. Diet consists mainly of termites, beetles and grasshoppers	VU[4]	**LOW**, just outside known distribution range.
Namaqua plated lizard	Gerrhosaurus typicus	Dry sandy areas and bare rocky hillsides	RARE[3], NT[4]	**HIGH**, overall geographical distribution includes this area; suitable habitat on site
Southern	Homopus	Rocky outcrops and ridges	NT[4]	**LOW**, just outside known

Common name	Species	Habitat	Status[3]	Likelihood of occurrence
speckled padloper	signatus cafer	in regions of relatively low rainfall. Occurs west of Cedarberg to the coast.		distribution range. Small amount of suitable habitat may occur on site.
Geometric tortoise	Psammobates geometricus	Flat, low-lying renosterveld of the south-western Cape. Tortoises prefer relatively open habitat.	EN[4]	**LOW**, outside known distribution range. Suitable habitat may occur on site.
Fisk's house snake	Lamprophis fiskii	Karoo, fynbos and succulent karoo.	VU[4]	**MEDIUM**, overall geographical distribution includes this area; suitable habitat on site
Yellowbellied house snake	Lamprophis fuscus	Old termitaria and under stones, underground. Found throughout more mesic parts of South Africa (Cape, east coast, Highveld).	NT[4]	**MEDIUM**, not previously recorded in neighbouring grids, but within overall distribution range and habitats are available on site.
Black spitting cobra	Naja nigricollis woodi	Favours rocky terrain, dry rocky watercourses. Known from Cedarberg.	RARE[3] (no record at www.iucnredlist.org)	**LOW**, overall geographical distribution includes this area; no ideally suitable habitat on site
Gronovi's dwarf burrowing skink	Scelotes gronovii	West Coast from Vredendal to Robben Island. Under flat rocks or litter in sandy areas.	NT[4]	**HIGH**, within geographical distribution range, previously recorded nearby and suitable habitat occurs on site.
Kasner's dwarf burrowing skink	Scelotes kasneri	Coastal dune areas from Lambert's Bay to Vredenburg. Coastal dunes under flat stones or under litter.	VU[4]	**HIGH**, within geographical distribution range, previously recorded nearby and suitable habitat occurs on site.

[3]Status according to Branch 1988.

[4]Status according to Groombridge 1994.\

ENVIRONMENTAL IMPACT REPORT:

Specialist faunal and wetland study on the potential impacts of the proposed Rheboksfontein Wind Energy Facility Project, Darling, Western Cape

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on behalf of
Moyeng Energy (Pty) Ltd

14 June 2011

DRAFT EIA REPORT: 3rd draft

David Hoare Consulting cc
Biodiversity Assessments, Vegetation Description / Mapping, Species Surveys

CONTROL SHEET FOR SPECIALIST REPORT

The table below lists the specific requirements for specialist studies, according to Regulation 33 of Government Notice No. R385 of 1996 EIA Regulations.

Activity	Yes	No	**Comment**
Details of: 1. the person who prepared the report; and	√		
2. the expertise of that person to carry out the specialist study or specialised process	√		
A declaration that the person is independent in a form as may be specified by the competent authority	√		
An indication of the scope of, and the purpose for which, the report was prepared	√		
A description of the methodology adopted in preparing the report or carrying out the specialised process	√		
A description of any assumptions made and any uncertainties or gaps in knowledge	√		
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	√		
Recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority	√		
A description of any consultation process that was undertaken during the course of carrying out the study	√		
A summary and copies of any comments that were received during any consultation process	√		
Any other information requested by the competent authority	√		

REGULATIONS GOVERNING THIS REPORT

This report has been prepared in terms the EIA Regulations promulgated under the *National Environmental Management Act* No. 107 of 1998 (NEMA) and is compliant with Regulation 385 Section 33 - Specialist reports and reports on specialized processes under the Act. Relevant clauses of the above regulation are quoted below and reflect the required information in the "Control sheet for specialist report" given above.

Regulation 33. (1): An applicant or the EAP managing an application may appoint a person who is independent to carry out a specialist study or specialized process.

Regulation 33. (2): A specialist report or a report on a specialized process prepared in terms of these Regulations must contain:
(a) details of (i) the person who prepared the report, and
(ii) the expertise of that person to carry out the specialist study or specialized process;
(b) declaration that the person is independent in a form as may be specified by the competent authority;
(c) indication of the scope of, and the purpose for which, the report was prepared;
(d) description of the methodology adopted in preparing the report or carrying out the specialized process;
(e) description of any assumptions made and any uncertainties or gaps in knowledge;
(f) description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment;
(g) recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority;
(h) description of any consultation process that was undertaken during the course of carrying out the study;
(i) summary and copies of any comments that were received during any consultation process;
(j) any other information requested by the competent authority.

Appointment of specialist

Dr David Hoare of David Hoare Consulting cc was commissioned by Savannah Environmental (Pty) Ltd to provide specialist consulting services for the Environmental Impact Assessment for the proposed Rheboksfontein Wind Energy Facility Project near Darling in the Western Province. The consulting services comprise an assessment of potential impacts on the fauna in the study area by the proposed project.

Details of specialist

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Summary of expertise

Dr David Hoare:

- Registered professional member of The South African Council for Natural Scientific Professions (Ecological Science, Botanical Science), registration number 400221/05.
- Founded David Hoare Consulting cc, an independent consultancy, in 2001.
- Ecological consultant since 1995.
- Conducted, or co-conducted, over 200 specialist ecological surveys as an ecological consultant.
- Published six technical scientific reports, 15 scientific conference presentations, seven book chapters and eight refereed scientific papers.
- Attended 15 national and international congresses & 5 expert workshops, lectured vegetation science / ecology at 2 universities and referee for 2 international journals.

Independence

David Hoare Consulting cc and its Directors have no connection with Moyeng Energy (Pty) Ltd. David Hoare Consulting cc is not a subsidiary, legally or financially, of the proponent. Remuneration for services by the proponent in relation to this project is not linked to approval by decision-making authorities responsible for authorising this proposed project and the consultancy has no interest in secondary or downstream developments as a result of the authorisation of this project. David Hoare is an independent consultant to Savannah Environmental (Pty) Ltd and has no business, financial, personal or other interest in the activity, application or appeal in respect of which he was 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. The percentage work received directly or indirectly from the proponent in the last twelve months is approximately 0% of turnover.

Scope and purpose of report

The scope and purpose of the report are reflected in the "Terms of reference" section of this report

Conditions relating to this report

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. David Hoare Consulting cc and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

This report must not be altered or added to without the prior written consent of the author. This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

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INTRODUCTION

Terms of reference and approach

Savannah Environmental (Pty) Ltd. was appointed by Moyeng Energy (Pty) Ltd to undertake an application for environmental authorisation through an Environmental Impact Assessment (EIA) for the proposed "Rheboksfontein Wind Energy Facility Project." The project involves the establishment of a wind energy facility and associated infrastructure, including wind turbines, undergound cables between turbines, a sub-station and internal access roads. The purpose of the EIA is to identify environmental impacts associated with the project.

In February 2010 David Hoare Consulting cc was appointed by Savannah Environmental (Pty) Ltd to undertake a fauna assessment of the study area. The specific terms of reference for the ecological study include:

- an indication of the methodology used in determining the significance of potential environmental impacts;
- a description of the environmental issues that were identified during the environmental impact assessment process;
- an assessment of the significance of direct, indirect and cumulative impacts in terms of standard criteria;
- a description and comparative assessment of all alternatives identified during the environmental impact assessment process;
- recommendations regarding practical mitigation measures for potentially significant impacts, for inclusion in the Environmental Management Plan;
- an indication of the extent to which the issue could be addressed by the adoption of achievable mitigation measures;
- a description of any assumptions, uncertainties and gaps in knowledge;
- an environmental impact statement which contains
- a summary of the key findings of the environmental impact assessment,
- an assessment of the positive and negative implications of the proposed activity,
- a comparative assessment of the positive and negative implications of the distribution line alternatives,
- a comparative assessment of the postivie and negative implications of the access road alternatives.

This report provides details of the results of the EIA phase. The findings of the study are based on a combination of a desktop assessment of the study area and fieldwork undertaken on site

Study area

At a regional level the study area falls within the Western Province to the north of the town of Darling. A more detailed description of the study area is provided in a section below.

METHODOLOGY

The project was to be undertaken in two phases, a Scoping phase and an Environmental Impact Assessment phase. The objective of the EIA phase study was to assess the significance of potential impacts on fauna and flora patterns within the study area. This report contains all the descriptive information on flora and fauna that were presented in the Scoping report as well as a comprehensive assessment of potential impacts. The results of the EIA phase study are provided in this report.

Assessment philosophy

Many parts of South Africa contain high levels of biodiversity at species and ecosystem level. At any single site there may be large numbers of species or high ecological complexity. Sites also vary in their natural character and uniqueness and the level to which they have been previously disturbed. Assessing the potential impacts of a proposed development often requires evaluating the conservation value of a site relative to other natural areas and relative to the national importance of the site in terms of biodiversity conservation. A simple approach to evaluating the relative importance of a site includes assessing the following:

- Is the site unique in terms of natural or biodiversity features?
- Is the protection of biodiversity features on site of national/provincial importance?
- Would development of the site lead to contravention of any international, national or provincial legislation, policy, convention or regulation?

Thus, the general approach adopted for this type of study is to identify any critical biodiversity issues that may lead to the decision that the proposed project cannot take place, i.e. to specifically focus on red flags and/or potential fatal flaws. Biodiversity issues are assessed by documenting whether any important biodiversity features occur on site, including species, ecosystems or processes that maintain ecosystems and/or species. These can be organised in a hierarchical fashion, as follows:

Species

- threatened animal species

Ecosystems

- critical biodiversity areas
- areas of high biodiversity
- centres of endemism

Processes

- corridors
- mega-conservancy networks

It is not the intention to provide comprehensive lists of all species that occur on site, since most of the species on these lists are usually common or widespread species. Rare, threatened, protected and conservation-worthy species and habitats are considered to be the highest priority, the presence of which are most likely to result in significant negative impacts on the ecological environment. The focus on national and provincial priorities and critical biodiversity issues is in line with National legislation protecting environmental and biodiversity resources, including, but not limited to the following which ensure protection of ecological processes, natural systems and natural beauty as well as the preservation of biotic diversity in the natural environment:

- Environment Conservation Act (Act 73 of 1989)
- National Environmental Management Act, 1998 (NEMA) (Act 107 of 1998)
- National Environmental Management Biodiversity Act, 2004. (Act 10 0f 2004)

Animal species of concern

The purpose of listing Red Data animal species was to provide information on the potential occurrence of species of special concern in the study area that may be affected by the proposed infrastructure. Species appearing on these lists could then be assessed in terms of their habitat requirements in order to determine whether any of them have a likelihood of occurring in habitats that may be affected by the proposed infrastructure.

Lists were compiled specifically for any species of conservation concern previously recorded in the area and any other species with potential conservation value. Lists of threatened animal and bird species that have a geographical range that includes the study area were obtained from literature sources (e.g. Barnes 2000, Branch 1988, 2001, Friedmann & Daly 2004, Mills & Hes 1997). The likelihood of any of them occurring was evaluated on the basis of habitat preference and habitats available at each of the proposed sites. The three parameters used to assess the probability of occurrence for each species were as follows:

- *Habitat requirements*: most Red Data animals have very specific habitat requirements and the presence of these habitat characteristics within the study area were assessed;
- *Habitat status*: in the event that available habitat is considered suitable for these species, the status or ecological condition was assessed. Often, a high level of degradation of a specific habitat type will negate the potential presence of Red Data species (especially wetland-related habitats where water-quality plays a major role); and
- *Habitat linkage*: movement between areas used for breeding and feeding purposes forms an essential part of ecological existence of many species. The connectivity of the study area to these surrounding habitats and adequacy of these linkages are assessed for the ecological functioning Red Data species within the study area.

For all threatened fauna that occur in the general geographical area of the site, a rating of the likelihood of it occurring on site is given as follows:

- <u>LOW</u>: no suitable habitats occur on site / habitats on site do not match habitat description for species;
- <u>MEDIUM</u>: habitats on site match general habitat description for species (e.g. fynbos), but detailed microhabitat requirements (e.g. mountain fynbos on shallow soils overlying Table Mountain sandstone) are absent on the site or are unknown from the descriptions given in the literature or from the authorities;
- <u>HIGH</u>: habitats found on site match very strongly the general and microhabitat description for the species (e.g. mountain fynbos on shallow soils overlying Table Mountain sandstone);
- <u>DEFINITE</u>: species found in habitats on site.

Sensitivity assessment

The study site was evaluated in terms of the potential for containing habitat for animal species of conservation concern. Any habitat considered important for species of concern was considered to be sensitive whereas habitat not important for species of conservation concern was considered t be not sensitive.

Table 1: Sensitivity analysis

Sensitivity class	**Description**
Low Sensitivity	Habitat with no breeding, inhabiting or foraging importance for animal species of conservation concern
Medium Sensitivity	Habitat with breeding, inhabiting or foraging importance for animal species of low conservation concern (Near Threatened, Declining, Rare or Restricted)
High Sensitivity	Habitat with breeding, inhabiting or foraging importance for animal species of high conservation concern (Critically Endangered, Endangered or Vulnerable)

Assessment of impacts

Direct, indirect and cumulative impacts of the issues identified through the scoping study, as well as all other issues identified in the EIA phase were assessed in terms of the following criteria:

- » The **nature**, which includes a description of what causes the effect, what will be affected and how it will be affected.
- » The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 was assigned as appropriate (with 1 being low and 5 being high):
- » The **duration**, wherein it was indicated whether:
  - ∗ the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - ∗ the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - ∗ medium-term (5–15 years) – assigned a score of 3;
  - ∗ long term (> 15 years) - assigned a score of 4; or
  - ∗ permanent - assigned a score of 5;
- » The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- » The **probability** *of occurrence*, which describes the likelihood of the impact actually occurring. Probability was estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- » the **significance**, was determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- » the **status**, which was described as either positive, negative or neutral.
- » the degree to which the impact can be reversed.
- » the degree to which the impact may cause irreplaceable loss of resources.
- » the degree to which the impact can be mitigated.

The **significance** was calculated by combining the criteria in the following formula:

$$S=(E+D+M)P$$

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

» < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
» 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
» > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

Limitations

- Red List species are, by their nature, usually very rare and difficult to locate. Compiling the list of species that could potentially occur in an area is limited by the paucity of collection records that make it difficult to predict whether a species may occur in an area or not. The methodology used in this assessment is designed to reduce the risks of ommitting any species, but it is always possible that a species that does not occur on a list may be located in an area where it was not previously known to exist.

DESCRIPTION OF STUDY AREA

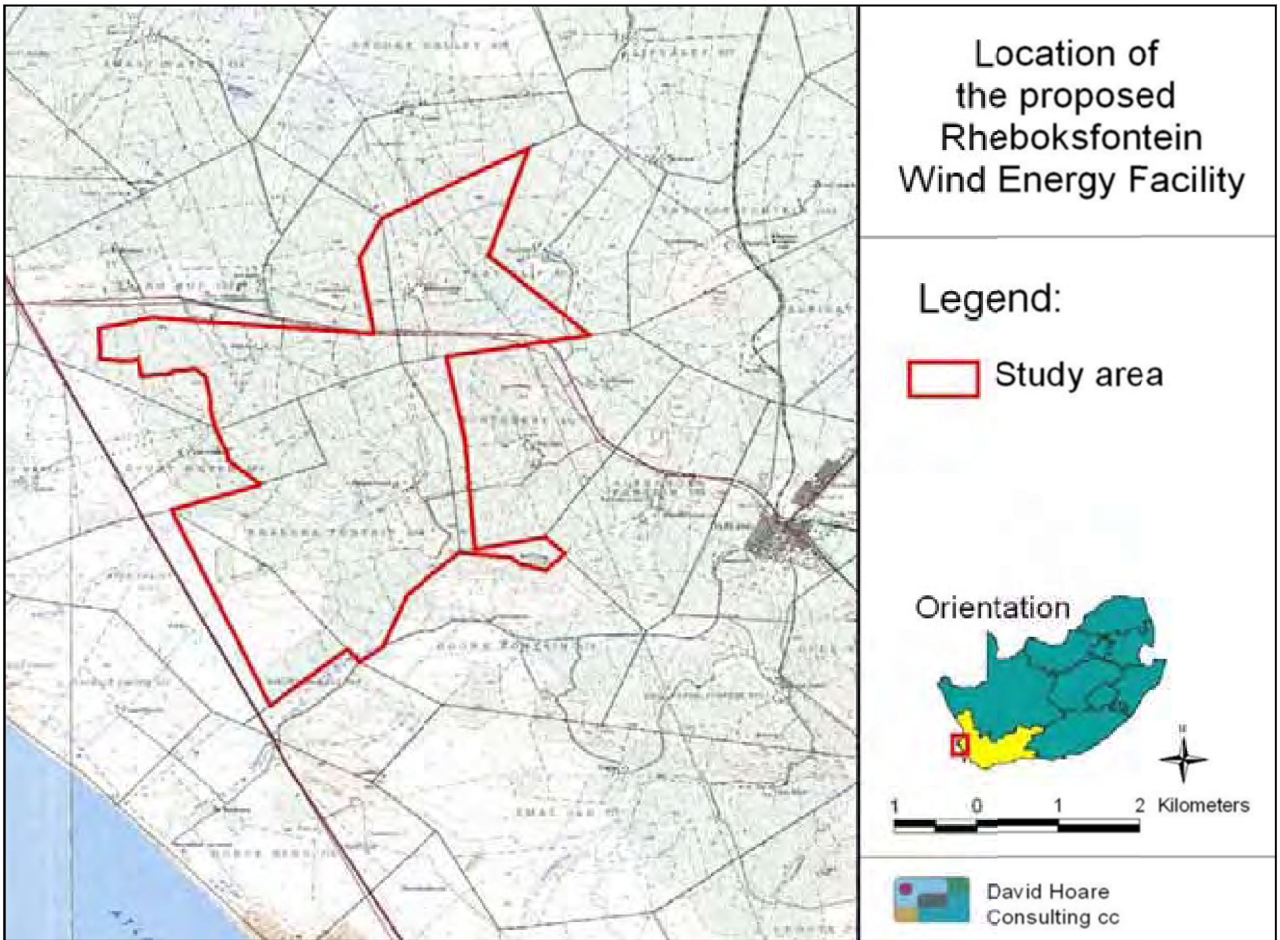
Location

The study site is situated west of Darling in the Western Cape Province and falls within the quarter degree grid 3318AD (Figure 1). The farm portions on which the proposed wind energy facility would occur include the following: Remaining extent of Farm 568 (Rheboksfontein), Farm 567 (Nieuwe Plaats), Remaining extent of Farm 571 (Bonteberg), Portion 1 of Farm 574 (Doornfontein), Portion 1 of Farm 551 (Plat Klip), Farm 1199 (Groot Berg) and Portion 2 of Farm 552 (Slang Kop). No alternative site is currently being considered for the proposed wind energy facility.

The study area is to the east of the R27 coastal road from the Cape (Melkbossttrand) to Velddrift. The R315 from Darling to Yzerfontein passes through the site. The site is therefore well-connected to regional routes.

Landuse / landcover and vegetation

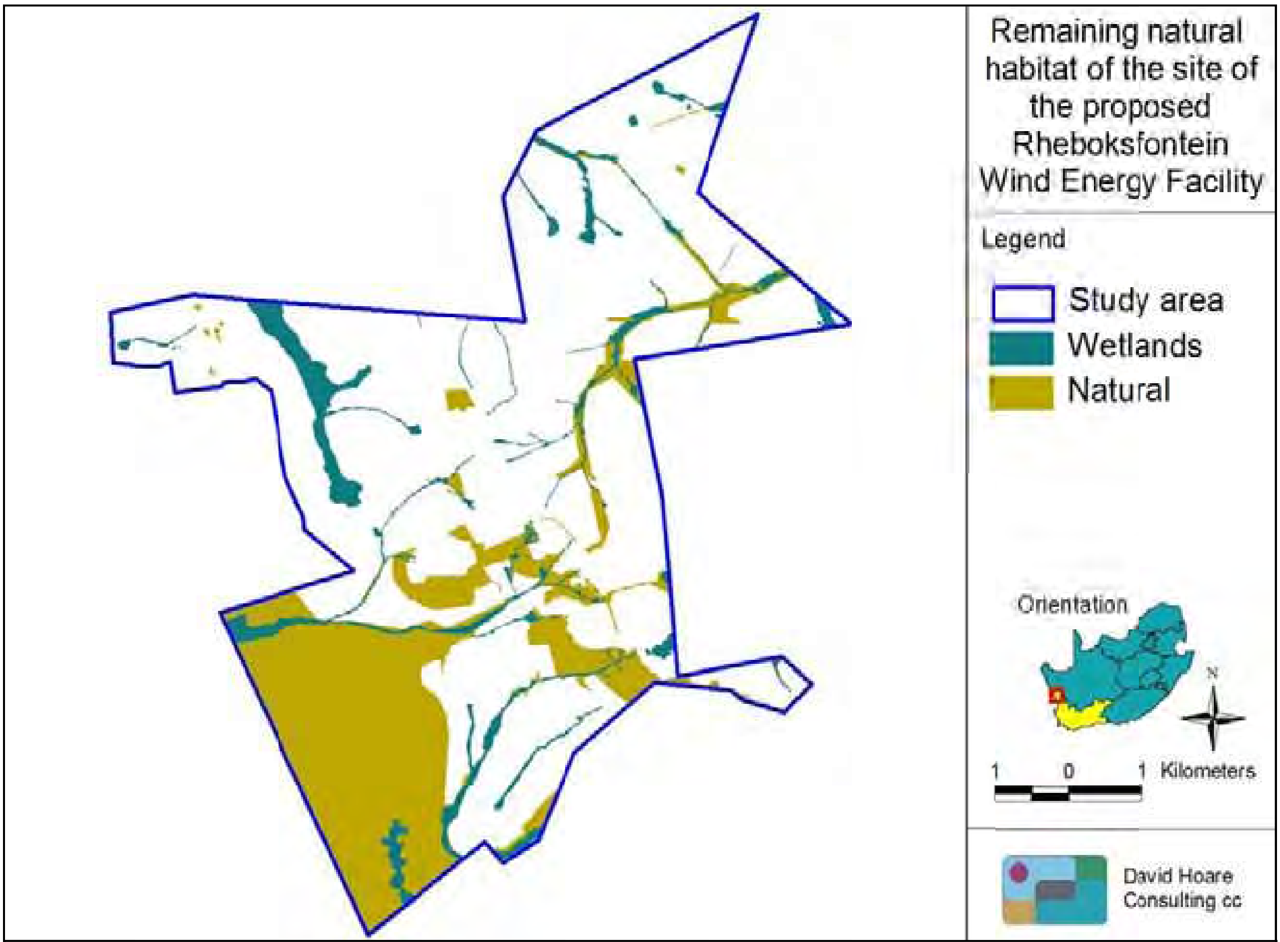
A landcover map of the study area (Fairbanks *et al*. 2000) indicates that a large proportion of the site consists of cultivation, degraded shrubland / low fynbos and grassland (both considered to be secondary vegetation on old lands) with a few small patches of shrubland / low fynbos (natural). The Surveyor General's 1:50 000 topocadastral maps for the study area



supports this observation and indicates that cultivation has taken place across most of the site. The field assessment confirmed these patterns. Large parts of the site were found to be cultivated and remaining areas of natural habitat were often not in pristine condition. There are, however, areas that could potentially support unique populations of animals, depending on their habitat requirements. The extent of these remaining areas of habitat is shown in Figure 2. This figure can also be considered to be a sensitivity map for fauna for the study area.

The study site is located within the Cape Floristic Region (CFR), which is recognised as one of the principal centres of diversity and endemism in Africa. Fynbos and Renosterveld are considered to be the main vegetation types in the CFR. Fynbos is very species rich, but has been transformed or degraded to a high degree and is therefore considered to be of high conservation value.

The site occurs within two vegetation types: Swartland Granite Renosterveld, classified as Critically Endangered, and Hopefield Sand Fynbos, classified as Endangered (Mucina *et al*. 2005, Mucina & Rutherford 2006). The vegetation-type descriptions provide an indication that vegetation on site consists primarily of fynbos and renosterveld. There are, however, also strips of thicket along drainage lines in the areas of steeper topography and wetland vegetation within the drainage lines. Areas closer to the coast have large proportions of sandy substrates or mobile sand. Despite high levels of transformation on site, there are a number of different habitat types that may provide suitable habitat for a variety of faunal species.



Red List animal species of the study area

All vertebrates (mammals, birds, reptiles, amphibians) of conservation concern that have a geographical distribution that includes the study area are listed in Appendix 1[1]. Based on habitat requirements, there are a number of threatened or near threatened species that were considered to have a possibility of occurring on site or making use of habitats available on site. These are the following:

- White-tailed Rat (EN)
- Cape Caco (VU)
- Namaqua Plated Lizard (NT)
- Fisk's House Snake (VU)
- Yellow-bellied House Snake (NT)
- Gronovi’s Dwarf Burrowing Skink (NT)
- Kasner’s Dwarf Burrowing Skink (VU)

There were also two threatened bat species that have a geographical distribution that includes the site and there is some possibility that they may be encountered on site, either foraging, nesting or roosting. These include the following:

- Lesueur’s Wing-gland bat (NT)
- Schreiber’s long-fingered bat (NT)

None of these species are protected according to section 56(1) of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004).

The remaining species with a geographical range that includes the site were assessed as having a low chance of occurring in available habitats in the study area or the study site is at the margin of their distribution range.

[1] The IUCN conservation status of some species has been updated since the Scoping Report was written. Appendix 1 contains fewer species than in the Scoping Report.

RELEVANT LEGISLATIVE AND PERMIT REQUIREMENTS

Relevant legislation is provided in this section to provide a description of the key legal considerations of importance to the proposed project. The applicable legislation is listed below.

Legislation

National Environmental Management Act, Act No. 107 of 1998 (NEMA)

NEMA requires, inter alia, that:

- "development must be socially, environmentally, and economically sustainable",
- "disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied." ,
- "a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions",

NEMA states that "the environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage."

Environment Conservation Act No 73 of 1989 Amendment Notice No R1183 of 1997

The ECA states that:

- Development must be environmentally, socially and economically sustainable. Sustainable development requires the consideration of inter alia the following factors:
- that pollution and degradation of the environment is avoided, or, where they cannot be altogether avoided, are minimised and remedied;
- that the use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource;
- that the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised; and
- that negative impacts on the environment and on peoples' environmental rights be anticipated and prevented, and where they cannot be altogether prevented are minimised and remedied.
- The developer is required to undertake Environmental Impact Assessments (EIA) for all projects listed as a Schedule 1 activity in the EIA regulations in order to control activities which might have a detrimental effect on the environment. Such activities will only be permitted with written authorisation from a competent authority.

National Environmental Management: Biodiversity Act (Act No 10 of 2004)

In terms of the Biodiversity Act, the developer has a responsibility for:

- The conservation of endangered ecosystems and restriction of activities according to the categorisation of the area (not just by listed activity as specified in the EIA regulations).
- Promote the application of appropriate environmental management tools in order to ensure integrated environmental management of activities thereby ensuring that all development within the area are in line with ecological sustainable development and protection of biodiversity.
- Limit further loss of biodiversity and conserve endangered ecosystems.

The Nature and Environmental Conservation Ordinance, 1974 (Ordinance 19 of 1974)

Provides for protection of fauna and flora in the Western Cape Province.

The Western Cape Nature Conservation Laws Amendment Act, 2000 (Ordinance 3 of 2000)

Provides for the amendment of various laws on nature conservation in order to transfer the administration of the provisions of those laws to the Western Cape Nature Conservation Board. Also provides updated lists of endangered and protected fauna and flora for the Province.

National Water Act

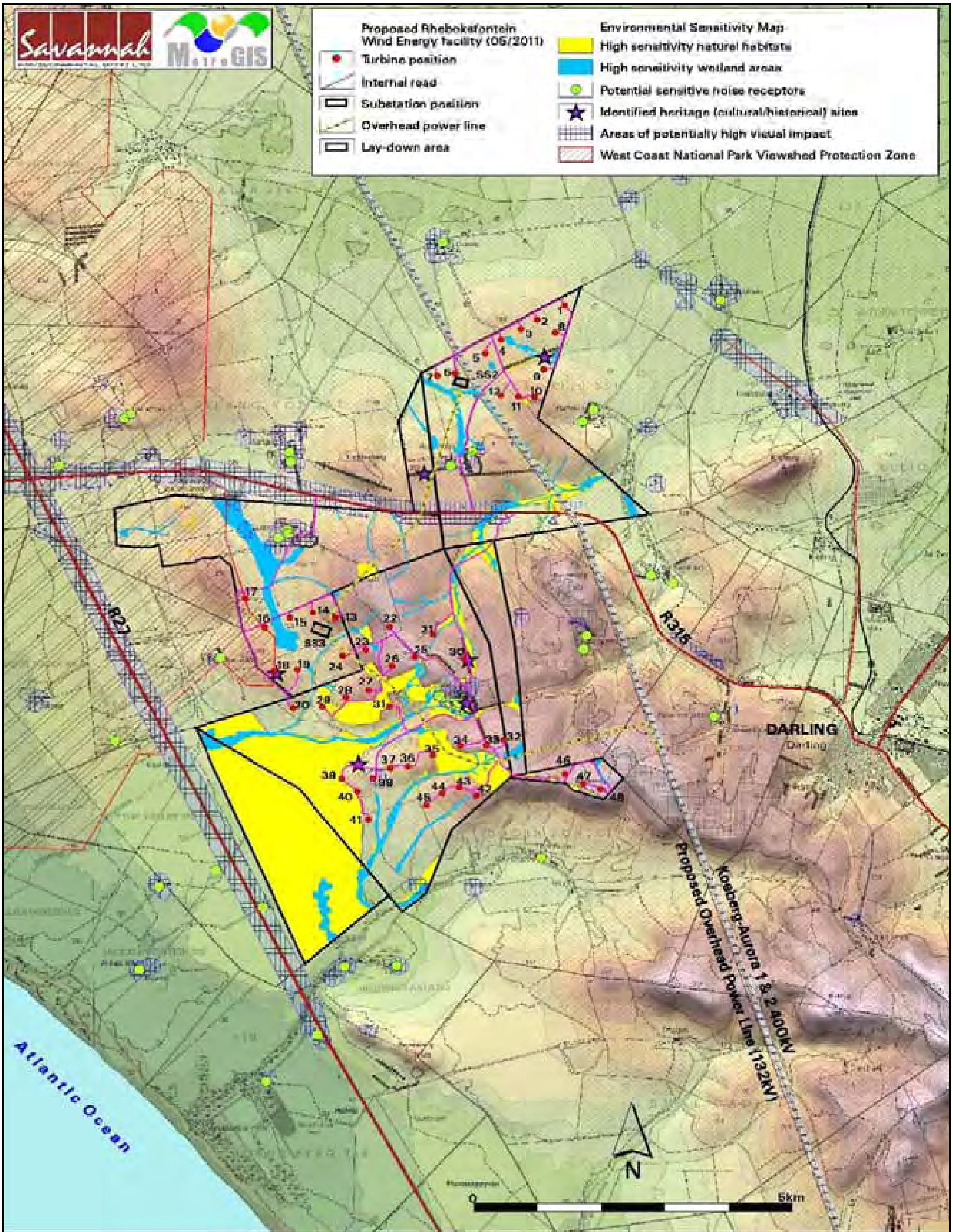
Wetlands, riparian zones and watercourses are defined in the Water Act as a water resource and any activities that are contemplated that could affect the wetlands requires authorisation (Section 21 of the National Water Act of 1998). A "watercourse" in terms of the National Water Act (act 36 of 1998) means:

- River or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and

Any collection of water which the Minister may, by notice in the gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

DESCRIPTION OF INFRASTRUCTURE

A total of 48 turbines have been proposed for the site. Each turbine will have a relatively small



footprint (i.e. 15 m x 15m). There will be disturbance beyond this during the construction phase since a lay-down area is required prior to raising the turbine to it's final position.

The power line from the wind energy facility to the substation and to the grid will be a 132kV line. The substation will be 80 m x 90 m in extent. There are 2 internal substations, internal cables for connecting turbines to one another and internal access roads to turbines. It is proposed that the internal access roads and the internal cables linking turbines will follow the same routes.

The position of the turbines, substations, internal underground cables and overhead power line relative to sensitive features in the study area is indicated in Figure 3.

IDENTIFICATION OF RISKS AND POTENTIAL IMPACTS

Potential issues relevant to potential impacts on the fauna of the study area include the following:

- Impacts on biodiversity: this includes any impacts on populations of individual species of concern.
- Impacts on sensitive habitats: this includes impacts on any habitats that are important for threatened fauna.
- Impacts on ecosystem function: this includes impacts on any processes or factors that maintain ecosystem health and character, including the following:
    - disruption to nutrient-flow dynamics;
    - impedance of movement of material or water;
    - habitat fragmentation;
    - changes to abiotic environmental conditions;
    - changes to disturbance regimes, e.g. increased or decreased incidence of fire;
    - changes to successional processes;
    - effects on pollinators;
    - increased invasion by alien plants.

  Changes to factors such as these may lead to a reduction in the resilience of habitats and ecosystems or loss or change in ecosystem function.

- Secondary and cumulative impacts on fauna: this includes an assessment of the impacts of the proposed project taken in combination with the impacts of other known projects for the area or secondary impacts that may arise from changes in the social, economic or ecological environment.

A number of direct risks to ecosystems would result from construction of the proposed WEF, as follows:

- Clearing of land for construction.
- Construction of access roads.
- Placement of underground cables linking turbines.
- Chemical contamination of the soil by construction vehicles and machinery.
- Storage of materials required for construction.

There are also risks associated with operation of the proposed WEF, as follows:

- Collisions with flying animals (bats and birds). This may have local impacts on populations as well as cumulative effects on species over wider areas.
- Maintenance of surrounding vegetation as part of management of WEF.

Description of potential impacts

Major potential impacts are described briefly below. These are compiled from a generic list of possible impacts derived from previous projects of this nature and from a literature review of the potential impacts of wind energy facilities on the ecological environment. There are two major ways that wind-energy development may influence ecosystem structure and functioning—through direct impacts on individual organisms and through impacts on habitat structure and functioning. The most important potential negative ecological impacts of a WEF are related to bird and bat mortality and loss of habitat.

Impact 1: Impacts on threatened animals

Nature: Threatened animal species are affected primarily by the overall loss of habitat, since direct construction impacts can often be avoided due to movement of individuals from the path of construction. Construction of turbines, access roads, transmission lines and other infrastructure associated with the wind energy facility will lead to direct loss of habitat. There are some small patches of natural habitat remaining on site. This vegetation potentially provides habitat for a number of threatened or near threatened species (threatened species include those classified as critically endangered, endangered or vulnerable), including the following: White-tailed Rat (EN), Cape Caco (VU), Namaqua Plated Lizard (NT), Fisk's House Snake (VU), Yellow-bellied House Snake (NT), Gronovi's Dwarf Burrowing Skink (NT) and Kasner's Dwarf Burrowing Skink (VU). The potential value of this natural habitat for these species of conservation concern is affected by the particular requirements of each species and the availability of habitat on site.

For threatened animal species, loss of a population or individuals could lead to:

- fragmentation of populations of affected species;
- reduction in area of occupancy of affected species; and
- loss of genetic variation within affected species.

These may all lead to a negative change in conservation status of the affected species, which implies a reduction in the chances of the species overall survival chances.

Impact 2: Impacts on bats

Nature: Bird and bat deaths are one of the most controversial biological issues related to wind turbines. The deaths of birds and bats at wind farm sites have raised concerns by conservation agencies internationally. In order to address this issue in South Africa, the Endangered Wildlife Trust (EWT) and BirdLife South Africa (BLSA) have combined efforts to lobby for the appropriate consideration of the potential negative effects of wind energy production. Impacts on birds as a result of the proposed WEF are assessed in a separate report.

Bats have been found to be particularly vulnerable to being killed by wind turbines. It has long been a mystery why they should be so badly affected since bat echo-location allows them to detect moving objects very well. A recent study in America has found that the primary cause for mortality is a combination of direct strikes and barotrauma (bats are killed when suddenly passing through a low air pressure region surrounding the turbine blade tips causing low pressure damage the bat's lungs, Baerwald *et al*. 2008). The relative importance of this impact on bat populations depends on which species are likely to be affected, the importance of the site for those species and whether the site is within a migration corridor for particular bat species.

The most vulnerable species are those that are already classified as threatened species, including those classified as critically endangered, endangered or vulnerable. For any other species a loss of individuals or localized populations is unlikely to lead to a change in the conservation status of the species unless the impact occurs across a wide area that co-incides with their overall distribution range. Loss of a population or individuals could lead to a direct change in the conservation status of the species. This may arise if the proposed infrastructure is located where it will impact on such individuals or populations or the habitat that they depend on. Consequences may include:

- fragmentation of populations of affected species;
- reduction in area of occupancy of affected species; and
- loss of genetic variation within affected species.

These may all lead to a negative change in conservation status of the affected species, which implies a reduction in the chances of the species overall survival chances.

It has been evaluated that there are two near threatened bat species that could potentially be affected by the proposed wind energy facility. These are Lesueur's Wing-gland bat (NT) and Schreiber's long-fingered bat (NT).

Impact 3: Impacts on watercourses and wetlands

Construction may lead to some direct or indirect loss of or damage to seasonal marsh wetlands or drainage lines or impacts that affect the catchment of these wetlands. This will lead to localised loss of wetland habitat and may lead to downstream impacts that affect a greater extent of wetlands or impact on wetland function. Where these habitats are already stressed due to degradation and transformation, the loss may lead to increased vulnerability (susceptibility to future damage) of the habitat. Physical alteration to wetlands can have an impact on the functioning of those wetlands. Consequences may include:

1. increased loss of soil;
2. loss of or disturbance to indigenous wetland vegetation;
3. loss of sensitive wetland habitats;
4. loss or disturbance to individuals of rare, endangered, endemic and/or protected species that occur in wetlands;
5. fragmentation of sensitive habitats;
6. impairment of wetland function;
7. change in channel morphology in downstream wetlands, potentially leading to further loss of wetland vegetation; and
8. reduction in water quality in wetlands downstream of road.

The site contains a number of non-perennial streams, drainage lines and wetlands. These are mapped on Figure 2.

ASSESSMENT OF IMPACTS

Impacts are assessed for each component of infrastructure for the proposed wind energy facility, as follows:

- wind turbines;
- substations;
- overhead power line (132kV);
- underground cables between turbines and linking turbines to internal substations in combination with internal access roads.

Wind turbines

Impact 1: Impacts on threatened animals

It has been evaluated that there are four threatened and two near threatened animal species that could potentially be affected by the proposed wind energy facility. These are White-tailed Rat (EN), Cape Caco (VU), Namaqua Plated Lizard (NT), Fisk's House Snake (VU), Yellow-bellied House Snake (NT), Gronovi's Dwarf Burrowing Skink (NT) and Kasner's Dwarf Burrowing Skink (VU). These species are most likely to be affected by the construction of the wind energy facility to a greater extent than the operation of the wind energy facility.

Extent: The impact will occur at the site of the proposed WEF, specifically at the scale of the individual infrastructure within the site. At it's greatest extent this may affect the entire site, but according to the proposed layout is not likely to affect any suitable habitat on site. There are no turbines proposed to be sited within untransformed habitat. The impact is scored as local.

Duration: The impact will either be of short-term duration (construction phase only).

Magnitude: Due to the fact that no natural habitat is affected, the magnitude of the impact is scored as minor (will not result in an impact on processes).

Probability: Because of the fact that no turbines infringes on natural habitat, the probability of the impact occurring is therefore relatively low and is scored as highly improbable.

Potential significance: The overall significance of the impact is rated as low.

Mitigation measures: None proposed. A previous recommendation to move one turbine was acted upon.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	Short term (1)	Short term (1)
Magnitude	minor (2)	minor (2)
Probability	Highly improbable (1)	Highly improbable (1)
Significance	**low (4)**	**low (4)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes

Can impacts be mitigated?	To some degree	
Mitigation: (1) None		
Cumulative impacts: Any other infrastructure could cause similar impacts.		
Residual Impacts: None.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 2: Impacts on bats

It has been evaluated that there are two near threatened bat species that could potentially be affected by the proposed wind energy facility. These are Lesueur's Wing-gland bat (NT) and Natal Long-fingered Bat (NT). These species are most likely to be affected by the operation of the WEF to a greater extent than the construction of the WEF.

Extent: The impact will occur at the site of the proposed WEF, but will have an impact at a more regional level, since it affects entire populations of affected species and may affect migration routes of species.

Duration: The impact will be of long-term duration, because it will occur for the entire duration of the operation of the wind energy facility.

Magnitude: If any populations of either species occur in the area, the potential magnitude of the impact could be moderate.

Probability: No known populations of either bat species occur in the grid in which the site is located. The probability of the impact occurring is therefore relatively low and is scored as improbable.

Potential significance: The overall significance of the impact is rated as low.

Mitigation measures: A monitoring programme should be implemented to document the effect of the WEF operation on bats. This should take place before construction (to provide a benchmark), and during operation. If the turbines are found to have a significant negative impact on bats then further measures will need to be implemented to control the impact, for example, halting operation during low wind conditions when bats are most active.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	regional (3)	regional (3)
Duration	long-term (4)	long-term (4)
Magnitude	medium (5)	Medium low (4)
Probability	improbable (2)	improbable (2)
Significance	**low (24)**	**low (22)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) A monitoring programme should be implemented to document the effect of wind turbines on bat species.		

Cumulative impacts: Any other infrastructure could cause similar impacts.
Residual Impacts: None.

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 3: Impacts on watercourses

There are a number of watercourses and wetlands on site that could potentially be affected by the proposed construction of turbines. However, no turbines are currently positioned within or immediately adjacent to mapped wetland areas.

Extent: The impact will be local and surrounding areas, although downstream areas could be affected.

Duration: The impact will be of medium-term duration (until a perennial cover of vegetation becomes re-established in disturbed areas).

Magnitude: Due to the fact that no wetlands or drainage lines are affected, the magnitude of the impact is scored as minor (will not result in an impact on processes)..

Probability: According to the current position of the turbines, it is improbable that the impact will occur.

Mitigation measures: Stormwater and runoff water must be controlled and managed to avoid impacts on watercourses.

Nature: Damage to wetland areas resulting in hydrological impacts		
	Without mitigation	**With mitigation**
Extent	local and surroundings (2)	local and surroundings (2)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Minor (2)	Minor (1)
Probability	Improbable (2)	Improbable (2)
Significance	**low (14)**	**low (12)**
Status (positive or negative)	negative	negative
Reversibility	Reversible with effective rehabilitation	Reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) Stormwater and runoff water must be controlled and managed where et emanates from infrastructure. (2) rehabilitate any disturbed areas immediately to stabilise landscapes		
Cumulative impacts: None.		
Residual Impacts: Despite proposed mitigation measures, it is expected that this impact will still occur to some degree.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Substations

Impact 1: Impacts on threatened animals

It has been evaluated that there are four threatened and two near threatened animal species that could potentially be affected by the proposed wind energy facility. These are White-tailed Rat (EN), Cape Caco (VU), Namaqua Plated Lizard (NT), Fisk's House Snake (VU), Yellow-bellied House Snake (NT), Gronovi's Dwarf Burrowing Skink (NT) and Kasner's Dwarf Burrowing Skink (VU). These species are most likely to be affected by the construction of the wind energy facility and associated infrastructure to a greater extent than the operation of the wind energy facility.

Extent: The impact will occur at the site of the proposed WEF, specifically at the scale of the individual infrastructure within the site. At it's greatest extent this may affect the entire site, but according to the proposed layout is not likely to affect any suitable habitat on site.

Duration: The impact will either be of short-term duration (construction phase only).

Magnitude: The scale of the impact is minor (will not result in an impact on processes).

Probability: Due to the fact that no natural habitat is affected, the probability of the impact occurring is highly improbable.

Potential significance: The overall significance of the impact is rated as low.

Mitigation measures: None. A previous recommendation to move substation 1 was acted upon.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	Short-term (1)	Short-term (1)
Magnitude	minor (1)	minor (1)
Probability	Highly improbable (1)	Highly improbable (1)
Significance	**low (3)**	**low (3)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) None.		
Cumulative impacts: Any other infrastructure could cause similar impacts.		
Residual Impacts: None.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 2: Impacts on bats

It has been evaluated that there are two near threatened bat species that could potentially be affected by the proposed wind energy facility. These are Lesueur's Wing-gland bat (NT) and Natal Long-fingered Bat (NT). These species are not likely to be affected by the construction or operation of the substations.

Extent: The impact will occur at the site of the proposed substations.

Duration: The impact will be of long-term duration, because it will occur for the entire duration of the operation of the wind energy facility.

Magnitude: If any populations of either species occur in the area, the potential magnitude of the impact could be very low.

Probability: No known populations of either bat species occur in the grid in which the site is located. The probability of the impact occurring is therefore relatively low. It is also very unlikely that the substation will have any effect on bats. The probability is therefore scored as highly improbable.

Potential significance: The overall significance of the impact is rated as low.

Mitigation measures: None required.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	long-term (4)	long-term (4)
Magnitude	Very low (1)	very low (1)
Probability	Highly improbable (1)	Highly improbable (1)
Significance	**low (6)**	**low (6)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) None required		
Cumulative impacts: No other impacts are likely to cause similar effects on bats.		
Residual Impacts: None.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 3: Impacts on watercourses

The two substations are positioned further than 50 m away from the edge of any watercourse.

Extent: The impact will be local and surrounding areas, although downstream areas could be affected.

Duration: The impact will be of short-term duration, because the substation is not positioned anywhere close to any watercourses.

Magnitude: Due to the fact that no natural habitat is affected, the potential magnitude of the impact is considered to be minor (will have no effect on processes).

Probability: Due to the fact that no natural habitat is affected, the probability of the impact occurring is highly improbable.

Mitigation measures: Stormwater and runoff water must be controlled and managed to avoid impacts on watercourses. A previous recommendation to move a substation was acted upon.

Nature: Damage to wetland areas resulting in hydrological impacts		
	Without mitigation	**With mitigation**
Extent	local and surroundings (2)	local and surroundings (2)
Duration	Short-term (1)	Short-term (1)
Magnitude	Minor (2)	Minor (1)
Probability	Highly improbable (1)	Highly improbable (1)
Significance	**low (5)**	**low (4)**
Status (positive or negative)	negative	negative
Reversibility	Reversible with effective rehabilitation	Reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) Control stormwater and runoff water emanating from infrastructure. (2) rehabilitate any disturbed areas immediately to stabilise landscapes		
Cumulative impacts: None.		
Residual Impacts: Despite proposed mitigation measures, it is expected that this impact will still occur to some degree.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Overhead power line

Impact 1: Impacts on threatened animals

It has been evaluated that there are four threatened and two near threatened animal species that could potentially be affected by the proposed wind energy facility. These are White-tailed Rat (EN), Cape Caco (VU), Namaqua Plated Lizard (NT), Fisk's House Snake (VU), Yellow-bellied House Snake (NT), Gronovi's Dwarf Burrowing Skink (NT) and Kasner's Dwarf Burrowing Skink (VU). These species are most likely to be affected by the construction of the wind energy facility and associated infrastructure to a greater extent than the operation of the wind energy facility.

Extent: The impact will occur at the site of the proposed power line, specifically at the scale of the individual towers. Part of the power line (near substation 1) is within untransformed habitat. The impact will occur at the site of this section of power line. There are also patches of untransformed habitat along the remainder of the alignment to the Dassenburg substation. This part of the power line is adjacent to two existing powerlines. The assumption is made that the towers will be placed next to or close to existing towers. There are therefore a number of places where existing twoers are within untransformed habitat.

Duration: The impact will either be of permanent duration if it leads to loss of habitat for species.

Magnitude: The scale of the impact is small (one section of power line on site and some areas along the remainder of the existing power line route to Dassenburg). The habitat on site at this point is in relatively good condition and includes variable sub-habitats. It is potentially suitable habitat for some of the species of conservation concern. Along the existing servitude and alignment to Dassenburg, the potential impact is ameliorated by the fact that two power lines already exist, access is therefore alrteady in place and there are existing disturbances at the existing towers. The potential magnitude of the impact could therefore be medium.

Probability: Because of the fact that this section of the power line infringes squarely on natural habitat, the probability of the impact occurring is relatively high and is scored as highly probable.

Potential significance: The overall significance of the impact is rated as medium.

Mitigation measures: For the power line from the site to the Dassenburg substation, towers must be placed as close to the existing towers on the existing power lines parallel to the proposed alignment.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	permanent (5)	permanent (5)
Magnitude	medium (4)	low (1)
Probability	Highly probable (4)	Highly probable (4)
Significance	**medium (40)**	**low (28)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) Place towers next to / near to existing towers along the route to Dassenburg (off-site)		
Cumulative impacts: Any other infrastructure could cause similar impacts.		
Residual Impacts: None.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 2: Impacts on bats

It has been evaluated that there are two near threatened bat species that could potentially be affected by the proposed wind energy facility. These are Lesueur's Wing-gland bat (NT) and Schreiber's long-fingered bat (NT). These species are not likely to be affected by the construction or operation of the overhead power line. At worst, there may be some collisions with cables, but due to the echolocation abilities of bats, is unlikely to occur very often. Bats do, however, occasionally turn off their echolocation and can run into things, but this is very unlikely to cause more than a small number of mortalities for the proposed project.

Extent: The impact will occur at the site of the proposed power line.

Duration: The impact will be of long-term duration, because it will occur for the entire duration of the operation of the wind energy facility.

Magnitude: If any populations of either species occur in the area, the potential magnitude of the impact could be low.

Probability: No known populations of either bat species occur in the grid in which the site is located. The probability of the impact occurring is therefore relatively low. It is also very unlikely that the power line will have any effect on bats. The probability is therefore scored as highly improbable.

Potential significance: The overall significance of the impact is rated as low.

Mitigation measures: None required.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	long-term (4)	long-term (4)
Magnitude	Very low (1)	very low (1)
Probability	Highly improbable (1)	Highly improbable (1)
Significance	**low (6)**	**low (6)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) None required		
Cumulative impacts: Any other infrastructure could cause similar impacts.		
Residual Impacts: None.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 3: Impacts on watercourses

The 132kV power line crosses wetlands and watercourses in various places, although it is unlikely that power line towers will be positioned within wetlands. The impact is assessed assuming that towers may be positioned in watercourses, thereby indicating the worst-case scenario. The assessment includes the entire length of the power line to the Dassenburg substation. This latter section of the power line includes a tower that will be placed very close to the permanent wetland part of a small pan between Saxonsea and Mamre.

Extent: The impact will be local and surrounding areas, although downstream areas could be affected.

Duration: The impact will be of permanent duration, because the vegetation will be permanently cleared in order to erect the tower.

Magnitude: The potential magnitude of the impact could be medium at a local scale.

Probability: According to the current position of the power line, it is probable that the impact will occur.

Mitigation measures: Stormwater and runoff water must be controlled and managed to avoid impacts on watercourses. A permit from DWA is required if there are expected to be any impacts on any wetland or water resources. Power line towers must not be positioned in watercourses.

Nature: Damage to wetland areas resulting in hydrological impacts		
	Without mitigation	**With mitigation**
Extent	local and surroundings (2)	local and surroundings (2)
Duration	Permanent (5)	Medium-term (3)
Magnitude	Medium (4)	Low (1)
Probability	probable (3)	improbable (2)
Significance	**medium (33)**	**low (12)**
Status (positive or negative)	negative	negative
Reversibility	Reversible with effective rehabilitation	Reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) Ensure towers are not positioned in watercourses. (2) Avoid unnecessary impacts on wetland areas. Impacts should be contained, as much as possible, within the power line servitude. (3) obtain a permit from DWA to impact on any wetland or water resource. (4) rehabilitate any disturbed areas immediately to stabilise landscapes		
Cumulative impacts: None.		
Residual Impacts: Despite proposed mitigation measures, it is expected that this impact will still occur to some degree.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Internal cables and access roads

Impact 1: Impacts on threatened animals

It has been evaluated that there are four threatened and two near threatened animal species that could potentially be affected by the proposed wind energy facility. These are White-tailed Rat (EN), Cape Caco (VU), Namaqua Plated Lizard (NT), Fisk's House Snake (VU), Yellow-bellied House Snake (NT), Gronovi's Dwarf Burrowing Skink (NT) and Kasner's Dwarf Burrowing Skink (VU). These species are most likely to be affected by the construction of the wind energy facility and associated infrastrucrure to a greater extent than the operation of the wind energy facility.

There is a single place where the main access road onto site crosses untransformed natural habitats. Otherwise all internal access roads and underground cables are along existing internal roads.

Extent: The impact will occur at the site of the one main access road crossing. This will affect a small proportion of suitable habitat on site. It is scored as local.

Duration: The impact will be of permanent duration if it leads to loss of habitat for species.

Magnitude: The scale of the impact is low and may cause a slight impact on processes.

Probability: Based on the current alignment of the main access roads, untransformed habitat will definitely be affected. It is, however, not certain that threatened animals occur within this habitat. The probability of the impact occurring is therefore scored as probable.

Potential significance: The overall significance of the impact is rated as medium.

Mitigation measures: Unnecessary impacts on surrounding natural vegetation must be avoided. The construction impacts must be contained to the servitude of the road. Rehabilitate disturbed areas immediately to stabilize the landscape.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	permanent (5)	permanent (5)
Magnitude	low (4)	low (3)
Probability	probable (3)	probable (3)
Significance	**medium (30)**	**low (27)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) The construction impacts must be contained to the footprint/servitude of the infrastructure (2) Limit unnecessary impacts on surrounding natural vegetation, e.g. driving around in the veld, use access roads only (3) rehabilitate any disturbed areas immediately to stabilise landscapes		
Cumulative impacts: Any other infrastructure could cause similar impacts.		
Residual Impacts: None.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 2: Impacts on bats

It has been evaluated that there are two near threatened bat species that could potentially be affected by the proposed wind energy facility. These are Lesueur's Wing-gland bat (NT) and Schreiber's long-fingered bat (NT). These species are not likely to be affected by the construction or operation of underground cables or access roads, except for a small loss of habitat.

Extent: The impact will occur at the site of the proposed wind energy facility.

Duration: The impact will be of long-term duration, because it will occur for the entire duration of the operation of the wind energy facility.

Magnitude: If any populations of either species occur in the area, the potential magnitude of the impact could be very low.

Probability: No known populations of either bat species occur in the grid in which the site is located. The probability of the impact occurring is therefore relatively low. It is also very unlikely that the infrastructure will have any effect on bats. The probability is therefore scored as highly improbable.

Potential significance: The overall significance of the impact is rated as low.

Mitigation measures: None required.

Nature: Impacts on individuals of threatened bat species		
	Without mitigation	**With mitigation**
Extent	local (1)	local (1)
Duration	long-term (4)	long-term (4)
Magnitude	Very low (1)	very low (1)
Probability	Highly improbable (1)	Highly improbable (1)
Significance	**low (6)**	**low (6)**
Status (positive or negative)	negative	negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) None required		
Cumulative impacts: Any other infrastructure could cause similar impacts.		
Residual Impacts: None.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

Impact 3: Impacts on watercourses

There is a single place where the main access road onto site crosses two drainage lines. Otherwise all internal access roads and underground cables are along existing internal roads.

Extent: The impact will be local and surrounding areas, although downstream areas could be affected.

Duration: The impact will be of long-term duration, because the vegetation will be permanently cleared in order to construct the infrastructure and may take an extended period of time to become re-established in disturbed areas.

Magnitude: The potential magnitude of the impact is likely to be moderate (result in processes continuing but in a modified way) at a local scale, due to the complete clearing of vegetation required.

Probability: According to the current position of the main access road, it is definite that the impact will occur.

Mitigation measures: Stormwater and runoff water must be controlled and managed to avoid impacts on watercourses. A permit from DWA is required if there are expected to be any impacts on any wetland or water resources. Cross watercourses close to existing disturbances. Cross watercourses perpendicularly, where possible, to minimize the construction footprint.

Adequate culvert and/or bridge structures are required at crossings. No infrastructure should be placed within the bed of watercourses. Construction must not cause the width of the watercourse to be narrowed. Disturbed areas must be rehabilitated as soon as possible.

Nature: Damage to wetland areas.		
	Without mitigation	**With mitigation**
Extent	local and surroundings (2)	local and surroundings (2)
Duration	Long-term (4)	Medium-term (3)
Magnitude	Moderate (6)	Moderate (5)
Probability	definite (5)	definite (5)
Significance	**medium (60)**	**medium (45)**
Status (positive or negative)	negative	negative
Reversibility	Reversible to some extent with effective rehabilitation	Reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To some degree	
Mitigation: (1) Cross wetlands perpendicularly. (2) Avoid unnecessary impacts on natural vegetation. Impacts should be contained, as much as possible, within the footprint of the proposed crossing. (3) obtain a permit from DWA to impact on any wetland or water resource. (4) rehabilitate any disturbed areas immediately to stabilise landscapes (5) For any new roads, adequate culvert and/or bridge structures are required to ensure that construction impacts do not permanently affect channel structure and morphology. (6) Construction of infrastructure must not cause the width of the watercourse to be narrowed or the general morphology to be altered.		
Cumulative impacts: None.		
Residual Impacts: Despite proposed mitigation measures, it is expected that this impact will still occur to some degree.		

*Significance calculated as (magnitude+duration+extent) x probability. Significance: <30 = low, 30–60 = medium, >60 = high.

DISCUSSION AND CONCLUSIONS

A large proportion of the study area is in a transformed state and consists primarily of agricultural lands. There are, however, areas of remaining natural vegetation as well as areas within cultivated lands that may provide habitat for threatened fauna. The current layout of infrastructure avoids remaining natural habitat to a large degree.

There are a number of animal species of conservation concern that may occur in habitats within the study area. Those of concern are the following:

- Lesueur's Wing-gland bat (NT)
- Natal Long-fingered bat (NT)
- White-tailed Rat (EN)
- Cape Caco (VU)
- Namaqua Plated Lizard (NT)
- Fisk's House Snake (VU)
- Yellow-bellied House Snake (NT)
- Gronovi's Dwarf Burrowing Skink (NT)
- Kasner's Dwarf Burrowing Skink (VU)

A risk assessment was undertaken which identified three main potential negative impacts on fauna, as follows:

- Impacts on habitats of non-flying threatened fauna;
- Impacts due to collision of bats with infrastructure (primarily turbine blades);
- Impacts of construction on wetlands / watercourses.

A summary of the potential significance of impacts (before and after mitigation) for different infrastructure components is given in Table 3. In all except one case, the significance of impacts was evaluated as being low or could be reduced to low significance with mitigation.

Recommendations

The following recommendations are made to reduce impacts or provide additional information that can lead to reduction or control of impacts:

- A monitoring programme should be implemented to document the effect of the WEF operation on bats. This should take place before construction (to provide a benchmark), during construction and during operation. This will provide information to quantify the impacts of the present project.

Conclusions

The overall impacts of the proposed project have been assessed as largely being of medium to low significance (see Table 3 below). If mitigation measures are put in place to manage impacts, then all potential impacts, except one, can be reduced to having low significance. The only impact of concern is the potential impact on wetlands, which is due to a single crossing of a wetland for the main access road onto site from the main road. If proper structures are put in place then impacts on this wetland system can be managed. The proposed project is therefore considered to be acceptable in terms of potential impacts on fauna and wetlands / watercourses and it is recommended that it should be permitted to go ahead.

Table 3: Summary of the significance of impacts for different infrastructure components before and after mitigation.

	Wind turbines		Substations		Overhead powerline		Internal cables & access roads	
Impacts on:	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation
1. threatened animals	low (4)	low (4)	low (3)	low (3)	medium (40)	low (28)	medium (30)	low (27)
2. bats	low (24)	low (22)	low (6)	low (6)	low (6)	low (6)	low (6)	low (6)
3. watercourses & wetlands	low (14)	low (12)	low (5)	low (4)	medium (33)	low (12)	medium (60)	medium (45)

MANAGEMENT PLAN

Control measures are only proposed for those impacts where mitigation measures are proposed to reduce the significance of impacts, i.e. some impacts are of low significance and thus no mitigation measures are proposed or no mitigation measures are possible or required.

OBJECTIVE: Monitor impacts on bats due to turbine blade collisions	
Project component/s	Turbines
Potential Impact	Loss of individuals of the threatened bat species
Activity/risk source	Operation
Mitigation: Target/Objective	Target: low mortalities within project control area Time period: implement pre-construction; continue throughout operation

Mitigation: Action/control	Responsibility	Timeframe
(1) establish an ongoing monitoring programme to detect and quantify any mortalities of individuals of threatened bat species	Management (environmental officer),	Estabish and implement pre-construction; continue throughout operation

Performance Indicator	Number of individuals killed by turbine blades within project area
Monitoring	• Determine densities of affected bat species within the area occupied by the wind energy facility before and after construction. • Document patterns of bat movement in the vicinity of the wind energy facility before and after construction. • Record bat mortalities and, as far as possible, the circumstances surrounding collisions. Standard protocols should be used when undertaking such surveys.

OBJECTIVE: Limit impacts on untransformed habitat due to construction of infrastructure

Project component/s	Main access road onto site near entrance
Potential Impact	Loss of untransformed natural habitat
Activity/risk source	Planning / construction
Mitigation: Target/Objective	Target: no unnecessary loss of natural habitat within project control area Time period: planning , construction

Mitigation: Action/control	Responsibility	Timeframe
(1) The construction impacts must be contained to the footprint/servitude of the infrastructure (2) Limit unnecessary impacts on surrounding natural vegetation, e.g. driving around in the veld, use access roads only (3) rehabilitate any disturbed areas immediately to stabilise landscapes	Management (environmental officer),	Planning, construction

Performance Indicator	Area of untrasnformed natural habitat lost within project area
Monitoring	• Determine area of natural habitat remaining before and after construction.

OBJECTIVE: Limit damage to watercourses / wetlands	
Project component/s	New crossing of wetland near entrance to site at main road.
Potential Impact	Damage to wetland areas by any means that will result in hydrological changes (includes erosion, siltation, dust, direct removal of soil of vegetation, dumping of material within wetlands). The focus should be on the functioning of the watercourse as a natural system
Activity/risk source	Construction, operation
Mitigation: Target/Objective	Target: no unnecessary damage to watercourses within project area Time period: construction, operation

Mitigation: Action/control	Responsibility	Timeframe
(1) for any new construction, cross watercourses perpendicularly to minimise disturbance footprints (2) rehabilitate any disturbed areas as quickly as possible (3) control stormwater and runoff water (4) appoint an independent environmental control officer during construction and an environmental manager during operation whose duty it will be to minimise impacts on surrounding sensitive habitats (5) obtain a permit from DWA to impact on any wetland or water resource.	Planning team; construction team, management, environmental control officer	Planning, construction, operation

Performance Indicator	No impacts on water quality, water quantity, wetland vegetation, natural status of watercourses
Monitoring	• Water quality monitoring to take place on a regular basis. This should include the water quality and quantity leaving the project area through the watercourses (should be monitored within main drainage systems that exit site). • Habitat loss in watercourses should be monitored before and after construction. • The environmental manager should be responsible for driving this process. • Reporting frequency depends on legal compliance framework.

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Appendix 1: Threatened vertebrate species with a geographical distribution that includes the current study area.

MAMMALS

Common name	**Taxon**	**Habitat**	**Status[2]**	**Likelihood of occurrence**
Lesueur's Wing-gland bat	Cistugo lesueuri	Rock crevices in fynbos.	NT (Friedmann & Daly 2004, listed as LC at www.iucnredlist.org, According to Monadjem et al. 2010, global status is VU)	**MEDIUM**, not previously recorded in grids, but overall geographical distribution includes this area; no suitable roosting habitat on site, but there may be nearby
Natal long-fingered bat	Miniopterus natalensis	Caves and sub-terranean habitats in Fynbos, savanna, woodland, succulent and Nama Karoo, grassland; cave-dwelling aerial insectivore.	NT (According to Monadjem et al. 2010 and www.iucnredlist.org, global status is LC)	**MEDIUM**, not previously recorded in grids, but overall geographical distribution includes this area; no suitable roosting habitat on site, but there may be nearby
White-tailed rat	Mystromus albicaudatus	Highveld and montane grassland, requires sandy soils with good cover. Found throughout South Africa except Northern Cape and Limpopo	EN (Friedmann & Daly 2004, no record at www.iucnredlist.org)	**HIGH**, previously recorded in neighbouring grid, presence of suitable substrate (sandy soils present)
Grant's golden mole	Eremitalpa granti	Strandveld Succulent Karoo, Namib Desert, in subterranean habitats in shifting sands	LC (According to www.iucnredlist.org, Listed as VU in Friedmann & Daly 2004)	**HIGH**, previously recorded in neighbouring grid, substrate properties on site are suitable for this species.

[1]Distribution according to Friedmann & Daly 2004.

[2]Status according to IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. (www.iucnredlist.org). Downloaded on 09 September 2010.

AMPHIBIANS

Common name	**Species**	**Habitat**	**Status[2]**	**Likelihood of occurrence**
Cape Caco	Cacosternum capense	Lowlands west of the Cape Fold mountains, from the Cape Flats northwards to Graafwater. Vredenburg (3217DD) is at the western limit of its distribution range. Inhabits flat or gently undulating low-lying areas with poorly drained loamy to clay soil, where it breeds in shallow, temporary, rain-filled pools and pans that form during the winter months. Also occurs in more sandy habitats. About 90% of recorded breeding sites occur in modified habitat, particularly agricultural lands.	VU	**HIGH**, previously recorded in grid and suitable habitat available on site.

[2]Status according to Minter et al. 2004 and IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. (www.iucnredlist.org). Downloaded on 09 September 2010..

REPTILES

Common name	**Species**	**Habitat**	**Status[3]**	**Likelihood of occurrence**
Cape sand snake	Psammophis leightoni leightoni	Coastal renosterveld, coastal fynbos and transitional strandveld in the extreme south-western Cape.	VU[4] (no record at www.iucnredlist.org)	**LOW**, just outside known distribution range, but suitable habitat on site.
Armadillo girdled lizard	Cordylus cataphractus	Rock cracks and crevices. Diet consists mainly of termites, beetles and grasshoppers	VU[4]	**LOW**, just outside known distribution range.
Namaqua plated lizard	Gerrhosaurus typicus	Dry sandy areas and bare rocky hillsides	RARE[3], NT[4]	**HIGH**, overall geographical distribution

Common name	Species	Habitat	Status[3]	Likelihood of occurrence
				includes this area; suitable habitat on site
Southern speckled padloper	Homopus signatus cafer	Rocky outcrops and ridges in regions of relatively low rainfall. Occurs west of Cedarberg to the coast.	NT[4]	**LOW**, just outside known distribution range. Small amount of suitable habitat may occur on site.
Geometric tortoise	Psammobates geometricus	Flat, low-lying renosterveld of the south-western Cape. Tortoises prefer relatively open habitat.	EN[4]	**LOW**, outside known distribution range. Suitable habitat may occur on site.
Fisk's house snake	Lamprophis fiskii	Karoo, fynbos and succulent karoo.	VU[4]	**MEDIUM**, overall geographical distribution includes this area; suitable habitat on site
Yellowbellied house snake	Lamprophis fuscus	Old termitaria and under stones, underground. Found throughout more mesic parts of South Africa (Cape, east coast, Highveld).	NT[4]	**MEDIUM**, not previously recorded in neighbouring grids, but within overall distribution range and habitats are available on site.
Black spitting cobra	Naja nigricollis woodi	Favours rocky terrain, dry rocky watercourses. Known from Cedarberg.	RARE[3] (no record at www.iucnredlist.org)	**LOW**, overall geographical distribution includes this area; no ideally suitable habitat on site
Gronovi's dwarf burrowing skink	Scelotes gronovii	West Coast from Vredendal to Robben Island. Under flat rocks or litter in sandy areas.	NT[4]	**HIGH**, within geographical distribution range, previously recorded nearby and suitable habitat occurs on site.
Kasner's dwarf burrowing skink	Scelotes kasneri	Coastal dune areas from Lambert's Bay to Vredenburg. Coastal dunes under flat stones or under litter.	VU[4]	**HIGH**, within geographical distribution range, previously recorded nearby and suitable habitat occurs on site.

[3]Status according to Branch 1988.

[4]Status according to Groombridge 1994.\

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SPECIALIST IMPACT ASSESSMENT FOR PROPOSED RHEBOKSFONTEIN WIND ENERGY FACILITY NEAR DARLING, WESTERN CAPE: VEGETATION COMPONENT

Prepared for: Savannah Environmental (Pty.) Ltd., Johannesburg

Client: Moyeng Energy (Pty) Ltd.

26 August 2010

EXECUTIVE SUMMARY

This botanical impact assessment was requested in order to help inform decisions regarding the establishment of a proposed private wind energy facility (WEF) on a site in the Darling area (Western Cape). The 3900ha study area consists of the Remaining extent of Farm 568 (Rheboksfontein), Farm 567 (Nieuwe Plaats), Remaining extent of Farm 571 (Bonteberg), Portion 1 of Farm 574 (Doornfontein), Portion 1 of Farm 551 (Plat Klip), Farm 1199 (Groot Berg) and Portion 2 of Farm 552 (Slang Kop). The study area lies east of the R27 and straddles the Yzerfontein to Darling road (R315). The proposal is to install a total of up to 80 wind turbines. The proposed WEF would also include 3 substations, a 32km long 132kV power line linking to the transmission grid at Dassenberg substation near Atlantis, access roads and a maintenance/control building.

The study area lies at the western edge of the Swartland section of the Cape Lowlands Renosterveld Project study area. This project identified the majority of the natural vegetation in the study area as part of the core conservation area, and as part of the immediate 5 year priority area for conservation action (von Hase *et al* 2003).

There are two natural vegetation types in the study area – Swartland Granite Renosterveld (which would originally have covered 80% of study area) and Hopefield Sand Fynbos. Both are nationally recognised as threatened, with the former being Critically Endangered and the latter Endangered in terms of the National Spatial Biodiversity Assessment (Rouget et al 2004). The Draft National List of Threatened Ecosystems lists Swartland Granite Renosterveld as Critically Endangered and Hopefield Sand Fynbos as Vulnerable (DEA 2009). Thus all remaining natural vegetation in the study area is of High sensitivity and conservation value. Natural vegetation covers an estimated 50% of the southern section of the site, but only about 10% of the northern section. The higher percentage of natural vegetation on the southern section is due to the fact that this is the part of the site dominated by infertile sandy soils, which are not suitable for most cultivation.

The vegetation in the study area ranges in condition from totally transformed agricultural land (about 70% of the area, or 2730ha) to partly disturbed (about 350ha) to largely pristine (about 550ha). All the largely pristine areas, but also the more natural sections of the partly disturbed areas, can be expected to support varying and significant numbers of threatened or localised plant species,

and it is possible that upwards of 35 plant species of conservation concern occur within the study area. This exceptionally high figure is indicative of the sensitivity and conservation importance of both the general area and the study area.

Disturbance in the area includes dryland cultivation (mainly for cereals and grazing for sheep and cattle), dairy farming and associated effluent drainage, heavy grazing and trampling by cattle and sheep, and alien vegetation invasion. The most heavily disturbed areas are those that have been regularly ploughed and sown with crops, plus those where dairy farming is undertaken, and these areas generally have no botanical value. Alien invasive vegetation is most severe in seasonally and permanently damp places, around homesteads, and in areas where there has been previous soil disturbance.

The following potentially negative ecological issues have been identified:

- Direct loss of vegetation at the construction phase (tower installation requires special cranes on heavy tracks; crane standpads; substations; access roads; powerline footings; concrete mixing sites).
- Temporary loss of vegetation at the construction phase (laydown areas; underground cabling; disturbance around towers; building material storage areas; access route along 32km powerline).
- Indirect ecological impacts at the operational phase (possible introduction of invasive alien ants and plants; possible disruption of natural fire regimes; possible fragmentation of natural habitat and ecological corridors).

The following potentially positive ecological impacts have been identified:

- Opportunity to formally conserve and manage significant priority areas of natural habitat on site (basically on-site offsets), preferably as Contract Reserves with CapeNature's Stewardship Program.
- Opportunity to reduce damaging effluent inflow into the important Tienie Versfeld Wildflower Reserve from the dairy farm on the property immediately upslope (Farm 552).

The primary negative impacts are the result of both direct and indirect factors. Direct impacts include loss of natural vegetation (<10ha) in development footprints, and direct, long term loss of natural vegetation (<10ha) in areas that will be disturbed by heavy construction machinery and power line installation, temporary dumping of sand and supplies, etc. Most of these impacts can be avoided by very minor changes to the turbine and road positions (usually requiring layout shifts of less than 50m), and these are duly recommended as mandatory mitigation.

Indirect impacts are often difficult to quantify and avoid. The indirect botanical impacts of the proposed development are fortunately likely to be negligible in relation to the existing and ongoing agricultural impacts on the site (*e.g*. grazing, fertiliser and pesticide usage and drift).

Cumulative effects are in many respects regional effects, and the impacts of this type of development will be significantly less than for various existing and ongoing agricultural operations in the region, as well as for the many unmanaged and expanding alien plant invasions on numerous properties in the region.

The proposed 32km power line to the Dassenberg substation crosses many areas of High botanical sensitivity (totalling 26km in length) but will have an acceptable overall Low-Medium negative impact overall, and the expected botanical impacts are difficult to mitigate. Substations 2 and 3 are in acceptable locations, but Substation 1 will have significant negative impacts on the Renosterveld in this area, and should thus be moved (300m north) into a nearby area of agricultural land. This also means that a number of proposed cable trenches through the Renosterveld will have to be rerouted, and in most cases these can easily be located within agricultural land, where they will have minimal botanical impact.

The possible positive direct impact depends to a large degree on the management of the remaining natural vegetation within the study area (about 900ha in moderate or good condition) as a conservation area (Sand Fynbos and Renosterveld are both very under-conserved, with less than 1% conserved), and the removal of livestock from these Renosterveld and Sand Fynbos areas during the main flowering season (May – September). A second positive indirect impact could be realized if current nutrient-rich effluent flows from the farm adjacent to the Tienie Versfeld Reserve are reduced or eliminated. An indirect positive impact is obviously the small contribution that this WEF will make to reducing CO_2 emissions, and the associated very small reduction in global warming effects.

Overall the proposed WEF is likely to have a Medium – High negative local (site scale; 1600ha site) and Medium regional (Darling Hills; < 100 000ha) negative impact on the vegetation on site, prior to mitigation. This could be reduced to

Low negative (site) and Very Low negative (regional) with proper mitigation, although the likelihood of all proposed mitigation taking place is considered only moderate, and a more likely post-mitigation significance is Low – Medium negative (at both site and regional scales). The most important unknown variables in this regard are the likelihood of being able to mitigate the current negative agricultural impacts on the adjacent Tienie Versfeld Wildflower Reserve, the likelihood of being able to manage the 32km long power line servitude appropriately, and the likelihood of most High sensitivity vegetation areas on site being managed under CapeNature's Stewardship program.

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DECLARATION OF INDEPENDENCE

In terms of Chapter 5 of the National Environmental Management Act of 1998 specialists involved in Impact Assessment processes must declare their independence and include an abbreviated Curriculum Vitae.

I, N.A. Helme, do hereby declare that I am financially and otherwise independent of the client and their consultants, and that all opinions expressed in this document are substantially my own.

NA Helme

Abridged CV:

Contact details as per letterhead.

Surname : HELME

First names : NICHOLAS ALEXANDER

Date of birth : 29 January 1969

University of Cape Town, South Africa. BSc (Honours) – Botany (Ecology & Systematics). 1990.

Since 1997 I have been based in Cape Town, and have been working as a specialist botanical consultant, specialising in the diverse flora of the south-western Cape. Since the end of 2001 I have been the Sole Proprietor of Nick Helme Botanical Surveys.

A selection of recent, relevant projects undertaken in the region include:

- Scoping study of Proposed Wind Energy Facility near Swellendam (CSIR 2010)
- Scoping study of proposed Wind Energy Facility near Britannia Bay (Savannah Environmental 2010)
- Scoping study of Proposed Wind Energy Facility near Bredasdorp (CSIR 2010)
- Scoping study of Proposed Wind Energy Facility near Caledon (Arcus Gibb 2009)
- Scoping and Impact Assessment of proposed Wind Energy Facility near Hopefield (Savannah Environmental 2008 & 2009)
- Scoping study of Proposed Wind Energy Facility near Vredendal (DJ Environmental 2009)
- Scoping study of Proposed Wind Energy Facility west of Bitterfontein (DJ Environmental 2009)
- Botanical Scoping and Impact Assessment of proposed St Helena Hills development (DJ Environmental 2009)
- Botanical Impact Assessment of Portion 4 of Farm 560, Yzerfontein (EnviroLogic 2009)
- Botanical Impact Assessment of Portion 9 of Farm 957, Saldanha (EnviroLogic 2008)
- Botanical Impact Assessment of proposed development on Portion 87 of the Farm Witteklip 123, Vredenburg (CCA Environmental 2008)
- Botanical Sensitivity study of Portion 4 of Farm Yzerfontein 560 (De Villiers family 2008)
- Botanical Scoping and Impact Assessment of proposed overnight sites in the West Coast National Park (SANParks 2008 & 2010)
- Fine Scale Vegetation Mapping for Saldanha Municipality (CapeNature 2007)
- Botanical Assessment of Rem. Erf 460 Ptn A, St Helena (Envirodinamik 2007)
- Stewardship assessment of Rainbow Chicken Sites (CapeNature 2007)

1. INTRODUCTION

This botanical impact assessment was requested in order to help inform decisions regarding the establishment of a proposed private wind energy facility (WEF) on a large site in the Darling area (Western Cape). The 3900ha study area consists of the Remaining extent of Farm 568 (Rheboksfontein), Farm 567 (Nieuwe Plaats), Remaining extent of Farm 571 (Bonteberg), Portion 1 of Farm 574 (Doornfontein), Portion 1 of Farm 551 (Plat Klip), Farm 1199 (Groot Berg) and Portion 2 of Farm 552 (Slang Kop). The study area lies east of the R27 and straddles the Yzerfontein to Darling road (R315). The proposal is to install a total of up to 80 wind turbines. The proposed WEF would also include 3 substations, a 32km 132kV powerline linking to the transmission grid at the Dassenberg substation near Atlantis, access roads and a maintenance /control building. Each turbine would be connected to the on-site substations by underground cabling and accessed via 6m wide access roads, with further footprints associated with the construction phase crane tracks, *etc*. The total area spanned by the turbine and road network is calculated to amount to about 2900ha.

The botanical Scoping study for this project was completed in March 2010 (Helme 2010). No alternative infrastructure layouts have been presented for assessment.

2. LIMITATIONS AND ASSUMPTIONS

The baseline information about the vegetation of this site is contained in Helme (2010) and is not comprehensively repeated in this Impact Assessment report. No fieldwork was specifically undertaken for this study, the primary reason being that all areas of natural vegetation in this area are considered to be no go areas for development (see below), and aerial image mapping was likely to be sufficiently accurate. The author is familiar with large parts of the study area, and was able to confidently interpret the Nov 19 2009 Google Earth imagery for this area, which was used as a basis for the sensitivity mapping in Helme (2010). The author has previously studied and sampled the vegetation in various localities within the study area, mostly as part of the fieldwork undertaken for the Cape Lowlands Renosterveld Project (Von Hase *et al* 2003), and on some adjacent sites (Helme 2010a). Given that all natural vegetation in the study area is classified either as Critically Endangered or Endangered on a national basis (Rouget et al 2004) it was assumed that all remaining areas of natural vegetation on site are of High botanical sensitivity and conservation value. Conservation value and sensitivity of habitats are a product of diversity, rarity of habitat, rarity of species, ecological viability and connectivity, vulnerability to impacts, and reversibility of threats. The confidence level in the botanical sensitivity mapping is regarded as high. A site visit at the Impact Assessment stage is unlikely to have significantly increased the accuracy of the initial findings of Helme 2010.

It is assumed that the layout provided by Moyeng Energy is 90% spatially accurate, although it is clear that certain infrastructure is not optimally situated from a botanical point of view, and the identification of such is one of the primary aims of this report. It is assumed that wind turbine foundations will permanently disturb an area of up to 20m by 20m; that permanent gravelled roads will be 6m wide; that adjacent laydown areas will temporarily disturb areas of up to 40m by 40m (or 20m by 70m), and possibly permanently disturb areas of up to 20m by 20m; and that the compacted area (long term to permanent disturbance) for crane travel will be up to 13m wide and parallel to and inclusive of the 6m wide gravelled roads (and thus 3m either side of the gravel roads). Disturbance corridors for underground cabling are estimated at up to 6m wide (3m for the trench and digger track, 3m for the temporary placement of soil). It is assumed that the three proposed substations will be constructed on site, and that the total footprint for each will be less than 0.5ha. The proposed 32km power line connection to the Dassenberg substation near Atlantis is not technically part of the study area, but is part of the proposed development and is here assessed. No alternative power line routes were provided.

It is not known where concrete will be sourced from (presumably from authorised areas near Saldanha) and the impact on limestone surface deposits (important botanical areas) is a potential indirect impact in those areas. It is assumed that the gravel, if needed (deemed unlikely, as most soils on site are not sandy), will come from existing, authorised borrow pits off-site. The former may have a significant impact on vegetation and should ideally have been clarified as part of this study (although not technically part of the study area), as impacts are relevant and indirectly related to this project – wherever they occur.

Figure 1: Proposed infrastructure layout for the northern area (north of R315). Brown lines are internal access roads, green lines are cable trenches, blue lines are internal, above ground electrical connections between the three substations, and white marks and numbers are turbine positions and numbers.

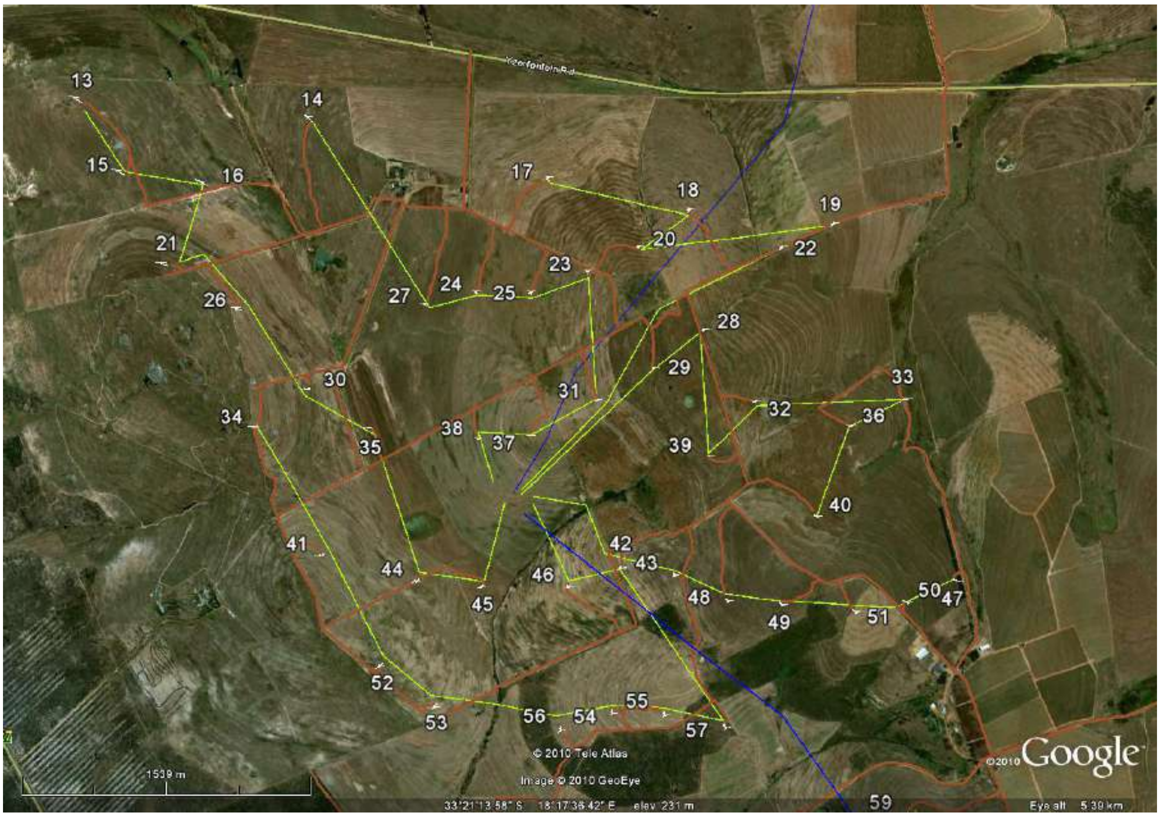

Figure 2: Proposed infrastructure layout for the central area.

Figure 3: Proposed infrastructure layout for the southern area.

3. TERMS OF REFERENCE

Terms of reference (TOR) for the Scoping and IA phases were the standard TOR as proposed by CapeNature, and DEA&DP's guidelines for biodiversity assessment (Brownlie 2005) were also adhered to. The CapeNature TOR are as follows:

- Produce a baseline analysis of the botanical attributes of the property as a whole (see Helme 2010).
- This report should clearly indicate any constraints that would need to be taken into account in considering the development proposals further (see Helme 2010).
- The baseline report must include a map of the identified sensitive areas as well as indications of important constraints on the property. It must also (see Helme 2010 for most of below information):
    - Describe the broad ecological characteristics of the site and its surrounds in terms of any mapped spatial components of ecological processes and/or patchiness, patch size, relative isolation of patches, connectivity, corridors, disturbance regimes, ecotones, buffering, viability, etc.

- In terms of biodiversity pattern, identify or describe:

Community and ecosystem level

a. The main vegetation type, its aerial extent and interaction with neighbouring types, soils or topography;
b. The types of plant communities that occur in the vicinity of the site
c. Threatened or vulnerable ecosystems (*cf. new SA vegetation map/National Spatial Biodiversity Assessment, etc.)*

Species level

d. The presence of any plant Species of Conservation Concern (SCC)
e. The viability of and estimated population size of the plant SCC present (include the degree of confidence in prediction based on availability of information and specialist knowledge, i.e. High=70-100% confident, Medium 40-70% confident, low 0-40% confident)
f. The likelihood of other SCC occurring in the vicinity (include degree of confidence).

Other pattern issues

g. Any significant landscape features or rare or important vegetation associations such as seasonal wetlands, alluvium, seeps, quartz patches or salt marshes in the vicinity.
h. The extent of alien plant cover of the site, and whether the infestation is the result of prior soil disturbance such as ploughing or quarrying (alien cover resulting from disturbance is generally more difficult to restore than infestation of undisturbed sites).
i. The condition of the site in terms of current or previous land uses.

j. In terms of **biodiversity process**, identify or describe:
k. The key ecological “drivers” of ecosystems on the site and in the vicinity, such as fire.
l. Any mapped spatial component of an ecological process that may occur at the site or in its vicinity (i.e. *corridors* such as watercourses, upland-lowland gradients, migration routes, coastal linkages or inland-trending dunes, and *vegetation boundaries* such as edaphic interfaces, upland-lowland interfaces or biome boundaries)
m. Any possible changes in key processes, e.g. increased fire frequency or drainage/artificial recharge of aquatic systems.
n. Would the conservation of the site lead to greater viability of the adjacent ecosystem?

- Would the site potentially contribute to meeting regional conservation targets for both biodiversity pattern and ecological processes?
- Is this a potential candidate site for conservation stewardship?
- What is the significance of the potential impact of the proposed project – with and without mitigation – on biodiversity pattern and process at the site, landscape, and regional scales? Include comment on cumulative impacts.
- Provide a map, at suitable scale, of key conservation areas and corridors.
- Recommend actions that should be taken to prevent or mitigate impacts. Indicate how these should be scheduled to ensure long-term protection, management and restoration of affected ecosystems and biodiversity.
- Indicate limitations and assumptions, particularly in relation to seasonality.

4. METHODOLOGY

The study approach was partly informed by the guidelines prepared by Brownlie (2005), and also by the TOR. Vegetation types used are as defined in the SA vegetation map (Mucina & Rutherford 2006), and ecosystem status is as per the National Spatial Biodiversity Assessment (Rouget et al 2004) and the subsequent Draft National List of Threatened Ecosystems (DEA 2009). Red List status of plant species is according to Raimondo et al (2009). Reference was made to extensive, detailed work done in similar habitats in the region for the Saldanha and Sandveld Fine Scale Vegetation Mapping Projects (Helme & Koopman 2007, Helme 2007a), and to the Darling Phase 2 WEF (Helme 2010a).

For previous records of rare plants in the area I was able to access the GIS based information on the Cape Rares database (Spatial layer of rare and threatened plant localities managed by the Threatened Species Programme of SANBI (January 2007). I was also able to access the GIS data collected by the Protea Atlas Project for the Proteaceae (Protea Atlas Project 2004).

Subsequent to the baseline report of Helme (2010) all areas of elevated botanical sensitivity (areas of natural vegetation) were mapped on the Nov 2009 Google Earth imagery and saved as .kmz files, and were then forwarded to the planning team, which has subsequently endeavoured to avoid most of these areas.

5. DESCRIPTION OF THE AFFECTED ENVIRONMENT

5.1 Regional context and ecological drivers

The primary description and mapping of the vegetation in the area can be found within the scoping study (Helme 2010), and is not repeated here in full.

The study area lies at the western edge of the greater Swartland bioregion, but is better described as being part of the Darling Hills. The sandy south-western portion of the site is part of the sandy coastal forelands commonly known as the Sandveld. The Swartland is a major grain producing area, whilst the Darling Hills support mixed farming, including grazing of livestock, cereal cultivation, dairy farming, and production of wine grapes. Due to the high agricultural potential of the granite-derived soils in the area the loss of natural vegetation to agriculture has been severe (>80% lost), and the Swartland and Darling Hills bioregion has a very large number of threatened plant species (probably more than 300; Raimondo *et al* 2009). Two extremely important conservation areas border the study area – Tienie Versfeld Wildflower Reserve in the northwest, and Rondeberg Private Nature Reserve in the south. The former is managed by SANBI (South African National Biodiversity Institute) and the latter is privately owned and managed. Both reserves are amongst the most important botanical conservation areas in the west coast area, with exceptionally high numbers of threatened plant species recorded from both reserves.

The vegetation in the study area ranges in condition from totally transformed agricultural land (about 70% of the area, or 2730ha) to partly disturbed (about 350ha) to largely pristine (about 550ha).

As can be seen from Figure 4 there were originally two vegetation types in the study area, and these two are both still present, although the Renosterveld is much reduced in extent due to extensive agriculture. Note that Figure 4 shows the original vegetation patterns, prior to human influence. About 80% of the overall study area supported Swartland Granite Renosterveld, with the sandy southwestern corner supporting Hopefield Sand Fynbos (Mucina & Rutherford 2006).

Swartland Granite Renosterveld has been very heavily impacted by agriculture within the region where it occurs (Darling to Malmesbury) and today less than 20% of its original extent remains (Rouget *et al* 2004). The vegetation type is regarded as a **Critically Endangered vegetation type**, with an unachievable national conservation target of 26%, and only 1% conserved (virtually all of this in private reserves; Rouget *et al* 2004). Intact examples of this vegetation type are typically home to a high number of rare and threatened plant species, many of which are endemic (restricted) or near endemic to the vegetation type. The Draft National List of Threatened Ecosystems (DEA 2009) has also classified this vegetation type as **Critically Endangered** (due to high levels of species endemism, and due to extent of habitat loss). About 20% of the remaining vegetation in the study area is of this type.

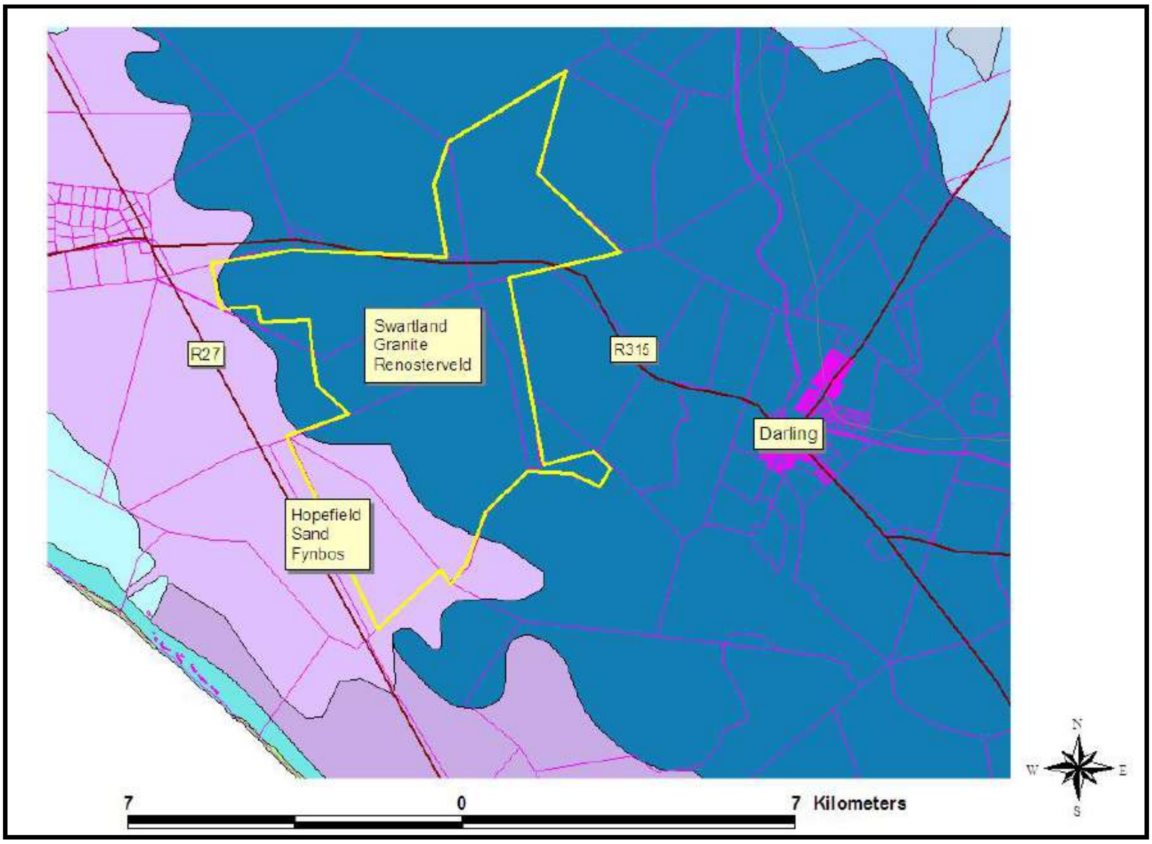

Figure 4: Extract of the SA Vegetation Map (Mucina & Rutherford 2006), showing that most of the area would have originally supported Swartland Granite Renosterveld, with a significant patch of Hopefield Sand Fynbos in the southwestern corner. Approximate study area outlined in yellow.

Hopefield Sand Fynbos is, as its name suggests, restricted to sandy soils in the Hopefield region, extending as far south as the study area. Some 41% of this vegetation type has been lost, with a conservation target of 30%. Nothing (0%) is formally conserved (Rouget et al 2004), although recent acquisitions by the West Coast National Park have incorporated sections of this habitat. The unit is classified as **Endangered** on a national basis by the national Spatial Biodiversity Assessment (Rouget et al 2004). The Draft National List of Threatened

Ecosystems (DEA 2009) has recently classified this vegetation type as **Vulnerable** (due to irreversible loss of habitat and high levels of species endemism), and this takes precedence over all preceding classifications. About 80% of the remaining vegetation in the study area is of this type.

Fire is a key ecosystem driver of both Renosterveld and Sand Fynbos (De Villiers 2005). It is essential that these vegetation types burn once every 12 to 25 years, as many of the species are adapted to regular fires and will only flower or germinate from seed after a fire. Fires at a frequency greater than this will dramatically reduce overall species diversity, and fires less often than once every 25 or 30 years will lead to gradual senescence of many species, and hence local extinctions.

An additional ecological driver is soil moisture; with distinct plant communities (and many rare species) associated with seasonally damp drainage lines, which comprise less than 10% of the overall site. Unfortunately some of these drainage lines have generally been heavily invaded by *Acacia saligna* (Port Jackson willow), which has resulted in reduced water availability, and increased shading, and others have been impacted by runoff from farming operations, leading to alien grass invasions, notably *Lolium* species (ryegrass).

5.2 Plant Species of Conservation Concern

As many as 35 threatened plant species may occur within the study area or its immediate surrounds, and the vast majority would occur within the areas of remnant natural vegetation. This is an exceptionally high figure, even for the Fynbos biome, and is indicative of the conservation importance and sensitivity of all remaining natural habitat in the area. An additional ten or more threatened plant species may occur within the area traversed by the proposed power line to the Dassenberg substation.

6. DESCRIPTION OF ISSUES IDENTIFIED AT THE SCOPING STAGE

Most of the key issues were included within the conclusions of the vegetation scoping document (Helme 2010), and the relevant ones are repeated here, and some are expanded:

- Loss of natural vegetation during the construction stage is the primary botanical impact. About half will be permanent, and the other half will be temporary, as trampled and partly disturbed areas should eventually recover. It is estimated (based on current layouts shown in Figures 1-3) that the total amount of vegetation lost would be less than 10ha of each category (<10ha temporary and <10ha temporary). Some of the direct negative effects associated with construction of the 32km long power line servitude could be significant, and the impact associated with the construction of Substation 1 would be significant, as it is within an area of natural vegetation.

- The least sensitive areas are the previously cultivated areas, which have a Low sensitivity on a regional scale. In order to minimise direct impacts on the vegetation these are the areas where the bulk of the infrastructure (such as the substations, turbines, roads, construction camp, and operations base) should be placed, if possible.
- Indirect negative effects (habitat fragmentation, disruption of natural fire regime, possible introduction and spread of alien invasive plants and insects) are likely to be relatively insignificant, especially in the context of the ongoing farming operations in the area. However, some of the indirect effects associated with construction and maintenance of the 32km long power line servitude could be significant.
- Cumulative negative effects are likely to be negligible, at least after mitigation.
- It is recommended that roads though areas of natural vegetation be kept to a minimum during planning, construction and operational stages, as this will be one of the primary sources of direct vegetation loss, alien plant and insect introduction, and habitat fragmentation (the latter both indirect effects). The proposed new power line would presumably require almost 32km of new access track for the heavy offroad vehicles required to install this line, even though it is adjacent to an existing 400kV line.
- Indirect botanical impacts after mitigation could be positive if all recommended mitigation is put in place, and all areas of natural vegetation are managed according to an OEMP and formally conserved within the Stewardship Program of CapeNature.
- It is strongly recommended that as part of the OEMP there be no livestock permitted in mapped areas of natural vegetation during the period May to end September. One of the primary reasons for this recommendation is that removal of grazing pressure will have a beneficial effect on the natural vegetation, particularly in terms of natural rehabilitation, in that flowering and seed set of the remaining natural plants (especially pioneers such as the annuals) will be significantly better in the absence of grazing

(which removes the flowers). If the nearby annuals and other plants are not grazed this means that natural rehabilitation of the areas disturbed by the project will be significantly improved, as there will be more locally indigenous seed available nearby for establishment in the disturbed areas.

6. METHODOLOGY FOR DETERMINING SIGNIFICANCE OF IMPACTS

Direct, indirect and cumulative impacts of the above issues, as well as all other issues identified, are assessed in terms of the following criteria:

» The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
» The **extent**, where it will be indicated whether the impact will be local (limited to the immediate area or site of development), regional, national or international. A score between 1 and 5 will be assigned as appropriate (with a score of 1 being low (site only) and a score of 5 being high (national or international extent).
» The **duration**, where it will be indicated whether:
  * the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  * the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  * medium-term (5–15 years) – assigned a score of 3;
  * long term (> 15 years) - assigned a score of 4; or
  * permanent - assigned a score of 5.
» The **magnitude**, quantified on a scale from 0-10, where a score is assigned:
  * 0 is small and will have no effect on the environment;
  * 2 is minor and will not result in an impact on processes;
  * 4 is low and will cause a slight impact on processes;
  * 6 is moderate and will result in processes continuing but in a modified way;
  * 8 is high (processes are altered to the extent that they temporarily cease); and
  * 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
» The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale, and a score assigned:
  * Assigned a score of 1–5, where 1 is very improbable (probably will not happen);
  * Assigned a score of 2 is improbable (some possibility, but low likelihood);

  * Assigned a score of 3 is probable (distinct possibility);
  * Assigned a score of 4 is highly probable (most likely); and
  * Assigned a score of 5 is definite (impact will occur regardless of any prevention measures).
- the **significance**, which shall be determined through a synthesis of the characteristics described above (refer formula below) and can be assessed as low, medium or high.
- the **status**, which will be described as either positive, negative or neutral.
- the *degree* to which the impact can be *reversed*.
- the *degree* to which the impact may cause *irreplaceable loss of reso*urces.
- the *degree* to which the impact can be *mitigated.*

The **significance** is determined by combining the criteria in the following formula:

S=(E+D+M)P; where

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

7. IMPACT ASSESSMENT

Impacts may be both direct and indirect, with the former occurring mostly at the construction stage and the latter mostly at the operational stage.

In the case of this project the primary direct impact is loss of natural vegetation (and associated possible Species of Conservation Concern) within some of the development footprints. All hard infrastructure located within or partly within natural vegetation will result in the permanent loss of that vegetation. The primary sources of permanent loss include (in descending order of importance, based on the proposed layout) the Substation 1, access roads, the turbine footprints (including permanent crane standpads), and power line tower footprints. The primary sources of temporary, long-term vegetation loss include excavation and sand piles for very large foundations and the cabling, the lay down areas, crane tracks, and roads alongside the power line.

Loss of regionally rare plant species would have a regional impact, as would loss of regionally endemic vegetation types (Swartland Granite Renosterveld and Hopefield Sand Fynbos). Although both these are direct impacts at the site scale they may have indirect consequences (impacts) at the regional scale.

The indirect, negative botanical impacts are not likely to be important, but may include a small degree of habitat fragmentation, and introduction of invasive alien plants and insects (mainly along tracks, due to introduced gravel required). A further potential (but unlikely) indirect impact relates to the source of the gravel for the roads (sources have not yet been identified, although it is assumed that a commercial source will be used) – many gravel quarries are located close to or in Renosterveld areas (pers. obs.). This impact has been deemed to be unlikely as the soils in the area are not deep sands and should not need to be extensively graveled. However, large amounts of concrete will be needed for the turbine foundations (~375m^3 each), and the limestone and crushed stone needed to produce this concrete may be derived from surface deposits in sensitive areas (e.g. near Saldanha), but as the concrete suppliers are currently undetermined the impacts cannot be assessed. Although it is not often appreciated, even though these suppliers have been authorized, the key point is that many of the suppliers are mining limestone resources which currently support numerous rare, localised and threatened plant species (Helme & Koopman 2007), and any increased demand results in further habitat loss in these sensitive areas.

The indirect impacts noted above are thus a mix of those that occur at the site and the regional scale.

7.1 Direct Impact: Permanent loss of natural vegetation

About 98% of the proposed development footprints within the study area will impact primarily on disturbed areas of no or very low botanical significance, but the infrastructure will also impact on small areas (<20ha in total) of Swartland Granite Renosterveld – a Critically Endangered vegetation type. Almost no loss of Hopefield Sand Fynbos is likely as a result of the proposed internal access roads, substation and turbine placements, but the proposed 32km power line and the access road to the R27 will have negative direct impacts on this vegetation type. The bulk of the loss of Granite Renosterveld would occur in the footprint of Substation 1, where cable trenches cross natural vegetation, and in areas where existing farm tracks through the strips of natural vegetation have to be widened to accommodate the large construction and transport vehicles (vehicles are long, wide and heavy). Direct impacts will also occur in the few places where turbines have been provisionally placed either partly or fully within natural vegetation. All areas where important direct vegetation impacts occur within the study site have been identified in Figure 5.

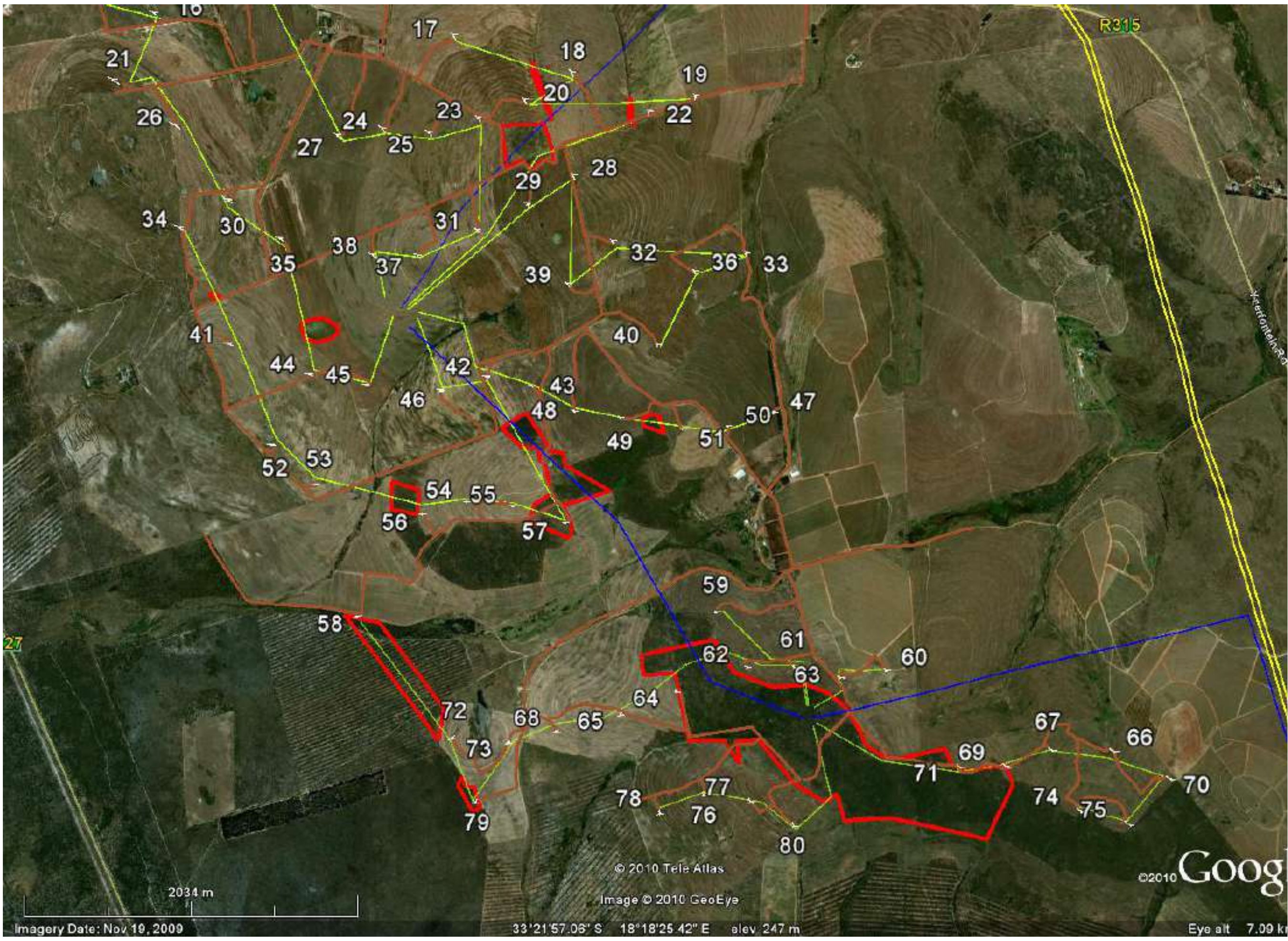

Figure 5: Red outlines (polygons) are 11 problem areas where proposed infrastructure currently intrudes into High sensitivity natural vegetation. The large area in the southeast (between turbines 62 and 71) includes the proposed position of Substation 1, and at least five associated cable trenches. These polygons are also available as .kmz files for use in Google Earth.

Direct impacts on individuals of some of the possible plant Species of Conservation Concern are likely within the development footprints which occur in the Renosterveld areas (9 of 11 polygons in Figure 5) and the Sand Fynbos areas (2 of 11 polygons in Figure 5), which will result in a reduction in total number of these species on site by between 1 and 10% (estimated). In a regional context, these losses range from insignificant to low-medium significance.

Table 1:

Nature: Permanent loss of vegetation in development footprint				
	Without mitigation	**Score**	**With Mitigation**	**Score**
Extent	Local and regional	2	Local and regional	2
Duration	Permanent	5	Permanent	5
Magnitude	Moderate	6	Low	4
Probability	Definite	5	Definite	5
Significance	**Medium - High**	**65**	**Medium – High***	**55**
Status	Negative		Negative	
Is impact reversible?	No		No	
Irreplaceable loss of vegetation?	Technically - yes		No	
Can impacts be mitigated?	NA		Yes	
Mitigation: See all points in Sections 10 and 12. Most notably the position of Substation 1 needs to be moved out of the High sensitivity vegetation.				
Cumulative impacts: The loss of vegetation is cumulative in that there is ongoing, regional habitat loss within the two Critically Endangered and Vulnerable vegetation types on site – mainly to agriculture, urbanization and alien plan invasion.				
Residual impacts: The residual impacts (some habitat will be lost) are best mitigated by effectively managing the proposed conservation areas on site, being all remaining areas of natural habitat on site.				

* Note: This assessment is deemed artificially high, and is a product of the use of a formula, and the high rating for a definite probability. A more realistic overall assessment would be Low negative.

7.2 Direct Impact: Long term but temporary loss of natural vegetation

The existing natural vegetation will be severely disturbed (but not totally lost) in various areas, mostly as a result of heavy machinery movement through some sensitive areas, road construction, cable trench excavation through sensitive areas, the power line construction where this goes through areas of natural vegetation, and the associated piling and scraping of soil for foundations where this is close to or in natural vegetation. Most of these areas should eventually recover to a significant degree (if natural vegetation is retained in the adjacent areas), but the crushed and dug up vegetation will take at least 12 years (and possibly much longer if rainfall is below normal) in order to recover to a point where at least 80% of the original diversity is once again present. Certain species may not return for many additional years, due to changes in soil structure (compaction or chemical changes). The impacts in this case thus rate as being long term.

Primary sources of disturbance will be the large crane that is used to put up the machinery, which has caterpillar tracks and a width of 13m; laydown areas next to the turbines; turning circles for long trucks; the construction of the new 32km long power line; and the burying of the underground cabling on site. Areas where most of the on site impacts are likely to occur are illustrated in Figure 5.

Table 2:

Nature: Long term but temporary loss of vegetation in footprint				
	Without mitigation	**Score**	**With Mitigation**	**Score**
Extent	Local and regional	2	Local and regional	2
Duration	Long term	4	Long term	4
Magnitude	Low - Moderate	5	Low	4
Probability	Definite	5	Definite	5
Significance	**Medium - High**	**55**	**Medium**	**50**
Status	Negative		Negative	
Is impact reversible?	Mostly		Mostly	
Irreplaceable loss of vegetation?	No		No	
Can impacts be mitigated?	NA		Partially	
Mitigation: See all points in Sections 10 and 12.				

Cumulative impacts: The loss of vegetation is cumulative in that there is ongoing regional habitat loss within these Critically Endangered and Endangered vegetation types – to agriculture, urbanisation and alien plan invasion, but long term impacts do not typically contribute to cumulative impacts as they are technically reversible.
Residual impacts: The residual impacts (habitat will be lost or degraded) are best mitigated by effectively managing the proposed conservation areas on site, being all remaining areas of natural habitat on site.

7.3 Direct Impact: Power line infrastructure

A new 132kV power line will need to be constructed between the 3 proposed new WEF substations and the existing Dassenberg substation that is located some 32km to the south, near Atlantis (see Figure 2). The proposed route runs parallel to the existing Koeberg to Aurora 400kV power line, and traverses mostly Atlantis Sand Fynbos, which is listed as a Critically Endangered vegetation type (DEA 2009). Because the proposed power line is so long it traverses numerous areas of High botanical sensitivity, and these are estimated to cover at least 26km of the proposed route. The only Low sensitivity areas along the proposed route are in the initial 10km where it crosses extensive agricultural lands (totalling almost 8km).

Power lines usually have relatively small footprints and have little influence on the vegetation, except where the servitude is too frequently and inappropriately bushcut. Servitude maintenance will presumably be carried out by Eskom contractors or Eskom staff, and is hence not possible to regulate in terms of a Record of Decision for the current application. Duration of impact is likely to be short to medium term, as even bushcut areas may recover to some extent, depending on the regularity and severity of the bushcutting. Temporary tracks required for installation should recover over a period of 5 years, but ideally the same permanent service road will be used for the power line installation as well.

It is possible and likely that many populations of threatened plant species will be negatively impacted by the proposed power line, although it is unlikely that regionally significant populations will be lost.

Table 3:

Nature: Permanent and Long term but temporary loss of vegetation in power line and servitude footprint				
	Without mitigation	**Score**	**With Mitigation**	**Score**
Extent	Local and regional	2	Local	1
Duration	Long term	4	Long term	4
Magnitude	Low - Moderate	5	Low	4
Probability	Definite	5	Highly probable	4
Significance	**Medium - High**	**55**	**Medium**	**36**
Status	Negative		Negative	
Is impact reversible?	Mostly		Mostly	
Irreplaceable loss of vegetation?	No		No	
Can impacts be mitigated?	NA		Partially	
Mitigation: No regular bushcutting of vegetation in servitude (this would require cooperation from Eskom); annual removal of all invasive alien vegetation in servitude using standard DWA approved methodology (this would require cooperation from Eskom).				
Cumulative impacts: Low; habitat will be lost, and is ongoing within the region.				
Residual impacts: The residual impacts (habitat will be lost or degraded) are not easily mitigated, other than by effectively managing the proposed conservation areas on site, being all remaining areas of natural habitat on site.				

7.4 Indirect impacts

Indirect ecological impacts are often difficult to identify, and even more difficult to quantify. Some possible indirect negative effects on the vegetation (shading, disturbance of wind flow, etc.) are likely to be minimal and are not assessed further.

Other indirect impacts are likely to be only moderately important, notably the likely disruption in optimal/natural fire regimes in the conservation areas, although this has probably already been partly disrupted by agriculture on site.

Sand Fynbos and Renosterveld are both **fire** driven vegetation types that require fire at least once every 15 years, and fire dependant vegetation types are not compatible with embedded and costly infrastructural developments. If Sand Fynbos and Renosterveld are not burnt for over 40 years it can be assumed that at least 30% of the species will become locally extinct, including many of the Species of Conservation Concern. This is one of the many reasons why infrastructure should not be placed within areas of natural vegetation, and developments that take this into account (such as the current one) largely avoid this issue.

The effects of **habitat fragmentation** may also be important in some cases, but the proposed development (after mitigation) should not result in significant further fragmentation of the remaining natural habitat on this site.

Further possible indirect effects include the source of road surfacing **material**, and the source of concrete. The former is usually quarried from borrow pits, which may be in sensitive ecological areas (often Renosterveld areas), and the large quantities needed could have significant negative impacts if not sourced from an appropriate area. However, at this stage the source, or indeed the need, has not been confirmed (and is deemed unlikely), and material would presumably be only from approved sites (although this does not mean that they are without impact).

Large quantities of concrete will be needed for the turbine foundations, and this could also have a significant negative effect on natural vegetation if this is sourced from an area where limestone and stone quarries have a negative impact on surrounding natural vegetation. Unfortunately no source has as yet been identified, and thus an accurate assessment of this possible indirect impact cannot be made. It is however likely that it will be sourced from nearby Saldanha quarries, some of which impact negatively on remaining natural vegetation in that botanically sensitive area (see Helme & Koopman 2007).

Table 4:

Nature: Various indirect impacts: mainly fire regime disruptions and minor habitat fragmentation.				
	Without mitigation	**Score**	**With Mitigation**	**Score**
Extent	Local	2	Local	2
Duration	Long term to Permanent	4	Long term	4
Magnitude	Low to Moderate	5	Low	4
Probability	Probable	3	Improbable	2
Significance	**Medium**	**33**	**Low**	**28**
Status	Negative		Negative	
Is impact reversible?	Partly – in the case of fire.		Partly	
Irreplaceable loss of vegetation?	Unlikely		Unlikely	
Can impacts be mitigated?	NA		Partially	
Mitigation: Controlled fires in conservation areas once every 15 years, according to EMP; remove most infrastructure from the 11 areas identified in Figure 5; keep access roads as narrow as possible where these cross conservation areas.				
Cumulative impacts: Very Low				
Residual impacts: The residual impacts are best mitigated by effectively managing the proposed conservation areas on site, being all remaining areas of natural habitat on site.				

7.5 Cumulative impacts

To some extent a cumulative impact is a regional impact, rather than the local site scale impact, *i.e*. if something has a regional impact it also has a cumulative impact.

The impacts of this type of development will be significantly less than for various existing and ongoing agricultural operations in the region, as well as for the many unmanaged and expanding alien plant invasions on numerous properties.

The proposed WEF thus has a fairly small but still important Low negative cumulative impact in the region, but this can be effectively mitigated on site by redesigning the layout to avoid the 11 High sensitivity areas identified in Figure 5, and by formal conservation and active management of the natural area on site. If effectively mitigated (by management and layout redesign), the overall effect could be positive.

The cumulative impacts of the proposed 32km power line are difficult to assess, as it depends on whether the servitude management is optimal from a conservation perspective or not. The impacts are likely to be significant (Medium negative) if the servitude management is not optimal from a conservation perspective, as at least 80% of the route is through a Critically Endangered vegetation type (Atlantis Sand Fynbos) in medium to good condition. If the servitude management is good then the cumulative impact may be reduced to Low negative.

7.6 Positive impacts

The proposed WEF could have a slight positive impact, in addition to the small global scale positive impact of helping to reduce CO_2 emissions by generating "clean energy". As climate change is predicted to hit the west coast particularly hard it is perhaps appropriate that wind energy facilities should be located in this area.

The second potentially positive impact will only come about if recommendations noted under Mitigation (Sects. 10 & 12) are effectively implemented and enforced.

Seasonal removal of livestock from High sensitivity areas of vegetation on the site could have a positive effect on the natural vegetation, in that it would allow plants to flower and set seed more readily, without being heavily grazed. Disturbed areas will not only rehabilitate faster without livestock grazing but many rarer, currently heavily grazed species may have a chance of increasing their numbers. Heavy grazing and trampling can also lead to erosion, eutrophication of wetlands, etc.

If the approximately 900ha of natural vegetation on the site are managed as a formal conservation area this would be a positive local and regional impact. Hopefield Sand Fynbos and Swartland Granite Renosterveld are both poorly conserved vegetation types (2.2% of original extent conserved, with national target of 30% for the former, and 1% and 26% for the latter), and thus any addition to the total areas conserved is to be welcomed. Formal conservation of these natural areas is best achieved by signing these areas up as a Contract Reserve within the Stewardship Program of CapeNature, and details of this are provided in the Mitigation section.

8. IMPACT STATEMENT AND SUMMARY TABLE

Overall the proposed WEF is likely to have a Medium local (site scale; 3900ha site) and Low to Medium regional (Darling Hills area; < 100 000ha) negative impact on the vegetation on site, prior to mitigation. This could be reduced to Low negative (local) and Low negative (regional) after mitigation.

The primary negative impacts on the site are mainly the result of direct impacts, including loss of natural vegetation (<20ha) in the development footprints, and medium to long term loss of natural vegetation (<10ha) in adjacent areas that will be disturbed by heavy construction machinery, temporary dumping, etc. Most of these impacts can be avoided / mitigated, by simply re-aligning the proposed layout in the 11 identified areas.

Additional direct impacts will occur off-site, in the area associated with the proposed 32km power line. About 80% of the proposed route is through natural vegetation that is classified as Critically Endangered.

Indirect impacts are often difficult to quantify and measure, and are often equally difficult to avoid or mitigate. If the mitigation recommendations (See Sects. 10 & 12) are all implemented then indirect impacts on the vegetation on site could be reduced to Low negative.

The primary and important potential positive impact of the development will depend to a large degree on the proper management of the remaining natural vegetation on site (about 900ha) as a formal conservation area under the Stewardship Program of CapeNature. An indirect positive impact is obviously the small contribution that this WEF would make to reducing CO_2 emissions, and the associated very small reduction in global warming effects.

Table 5: Overall summary table of proposed WEF impacts on vegetation on site (local scale)

Nature: Long term to permanent loss of vegetation and threatened species, as well as disruption of ecological processes				
	Without mitigation	**Score**	**With Mitigation**	**Score**
Extent	Local and regional	2	Local	1
Duration	Long term to Permanent	4	Mostly long term; some permanent	4
Magnitude	Moderate	6	Low - Moderate	3
Probability	Definite	5	Highly probable	4
Significance	**Medium - High**	**60**	**Low**	**32**
Status	Negative		Negative	
Is impact reversible?	Not in direct building footprints (<20ha), but some are in other disturbance areas (<10ha), although will take many years; many indirect impacts difficult to reverse.		Not in direct building footprints (<20ha), but some are in other disturbance areas (<10ha), although will take many years; many indirect impacts difficult to reverse.	
Irreplaceable loss of vegetation?	Yes, but relatively small areas		No	
Can impacts be mitigated?	NA		Partially and to a large extent	
Mitigation: See all points in Sections 10 & 12.				
Cumulative impacts: Low to Medium negative; but Low after mitigation				
Residual impacts: The residual impacts (some habitat will be lost or degraded, notably in the 32km power line route) are best mitigated by effectively managing the proposed conservation areas on site, being all remaining areas of natural habitat on site (about 900ha).				

9. ASSESSMENT OF ALTERNATIVES

No alternative development sites or layouts were considered in this process. Three substation positions (not alternatives, as all three are needed) were however proposed, and these are assessed below.

Substation 1

High negative botanical impact, as is located in an area of High sensitivity Renosterveld, with various Species of Conservation Concern likely to be present.

Impacts before mitigation: High negative direct impacts, plus Medium negative indirect impacts.

Recommended mitigation: Move 300m to the north, which would put it between turbines 61 and 63, in an area of agricultural land (Very Low botanical sensitivity).

Impacts after mitigation: Very Low negative

Substations 2 and 3

Both located in agricultural areas of Very Low botanical sensitivity, and thus there are negligible botanical impacts, and the substations do not need to be relocated.

10. REHABILITATION GUIDELINES AND CEMP & OEMP REQUIREMENTS

Areas requiring rehabilitation will include all areas of natural or partly natural vegetation disturbed during the construction phase and that are not required for regular maintenance operations, or for cultivation. The main areas thus requiring rehabilitation will be recent disturbance to the edges of roads that pass through natural vegetation, the crane tracks alongside the permanent 6m roads, and any cable routings where these fall within areas of natural vegetation.

Rehabilitation should only commence once all construction related disturbance associated with the project has been completed.

Most of the ecological management of the site refers only to the High Sensitivity vegetation areas identified in the baseline report of Helme (2010). As the applicant does not plan to buy the land these requirements will thus involve contracts between the applicant and the landowners, who will presumably continue to farm most of the land.

Detailed requirements for the Construction Phase Environmental Management Plan (CEMP) are as follows:

1) If any infrastructure is to be placed within the identified areas of High botanical sensitivity (Renosterveld or Sand Fynbos) all these development footprints (for roads, buildings, underground cables, laydown areas and turbine footings) should be surveyed and fenced off with two strand wire and clearly indicated with flags and/or danger tape strips. Only once this has been done can anything else proceed. It should be made very clear to all contractors that there is to be no disturbance outside these demarcated areas, at least not without the permission of the ECO.

Objective: Fencing of development footprints in sensitive areas is in order to minimise disturbance to adjacent sensitive areas and to make it clear to contractors where they should and should not go.

Project component/s	All phases of construction
Potential impact	Substantially increased damage to adjacent sensitive vegetation, due largely to ignorance of where such areas are located.
Activity risk/source	There is no reason why this objective should not be achieved, although it will carry cost implications.
Mitigation: target/objective	No loss of or damage to sensitive vegetation in areas outside immediate development footprint; <1ha of construction related disturbance in sensitive areas outside fenced footprints; measured monthly during duration of construction.

Mitigation: Action/control	Responsibility	Timeframe
Two strand wire fencing with droppers every 10m, around all development footprints in areas of natural vegetation; wire to be inter-threaded with danger tape, and signage saying “Sensitive Area – Keep Out” placed on fences every 50m.	ECO	To be completed prior to any construction related activity on site; auditing monthly.

Performance indicator	No damage to surrounding natural vegetation
Monitoring	ECO to monitor all construction areas on a weekly and

	monthly basis until all construction is completed; immediate report backs to site manager; and ECO to speak to contractors responsible for any infringements

2) Prior to any earthworks within High sensitivity Renosterveld areas a major plant Search and Rescue program should be undertaken. Search and Rescue (S&R) of certain translocatable, selected succulents, shrubs and bulbs occurring in long term & permanent, hard surface development footprints (i.e. all buildings, new roads and tracks, laydown areas, and turbine positions) should take place. All such development footprints must be surveyed and pegged out as soon as possible, and then a horticulturist with West Coast Search and Rescue experience should be appointed to undertake the S&R. All rescued species should be bagged (and cuttings taken where appropriate) and kept in an on-site shade nursery (if water can be provided; otherwise off site) and should be returned to site once all construction is completed and rehabilitation of disturbed areas is required. Replanting should only occur in autumn or early winter (April – May), once the first rains have fallen, in order to facilitate establishment. Genera that can be considered for rescue are all bulbs and tuberous species (*Haemanthus, Brunsvigia, Babiana, Trachyandra, Albuca, Veltheimia, Arctopus*, *etc*.), plus selected specimens of succulents such as *Ruschia* and *Lampranthus* species, and shrubs and restios such as *Phylica harveyi* and *Thamnochortus* species.

Objective: Search and Rescue of all translocatable indigenous plants from development footprints prior to any development, and maintenance of these in a nursery (on site) for use in rehabilitation in disturbed areas on completion of all construction.

Project component/s	All phases of construction; replanting during main post construction phase
Potential impact	Substantially increased loss of natural vegetation at construction phase and waste of on-site plant resources, and lack of locally sourced material for rehabilitation of disturbed areas; increased cost of having to buy in material for rehabilitation.
Activity risk/source	There is no reason why this objective should not be achieved, although it will carry cost implications (and savings)
Mitigation:	Rescue, maintenance and subsequent replanting of at

target/objective	least 20% of the natural vegetation in all development footprints within any areas of High sensitivity natural vegetation on site.

Mitigation: Action/control	Responsibility	Timeframe
Genera that can be considered for rescue are all bulbs and tuberous species (*Haemanthus, Brunsvigia, Babiana, Trachyandra, Albuca, Veltheimia, Arctopus*, *etc*.), plus selected specimens of succulents such as *Ruschia* and *Lampranthus* species, and shrubs and restios such as *Phylica harveyi* and *Thamnochortus* species. Material to be bagged up or stored in suitable conditions in an on-site greenhouse (with irrigation where needed); to be replanted in areas requiring rehabilitation in May/June following cessation of all construction related disturbance in particular area.	ECO and appointed horticultural subcontractor	Search and Rescue to be completed in all areas of natural vegetation prior to any construction related activities in these areas; maintenance of material in nursery until May following cessation of disturbance, and replanting of material in May/June.

Performance indicator	Establishment of greenhouse; horticulturist to submit list of target species to botanist for approval; rescue of material; replanting in rehabilitation areas to cover 20% of these areas within 3 months of replanting
Monitoring	ECO to monitor Search and Rescue; horticulturist to liase with botanist; botanist to review rehabilitation success after 3 months of replanting of rehabilitation areas.

3) An ECO must be present during the duration of the construction phase.

4) Any excavation within designated High sensitivity areas, including those for cables, must be supervised by the ECO. No excavations may be left open for more than 1 week, and they should preferably be closed up within 1 day, using the carefully stockpiled soil that came out of the trench.

Objective: Minimise disturbance associated with cabling and trench digging in High sensitivity areas; maximise rehabilitation success of these disturbed areas

Project component/s	All phases of construction; rehabilitation immediately post disturbance cessation
Potential impact	Substantially increased disturbance to areas around cabling trenches and reduced rehabilitation success; open trenches have negative impact on fauna
Activity risk/source	There is no reason why this objective should not be achieved
Mitigation: target/objective	Minimise period of sand stockpiling alongside trenches and make sure that it is less than one week before trenches are infilled and rehabilitated; target should be one day.

Mitigation: Action/control	Responsibility	Timeframe
All cable trenches, etc,. through sensitive areas should be dug carefully in order to minimise damage to surrounding areas; all stockpiled sand should be replaced within one week of trench opening; all disturbed areas to be immediately mulched and sown with previously stockpiled local mulch containing indigenous seed.	ECO and appointed horticultural subcontractor	Infilling to be complete within one week of cable trench commencement (ideally within 1 day); rehabilitation to be undertaken within one week of infilling.

Performance indicator	Trenches should ideally not disturb an area more than 8m wide in total (including tracks and sand pile areas); trenches should not lie open for more than 7 days and should ideally be closed up the same day; sowing of mulch and seed in rehabilitation areas to cover at least 30% of these areas within 3 months of trench infilling
Monitoring	ECO to monitor trenching and rehabilitation; horticulturist to liase with botanist about rehabilitation; botanist to review rehabilitation success after 3 months of sowing in rehabilitation areas, and to recommend

	additional measures if rehabilitation deemed insufficient.

5) No dumping or temporary storage of any materials may take place outside designated and demarcated laydown areas.

6) Compacted areas that are no longer needed after construction (e.g. parts of the laydown areas, and the crane tracks) may need to be ripped or scarified to break up the compacted surface (at the discretion of the horticultural / rehabilitation contractor). The areas should then be sown with seed mix collected on site (see point 7).

Objective: Maximise rehabilitation potential of compacted areas of natural vegetation not needed beyond the construction phase

Project component/s	All phases of construction; rehabilitation immediately post disturbance cessation
Potential impact	Reduced long term rehabilitation success in areas of compacted soil such as around turbines on crane standpands
Activity risk/source	There is no reason why this objective should not be achieved
Mitigation: target/objective	Rip selected compacted areas after end of disturbance to provide better medium for rehabilitation; well established natural vegetation within two years of ripping

Mitigation: Action/control	Responsibility	Timeframe
ECO should liaise with botanist and horticulturist after completion of main construction phase to identify main areas of compaction in need of ripping and discuss best methodology; ripping may need to be done by tractor, followed by immediate mulching and sowing of previously stockpiled local mulch containing indigenous seed, and possibly hydroseeding with selected local seed.	ECO and appointed horticultural subcontractor, in liaison with botanist	On cessation of main construction disturbance; ripping to be undertaken in April or May, with mulching and sowing immediately thereafter.

Performance indicator	Compacted areas should be restored to an indigenous vegetation cover of at least 30% within 1 year of rehabilitation commencement
Monitoring	ECO to monitor ripping very closely; horticulturist to liase with botanist about priority areas in need of ripping and rehabilitation; botanist to review rehabilitation success after 1 and 2 years, and to recommend additional measures if rehabilitation deemed insufficient.

7) The appointed horticulturist must collect a locally indigenous seed mix from the natural vegetation on site (preferably by means of vacuum harvesting) and must store this for later use in areas in need of rehabilitation, being any areas of ground that are not under cultivation.

8) Only suitable locally indigenous Hopefield Sand Fynbos or Swartland Granite Renosterveld species should be used for rehabilitation or planting anywhere on site. This means that no exotic or invasive species should be used for rehabilitation, and this includes commonly used invasive grass species such as ryegrass (*Lolium* spp).

9) The applicant should appoint an expert environmental manager to plan, coordinate and carry out the required block burns in the main patches of High sensitivity natural vegetation on site, which should ideally be undertaken prior to infrastructure development. This should be done in conjunction with and in line with the management plan to be prepared by CapeNature as part of the Stewardship Program. All areas of existing natural vegetation should be burnt on a cycle of once every 12 to 25 years. The best time to undertake block burns is in late autumn, as plant recovery will then be best. All areas to be burnt must be cleared of alien vegetation at least one year before.

Objective: Undertake controlled fires in identified blocks of natural vegetation to reduce the risk of wildfires and to allow for vital ecological processes such as regeneration and flowering of fire dependant plant species.

Project component/s	Prior to construction phase. Ideally undertaken prior to infrastructure development, but can also be undertaken afterwards (at higher risk); needs to be done every 12-25 years, with most of the areas currently overdue for a fire.
Potential impact	Substantially increased risk of wildfire; probable local

	extinction of fire dependant plant species
Activity risk/source	There is no reason why this objective should not be achieved, although it is a hazardous undertaking and needs to be carefully coordinated by an expert, and clearly would require cooperation from the landowners.
Mitigation: target/objective	Ecologically functional natural vegetation in the High sensitivity areas on site; reduced risk of wildfires in very old, woody vegetation.

Mitigation: Action/control	Responsibility	Timeframe
Areas that need fire include most High Sensitivity areas of natural vegetation identified in scoping report of Helme 2010. All areas due to be burnt must be properly cleared of all invasive alien vegetation at least one year prior to fire. Extensive inputs needed from fire specialist. Local authority fire services should assist, as should local landowners and CapeNature. A windless day in March or April is recommended, with no wind predicted for following two days. Minimum areas burnt at any one time should be 10ha, in order to reduce edge effects. Site can be burnt sequentially in blocks, over a period of 5 years.	ECO and appointed specialist fire subcontractor	Ideally before construction (less risky to infrastructure), but can be done afterwards. Best regeneration after a late summer fire. All areas of natural vegetation currently older than 15 yrs must be burnt within 4 yrs of project authorisation.

Performance indicator	All areas of natural vegetation currently older than 15 years should be burnt within 4 years of project authorisation. Natural vegetation re-establishment within burnt areas should be substantial within 2 yrs (>30% cover).
Monitoring	ECO and specialist fire consultant to monitor and coordinate process, in liaison with botanist; botanist to review regeneration success 2 years after fire.

Operational Phase EMP Requirements:

10) It is strongly recommended that the landowners should refrain from grazing livestock in the High sensitivity vegetation areas in the main winter and spring growing and flowering periods (1 May – end October). One of the primary reasons for this is that removal of livestock grazing pressure will have a beneficial effect on the natural vegetation, particularly in terms of natural rehabilitation, in that flowering and seed set of the remaining natural plants (especially pioneers such as the annuals) will be significantly better in the absence of grazing (which removes the flowers). If the nearby annuals and other plants are not grazed this means that natural rehabilitation of the areas disturbed by the project will be significantly improved, as there will be much more locally indigenous seed available nearby for establishment in the disturbed areas, and the site may also act as a seed source for some nearby overgrazed areas.

Objective: No grazing of livestock in the High sensitivity vegetation areas in the main winter and spring growing and flowering periods (1 May – end October).

Project component/s	Construction and Operational phase; ongoing
Potential impact	Grazing and trampling substantially decreases rehabilitation success, posing a risk of erosion and biodiversity loss; grazing and trampling impacts negatively on flowering and seed set of many rare plant species
Activity risk/source	There is no reason why this objective should not be achieved, but it would require cooperation from the landowners
Mitigation: target/objective	Ecologically functional and flourishing natural vegetation in the area, with rare species flowering and setting seed successfully.

Mitigation: Action/control	Responsibility	Timeframe
Removal of all livestock from all High sensitivity areas of natural vegetation on site from 1 May to end October.	ECO (construction phase) and CapeNature, site manager and landowners (operational phase)	Ongoing from construction into operational phase

Performance indicator	No livestock on site in High sensitivity areas of natural vegetation during period 1 May to end October. No evidence of grazing or trampling in these areas during this period, and good flowering and seed set in palatable plant species.
Monitoring	Botanist to review regeneration and seed set success in palatable species every two years, and to check site for compliance in terms of livestock.

12) A botanist familiar with the vegetation of the area should monitor the rehabilitation success on an annual basis in August or September (for the first five years after construction commences), and make recommendations to the applicant (and landowners) on how to improve any problem areas. This monitoring need not take more than two days annually (one day on site, one day writeup).

13) All temporary fencing and danger tape should be removed once the construction phase has been completed.

14) Ongoing alien plant monitoring and removal should be undertaken on all areas of natural vegetation on an annual basis. DWA approved methodology should be employed for all alien clearing operations. Areas should not be burnt until an area has been clear for at least two years, in order to prevent coppicing and massive seed germination. *Acacia cyclops* (rooikrans) and *Acacia saligna* (Port Jackson) are the primary invasive aliens, and both provide valuable firewood that can be sold to defray costs. No bulldozing or mechanical removal is allowed, as this disturbs the soil and creates ideal conditions for re-invasion. All stems must be cut as close to ground level as possible, using loppers or chainsaws (depending on size), and stumps must be immediately hand painted with a suitable Triclopyr herbicide (e.g. Garlon, Timbrel, with colour dye) to prevent resprouting. If this is not done within 5 minutes of being cut Port Jackson will resprout, wasting the original effort. Rooikrantz does not usually resprout, but it may do so in some situations, and it is safer to paint herbicide on all stumps. No herbicide spraying should be undertaken anywhere within natural vegetation, due to the extensive collateral damage. All cut branches should be stacked into a pyramid (cut ends up) and left to dry – where rodents will eat the available seed under the pile, reducing seed germination. Annual follow ups are required in all areas that have been previously cleared. Small seedlings may be hand pulled.

Objective: Removal of all woody alien invasive vegetation on the site within two years of project commencement, and particularly within the High sensitivity areas of natural vegetation. To be undertaken from project inception, on an ongoing basis.

Project component/s	Construction and Operational phase; ongoing
Potential impact	Alien invasive vegetation is currently a moderate threat to the priority natural vegetation on site, and may displace rare species, dry out wetlands, and result in habitat loss, as well as increasing the fuel load and the consequent risk of a wildfire. If unchecked the alien vegetation could come to dominate the entire site within 20 years, with loss of rare species.
Activity risk/source	There is no reason why this objective should not be achieved, although it will be costly, and adequate budget must be made available for ongoing clearing costs.
Mitigation: target/objective	Ecologically functional natural vegetation in High botanical sensitivity portions of site; all High Sensitivity areas are clear of alien vegetation within 2 years of project inception.

Mitigation: Action/control	Responsibility	Timeframe
DWA approved methodology should be employed for all alien clearing operations, and it is strongly suggested that someone who has extensive training in this regard be employed to manage the program. Dense areas should be tackled last – the priority is to prevent their spread, and then gradually clear the entire area, maximising cost efficiency. Areas should not be burnt until an area has been clear for at least one year, in order to prevent coppicing and massive seed germination. *Acacia cyclops* (rooikrans) and *Acacia saligna* (Port Jackson) are the primary invasive aliens, and both provide firewood that can be sold to defray costs. No bulldozing or	ECO (construction phase) and appointed alien clearing contractors (operational phase and perhaps also overlapping with construction phase)	Ongoing from construction into operational phase. High sensitivity areas should be cleared initially only from November - April; and all follow ups only from Oct – April, to minimise damage to seasonal species

removal by any machinery is allowed, as this disturbs the soil and creates ideal conditions for re-invasion. All stems must be cut as close to ground level as possible, using loppers or chainsaws (depending on size), and stumps must be immediately hand painted with a suitable Triclopyr herbicide (e.g. Garlon, Timbrel, with colour dye) to prevent resprouting. If this is not done within 5 minutes of being cut Port Jackson will resprout, wasting the original effort. Rooikrantz does not usually resprout, but it may do so in some situations, and it is safer to paint herbicide on all stumps. No herbicide spraying should be undertaken anywhere, due to the extensive collateral damage. All cut branches should be stacked into a pyramid (cut end up) and left to dry – where rodents will eat the available seed under the pile, reducing seed germination. Annual follow ups are required in all areas that have been previously cleared (to be undertaken Oct-April). Small seedlings may be hand pulled.		

Performance indicator	All High Sensitivity areas of vegetation to be cleared of invasive aliens within 2 years of project inception (initial clearing); <1% alien cover in these areas in following years
Monitoring	Annual audits of alien clearing by botanist or CapeNature representative to determine compliance, and to suggest any changes to program

15) Objective: Significant reduction in effluent and fertiliser inflows into wetlands on Tienie Versfeld Nature Reserve, establishment of 50m buffer along Reserve southern edge; and reduction in pesticide drift into the Reserve.

Project component/s	Construction and Operational phase; ongoing
Potential impact	Current effluent inflows from dairy farming operations pose a severe threat to the wetlands in the Reserve; fertilizer inflows supplement this; pesticide drift from adjacent crops impacts on important insects (pollinators, etc.) in the Reserve.
Activity risk/source	There is no reason why this objective should not be achieved, but it would require cooperation from the landowner
Mitigation: target/objective	>75% reduction in current levels of nutrient (fertiliser and effluent) inflows into wetlands in the Reserve from adjacent property; minimal pesticide drift into Reserve

Mitigation: Action/control	Responsibility	Timeframe
Fence off a 50m buffer from southern boundary of Reserve and rehabilitate this area over time, using Renosterveld seed mix provided by botanist approved restoration ecologist; freshwater biologist to advise and implement on effluent control and purification; no pesticide spraying within buffer area	ECO and landowner (construction phase; fencing); freshwater biologist & landowner (effluent control measures); CapeNature, site manager and landowners (operational phase)	Fencing, rehabilitation and effluent control to be undertaken within one year of project initiation; monitoring and modification to be ongoing

Performance indicator	Observable and measurable reductions in nutrient inflows into reserve; visible establishment of Renosterveld species in 50m cultivation buffer
Monitoring	Freshwater ecologist and botanist to review situation annually after implementation.

16) The applicant must ensure that there is sufficient budget to implement all management recommendations noted above.

11. CONCLUSIONS

- There are two natural vegetation types on site, both of which are regarded as threatened on a national basis. About 900ha of the 3900ha study site supports vegetation in medium to pristine condition, and was mapped as being of High sensitivity in the baseline study of Helme (2010). Ideally no development should occur within identified High sensitivity areas, and all infrastructure should be located at least 30m from the edge of any High sensitivity areas. The remainder of the study area (about 3000ha) is of Low botanical sensitivity, and presents no botanical constraints to the proposed facility. The proposed 32km power line to Dassenberg substation would run through at about 26km of High sensitivity vegetation, most of which is Atlantis Sand Fynbos (Critically Endangered).
- Overall the proposed WEF is likely to have a Medium – High negative local (site scale; 1600ha site) and Medium regional (Darling Hills; < 100 000ha) negative impact on the vegetation on site, prior to mitigation. This could be reduced to Low negative (local) and Very Low negative (regional) with proper mitigation although the likelihood of all proposed mitigation taking place is considered only moderate, and a more likely post-mitigation significance is **Low – Medium negative** (at both site and regional scales). The most important unknown variables in this regard are the likelihood of being able to mitigate the current negative impacts on the adjacent Tienie Versfeld Wildflower Reserve, the likelihood of being able to manage the 32km long power line servitude appropriately, and the likelihood of most High sensitivity vegetation areas on site being managed under CapeNature's Stewardship program.

12. RECOMMENDED SITE SPECIFIC MITIGATION

- It is recommended that all hard infrastructure be located within existing areas of Low sensitivity, as far as possible. This means that some relocation of infrastructure will be necessary, and all problem areas are identified in Figure 5. Where infrastructure is located within the red areas in Figure 5 this must be re-designed so that these sensitive areas are not impacted.
- It is recommended that all turbines and substations be located at least 30m from any mapped High sensitivity areas on site (see sensitivity maps in baseline study of Helme 2010).
- Substation 1 must be moved out of its current location in a High sensitivity area, along with all infrastructure feeding into it. It is suggested that it be moved 300m north, into a Low sensitivity area in the space between turbines 61 and 63.
- An ECO must be permanently on site throughout the road construction, cable laying, turbine foundation excavation, and during the erection of the turbines, and at other times should visit the site at least once a week until the construction phase is completed.
- Any excavation, including those for cables, must be supervised by the ECO. No excavations may be left open for more than 1 week, and they should preferably be closed up within 1 day, using the carefully stockpiled soil that came out of the trench. In the case of turbine footings some 45m^3 of soil will presumably be displaced by the concrete, and this should not be dumped on any natural vegetation.
- No dumping or temporary storage of any materials may take place outside designated and demarcated laydown areas, and these must all be located within areas of Low botanical sensitivity (agricultural areas).
- No agriculture should be allowed to take place within 50m of the southern boundary of the Tienie Versfeld Wildflower Reserve, and this area should be gradually rehabilitated to Renosterveld, with professional input from a restoration ecologist. This buffer is the minimum required to ensure that fertilizer and pesticide drift from the adjacent fields does not further harm the vegetation in this important Reserve. In addition, no nutrient – rich effluent should flow into this Reserve from the study area, as the current effluent inflows from the dairy farming operations are severely degrading the wetland areas in the Reserve. Specialist input should be obtained from a freshwater biologist on how to control this, and their recommendations must be implemented within 1 year of project authorisation.

- All feasible (as determined by CapeNature) areas of High botanical sensitivity (identified in Helme 2010) must be formally declared and registered as a Contract Nature Reserve with CapeNature's Stewardship Program, within one year of project initiation (defined as installation of the first project related infrastructure; subject to CapeNature capacity). This may entail a rezoning of these areas (to Open Space), and will require that a management plan for these areas is drawn up, which should include the clause that these areas may not be grazed by livestock between 1 May and end October. In some cases small, isolated patches or strips of mapped High sensitivity habitat may not be deemed feasible or suitable by CapeNature, and in this case these areas could then be excluded from the final Contract Reserve. Significant financial incentives are available for landowners who register land as a Contract Reserve, including write-offs of the management costs and portions of the capital costs, and a reduction in annual Land Tax. Associated with these benefits are requirements for a management plan and environmental auditing to ensure that management is adequately carried out. In this case all costs associated with rezoning and management of these areas will remain the responsibility of the applicant and/or landowners.
- A CEMP and OEMP should be drawn up, which must outline management steps for all the areas of natural vegetation on the site. See Section 10 for detailed guidelines.
- A botanist familiar with the vegetation of the area should ensure that adequate botanical inputs are made into the construction and operational phase EMPs.
- It is recommended that all areas of identified High sensitivity natural vegetation older than 15 years within the study area be burned in a controlled fire prior to any construction. This can be done in three or four blocks (possibly over a period of two years), and should be undertaken by a professional team with experience in block burning. The best time to undertake block burns is in late autumn, as plant recovery will then be best, and it will minimise the erosion of the exposed soils. All areas to be burnt must be cleared of alien vegetation at least one year before.
- If not burnt prior to construction all the above noted areas of natural vegetation older than 15yrs should be burnt within five years of the start of construction. Renosterveld and Sand Fynbos areas should be burnt once every 12 to 15 years.

- It is recommended that the proposed 32km power line servitude not be bushcut, and that alien vegetation management be undertaken in the area on an annual basis.

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3 June 2011

Savannah Environmental
Sunninghill, Johannesburg
ATT: Jo-Anne Thomas

Dear Jo-Anne

Addendum to the Rheboksfontein WEF Vegetation IA (Moyeng Energy)

This Addendum assesses the botanical impacts of the recently (May 2011) proposed layout alternative for this site. The alternative is henceforth referred to in this Addendum as Alternative 2, with the original alternative (assessed in my report dated 26 Aug 2010) referred to as Alternative 1.

Aside from the obvious difference in the total number of proposed turbines (80 in Alternative 1 versus 48 in Alternative 2), there are also certain layout differences that need to be assessed. The proposed Alternative 2 layout is shown in Figures 1-3.

Substation 1 (southernmost) is no longer needed (which is a very positive change, as it was in a Very High sensitivity area), and Substations 2 and 3 are in the same positions as assessed in Aug 2010, and are not shown (and are in acceptable locations).

1) Botanical Issues Identified

This section highlights the key botanical issues associated with Alternative 2. Note that all natural vegetation referred to below is Critically Endangered Swartland Granite Renosterveld.

Northern Area (turbines 1-12): None

Central Area (13-31):

- Turbine 26 too close (12m) to small rocky outcrop and small patch of natural vegetation
- Turbine 29 within area of natural vegetation
- Turbine 30 too close (11m) to natural vegetation
- Road between 28 and 30 crosses area of natural vegetation (over a distance of 250m).

Southern Area (32-48):

- Turbine 35 too close (13m) to natural vegetation
- Road and cable trench west of turbine 38 passes through natural vegetation (340m)
- Road and trench between turbines 33 and 46 passes through natural vegetation (510m)
- Road and trench between turbines 37 and 40 passes through natural vegetation and rocky area (200m)
- Turbine 40 within area of natural vegetation
- Turbine 48 within an area of partly natural vegetation.

Figure 1: Proposed Alternative 2 layout in northern area. Roads and cable trenches are assumed to be closely parallel, and are indicated in brown and yellow. The red balloon is the primary laydown area.

Figure 2: Proposed Alternative 2 layout in central area. Roads and cable trenches are assumed to be closely parallel, and are indicated in brown, green and yellow. The red balloon is the primary laydown area.

Figure 3: Proposed Alternative 2 layout in southern area. Roads and cable trenches are assumed to be closely parallel, and are indicated in brown, green and yellow. The red balloon is the primary laydown area.

2) Likely Botanical Impacts

As per the original assessment. Direct and indirect botanical impacts are likely to occur where infrastructure is placed within or very close to areas of the Critically Endangered Natural vegetation. Ten separate areas of botanical concern have been identified in the previous section. At least six of these are likely to be relatively easy to fully mitigate, by simply shifting the layout to avoid the sensitive areas, but the remaining four areas are access roads and associated cable trenches, and may not be possible to relocate, in which case the impacts cannot be mitigated to any significant extent.

This assessment thus assumes that the six problematic turbine positions can be adequately shifted to avoid botanical impacts, and that the four roads cannot, and will thus be the primary sources of negative botanical impact. The total road length in these four areas is about 1300m, and assuming that the new access roads and cable trenches will impact on a strip about 8m wide, this means that the total unmitigated botanical impact could mean loss of at least 1.4ha of Critically Endangered vegetation. If the six problematic turbine positions cannot (or are not) shifted then an additional approximately 1.6ha of Critically Endangered vegetation would be permanently lost or severely damaged.

Various threatened and regionally endemic plant species are likely to be located within the development footprints of the identified areas of impact, although the quantity and significance thereof is not known. Direct impacts would effectively mean the permanent loss of the populations of any such species within the development footprints.

3) Assessment of Impact

As it currently stands the proposed Alternative 2 development layout is likely to result in the permanent loss of at least 3ha of Critically Endangered vegetation, and portions of local populations of an unknown number of plant Species of Conservation Concern. This is likely to have a **Medium negative** impact at the regional scale.

If the six problematic turbines can be shifted and only the 1300m of road and cable trench remain as the primary impact the overall botanical impact could be reduced to **Low to Medium negative** at a regional scale, provided that all other essential mitigation as noted in the August 2010 Impact Assessment is implemented correctly and timeously.

This level of botanical impact is the same as for Alternative 1, both pre and post mitigation.

4) Essential mitigation (specific to Alternative 2)

The following layout mitigation is regarded as essential in order to reduce the botanical impacts of the Alternative 2 layout from Medium negative to Low – Medium negative.

<u>Central Area (turbines 13-31):</u>

- Relocate Turbine 26 100m to W.
- Relocate Turbine 29 about 50m to SE.
- Move Turbine 30 40m to NW, W or SW.

<u>Southern Area (32-48):</u>

- Relocate Turbine 35 50m to NW, W or SW.
- Road and trench between turbines 37 and 40 should be rerouted to avoid natural vegetation and rocky area, possibly by connecting directly between turbines 39 and 44.
- Relocate Turbine 40 50m to E.
- Relocate Turbine 48 110m to N.

All non layout specific mitigation as outlined in the August 2010 assessment of Alternative 1 is still regarded <u>as essential</u> should either Alternative 1 or 2 be authorised.

5) Conclusion

There is no strongly preferred development layout alternative, and both are acceptable after mitigation, from a botanical perspective. Both Alternatives 1 and 2 require a roughly similar number of essential layout alterations, along with identical site management requirements (see 2010 assessment for these).

Yours sincerely

NA Helme

GEOLOGICAL REPORT

SPECIALIST INPUT FOR THE ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED RHEBOKSFONTEIN WIND ENERGY FACILITY NEAR DARLING, WESTERN CAPE PROVINCE, SOUTH AFRICA

Technical Report No: OGS2010-08-18-2

August 2010

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List of abbreviations and definitions

The study area:	The area as delineated on **Figure 1**
EIA:	Environmental Impact Assessment
WEF:	Wind Energy Facility
EMP:	Environmental Management Plan
AMSL:	Above mean sea level
Ma:	Million years ago
NGL:	Natural Ground Level
ECO:	Environmental Control Officer
Namibian age:	The geological time period from 900 to 542Ma
Quaternary age:	The geological time period from 2Ma to present

1. INTRODUCTION

1.1. Background

Moyeng Energy is in the process of carrying out the Impact Assessment phase of the EIA for the proposed Rheboksfontein Wind Energy Facility near Darling in the Western Cape. The proposed activity is defined as the establishment of a wind energy facility and associated infrastructure. An area of approximately 39km^2 is being considered within which the facility is to be constructed (the study area). The proposed wind energy facility would include:

- Up to 80 wind turbines and foundations to support them;
- Underground cables between the turbines;
- Substations;
- A 132kV power line linking to the existing grid;
- Internal access roads between the turbines;
- Maintenance/control building.

The proposed study area is located on the farm portions: Remaining extent of Farm 568 (Rheboksfontein), Farm 567 (Nieuwe Plaats), Remaining extent of Farm 571 (Bonteberg), Portion 1 of Farm 574 (Doornfontein), Portion 1 of Farm 551 (Plat Klip), Farm 1199 (Groot Berg) and Portion 2 of Farm 552 (Slang Kop). No alternative areas have been proposed.

1.2. Legislation

In terms of the EIA regulations published in terms of Section 24(5) of the National Environmental Management Act (NEMA, No 107 of 1998), the applicant requires authorisation from the National Department of Environmental Affairs (DEA) (in consultation with the Western Cape Department of Environmental Affairs and Development Planning (DEA&DP)) for the undertaking of the proposed project. This specialist study fulfils the requirements under section 33 of the EIA regulations i.t.o. NEMA, published in Government Gazette R385 of 2006.

1.3. Terms of reference

Savannah Environmental (Pty) Ltd has been appointed by Moyeng Energy to carry out the EIA process for the proposed activity. Specialist geological input is required in order to assess the environmental impacts on the geology and soil properties and erosion potential over the study area. Savannah Environmental (Pty) Ltd has appointed Outeniqua Geotechnical Services to conduct a specialist geological study of the study area.

The following scope of work has been given:

- Carry out a desk-top study of available information pertaining to the geology and soil types of the study area and the environmental impacts on the geological environment that are likely to be associated with the proposed activity.
- Conduct a brief site visit to collect visual data pertaining to the geology, soil types and potential soil degradation issues.
- Conduct a geological impact assessment and prepare a report on the findings.

The following aspects are covered in this report:

- A description of the environment that may be affected by the activity (the study area);
- A description of the geology and soil types in the study area;
- An assessment of the potential environmental impacts on the soil profile and other geological features (with emphasis on erosion and soil degradation);
- Mitigating measures for the EMP.

In addition to this, a preliminary indication of the potential geotechnical constraints on the proposed project is provided. These constraints may impact on the engineering design of access roads and foundations, and include such issues as founding conditions and problem soils, groundwater problems, excavatability, sources of natural construction material, etc.

1.4. Limitations

Information provided in this specialist report has been based on information provided by Savannah Environmental (Pty) Ltd, published scientific literature and maps. The study area was visited briefly but no detailed soil investigation (trial pits, soil testing), geomorphological or geohydrological assessment or verification of the official geological mapping was conducted. The information provided in this report is deemed adequate for the EIA process and preliminary planning phase but further geotechnical information may be required for the detailed engineering design phase.

1.5. Authors credentials & declaration of independence

The author of this report, Iain Paton of Outeniqua Geotechnical Services cc (OGS), is a professional engineering geologist registered with the South African Council for Natural and Scientific Professions (Pr Sci Nat # 400236/07) with 12 years experience in the mining, petroleum and construction industries and is a member of the South African Institute of Engineering and Environmental Geologists. Iain Paton declares that he does not have any financial interest in the undertaking of the activity, other than remuneration for work performed in the compilation of this specialist report.

2. SITE DESCRIPTION

2.1. Location

The study area is located 8km northwest of the town of Darling along the R315 towards the R27. Darling is approximately 75km north of Cape Town.

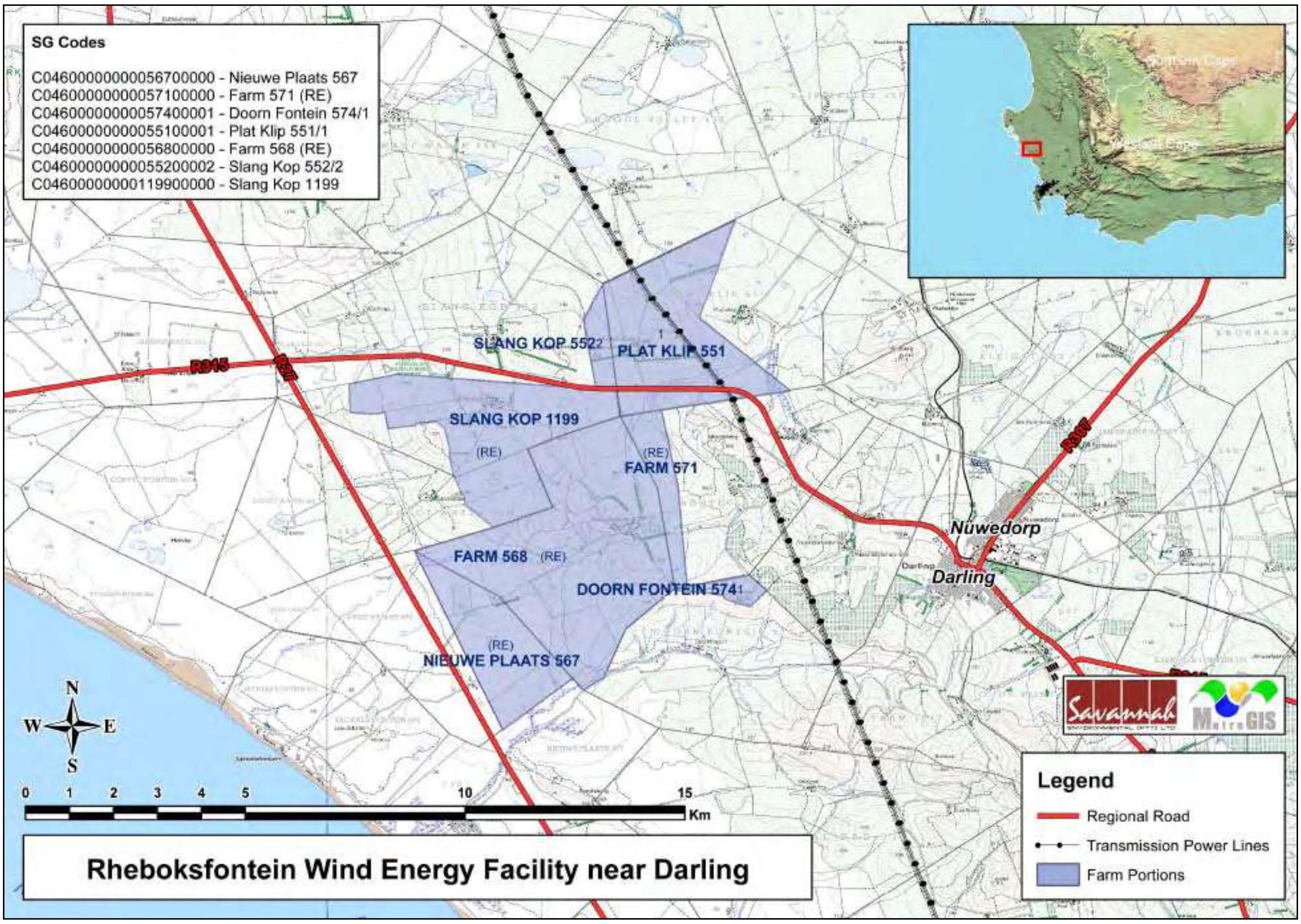

Figure 1: Locality map of study area (purple shaded areas)

2.2. Topography, climate & vegetation cover

The topography of the study area is characterised by a gently undulating upland area in the central and eastern portions of the study area which slopes down gradually northwards and westwards from a maximum altitude of 315m to 65m AMSL in the southernmost tip of the study area. Slope gradients are mostly low to moderate (1-10°), and are steepest in the higher altitude central area near Rheboksfontein Farmstead and Bakenkop peak (>10°).

The climatic N-number for the area, which is 3-4, indicates that chemical weathering processes are dominant[6], however the Thornthwaite moisture index map[5] indicates that the study area is situated in a semi-humid to semi-arid climatic area, where the moisture index is around -20 and there is typically a soil moisture deficit. This will tend to restrict the chemical weathering process.

The present land-use of the area is agricultural (grassland pasture and crops). There are areas within the study area which have little or no vegetation cover.

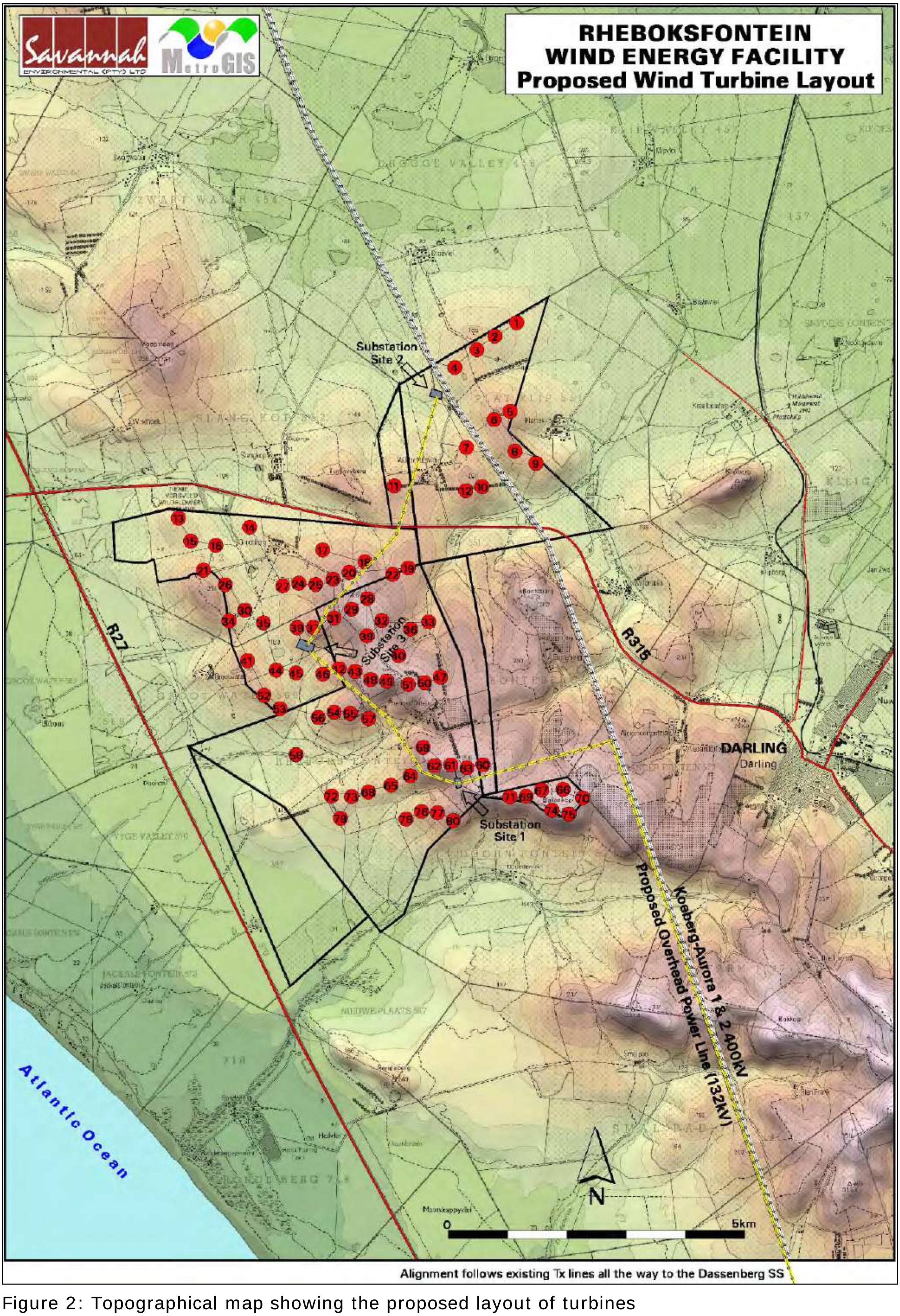

Figure 2: Topographical map showing the proposed layout of turbines

2.3. Geology & soil types

The geology of the study area is dominated by granitic rocks of the Darling Pluton of the Cape Granite Suite, dated at 560Ma (Namibian age). The lithology is mainly coarse-grained porphyritic granite with biotitic or fine-grained leucocratic variants and minor granodiorite. Other intrusive rocks include limited and localised dolerite and granodiorite dykes. Thick deposits of Quaternary age sands are mapped in the southwestern corner of the study area. A thin, localised outcrop of Tygerberg Formation (Namibian age) feldspathic sandstone, phyllite or greywacke occurs to the west of the Rheboksfontein farmstead. Rock outcrops occur over approximately 10% of the study area, specifically on the steep slopes to the west and south of the Rheboksfontein farmstead.

The southwestern Cape is a seismically active area and the most devastating earthquake in South African recorded history occurred at Tulbagh, approximately 80km east of Darling. Numerous faults have been mapped in the vicinity of Darling which form part of the Vredenburg-Stellenbosch fault zone.

Localised outcrops of weathered granite occur on the upland areas but the majority of the study area is covered by residual and transported soils. A thin transported gravelly silty sand layer (fine colluvium/hillwash) overlies residual gravelly silty sands, ferricrete gravel and sandy clay associated with the in situ chemical weathering of the underlying granite. Thick, unconsolidated, wind-blown sands comprise the Quaternary deposits in the southwestern corner (about 10% of the study area).

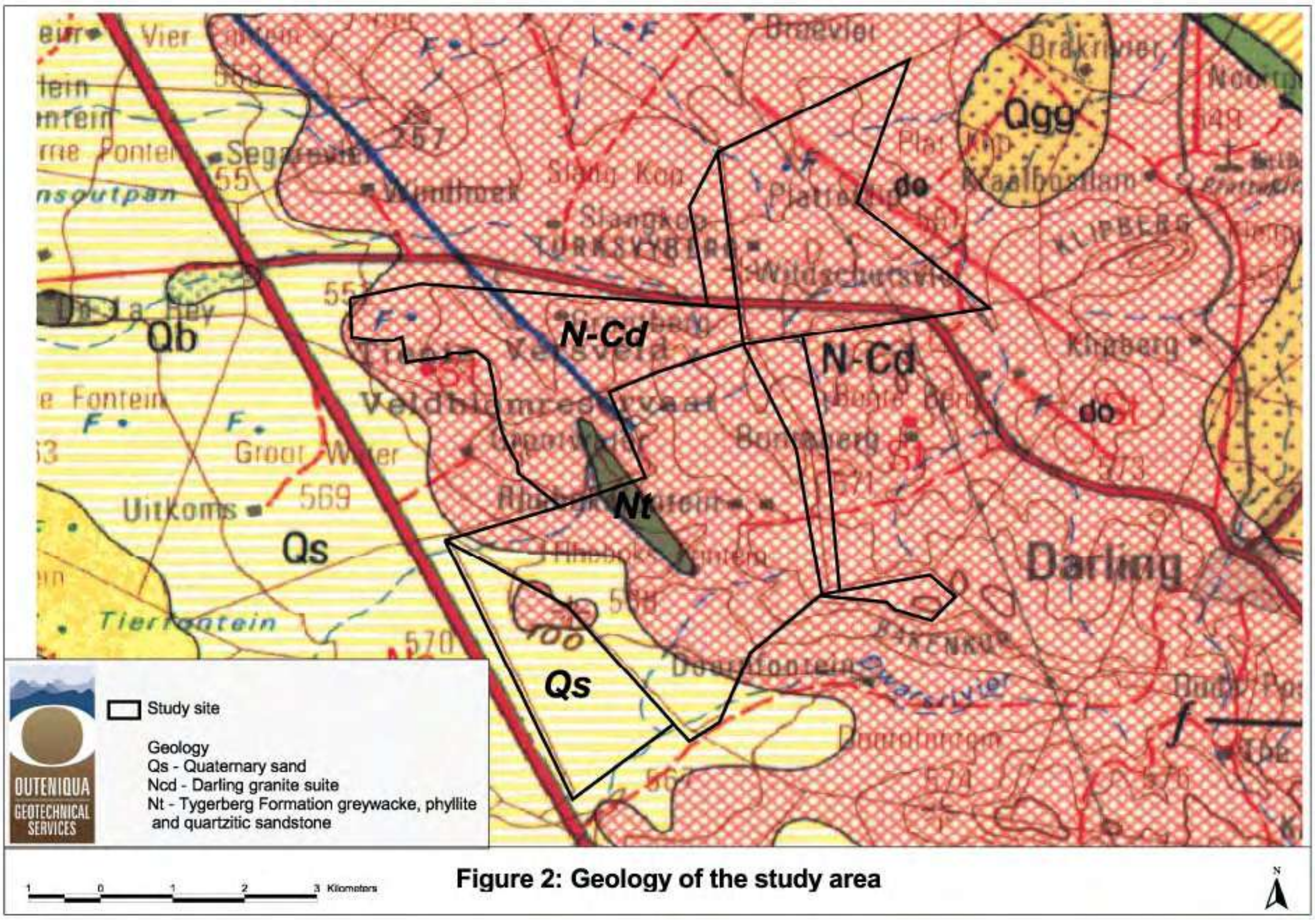

Figure 3: Geological map of the study area (black lines).

2.4. Hydrology

The hydrology of the study area plays an important role in the erosion potential. Rainfall, if not intercepted by vegetation or by artificial surfaces, falls on the earth where it may evaporate, infiltrate, lie in depression storage or end up as surface run-off. The permeability of the ground influences the percentage of rainfall which infiltrates. Where soil cover is thin or impermeable, infiltration will tend to be lower and vice versa and thus surface run-off is generally inversely proportional to infiltration, ceteris paribus. Rainfall intensity and slope gradient influence the velocity and energy of the surface run-off. The hydraulic energy of the run-off and the soil properties are the main determining factors of water erosion potential. The presence of vegetation and other erosion inhibitors will tend to reduce the hydraulic energy as well as providing an anchoring effect on the soil mass. Higher energy run-off will be concentrated along natural drainage lines particularly in high relief areas with lower energy sheet-wash on low relief areas, i.e. topography is a controlling factor.

3. GEOLOGICAL IMPACT ASSESSMENT

The geological impact assessment aims to assess the impact that the proposed development will have on the geological environment which includes the parent rock and the natural soil profile. Important or prominent geological features (geosites) that contribute to the aesthetic scenery or geological interest in the area, such as fossil sites, prominent rock outcrops or features, are also considered in the impact study. Geological features, such as caves, addits, middens, worship rocks, etc. which are important from historical, cultural, archaeological or religious heritage standpoint are not assessed in this report as they are generally covered in the Heritage Impact Assessment. Geohydrological assessments also do not form part of this study.

3.1. Soil degradation

Soil degradation is the removal, alteration or damage to soil and soil forming processes, usually due to human activity. The stripping of vegetation or disturbance to the natural ground level over disturbance areas will negatively impact on soil formation, natural weathering processes, moisture levels, soil stability and biological activity. Soil degradation includes erosion (due to water and wind), salinisation, acidification, water-logging, pollution, soil mining and burial, compaction and crusting[8].

The proposed activity will include excavation or displacement of soil, topsoil burial, stockpiling, mixing, wetting and compaction of topsoil and pollution of soil. These activities carry potential negative direct impacts which contribute to soil degradation. These activities could also cause negative indirect impacts such as increased siltation in other areas away from the site causing negative impact on water sources and agriculture with socio-economic repercussions. The severity or significance of the various impacts is related to the nature and extent of the activity. There are no known positive impacts relating to the geological environment and the impacts are dominantly related to the construction phase with very little additional impacts in the post construction and decommissioning phases.

Soil erosion is a natural process whereby the ground level is lowered by wind or water action and may occur as a result of inter alia chemical processes and/or physical transport on the land surface[1]. Soil erosion induced or increased by human activity is termed "accelerated erosion" and is an integral element of global soil degradation. Accelerated soil erosion is generally considered the most important geological impact in any development due to its potential impact on a local and regional scale (i.e. on and off site) and as a potential threat to agricultural production and self sufficiency. Soil erodability – the susceptibility of soil to erosion – is a complex variable, not only because it depends on soil chemistry, texture and characteristics, but because it varies with time and other conditions[8].

The Erosion Index for South Africa[4] indicates that the area where the site is located has a moderate to low susceptibility to erosion. The erodibility index is determined by combining the effects of slope, geology and soil type, rainfall intensity and land use. Soil erosion tends to be more critical at the foot of steep slopes where run-off velocity is high and soil types are typically thicker, fine-grained and unconsolidated. Erosion gulleys will tend to concentrate along natural drainage lines where run-off is concentrated and where vegetation is limited or has been disturbed or damaged (e.g. overgrazing). The severity of erosion is affected by, amongst other factors, the thickness, texture and consistency of the soil. The occurrence of rock outcrops, or areas with shallow rock, will have a significant reducing effect on the erosion potential of this area. Construction activity on slopes will tend to promote soil erosion and these areas will require more protection before, during and after construction.

The proposed development layout indicates that turbines are concentrated on the upper slopes and plateau areas underlain by granite. This is primarily to maximise wind resource. These areas also tend to be less sensitive i.t.o. erodibility potential as the hydraulic energy is generally low and the unconsolidated transported soils are generally thinner. **Table 1** outlines the sensitivity in terms of erosion susceptibility.

Sensitivity Level	Area/Terrain	Comments/Recommendations
High	• Natural drainage lines/ watercourses (including buffer zone 30m each side from centreline) • Steep slopes (>1:4) and foothills below steep slopes	No-go areas without special mitigating measures
Moderate	Rest of site including proposed power line	No significant erosion taking place at present - Normal mitigating measures apply
Low	N/A	

Table 1: Sensitivity to erosion

The highly sensitive areas will include drainage lines, steep slopes and distal or lower slopes (foothills) where topsoil is generally thicker and agricultural crops tend to be concentrated. The rest of the site is considered moderate due to the presence of erodible fine grained unconsolidated granular soils (silty sands), but at present there is no sign of severe erosion taking place. Erosion will occur if vegetation is cleared and soil is loosened by construction activity. It is the aim of the environmental impact assessment to evaluate this impact and attempt to provide mitigating measures to reduce the impact.

3.2. Degradation of parent rock

Apart from the impact on the overlying soil, excavations into bedrock may result in unsightly scars, resulting in potential visual impacts. More importantly, deep or poorly planned excavations may potentially affect the stability of the surroundings, such as rock slides along road cuttings. It is a common misconception that excavations into bedrock do not affect ecosystems. Excavations into bedrock may affect the geohydrology of an area and can even contaminate groundwater. Blasting operations associated with excavations into rock have obvious environmental issues, chiefly including noise pollution, dust, vibrations and chemical hazards.

Fortunately, the proposed activity is unlikely to have significant impact in this regard because the proposed activity is unlikely to involve excavations deeper than 2-3m and, where required, access roads can probably be constructed without significant cuttings.

3.3. Degradation of geo-sites

Geo-sites are interesting or academically important geological exposures or features that require protection for obvious reasons and the environmental impact process needs to cater for these aspects, if they occur within the site. The occurrence of these sites is not always apparent unless the particular feature is well known (such as a prominent rock feature like the Maltese Cross in the Cederberg). Geo-sites that are less well-known or that have local significance are usually brought to light during the Public Participation Process. At this stage, there are no known geo-sites on the site.

3.4. Assessment of impacts

The proposed activity involves earthworks on numerous small construction footprints around each turbine with additional sites earmarked for substations, workshops, etc and interleading gravel access roads. The proposed layout plan is shown in **Figure 2**. No alternative study area has been proposed but the structures can be shifted within the broader study area to accommodate sensitive areas, if these occur where structures are planned. As mentioned, sensitive areas include drainage lines, riverbanks and lower distal slopes (foothills) where finer grained topsoil is thicker. Fortunately, these areas are usually excluded due to lower wind resources.

The most important geological issues are the direct impacts of soil degradation and erosion of topsoil from the area of activity. This would affect the ecosystems operating in the topsoil and the plant and animal species that depend on it for growth and survival. Other direct impacts would include the loss of agricultural potential of the area. The significance of these impacts obviously depends on the present quality of the topsoil and the agricultural potential of the area (not discussed further in this report).

Indirect impacts could include increased siltation in nearby streams and dams caused by an increase in erosion from the site and socio-economic impacts resulting from the loss of topsoil and lower agricultural potential.

Direct, indirect and cumulative impacts are assessed in terms of the following criteria:

- The nature of the impact - what causes the impact, what will be impacted and how it will be impacted;
- The extent of the impact - whether it is local (limited to the immediate area or site of the development) or regional (on a scale of 1 to 5).
- The duration of the impact – whether it will be very short (less than 1 year), short (1-5 years), medium (5-15 years), long (>15 years) or permanent (on a scale of 1 to 5, respectively).
- The magnitude, quantified on a scale of 0-10, where 0 is small and will have no impact on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will have a slight impact on processes, 6 is moderate and will result in processes continuing, but in a modified way, 8 is high and processes are altered the extent that they temporarily cease, and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The probability of occurrence, which describes the likelihood of the impact actually occurring (on a scale of 1 to 5 – very improbable to definite).
- The significance, which is determined through a synthesis of the characteristics described above and is assessed as low, medium or high.
- The status, which is described as positive, negative or neutral.

- The degree to which the impact can be reversed.
- The degree to which the impact may cause the irreplaceable loss of resources.
- The degree to which the impact can be mitigated.
- The possibility of significant cumulative impacts of a number of individual areas of activity.
- The possibility of residual impacts existing after mitigating measures have been put in place

The significance is calculated by combining the criteria in the following formula:

S = (E+D+M)P

Where:
S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The significance weightings for each potential impact are as follows:

<30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area);
30-60 points: Moderate (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated);
>60 points: High (i.e. where the impact will influence the decision to develop in the area).

3.4.1. Direct impacts

An assessment of the individual direct potential impacts associated with the proposed activity is outlined in Table 2.

Nature: Soil degradation – Removal or burial of topsoil in disturbance areas (areas where construction activity takes place around proposed turbines, structures or along access roads or power line routes) impacting on soil forming processes and resources.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long term (4)	Medium term (3)
Magnitude	High (8)	Moderate (6)
Probability	Definite (4)	Definite (4)
Significance	**Moderate (52)**	**Moderate (40)**
Status	Negative	Negative
Reversibility	Partially reversible	Partially reversible
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	To a certain extent	
Mitigation:	• Minimise disturbance areas and use existing disturbed areas (and access roads) or low sensitivity areas where possible. • Rehabilitate soil in areas of disturbance after construction.	
Cumulative impacts:	This is the second wind farm in the area. Potential removal of soil/rock from foundations is 80 turbines x 600m^3=48 000m^3. This excludes removal or burial of topsoil around turbines for	

	assembly platforms. The cumulative impact of topsoil removal and/or burial related to all development in the surrounding area is considered moderate even with mitigation.
Residual impacts:	Minor negative – slow regeneration of topsoil.

Nature: Soil degradation – Pollution, salinisation, acidification or water-logging of natural soil in construction areas affecting soil formation processes.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium term (3)	Short term (2)
Magnitude	Moderate (6)	Low (4)
Probability	Very probable (4)	Probable (3)
Significance	**Moderate (40)**	**Low (21)**
Status	Negative	Negative
Reversibility	Irreversible	Reversible
Irreplaceable loss of resources?	Yes	Minor
Can impacts be mitigated?	Yes	
Mitigation:	• Minimise disturbance areas and use existing disturbed areas (and access roads) or low sensitivity areas where possible. • Control use and disposal of potential contaminants (e.g. construction water laden with cement, etc.) or hazardous materials (e.g. fuel). • Rehabilitate soil in areas of disturbance - remove contaminants after construction.	
Cumulative impacts:	The cumulative impact of soil pollution is considered low at present due to the limited and localised nature of the surrounding developments and the proposed activity.	
Residual impacts:	Minor negative – slow regeneration of vegetation & soil.	

Nature: Soil degradation – Loosening, mixing, dumping and stockpiling of soil onto topsoil and compaction of topsoil affecting soil stability and organic processes.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Short term (2)	Very short term (1)
Magnitude	Moderate (6)	Low (4)
Probability	Highly Probable (4)	Highly Probable (4)
Significance	**Moderate (36)**	**Low (24)**
Status	Negative	Negative
Reversibility	Partially reversible	Partially reversible
Irreplaceable loss of resources?	Yes	Minor
Can impacts be mitigated?	To a certain extent	
Mitigation:	• Prevent unnecessary removal and stockpiling of soil. • Rehabilitate soil and vegetation in areas of activity as soon as possible after construction is complete in that area. • Keep to existing roads, where practical, to minimise compaction of undisturbed soil.	
Cumulative impacts:	The cumulative impact of soil mixing, etc is low at present due to the limited and localised nature of the surrounding developments and the proposed activity.	
Residual impacts:	Minor negative – slow regeneration of soil processes in and under topsoil	

Nature: Soil degradation – Increased sheet, rill or gulley erosion and deposition down-slope due to the removal of vegetation and other activity in construction areas.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium term (3)	Very short term (1)
Magnitude	Moderate (6)	Low (4)
Probability	Highly probable (4)	Probable (3)
Significance	**Moderate (40)**	**Low (18)**
Status	Negative	Negative
Reversibility	Practically irreversible	Practically irreversible
Irreplaceable loss of resources?	Moderate	Minor
Can impacts be mitigated?	Yes	
Mitigation:	• Restrict zone of disturbance to area of construction. • Implement effective erosion control measures. • Carry out earthworks in phases across site to minimise exposed ground at any one time. • Keep to existing roads, where practical, to minimise loosening of undisturbed ground. • Ensure stable slopes of stockpiles/excavations to minimise slumping	
Cumulative impacts:	The cumulative impact of soil erosion is low at present due to the limited and localised nature of the proposed activity and the surrounding developments.	
Residual impacts:	Minor – Localised movement of sediment. Slow regeneration of soil processes	

Nature: Degradation of bedrock – Excavations and or blasting causing removal of rock, degradation to local geology and instability.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Minor (2)	Minor (2)
Probability	Probable, if blasting occurs (3)	Probable, if blasting occurs (3)
Significance	**Low (24)**	**Low (24)**
Status	Negative	Negative
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	Yes, but insignificant	Yes, but insignificant
Can impacts be mitigated?	To a certain degree	
Mitigation:	• Restrict zone of disturbance and plan excavations carefully. • Plan any new access roads taking contour lines into consideration to minimise cutting and filling operations. • Keep to existing roads, where practical, to minimise impacts on undisturbed ground.	
Cumulative impacts:	Turbine foundations are preferably socketed into solid rock. This will require some excavations into the rock but excavations will have minor impact. The cumulative impact of all the development in the area is considered low.	
Residual impacts:	Minor – Some unsightly scars in landscape where access roads are cut.	

Table 2: Assessment of potential direct impacts

3.4.2. Indirect impacts

An assessment of the indirect potential impacts associated with the proposed activity is outlined in **Table 3** below.

Nature: Soil degradation - Deposition down-slope affecting soil forming processes and siltation of waterways and dams.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Moderate (48)**	**Low (30)**
Status	Negative	Negative
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	Moderate – depends on planning	Minor
Can impacts be mitigated?	To a certain degree	
Mitigation:	• Install anti-erosion measures such as silt fences in disturbance areas. • No development in water courses/natural drainage lines as sediment transport is higher in these areas.	
Cumulative impacts:	The cumulative impact on the surrounding area is considered low at this stage because the area is still largely undeveloped.	
Residual impacts:	Minor localised movement of soil across site	

Table 3: Assessment of potential indirect impacts

3.4.3 Impact statement

The overall impact of the proposed activity on the geological environment is considered to be moderate without mitigating measures. With effective implementation of mitigating measures the impacts identified above can be reduced to a low level.

The potential impacts associated with the proposed power line route are likely to be similar to the rest of the site. However, there is a higher risk of erosion with work on steep slopes and obvious higher costs associated with construction due to topographical constraints. Where power lines cross areas of high erosion sensitivity as identified in Table 1, extra care should be taken to mitigate potential impact of erosion.

3.5. Mitigating measures

Negative impacts can be mitigated to a large degree by the implementation of an appropriate and effective EMP.

The objectives, impacts, risks and mitigating measures that are required for inclusion in the EMP are outlined in **Table 4** below:

OBJECTIVE: Soil and rock degradation and erosion control
The geological environment, including the natural soil and bedrock, needs to be preserved as far as possible to minimise the cumulative impact on the surrounding environment. Most importantly, soil erosion of topsoil (the organic-rich portion of the soil profile) and subsequent deposition elsewhere carries a moderate impact significance and this needs to be mitigated.

A set of strictly adhered mitigation measures are required to effectively limit the impact on the geological environment. The disturbance areas where human impact is likely are the focus of the mitigation measures laid out below.

Project components and areas of activity	Wind turbines
	Access roads
	Substations
	Workshops
	Underground cabling and pipeline routes
	Overhead power line routes
Potential Impact	Degradation of soil
	Degradation of local geology
	Soil erosion
	Siltation of drainage lines
Activities/risk sources	Rainfall and wind
	Excavation, mixing, dumping, stockpiling and compaction of soil
	Concentrated discharge of water from construction activity
Mitigation: Target/Objective	To minimise degradation of rock and soil by construction activity
	To conserve topsoil by stockpiling and re-using in disturbance areas
	To minimise erosion of soil from site during construction
	To minimise deposition of soil into drainage lines

Mitigation: Action/control	Responsibility	Timeframe
Identify disturbance areas and restrict construction activity to these areas.	ECO/Contractor	Before and during construction
Access roads to be carefully planned and constructed to minimise the impacted area and prevent unnecessary excavation, placement and compaction of soil.	Engineer/ECO/ Contractor	Before and during construction
Dust control on construction site: Wetting/covering of denuded areas.	Contractor	During construction
Rehabilitate disturbance areas as soon as an area is vacated.	Contractor	During and after construction
Strictly control vibration from compaction plant or excavation plant.	Contractor	During construction
Soil conservation: Stockpile topsoil for re-use in	Contractor	Before and during

rehabilitation phase. Maintain stockpile shape and size and protect from erosion.		construction
Erosion control measures: Run-off attenuation on slopes (sand bags, logs), silt fences, stormwater catch-pits, shade nets or temporary mulching over denuded areas.	Contractor/ECO	Erection: Before construction Maintenance: Duration of contract
Where access roads cross natural drainage lines, culverts must be designed to allow free flow. Regular maintenance must be carried out	Engineer/ECO/ Contractor	Before construction and maintenance over duration of contract
Control depth of excavations and stability of cut faces/sidewalls	Engineer/ECO/ Contractor	Before construction and maintenance over duration of contract

Performance Indicator	• Acceptable level of soil erosion around site, as determined by ECO • Acceptable level of increased siltation in drainage lines, as determined by ECO • Acceptable level of soil degradation, as determined by ECO • Acceptable state of excavations, as determined by ECO • No activity in restricted areas
Monitoring	• Fortnightly inspections of the site • Fortnightly inspections of sediment control devices • Fortnightly inspections of surroundings, including drainage lines • Immediate reporting of ineffective sediment control systems • An incident reporting system will record non-conformances

Table 4: EMP guidelines

4. GEOTECHNICAL RISKS

A basic preliminary assessment of the geotechnical nature of the study area affords the opportunity to identify any potential fatal flaws with the proposed site, in terms of the suitability of the site for development. A basic assessment of the main geotechnical risks that may impact on the civil engineering design is given in **Table 5**.

Geotechnical Risk	Effect on the proposed development	Risk level	Comment & recommendations
Collapsible & compressible soil	Soil horizons with a potentially collapsible or compressible fabric unsuitable for foundations.	Medium	Unconsolidated transported soils and completely weathered granitic soils are potentially compressible and collapsible under load. Turbines preferably socketed into soft rock, alternatively engineered soil rafts. Light structures can be founded on dense residual soils or engineered fill.

Geotechnical Risk	Effect on the proposed development	Risk level	Comment & recommendations
Differential settlement (DS)	Foundations placed across different soil types or rock may settle differentially.	Medium-High	Depth to bedrock or very dense soil horizons (residual) will vary widely across the site. Recommend found individual structures on similar mediums (either rock or engineered soil rafts).
Bearing capacity	Soils with low in situ bearing capacity resulting in high settlements of structures if not compacted or engineered properly	Low-Medium	Transported sands: 50-80kPa, depending on level of consolidation. Not favourable for turbines. Completely-highly weathered granite: 50-250kPa, depending on moisture, structure and consistency. Not ideal for turbines. Moderately weathered granite (soft rock): >250kPa. Ideal for turbines.
Saturated soils, groundwater problems, perched or permanent water tables	Seepage from sidewalls of excavations affecting stability or dewatering of trenches necessary.	Low-medium	Perched water tables could develop at interface of topsoil and underlying residual soil (clayey-impermeable) in low lying areas or drainage lines only.
Active soil	Heaving clays affecting foundation stability	Medium-high	Active clay anticipated in residual weathered granite. Found all turbines below clay on soft rock or engineered soil raft.
Excavations	Boulders or rock affecting excavations	Medium	Difficult excavations expected below 1.5m in most turbine sites.
	Unstable excavations requiring shoring	Low-medium	Sidewalls of excavations exceeding 1m in soils will be unstable. Temporary slopes to be battered to 1:2. Excavations into rock will be marginally stable.
Slope stability	Geological instability causing damage to structures founded on slopes	Low	Unstable slopes unlikely. Turbines should not be located on steep slopes which could be unstable.
Seismic activity	Structures at risk of damage due to seismicity	Medium	Western Cape is a potentially active seismic area. Peak ground acceleration of 100-200cm/s^2 and potential damage on Modified Mercalli Scale of VII with a 10% chance of being exceeded within 50 years.
Flood potential or storm water damage	Low lying areas affected by poor drainage.	Low	Most of the upland areas are well drained.
	Steep slopes affected by uncontrolled run-off	Low	Turbines should not be located on steep slopes which could be unstable.
Unconsolidated fill	Unconsolidated fill material affecting foundations	Low	Minor fill associated with existing farm buildings.
Availability of local construction material	Large distances to nearest quarry for sources of suitable construction material negatively affect construction costs	Medium	Nearest major centre is Cape Town (80km). Potential local sources of construction material (on site) are restricted to selected fill (weathered granite).

Geotechnical Risk	Effect on the proposed development	Risk level	Comment & recommendations
Mining Activity	Past, present or future mining activity which may affect development of the site	Low	No known mining activity (developer should confirm this with land owner)

Table 5: Geotechnical constraints on the proposed development

The above classification highlights some basic potential constraints, none of which are considered insurmountable. A detailed geotechnical investigation should be undertaken before the engineering design phase to confirm this information which is provided as an indication only.

5. CONCLUSIONS

This geological specialist study describes the geological environment and aims to assess the impact that the proposed development will have on this facet of the environment with special focus on soil resources. The proposed areas of activity are underlain by thin transported topsoil and variable thickness of residual granitic soils on weathered granite rock. The surficial soils have a fine grained component which is potentially erodible. There is no sign of severe erosion on the site and this is largely due to effective land management. Any activity will have direct impacts on soil resources and this can have indirect impacts on agriculture and conservation. However, the proposed activity is likely to have a moderate level of impact on the geological environment. This can be mitigated by effective implementation of the EMP to reduce the impact to a low level with an acceptable loss of resources.

A basic assessment of the potential geotechnical constraints on the project indicates no insurmountable problems or "fatal flaws" which have may have an impact on the design and construction processes, but certain geotechnical risk elements are briefly discussed. A more detailed geotechnical investigation is required to address these issues.

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31 May 2011

Jo-Anne Thomas
Savannah Environmental (Pty) Ltd
PO Box 148
Sunninghill
2157

RE: REVISED LAYOUT PLAN – RHEBOKSFONTEIN WIND ENERGY FACILITY

The proposed new layout plan for the above project (Layout 2011) has reference.

In terms of the impact on the geological environment, the revised layout will not affect the findings of the geological impact assessment report, dated 18 August 2010 and the conclusions thereof still apply. In terms of the impact on the geological environment, the new layout is better than the original layout in that there are fewer proposed structures and therefore the cumulative impact will be lower. However, it is noted on the new layout that some of the proposed turbine positions are located in close proximity to natural drainage lines and these areas were flagged in the study as highly sensitive areas in terms of soil erosion. It is recommended that the exact position of structures that are to be located near sensitive areas should checked by visual assessment on site by a competent person(s) to determine the suitability thereof.

Regards

Iain Paton Pr. Sci. Nat.

HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED RHEBOKSFONTEIN WIND ENERGY FACILITY, MALMESBURY MAGISTERIAL DISTRICT, WESTERN CAPE

(Assessment conducted under Section 38 (8) of the
National Heritage Resources Act (No. 25 of 1999) as part of an EIA)

Prepared for

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Phone (011) 2346621
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27 August 2010

Prepared by

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EXECUTIVE SUMMARY

ACO Associates was appointed by Savannah Environmental to undertake a Heritage Impact Assessment for the proposed Rheboksfontein Wind Energy Facility (WEF) on several farm portions in the Malmesbury Magisterial District (Table 1 & Figure 1). The proposed WEF will include up to 80 turbines along with access roads, underground cables, substations, maintenance facilities and overhead power lines to link into the national electricity grid. The total area under consideration is approximately 38.78 km^2. No alternative development options have been identified.

The study area comprises rolling hills used predominantly for agriculture or grazing. Patches of indigenous Renosterveld still occur on some of the steeper slopes and in rocky areas unsuited to agriculture.

This study included background research of existing literature, examination of historical aerial photography and a foot survey of selected areas to be impacted. It was not possible to search every turbine location due to the presence of wheat growing in the fields. Ground visibility was thus very low in places but better in grassed fields. Heritage finds were recorded photographically and GPS co-ordinates were taken as appropriate.

The background review revealed a rich agricultural history dating back to the very early days of the Cape Colony. The cultural landscape includes many tree lines which characterise the area. The area saw military action during the Anglo-Boer War in 1901 and during WWII an air force base operated from Darling. The modern heritage relates largely to the wild flowers that proliferate during the Spring months. The archaeology of the area is poorly known with virtually nothing recorded inland of the coast where Middle and Later Stone Age archaeological sites are well known. It is thought, however, that the Darling Hills would have been used for grazing by the local Khoekhoen.

No palaeontological material was located and none is expected to occur. Scattered archaeological stone artefacts of varying age were noted but only one site was discovered. It lies at turbine location 52 and consists of a scatter of stone artefacts accompanied by a few historical items which may or may not be associated. No other sites are known in the area and in heritage terms this one thus is of fairly high significance.

Three farm complexes are located within the study area. One (Rheboksfontein) has a house that may date back to the late 18th century, while all other buildings in the study area are mid-19th to 20th century. No direct impacts to the built environment will occur but indirect impacts through visual intrusion into their landscape setting will occur. Only Rheboksfontein is significant in this regard due to its age and specific placement in the natural landscape. It is noted that one building that is not old enough to receive NHRA protection will be reused for the WEF; this will not impact on heritage.

One grave, dated 1983, was found. It is not old enough to be covered by the NHRA.

The most significant impacts will be to the cultural landscape and sense of place of the area. These impacts are broad and not limited to the WEF footprint. Tree lines characterise the landscape and three are threatened by the proposed WEF. It is noted that they are, in a sense, dynamic resources with some lines having been removed over the years and others planted. However, there is continuity in their presence. The cultural landscape is one of agriculture and livestock grazing, of which the latter component likely stretches back into pre-colonial times. The wind turbines will introduce a significant visual intrusion to this environment that may require some mitigation.

While the proposed WEF is certainly going to impose significant impacts to the landscape, the need for renewable energy sources is recognised and it is suggested here that construction of the WEF may be able to proceed, but with certain conditions.

Subject to the approval of Heritage Western Cape, it is recommended that the proposed project be allowed to proceed but subject to the following conditions:

- Archaeological test excavations and subsequent mitigation must be carried out for site Rheboksfontein 1 alongside Turbine 52, unless this turbine can be shifted or omitted entirely;
- The VIA should determine the extent and significance of visual impacts to both the scenic qualities of the landscape and to specific places of concern, including the view westwards from the Rheboksfontein farm house and the hill over which the power line passes east of Grootberg. Aside from Turbine 52, the omission of other turbines that will result in significant visual impacts should be recommended as appropriate;
- Tree lines should be protected as far as possible, with particular importance being attached to the three highlighted above;
- During construction it should be ensured that no secondary impacts to heritage resources will occur as a result of large trucks and cranes accessing the project area; and
- A plan should be in place to decommission or re-use the WEF at the end of its lifetime. Under no circumstances can the turbines be allowed to fall into disrepair and become abandoned on site.

27 August 2010

Declaration of independence:

I, Jayson Orton, am an independent specialist consultant who is in no way connected with the proponent, other than in terms of the delivery of consulting services.

I hold a Masters degree and have been consulting since 2004 in the Northern, Eastern and Western Cape Provinces. I am an accredited Principal Investigator with the Association of Southern African Professional Archaeologists (ASAPA).

Contents

1. INTRODUCTION

ACO Associates was appointed by Savannah Environmental to undertake a Heritage Impact Assessment for the proposed Rheboksfontein Wind Energy Facility (WEF) on several farm portions in the Malmesbury Magisterial District (Table 1 & Figure 1). The proposed WEF will include up to 80 turbines along with access roads, underground cables, substations, maintenance facilities and an overhead power line to link into the national electricity grid. The total area under consideration is approximately 38.78 km^2. No alternative development options have been identified.

Table 1: Properties associated with the proposed WEF.

Farm names and portions included in WEF area	Area of property
Remainder of Rheboksfontein 568	1448.31 ha
Groot Berg 1199	845.12 ha
Portion 2 of Slangkop 552	88.25 ha
Remainder of Portion 1 of Platklip 551	816.97 ha
Remainder of Bonteberg 571	177.16 ha
Remainder of Nieuwe Plaats 567	445.08 ha
Portion 1 of Doornfontein 574	56.66 ha

An earlier scoping assessment was conducted by Webley and Hart (2010). They recommended a field survey during the EIA phase to locate any archaeological resources that may be present as well as to document the three farm complexes present within the study area. The current report aims to fulfil these recommendations and assess the significance of impacts to these and all heritage resources located.

Note that the routings of roads and power line were not finalised at the time of the field assessment and only a comment on the proposed route is made in this report based on aerial photography and knowledge gained during the survey. The co-ordinates of all turbine and substations positions were provided and used to guide the fieldwork component.

2. HERITAGE LEGISLATION

The National Heritage Resources Act (NHRA) No. 25 of 1999 protects a variety of heritage resources including palaeontological, prehistoric and historical material (including ruins) more than 100 years old (Section 35), human remains older than 60 years and situated outside a formal cemetery administered by a local authority (Section 36) and non-ruined structures older than 60 years (Section 34). Landscapes with cultural significance are also protected under the definition of the National Estate (Section 3 (3.2d)).

Since the project is being conducted as part of an Environmental Impact Assessment, Heritage Western Cape (HWC) is required to provide comment on the proposed development in order to facilitate final decision making by the Department of Environmental Affairs.

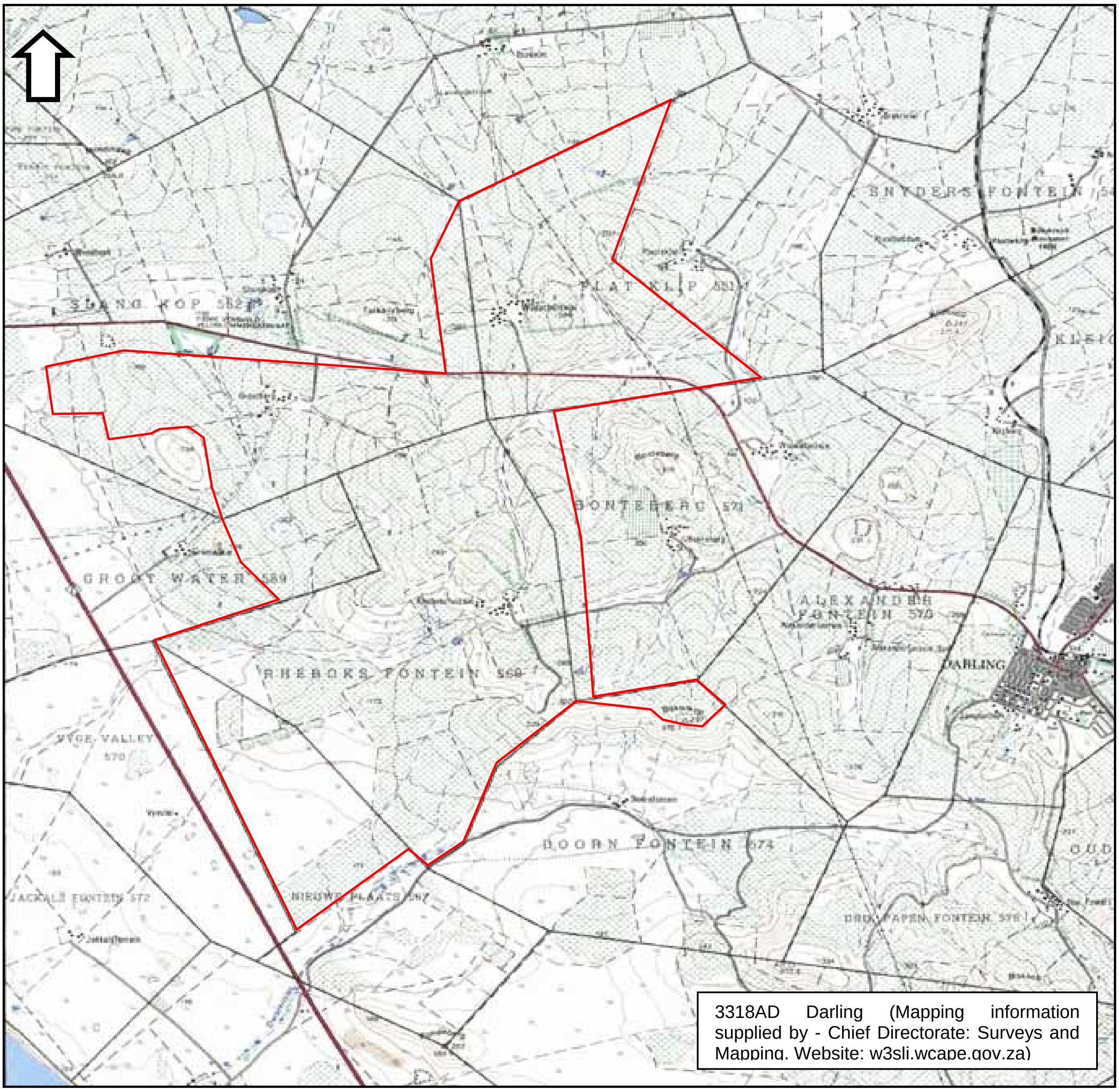

Figure 1: Map showing the location of the study area. The town of Darling lies to the east while the R27 road cuts through the south-western corner of the map.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

The site is very large and covers parts of several farms in the Darling Hills to the west of the small town of Darling. The area is underlain by granite which forms many undulating hills – the only significant topography for many kilometres in any direction. Above the granite basement one finds Malmesbury shales, while the surrounding flat lands towards the coast are overlain by recent wind-blown sediments. The site lies between 4 km and 13 km from the coast.

The majority of the land is currently farmed, being used either for agriculture or grazing. Significant patches of indigenous Renosterveld are still present though, most often in areas where ploughing is not feasible. Trees are rare in the landscape and are primarily associated with rocky areas or farm complexes. In the former instance they are indigenous while in the latter all are exotic and related to the agricultural landscape. Lines of gum trees are particularly evident in the region, although many have been cut down in recent years, particularly alongside fields where vineyards have been introduced. A few small stream channels cross the area and occasional small, natural pans are also to be found. Figures 2 to 12 show a selection of views that characterise the receiving environment.

Figure 2: View towards the northwest across the north-western portion of the study area. The existing turbines at the Darling National Demonstration Wind Farm can be seen on the right, while Langebaan Lagoon and the Churchhaven Peninsula are just visible behind them.

Figure 3: View westwards from the western part of the site showing the proximity to the ocean.

Figure 4: View south from the very centre of the study area with a patch of Renosterveld in the middle ground.

4. METHODS

Background research was conducted in order to establish precisely what heritage was already on record in the vicinity. This included a deeds office search of local farms and extensive reading and research in books and on the internet. We also sourced historical aerial photography.

Figure 5: An example of the intensely transformed landscape in the study area.

Figure 6: View east of Rheboksfontein farm complex with Renosterveld in middle ground.

Figure 7: View towards the north through the centre of the study area showing the general transformation of the landscape and its typical gently rolling topography.

Figure 8: View east in the centre of the study area showing agricultural land with a Renosterveld-clad hilltop in the background.

Figure 9: One of the many granite outcrops in the study area, this one near the western edge of the site.

An initial general ground survey was conducted on the 8th of July 2010 with four archaeologists. This enabled us to become familiar with the landscape and record any heritage that we located on site, regardless of whether it would be impacted or not. When final turbine positions became available these were loaded onto a hand-held GPS receiver and one archaeologist returned to the site on the 28th of July and the 12th of August to establish whether any direct impacts would be experienced at the relevant locations.

Figure 10: View towards the north east from a large granite outcrop in the south-western part of the study area. Planted and grassed fields are visible in the background.

Figure 11: A rare example of an indigenous tree in the study area.

Figure 12: A natural pan in the central part of the study area.

Figure 13: A river floodplain in the western part of the study area.

Figure 14: A natural drainage line runs between the hills.

Not all turbine locations were visited. Due to visibility issues there was little point in visiting those that were located in the middle of planted fields. Instead, the approach taken was one in which targeted searches of particular locations were made with a view towards maximising our understanding of the archaeological landscape and enhancing our chances of correctly assessing the impacts to archaeological resources. The knowledge so gained also aided in the desktop assessment of the power line routes.

Heritage resources are graded following the system established by Winter and Baumann (2005) in the guidelines for involving heritage practitioners in EIAs (Table 2). Their positions were recorded via a hand-held GPS receiver on the WGS84 datum and they were photographed.

Table 2: Grading of heritage resources (Source: Winter & Baumann 2005: Box 5).

Grade	Level of significance	Description
1	National	Of high intrinsic, associational and contextual heritage value within a national context, i.e. formally declared or potential Grade 1 heritage resources.
2	Provincial	Of high intrinsic, associational and contextual heritage value within a provincial context, i.e. formally declared or potential Grade 2 heritage resources.
3A	Local	Of high intrinsic, associational and contextual heritage value within a local context, i.e. formally declared or potential Grade 3A heritage resources.
3B	Local	Of moderate to high intrinsic, associational and contextual value within a local context, i.e. potential Grade 3B heritage resources.
3C	Local	Of medium to low intrinsic, associational or contextual heritage value within a national, provincial and local context, i.e. potential Grade 3C heritage resources.

4.1. Limitations

The archaeological aspect of the survey was hampered considerably by the variable state of the agricultural fields at the time of our visits. Most had been recently planted and were carpeted in young wheat plants that prevented ground visibility (Figures 7, 8 & 10). In such areas it was often not possible to visit the actual turbine location and, where possible, areas of ground near these turbines were looked at. Other areas, however, were grassed grazing lands and there ground visibility was better, but still far from ideal (Figures 5 & 10). Given our expectations with regards to archaeology, it seems unlikely that this lack of visibility will have serious negative implications on the overall conclusions of the impact assessment. Similarly, the failure to examine every turbine location is deemed insignificant.

5. HERITAGE CONTEXT

The site lies within a strongly transformed environment with a well established agricultural landscape (Figure 15). Agriculture is focused very heavily on wheat and dairy farming, but in recent years wheat fields have been replaced by vineyards in some areas. East of the Darling Hills the heavily farmed Swartland region extends towards the Cape Fold Belt Mountains. Since the late 1600s the area was well used as grazing land by the Dutch East India Company (VOC) and referred to as Groenekloof. It was on the original route from Cape Town to Namaqualand (Figure 16).

In 1700 the VOC gave land in Groenekloof to Henning Hiasing and in return he had to supply the company with meat for four years. In 1711 the area was investigated for further letting and soon afterwards many burghers were grazing their stock and planting wheat for their labourers in the area (Burden 2009). By the start of the 18th century some 29 farms were already occupied in the area (Darling Tourism, n.d.). Farmsteads dot the landscape among the hills. Many are likely late 19th century, but far older buildings are certainly present. The nearby town of Darling was only established in 1853 on a part of the farm Langfontein (Fransen, 2006). A more extensive background to the region has already been compiled by Webley & Hart (2010) during the scoping stage of this project.

Two little-known aspects of Darling's history are that the town saw action during the Anglo-Boer War in 1901 (Ihlenfeldt, 2009) and an air force base operated from the local airfield during World War II (McLean, 2009). Hildebrand, a Boer commander, was killed during conflict with the British on 12th November 1901. His body was initially hidden in a nearby porcupine burrow, then the following day it was wrapped in blankets and buried on the spot. A few months later he was disinterred and given a proper burial in a coffin. A white marble headstone was erected some time later and followed, in 1939/40, by the monument which includes the original headstone (Ihlenfeldt, 2009).

One of Darling's main attractions is now the carpet of Spring flowers that adorns the fields each year. This is an aspect of local heritage that is perhaps most tangible. Mature trees are generally only associated with the farms. Very occasional tree lines are present, but some have been cut down in the recent past.

Figure 15: Aerial photograph of the region showing the site (red polygon) located within the western part of the heavily transformed agricultural land of the Darling Hills and Swartland.

The archaeology of the area is not well known. The Darling Hills would undoubtedly have been used extensively by the Khoekhoen for grazing their stock and their settlements would likely have dotted the open landscape. Smith (1984) hypothesised that the Darling Hills would have formed part of the local Khoekhoe tribe's annual transhumance cycle. The local geology is not conducive to the formation of rock shelters and none are known. One does routinely come across stone artefacts of various ages in the wheat lands of the Cape and such finds would be expected here. The presence of Stone Age people in the general area is well documented by the excavations of both Middle (MSA) and Later Stone Age (LSA) archaeological sites at Yzerfontein, some 9 km to the southwest (Avery et al., 2008; Halkett et al., 2003; Klein et al., 2004; Orton, 2007, 2009).

Two surveys in the vicinity of the study area found no heritage resources (Halkett 2001; Hart 2008) but one by Orton (2010) showed scattered artefacts to be present. These may be more common on the aeolian sands and less so on the Malmesbury shale and granite areas.

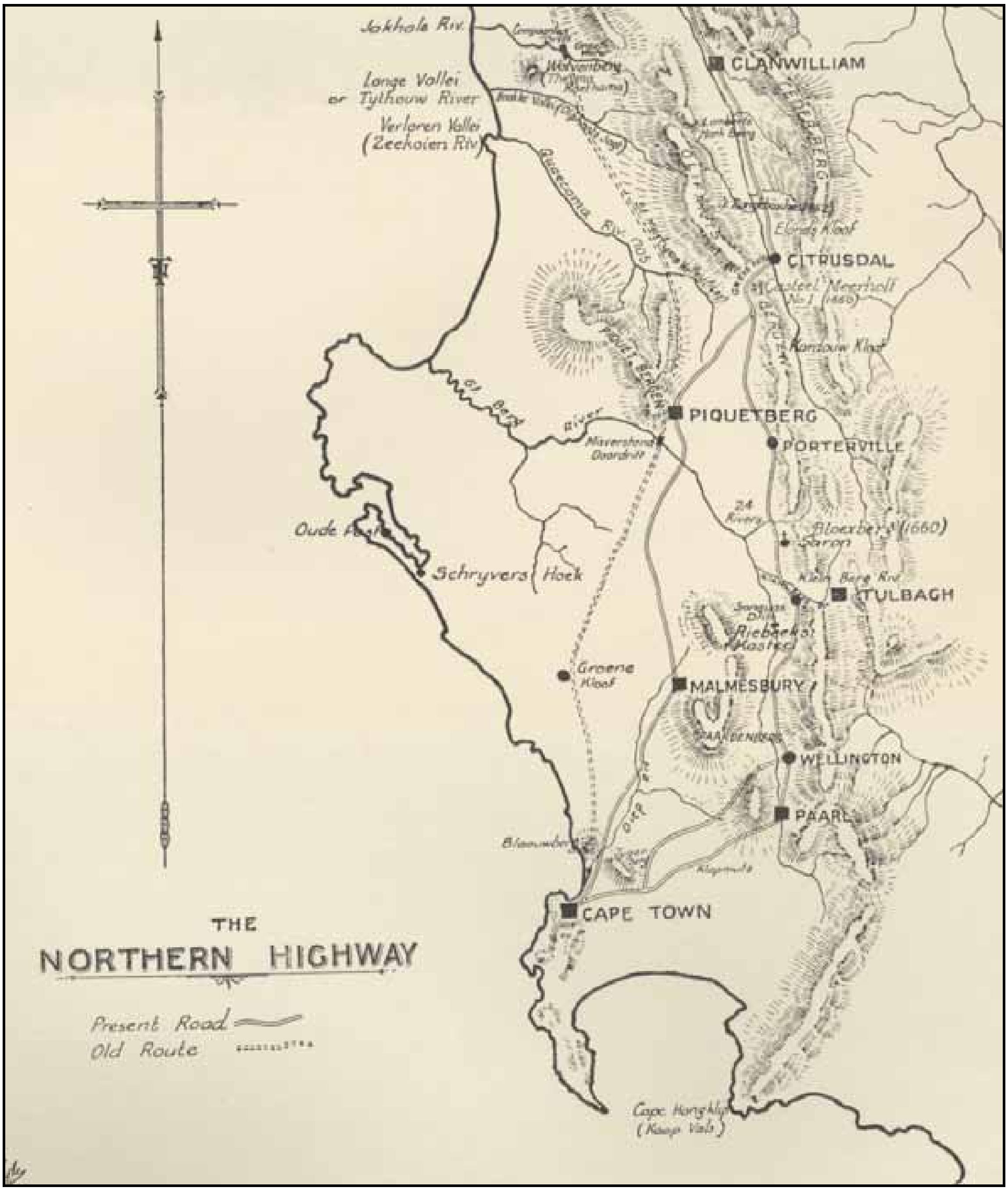

Figure 16: Extract from Mossop's (1927) map showing the main route to the north taken by early travellers. Groene Kloof is the first place marked north of Cape Town.

6. FINDINGS

6.1. Palaeontology

The Malmesbury shale is not known to contain fossils but there is a small potential for them to be present. Fossils are completely unknown from the Cape Granite Suite rocks that cover most of the study area, but in the low-lying areas to the west important fossils are known from the Cenozoic deposits (Almond & Pether, 2008). Most of the sand on the slopes below the granite hills in the study area, however, is windblown Holocene sand and unlikely to contain any significant fossil heritage.

6.2. Archaeology

Archaeological resources were found to be rare and widely scattered in the study area with only one concentration worthy of being called a site. Most surface finds were isolated artefacts relating to the Early (ESA) and Later Stone Ages (LSA) and these are of no significance at all. Beyond indicating the presence of Stone Age people in the landscape, nothing may be learned from these artefacts as they do not occur in informative contexts. The single site discovered, named Rheboksfontein 1, is described more fully below. Figure 17 shows the distribution of Stone Age archaeological resources in the study area, while Figure 18 to 22 show some examples of isolated artefacts. No ruins have been located.

Figure 17: Aerial view of the study area showing the location of all Stone Age artefacts found. The inset shows the vicinity around the Rheboksfontein 1 site. The red circle denotes the site, while all yellow circles are isolated occurrences.

Figure 18: An ESA radial core in silcrete.

Figure 19: A sandstone lower grindstone fragment found close to Rheboksfontein 1.

Figure 20: A quartz porphyry single platform core.

Figure 21: A silcrete retouched flake.

Figure 22: A quartz single platform core

6.2.1. Rheboksfontein 1

This site lies at S 33° 21' 51.8" E 18° 16' 53.4" on the crest of the ridge that overlooks the coastal plain (Figure 23). It is located around the eastern and north-eastern side of a small granite dome, but it is likely that much of the site has been ploughed (Figure 24 & 25). This does not reduce its significance much, however, since excavations can still reveal the full suite of artefacts present on the site, thus allowing a better characterisation of it. It should be noted that on average only some 2% to 5% of artefacts are exposed on the surface of ploughed land (Shott 1995 and references therein) which means that a site appearing insignificant on the surface may not actually be so. It has also been found that the exposed surface assemblage in a ploughed field will change with each successive ploughing episode such that the true character of a site may not be known without several visits (Shott 1995) or perhaps an excavation.

The position of the site allows spectacular views in most directions, perhaps important for game spotting, but it seems that the crucial feature of the site is the presence of a large hollow that catches rain water (Figure 26). At the time of recording, this hollow was more than 20 cm deep and some 4 to 5 m wide representing a considerable volume of water.

Interestingly there were both indigenous and colonial artefacts found on the site (Figure 27). Whether the two are actually related one cannot say. The colonial artefacts consisted of two fragments of Chinese coarse porcelain and part of the base of a wine bottle. Although this type of ceramic arrived in the first half of colonial occupation, one cannot rely on them to date their deposition at the site.

Figure 23: View towards the west showing the position of the Rheboksfontein 1 archaeological site on the ridge overlooking the coastal plain.

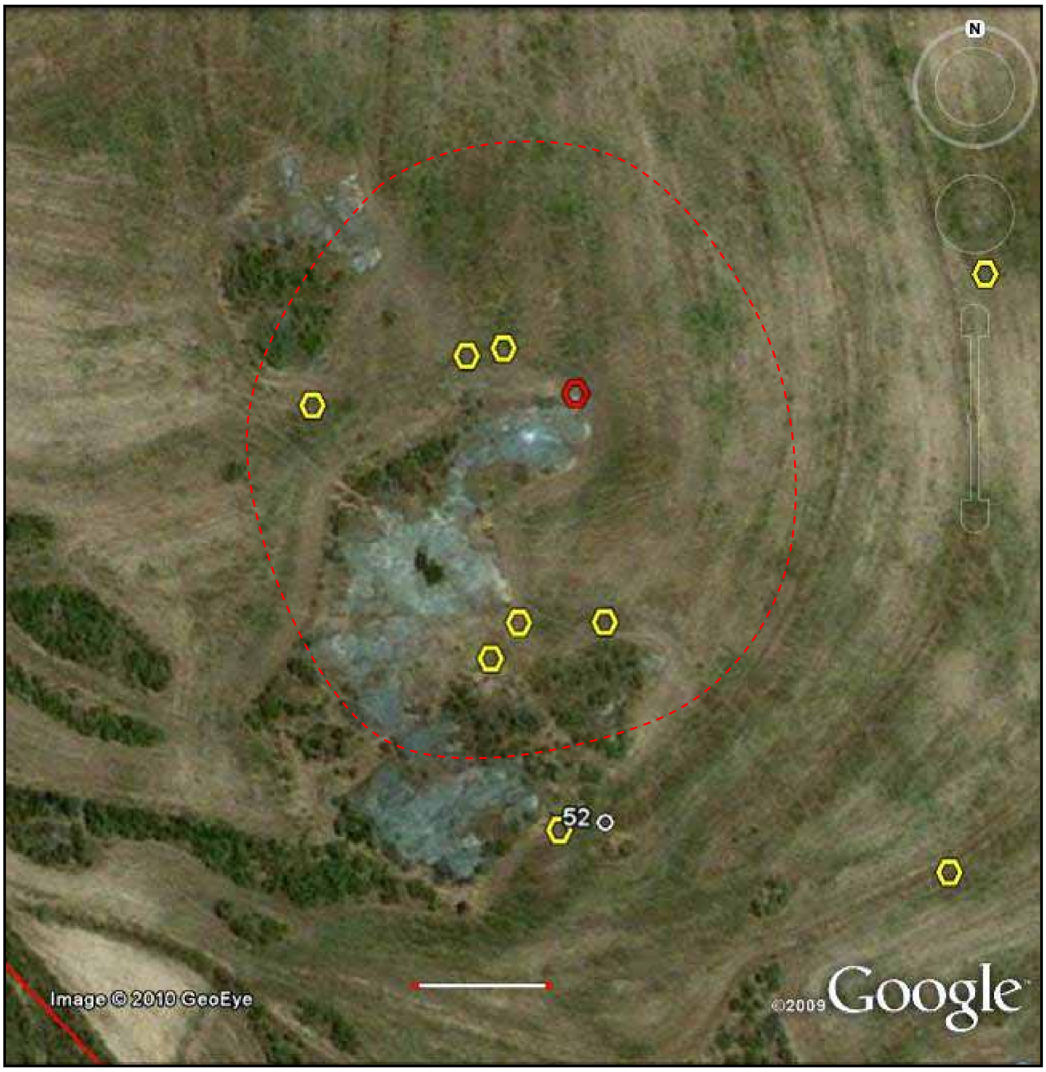

Figure 24: Aerial photograph of Rheboksfontein 1 showing the epicentre of the artefact scatter photographed in Figure 27 (red symbol), outlying artefacts (yellow symbols) and a suggested practical limit for the edges of the archaeological site (red dashed circle). The dark patch on the granite is the area of water. The white bar at the bottom is 25 m long. The white symbol numbered 52 is a proposed turbine position.

Figure 25: View of Rheboksfontein 1 looking towards the southwest. The highest concentration of artefacts was found in the centre of this view, near the bushes.

Figure 26: View towards the south from Rheboksfontein 1 showing the hollow filled with rain water.

Among the pre-colonial artefacts, cobbles and fragments of cobbles, whether utilised or not, were visually dominant. Such artefacts included unused manuports as well as a grooved lower grindstone, a faceted upper grindstone and a few hammer stones (Figure 28). Flaked artefacts were also present with quartz dominant, followed by quartzite and silcrete. Something that must have been collected from elsewhere as a curiosity is half a bifacial point of the sort commonly referred to as a Still Bay point (Figure 29). Such artefacts were generally made during a period of the MSA dating some 74 000 to 69 000 years ago (Jacobs *et al.* 2008). The Still Bay period is best documented at sites along the south coast of South Africa but several isolated occurrences have been recorded on the west coast between Cape Town and Namaqualand and this observation adds to those.

Although the artefacts and context themselves do not inherently warrant a provisional grading above 3C, the site should be graded 3B due its uniqueness. Contact period sites are generally very rare and no other archaeological sites have been recorded in the vicinity.

Figure 27: Artefacts found at Rheboksfontein 1. Scale bar in cm.

Figure 28: Ground artefacts from Rheboksfontein 1 (not to scale). Left: the grooved lower grindstone; Centre: a grindstone fragment displaying traces of red ochre; Right: a faceted upper grindstone.

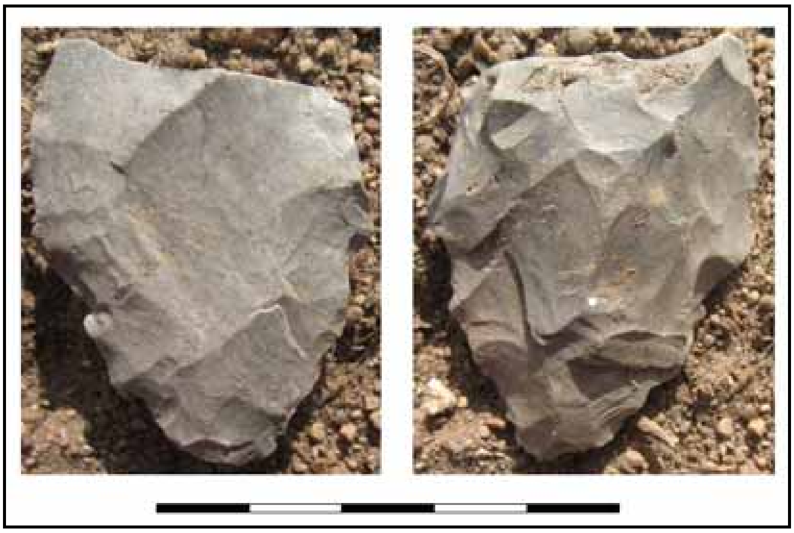

Figure 29: Close up views of both sides of the broken bifacial point from Rheboksfontein 1. Scale in cm.

Historical archaeological material was very sparse. Besides the artefacts found at Rheboksfontein 1, just three other historical ceramic fragments were noted. One lay in a field 1.4 km north of the Wildschutsvlei farm complex (Figure 30), while the other two were at a granite outcrop 1.4 km southwest of the Grootberg farm complex.

Figure 30: The plate fragment from Wildschutsvlei.

Figure 31: The two plate fragments from Grootberg.

6.3. Built environment

Several structures are present within the study area. Most are directly related to the three farm complexes, with few isolated buildings found. These complexes will be discussed in turn from north to south, but only briefly since none will be directly impacted by the proposed WEF. A buffer zone of 400 m between existing structures and the turbines has been established during the planning stage. All impacts would be indirect, relating to the context and sense of place in which the structures find themselves. Although historical aerial photography was consulted to ascertain the minimum ages of some structures, these photographs are only presented and discussed in Section 6.6 below.

6.3.1. Wildschutsvlei farm complex

This complex lies on the remainder of Portion 1 of Platklip 551 (Figure 32). The majority of its buildings are 20th century, with some certainly less than 60 years of age. One building, a large barn probably has its origins in the mid- to late 19th century, while the majority seem to be early 20th century.

Figure 32: View of the Wildschutsvlei farm complex, looking towards the south.

The barn has two adjoining sections and was built from clay bricks and mud. Fenestration varies and there appear to have been changes as shown by the fitting of a rectangular frame into an originally arched opening. If this had been a relieving arch then it would have been higher with the intervening space bricked up. It has been modified through the addition or changing of various openings such that its heritage significance is low. Figures 33 to 36 show this structure.

Figure 33: The east side of the barn.

Figure 34: The north end of the barn.

Figure 35: An external opening on the west side of the barn.

Figure 36: An opening inside the western half of the barn in the central wall.

The main farmhouse at Wildschutsvlei is entirely modern from the outside and if there is any old core to it then it would likely be beyond redemption. Various labourers cottages and one larger house dating to the early 20th century are present (Figures 37-41), along with sheds and a livestock dipping facility (Figures 42-45). While one cottage appears to have been built in a typical 1920s farm cottage style (possible grade 3C structure), other structures include decorative breeze blocks that were fashionable during the 1930s and 1940s. None of these other structures carries particular heritage significance and none are worthy of grading. Overall, the Wildschutsvlei farm complex is not seen as a highly significant heritage resource.

Figure 37: A labourers cottage with 1920s characteristics.

Figure 38: An early 20th century cottage.

Figure 39: An early 20th century cottage.

Figure 40: An early 20th century cottage/store.

Figure 41: House east of the main farm house that has had extensive modification.

Figure 42: A shed built with decorative Breeze blocks suggesting 1930s or 1940s.

Figure 43: An early 20th century outbuilding.

Figure 44: A shed built with decorative breeze blocks suggesting 1930s or 1940s. Its roof has been changed more recently.

Figure 45: A livestock dipping facility.

6.3.2. Grootberg farm complex

This complex lies on Grootberg 1199. Again the majority of buildings appear to date to the 20th century but there are some with likely late 19th century roots, particularly a large barn and some components of the dairy. The primary dwellings shows up on the 1938 aerial photograph but has been so extensively modified that its remaining core is probably beyond redemption. The barn may have originally been built to have a thatched roof but now has a corrugated asbestos roof (Figure 46). Spalling plaster inside the core structure revealed soft red clay bricks held together with the usual brown mud (Figure 47). This structure is of low heritage significance and, given the additions, it is probably not worth grading.

Figure 46: The large barn with its additions.

Figure 47: Clay bricks and mud in the core structure.

The dairy complex has a central core that may well date to the late 19th century (Figure 48). It has what seems to be a later addition to the north with far thinner walls (Figure 49). Both components share a gable style which is suggestive of the early 20th century so it seems likely that the core structure was modified at the time of the addition. Quite likely the core was a barn which was later converted into a dairy. Other additions also appear to have some antiquity with stone walls being present (Figure 50). This structure is of moderate heritage interest and might be provisionally graded 3C. One other structure in the main complex that has some antiquity is a large barn-type structure with a palm tree alongside it (Figure 51). With its modifications it retains little significance and does not merit grading.

Figure 48: The western face of the dairy complex.

Figure 49: The core of the dairy with its thick wall revealed in a Doorway and the northern addition with thinner walls.

Figure 50: An addition to the dairy displaying stone walls up to door-height.

Figure 51: Another structure with modern alterations.

Several workers' cottages lie to the southwest of the main complex. Although the styles differ, all appear consistent with an early to mid- 20th century age (Figures 52-54) and none appear on the 1938 aerial photograph. They are fairly typical of Western Cape farm labourers' cottages. Two other still extant cottages to the northwest of the complex (not photographed) are present in 1938. The entire farm complex as a whole is not seen as highly significant and has relatively little heritage value.

One other structure occurs on Grootberg. It lies about 900 m to the northwest of the farm complex, at the south-eastern corner of the Tienie Versveld Wild Flower Reserve. It was apparently a school at some point. The structure has metal windows and air vents and probably dates to somewhere around the 1940s or 1950s (Figure 55). It does not appear on the 1938 aerial photograph of the area. It has been suggested that the school building be used to house facilities associated with the WEF. It is currently in a state of disrepair and can be provisionally graded 3C.

Figure 52: Farm labourer's cottage.

Figure 53: Farm labourer's cottage.

Figure 54: Farm labourer's cottage.

Figure 55: The old school building.

6.3.3. Rheboksfontein farm complex

This complex lies on the remainder of Rheboksfontein 568 and includes several dwellings, a dairy and outbuildings with a labourers' village sited 250 m to the west (Figure 56).

Figure 56: The farm complex at Rheboksfontein as viewed from the northwest. The lowest buildings on the slope are the labourers' village.

The most significant building on the site is the primary residence on Rheboksfontein. The main house here appears to be quite old, originally dating perhaps to the 18^{th} century, but several additions and modifications have occurred over the years. It is a long house with interior passageway and is built across a slope with commanding views over the coastal plain to the west. At least one of the interior walls (that along the west side of the passage) is thicker at the base than it is at the top. The house was undoubtedly thatched originally, but the thatch has been removed and the current corrugated iron roof now overlaps the end gables (Figures 57 - 58). The side walls appear to have been raised at the same time with air vents into the solder having been installed (Figures 59 & 60). A solder door is present in the southern end-gable, but the staircase has been removed, probably when the wood became too rotten to be safe (Figure 59). The front porch has strongly Victorian characteristics (Figure 60), and, along with the ornate Victorian-type cast-iron air vents (Figure 61), this suggests that it was during the late 1800s that the bulk of the older modifications to the house were made. It is not possible to determine whether the original structure may have been lengthened to the current 40 m, but this does seem a possibility. A provisional grading of 3B may be assigned to this building, although without the more recent and sometimes very insensitive alterations it would have been a potential 3A.

A key feature of the Rheboksfontein house is its placement in the landscape. It lies at the head of a valley that offers commanding views out onto the coastal plain to the west. Its axis runs north-south across the slope and a small river valley bisects the slope to the north and south of it.

Figure 57: The northwest corner of the Rheboksfontein main house.

Figure 58: The eastern side of the Rheboksfontein main house.

Figure 59: The southern end-gable with the solder staircase missing.

Figure 60: The front, west-facing façade and porch with its curved corrugated iron roof.

Figure 61: One of the many identical air vents positioned just below the roof.

Another older structure occurring in the complex is the dairy (Figure 62). This structure lies just to the northeast of the main house. It likely dates to the early 20th century and has experienced substantial additions and modifications. It retains very little heritage value and does not merit grading. The dairy has recently been replaced by new structures to the north and the building now serves other purposes.

Associated with each of the above structures is a water tank. Both are circular with pitched corrugated iron roofs and hold little heritage value. That alongside the dairy can be seen in Figure 62. They are probably both of similar age to the dairy. East of the dairy is a cottage that likely has its roots in the late 19th century but has been heavily altered in recent years (Figure 63).

Figure 62: View of the western side of the dairy showing the extensive alterations.

Figure 63: View of the north side of the dairy complex with the associated cottage on the left.

To the southeast of the main house is a cottage that appears to be of early to mid- 20th century construction and seems in good condition, although its western entrance has been bricked up (Figure 64). It could be assigned a provisional grading of 3C. Just north of the main house is a row of labourers' cottages (Figure 65), while nine more cottages occur to the northwest in the small workers' village (Figure 56). All these cottages are likely more than 60 years old.

An interesting building style is represented by a ruined structure to the north of the farm house. It was originally of corrugated iron fastened to a wooden framework, but has had bricks built into the frame, perhaps for insulation (Figures 66 & 67). Being in ruin, it would need to be older than 100 years to be protected; this seems unlikely.

Another structure of heritage concern at Rheboksfontein is another corrugated iron building that pre-dates 1938. It is unknown whether this cottage is built using the same method as the ruin described above, but this does seem likely. It also has a small stoep and external chimney stack built on to it (Figure 68). Given its reasonable condition, it may be provisionally graded 3C.

Overall, one can consider the Rheboksfontein complex to be the most significant of the three described, since it has more protected buildings and also includes by far the oldest structure within the study area.

Figure 64: The cottage southeast of the main house.

Figure 65: A row of cottages north of the farm house

Figure 66: The corrugated iron structure with bricked in walls.

Figure 67: View of the inside of the ruined corrugated iron structure.

Figure 68: The west face of the corrugated iron cottage.

6.4. Graves

No farm graveyards are known to be present within the proposed WEF site. Just one grave was located during the survey and it lies on a hilltop on Wildschutsvlei at S 33° 19' 20.4" E 18° 19' 27.4". Provision for two graves has been made, but only one of them was used (Figures 69 – 71). Being less than 60 years old (Lionel Basson 24.6.1908 – 22.4.1983), this grave is not covered by the NHRA (see Section 36 (3b)). The grave originally had four trees and a small wire fence around it but one of the trees is no longer present and the fence is represented only by some of its poles.

Figure 69: The site of the Basson grave.

Figures 70 & 71: The grave and headstone.

6.5. Cultural landscapes and sense of place

The region's landscape is strongly dominated by agriculture with the vast majority of the ground area having been transformed into either wheat fields or grazing lands. The fertile granitic soils have long been used for grazing with colonial use of the area for this purpose extending back into the 17th century. In recent times vineyards have also been planted, usually replacing wheat fields. Modifications to the landscape almost exclusively revolve around agriculture and farm complexes. Several tree lines or clusters of large trees are present in the region, but with some having been chopped down in recent years. Some are very prominent on the 1938 aerial photographs of the area. Several significant gum tree lines are still present as described in Table 3. Others that have either already been destroyed or are not very significant are not listed here. One grove of poplar trees was also noted, but is seen as less significant than the lines.

Figure 72: Resprouting gum trees on Wildschutsvlei (No. 1 in Table 3).

Table 3: Treelines and groves.

No.	Location	Farm	Description
1	S 33°18'55.8" E 18°19'38.1"	Wildschutsvlei	A line of gum trees approximately 900 m long and running west-southwest to east-northeast. The western half of the line has been chopped down but has resprouted to some degree (Figure 72).
2	S 33°20'01.1" E 18°18'24.4"	Wildschutsvlei	A line of gum trees 570 m long and extending in a west-south-westerly direction from the farm complex (Figure 73). This line is in a visually prominent location on the crest of a hill. The line post-dates 1938.
3	S 33°21'44.8" E 18°18'50.0"	Rheboksfontein	A 480 m long line of very large gum trees runs north-south along the western side of a river valley some 500 m north of the farm complex (Figure 74). This line post-dates 1938.
4	33°22'42.57"S 18°17'43.02"E	Rheboksfontein	A grove of poplar trees about 30 m by 110 m in size and lying 1.8 km southwest of the farm complex. The 1938 aerial photograph reveals that a small house was present to the northwest of the grove in past times.

Figure 73: The prominent tree line west of Wildschutsvlei (No. 2 in Table 3).

Figure 74: The line of very large gum trees north of Rheboksfontein (No. 3 in Table 3). The tree line in Figure 73 can be seen in the distance.

Such tree lines define certain parts of the Western Cape Province where they are very prominent. This area is one of them, with the 26 km long avenue along the R304 leading to Mamre being particularly well known. Unfortunately with the advent of vineyards to the Darling Hills, many historic tree lines are being destroyed, thus damaging the character of the region.

Also of significance is the number of farm complexes that occur within relatively close proximity to the study area and proposed WEF (Figure 75). Some of these no doubt include old buildings of heritage significance whose context and sense of place would be degraded to varying degrees by the presence of the WEF, depending on the visibility of the turbines from each. Particularly notable among these is the T-shaped Doornfontein farm house to the south of the proposed WEF site. Fransen (2006) suggests that this house may date from well before 1838, when the farm was officially granted, although some of the external features of its façade date to about 1860. Other homesteads mentioned by Fransen (2006) include Slangkop, (northwest of the study area) dating to 1880 but with more recent modifications and Droevlei (to the north) dating to 1861 and with extensive modification. The house at Bonteberg is reportedly very old but this is subject to confirmation.

Figure 75: Aerial view of the region showing farm complexes (yellow icons) in close proximity to the study area. The town of Darling and the Anglo-Boer War Memorial (both with red icons) are also indicated. The white scale bar at the lower left corner of the study area represents 3 km.

A few other important heritage sites are located in the vicinity. The Hildebrand Monument (1902) lies some 4.2 km from the nearest proposed turbines. The monument was built in 1939 to commemorate the death of Field Cornet C.P. Hildebrand of the Boer Forces at that place. He was killed in action during the 1899 to 1902 Anglo-Boer War and his marble grave stone has been incorporated into the structure of the monument. Darling was the southernmost town reached by the Boer Forces during the war (Darling Tourism, n.d.). Although the WEF would be visible, the monument lies in well transformed agricultural lands far enough to the east that no significant alteration to the sense of place will occur (Figure 75).

Slightly further afield is Maclear's Swartland survey beacon on the farm Klip Valey 457. The beacon is a declared Provincial Heritage Site (1980) for its historical and architectural merits and is the western terminus of Sir Thomas Maclear’s Swartland survey baseline. It is a pyramid-shaped sandstone beacon and lies just more than 6 km northeast of the nearest proposed turbines. The beacon is currently surrounded by well transformed agricultural land and, although one would be able to see the WEF from it, it is far enough away that no significant impacts to its sense of place will be felt.

Owing to its fertile nature, much of the natural landscape has been transformed through agriculture as noted above. One area, however, has been preserved as the Tienie Versveld Wild Flower Reserve. This lies along the R315 (Yzerfontein Road) and abuts the northern edge of the Grootberg section of the study area (Figure 76). The reserve has scenic and tourism value and the transformation of the area through installation of wind turbines would negatively impact on one’s experiences there. Two turbines lie within 500 m of the reserve boundary.

Figure 76: View towards the south from the entrance of the Tienie Versveld Wild Flower Reserve along the R315. The left hand building in the background is the old school which might be reused as part of the WEF.

In a more general sense, the Darling Hills area as a whole can be considered a cultural landscape. Its uniqueness among the lowlands of the west coast presents a distinctive physical landscape, and, with its many springs and fertile grazing, one that has attracted farming since the very earliest days of the colony. Before this the Khoekhoe people would have grazed their livestock there too, as suggested by Smith’s (1984) likely route of Khoekhoe transhumance (Figure 77). The finding of a possible Khoekhoe archaeological site as described above may lend support to this notion. The uniqueness of the region is also significant from the point of view of scenic routes. Both the R27 (West Coast Road) and the R315 (Yzerfontein Road), running to the west and north of the study area respectively, can be considered scenic routes. While the turbines would be less prominent from the R27 (2 km distant and partly shielded by hills), the R315 runs right through the proposed WEF with the nearest turbine being just 500 m from the road. The cumulative impact of so many wind turbines in this region is significant and will result in a dramatic transformation of the cultural landscape. It is particularly pertinent to note that quite a large proportion of the high-lying Darling Hills is included in the proposed WEF area.

The concept of ‘sense of place’ as used above can be tricky to understand but it essentially includes all aspects of a place that make it special for any particular reason. Cornell and Malan (2008:2) suggest that “characteristic features, historical context, position in the landscape, tangible remains, associations, smells, views, aesthetic beauty, memories, plants (and) traditional uses” all play their part in creating a sense of place. An intrusion into the landscape of the size of the proposed WEF would greatly alter some of these characteristics for the places mentioned above. This aspect of the overall impact assessment also needs to be considered by the visual impact assessor.

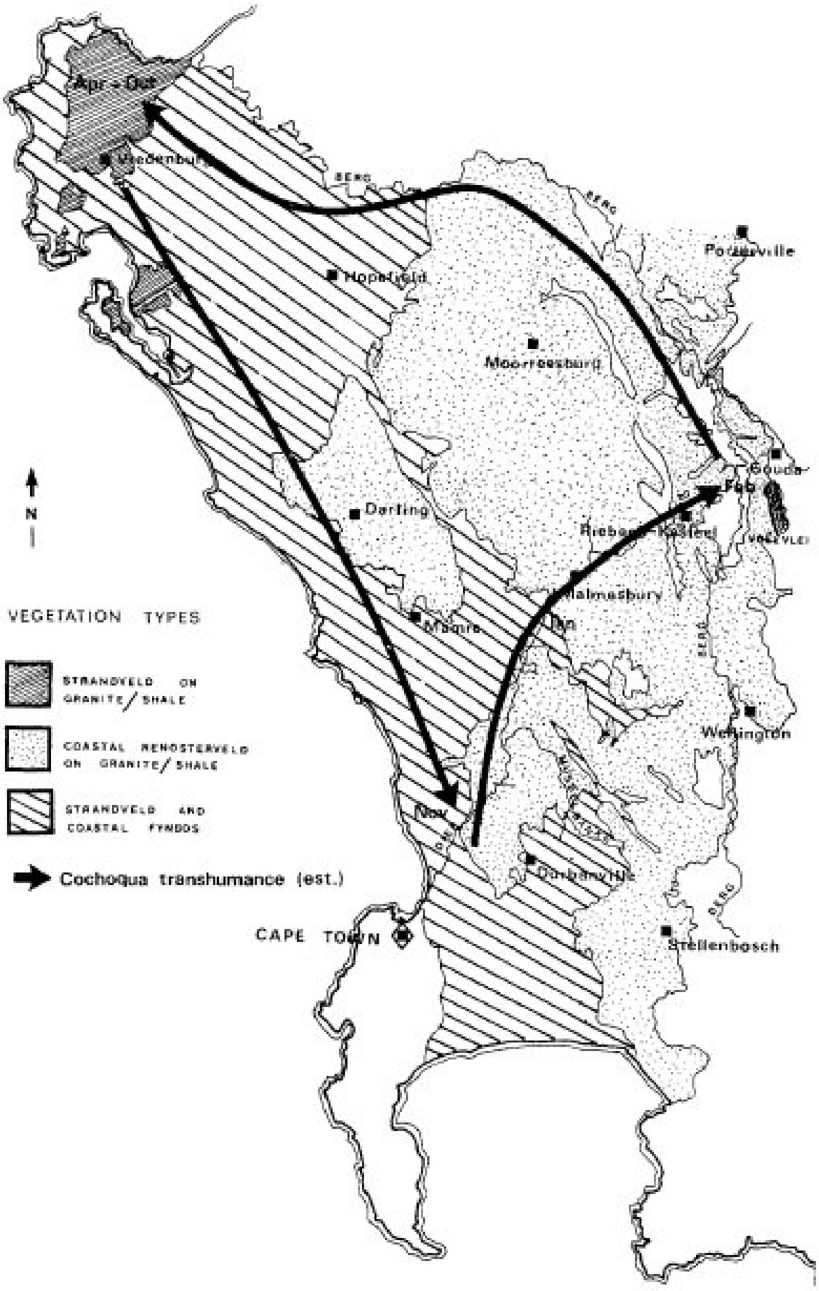

Figure 77: Estimation of the route of seasonal transhumance used by the south-western Cape Khoekhoen. The stippled area denotes Renosterveld on granite and shale substrates which was suggested to have been important for summer grazing (source: Smith 1984: fig. 1).

The only significant modern intrusion into this cultural landscape is the existing Darling National Demonstration Wind Farm which is currently proposed to be extended to a total of 20 turbines (EEU 2010; Orton 2010). A communications tower is also present within the study area but it presents a relatively minor intrusion.

A further factor to consider is that the existing four turbines at the Darling National Demonstration Wind Farm have for some years provided a curiosity for people driving the local roads. To some degree this can be regarded as a positive impact in terms of local scenic value. However, with a combined total of approximately 100 turbines in the vicinity, this value will most likely be eroded.

6.6. History

6.6.1. Survey diagrams and farm grants

While many loan farms were occupied already in the early 1700s, it was only in the early 19th century that they were formally granted to the farmers, primarily as Freehold farms. The farmers likely used the land as loan farms before then, but Quitrent and Freehold grants had to be registered by title deed, hence the need for an official survey. Survey diagrams of the farms in the area show that they were first surveyed in 1816 and granted as freehold land grants during the course of the following 22 years, although the earliest grant, Bonteberg, was made as a quitrent (Table 4). Note that subdivisions and consolidations through the years have altered the farm boundaries as shown on Figure 1 with some new farm numbers having been allocated in the area as a result.

Table 4: Historical information for the properties associated with the proposed WEF. Note that not all information could be readily traced through the survey diagrams. *This date could not be verified on a survey diagram but on the basis of the others it seems a safe assumption. **Names and numbers as recorded on the survey diagrams where available.

Current farm name and portion included in WEF area	Original farm name and number	Date of survey	Date of land grant	Granted to**	Cape Freehold / Quitrent number**
Remainder of Rheboksfontein 568	Rheboksfontein 568	1816	15.11.1837	J.F. Kirsten	C.Fr.4-72
Groot Berg 1199	Grootwater 569	1816*	18.10.1838	F.A. Sadie	
Groot Berg 1199	Slangkop 552	1816	01.03.1838	Henry Crowcher	C.F.5.6
Portion 2 of Slangkop 552	Slangkop 552	1816	01.03.1838	Henry Crowcher	C.F.5.6
Remainder of Portion 1 of Platklip 551	Platklip 551	1816	15.08.1839		C.Fr.6-11
Remainder of Bonteberg 571	Bonteberg 571	1816	06.11.1822		C.Q.3-37
Remainder of Nieuwe Plaats 567	Nieuwe Plaats 567	1816	25.09.1838	Jan Fictor Ehlers	C.F.5.13
Portion 1 of Doornfontein 574	Doornfontein 574	1816	18.10.1838	Jacob van Renen, F. son	C.F.5.14

While the history of the place will obviously remain unchanged, it is significant that this history is integrally tied to grazing and agriculture throughout its development. Although this did change to some degree with the installation of the current turbines at the Darling National Demonstration Wind Farm, the scale of the currently proposed development will result in a change in the trajectory of local history.

6.6.2. Aerial photos

Historical aerial photography from the 1938 run (Job 126) was sourced and consulted to determine the ages of buildings and also to what degree the farm complexes have been altered. Unfortunately the aerial photography dating to 1944 and 1953 did not cover this area. Generally one finds that all buildings extant at that time are still present today, but that many additional buildings have been constructed. The character of the complexes has been altered through the addition of modern structures and alterations to old buildings have, in some cases, rendered them worthless from a heritage viewpoint. Also clear from the photographs is how extensive the agricultural activity already was at that stage. This is strong testimony to the long tradition of agriculture stretching back to the earliest days of the colony.

At Wildschutsvlei we find that an extensive windbreak was planted around the complex and that these trees are almost non-existent today (Figure 78). The werf was far sparser with the current configuration appearing quite cluttered in comparison. However, it is notable that many of the labourers' cottages were already present in 1938. We also see that the beautiful tree line currently lying to the west of the complex was not present in 1938, but that it replaced another one that lay just to the north. Other tree lines have been removed, while some new ones have been planted.

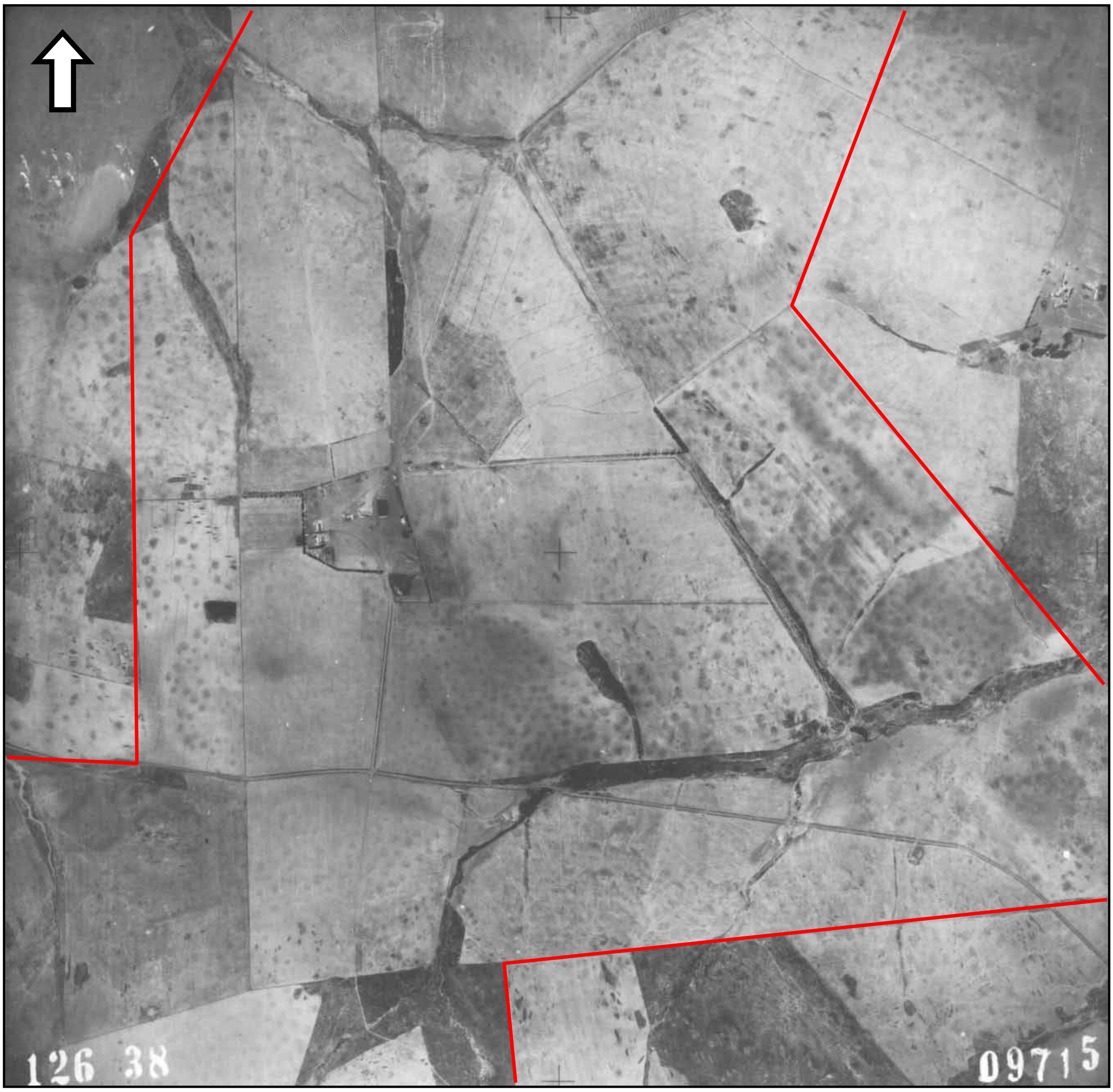

Figure 78: 1938 aerial photograph of the Wildschutsvlei area with the proposed WEF boundaries superimposed in red. The farm complex is visible in the centre. Source: Chief Directorate Surveys and Mapping.

The Grootberg farm complex also had far fewer structures in earlier years and was very open and simply laid out (Figure 79). It seems to have had fewer additional buildings added than Wilschutsvlei. Interestingly, just two workers' cottages are present, with the majority thus having been added post-1938. The complex was practically devoid of trees with much of the current vegetation having been planted in recent years to surround one of the modern houses. Little remains of a prominent rectangular gum tree plantation that was located at the southern edge of the complex.

Figure 79: 1938 aerial photograph of the Grootberg area with the proposed WEF boundaries superimposed in red. The farm complex is visible near the upper right hand corner. Source: Chief Directorate Surveys and Mapping.

The Rheboksfontein farm complex was perhaps the most well established of the three in 1938 (Figure 80-81). Many structures were present back then, but sadly a number of the more significant ones have had extensive modern alteration. Curiously, the very insensitive addition to the northwest corner of the main house had a precedent, since the photograph shows that an addition was already present more than 70 years ago. It is interesting to note that extensive tree lines extend both to the northwest and southeast from the complex. Both of these have been chopped down and the southern one planted over. The northern one, however, still has stumps in the ground that are resprouting. The largest and most impressive tree line present today did not exist in 1938, this being the one running along the stream north of the farm complex.

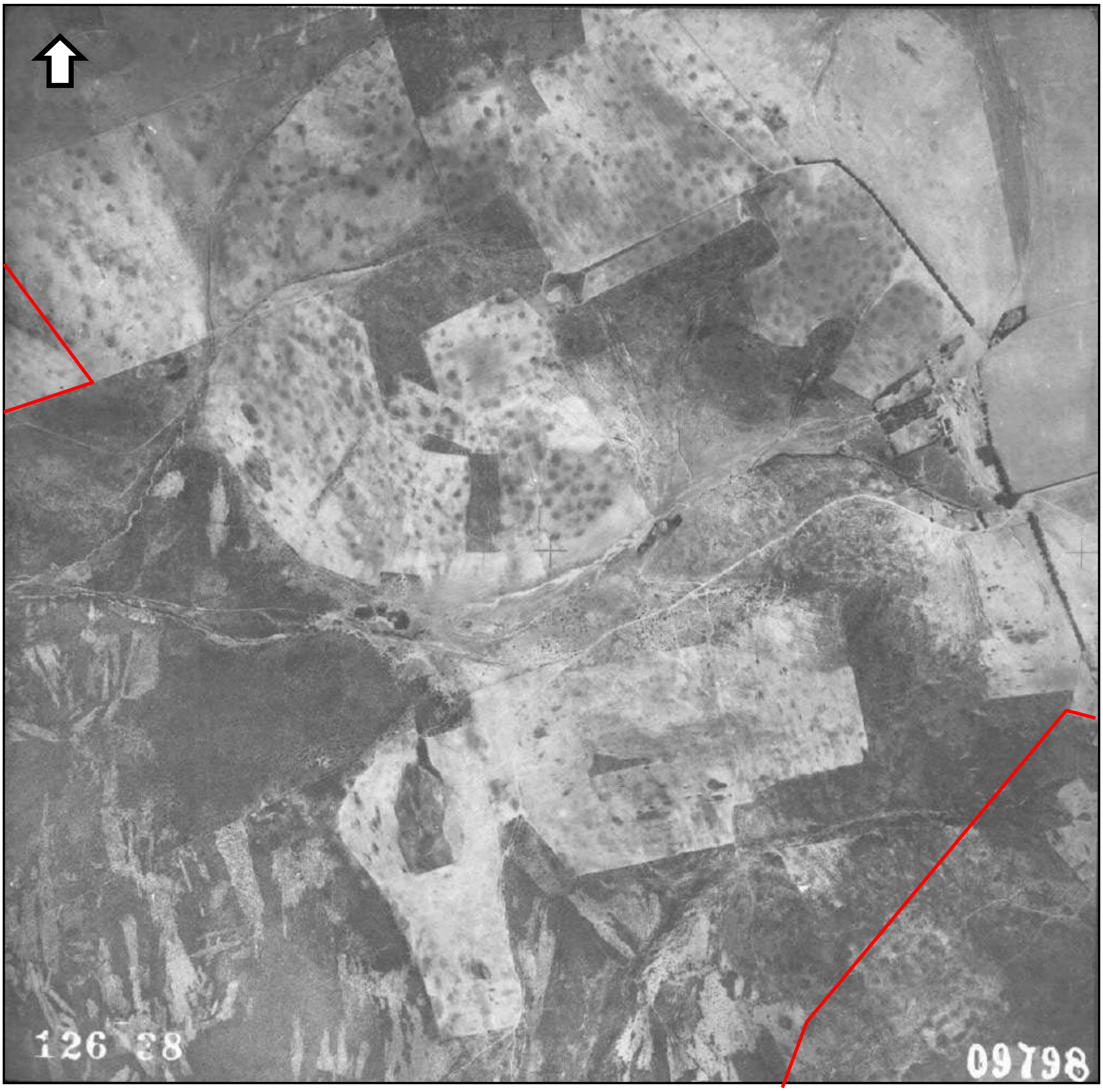

Figure 80: 1938 aerial photograph of the Rheboksfontein area with the proposed WEF boundaries superimposed in red. The farm complex is visible near the upper right hand edge and is enlarged in Figure 81. Source: Chief Directorate Surveys and Mapping.

7. ASSESSMENT OF IMPACTS

This WEF is located in a sensitive location primarily due to its scenic importance. The scale of the project may be larger than the local topography and cultural landscape are able to absorb and some turbines may need to be eliminated from the final product. A VIA is certainly required (and is being undertaken within a separate specialist study), and this will provide key results to inform the decision-making process.

Figure 81: Enlargement of the Rheboksfontein farm complex. Source: Chief Directorate Surveys and Mapping.

Although field assessment of the proposed power line that links into the electricity grid was not undertaken, this line is mapped in Figure 82. It is noted that it does not pass by any homesteads on its 2 km stretch between the edge of the WEF area and the existing power line servitude to the southeast. It does, however, pass within 100 m of the edge of the Wildschutsvlei farm complex which was rated as having low overall heritage significance. One potential concern to be addressed by the VIA is the fact that to the east of the Grootberg complex the power line runs over the crest of a hill and would be visually very prominent. Shifting of this section may be required to soften the visual impacts from the R315 road and the Tienie Versveld Wild Flower Reserve.

The density of archaeological material on the landscape suggests that significant archaeological impacts are highly unlikely to occur. However, when pylon placements are available they should be examined on current aerial photography to identify any potentially sensitive areas that may require field proofing.

Specific concerns over the various categories of heritage discussed by this HIA are addressed below as appropriate and threatened heritage resources pertaining to the WEF project area are mapped in Figure 82. It should be noted, however, that visual impacts to more distant heritage resources are possible through implementation of the proposed project.

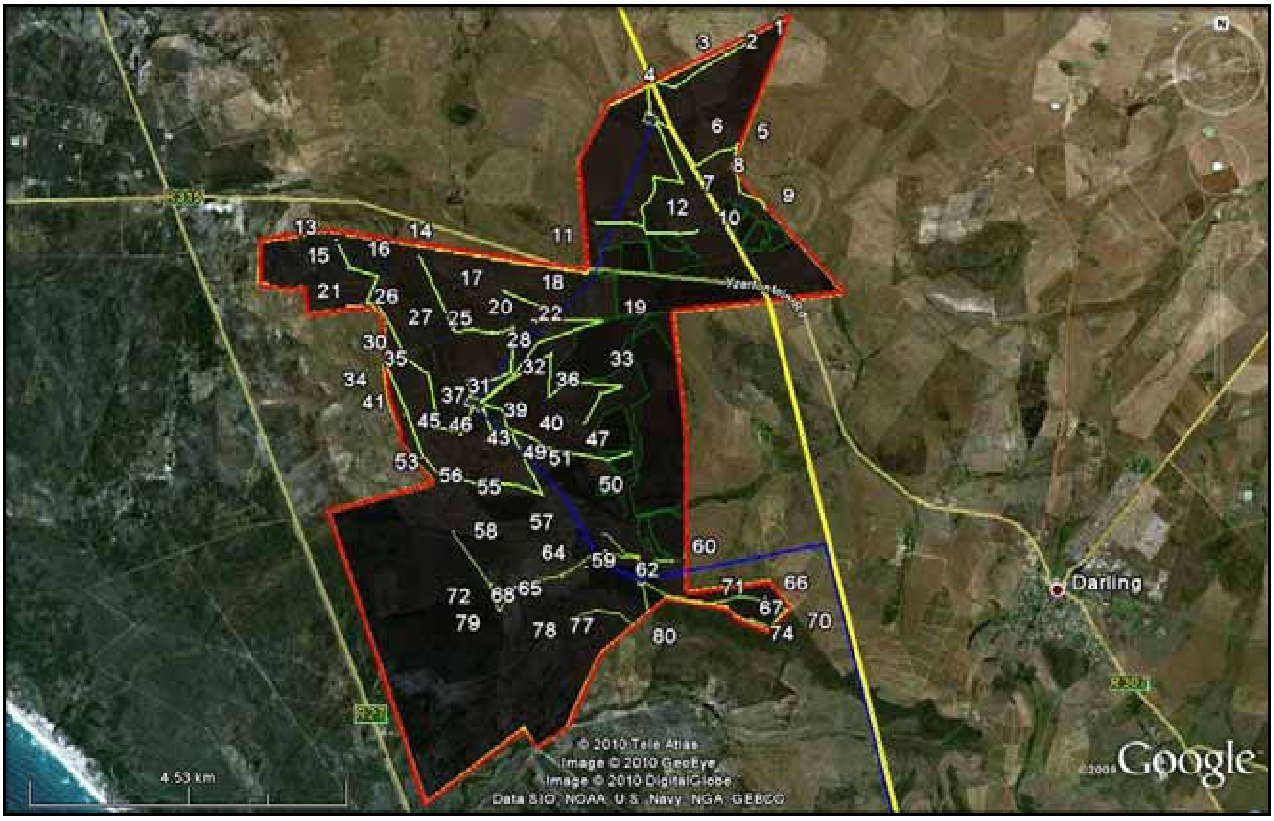

Figure 82: Aerial view of the proposed WEF area showing the overhead power line in dark blue. The yellow line running north-south is an existing power line whose course would be followed up to the Dassenburg substation.

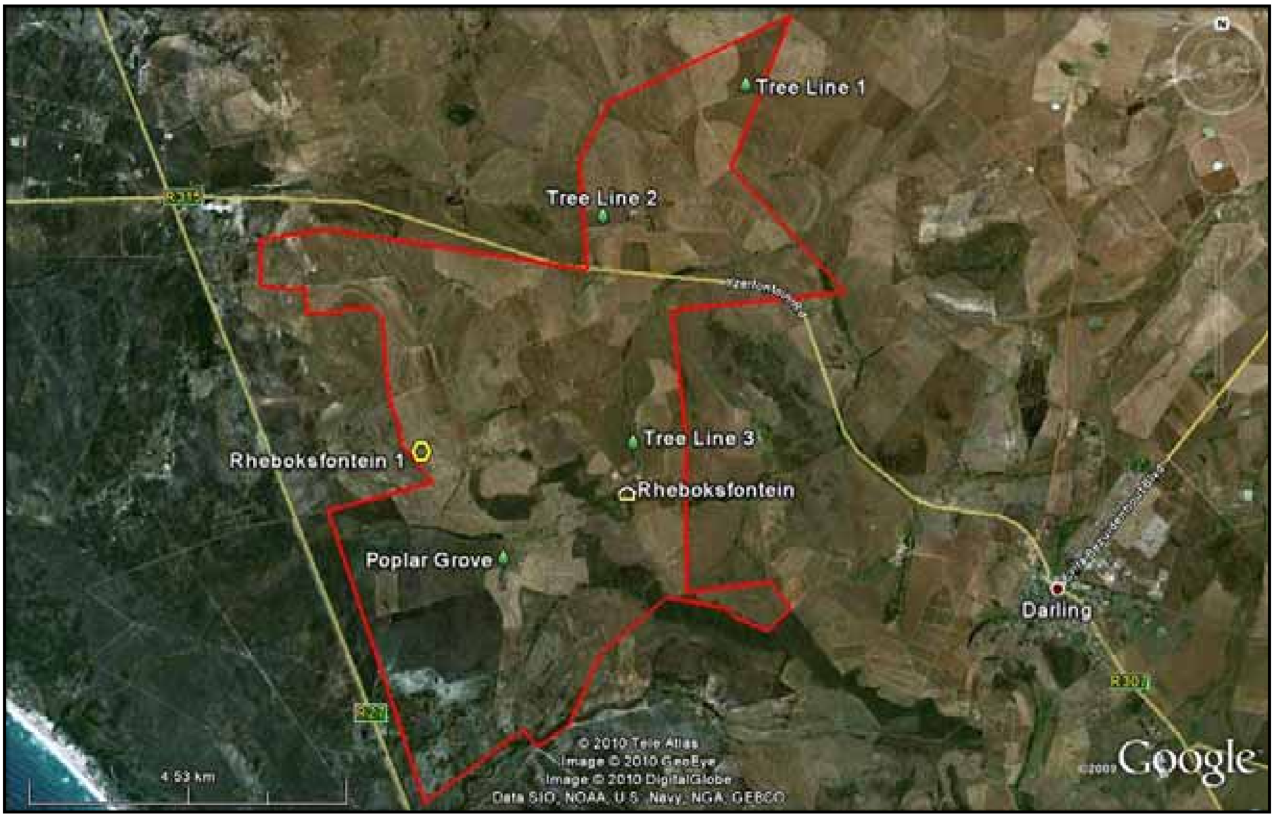

Figure 82: Specific heritage resources potentially under threat from the proposed WEF.

7.1. Palaeontology

No fossils are likely to be intersected by the proposed development and, following Almond and Pether (2008), no palaeontological impact assessment is considered necessary. Palaeontological impacts are summarised in Table 5.

Table 5: Summary of impacts to palaeontological material

NATURE OF IMPACT: Impacts to palaeontological material could involve displacement or destruction of material at turbine locations and in the paths of power lines and access roads.		
	Without mitigation	With mitigation
EXTENT	Local (1)	n/a
DURATION	Long term (4)	n/a
MAGINITUDE	Small (2)	n/a
PROBABILITY	Very improbable (1)	n/a
SIGNIFICANCE	Low (7)	n/a
STATUS	Neutral	n/a
REVERSIBILITY	Non-reversible	n/a
IRREPLACEABLE LOSS OF RESOURCES?	No	n/a
CAN IMPACTS BE MITIGATED?	No	n/a
MITIGATION: No palaeontological resources were located or are known from the vicinity. As such, no mitigation can be suggested or implemented.		
CUMULATIVE IMPACTS: n/a		
RESIDUAL IMPACTS: n/a		

7.2. Archaeology

One significant archaeological site was encountered at turbine location 52, along the western edge of the study area. The site has the potential to provide data that would improve our understanding of the pre-colonial history of the area and, since it is directly threatened, it requires mitigation. This could be easily accomplished through either moving the turbine and associated infrastructure or mapping the site and sampling the soil around the granite outcrop to obtain a suitably representative sample of the kinds of artefacts present on the site. Most artefacts are likely to be buried, hence the need for subsurface excavation. Although the core of the site appears to be just north of the proposed turbine location, the site has become somewhat dispersed by ploughing with the result that artefacts are spread quite widely. The required access road and subsurface power lines would certainly have a detrimental effect on the site. The possibility of intact archaeological deposits occurring beneath the plough zone cannot be excluded and this would need to be established during mitigation. If intact deposits are located then the mitigation may need to be expanded. As such, a test excavation would seem appropriate in order to enable planning of full mitigation. Owing to the dispersed nature of the material, it seems likely that excavation will be more appropriate than moving the turbine position, unless this turbine is omitted entirely. The recommended buffer of 500 m from heritage sites (CNdV Africa 2006) is not necessary here with an activity exclusion buffer of perhaps 100 m from the GPS location being more appropriate. Archaeological impacts are summarised in Table 6.

Table 6: Summary of impacts to archaeological material

NATURE OF IMPACT: Impacts to archaeological material could involve displacement or destruction of material at turbine locations and in the paths of power lines and access roads.		
	Without mitigation	With mitigation
EXTENT	Local (3)	Local (1)
DURATION	Permanent (5)	Permanent (5)
MAGINITUDE	High (8)	Minor (2)
PROBABILITY	Highly probable (4)	Very improbable (1)
SIGNIFICANCE	High (64)	Low (8)
STATUS	Negative	Positive
REVERSIBILITY	Non-reversible	Non-reversible
IRREPLACEABLE LOSS OF RESOURCES?	Yes	No
CAN IMPACTS BE MITIGATED?	No	Yes
MITIGATION: Only one archaeological site was located (at Turbine 52). Mitigation could involve either avoiding the site or conducting archaeological excavations.		
CUMULATIVE IMPACTS: No other archaeological sites are known from the area and if the density is as low as it appears then the loss of one site could be quite a significant proportion of the local archaeological heritage.		
RESIDUAL IMPACTS: n/a		

7.3. Built environment

The Rheboksfontein farm house is the most significant structure within the proposed WEF area, and is the only one to receive a provisional grading higher than 3C. A slightly larger buffer should be considered around this house in order to protect its landscape context and sense of place, and particularly the view westwards from the house itself. The buffer around the actual house should be at least 500 m as recommended by CNdV Africa (2006). An appropriate buffer should be determined through the VIA. For the other complexes which have far less heritage value the proposed buffer of 400 m is suitable.

No built structures will be directly impacted by the proposed wind turbines, but it is proposed that one mid-20th century structure be reused during the development. Impacts to the built environment are summarised in Table 7.

7.4. Graves

Just one grave was found. It is too young to be covered by the NHRA but it is noted that the nearest proposed turbine positions are approximately 120 m and 200 m distant. It would be prudent to cordon off the area so as to protect the grave from any harm during construction of the WEF.

7.5. Cultural landscapes and sense of place

Impacts to the cultural landscape and sense of place will be significant. These impacts are of two main types. The first type is visual impacts which should be assessed as part of the visual impact assessment. Aspects to consider include proximity to and visibility from scenic routes of the turbines, proximity to and visibility from significant homesteads, particularly Rheboksfontein and the degree to which the overall vicinity of the Darling Hills landscape will be altered. The proposed WEF occupies a prominent and quite large part of the Darling Hills. The second aspect to consider here is the loss of tree lines from the area. This will depend on how extensively the proponents would want to clear the landscape of potential obstructions in terms of maximising the consistency of wind flow. Three gum tree lines are of concern, while a poplar grove is less significant. The analysis of historical aerial photography has shown that these tree lines are dynamic, with some being removed and new ones being planted. As such this report finds that all mature tree lines, even those that are younger than 60 years of age, should be considered an integral part of the cultural landscape. Impacts to the cultural landscape are summarised in Table 9.

Table 7: Summary of impacts to the built environment

NATURE OF IMPACT: Impacts to the built environment are in the form of erosion of context through visual impacts (the latter will be expanded upon in the VIA). No direct impacts to built environment items will occur.		
	Without mitigation	With mitigation
EXTENT	Local (2)	Local (1)
DURATION	Long term (4)	Long term (4)
MAGINITUDE	Low (4)	Minor (2)
PROBABILITY	Definite (5)	Highly probably (4)
SIGNIFICANCE	Medium (50)	Low (28)
STATUS	Negative	Negative
REVERSIBILITY	Reversible	Reversible
IRREPLACEABLE LOSS OF RESOURCES?	No	No
CAN IMPACTS BE MITIGATED?	No	Yes
MITIGATION: Only the Rheboksfontein farmhouse is regarded as having the potential to be impacted significantly. Mitigation could involve shifting turbine positions to avoid obstructing the open space extending westwards from the house.		
CUMULATIVE IMPACTS: An increase in the loss of context would be experienced through additional WEFs in the area.		
RESIDUAL IMPACTS: n/a		

Table 8: Summary of impacts to cultural landscapes and sense of place

NATURE OF IMPACT: Impacts will be through visual intrusion into the landscape which results in erosion of landscape context and decreasing quality of sense of place.		
	Without mitigation	With mitigation
EXTENT	Local (4)	Local (3)
DURATION	Long term (4)	Long term (4)
MAGINITUDE	High (8)	Moderate (6)
PROBABILITY	Definite (5)	Definite (5)
SIGNIFICANCE	High (80)	High (65)
STATUS	Negative	Negative
REVERSIBILITY	Reversible	Reversible
IRREPLACEABLE LOSS OF RESOURCES?	No	No
CAN IMPACTS BE MITIGATED?	No	Yes
MITIGATION: Turbines and power lines can be shifted into visually unobtrusive locations to avoid excessive intrusion into the cultural landscape.		
CUMULATIVE IMPACTS: If other WEFs were constructed in the area then the erosion of context and sense of place would escalate.		
RESIDUAL IMPACTS: Will only occur if turbines and concrete footings are left standing after decommissioning and rehabilitation does not happen.		

7.6. History

The local history is centred on farming, both agriculture and livestock. The addition of wind turbines to the landscape will add a new land use to the traditional one, but this is not seen as a significant impact in heritage terms, since the tradition of farming in the area will continue unhindered.

8. CONCLUSION AND RECOMMENDATIONS

While the proposed WEF is certainly going to impose significant impacts to the landscape, the need for renewable energy sources is recognised and it is suggested here that construction of the WEF may be able to proceed, but with certain conditions.

As such, and subject to the approval and permit of Heritage Western Cape, it is recommended that the proposed project be allowed to proceed but subject to the following conditions:

- Archaeological test excavations and subsequent mitigation must be carried out for site Rheboksfontein 1 alongside Turbine 52, unless this turbine can be shifted or omitted entirely;
- The VIA should determine the extent and significance of visual impacts to both the scenic qualities of the landscape and to specific places of concern, including the view westwards from the Rheboksfontein farm house and the hill over which the power line passes east of Grootberg. Aside from Turbine 52, the omission of other turbines that will result in significant visual impacts should be recommended as appropriate;
- Tree lines should be protected as far as possible, with particular importance being attached to the three highlighted in this report;
- During construction it should be ensured that no secondary impacts to heritage resources will occur as a result of large trucks and cranes accessing the project area; and
- A plan should be in place to decommission or reuse the WEF at the end of its lifetime. Under no circumstances can the turbines be allowed to fall into disrepair and become abandoned on site.

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10. INVESTIGATION TEAM

Fieldwork:	J. Orton T. Hart L. Webley K. Bluff
Report:	J. Orton

SUPPLEMENTARY HERITAGE REPORT ASSESSING THE FINAL LAYOUT OF THE PROPOSED RHEBOKSFONTEIN WIND FARM, MALMESBURY MAGISTERIAL DISTRICT, WESTERN CAPE

(Assessment conducted under Section 38 (8) of the
National Heritage Resources Act (No. 25 of 1999) as part of an EIA)

Prepared for

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27 August 2010

08 June 2011

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EXECUTIVE SUMMARY

The UCT Archaeology Contracts Office was requested by Savannah Environmental to provide a supplementary assessment of the final turbine layout for the proposed Rheboksfontein Wind Energy Facility (WEF) to be located in the Darling Hills, west of the town of Darling. The layout was revised following input by the various specialists involved in the EIA and the EIA Report will be resubmitted to the DEA for further consideration.

The revised layout has resulted in some reduction in impacts to heritage but four main concerns still exist:

- Impacts to the one significant archaeological site are probably slightly increased and mitigation will certainly be required;
- Impacts to two significant tree lines will probably still occur (one will have a turbine sited immediately alongside it and another will be crossed by a power line). These tree lines should be retained undisturbed;
- Roads have been planned at 90° to the slopes in visually prominent locations and will result in visual scarring and fragmentation of the agricultural and natural landscape; and
- Overall visual impacts are highly unlikely to be effectively mitigated.

Overall, there may well be potential to construct a WEF in the proposed location but, owing to the nature of the topography and the very low absorption capacity, impacts of high to very high heritage significance will definitely occur. These are primarily visual in nature and related to residents, tourists and the local scenic routes. The site is within a visually prominent landscape and stands in stark contrast to some of the far more remote, and hence more appropriate, locations that have been proposed for similar facilities in recent years. Careful planning and decision-making will be required if the proposed WEF is to be constructed and operated with an acceptable level of impact in an area that, from a heritage perspective, is generally unsuited to the type of development proposed.

Contents

1. INTRODUCTION

The UCT Archaeology Contracts Office was requested by Savannah Environmental to provide a supplementary assessment of the final turbine layout for the proposed Rheboksfontein Wind Energy Facility (WEF) to be located in the Darling Hills, west of the town of Darling (Figure 1). The Department of Environmental Affairs (DEA) rejected the final Environmental Impact Assessment Report (EIAR) due to its failure to assess a final layout which had responded to the specialist studies' identification of sensitive areas. The EIAR is to be resubmitted with this information included and the present report thus assesses the impacts to heritage based on this final layout (Figure 2). It also serves to integrate the conclusions of the initial Heritage Impact Assessment (Orton 2010) and the Visual Impact Asesment (Du Plessis 2010, 2011). The present report should therefore be read in conjunction with the other reports.

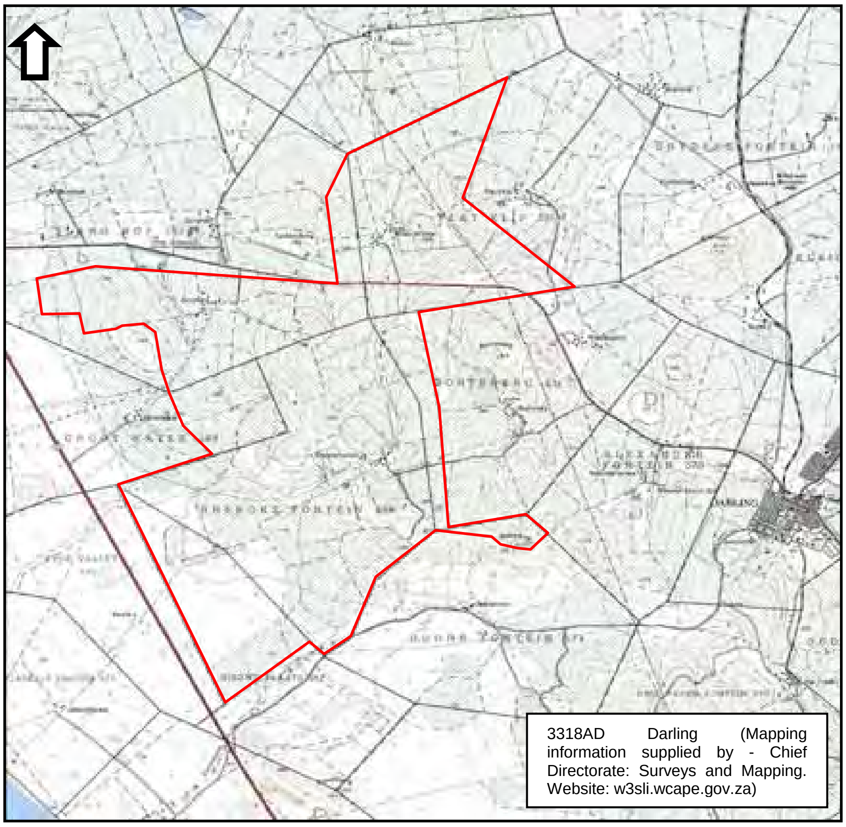

Figure 1: Map showing the location of the total area under consideration for the proposed Rheboksfontein WEF. The R27 road runs along the west side of the map and the town of Darling lies in the east.

2. METHODS

This supplementary report has been compiled with no further fieldwork and is based on earlier observations from the EIA Phase fieldwork and the final proposed turbine layout as indicated in Figure 2. Note that the footprint areas at each turbine are considered as being 40 m by 40 m.

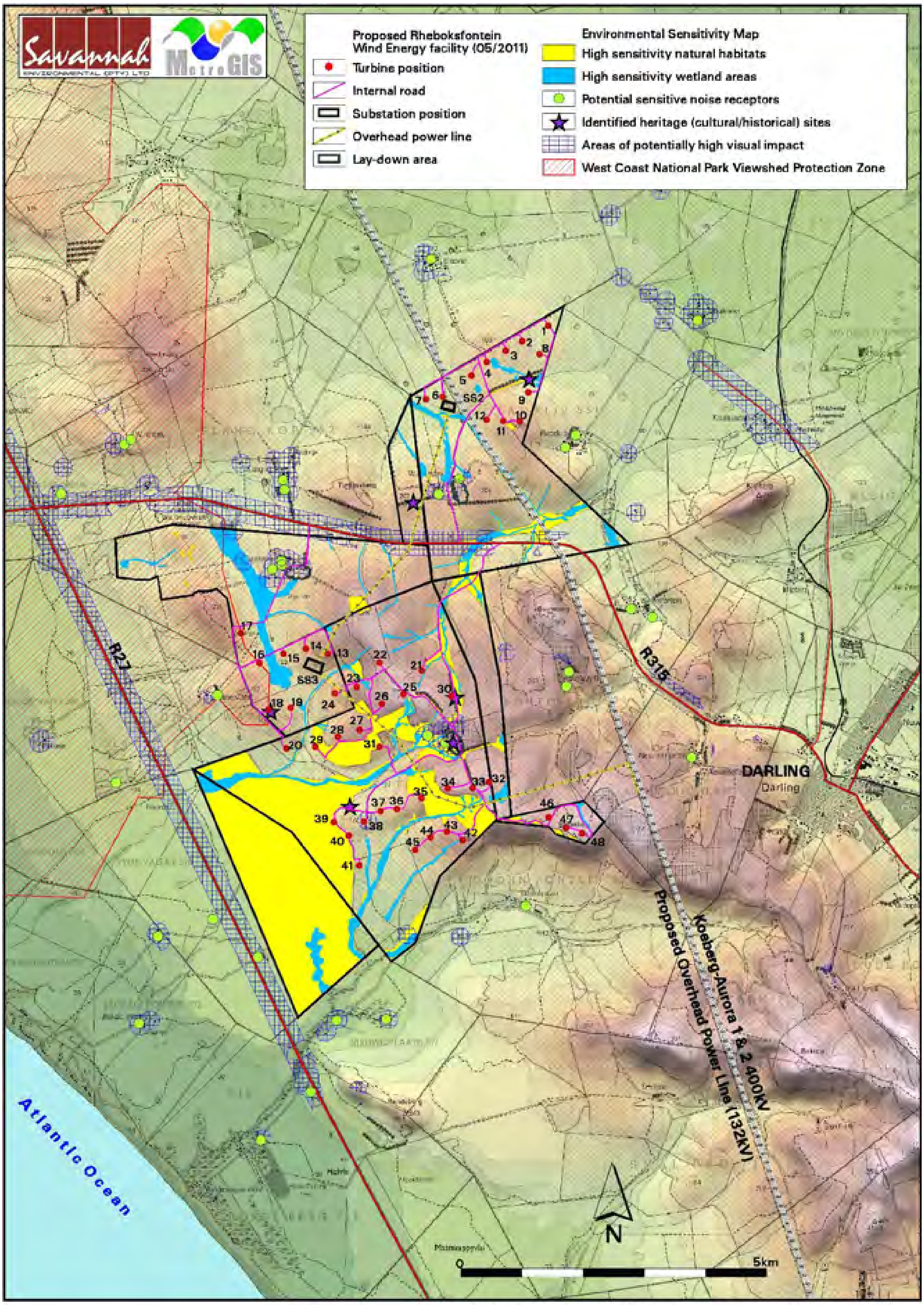

Figure 2: Final turbine layout for the proposed Rheboksfontein WEF.

3. SUMMARY OF LAYOUT CHANGES

The most significant changes to the proposed turbine layout are as follows:

- The overall number of turbines has been reduced from 80 to 48;
- All turbines that were situated within approximately 2 km of the Yzerfontein Road or within the West Coast National Park viewshed protection zone have been omitted and in turn:
    - The northernmost cluster has increased in density;
    - The turbines close to the Tienie Versveld Wildflower Reserve are omitted;
- The outlying cluster on Bakenkop in the southeast has been reduced from 7 to 3 turbines; and
- The southernmost of the three proposed substations has been omitted.

4. REVIEW OF IMPACTS

4.1. Palaeontology

No significant impacts to palaeontological heritage were considered likely in the initial assessment and the reduced number of turbines only serves to reduce the chances of intersecting fossils during construction.

4.2. Archaeology

Only one significant archaeological site was recorded during the initial work. Heritage Western Cape, in their comment dated 3rd November 2010, stated:

> "The archaeological test excavations and subsequent mitigation recommended by the archaeological consultant must be carried out for Rheboksfontein 1 Site, unless this turbine can be shifted to create a 100m buffer, or is omitted entirely."

It is noted that the revised layout has in fact resulted in the turbine in question (Number 18) being moved closer to the core area of the archaeological site, but on its northern side (Figure 3). There is no doubt that the site will e impacted with the proposed position of the turbine. While the site is important, it does not require *in situ* preservation and thus the stated mitigation should be carried out. This would be relatively easy to accomplish.

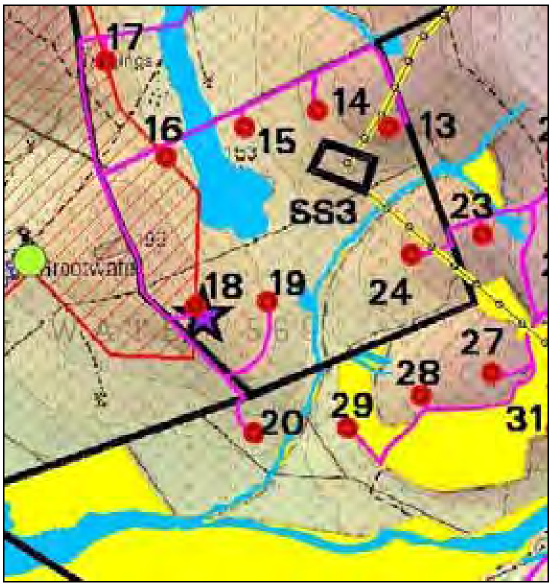

Figure 3: Extract from the revised turbine layout showing the position of Turbine 18 relative to the archaeological site, Rheboksfontein 1 (purple star).

4.3. Built environment

No new direct impacts to the built environment will be felt. It has been suggested that the old school building close to the Tienie Versveld Reserve be reused by the development. The building would be renovated to house office space. This is seen as having a positive impact since the current state of the building makes it something of an eyesore. While the building may be just older than 60 years, it is clear that it holds no heritage value. A storage facilioty will also be required for the development. Two options exist here: either a new structure could be built alongside or behind the school building or an existing shed/store within the farm complex could be rented and used. The latter option is considered to be better, since the addition of further structures close to the Tienie Versveld Reserve may be undesirable. It is noted that Turbine 31 has been shifted slightly downhill to avoid sensitive vegetation but this has resulted in further encroachment into the viewscape to the west of the Rheboksfontein farm house. The location of this house was no doubt especially chosen to allow uninterrupted views westwards towards the distant ocean. Its axis deliberately runs across the relatively steep slope in order to create the desired view. Turbine 31 will further impinge on this view (Figure 4), although it is noted that this impact is fully reversible.

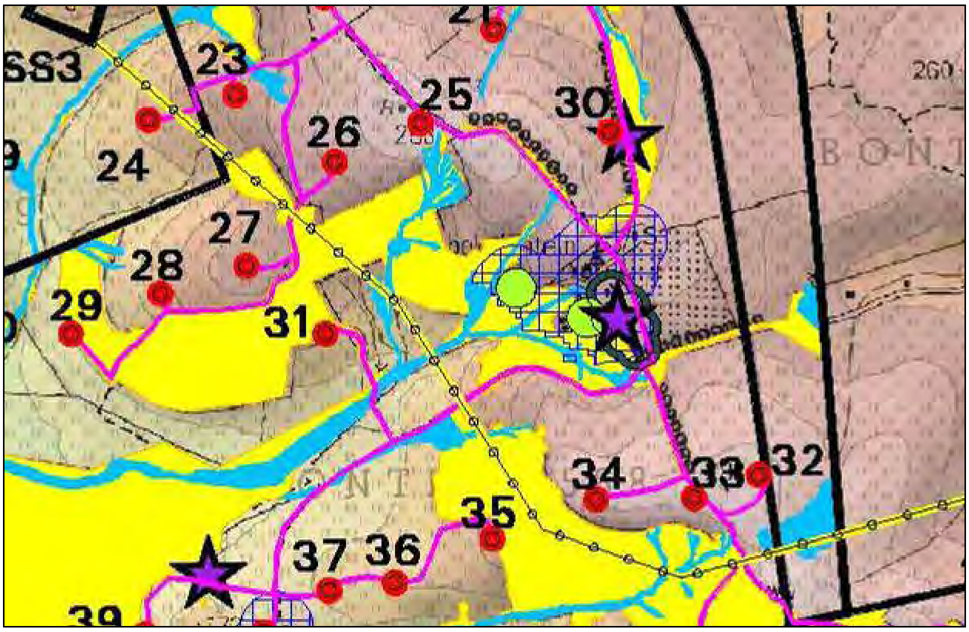

Figure 4: Extract from the revised turbine layout showing the position of Turbine 31 relative to the Rheboksfontein farm house (central purple star).

4.4. Graves

No known graves will be directly impacted. However, two turbines will be placed in close proximity to a recent grave (dated 1983) that is not protected under the National Heritage Resources Act (No. 25 of 1999). Note that a remote possibility of intersecting unmarked pre-colonial graves does exist and that should such graves be found they will need to be exhumed by an accredited archaeologist under a permit issued by Heritage Western Cape.

4.5. Cultural landscapes

The primary concern in the initial report was the large tree lines that occur within the study area. Two particularly significant lines were under threat but, with the revised layout omitting turbines within 2 km of the Yzerfontein Road, the western tree line on Wildschutsvlei is now at least partially protected. It still faces a threat from the proposed power line which may result in the loss of part of it (Figure 5). The north-eastern tree line has turbines located in its vicinity (Figure

6). It is noted that the revised layout has resulted in no change at the tree line on Rheboksfontein where turbine No. 30 will likely result in the necessity to remove this tree line (upper purple star in Figure 4). Furthermore, it is noted that access roads are planned to run along tree-lined farm roads and these tree lines should also be retained.

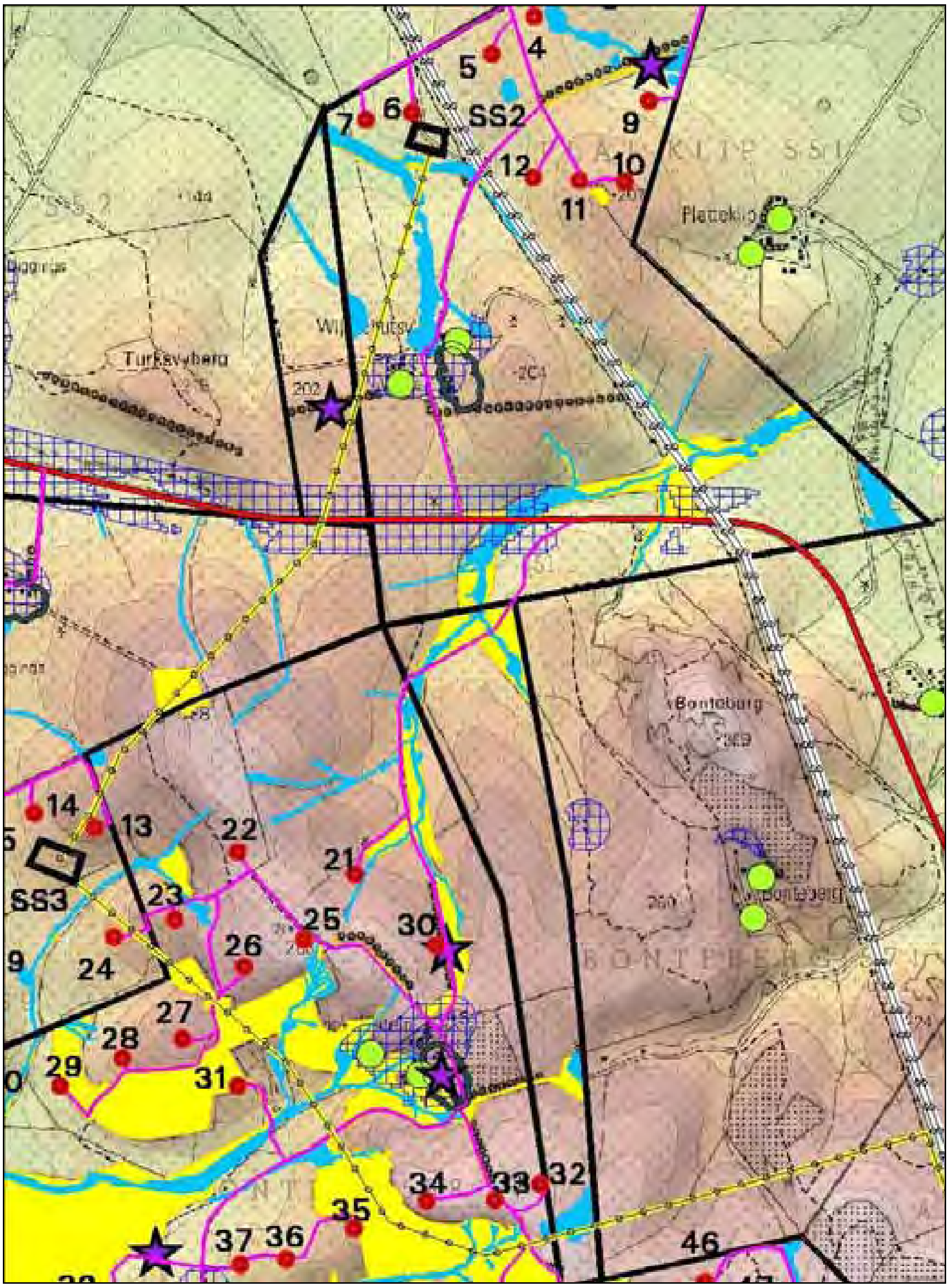

Figure 5: Extract from the revised turbine layout showing the position of the power line (yellow line) relative to the western tree line at Wildschutsvlei (purple star just north of the Yzerfontein Road) and the local topography.

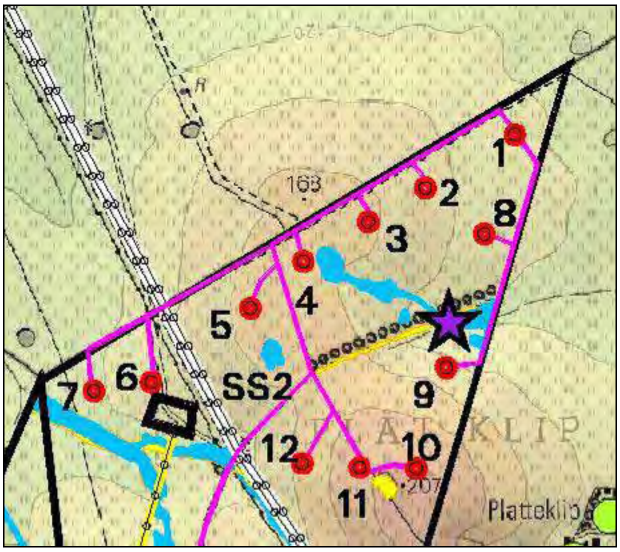

Figure 6: Extract from the revised turbine layout showing the position of turbines relative to the north-eastern tree line on Wildschutsvlei (purple star).

It is considered necessary to retain these tree lines in their entirety as part of the visual mitigation, since retention of existing vertical elements in the landscape will help reduce the impact of the new vertical elements (the turbines), albeit in a small way.

It is noted that the power line linking the northern and southern parts of the proposed WEF will traverse the crest of a hill to the south of the Yzerfontein Road (Figure 5). This would slightly increase the visual impacts as viewed from this road or from the Tienie Versveldt Reserve. Although the power line continues southwards traversing the western face of the Darling Hills, it would likely pose a very small impact given the backdrop of wind tubines against which it would be set. It will also pass through the viewscape of the Rheboksfontein farm house.

Concern exists over the visual scarring and fragmentation of the agricultural and natural landscape that will result from construction of roads. The VIA made the following comment:

> "Mitigation of secondary visual impacts associated with the construction of roads include careful planning of the access road network, taking due cognisance of the topography. Roads should be laid out along the contour wherever possible, and should never traverse slopes at 90 degrees (Du Plessis 2010)."

It is noted that the planned roads in the revised layout do include some that run at 90° to the slope. Most notable are the road linking turbines 42 to 45 and that from turbines 27 to 29 (Figure 7). Both of these rows overlook the coastal plain and would be directly visible from the R27, a significant scenic route. It is felt that turbines within a landscape that appears spatially intact will create less impact than ones in a landscape visibly carved by roads.

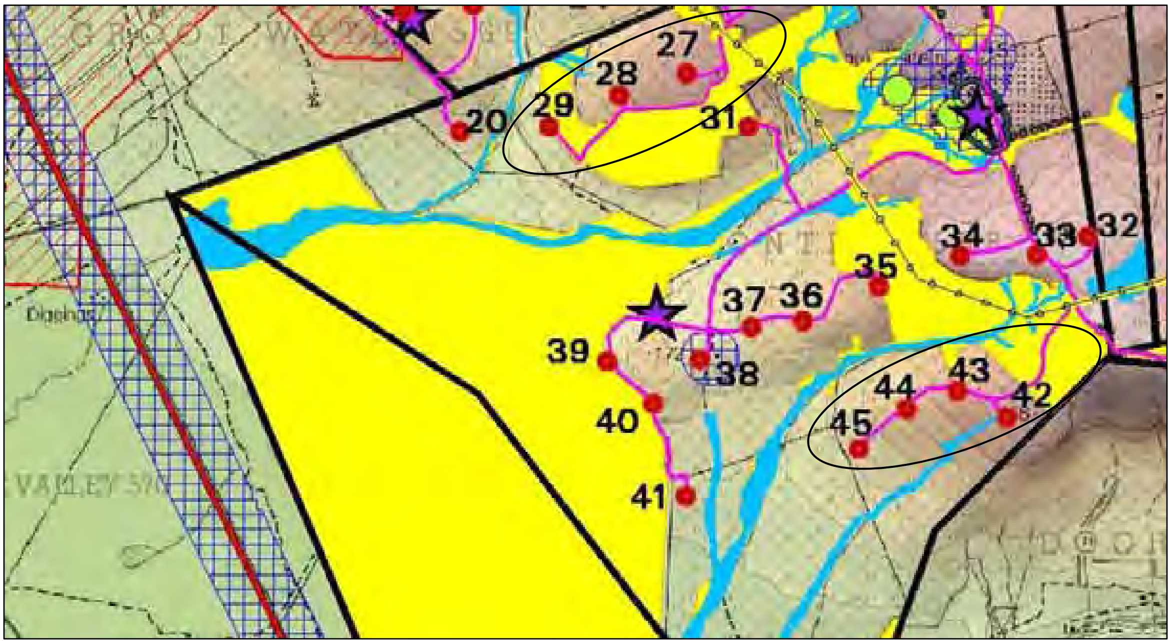

Figure 7: Extract from the revised turbine layout showing the positions of problematic road alignments (circled). The R27 scenic route crosses the western part of the map.

4.6. Visual Impacts

The Visual Impact Assessment conducted by Du Plessis (2010) made the following comments in its discussion on the potential to mitigate visual impacts:

> "The primary visual impact, namely the appearance of the Wind Energy Facility (mainly the wind turbines) is not possible to mitigate."
>
> "The overall potential for mitigation is generally low or non-existent."

These comments are pertinent in a unique landscape frequented by many people. The area has importance for tourism for at least three reasons:

1. The Darling region is well known for its Spring Flower displays and a small nature reserve exists to showcase these flowers;
2. Pieter Dirk Uys, renowned political satirist and AIDS activist, draws people from far and wide to attend his shows in Darling; and
3. The local wine farms draw tourists to the Darling Wine Route.

The VIA arrives at the following conclusions in its assessment of various categories of visual impacts[1]:

• Potential impacts to major roads, minor roads and scenic routes	High significance (75)
• Potential impacts to residents of towns, settlements and homesteads	High significance(80)
• Potential visual impact on visitors to tourist destinations and entities of cultural and historical value	High significance (75)
• Potential visual impact on the West Coast National Park and on the private nature reserves and conservancies	High significance (70)

The high degree of significance for all categories arises for two primary reasons:

[1] The values are calculated according to a set scale where impacts of low significance are scored < 30, impacts of medium significance are 30 – 60 points and impacts of high significance are > 60 points.

- The Darling Hills protrude significantly from the predominantly flat wheat lands of the Swartland creating very prominent relief. The siting of the WEF atop these hills results in its visibility from a great distance; and
- The proximity of many sensitive visual receptors, both resident (farmsteads and local towns) and transient (tourists) and the general proximity of the site to a large metropolitan centre (Cape Town).

In its conclusions, the VIA states the following:

> "Considering all factors, it is the opinion of the author that the study area is not ideally suited to the development of a WEF primarily due to its inherent and growing tourism value. The WEF will represent a visual impact, but this impact is not likely to detract for the tourism appeal, numbers of tourists or tourism potential of the existing centres. Those who will be most impacted upon visually, would be the users of the tourist routes (specifically the R27). This impact will, however be short lived, and is not likely to affect tourists once their destinations have been reached.
>
> "Therefore, the potential visual impact of the proposed WEF is not considered to be a fatal flaw for the development."

Du Plessis (2010) reasons that the WEF might invoke a curiosity factor such that people might travel to see it. Although in the short term this is indeed likely, one also needs to consider that visitors from Europe and North America would be familiar with WEFs and would be unlikely to appreciate them in an area they are visiting as a tourist, and local residents might only be interested in seeing them once (although they may well have already satisfied their interest through the existing small facilities at Darling and Klipheuwel). The novelty of the turbines is unlikely to draw repeated visits in the same way that the annual display of Spring flowers would.

In his addendum to his original VIA, Du Plessis (2011) states that the magnitude and extent of visual impacts is reduced through reduction of the number of turbines but that the nature and significance of visual impacts remain unchanged for the revised layout. He does not consider visual impacts to be a fatal flaw.

4.7. Power line routes

During the initial assessment no attempt was made to survey the proposed external power line route running southwards from the development site to the substation in Atlantis. This was for several reasons:

1. They cross many farms and gaining access to all would have been very difficult and time-consuming;
2. Much of the route lies over deep, white wind-blown sands which, in that area, tend to reveal very little if any archaeology;
3. The spatial impact of their footprints is very small and unlikely to have affected the overall outcome of the assessment from an archaeological point of view; and
4. From Rheboksfontein, the alignment follows the line of an existing power line and new non-archaeological impacts are not expected to occur.

Internal power line routes would be subject to the same assessment as the remainder of the proposed facility and no impacts specific to them are foreseen.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. General statement

Overall, there may well be potential to construct a WEF in the proposed location but, owing to the nature of the topography and its very low absorption capacity, impacts of high to very high heritage significance will definitely occur. These are primarily visual in nature and related to residents, tourists and the local scenic routes. The site is within a visually prominent landscape that has cultural and tourism value and stands in stark contrast to some of the far more remote, and hence more appropriate, locations that have been proposed for similar facilities in recent years. Careful planning and decision-making will be required if the proposed WEF is to be constructed and operated within an acceptable level of impact in an area that, from a heritage perspective, is generally unsuited to the type of development proposed.

5.2. Comment on cumulative impacts

It should be noted that a small WEF (Darling) with four turbines currently stands to the northwest of the proposed Rheboksfontein WEF. This facility currently has an application in to expand to twenty turbines and will be known as the Darling and Kerriefontein WEF. The following observations are relevant to heritage values when considering the proposed Rheboksfontein WEF:

- At the Darling facility the existing turbines are 50 m in height and the proposed expansion would utilise 60 m high turbines. These are somewhat lower than those proposed for the Rheboksfontein WEF (approximately 82 m high);
- The Kerriefontein WEF is located in a single cluster on the western side of the Darling Hills such that its visual exposure is substantially smaller than Rheboksfontein; and
- Owing to its position relative to the total extent of the Darling Hills area, the Darling and Kerriefontein WEF is located in a far more suitable position.

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Moyeng Energy (Pty) Ltd

REVISED NOISE IMPACT STUDY FOR ENVIRONMENTAL IMPACT ASSESSMENT

Establishment of the Rheboksfontein Wind Energy Facility on various farms near Darling, Western Cape

Study done for:

M² Environmental Connections cc
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Title:

Revised Noise Impact Study for Environmental Impact Assessment: Establishment of the Rheboksfontein Wind Energy Facility on various farms near Darling, Western Cape.

Client:

Savannah Environmental (Pty) Ltd for Moyeng Energy (Pty) Ltd

PO BOX 148
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Report no:

ME-RF/NIA/201008-Rev 2

Authors:

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Review:

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Date:

June 2011

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GLOSSARY OF ABBREVIATIONS

DEA	Department of Environmental Affairs
DEADP	Department of Environmental Affairs and Development Planning
EAP	Environmental Assessment Practitioner
ECA	Environment Conservation Act (Act 78 of 1989)
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
FEL	Front End Loader
IAPs	Interested and Affected Parties
i.e.	that is
IEM	Integrated Environmental Management
km	kilometres
LHD	Load haul dumper
m	Meters (measurement of distance)
m^2	Square meter
m^3	Cubic meter
mamsl	Meters above mean sea level
MENCO	M^2 Environmental Connections cc
NEMA	National Environmental Management Act, 1998 (Act 107 of 1998)
NCR	Noise Control Regulations (under Section 25 of the ECA)
NGO	Non-government Organisation
PPE	Personal Protective Equipment
PPP	Public Participation Process
SABS	South African Bureau of Standards
SANS	South African National Standards
SHEQ	Safety Health Environment and Quality
TLB	Tip Load Bucket
WEF	Wind Energy Facility
WHO	World Health Organisation
WTG	Wind Turbine Generator

GLOSSARY OF TERMS

1/3-Octave Band	A filter with a bandwidth of one-third of an octave representing four semitones, or notes on the musical scale. This relationship is applied to both the width of the band, and the center frequency of the band. See also definition of octave band.
A – Weighting	An internationally standardised frequency weighting that approximates the frequency response of the human ear and gives an objective reading that therefore agrees with the subjective human response to that sound.
Air Absorption	The phenomena of attenuation of sound waves with distance propagated in air, due to dissipative interaction within the gas molecules.
Alternatives	A possible course of action, in place of another, that would meet the same purpose and need (of proposal). Alternatives can refer to any of the following, but are note limited hereto: alternative sites for development, alternative site layouts, alternative designs, alternative processes and materials. In Integrated Environmental Management the so-called “no go” alternative refers to the option of not allowing the development and may also require investigation in certain circumstances.
Ambient	The conditions surrounding an organism or area.
Ambient Noise	The all-encompassing sound at a point being composed of sounds from many sources both near and far. It includes the noise from the noise source under investigation.
Ambient Sound	The all-encompassing sound at a point being composite of sounds from near and far.
Ambient Sound Level	Means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such a meter was put into operation. In this report the term Background Ambient Sound Level will be used.
Amplitude Modulated Sound	A sound that noticeably fluctuates in loudness over time.
Applicant	Any person who applies for an authorisation to undertake a listed activity or to cause such activity in terms of the relevant environmental legislation.
Assessment	The process of collecting, organising, analysing, interpreting and communicating data that is relevant to some decision.
Audible Frequency Range	Generally assumed to be the range from about 20 Hz to 20,000 Hz, the range of frequencies that our ears perceive as sound.
Background Ambient Sound Level	The level of the ambient sound indicated on a sound level meter in the absence of the sound under investigation (e.g. sound from a particular noise source or sound generated for test purposes). Ambient sound level as per Noise Control Regulations.
C-Weighting	This is an international standard filter, which can be applied to a pressure signal or to a *SPL* or *PWL* spectrum, and which is essentially a pass-band filter in the frequency range of approximately 63 to 4000 Hz. This filter provides a more constant, flatter, frequency response, providing significantly less adjustment than the A-scale filter for frequencies less than 1000 Hz.
dB(A)	Sound Pressure Level in decibel that has been A-weighted, or filtered, to match the response of the human ear.
Decibel (db)	A logarithmic scale for sound corresponding to a multiple of 10 of the threshold of hearing. Decibels for sound levels in air are referenced to an atmospheric pressure of 20 μ Pa.
Diffraction	Modification of the progressive wave distribution due to the presence of obstacles in the field. Reflection and refraction are special cases of diffraction.
Direction of Propagation	The direction of flow of energy associated with a wave.
Disturbing noise	Means a noise level that exceeds the zone sound level or, if no zone sound level has been designated, a noise level that exceeds the ambient sound level

	at the same measuring point by 7 dBA or more.
Environment	The external circumstances, conditions and objects that affect the existence and development of an individual, organism or group; these circumstances include biophysical, social, economic, historical, cultural and political aspects.
Environmental Control Officer	Independent Officer employed by the applicant to ensure the implementation of the Environmental Management Plan (EMP) and manages any further environmental issues that may arise.
Environmental impact	A change resulting from the effect of an activity on the environment, whether desirable or undesirable. Impacts may be the direct consequence of an organisation's activities or may be indirectly caused by them.
Environmental Impact Assessment	An Environmental Impact Assessment (EIA) refers to the process of identifying, predicting and assessing the potential positive and negative social, economic and biophysical impacts of any proposed project, plan, programme or policy that requires authorisation of permission by law and that may significantly affect the environment. The EIA includes an evaluation of alternatives, as well as recommendations for appropriate mitigation measures for minimising or avoiding negative impacts, measures for enhancing the positive aspects of the proposal, and environmental management and monitoring measures.
Environmental issue	A concern felt by one or more parties about some existing, potential or perceived environmental impact.
Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$)	The value of the average A-weighted sound pressure level measured continuously within a reference time interval *T*, which have the same mean-square sound pressure as a sound under consideration for which the level varies with time.
Equivalent continuous A-weighted rating level ($L_{Req,T}$)	The Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$) to which various adjustments has been added. More commonly used as ($L_{Req,d}$) over a time interval 06:00 – 22:00 (T=16 hours) and ($L_{Req,n}$) over a time interval of 22:00 – 06:00 (T=8 hours).
Footprint area	Area to be used for the construction of the proposed development, which does not include the total study area.
Frequency	The rate of oscillation of a sound, measured in units of Hertz (Hz) or kiloHertz (kHz). One hundred Hz is a rate of one hundred times per second. The frequency of a sound is the property perceived as pitch: a low-frequency sound (such as a bass note) oscillates at a relatively slow rate, and a high-frequency sound (such as a treble note) oscillates at a relatively high rate.
Green field	A parcel of land not previously developed beyond that of agriculture or forestry use; virgin land. The opposite of Green field is Brown field, which is a site previously developed and used by an enterprise, especially for a manufacturing or processing operation. The term Brown field suggests that an investigation should be made to determine if environmental damage exists.
G-Weighting	An International Standard filter used to represent the infrasonic components of a sound spectrum.
Harmonics	Any of a series of musical tones for which the frequencies are integral multiples of the frequency of a fundamental tone.
Infrasound	Sound with a frequency content below the threshold of hearing, generally held to be about 20 Hz. Infrasonic sound with sufficiently large amplitude can be perceived, and is both heard and felt as vibration. Natural sources of infrasound are waves, thunder and wind.
Integrated Development Plan	A participatory planning process aimed at developing a strategic development plan to guide and inform all planning, budgeting, management and decision-making in a Local Authority, in terms of the requirements of Chapter 5 of the Municipal Systems Act, 2000 (Act 32 of 2000).
Integrated Environmental Management	IEM provides an integrated approach for environmental assessment, management, and decision-making and to promote sustainable development and the equitable use of resources. Principles underlying IEM provide for a democratic, participatory, holistic, sustainable, equitable and accountable

	approach.
Interested and affected parties	Individuals or groups concerned with or affected by an activity and its consequences. These include the authorities, local communities, investors, work force, consumers, environmental interest groups and the general public.
Key issue	An issue raised during the Scoping process that has not received an adequate response and that requires further investigation before it can be resolved.
Listed activities	Development actions that is likely to result in significant environmental impacts as identified by the delegated authority (formerly the Minister of Environmental Affairs and Tourism) in terms of Section 21 of the Environment Conservation Act.
Loudness	The attribute of an auditory sensation that describes the listener's ranking of sound in terms of its audibility.
Magnitude of impact	Magnitude of impact means the combination of the intensity, duration and extent of an impact occurring.
Masking	The raising of a listener's threshold of hearing for a given sound due to the presence of another sound.
Mitigation	To cause to become less harsh or hostile.
Negative impact	A change that reduces the quality of the environment (for example, by reducing species diversity and the reproductive capacity of the ecosystem, by damaging health, or by causing nuisance).
Noise	a. Sound that a listener does not wish to hear (unwanted sounds). b. Sound from sources other than the one emitting the sound it is desired to receive, measure or record. c. A class of sound of an erratic, intermittent or statistically random nature.
Noise Level	The term used in lieu of sound level when the sound concerned is being measured or ranked for its undesirability in the contextual circumstances.
Noise-sensitive development	developments that could be influenced by noise such as: a) districts (see table 2 of SANS 10103:2008) 1. rural districts, 2. suburban districts with little road traffic, 3. urban districts, 4. urban districts with some workshops, with business premises, and with main roads, 5. central business districts, and 6. industrial districts; b) educational, residential, office and health care buildings and their surroundings; c) churches and their surroundings; d) auditoriums and concert halls and their surroundings; e) recreational areas; and f) nature reserves. In this report Noise-sensitive developments is also referred to as a Potential Sensitive Receptor
Octave Band	A filter with a bandwidth of one octave, or twelve semi-tones on the musical scale representing a doubling of frequency.
Positive impact	A change that improves the quality of life of affected people or the quality of the environment.
Property	Any piece of land indicated on a diagram or general plan approved by the Surveyor-General intended for registration as a separate unit in terms of the Deeds Registries Act and includes an erf, a site and a farm portion as well as the buildings erected thereon
Public Participation Process	A process of involving the public in order to identify needs, address concerns, choose options, plan and monitor in terms of a proposed project, programme or development
Reverberant Sound	The sound in an enclosure excluding that is received directly from the source.
Reverberation	The persistence, after emission of a sound has stopped, of a sound field within

	an enclosure.
Significant Impact	An impact can be deemed significant if consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provides reasonable grounds for mitigating measures to be included in the environmental management report. The onus will be on the applicant to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account.
Sound Level	The level of the frequency weighted and time weighted sound pressure as determined by a sound level meter.
Sound Power	Of a source, the total sound energy radiated per unit time.
Sound Pressure Level (SPL)	Of a sound, 20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level. International values for the reference sound pressure level are 20 micropascals in air and 100 millipascals in water. SPL is reported as L_p in dB (not weighted) or in various other weightings.
Soundscape	Sound or a combination of sounds that forms or arises from an immersive environment. The study of soundscape is the subject of acoustic ecology. The idea of soundscape refers to both the natural acoustic environment, consisting of natural sounds, including animal vocalizations and, for instance, the sounds of weather and other natural elements; and environmental sounds created by humans, through musical composition, sound design, and other ordinary human activities including conversation, work, and sounds of mechanical origin resulting from use of industrial technology. The disruption of these acoustic environments results in noise pollution.
Study area	Refers to the entire study area encompassing all the alternative routes as indicated on the study area map.
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland Commission, 1987).
Zone of Potential Influence	The area defined as the radius about an object, or objects beyond which the noise impact will be insignificant.
Zone Sound Level	Means a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. This is similar to the Rating Level as defined in SANS10103.

1 INTRODUCTION

1.1 INTRODUCTION AND PURPOSE

M2 Environmental Connections was commissioned to undertake a specialist study to determine the potential noise impact on the surrounding environment, due to the establishment of the Rheboksfontein Wind Energy Facility on various farms close to the town of Darling, Western Cape.

This report describes the potential impact that such a Wind Energy Facility may have on the surrounding environment, highlighting the methodologies used, potential issues identified, findings and recommendations. This revision reviews an updated turbine layout due to comments received by the Department of Environmental Affairs, implementing the changed layout as a mitigatory measure.

1.2 BRIEF PROJECT DESCRIPTION

Moyeng Energy (Pty) Ltd proposes the establishment of a wind energy facility and associated infrastructure with a revised turbine layout, on various farms and farm portions near the town of Darling, Western Cape. The study area is approximately 70 km^2, with the area investigated in terms of the noise impact covering approximately 132 km^2.

The facility and associated infrastructure includes:

- Up to **48 wind turbines** and associated **Concrete foundations**,
- Underground **cables** between the wind turbine generators,
- A maintenance/control building;
- **Substation** to allow connection between the Wind Energy Facility and the existing Eskom electrical grid;
- 132 kV **Power Line(s)** linking to the transmission grid; and
- **Internal Access Roads** between the turbines.

1.3 TERMS OF REFERENCE

SANS 10328:2008 (Edition 2) specifies the methodology to assess the noise impacts on the environment due to a proposed activity that might impact on the environment. The standard also stipulates the minimum requirements to be investigated for EIA. These minimum requirements are:

1. the purpose of the investigation

2. a brief description of the planned development or the changes that are being considered
3. a brief description of the existing environment including, where relevant, the topography, surface conditions and meteorological conditions during measurements
4. the identified noise sources together with their respective sound pressure levels or sound power levels (or both) and, where applicable, the operating cycles, the nature of sound emission, the spectral composition and the directional characteristics
5. the identified noise sources that were not taken into account and the reasons as to why they were not investigated
6. the identified noise-sensitive developments and the noise impact on them
7. where applicable, any assumptions, with references, made with regard to any calculations or determination of source and propagation characteristics
8. an explanation, either by a brief description or by reference, of all measuring and calculation procedures that were followed, as well as any possible adjustments to existing measuring methods that had to be made, together with the results of calculations
9. an explanation, either by description or by reference, of all measuring or calculation methods (or both) that were used to determine existing and predicted rating levels, as well as other relevant information, including a statement of how the data were obtained and applied to determine the rating level for the area in question
10. the location of measuring or calculating points in a sketch or on a map
11. quantification of the noise impact with, where relevant, reference to the literature consulted and the assumptions made
12. alternatives that were considered and the results of those that were investigated
13. a list of all the interested or affected parties that offered any comments with respect to the environmental noise impact investigation
14. a detailed summary of all the comments received from interested or affected parties as well as the procedures and discussions followed to deal with them
15. conclusions that were reached
16. proposed recommendations
17. if remedial measures will provide an acceptable solution which would prevent a significant impact, these remedial measures should be outlined in detail and included in the final record of decision if the approval is obtained from the relevant authority. If the remedial measures deteriorate

after time and a follow-up auditing or maintenance programme (or both) is instituted, this programme should be included in the final recommendations and accepted in the record of decision if the approval is obtained from the relevant authority; and

18. any follow-up investigation which should be conducted at completion of the project as well as at regular intervals after the commissioning of the project so as to ensure that the recommendations of this report will be maintained in the future.

1.4 STUDY AREA

The wind energy facility is proposed on the following farms near the town of Darling:

- Remaining extent of Farm 568 (Rheboksfontein),
- Farm 567 (Nieuwe Plaats),
- Remaining extent of Farm 571 (Bonteberg),
- Portion 1 of Farm 574 (Doornfontein),
- Portion 1 of Farm 551 (Plat Klip),
- Farm 1199 (Groot Berg), and
- Portion 2 of Farm 552 (Slang Kop).

The proposed WEF will be situated in an undeveloped rural area between the towns of Darling and Yzerfontein. The area is characterized by two landscape types, i.e. a relatively flat, low-lying sandy coastal plain to the west of the R27 West Coast road and low hills to the east of the R27, rising to between 160 and 260m above sea level. A site locality map is presented in **Figure 1-1**. It is important to note that the site is also directly adjacent to the Darling Windfarm, located below the crest of Moedmaag Hill, slightly east of the R27.

The area is mainly used for various agricultural activities. These agricultural activities and the roads (R27 and R315) are the main noise source in the vicinity of the study area during the day. Traffic on the R27 and R315 dies down in the evening. Late at night/early morning there is no traffic on the R315. The ocean and other natural sounds define the ambient sound environment late at night and early in the mornings.

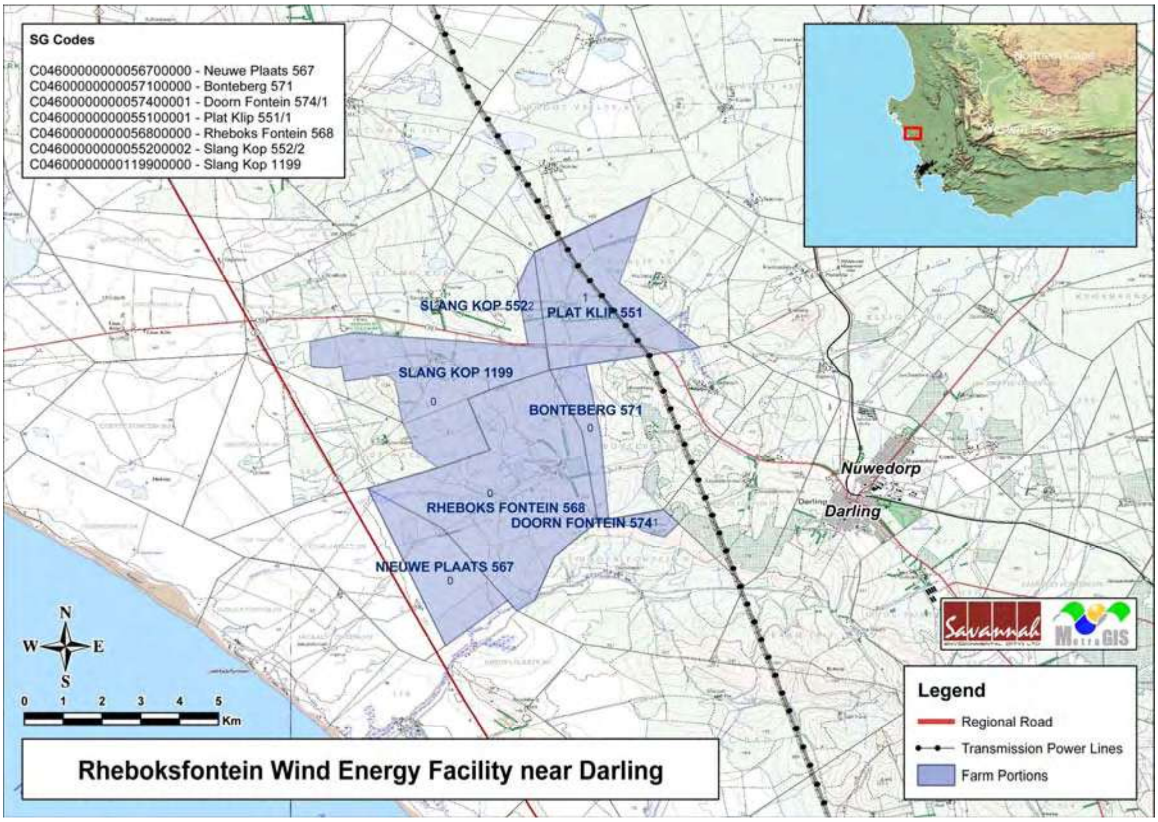

Figure 1-1: Site map indicating locations of the various portions proposed to be used for the WEF

1.5 AVAILABLE INFORMATION

- The Scoping report (2010) compiled for this project by the author;
- The Environmental Noise Impact Assessment Report No. ME-RF/NIA/201008-Rev 0 (2010) compiled by the author based on the old turbine layout; and
- Wind speed and direction data is available from the developer, but due to the commercial value is considered confidential.

1.6 NOISE SENSITIVE DEVELOPMENTS

Noise Sensitive Developments (Potential Sensitive Receptors) were initially identified using GoogleEarth®, supported by a site visit to confirm the status of the identified dwellings during end March 2010. The reason for the site visit is that there could be a number of derelict or abandoned dwellings that was seen as potential sensitive receptors, small dwellings that could not be identified on the aerial image, or those dwellings that were built after the date of the aerial photograph.

Potential receptors within 2 km of the edge of the WEF were identified, and are presented in **Figure 1-2** (with the coordinates of the Potential receptor in **Table 1.1**).

The assessment indicated the presence of a number of potential sensitive receptors, mainly various farmsteads around and within the boundaries of the proposed WEF portions.

It should also be noted that while only one receptor is indicated per site, it should rather be seen as a small community of receptors. This is because at most of the farm dwellings there are a number of other houses occupied by farm workers and their families.

Table 1.1: Locations of the identified receptors (Datum type: Universal Transverse Mercator, zone 34)

Receptor	Location X	Location Y
PSR01	243564.2	6308518
PSR02	244555.9	6303801
PSR03	246183	6301594
PSR04	245286.5	6301297
PSR05	245007.1	6299862
PSR06	246928.7	6300986
PSR07	247837.9	6298798
PSR08	247033.8	6297989
PSR09	248238	6299976
PSR10	249049.3	6300009
PSR11	246185.5	6305268
PSR12	247044	6307346
PSR13	247200.9	6307423
PSR14	247191	6307485
PSR15	244587.2	6309347
PSR16	244685.7	6309424
PSR17	247190.5	6308812
PSR18	247215.9	6308652
PSR19	249737.8	6308629
PSR20	250070.1	6308884
PSR21	251794.6	6309434
PSR22	251963.9	6309642
PSR23	249539.2	6312478
PSR24	253922.5	6311561
PSR25	252922.6	6306810
PSR26	253274.5	6306681
PSR27	249634.8	6304672
PSR28	249928.7	6304557
PSR29	251926.9	6305758
PSR30	251886.4	6305520
PSR31	253958.8	6304396
PSR32	253958.8	6304396

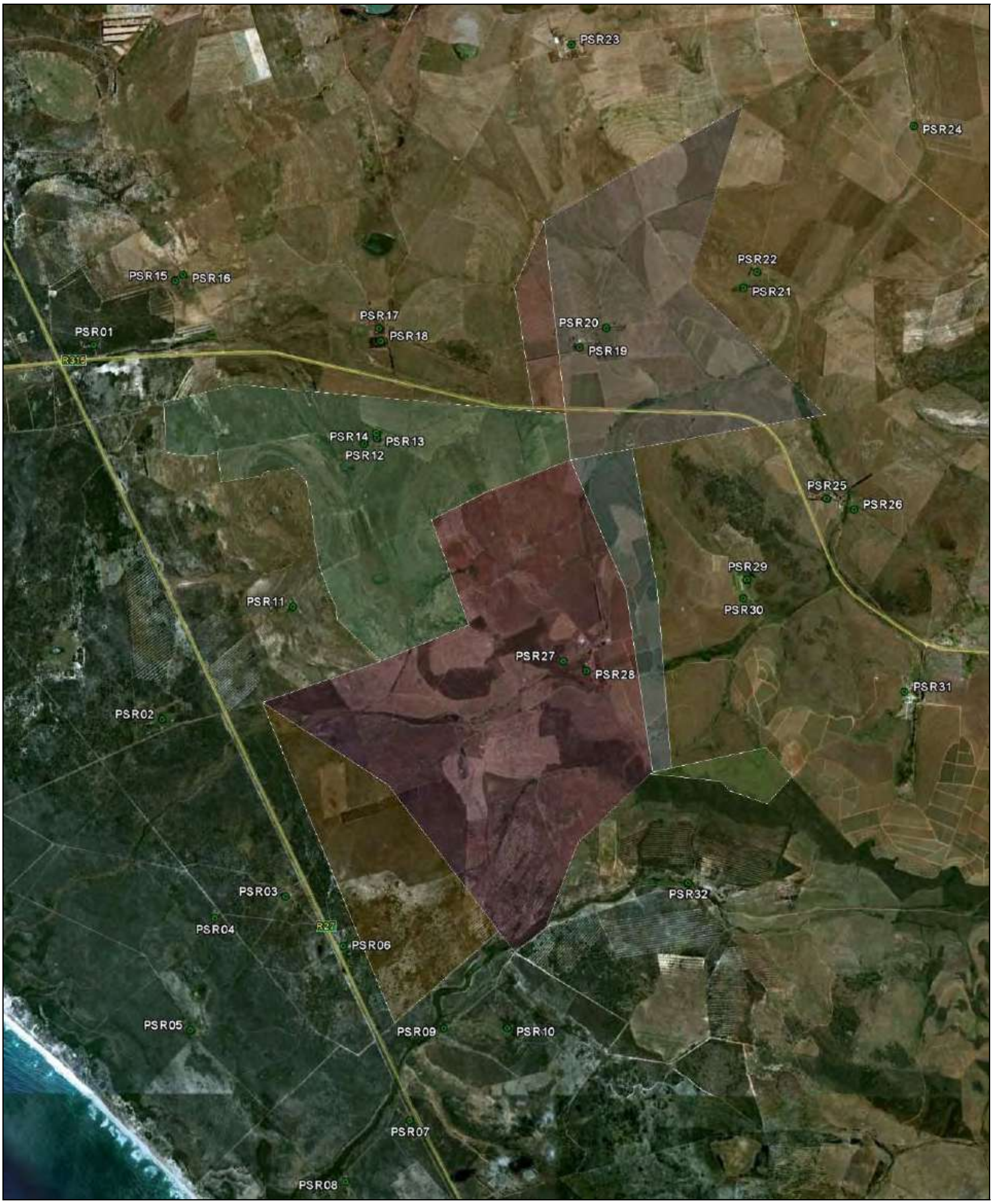

Figure 1-2: Aerial image indicating potential sensitive receptors (green dots) and locations of the farm and portions of the proposed WEF.

2 POLICIES AND THE LEGAL CONTEXT

2.1 THE REPUBLIC OF SOUTH AFRICA CONSTITUTION ACT ("THE CONSTITUTION")

The environmental rights contained in section 24 of the Constitution provide that everyone is entitled to an environment that is not harmful to his or her well-being. In the context of noise, this requires a determination of what level of noise is harmful to well-being. The general approach of the common law is to define an acceptable level of noise as that which the reasonable person can be expected to tolerate in the particular circumstances. The subjectivity of this approach can be problematic which has led to the development of noise standards (see Section 2.6).

"Noise pollution" is specifically included in Part B of Schedule 5 of the Constitution, which means that noise pollution control is a local authority competence, provided that the local authority concerned has the capacity to carry out this function.

2.2 THE ENVIRONMENT CONSERVATION ACT

The Environment Conservation Act ("ECA") allows the Minister of Environmental Affairs and Tourism ("now the Ministry of Water and Environmental Affairs") to make regulations regarding noise, among other concerns. The Minister has made noise control regulations under the ECA adopted by the Western Cape Province. See also **section 2.5**.

2.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT

The National Environmental Management Act ("NEMA") defines "pollution" to include any change in the environment, including noise. A duty therefore arises under section 28 of NEMA to take reasonable measures while establishing and operating the WEF to prevent noise pollution occurring. NEMA sets out measures which may be regarded as reasonable. They include measures:

1. to investigate, assess and evaluate the impact on the environment;
2. to inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment;

3. to cease, modify or control any act, activity or process causing the pollution or degradation;
4. to contain or prevent the movement of;
5. to eliminate any source of the pollution or degradation; or
6. to remedy the effects of the pollution or degradation.

2.4 NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT ("AQA")

Section 34 of the National Environmental Management: Air Quality Act (Act 39 of 2004) makes provision for:

(1) the Minister to prescribe essential national noise standards -

(a) for the control of noise, either in general or by specified machinery or activities or in specified places or areas; or

(b) for determining –

(i) a definition of noise; and

(ii) the maximum levels of noise.

(2) When controlling noise the provincial and local spheres of government are bound by any prescribed national standards.

This section of the Act is in force but no such standards have yet been promulgated.

An atmospheric emission licence issued in terms of section 22 may contain conditions in respect of noise. This however will not be relevant to the WEF, as no atmospheric emissions will take place.

2.5 NOISE CONTROL REGULATIONS

In terms of section 25 of the ECA, the national noise-control regulations (GN R154 in *Government Gazette* No. 13717 dated 10 January 1992) were promulgated. The NCRs were revised under Government Notice Number R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations.

Subsequently, in terms of Schedule 5 of the Constitution of South Africa of 1996 legislative responsibility for administering the noise control regulations was devolved to provincial and local authorities. Provincial Noise Control Regulations exist in the Free State, Western Cape and Gauteng provinces.

Provincial Noise Control Regulations exist in the Western Cape Province (Provincial Notice 627 of 20 November 1998).

In terms of these regulations, if the predicted level of noise emanating from a proposed activity is likely to cause the noise levels on surrounding land to exceed 65 dBA (61 dBA for an industrial noise), noise mitigation measures are required to be implemented to ensure that the noise levels on the affected land are reduced so as not to exceed 65 dBA.

In addition, increases above 7 dBA from the background ambient noise levels are considered a “Disturbing noise”.

Draft Noise Control Regulations have been promulgated in the Western Cape for review and comment (PN 14/2007 of 25 January 2007). It is not yet implemented.

2.6 NOISE STANDARDS

Four South African Bureau of Standards (SABS) scientific standards are considered relevant to noise from a Wind Energy Facility. They are:

- SANS 10103:2004. ‘The measurement and rating of environmental noise with respect to annoyance and to speech communication’.
- SANS 0210:2004. ‘Calculating and predicting road traffic noise’.
- SANS 10328:2003. ‘Methods for environmental noise impact assessments’.
- SANS 10357:2004. ‘The calculation of sound propagation by the Concave method’.

The relevant standards use the equivalent continuous rating level as a basis for determining what is acceptable. The levels may take single event noise into account but single event noise by itself does not determine whether noise levels are acceptable for land use purposes. The recommendations that the standards make are likely to inform decisions by authorities but non-compliance with the standards will not necessarily render an activity unlawful *per se.*

2.7 Draft model Air Quality Management By-law for adoption and adaptation by Municipalities

Draft model air quality management by-laws for adoption and adaptation by municipalities was published by the Department of Environmental Affairs in the Government Gazette of 15 July 2009 as General Notice (for comments) 964 of 2009.

Section 18 specifically focuses on Noise Pollution Management, with sub-section 1 stating:

"*No person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, animal, machine, device or apparatus or any combination thereof.*"

The draft regulations differ from the current provincial Noise Control Regulations, because it defines a disturbing noise as a noise that is measurable or calculable of which the rating level exceeds the equivalent continuous rating level as defined in SANS 10103:2008.

2.8 International Guidelines

While there exist a number of international guidelines and standards that could encompass a document in itself, the three mentioned below were selected as they are used by different countries in the subject of environmental noise management, with the last two documents specifically focussing on the noises associated by wind energy facilities.

2.8.1 Guidelines for Community Noise (WHO, 1999)

The World Health Organization's (WHO) document on the *Guidelines for Community Noise* is the outcome of the WHO- expert task force meeting held in London, United Kingdom, in April 1999. It is based on the document entitled "Community Noise" that was prepared for the World Health Organization and published in 1995 by the Stockholm University and Karolinska Institute.

The scope of WHO's effort to derive guidelines for community noise is to consolidate actual scientific knowledge on the health impacts of community noise and to provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments.

Guidance on the health effects of noise exposure of the population has already been given in an early publication of the series of Environmental Health Criteria. The health risk to humans from exposure to environmental noise was evaluated and guidelines values derived. The issue of noise control and health protection was briefly addressed.

The document uses the L_{Aeq} and $L_{A,max}$ noise descriptors to define noise levels.

2.8.2 The Assessment and Rating of Noise from Wind Farms (ETSU, 1997)

This report describes the findings of a Working Group on Wind Turbine Noise, facilitated by the United Kingdom Department of Trade and Industry. It was developed as an Energy Technology Support Unit[1] (ETSU) project. The aim of the project was to provide information and advice to developers and planners on noise from wind turbines. The report represents the consensus view of a number of experts (experienced in assessing and controlling the environmental impact of noise from wind farms). Their findings can be summarised as follows:

1. Absolute noise limits applied at all wind speeds are not suited to wind farms; limits set relative to the background noise (including wind as seen in Figure 3-2) are more appropriate
2. $L_{A90,10mins}$ is a much more accurate descriptor when monitoring ambient and turbine noise levels
3. The effects of other wind turbines in a given area should be added to the effect of any proposed wind energy facility, to calculate the cumulative effect
4. Noise from a wind energy facility should be restricted to no more than 5 dBA above the current ambient noise level at a potential sensitive receptor
5. Wind farms should be limited to within the range of 35dBA to 40dBA (day-time) in a low noise environment. A fixed limit of 43 dBA should be implemented during all night time noise environments. This should increase to 45 dBA (day and night) if the potential receptor has financial investments in the wind energy facility

[1] ETSU was set up in 1974 as an agency by the United Kingdom Atomic Energy Authority to manage research programmes on renewable energy and energy conservation. The majority of projects managed by ETSU were carried out by external organisations in academia and industry. In 1996, ETSU became part of AEA Technology plc which was separated from the UKAEA by privatisation.

7. A penalty system should be implemented for wind turbine/s that operates with a tonal characteristic

2.8.3 Noise Guidelines for Wind Farms (MoE, 2008)

This document establishes the sound level limits for land-based wind power generating facilities and describes the information required for noise assessments and submissions under the Environmental Assessment Act and the Environmental Protection Act, Canada.

The document defines:

- Sound Level Limits for different areas (similar to rural and urban areas), defining limits for different wind speeds at 10 m height
- The Noise Assessment Report, including;
  - Information that must be part of the report
  - Full description of noise sources
  - Adjustments, such as due to the wind speed profile (wind shear)
  - The identification and defining of potential sensitive receptors
  - Prediction methods to be used (ISO 9613-2)
  - Cumulative impact assessment requirements
  - It also defines specific model input parameters
  - Methods on how the results must be presented
  - Assessment of Compliance (defining magnitude of noise levels)

The document used the $L_{Aeq,1h}$ noise descriptor to define noise levels.

3 CURRENT ENVIRONMENTAL SOUND CHARACTER

3.1 MEASUREMENT PROCEDURE

Ambient (background) noise levels were measured during night time in accordance with the South African National Standard SANS 10103:2003 "*The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication*". The standard specifies the acceptable techniques for sound measurements including:

- type of equipment;
- minimum duration of measurement;
- microphone positions;
- calibration procedures and instrument checks; and
- weather conditions.

It should be noted that wind induced noises are normally seen as unwanted noises, and samples reflecting significant background interference due to wind induced noises are normally discarded. However, for the purpose of this study it was selected to include these samples as the typical operating noise of the wind energy facility will only be emitted during times when wind induced noise levels are relevant.

The equipment defined in **Table 3.1** was used for gathering data:

Table 3.1: Equipment used to gather data

Equipment	Model	Serial no	Calibration
SLM	Rion NL-32	01182945	12 May 2009
Microphone	Rion UC-53A	315479	12 May 2009
Preamplifier	Rion NH-21	28879	12 May 2009
Calibrator	Rion NC-74	34494286	3 April 2009
Wind meter	Kestrel 4000	587391	Calibrated[2]

* Microphone fitted with the WS-01/ WS-03/WS-10 windshield.

[2] Factory Calibrated

3.2 ONSITE MEASUREMENTS

Measurements were taken in the mornings between 2 am and 6 am on 30 and 31 March 2010, with the sound measuring equipment calibrated directly before, and directly after the measurement was taken. In all cases drift was less than 1 dBA.

Figure 3-1: Monitoring points selected near the proposed WEF

The locations used to measure ambient (background) sound levels are presented in **Figure 3-1**. These points are considered sufficient to determine the ambient (background) sound levels in the area. The results are presented in **Table 3.2** below.

Table 3.2: Results of ambient (night) sound level monitoring

Point name	Latitude, Longitude	Wind speed Ave. (m/s)	$L_{Aeq,T}$ (dBA)	$L_{A, max}$ (dBA)	$L_{A, min}$ (dBA)	Temp (°C)	Humidity (%)
RAN-01	-33.363029° 18.339970°	3.1	36.6	51.3	27.5	14.1	84
RAN-02	-33.337002° 18.288231°	2.0	26.7	40.7	22.0	14.4	86.3
RAN-03	-33.331907° 18.262178°	2.2	28.3	45.1	23.7	15	86
RAN-04	-33.369426° 18.321536°	1.8	29.7	49.2	22.4	15.7	84.3

From the data obtained, it can be seen that the ambient (background) sound levels ranges between 22 (minimum) and 29.7 ($L_{Aeq,10min}$) dBA during times when there is no wind, or very little air movement.

Important to note that the average wind speed at RAN-01 was 3.1 m/s, with numerous gusts up to 6 m/s. During sampling no other sounds were detected that were not from natural sources. The night-time ambient sound level at RAN-01 therefore ranged between 27 (minimum) and 36.6 ($L_{Aeq,10min}$) dBA, mainly due to increased wind speeds.

3.3 INFLUENCE OF WIND ON AMBIENT SOUND LEVELS

Unfortunately, current regulations and standards do not consider changing ambient (background) sound levels due to natural events, such as can be found near the coast (from the ocean waves) or areas where wind induced noises are prevalent, which is unfeasible with wind energy facilities, as these facilities will only operate when the wind is blowing. It is therefore important that the impact of wind-induced noises be considered when determining the impact of an activity such as a wind energy facility.

Figure 3-2 illustrates this situation where the sound pressure levels associated with wind action increase as wind speeds increase. The sound levels measured (mainly wind impacting on the background ambient sound levels) is also indicated on this Figure (in yellow).

The curve developed is based on the noise measurements collected at a number of sites in South Africa. While not site specific, the principle is to fit a curve using the available data that can be used to estimate cautious ambient sound levels during times when wind is blowing. The curve used is based on a curve developed near the Silverton Wind Farm in Australia.

Figure 3-2 was developed by plotting Sound Pressure Levels ($L_{Aeq,10min}$) versus average wind speed (averaged over the 10 minutes that the measurement was collected), and the estimated curve adjusted downward with 3dBA below the lowest ambient sound levels measured at wind speeds higher than 3 m/s. For the modelling, the appropriate ambient sound levels from this curve will be used. Due to the downward adjustment, the potential full effect of the wind-related ambient noise levels will be reduced (the level used would be at least 3 dBA less than the real ambient sound level).

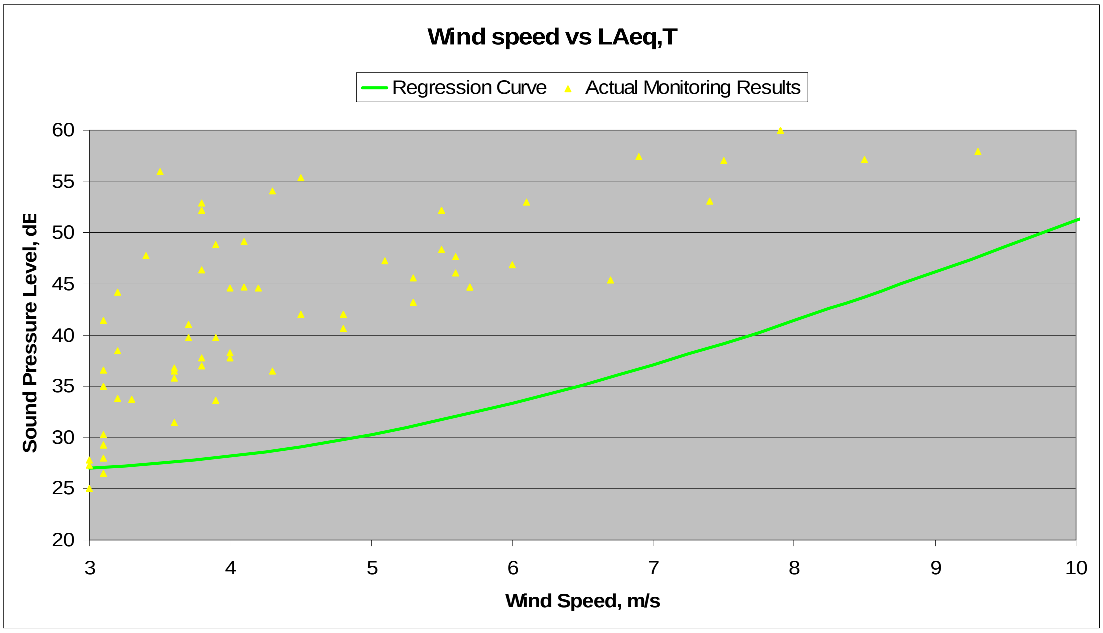

Figure 3-2: Ambient sound levels as wind speed increase

Reasons for a 3dBA penalty used in **Figure 3-2** include the following:

- Uncertainty factors, such as the small inaccuracies/interference that can be incurred during monitoring; This should cover the following points:
    1. Instrument Accuracy and chain of instruments (tripod, cables, Sound Level Meter, Pre-amplifier, Microphone, Calibration – 1 dBA)
    2. Wind shield used to do measurements (2 dBA)
    3. Wind Turbulence and Gustiness making sampling more difficult that would reduce repeatability (2 dBA)
    4. Wind Shear effects (Refer to **section 6.3.3.1** – 2 dBA)

The RMS value of these uncertainties is approximately 3 dBA.

3.4 Accuracy of Ambient Measurements

It should be noted that it is desired that all measurement points be at least 200 m away from any dwelling, and in most cases preferably more than 500 m. In addition the points were selected to be away from structures (buildings, trees, etc.) that could significantly impact the ambient sound levels during periods when wind is blowing. During times when wind is blowing, ambient sound levels are generally higher near dwellings or other structures than at areas away from such structures.

Even with no wind blowing, there is a number of factors that determine by how much ambient sound levels close to a dwelling might differ from the ambient sound level further away, including:

- Whether there are any wind pumps close to the dwelling,
- Type of trees around dwelling (conifers vs. broad-leaved trees, habitat that it provides to birds, food that it may provide to birds)
- The number, type and distance between the dwelling (measuring point) and trees. This is especially relevant when the trees are directly against the house (where the branches can touch the roof).
- The material used in the construction of the dwelling.
- How well the dwelling was maintained.
- What type and how many farm animals are in the vicinity of the dwelling.
- Whether and what type of activities are taking place.

As no samples are collected at any active farming dwellings, daytime ambient sound levels at Potentially Sensitive Receptors are likely underestimated. When considering the probability that a PSR might experience a noise impact from a proposed activity, this fact is however taken into account. It should be noted that noise samples collected in the vicinities of residential dwellings ranged between 30 dBA (no activities) to higher than 50 dBA (dwelling with surrounding farming activities).

3.5 Ambient Sound Map

An ambient sound level map was compiled illustrating the observed scenario, being:

- Day-time (06:00 – 22:00) ambient background sound levels in wind-still conditions, daily traffic used for modelling as follows:
  - *R27: 100 vehicles/hour (5% trucks) travelling at 120 km/h;*
  - *R315: 72 vehicles/hour (2% trucks) travelling at 110 km/h,*

The night-time sample revealed:

- Night-time (22:00 – 06:00). Measurements were taken after 2 am the morning of the 31st March 2010 (*No traffic on R315 with a small number of cars observed on the R27. No night ambient sound level map was developed.*).

3.5.1 Ambient Sound Levels

For background modelling purposes ambient sound levels associated with low wind speeds were selected with the output represented in **Figure 3-3**.

A reader should note that the A-weighted noise levels as illustrated is the “average” or “equivalent” noise level that receptors could experience. While receptors close enough to the road will detect vehicles travelling on the road, they experience that peak noise levels only for a short while. The rest of the time noise levels would return to the ambient sound level. The A-weighted Equivalent noise levels as illustrated are therefore used to “average” the exposure that receptors experience due to traffic in a set time period and is used to define the potential impact that receptors are experiencing.

It should be noted that other noise sources were not added to this ambient sound map. Typical sources during the day would be:

- Dogs barking and farm animals,
- Radios or TVs playing in the background,
- People speaking,
- Other activities, such as farming activities.

While some of these noise sources cannot be considered insignificant, the sheer task of adding all noise sources makes this task almost impossible. In addition, the more other noise sources are added, the lower the projected impact of the activity under investigation, due to the increased ambient sound levels. This is however considered during the impact assessment phase when the probability is estimated, because these types of ambient sounds tend to mask noises during the day.

The ambient sound map only illustrates the likely soundscape in the area, considering only the main noise sources such as existing roads, industrial and mining activities. It excludes the noise under investigation, as well as small noise sources (associated with typical farming activities, domestic and agricultural animals etc.).

The Darling Experimental Wind Farm is another important noise source in the area when wind is blowing. Unfortunately little information is available on the noise emission characteristics of the wind turbines used in the wind farm, even after a written request to the developer. It will not be considered as a noise source during the daytime ambient sound map (wind still conditions), but will be considered as a potential noise source during the operational phase.

Figure 3-3: Daytime (06:00 – 22:00) ambient sound levels: Contours of constant sound levels

While no night ambient sound map are developed, noise from the Darling Experimental wind farm will be considered using the noise emission characteristics as proposed in **section 7.3.1**.

4 POTENTIAL NOISE SOURCES

Increased noise levels are directly linked with the various activities associated with the construction of the WEF and related infrastructure, as well as the operational phase of the activity.

4.1 Potential Noise Sources: Construction Phase

4.1.1 Construction equipment

Construction activities include:

- construction of access roads,
- establishment of turbine tower foundations and electrical substation(s),
- the possible establishment, operation and removal of concrete batching plants,
- delivery of turbine, substation and power line components, as well as other materials to the site,
- digging of trenches to accommodate underground power cables; and
- the erection of turbine towers and assembly of wind turbine generators.

The equipment likely to be required to complete the above tasks will typically include:

- excavator/graders, bulldozer(s), dump trucks(s), vibratory roller, bucket loader, rock breaker(s), drill rig, flat bed truck(s), concrete truck(s), crane(s), fork lift(s) ,various 4WD and service vehicles, as well as other smaller machinery such as concrete vibrators etc.

Octave sound power levels typical for this equipment are presented in Appendix B.

4.1.2 Material supply: Concrete batching plants and use of Borrow Pits

There exist three options for the supply of the concrete to the development site. These options are:

1. The transport of "ready-mix" concrete from the closest centre to the development,
2. The transport of aggregate and cement from the closest centre to the development, with the establishment of a small concrete batching plant close to the activities. This would most likely be a movable plant.
3. The establishment of a small quarrying activity, where aggregate will be mined, crushed and screened and used onsite. Cement will still be transported to the site, where there will be a small movable concrete batching plant. In terms of

noise generation, this will be the worst case scenario. The developer however indicated that a borrow pit will not be considered at this facility.

The developer indicated that option 2 would be the preferred option.

4.1.3 Blasting

Blasting may be required as part of the civil works to clear obstacles or to prepare foundations. However, blasting will not be considered during the EIA phase for the following reasons:

- Blasting is highly regulated, and control of blasting to protect human health, equipment and infrastructure will ensure that any blasts will use minimum explosives and will occur in a controlled manner. The breaking of obstacles with explosives is also a specialized field, and when correct techniques are used, causes significantly less noise than using a rock-breaker.
- People are generally more concerned over ground vibration and air blast levels that might cause building damage than the impact of the noise from the blast. However, these are normally associated with close proximity mining/quarrying.
- Blasts are an infrequent occurrence, with a loud but a relative instantaneous character. Potentially affected parties normally receive sufficient notice (siren), and the knowledge that the duration of the siren noise as well as the blast will be over relative fast result in a higher acceptance of the noise. Note that with the selection of explosives and blasting methods, noise levels from blasting is relatively easy to control.

4.1.4 Traffic

A significant source of noise during the construction phase is additional traffic to and from the site, as well as traffic on the site. This will include trucks transporting equipment, aggregate and cement as well as various components used to construct the wind turbine.

Construction traffic is expected to be generated throughout the entire construction period, however, the volume and type of traffic generated will be dependent upon the construction activities being conducted, which will vary during the construction period. Noise levels due to traffic will be estimated using the methodology stipulated in SANS 10210:2004 (Calculating and predicting road traffic noise).

4.2 Potential Noise Sources: Operational Phase

Noise emitted by wind turbines can be associated with two types of noise sources. These are aerodynamic sources due to the passage of air over the wind turbine blades and mechanical sources which are associated with components of the power train within the turbine, such as the gearbox and generator and control equipment for yaw, blade pitch, etc. These sources normally have different characteristics and can be considered separately. In addition there are other lesser noise sources, such as the substations themselves, traffic (maintenance) as well as transmission line noise.

4.2.1 Wind Turbine Noise: Aerodynamic sources

Aerodynamic noise is emitted by a wind turbine blade through a number of sources such as:

1. Self noise due to the interaction of the turbulent boundary layer with the blade trailing edge.
2. Noise due to inflow turbulence (turbulence in the wind interacting with the blades).
3. Discrete frequency noise due to trailing edge thickness.
4. Discrete frequency noise due to laminar boundary layer instabilities (unstable flow close to the surface of the blade).
5. Noise generated by the rotor tips.

Noise due to aerodynamic instabilities (mechanisms 3 and 4) can be reduced to insignificant levels by careful design. The other mechanisms are an inescapable consequence of the aerodynamics of the turbine which produces the power and between them they will make up most if not all of the aerodynamic noise radiated by the wind turbine. The relative contribution of each source will depend upon the detailed design of the turbine and the wind speed and turbulence at the time.

The mechanisms responsible for tip noise (mechanism 5) are currently under investigation from various turbine developers, but it appears that methods for its control through design of the tip shape may be available. Self noise (mechanism 1) is most significant at low wind speeds whereas noise due to inflow turbulence (mechanism 2) becomes the dominant source at the higher wind speeds. Both mechanisms increase in strength as the wind speed increases, particularly inflow turbulence. The overall result is that at low to moderate wind speeds the noise from a fixed speed wind turbine increases at a rate of 0.5-1.5 dBA /m/s up to a maximum at wind speeds of 7 -12 m/s (noise generated by the WTG does not increase significantly at wind speeds above 12 m/s).

Therefore, as the wind speed increases, noises created by the wind turbine also increases. At a low wind speed the noise created by the wind turbine is generally (relatively) low, and increases to a maximum at a certain wind speed when it either remains constant, increase very slightly or even drops as illustrated in **Figure 4-1**.

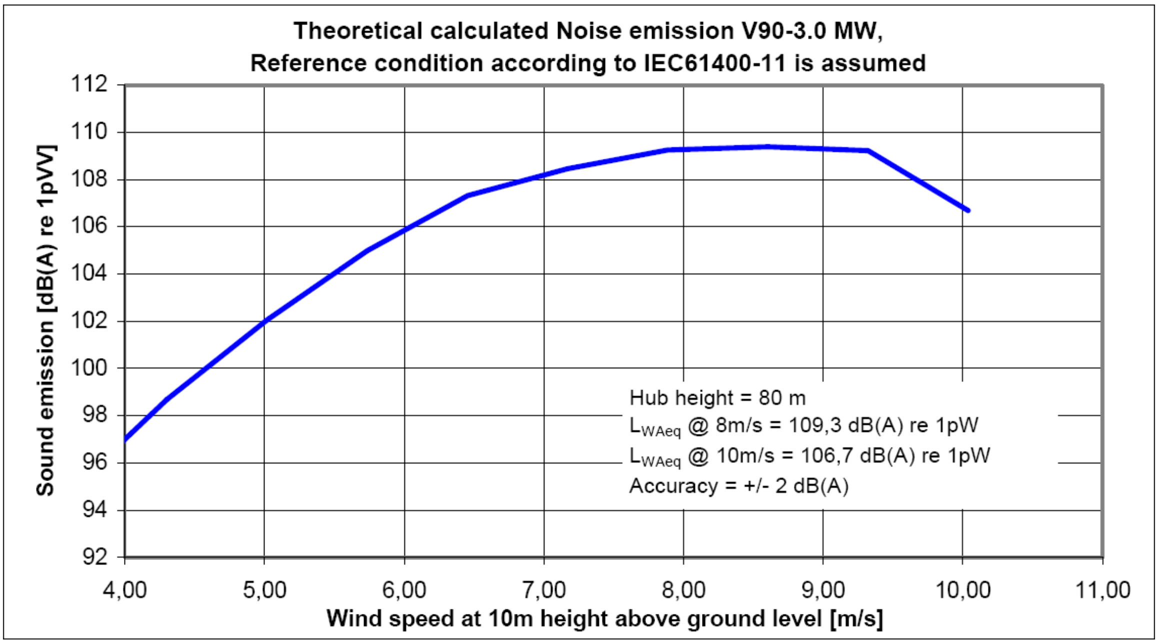

Figure 4-1: Noise Curve Vestas V90 – 3.0 MW, 60Hz (figure for illustration purposes)

Typical noise characteristics can be measured for each type of wind turbine, and minimum/average/maximum curves as seen in **Figure 4-2** can be compiled. The more accurate the data, the more accurate the modelling would be.

The developer highlighted that the Gamesa G90 2.0MW wind turbine (instead of the Vestas V90 2.0MW used in revision 0) could possibly be considered for use at the WEF. For the purpose of this investigation this wind turbine was selected.

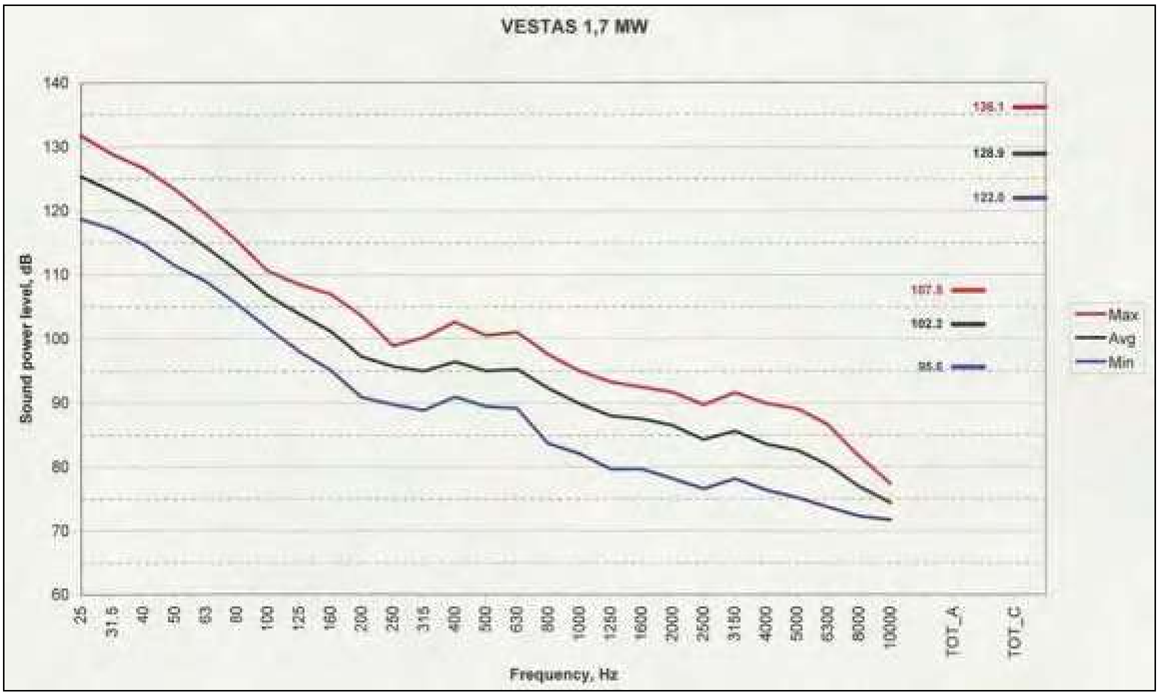

Figure 4-2: Sound power level emission of a Vestas, V66 wind turbine

Sound power emissions (in octave sound power levels) for the Vestas wind turbine are presented in **Table 4.1** (used for the unmitigated layout), with **Table 4.2** presenting the sound power emission levels of the Gamesa G90 2.0 MW turbine. However, full spectral noise emission data was not available for the Gamesa G90 wind turbine at the writing of this report, and due to the complex propagation of sound, it was selected to use the spectral data from a much larger wind turbine (Vestas V90 3.0 MW - **Table 4.3**), following the precautionary principle. ***Using this larger wind turbine it is estimated that this predictions would likely over-estimate the noise magnitude at the potentially noise sensitive receptors with 0 – 3 dBA.***

The propagation model makes use of various frequencies because these frequencies are affected in different ways as it propagates through air, over barriers and over different ground conditions.

Table 4.1: Sound Power Emissions of the Vestas V90 2.0MW (Ref 961263)

Wind Speed (m/s)	Frequency (Hz)	31.5 (dB)	63 (dB)	125 (dB)	250 (dB)	500 (dB)	1000 (dB)	2000 (dB)	4000 (dB)	L_{WA} (dBA)
5	$L_{wA,P}$	71.1	80.2	84.3	88.5	91.6	94.1	92.9	90.7	**99.2**
	$L_{w,P}$	109.0	105.9	100.7	97.2	94.8	94.1	91.7	89.7	**111.5**
7	$L_{wA,P}$	74.9	84.4	89.7	92.9	96.1	98.6	97.1	94.7	**103.6**
	$L_{w,P}$	113.6	110.5	106.0	101.6	99.3	98.7	96.0	93.8	**116.2**
8	$L_{wA,P}$	75.8	85.4	90.6	93.4	96.4	98.6	97.4	95.2	**103.9**
	$L_{w,P}$	114.4	111.4	106.9	102.2	99.5	98.7	96.3	94.2	**117.0**

1: This wind turbine was used for the original layout. It is presented in this report as the unmitigated option.

Table 4.2: Sound Power Emissions of the Gamesa G90 2.0MW (Ref GD039985 R01 G90)

Wind Speed (m/s)	Frequency (Hz)	63 (dB)	125 (dB)	250 (dB)	500 (dB)	1000 (dB)	2000 (dB)	4000 (dB)	L_{Wp} (dBA)
8	$L_{wA,P}$	86.7	94.3	99.3	101.1	98.9	94.4	89.3	**105.7**
	$L_{w,P}$	112.4	110.3	107.7	104.5	99.2	93.3	88.4	**115.8**

2: This wind turbine is proposed for the revised layout. It is presented in this report as the mitigated option.

Table 4.3: Sound Power Emissions of the Vestas V90 3.0MW (Ref: 0005-9597)

Wind Speed (m/s)	Frequency (Hz)	31.5 (dB)	63 (dB)	125 (dB)	250 (dB)	500 (dB)	1000 (dB)	2000 (dB)	4000 (dB)	L (dBA)
5	$L_{wA,P}$	68.6	80.9	91.3	90.4	92.4	94.4	93.3	90.0	**100.1**
	$L_{w,P}$	107.6	106.1	109.9	99.3	95.5	94.6	92.2	89.0	**113.3**
7	$L_{wA,P}$	79.2	89.1	92.1	94.7	97.1	99.8	99.0	95.1	**105.0**
	$L_{w,P}$	119.0	117.9	107.5	103.5	100.3	99.9	97.9	94.1	**121.8**
8	$L_{wA,P}$	80.4	91.1	93.1	95.8	98.1	100.6	99.8	95.9	**105.9**
	$L_{w,P}$	119.6	120.0	108.7	104.5	101.4	100.7	98.7	94.9	**123.2**

3: This wind turbine was used for the revised layout. It is presented in this report as the mitigated option.

4.2.2 Wind Turbine: Mechanical sources

Mechanical noise is normally perceived within the emitted noise from wind turbines as an audible tone(s) which is subjectively more intrusive than a broad band noise of the same sound pressure level. Sources for this noise are normally associated with: the gearbox and the tooth mesh frequencies of the step up stages; generator noise caused by coil flexure of the generator windings which is associated with power regulation and control; generator noise caused by cooling fans; and control equipment noise caused by hydraulic compressors for pitch regulation and yaw control.

Tones are noises with a narrow sound frequency composition (e.g., the whine of an electrical motor). Annoying tones can be created in numerous ways: machinery with rotating parts such as motors, gearboxes, fans and pumps often create tones. An imbalance or repeated impacts may cause vibration that, when transmitted through surfaces into the air, can be heard as tones. Pulsating flows of liquids or gases can also create tones, which may be caused by combustion processes or flow restrictions. The best and most well-known example of a tonal noise is the buzz created by a flying mosquito.

Where complaints have been received due to the operation of wind farms, tonal noise from the installed wind turbines appears to have increased the annoyance perceived by the complainants and indeed has been the primary cause for complaint.

However, tones were normally associated with the older models of turbines. All turbine manufacturers have started to ensure that sufficient forethought is given to the design of quieter gearboxes and the means by which these vibration transmission paths may be broken. Through the use of careful gearbox design and/or the use of anti-vibration techniques, it is possible to minimise the transmission of vibration energy into the turbine supporting structure.

The benefits of these design improvements have started to filter through into wind farm developments which are using these modified wind turbines. ***New generation wind turbine generators do not emit any clearly distinguishable tones***.

4.2.3 Transformer noises (Substations)

Also known as magnetostriction, this is when the sheet steel used in the core of the transformer tries to change shape when being magnetised. When the magnetism is taken away, the shape returns, only to try and deform in a different manner when the polarity is changed.

This deformation is not uniform; consequently it varies all over a sheet. With a transformer core being composed of many sheets of steel, these deformations are taking place erratically all over each sheet, and each sheet is behaving erratically with respect to its neighbour. The resultant is the “hum” frequently associated with transformers. While this may be a soothing sound in small home appliances, various complaints are logged in areas where people stay close to these transformers. At a voltage frequency of 50 Hz, these “vibrations” takes place 100 times a second, resulting in a tonal noise at 100Hz.

However, this is a relative easy noise to mitigate with the use of acoustic shielding and/or placement of the transformer equipment and will not be considered further in this EIA study.

4.2.4 Transmission Line Noise (Corona noise)

Corona noise is caused by the partial breakdown of the insulation properties of air surrounding the conducting wires. It can generate an audible and radio-frequency noise, but generally only occurs in humid conditions as provided by fog or rain. A minimum line potential of 70 kV or higher is generally required to generate corona noise depending on the electrical design. Corona noise does not occur on domestic distribution lines.

Corona noise has two major components: a low frequency tone associated with the frequency of the AC supply (100 Hz for 50 Hz source) and broadband noise. The tonal component of the noise is related to the point along the electric waveform at which the air begins to conduct. This varies with each cycle and consequently the frequency of the emitted tone is subject to great fluctuations. Corona noise can be characterised as broadband 'crackling' or 'buzzing', but fortunately it is generally only a feature during fog or rain.

It will not be further investigated, as corona discharges results in:

- Power losses,
- Audible noises,
- Electromagnetic interference,
- A purple glow,
- Ozone production; and
- Insulation damage.

In addition this is associated with high voltage transmission lines, and not the lower voltage distribution lines proposed for construction by the developer.

As such Electrical Service Providers (such as Eskom) goes to great lengths to design power transmission equipment to minimise the formation of corona discharges. In addition, it is an infrequent occurrence with a relative short duration compared to other operational noises.

4.2.5 Low Frequency Noise

4.2.5.1 Background and Information

Low frequency sound is the term used to describe sound energy in the region below ~200Hz. The rumble of thunder and the throb of a diesel engine are both examples of sounds with most of their energy in this low frequency range. Infrasound is often used to describe sound energy in the region below 20Hz.

Almost all noise in the environment has components in this region although they are of such a low level that they are not significant (wind, ocean, thunder). See also **Figure 4-3**, which indicates the sound power levels in the different octave bands from measurements taken at different wind speeds with no other audible noise sources present. Sound which has most of its energy in the 'infrasound' range is only significant if it is at a very high level, far above normal environmental levels.

4.2.5.2 The generation of Low Frequency Sounds

Because of the low rotational rates of the blades of a WTG, the peak acoustic energy radiated by large wind turbines is in the infrasonic range with a peak in the 8-12 Hz range. For smaller machines, this peak can extend into the low-frequency "audible" (20-20KHz) range because of higher rotational speeds and multiple blades.

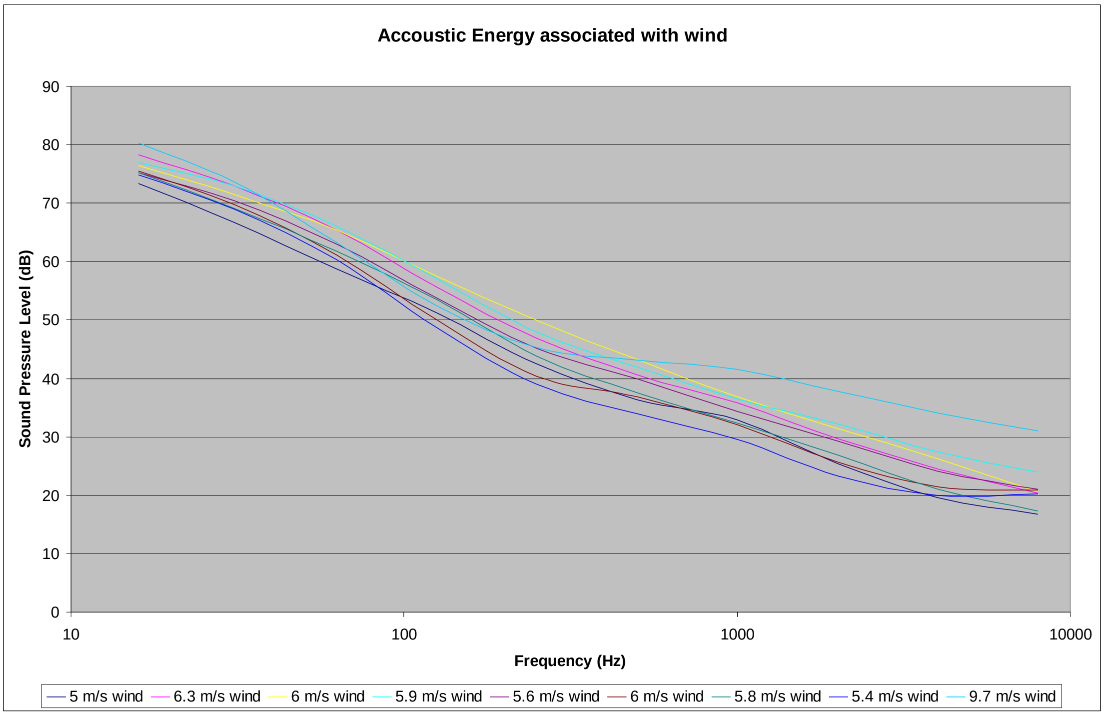

Figure 4-3: Third octave band sound power levels at various wind speeds

4.2.5.3 Detection of Low Frequency Sounds

The levels of infrasound radiated by the largest wind turbines are very low in comparison to other sources of acoustic energy in this frequency range such as sonic booms, shock waves from explosions, etc. The danger of hearing damage from wind turbine low-frequency emissions is remote to non-existent. However, sounds in a frequency range less than 100Hz can, under the right circumstances, be responsible for annoying nearby residents. Typically, except very near the source, most people outside cannot detect the presence of low-frequency noise from a wind turbine. It should be noted that there are people more sensitive for these low frequency sounds.

People however can, if the noise has an impulsive characteristic, "hear" it within homes in nearby dwellings under the right set of circumstances. Often it is not clear with low-frequency noise if people are hearing or feeling it or a combination of both stimuli. Because of the impulsive nature of the acoustic low-frequency energy being emitted, there is an interaction between the incident acoustic pulses and the resonance's of the homes which serve to amplify the stimuli creating vibrations as well as redistributing the energy higher into the audible frequency region. Thus the annoyance is often connected with the periodic nature of the emitted sounds rather than the frequency of the acoustic energy.

Impulsive noise generation is generally confined to turbines whose rotors operate downwind of the support tower (downwind machine). In this case, impulses are generated by the interaction of the aerodynamic lift created on the rotor blades and the wake vortices being shed from the tower elements. In the past 20 years modern wind turbines have nearly exclusively been designed as machines that have their rotors upstream of the tower. Those, except in very rare circumstances, do not generate impulses since there is nothing blocking the flow upwind of the rotor. The low-frequency noise generated from an upwind turbine is primarily the result of the interaction of the aerodynamic lift on the blades and the atmospheric turbulence in the wind. Because atmospheric turbulence is a random phenomenon, the radiated low-frequency noise also exhibits a random or non-coherent characteristic. Impulsive noise generated by the tower wake/rotor interaction, on the other hand, tends to be much less random or coherent and therefore much more detectable when it interacts with an intervening resonant structure.

For a healthy young adult the range of hearing is often quoted as extending from 20Hz to 20,000Hz although the sensitivity of the ear varies significantly with frequency and is most sensitive to sounds with frequencies between around 500Hz and 4,000Hz where the majority of information in speech signals is contained. Above and below this, the ear becomes decreasingly sensitive and is very insensitive at very low frequencies, meaning that sound levels have to be very high for such sounds to be perceived. Refer also to **Figure 4-4**.

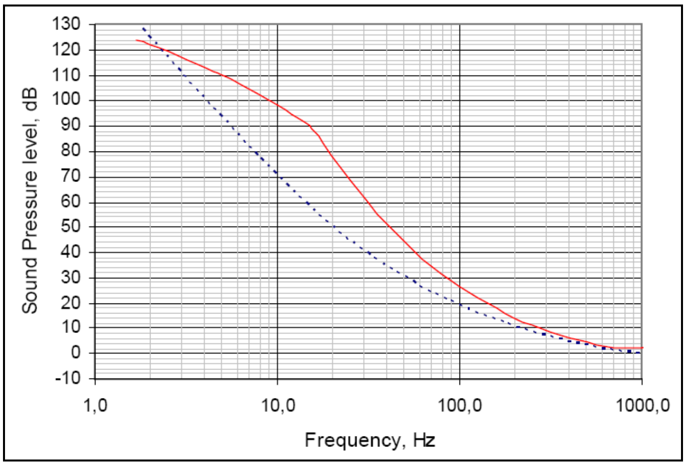

Figure 4-4: The average hearing threshold for humans (pure tones) in a free field (red line). The A-weighting line is the broken line.

However, various investigations have shown that the perception and the effects of sounds differ considerably at low frequencies as compared to mid- and high frequencies. The main aspects to these differences are:

- a weakening of pitch sensation as the frequency of the sound decreases below 60 Hz;
- perception of sounds as pulsations and fluctuations;
- a much more rapid increase of loudness and annoyance with increasing sound level at low frequencies than at mid- or high frequencies;
- complaints about the feeling of ear pressure;
- annoyance caused by secondary effects like rattling of building elements, e.g. windows and doors or the tinkling of bric-a-brac;
- other psycho acoustic effects, e.g. sleep deprivation, a feeling of uneasiness; and
- reduction in building sound transmission loss at low frequencies compared to mid- or high frequencies.

4.2.5.4 Measurement, Isolation and Assessment of Low Frequency Sounds

There remain significant debate regarding the noise from WTG's, public response to that noise, as well as the presence or not of low frequency sound and how it affects people. While low frequency sounds can be measured, it is far more difficult to isolate low frequency sounds due to the numerous sources generating these sounds.

However, from sound power level emission graphs such as **Figure 4-2** and the data contained in **Table 4.1**, it can be seen that a wind turbine has significant potential to generate low frequency sounds with sufficient energy to warrant the need to investigate WTG as a source of low frequency sounds. However, the reader is also referred to **Figure 4-3** and **Figure 4-5** for examples of various other sources and associated levels of low frequency sounds. From these two figures it is clear that there is significant acoustic energy in the lower frequencies (less than 100 Hz) in the environment around us.

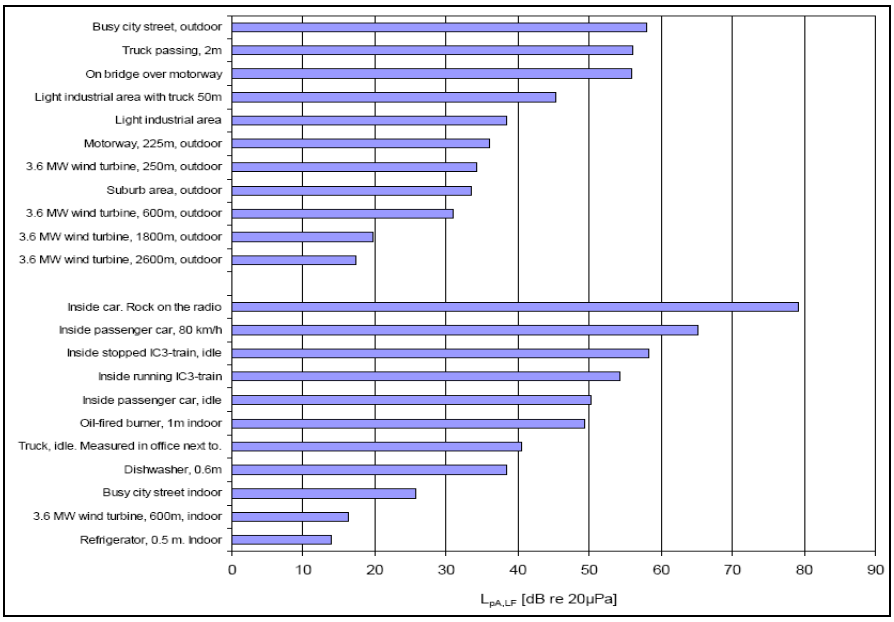

Figure 4-5: Examples on A-weighted low frequency levels $L_{pA,LF}$ from a number of indoor and outdoor sources.

Unfortunately there isn't a standardised test, nor an assessment procedure available for the assessment of low frequency sounds, neither is there an accepted methodology on how low frequency sounds can be modelled or predicted. This is because low frequency sound can travel large distances, and are present all around us, with a significant component generated by nature itself (ocean, wind, etc.).

SANS 10103:2004 proposes a method to identify whether low frequency noise could be an issue. It proposes that if the difference between the A-frequency weighted and the C-frequency weighted equivalent continuous (L_{Aeq} >> L_{Ceq}) sound pressure levels is greater than 10 dB, a predominant low frequency component **may** be present. However, at all cases existing acoustic energy in low frequencies associated with wind must be considered.

4.2.6 Amplitude modulation

There is one other characteristic of wind turbine sound that increases the sleep disturbance potential above that of other long-term noise sources. The amplitude modulation of the sound emissions from the wind turbines create a repetitive rise and fall in sound levels synchronised to the blade rotation speed, sometimes referred to as a "swish" or "thump". Many common weather conditions increase the magnitude of amplitude modulation. Most of these occur at night.

The graph in **Figure 4-6** shows this effect in the first floor bedroom of a farm home in the U.K. The home is located 930 meters from the nearest turbine (type or details of turbine unknown). The conditions documented by an independent acoustical consultant show the sound level varying over a 9 dBA range from 28 to 37 dBA. The pattern repeats approximately every second often for hours at a time. It is also reported that for many people, especially seniors, children and those with pre-existing medical conditions, this represents a major challenge to restful sleep.

This statement was also confirmed by Delta (2008, reference 2), stating that sounds from modern large wind turbines are dominated by the aerodynamic noise from the blades rotating in the air. The mid and high frequency aerodynamic noise is modulated by the low blade passage frequency (~1 Hz).

Unfortunately the mechanism of this noise is not known though various possible reasons have been put forward. Although the prevalence of complaints about amplitude modulation is relatively small, it is not clear whether this is because it does not occur often enough or whether it is because housing is not in the right place to observe it. Furthermore the fact that the mechanism is unknown means that it is not possible to predict when or whether it will occur.

Even though there are thousands of wind turbine generators in the world, amplitude modulation is one subject receiving the least complaints and due to this very few complaints, little research went into this subject. It is included in this report to highlight all potential risks, albeit extremely low risks such as this (low significance due to very low probability).

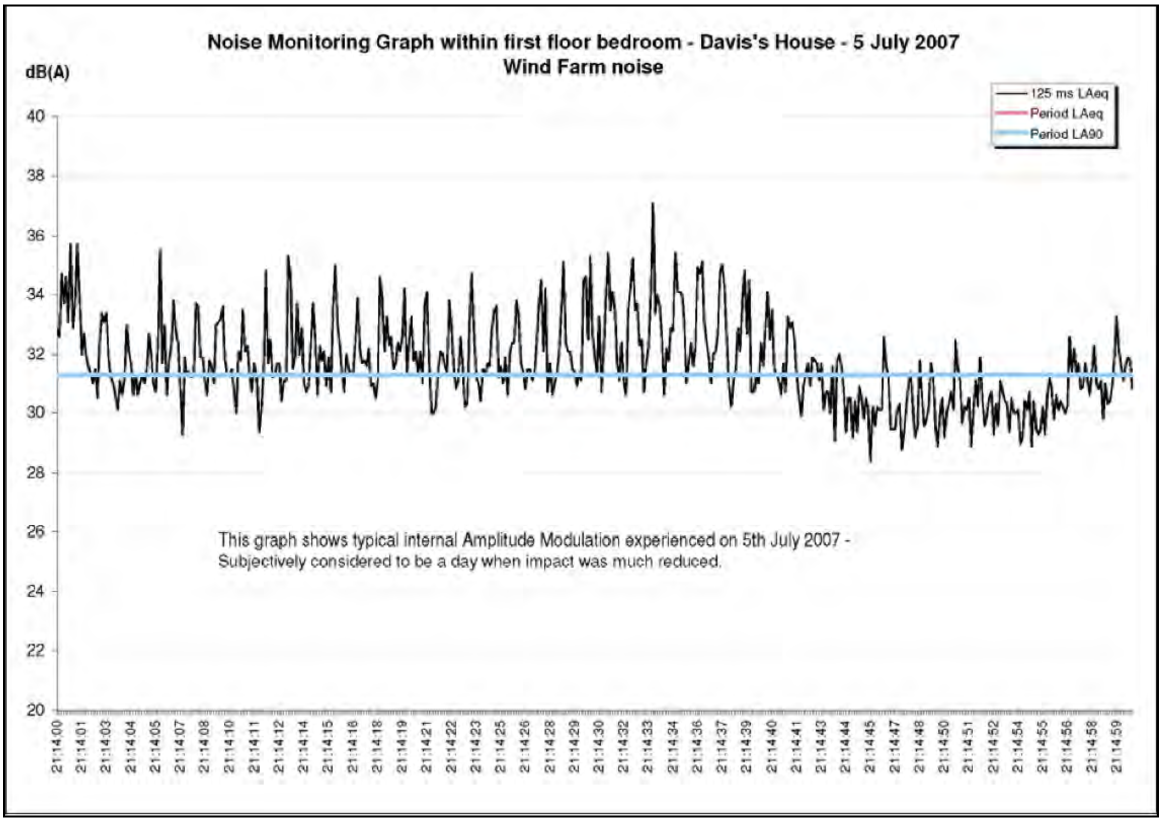

Figure 4-6: Amplitude modulation in a home 930 meters away from a WTG.

5 METHODOLOGY: CALCULATION OF FUTURE NOISE EMISSIONS DUE TO PROPOSED PROJECT

5.1 NOISE EMISSIONS INTO THE SURROUNDING ENVIRONMENT

The noise emissions into the environment from the various sources as defined by the project developer were calculated for the construction and operational phases in detail, using the sound propagation model described in both SANS 10357 as well as ISO 9613-2.

The following was considered:

- The octave band sound pressure emission levels of processes and equipment (SANS and ISO)
- The distance of the receiver from the noise sources (SANS and ISO)
- The impact of atmospheric absorption (SANS and ISO)
- The meteorological conditions in terms of Pasquill stability (considering refraction effects due to wind direction – SANS only)
- The operational details of the proposed project, such as the location of each Wind Turbine Generator (SANS and ISO)
- Topographical layout (SANS and ISO)
- Acoustical characteristics of the ground. Soft ground conditions were modelled, as the area where the facility is proposed to be constructed is well vegetated and sufficiently uneven to allow the consideration of soft ground conditions (50% soft for both the SANS and ISO models). This is also the point where the SANS and ISO model differ significantly in the method how attenuation is calculated, with the ISO model largely minimising ground attenuation due to the height of the point source *[the wind turbines in this case]*). The result is that noises originating from noise sources situated very high would be attenuated far less due to ground effects than noises originating closer to the ground surface using the ISO model

The noise emission into the environment due to additional traffic will be calculated using the sound propagation model described in SANS 10210. Corrections such as the following will be considered:

- Distance of receptor from the road
- Road construction material
- Average speeds of travel
- Types of vehicles used
- Ground acoustical conditions

5.2 FACTORS THAT MUST BE CONSIDERED THAT MIGHT COMPLICATE THE ACCURACY OF NOISE PROPAGATION MODELLING

Reviewing numerous literatures, the following factors were highlighted to complicate noise propagation modelling and prediction when working with wind turbines:

- As previously discussed, a wind turbine can cause a modulation of sound when the blades of the hub rotate, and depend on where the receptor to this sound is located. The threshold for detection of this modulation could be as much as 2 dB below a masking noise (white noise). Modulating sound characteristics from a wind turbine therefore makes it more likely to be noticed and less likely to be masked by background noise (Pederson, 2003). This not considered by predictive models.
- Residents complaining about wind turbine noise perceived the sound characteristics as more annoying than noise levels. People were able to distinguish between background ambient sounds, and the sounds that the blades made. The noise produced by the blades leads to most of the complaints. Most of the annoyance was experienced between 16.00 p.m. and midnight (Pederson, 2003). This could be an issue as noise propagation modelling would be reporting an equivalent, or “average” sound pressure level, a parameter that ignores the “character” of the sound.
- Night time meteorological conditions might be significantly different from the conditions assumed in noise propagation models. This is because of temperature gradients in the atmosphere. On a typical sunny afternoon, air is warmest near the ground and temperature decreases at higher altitudes. This temperature gradient causes sound waves to refract upward (due to the relative higher density of colder air) away from the ground and results in lower noise levels being heard at the listener’s position. At night, this temperature gradient will reverse, resulting in cooler temperatures near the ground. This condition, that is often referred to as a temperature inversion, will cause sound to be bent downward towards the ground and results in louder noise levels at a potentially sensitive receptor. Temperature gradients can and will influence sound propagation over long distances and further complicate predictive modelling. The result is that predictive models will under-estimate noise levels.
- The noise emission characteristics of the proposed wind turbines at the height at which the turbine will be installed. Available data for wind turbines show that height above ground level does have an impact on the sound pressure levels at a receptor on ground level. Taller turbines can be heard further than turbines.

- Due to the height of these wind turbines, trees and other structures do not assist with the sound attenuation. It is therefore more difficult to model the effect of ground attenuation. This can result in significant under or over-estimation.
- Apart from the fact that higher turbines are constructed to optimally “harvest” wind energy, higher wind turbines is normally fitted with larger blades. The result is that the sound power levels associated with the wind turbine also increase.
- Wind speeds at hub (nacelle) height could be significantly higher than the wind speeds at ground level (the “van den Berg Effect”). The “real” noise generated by the wind turbine would therefore be significantly higher than expected. In addition, as the wind speed at ground level is less than expected, ambient sound levels at the potentially sensitive receptors will be less, resulting in less “masking” potential from the wind at ground level.
- Down wind effects. Wind alters sound propagation by the mechanism of refraction; that is, wind bends sound waves. These wind gradients, with faster winds at higher elevation and slower winds at lower elevation causes sound waves to be bend downwards as they propagate down wind of the source and to bend upwards when propagating upwind.
- Noise propagation models are only accurate some of the time, for certain conditions. Unfortunately, it is impossible to consider all possible conditions. Therefore, there may be times when noise levels in practice exceed those predicted. If these conditions occur with any regularity, it would impact on closer receptors.
- There is no model that can predict the acceptability of a sound from a source by an individual. While sound pressure level is an important factor, it is certainly not the only one.
- The background sound in an area is important as it directly affects audibility through masking. However, background sound levels summarized (averaged) as an equivalent sound level ignores the random character of the sound. Background sound levels is a variable and typically changes from moment to moment, such as when vehicles pass nearby, birds chirp and the wind gusts. During these instances a noise might be less noticeable, possibly inaudible at times. However, at other times a noise source might be highly detectable.
- Cumulative effects from a number of wind turbines must be considered. A large wind farm (100+ turbines) cannot be treated the same way as a small wind farm (less than 20 turbines). Similarly, the cumulative effects from a number of wind turbines close to potentially sensitive receptors must be considered for the appropriate wind directions and speed.

- There is significant acoustic energy in the lower frequencies in the sounds generated by a wind turbine. With the possible effects of amplitude modulation, it remains an unknown factor.
- The location where the wind farm is to be developed. Areas close to urban development effectively removes these areas for future residential use due to the increased rating levels.
- Topographical layout should be considered. This is especially important when the turbines are to be installed on a ridge, with potential receptors being situated in a valley downwind from the turbines.

Due to these complicating factors, a precautionary stance should be taken.

6 METHODOLOGY: NOISE IMPACT ASSESSMENT AND SIGNIFICANCE

6.1 NOISE IMPACTS ON ANIMALS

Unfortunately there exist far less studies on the effects of noise on animals than on humans. However, a great deal of research was conducted in the 1960's and 1970's on the effects of aircraft noise on animals. Most of the studies however are highly relevant to other noise sources, including those associated with Wind Energy Facilities.

Overall, the research suggests that species differ in their response to:

- Various types of noise,
- Durations of noise,
- Sources of noise.

A general animal behavioural reaction to aircraft noise is the startle response. However, the strength and length of the startle response appears to be dependent on:

- which species is exposed,
- whether there is one animal or a group,
- whether there have been some previous exposures.

Unfortunately there are numerous other factors in the environment of animals that also influence the effects of noise. This includes predators, weather, changing prey/food base and ground-based disturbance, especially anthropogenic. This hinders the ability to define the real impact of noise on animals.

From this and other studies the following can be concluded:

- Animals respond to impulsive (sudden) noises (higher than 90 dBA) by running away. If the noises continue animals would try to relocate. This is not relevant to wind energy facilities because the turbines do not generate impulsive noises close to these sound levels.
- Animals of all species exhibit adaptation with noise, including aircraft noise and sonic booms (far worse than noises associated with Wind Turbines).
- More sensitive species would relocate to a more quiet area, especially species that depend on hearing to hunt or evade prey, or species that makes use of sound/hearing to locate a suitable mate.
- Noises associated with helicopters, motor- and quad bikes significantly impacts on animals.

6.1.1 Domestic Animals

It has been observed that most domestic animals are generally not bothered by noise, excluding most impulsive noises. In the intensity range that a Wind Turbine generates noise it should not impact on any domestic animal.

6.1.2 Wildlife

Depending on the turbine, some may create significant enough acoustic energy in the low frequency range that might impact on animals that makes use of vibrations to hunt. However this would be only relevant very close to the wind turbine, a zone normally already disturbed due to the construction and maintenance activities. In general, most anthropogenic activities already disturbed sensitive animals that might have been impacted by the noise from a wind turbine.

Noise impacts are also very highly species dependent. Studies showed that most animals adapt to noises, and would even return to a site after an initial disturbance, even if the noise continuous. The more sensitive animals that might be impacted by noise would most likely relocate to a more quiet area.

Unfortunately there are not specific studies discussing the potential impacts of noise associated wind turbines on wildlife. It may be that noises from wind turbines may mask the sounds of a predator approaching; similarly predators depending on hearing would not be able to locate their prey. However, due to significant background ambient sounds during periods when the wind turbines are operating (wind induced noises), the potential impact from a wind turbine on such animals are questioned.

A noteworthy study was conducted by Stephen Pearce-Higgins *et al* (2009). This survey of breeding birds in non-agricultural British uplands (moors and grassland) included weekly surveys during the breeding season at 12 different wind farm sites, along with comparable nearby landscapes without turbines. Half the wind farms were from the previous generation (way back in the 1990's), with hub heights of 40m and less; the other half had hub heights of 60-70m. Of the twelve species that were observed often enough to provide good data, five seemed relatively unaffected by turbines (including kestrel, lapwing, grouse, skylark, and stonechat), while 7 species were less likely to nest within 500m of turbines, with smaller (i.e., not statistically significant) effects extending to 800m, or roughly half a mile. For six of the species (buzzard, hen harrier, plover, snipe, curlew, and wheatear), numbers were reduced by 39-52%.

The authors note that there is a pressing need for examination of the reasons for the depressed numbers and state: "*we do not know whether our observations of avoidance of turbines reflect a behavioural displacement, the local population consequences of collision mortality or reduced productivity, or both. The distinction is important. If there is high mortality of birds breeding close to the turbines associated with collision, then a wind farm may become a population sink if repeatedly colonized by naïve birds. If, however, the birds simply avoid breeding close to the turbines, then displaced birds may settle elsewhere with little cost.*"

They also note that "*species occupying remote semi-natural habitats may be more sensitive to wind farm development than species occupying intensive production landscapes*."

This indicates that the potential significance of a noise impact would depend on the species concerned. Less sensitive species would not be bothered by the noises from the wind turbines, whereas the more sensitive species might relocate. Unfortunately, there is no database of potential sensitive species in South Africa. Taking the precautionary route, it is suggested that construction do not take place within 500 meters from any sensitive species as identified by the Fauna/Avifauna study during the breeding season.

6.2 WHY NOISE CONCERNS COMMUNITIES

Noise can be defined as "unwanted sound", and an audible acoustic energy that adversely affects the physiological and/or psychological well-being of people, or which disturbs or impairs the convenience or peace of any person. One can generalise by saying that sound becomes unwanted when it:

- Hinders speech communication,
- Impedes the thinking process,
- Interferes with concentration,
- Obstructs activities (work, leisure and sleeping),
- Presents a health risk due to hearing damage.

However, it is important to remember that whether a given sound is "noise" depends on the listener or hearer. The driver playing loud rock music on their car radio hears only music, but the person in the traffic behind them hears nothing but noise.

Response to noise is unfortunately not an empirical absolute, as it is seen as a multi-faceted psychological concept, including behavioural and evaluative aspects. For instance, in some cases annoyance is seen as an outcome of disturbances, in other cases it is seen as an indication of the degree of helplessness with respect to the noise source.

Noise does not need to be loud to be considered "disturbing". One can refer to a dripping tap in the quiet of the night, or the irritating "thump-thump" of the music from a neighbouring house at night when one would like to sleep.

Severity of the annoyance depends on factors such as:

- Background sound levels, and the background sound levels the receptor is used to,
- The manner in which the receptor can control the noise (helplessness),
- The time, unpredictability, frequency distribution, duration, and intensity of the noise,
- The physiological state of the receptor,
- The attitude of the receptor about the emitter (noise source).

6.3 IMPACT ASSESSMENT CRITERIA

6.3.1 Overview: The common characteristics

The word "noise" is generally used to convey a negative response or attitude to the sound received by a listener. There are four common characteristics of sound, any or all of which determine listener response and the subsequent definition of the sound as "noise". These characteristics are:

- Intensity
- Loudness
- Annoyance
- Offensiveness

Of the four common characteristics of sound, intensity is the only one which is not subjective and can be quantified. Loudness is a subjective measure of the effect sound has on the human ear. As a quantity it is therefore complicated but has been defined by experimentation on subjects known to have normal hearing.

The annoyance and offensive characteristics of noise are also subjective. Whether or not a noise causes annoyance mostly depends upon its reception by an individual, the environment in which it is heard, the type of activity and mood of the person and how acclimatised or familiar that person is to the sound.

6.3.2 Noise criteria of concern

The criteria used in this report were drawn from the criteria for the description and assessment of environmental impacts from the EIA Regulations, published by the Department of Environmental Affairs (April 1998) in terms of the NEMA, SANS 10103 as well as guidelines from the World Health Organization.

There are number of criteria that are of concern for the assessment of noise impacts. These can be summarised in the following manner:

- *Increase in noise levels:* People or communities often react to an increase in the ambient noise level they are used to, which is caused by a new source of noise. With regards to the Noise Control Regulations (promulgated in terms of the ECA), an increase of more than 7 dBA is considered a disturbing noise. See also **Figure 6-2**.
- *Zone Sound Levels:* Previously referred as the acceptable rating levels, it sets acceptable noise levels for various areas. See also **Table 6.1**.
- *Absolute or total noise levels:* Depending on their activities, people generally are tolerant to noise up to a certain absolute level, e.g. 65 dBA. Anything above this level will be considered unacceptable.

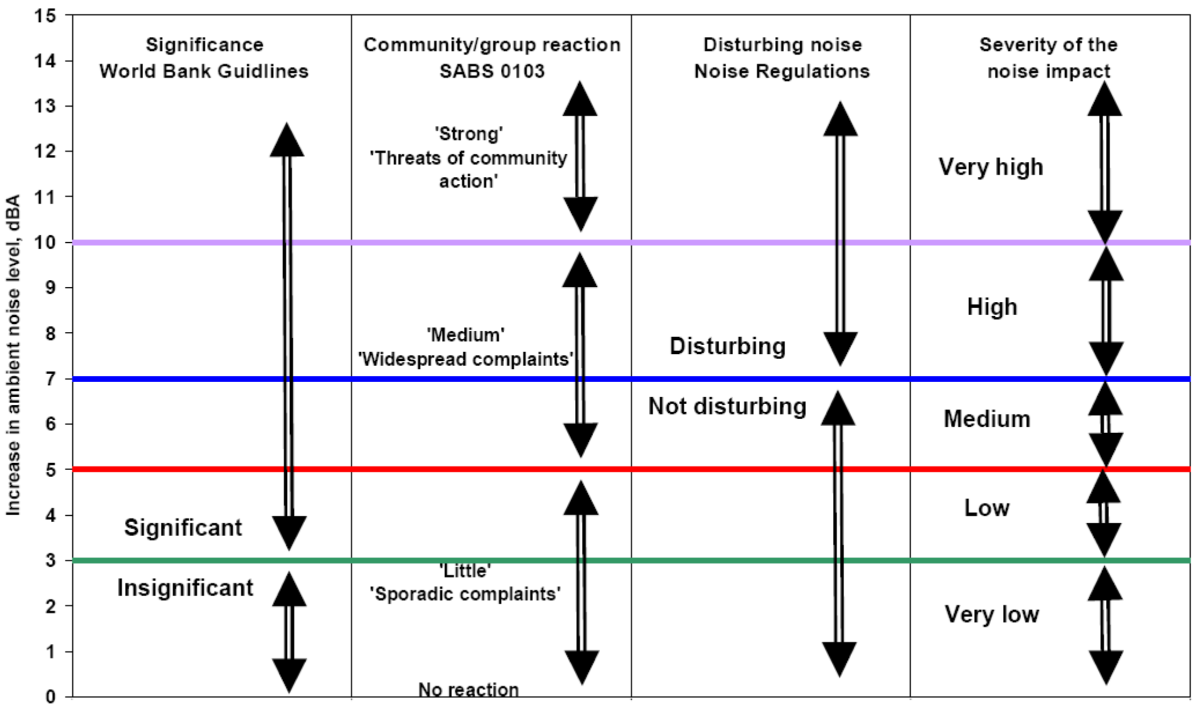

Figure 6-1: Criteria to assess the significance of impacts stemming from noise

In South Africa the document that addresses the issues concerning environmental noise is SANS 10103:2008 (See also **Table 6.1**) It provides the maximum average background ambient sound levels, $L_{Req,d}$ and $L_{Req,n}$, during the day and night respectively to which different types of developments may be exposed. For rural areas the Zone Sound Levels are:

- Day (06:00 to 22:00) - $L_{Req,d}$ = 45 dBA, and
- Night (22:00 to 06:00) - $L_{Req,n}$ = 35 dBA.

SANS 10103 also provides a guideline for estimating community response to an increase in the general ambient noise level caused by an intruding noise. If Δ is the increase in noise level, the following criteria are of relevance:

- **Δ ≤ 3 dBA:** An increase of 3 dBA or less will not cause any response from a community. It should be noted that for a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level would not be noticeable.
- **3 < Δ ≤ 5 dBA:** An increase of between 3 dBA and 5 dBA will elicit 'little' community response with 'sporadic complaints'. People will just be able to notice a change in the sound character in the area.
- **5 < Δ ≤ 15 dBA:** An increase of between 5 dBA and 15 dBA will elicit a 'medium' community response with 'widespread complaints'. In addition, an increase of 10 dBA is subjectively perceived as a doubling in the loudness of a noise. For an increase of more than 15 dBA the community reaction will be 'strong' with 'threats of community action'.

Table 6.1: Acceptable Zone Sound Levels for noise in districts (SANS 10103:2008)

1	2	3	4	5	6	7
Type of district	**Equivalent continuous rating level ($L_{Req,T}$) for noise,** dBA					
	Outdoors			**Indoors, with open windows**		
	Day-night $L_{R,dn}$[a]	**Day-time** $L_{Req,d}$[b]	**Night-time** $L_{Req,n}$[b]	**Day-night** $L_{R,dn}$[a]	**Day-time** $L_{Req,d}$[b]	**Night-time** $L_{Req,n}$[b]
RESIDENTIAL DISTRICTS						
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
NON RESIDENTIAL DISTRICTS						
d) Urban districts with some workshops, with business premises, and with main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

6.3.3 Determining appropriate Zone Sound Levels

SANS 10103:2008 unfortunately does not cater for instances when background ambient sound levels change due to the impact of external forces. Locations close to the sea for instance always have an ambient sound level exceeding 35 dBA, and, in cases where the sea is rather turbulent, it can easily exceed 45 dBA. Similarly, noise induced by high winds is not included in the SANS standard.

Setting noise limits relative to the ambient sound level is relatively straightforward when the prevailing ambient sound level and source level are constant. However, wind turbines emit noise that is related to wind speed, and the environment within which they are heard will probably also be dependent upon the strength of the wind and the noise associated with its effects. It is therefore necessary to derive a ambient sound level that is indicative of the noise environment at the receiving property for different wind speeds so that the turbine noise level at any particular wind speed can be compared with the ambient sound level in the same wind conditions.

Therefore, when assessing the overall noise levels emitted by a wind energy facility it is necessary to consider the full range of operating wind speeds of the wind turbines. This covers the wind speed range from around 3-5m/s (the turbine cut-in wind speed) up to a wind speed range of 25-35m/s measured at the hub height of a wind turbine. However, the Noise Working Group (1996) proposes that noise limits only be placed up to a wind speed of 12 m/s for the following reasons:

1. Wind speeds are not often measured at wind speeds greater than 12 m/s at 10m height.
2. Reliable measurements of background ambient sound levels and turbine noise will be difficult to make in high winds due to the effects of wind noise on the microphone and the fact that one could have to wait several months before such winds were experienced.
3. Turbine manufacturers are unlikely to be able to provide information on sound power levels at such high wind speeds for similar reasons.
4. If a wind farm meets noise limits at wind speeds lower than 12m/s it is most unlikely to cause any greater loss of amenity at higher wind speeds. Turbine noise levels increase to a maximum (between 7 and 9 m/s, depending on the turbine) where it remains relative constant as wind speeds increase; however, background ambient sound levels increases significantly with increasing wind speeds due to the force of the wind.

Available data indicates that noises from a Wind Turbine is drowned by other noises (wind howling around building, rustling of leaves in trees, rattling noises, etc) above a wind speed of 10 m/s, even if the wind blows in the direction of the receiver.

A cautious ambient sound vs. wind speed regression curve is illustrated in **Figure 6-2**. It should be noted that curves for daytime (6:00 – 22:00) and night time (22:00 – 6:00) would be different, but as wind speeds increase, the wind induced noise levels approach the noise emitted by the wind turbine(s).

For the purpose of the EIA, **Figure 6-2** will be considered, the change in sound levels that the receptors may experience together with the zone sound levels as stipulated in SANS 10103.

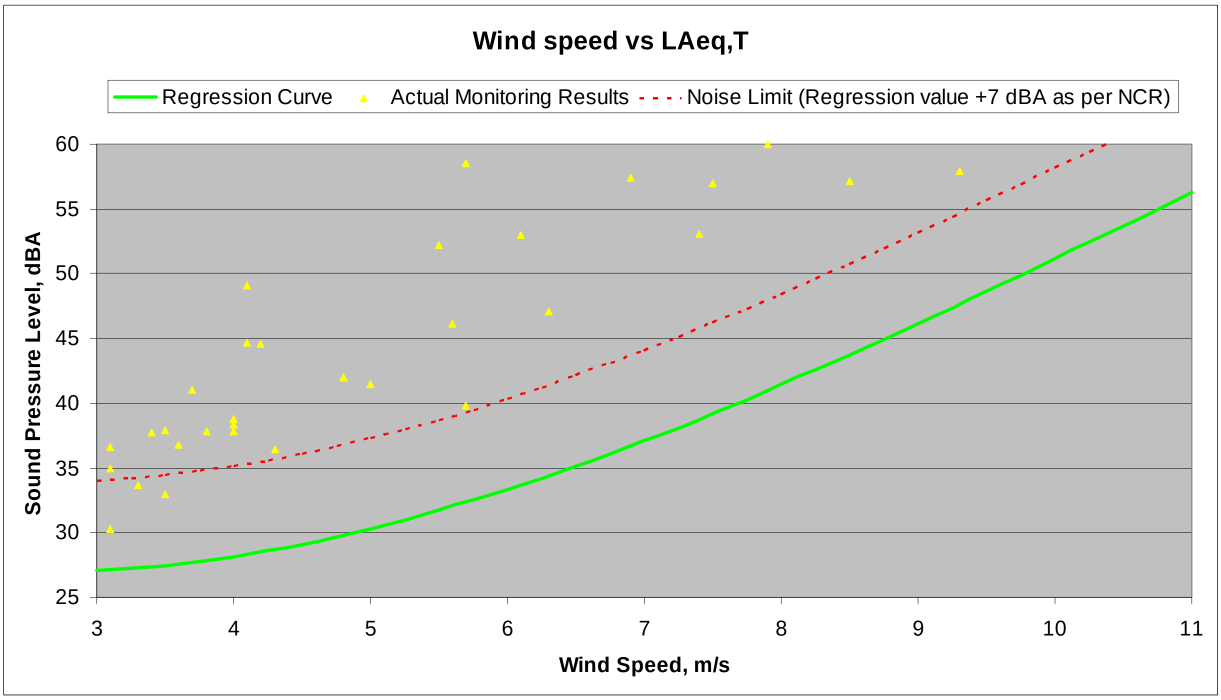

Figure 6-2: Background ambient sound levels associated with increased wind speeds

6.3.3.1 Relationship between wind speed at different levels and noise at ground level

Normally, as the height above ground level increase, wind speed also increases. For acoustical purposes prediction of the wind speed at hub height is based on the wind speed v_{ref} at the reference height (normally 10 meters) for wind speed measurements, extrapolated to a wind speed v_h at hub height, using the widely used formula:

$$v_h = v_{ref} \times \frac{\log\left(h/m\right)}{\log\left(h_{ref}/m\right)}$$

However, depending on topographical layout, this relationship may not be true at all times. Authors such as Van den Berg (2003) indicated that wind speeds at hub height could be significantly higher than expected, at the same time being significantly higher than ground level wind speeds. In these cases the wind turbines are operational and emitting noise, yet the wind induced ambient sound levels are less than expected (less masking of turbine noise). This is one of the reasons the ambient curve (**Figure 6-2**) is adjusted with -3 dBA, allowing the ambient sound levels to be less at all times than potential "real" ambient sound levels.

This should be considered when evaluating the significance of the impact, especially when the wind turbines are situated on a hill, with the prevailing wind direction being in the direction of potential sensitive receptors living in a valley downwind of the wind energy facility. It is proposed by this author that the precautionary approach be considered, and when there is one or more turbines within 1,000 meters from a downwind receptor(s), that the probability of this impact occuring be elevated with at least one step/factor (e.g. from ***Likely*** to ***Highly Likely***). This is one of the reasons the ambient curve (**Figure 6-2**) is adjusted with -3 dBA, allowing the ambient sound levels to be less at all times than potential "real" ambient sound levels.

6.3.3.2 Other noise sources of significance

In addition other noise sources that may be present should also be considered. During the day all living beings are bombarded with the sounds from numerous sources considered "normal", such as animal sounds, conversation, amenities and appliances (TV/Radio/CD playing in background, computer(s), freezers/fridges, etc). This excludes activities that may generate additional noise associated with normal work.

At night sounds that are present are natural sounds from animals, wind as well as other sounds we consider "normal", such as the hum from variety of appliances (magnetostriction) drawing standby power, freezers and fridges.

Figure 6-3 illustrates the sound levels associated with some equipment, or sound levels at certain places.

6.3.4 Determining the Significance of the Noise Impact

The level of detail as depicted in the EIA regulations was fine-tuned by assigning specific values to each impact. In order to establish a coherent framework within which all impacts could be objectively assessed, it was necessary to establish a rating system, which was applied consistently to all the criteria. For such purposes each aspect was assigned a value, ranging from one (1) to five (5), depending on its definition. This assessment is a relative evaluation within the context of all the activities and the other impacts within the framework of the project. An explanation of the impact assessment criteria is defined in **Table 6.2.**

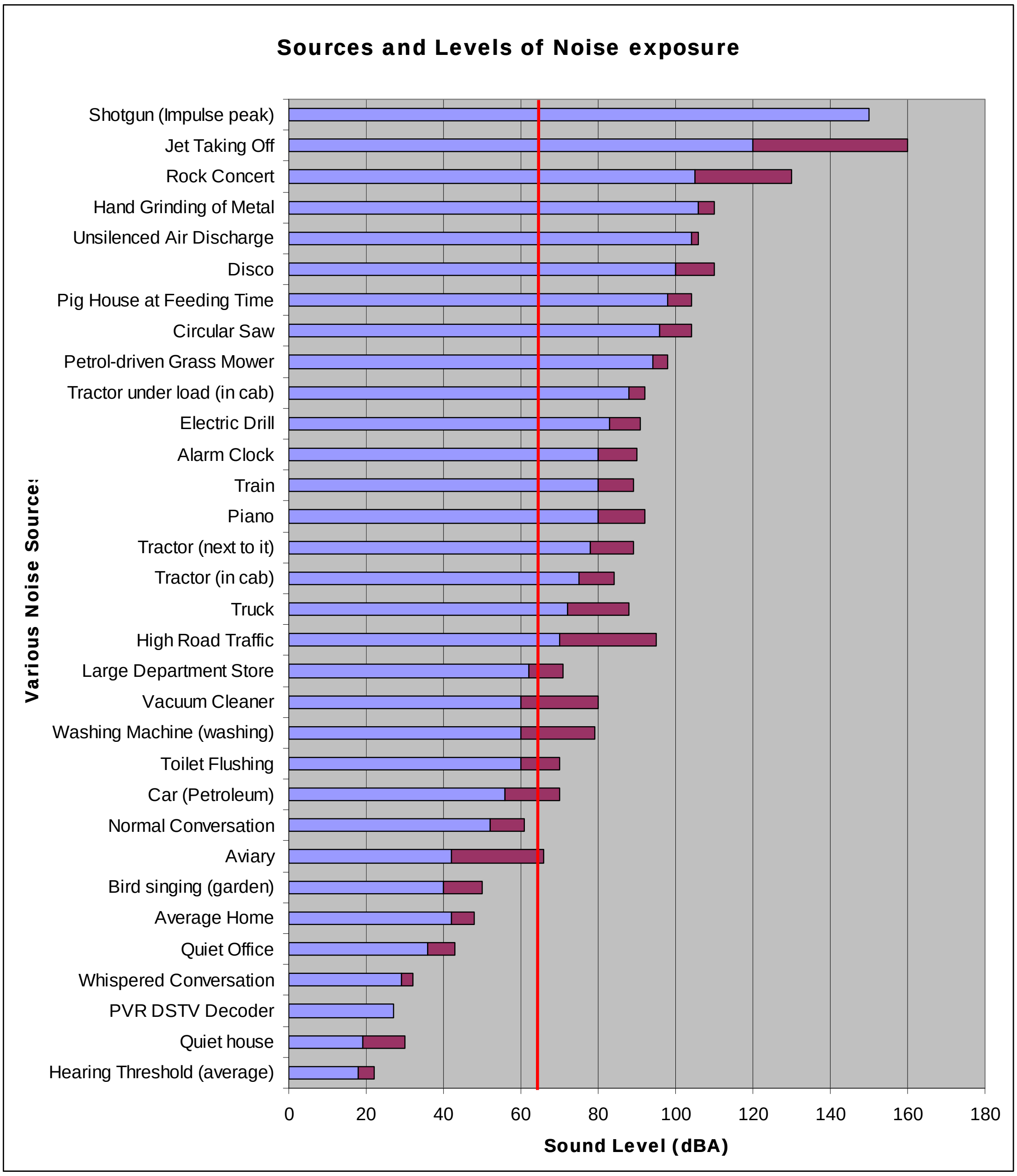

Figure 6-3: Typical Noise Sources and associated Sound Pressure Level

Table 6.2: Impact Assessment Criteria

Duration	
The lifetime of the impact that is measured in relation to the lifetime of the proposed development (construction, operational and closure phases). Will the receptors be subjected to increased noise levels for the lifetime duration of the project, or only infrequently.	
Temporary	The impact will either disappear with mitigation, will be mitigated through a natural process, or will last less than an hour.
Short term	The impact will be applicable less than 24 hours.
Medium term	The impact will last up to a week.
Long term	The impact will last up to a month.
Permanent	Any impacts lasting more than a month. It is considered non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact is transient.
Spatial scale	
Classification of the physical and spatial scale of the impact	
Site	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.
Local	The impact could affect the local area (within 1,000 m from site).
Regional	The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns.
National	The impact could have an effect that expands throughout the country (South Africa).
International	Where the impact has international ramifications that extend beyond the boundaries of South Africa.
Probability	
This describes the likelihood of the impacts actually occurring, and whether it will impact on an identified receptor. The impact may occur for any length of time during the life cycle of the activity, and not at any given time. The classes are rated as follows:	
Improbable	The possibility of the impact occurring is none, due either to the circumstances, design or experience. The chance of this impact occurring is zero (0 %).
Possible	The possibility of the impact occurring is very low, due either to the circumstances, design or experience. The chances of this impact occurring is defined to be up to 25 %.
Likely	There is a possibility that the impact will occur to the extent that provisions must therefore be made. The chances of this impact occurring is defined to be between 25% and 50 %.
Highly Likely	It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up before carrying out the activity. The chances of this impact occurring is defined to be between 50 % to 75 %.
Definite	The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied on. The chance of this impact occurring is defined to be between 75% and 100 %.
Magnitude	
This defines the impact as experienced by any receptor. In this report the receptor is defined as any resident in the area, but excludes faunal species.	
Low	Increase in sound pressure levels between 0 and 3 from the expected wind induced ambient sound level. The change may just be discernable. Total projected noise level is less than the Zone Sound Level in wind-still conditions.
Low Medium	Increase in sound pressure levels between 3 and 5 from the expected wind induced ambient sound level. The change is easily discernable. Total projected noise level is less than the Zone Sound Level in wind-still conditions.
Medium	Increase in sound pressure levels between 5 and 7 from the expected wind induced ambient sound level. Sporadic complaints. Any point where the zone sound levels are exceeded during wind still conditions.
High	Increase in sound pressure levels between 7 and 10 (**Figure 6-2** – any point above red line). Change of 10 dBA is perceived as 'twice as loud', leading to widespread complaints. Defined by the National Noise Regulations as being legally 'disturbing'. Any point where noise levels exceed zone sound level.
Very High	Increase in sound pressure levels higher than 10. Defined by the National Noise Regulations as being legally 'disturbing'. Threats of community or group action. Any point where noise

	levels exceed 65 dBA at any receptor.

In order to assess each of these factors for each impact, the following ranking scales as contained in **Table 6.3** will be used.

Table 6.3: Assessment Criteria: Ranking Scales

PROBABILITY		MAGNITUDE	
Description / Meaning	**Score**	**Description / Meaning**	**Score**
Definite/don't know	5	Very high/don't know	10
Highly likely	4	High	8
Likely	3	Medium	6
Possible	2	Low Medium	4
Improbable	1	Low	2
DURATION		**SPATIAL SCALE**	
Description / Meaning	**Score**	**Description / Meaning**	**Score**
Permanent	5	International	5
Long Term	4	National	4
Medium Term	3	Regional	3
Short term	2	Local	2
Temporary	1	Footprint	1

6.3.5 Identifying the Potential Impacts without Mitigation Measures (WOM)

Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned probabilities, resulting in a value for each impact (prior to the implementation of mitigation measures).

Significance without mitigation is rated on the following scale:

SR **< 30**	**Low (L)**	**Impacts with little real effect and which should not have an influence on or require modification of the project design or alternative mitigation. No mitigation is required.**
30 < **SR** < 60	Medium (M)	Where it could have an influence on the decision unless it is mitigated. An impact or benefit which is sufficiently important to require management. Of moderate significance - could influence the decisions about the project if left unmanaged.
SR > 60	High (H)	Impact is significant, mitigation is critical to reduce impact or risk. Resulting impact could influence the decision depending on the possible mitigation. An impact which could influence the decision about whether or not to proceed with the project.

6.3.6 Identifying the Potential Impacts with Mitigation Measures (WM)

In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it will be necessary to re-evaluate the impact. Significance with mitigation is rated on the following scale:

SR **< 30**	**Low (L)**	**The impact is mitigated to the point where it is of limited importance.**
30 < **SR** < 60	Medium (M)	Notwithstanding the successful implementation of the mitigation measures, to reduce the negative impacts to acceptable levels, the negative impact will remain of significance. However, taken within the overall context of the project, the persistent impact does not constitute a fatal flaw.
SR > 60	High (H)	The impact is of major importance. Mitigation of the impact is not possible on a cost-effective basis. The impact is regarded as high importance and taken within the overall context of the project, is regarded as a fatal flaw. An impact regarded as high significance, after mitigation could render the entire development option or entire project proposal unacceptable.

6.4 EXPRESSION OF THE NOISE IMPACTS

The noise impacts can be expressed in terms of the increase in present ambient sound levels caused by noise emissions from the proposed project. For this purpose, contours of equal increases in ambient sound levels in 2dBA steps will be used during the EIA phase. In addition predicted ambient sound levels will be presented in appropriate contours of constant sound pressure levels to illustrate the projected noise levels in the area.

For modelling and assessing the potential noise impact the values as proposed in **Table 6-4** will be considered.

Table 6-4: Proposed ambient sound levels and acceptable rating levels

Wind Speed (m/s)	$L_{Aeq,ambient}$ (**Figure 6-2**) dBA	Night-time Zone Sound Level (SANS 10103:2008) dBA	Proposed Night Rating Level (considering impact of wind) dBA (non-project participants)	Maximum Proposed Acceptable Night Rating Level dBA (+5 dBA) (Project participants)
3	27.04	35	35	40
4	28.15	35	35	40
5	30.30	35	35	40
6	33.33	35	35	40
7	37.09	35	37.1	42.1
8	41.40	35	41.4	46.4

7 RESULTS AND IMPACT ASSESSMENT

7.1 CONSTRUCTION PHASE: ORIGINAL LAYOUT

7.1.1 Construction Activities

Construction activities highly depend on the final operational layout. The original provisional layout as provided by the developer is presented in **Figure 7-1**. As can be seen from this proposal, a number of different activities will take place, each with a specific impact on the closest potential sensitive receptor. The following activities are proposed:

- The development of access roads: While the main access roads follow existing roads, the internal roads must be constructed. However, being gravel roads, the construction of these internal roads is a fast (temporary) and an uncomplicated process, with a small noise footprint. In addition, as this will take place during the day-time, the probability of impact on receptors is very low.
- Construction of the wind turbines, and lesser extent, the substation and workshop: This involves the clearing and levelling of the surface, the digging of foundations, concreting (mixing and pouring) and the erection of the towers, fixing of turbines and blades. The noisiest activity is normally bulldozing and excavation. The geological and geotechnical characteristics, project constraints and schedules would determine the size of the equipment. For the purpose of this assessment very large equipment was selected for modelling purposes. If these activities take place closer than 500 meters from sensitive receptors, it could impact on these receptors, as the activities could be noisy and takes place over a period of days.
- The development of the internal power lines to the substation: The developer indicated that these would comprise underground cables, which requires the digging of trenches and the laying of trunking (sleeve). The excavation is normally with a small TLB/Bobcat excavator. These activities are also relatively fast with a low risk of impacting on potential receptors.
- Development of overland 132kV power lines: The cabling is normally overland, carried by a number of pylons to the closest feed-in substation (ESKOM). The potential impact on receptors again depends on the distance between the area where a pylon is constructed and a potential receptor, but in general this noise impact is considered relatively insignificant, due to the temporary nature as well as low probability to impact on receptors.

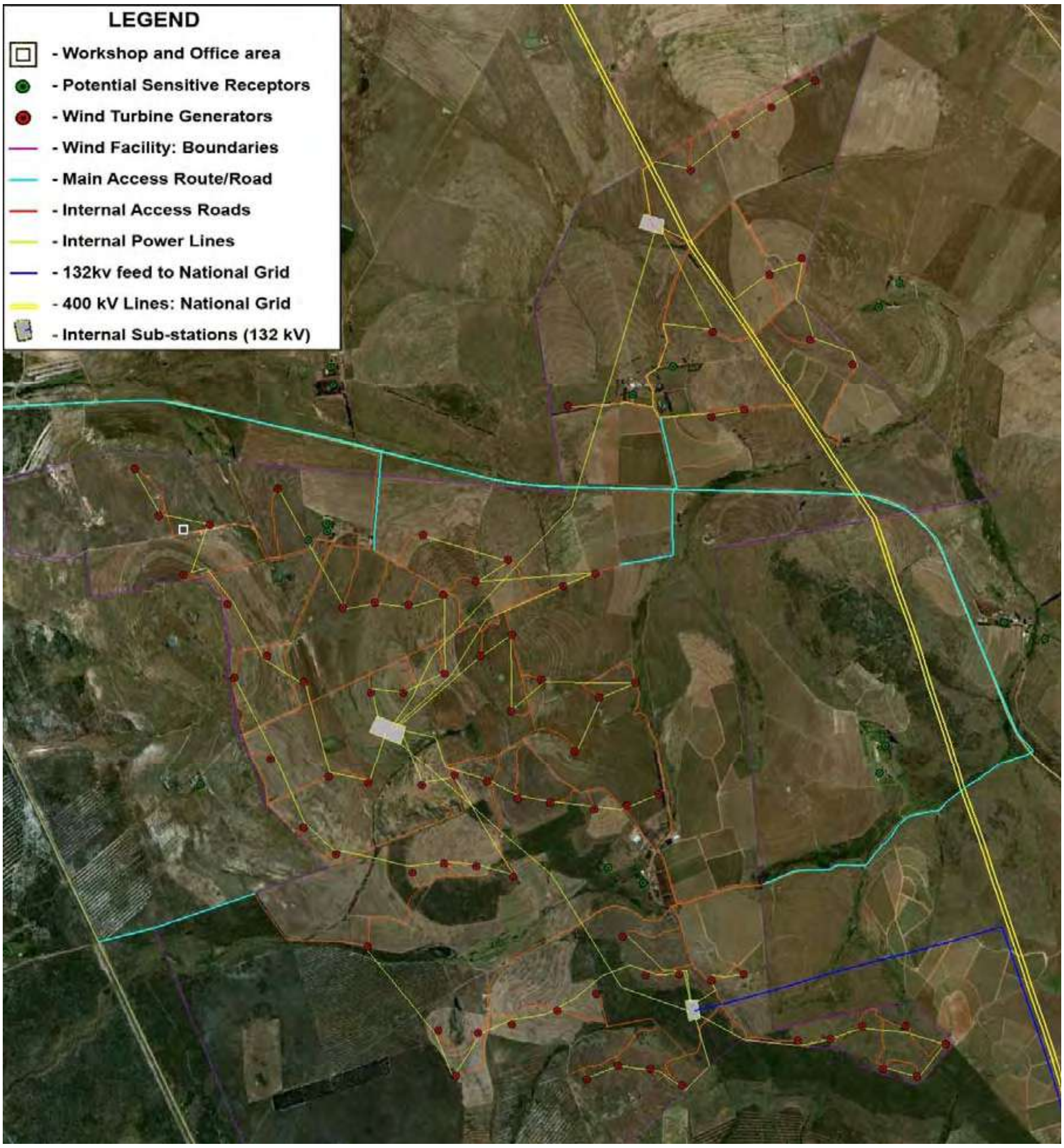

Figure 7-1: Full infrastructure proposal including alternatives

7.1.2 Description of Construction Activities Modelled

The following activities were assumed to take place simultaneously together with the normal activities observed during the site visit (see **Figure 7-2**):

- Various vehicle traffic from the R315 to the workshop/store area, from where traffic moves to the various sites where other construction activities are taking place. Traffic is set as a maximum of 5 trucks with 5 light construction vehicles (maximum) per hour travelling at an average speed of 40 km/h on the gravel road. This should represent the worst case scenario. This peak traffic would also increase the average traffic on the R27 slightly (the noise impact that the additional traffic on the R27 will have is considered to be insignificant).
- A worst case is selected to estimate the potential construction impact due to noise. For modelling purposes five sites were selected where various activities are taking place simultaneously. For the purpose of the EIA the activities that are most likely to create the loudest noises are:
    1. General work at the workshop area. This would be activities such as equipment maintenance, off-loading and material handling. All vehicles will travel to this site where most equipment and material will be off-loaded (General noise, crane). Material such as aggregate and sand will be taken directly to the construction area (foundation establishment). Activities are taking place for 16 hours during the 16 hour day-time period.
    2. Surface preparation prior to civil work. This could be the removal of topsoil for ground levelling purposes, or the preparation of an access road (bulldozer) and compaction. Activities are taking place for 8 hours during the 16 hour day-time period.
    3. Preparation of foundation area (sub-surface removal until secure base is reached – excavator, compaction and general noise). Activities are taking place for 10 hours during the 16 hour day-time period.
    4. Pouring of foundation concrete (general noise, electric generator/compressor, concrete vibrators, mobile concrete plant, TLB). As foundations must be poured in one go, the activity is projected to take place over the full 16 hour day-time period.
    5. Erecting of the wind turbine generator (general noise, electric generator/compressor, crane). Activities are taking place for 16 hours during the 16 hour day-time period.

Figure 7-2: Illustration of location of various construction activities: Original Layout

The following equipment is presumed to be onsite:

- 1x Bulldozer,
- 1x Grader,
- 1x Front-end loader and/or 1x Excavator,
- 1x Drilling machine (blasting purposes),
- 2x Electric Generator/Air Compressor
- 1x TLB,
- 1x Mobile Concrete Batching Plant/Truck,
- 2x Cranes,
- 2x Load haul dumpers.
- 5x light delivery vehicles/people carriers (travelling onsite).

There will be a number of smaller equipment, but the addition of the general noise source covers most of these noise sources. All equipment would be operating under full load (generate the most noise). Atmospheric conditions would be ideal for sound propagation.

Note that the scenario selected will present the worst case scenario, with all equipment operating under full load, with activities selected/positioned to be close to a sensitive receptor, and all activities taking place simultaneously.

7.1.3 Results: Construction Phase

The results from the construction phase based on the original turbine layout are presented in the figures below.

For the purpose of this evaluation the area selected represents the worst case scenario, where the potential receptor is very close to the construction sites, where potential noisy activities could impact on them.

The scenario as defined in section 7.1.2 was modelled with the output presented in **Figure 7-3** with the change in sound levels in **Figure 7-4**. Only the calculated day-time ambient noise levels are presented, as construction activities that might impact on sensitive receptors will be limited to the 06:00 – 22:00 time period.

The worse case scenario is presented with the all activities take place simultaneously during wind-still conditions, in good sound propagation conditions (20^{o}C and 80% humidity) with equipment under full load. Modelled noise levels are defined in **Table 7.1** with the impact tables presented in **Table 7.2**.

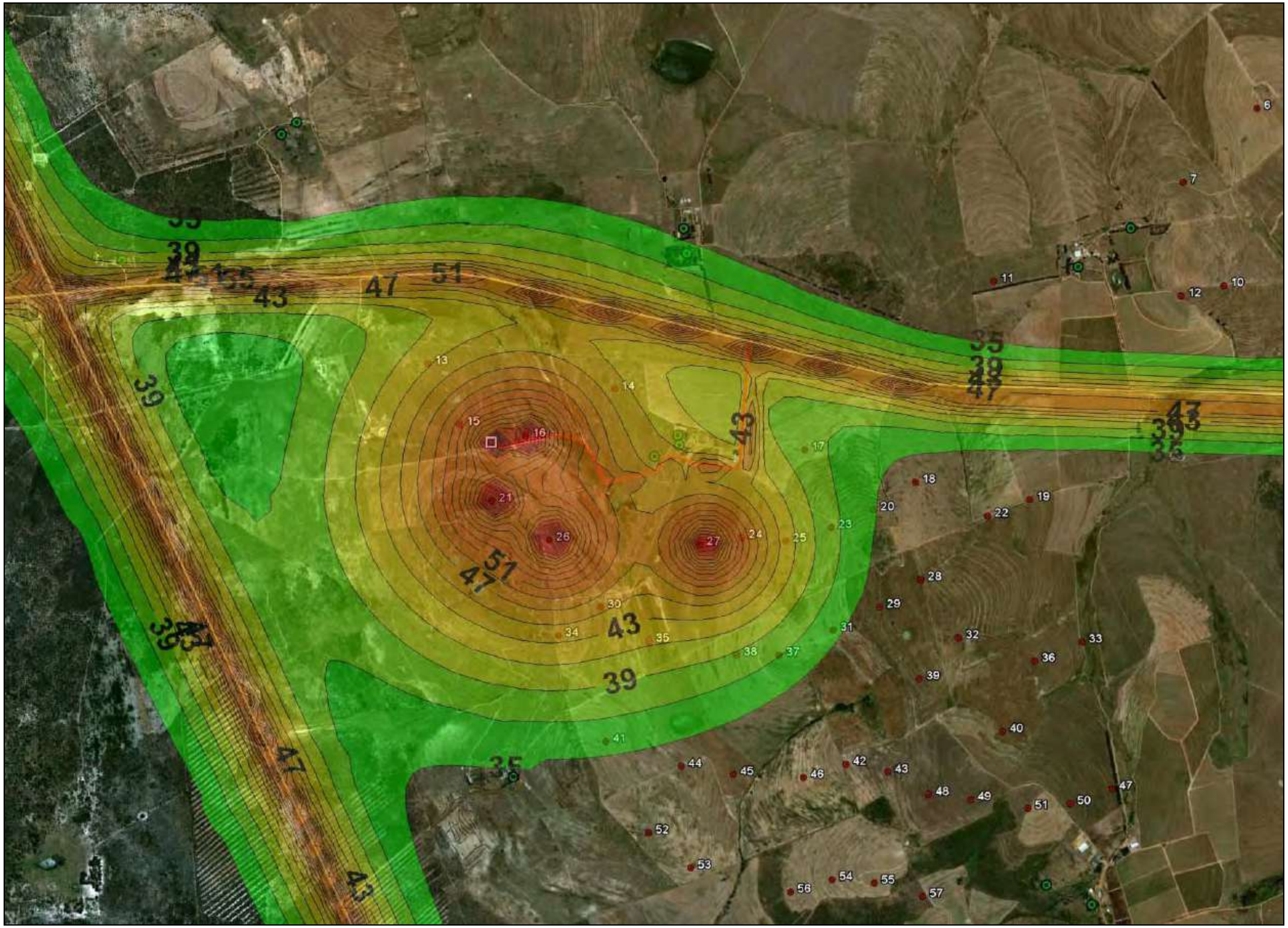

Figure 7-3: Construction noise: Contours of constant sound levels (First layout)

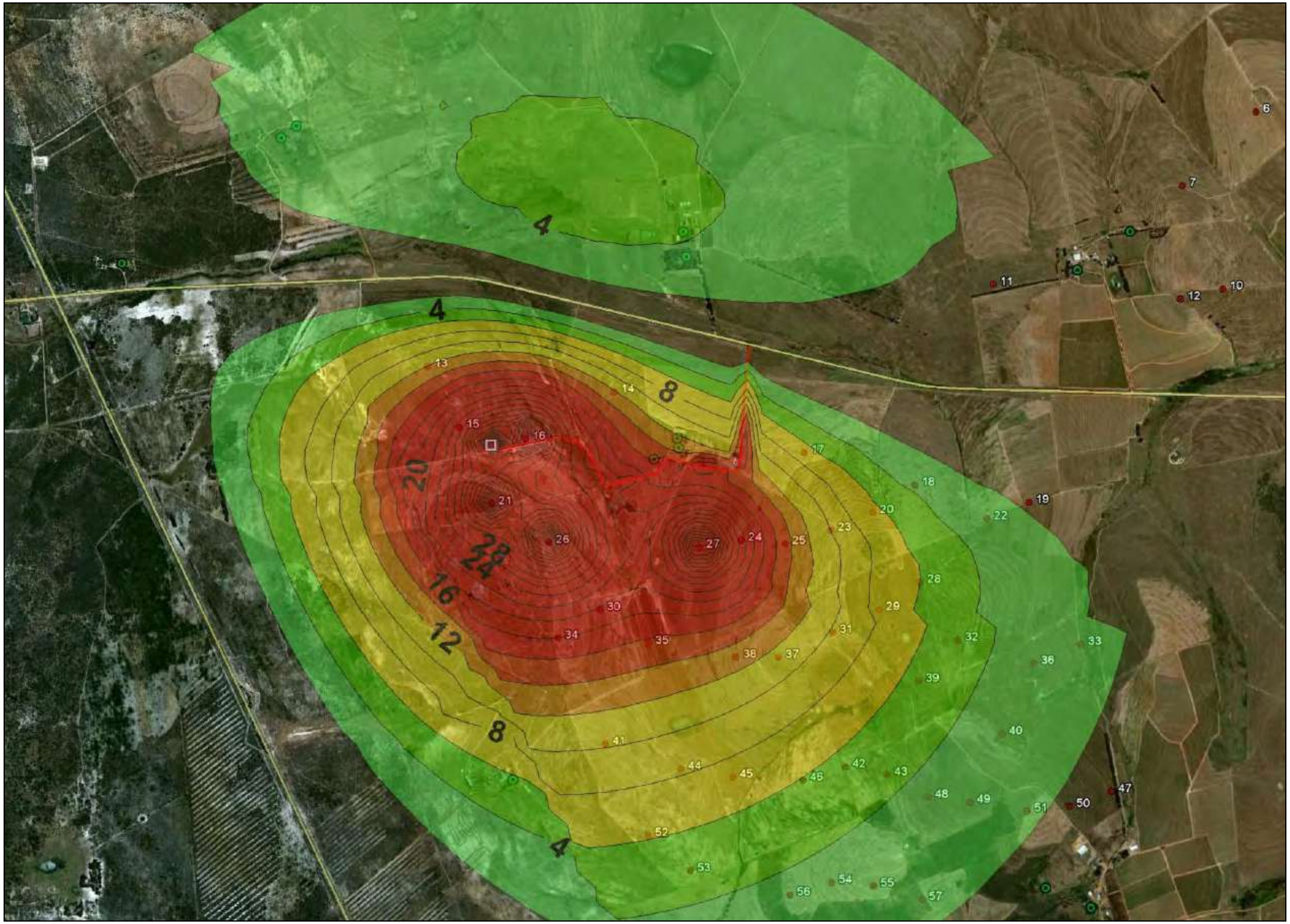

Figure 7-4: Construction noise: Change in ambient sound levels (contours of constant noise)

7.1.4 Impact Assessment: Construction Phase without mitigation

The impact assessment for the various construction activities that may impact on the surrounding environment is presented in the following **Tables**. Only receptors that might be subjected to increased noise levels presented.

Table 7.1: Construction: Defining noise impact on Receptors (dBA) (Datum type: Universal Transverse Mercator, zone 34 - South)

Receptor	Location X (m)	Location Y (m)	Day Ambient Noise Level[3]	Ambient Sound Level (refer section 3.4)	Change* in Noise Levels	Acceptable Zone Sound Levels ($L_{Req,d}$)	Significance of noise Impact (See Table 6.2, Table 6.3 and Table 7.2)	
PSR12	247044	6307346	44.14	28.6	*15.54*	45	**30**	**Low**
PSR13	247201	6307423	42.59	29.6	*12.99*	45	**30**	**Low**
PSR14	247191	6307485	42.07	30.05	*12.02*	45	**30**	**Low**

- Note: Change in ambient sound levels during the day are over-estimated, as it considers the ambient sound levels at the PSR to be very quiet during the day, which is not correct. Likely ambient sound levels near an active dwelling would be 40 – 60 dBA, depending on the activities taking place in the area. Also refer **section 3.4.**

Table 7.2: Construction: Impact Assessment Table without mitigation

Construction Phase		Magnitude	Duration	Extent	Probability	Significance
PSR12	Unmanaged	8	4	3	2	**30**
PSR13	Unmanaged	8	4	3	2	**30**
PSR14	Unmanaged	8	4	3	2	**30**

Table 7.3: Impact Assessment: Construction Activities without mitigation

Nature:	***Numerous simultaneous construction activities, number of PSR's can be impacted.***
Acceptable Rating Level	Rural district: 45 dBA outside during day (refer **Table 6.1**). Use $L_{Req,D}$ of 45 dBA.
Extent ($\Delta L_{Aeq,D}$>7dBA)	**Regional** – Change in ambient sound levels will extend more than 1,000 meters from activity (3)
Duration	**Long term** – Activities in the vicinity of the receptors could last up to a month (4)
Magnitude	***Estimated noise level*** ($L_{Aeq,D}$) ***up to 45 dBA*** $\Delta L_{Aeq,D}$ = 0 - 15 dBA **High** (8)
Probability	**Possible** – While the sound intensity and change in ambient sounds are high, it would be limited during the day when the potential sensitive receptors are either away or busy with their normal daily activities. Noises created by their normal daily activities would mask most construction related noises. This will minimises the possibility that this additional noise would impact on their quality of living. (2)
Significance	**30 (Low)**
Status	Negative
Reversibility	High
Irreplaceable loss of resources?	*Not relevant*
Comments	*Variety of activities could impact on receptors where the activity takes place within 500 meters from the house. Selection of noisy equipment working at full load 100% of the time represents worst*

[3] Ambient sound level was calculated using the SANS methods discussed in this report.

	case scenario.
Can impacts be mitigated?	Yes
Mitigation:	• Reducing the number simultaneous construction activities when working close to a receptor. ***Noise reduction between 3 and 6 dBA.*** • Ensuring that all equipment and machinery are well maintained and equipped with silencers (where possible). ***Noise reduction between 1 and 5 dBA.*** • Considering the noise emission characteristics of equipment when selecting equipment for a project/operation, and select the smallest, or least noisy machine available to do the specific work. ***Noise reduction between 3 – 15 dBA.*** • Working together with the local communities, and provide prior warning when a noisy activity is to take place. ***Higher acceptance to the noise, less annoyance, reduce probability of impact.*** • Only conduct very noisy activities between 10am and 4pm. ***Reduce probability that it will impact on receptors.*** • Conduct noisy activities in the shortest possible time (especially site preparation with bulldozer and civil work using an excavator). ***Noise reduction between 0 and 3 dBA***. • Move the closest turbines further from the receptors, or do not construct any turbines within 500 meters from potential receptors. This will move the construction sites. The increased distances from the activities and the receptors could have the single most significant reduction in noise levels. ***Variable, depends on distance between receptor and noise source***.
Cumulative impacts:	This impact is cumulative with existing ambient background noises as well as other noisy activities conducted in the same area.
Residual Impacts:	This impact will only disappear once construction activities cease.

7.2 CONSTRUCTION PHASE: REVISED LAYOUT

7.2.1 Construction Activities

The revised provisional layout as provided by the developer is presented in **Figure 7-5**. The construction activities are similar as defined in **section 7.1.1**.

7.2.2 Description of Construction Activities Modelled

The activities to take place as well as the equipment to be used were defined in **section 7.1.2** and illustrated in **Figure 7-6**.

As with the original report, this selected scenario will present the worst case scenario, with all equipment operating under full load, with activities selected/positioned to be close to a sensitive receptor, and all activities taking place simultaneously.

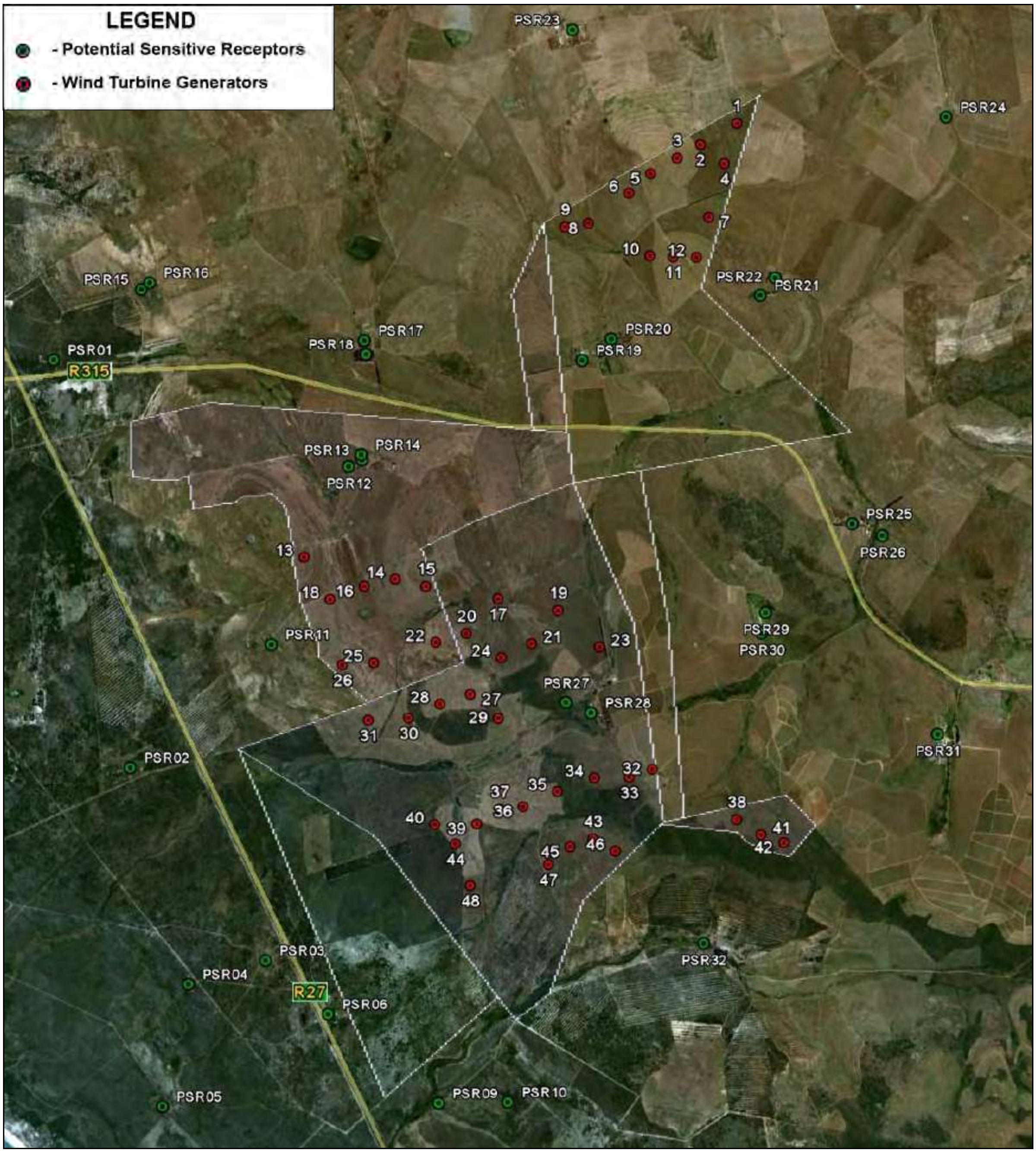

Figure 7-5: Revised Wind Turbine layout showing PSRs

Figure 7-6: Illustration of location of various construction activities: Revised Layout – worst case scenario

7.2.3 Results: Construction Phase

The results from the construction phase based on the revised turbine layout are presented in the figures below.

As mentioned previously, the area selected where the activities are taking place represents the worst case scenario, where the potential receptor is very close to the construction sites.

The scenario as defined in the previous sections was modelled with the output presented in **Figure 7-7** with the change in sound levels presented in **Figure 7-8**. Only the calculated day-time ambient noise levels are presented, as construction activities that might impact on sensitive receptors will be limited to the 06:00 – 22:00 time period.

The worse case scenario is presented with the all activities take place simultaneously during wind-still conditions, in good sound propagation conditions (20^{o}C and 80% humidity) with equipment under full load. Modelled noise levels are defined in **Table 7.4** with the impact tables presented in **Table 7.5**. Only receptors that might be subjected to increased noise levels presented.

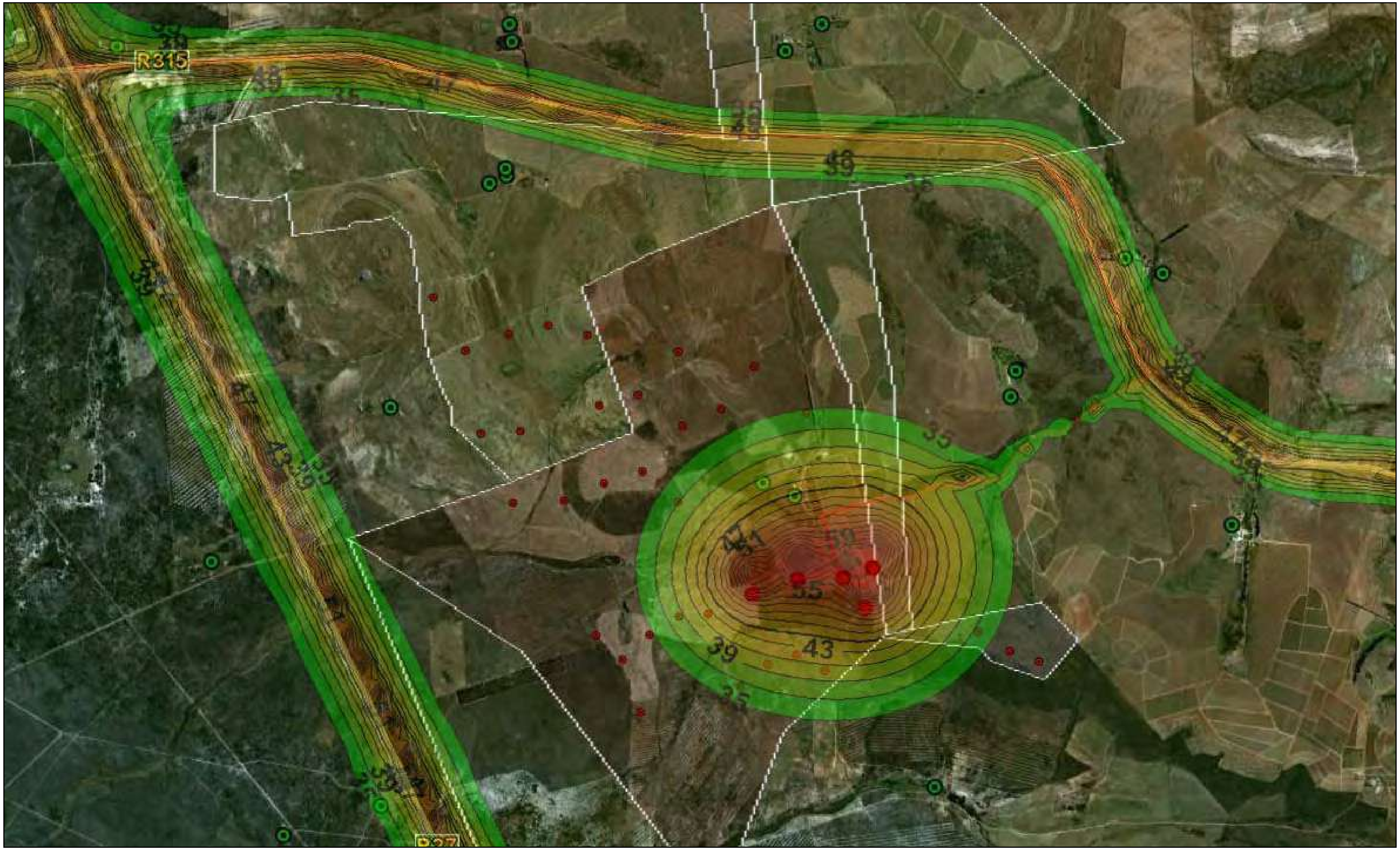

Figure 7-7: Construction noise: Contours of constant sound levels – Revised Layout

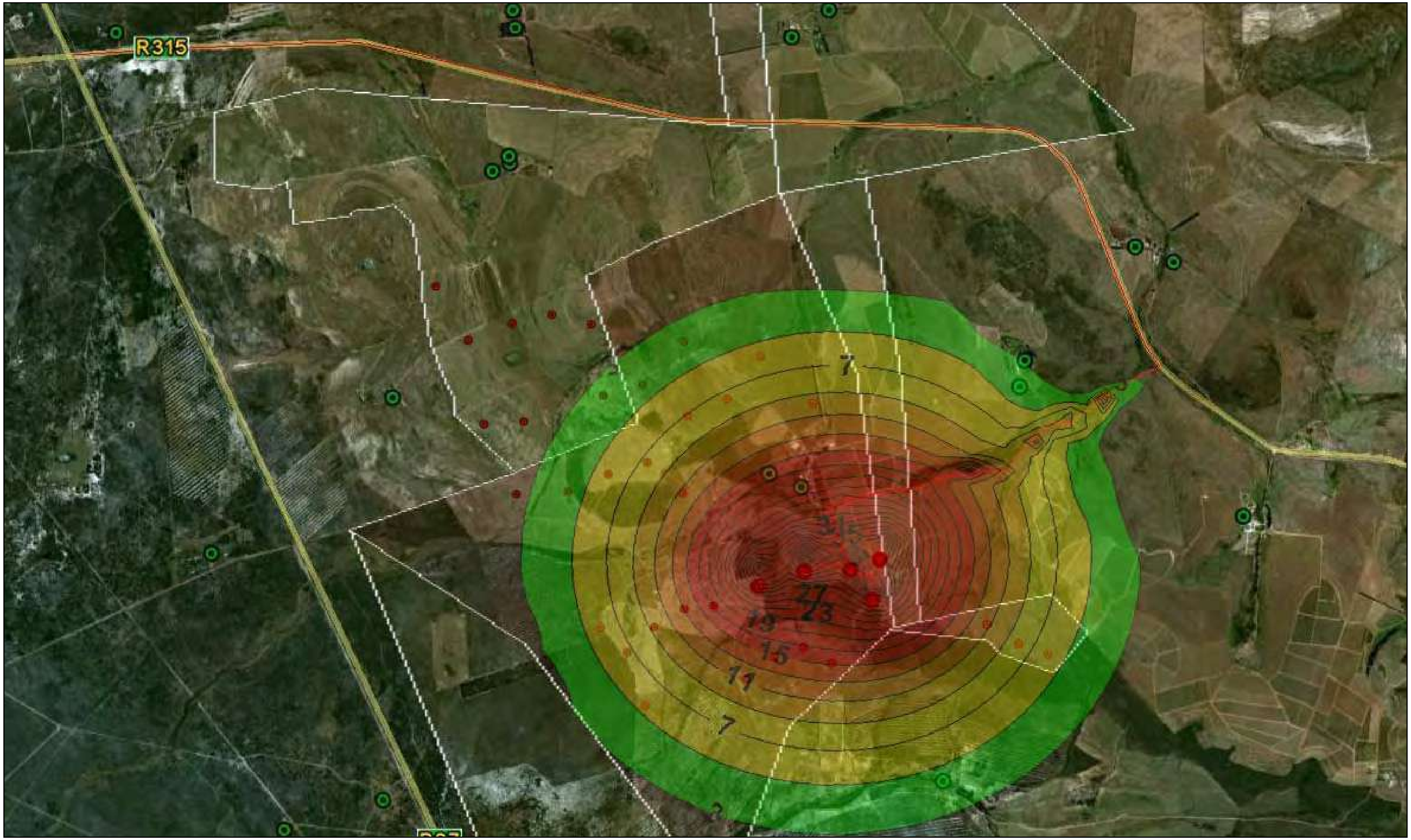

Figure 7-8: Construction noise: Change in ambient sound levels (contours of constant noise) – Revised Layout

7.2.4 Impact Assessment: Construction Phase with revised layout

The impact assessment for the various construction activities that may impact on the surrounding environment is presented in the following **Tables**.

Table 7.4: Construction: Defining noise impact on Receptors (dBA) (Datum type: Universal Transverse Mercator, zone 34 - South) with revised layout

Receptor	Location X (m)	Location Y (m)	Day Ambient Noise Level[4]	Ambient Sound Level (refer section 3.4)	Change* in Noise Levels	Acceptable Zone Sound Levels ($L_{Req,d}$)	Significance of noise Impact (See Table 6.2, Table 6.3 and Table 7.2)	
PSR27	249635	6304672	40.0	25.35	*14.6*	45	26	Low
PSR28	249929	6304557	43.2	25.35	*17.8*	45	26	Low

- Note: Change in ambient sound levels during the day are over-estimated, as it considers the ambient sound levels at the PSR to be very quiet during the day, which is not correct. Likely ambient sound levels near an active dwelling would be 40 – 60 dBA, depending on the activities taking place in the area. Also refer **section 3.4.**

Table 7.5: Construction: Impact Assessment Table with revised layout

Construction Phase		Magnitude	Duration	Extent	Probability	Significance
PSR27	Managed	6	4	3	2	26
PSR28	Managed	6	4	3	2	26

Table 7.6: Impact Assessment: Construction Activities with revised layout

Nature:	***Numerous simultaneous construction activities, number of PSR's can be impacted.***
Acceptable Rating Level	Rural district: 45 dBA outside during day (refer **Table 6.1**). Use $L_{Req,D}$ of 45 dBA.
Extent ($\Delta L_{Aeq,D}$>7dBA)	**Regional** – Change in ambient sound levels will extend more than 1,000 meters from activity (3)
Duration	**Long term** – Activities in the vicinity of the receptors could last up to a month (4)
Magnitude	***Estimated noise level*** ($L_{Aeq,D}$) ***up to 43 dBA*** ΔLAeq,D = 0 - 20 dBA (very quiet environment not realistic, see **sections 3.4** and **3.5.1.** **High** (8)
Probability	**Possible** – The projected sound intensity is less than the Rating level. The change in ambient sounds is high due to very low ambient levels selected. Noises would be limited during the day when the potential sensitive receptors are either away or busy with their normal daily activities. Noises created due to their normal daily activities would mask most construction related noises. This will minimises the possibility that this additional noise would impact on their quality of living. (2)
Significance	**26 (Low)**
Status	Negative
Reversibility	High
Irreplaceable loss of resources?	*Not relevant*
Comments	*Selection of noisy equipment working at full load 100% of the time as well as high humidity represents worst case scenario.*
Can impacts be mitigated?	Not required
Mitigation:	Refer Table 7.3.
Cumulative impacts:	This impact is cumulative with existing ambient background noises as well as other noisy activities conducted in the same area.

[4] Ambient sound level was calculated using the SANS methods discussed in this report.

Residual Impacts:	This impact will only disappear once construction activities cease.

7.3 OPERATIONAL PHASE IMPACT: ORIGINAL LAYOUT

7.3.1 Description of Operational Activities Modelled

Typical daytime activities would include:

- The operation of the various Wind Turbines,
- Maintenance activities (relative insignificant noise source).

The day-time period (working day) however was not considered for the EIA. This is because noise generated during the day by the WEF is normally masked by other noises generated by a variety of other sources surrounding potential sensitive receptors during the day-time period. The reader is also referred to **Figure 6-3**.

However, times when a quiet environment is desired (at night for sleeping, weekends etc.) noise levels are more critical. The time period investigated therefore would be the quiet period, normally associated with the 22:00 – 06:00 slot. Maintenance activities would therefore not be considered, concentrating on the ambient sound levels created due to the operation of the various WTGs at night. In addition the applicable Zone Sound Levels at night is 10 dBA less (35 dBA) than the daytime levels (45 dBA).

The sound power emission levels for the original selected turbine are presented in **Table 7.8**. The predominant wind directions are south and south-southwest. However, only a southern wind blowing at a 5 m/s wind speed will be modelled in detail, using the layout presented in **Figure 7-1**. Projected noise levels at potential sensitive receptors will be modelled for various wind directions and speeds, but only presented in table format in **Appendix B**. Ambient sound levels associated with the specific wind speeds will be considered at all times.

To allow for an estimation of the potential impacts (and significance) of noises associated with the proposed WEF, the number of WTGs (at the locations as supplied by the developer) was modelled using the propagation conditions and noise characteristics as per **Table 7.7** and **Table 7.8**.

Table 7.7: Selected parameters for the Noise Prediction Model: EIA Phase

	Temperature	Atmospheric Pressure	Humidity
Meteorological conditions	10°C	93 kPa	90%

Table 7.8: Sound Power Emission Levels for the Vestas V90 2.0MW Turbine

Wind Speed (m/s)	Associated Ambient Sound (dBA)	Frequency (Hz)	63 (dB)	125 (dB)	250 (dB)	500 (dB)	1000 (dB)	2000 (dB)	4000 (dB)	L_{WA} (dBA)
5	**29.85**	$L_{wA,P}$	80.2	84.3	88.5	91.6	94.1	92.9	90.7	**99.2**
		$L_{w,P}$	105.9	100.7	97.2	94.8	94.1	91.7	89.7	
7	**35.05**	$L_{wA,P}$	85.4	90.6	93.4	96.4	98.6	97.4	95.2	**103.9**
		$L_{w,P}$	111.4	106.9	102.2	99.5	98.7	96.3	94.2	

In addition it will be required to consider the potential noise contribution from the Darling Windfarm. However, this wind farm is too far from the proposed WEF and will not result in a significant cumulative noise increase impact on surrounding PSRs.

As mentioned in the Scoping Report, potential impacts due to low frequency sounds must also be considered. For this purpose the sound power level at both the 16 and 31.5 Hz frequency band will also be estimated and used to calculate the C-Weighted Noise Levels. Existing acoustic energy in the low frequency range will also be considered (refer **Figure 4-3**).

It should be noted that SANS 10357:2004 does not provide methods to estimate sound propagation below 63 Hz. While this report does calculate the sound power levels at lower frequency bands (to allow the calculation of the C-weighted Sound Power Levels to estimate the potential/probability for low frequency noises), the reader should know that this is for information purposes only. In terms of accuracy, the sound power level at these frequency bands is estimated at ±5 dBA (due to the unknown adjustment factor for meteorological effects at that octave band frequency).

7.3.2 Results: Operational Phase (Original Layout)

Noise in the area due to the operation of the wind energy facility is illustrated in **Figure 7-9**, with the change in ambient sound levels experienced by the receptors indicated in **Figure 7-10**. **Figure 7-9** and **Figure 7-10** is for the situation when there is a southern wind blowing at a speed of 5 m/s.

Maps were not developed for the other wind directions, as in terms of the scale of the project, the maps looks very similar to each other.

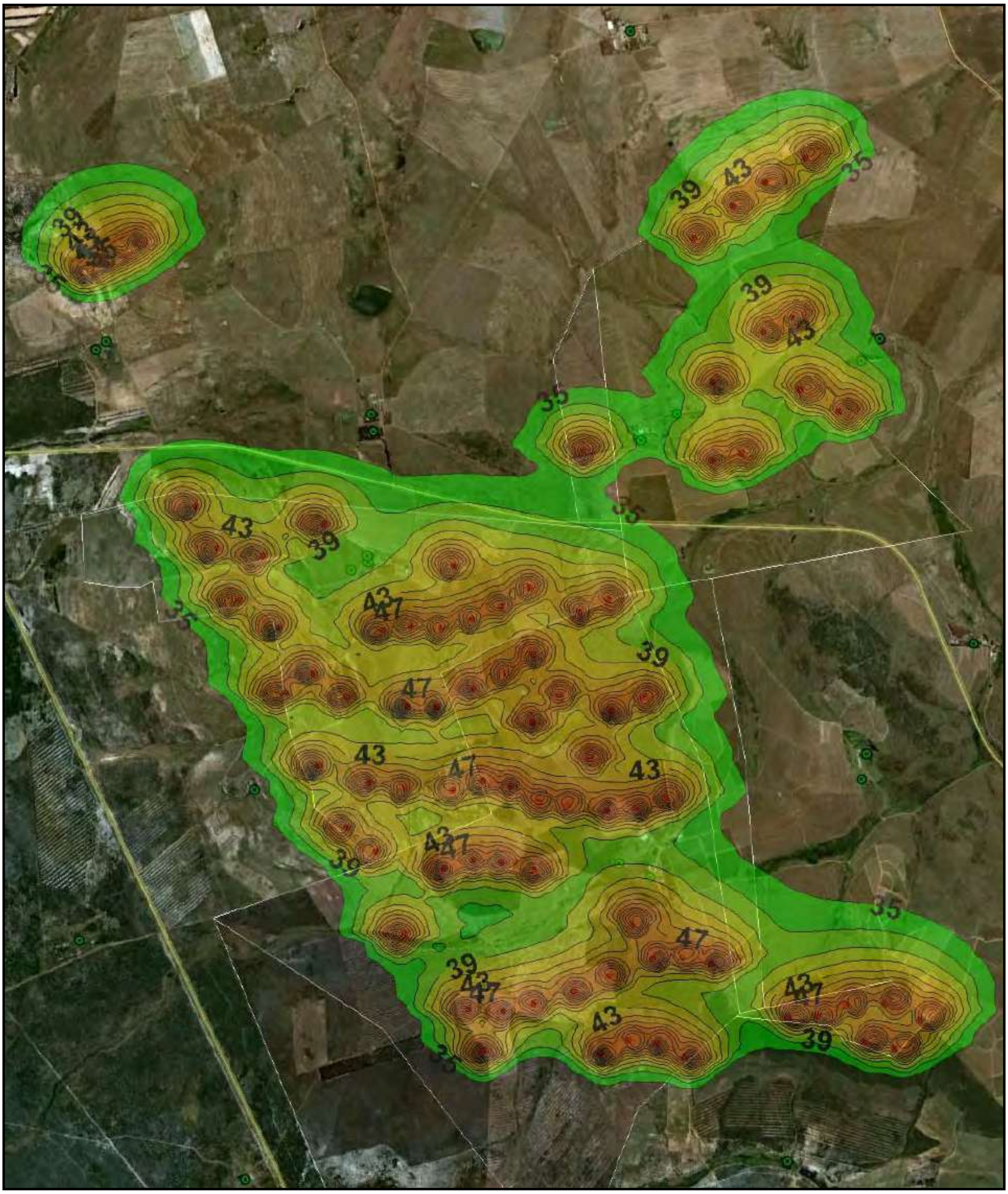

Figure 7-9: Operational Phase: Sound Levels from WEF, Contours of constant sound levels with a southern wind blowing at 5 m/s

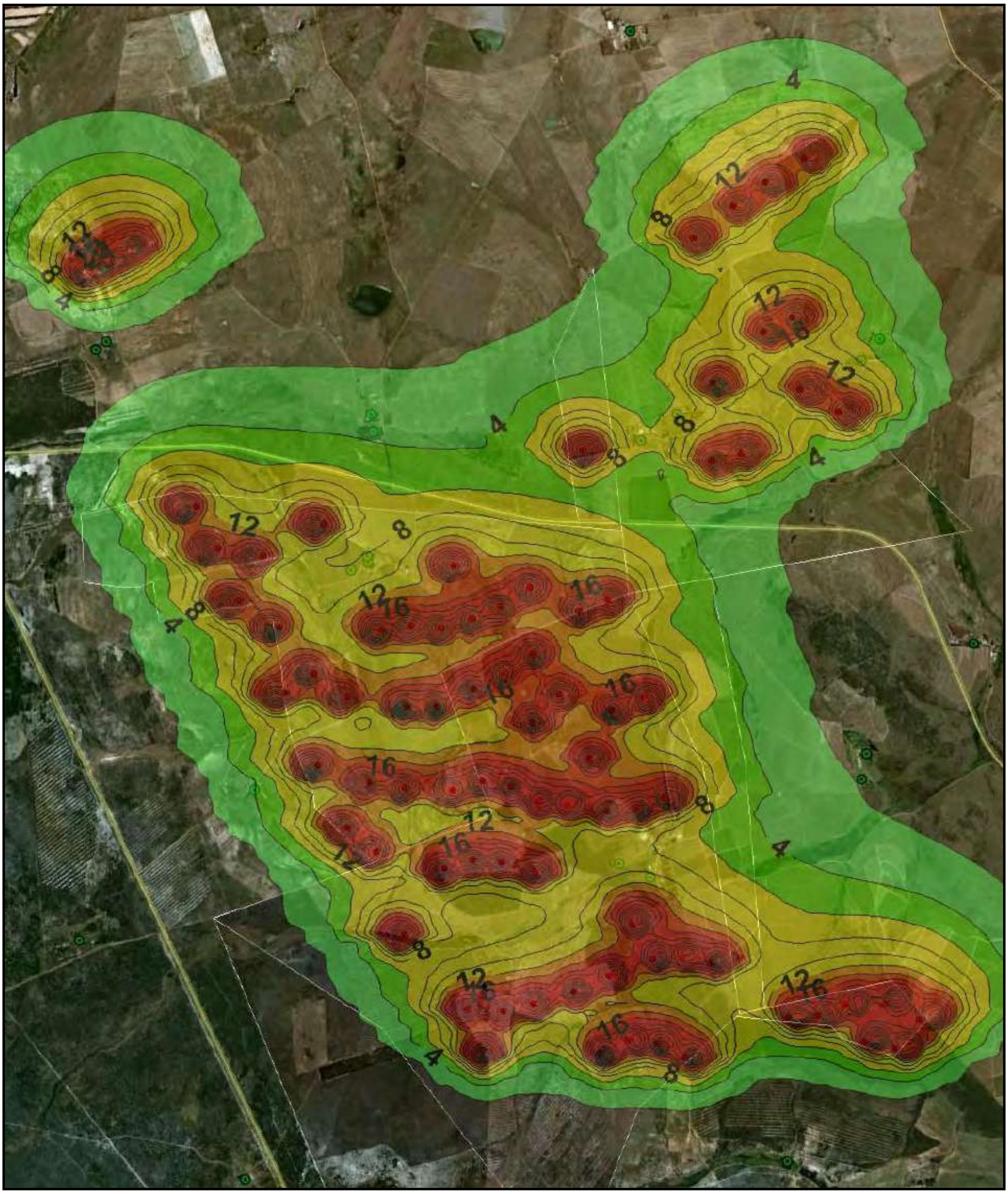

Figure 7-10: Operational Phase: Change in ambient sound levels, contours of constant noise levels with a southern wind blowing at 5 m/s

The potential sound pressure levels at the PSRs for other wind speeds were however calculated and tabulated in **Table 7.9**.

These tables present the sound pressure levels (both $L_{Aeq,N}$ and estimated $L_{C,N}$) at the various identified receptors. As per SANS 10103:2008, if the difference between the A-frequency weighted and the C-frequency weighted equivalent continuous sound pressure levels is greater than 10 dB, a predominant low frequency component **may** be present.

As can be seen from these tables, low frequency noises are present, as the estimated C-weighted sound pressure levels are significantly higher than the corresponding A-weighted sound pressure levels. However, it should also be noted that the estimated ambient C-weighted sound levels at the modeled wind speed are already high with the C-weighted sound pressure levels associated with the wind turbines being lower than the wind induced noise levels at the relevant wind speeds. Therefore most of the acoustic energy in the low frequencies would be due to wind induced noises, and not from the wind turbines.

The receptors that might be impacted by the Wind Turbines (original layout) with a 5 m/s wind include:

- Southern wind: PSR12, PSR13, PSR14, PSR19, PSR20, PSR21, PSR27 and PSR28.
- Easterly: PSR12, PSR13, PSR14, PSR19, PSR20, PSR21, PSR22, PSR27 and PSR28.
- Northerly: PSR11, PSR12, PSR13, PSR14, PSR16[5], PSR20, PSR27, PSR28.
- Westerly: PSR11, PSR12, PSR13, PSR14, PSR19, PSR20, PSR27 and PSR28.

Table 7.9: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for a Southern wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	C-weighted Sound Pressure Level due to WEF (dBC)
PSR01	29.85	76	30.33	0.48	41.35
PSR02	29.85	76	29.99	0.14	38.51
PSR03	29.85	76	29.93	0.08	37.38
PSR04	29.85	76	29.89	0.04	34.32
PSR05	29.85	76	29.87	0.02	30.42
PSR06	29.85	76	29.92	0.07	37.07
PSR07	29.85	76	29.87	0.02	31.19
PSR08	29.85	76	29.86	0.01	28.59
PSR09	29.85	76	29.89	0.04	35.24
PSR10	29.85	76	29.9	0.05	35.94
PSR11	29.85	76	33.21	3.36	52.2

[5] Noise impact would be due to the Darling Experimental Wind farm and not the Rheboksfontein Wind Energy Facility.

PSR12	29.85	76	38.26	8.41	57.42
PSR13	29.85	76	38.32	8.47	57.34
PSR14	29.85	76	37.91	8.06	57.07
PSR15	29.85	76	31.16	1.31	48.55
PSR16	29.85	76	31.34	1.49	49.65
PSR17	29.85	76	33.14	3.29	49.52
PSR18	29.85	76	33.73	3.88	50.55
PSR19	29.85	76	36.58	6.73	55.05
PSR20	29.85	76	37.07	7.22	56.36
PSR21	29.85	76	36.94	7.09	55.52
PSR22	29.85	76	34.09	4.24	51.92
PSR23	29.85	76	30.77	0.92	42.86
PSR24	29.85	76	30.07	0.22	37.44
PSR25	29.85	76	30.32	0.47	41.25
PSR26	29.85	76	30.23	0.38	40.31
PSR27	29.85	76	39.26	9.41	58.98
PSR28	29.85	76	40.78	10.93	59.88
PSR29	29.85	76	31.37	1.52	45.86
PSR30	29.85	76	31.65	1.8	46.57
PSR31	29.85	76	30.6	0.75	42.25
PSR32	29.85	76	30.6	0.75	42.25

Table 7.10 presents the Wind Turbines identified that might have a noise impact on the surrounding potential sensitive receptors.

Table 7.10: Wind Turbines that might be problematic in terms of noise impact on potential sensitive receptors with a 5m/s wind

Wind direction	Wind Turbines
South	1, 27, 28, 29, 30, 31, 43, 46, 78, 79
East	25, 28, 29, 31, 34, 69, 70, 71, 79, 80
North	26, 33, 60, 66, 68, 69, 70, 80 as well as the eastern most turbine of the Darling Windfarm[6]
West	26, 29, 31, 43, 46, 60, 69, 78, 79

7.3.3 Impact Assessment: Operational Phase without mitigation (Original Layout)

This Environmental Noise Impact Assessment focuses on the impacts on the surrounding sound environment during times when a quiet environment is highly desirable. Noise limits are therefore appropriate for the most noise-sensitive activity, such as sleeping, or areas used for relaxation or other activities (places of worship, school, etc). Zone Sound Levels are therefore important, and a $L_{Req,N}$ of 35 dBA as proposed by SANS 10103 is used.

[6] Impact on PSR16 due to existing Darling Windfarm. The Rheboksfontein WEF will not impact on this receptor, neither contribute cumulatively to the noise impact.

Appropriate Zone Sound Levels is important, yet it has been indicated that the SANS recommended fixed Night Rating Level ($L_{Req,N}$) of 35 dBA might be inappropriate due to the increased ambient sounds as wind speeds increase. This is especially inappropriate at wind speeds above 6 m/s.

A more appropriate method to determine the potential impact would be to make use of the change in ambient sound levels that receptors may experience. Using the $\Delta L_{Aeq,N}$ of 5 dBA (or higher), it can be seen that a number of receptors could be impacted.

Using the criteria (**$L_{Req,N}$<35 dBA**, **$\Delta L_{Aeq,N}$>5 dBA**) it can be seen that a number of receptors could be impacted during times when a quiet environment is desirable.

Using the model parameters as outlined, the following can be concluded:

- The ambient sound levels will exceed the zone sound level of $L_{Req,N}$ of 35 dBA for a number of receptors. While the noise contribution from the individual wind turbines may be less than 35 dBA, the cumulative effect results in a significant increase in ambient noise levels when numerous turbines are operational at one time.
- There are a number of receptors that would detect the change in ambient sound levels.
- The operation of the wind turbines will slightly add to the acoustical energy in the low frequencies. However most of the acoustical energy in the low frequencies is due to the wind induced noise.
- The workshop area is sufficiently away from the closest receptors (more than 1,000 meters) not be have a noise impact during either night or day, subject that no noisy activities takes place during night.

Applying the precautionary principle, the assessment of potential impacts is presented in

Table 7.11: Impact Assessment: Operational phase without mitigation

Nature:	*Numerous turbines operating simultaneously. See also* ***Table 7.10.***
Acceptable Rating Level (Zone Sound Level)	Rural district with little road traffic: 35 dBA outside during night (refer **Table 6.1**). Use $L_{Req,N}$ of 35 dBA.
Extent ($\Delta L_{Aeq,N}$>7dBA)	**Local** – Impact will extend less than 1,000 meters from activity (2)
Duration	**Permanent** – WEF will operate for a number of years (5)
Magnitude	***Estimated noise level*** ($L_{Aeq,N}$) ***higher as 35 dBA*** $\Delta L_{Aeq,N}$ >> 7 dBA **High** (8)
Probability	**Definite** (5)
Significance	**75 (High)**
Status	Negative
Reversibility	High
Irreplaceable loss of resources?	*Not relevant*
Comments	*Number of Receptors that would be impacted.*
Can impacts be mitigated?	Yes

Mitigation:	• Turbines highlighted in red in Table 7.10 should be moved to a location where it is more than 1,000 meters from receptors. • If a turbine is to be developed within 1000 meters from a downwind receptor, the developer must highlight this to the receptor that might be impacted, as well as the estimated percentage that the wind blows into the direction of the PSR. • The noise emission specifications of wind turbine generators must be considered when selecting the equipment. This could be smaller equipment, more quiet equipment or both. • A combination of the options proposed above.
Cumulative impacts:	This impact is cumulative with existing ambient background noises as well as with other noise sources, including other turbines in the Wind Energy Facility.
Residual Impacts:	This impact will only disappear once the Wind Energy Facility is decommissioned.

7.4 OPERATIONAL PHASE IMPACT: REVISED LAYOUT

7.4.1 Description of Operational Activities Modelled

A new revised turbine layout was developed for evaluation after considering all comments received during the EIA phase.

The sound power emission levels for currently considered turbine are presented in **Table 7.12**. As previous, a southern wind blowing at a 5 m/s wind speed will be modelled in detail, using the revised layout presented in **Figure 7-5**. Projected noise levels at potential sensitive receptors will be modelled for various wind directions at 5 m/s. Ambient sound levels associated with the specific wind speeds will be considered at all times. Both the Concawe and ISO model will be used. Only winds at 5 m/s will be used, due to the highest risk of a noise impact being associated with lower wind speeds (before wind induced noises start to dominate).

Table 7.12: Sound Power Emission Levels for the Vestas V90 3.0MW Turbine

Wind Speed (m/s)	Associated Ambient Sound (dBA)	Frequency (Hz)	63 (dB)	125 (dB)	250 (dB)	500 (dB)	1000 (dB)	2000 (dB)	4000 (dB)	L_{WA} (dBA)
5	**29.85**	$L_{wA,P}$	80.9	91.3	90.4	92.4	94.4	93.3	90.0	**100.1**
		$L_{w,P}$	106.1	109.9	99.3	95.5	94.6	92.2	89.0	
7	**35.05**	$L_{wA,P}$	89.1	92.1	94.7	97.1	99.8	99.0	95.1	**105.0**
		$L_{w,P}$	117.9	107.5	103.5	100.3	99.9	97.9	94.1	

The potential impact of the Darling Wind Farm will again be considered as previously using the noise emission data of the Vestas V90 2.0MW.

As a different wind turbine is proposed, potential impacts due to low frequency sounds will again be considered.

7.4.2 Results: Operational Phase (Revised Layout)

Noise in the area due to the operation of the wind energy facility is illustrated in **Figure 7-11**, with the change in ambient sound levels experienced by the receptors indicated in **Figure 7-12**. **Figure 7-11** and **Figure 7-12** is for the situation when there is a southern wind blowing at a speed of 5 m/s.

Maps were not developed for the other wind directions, as in terms of the scale of the project, the maps looks very similar to each other. The potential sound pressure levels at the PSRs for other wind speeds were however calculated and tabulated in **Appendix B**.

The receptors that might be impacted by the Wind Turbines (revised layout) with a 5 m/s wind include (Concawe model):

- Southern wind - **Table 7.13**: PSR27 and PSR28.
- Northerly wind - **Table 7.15**: PSR11, PSR27, PSR28.
- Easterly wind - **Table 7.16**: PSR11, PSR27 and PSR28.
- Westerly wind - **Table 7.17**: PSR21, PSR22, PSR27 and PSR28.

The receptors that might be impacted by the Wind Turbines (revised layout) with a 5 m/s wind include (ISO model – any wind direction):

- Any wind direction (downwind model) - Table 7.18: PSR11, PSR27, PSR28.

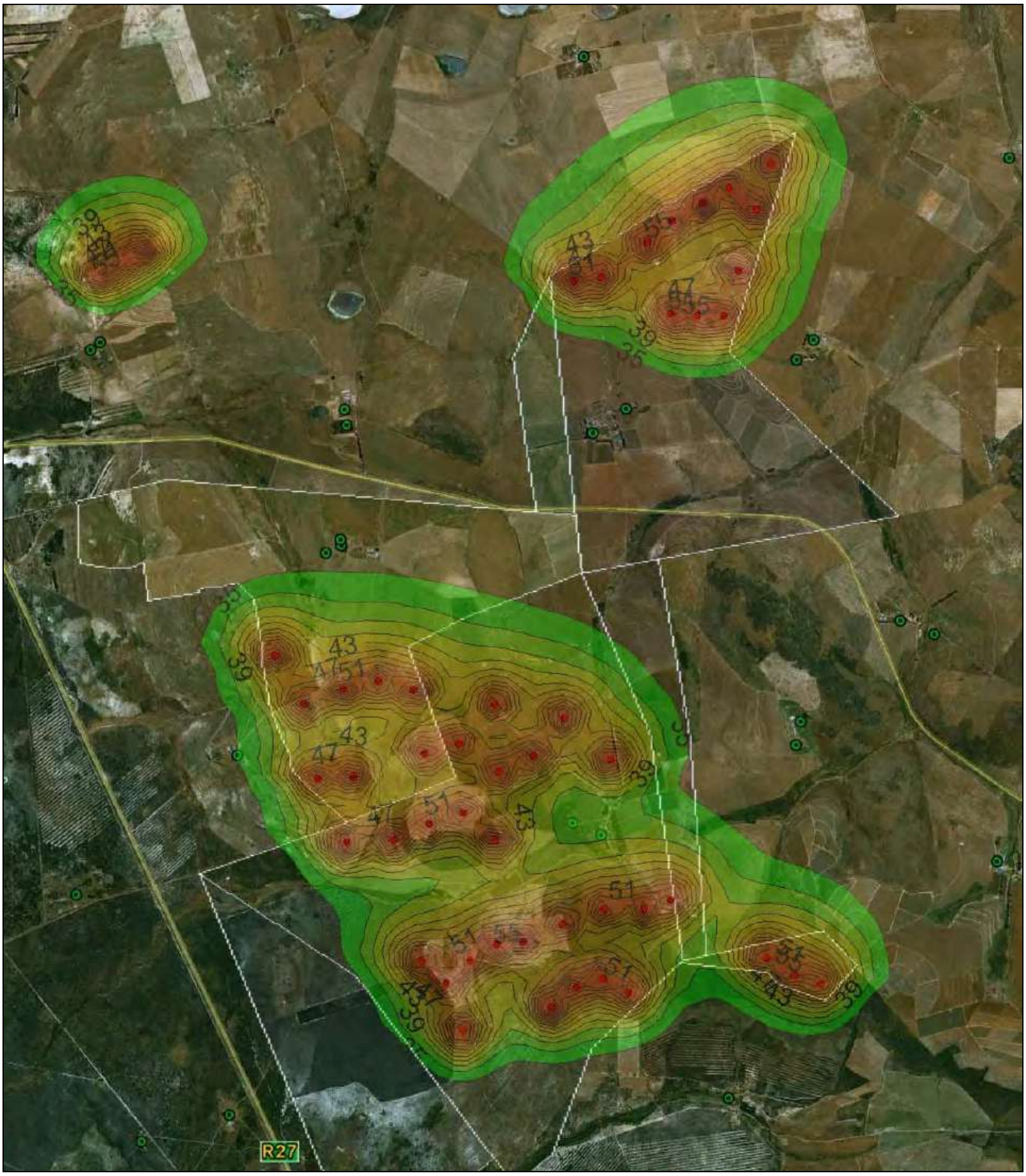

Figure 7-11: Operational Phase: Sound Levels from WEF, Contours of constant sound levels with a southern wind blowing at 5 m/s (Revised layout - Concawe Model)

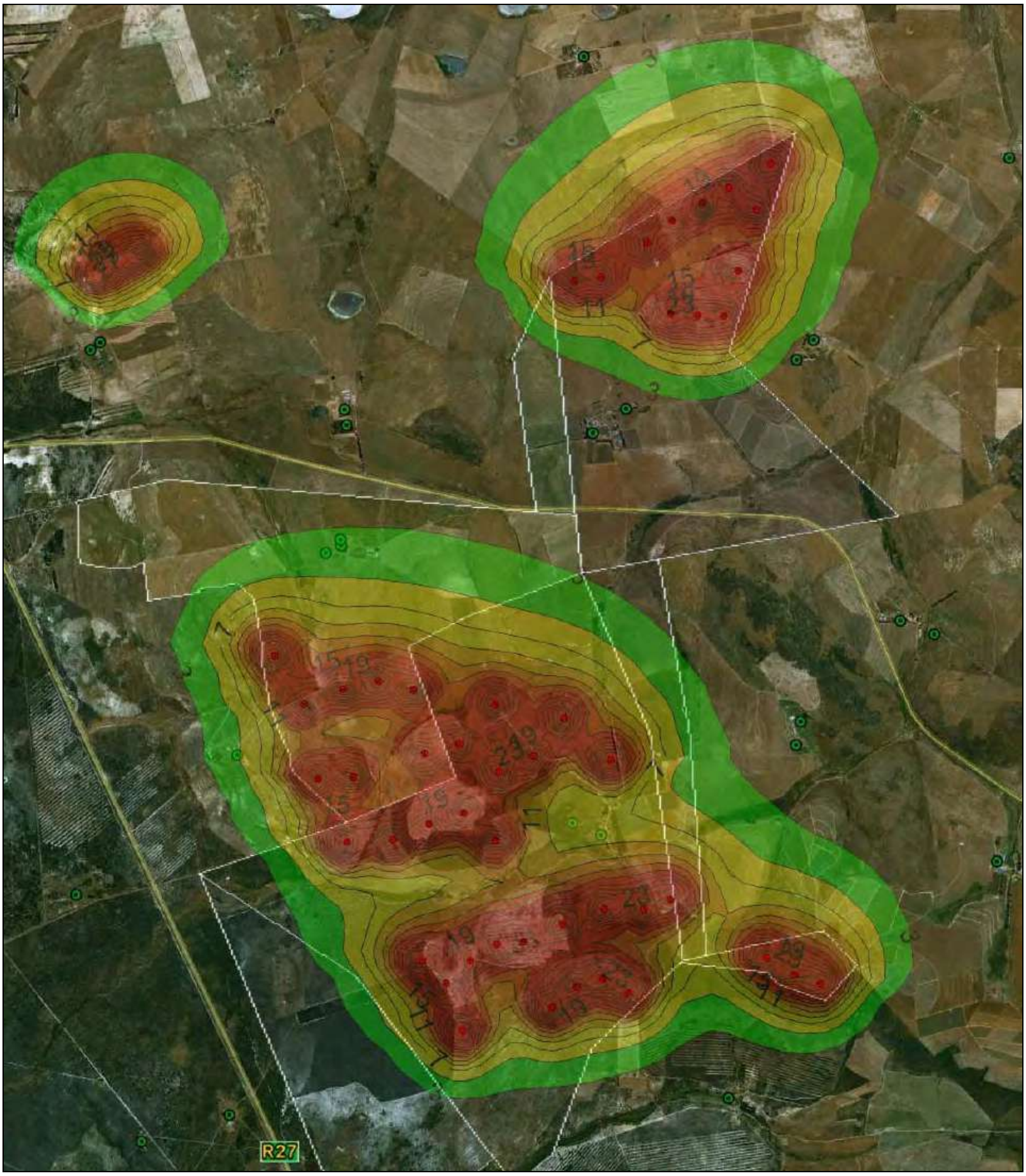

Figure 7-12: Operational Phase: Change in ambient sound levels, contours of constant noise levels with a southern wind blowing at 5 m/s (Revised layout - Concawe Model)

Table 7.13: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for a Southern wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	34.6	4.8	52.7
PSR21	29.85	76	32.5	2.7	50.2
PSR22	29.85	76	32.3	2.5	49.8
PSR27	29.85	76	37.9	8.0	56.7
PSR28	29.85	76	38.2	8.4	56.7

Table 7.14: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for a Northern wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	34.0	5.6	53.3
PSR21	29.85	76	35.4	5.6	52.5
PSR22	29.85	76	35.2	5.4	52.8
PSR27	29.85	76	38.3	8.4	57.1
PSR28	29.85	76	37.0	7.2	55.9

Table 7.15: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for a Western wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	32.8	2.9	51.1
PSR21	29.85	76	35.7	5.8	52.9
PSR22	29.85	76	35.6	5.8	53.3
PSR27	29.85	76	38.6	8.7	57.3
PSR28	29.85	76	37.6	7.7	56.4

Table 7.16: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for an Eastern wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	37.0	7.1	54.7
PSR21	29.85	76	32.4	2.5	49.7
PSR22	29.85	76	32.2	2.4	49.3

PSR27	29.85	76	37.1	7.3	56.1
PSR28	29.85	76	37.1	7.3	55.7

Table 7.17: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for 5 m/s wind (ISO model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	35.6	5.8	51.8
PSR21	29.85	76	34.6	4.8	50.4
PSR22	29.85	76	34.4	4.6	50.1
PSR27	29.85	76	38.5	8.7	55.0
PSR28	29.85	76	38.2	8.3	54.6

The Wind Turbines identified that might have a noise impact on the surrounding potential sensitive receptors are defined in **Appendix B**.

7.4.3 Impact Assessment: Operational Phase without mitigation (Revised Layout)

This Environmental Noise Impact Assessment focuses on the impacts on the surrounding sound environment during times when a quiet environment is highly desirable. Noise limits are therefore appropriate for the most noise-sensitive activity, such as sleeping, or areas used for relaxation or other activities (places of worship, school, etc). Zone Sound Levels are therefore important, and a $L_{Req,N}$ of 35 dBA as proposed by SANS 10103 is used.

Appropriate Zone Sound Levels is important, yet it has been indicated that the SANS recommended fixed Night Rating Level ($L_{Req,N}$) of 35 dBA might be inappropriate due to the increased ambient sounds as wind speeds increase. This is especially inappropriate at wind speeds above 6 m/s.

A more appropriate method to determine the potential impact would be to make use of the change in ambient sound levels that receptors may experience as proposed in **section 6.4** (**Table 6-4**). This is also the method prescribed by the Western Cape Provincial Noise Control Regulations (see **section 2.5**).

Table 7.18: Operation: Impact Assessment Table[*] with revised layout

	Wind Direction	Magnitude	Duration	Extent	Probability	Significance
PSR11	South	6	5	2	3	**39**
PSR21	South	4	5	2	3	**33**
PSR22	South	4	5	2	3	**33**
PSR27	South	8	5	2	5	**75**
PSR28	South	8	5	2	5	**75**
PSR11	North	4	5	2	3	**33**
PSR21	North	6	5	2	3	**39**
PSR22	North	6	5	2	3	**39**
PSR27	North	8	5	2	5	**75**
PSR28	North	8	5	2	5	**75**
PSR11	West	4	5	2	3	**33**
PSR21	West	6	5	2	3	**39**
PSR22	West	6	5	2	3	**39**
PSR27	West	8	5	2	5	**75**
PSR28	West	8	5	2	5	**75**
PSR11	East	8	5	2	3	**45**
PSR21	East	4	5	2	3	**33**
PSR22	East	4	5	2	3	**33**
PSR27	East	8	5	2	5	**75**
PSR28	East	8	5	2	5	**75**

[*] *Only receptors shown that could be impacted where noise levels might exceed 35 dBA or a disturbing noise registered. Risk of a noise impact on all other receptors low with a low significance.*

Applying the precautionary principle, the assessment of potential impacts is presented in **Table 7.19.**

Table 7.19: Impact Assessment: Operational phase for revised layout

Nature:	*Numerous turbines operating simultaneously. See also* ***Table 7.10.***
Acceptable Rating Level (Zone Sound Level)	Rural district with little road traffic: 35 dBA outside during night (refer **Table 6.1**). Use $L_{Req,N}$ of 35 dBA.
Extent ($\Delta L_{Aeq,N}$>7dBA)	**Local** – Impact will extend less than 1,000 meters from activity (2)
Duration	**Permanent** – WEF will operate for a number of years (5)
Magnitude	***Estimated noise level*** ($L_{Aeq,N}$) ***higher as 35 dBA*** $\Delta L_{Aeq,N}$ > 7 dBA **High** (8)
Probability	**Definite** (5)
Significance	**75 (High)**
Status	Negative
Reversibility	High
Irreplaceable loss of resources?	*Not relevant*
Comments	*The number of Receptors that would be impacted did reduce from the original layout but mitigation is still required.*
Can impacts be mitigated?	Yes
Mitigation:	• Turbines highlighted in orange in Appendix B should be moved to a location where it is more than 1,000 meters from receptors *(turbines 12, 18, 21, 23, 24, 26, 29, 33, 34)*. • If a turbine is to be developed within 1000 meters from a downwind receptor, the developer must highlight this to the receptor that might be impacted, as well as the estimated percentage that the wind blows into the direction of the PSR. • The noise emission specifications of wind turbine generators must be

	considered when selecting the equipment. This could be smaller equipment, more quiet equipment or both. • A combination of the options proposed above.
Cumulative impacts:	This impact is cumulative with existing ambient background noises as well as with other noise sources, including other turbines in the Wind Energy Facility.
Residual Impacts:	This impact will only disappear once the Wind Energy Facility is decommissioned.

7.5 OPERATIONAL PHASE IMPACT: REVISED LAYOUT WITH MITIGATION MEASURES

7.5.1 Description of Operational Activities Modelled

As can be seen from the previous section, the noise impact due to the operation of the WEF could be of high significance to a few potentially sensitive receptors, additional mitigation would be required. During this process a number of alternatives were considered, such as:

- The use of different wind turbines,
- Changing the layout of the WEF,
- Operating the selected wind turbine in a different mode that reduce noise emissions,
- Removing certain wind turbines from the layout.

The proposed mitigation were modelled and the effectiveness of the noise reduction considered against the layout that impacts the least on the effective power generation capacity of the larger WEF.

The selected mitigation included the following measures:

- Selecting the smaller Vestas V90 2.0 MW wind turbine (**Table 4.1**),
- Moving a number of wind turbines further from potentially sensitive receptors, indicated with a –R after the turbine number (**Figure 7-13**),
- Relocating a number of wind turbines to a different location in the layout, indicated with a –R after the turbine number (**Figure 7-13**).

7.5.2 Results: Operational Phase (Revised Layout with mitigation measures implemented)

Noise in the area due to the operation of the wind energy facility is illustrated in **Figure 7-14**, with the change in ambient sound levels experienced by the receptors indicated in **Figure 7-15**. As previously, these figures are for the situation when there is a southern wind blowing at a speed of 5 m/s.

The receptors that might have been impacted by the operation of Wind Turbines (for the revised layout) with a 5 m/s wind included (Concawe model):

- Southern wind - **Table 7.13**: PSR27 and PSR28.
- Northerly wind - **Table 7.15**: PSR11, PSR27, PSR28.
- Easterly wind - **Table 7.16**: PSR11, PSR27 and PSR28.
- Westerly wind - **Table 7.17**: PSR21, PSR22, PSR27 and PSR28.

The receptors that might have been impacted by the Wind Turbines (revised layout using a downwind model) with a 5 m/s wind included:

- Any wind direction (downwind model) - **Table 7.18**: PSR11, PSR27, PSR28.

As can be seen from the following tables (**Table 7.20**, **Table 7.21**, **Table 7.22**, **Table 7.23** and **Table 7.24**) the estimated magnitude as well as the projected change in ambient sound levels are in compliance of all regulations, with only the total estimated noise levels at PSR27 exceeding the rural rating level of 35 dBA as recommended by SANS 10103:2008.

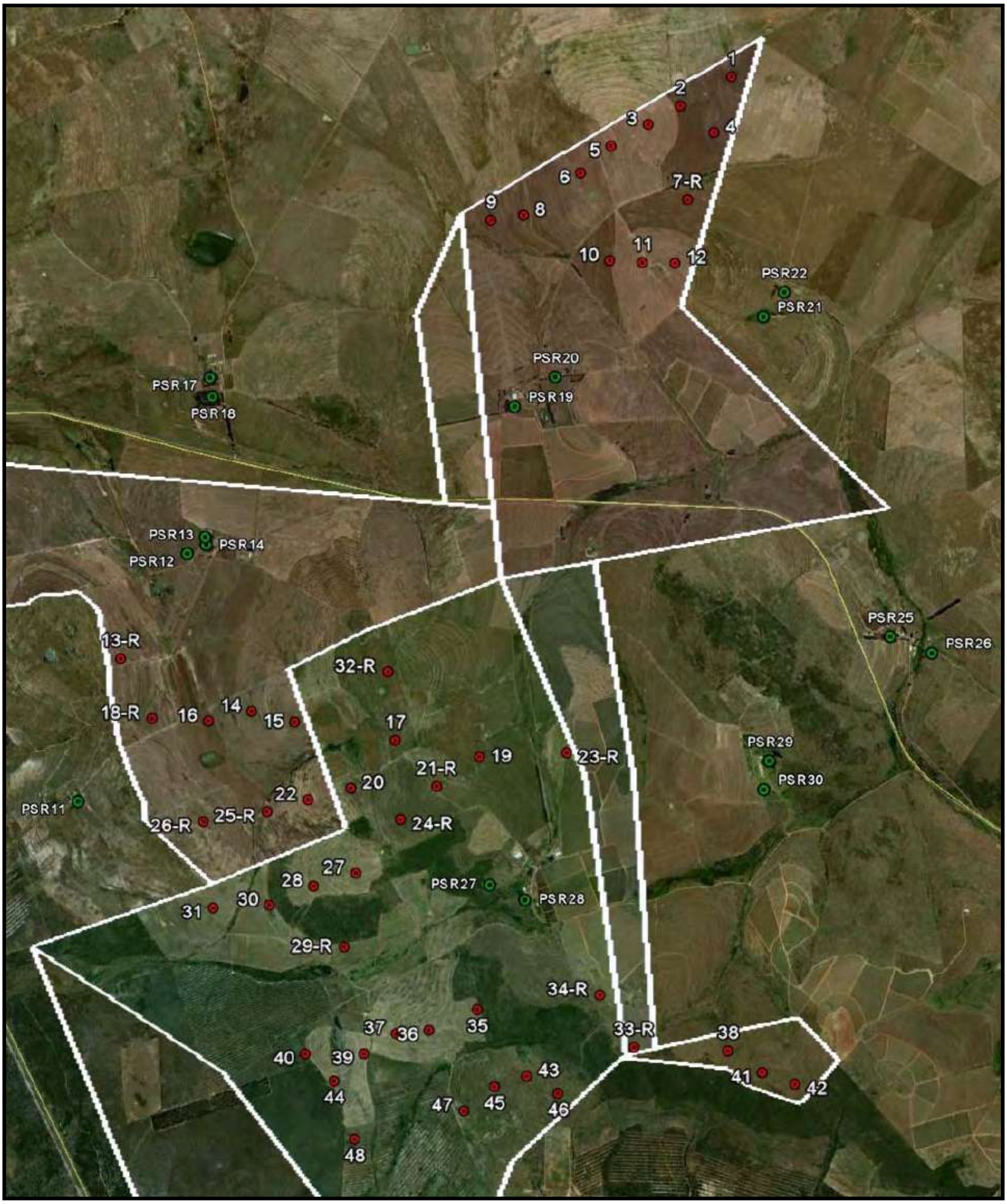

Figure 7-13: Proposed Layout with mitigation measures implemented (wind turbines moved indicated with an –R)

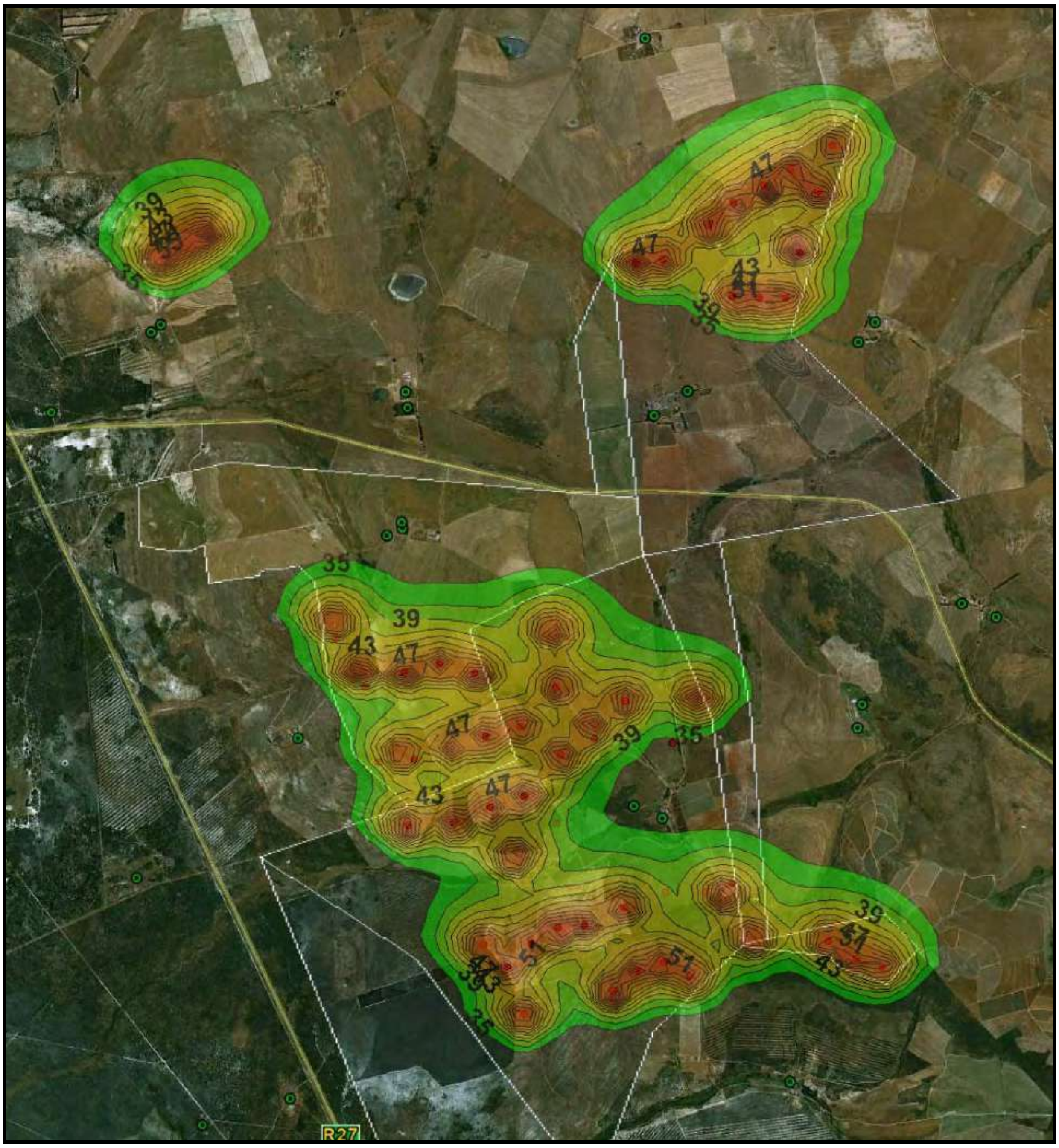

Figure 7-14: Operational Phase: Sound Levels from WEF, Contours of constant sound levels with a southern wind blowing at 5 m/s (Revised layout - Concawe Model)

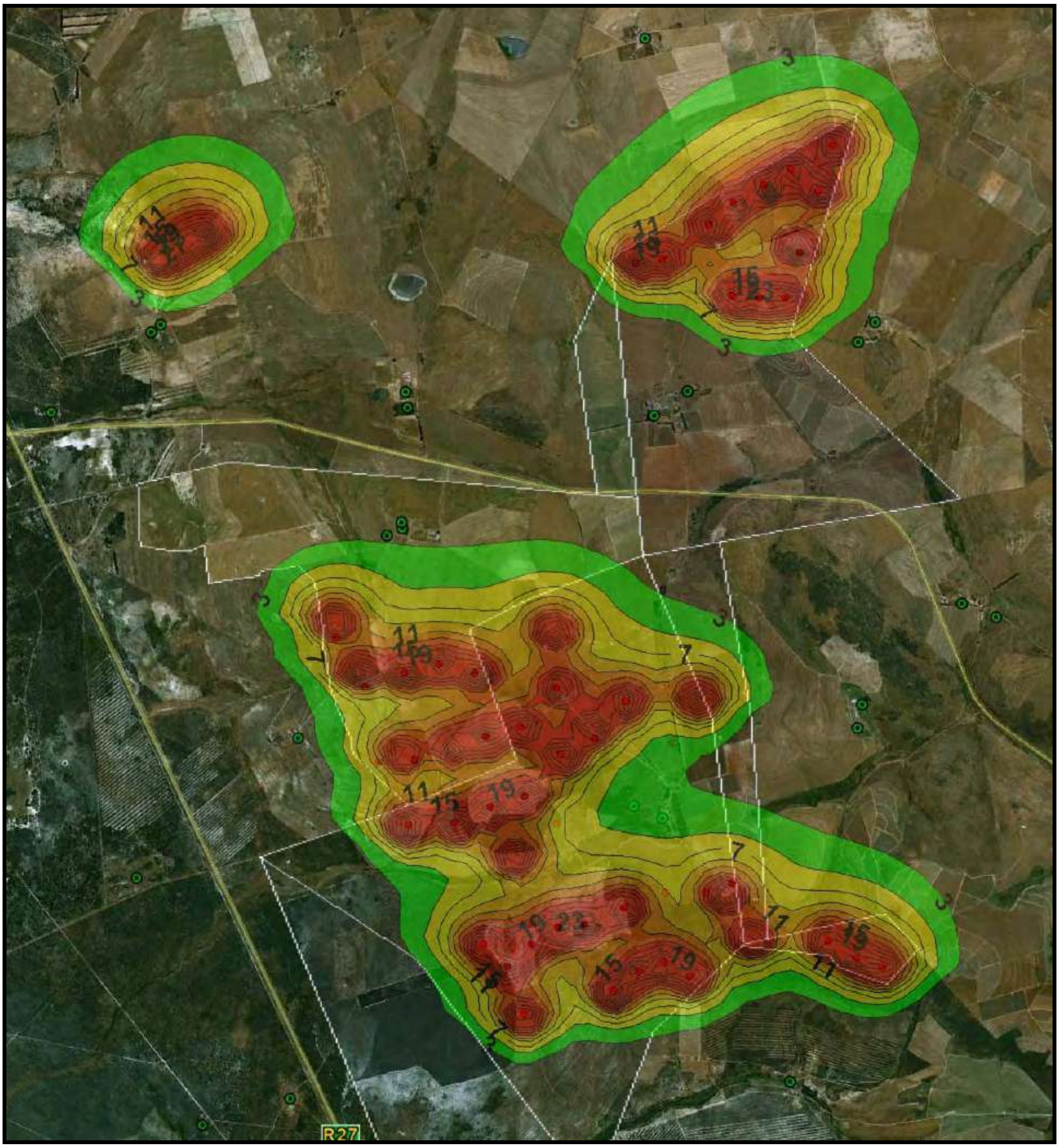

Figure 7-15: Operational Phase: Change in ambient sound levels, contours of constant noise levels with a southern wind blowing at 5 m/s (Revised layout - Concawe Model)

Table 7.20: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for a Southern wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	32.4	2.6	51.5
PSR21	29.85	76	31.6	1.8	50.0
PSR22	29.85	76	31.5	1.7	49.6
PSR27	29.85	76	34.0	4.1	54.5
PSR28	29.85	76	34.1	4.3	53.9

Table 7.21: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for a Northern wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	33.3	3.4	51.9
PSR21	29.85	76	33.7	3.9	51.6
PSR22	29.85	76	33.6	3.8	52.1
PSR27	29.85	76	34.6	4.7	54.3
PSR28	29.85	76	33.4	3.6	53.4

Table 7.22: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for a Western wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	31.5	1.6	49.9
PSR21	29.85	76	33.9	4.0	52.0
PSR22	29.85	76	33.9	4.0	52.6
PSR27	29.85	76	35.1	5.3	54.9
PSR28	29.85	76	34.3	4.4	54.1

Table 7.23: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for an Eastern wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	34.1	4.3	52.8
PSR21	29.85	76	31.5	1.7	49.5
PSR22	29.85	76	31.4	1.6	49.0
PSR27	29.85	76	33.0	3.2	53.9
PSR28	29.85	76	33.1	3.3	53.2

Table 7.24: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for 5 m/s wind (ISO model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	32.9	3.1	49.1
PSR21	29.85	76	32.6	2.8	48.2
PSR22	29.85	76	32.4	2.6	47.9
PSR27	29.85	76	34.8	4.9	51.8
PSR28	29.85	76	34.2	4.4	51.2

7.5.3 Impact Assessment: Operational Phase with mitigation (Revised Layout)

This Environmental Noise Impact Assessment focuses on the impacts on the surrounding sound environment during times when a quiet environment is highly desirable. It considers the potential environmental noise impact on potentially sensitive receptors when the WEF is operating after the implementation of the proposed mitigation measures. An impact assessment on the result is presented in **Table 7.25**.

Table 7.25: Operation: Impact Assessment Table* with revised layout after implementation of proposed mitigation measures

	Wind Direction	Magnitude	Duration	Extent	Probability	Significance
PSR11	South	2	5	2	1	9
PSR21	South	2	5	2	1	9
PSR22	South	2	5	2	1	9
PSR27	South	4	5	2	2	22
PSR28	South	4	5	2	2	22
PSR11	North	4	5	2	2	22
PSR21	North	4	5	2	1	11
PSR22	North	4	5	2	1	11
PSR27	North	4	5	2	2	22
PSR28	North	4	5	2	2	22
PSR11	West	2	5	2	1	9
PSR21	West	4	5	2	1	11
PSR22	West	4	5	2	1	11
PSR27	West	6	5	2	2	26
PSR28	West	4	5	2	2	22
PSR11	East	4	5	2	1	11
PSR21	East	2	5	2	1	9
PSR22	East	2	5	2	1	9
PSR27	East	4	5	2	2	22
PSR28	East	4	5	2	2	22

* *Only receptors shown that were impacted on in the previous section.*

Applying the precautionary principle, the assessment of potential impacts is presented in **Table 7.26**.

Table 7.26: Impact Assessment: Operational phase for revised layout

Nature:	*Numerous turbines operating simultaneously. See also* ***Table 7.10.***
Acceptable Rating Level (Zone Sound Level)	Rural district with little road traffic: 35 dBA outside during night (refer **Table 6.1**). Use $L_{Req,N}$ of 35 dBA.
Extent ($\Delta L_{Aeq,N}$>7dBA)	**Local** – Impact will extend less than 1,000 meters from activity (2)
Duration	**Permanent** – WEF will operate for a number of years (5)
Magnitude	***Estimated noise level*** ($L_{Aeq,N}$) ***higher as 35 dBA*** $\Delta L_{Aeq,N}$ < 7 dBA **High** (6) (PSR27 with western winds)
Probability	**Possible** (2)
Significance	**26 (Low)**
Status	Negative
Reversibility	High
Irreplaceable loss of resources?	*Not relevant*
Comments	*Due to mentioned unknowns (**section 5.2**), this report took a precautious stance, however, referring to **Figure 6-2**, this is mainly due to the very conservative ambient sound level selected. It should be noted that it is highly likely that ambient sound levels will be significantly higher due to wind induced noises, which would reduce both the noise impact magnitude as well as the probability that the noise impact may occur.*
Can impacts be mitigated?	Yes, but noise impact considered sufficiently mitigated
Mitigation:	• If required, the Vestas V90 2.0 MW turbine can be run in different modes to reduce the noise emissions from the wind turbine.
Cumulative impacts:	This impact is cumulative with existing ambient background noises as well as with other noise sources, including other turbines in the Wind Energy Facility.
Residual Impacts:	This impact will only disappear once the Wind Energy Facility is decommissioned.

8 MITIGATION OPTIONS

8.1 CONSTRUCTION PHASE

The mitigation of noise during the construction phase is normally relatively easy to achieve. Mitigation options included both management measures as well as technical changes. The revised layout removed a number of wind turbines, and slightly moved others. The result is that the projected noise impact due to construction activities was slightly reduced. Further mitigation is not required, but potential options are mentioned to further assist in maintaining a low risk of a noise impact during the construction phase.

Management options include:

- Ensure a good working relationship between the developer and all potentially sensitive receptors. Communication channels should be established to ensure prior notice to the sensitive receptor if work is to take place close them. Information that should be provided to the potentially sensitive receptor(s) include:
  - Proposed working times,
  - how long the activity is anticipated to take place,
  - what is being done, or why the activity is taking place, and
  - contact details of a responsible person where any complaints can be lodged should there be an issue of concern.
- When working close (within 500 meters) to a potentially sensitive receptor(s), limit the number of simultaneous activities to the minimum (due to cumulative effects for a number of simultaneous activities),
- When working very close to potentially sensitive receptors, co-ordinate the working time with periods when the receptors are not at home. An example would be to work within the 8am to 2pm time-slot to minimise the significance of the impact because:
  - Potentially receptors are most likely at school or at work, minimizing the probability of an impact happening.
  - Normal daily activities will generate other noises that would most likely mask construction noises, minimizing the probability of an impact happening.

Technical solutions to reduce the noise impact during the construction phase include:

- Using the smallest/quietest equipment for the particular purpose. For modelling purposes the noise emission characteristics of both a large bulldozer and excavator (typically used in mining operations) was used, that would most likely over-estimate the noise levels. The use of smaller equipment therefore would have a far less noise impact.
- Ensuring that equipment is well maintained and fitted with the correct and appropriate noise abatement measures.

8.2 Operational Phase

While this document took a cautious approach, the significance of the noise impact was determined to be low (26 – after implementation of all mitigation measures).

Although not required, other precautionary measures that could also reduce the potential noise impact would include:

- The developer can consider larger wind turbines which would require less wind turbines for the same power generation potential, but increase the buffer zone appropriately (***modelling would be required to define the recommended buffer zone***)
- The developer and consider to use smaller and/or quieter wind turbines.
- Reducing the number of wind turbines in areas where there are sensitive receptors.
- Developing the same number of wind turbines over a larger area.
- Ensuring a larger setback around potentially sensitive receptors taking cognisance of prevailing wind directions.
- The voluntary relocation of the receptors that are impacted.
- A combination of the above options.

Mitigation measures that would reduce a potential noise impact after the implementation of the facility includes (if a noise complaint is registered):

- Operating all, or selected wind turbines in a different mode. For the purpose of the Impact Assessment (with mitigation) the Vestas V90 2.0MW turbine operating in mode 0 was used. The Vestas as well as most other manufacturers allow the turbines to be operated in a different mode. This allows the wind turbine generator to operate more silently, albeit with a slight reduction of electrical power generation capability.

- Problematic wind turbines could also be disabled, or the rotational speeds significantly decreased during periods when a quieter environment is desired (and complaints registered).

In addition:

1. Good public relations are essential, and at all stages surrounding receptors should be educated with respect to the sound generated by wind turbines. The information presented to stakeholders should be factual and should not set unrealistic expectations. It is counterproductive to suggest that the wind turbines will be inaudible, or to use vague terms like “quiet”. Modern wind turbines produce a sound due to the aerodynamic interaction of the wind with the turbine blades, audible as a “swoosh”, which can be heard at some distance from the turbines. The magnitude of the sound will depend on a multitude of variables and will vary from day to day and from place to place with environmental and operational conditions. Audibility is distinct from the sound level, since it depends on the relationship between the sound level from the wind turbines and the ambient background sound level.
2. Community involvement needs to continue throughout the project. Annoyance is a complicated psychological phenomenon; as with many industrial operations, expressed annoyance with sound can reflect an overall annoyance with the project, rather than a rational reaction to the sound itself. Wind projects offer a benefit to the environment and the energy supply for the greater population, and offer economic benefits to the land owners leasing installation sites to the wind farm. A positive community attitude throughout the greater area should be fostered, particularly with those residents near the wind farm, to ensure they do not feel taken advantage of.
3. The developer must implement a line of communication where complaints could be lodged/registered. All potentially sensitive receptors should be made aware of this line of communication. The wind energy facility should maintain a commitment to the local community and respond to concerns in an expedient fashion. Sporadic and legitimate noise complaints could develop. For example, sudden and sharp increases in sound levels could result from mechanical malfunctions or perforations or slits in the blades. Problems of this nature can be corrected quickly, and it is in the developer’s interest to do so.

9 ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan is relevant to the revised layout.

9.1 CONSTRUCTION PHASE

Projected noise levels during construction of the Wind Energy Facility were modelled using the methods as proposed by SANS 10357:2004. The resulting future noise projections indicated that the construction activities, as modelled for the worst case scenario, might not comply with the Noise Control Regulations (PN 627), but would comply with the acceptable day rating levels as per the SANS 10103:2008 guidelines. Non-compliance with the Noise Control Regulations is not considered critical due to the very low ambient sound levels selected.

Various construction activities would be taking place during the development of the facility, but due to the relative proximity to the closest potentially sensitive receptors (such as PSR27 and PSR28), it could pose a noise risk to them. The significance of this noise impact was defined to be of a low significance. However, mitigation measures were still proposed that could further reduce the potential noise impacts, risks and the probability of any complaints being registered.

The following measures are recommended to define the performance of the developer in mitigating the projected impacts and reducing the significance of the noise impact.

OBJECTIVE	**Control noise pollution stemming from construction activities**
Project Component(s)	Construction of infrastructure, including but not limited to: turbine system (foundation, tower, nacelle and rotor), substation(s), access roads and electrical power cabling.
Potential Impact	• Increased noise levels at potentially sensitive receptors • Potentially changing the acceptable land use capability
Activity/Risk source	Any construction activities taking place within 500 meters from potentially sensitive receptors (PSR)
Mitigation Target/Objective	• Ensure equivalent A-weighted noise levels below 45 dBA at potentially sensitive receptors. • Ensure that maximum noise levels at potentially sensitive receptors be less than 65 dBA. • Prevent the generation of disturbing or nuisance noises • Ensure acceptable noise levels at surrounding stakeholders and potentially sensitive receptors. • Ensuring compliance with the Noise Control Regulations

Mitigation: Action/Control	**Responsibility**	**Timeframe**

Establish a line of communication and notify all stakeholders and PSRs of the means of registering any issues, complaints or comments.	- Environmental Control Officer	All phases of project
Notify potentially sensitive receptors about work to take place at least 2 days before the activity in the vicinity (within 500 meters) of the PSR is to start. Following information to be presented in writing: - Description of Activity to take place - Estimated duration of activity - Working hours - Contact details of responsible party	- Contractor - Environmental Control Officer	At least 2 days, but not more than 5 days before activity is to commence
Ensure that all equipment are maintained and fitted with the required noise abatement equipment.	- Environmental Control Officer	Weekly inspection
Measure the peak noise levels of equipment used when operational and keep database of noise levels	- Acoustical Consultant / Approved Noise Inspection Authority	Start of project Twice annually
When any noise complaints are received, noise monitoring should be conducted at the complainant, followed by feedback regarding noise levels measured	- Acoustical Consultant / Approved Noise Inspection Authority	Within 7 days after complaint was registered
The construction crew must abide by the local by-laws regarding noise.	- Contractor - Environmental Control Officer	Duration of construction phase
Where possible construction work should be undertaken during normal working hours (06H00 – 22H00), from Monday to Saturday; If agreements can be reached (in writing) with the all the surrounding (within a 1,000 distance) potentially sensitive receptors, these working hours can be extended.	- Contractor	As required

Performance indicator	• **Equivalent A-weighted noise levels below 45 dBA at potentially sensitive receptors (8 hours).** • **Ensure that maximum noise levels at potentially sensitive receptors are less than 65 dBA.** • **No noise complaints are registered**
Monitoring	Noise monitoring to be conducted downwind from all noisy activities or at PSRs when work is taking place within 500 meters from a potentially sensitive receptor. Monitoring to take place every time that a noise complaint is registered.

9.2 OPERATIONAL PHASE

Projected noise levels during operation of the Wind Energy Facility were modelled using the methodology as proposed by both SANS 10357:2004 and ISO 9613-2.

The resulting future noise projections indicated that the operation of the facility would comply with the Noise Control Regulations (PN 627), but may not comply with the SANS 10103:2008 guidelines during optimal sound propagation conditions with a western wind. The significance of this noise impact on PSR 27 was determined to be of a medium significance during such an instance, but due to the precautious approach of this assessment, further mitigation is not consider necessary.

The following measures are recommended to define the performance of the developer in mitigating the projected impacts and reducing the significance of the noise impact.

OBJECTIVE	**Control noise pollution stemming from operation of WEF**
Project Component(s)	Operational Phase
Potential Impact	• Increased noise levels at potentially sensitive receptors • Changing ambient sound levels could change the acceptable land use capability • Disturbing character of sound
Activity/Risk source	Simultaneous operation of a number of Wind Turbines
Mitigation Target/Objective	• Ensure that the change in ambient sound levels as experienced by Potentially Sensitive Receptors is less than 5 dBA. • Prevent the generation of nuisance noises • Ensure acceptable noise levels at surrounding stakeholders and potentially sensitive receptors.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Defining the ambient sound levels in 10 minute bins over a period of 14 days before the operational phase starts inside and outside of the dwellings at PSR11, PSR21 and PSR27. 10 minute sampling bins should be co-ordinated with 10 m wind speed.	- Acoustical Consultant	Before operational phase commence
Design and implement a noise monitoring programme	- Acoustical Consultant	Before operational phase commence
Add additional noise monitoring points at any complainants that registered a noise complaint relating to the operation of the WEF	- Acoustical Consultant / Approved Noise Inspection Authority	With quarterly monitoring

Performance indicator	**Ensure that the change in ambient sound levels as experienced by Potentially Sensitive Receptors is less than 7 dBA**
Monitoring	Quarterly noise monitoring by an Acoustic Consultant or Approved Noise Inspection Authority for the first two years of operation. Monitoring should take place over a 24 hour period in 10 minute bins, with the results co-ordinated with the 10 m wind speed. Noise monitoring programme to be developed and implemented at the start of operation.

10 CONCLUSIONS

This report is an Environmental Noise Impact Assessment of the predicted noise environment due to the development of the Rheboksfontein Wind Energy Facility close to Darling, making use of a predictive model to identify issues of concern.

While modelling indicated no single turbine that would impact on the potentially sensitive receptors, the evaluation showed that the cumulative impact of a number of turbines would increased the total noise levels (and change in ambient sound levels) in the area.

With the input data as used, this assessment indicated that the proposed project would comply with the Provincial Noise Control Regulations (PN 627) and generally with the SANS 10103 guideline values. However, it is possible that the operation of the WEF could impact on PSR27 during optimal noise propagation conditions (high humidity, cold temperatures found early in the mornings during winter months) with a western wind blowing. During these periods PSR27 may experience noise levels exceeding 35 dBA. However, considering the precautious approach as well the likelihood that the PSR would be indoors (10 dBA attenuation), the significance of the potential noise impact is considered low.

Mitigation measures were however proposed if any noise complaints are registered that would reduce any noise impacts.

With its potential for environmental and economic advantages, wind power generation have significant potential to become a large industry in South Africa. However, when wind farms come close to potentially sensitive receptors, consideration must be given to ensuring a compatible co-existence. The potentially sensitive receptors should not be adversely affected and yet, at the same time the wind farms need to reach an optimal scale in terms of layout and number of units.

Wind turbines produce sound, primarily due to mechanical operations and aerodynamics effects at the blades. Modern wind turbine manufacturers have virtually eliminated the noise impact caused by mechanical sources, and instituted measures to reduce the aerodynamic effects. But, as with many other activities, the wind turbines emit sound power levels at a level that does impact areas at some distance away. When potentially sensitive receptors are nearby, care must be taken to ensure that the operations at the wind farm do not unduly cause annoyance or otherwise interfere with the quality of life of the receptors.

It should be noted that this does not suggest that the sound from the wind turbines should be inaudible under all circumstances - this is an unrealistic expectation that is not required or expected from any other agricultural, commercial, industrial or transportation related noise source – but rather that the sound due to the wind turbines should be at a reasonable level in relation to the ambient sound levels.

11 RECOMMENDATIONS

The current impact that the proposed WEF (with mitigation measures as proposed) could have on the surrounding environment is considered to be of a low significance. Further mitigation measures are not required.

It should be noted that should the developer select to relocate any wind turbines the noise analysis should be redone if any wind turbines are within 1,000 from a potentially sensitive receptor.

In addition, should the layout (or type of wind turbines used) change significantly, it is recommended that the new layout be remodelled in terms of the potential noise impact by an independent acoustics specialist.

It is considered critical that the developer define those ambient sound levels in the area for a longer period before the wind energy facility is commissioned. As a minimum the ambient sound levels should be defined in 10 minute bins over a period of 14 days inside and outside of the dwellings at PSR11, PSR21 and PSR27. The 10 minute sampling bins should be co-ordinated with 10 m wind speed.

In addition quarterly monitoring noise monitoring is recommended during the first two years of the operational phase of the facility. This monitoring is to take place during late afternoon (16:00 – 18:00), late evening (20:00 – 24:00) as well as early in the morning (03:00 – 06:00) in 10 minute bins. At least two of these samples should be during times when the Wind Energy Facility is operational.

Quarterly monitoring is suggested at PSR11, PSR21 and PSR27 for the first two years, as well as any other receptors that have complained to the developer regarding noise originating from the facility. Annual feedback regarding noise monitoring should be presented to all stakeholders and other Interested and Affected parties in the area. Noise monitoring must be continued as long as noise complaints are registered.

This report should also be made available to all potential sensitive receptors in the area, or the contents explained to them to ensure that they understand all the potential risks that the development of a wind energy facility may have on them and their families.

12 THE AUTHOR

The author of this report, M. de Jager (B. Ing (Chem), UP) graduated in 1998 from the University of Pretoria. He has been interested in acoustics as from school days, doing projects mainly related to loudspeaker enclosure design. Interest in the matter brought him into the field of Environmental Noise Measurement, Prediction and Control. As from 2007 he has been involved with the following projects:

- Full Noise Impact Studies for a number of Wind Energy Facilities, including: Cookhouse, Amakhala Emoyeni, Dassiesfontein/Klipheuwel, Rheboksfontein, AB, Dorper, Suurplaat, Gouda, Riverbank, Deep River, West Coast, West Coast One, Karoo REF, Velddrift, Canyon Springs, Happy Valley and Saldanha.
- Full Noise Impact Studies for a number of mining projects, including: Skychrome (Pty) Ltd (A Ferro-chrome mine), Mooinooi Chrome Mine (WCM), Buffelsfontein East and West (WCM), Elandsdrift (Sylvania), Jagdlust Chrome Mine (ECM), Apollo Brick (Pty) Ltd (Clay mine and brick manufacturer), Arthur Taylor Expansion project (X-Strata Coal SA), Klipfontein Colliery (Coal mine), Landau Expansion project (Coal mine), Modelling for Tweefontein Colliery Expansion.

The author is an independent consultant to the project, the developer as well as Savannah Environmental (Pty) Ltd. He,

- does not and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations;
- have and will not have no vested interest in the proposed activity proceeding;
- have no, and will not engage in conflicting interests in the undertaking of the activity;
- undertake to disclose all material information collected, calculated and/or findings, whether favorable to the developer or not;
- will ensure that all information containing all relevant facts be included in this report.

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APPENDIX A

TYPICAL SOUND POWER LEVELS, VARIOUS TYPES OF EQUIPMENT

Frequency	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**
A-Weight Factor	**-26.22**	**-16.19**	**-8.67**	**-3.25**	**0**	**1.2**	**0.96**
Equipment / Process	**Sound power level, dB re1 pW, in octave band, Hz**						
Crusher	121.1	122.3	120.1	120	117.3	112.5	106.3
Mobile Crusher/Screen (Rock)	114.2	109.5	106.2	106	104.1	102.2	101
Crushing/Screening (Coal, small)	100.5	96.9	97.3	99.2	98.4	98.8	94.3
CAT D10 Bulldozer	118.3	115.2	111	109.1	107.5	103	97
CAT D11 Bulldozer	121.22	112.2	111.4	110.9	110.4	101.45	93.67
Front End Loader	105	117	113	114	111	107	101
Road Truck average	90	101	102	105	105	104	99
Drilling Machine	107.2	109.4	109.2	106.1	104.7	101.2	99.8
CAT Water Dozer	112.9	114.5	111.45	109.7	108.35	107.2	104
Excavator	110	112	118	105	106	99	95
Terex 30 ton haul dumper	102.4	105.3	108.9	108.8	108.2	105.1	99.2
Hitachi EX1200 Excavator	113.2	116	119.7	112.5	109.8	108.4	105.4
Cement truck (with cement)	104	107	106	108	107	105	102
Operational Hitachi Grader	107.7	107.9	106.8	106.2	104.2	101.1	97.2
Grader	100	111	108	108	106	104	98
Haul truck	107.9	113.2	116.9	114.4	110.6	106.8	100.2
Road Transport Reversing/Idling	108.2	104.6	101.2	99.7	105.4	100.7	98.7
Vesta V66, max	125.1	113.6	106.3	106.2	100.4	96.4	95.3
Vesta V66, ave	120.1	109.4	100.9	100.5	95.3	91.3	88.8
Vesta V66, min	114.4	104	94.84	94.8	87.5	83.3	80.7
Nordex N90 2.5MW at 4m/s	110.42	104.49	101.37	96.35	91.6	89.3	85.54
Nordex N90 2.5MW at 7m/s	117.92	111.99	108.87	103.85	99.1	96.8	93.04
Vestas V90 2.0 MW at 5m/s	105.9	100.7	97.2	94.8	94.1	91.7	89.7
Vestas V90 2.0 MW at 7m/s	111.4	106.9	102.2	99.5	98.7	96.3	94.2
RePower MM92 at 7.5m/s	109.25	107.41	105.63	101.9	96.73	89.81	83.09
General noise	100	100	103	105	105	100	100
CAT Rock Breaker	119.1	118.2	115.2	115.7	114.9	115.7	110.4
Crane	89	98	101	103	102	102	98
Portable Diesel Generator	96.7	99.5	101.2	97.4	91.3	89.6	81.1

APPENDIX B

DETAILED ANALYSIS OF SOUND POWER LEVELS:

- CONTRIBUTIONS FROM TURBINES

Table B.1: Turbines that could potentially impact on Potentially Sensitive Receptors for a 5 m/s wind (Revised Layout)

	Southern Wind				
Turbine	PSR11	PSR21	PSR22	PSR27	PSR28
26	28.62072	8.224793	8.0309	9.556349	9.060085
29	12.06988	8.474546	8.369577	29.51218	22.72598
32	8.593233	8.538845	8.435349	23.29093	28.40957
33	8.73822	8.470214	8.373653	26.1429	29.66957
34	9.041821	8.418806	8.326468	28.87105	31.3834
35	9.38358	8.309278	8.229364	27.46547	28.1041
	Northern Wind				
Turbine	PSR11	PSR21	PSR22	PSR27	PSR28
7	8.0309	26.80278	27.30016	8.0309	8.0309
12	8.172097	28.64187	27.58712	8.547449	8.531071
13	26.87498	8.0309	8.0309	9.557215	9.126923
18	29.99974	8.0309	8.0309	10.49905	9.707961
19	10.00235	8.0309	8.0309	27.07652	24.904
21	9.620304	8.0309	8.0309	31.82688	27.14703
23	8.69852	8.0309	8.0309	31.47495	31.19139
24	10.44224	8.0309	8.0309	27.93237	23.79879
	Western Wind				
Turbine	PSR11	PSR21	PSR22	PSR27	PSR28
7	8.0309	25.46325	27.30016	8.0309	8.0309
11	8.0309	26.47329	25.15683	8.0309	8.0309
12	8.0309	29.72533	29.12145	8.0309	8.0309
21	8.939476	8.497611	8.367887	30.29102	27.14703
24	9.458898	8.338968	8.234386	29.23465	25.1467
27	10.09599	8.0309	8.0309	26.37661	22.94005
29	9.304193	8.0309	8.0309	30.50677	26.67975
34	8.0309	8.0309	8.0309	21.92989	27.97015
35	8.325719	8.0309	8.0309	23.39578	26.76733
	Eastern Wind				
Turbine	PSR11	PSR21	PSR22	PSR27	PSR28
18	29.99974	8.0309	8.0309	8.995622	8.650614
23	10.0894	8.0309	8.0309	30.6367	30.29909
26	29.82142	8.0309	8.0309	9.556349	9.060085
32	9.144215	8.0309	8.0309	24.63085	28.40957
33	9.345312	8.0309	8.0309	26.1429	28.58699
34	9.758401	8.0309	8.0309	27.59965	27.97015

Moyeng Energy (Pty) Ltd

REVISED NOISE IMPACT STUDY FOR ENVIRONMENTAL IMPACT ASSESSMENT

Establishment of the Rheboksfontein Wind Energy Facility on various farms near Darling, Western Cape

Study done for:

Savannah Environmental (Pty) Ltd

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Title:

Revised Noise Impact Study for Environmental Impact Assessment: Establishment of the Rheboksfontein Wind Energy Facility on various farms near Darling, Western Cape.

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Date:

June 2011

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GLOSSARY OF ABBREVIATIONS

DEA	Department of Environmental Affairs
DEADP	Department of Environmental Affairs and Development Planning
EAP	Environmental Assessment Practitioner
ECA	Environment Conservation Act (Act 78 of 1989)
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
FEL	Front End Loader
IAPs	Interested and Affected Parties
i.e.	that is
IEM	Integrated Environmental Management
km	kilometres
LHD	Load haul dumper
m	Meters (measurement of distance)
m^2	Square meter
m^3	Cubic meter
mamsl	Meters above mean sea level
MENCO	M^2 Environmental Connections cc
NEMA	National Environmental Management Act, 1998 (Act 107 of 1998)
NCR	Noise Control Regulations (under Section 25 of the ECA)
NGO	Non-government Organisation
PPE	Personal Protective Equipment
PPP	Public Participation Process
SABS	South African Bureau of Standards
SANS	South African National Standards
SHEQ	Safety Health Environment and Quality
TLB	Tip Load Bucket
WEF	Wind Energy Facility
WHO	World Health Organisation
WTG	Wind Turbine Generator

GLOSSARY OF TERMS

1/3-Octave Band	A filter with a bandwidth of one-third of an octave representing four semitones, or notes on the musical scale. This relationship is applied to both the width of the band, and the center frequency of the band. See also definition of octave band.
A – Weighting	An internationally standardised frequency weighting that approximates the frequency response of the human ear and gives an objective reading that therefore agrees with the subjective human response to that sound.
Air Absorption	The phenomena of attenuation of sound waves with distance propagated in air, due to dissipative interaction within the gas molecules.
Alternatives	A possible course of action, in place of another, that would meet the same purpose and need (of proposal). Alternatives can refer to any of the following, but are note limited hereto: alternative sites for development, alternative site layouts, alternative designs, alternative processes and materials. In Integrated Environmental Management the so-called "no go" alternative refers to the option of not allowing the development and may also require investigation in certain circumstances.
Ambient	The conditions surrounding an organism or area.
Ambient Noise	The all-encompassing sound at a point being composed of sounds from many sources both near and far. It includes the noise from the noise source under investigation.
Ambient Sound	The all-encompassing sound at a point being composite of sounds from near and far.
Ambient Sound Level	Means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such a meter was put into operation. In this report the term Background Ambient Sound Level will be used.
Amplitude Modulated Sound	A sound that noticeably fluctuates in loudness over time.
Applicant	Any person who applies for an authorisation to undertake a listed activity or to cause such activity in terms of the relevant environmental legislation.
Assessment	The process of collecting, organising, analysing, interpreting and communicating data that is relevant to some decision.
Audible Frequency Range	Generally assumed to be the range from about 20 Hz to 20,000 Hz, the range of frequencies that our ears perceive as sound.
Background Ambient Sound Level	The level of the ambient sound indicated on a sound level meter in the absence of the sound under investigation (e.g. sound from a particular noise source or sound generated for test purposes). Ambient sound level as per Noise Control Regulations.
C-Weighting	This is an international standard filter, which can be applied to a pressure signal or to a *SPL* or *PWL* spectrum, and which is essentially a pass-band filter in the frequency range of approximately 63 to 4000 Hz. This filter provides a more constant, flatter, frequency response, providing significantly less adjustment than the A-scale filter for frequencies less than 1000 Hz.
dB(A)	Sound Pressure Level in decibel that has been A-weighted, or filtered, to match the response of the human ear.
Decibel (db)	A logarithmic scale for sound corresponding to a multiple of 10 of the threshold of hearing. Decibels for sound levels in air are referenced to an atmospheric pressure of 20 μ Pa.
Diffraction	Modification of the progressive wave distribution due to the presence of obstacles in the field. Reflection and refraction are special cases of diffraction.
Direction of Propagation	The direction of flow of energy associated with a wave.
Disturbing noise	Means a noise level that exceeds the zone sound level or, if no zone sound level has been designated, a noise level that exceeds the ambient sound level

at the same measuring point by 7 dBA or more.

Environment — The external circumstances, conditions and objects that affect the existence and development of an individual, organism or group; these circumstances include biophysical, social, economic, historical, cultural and political aspects.

Environmental Control Officer — Independent Officer employed by the applicant to ensure the implementation of the Environmental Management Plan (EMP) and manages any further environmental issues that may arise.

Environmental impact — A change resulting from the effect of an activity on the environment, whether desirable or undesirable. Impacts may be the direct consequence of an organisation's activities or may be indirectly caused by them.

Environmental Impact Assessment — An Environmental Impact Assessment (EIA) refers to the process of identifying, predicting and assessing the potential positive and negative social, economic and biophysical impacts of any proposed project, plan, programme or policy that requires authorisation of permission by law and that may significantly affect the environment. The EIA includes an evaluation of alternatives, as well as recommendations for appropriate mitigation measures for minimising or avoiding negative impacts, measures for enhancing the positive aspects of the proposal, and environmental management and monitoring measures.

Environmental issue — A concern felt by one or more parties about some existing, potential or perceived environmental impact.

Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$) — The value of the average A-weighted sound pressure level measured continuously within a reference time interval *T*, which have the same mean-square sound pressure as a sound under consideration for which the level varies with time.

Equivalent continuous A-weighted rating level ($L_{Req,T}$) — The Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$) to which various adjustments has been added. More commonly used as ($L_{Req,d}$) over a time interval 06:00 – 22:00 (T=16 hours) and ($L_{Req,n}$) over a time interval of 22:00 – 06:00 (T=8 hours).

Footprint area — Area to be used for the construction of the proposed development, which does not include the total study area.

Frequency — The rate of oscillation of a sound, measured in units of Hertz (Hz) or kiloHertz (kHz). One hundred Hz is a rate of one hundred times per second. The frequency of a sound is the property perceived as pitch: a low-frequency sound (such as a bass note) oscillates at a relatively slow rate, and a high-frequency sound (such as a treble note) oscillates at a relatively high rate.

Green field — A parcel of land not previously developed beyond that of agriculture or forestry use; virgin land. The opposite of Green field is Brown field, which is a site previously developed and used by an enterprise, especially for a manufacturing or processing operation. The term Brown field suggests that an investigation should be made to determine if environmental damage exists.

G-Weighting — An International Standard filter used to represent the infrasonic components of a sound spectrum.

Harmonics — Any of a series of musical tones for which the frequencies are integral multiples of the frequency of a fundamental tone.

Infrasound — Sound with a frequency content below the threshold of hearing, generally held to be about 20 Hz. Infrasonic sound with sufficiently large amplitude can be perceived, and is both heard and felt as vibration. Natural sources of infrasound are waves, thunder and wind.

Integrated Development Plan — A participatory planning process aimed at developing a strategic development plan to guide and inform all planning, budgeting, management and decision-making in a Local Authority, in terms of the requirements of Chapter 5 of the Municipal Systems Act, 2000 (Act 32 of 2000).

Integrated Environmental Management — IEM provides an integrated approach for environmental assessment, management, and decision-making and to promote sustainable development and the equitable use of resources. Principles underlying IEM provide for a democratic, participatory, holistic, sustainable, equitable and accountable

	approach.
Interested and affected parties	Individuals or groups concerned with or affected by an activity and its consequences. These include the authorities, local communities, investors, work force, consumers, environmental interest groups and the general public.
Key issue	An issue raised during the Scoping process that has not received an adequate response and that requires further investigation before it can be resolved.
Listed activities	Development actions that is likely to result in significant environmental impacts as identified by the delegated authority (formerly the Minister of Environmental Affairs and Tourism) in terms of Section 21 of the Environment Conservation Act.
Loudness	The attribute of an auditory sensation that describes the listener's ranking of sound in terms of its audibility.
Magnitude of impact	Magnitude of impact means the combination of the intensity, duration and extent of an impact occurring.
Masking	The raising of a listener's threshold of hearing for a given sound due to the presence of another sound.
Mitigation	To cause to become less harsh or hostile.
Negative impact	A change that reduces the quality of the environment (for example, by reducing species diversity and the reproductive capacity of the ecosystem, by damaging health, or by causing nuisance).
Noise	a. Sound that a listener does not wish to hear (unwanted sounds). b. Sound from sources other than the one emitting the sound it is desired to receive, measure or record. c. A class of sound of an erratic, intermittent or statistically random nature.
Noise Level	The term used in lieu of sound level when the sound concerned is being measured or ranked for its undesirability in the contextual circumstances.
Noise-sensitive development	developments that could be influenced by noise such as: a) districts (see table 2 of SANS 10103:2008) 1. rural districts, 2. suburban districts with little road traffic, 3. urban districts, 4. urban districts with some workshops, with business premises, and with main roads, 5. central business districts, and 6. industrial districts; b) educational, residential, office and health care buildings and their surroundings; c) churches and their surroundings; d) auditoriums and concert halls and their surroundings; e) recreational areas; and f) nature reserves. In this report Noise-sensitive developments is also referred to as a Potential Sensitive Receptor
Octave Band	A filter with a bandwidth of one octave, or twelve semi-tones on the musical scale representing a doubling of frequency.
Positive impact	A change that improves the quality of life of affected people or the quality of the environment.
Property	Any piece of land indicated on a diagram or general plan approved by the Surveyor-General intended for registration as a separate unit in terms of the Deeds Registries Act and includes an erf, a site and a farm portion as well as the buildings erected thereon
Public Participation Process	A process of involving the public in order to identify needs, address concerns, choose options, plan and monitor in terms of a proposed project, programme or development
Reverberant Sound	The sound in an enclosure excluding that is received directly from the source.
Reverberation	The persistence, after emission of a sound has stopped, of a sound field within

	an enclosure.
Significant Impact	An impact can be deemed significant if consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provides reasonable grounds for mitigating measures to be included in the environmental management report. The onus will be on the applicant to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account.
Sound Level	The level of the frequency weighted and time weighted sound pressure as determined by a sound level meter.
Sound Power	Of a source, the total sound energy radiated per unit time.
Sound Pressure Level (SPL)	Of a sound, 20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level. International values for the reference sound pressure level are 20 micropascals in air and 100 millipascals in water. SPL is reported as L_p in dB (not weighted) or in various other weightings.
Soundscape	Sound or a combination of sounds that forms or arises from an immersive environment. The study of soundscape is the subject of acoustic ecology. The idea of soundscape refers to both the natural acoustic environment, consisting of natural sounds, including animal vocalizations and, for instance, the sounds of weather and other natural elements; and environmental sounds created by humans, through musical composition, sound design, and other ordinary human activities including conversation, work, and sounds of mechanical origin resulting from use of industrial technology. The disruption of these acoustic environments results in noise pollution.
Study area	Refers to the entire study area encompassing all the alternative routes as indicated on the study area map.
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland Commission, 1987).
Zone of Potential Influence	The area defined as the radius about an object, or objects beyond which the noise impact will be insignificant.
Zone Sound Level	Means a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. This is similar to the Rating Level as defined in SANS10103.

1 INTRODUCTION

1.1 INTRODUCTION AND PURPOSE

M2 Environmental Connections was commissioned to undertake a specialist study to determine the potential noise impact on the surrounding environment, due to the establishment of the Rheboksfontein Wind Energy Facility on various farms close to the town of Darling, Western Cape.

This report describes the potential impact that such a Wind Energy Facility may have on the surrounding environment, highlighting the methodologies used, potential issues identified, findings and recommendations. This revision reviews an updated turbine layout due to comments received by the Department of Environmental Affairs, implementing the changed layout as a mitigatory measure.

1.2 BRIEF PROJECT DESCRIPTION

Moyeng Energy (Pty) Ltd proposes the establishment of a wind energy facility and associated infrastructure with a revised turbine layout, on various farms and farm portions near the town of Darling, Western Cape. The study area is approximately 70 km^2, with the area investigated in terms of the noise impact covering approximately 132 km^2.

The facility and associated infrastructure includes:

- Up to **48 wind turbines** and associated **Concrete foundations**,
- Underground **cables** between the wind turbine generators,
- A maintenance/control building;
- **Substation** to allow connection between the Wind Energy Facility and the existing Eskom electrical grid;
- 132 kV **Power Line(s)** linking to the transmission grid; and
- **Internal Access Roads** between the turbines.

1.3 TERMS OF REFERENCE

SANS 10328:2008 (Edition 2) specifies the methodology to assess the noise impacts on the environment due to a proposed activity that might impact on the environment. The standard also stipulates the minimum requirements to be investigated for EIA. These minimum requirements are:

1. the purpose of the investigation

2. a brief description of the planned development or the changes that are being considered
3. a brief description of the existing environment including, where relevant, the topography, surface conditions and meteorological conditions during measurements
4. the identified noise sources together with their respective sound pressure levels or sound power levels (or both) and, where applicable, the operating cycles, the nature of sound emission, the spectral composition and the directional characteristics
5. the identified noise sources that were not taken into account and the reasons as to why they were not investigated
6. the identified noise-sensitive developments and the noise impact on them
7. where applicable, any assumptions, with references, made with regard to any calculations or determination of source and propagation characteristics
8. an explanation, either by a brief description or by reference, of all measuring and calculation procedures that were followed, as well as any possible adjustments to existing measuring methods that had to be made, together with the results of calculations
9. an explanation, either by description or by reference, of all measuring or calculation methods (or both) that were used to determine existing and predicted rating levels, as well as other relevant information, including a statement of how the data were obtained and applied to determine the rating level for the area in question
10. the location of measuring or calculating points in a sketch or on a map
11. quantification of the noise impact with, where relevant, reference to the literature consulted and the assumptions made
12. alternatives that were considered and the results of those that were investigated
13. a list of all the interested or affected parties that offered any comments with respect to the environmental noise impact investigation
14. a detailed summary of all the comments received from interested or affected parties as well as the procedures and discussions followed to deal with them
15. conclusions that were reached
16. proposed recommendations
17. if remedial measures will provide an acceptable solution which would prevent a significant impact, these remedial measures should be outlined in detail and included in the final record of decision if the approval is obtained from the relevant authority. If the remedial measures deteriorate

after time and a follow-up auditing or maintenance programme (or both) is instituted, this programme should be included in the final recommendations and accepted in the record of decision if the approval is obtained from the relevant authority; and

18. any follow-up investigation which should be conducted at completion of the project as well as at regular intervals after the commissioning of the project so as to ensure that the recommendations of this report will be maintained in the future.

1.4 STUDY AREA

The wind energy facility is proposed on the following farms near the town of Darling:

- Remaining extent of Farm 568 (Rheboksfontein),
- Farm 567 (Nieuwe Plaats),
- Remaining extent of Farm 571 (Bonteberg),
- Portion 1 of Farm 574 (Doornfontein),
- Portion 1 of Farm 551 (Plat Klip),
- Farm 1199 (Groot Berg), and
- Portion 2 of Farm 552 (Slang Kop).

The proposed WEF will be situated in an undeveloped rural area between the towns of Darling and Yzerfontein. The area is characterized by two landscape types, i.e. a relatively flat, low-lying sandy coastal plain to the west of the R27 West Coast road and low hills to the east of the R27, rising to between 160 and 260m above sea level. A site locality map is presented in **Figure 1-1**. It is important to note that the site is also directly adjacent to the Darling Windfarm, located below the crest of Moedmaag Hill, slightly east of the R27.

The area is mainly used for various agricultural activities. These agricultural activities and the roads (R27 and R315) are the main noise source in the vicinity of the study area during the day. Traffic on the R27 and R315 dies down in the evening. Late at night/early morning there is no traffic on the R315. The ocean and other natural sounds define the ambient sound environment late at night and early in the mornings.

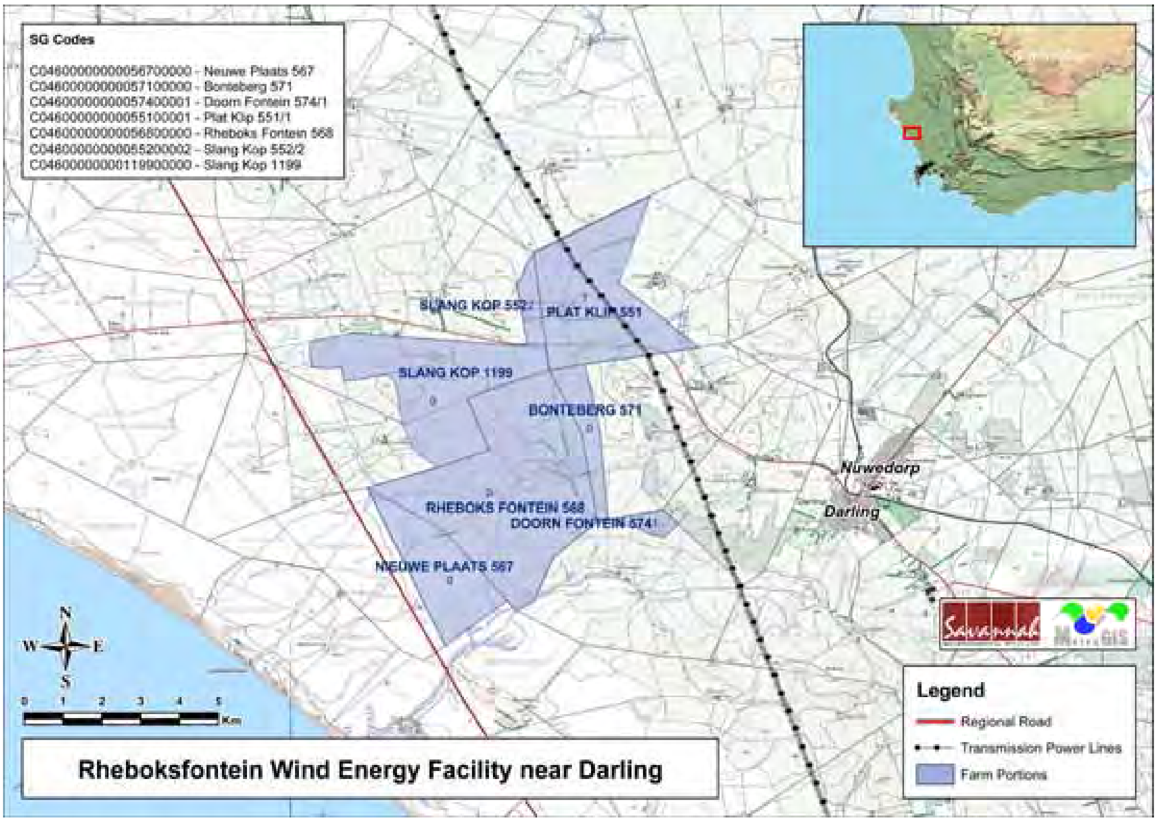

Figure 1-1: Site map indicating locations of the various portions proposed to be used for the WEF

1.5 Available Information

- The Scoping report (2010) compiled for this project by the author;
- The Environmental Noise Impact Assessment Report No. ME-RF/NIA/201008-Rev 0 (2010) compiled by the author based on the old turbine layout; and
- Wind speed and direction data is available from the developer, but due to the commercial value is considered confidential.

1.6 Noise Sensitive Developments

Noise Sensitive Developments (Potential Sensitive Receptors) were initially identified using GoogleEarth®, supported by a site visit to confirm the status of the identified dwellings during end March 2010. The reason for the site visit is that there could be a number of derelict or abandoned dwellings that was seen as potential sensitive receptors, small dwellings that could not be identified on the aerial image, or those dwellings that were built after the date of the aerial photograph.

Potential receptors within 2 km of the edge of the WEF were identified, and are presented in **Figure 1-2** (with the coordinates of the Potential receptor in **Table 1.1**).

The assessment indicated the presence of a number of potential sensitive receptors, mainly various farmsteads around and within the boundaries of the proposed WEF portions.

It should also be noted that while only one receptor is indicated per site, it should rather be seen as a small community of receptors. This is because at most of the farm dwellings there are a number of other houses occupied by farm workers and their families.

Table 1.1: Locations of the identified receptors (Datum type: Universal Transverse Mercator, zone 34)

Receptor	Location X	Location Y
PSR01	243564.2	6308518
PSR02	244555.9	6303801
PSR03	246183	6301594
PSR04	245286.5	6301297
PSR05	245007.1	6299862
PSR06	246928.7	6300986
PSR07	247837.9	6298798
PSR08	247033.8	6297989
PSR09	248238	6299976
PSR10	249049.3	6300009
PSR11	246185.5	6305268
PSR12	247044	6307346
PSR13	247200.9	6307423
PSR14	247191	6307485
PSR15	244587.2	6309347
PSR16	244685.7	6309424
PSR17	247190.5	6308812
PSR18	247215.9	6308652
PSR19	249737.8	6308629
PSR20	250070.1	6308884
PSR21	251794.6	6309434
PSR22	251963.9	6309642
PSR23	249539.2	6312478
PSR24	253922.5	6311561
PSR25	252922.6	6306810
PSR26	253274.5	6306681
PSR27	249634.8	6304672
PSR28	249928.7	6304557
PSR29	251926.9	6305758
PSR30	251886.4	6305520
PSR31	253958.8	6304396
PSR32	253958.8	6304396

Figure 1-2: Aerial image indicating potential sensitive receptors (green dots) and locations of the farm and portions of the proposed WEF.

2 POLICIES AND THE LEGAL CONTEXT

2.1 THE REPUBLIC OF SOUTH AFRICA CONSTITUTION ACT ("THE CONSTITUTION")

The environmental rights contained in section 24 of the Constitution provide that everyone is entitled to an environment that is not harmful to his or her well-being. In the context of noise, this requires a determination of what level of noise is harmful to well-being. The general approach of the common law is to define an acceptable level of noise as that which the reasonable person can be expected to tolerate in the particular circumstances. The subjectivity of this approach can be problematic which has led to the development of noise standards (see Section 2.6).

"Noise pollution" is specifically included in Part B of Schedule 5 of the Constitution, which means that noise pollution control is a local authority competence, provided that the local authority concerned has the capacity to carry out this function.

2.2 THE ENVIRONMENT CONSERVATION ACT

The Environment Conservation Act ("ECA") allows the Minister of Environmental Affairs and Tourism ("now the Ministry of Water and Environmental Affairs") to make regulations regarding noise, among other concerns. The Minister has made noise control regulations under the ECA adopted by the Western Cape Province. See also **section 2.5**.

2.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT

The National Environmental Management Act ("NEMA") defines "pollution" to include any change in the environment, including noise. A duty therefore arises under section 28 of NEMA to take reasonable measures while establishing and operating the WEF to prevent noise pollution occurring. NEMA sets out measures which may be regarded as reasonable. They include measures:

1. to investigate, assess and evaluate the impact on the environment;
2. to inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment;

3. to cease, modify or control any act, activity or process causing the pollution or degradation;
4. to contain or prevent the movement of;
5. to eliminate any source of the pollution or degradation; or
6. to remedy the effects of the pollution or degradation.

2.4 NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT ("AQA")

Section 34 of the National Environmental Management: Air Quality Act (Act 39 of 2004) makes provision for:

(1) the Minister to prescribe essential national noise standards -

(a) for the control of noise, either in general or by specified machinery or activities or in specified places or areas; or

(b) for determining –

(i) a definition of noise; and

(ii) the maximum levels of noise.

(2) When controlling noise the provincial and local spheres of government are bound by any prescribed national standards.

This section of the Act is in force but no such standards have yet been promulgated.

An atmospheric emission licence issued in terms of section 22 may contain conditions in respect of noise. This however will not be relevant to the WEF, as no atmospheric emissions will take place.

2.5 NOISE CONTROL REGULATIONS

In terms of section 25 of the ECA, the national noise-control regulations (GN R154 in *Government Gazette* No. 13717 dated 10 January 1992) were promulgated. The NCRs were revised under Government Notice Number R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations.

Subsequently, in terms of Schedule 5 of the Constitution of South Africa of 1996 legislative responsibility for administering the noise control regulations was devolved to provincial and local authorities. Provincial Noise Control Regulations exist in the Free State, Western Cape and Gauteng provinces.

Provincial Noise Control Regulations exist in the Western Cape Province (Provincial Notice 627 of 20 November 1998).

In terms of these regulations, if the predicted level of noise emanating from a proposed activity is likely to cause the noise levels on surrounding land to exceed 65 dBA (61 dBA for an industrial noise), noise mitigation measures are required to be implemented to ensure that the noise levels on the affected land are reduced so as not to exceed 65 dBA.

In addition, increases above 7 dBA from the background ambient noise levels are considered a "Disturbing noise".

Draft Noise Control Regulations have been promulgated in the Western Cape for review and comment (PN 14/2007 of 25 January 2007). It is not yet implemented.

2.6 NOISE STANDARDS

Four South African Bureau of Standards (SABS) scientific standards are considered relevant to noise from a Wind Energy Facility. They are:

- SANS 10103:2004. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication'.
- SANS 0210:2004. 'Calculating and predicting road traffic noise'.
- SANS 10328:2003. 'Methods for environmental noise impact assessments'.
- SANS 10357:2004. 'The calculation of sound propagation by the Concave method'.

The relevant standards use the equivalent continuous rating level as a basis for determining what is acceptable. The levels may take single event noise into account but single event noise by itself does not determine whether noise levels are acceptable for land use purposes. The recommendations that the standards make are likely to inform decisions by authorities but non-compliance with the standards will not necessarily render an activity unlawful *per se.*

2.7 Draft model Air Quality Management By-law for adoption and adaptation by Municipalities

Draft model air quality management by-laws for adoption and adaptation by municipalities was published by the Department of Environmental Affairs in the Government Gazette of 15 July 2009 as General Notice (for comments) 964 of 2009.

Section 18 specifically focuses on Noise Pollution Management, with sub-section 1 stating:

"*No person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, animal, machine, device or apparatus or any combination thereof.*"

The draft regulations differ from the current provincial Noise Control Regulations, because it defines a disturbing noise as a noise that is measurable or calculable of which the rating level exceeds the equivalent continuous rating level as defined in SANS 10103:2008.

2.8 International Guidelines

While there exist a number of international guidelines and standards that could encompass a document in itself, the three mentioned below were selected as they are used by different countries in the subject of environmental noise management, with the last two documents specifically focussing on the noises associated by wind energy facilities.

2.8.1 Guidelines for Community Noise (WHO, 1999)

The World Health Organization's (WHO) document on the *Guidelines for Community Noise* is the outcome of the WHO- expert task force meeting held in London, United Kingdom, in April 1999. It is based on the document entitled "Community Noise" that was prepared for the World Health Organization and published in 1995 by the Stockholm University and Karolinska Institute.

The scope of WHO's effort to derive guidelines for community noise is to consolidate actual scientific knowledge on the health impacts of community noise and to provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments.

Guidance on the health effects of noise exposure of the population has already been given in an early publication of the series of Environmental Health Criteria. The health risk to humans from exposure to environmental noise was evaluated and guidelines values derived. The issue of noise control and health protection was briefly addressed.

The document uses the L_{Aeq} and $L_{A,max}$ noise descriptors to define noise levels.

2.8.2 The Assessment and Rating of Noise from Wind Farms (ETSU, 1997)

This report describes the findings of a Working Group on Wind Turbine Noise, facilitated by the United Kingdom Department of Trade and Industry. It was developed as an Energy Technology Support Unit[1] (ETSU) project. The aim of the project was to provide information and advice to developers and planners on noise from wind turbines. The report represents the consensus view of a number of experts (experienced in assessing and controlling the environmental impact of noise from wind farms). Their findings can be summarised as follows:

1. Absolute noise limits applied at all wind speeds are not suited to wind farms; limits set relative to the background noise (including wind as seen in Figure 3-2) are more appropriate
2. $L_{A90,10mins}$ is a much more accurate descriptor when monitoring ambient and turbine noise levels
3. The effects of other wind turbines in a given area should be added to the effect of any proposed wind energy facility, to calculate the cumulative effect
4. Noise from a wind energy facility should be restricted to no more than 5 dBA above the current ambient noise level at a potential sensitive receptor
5. Wind farms should be limited to within the range of 35dBA to 40dBA (day-time) in a low noise environment. A fixed limit of 43 dBA should be implemented during all night time noise environments. This should increase to 45 dBA (day and night) if the potential receptor has financial investments in the wind energy facility

[1] ETSU was set up in 1974 as an agency by the United Kingdom Atomic Energy Authority to manage research programmes on renewable energy and energy conservation. The majority of projects managed by ETSU were carried out by external organisations in academia and industry. In 1996, ETSU became part of AEA Technology plc which was separated from the UKAEA by privatisation.

7. A penalty system should be implemented for wind turbine/s that operates with a tonal characteristic

2.8.3 Noise Guidelines for Wind Farms (MoE, 2008)

This document establishes the sound level limits for land-based wind power generating facilities and describes the information required for noise assessments and submissions under the Environmental Assessment Act and the Environmental Protection Act, Canada.

The document defines:

- Sound Level Limits for different areas (similar to rural and urban areas), defining limits for different wind speeds at 10 m height
- The Noise Assessment Report, including;
    - Information that must be part of the report
    - Full description of noise sources
    - Adjustments, such as due to the wind speed profile (wind shear)
    - The identification and defining of potential sensitive receptors
    - Prediction methods to be used (ISO 9613-2)
    - Cumulative impact assessment requirements
    - It also defines specific model input parameters
    - Methods on how the results must be presented
    - Assessment of Compliance (defining magnitude of noise levels)

The document used the $L_{Aeq,1h}$ noise descriptor to define noise levels.

3 CURRENT ENVIRONMENTAL SOUND CHARACTER

3.1 Measurement Procedure

Ambient (background) noise levels were measured during night time in accordance with the South African National Standard SANS 10103:2003 "*The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication*". The standard specifies the acceptable techniques for sound measurements including:

- type of equipment;
- minimum duration of measurement;
- microphone positions;
- calibration procedures and instrument checks; and
- weather conditions.

It should be noted that wind induced noises are normally seen as unwanted noises, and samples reflecting significant background interference due to wind induced noises are normally discarded. However, for the purpose of this study it was selected to include these samples as the typical operating noise of the wind energy facility will only be emitted during times when wind induced noise levels are relevant.

The equipment defined in **Table 3.1** was used for gathering data:

Table 3.1: Equipment used to gather data

Equipment	Model	Serial no	Calibration
SLM	Rion NL-32	01182945	12 May 2009
Microphone	Rion UC-53A	315479	12 May 2009
Preamplifier	Rion NH-21	28879	12 May 2009
Calibrator	Rion NC-74	34494286	3 April 2009
Wind meter	Kestrel 4000	587391	Calibrated[2]

* Microphone fitted with the WS-01/ WS-03/WS-10 windshield.

[2] Factory Calibrated

3.2 ONSITE MEASUREMENTS

Measurements were taken in the mornings between 2 am and 6 am on 30 and 31 March 2010, with the sound measuring equipment calibrated directly before, and directly after the measurement was taken. In all cases drift was less than 1 dBA.

Figure 3-1: Monitoring points selected near the proposed WEF

The locations used to measure ambient (background) sound levels are presented in **Figure 3-1**. These points are considered sufficient to determine the ambient (background) sound levels in the area. The results are presented in **Table 3.2** below.

Table 3.2: Results of ambient (night) sound level monitoring

Point name	Latitude, Longitude	Wind speed Ave. (m/s)	$L_{Aeq,T}$ (dBA)	$L_{A, max}$ (dBA)	$L_{A, min}$ (dBA)	Temp (°C)	Humidity (%)
RAN-01	-33.363029° 18.339970°	3.1	36.6	51.3	27.5	14.1	84
RAN-02	-33.337002° 18.288231°	2.0	26.7	40.7	22.0	14.4	86.3
RAN-03	-33.331907° 18.262178°	2.2	28.3	45.1	23.7	15	86
RAN-04	-33.369426° 18.321536°	1.8	29.7	49.2	22.4	15.7	84.3

From the data obtained, it can be seen that the ambient (background) sound levels ranges between 22 (minimum) and 29.7 ($L_{Aeq,10min}$) dBA during times when there is no wind, or very little air movement.

Important to note that the average wind speed at RAN-01 was 3.1 m/s, with numerous gusts up to 6 m/s. During sampling no other sounds were detected that were not from natural sources. The night-time ambient sound level at RAN-01 therefore ranged between 27 (minimum) and 36.6 ($L_{Aeq,10min}$) dBA, mainly due to increased wind speeds.

3.3 INFLUENCE OF WIND ON AMBIENT SOUND LEVELS

Unfortunately, current regulations and standards do not consider changing ambient (background) sound levels due to natural events, such as can be found near the coast (from the ocean waves) or areas where wind induced noises are prevalent, which is unfeasible with wind energy facilities, as these facilities will only operate when the wind is blowing. It is therefore important that the impact of wind-induced noises be considered when determining the impact of an activity such as a wind energy facility.

Figure 3-2 illustrates this situation where the sound pressure levels associated with wind action increase as wind speeds increase. The sound levels measured (mainly wind impacting on the background ambient sound levels) is also indicated on this Figure (in yellow).

The curve developed is based on the noise measurements collected at a number of sites in South Africa. While not site specific, the principle is to fit a curve using the available data that can be used to estimate cautious ambient sound levels during times when wind is blowing. The curve used is based on a curve developed near the Silverton Wind Farm in Australia.

Figure 3-2 was developed by plotting Sound Pressure Levels ($L_{Aeq,10min}$) versus average wind speed (averaged over the 10 minutes that the measurement was collected), and the estimated curve adjusted downward with 3dBA below the lowest ambient sound levels measured at wind speeds higher than 3 m/s. For the modelling, the appropriate ambient sound levels from this curve will be used. Due to the downward adjustment, the potential full effect of the wind-related ambient noise levels will be reduced (the level used would be at least 3 dBA less than the real ambient sound level).

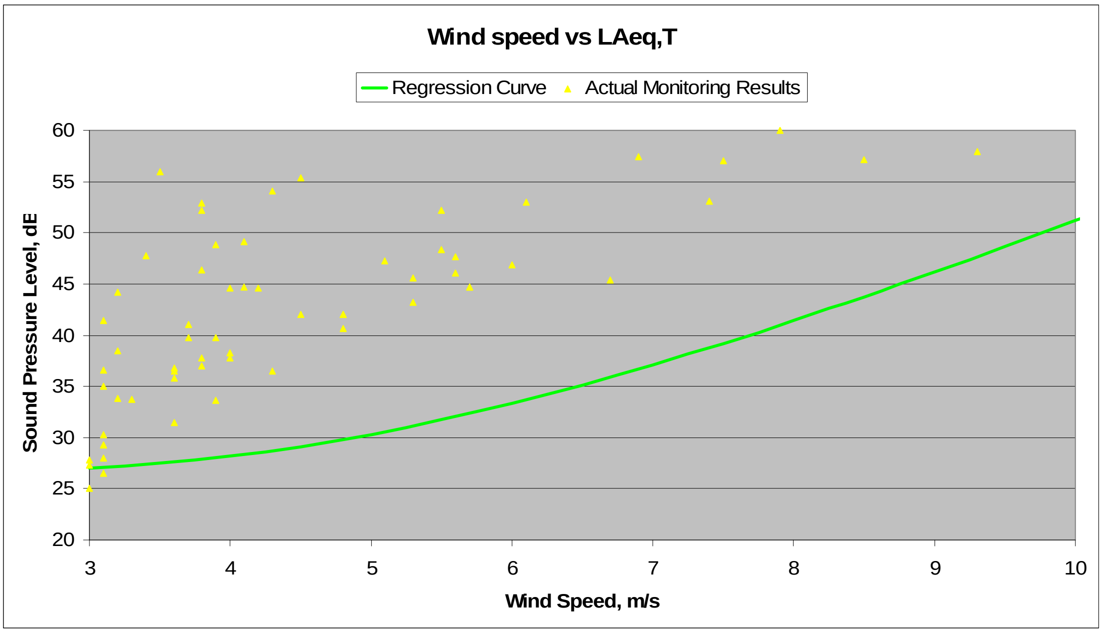

Figure 3-2: Ambient sound levels as wind speed increase

Reasons for a 3dBA penalty used in **Figure 3-2** include the following:

- Uncertainty factors, such as the small inaccuracies/interference that can be incurred during monitoring; This should cover the following points:
    1. Instrument Accuracy and chain of instruments (tripod, cables, Sound Level Meter, Pre-amplifier, Microphone, Calibration – 1 dBA)
    2. Wind shield used to do measurements (2 dBA)
    3. Wind Turbulence and Gustiness making sampling more difficult that would reduce repeatability (2 dBA)
    4. Wind Shear effects (Refer to **section 6.3.3.1** – 2 dBA)

The RMS value of these uncertainties is approximately 3 dBA.

3.4 Accuracy of Ambient Measurements

It should be noted that it is desired that all measurement points be at least 200 m away from any dwelling, and in most cases preferably more than 500 m. In addition the points were selected to be away from structures (buildings, trees, etc.) that could significantly impact the ambient sound levels during periods when wind is blowing. During times when wind is blowing, ambient sound levels are generally higher near dwellings or other structures than at areas away from such structures.

Even with no wind blowing, there is a number of factors that determine by how much ambient sound levels close to a dwelling might differ from the ambient sound level further away, including:

- Whether there are any wind pumps close to the dwelling,
- Type of trees around dwelling (conifers vs. broad-leaved trees, habitat that it provides to birds, food that it may provide to birds)
- The number, type and distance between the dwelling (measuring point) and trees. This is especially relevant when the trees are directly against the house (where the branches can touch the roof).
- The material used in the construction of the dwelling.
- How well the dwelling was maintained.
- What type and how many farm animals are in the vicinity of the dwelling.
- Whether and what type of activities are taking place.

As no samples are collected at any active farming dwellings, daytime ambient sound levels at Potentially Sensitive Receptors are likely underestimated. When considering the probability that a PSR might experience a noise impact from a proposed activity, this fact is however taken into account. It should be noted that noise samples collected in the vicinities of residential dwellings ranged between 30 dBA (no activities) to higher than 50 dBA (dwelling with surrounding farming activities).

3.5 Ambient Sound Map

An ambient sound level map was compiled illustrating the observed scenario, being:

- Day-time (06:00 – 22:00) ambient background sound levels in wind-still conditions, daily traffic used for modelling as follows:
  - *R27: 100 vehicles/hour (5% trucks) travelling at 120 km/h;*
  - *R315: 72 vehicles/hour (2% trucks) travelling at 110 km/h,*

The night-time sample revealed:

- Night-time (22:00 – 06:00). Measurements were taken after 2 am the morning of the 31st March 2010 (*No traffic on R315 with a small number of cars observed on the R27. No night ambient sound level map was developed.*).

3.5.1 Ambient Sound Levels

For background modelling purposes ambient sound levels associated with low wind speeds were selected with the output represented in **Figure 3-3**.

A reader should note that the A-weighted noise levels as illustrated is the "average" or "equivalent" noise level that receptors could experience. While receptors close enough to the road will detect vehicles travelling on the road, they experience that peak noise levels only for a short while. The rest of the time noise levels would return to the ambient sound level. The A-weighted Equivalent noise levels as illustrated are therefore used to "average" the exposure that receptors experience due to traffic in a set time period and is used to define the potential impact that receptors are experiencing.

It should be noted that other noise sources were not added to this ambient sound map. Typical sources during the day would be:

- Dogs barking and farm animals,
- Radios or TVs playing in the background,
- People speaking,
- Other activities, such as farming activities.

While some of these noise sources cannot be considered insignificant, the sheer task of adding all noise sources makes this task almost impossible. In addition, the more other noise sources are added, the lower the projected impact of the activity under investigation, due to the increased ambient sound levels. This is however considered during the impact assessment phase when the probability is estimated, because these types of ambient sounds tend to mask noises during the day.

The ambient sound map only illustrates the likely soundscape in the area, considering only the main noise sources such as existing roads, industrial and mining activities. It excludes the noise under investigation, as well as small noise sources (associated with typical farming activities, domestic and agricultural animals etc.).

The Darling Experimental Wind Farm is another important noise source in the area when wind is blowing. Unfortunately little information is available on the noise emission characteristics of the wind turbines used in the wind farm, even after a written request to the developer. It will not be considered as a noise source during the daytime ambient sound map (wind still conditions), but will be considered as a potential noise source during the operational phase.

Figure 3-3: Daytime (06:00 – 22:00) ambient sound levels: Contours of constant sound levels

While no night ambient sound map are developed, noise from the Darling Experimental wind farm will be considered using the noise emission characteristics as proposed in **section 7.3.1**.

4 POTENTIAL NOISE SOURCES

Increased noise levels are directly linked with the various activities associated with the construction of the WEF and related infrastructure, as well as the operational phase of the activity.

4.1 Potential Noise Sources: Construction Phase

4.1.1 Construction equipment

Construction activities include:

- construction of access roads,
- establishment of turbine tower foundations and electrical substation(s),
- the possible establishment, operation and removal of concrete batching plants,
- delivery of turbine, substation and power line components, as well as other materials to the site,
- digging of trenches to accommodate underground power cables; and
- the erection of turbine towers and assembly of wind turbine generators.

The equipment likely to be required to complete the above tasks will typically include:

- excavator/graders, bulldozer(s), dump trucks(s), vibratory roller, bucket loader, rock breaker(s), drill rig, flat bed truck(s), concrete truck(s), crane(s), fork lift(s) ,various 4WD and service vehicles, as well as other smaller machinery such as concrete vibrators etc.

Octave sound power levels typical for this equipment are presented in Appendix B.

4.1.2 Material supply: Concrete batching plants and use of Borrow Pits

There exist three options for the supply of the concrete to the development site. These options are:

1. The transport of “ready-mix” concrete from the closest centre to the development,
2. The transport of aggregate and cement from the closest centre to the development, with the establishment of a small concrete batching plant close to the activities. This would most likely be a movable plant.
3. The establishment of a small quarrying activity, where aggregate will be mined, crushed and screened and used onsite. Cement will still be transported to the site, where there will be a small movable concrete batching plant. In terms of

noise generation, this will be the worst case scenario. The developer however indicated that a borrow pit will not be considered at this facility.

The developer indicated that option 2 would be the preferred option.

4.1.3 Blasting

Blasting may be required as part of the civil works to clear obstacles or to prepare foundations. However, blasting will not be considered during the EIA phase for the following reasons:

- Blasting is highly regulated, and control of blasting to protect human health, equipment and infrastructure will ensure that any blasts will use minimum explosives and will occur in a controlled manner. The breaking of obstacles with explosives is also a specialized field, and when correct techniques are used, causes significantly less noise than using a rock-breaker.
- People are generally more concerned over ground vibration and air blast levels that might cause building damage than the impact of the noise from the blast. However, these are normally associated with close proximity mining/quarrying.
- Blasts are an infrequent occurrence, with a loud but a relative instantaneous character. Potentially affected parties normally receive sufficient notice (siren), and the knowledge that the duration of the siren noise as well as the blast will be over relative fast result in a higher acceptance of the noise. Note that with the selection of explosives and blasting methods, noise levels from blasting is relatively easy to control.

4.1.4 Traffic

A significant source of noise during the construction phase is additional traffic to and from the site, as well as traffic on the site. This will include trucks transporting equipment, aggregate and cement as well as various components used to construct the wind turbine.

Construction traffic is expected to be generated throughout the entire construction period, however, the volume and type of traffic generated will be dependent upon the construction activities being conducted, which will vary during the construction period. Noise levels due to traffic will be estimated using the methodology stipulated in SANS 10210:2004 (Calculating and predicting road traffic noise).

4.2 POTENTIAL NOISE SOURCES: OPERATIONAL PHASE

Noise emitted by wind turbines can be associated with two types of noise sources. These are aerodynamic sources due to the passage of air over the wind turbine blades and mechanical sources which are associated with components of the power train within the turbine, such as the gearbox and generator and control equipment for yaw, blade pitch, etc. These sources normally have different characteristics and can be considered separately. In addition there are other lesser noise sources, such as the substations themselves, traffic (maintenance) as well as transmission line noise.

4.2.1 Wind Turbine Noise: Aerodynamic sources

Aerodynamic noise is emitted by a wind turbine blade through a number of sources such as:

1. Self noise due to the interaction of the turbulent boundary layer with the blade trailing edge.
2. Noise due to inflow turbulence (turbulence in the wind interacting with the blades).
3. Discrete frequency noise due to trailing edge thickness.
4. Discrete frequency noise due to laminar boundary layer instabilities (unstable flow close to the surface of the blade).
5. Noise generated by the rotor tips.

Noise due to aerodynamic instabilities (mechanisms 3 and 4) can be reduced to insignificant levels by careful design. The other mechanisms are an inescapable consequence of the aerodynamics of the turbine which produces the power and between them they will make up most if not all of the aerodynamic noise radiated by the wind turbine. The relative contribution of each source will depend upon the detailed design of the turbine and the wind speed and turbulence at the time.

The mechanisms responsible for tip noise (mechanism 5) are currently under investigation from various turbine developers, but it appears that methods for its control through design of the tip shape may be available. Self noise (mechanism 1) is most significant at low wind speeds whereas noise due to inflow turbulence (mechanism 2) becomes the dominant source at the higher wind speeds. Both mechanisms increase in strength as the wind speed increases, particularly inflow turbulence. The overall result is that at low to moderate wind speeds the noise from a fixed speed wind turbine increases at a rate of 0.5-1.5 dBA /m/s up to a maximum at wind speeds of 7 -12 m/s (noise generated by the WTG does not increase significantly at wind speeds above 12 m/s).

Therefore, as the wind speed increases, noises created by the wind turbine also increases. At a low wind speed the noise created by the wind turbine is generally (relatively) low, and increases to a maximum at a certain wind speed when it either remains constant, increase very slightly or even drops as illustrated in **Figure 4-1**.

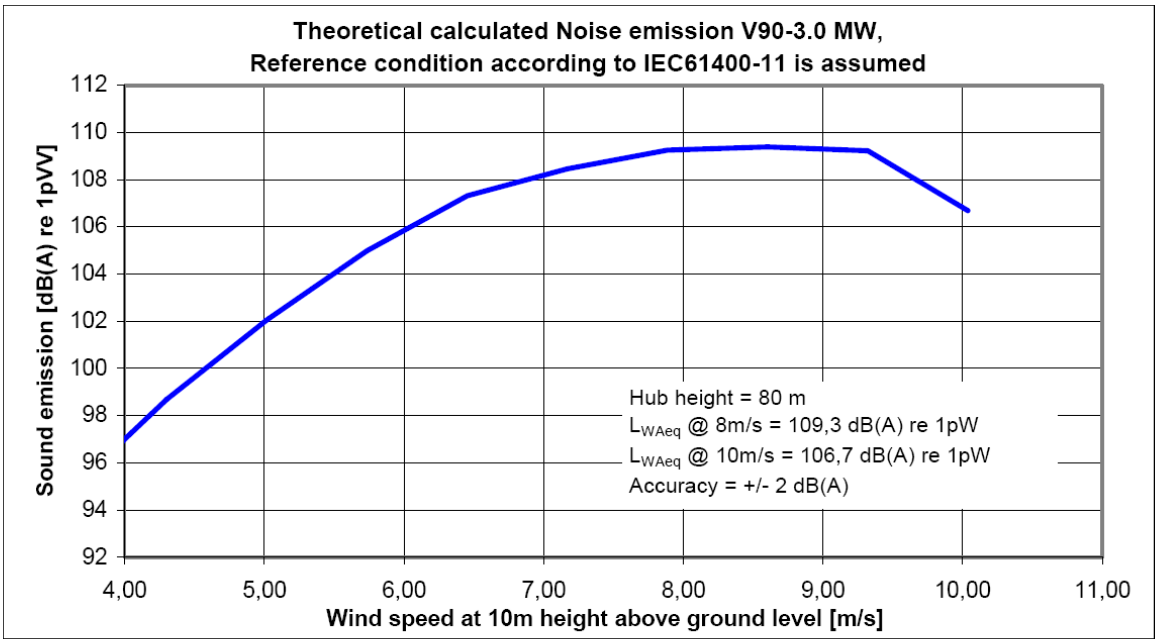

Figure 4-1: Noise Curve Vestas V90 – 3.0 MW, 60Hz (figure for illustration purposes)

Typical noise characteristics can be measured for each type of wind turbine, and minimum/average/maximum curves as seen in **Figure 4-2** can be compiled. The more accurate the data, the more accurate the modelling would be.

The developer highlighted that the Gamesa G90 2.0MW wind turbine (instead of the Vestas V90 2.0MW used in revision 0) could possibly be considered for use at the WEF. For the purpose of this investigation this wind turbine was selected.

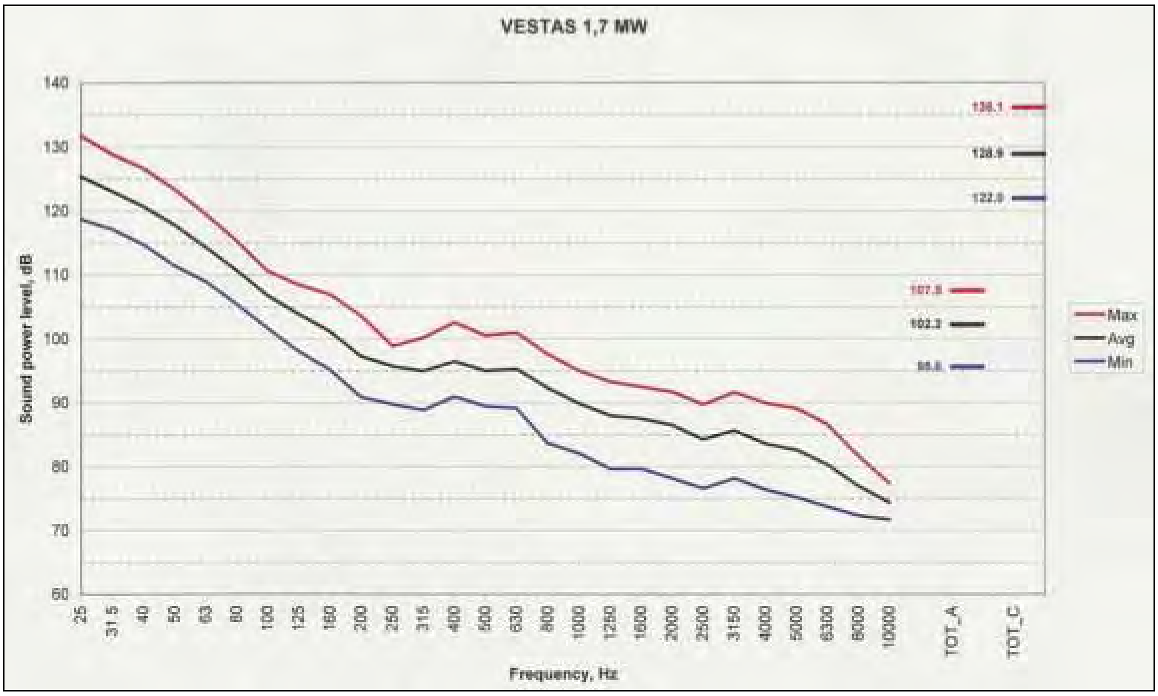

Figure 4-2: Sound power level emission of a Vestas, V66 wind turbine

Sound power emissions (in octave sound power levels) for the Vestas wind turbine are presented in **Table 4.1** (used for the unmitigated layout), with **Table 4.2** presenting the sound power emission levels of the Gamesa G90 2.0 MW turbine. However, full spectral noise emission data was not available for the Gamesa G90 wind turbine at the writing of this report, and due to the complex propagation of sound, it was selected to use the spectral data from a much larger wind turbine (Vestas V90 3.0 MW - **Table 4.3**), following the precautionary principle. *Using this larger wind turbine it is estimated that this predictions would likely over-estimate the noise magnitude at the potentially noise sensitive receptors with 0 – 3 dBA.*

The propagation model makes use of various frequencies because these frequencies are affected in different ways as it propagates through air, over barriers and over different ground conditions.

Table 4.1: Sound Power Emissions of the Vestas V90 2.0MW (Ref 961263)

Wind Speed (m/s)	Frequency (Hz)	31.5 (dB)	63 (dB)	125 (dB)	250 (dB)	500 (dB)	1000 (dB)	2000 (dB)	4000 (dB)	L_{WA} (dBA)
5	$L_{wA,P}$	71.1	80.2	84.3	88.5	91.6	94.1	92.9	90.7	**99.2**
	$L_{w,P}$	109.0	105.9	100.7	97.2	94.8	94.1	91.7	89.7	**111.5**
7	$L_{wA,P}$	74.9	84.4	89.7	92.9	96.1	98.6	97.1	94.7	**103.6**
	$L_{w,P}$	113.6	110.5	106.0	101.6	99.3	98.7	96.0	93.8	**116.2**
8	$L_{wA,P}$	75.8	85.4	90.6	93.4	96.4	98.6	97.4	95.2	**103.9**
	$L_{w,P}$	114.4	111.4	106.9	102.2	99.5	98.7	96.3	94.2	**117.0**

1: This wind turbine was used for the original layout. It is presented in this report as the unmitigated option.

Table 4.2: Sound Power Emissions of the Gamesa G90 2.0MW (Ref GD039985 R01 G90)

Wind Speed (m/s)	Frequency (Hz)	63 (dB)	125 (dB)	250 (dB)	500 (dB)	1000 (dB)	2000 (dB)	4000 (dB)	L_{Wp} (dBA)
8	$L_{wA,P}$	86.7	94.3	99.3	101.1	98.9	94.4	89.3	**105.7**
	$L_{w,P}$	112.4	110.3	107.7	104.5	99.2	93.3	88.4	**115.8**

2: This wind turbine is proposed for the revised layout. It is presented in this report as the mitigated option.

Table 4.3: Sound Power Emissions of the Vestas V90 3.0MW (Ref: 0005-9597)

Wind Speed (m/s)	Frequency (Hz)	31.5 (dB)	63 (dB)	125 (dB)	250 (dB)	500 (dB)	1000 (dB)	2000 (dB)	4000 (dB)	L (dBA)
5	$L_{wA,P}$	68.6	80.9	91.3	90.4	92.4	94.4	93.3	90.0	**100.1**
	$L_{w,P}$	107.6	106.1	109.9	99.3	95.5	94.6	92.2	89.0	**113.3**
7	$L_{wA,P}$	79.2	89.1	92.1	94.7	97.1	99.8	99.0	95.1	**105.0**
	$L_{w,P}$	119.0	117.9	107.5	103.5	100.3	99.9	97.9	94.1	**121.8**
8	$L_{wA,P}$	80.4	91.1	93.1	95.8	98.1	100.6	99.8	95.9	**105.9**
	$L_{w,P}$	119.6	120.0	108.7	104.5	101.4	100.7	98.7	94.9	**123.2**

3: This wind turbine was used for the revised layout. It is presented in this report as the mitigated option.

4.2.2 Wind Turbine: Mechanical sources

Mechanical noise is normally perceived within the emitted noise from wind turbines as an audible tone(s) which is subjectively more intrusive than a broad band noise of the same sound pressure level. Sources for this noise are normally associated with: the gearbox and the tooth mesh frequencies of the step up stages; generator noise caused by coil flexure of the generator windings which is associated with power regulation and control; generator noise caused by cooling fans; and control equipment noise caused by hydraulic compressors for pitch regulation and yaw control.

Tones are noises with a narrow sound frequency composition (e.g., the whine of an electrical motor). Annoying tones can be created in numerous ways: machinery with rotating parts such as motors, gearboxes, fans and pumps often create tones. An imbalance or repeated impacts may cause vibration that, when transmitted through surfaces into the air, can be heard as tones. Pulsating flows of liquids or gases can also create tones, which may be caused by combustion processes or flow restrictions. The best and most well-known example of a tonal noise is the buzz created by a flying mosquito.

Where complaints have been received due to the operation of wind farms, tonal noise from the installed wind turbines appears to have increased the annoyance perceived by the complainants and indeed has been the primary cause for complaint.

However, tones were normally associated with the older models of turbines. All turbine manufacturers have started to ensure that sufficient forethought is given to the design of quieter gearboxes and the means by which these vibration transmission paths may be broken. Through the use of careful gearbox design and/or the use of anti-vibration techniques, it is possible to minimise the transmission of vibration energy into the turbine supporting structure.

The benefits of these design improvements have started to filter through into wind farm developments which are using these modified wind turbines. *New generation wind turbine generators do not emit any clearly distinguishable tones.*

4.2.3 Transformer noises (Substations)

Also known as magnetostriction, this is when the sheet steel used in the core of the transformer tries to change shape when being magnetised. When the magnetism is taken away, the shape returns, only to try and deform in a different manner when the polarity is changed.

This deformation is not uniform; consequently it varies all over a sheet. With a transformer core being composed of many sheets of steel, these deformations are taking place erratically all over each sheet, and each sheet is behaving erratically with respect to its neighbour. The resultant is the "hum" frequently associated with transformers. While this may be a soothing sound in small home appliances, various complaints are logged in areas where people stay close to these transformers. At a voltage frequency of 50 Hz, these "vibrations" takes place 100 times a second, resulting in a tonal noise at 100Hz.

However, this is a relative easy noise to mitigate with the use of acoustic shielding and/or placement of the transformer equipment and will not be considered further in this EIA study.

4.2.4 Transmission Line Noise (Corona noise)

Corona noise is caused by the partial breakdown of the insulation properties of air surrounding the conducting wires. It can generate an audible and radio-frequency noise, but generally only occurs in humid conditions as provided by fog or rain. A minimum line potential of 70 kV or higher is generally required to generate corona noise depending on the electrical design. Corona noise does not occur on domestic distribution lines.

Corona noise has two major components: a low frequency tone associated with the frequency of the AC supply (100 Hz for 50 Hz source) and broadband noise. The tonal component of the noise is related to the point along the electric waveform at which the air begins to conduct. This varies with each cycle and consequently the frequency of the emitted tone is subject to great fluctuations. Corona noise can be characterised as broadband 'crackling' or 'buzzing', but fortunately it is generally only a feature during fog or rain.

It will not be further investigated, as corona discharges results in:

- Power losses,
- Audible noises,
- Electromagnetic interference,
- A purple glow,
- Ozone production; and
- Insulation damage.

In addition this is associated with high voltage transmission lines, and not the lower voltage distribution lines proposed for construction by the developer.

As such Electrical Service Providers (such as Eskom) goes to great lengths to design power transmission equipment to minimise the formation of corona discharges. In addition, it is an infrequent occurrence with a relative short duration compared to other operational noises.

4.2.5 Low Frequency Noise

4.2.5.1 Background and Information

Low frequency sound is the term used to describe sound energy in the region below ~200Hz. The rumble of thunder and the throb of a diesel engine are both examples of sounds with most of their energy in this low frequency range. Infrasound is often used to describe sound energy in the region below 20Hz.

Almost all noise in the environment has components in this region although they are of such a low level that they are not significant (wind, ocean, thunder). See also **Figure 4-3**, which indicates the sound power levels in the different octave bands from measurements taken at different wind speeds with no other audible noise sources present. Sound which has most of its energy in the 'infrasound' range is only significant if it is at a very high level, far above normal environmental levels.

4.2.5.2 The generation of Low Frequency Sounds

Because of the low rotational rates of the blades of a WTG, the peak acoustic energy radiated by large wind turbines is in the infrasonic range with a peak in the 8-12 Hz range. For smaller machines, this peak can extend into the low-frequency "audible" (20-20KHz) range because of higher rotational speeds and multiple blades.

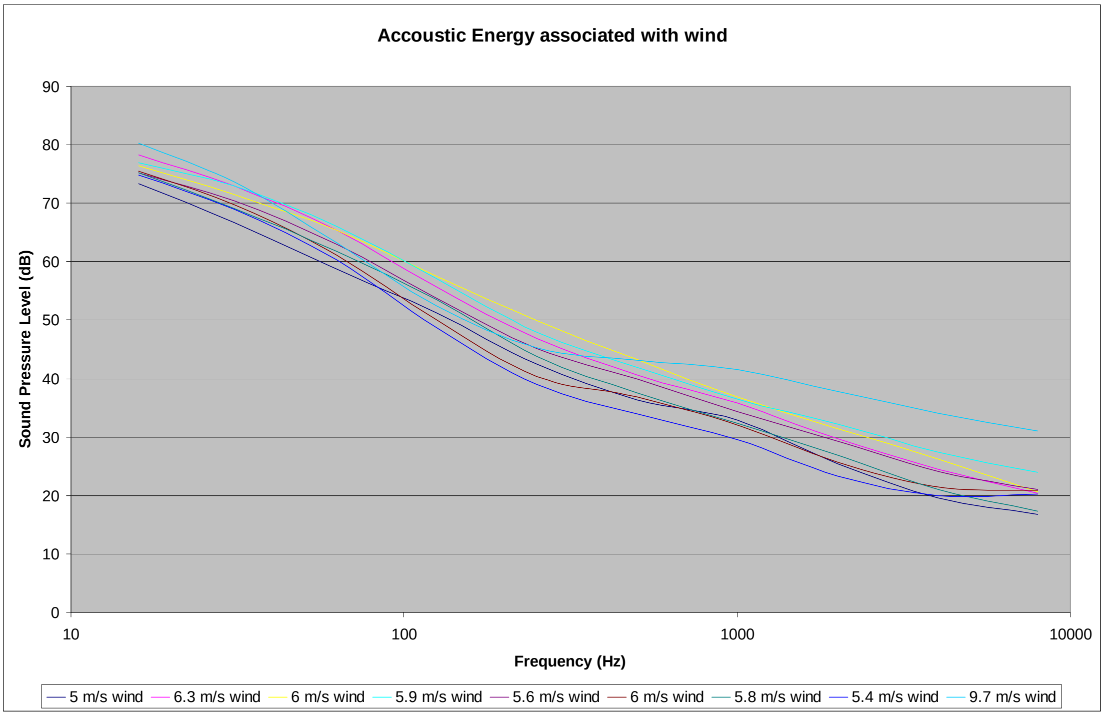

Figure 4-3: Third octave band sound power levels at various wind speeds

4.2.5.3 Detection of Low Frequency Sounds

The levels of infrasound radiated by the largest wind turbines are very low in comparison to other sources of acoustic energy in this frequency range such as sonic booms, shock waves from explosions, etc. The danger of hearing damage from wind turbine low-frequency emissions is remote to non-existent. However, sounds in a frequency range less than 100Hz can, under the right circumstances, be responsible for annoying nearby residents. Typically, except very near the source, most people outside cannot detect the presence of low-frequency noise from a wind turbine. It should be noted that there are people more sensitive for these low frequency sounds.

People however can, if the noise has an impulsive characteristic, "hear" it within homes in nearby dwellings under the right set of circumstances. Often it is not clear with low-frequency noise if people are hearing or feeling it or a combination of both stimuli. Because of the impulsive nature of the acoustic low-frequency energy being emitted, there is an interaction between the incident acoustic pulses and the resonance's of the homes which serve to amplify the stimuli creating vibrations as well as redistributing the energy higher into the audible frequency region. Thus the annoyance is often connected with the periodic nature of the emitted sounds rather than the frequency of the acoustic energy.

Impulsive noise generation is generally confined to turbines whose rotors operate downwind of the support tower (downwind machine). In this case, impulses are generated by the interaction of the aerodynamic lift created on the rotor blades and the wake vortices being shed from the tower elements. In the past 20 years modern wind turbines have nearly exclusively been designed as machines that have their rotors upstream of the tower. Those, except in very rare circumstances, do not generate impulses since there is nothing blocking the flow upwind of the rotor. The low-frequency noise generated from an upwind turbine is primarily the result of the interaction of the aerodynamic lift on the blades and the atmospheric turbulence in the wind. Because atmospheric turbulence is a random phenomenon, the radiated low-frequency noise also exhibits a random or non-coherent characteristic. Impulsive noise generated by the tower wake/rotor interaction, on the other hand, tends to be much less random or coherent and therefore much more detectable when it interacts with an intervening resonant structure.

For a healthy young adult the range of hearing is often quoted as extending from 20Hz to 20,000Hz although the sensitivity of the ear varies significantly with frequency and is most sensitive to sounds with frequencies between around 500Hz and 4,000Hz where the majority of information in speech signals is contained. Above and below this, the ear becomes decreasingly sensitive and is very insensitive at very low frequencies, meaning that sound levels have to be very high for such sounds to be perceived. Refer also to **Figure 4-4**.

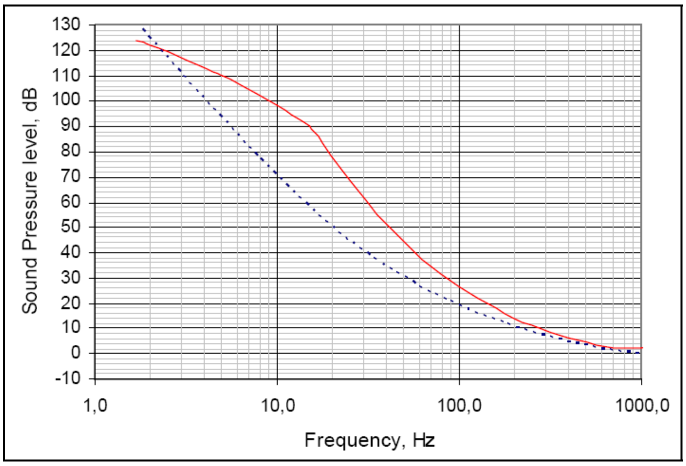

Figure 4-4: The average hearing threshold for humans (pure tones) in a free field (red line). The A-weighting line is the broken line.

However, various investigations have shown that the perception and the effects of sounds differ considerably at low frequencies as compared to mid- and high frequencies. The main aspects to these differences are:

- a weakening of pitch sensation as the frequency of the sound decreases below 60 Hz;
- perception of sounds as pulsations and fluctuations;
- a much more rapid increase of loudness and annoyance with increasing sound level at low frequencies than at mid- or high frequencies;
- complaints about the feeling of ear pressure;
- annoyance caused by secondary effects like rattling of building elements, e.g. windows and doors or the tinkling of bric-a-brac;
- other psycho acoustic effects, e.g. sleep deprivation, a feeling of uneasiness; and
- reduction in building sound transmission loss at low frequencies compared to mid- or high frequencies.

4.2.5.4 Measurement, Isolation and Assessment of Low Frequency Sounds

There remain significant debate regarding the noise from WTG's, public response to that noise, as well as the presence or not of low frequency sound and how it affects people. While low frequency sounds can be measured, it is far more difficult to isolate low frequency sounds due to the numerous sources generating these sounds.

However, from sound power level emission graphs such as **Figure 4-2** and the data contained in **Table 4.1**, it can be seen that a wind turbine has significant potential to generate low frequency sounds with sufficient energy to warrant the need to investigate WTG as a source of low frequency sounds. However, the reader is also referred to **Figure 4-3** and **Figure 4-5** for examples of various other sources and associated levels of low frequency sounds. From these two figures it is clear that there is significant acoustic energy in the lower frequencies (less than 100 Hz) in the environment around us.

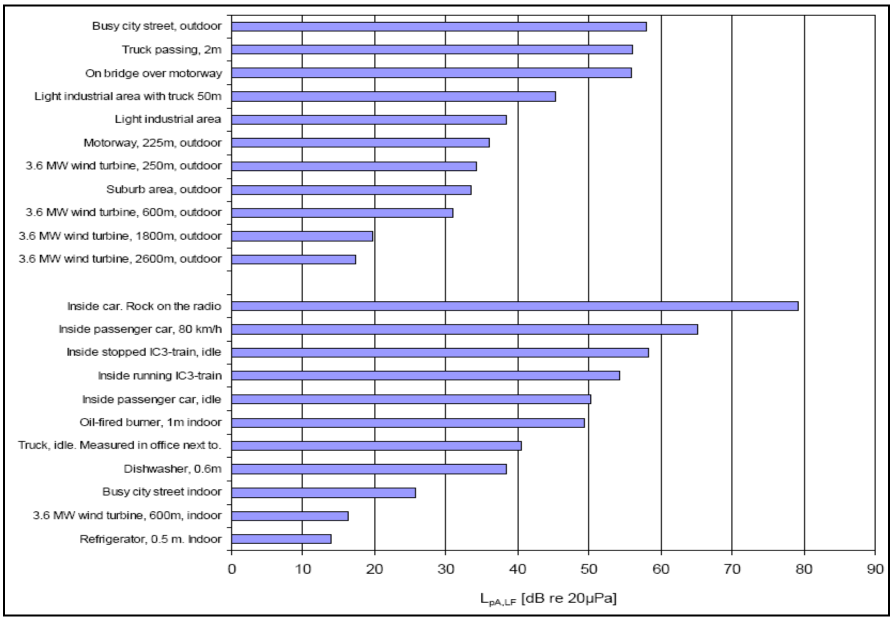

Figure 4-5: Examples on A-weighted low frequency levels $L_{pA,LF}$ from a number of indoor and outdoor sources.

Unfortunately there isn't a standardised test, nor an assessment procedure available for the assessment of low frequency sounds, neither is there an accepted methodology on how low frequency sounds can be modelled or predicted. This is because low frequency sound can travel large distances, and are present all around us, with a significant component generated by nature itself (ocean, wind, etc.).

SANS 10103:2004 proposes a method to identify whether low frequency noise could be an issue. It proposes that if the difference between the A-frequency weighted and the C-frequency weighted equivalent continuous (L_{Aeq} >> L_{Ceq}) sound pressure levels is greater than 10 dB, a predominant low frequency component **may** be present. However, at all cases existing acoustic energy in low frequencies associated with wind must be considered.

4.2.6 Amplitude modulation

There is one other characteristic of wind turbine sound that increases the sleep disturbance potential above that of other long-term noise sources. The amplitude modulation of the sound emissions from the wind turbines create a repetitive rise and fall in sound levels synchronised to the blade rotation speed, sometimes referred to as a "swish" or "thump". Many common weather conditions increase the magnitude of amplitude modulation. Most of these occur at night.

The graph in **Figure 4-6** shows this effect in the first floor bedroom of a farm home in the U.K. The home is located 930 meters from the nearest turbine (type or details of turbine unknown). The conditions documented by an independent acoustical consultant show the sound level varying over a 9 dBA range from 28 to 37 dBA. The pattern repeats approximately every second often for hours at a time. It is also reported that for many people, especially seniors, children and those with pre-existing medical conditions, this represents a major challenge to restful sleep.

This statement was also confirmed by Delta (2008, reference 2), stating that sounds from modern large wind turbines are dominated by the aerodynamic noise from the blades rotating in the air. The mid and high frequency aerodynamic noise is modulated by the low blade passage frequency (~1 Hz).

Unfortunately the mechanism of this noise is not known though various possible reasons have been put forward. Although the prevalence of complaints about amplitude modulation is relatively small, it is not clear whether this is because it does not occur often enough or whether it is because housing is not in the right place to observe it. Furthermore the fact that the mechanism is unknown means that it is not possible to predict when or whether it will occur.

Even though there are thousands of wind turbine generators in the world, amplitude modulation is one subject receiving the least complaints and due to this very few complaints, little research went into this subject. It is included in this report to highlight all potential risks, albeit extremely low risks such as this (low significance due to very low probability).

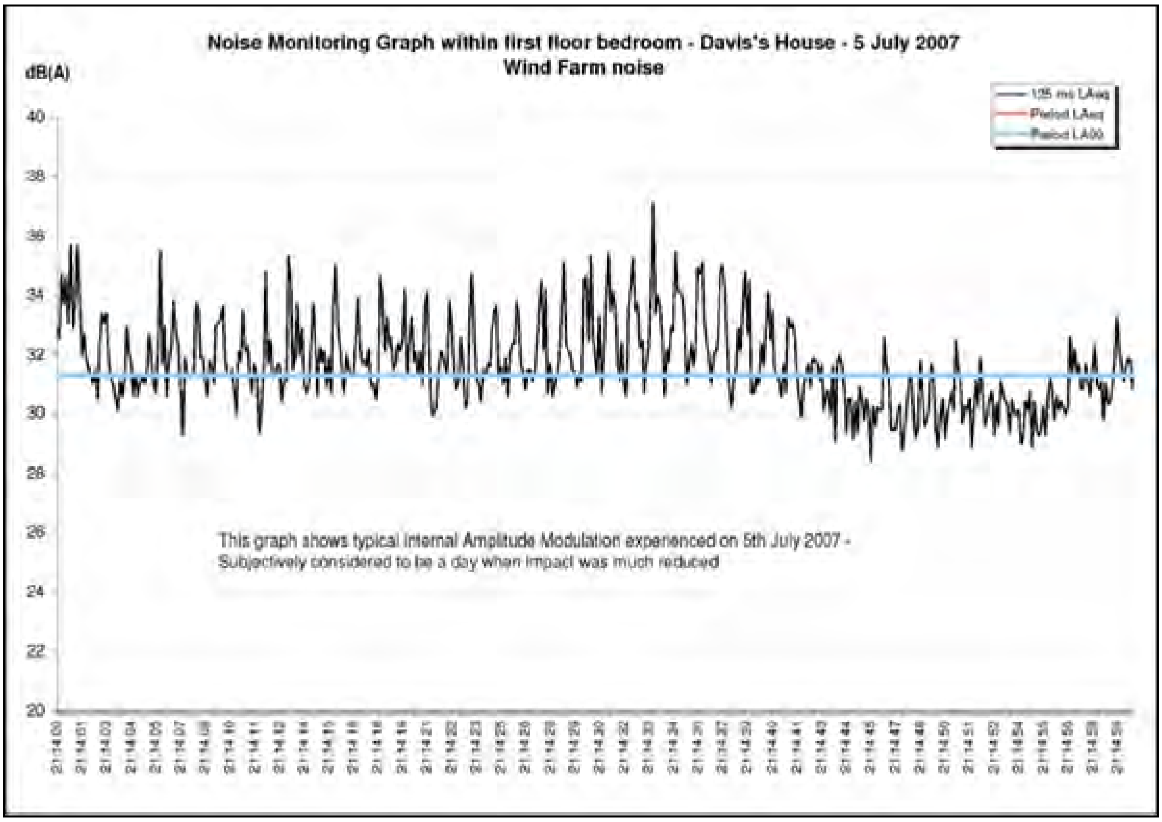

Figure 4-6: Amplitude modulation in a home 930 meters away from a WTG.

5 METHODOLOGY: CALCULATION OF FUTURE NOISE EMISSIONS DUE TO PROPOSED PROJECT

5.1 NOISE EMISSIONS INTO THE SURROUNDING ENVIRONMENT

The noise emissions into the environment from the various sources as defined by the project developer were calculated for the construction and operational phases in detail, using the sound propagation model described in both SANS 10357 as well as ISO 9613-2.

The following was considered:

- The octave band sound pressure emission levels of processes and equipment (SANS and ISO)
- The distance of the receiver from the noise sources (SANS and ISO)
- The impact of atmospheric absorption (SANS and ISO)
- The meteorological conditions in terms of Pasquill stability (considering refraction effects due to wind direction – SANS only)
- The operational details of the proposed project, such as the location of each Wind Turbine Generator (SANS and ISO)
- Topographical layout (SANS and ISO)
- Acoustical characteristics of the ground. Soft ground conditions were modelled, as the area where the facility is proposed to be constructed is well vegetated and sufficiently uneven to allow the consideration of soft ground conditions (50% soft for both the SANS and ISO models). This is also the point where the SANS and ISO model differ significantly in the method how attenuation is calculated, with the ISO model largely minimising ground attenuation due to the height of the point source *[the wind turbines in this case]*). The result is that noises originating from noise sources situated very high would be attenuated far less due to ground effects than noises originating closer to the ground surface using the ISO model

The noise emission into the environment due to additional traffic will be calculated using the sound propagation model described in SANS 10210. Corrections such as the following will be considered:

- Distance of receptor from the road
- Road construction material
- Average speeds of travel
- Types of vehicles used
- Ground acoustical conditions

5.2 Factors that must be considered that might complicate the accuracy of noise propagation modelling

Reviewing numerous literatures, the following factors were highlighted to complicate noise propagation modelling and prediction when working with wind turbines:

- As previously discussed, a wind turbine can cause a modulation of sound when the blades of the hub rotate, and depend on where the receptor to this sound is located. The threshold for detection of this modulation could be as much as 2 dB below a masking noise (white noise). Modulating sound characteristics from a wind turbine therefore makes it more likely to be noticed and less likely to be masked by background noise (Pederson, 2003). This not considered by predictive models.
- Residents complaining about wind turbine noise perceived the sound characteristics as more annoying than noise levels. People were able to distinguish between background ambient sounds, and the sounds that the blades made. The noise produced by the blades leads to most of the complaints. Most of the annoyance was experienced between 16.00 p.m. and midnight (Pederson, 2003). This could be an issue as noise propagation modelling would be reporting an equivalent, or "average" sound pressure level, a parameter that ignores the "character" of the sound.
- Night time meteorological conditions might be significantly different from the conditions assumed in noise propagation models. This is because of temperature gradients in the atmosphere. On a typical sunny afternoon, air is warmest near the ground and temperature decreases at higher altitudes. This temperature gradient causes sound waves to refract upward (due to the relative higher density of colder air) away from the ground and results in lower noise levels being heard at the listener's position. At night, this temperature gradient will reverse, resulting in cooler temperatures near the ground. This condition, that is often referred to as a temperature inversion, will cause sound to be bent downward towards the ground and results in louder noise levels at a potentially sensitive receptor. Temperature gradients can and will influence sound propagation over long distances and further complicate predictive modelling. The result is that predictive models will under-estimate noise levels.
- The noise emission characteristics of the proposed wind turbines at the height at which the turbine will be installed. Available data for wind turbines show that height above ground level does have an impact on the sound pressure levels at a receptor on ground level. Taller turbines can be heard further than turbines.

- Due to the height of these wind turbines, trees and other structures do not assist with the sound attenuation. It is therefore more difficult to model the effect of ground attenuation. This can result in significant under or over-estimation.
- Apart from the fact that higher turbines are constructed to optimally "harvest" wind energy, higher wind turbines is normally fitted with larger blades. The result is that the sound power levels associated with the wind turbine also increase.
- Wind speeds at hub (nacelle) height could be significantly higher than the wind speeds at ground level (the "van den Berg Effect"). The "real" noise generated by the wind turbine would therefore be significantly higher than expected. In addition, as the wind speed at ground level is less than expected, ambient sound levels at the potentially sensitive receptors will be less, resulting in less "masking" potential from the wind at ground level.
- Down wind effects. Wind alters sound propagation by the mechanism of refraction; that is, wind bends sound waves. These wind gradients, with faster winds at higher elevation and slower winds at lower elevation causes sound waves to be bend downwards as they propagate down wind of the source and to bend upwards when propagating upwind.
- Noise propagation models are only accurate some of the time, for certain conditions. Unfortunately, it is impossible to consider all possible conditions. Therefore, there may be times when noise levels in practice exceed those predicted. If these conditions occur with any regularity, it would impact on closer receptors.
- There is no model that can predict the acceptability of a sound from a source by an individual. While sound pressure level is an important factor, it is certainly not the only one.
- The background sound in an area is important as it directly affects audibility through masking. However, background sound levels summarized (averaged) as an equivalent sound level ignores the random character of the sound. Background sound levels is a variable and typically changes from moment to moment, such as when vehicles pass nearby, birds chirp and the wind gusts. During these instances a noise might be less noticeable, possibly inaudible at times. However, at other times a noise source might be highly detectable.
- Cumulative effects from a number of wind turbines must be considered. A large wind farm (100+ turbines) cannot be treated the same way as a small wind farm (less than 20 turbines). Similarly, the cumulative effects from a number of wind turbines close to potentially sensitive receptors must be considered for the appropriate wind directions and speed.

- There is significant acoustic energy in the lower frequencies in the sounds generated by a wind turbine. With the possible effects of amplitude modulation, it remains an unknown factor.
- The location where the wind farm is to be developed. Areas close to urban development effectively removes these areas for future residential use due to the increased rating levels.
- Topographical layout should be considered. This is especially important when the turbines are to be installed on a ridge, with potential receptors being situated in a valley downwind from the turbines.

Due to these complicating factors, a precautionary stance should be taken.

6 METHODOLOGY: NOISE IMPACT ASSESSMENT AND SIGNIFICANCE

6.1 NOISE IMPACTS ON ANIMALS

Unfortunately there exist far less studies on the effects of noise on animals than on humans. However, a great deal of research was conducted in the 1960's and 1970's on the effects of aircraft noise on animals. Most of the studies however are highly relevant to other noise sources, including those associated with Wind Energy Facilities.

Overall, the research suggests that species differ in their response to:

- Various types of noise,
- Durations of noise,
- Sources of noise.

A general animal behavioural reaction to aircraft noise is the startle response. However, the strength and length of the startle response appears to be dependent on:

- which species is exposed,
- whether there is one animal or a group,
- whether there have been some previous exposures.

Unfortunately there are numerous other factors in the environment of animals that also influence the effects of noise. This includes predators, weather, changing prey/food base and ground-based disturbance, especially anthropogenic. This hinders the ability to define the real impact of noise on animals.

From this and other studies the following can be concluded:

- Animals respond to impulsive (sudden) noises (higher than 90 dBA) by running away. If the noises continue animals would try to relocate. This is not relevant to wind energy facilities because the turbines do not generate impulsive noises close to these sound levels.
- Animals of all species exhibit adaptation with noise, including aircraft noise and sonic booms (far worse than noises associated with Wind Turbines).
- More sensitive species would relocate to a more quiet area, especially species that depend on hearing to hunt or evade prey, or species that makes use of sound/hearing to locate a suitable mate.
- Noises associated with helicopters, motor- and quad bikes significantly impacts on animals.

6.1.1 Domestic Animals

It has been observed that most domestic animals are generally not bothered by noise, excluding most impulsive noises. In the intensity range that a Wind Turbine generates noise it should not impact on any domestic animal.

6.1.2 Wildlife

Depending on the turbine, some may create significant enough acoustic energy in the low frequency range that might impact on animals that makes use of vibrations to hunt. However this would be only relevant very close to the wind turbine, a zone normally already disturbed due to the construction and maintenance activities. In general, most anthropogenic activities already disturbed sensitive animals that might have been impacted by the noise from a wind turbine.

Noise impacts are also very highly species dependent. Studies showed that most animals adapt to noises, and would even return to a site after an initial disturbance, even if the noise continuous. The more sensitive animals that might be impacted by noise would most likely relocate to a more quiet area.

Unfortunately there are not specific studies discussing the potential impacts of noise associated wind turbines on wildlife. It may be that noises from wind turbines may mask the sounds of a predator approaching; similarly predators depending on hearing would not be able to locate their prey. However, due to significant background ambient sounds during periods when the wind turbines are operating (wind induced noises), the potential impact from a wind turbine on such animals are questioned.

A noteworthy study was conducted by Stephen Pearce-Higgins *et al* (2009). This survey of breeding birds in non-agricultural British uplands (moors and grassland) included weekly surveys during the breeding season at 12 different wind farm sites, along with comparable nearby landscapes without turbines. Half the wind farms were from the previous generation (way back in the 1990's), with hub heights of 40m and less; the other half had hub heights of 60-70m. Of the twelve species that were observed often enough to provide good data, five seemed relatively unaffected by turbines (including kestrel, lapwing, grouse, skylark, and stonechat), while 7 species were less likely to nest within 500m of turbines, with smaller (i.e., not statistically significant) effects extending to 800m, or roughly half a mile. For six of the species (buzzard, hen harrier, plover, snipe, curlew, and wheatear), numbers were reduced by 39-52%.

The authors note that there is a pressing need for examination of the reasons for the depressed numbers and state: "*we do not know whether our observations of avoidance of turbines reflect a behavioural displacement, the local population consequences of collision mortality or reduced productivity, or both. The distinction is important. If there is high mortality of birds breeding close to the turbines associated with collision, then a wind farm may become a population sink if repeatedly colonized by naïve birds. If, however, the birds simply avoid breeding close to the turbines, then displaced birds may settle elsewhere with little cost.*"

They also note that "*species occupying remote semi-natural habitats may be more sensitive to wind farm development than species occupying intensive production landscapes*."

This indicates that the potential significance of a noise impact would depend on the species concerned. Less sensitive species would not be bothered by the noises from the wind turbines, whereas the more sensitive species might relocate. Unfortunately, there is no database of potential sensitive species in South Africa. Taking the precautionary route, it is suggested that construction do not take place within 500 meters from any sensitive species as identified by the Fauna/Avifauna study during the breeding season.

6.2 WHY NOISE CONCERNS COMMUNITIES

Noise can be defined as "unwanted sound", and an audible acoustic energy that adversely affects the physiological and/or psychological well-being of people, or which disturbs or impairs the convenience or peace of any person. One can generalise by saying that sound becomes unwanted when it:

- Hinders speech communication,
- Impedes the thinking process,
- Interferes with concentration,
- Obstructs activities (work, leisure and sleeping),
- Presents a health risk due to hearing damage.

However, it is important to remember that whether a given sound is "noise" depends on the listener or hearer. The driver playing loud rock music on their car radio hears only music, but the person in the traffic behind them hears nothing but noise.

Response to noise is unfortunately not an empirical absolute, as it is seen as a multi-faceted psychological concept, including behavioural and evaluative aspects. For instance, in some cases annoyance is seen as an outcome of disturbances, in other cases it is seen as an indication of the degree of helplessness with respect to the noise source.

Noise does not need to be loud to be considered "disturbing". One can refer to a dripping tap in the quiet of the night, or the irritating "thump-thump" of the music from a neighbouring house at night when one would like to sleep.

Severity of the annoyance depends on factors such as:

- Background sound levels, and the background sound levels the receptor is used to,
- The manner in which the receptor can control the noise (helplessness),
- The time, unpredictability, frequency distribution, duration, and intensity of the noise,
- The physiological state of the receptor,
- The attitude of the receptor about the emitter (noise source).

6.3 IMPACT ASSESSMENT CRITERIA

6.3.1 Overview: The common characteristics

The word "noise" is generally used to convey a negative response or attitude to the sound received by a listener. There are four common characteristics of sound, any or all of which determine listener response and the subsequent definition of the sound as "noise". These characteristics are:

- Intensity
- Loudness
- Annoyance
- Offensiveness

Of the four common characteristics of sound, intensity is the only one which is not subjective and can be quantified. Loudness is a subjective measure of the effect sound has on the human ear. As a quantity it is therefore complicated but has been defined by experimentation on subjects known to have normal hearing.

The annoyance and offensive characteristics of noise are also subjective. Whether or not a noise causes annoyance mostly depends upon its reception by an individual, the environment in which it is heard, the type of activity and mood of the person and how acclimatised or familiar that person is to the sound.

6.3.2 Noise criteria of concern

The criteria used in this report were drawn from the criteria for the description and assessment of environmental impacts from the EIA Regulations, published by the Department of Environmental Affairs (April 1998) in terms of the NEMA, SANS 10103 as well as guidelines from the World Health Organization.

There are number of criteria that are of concern for the assessment of noise impacts. These can be summarised in the following manner:

- *Increase in noise levels:* People or communities often react to an increase in the ambient noise level they are used to, which is caused by a new source of noise. With regards to the Noise Control Regulations (promulgated in terms of the ECA), an increase of more than 7 dBA is considered a disturbing noise. See also **Figure 6-2**.
- *Zone Sound Levels:* Previously referred as the acceptable rating levels, it sets acceptable noise levels for various areas. See also **Table 6.1**.
- *Absolute or total noise levels:* Depending on their activities, people generally are tolerant to noise up to a certain absolute level, e.g. 65 dBA. Anything above this level will be considered unacceptable.

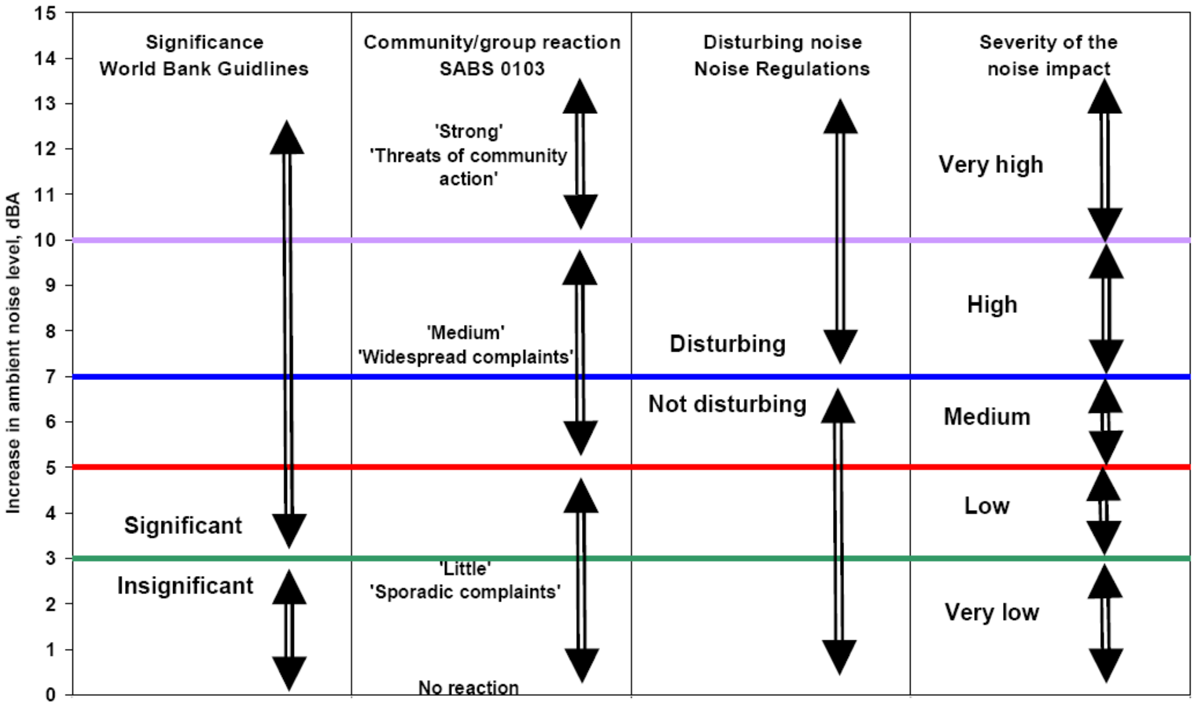

Figure 6-1: Criteria to assess the significance of impacts stemming from noise

In South Africa the document that addresses the issues concerning environmental noise is SANS 10103:2008 (See also **Table 6.1**) It provides the maximum average background ambient sound levels, $L_{Req,d}$ and $L_{Req,n}$, during the day and night respectively to which different types of developments may be exposed. For rural areas the Zone Sound Levels are:

- Day (06:00 to 22:00) - $L_{Req,d}$ = 45 dBA, and
- Night (22:00 to 06:00) - $L_{Req,n}$ = 35 dBA.

SANS 10103 also provides a guideline for estimating community response to an increase in the general ambient noise level caused by an intruding noise. If Δ is the increase in noise level, the following criteria are of relevance:

- **Δ ≤ 3 dBA:** An increase of 3 dBA or less will not cause any response from a community. It should be noted that for a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level would not be noticeable.
- **3 < Δ ≤ 5 dBA:** An increase of between 3 dBA and 5 dBA will elicit 'little' community response with 'sporadic complaints'. People will just be able to notice a change in the sound character in the area.
- **5 < Δ ≤ 15 dBA:** An increase of between 5 dBA and 15 dBA will elicit a 'medium' community response with 'widespread complaints'. In addition, an increase of 10 dBA is subjectively perceived as a doubling in the loudness of a noise. For an increase of more than 15 dBA the community reaction will be 'strong' with 'threats of community action'.

Table 6.1: Acceptable Zone Sound Levels for noise in districts (SANS 10103:2008)

1	2	3	4	5	6	7
Type of district	**Equivalent continuous rating level ($L_{Req,T}$) for noise,** dBA					
	Outdoors			**Indoors, with open windows**		
	Day-night $L_{R,dn}$ [a]	**Day-time** $L_{Req,d}$ [b]	**Night-time** $L_{Req,n}$ [b]	**Day-night** $L_{R,dn}$ [a]	**Day-time** $L_{Req,d}$ [b]	**Night-time** $L_{Req,n}$ [b]
RESIDENTIAL DISTRICTS						
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
NON RESIDENTIAL DISTRICTS						
d) Urban districts with some workshops, with business premises, and with main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

6.3.3 Determining appropriate Zone Sound Levels

SANS 10103:2008 unfortunately does not cater for instances when background ambient sound levels change due to the impact of external forces. Locations close to the sea for instance always have an ambient sound level exceeding 35 dBA, and, in cases where the sea is rather turbulent, it can easily exceed 45 dBA. Similarly, noise induced by high winds is not included in the SANS standard.

Setting noise limits relative to the ambient sound level is relatively straightforward when the prevailing ambient sound level and source level are constant. However, wind turbines emit noise that is related to wind speed, and the environment within which they are heard will probably also be dependent upon the strength of the wind and the noise associated with its effects. It is therefore necessary to derive a ambient sound level that is indicative of the noise environment at the receiving property for different wind speeds so that the turbine noise level at any particular wind speed can be compared with the ambient sound level in the same wind conditions.

Therefore, when assessing the overall noise levels emitted by a wind energy facility it is necessary to consider the full range of operating wind speeds of the wind turbines. This covers the wind speed range from around 3-5m/s (the turbine cut-in wind speed) up to a wind speed range of 25-35m/s measured at the hub height of a wind turbine. However, the Noise Working Group (1996) proposes that noise limits only be placed up to a wind speed of 12 m/s for the following reasons:

1. Wind speeds are not often measured at wind speeds greater than 12 m/s at 10m height.
2. Reliable measurements of background ambient sound levels and turbine noise will be difficult to make in high winds due to the effects of wind noise on the microphone and the fact that one could have to wait several months before such winds were experienced.
3. Turbine manufacturers are unlikely to be able to provide information on sound power levels at such high wind speeds for similar reasons.
4. If a wind farm meets noise limits at wind speeds lower than 12m/s it is most unlikely to cause any greater loss of amenity at higher wind speeds. Turbine noise levels increase to a maximum (between 7 and 9 m/s, depending on the turbine) where it remains relative constant as wind speeds increase; however, background ambient sound levels increases significantly with increasing wind speeds due to the force of the wind.

Available data indicates that noises from a Wind Turbine is drowned by other noises (wind howling around building, rustling of leaves in trees, rattling noises, etc) above a wind speed of 10 m/s, even if the wind blows in the direction of the receiver.

A cautious ambient sound vs. wind speed regression curve is illustrated in **Figure 6-2**. It should be noted that curves for daytime (6:00 – 22:00) and night time (22:00 – 6:00) would be different, but as wind speeds increase, the wind induced noise levels approach the noise emitted by the wind turbine(s).

For the purpose of the EIA, **Figure 6-2** will be considered, the change in sound levels that the receptors may experience together with the zone sound levels as stipulated in SANS 10103.

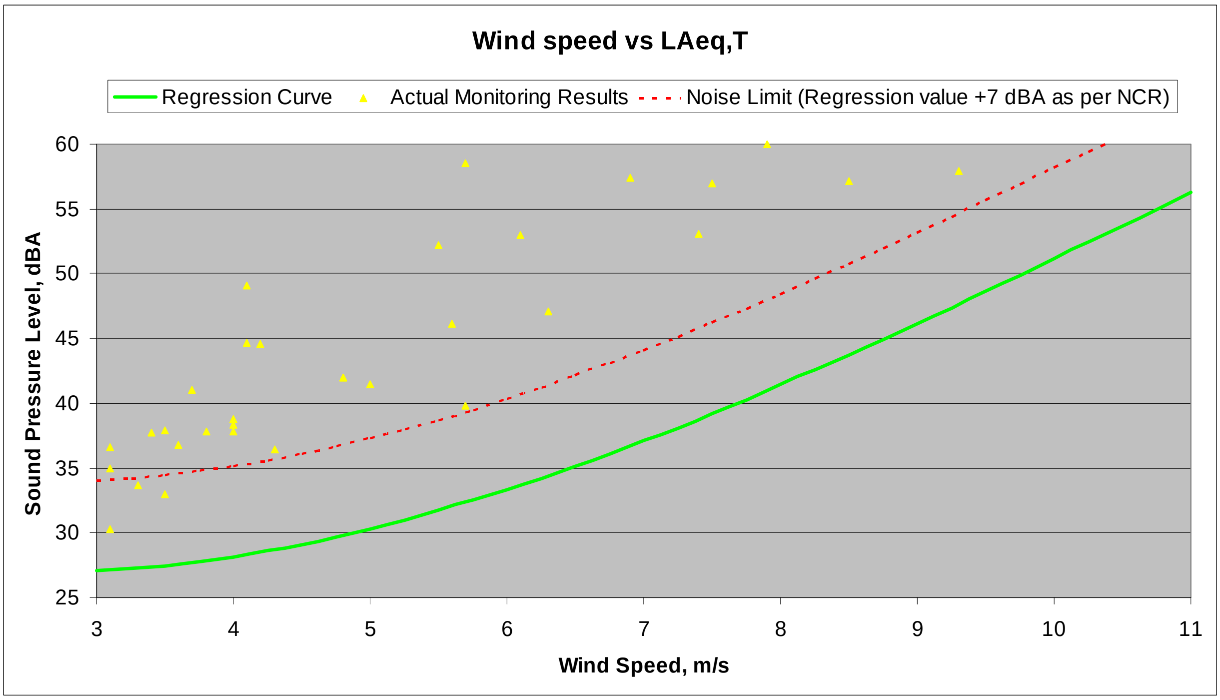

Figure 6-2: Background ambient sound levels associated with increased wind speeds

6.3.3.1 Relationship between wind speed at different levels and noise at ground level

Normally, as the height above ground level increase, wind speed also increases. For acoustical purposes prediction of the wind speed at hub height is based on the wind speed v_{ref} at the reference height (normally 10 meters) for wind speed measurements, extrapolated to a wind speed v_h at hub height, using the widely used formula:

$$v_h = v_{ref} \times \frac{\log\left(h/m\right)}{\log\left(h_{ref}/m\right)}$$

However, depending on topographical layout, this relationship may not be true at all times. Authors such as Van den Berg (2003) indicated that wind speeds at hub height could be significantly higher than expected, at the same time being significantly higher than ground level wind speeds. In these cases the wind turbines are operational and emitting noise, yet the wind induced ambient sound levels are less than expected (less masking of turbine noise). This is one of the reasons the ambient curve (**Figure 6-2**) is adjusted with -3 dBA, allowing the ambient sound levels to be less at all times than potential "real" ambient sound levels.

This should be considered when evaluating the significance of the impact, especially when the wind turbines are situated on a hill, with the prevailing wind direction being in the direction of potential sensitive receptors living in a valley downwind of the wind energy facility. It is proposed by this author that the precautionary approach be considered, and when there is one or more turbines within 1,000 meters from a downwind receptor(s), that the probability of this impact occuring be elevated with at least one step/factor (e.g. from *Likely* to *Highly Likely*). This is one of the reasons the ambient curve (**Figure 6-2**) is adjusted with -3 dBA, allowing the ambient sound levels to be less at all times than potential "real" ambient sound levels.

6.3.3.2 Other noise sources of significance

In addition other noise sources that may be present should also be considered. During the day all living beings are bombarded with the sounds from numerous sources considered "normal", such as animal sounds, conversation, amenities and appliances (TV/Radio/CD playing in background, computer(s), freezers/fridges, etc). This excludes activities that may generate additional noise associated with normal work.

At night sounds that are present are natural sounds from animals, wind as well as other sounds we consider "normal", such as the hum from variety of appliances (magnetostriction) drawing standby power, freezers and fridges.

Figure 6-3 illustrates the sound levels associated with some equipment, or sound levels at certain places.

6.3.4 Determining the Significance of the Noise Impact

The level of detail as depicted in the EIA regulations was fine-tuned by assigning specific values to each impact. In order to establish a coherent framework within which all impacts could be objectively assessed, it was necessary to establish a rating system, which was applied consistently to all the criteria. For such purposes each aspect was assigned a value, ranging from one (1) to five (5), depending on its definition. This assessment is a relative evaluation within the context of all the activities and the other impacts within the framework of the project. An explanation of the impact assessment criteria is defined in **Table 6.2.**

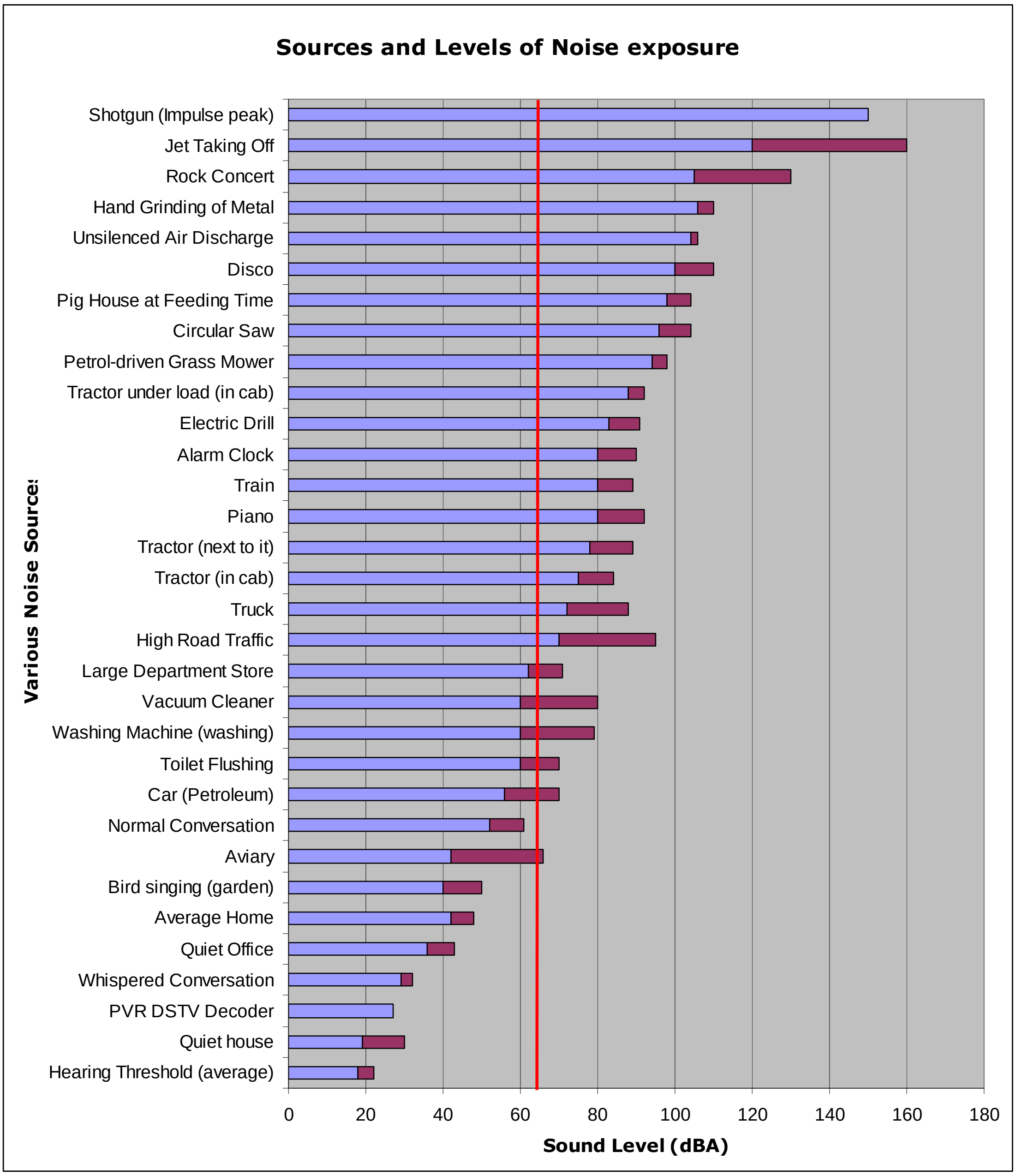

Figure 6-3: Typical Noise Sources and associated Sound Pressure Level

Table 6.2: Impact Assessment Criteria

Duration	
The lifetime of the impact that is measured in relation to the lifetime of the proposed development (construction, operational and closure phases). Will the receptors be subjected to increased noise levels for the lifetime duration of the project, or only infrequently.	
Temporary	The impact will either disappear with mitigation, will be mitigated through a natural process, or will last less than an hour.
Short term	The impact will be applicable less than 24 hours.
Medium term	The impact will last up to a week.
Long term	The impact will last up to a month.
Permanent	Any impacts lasting more than a month. It is considered non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact is transient.
Spatial scale	
Classification of the physical and spatial scale of the impact	
Site	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.
Local	The impact could affect the local area (within 1,000 m from site).
Regional	The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns.
National	The impact could have an effect that expands throughout the country (South Africa).
International	Where the impact has international ramifications that extend beyond the boundaries of South Africa.
Probability	
This describes the likelihood of the impacts actually occurring, and whether it will impact on an identified receptor. The impact may occur for any length of time during the life cycle of the activity, and not at any given time. The classes are rated as follows:	
Improbable	The possibility of the impact occurring is none, due either to the circumstances, design or experience. The chance of this impact occurring is zero (0 %).
Possible	The possibility of the impact occurring is very low, due either to the circumstances, design or experience. The chances of this impact occurring is defined to be up to 25 %.
Likely	There is a possibility that the impact will occur to the extent that provisions must therefore be made. The chances of this impact occurring is defined to be between 25% and 50 %.
Highly Likely	It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up before carrying out the activity. The chances of this impact occurring is defined to be between 50 % to 75 %.
Definite	The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied on. The chance of this impact occurring is defined to be between 75% and 100 %.
Magnitude	
This defines the impact as experienced by any receptor. In this report the receptor is defined as any resident in the area, but excludes faunal species.	
Low	Increase in sound pressure levels between 0 and 3 from the expected wind induced ambient sound level. The change may just be discernable. Total projected noise level is less than the Zone Sound Level in wind-still conditions.
Low Medium	Increase in sound pressure levels between 3 and 5 from the expected wind induced ambient sound level. The change is easily discernable. Total projected noise level is less than the Zone Sound Level in wind-still conditions.
Medium	Increase in sound pressure levels between 5 and 7 from the expected wind induced ambient sound level. Sporadic complaints. Any point where the zone sound levels are exceeded during wind still conditions.
High	Increase in sound pressure levels between 7 and 10 (**Figure 6-2** – any point above red line). Change of 10 dBA is perceived as 'twice as loud', leading to widespread complaints. Defined by the National Noise Regulations as being legally 'disturbing'. Any point where noise levels exceed zone sound level.
Very High	Increase in sound pressure levels higher than 10. Defined by the National Noise Regulations as being legally 'disturbing'. Threats of community or group action. Any point where noise

	levels exceed 65 dBA at any receptor.

In order to assess each of these factors for each impact, the following ranking scales as contained in **Table 6.3** will be used.

Table 6.3: Assessment Criteria: Ranking Scales

PROBABILITY		MAGNITUDE	
Description / Meaning	**Score**	**Description / Meaning**	**Score**
Definite/don't know	5	Very high/don't know	10
Highly likely	4	High	8
Likely	3	Medium	6
Possible	2	Low Medium	4
Improbable	1	Low	2
DURATION		**SPATIAL SCALE**	
Description / Meaning	**Score**	**Description / Meaning**	**Score**
Permanent	5	International	5
Long Term	4	National	4
Medium Term	3	Regional	3
Short term	2	Local	2
Temporary	1	Footprint	1

6.3.5 Identifying the Potential Impacts without Mitigation Measures (WOM)

Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned probabilities, resulting in a value for each impact (prior to the implementation of mitigation measures).

Significance without mitigation is rated on the following scale:

SR **< 30**	**Low (L)**	**Impacts with little real effect and which should not have an influence on or require modification of the project design or alternative mitigation. No mitigation is required.**
30 < **SR** < 60	Medium (M)	Where it could have an influence on the decision unless it is mitigated. An impact or benefit which is sufficiently important to require management. Of moderate significance - could influence the decisions about the project if left unmanaged.
SR > 60	High (H)	Impact is significant, mitigation is critical to reduce impact or risk. Resulting impact could influence the decision depending on the possible mitigation. An impact which could influence the decision about whether or not to proceed with the project.

6.3.6 Identifying the Potential Impacts with Mitigation Measures (WM)

In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it will be necessary to re-evaluate the impact. Significance with mitigation is rated on the following scale:

SR **< 30**	**Low (L)**	**The impact is mitigated to the point where it is of limited importance.**
30 < **SR** < 60	Medium (M)	Notwithstanding the successful implementation of the mitigation measures, to reduce the negative impacts to acceptable levels, the negative impact will remain of significance. However, taken within the overall context of the project, the persistent impact does not constitute a fatal flaw.
SR > 60	High (H)	The impact is of major importance. Mitigation of the impact is not possible on a cost-effective basis. The impact is regarded as high importance and taken within the overall context of the project, is regarded as a fatal flaw. An impact regarded as high significance, after mitigation could render the entire development option or entire project proposal unacceptable.

6.4 EXPRESSION OF THE NOISE IMPACTS

The noise impacts can be expressed in terms of the increase in present ambient sound levels caused by noise emissions from the proposed project. For this purpose, contours of equal increases in ambient sound levels in 2dBA steps will be used during the EIA phase. In addition predicted ambient sound levels will be presented in appropriate contours of constant sound pressure levels to illustrate the projected noise levels in the area.

For modelling and assessing the potential noise impact the values as proposed in **Table 6-4** will be considered.

Table 6-4: Proposed ambient sound levels and acceptable rating levels

Wind Speed (m/s)	$L_{Aeq,ambient}$ (**Figure 6-2**) dBA	Night-time Zone Sound Level (SANS 10103:2008) dBA	Proposed Night Rating Level (considering impact of wind) dBA (non-project participants)	Maximum Proposed Acceptable Night Rating Level dBA (+5 dBA) (Project participants)
3	27.04	35	35	40
4	28.15	35	35	40
5	30.30	35	35	40
6	33.33	35	35	40
7	37.09	35	37.1	42.1
8	41.40	35	41.4	46.4

7 RESULTS AND IMPACT ASSESSMENT

7.1 CONSTRUCTION PHASE: ORIGINAL LAYOUT

7.1.1 Construction Activities

Construction activities highly depend on the final operational layout. The original provisional layout as provided by the developer is presented in **Figure 7-1**. As can be seen from this proposal, a number of different activities will take place, each with a specific impact on the closest potential sensitive receptor. The following activities are proposed:

- The development of access roads: While the main access roads follow existing roads, the internal roads must be constructed. However, being gravel roads, the construction of these internal roads is a fast (temporary) and an uncomplicated process, with a small noise footprint. In addition, as this will take place during the day-time, the probability of impact on receptors is very low.
- Construction of the wind turbines, and lesser extent, the substation and workshop: This involves the clearing and levelling of the surface, the digging of foundations, concreting (mixing and pouring) and the erection of the towers, fixing of turbines and blades. The noisiest activity is normally bulldozing and excavation. The geological and geotechnical characteristics, project constraints and schedules would determine the size of the equipment. For the purpose of this assessment very large equipment was selected for modelling purposes. If these activities take place closer than 500 meters from sensitive receptors, it could impact on these receptors, as the activities could be noisy and takes place over a period of days.
- The development of the internal power lines to the substation: The developer indicated that these would comprise underground cables, which requires the digging of trenches and the laying of trunking (sleeve). The excavation is normally with a small TLB/Bobcat excavator. These activities are also relatively fast with a low risk of impacting on potential receptors.
- Development of overland 132kV power lines: The cabling is normally overland, carried by a number of pylons to the closest feed-in substation (ESKOM). The potential impact on receptors again depends on the distance between the area where a pylon is constructed and a potential receptor, but in general this noise impact is considered relatively insignificant, due to the temporary nature as well as low probability to impact on receptors.

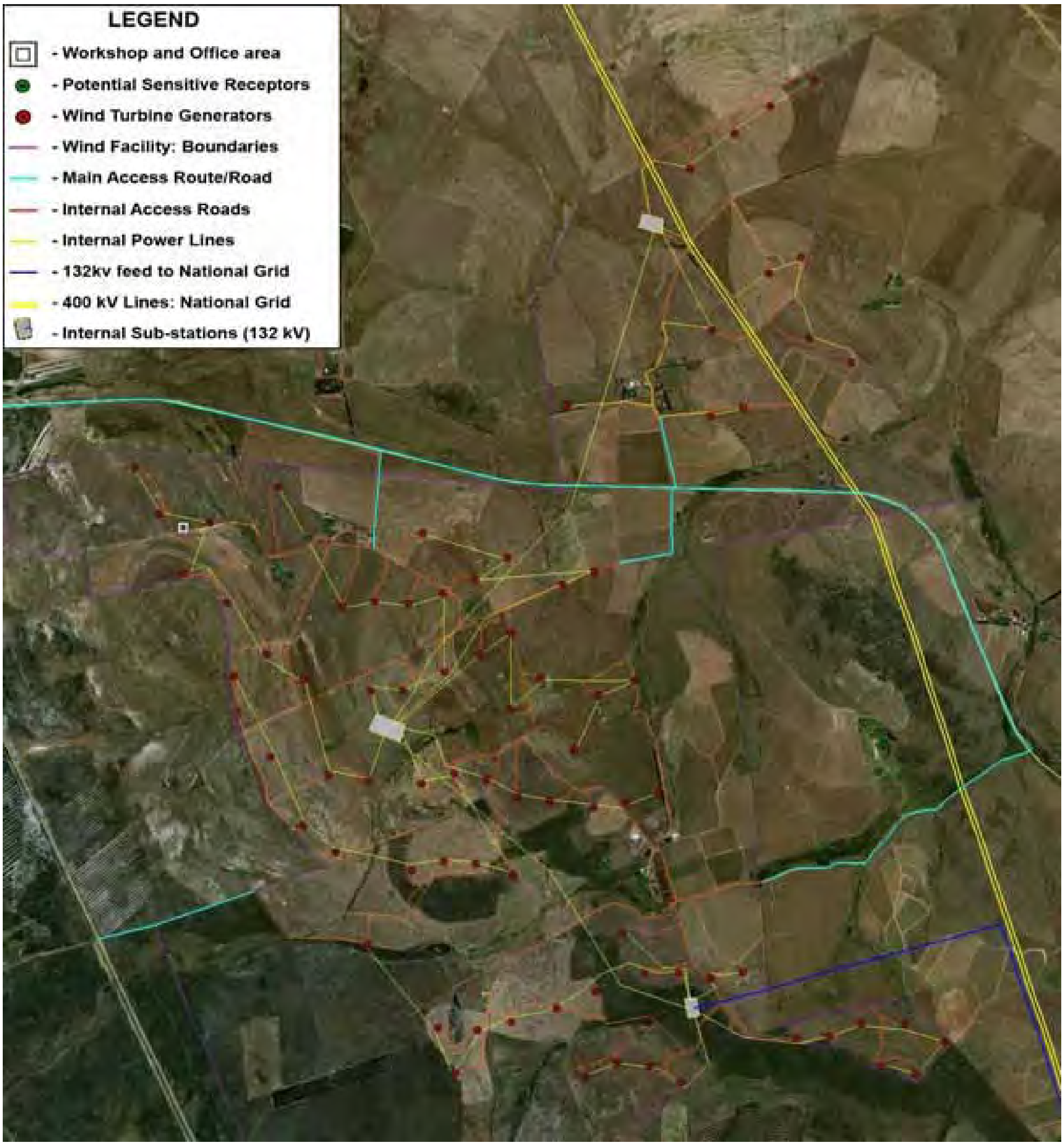

Figure 7-1: Full infrastructure proposal including alternatives

7.1.2 Description of Construction Activities Modelled

The following activities were assumed to take place simultaneously together with the normal activities observed during the site visit (see **Figure 7-2**):

- Various vehicle traffic from the R315 to the workshop/store area, from where traffic moves to the various sites where other construction activities are taking place. Traffic is set as a maximum of 5 trucks with 5 light construction vehicles (maximum) per hour travelling at an average speed of 40 km/h on the gravel road. This should represent the worst case scenario. This peak traffic would also increase the average traffic on the R27 slightly (the noise impact that the additional traffic on the R27 will have is considered to be insignificant).
- A worst case is selected to estimate the potential construction impact due to noise. For modelling purposes five sites were selected where various activities are taking place simultaneously. For the purpose of the EIA the activities that are most likely to create the loudest noises are:
    1. General work at the workshop area. This would be activities such as equipment maintenance, off-loading and material handling. All vehicles will travel to this site where most equipment and material will be off-loaded (General noise, crane). Material such as aggregate and sand will be taken directly to the construction area (foundation establishment). Activities are taking place for 16 hours during the 16 hour day-time period.
    2. Surface preparation prior to civil work. This could be the removal of topsoil for ground levelling purposes, or the preparation of an access road (bulldozer) and compaction. Activities are taking place for 8 hours during the 16 hour day-time period.
    3. Preparation of foundation area (sub-surface removal until secure base is reached – excavator, compaction and general noise). Activities are taking place for 10 hours during the 16 hour day-time period.
    4. Pouring of foundation concrete (general noise, electric generator/compressor, concrete vibrators, mobile concrete plant, TLB). As foundations must be poured in one go, the activity is projected to take place over the full 16 hour day-time period.
    5. Erecting of the wind turbine generator (general noise, electric generator/compressor, crane). Activities are taking place for 16 hours during the 16 hour day-time period.

Figure 7-2: Illustration of location of various construction activities: Original Layout

The following equipment is presumed to be onsite:

- 1x Bulldozer,
- 1x Grader,
- 1x Front-end loader and/or 1x Excavator,
- 1x Drilling machine (blasting purposes),
- 2x Electric Generator/Air Compressor
- 1x TLB,
- 1x Mobile Concrete Batching Plant/Truck,
- 2x Cranes,
- 2x Load haul dumpers.
- 5x light delivery vehicles/people carriers (travelling onsite).

There will be a number of smaller equipment, but the addition of the general noise source covers most of these noise sources. All equipment would be operating under full load (generate the most noise). Atmospheric conditions would be ideal for sound propagation.

Note that the scenario selected will present the worst case scenario, with all equipment operating under full load, with activities selected/positioned to be close to a sensitive receptor, and all activities taking place simultaneously.

7.1.3 Results: Construction Phase

The results from the construction phase based on the original turbine layout are presented in the figures below.

For the purpose of this evaluation the area selected represents the worst case scenario, where the potential receptor is very close to the construction sites, where potential noisy activities could impact on them.

The scenario as defined in section 7.1.2 was modelled with the output presented in **Figure 7-3** with the change in sound levels in **Figure 7-4**. Only the calculated day-time ambient noise levels are presented, as construction activities that might impact on sensitive receptors will be limited to the 06:00 – 22:00 time period.

The worse case scenario is presented with the all activities take place simultaneously during wind-still conditions, in good sound propagation conditions (20^{o}C and 80% humidity) with equipment under full load. Modelled noise levels are defined in **Table 7.1** with the impact tables presented in **Table 7.2**.

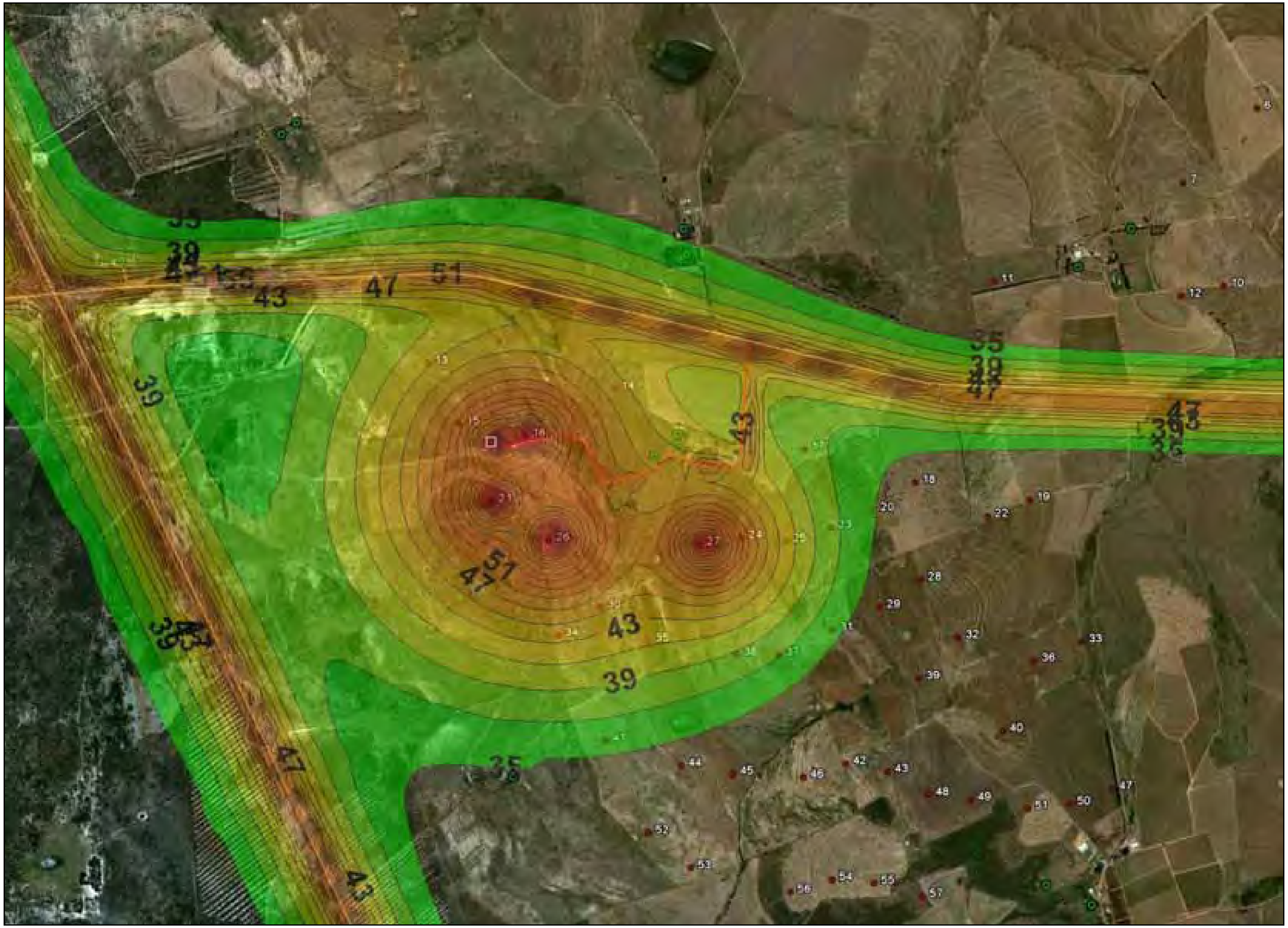

Figure 7-3: Construction noise: Contours of constant sound levels (First layout)

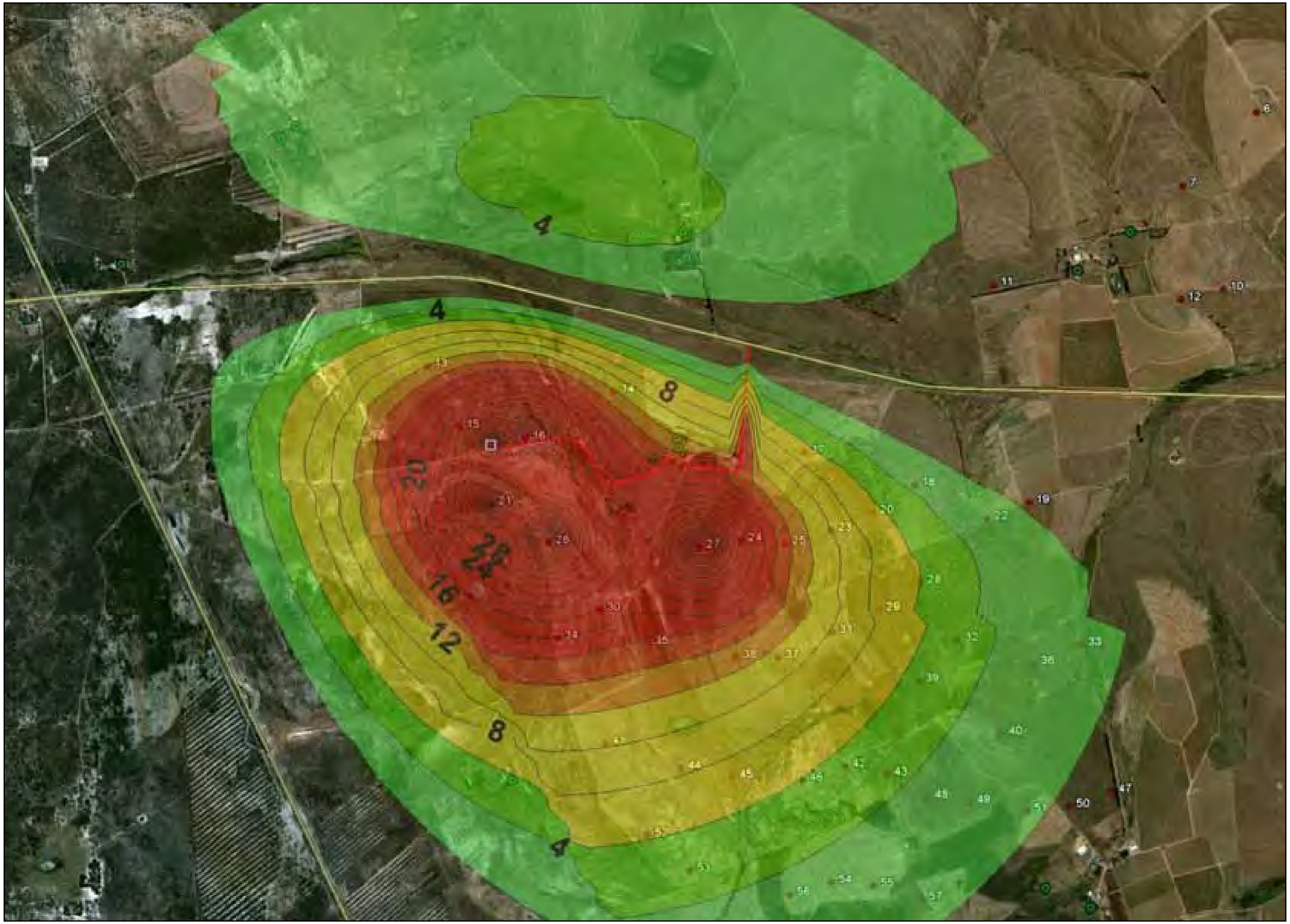

Figure 7-4: Construction noise: Change in ambient sound levels (contours of constant noise)

7.1.4 Impact Assessment: Construction Phase without mitigation

The impact assessment for the various construction activities that may impact on the surrounding environment is presented in the following **Tables**. Only receptors that might be subjected to increased noise levels presented.

Table 7.1: Construction: Defining noise impact on Receptors (dBA) (Datum type: Universal Transverse Mercator, zone 34 - South)

Receptor	Location X (m)	Location Y (m)	Day Ambient Noise Level[3]	Ambient Sound Level (refer section 3.4)	Change* in Noise Levels	Acceptable Zone Sound Levels ($L_{Req,d}$)	Significance of noise Impact (See Table 6.2, Table 6.3 and Table 7.2)	
PSR12	247044	6307346	44.14	28.6	*15.54*	45	**30**	**Low**
PSR13	247201	6307423	42.59	29.6	*12.99*	45	**30**	**Low**
PSR14	247191	6307485	42.07	30.05	*12.02*	45	**30**	**Low**

- Note: Change in ambient sound levels during the day are over-estimated, as it considers the ambient sound levels at the PSR to be very quiet during the day, which is not correct. Likely ambient sound levels near an active dwelling would be 40 – 60 dBA, depending on the activities taking place in the area. Also refer **section 3.4.**

Table 7.2: Construction: Impact Assessment Table without mitigation

Construction Phase		Magnitude	Duration	Extent	Probability	Significance
PSR12	Unmanaged	8	4	3	2	**30**
PSR13	Unmanaged	8	4	3	2	**30**
PSR14	Unmanaged	8	4	3	2	**30**

Table 7.3: Impact Assessment: Construction Activities without mitigation

Nature:	*Numerous simultaneous construction activities, number of PSR's can be impacted.*
Acceptable Rating Level	Rural district: 45 dBA outside during day (refer **Table 6.1**). Use $L_{Req,D}$ of 45 dBA.
Extent (**Δ**$L_{Aeq,D}$>7dBA)	**Regional** – Change in ambient sound levels will extend more than 1,000 meters from activity (3)
Duration	**Long term** – Activities in the vicinity of the receptors could last up to a month (4)
Magnitude	*Estimated noise level* ($L_{Aeq,D}$) *up to 45 dBA* $\Delta L_{Aeq,D}$ = 0 - 15 dBA **High** (8)
Probability	**Possible** – While the sound intensity and change in ambient sounds are high, it would be limited during the day when the potential sensitive receptors are either away or busy with their normal daily activities. Noises created by their normal daily activities would mask most construction related noises. This will minimises the possibility that this additional noise would impact on their quality of living. (2)
Significance	**30 (Low)**
Status	Negative
Reversibility	High
Irreplaceable loss of resources?	*Not relevant*
Comments	*Variety of activities could impact on receptors where the activity takes place within 500 meters from the house. Selection of noisy equipment working at full load 100% of the time represents worst*

[3] Ambient sound level was calculated using the SANS methods discussed in this report.

	case scenario.
Can impacts be mitigated?	Yes
Mitigation:	• Reducing the number simultaneous construction activities when working close to a receptor. *Noise reduction between 3 and 6 dBA.* • Ensuring that all equipment and machinery are well maintained and equipped with silencers (where possible). *Noise reduction between 1 and 5 dBA.* • Considering the noise emission characteristics of equipment when selecting equipment for a project/operation, and select the smallest, or least noisy machine available to do the specific work. *Noise reduction between 3 – 15 dBA.* • Working together with the local communities, and provide prior warning when a noisy activity is to take place. *Higher acceptance to the noise, less annoyance, reduce probability of impact.* • Only conduct very noisy activities between 10am and 4pm. *Reduce probability that it will impact on receptors.* • Conduct noisy activities in the shortest possible time (especially site preparation with bulldozer and civil work using an excavator). *Noise reduction between 0 and 3 dBA.* • Move the closest turbines further from the receptors, or do not construct any turbines within 500 meters from potential receptors. This will move the construction sites. The increased distances from the activities and the receptors could have the single most significant reduction in noise levels. *Variable, depends on distance between receptor and noise source.*
Cumulative impacts:	This impact is cumulative with existing ambient background noises as well as other noisy activities conducted in the same area.
Residual Impacts:	This impact will only disappear once construction activities cease.

7.2 CONSTRUCTION PHASE: REVISED LAYOUT

7.2.1 Construction Activities

The revised provisional layout as provided by the developer is presented in **Figure 7-5**. The construction activities are similar as defined in **section 7.1.1**.

7.2.2 Description of Construction Activities Modelled

The activities to take place as well as the equipment to be used were defined in **section 7.1.2** and illustrated in **Figure 7-6**.

As with the original report, this selected scenario will present the worst case scenario, with all equipment operating under full load, with activities selected/positioned to be close to a sensitive receptor, and all activities taking place simultaneously.

Figure 7-5: Revised Wind Turbine layout showing PSRs

Figure 7-6: Illustration of location of various construction activities: Revised Layout – worst case scenario

7.2.3 Results: Construction Phase

The results from the construction phase based on the revised turbine layout are presented in the figures below.

As mentioned previously, the area selected where the activities are taking place represents the worst case scenario, where the potential receptor is very close to the construction sites.

The scenario as defined in the previous sections was modelled with the output presented in **Figure 7-7** with the change in sound levels presented in **Figure 7-8**. Only the calculated day-time ambient noise levels are presented, as construction activities that might impact on sensitive receptors will be limited to the 06:00 – 22:00 time period.

The worse case scenario is presented with the all activities take place simultaneously during wind-still conditions, in good sound propagation conditions (20^{o}C and 80% humidity) with equipment under full load. Modelled noise levels are defined in **Table 7.4** with the impact tables presented in **Table 7.5**. Only receptors that might be subjected to increased noise levels presented.

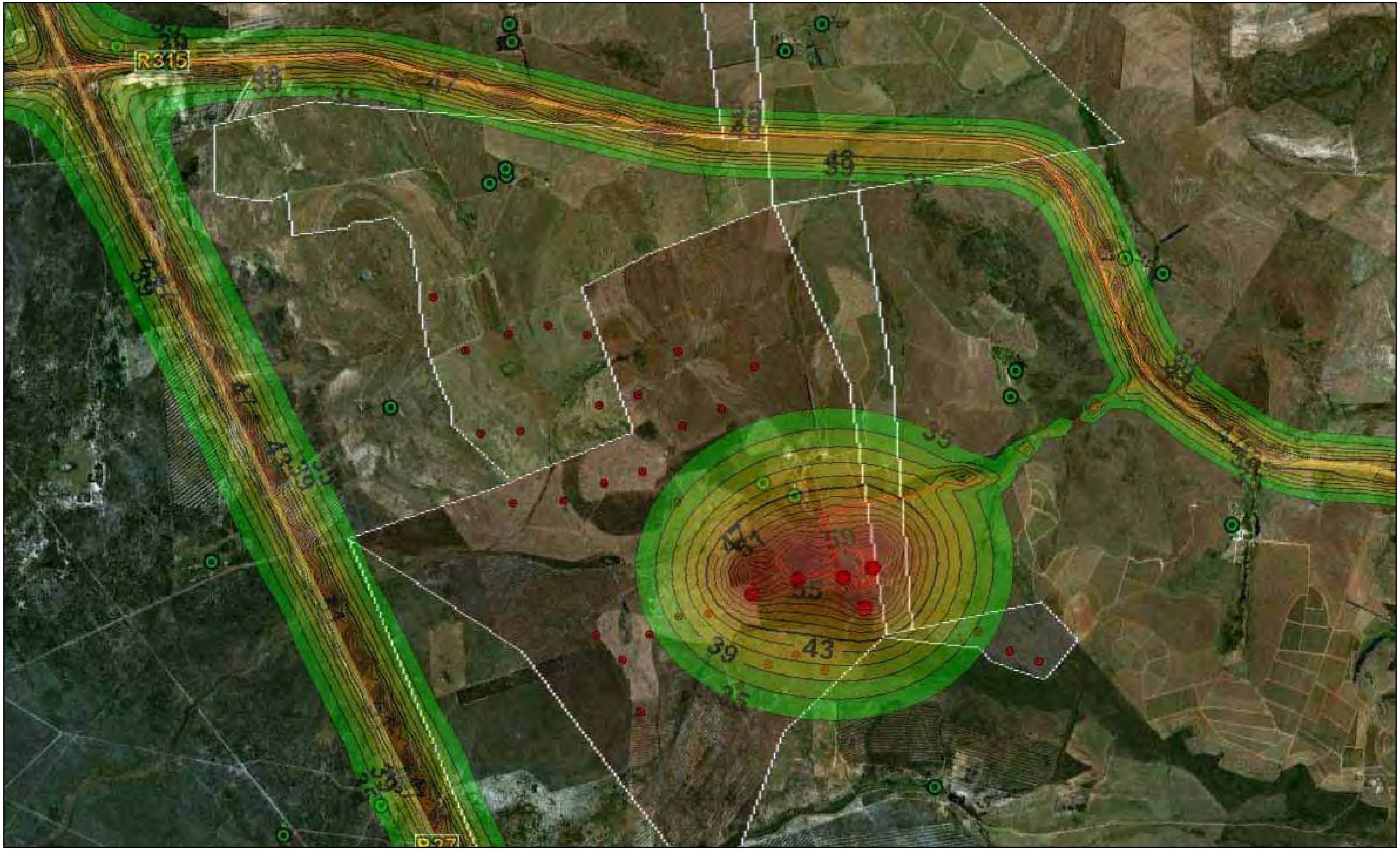

Figure 7-7: Construction noise: Contours of constant sound levels – Revised Layout

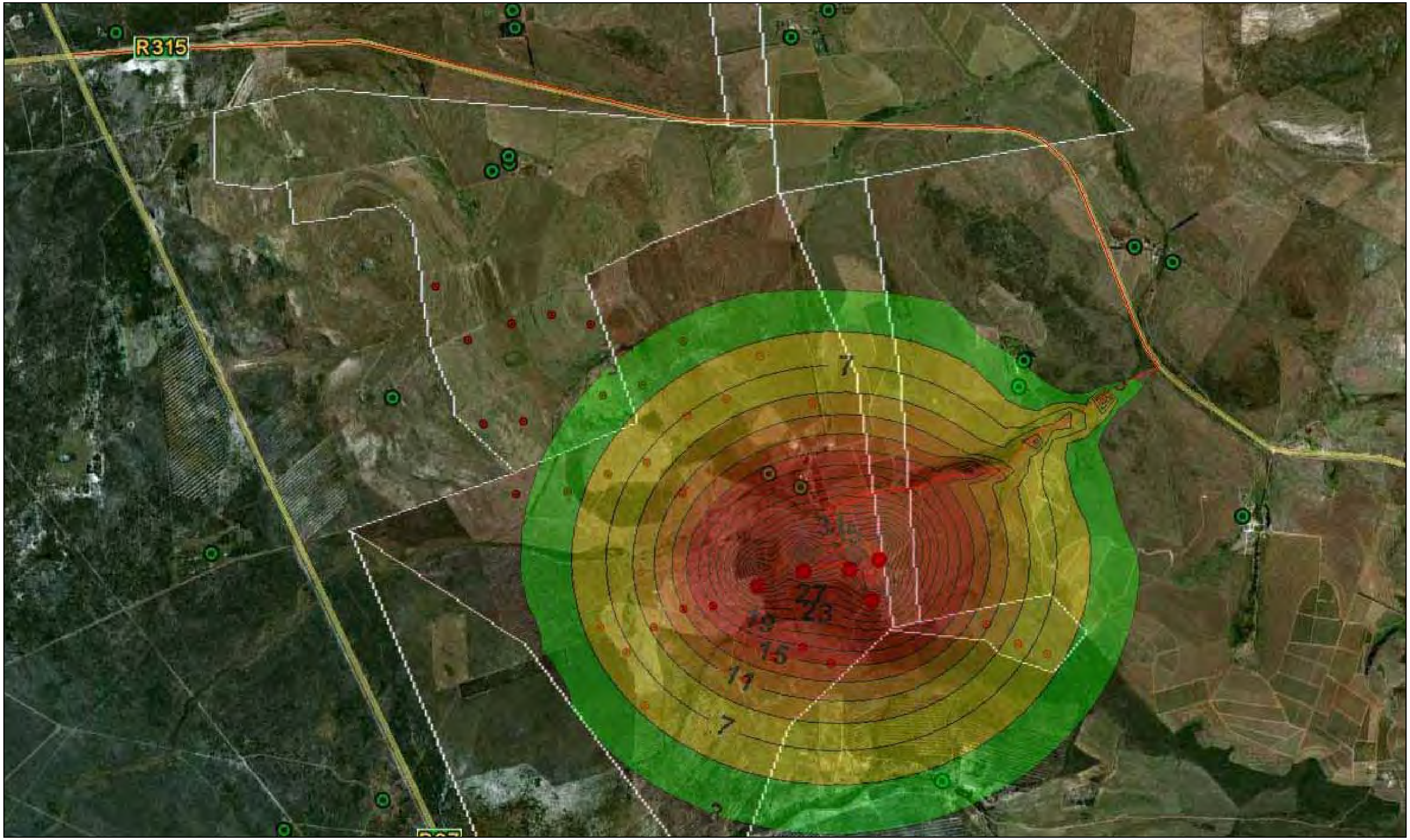

Figure 7-8: Construction noise: Change in ambient sound levels (contours of constant noise) – Revised Layout

7.2.4 Impact Assessment: Construction Phase with revised layout

The impact assessment for the various construction activities that may impact on the surrounding environment is presented in the following **Tables**.

Table 7.4: Construction: Defining noise impact on Receptors (dBA) (Datum type: Universal Transverse Mercator, zone 34 - South) with revised layout

Receptor	Location X (m)	Location Y (m)	Day Ambient Noise Level[4]	Ambient Sound Level (refer section 3.4)	Change* in Noise Levels	Acceptable Zone Sound Levels ($L_{Req,d}$)	Significance of noise Impact (See Table 6.2, Table 6.3 and Table 7.2)	
PSR27	249635	6304672	40.0	25.35	*14.6*	45	26	Low
PSR28	249929	6304557	43.2	25.35	*17.8*	45	26	Low

- Note: Change in ambient sound levels during the day are over-estimated, as it considers the ambient sound levels at the PSR to be very quiet during the day, which is not correct. Likely ambient sound levels near an active dwelling would be 40 – 60 dBA, depending on the activities taking place in the area. Also refer **section 3.4.**

Table 7.5: Construction: Impact Assessment Table with revised layout

Construction Phase		Magnitude	Duration	Extent	Probability	Significance
PSR27	Managed	6	4	3	2	26
PSR28	Managed	6	4	3	2	26

Table 7.6: Impact Assessment: Construction Activities with revised layout

Nature:	*Numerous simultaneous construction activities, number of PSR's can be impacted.*
Acceptable Rating Level	Rural district: 45 dBA outside during day (refer **Table 6.1**). Use $L_{Req,D}$ of 45 dBA.
Extent ($\Delta L_{Aeq,D}$>7dBA)	**Regional** – Change in ambient sound levels will extend more than 1,000 meters from activity (3)
Duration	**Long term** – Activities in the vicinity of the receptors could last up to a month (4)
Magnitude	*Estimated noise level* ($L_{Aeq,D}$) *up to 43 dBA* ΔLAeq,D = 0 - 20 dBA (very quiet environment not realistic, see **sections 3.4** and **3.5.1.** **High** (8)
Probability	**Possible** – The projected sound intensity is less than the Rating level. The change in ambient sounds is high due to very low ambient levels selected. Noises would be limited during the day when the potential sensitive receptors are either away or busy with their normal daily activities. Noises created due to their normal daily activities would mask most construction related noises. This will minimises the possibility that this additional noise would impact on their quality of living. (2)
Significance	**26 (Low)**
Status	Negative
Reversibility	High
Irreplaceable loss of resources?	*Not relevant*
Comments	*Selection of noisy equipment working at full load 100% of the time as well as high humidity represents worst case scenario.*
Can impacts be mitigated?	Not required
Mitigation:	Refer Table 7.3.
Cumulative impacts:	This impact is cumulative with existing ambient background noises as well as other noisy activities conducted in the same area.

[4] Ambient sound level was calculated using the SANS methods discussed in this report.

Residual Impacts:	This impact will only disappear once construction activities cease.

7.3 Operational Phase Impact: Original Layout

7.3.1 Description of Operational Activities Modelled

Typical daytime activities would include:

- The operation of the various Wind Turbines,
- Maintenance activities (relative insignificant noise source).

The day-time period (working day) however was not considered for the EIA. This is because noise generated during the day by the WEF is normally masked by other noises generated by a variety of other sources surrounding potential sensitive receptors during the day-time period. The reader is also referred to **Figure 6-3**.

However, times when a quiet environment is desired (at night for sleeping, weekends etc.) noise levels are more critical. The time period investigated therefore would be the quiet period, normally associated with the 22:00 – 06:00 slot. Maintenance activities would therefore not be considered, concentrating on the ambient sound levels created due to the operation of the various WTGs at night. In addition the applicable Zone Sound Levels at night is 10 dBA less (35 dBA) than the daytime levels (45 dBA).

The sound power emission levels for the original selected turbine are presented in **Table 7.8**. The predominant wind directions are south and south-southwest. However, only a southern wind blowing at a 5 m/s wind speed will be modelled in detail, using the layout presented in **Figure 7-1**. Projected noise levels at potential sensitive receptors will be modelled for various wind directions and speeds, but only presented in table format in **Appendix B**. Ambient sound levels associated with the specific wind speeds will be considered at all times.

To allow for an estimation of the potential impacts (and significance) of noises associated with the proposed WEF, the number of WTGs (at the locations as supplied by the developer) was modelled using the propagation conditions and noise characteristics as per **Table 7.7** and **Table 7.8**.

Table 7.7: Selected parameters for the Noise Prediction Model: EIA Phase

	Temperature	Atmospheric Pressure	Humidity
Meteorological conditions	10°C	93 kPa	90%

Table 7.8: Sound Power Emission Levels for the Vestas V90 2.0MW Turbine

Wind Speed (m/s)	Associated Ambient Sound (dBA)	Frequency (Hz)	63 (dB)	125 (dB)	250 (dB)	500 (dB)	1000 (dB)	2000 (dB)	4000 (dB)	L_{WA} (dBA)
5	**29.85**	$L_{wA,P}$	80.2	84.3	88.5	91.6	94.1	92.9	90.7	**99.2**
		$L_{w,P}$	105.9	100.7	97.2	94.8	94.1	91.7	89.7	
7	**35.05**	$L_{wA,P}$	85.4	90.6	93.4	96.4	98.6	97.4	95.2	**103.9**
		$L_{w,P}$	111.4	106.9	102.2	99.5	98.7	96.3	94.2	

In addition it will be required to consider the potential noise contribution from the Darling Windfarm. However, this wind farm is too far from the proposed WEF and will not result in a significant cumulative noise increase impact on surrounding PSRs.

As mentioned in the Scoping Report, potential impacts due to low frequency sounds must also be considered. For this purpose the sound power level at both the 16 and 31.5 Hz frequency band will also be estimated and used to calculate the C-Weighted Noise Levels. Existing acoustic energy in the low frequency range will also be considered (refer **Figure 4-3**).

It should be noted that SANS 10357:2004 does not provide methods to estimate sound propagation below 63 Hz. While this report does calculate the sound power levels at lower frequency bands (to allow the calculation of the C-weighted Sound Power Levels to estimate the potential/probability for low frequency noises), the reader should know that this is for information purposes only. In terms of accuracy, the sound power level at these frequency bands is estimated at ±5 dBA (due to the unknown adjustment factor for meteorological effects at that octave band frequency).

7.3.2 Results: Operational Phase (Original Layout)

Noise in the area due to the operation of the wind energy facility is illustrated in **Figure 7-9**, with the change in ambient sound levels experienced by the receptors indicated in **Figure 7-10**. **Figure 7-9** and **Figure 7-10** is for the situation when there is a southern wind blowing at a speed of 5 m/s.

Maps were not developed for the other wind directions, as in terms of the scale of the project, the maps looks very similar to each other.

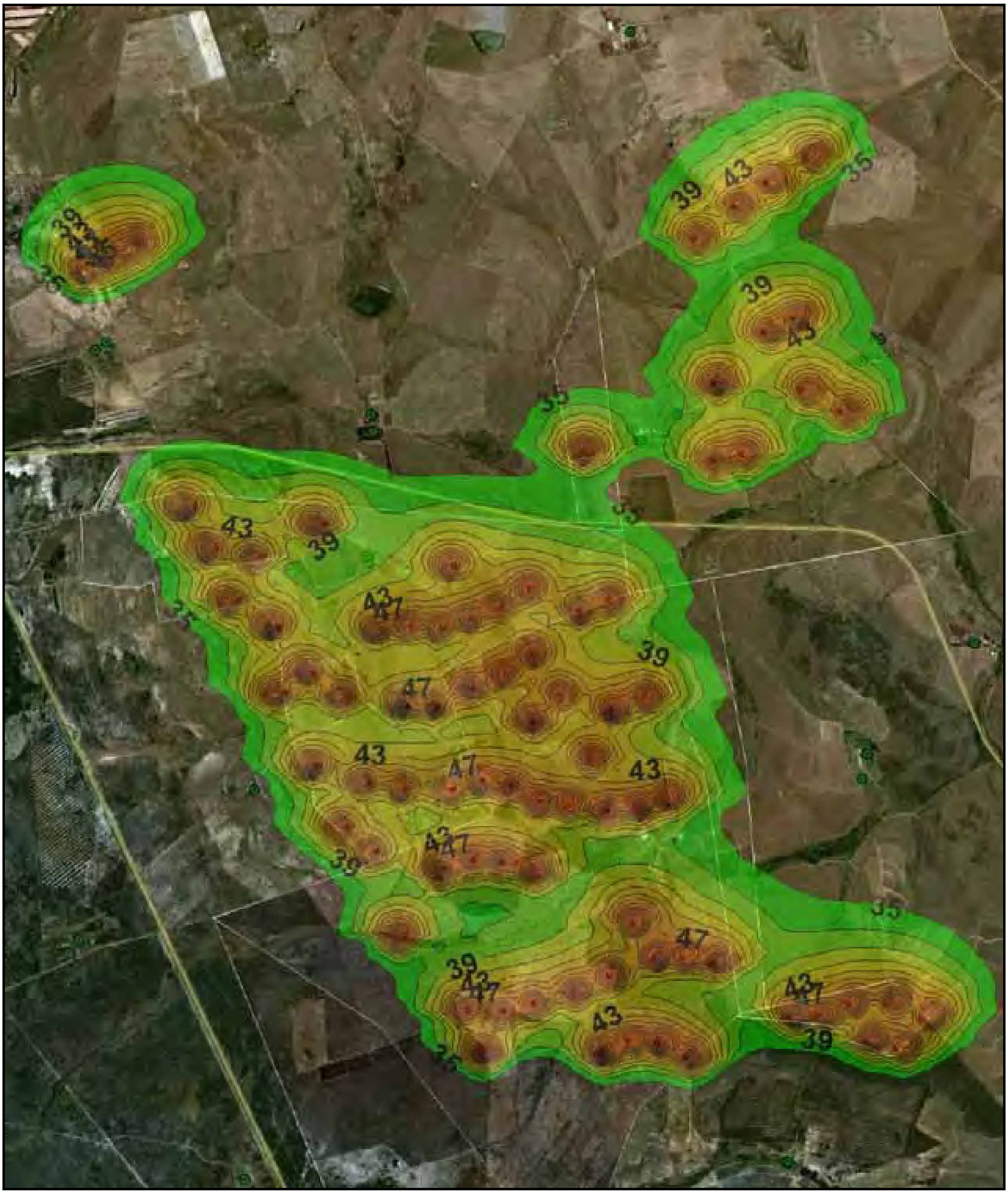

Figure 7-9: Operational Phase: Sound Levels from WEF, Contours of constant sound levels with a southern wind blowing at 5 m/s

Figure 7-10: Operational Phase: Change in ambient sound levels, contours of constant noise levels with a southern wind blowing at 5 m/s

The potential sound pressure levels at the PSRs for other wind speeds were however calculated and tabulated in **Table 7.9**.

These tables present the sound pressure levels (both $L_{Aeq,N}$ and estimated $L_{C,N}$) at the various identified receptors. As per SANS 10103:2008, if the difference between the A-frequency weighted and the C-frequency weighted equivalent continuous sound pressure levels is greater than 10 dB, a predominant low frequency component **may** be present.

As can be seen from these tables, low frequency noises are present, as the estimated C-weighted sound pressure levels are significantly higher than the corresponding A-weighted sound pressure levels. However, it should also be noted that the estimated ambient C-weighted sound levels at the modeled wind speed are already high with the C-weighted sound pressure levels associated with the wind turbines being lower than the wind induced noise levels at the relevant wind speeds. Therefore most of the acoustic energy in the low frequencies would be due to wind induced noises, and not from the wind turbines.

The receptors that might be impacted by the Wind Turbines (original layout) with a 5 m/s wind include:

- Southern wind: PSR12, PSR13, PSR14, PSR19, PSR20, PSR21, PSR27 and PSR28.
- Easterly: PSR12, PSR13, PSR14, PSR19, PSR20, PSR21, PSR22, PSR27 and PSR28.
- Northerly: PSR11, PSR12, PSR13, PSR14, PSR16[5], PSR20, PSR27, PSR28.
- Westerly: PSR11, PSR12, PSR13, PSR14, PSR19, PSR20, PSR27 and PSR28.

Table 7.9: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for a Southern wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	C-weighted Sound Pressure Level due to WEF (dBC)
PSR01	29.85	76	30.33	0.48	41.35
PSR02	29.85	76	29.99	0.14	38.51
PSR03	29.85	76	29.93	0.08	37.38
PSR04	29.85	76	29.89	0.04	34.32
PSR05	29.85	76	29.87	0.02	30.42
PSR06	29.85	76	29.92	0.07	37.07
PSR07	29.85	76	29.87	0.02	31.19
PSR08	29.85	76	29.86	0.01	28.59
PSR09	29.85	76	29.89	0.04	35.24
PSR10	29.85	76	29.9	0.05	35.94
PSR11	29.85	76	33.21	3.36	52.2

[5] Noise impact would be due to the Darling Experimental Wind farm and not the Rheboksfontein Wind Energy Facility.

PSR12	29.85	76	38.26	8.41	57.42
PSR13	29.85	76	38.32	8.47	57.34
PSR14	29.85	76	37.91	8.06	57.07
PSR15	29.85	76	31.16	1.31	48.55
PSR16	29.85	76	31.34	1.49	49.65
PSR17	29.85	76	33.14	3.29	49.52
PSR18	29.85	76	33.73	3.88	50.55
PSR19	29.85	76	36.58	6.73	55.05
PSR20	29.85	76	37.07	7.22	56.36
PSR21	29.85	76	36.94	7.09	55.52
PSR22	29.85	76	34.09	4.24	51.92
PSR23	29.85	76	30.77	0.92	42.86
PSR24	29.85	76	30.07	0.22	37.44
PSR25	29.85	76	30.32	0.47	41.25
PSR26	29.85	76	30.23	0.38	40.31
PSR27	29.85	76	39.26	9.41	58.98
PSR28	29.85	76	40.78	10.93	59.88
PSR29	29.85	76	31.37	1.52	45.86
PSR30	29.85	76	31.65	1.8	46.57
PSR31	29.85	76	30.6	0.75	42.25
PSR32	29.85	76	30.6	0.75	42.25

Table 7.10 presents the Wind Turbines identified that might have a noise impact on the surrounding potential sensitive receptors.

Table 7.10: Wind Turbines that might be problematic in terms of noise impact on potential sensitive receptors with a 5m/s wind

Wind direction	Wind Turbines
South	1, 27, 28, 29, 30, 31, 43, 46, 78, 79
East	25, 28, 29, 31, 34, 69, 70, 71, 79, 80
North	26, 33, 60, 66, 68, 69, 70, 80 as well as the eastern most turbine of the Darling Windfarm[6]
West	26, 29, 31, 43, 46, 60, 69, 78, 79

7.3.3 Impact Assessment: Operational Phase without mitigation (Original Layout)

This Environmental Noise Impact Assessment focuses on the impacts on the surrounding sound environment during times when a quiet environment is highly desirable. Noise limits are therefore appropriate for the most noise-sensitive activity, such as sleeping, or areas used for relaxation or other activities (places of worship, school, etc). Zone Sound Levels are therefore important, and a $L_{Req,N}$ of 35 dBA as proposed by SANS 10103 is used.

[6] Impact on PSR16 due to existing Darling Windfarm. The Rheboksfontein WEF will not impact on this receptor, neither contribute cumulatively to the noise impact.

Appropriate Zone Sound Levels is important, yet it has been indicated that the SANS recommended fixed Night Rating Level ($L_{Req,N}$) of 35 dBA might be inappropriate due to the increased ambient sounds as wind speeds increase. This is especially inappropriate at wind speeds above 6 m/s.

A more appropriate method to determine the potential impact would be to make use of the change in ambient sound levels that receptors may experience. Using the $\Delta L_{Aeq,N}$ of 5 dBA (or higher), it can be seen that a number of receptors could be impacted.

Using the criteria (**$L_{Req,N}$<35 dBA**, **$\Delta L_{Aeq,N}$>5 dBA**) it can be seen that a number of receptors could be impacted during times when a quiet environment is desirable.

Using the model parameters as outlined, the following can be concluded:

- The ambient sound levels will exceed the zone sound level of $L_{Req,N}$ of 35 dBA for a number of receptors. While the noise contribution from the individual wind turbines may be less than 35 dBA, the cumulative effect results in a significant increase in ambient noise levels when numerous turbines are operational at one time.
- There are a number of receptors that would detect the change in ambient sound levels.
- The operation of the wind turbines will slightly add to the acoustical energy in the low frequencies. However most of the acoustical energy in the low frequencies is due to the wind induced noise.
- The workshop area is sufficiently away from the closest receptors (more than 1,000 meters) not be have a noise impact during either night or day, subject that no noisy activities takes place during night.

Applying the precautionary principle, the assessment of potential impacts is presented in

Table 7.11: Impact Assessment: Operational phase without mitigation

Nature:	*Numerous turbines operating simultaneously. See also Table 7.10.*
Acceptable Rating Level (Zone Sound Level)	Rural district with little road traffic: 35 dBA outside during night (refer **Table 6.1**). Use $L_{Req,N}$ of 35 dBA.
*Extent (**Δ**$L_{Aeq,N}$>7dBA)*	**Local** – Impact will extend less than 1,000 meters from activity (2)
Duration	**Permanent** – WEF will operate for a number of years (5)
Magnitude	*Estimated noise level ($L_{Aeq,N}$) higher as 35 dBA* $\Delta L_{Aeq,N}$ >> 7 dBA **High** (8)
Probability	**Definite** (5)
Significance	**75 (High)**
Status	Negative
Reversibility	High
Irreplaceable loss of resources?	*Not relevant*
Comments	*Number of Receptors that would be impacted.*
Can impacts be mitigated?	Yes

Mitigation:	• Turbines highlighted in red in Table 7.10 should be moved to a location where it is more than 1,000 meters from receptors. • If a turbine is to be developed within 1000 meters from a downwind receptor, the developer must highlight this to the receptor that might be impacted, as well as the estimated percentage that the wind blows into the direction of the PSR. • The noise emission specifications of wind turbine generators must be considered when selecting the equipment. This could be smaller equipment, more quiet equipment or both. • A combination of the options proposed above.
Cumulative impacts:	This impact is cumulative with existing ambient background noises as well as with other noise sources, including other turbines in the Wind Energy Facility.
Residual Impacts:	This impact will only disappear once the Wind Energy Facility is decommissioned.

7.4 OPERATIONAL PHASE IMPACT: REVISED LAYOUT

7.4.1 Description of Operational Activities Modelled

A new revised turbine layout was developed for evaluation after considering all comments received during the EIA phase.

The sound power emission levels for currently considered turbine are presented in **Table 7.12**. As previous, a southern wind blowing at a 5 m/s wind speed will be modelled in detail, using the revised layout presented in **Figure 7-5**. Projected noise levels at potential sensitive receptors will be modelled for various wind directions at 5 m/s. Ambient sound levels associated with the specific wind speeds will be considered at all times. Both the Concawe and ISO model will be used. Only winds at 5 m/s will be used, due to the highest risk of a noise impact being associated with lower wind speeds (before wind induced noises start to dominate).

Table 7.12: Sound Power Emission Levels for the Vestas V90 3.0MW Turbine

Wind Speed (m/s)	Associated Ambient Sound (dBA)	Frequency (Hz)	63 (dB)	125 (dB)	250 (dB)	500 (dB)	1000 (dB)	2000 (dB)	4000 (dB)	L_{WA} (dBA)
5	29.85	$L_{wA,P}$	80.9	91.3	90.4	92.4	94.4	93.3	90.0	100.1
		$L_{w,P}$	106.1	109.9	99.3	95.5	94.6	92.2	89.0	
7	35.05	$L_{wA,P}$	89.1	92.1	94.7	97.1	99.8	99.0	95.1	105.0
		$L_{w,P}$	117.9	107.5	103.5	100.3	99.9	97.9	94.1	

The potential impact of the Darling Wind Farm will again be considered as previously using the noise emission data of the Vestas V90 2.0MW.

As a different wind turbine is proposed, potential impacts due to low frequency sounds will again be considered.

7.4.2 Results: Operational Phase (Revised Layout)

Noise in the area due to the operation of the wind energy facility is illustrated in **Figure 7-11**, with the change in ambient sound levels experienced by the receptors indicated in **Figure 7-12**. **Figure 7-11** and **Figure 7-12** is for the situation when there is a southern wind blowing at a speed of 5 m/s.

Maps were not developed for the other wind directions, as in terms of the scale of the project, the maps looks very similar to each other. The potential sound pressure levels at the PSRs for other wind speeds were however calculated and tabulated in **Appendix B**.

The receptors that might be impacted by the Wind Turbines (revised layout) with a 5 m/s wind include (Concawe model):

- Southern wind - **Table 7.13**: PSR27 and PSR28.
- Northerly wind - **Table 7.15**: PSR11, PSR27, PSR28.
- Easterly wind - **Table 7.16**: PSR11, PSR27 and PSR28.
- Westerly wind - **Table 7.17**: PSR21, PSR22, PSR27 and PSR28.

The receptors that might be impacted by the Wind Turbines (revised layout) with a 5 m/s wind include (ISO model – any wind direction):

- Any wind direction (downwind model) - Table 7.18: PSR11, PSR27, PSR28.

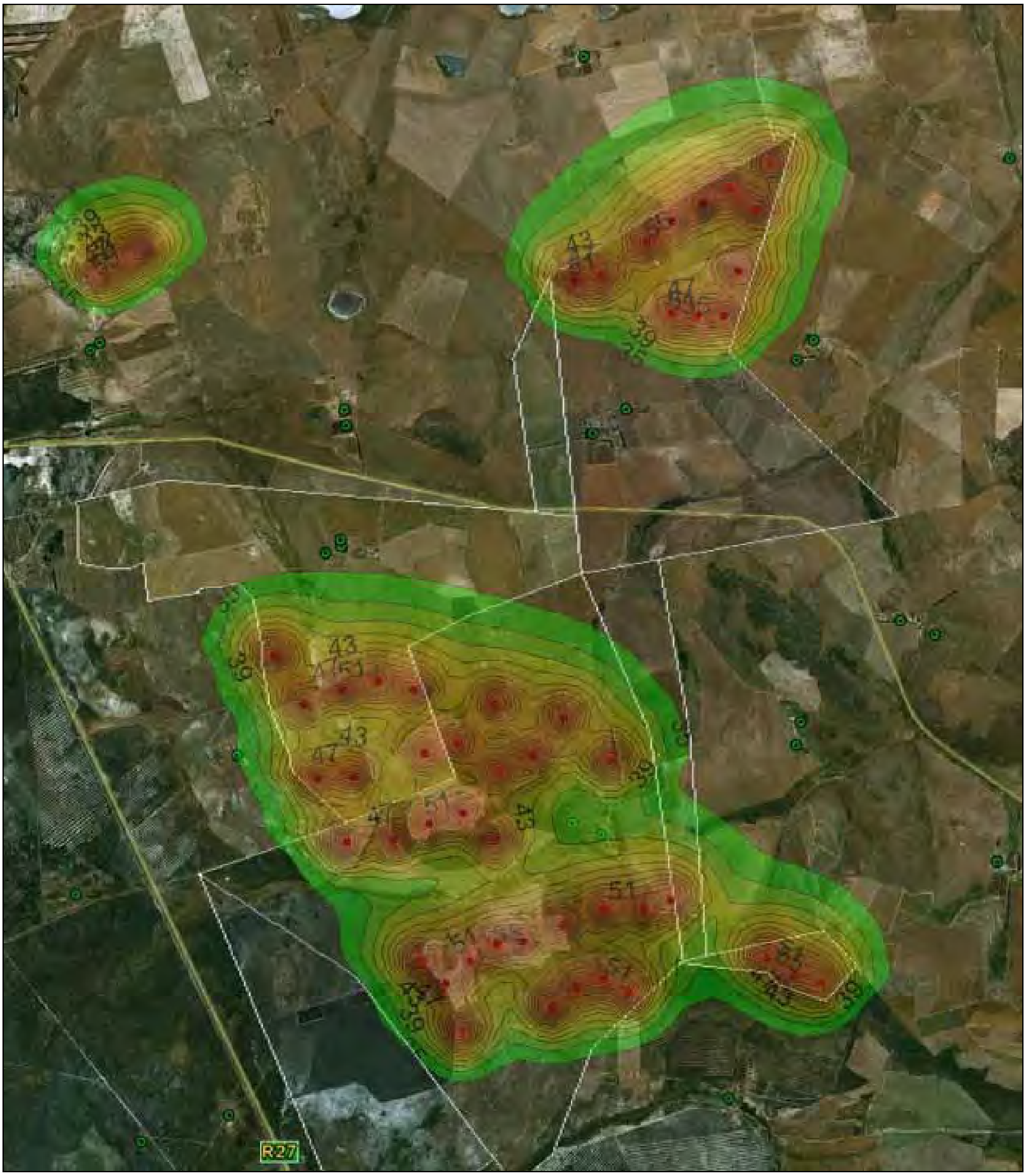

Figure 7-11: Operational Phase: Sound Levels from WEF, Contours of constant sound levels with a southern wind blowing at 5 m/s (Revised layout - Concawe Model)

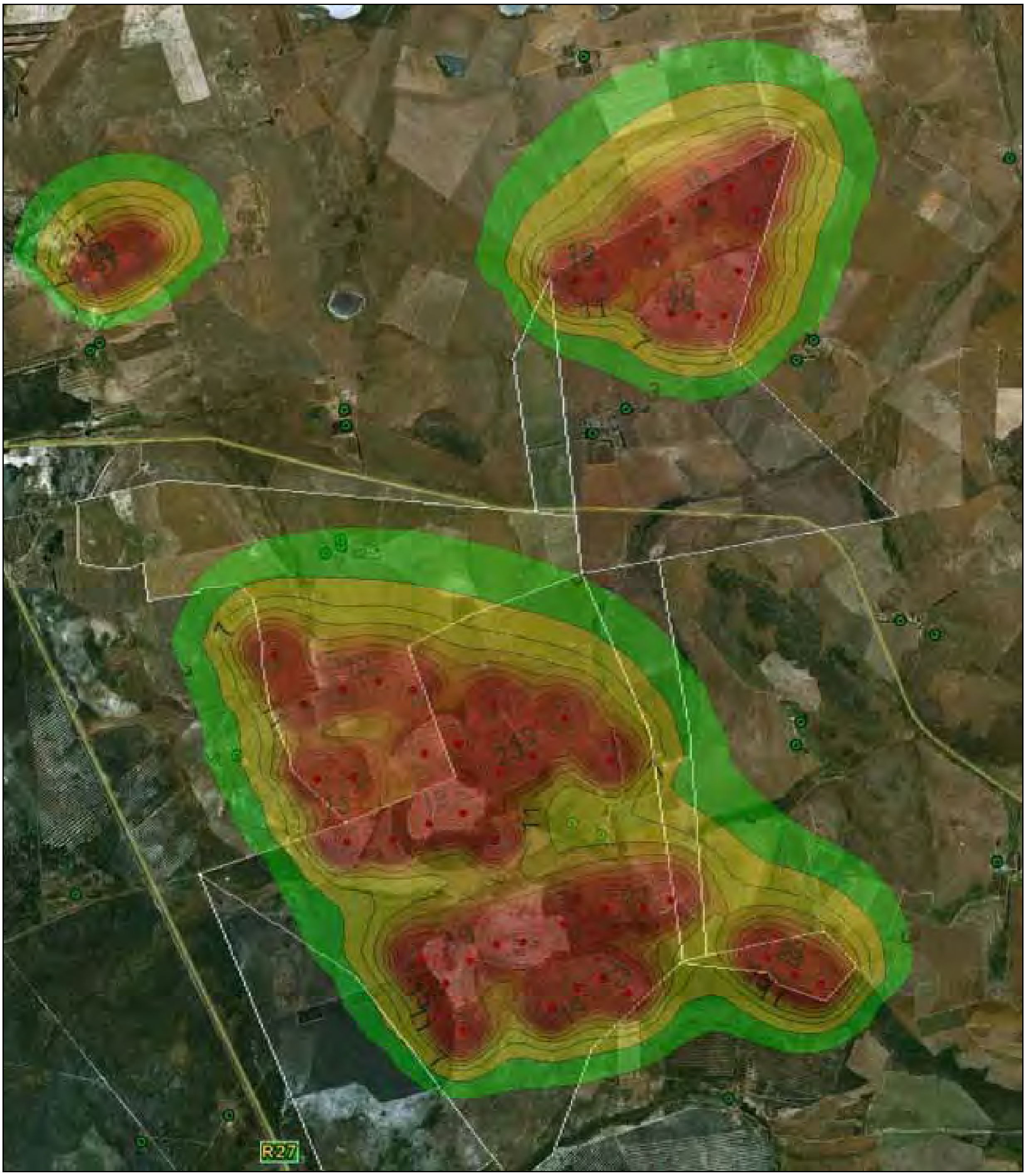

Figure 7-12: Operational Phase: Change in ambient sound levels, contours of constant noise levels with a southern wind blowing at 5 m/s (Revised layout - Concawe Model)

Table 7.13: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for a Southern wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	34.6	4.8	52.7
PSR21	29.85	76	32.5	2.7	50.2
PSR22	29.85	76	32.3	2.5	49.8
PSR27	29.85	76	37.9	8.0	56.7
PSR28	29.85	76	38.2	8.4	56.7

Table 7.14: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for a Northern wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	34.0	5.6	53.3
PSR21	29.85	76	35.4	5.6	52.5
PSR22	29.85	76	35.2	5.4	52.8
PSR27	29.85	76	38.3	8.4	57.1
PSR28	29.85	76	37.0	7.2	55.9

Table 7.15: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for a Western wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	32.8	2.9	51.1
PSR21	29.85	76	35.7	5.8	52.9
PSR22	29.85	76	35.6	5.8	53.3
PSR27	29.85	76	38.6	8.7	57.3
PSR28	29.85	76	37.6	7.7	56.4

Table 7.16: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for an Eastern wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	37.0	7.1	54.7
PSR21	29.85	76	32.4	2.5	49.7
PSR22	29.85	76	32.2	2.4	49.3

PSR27	29.85	76	37.1	7.3	56.1
PSR28	29.85	76	37.1	7.3	55.7

Table 7.17: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for 5 m/s wind (ISO model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	35.6	5.8	51.8
PSR21	29.85	76	34.6	4.8	50.4
PSR22	29.85	76	34.4	4.6	50.1
PSR27	29.85	76	38.5	8.7	55.0
PSR28	29.85	76	38.2	8.3	54.6

The Wind Turbines identified that might have a noise impact on the surrounding potential sensitive receptors are defined in **Appendix B**.

7.4.3 Impact Assessment: Operational Phase without mitigation (Revised Layout)

This Environmental Noise Impact Assessment focuses on the impacts on the surrounding sound environment during times when a quiet environment is highly desirable. Noise limits are therefore appropriate for the most noise-sensitive activity, such as sleeping, or areas used for relaxation or other activities (places of worship, school, etc). Zone Sound Levels are therefore important, and a $L_{Req,N}$ of 35 dBA as proposed by SANS 10103 is used.

Appropriate Zone Sound Levels is important, yet it has been indicated that the SANS recommended fixed Night Rating Level ($L_{Req,N}$) of 35 dBA might be inappropriate due to the increased ambient sounds as wind speeds increase. This is especially inappropriate at wind speeds above 6 m/s.

A more appropriate method to determine the potential impact would be to make use of the change in ambient sound levels that receptors may experience as proposed in **section 6.4** (**Table 6-4**). This is also the method prescribed by the Western Cape Provincial Noise Control Regulations (see **section 2.5**).

Table 7.18: Operation: Impact Assessment Table* with revised layout

	Wind Direction	Magnitude	Duration	Extent	Probability	Significance
PSR11	South	6	5	2	3	**39**
PSR21	South	4	5	2	3	**33**
PSR22	South	4	5	2	3	**33**
PSR27	South	8	5	2	5	**75**
PSR28	South	8	5	2	5	**75**
PSR11	North	4	5	2	3	**33**
PSR21	North	6	5	2	3	**39**
PSR22	North	6	5	2	3	**39**
PSR27	North	8	5	2	5	**75**
PSR28	North	8	5	2	5	**75**
PSR11	West	4	5	2	3	**33**
PSR21	West	6	5	2	3	**39**
PSR22	West	6	5	2	3	**39**
PSR27	West	8	5	2	5	**75**
PSR28	West	8	5	2	5	**75**
PSR11	East	8	5	2	3	**45**
PSR21	East	4	5	2	3	**33**
PSR22	East	4	5	2	3	**33**
PSR27	East	8	5	2	5	**75**
PSR28	East	8	5	2	5	**75**

* *Only receptors shown that could be impacted where noise levels might exceed 35 dBA or a disturbing noise registered. Risk of a noise impact on all other receptors low with a low significance.*

Applying the precautionary principle, the assessment of potential impacts is presented in **Table 7.19.**

Table 7.19: Impact Assessment: Operational phase for revised layout

Nature:	*Numerous turbines operating simultaneously. See also Table 7.10.*
Acceptable Rating Level (Zone Sound Level)	Rural district with little road traffic: 35 dBA outside during night (refer **Table 6.1**). Use $L_{Req,N}$ of 35 dBA.
*Extent (**Δ**$L_{Aeq,N}$>7dBA)*	**Local** – Impact will extend less than 1,000 meters from activity (2)
Duration	**Permanent** – WEF will operate for a number of years (5)
Magnitude	*Estimated noise level* ($L_{Aeq,N}$) *higher as 35 dBA* $\Delta L_{Aeq,N}$ > 7 dBA **High** (8)
Probability	**Definite** (5)
Significance	**75 (High)**
Status	Negative
Reversibility	High
Irreplaceable loss of resources?	*Not relevant*
Comments	*The number of Receptors that would be impacted did reduce from the original layout but mitigation is still required.*
Can impacts be mitigated?	Yes
Mitigation:	• Turbines highlighted in orange in Appendix B should be moved to a location where it is more than 1,000 meters from receptors *(turbines 12, 18, 21, 23, 24, 26, 29, 33, 34)*. • If a turbine is to be developed within 1000 meters from a downwind receptor, the developer must highlight this to the receptor that might be impacted, as well as the estimated percentage that the wind blows into the direction of the PSR. • The noise emission specifications of wind turbine generators must be

	considered when selecting the equipment. This could be smaller equipment, more quiet equipment or both. • A combination of the options proposed above.
Cumulative impacts:	This impact is cumulative with existing ambient background noises as well as with other noise sources, including other turbines in the Wind Energy Facility.
Residual Impacts:	This impact will only disappear once the Wind Energy Facility is decommissioned.

7.5 Operational Phase Impact: Revised Layout with Mitigation Measures

7.5.1 Description of Operational Activities Modelled

As can be seen from the previous section, the noise impact due to the operation of the WEF could be of high significance to a few potentially sensitive receptors, additional mitigation would be required. During this process a number of alternatives were considered, such as:

- The use of different wind turbines,
- Changing the layout of the WEF,
- Operating the selected wind turbine in a different mode that reduce noise emissions,
- Removing certain wind turbines from the layout.

The proposed mitigation were modelled and the effectiveness of the noise reduction considered against the layout that impacts the least on the effective power generation capacity of the larger WEF.

The selected mitigation included the following measures:

- Selecting the smaller Vestas V90 2.0 MW wind turbine (**Table 4.1**),
- Moving a number of wind turbines further from potentially sensitive receptors, indicated with a –R after the turbine number (**Figure 7-13**),
- Relocating a number of wind turbines to a different location in the layout, indicated with a –R after the turbine number (**Figure 7-13**).

7.5.2 Results: Operational Phase (Revised Layout with mitigation measures implemented)

Noise in the area due to the operation of the wind energy facility is illustrated in **Figure 7-14**, with the change in ambient sound levels experienced by the receptors indicated in **Figure 7-15**. As previously, these figures are for the situation when there is a southern wind blowing at a speed of 5 m/s.

The receptors that might have been impacted by the operation of Wind Turbines (for the revised layout) with a 5 m/s wind included (Concawe model):

- Southern wind - **Table 7.13**: PSR27 and PSR28.
- Northerly wind - **Table 7.15**: PSR11, PSR27, PSR28.
- Easterly wind - **Table 7.16**: PSR11, PSR27 and PSR28.
- Westerly wind - **Table 7.17**: PSR21, PSR22, PSR27 and PSR28.

The receptors that might have been impacted by the Wind Turbines (revised layout using a downwind model) with a 5 m/s wind included:

- Any wind direction (downwind model) - **Table 7.18**: PSR11, PSR27, PSR28.

As can be seen from the following tables (**Table 7.20**, **Table 7.21**, **Table 7.22**, **Table 7.23** and **Table 7.24**) the estimated magnitude as well as the projected change in ambient sound levels are in compliance of all regulations, with only the total estimated noise levels at PSR27 exceeding the rural rating level of 35 dBA as recommended by SANS 10103:2008.

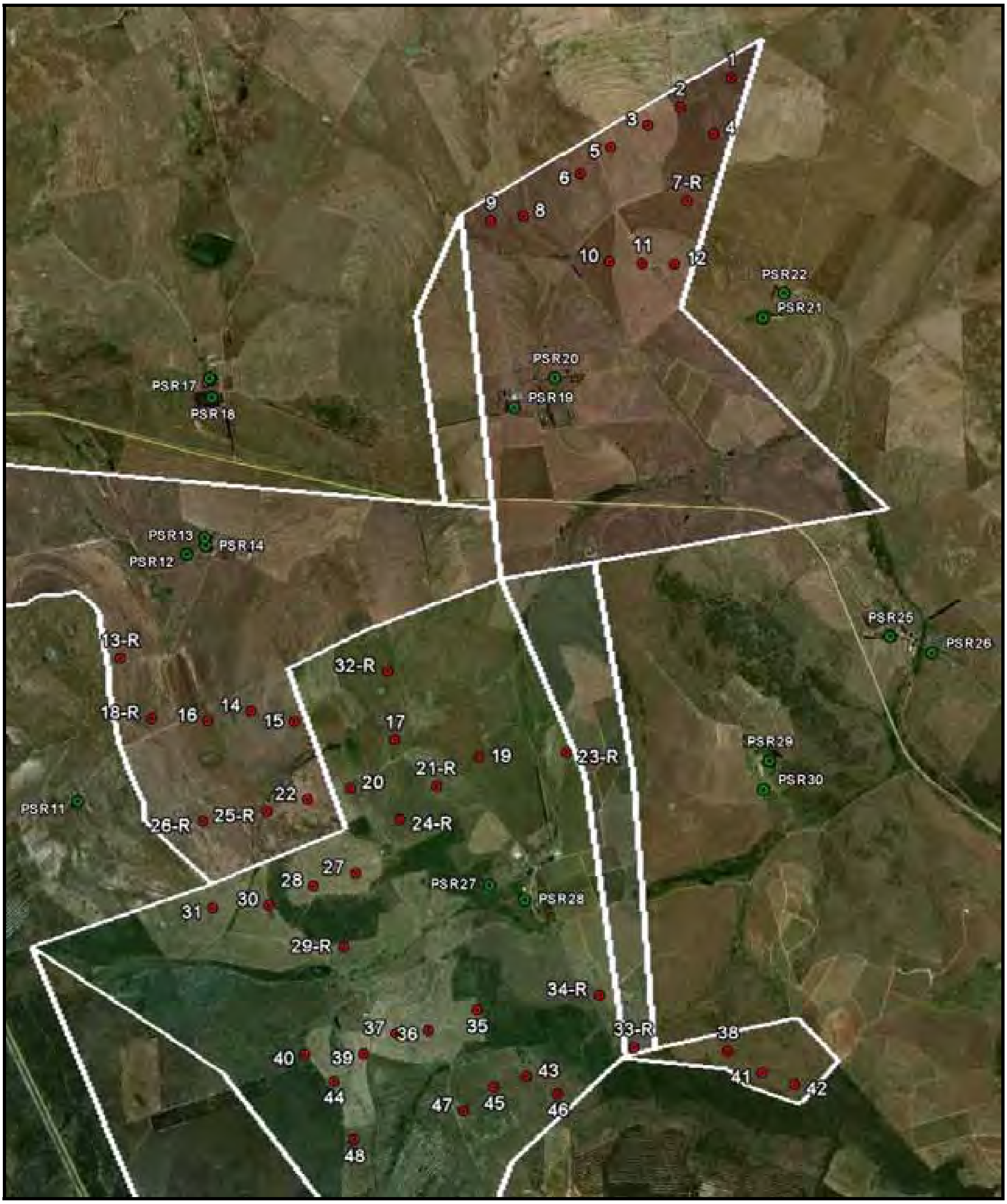

Figure 7-13: Proposed Layout with mitigation measures implemented (wind turbines moved indicated with an –R)

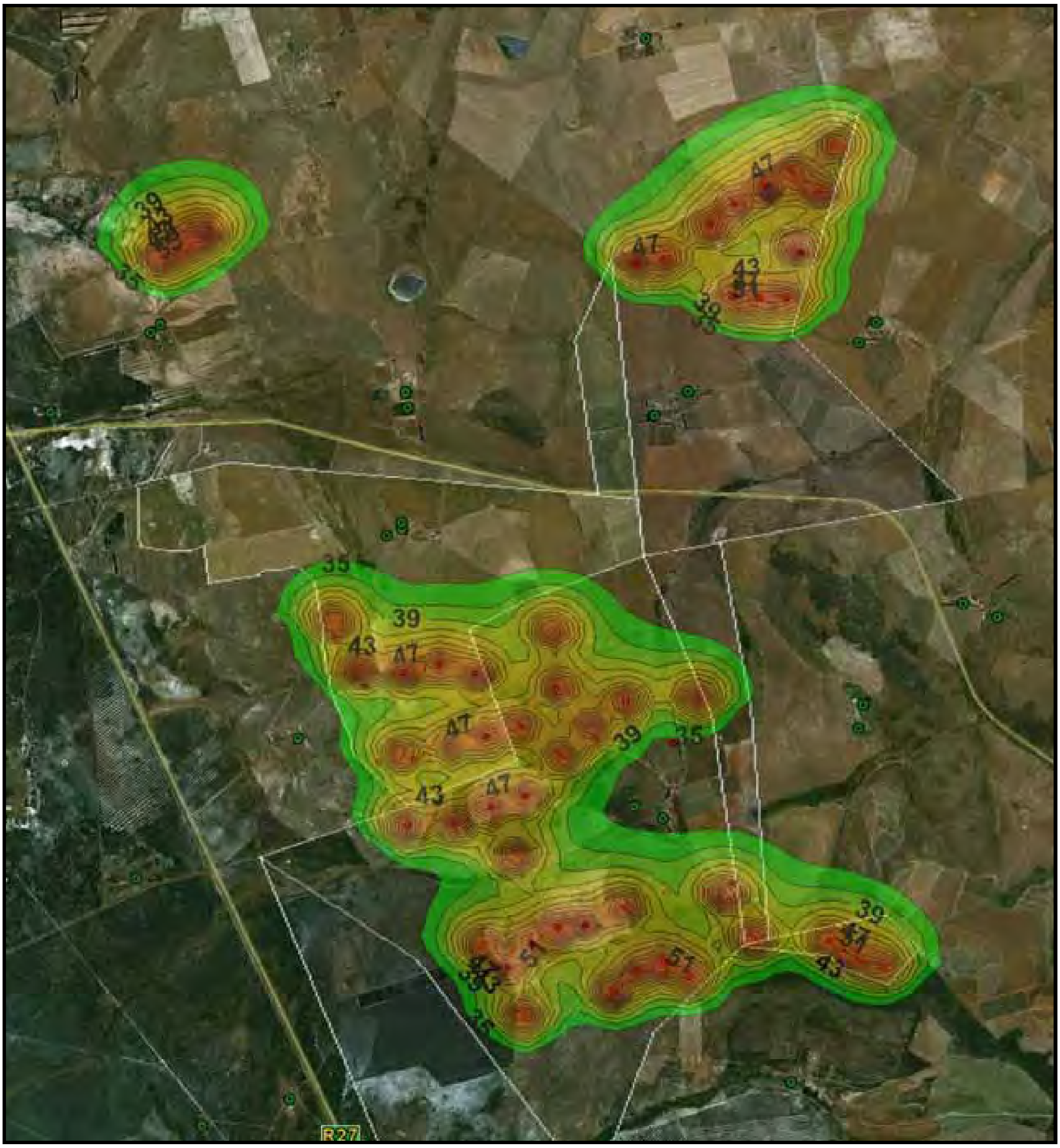

Figure 7-14: Operational Phase: Sound Levels from WEF, Contours of constant sound levels with a southern wind blowing at 5 m/s (Revised layout - Concawe Model)

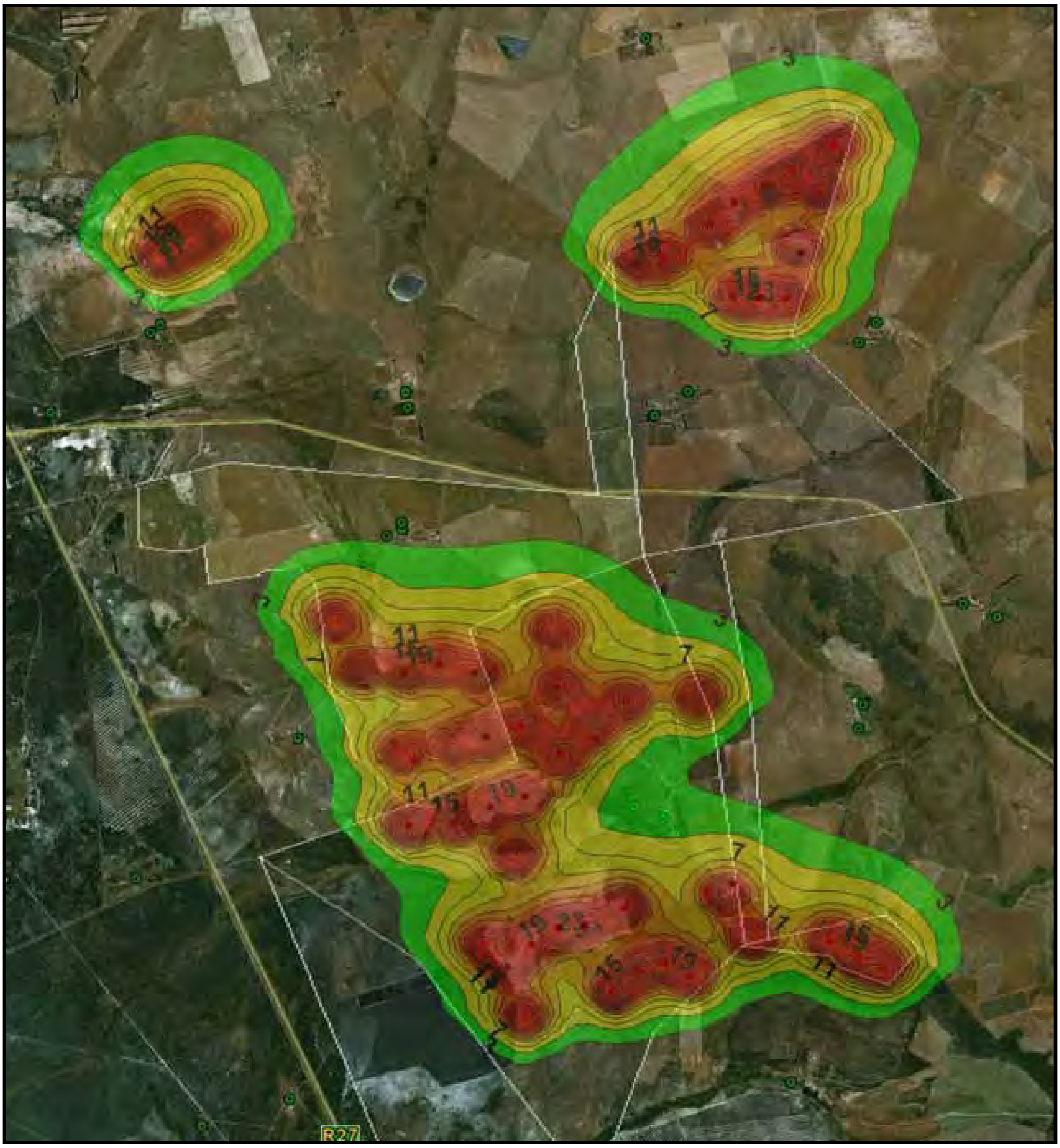

Figure 7-15: Operational Phase: Change in ambient sound levels, contours of constant noise levels with a southern wind blowing at 5 m/s (Revised layout - Concawe Model)

Table 7.20: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for a Southern wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	32.4	2.6	51.5
PSR21	29.85	76	31.6	1.8	50.0
PSR22	29.85	76	31.5	1.7	49.6
PSR27	29.85	76	34.0	4.1	54.5
PSR28	29.85	76	34.1	4.3	53.9

Table 7.21: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for a Northern wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	33.3	3.4	51.9
PSR21	29.85	76	33.7	3.9	51.6
PSR22	29.85	76	33.6	3.8	52.1
PSR27	29.85	76	34.6	4.7	54.3
PSR28	29.85	76	33.4	3.6	53.4

Table 7.22: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for a Western wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	31.5	1.6	49.9
PSR21	29.85	76	33.9	4.0	52.0
PSR22	29.85	76	33.9	4.0	52.6
PSR27	29.85	76	35.1	5.3	54.9
PSR28	29.85	76	34.3	4.4	54.1

Table 7.23: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for an Eastern wind blowing at 5 m/s (as calculated with the Concawe model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	34.1	4.3	52.8
PSR21	29.85	76	31.5	1.7	49.5
PSR22	29.85	76	31.4	1.6	49.0
PSR27	29.85	76	33.0	3.2	53.9
PSR28	29.85	76	33.1	3.3	53.2

Table 7.24: Sound Pressure Levels and change in ambient sound levels at relevant PSRs for 5 m/s wind (ISO model)

PSR	Associated A-Weighted Background Sound Level (dBA)	Estimated C-Weighted Background Sound Level (dBC)	A-weighted Sound Pressure Level due to WEF (dBA)	Change in A-weighted Sound Pressure Level due to WEF (dBA)	Estimated C-weighted Sound Pressure Level due to WEF (dBC)
PSR11	29.85	76	32.9	3.1	49.1
PSR21	29.85	76	32.6	2.8	48.2
PSR22	29.85	76	32.4	2.6	47.9
PSR27	29.85	76	34.8	4.9	51.8
PSR28	29.85	76	34.2	4.4	51.2

7.5.3 Impact Assessment: Operational Phase with mitigation (Revised Layout)

This Environmental Noise Impact Assessment focuses on the impacts on the surrounding sound environment during times when a quiet environment is highly desirable. It considers the potential environmental noise impact on potentially sensitive receptors when the WEF is operating after the implementation of the proposed mitigation measures. An impact assessment on the result is presented in **Table 7.25**.

Table 7.25: Operation: Impact Assessment Table* with revised layout after implementation of proposed mitigation measures

	Wind Direction	Magnitude	Duration	Extent	Probability	Significance
PSR11	South	2	5	2	1	9
PSR21	South	2	5	2	1	9
PSR22	South	2	5	2	1	9
PSR27	South	4	5	2	2	22
PSR28	South	4	5	2	2	22
PSR11	North	4	5	2	2	22
PSR21	North	4	5	2	1	11
PSR22	North	4	5	2	1	11
PSR27	North	4	5	2	2	22
PSR28	North	4	5	2	2	22
PSR11	West	2	5	2	1	9
PSR21	West	4	5	2	1	11
PSR22	West	4	5	2	1	11
PSR27	West	6	5	2	2	26
PSR28	West	4	5	2	2	22
PSR11	East	4	5	2	1	11
PSR21	East	2	5	2	1	9
PSR22	East	2	5	2	1	9
PSR27	East	4	5	2	2	22
PSR28	East	4	5	2	2	22

* *Only receptors shown that were impacted on in the previous section.*

Applying the precautionary principle, the assessment of potential impacts is presented in **Table 7.26**.

Table 7.26: Impact Assessment: Operational phase for revised layout

Nature:	*Numerous turbines operating simultaneously. See also Table 7.10.*
Acceptable Rating Level (Zone Sound Level)	Rural district with little road traffic: 35 dBA outside during night (refer **Table 6.1**). Use $L_{Req,N}$ of 35 dBA.
*Extent (**Δ**$L_{Aeq,N}$>7dBA)*	**Local** – Impact will extend less than 1,000 meters from activity (2)
Duration	**Permanent** – WEF will operate for a number of years (5)
Magnitude	*Estimated noise level* ($L_{Aeq,N}$) *higher as 35 dBA* $\Delta L_{Aeq,N}$ < 7 dBA **High** (6) (PSR27 with western winds)
Probability	**Possible** (2)
Significance	**26 (Low)**
Status	Negative
Reversibility	High
Irreplaceable loss of resources?	*Not relevant*
Comments	*Due to mentioned unknowns (section 5.2), this report took a precautious stance, however, referring to Figure 6-2, this is mainly due to the very conservative ambient sound level selected. It should be noted that it is highly likely that ambient sound levels will be significantly higher due to wind induced noises, which would reduce both the noise impact magnitude as well as the probability that the noise impact may occur.*
Can impacts be mitigated?	Yes, but noise impact considered sufficiently mitigated
Mitigation:	• If required, the Vestas V90 2.0 MW turbine can be run in different modes to reduce the noise emissions from the wind turbine.
Cumulative impacts:	This impact is cumulative with existing ambient background noises as well as with other noise sources, including other turbines in the Wind Energy Facility.
Residual Impacts:	This impact will only disappear once the Wind Energy Facility is decommissioned.

8 MITIGATION OPTIONS

8.1 CONSTRUCTION PHASE

The mitigation of noise during the construction phase is normally relatively easy to achieve. Mitigation options included both management measures as well as technical changes. The revised layout removed a number of wind turbines, and slightly moved others. The result is that the projected noise impact due to construction activities was slightly reduced. Further mitigation is not required, but potential options are mentioned to further assist in maintaining a low risk of a noise impact during the construction phase.

Management options include:

- Ensure a good working relationship between the developer and all potentially sensitive receptors. Communication channels should be established to ensure prior notice to the sensitive receptor if work is to take place close them. Information that should be provided to the potentially sensitive receptor(s) include:
    - Proposed working times,
    - how long the activity is anticipated to take place,
    - what is being done, or why the activity is taking place, and
    - contact details of a responsible person where any complaints can be lodged should there be an issue of concern.
- When working close (within 500 meters) to a potentially sensitive receptor(s), limit the number of simultaneous activities to the minimum (due to cumulative effects for a number of simultaneous activities),
- When working very close to potentially sensitive receptors, co-ordinate the working time with periods when the receptors are not at home. An example would be to work within the 8am to 2pm time-slot to minimise the significance of the impact because:
    - Potentially receptors are most likely at school or at work, minimizing the probability of an impact happening.
    - Normal daily activities will generate other noises that would most likely mask construction noises, minimizing the probability of an impact happening.

Technical solutions to reduce the noise impact during the construction phase include:

- Using the smallest/quietest equipment for the particular purpose. For modelling purposes the noise emission characteristics of both a large bulldozer and excavator (typically used in mining operations) was used, that would most likely over-estimate the noise levels. The use of smaller equipment therefore would have a far less noise impact.
- Ensuring that equipment is well maintained and fitted with the correct and appropriate noise abatement measures.

8.2 OPERATIONAL PHASE

While this document took a cautious approach, the significance of the noise impact was determined to be low (26 – after implementation of all mitigation measures).

Although not required, other precautionary measures that could also reduce the potential noise impact would include:

- The developer can consider larger wind turbines which would require less wind turbines for the same power generation potential, but increase the buffer zone appropriately (*modelling would be required to define the recommended buffer zone*)
- The developer and consider to use smaller and/or quieter wind turbines.
- Reducing the number of wind turbines in areas where there are sensitive receptors.
- Developing the same number of wind turbines over a larger area.
- Ensuring a larger setback around potentially sensitive receptors taking cognisance of prevailing wind directions.
- The voluntary relocation of the receptors that are impacted.
- A combination of the above options.

Mitigation measures that would reduce a potential noise impact after the implementation of the facility includes (if a noise complaint is registered):

- Operating all, or selected wind turbines in a different mode. For the purpose of the Impact Assessment (with mitigation) the Vestas V90 2.0MW turbine operating in mode 0 was used. The Vestas as well as most other manufacturers allow the turbines to be operated in a different mode. This allows the wind turbine generator to operate more silently, albeit with a slight reduction of electrical power generation capability.

- Problematic wind turbines could also be disabled, or the rotational speeds significantly decreased during periods when a quieter environment is desired (and complaints registered).

In addition:

1. Good public relations are essential, and at all stages surrounding receptors should be educated with respect to the sound generated by wind turbines. The information presented to stakeholders should be factual and should not set unrealistic expectations. It is counterproductive to suggest that the wind turbines will be inaudible, or to use vague terms like "quiet". Modern wind turbines produce a sound due to the aerodynamic interaction of the wind with the turbine blades, audible as a "swoosh", which can be heard at some distance from the turbines. The magnitude of the sound will depend on a multitude of variables and will vary from day to day and from place to place with environmental and operational conditions. Audibility is distinct from the sound level, since it depends on the relationship between the sound level from the wind turbines and the ambient background sound level.
2. Community involvement needs to continue throughout the project. Annoyance is a complicated psychological phenomenon; as with many industrial operations, expressed annoyance with sound can reflect an overall annoyance with the project, rather than a rational reaction to the sound itself. Wind projects offer a benefit to the environment and the energy supply for the greater population, and offer economic benefits to the land owners leasing installation sites to the wind farm. A positive community attitude throughout the greater area should be fostered, particularly with those residents near the wind farm, to ensure they do not feel taken advantage of.
3. The developer must implement a line of communication where complaints could be lodged/registered. All potentially sensitive receptors should be made aware of this line of communication. The wind energy facility should maintain a commitment to the local community and respond to concerns in an expedient fashion. Sporadic and legitimate noise complaints could develop. For example, sudden and sharp increases in sound levels could result from mechanical malfunctions or perforations or slits in the blades. Problems of this nature can be corrected quickly, and it is in the developer's interest to do so.

9 ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan is relevant to the revised layout.

9.1 CONSTRUCTION PHASE

Projected noise levels during construction of the Wind Energy Facility were modelled using the methods as proposed by SANS 10357:2004. The resulting future noise projections indicated that the construction activities, as modelled for the worst case scenario, might not comply with the Noise Control Regulations (PN 627), but would comply with the acceptable day rating levels as per the SANS 10103:2008 guidelines. Non-compliance with the Noise Control Regulations is not considered critical due to the very low ambient sound levels selected.

Various construction activities would be taking place during the development of the facility, but due to the relative proximity to the closest potentially sensitive receptors (such as PSR27 and PSR28), it could pose a noise risk to them. The significance of this noise impact was defined to be of a low significance. However, mitigation measures were still proposed that could further reduce the potential noise impacts, risks and the probability of any complaints being registered.

The following measures are recommended to define the performance of the developer in mitigating the projected impacts and reducing the significance of the noise impact.

OBJECTIVE	**Control noise pollution stemming from construction activities**
Project Component(s)	Construction of infrastructure, including but not limited to: turbine system (foundation, tower, nacelle and rotor), substation(s), access roads and electrical power cabling.
Potential Impact	• Increased noise levels at potentially sensitive receptors • Potentially changing the acceptable land use capability
Activity/Risk source	Any construction activities taking place within 500 meters from potentially sensitive receptors (PSR)
Mitigation Target/Objective	• Ensure equivalent A-weighted noise levels below 45 dBA at potentially sensitive receptors. • Ensure that maximum noise levels at potentially sensitive receptors be less than 65 dBA. • Prevent the generation of disturbing or nuisance noises • Ensure acceptable noise levels at surrounding stakeholders and potentially sensitive receptors. • Ensuring compliance with the Noise Control Regulations

Mitigation: Action/Control	**Responsibility**	**Timeframe**

Establish a line of communication and notify all stakeholders and PSRs of the means of registering any issues, complaints or comments.	- Environmental Control Officer	All phases of project
Notify potentially sensitive receptors about work to take place at least 2 days before the activity in the vicinity (within 500 meters) of the PSR is to start. Following information to be presented in writing: - Description of Activity to take place - Estimated duration of activity - Working hours - Contact details of responsible party	- Contractor - Environmental Control Officer	At least 2 days, but not more than 5 days before activity is to commence
Ensure that all equipment are maintained and fitted with the required noise abatement equipment.	- Environmental Control Officer	Weekly inspection
Measure the peak noise levels of equipment used when operational and keep database of noise levels	- Acoustical Consultant / Approved Noise Inspection Authority	Start of project Twice annually
When any noise complaints are received, noise monitoring should be conducted at the complainant, followed by feedback regarding noise levels measured	- Acoustical Consultant / Approved Noise Inspection Authority	Within 7 days after complaint was registered
The construction crew must abide by the local by-laws regarding noise.	- Contractor - Environmental Control Officer	Duration of construction phase
Where possible construction work should be undertaken during normal working hours (06H00 – 22H00), from Monday to Saturday; If agreements can be reached (in writing) with the all the surrounding (within a 1,000 distance) potentially sensitive receptors, these working hours can be extended.	- Contractor	As required

Performance indicator	• **Equivalent A-weighted noise levels below 45 dBA at potentially sensitive receptors (8 hours).** • **Ensure that maximum noise levels at potentially sensitive receptors are less than 65 dBA.** • **No noise complaints are registered**
Monitoring	Noise monitoring to be conducted downwind from all noisy activities or at PSRs when work is taking place within 500 meters from a potentially sensitive receptor. Monitoring to take place every time that a noise complaint is registered.

9.2 OPERATIONAL PHASE

Projected noise levels during operation of the Wind Energy Facility were modelled using the methodology as proposed by both SANS 10357:2004 and ISO 9613-2.

The resulting future noise projections indicated that the operation of the facility would comply with the Noise Control Regulations (PN 627), but may not comply with the SANS 10103:2008 guidelines during optimal sound propagation conditions with a western wind. The significance of this noise impact on PSR 27 was determined to be of a medium significance during such an instance, but due to the precautious approach of this assessment, further mitigation is not consider necessary.

The following measures are recommended to define the performance of the developer in mitigating the projected impacts and reducing the significance of the noise impact.

OBJECTIVE	**Control noise pollution stemming from operation of WEF**
Project Component(s)	Operational Phase
Potential Impact	• Increased noise levels at potentially sensitive receptors • Changing ambient sound levels could change the acceptable land use capability • Disturbing character of sound
Activity/Risk source	Simultaneous operation of a number of Wind Turbines
Mitigation Target/Objective	• Ensure that the change in ambient sound levels as experienced by Potentially Sensitive Receptors is less than 5 dBA. • Prevent the generation of nuisance noises • Ensure acceptable noise levels at surrounding stakeholders and potentially sensitive receptors.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Defining the ambient sound levels in 10 minute bins over a period of 14 days before the operational phase starts inside and outside of the dwellings at PSR11, PSR21 and PSR27. 10 minute sampling bins should be co-ordinated with 10 m wind speed.	- Acoustical Consultant	Before operational phase commence
Design and implement a noise monitoring programme	- Acoustical Consultant	Before operational phase commence
Add additional noise monitoring points at any complainants that registered a noise complaint relating to the operation of the WEF	- Acoustical Consultant / Approved Noise Inspection Authority	With quarterly monitoring

Performance indicator	**Ensure that the change in ambient sound levels as experienced by Potentially Sensitive Receptors is less than 7 dBA**
Monitoring	Quarterly noise monitoring by an Acoustic Consultant or Approved Noise Inspection Authority for the first two years of operation. Monitoring should take place over a 24 hour period in 10 minute bins, with the results co-ordinated with the 10 m wind speed. Noise monitoring programme to be developed and implemented at the start of operation.

10 CONCLUSIONS

This report is an Environmental Noise Impact Assessment of the predicted noise environment due to the development of the Rheboksfontein Wind Energy Facility close to Darling, making use of a predictive model to identify issues of concern.

While modelling indicated no single turbine that would impact on the potentially sensitive receptors, the evaluation showed that the cumulative impact of a number of turbines would increased the total noise levels (and change in ambient sound levels) in the area.

With the input data as used, this assessment indicated that the proposed project would comply with the Provincial Noise Control Regulations (PN 627) and generally with the SANS 10103 guideline values. However, it is possible that the operation of the WEF could impact on PSR27 during optimal noise propagation conditions (high humidity, cold temperatures found early in the mornings during winter months) with a western wind blowing. During these periods PSR27 may experience noise levels exceeding 35 dBA. However, considering the precautious approach as well the likelihood that the PSR would be indoors (10 dBA attenuation), the significance of the potential noise impact is considered low.

Mitigation measures were however proposed if any noise complaints are registered that would reduce any noise impacts.

With its potential for environmental and economic advantages, wind power generation have significant potential to become a large industry in South Africa. However, when wind farms come close to potentially sensitive receptors, consideration must be given to ensuring a compatible co-existence. The potentially sensitive receptors should not be adversely affected and yet, at the same time the wind farms need to reach an optimal scale in terms of layout and number of units.

Wind turbines produce sound, primarily due to mechanical operations and aerodynamics effects at the blades. Modern wind turbine manufacturers have virtually eliminated the noise impact caused by mechanical sources, and instituted measures to reduce the aerodynamic effects. But, as with many other activities, the wind turbines emit sound power levels at a level that does impact areas at some distance away. When potentially sensitive receptors are nearby, care must be taken to ensure that the operations at the wind farm do not unduly cause annoyance or otherwise interfere with the quality of life of the receptors.

It should be noted that this does not suggest that the sound from the wind turbines should be inaudible under all circumstances - this is an unrealistic expectation that is not required or expected from any other agricultural, commercial, industrial or transportation related noise source – but rather that the sound due to the wind turbines should be at a reasonable level in relation to the ambient sound levels.

11 RECOMMENDATIONS

The current impact that the proposed WEF (with mitigation measures as proposed) could have on the surrounding environment is considered to be of a low significance. Further mitigation measures are not required.

It should be noted that should the developer select to relocate any wind turbines the noise analysis should be redone if any wind turbines are within 1,000 from a potentially sensitive receptor.

In addition, should the layout (or type of wind turbines used) change significantly, it is recommended that the new layout be remodelled in terms of the potential noise impact by an independent acoustics specialist.

It is considered critical that the developer define those ambient sound levels in the area for a longer period before the wind energy facility is commissioned. As a minimum the ambient sound levels should be defined in 10 minute bins over a period of 14 days inside and outside of the dwellings at PSR11, PSR21 and PSR27. The 10 minute sampling bins should be co-ordinated with 10 m wind speed.

In addition quarterly monitoring noise monitoring is recommended during the first two years of the operational phase of the facility. This monitoring is to take place during late afternoon (16:00 – 18:00), late evening (20:00 – 24:00) as well as early in the morning (03:00 – 06:00) in 10 minute bins. At least two of these samples should be during times when the Wind Energy Facility is operational.

Quarterly monitoring is suggested at PSR11, PSR21 and PSR27 for the first two years, as well as any other receptors that have complained to the developer regarding noise originating from the facility. Annual feedback regarding noise monitoring should be presented to all stakeholders and other Interested and Affected parties in the area. Noise monitoring must be continued as long as noise complaints are registered.

This report should also be made available to all potential sensitive receptors in the area, or the contents explained to them to ensure that they understand all the potential risks that the development of a wind energy facility may have on them and their families.

12 THE AUTHOR

The author of this report, M. de Jager (B. Ing (Chem), UP) graduated in 1998 from the University of Pretoria. He has been interested in acoustics as from school days, doing projects mainly related to loudspeaker enclosure design. Interest in the matter brought him into the field of Environmental Noise Measurement, Prediction and Control. As from 2007 he has been involved with the following projects:

- Full Noise Impact Studies for a number of Wind Energy Facilities, including: Cookhouse, Amakhala Emoyeni, Dassiesfontein/Klipheuwel, Rheboksfontein, AB, Dorper, Suurplaat, Gouda, Riverbank, Deep River, West Coast, West Coast One, Karoo REF, Velddrift, Canyon Springs, Happy Valley and Saldanha.
- Full Noise Impact Studies for a number of mining projects, including: Skychrome (Pty) Ltd (A Ferro-chrome mine), Mooinooi Chrome Mine (WCM), Buffelsfontein East and West (WCM), Elandsdrift (Sylvania), Jagdlust Chrome Mine (ECM), Apollo Brick (Pty) Ltd (Clay mine and brick manufacturer), Arthur Taylor Expansion project (X-Strata Coal SA), Klipfontein Colliery (Coal mine), Landau Expansion project (Coal mine), Modelling for Tweefontein Colliery Expansion.

The author is an independent consultant to the project, the developer as well as Savannah Environmental (Pty) Ltd. He,

- does not and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations;
- have and will not have no vested interest in the proposed activity proceeding;
- have no, and will not engage in conflicting interests in the undertaking of the activity;
- undertake to disclose all material information collected, calculated and/or findings, whether favorable to the developer or not;
- will ensure that all information containing all relevant facts be included in this report.

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APPENDIX A

TYPICAL SOUND POWER LEVELS, VARIOUS TYPES OF EQUIPMENT

Frequency	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**
A-Weight Factor	**-26.22**	**-16.19**	**-8.67**	**-3.25**	**0**	**1.2**	**0.96**
Equipment / Process	**Sound power level, dB re1 pW, in octave band, Hz**						
Crusher	121.1	122.3	120.1	120	117.3	112.5	106.3
Mobile Crusher/Screen (Rock)	114.2	109.5	106.2	106	104.1	102.2	101
Crushing/Screening (Coal, small)	100.5	96.9	97.3	99.2	98.4	98.8	94.3
CAT D10 Bulldozer	118.3	115.2	111	109.1	107.5	103	97
CAT D11 Bulldozer	121.22	112.2	111.4	110.9	110.4	101.45	93.67
Front End Loader	105	117	113	114	111	107	101
Road Truck average	90	101	102	105	105	104	99
Drilling Machine	107.2	109.4	109.2	106.1	104.7	101.2	99.8
CAT Water Dozer	112.9	114.5	111.45	109.7	108.35	107.2	104
Excavator	110	112	118	105	106	99	95
Terex 30 ton haul dumper	102.4	105.3	108.9	108.8	108.2	105.1	99.2
Hitachi EX1200 Excavator	113.2	116	119.7	112.5	109.8	108.4	105.4
Cement truck (with cement)	104	107	106	108	107	105	102
Operational Hitachi Grader	107.7	107.9	106.8	106.2	104.2	101.1	97.2
Grader	100	111	108	108	106	104	98
Haul truck	107.9	113.2	116.9	114.4	110.6	106.8	100.2
Road Transport Reversing/Idling	108.2	104.6	101.2	99.7	105.4	100.7	98.7
Vesta V66, max	125.1	113.6	106.3	106.2	100.4	96.4	95.3
Vesta V66, ave	120.1	109.4	100.9	100.5	95.3	91.3	88.8
Vesta V66, min	114.4	104	94.84	94.8	87.5	83.3	80.7
Nordex N90 2.5MW at 4m/s	110.42	104.49	101.37	96.35	91.6	89.3	85.54
Nordex N90 2.5MW at 7m/s	117.92	111.99	108.87	103.85	99.1	96.8	93.04
Vestas V90 2.0 MW at 5m/s	105.9	100.7	97.2	94.8	94.1	91.7	89.7
Vestas V90 2.0 MW at 7m/s	111.4	106.9	102.2	99.5	98.7	96.3	94.2
RePower MM92 at 7.5m/s	109.25	107.41	105.63	101.9	96.73	89.81	83.09
General noise	100	100	103	105	105	100	100
CAT Rock Breaker	119.1	118.2	115.2	115.7	114.9	115.7	110.4
Crane	89	98	101	103	102	102	98
Portable Diesel Generator	96.7	99.5	101.2	97.4	91.3	89.6	81.1

APPENDIX B

DETAILED ANALYSIS OF SOUND POWER LEVELS:

- CONTRIBUTIONS FROM TURBINES

Table B.1: Turbines that could potentially impact on Potentially Sensitive Receptors for a 5 m/s wind (Revised Layout)

	Southern Wind				
Turbine	PSR11	PSR21	PSR22	PSR27	PSR28
26	28.62072	8.224793	8.0309	9.556349	9.060085
29	12.06988	8.474546	8.369577	29.51218	22.72598
32	8.593233	8.538845	8.435349	23.29093	28.40957
33	8.73822	8.470214	8.373653	26.1429	29.66957
34	9.041821	8.418806	8.326468	28.87105	31.3834
35	9.38358	8.309278	8.229364	27.46547	28.1041
	Northern Wind				
Turbine	PSR11	PSR21	PSR22	PSR27	PSR28
7	8.0309	26.80278	27.30016	8.0309	8.0309
12	8.172097	28.64187	27.58712	8.547449	8.531071
13	26.87498	8.0309	8.0309	9.557215	9.126923
18	29.99974	8.0309	8.0309	10.49905	9.707961
19	10.00235	8.0309	8.0309	27.07652	24.904
21	9.620304	8.0309	8.0309	31.82688	27.14703
23	8.69852	8.0309	8.0309	31.47495	31.19139
24	10.44224	8.0309	8.0309	27.93237	23.79879
	Western Wind				
Turbine	PSR11	PSR21	PSR22	PSR27	PSR28
7	8.0309	25.46325	27.30016	8.0309	8.0309
11	8.0309	26.47329	25.15683	8.0309	8.0309
12	8.0309	29.72533	29.12145	8.0309	8.0309
21	8.939476	8.497611	8.367887	30.29102	27.14703
24	9.458898	8.338968	8.234386	29.23465	25.1467
27	10.09599	8.0309	8.0309	26.37661	22.94005
29	9.304193	8.0309	8.0309	30.50677	26.67975
34	8.0309	8.0309	8.0309	21.92989	27.97015
35	8.325719	8.0309	8.0309	23.39578	26.76733
	Eastern Wind				
Turbine	PSR11	PSR21	PSR22	PSR27	PSR28
18	29.99974	8.0309	8.0309	8.995622	8.650614
23	10.0894	8.0309	8.0309	30.6367	30.29909
26	29.82142	8.0309	8.0309	9.556349	9.060085
32	9.144215	8.0309	8.0309	24.63085	28.40957
33	9.345312	8.0309	8.0309	26.1429	28.58699
34	9.758401	8.0309	8.0309	27.59965	27.97015

Heritage Western Cape RoD .... DEA Ref No: .12/12/20/1582..

PALAEONTOLOGICAL IMPACT ASSESSMENT

(Desktop Study)

PROPOSED RHEBOKSFONTEIN WIND ENERGY FACILITY NEAR DARLING

Malmesbury District, Western Cape

By

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For

Moyeng Energy (Pty) Ltd

10 September 2010

SUMMARY

This assessment has been prepared at the request of Savannah Environmental (Pty) Ltd. It is the part of the Heritage Impact Assessment in the EIA process being undertaken by Savannah Environmental for their client, Moyeng Energy (Pty) Ltd. The context of the assessment is the proposed construction of a wind energy facility (WEF, a wind farm), called Rheboksfontein Wind Energy Facility, on various farm portions near Darling in the Malmesbury Magisterial District, Swartland Municipality, Western Cape (Figure 1).

It is possible that palaeontological materials (fossils) will be uncovered in the making of excavations for the foundation of the wind turbines, the connecting cable trenches and other facilities. The National Heritage Resources Act (NHRA No. 25 of 1999) protects archaeological and palaeontological materials. Note that sampling of fossil content (palaeontological mitigation) cannot usually be done prior to the commencement of excavations. The action plans and protocols for palaeontological mitigation must therefore be included in the Environmental Management Plan (EMP) for the project.

The geological context of the area is reviewed in order to assess the nature of the expected palaeontological heritage resources. Notwithstanding, it is not possible to predict the buried fossil content of an area other than in general terms. In particular, the important fossil bone material is generally sparsely scattered in most deposits and much depends on spotting this material as it is uncovered during digging *i.e.* by monitoring excavations.

The foundation excavations for the ~80 planned wind turbines are to be 15 by 15 m and up to 4 m deep. The proposed positions of the installations (Figure 5) are all on the various granites of the Darling Batholith. These granite hills, with a thin mantle of ploughed Q2 sandy soils, have a low fossil potential. Notwithstanding, fossils may occur in particular circumstances, such as buried crevices and small ravines that may be exposed by removal of the surface soil. The Q1 coversand area in the southwestern corner, where higher fossil potential resides, has been avoided. Although the fossil potential is overall low, the installations involve the disturbance of a considerable volume of deposits, increasing the probability that fossils will be encountered.

Fossils have national and international significance; examples of some significant sites exposed beneath coversands are cited. They are rare objects, particularly vertebrate fossils (bones), which are generally preserved due to unusual circumstances. They have high scientific value. Such fossils are non-renewable resources. Provided that no subsurface disturbance occurs, the fossils remain sequestered there. Excavations into the coastal plain provide access to the hidden fossils and are potentially positive for palaeontology, but only if every effort is made to watch out for and rescue the fossils. Even so, there is a medium to high risk of valuable fossils being lost in spite of management actions to mitigate such

loss. Machinery may destroy fossils, or they may remain be hidden in "spoil" of excavated material, or may simply be ignored. This loss of the opportunity to recover fossils and their contexts when exposed at a particular site is irreversible. The status of the potential impact for palaeontology is not neutral or negligible.

Summary Impact Table

<table>
<tr><td colspan="3">Nature

Construction activities (excavations) may result in a negative direct impact on the fossil content of the affected subsurface. Fossils and significant observations will be lost in the absence of management actions to mitigate such loss. This loss of the opportunity to recover them and their contexts when exposed at a particular site is irreversible.

Conversely, construction excavations furnish the "windows" into the coastal plain depository that would not otherwise exist and thereby provide access to the hidden fossils. The impact is positive for palaeontology, <u>provided that efforts are made to watch out for and rescue the fossils</u>.

There remains a medium to high risk of valuable fossils being lost in spite of management actions to mitigate such loss.</td></tr>
<tr><td><u>Impact on Fossil Resource</u></td><td>Without mitigation</td><td>With mitigation</td></tr>
<tr><td>Extent</td><td>3-5 (regional-international)</td><td>3-5 (regional-international)</td></tr>
<tr><td>Duration</td><td>5 (permanent loss)</td><td>5 (part loss, part gain, perm.)</td></tr>
<tr><td>Magnitude</td><td>10 (destruction)</td><td>6 (partly rescued)</td></tr>
<tr><td>Probability</td><td>3</td><td>3</td></tr>
<tr><td>Significance</td><td>54-60</td><td>42-48</td></tr>
<tr><td>Status</td><td>Negative</td><td>Positive</td></tr>
<tr><td>Reversibility</td><td>Irreversible</td><td>Irreversible</td></tr>
<tr><td>Irreplaceable loss of</td><td>Yes</td><td>Partly</td></tr>
</table>

resources?		
Can impacts be mitigated?	Partly	
Mitigation:	Monitoring and inspection of construction-phase excavations	

The potential impact has a moderate influence upon the proposed development, consisting of implemented mitigation measures recommended below, to be followed during the construction phase.

Monitoring by on-site personnel and field inspections by a palaeontologist are recommended during construction of excavations.

Monitoring's purpose is intervention when bones are turned up during excavation. Fossil Finds Procedures are proposed for the appropriate responses to the discovery of paleontological materials during construction excavations when a palaeontologist is not on site.

Inspection or "Primary Fieldwork" will arise in response to finds of fossils during monitoring. The primary fieldwork entails the specialist documentation and sampling of pits, to establish their stratigraphic and palaeoenvironmental contexts of finds in the specific pits. Whether fossils are found or not, it is recommended that a representative selection of pits in the area be described/documented.

The greater risk to fossil material exists in the lower-lying areas. The proposed wind turbines are mainly positioned on higher ground on the flanks and tops of the hills (Figure 5). This serves to minimise the risk of encountering fossils. A more precise mitigation plan can be formulated once the installation sites are finalized.

GLOSSARY

~ (tilde): Used herein as “approximately” or “about”.

Aeolian: Pertaining to the wind. Refers to erosion, transport and deposition of sedimentary particles by wind. A rock formed by the solidification of aeolian sediments is an aeolianite.

AIA: Archaeological Impact Assessment.

Alluvium: Sediments deposited by a river or other running water.

Archaeology: Remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years, including artefacts, human and hominid remains and artificial features and structures.

asl.: above (mean) sea level.

Basement (rock): The thick foundation of ancient and oldest metamorphic and igneous rock that forms the crust of continents, often in the form of granites and gneisses.

Batholith: A large, intrusive mass of cooled magma forming a complex of related, adjacent granitic rocks.

Bedrock: Hard rock formations underlying much younger sedimentary deposits.

Calcareous: sediment, sedimentary rock, or soil type which is formed from or contains a high proportion of calcium carbonate in the form of calcite or aragonite.

Calcrete: An indurated deposit (duricrust) mainly consisting of Ca and Mg carbonates. The term includes both pedogenic types formed in the near-surface soil context and non-pedogenic or groundwater calcretes related to water tables at depth. Pedogenic types exhibit the micro-morphological features of soils, often include fossil roots (rhizoliths) and form by evapo-transpiration in semi-arid regions. Subdivisions are usually made on the basis of degree and type of cementation (*e.g*. powder, nodular, honeycomb, laminar and massive/hardpan).

Cenozoic: An Era in the Geological Time Scale. The most recent era ongoing since about 65 million years ago.

Colluvium: Hillwash deposits formed by gravity transport downhill. Includes soil creep, sheetwash, small-scale rainfall rivulets and gullying, slumping and sliding processes that move and deposit material towards the foot of the slopes.

Coversands: Aeolian blanket deposits of sandsheets and dunes.

DWAF: Department of Water Affairs and Forestry. (Now the Department of Water and Environmental Affairs (DWEA).

Early Stone Age: The archaeology of the Stone Age between 2 000 000 and 250 000 years ago.

EIA: Environmental Impact Assessment.

EMP: Environmental Management Plan.

Fluvial deposits: Sedimentary deposits consisting of material transported by, suspended in and laid down by a river or stream.

Fm.: Formation.

Fossil: Mineralised bones of animals, shellfish, plants and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

Heritage: That which is inherited and forms part of the National Estate (Historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999).

HIA: Heritage Impact Assessment.

ka: Thousand years or kilo-annum (10^3 years). Implicitly means "ka ago" *i.e*. duration from the present, but "ago" is omitted. The "Present" refers to 1950 AD. Generally not used for durations not extending from the Present. Sometimes "kyr" is used instead.

Late Stone Age: The archaeology of the last 20 000 years associated with fully modern people.

Ma: Millions years, mega-annum (10^6 years). Implicitly means "Ma ago" *i.e.* duration from the present, but "ago" is omitted. The "Present" refers to 1950 AD. Generally not used for durations not extending from the Present.

Midden: A pile of debris, normally shellfish and bone that have accumulated as a result of human activity.

Middle Stone Age: The archaeology of the Stone Age between 20-300 000 years ago associated with early modern humans.

Miocene: Epoch in the Geological Time Scale, from 23-5 Ma.

National Estate: The collective heritage assets of the Nation.

Optically stimulated luminescence (OSL): One of the radiation exposure dating methods based on the measurement of trapped electronic charges that accumulate in crystalline materials as a result of low-level natural radioactivity from U, Th and K. In OSL dating of aeolian quartz and feldspar sand grains, the trapped charges are zeroed by exposure to daylight at the time of deposition. Once buried, the charges accumulate and the total radiation exposure (total dose) received by the sample is estimated by laboratory measurements. The level of radioactivity (annual doses) to which the sample grains have been exposed is measured in the field or from the separated minerals containing radioactive elements in the sample. Ages are obtained as the ratio of total dose to annual dose, where the annual dose is assumed to have been similar in the past.

Palaeontology: The study of any fossilised remains or fossil traces of animals or plants which lived in the geological past and any site which contains such fossilised remains or traces.

Palaeosol: An ancient, buried soil whose composition may reflect a climate significantly different from the climate now prevalent in the area where the soil is found. Burial reflects the subsequent environmental change.

Palaeosurface: An ancient land surface, usually buried and marked by a palaeosol, but may be exhumed by erosion (*e.g*. wind erosion/deflation) or by mining.

Peat**:** partially decomposed mass of semi-carbonized vegetation which has grown under waterlogged, anaerobic conditions, usually in bogs or swamps.

Pedogenesis/pedogenic: The process of turning sediment into soil by chemical weathering and the activity of organisms (plants growing in it, burrowing animals such as worms, the addition of humus etc).

PIA: Palaeontological Impact Assessment.

Pleistocene: Epoch , from 2.6 Ma to 11.7 ka.

Pliocene: Epoch in the Geological Time Scale, from 5.3-2.6 Ma.

Quaternary: Period in the Geological Time Scale that includes both the Pleistocene and Holocene, *i.e.* 2.6 Ma to the present.

SAHRA: South African Heritage Resources Agency.

Stone Age: The earliest technological period in human culture when tools were made of stone, wood, bone or horn. Metal was unknown.

w.r.t.: with respect to.

1. INTRODUCTION

This assessment has been prepared at the request of Savannah Environmental (Pty) Ltd. It is the part of the Heritage Impact Assessment in the EIA process being undertaken by Savannah Environmental for their client, Moyeng Energy (Pty) Ltd.

The context of the assessment is the proposed construction of a wind energy facility (WEF, a wind farm), called Rheboksfontein Wind Energy Facility, on various farm portions near Darling in the Malmesbury Magisterial District, Swartland Municipality, Western Cape (Figure 1).

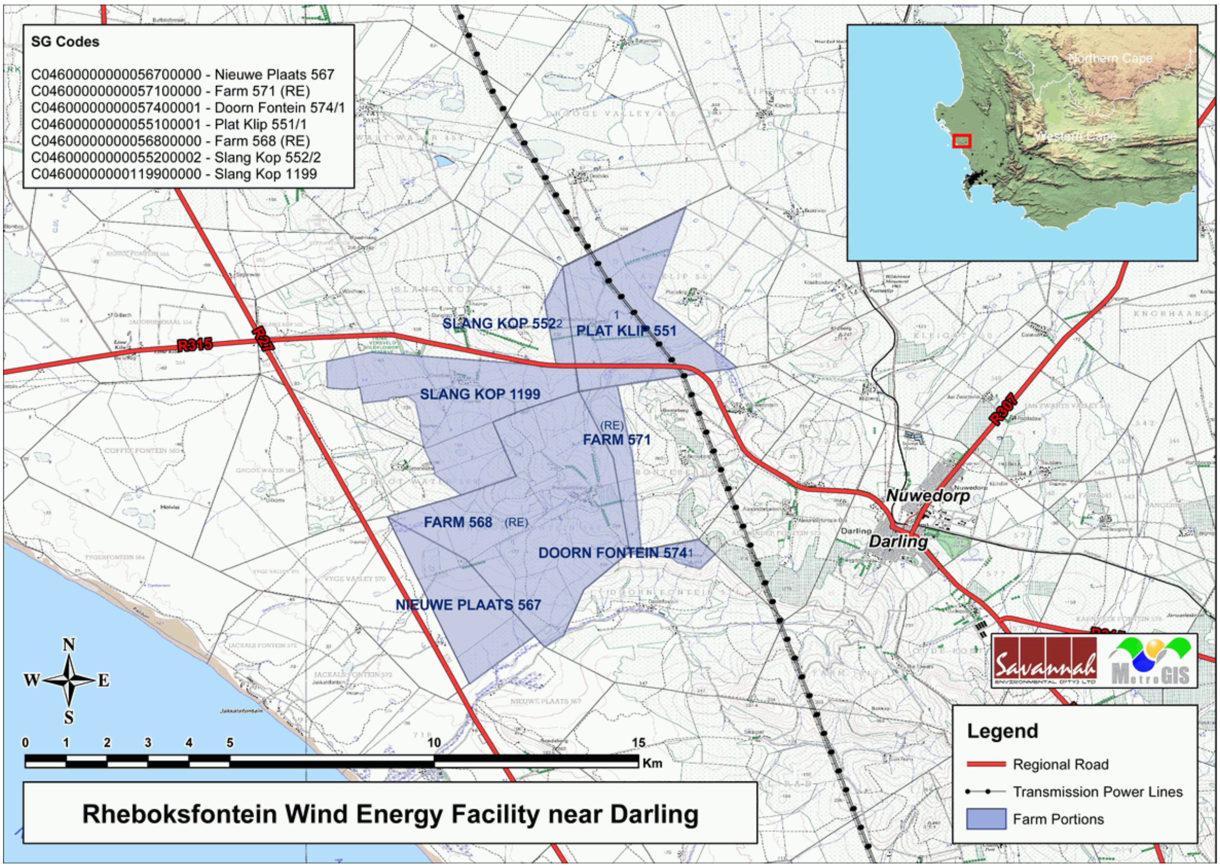

Figure 1. Location of the farm portions for the Rheboksfontein Wind Energy Facility proposed by Moyeng Energy (Pty) Ltd, near Darling. Supplied by Savannah Environmental.

The proposed development will involve the installation of up to 80 wind turbines on concrete foundations, underground cabling to substations and a power line to the national grid network into which the generated electricity will feed. Also involved are existing road upgrades, new access roads, temporary construction-related areas and operational facilities.

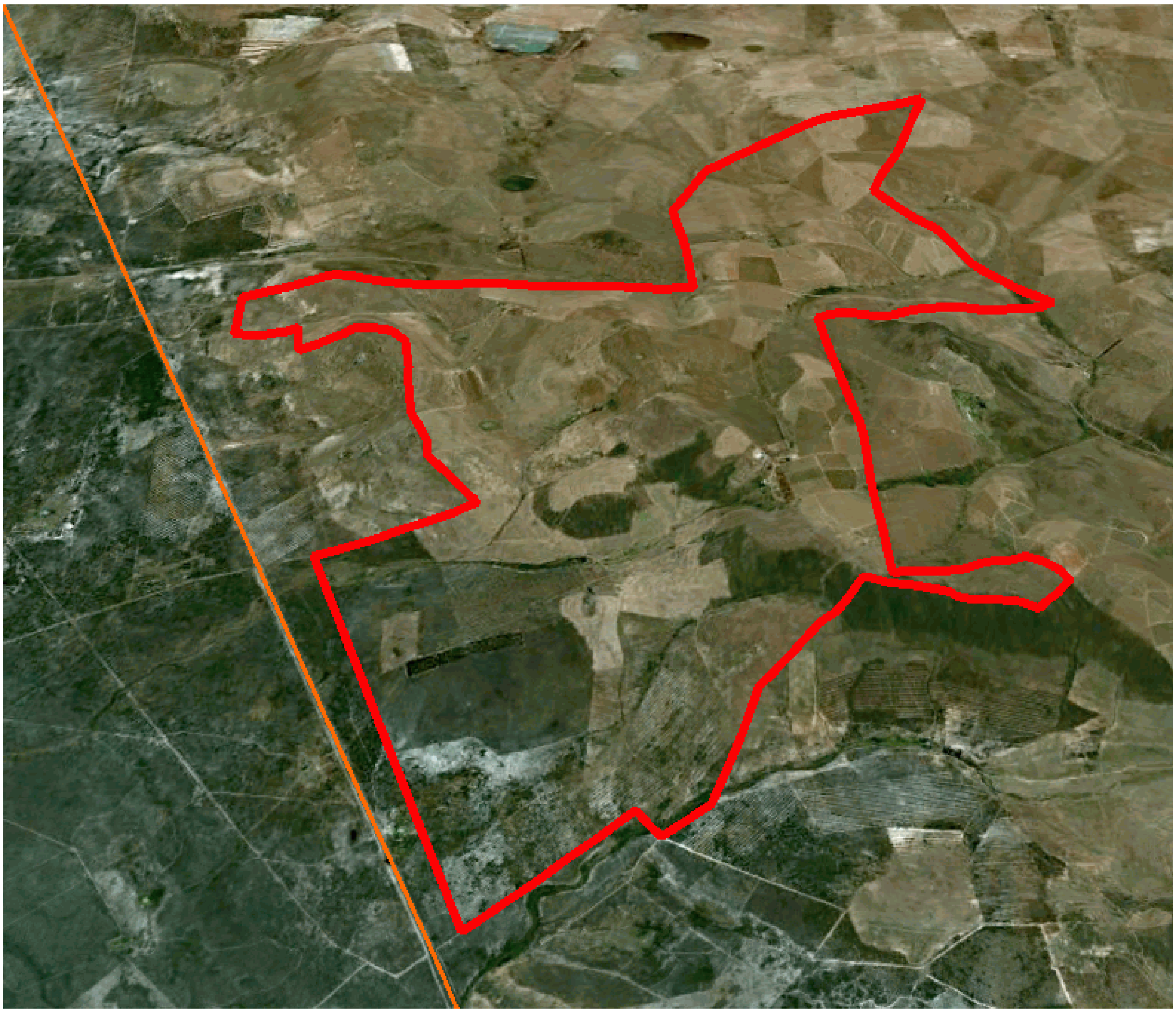

Figure 2. Simulated oblique aerial view of the setting of the proposed Rheboksfontein Wind Energy Facility, looking from the south. From Google Earth.

The Palaeontological Impact Assessment (PIA) assesses the probability of palaeontological materials (fossils) being uncovered in the subsurface and being disturbed or destroyed in the process of making excavations. The main purposes are to:

- Outline the nature of possible palaeontological heritage resources in the subsurface of the affected area.
- Suggest the mitigatory actions to be taken with respect to the occurrence of fossils during the construction phase.

The report proposes appropriate responses and procedures for fossil finds during the making of construction excavations when a palaeontologist is not on site.

2. APPROACH AND METHODOLOGY

2.1 Available Information

The main information for the area is Visser & Schoch (1973) and the accompanying geological map, the relevant part of which is reproduced as Figure 3. Other references are cited in the normal manner and included in the References section.

2.2 Assumptions and Limitations

It is not possible to predict the buried fossil content of an area other than in general terms. In particular, the important fossil bone material is generally sparsely scattered in most deposits and much depends on spotting this material as it is uncovered during digging *i.e.* by monitoring excavations.

The premininary layout of the 80 installations has been provided by Moyeng Energy (Figure 5). The concrete foundations are to be 15X15 m slabs up to 4 m thick. This will create subsurface sections of ~60 m and ~4 m in lateral and vertical extents, respectively.

Specific details of geological sections in the area are not readily available. The most likely source of subsurface information would be water boreholes logged during investigations by the Dept. of Water Affairs, but these contain just very basic lithological information. No subsurface geotechnical investigation reports of the site are available.

3. PALAEONTOLOGICAL HERITAGE MANAGEMENT

The rescue of fossils or sampling of fossil content (palaeontological mitigation) cannot usually be done prior to the commencement of excavations for infrastructure and foundations.

Although fossils may be exposed on the surface in the vicinity of some of the sites, this material is usually disturbed and fragmentary. In most cases, such surficial or shallowly-buried material is in an archaeological context, to be dealt with by qualified archaeologists. The intent of palaeontological mitigation is to sample the *in situ* fossil content and describe the exposed, pristine stratigraphic sections. These palaeontological interventions thus happen once the EIA process is done, the required approvals have been obtained and excavation of the pits is proceeding.

The action plans and protocols for palaeontological mitigation must therefore be included in the Environmental Management Plan (EMP) for the project.

Palaeontological mitigation is a longer-term process and generally does not *a priori* impede a project. It is possible that during the course of works an exceptional occurrence could be uncovered that may require a more extended mitigation programme or perhaps conservation *in situ*. In the case of a wind farm, the latter events could be accommodated by the relocation of the tower a short distance off, or the rerouting of a trench.

4. GEOLOGICAL SETTING

4.1. Local Geology

The Rheboksfontein WEF project area is situated mainly on higher ground west of Darling on the northern part of the Darling Batholith of the Cape Granite Suite (Figures 2-4). . These have been eroded to form gently-rounded hills and ridges with scattered rock outcrops, separated by small, ephemeral streams and some larger drainages fed by headwater springs or seeps. The land use of the area is reflected in contour-ploughed hillsides and is presumably mainly wheat fields and fodders grown on the mostly thin soil that mantles the granite.

In the west, the inner edge of the coastal plain is defined by the granite hills rising gently from ~80 m asl. up to ~200 m asl. A broad ridge of high ground, with summits near 300 m asl., forms a watershed extending from Bakenkop (315 m asl.) in the southeast across the central-east part of the area. A larger drainage has its headwater streams rising on the western flank of the ridge and its course extends to the coast. The other larger drainage rises from the eastern flank and extends north and then eastward, to exit the area in the northeast, where its valley elevation is ~100 m sal. In the south, streams draining the south-facing flanks of Bakenkop ridge flow down to join the Dwarsrivier.

The only part of the project area where coastal-plain deposits potentially reside is in the southwest (Figure 3), where they are concealed beneath geologically-recent, pale windblown sands (Unit Q1).

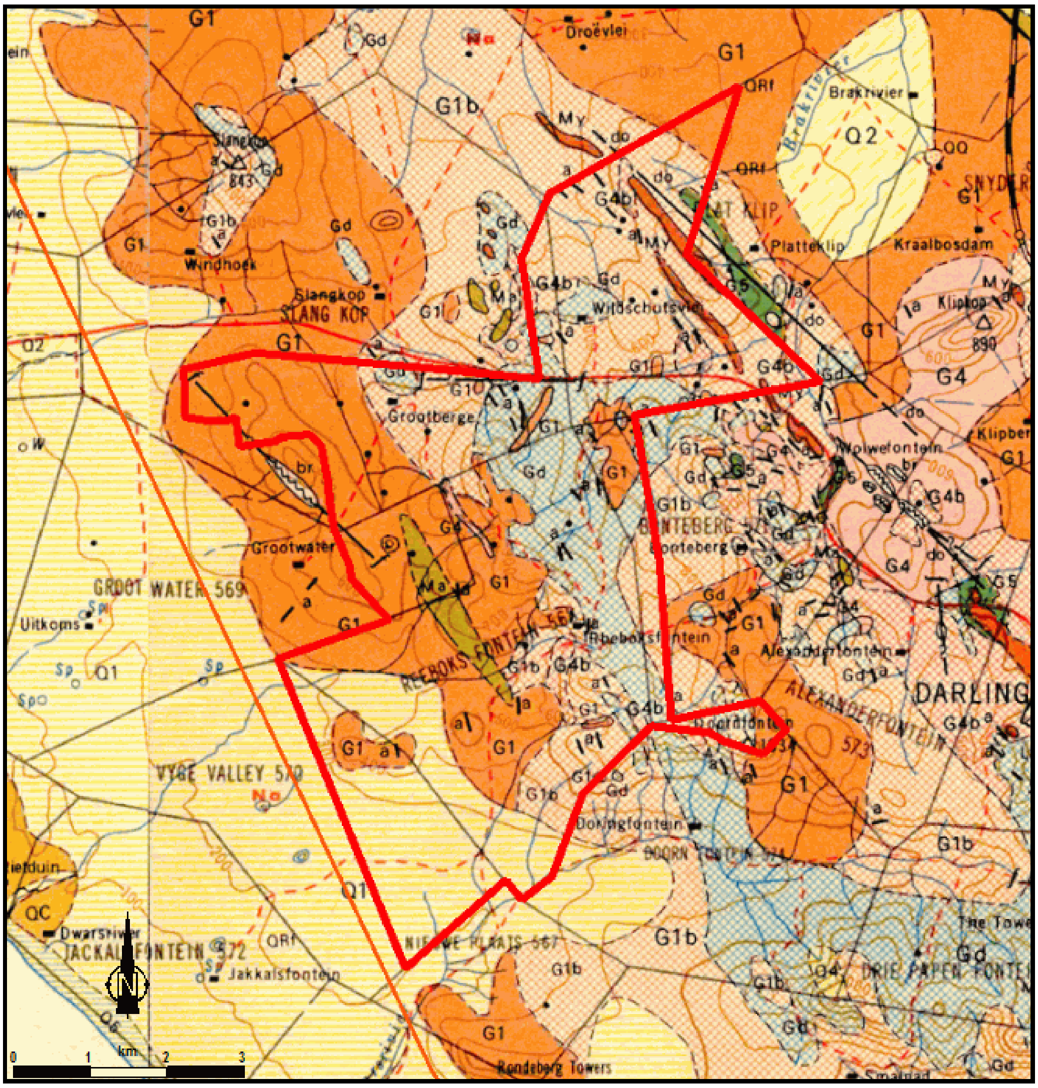

Figure 3. Geology of the project area. From Visser & Schoch (1972), 1:125000 Map Sheet 255: 3217D & 3218C (St Helenabaai), 3317B & 3318A (Saldanhabaai). Contours 100 feet interval.

Q1: A widespread surface unit is the recent soil-unit Q1, white to slightly-reddish sandy soil, which is mainly stabilized sand sheet and locally old dunes blanketing the underlying geology.

Q2: An older surface soil-unit Q2, shallow sandy soil with heuweltjies (heuweltjiesveld), occurs inland the coast. Incipient calcretes occur in Q2. It overlies the Langebaan "Limestone" Formation.

QC: The **Langebaan "Limestone" Formation**, aeolianite Unit QC, consists of fossil dunes and sandsheets. It is underlain mainly by marine deposits of Pliocene age (Varswater & Uyekraal fms). Closer to the coast, Quaternary beach deposits are interbedded in the aeolianites.

G1 - G4: Various granites of the **Darling Batholith** (Contreberg, Darling Rondeberg & Klipberg granites).

Ma: **Malmesbury Group** metasediments. A floating island/raft of “undigested” sediments.

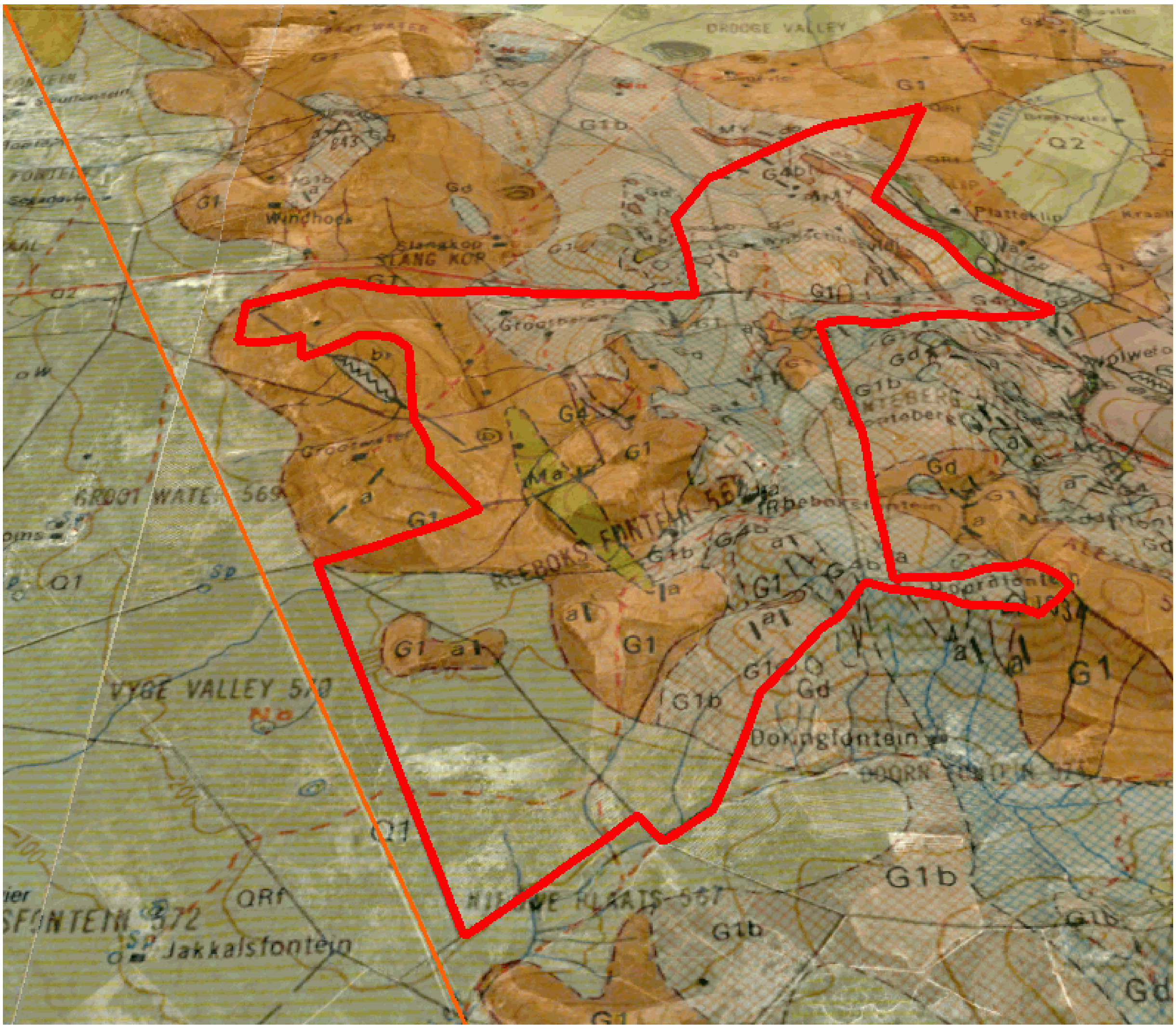

Figure 4. Geology of the project area, 3D overlay in Google Earth.

The oldest Cenozoic fossiliferous marine deposits found on the coastal plain are of mid-Miocene age ~16 Ma. These deposits now occur up to about 100 m asl., but are poorly preserved. In this area they have been eroded away and there is little evidence of this time when the sea lapped against the granite hills.

Subsequent early Pliocene palaeoshoreline deposits (5-4 Ma) are found below ~50 m asl. (Pether *et al.*, 2000). In the southwestern Cape, these marine deposits are collectively known as the **Varswater Formation**. For the most part, the Varswater Fm. is concealed beneath Langebaan Fm. aeolianites, but its distribution is known from boreholes. The type locality is at the West Coast Fossil Park, where the extensive vertebrate assemblage recovered from the phosphate quarry indicates the early Pliocene age (Hendey, 1981).

During the early Pliocene the coastal plain was submerged to a level now at ~50 m asl. and the high shoreline was near the granite hills, across a narrow coastal plain formed on the earlier Miocene deposits. When sea level later receded, fossiliferous shallow-marine deposits of the Varswater Formation were left mantling the emerged coastal plan. Sea level rose again in the middle Pliocene (~3.4 Ma) to a level now ~30 m asl. When sea level receded again, the Uyekraal Formation "Shelly Sands" were deposited as the shorelines prograded seawards to form the lower, outer part of the coastal plain.

The **Langebaan Formation** overlies these marine deposits and most visibly includes the ridges and mounds of old calcareous aeolianites (dune sandstones), beneath a capping calcrete crust, that are evident in the coastal landscape (Figure 3, deep yellow, QC). Previously called the "Langebaan Limestones", much of the sand is tiny fragments of shell and was blown off (deflated) from beaches. The cementing of this "calcarenite" is generally quite weak, but much denser cementing has taken place in the uppermost part of the fossil dunes in the shape of a "carapace" or capping of calcrete. The calcrete is a type of soil called a pedocrete, formed in the near-surface by evapo-transpiration after the dunes became inactive and were vegetated.

The "Langebaan Limestones" contain further calcretes and leached *terra rosa* soils at depth, attesting to reduced rates of sand accumulation, with soil formation showing the surface stability. The aeolianites overlie wind-deflation erosion surfaces formed on the underlying marine deposits, *i.e.* the Varswater and Uyekraal formations. At this stage the Langebaan Fm. includes various aeolianites of different ages and is an "amalgam" of the dune plumes that formed on the coastal plain, at differing places and times, mainly during the last ~5 Ma (Pliocene to the late Pleistocene). This is reflected in the different ages indicated from fossils found at various places. For example, a late Pliocene or younger age (Diazville lower quarry, Roberts & Brink, 2002), early Pleistocene (Skurwerug, Hendey & Cooke, 1985), middle and late Pleistocene ages are indicated by relationships to Last Interglacial (~125 ka) and earlier shoreline deposits and by dating of aeolianites by luminescence methods (Roberts *et al.*, 2009).

Some aeolianite accumulations could be distinctly older. For instance, the aeolianite ridge stretching north from Saldanha Bay up the coast to near Paternoster has been found to have fossil eggshell fragments of extinct ostriches (*Diamantornis wardi*) and extinct land snail forms (Roberts & Brink, 2002). *Diamantornis wardi* is dated as mid-Miocene (10-12 Ma) in the Namib Desert (Senut & Pickford, 1995). These aeolianites, previously considered to belong to the Langebaan Formation, are now called the **Prospect Hill Formation** (Figure 4) due to the significantly older age indicated by the fossils (Roberts & Brink, 2002).

However, the matter is not clear cut as sand-size marine microfossil species, blown from the ancient beaches of the time, suggest that the dunes formed by deflation of younger Pliocene deposits (Dale & McMillan, 1999).

None of the aforementioned formations crop out in the project area. The marine formations are buried, but the Langebaan Formation aeolianites are exposed at the coast (Figure 3, QC).

Developed on the granite hills is the most extensive surface unit, **Unit Q2**. On the granite hills Unit Q2 is just a soil mantle and so is ignored for the purposes of geological mapping (Figure 3); it is mapped where there is an underlying thickness of deposits post-dating the Langebaan "Limestone" aeolianites. Unit Q2 is characterized by its surface manifestation as the distinct "heuweltjiesveld", the densely dot-patterned landscape of low hillocks that are termitaria made by *Microhodotermes viator*. Although the termitaria are not everywhere is densely-distributed as at the West Coast One WEF project area, inspection of aerial images show they are ubiquitous.

"Heuweltjies" are longed-lived features that are persistently inhabited by generations of termites. They occur in a background of light reddish-brown, sandy soil, but they have internal calcretes due to enrichment in calcium by the plant-gathering activity of the termites. Radiocarbon dating by of the calcrete in an actively inhabited example near Clanwilliam suggests that it had been in existence for at least 4000 years (Moore & Picker, 1991). Notwithstanding, it seems that over large areas the termitaria are inactive and are now "fossil" features in the landscape.

The dot-patterned "heuweltjiesveld" is merely the surface-soil characteristic of Unit Q2. Unit Q2 will underlie Q1 under the lower ground in the southwestern project area (Figures 3 & 4).

Not much detail is known about Unit Q2 at depth (sub-Q2). Pedogenic layers of ferruginous concretions, clayey beds and minor calcretes occur among sandy-soil beds. Clearly Q2 will differ from place to place according to the local setting. In this area, in addition to windblown sands from the south, Q2 will likely comprise the local colluvial/hillwash/sheetwash deposits, small slope-stream deposits, alluvium in the lower valleys and wind-reworked local alluvial and colluvial sands.

Surface **Unit Q1** is the youngest geological unit and is "white to slightly-reddish sandy soil" (Visser & Toerien, 1971; Visser & Schoch, 1973). These are patches of pale sand deposited in geologically-recent times. In places these sands are undergoing semi-active transport and locally have been remobilized into active sandsheets and dunes. Visser & Schoch (1973) consider the sands to be largely derived from older, underlying Q2 sands and to a lesser extent from the erosion of bedrock, the coastal dunes and the alluvial deposits of past and present drainage systems. Unit Q1 entirely covers the lower ground in the southwestern project area (Figures 3 & 4).

Chase & Thomas (2007) have cored Q1 sands and applied optically stimulated luminescence (OSL) dating techniques to establish the timing of sand accumulation. Their results indicate several periods of deposition of Q1 during the last 100 ka, with activity/deposition at 4–5, 16–24, 30–33, 43–49 and 63–73 ka. Underlying sands produced dates from ~150 to ~300 ka, evidently reflecting the accumulation of Unit Q2.

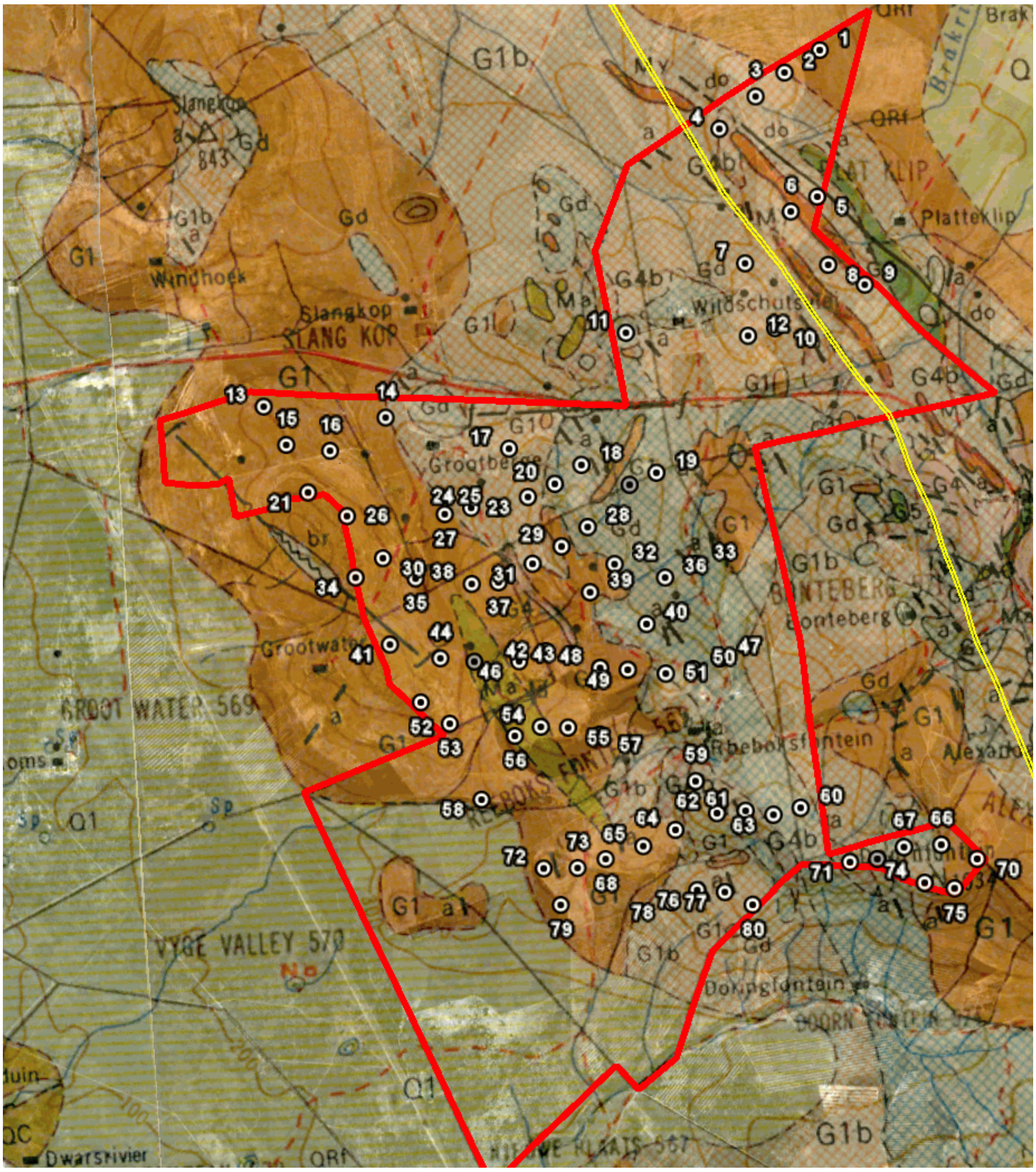

Figure 5. Proposed locations of the 80 wind turbines.

4.2. Expected Palaeontology

Unit Q2 will be intersected on the granite hills, where most of the installations are to be (Figure 5). The foundation excavations will in most cases fully penetrate thin Q2 soil to the granite bedrock. Presumably the latter will be excavated to "refusal", *i.e.* solid, unweathered bedrock. The overall potential for fossils in the disturbed soil mantle is very low. Notwithstanding, the excavations may expose buried crevices and "gullies" in the granite slopes where the potential for fossil finds is locally high. These may be associated with deposits of seeps and small vleis at the headwaters of drainages.

The subsurface unit Q2 will thicken downslope off the granite hills. Thicknesses of colluvium and alluvium will occur in the larger valleys of the area. Both colluvial and alluvial sediments will interfinger with aeolian deposits. Again, the fossil potential is overall low. Alluvial deposits of small fluvial systems also will feature and extend out onto the coastal plain. Associated with these may be terminal or pooled vleis and pans.

No installations are positioned directly on the Q1 coversand area in the southwestern corner, where there is a higher risk of fossil occurrences.. Here excavations will likely penetrate through to Unit Q2. Under the Q2 surface are likely to be older aeolian sandsheets and deposits related to colluvial processes and drainages extending from the flanking hillslopes. Older aeolianites of the Langebaan Formation might be intersected beneath the Q2 unit.

4.2.1. Fossils in aeolian settings

Not unexpectedly, the most common fossils in dunes and sandsheets are land snail shells, tortoise shells/bones and the bones of moles. Less easily seen, but obtainable by sieving, are the bones of rodents, small birds and reptiles. These fossils may occur anywhere, but are scarce within the main bulk of dune and coversands. Fossils are more common on old buried surfaces, called palaeo-surfaces, that separate periods of sand accumulation, when the surface was stabilized and colonized by vegetation and animals. The causes of diminished sand supply are inter-related factors of climate change, such as changes in windiness, rainfall and sand availability. Palaeosurfaces are marked by various degrees of soil formation. The main palaeosurface is beneath Q1, *i.e*. the top of Unit Q2. Lesser palaeosurfaces may occur in Q1 and are expected within sub-Q2 and at its base on the Langebaan aeolianite.

Fossil bones of larger animals (antelopes, ostriches, jackals, porcupines) usually occur very sparsely on palaeosurfaces over a broad area. In many cases these appear to be isolated finds, but what appears to be a single bone may lead to further finds at the spot, such as a scatter of bones accumulated by hyaenas, which may include quite a variety of animals.

Hyaena bone concentrations are also found in the holes made by aardvarks, which the hyaena has taken over to use as a lair.

Although fossils in aeolian accumulations are more common in association with longer-lived, more-stable surfaces, the best concentrations of fossils are formed where the wind scours away and removes previously-deposited sand, producing a scoop-shaped palaeosurface called a "blowout". The fossils that were sporadically distributed within the sands are then concentrated on the bottom of the "deflation" blowout. A concentration of snail shells is a clue indicating that a closer look may be worthwhile.

Large hollow areas created by wind erosion blowout may subsequently become a pond of standing water, due to increased rainfall, lack of a drainage outlet and rising local water table. This occurs on a variety of scales, from a mere small boggy area, an ephemeral pan, to vleis of longer duration.

4.2.2. Fossils in vleis

Vleis occur where groundwater seepage surfaces and these preserve a great variety of fossil material. As local sources of water, they attract the larger herbivores from the surrounding area, their predators and scavengers and thus become a spot where fossils occur. There is the fossil record of the pond/vlei life itself, a lot of which also turns up rather mysteriously, like the frogs, aquatic snails and small fish. The best bet is for their eggs being inadvertently brought in by birds, a sample of which are also entombed.

Microfossils include the ostracods (microscopic crustaceans with often very specific requirements) and the diatoms (minute plants with glass shells). More locally, reeds, leaves, fruiting bodies and root masses are preserved in the muds. Ancient ponds and vleis, as natural traps of windborne material, also provide a glimpse of the greater, surrounding vegetation, in the form of pollen capsules from near and far, and windborne charcoal fragments from fires, usually of fairly close origin.

4.2.3. Fossils in watercourses

The drainages descending the flanks of the adjacent hills currently deposit minor alluvium on the plain below. These drainages must have been more active in the past during periods of wetter climate. Very likely there are deposits of these small-scale fluvial systems beneath Q2 coversand/soil. The fossil potential is low, such as abraded bone fragments and loose teeth occurring sparsely in channel lags. However, associated seeps and vleis have good fossil potential, as outlined above.

4.2.4. Buried archaeological material

Ancestral South Africans were around during the times of formation of units Q1 and Q2, as well as the younger parts of the Langebaan Fm. Thus it is perfectly possible that some of the bones found in the sands may be associated with past human activities. This is indicated by the co-occurrence of mussel and limpet shells, stone tools, pottery and charcoal from cooking hearths. Archaeological material and bones are often exposed where blowouts have formed, due to loss of vegetation and disturbance. Middle Stone Age implements and associated fossil bone are found on the upper part of Unit Q2.

5. APPLICABLE LEGISLATION

The National Heritage Resources Act (NHRA No. 25 of 1999) protects archaeological and palaeontological sites and materials, as well as graves/cemeteries, battlefield sites and buildings, structures and features over 60 years old. The South African Heritage Resources Agency (SAHRA) administers this legislation nationally, with Heritage Resources Agencies acting at provincial level.

According to the Act (Sect. 35), it is an offence to destroy, damage, excavate, alter of remove from its original place, or collect, any archaeological, palaeontological and historical material or object, without a permit issued by the South African Heritage Resources Agency (SAHRA) or applicable Provincial Heritage Resources Agency, *viz*. Heritage Western Cape (HWC).

Notification of SAHRA or the applicable Provincial Heritage Resources Agency is required for proposed developments exceeding certain dimensions (Sect. 38).

6. THRESHOLDS

The areal scale of subsurface disturbance and exposure exceeds 300 m in linear length and 5000 m^2 (NHRA 25 (1999), Section 38 (1)). It must therefore be assessed for heritage impacts (an HIA) that includes assessment of potential palaeontological heritage (a PIA).

For the evaluation of the palaeontological impact it is the extent/scale of the deeper excavations to be made that are the main concern, mainly the foundations for the wind towers, the trenches for connecting cabling and foundation trenches for buildings, latrine pits, dump pits etc.

The wind turbine foundations are square concrete platforms with sides of 15 m in length, sunk about 4 m below ground level. These large excavations are very likely to uncover fossil and archaeological material, particularly as there will be a considerable number of them (~80) positioned over and “sampling” a wide area. Each finished excavation of these maximum dimensions exposes 465 m^2 of subsurface section in its sides and bottom. Much more section is exposed incrementally during the digging of the excavation. For instance, even with partial exposure, well in excess of 1000 m^2 could be temporarily exposed. Thus, in spite of the overall low fossil potential, there is a definite probability that fossils may be exposed in some of the 80 excavations.

The cabling trenches, although probably quite narrow and shallow (~1.0 m deep), are likely to be of considerable length in crossing the area to the substation. This increases the likelihood of fossil and archaeological material being uncovered. The footings of the transmission line pylons that connect to the grid are likely to be minor in scale and have the least likelihood of fossil finds, although not altogether absent.

7. SIGNIFICANCE

Fossil finds in this context stand to have heritage/scientific benefits in increasing the knowledge of the coversands of the coastal plain. The various periods during which the coversand formations (units Q1 and Q2) and the underlying formations (older aeolian sands) were deposited in different areas are not well-constrained by fossil evidence, as very few fossils have been collected/rescued. Only recently has a modern dating method (OSL) been applied at a few localities (Chase & Thomas, 2007; Roberts *et al*., 2009). The coastal plain deposits of the West Coast One area are very poorly known.

Past discoveries show that the fossil potential within and beneath coversands and dunes can be very significant. The most well-studied is Elandsfontein, where blowouts of the coversand exposed thousands of underlying fossil bones and Stone Age tools, the occurrence of which is associated with a fossil vlei formed due to higher water tables in the past (Klein *et al*., 2007). Notably, prior to the wind erosion of coversands at Elandsfontein, there would have been no indication of the fossil wealth just below. At Geelbek Dunefield the deflation hollows located between the wind-blown, actively-mobile sand dunes are a source of mammalian fossils and Stone Age tools, with more being constantly exposed (Kandel *et al*., 2003). An example of fossiliferous deposits in a small-scale fluvial setting, beneath Q2 sands, are those of the old Baard's Quarry near Langebaanweg Station, where the first finds of fossils from that now-famous Langebaanweg locality were made (Tankard, 1974; Hendey, 1978). All these fossil localities have attracted international attention.

Although the 4 m deep excavations involved in the installations are of limited depth *cf*. mine quarries and the fossil potential is low overall, the number of excavations involved increases the probability of fossils being turned up. Mitigation during the construction phase of the proposed project has the potential for further discoveries that stand to have heritage/scientific benefits.

In summary, the significance of fossils that may be found involves:

- Significance in the history of coastal-plain evolution.
- Significance for the history of past climatic changes.
- Significance in the history of past biota and environments. Rescuing of fossil bones is very important. These may not necessarily represent species that we would expect nowadays. Modern analytical techniques such as stable isotopic analyses can reveal indications of diets and environmental conditions of the past.
- Associations of fossils with buried archaeological material and human prehistory.
- For radiometric and other dating techniques (rates of coastal change).
- Preservation of materials for the application of yet unforeseen investigative techniques.

There is a significance to fossils beyond their conventional academic/scientific importance that is more firmly in the realm of cultural aesthetics. Culture is embedded in land/place/animals and fossils are part of the physical strata of the landscape. Fossils inform the appreciation of the space-time depth of landscape and its biota, living and extinct. Such realizations are inspired by encounters with fossils. Ultimately this heritage resource must be rendered known and accessible to the wider community *via* educational programmes emanating from *e.g*. museums, sponsorship, NGOs. The first priority, however, is to rescue fossils and attendant information that would otherwise be lost.

There is a potential positive socio-economic impact to a significant find of fossils. This may be minor and short-term, *e.g*. the local spending involved in labour and supplies for the fieldwork to excavate the find. It may bring long-term benefits, such as the establishment of a local museum and tourist attraction. Corporate involvement in sponsorship of such initiatives is demonstrative of social responsibility.

8. NATURE OF THE IMPACT OF DEVELOPMENT EXCAVATIONS ON FOSSILS

Fossils are rare objects, often preserved due to unusual circumstances. This is particularly applicable to vertebrate fossils (bones), which tend to be sporadically preserved and have high value w.r.t. palaeoecological and biostratigraphic (dating) information. Such fossils are non-renewable resources. Provided that no subsurface disturbance occurs, the fossils remain sequestered there.

When excavations are made they furnish the "windows" into the coastal plain depository that would not otherwise exist and thereby provide access to the hidden fossils. The impact is positive for palaeontology, <u>provided that efforts are made to watch out for and rescue the fossils</u>. Fossils and significant observations will be lost in the absence of management actions to mitigate such loss. This loss of the opportunity to recover them and their contexts when exposed at a particular site is irreversible.

The status of the potential impact for palaeontology is not neutral or negligible.

Although coastal coversands are not generally very fossiliferous, it is quite possible that fossiliferous material could occur. The very scarcity of fossils makes for the added importance of them being sought.

There remains a medium to high risk of valuable fossils being lost in spite of management actions to mitigate such loss. Machinery involved in excavation may damage or destroy fossils, or they may be hidden in "spoil" of excavated material. Worse, they may simply be ignored as "Just another bone".

9. IMPACT ASSESSMENT

9.1. Nature of the Impact

9.1.1. Extents

The physical extent of impacts on potential palaeontological resources relates directly to the extents of subsurface disturbance during construction.

The cultural, heritage and scientific impacts are of regional to national extent, as is implicit in the NHRA 25 (1999) legislation and, if scientifically important specimens or assemblages are uncovered, are of international interest. This is evident in the amount of foreign-funded research that takes place by scientists of other nationalities. Loss of opportunities that may arise from a significant fossil occurrence (tourism, employment) filters down to regional/local levels.

9.1.2. Duration

According with the above, the physical duration of the impact is shorter term (< year) and primarily related to the period over which foundations, trenches and other infrastructural excavations are made. This is the "time window" for mitigation.

Again, the impact of both the finding or the loss of fossils is permanent. The found fossils must be preserved "for posterity"; the lost, overlooked or destroyed fossils are lost to posterity.

9.1.3. Magnitude

Thus the potential impact of construction on fossil resources is high in the absence of mitigation. As mentioned, it is quite likely that scientifically valuable fossils may be lost in spite of mitigation.

9.1.4. Probability

The likelihood of impact is probable and likely to occur under most conditions in this context, *i.e*. it is medium.

9.1.5. Confidence

The level of confidence of the probability and intensity of impact is medium to high.

9.2. Summary table

Nature

Construction activities (excavations) may result in a negative direct impact on the fossil content of the affected subsurface. Fossils and significant observations will be lost in the absence of management actions to mitigate such loss. This loss of the opportunity to recover them and their contexts when exposed at a particular site is irreversible.

Conversely, construction excavations furnish the "windows" into the coastal plain depository that would not otherwise exist and thereby provide access to the hidden fossils. The impact is positive for palaeontology, provided that efforts are made to watch out for and rescue the fossils.

There remains a medium to high risk of valuable fossils being lost in spite of management actions to mitigate such loss.

Impact on Fossil Resource	**Without mitigation**	**With mitigation**
Extent	3-5 (regional-international)	3-5 (regional-international)
Duration	5 (permanent loss)	5 (part loss, part gain, perm.)
Magnitude	10 (destruction)	6 (partly rescued)
Probability	3	3
Significance	54-60	42-48

Status	Negative	Positive
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	Yes	Partly
Can impacts be mitigated?	Partly	
Mitigation:	Monitoring and inspection of construction-phase excavations	

10. RECOMMENDATIONS

The potential impact has a moderate influence upon the proposed development, consisting of implemented mitigation measures recommended below, to be followed during the construction phase.

Monitoring by on-site personnel and field inspections by a palaeontologist are recommended during construction of excavations.

10.1. Monitoring

OBJECTIVE: To see and rescue fossil material that may be exposed in the various excavations made for installation foundations and cabling.	
Project components	Foundation excavations for wind turbines. Foundation excavations for substations. Trenches for cabling linking turbines and substations. Spoil from excavations.
Potential impact	Loss of fossils by their being unnoticed and/ or destroyed.
Activity/ risk source	All bulk earthworks.
Mitigation: target/	To facilitate the likelihood of noticing fossils and ensure

objective	appropriate actions in terms of the relevant legislation.	
Mitigation: Action / control	**Responsibility**	**Timeframe**
Inform staff of the need to watch for potential fossil occurrences.	Moyeng, Savannah, ECO, contractors.	Pre-construction.
Inform staff of the procedures to be followed in the event of fossil occurrences.	ECO/specialist.	Pre-construction.
Monitor for presence of fossils	Contracted personnel and ECO.	Construction.
Liaise on nature of potential finds and appropriate responses.	ECO and specialist.	Construction.
Inspect main finds and selected, higher-risk excavations	Specialist.	Construction.
Obtain permit from HWC for finds.	Specialist.	Construction
Performance Indicator	Reporting of and liaison about possible fossil finds. Fossils noticed and rescued.	
Monitoring	Due effort to meet the requirements of the monitoring procedures.	

As outlined above, the potential for finding important fossils, although low, is not altogether lacking. Interventions are particularly required if bones are turned up during excavation.

These are rare and valuable and every effort should be made to spot them and effect rescue of them.

Below are proposed procedures in the event of discovery of fossil material. They are of a general nature, to be adapted according to feasibility w.r.t. the logistics and personnel.

It is quite likely that a continuous monitoring presence over the period during which excavations are made, by either an archaeologist or palaeontologist, will not be practical. It is therefore proposed that personnel involved in the making of excavations keep a lookout for fossil material during digging.

To this end, responsible persons must be designated. This will include hierarchically:

- The field supervisor/foreman, who is going to be most often in the field.
- The Environmental Control Officer (ECO) for the project.
- The Project Manager.

The field supervisor/foreman and workers involved in digging excavations must be informed of the need to watch for fossil bones and buried potential archaeological material. Workers seeing potential objects are to report to the field supervisor who, in turn, will report to the ECO. The ECO will inform the archaeologist and/or palaeontologist contracted to be on standby in the case of fossil finds.

Should the monitoring of the excavations be a stipulation in the Archaeo-logical Impact Assessment, the contracted Monitoring Archaeologist (MA) can also monitor for the presence of fossils and make a field assessment of any material brought to attention. The MA is usually sufficiently informed to identify fossil material and this avoids additional monitoring by a palaeontologist. In shallow coastal excavations, the fossils encountered are usually in an archaeological context.

The MA then becomes the responsible field person and fulfils the role of liaison with the palaeontologist and coordinates with Moyeng Energyand the Environmental Control Officer (ECO). If fossils are exposed in non-archaeological contexts, the palaeontologist should be summoned to document and sample/collect them.

It may prove more feasible to have a dedicated monitor for exposed archaeological and palaeontological material in the numerous excavations, such person to be trained and supplied with the requisites.

10.2. Fossil Find Procedures

In the context of the sites under consideration, it is improbable that fossil finds will require declarations of permanent "no go" zones. At most a temporary pause in activity at a limited locale may be required. The strategy is to rescue the material as quickly as possible.

The procedures suggested below are couched in terms of finds of fossil bones. However, they may also serve as a guideline for the other fossil material that may occur (see ***10.2.5*** below). Bone finds can be classified as two types: isolated bone finds and bone cluster finds.

10.2.1. Isolated Bone Finds

In the process of digging the excavations, isolated bones may be spotted in the hole sides or bottom, or as they appear on the spoil heap. By this is meant bones that occur singly, in different parts of the excavation. If the number of distinct bones exceeds 6 pieces, the finds must be treated as a bone cluster (below).

Bones may also be spotted when excavated material is spread out to make roads and lay-down areas/pads.

Response by personnel in the event of isolated bone finds

- **Action 1:** An isolated bone exposed in an excavation or spoil heap must be retrieved before it is covered by further spoil from the excavation and set aside.
- **Action 2:** The site foreman and ECO must be informed.
- **Action 3:** The responsible field person (site foreman or ECO) must take custody of the fossil. The following information to be recorded:
    - Position (excavation position).
    - Depth of find in hole.
    - Digital image of hole showing vertical section (side).
    - Digital image of fossil.
- The fossil should be placed in a bag (*e.g.* a Ziplock bag), along with any detached fragments. A label must be included with the date of the find, position info., depth.

- **Action 4:** ECO to inform Moyeng Energy, Moyeng Energy contacts the standby archaeologist and/or palaeontologist. ECO to describe the occurrence and provide images asap. by email.

Response by Palaeontologist in the event of isolated bone finds

The palaeontologist will assess the information and liaise with Moyeng Energy and the ECO and a suitable response will be established.

10.2.2. Bone Cluster Finds

A bone cluster is a major find of bones, *i.e*. several bones in close proximity or bones resembling part of a skeleton. These bones will likely be seen in broken sections of the sides of the hole and as bones appearing in the bottom of the hole and on the spoil heap, or when excavated material is spread out to make roads and lay-down areas/pads.

Response by personnel in the event of a bone cluster find

- **Action 1:** Immediately stop excavation in the vicinity of the potential material. Mark (flag) the position and also spoil that may contain fossils.
- **Action 2:** Inform the site foreman and the ECO.
- **Action 3:** ECO to inform Moyeng Energy, Moyeng Energy contacts the standby archaeologist and/or palaeontologist. ECO to describe the occurrence and provide images asap. by email.

Response by Palaeontologist in the event of a bone cluster find

The palaeontologist will assess the information and liaise with ERM and the ECO and a suitable response will be established. It is likely that a Field Assessment by the palaeontologist will be carried out asap.

It will probably be feasible to "leapfrog" the find and continue the excavation farther along, or proceed to the next excavation, so that the work schedule is minimally disrupted. The response time/scheduling of the Field Assessment is to be decided in consultation with developer/owner and the environmental consultant.

The field assessment could have the following outcomes:

- If a human burial, the appropriate authority is to be contacted (see AIA). The find must be evaluated by a human burial specialist to decide if Rescue Excavation is feasible, or if it is a Major Find.

- If the fossils are in an archaeological context, an archaeologist must be contacted to evaluate the site and decide if Rescue Excavation is feasible, or if it is a Major Find.

- If the fossils are in an palaeontological context, the palaeontologist must evaluate the site and decide if Rescue Excavation is feasible, or if it is a Major Find.

10.2.3. Rescue Excavation

Rescue Excavation refers to the removal of the material from the just the “design” excavation. This would apply if the amount or significance of the exposed material appears to be relatively circumscribed and it is feasible to remove it without compromising contextual data. The time span for Rescue Excavation should be reasonably rapid to avoid any or undue delays, *e.g*. 1-3 days and definitely less than 1 week.

In principle, the strategy during mitigation is to “rescue” the fossil material as quickly as possible. The strategy to be adopted depends on the nature of the occurrence, particularly the density of the fossils. The methods of collection would depend on the preservation or fragility of the fossils and whether in loose or in lithified sediment. These could include:

- On-site selection and sieving in the case of robust material in sand.

- Fragile material in loose/crumbly sediment would be encased in blocks using Plaster-of Paris or reinforced mortar.

If the fossil occurrence is dense and is assessed to be a “Major Find”, then carefully controlled excavation is required.

10.2.4. Major Finds

A Major Find is the occurrence of material that, by virtue of quantity, importance and time constraints, cannot be feasibly rescued without compromise of detailed material recovery and contextual observations.

A Major Find is not expected.

Management Options for Major Finds

In consultation with developer/owner and the environmental consultant, the following options should be considered when deciding on how to proceed in the event of a Major Find.

Option 1: Avoidance

Avoidance of the major find through project redesign or relocation. This ensures minimal impact to the site and is the preferred option from a heritage resource management perspective. When feasible, it can also be the least expensive option from a construction perspective.

The find site will require site protection measures, such as erecting fencing or barricades. Alternatively, the exposed finds can be stabilized and the site refilled or capped. The latter is preferred if excavation of the find will be delayed substantially or indefinitely. Appropriate protection measures should be identified on a site-specific basis and in wider consultation with the heritage and scientific communities.

This option is preferred as it will allow the later excavation of the finds with due scientific care and diligence.

Option 2: Emergency Excavation

Emergency excavation refers to the "no option" situation wherein avoidance is not feasible due to design, financial and time constraints. It can delay construction and emergency excavation itself will take place under tight time constraints, with the potential for irrevocable compromise of scientific quality. It could involve the removal of a large, disturbed sample by excavator and conveying this by truck from the immediate site to a suitable place for "stockpiling". This material could then be processed later.

Consequently, emergency excavation is not a preferred option for a Major Find.

10.2.5. Other Fossil Occurrences

Occurrences of snails

Land snails are usually quite common and usually can be seen on the sides of the excavations, although they might be widely scattered. In which case they can be left for sampling by the palaeontologist during the Inspection/Primary Fieldwork phase. Extinct species and forms of land snails have been recognized from various formations. Many snails are quite specific to particular environments. Aquatic snails occur in the deposits of vleis and watercourses and should occur in distinct beds.

If fossil snails are very sparse they should be captured. Proceed as for "Isolated Bone Finds".

Occurrences of buried layers or lenses of marine shells

A buried archaeological site or midden. Proceed as for “Bone Cluster Finds”.

Occurrences of buried Stone Age artefacts

A buried archaeological site. Proceed as for “Bone Cluster Finds”.

Occurrences of buried logs, peats or coal-like material.

Could be a stream channel or vlei deposit. Proceed as for “Bone Cluster Finds”.

10.3. Inspection

Inspection or “Primary Fieldwork” will arise in response to finds of fossils during monitoring. The primary fieldwork phase entails the specialist documentation and sampling of pits, to establish their stratigraphic and palaeoenvironmental contexts of finds in the specific pits.

Notwithstanding whether fossils are found or not, it is recommended that a representative selection of pits in the area be described/documented.

When a set of excavations are completed:

- The excavation faces must be inspected in detail for less obvious fossil content and representative samples of fossils must be collected.
- The fossiliferous sections and other key vertical sections representative of the exposures must be systematically measured, described in detail sedimentologically (logged), duly photographed at various appropriate scales and the sediments sampled, including apparently “barren” units. The latter may contain microfossils and lithological components of relevance.

For best cost-effectiveness, this activity should coincide with times of maximum exposure, when a large number of open pits are available. Timing is to be decided in consultation with developer/owner and the environmental consultant.

11. COMMUNICATION

11.1. Moyeng Energy (Pty) Ltd

ECO: To be provided once confirmed.

Site Foreman: To be provided once confirmed.

Project Manager: To be provided once confirmed.

11.2. Savannah Environmental (Pty) Ltd

Environmental Consultant: Ravisha Ajodhapersadh
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Cell: 084 300 0660
PO Box 148
Sunninghill, 2157

11.3. Archaeology

Archaeology Contracts Office, Dept. Archaeology, University of Cape Town

Monitoring/responsible archaeologist: To be provided.

Tel (021) 650 2357. Fax (021) 650 2352

11.4. Palaeontology

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Alternates

West Coast Fossil Park. Pippa Haarhoff: 083 289 6902, 022 766 1606.

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Iziko Museums of Cape Town: SA Museum, 021 481 3800.

Dr Graham Avery. 021 481 3895, 083 441 0028.

Dr Deano Stynder. 021 481 3894.

12. FOSSIL FINDS: ADDITIONAL NOTES

12.1. Application for a Palaeontological Permit

A permit from Heritage Western Cape (HWC) is required to excavate fossils. The applicant should be the qualified specialist responsible for assessment, collection and reporting (palaeontologist).

However, as the probability of fossil finds is low, a permit has not been applied for prior to the making of excavations. Should fossils be found, application for a retrospective palaeontological permit will be made to HWC immediately.

The application requires details of the registered owners of the sites, their permission and a site-plan map.

All samples of fossils must be deposited at a SAHRA-approved institution.

12.2. Reporting

Should fossils be found a detailed report on the occurrence/s must be submitted. This report is in the public domain and copies of the report must be deposited at the IZIKO S.A. Museum and Heritage Resources Western Cape. It must fulfil the reporting standards and data requirements of these bodies.

The report will be in standard scientific format, basically:

- A summary/abstract.
- Introduction.
- Previous work/context.
- Observations (incl. graphic sections, images).
- Palaeontology.
- Interpretation.
- Concluding summary.
- References.
- Appendices

The draft report will be reviewed by the client, or externally, before submission of the Final Report.

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John Pether

10 September 2010

SOCIAL IMPACT ASSESSMENT
FOR
RHEBOKSFONTEIN WIND ENERGY FACILITY
(NEAR DARLING)

DRAFT

September 2010

Prepared for

SAVANNAH ENVIRONMENTAL (Pty) Ltd

By

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EXECUTIVE SUMMARY

INTRODUCTION AND LOCATION

Savannah Environmental (Pty) Ltd were appointed by Moyeng Energy as the lead consultants to manage the Environmental Impact Assessment (EIA) process for the establishment of the proposed Rheboksfontein wind energy facility (WEF) and associated infrastructure on a site located approximately 3 km to the west of the town of Darling in the Western Cape Province. The study area is located within the Swartland Local Municipality.

Tony Barbour Consulting was appointed by Savannah Environmental (Pty) Ltd to undertake a specialist Social Impact Assessment (SIA) as part of the EIA process. The terms of reference for the study include a scoping level assessment followed by a detailed assessment of the social issues as part of the EIA. This report contains the findings of the Draft SIA undertaken as part of the EIA process.

DESCRIPTION OF THE PROPOSED WIND ENERGY FACILITY

A total of 80 x 1.5-3 MW (capacity) turbines are proposed. The wind turbines associated with a typical the WEF consist of four primary components:

- The **foundation unit** upon which the turbine is anchored to the ground;
- The **tower** which is typically between 80m and 100m in height. The tower is a hollow structure allowing access to the nacelle (see below). The height of the tower is a key factor in determining the amount of electricity a turbine can generate. The tower houses the transformer which converts the electricity to the correct voltage for transmission into the grid;
- The **nacelle** (generator/turbine housing). The nacelle houses the gearbox and generator as well as a wind sensor to identify wind direction. The nacelle turns automatically ensuring the blades always face into the wind to maximise the amount of electricity generated.
- The **rotor** which is comprised of three rotor blades (each up to 60 m in length). The rotor blades use the latest advances in aeronautical engineering materials science to maximise efficiency. The greater the number of turns of the rotor the more electricity is produced.

Based on information for other wind energy facilities the basic infrastructure associated with the establishment of the proposed wind energy facility would include:

- Internal roads (approximately 6 m in width) linking the wind turbines and other infrastructure on the site. Existing farm roads will be used as far as possible;
- Underground (~ 1m deep) 33 kV cabling, linking the wind turbines to 33/132 kV substations within the WEF site. In as far as possible, cabling will follow the internal access roads;
- 3 x 33/132 kV substations within the WEF site. Each of these substations will have a high-voltage (HV) yard footprint of approximately 1 200 m²;
- A 132 kV overhead power line network, linking the 33/132 kV substations to a 132 kV feeder line, which, in turn will link the site to a 132/400 kV substation located off-site;

- An on-site office/workshop building(s)/equipment store complex, with a combined footprint of approximately 400 m^2.

Based on information provided by the client the total estimated capital expenditure associated with the construction of 80 wind turbines is anticipated to be in the region of R 4 billion. The construction phase is expected to extend over a period of 3 years and could create approximately 120 employment opportunities. The estimated lifespan of the WEF is 25-30 years and the annual wage bill will be in the region of R 5.5 million.

APPROACH TO THE STUDY

The approach to the Social Impact Assessment (SIA) study is based on the Western Cape Department of Environmental Affairs and Development Planning Guidelines for Social Impact Assessment (February 2007). These guidelines are based on international best practice and have also been endorsed by DWEA. The key activities in the SIA process embodied in the guidelines include:

- Describing and obtaining an understanding of the proposed intervention (type, scale, location), the settlements and communities likely to be affected by the proposed project;
- Collecting baseline data on the current social and economic environment;
- Identifying the key potential social issues associated with the proposed project. This requires a site visit to the area and consultation with affected individuals and communities. As part of the process a basic information document was prepared and made available to key interested and affected parties. The aim of the document was to inform the affected parties of the nature and activities associated with the construction and operation of the proposed development so as to enable them to better understand and comment on the potential social issues and impacts;
- Assessing and documenting the significance of social impacts associated with the proposed intervention;
- Identifying alternatives and mitigation measures.

In this regard the study involved:

- The Social Scoping Report prepared for the Scoping Report (Tony Barbour Consultants, 2010);
- Review of project related information, including other specialist studies;
- Interviews with key interested and affected parties;
- Experience of the authors with the area and local conditions;
- Experience with similar projects, including the Darling Wind Farm and Eskom Wind Energy Facility located north of the Olifants River on the West Coast of South Africa.

SUMMARY OF KEY FINDINGS

The key findings of the study with regard to the proposed WEF are summarised under the following sections:

- Fit with policy and planning (“planning fit”);
- Construction phase impacts;
- Operational phase impacts;
- Cumulative impacts;
- Decommissioning phase impacts;
- No-development option.

The report also considers the potential health impacts associated with WEFs.

FIT WITH POLICY AND PLANNING

The key documents reviewed included:

- The White Paper on Renewable Energy (2003);
- Climate Change Strategy and Action Plan for the Western Cape (2008);
- White Paper on Sustainable Energy for the Western Cape (Final Draft, 2008);
- Strategic Initiative to Introduce Commercial Land Based Wind Energy Development to the Western Cape. Towards a Regional Methodology for Wind Energy Site Selection (2006);
- The Western Cape Provincial Spatial Development Framework (2009);
- Guideline for the Management of Development on Mountains, Hills and Ridges in the Western Cape (2002);
- The Swartland Integrated Development Plan (IDP) (2007-2011);
- The Swartland Local Economic Development Strategy (2007).

The findings of the review indicated that wind energy is strongly supported at a national and local level. At a national level the While Paper on Energy Policy (1998) notes:

- Renewable resources generally operate from an unlimited resource base and, as such, can increasingly contribute towards a long-term sustainable energy future;
- The support for renewable energy policy is guided by a rationale that South Africa has a very attractive range of renewable resources, particularly solar and ***wind*** and that renewable applications are in fact the least cost energy service in many cases; more so when social and environmental costs are taken into account.

In terms of the Western Cape Regional Methodology for Wind Energy Site Selection (2006), PSDF (2009) and Guidelines for development on Mountains, Hills and Ridges (2002), the findings of the review indicate that the proposed WEF and one of the power line options (Alternative 1) are in conflict with a number of location based principles. These relate to development on mountains, specifically the crest of hills and mountains, preference to disturbed landscapes and preservation of existing visual and sense of place values. The proposed 132 kV lines does, however, conform to the recommendations contained in the WCPSDF, in that it follows and an existing Eskom servitude.

The SIA recognises that the location of the WEF is informed by the quality of the wind resource, which, in turn, increases the WEF’s potential to contribute to the generation of renewable energy in South Africa. However, the impact of large WEFs, such as the Rheboksfontein WEF, on the visual and rural landscape character of the area cannot be ignored. This finding is supported by the findings of the VIA and the HIA. The impact of WEFs on rural landscapes is an issue that will need to be addressed by the relevant environmental and planning authorities, specifically given the large number of applications for WEFs that have been submitted in the Western Cape area over the last 12 months.

CONSTRUCTION PHASE

The key social issues associated with the construction phase include:

- Creation of employment and business opportunities and opportunity for skills development and on-site training

Based on information provided by the developer the total estimated capital expenditure associated with the construction of 80 wind turbines is in the region of R 4 billion. The construction phase is expected to extend over a period of 3 years and create approximately 120 employment opportunities. Of this total, approximately 25% (or 30) of opportunities will be available to skilled personnel (engineers, technicians, management and supervisory), 35% (or 42) to semi-skilled personnel (drivers, equipment operators), and 40% (or 48) to low skilled personnel (construction labourers, security staff). The work associated with the construction phase will be undertaken by contractors and will include the establishment of the access roads and services and the erection of the wind turbines. Experience with large construction projects is that contractors typically make use of their own skilled and semi-skilled staff. The direct employment opportunities for members from the local communities of Darling and Yzerfontein are therefore likely to be limited to low skilled opportunities, which account for approximately 48 jobs. The majority of these opportunities are likely to benefit Historically Disadvantaged (HD) members of the community. However, the creation of local employment opportunities can be enhanced by the appointment of local contractors.

The wage bill associated with the construction phase is estimated at R18.66 million per annum (current value). The total wage bill for the three-year construction phase will therefore be in the region of R55.98 million. The benefits to the local economy will however be confined to the construction period (36 months).

The proposed development will also create an opportunity to provide on-site training and increase skills levels. However, the majority of these opportunities are likely to benefit the workers employed by the contractors and, as such may not benefit members of the local community. This issue can, however, be addressed through the implementation of effective enhancement measures.

In terms of business opportunities for local companies, the expenditure of in the region of R 4 billion during the construction phase will create business opportunities for the regional and local economy. However, given the technical nature of the project and the high import content associated with wind turbines the opportunities for the local Darling economy are likely to be limited. However, local engineering companies based in Cape Town, Malmesbury and Saldanha may be in a position to benefit from the construction of certain, less technical components of the wind turbines. The local service and hospitality sector is also likely to benefit from the development. These benefits would be linked to accommodation, catering, cleaning, transport and security, etc.

Potential negative impacts

- Impacts associated with the presence of construction workers on local communities;
- Increased risk of stock theft, poaching and damage to farm infrastructure associated with presence of construction workers on the site;
- Impact of heavy vehicles on local roads;
- Loss of agricultural land associated with construction related activities.

The significance of the all of the potential negative social impacts with mitigation was assessed to be of Low significance. All of the potential negative impacts can therefore be effectively mitigated if the recommended mitigation measures are implemented. However, the impact on individuals who are directly impacted on by construction workers (i.e. contract HIV/ AIDS) was assessed to be of Medium-High negative significance. Table 1 summarises the significance of the impacts associated with the construction phase.

Table 1: Summary of social impacts during construction phase

Impact	**Significance No Mitigation**	**Significance With Mitigation**
Creation of employment and business opportunities	Low (Positive impact)	Medium (Positive impact)
Presence of construction workers and potential impacts on family structures and social networks	Low (Negative impact for community as a whole) Medium-High (Negative impact of individuals)	Low (Negative impact for community as a whole) Medium-High (Negative impact of individuals)
Risk of stock theft, poaching and damage to farm infrastructure	Medium (Negative impact)	Low (Negative impact)
Impact of heavy vehicles on roads	Low (Negative impact)	Low (Negative impact)
Loss of farmland	High (Negative impact)	Low (Negative impact)

OPERATIONAL PHASE

The key social issues affecting the operational phase include:

Potential positive impacts

- Creation of employment and business opportunities. The operational phase will also create opportunities for skills development and training;
- The development of clean energy as an alternative energy source and the establishment of a Cleaner Development Mechanism (CDM) project;
- Potential benefit for local tourism.

The proposed WEF will create employment of approximately 35 full time employees over a 25-year period. Of this total approximately 25% of opportunities will be available to skilled personnel (forecasters, technicians, management and supervisory, etc), 35% to semi-skilled personnel (drivers, equipment operators), and 40% to low skilled personnel (road maintenance, security, etc). Given that the wind energy sector in South Africa is relatively new it may be necessary to import the required operational and maintenance skills from other parts of South Africa or even overseas. To address this issue the developer should implement a skills development and mentorship programme for local candidates aimed at addressing this issue. This would support the strategic goals of promoting local employment and skills development contained in the Swartland Integrated Development Plan (IDP).

At this stage it is unclear where the permanent staff will reside. However, a number of people are likely to be located in Darling and possibly Yzerfontein. A percentage of permanent employees may purchase houses in one of these towns, while others may decide to rent. Both options would represent a positive economic benefit for the region. In addition, a percentage of the monthly wage bill earned by permanent staff would be spent in the regional and local economy. This will benefit local businesses in the relevant towns. The wage bill associated with the operational phase is estimated at R5.5 million per year (current value). The benefits to the local economy will extend over the anticipated 25-30 year operational lifespan of the project.

The local hospitality industry is also likely to benefit from the operational phase. These benefits are associated with site visits by company staff members and other professionals (engineers, technicians etc) who are involved in the company and the project but who are not linked to the day-to-day operations.

The proposed development also represents an investment in clean, renewable energy, which, given the challenges created by climate change, represents a positive social benefit for society as a whole.

Potential negative impacts

- Impact of the proposed wind energy facility on the current farming activities, specifically the potential loss of productive farm land;
- The visual impacts and associated impact on sense of place;

Of these impacts the impact on sense of place and the landscape represents a significant concern. The findings of the SIA indicate that while none of the local farmers interviewed identified visual impacts as a significant concern, this does not imply that proposed WEF will not impact on the areas sense of place and the landscape. Experience from elsewhere, such as Australia and Scotland, indicates that impacts on the landscape represent one of the most significant concerns associated with wind farms. The significance of the impact on the sense of place and landscape is linked to the location of the site in terms of the Darling Hills, visibility from the R27 and R315 (both of which are scenic routes), and the importance of tourism to the local economy. The potential for mitigating the impact on the areas sense of place and the landscape is low. The significance of this impact with mitigation is assessed to be High Negative. In addition, the lack of a National / Provincial set of Guidelines for Wind Farms and spatial information on sensitive landscapes is a major concern.

The significance of the impacts associated with the operational phase are summarised in Table 2.

Table 2: Summary of social impacts during operational phase

Impact	Significance No Mitigation	Significance With Mitigation
Creation of employment and business opportunities	Medium (Positive impact)	Medium (Positive impact)
Promotion of renewable energy projects	High (Positive impact)	High (Positive impact)
Impact on tourism	Low (Positive)	Medium (Positive)
Impact on farming activities	Low (Negative impact)	Low (Neutral impact)
Visual impact and impact on sense of place	High (Negative impact)	High (Negative impact)

POWER LINE ROUTES

The proposed 132 kV line is approximately 34 km in length, and largely (~32 km) follows the alignment of the existing Aurora-Atlantis 400 kV transmission line corridor (two existing 400 kV lines). The existing 400 kV corridor traverses farmland for the majority of its length. The social impacts associated with this section of the alignment are therefore not regarded as significant and do not have bearing on the assessment.

From a social perspective, only the initial ~2 km section of the proposed alignment is of relevance. This short linking section between the Rheboksfontein WEF and the existing transmission line corridor traverses high potential land on Bonteberg and Alexanderfontein Farms. Vineyard and olive groves are established in the relevant area. Impacts would include loss of high potential land to pylon footprints, and more significantly, restricted movement of farming implements.

It is recommended that the possibility of siting the alignment along the Alexanderfontein-Doornfontein boundary should be investigated as an alternative for this segment. However, care should be taken to site the alignment towards the east of the relevant ridgeline in order to avoid visual impacts on Doornfontein.

CUMULATIVE IMPACTS

At least one other WEF development is currently being proposed in the vicinity of the Rheboksfontein WEF site, namely the Darling/ Kerriefontein WEF, which consists of 16 wind turbines. Due to the relatively small scale of the (16 turbines) facility the potential cumulative impacts are not regarded as significant. However, a number of WEFs are proposed further north along the R27, in the Saldanha Bay area. These include the 22 turbine Uyekraal WEF (~6 km south-east of Vredenburg) and the 98-129 turbine Mainstream Nooitgedacht facility (~4.5 km north-east of Vredenburg). This raises the potential for cumulative impacts associated with sequential visibility (e.g. the effect of seeing two or more wind farms along a single journey, e.g. road or walking trail).

The findings of the SIA also indicate that the establishment of WEFs in the area conflicts with a number of key principles contained in the WCPSDF and the Guidelines for development on Mountains, Hills and Ridges. These impacts would be compounded by the development of more than one WEF in the area. Based on the findings of the VIA, HIA and SIA the establishment of more than one, large WEF in the area is therefore not supported.

POTENTIAL HEALTH IMPACTS

The potential health impacts typically associated with WEFs include, noise, shadow flicker and electromagnetic radiation. As indicated in Section 4.5.5, the findings of a literature review undertaken by the Australian Health and Medical Research Council published in July 2010 indicate that there is no evidence of wind farms posing a threat to human health. The research also found that wind energy is associated with fewer health effects than other forms of traditional energy generation and in fact will have positive health benefits (WHO, 2004).

Based on these findings it is assumed that the significance of the potential health risks posed by the proposed Rheboksfontein WEF are of low negative significance. However, the owner of Rondeberg Farm, Mr. Mark Duckitt, has indicated that noise generated by the movement of the turbines is a concern. In this regard Mr. Duckitt has requested that Moyeng Energy determine the current ambient noise levels and implement a monitoring programme to monitor noise levels associated with the proposed Rheboksfontein WEF.

NO DEVELOPMENT OPTION

The No-Development option would represent a lost opportunity for South Africa to supplement is current energy needs with clean, renewable energy. Given South Africa's position as one of the highest per capita producer of carbon emissions in the world, this would represent a High negative social cost.

The no-development option also represents a lost opportunity in terms of the employment and business opportunities (construction and operational phase) associated with the WEF. This also represents a negative social cost. However, as indicated above, there are concerns related to the negative impact of the proposed WEF on the areas sense of place and the landscape.

DECOMMISSIONING PHASE

Typically, the major social impacts associated with the decommissioning phase are linked to the loss of jobs and associated income. This has implications for the households who are directly affected, the communities within which they live, and the relevant local authorities. However, in the case of the wind energy facility decommissioning phase is likely to involve the disassembly and replacement of the existing turbines with more modern technology. This is likely to take place in the 20-30 years post commissioning. All of the components of the wind turbine, with the exception of the turbine blades, can be reused or recycled. The decommissioning phase is therefore likely to create additional, construction type jobs, as opposed to the jobs losses typically associated with decommissioning.

The potential impacts associated with the decommissioning phase can also be effectively managed with the implementation of a retrenchment and downscaling programme. With mitigation, the impacts are assessed to be Low (negative).

Moyeng Energy should also establish an Environmental Rehabilitation Trust Fund to cover the costs of decommissioning and rehabilitation of disturbed areas. The Trust Fund should be funded by a percentage of the revenue generated from the sale of energy to the national grid over the 25-30 year operational life of the facility.

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of the SIA it would appear that none of the landowners who stand to be directly affected by the proposed Rheboksfontein WEF are opposed to the development. The findings of the SIA also indicate that the development will create employment and business opportunities for locals during both the construction and operational phase of the project. In order to enhance the local employment and business opportunities the mitigation measures listed in the report should be implemented. Moyeng, in consultation with the Swartland LM, should also investigate the opportunity of establishing a Community Trust. The revenue for the trust would be derived from the income generated from the sale of energy from the WEF. The mitigation measures listed in the report to address the potential negative impacts during the construction phase should also be implemented.

The proposed development also represents an investment in clean, renewable energy infrastructure, which, given the challenges created by climate change, represents a positive social benefit for society as a whole.

However, the impact of large WEFs, such as the Rheboksfontein WEF, on the visual and landscape character of the area cannot be ignored. The significance of the impact on the sense of place and landscape is linked to the location of the site in terms of the Darling Hills, visibility from the R27 and R315 (both of which are scenic routes), and the importance of tourism to the local economy. The impact of WEFs on rural landscapes is an issue that will need to be addressed by the relevant environmental and planning authorities, specifically given the large number of applications for WEFs in the area that have been submitted over the last 12 months.

The findings of the SIA also indicate that the establishment of WEFs in the area conflicts with a number of key principles contained in the WCPSDF and the Guidelines for development on Mountains, Hills and Ridges. These impacts would be compounded by the development of more than one WEF in the area. Based on the findings of the VIA, HIA and SIA the establishment of more than one, large WEF in the Darling Hills area is therefore not supported.

ACRONYMS

CCT	City of Cape Town
DEA&DP	Department of Environmental Affairs and Development Planning (Western Cape)
DWEA	Department of Water and Environmental Affairs (National)
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMI	Electromagnetic Interference
EMP	Environmental Management Plan
HD	Historically Disadvantaged
HV	High-voltage
IDP	Integrated Development Plan
IPP	Independent Power Producer
kV	Kilovolts
LED	Local Economic Development
LM	Local Municipality
Mtoe	Million tonnes of oil equivalent
MF	Management Forum
MW	Megawatt
PGWC	Provincial Government Western Cape
SDF	Spatial Development Framework
SIA	Social Impact Assessment
WCDM	West Coast District Municipality
WEF	Wind Energy Facility

TABLE OF CONTENTS

SECTION 1: INTRODUCTION

1.1 INTRODUCTION

Savannah Environmental (Pty) Ltd was appointed by Moyeng Energy as the lead consultants to manage the Environmental Impact Assessment (EIA) process for the establishment of the proposed Rheeboksfontein wind energy facility (WEF) and associated infrastructure on a site located approximately 3 km to the west of the town of Darling in the Western Cape Province (see Figure 1.1).

Tony Barbour Consulting was appointed by Savannah Environmental (Pty) Ltd to undertake a specialist Social Impact Assessment (SIA) as part of the EIA process. The terms of reference for the study include a scoping level assessment followed by a detailed assessment of the social issues as part of the EIA. This report contains the findings of the Draft SIA undertaken as part of the EIA process.

1.2 TERMS OF REFERENCE

The terms of reference for the SIA require:

- A description of the environment that may be affected by the activity and the manner in which the environment may be affected by the proposed facility;
- A description and assessment of the potential social issues associated with the proposed facility;
- Identification of enhancement and mitigation aimed at maximising opportunities and avoiding and or reducing negative impacts.

1.3 DEVELOPMENT PROPOSAL AND LOCATION

The proposed development consists of the establishment of up to 80 turbines and associated infrastructure, including 132 kV lines to link up with an existing Eskom substation (Atlantis) located approximately 30 km south-east of the site. The proposed Rheboksfontein site covers and area of 39 km² and is located approximately 3 km to the west of the town of Darling, and approximately 8 km east of the Atlantic coastline (see Figure 1.1). The site falls within the Swartland Local Municipality (West Coast District Municipality) of the Western Cape Province. A portion of the proposed 132 kV power line alignment is located within the jurisdiction of the City of Cape Town (Atlantis). The site is made up of seven cadastral portions, forming part of two farming operations/ ownership régimes.

A more detailed overview of the proposed WEF development is provided in Sections 2 (Project Description) and 3 (Study Area) of this report.

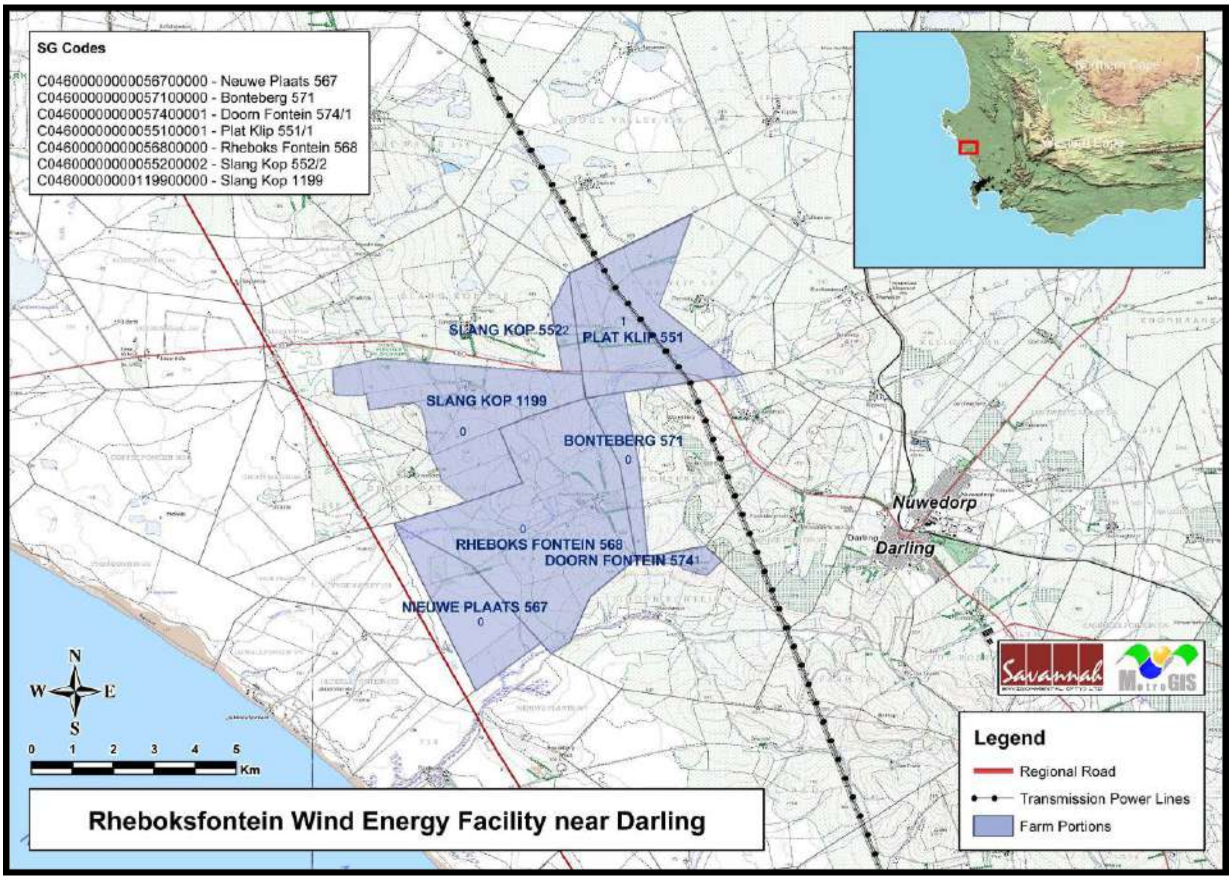

Figure 1.1: Location of proposed Rheboksfontein WEF

1.4 ASSUMPTIONS AND LIMITATIONS

1.4.1 Assumptions

Strategic importance of the project and no-go option

It is assumed that the strategic importance of promoting renewable energy, including wind energy, is supported by the national and provincial energy policies.

Technical suitability

It is assumed that the development site identified by Moyeng Energy represents a technically suitable site for the establishment of a wind energy facility.

1.4.2 Limitations

Demographic data

The demographic data used in the study is largely based on the findings of the 2001 Census, or on sources which are based projections on the Census 2001 data. While this data does provide useful information on the demographic profile of the affected area, the actual data is dated and should be treated with care[1].

1.5 APPROACH TO STUDY

The approach to the Social Impact Assessment (SIA) study is based on the Western Cape Department of Environmental Affairs and Development Planning Guidelines for Social Impact Assessment (February 2007). These guidelines are based on international best practice and have also been endorsed by DEA. The key activities in the SIA process embodied in the guidelines include:

- Describing and obtaining an understanding of the proposed intervention (type, scale, location), the communities likely to be affected and determining the need and scope of the SIA;
- Collecting baseline data on the current social environment and historical social trends;
- Identifying and collecting data on the Social Impact Assessment variables and social change processes related to the proposed intervention. This requires consultation with affected individuals and communities;
- Assessing and documenting the significance of social impacts associated with the proposed intervention;
- Identifying alternatives and mitigation measures.

In this regard the study involved:

- Review of demographic data from the 2001 Census Survey and other available sources;
- Review of relevant planning and policy frameworks for the area;
- Site specific information collected during the site visit to the area and interviews with interested and affected parties;
- Review of information from similar studies, including the EIAs undertaken for the Darling Wind Farm, Eskom West Coast Wind Energy Facility and Hopefield Wind Energy Facility;
- Literature review of social issues associated with wind energy facilities.

The identification of potential social issues associated with proposed wind energy facility is based on observations during the project site visit, review of relevant documentation, experience with similar projects and the area. Annexe A contains a list of the secondary information reviewed and interviews conducted. Annexe B summarises the assessment methodology used to assign significance ratings to the assessment process.

1.5.1 Definition of social impacts

Social impacts can be defined as “The consequences to human populations of any public or private actions (these include policies, programmes, plans and/or projects) that alter the ways in which people live, work, play, relate to one another, organise to meet their needs and generally live and cope as members of society. These impacts are felt at various levels, including individual level, family or household level,

[1] The last comprehensive national census was conducted in 2001. Census 2001 provided demographic and socio-economic data from National to Municipal Ward level. The next comprehensive national census is planned for 2011.

community, organisation or society level. Some social impacts are felt by the body as a physical reality, while other social impacts are perceptual or emotional" (Vanclay, 2002).

When considering social impacts it is important to recognise that social change is a natural and on-going process (Burdge, 1995). However, it is also important to recognise and understand that policies, plans, programmes and/or projects implemented by government departments and/or private institutions have the potential to influence and alter both the ***rate*** and ***direction*** of social change. Many social impacts are not in themselves "impacts" but change process that may lead to social impacts (Vanclay, 2002). For example the influx of temporary construction workers is in itself not a social impact. However, their presence can result in range of social impacts, such as increase in antisocial behaviour. The approach adopted by Vanclay stresses the importance of understanding the processes that can result in social impacts. It is therefore critical for social assessment specialists to think through the complex causal mechanisms that produce social impacts. By following impact pathways, or causal chains, and specifically, by thinking about interactions that are likely to be caused, the full range of impacts can be identified (Vanclay, 2002).

An SIA should therefore enable the authorities, project proponents, individuals, communities and organisations to understand and be in a position to identify and anticipate the potential social consequences of the implementation of a proposed policy, programme, plan or project. The SIA process should alert communities and individuals to the proposed project and possible social impacts, while at the same time allowing them to assess the implications and identify potential alternatives. The assessment process should also alert proponents and planners to the likelihood and nature of social impacts and enable them to anticipate and predict these impacts in advance so that the findings and recommendations of the assessment are incorporated into and inform the planning and decision-making process.

However, the issue of social impacts is complicated by the way in which different people from different cultural, ethic, religious, gender, and educational backgrounds etc view the world. This is referred to as the "social construct of reality". The social construct of reality informs people's worldview and the way in which they react to changes.

1.5.2 Timing of social impacts

Social impacts vary in both time and space. In terms of timing, all projects and policies go through a series of phases, usually starting with initial planning, followed by implementation (construction), operation and finally closure (decommissioning). The activities, and hence the type and duration of the social impacts associated with each of these phases are likely to differ.

1.6 SPECIALIST DETAILS

The lead author of this report is an independent specialist with 20 years experience in the field of environmental management. In terms of SIA experience Tony Barbour has undertaken in the region of 60 SIA's and is the author of the Guidelines for Social Impact Assessments for EIA's adopted by the Department of Environmental Affairs and Development Planning (DEA&DP) in the Western Cape in 2007. These guidelines have also been endorsed by DWEA.

Tony Barbour has also undertaken the specialist SIA studies for a number of WEFs, including the Darling Wind Farm (Western Cape), Eskom's West Coast WEF (Western Cape), Hopefield WEF (Western Cape), Cookhouse WEF (Eastern Cape), Abs WEF (Eastern Cape) and Dorper WEF (Eastern Cape).

Schalk van der Merwe, the co-author of this report, has an MPhil in Environmental Management from the University of Cape Town and has worked closely with Tony Barbour on a number of SIAs over the last seven years, including a number of SIAs for WEFs.

1.7 DECLARATION OF INDEPENDENCE

This confirms that Tony Barbour and Schalk van der Merwe, the specialist consultants responsible for undertaking the study and preparing the Draft SIA Report, are independent and do not have vested or financial interests in the proposed Wind Energy Facility being either approved or rejected.

1.8 REPORT STRUCTURE

The report is divided into six sections, namely:

- Section 1: Introduction;
- Section 2: Project description;
- Section 3: Description of the study area;
- Section 4: Policy and planning context;
- Section 5: Identification and assessment of key issues;
- Section 6: Key Findings and recommendations.

SECTION 2: PROJECT DESCRIPTION

2.1 INTRODUCTION

This section provides and overview of:

- The basic development proposal;
- Alternatives assessed in the EIA phase;
- Key aspects associated with the construction phase;
- Key aspects associated with the operational phase;
- Key aspects associated with the decommissioning phase;
- Other wind energy projects currently proposed in the vicinity of the Rheboksfontein site.

2.2 LOCATION OF THE PROPOSED WEF AND AFFECTED FARMS

The Rheboksfontein WEF is proposed on a site located approximately 3 km to the west of the town of Darling, and approximately 8 km east of the Atlantic coastline (Figure 2.1).

The site is comprised of 7 cadastral portions, associated with two ownership régimes, namely:

- Rheboksfontein:
- Remaining extent of Farm 568 (Rheboksfontein);
- Farm 567 (Nieuwe Plaats);
- Remaining extent of Farm 571 (Bonteberg);
- Portion 1 of Farm 574 (Doornfontein);
- Portion 1 of Farm 551 (Plat Klip);
- Portion 2 of Farm 552 (Slang Kop).
- Grootberg:
- Farm 1199 (Groot Berg).

The relevant 7 cadastral units cover and area of approximately 39 km².

The site is traversed from west to east by the R315 (Darling-Yzerfontein road). The Platklip and Slangkop portions are located to the north of the R315; the remaining portions to the south. The R27 is located immediately to the west of the site.

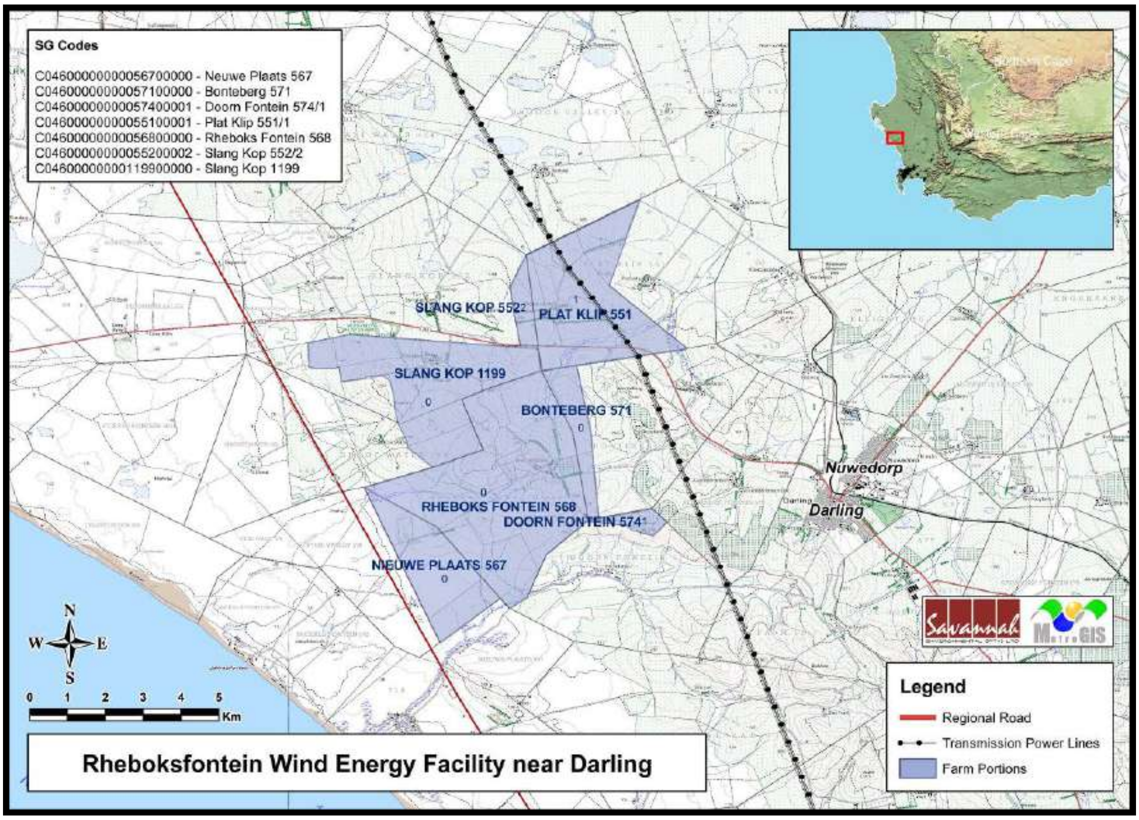

Figure 2.1: Properties comprising the proposed Rheboksfontein WEF

2.3 DESCRIPTION OF THE WIND ENERGY FACILITY

2.3.1 Wind turbines

Moyeng Energy is proposing the construction of up to 80 x 1.8 - 2.5 MW (capacity) turbines, yielding a total potential capacity of up to 200 MW. The proposed WEF consists of multiple wind turbines (Figure 2.2), which are used to capture the kinetic energy of the wind and generate electricity. This captured kinetic energy is used to drive a generator located within the wind turbine and the energy is subsequently converted into electrical energy. A typical wind turbine consists of four primary components:

- The **foundation unit** upon which the turbine is anchored to the ground. The area and depth of the concrete foundation are in the region of 225 m² (footprint) x 4m (depth), depending on the local geological conditions;
- The **tower** which is typically between 80m and 100m in height. The tower is a hollow structure allowing access to the nacelle. The height of the tower is a key factor in determining the amount of electricity a turbine can generate. The tower houses the transformer which converts the electricity to the correct voltage for transmission into the grid;
- The **nacelle** (generator/turbine housing). The nacelle houses the gearbox and generator as well as a wind sensor to identify wind direction. The nacelle turns automatically ensuring the blades always face into the wind to maximise the amount of electricity generated;

- The **rotor** which is comprised of three rotor blades (each up to 60 m in length). The rotor blades use the latest advances in aeronautical engineering materials science to maximise efficiency. The greater the number of turns of the rotor the more electricity is produced.

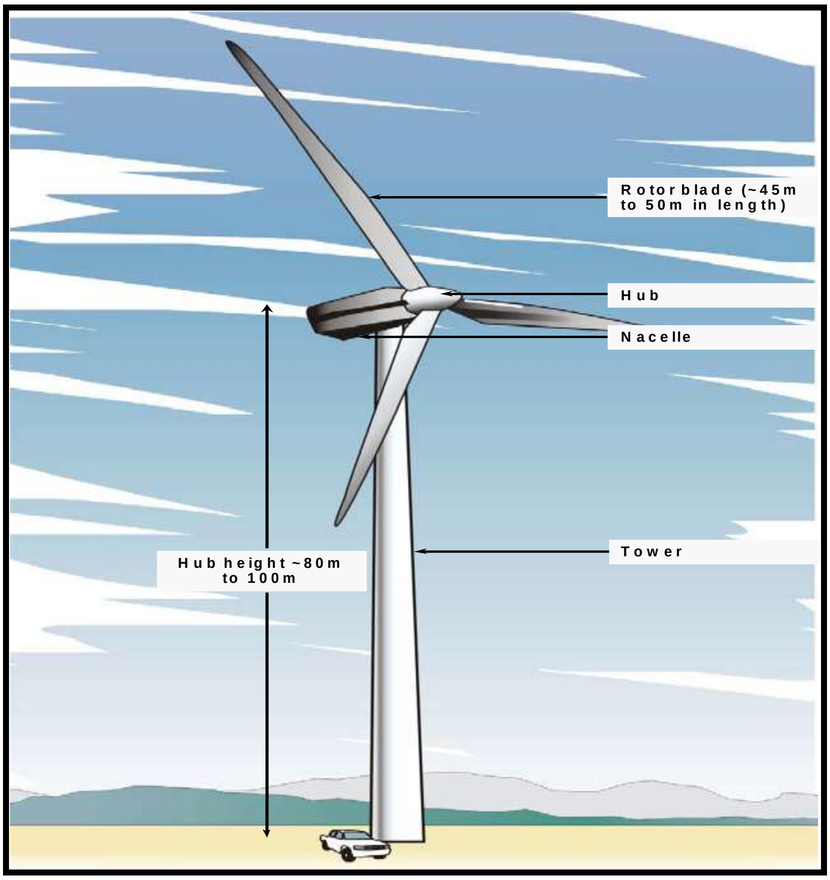

Figure 2.2: Typical turbine structure and components

The amount of energy a turbine can harness is dependent on the wind velocity and the length of the rotor blades. Wind turbines start generating power at wind speeds of between 10 - 15 km/hour, with speeds between 45 - 60 km/hour required for full power operation. In a situation where wind speeds are excessive, the turbine automatically shuts down to prevent damage.

The most suitable turbines (manufacturer and specifications) will be determined once the most suitable turbine footprints have been identified (i.e. based on the outcome of the current EIA process), and wind monitoring is completed for an extended period on the site.

2.3.2 Associated on-site infrastructure

Associated on-site infrastructure will include:

- Internal roads (approximately 6 m in width) linking the wind turbines and other infrastructure on the site. Existing farm roads will be used as far as possible;

- Underground (~ 1m deep) 33 kV cabling, linking the wind turbines to 33/132 kV substations within the WEF site. In as far as possible, cabling will follow the internal access roads;
- 3 x 33/132 kV substations within the WEF site. Each of these substations will have a high-voltage (HV) yard footprint of approximately 1 200 m^2;
- A 132 kV overhead power line network, linking the 33/132 kV substations to a 132 kV feeder line, which, in turn will link the site to a 132/400 kV substation located off-site (see 2.2.4. below);
- An on-site office/workshop building(s)/equipment store complex, with a combined footprint of approximately 400 m^2.

2.3.3 Integration into Eskom grid

The project will be developed as an Independent Power Producer (IPP) project and the energy will be fed into the existing Eskom grid. In order to do so, the construction of 132 kV power lines would be required in order to link the 33/132 kV substations associated with the WEF to the existing Eskom Atlantis 132/ 400 kV substation (located approximately 30 km south-east of the WEF site).

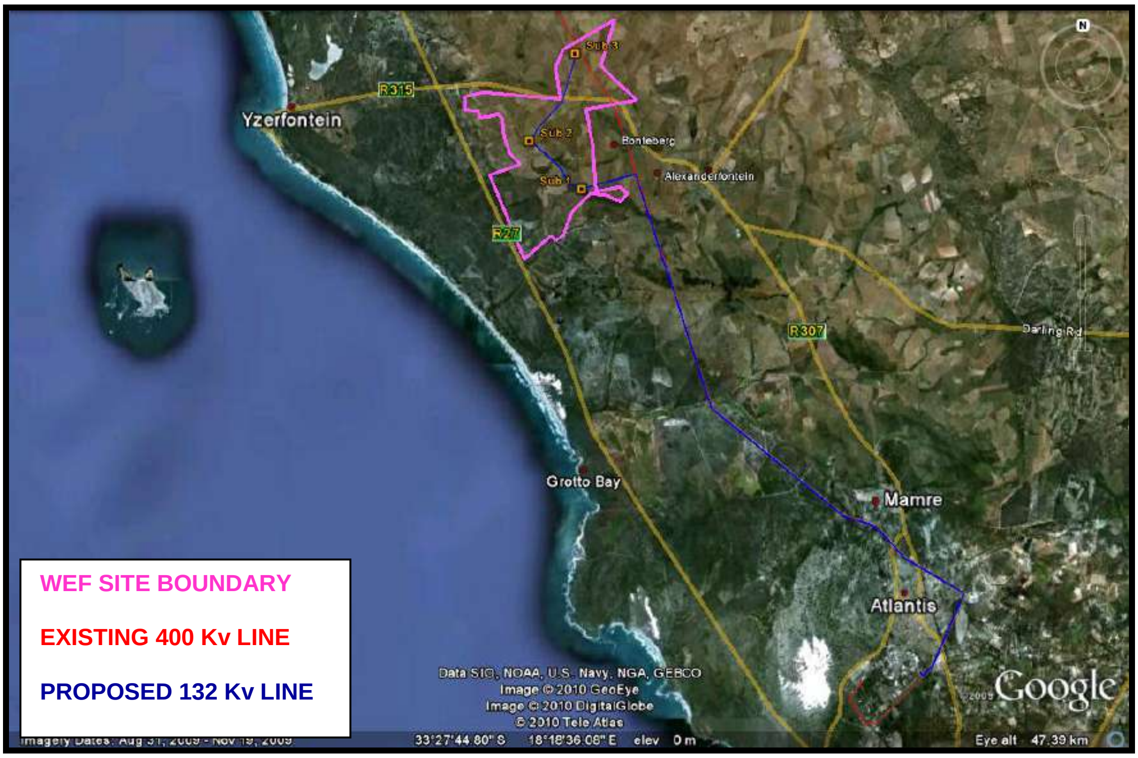

Figure 2.3: Proposed 33/132 kV substations and 132 kV power line alignment.

The extreme north-eastern section of the site (viz. Platklip) is traversed by 2 x existing 400 kV Eskom transmission lines (Aurora-Atlantis line). The Rheboksfontein WEF would however not be able to link directly into the grid via these lines, as the voltage would first need to be switched from 132 kV to 400 kV. For this reason, the construction of 132 kV lines to the Atlantis substation is proposed instead.

The pylons will be approximately 35m tall and each line would require a 35m wide servitude.

Only one alignment alternative has been proposed for assessment (See Figure 2.3). With the exception of a short linking section from the WEF to the existing 400 kV Aurora-Atlantis transmission line corridor (located to the east of the WEF site at this point), an alignment following the existing 400 kV transmission line corridor to the Atlantis substation is proposed. The total alignment is approximately 34 km in length.

The proposed alignment of the short linking section is perpendicular to the existing Aurora-Atlantis 400 kV corridor. The linking section is approximately 2km in length. The relevant section would traverse high potential agricultural land located on Bonteberg and Alexanderfontein Farms (not part of WEF site).

The distance from the point of convergence along the existing 400 kV servitude to the Atlantis substation is approximately 32 km. The bulk of this section (approximately 23 km) traverses privately owned farmland. Only the northernmost 2.5 km (i.e. directly to the east of the WEF site) traverses cultivated land (olive grove). The land is located on Alexanderfontein Farm.

The final 9 km of the alignment is located in close proximity to or within the built edge of the town of Atlantis (City of Cape Town). Of this 9 km, approximately 7 km skirts the Atlantis built edge to the north and east of the town. The final 2 km is, however, runs between the Atlantis suburb of Protea Park, and the settlement of Witsand. An existing servitude reserve associated with the existing 400 kV transmission line currently exists along this segment. At its narrowest, the reserve measures approximately 200 m in width. Only 2 x kV lines (combined servitude requirement of 2 x 55 m = 110 m) are currently located within the open space. It is not known whether unreserved capacity exists in the remainder of the reserve in order to accommodate the proposed 132 kV lines from the Rheboksfontein WEF.

2.3.4 Phasing

Moyeng Energy anticipates implementation of the project in a single phase.

2.3.5 Access roads

Use would be made of existing public roads to access the relevant sites both during construction and operational phases. Access to both site portions (i.e. to the north and south of the R315, respectively) would be obtained from the R315.

2.4 ALTERNATIVES BEING ASSESSED

The selection of the Rheboksfontein WEF site was based on a detailed pre-feasibility study that considered wind conditions in the area, land availability and road access. No alternative sites were identified for assessment in this EIA process. Consequently, no site alternatives to the WEF site will be assessed during the EIA process.

Provisional locations have been identified for the 80 wind turbines and 3 on site 33/132kV substations. These are illustrated in Figure 2.4.

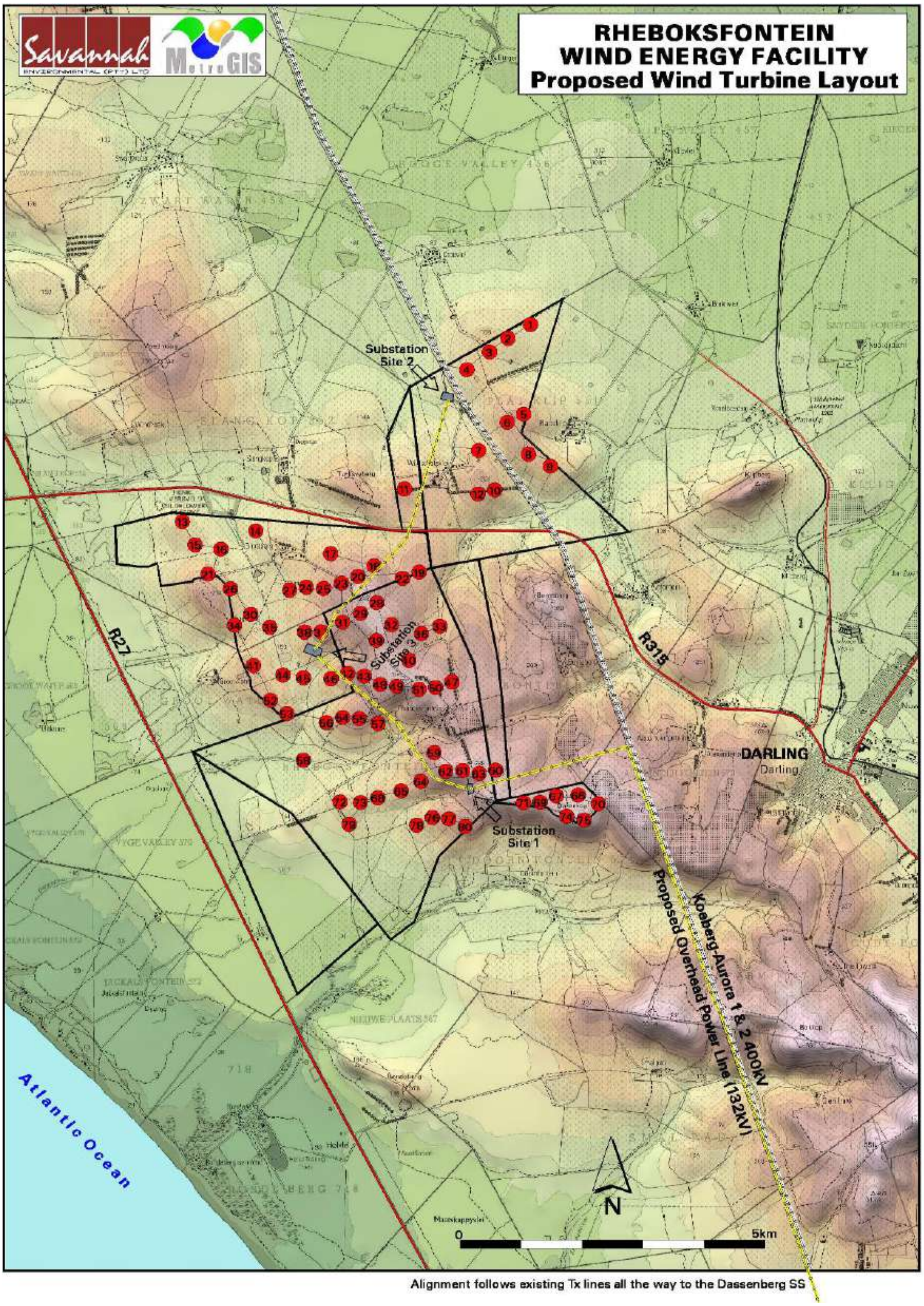

Figure 2.4. Proposed location of the 80 x wind turbines

The final location of the wind turbines and substations will be informed by technical considerations (including the on-site wind regime) and inputs from the relevant specialist studies (including this SIA) currently being undertaken as part of the EIA process.

Only one alignment alternative is proposed for the 132 kV lines (See Section 2.3.3 above). The final determination of the alignment will be informed by technical considerations and inputs from the relevant specialist studies (including this SIA) currently being undertaken as part of the EIA process.

2.4.1 Do nothing / No development Alternative

The do nothing / no development alternative involves maintaining the current status quo and existing land uses.

2.5 CONSTRUCTION PHASE

2.5.1 Duration

It is estimated that the construction of the proposed 80 turbines and associated infrastructure (including substation, distribution lines and access roads) would take approximately 36 months (3 years) to complete.

2.5.2 Capital expenditure

The total construction capital expenditure associated with the establishment of the WEF and 132 kV lines is estimated to be in the region of R4 billion (current value 2010 values). This includes the costs associated with provision of infrastructure, access roads, substations and transmission lines. The work associated with the construction phase will be undertaken by contractors and will include the establishment of access roads, substations, overhead power lines, and the erection of the wind turbines.

2.5.3 Employment opportunities and wages

Information provided by Moyeng Energy indicates that the project will provide approximately 120 direct construction employment opportunities for an uninterrupted period of approximately 36 months. Moyeng Energy estimates that approximately 25% (or 30) of opportunities will be available to skilled personnel (engineers, technicians, management and supervisory), 35% (or 42) to semi-skilled personnel (drivers, equipment operators), and 40% (or 48) to low skilled personnel (construction labourers, security staff).

Contractors typically make use of their own skilled and semi-skilled staff. Direct employment opportunities for members of local communities are therefore likely to be limited to low skilled opportunities. The wage bill associated with the construction phase is estimated at R18.66 million per annum (current value). The total wage bill for the three-year construction phase will therefore be in the region of R55.98 million.

2.5.4 Labour accommodation

According to Information provided by Moyeng Energy, no on-site labour camp is envisaged. Workers will be accommodated in nearby towns (Darling, etc), and transported to and from site on a daily basis. Given the relative proximity of the site to Atlantis, Cape Town, Malmesbury and other potential labour sending areas, it is likely that a significant proportion of workers may choose to commute from home on a daily basis. Overnight on-site worker presence will be limited to security staff.

2.5.5 Transportation of components and equipment

Transportation of components and equipment onto and within the Rheboksfontein site would require a substantial number of abnormal load movements. Information provided by Moyeng Energy indicates that an estimated total of 400 abnormal load trips are associated with the transport of turbine components onto site (i.e. 5 x trips per turbine). These include abnormally long loads (associated with ~40-55 m rigid turbine blades), as well as abnormally heavy ones (associated with ~ 80 t nacelles). In addition, a crawler crane (~ 750 t) and assembly cranes will also need to be transported onto and off the sites. Other heavy equipment will include normal civil engineering construction equipment such as graders, excavators, cement trucks, etc.

Access to the site would be from the R27 (West Coast Road), and then via the R315 (Darling-Yzerfontein Road). Two access points will be required off the R315, one to provide access to the WEF site portion located to the north of the R315, and the other for the section located to the south. The relevant internal farm roads onto and within the site will be upgraded where required prior to the commencement of the construction phase.

2.6 OPERATIONAL PHASE

2.6.1 Operational expenditure

The annual operating budget for the Rheboksfontein facility is estimated at R75 million per year (at current 2010 values).

2.6.2 Employment

Estimates provided by Moyeng Energy indicate that a total compliment of approximately 35 administrative, management, monitoring and maintenance staff will be required for the operation of the Rheboksfontein facility.

Moyeng Energy estimates that approximately 25% of opportunities will be available to skilled personnel (forecasters, technicians, management and supervisory, etc), 35% to semi-skilled personnel (drivers, equipment operators), and 40% to low skilled personnel (road maintenance, security, etc). The wage bill associated with the operational phase is estimated at R5.4425 million per year (current value).

Given the requirement of specialised skills, and that the wind energy sector in South Africa is relatively new, it may be necessary to import the required operational and maintenance skills from other parts of South Africa or even overseas.

2.6.3 Skills development and training

It is anticipated that direct training (by the manufacturers of the technology to be used) and skills transfers will be implemented as part of the project, specifically for the operational phase of the project. In this regard on-site training will be provided to all relevant personnel prior to commencement of the operational phase. The relevant training programmes will cater for wind resource technicians, maintenance personnel, plant operators, occupational health and safety aspects and environmental monitoring. The opportunities for members from the local community will be dependent upon their education levels.

2.6.4 On-site presence

Turbines are designed to operate continuously, unattended and with low maintenance for more than 20 years or >120 000 hours of operation. Once operating, a wind farm can be monitored and controlled remotely, with a mobile team for maintenance, as and when required. Information provided by Moyeng Energy indicates that no on-site staff presence will be required. Experience with other WEFs and similar facilities of this scale however indicates that a small, core, on-site staff component will likely be required. It is likely that these staff would be accommodated in Darling.

2.6.5 Other potential land uses on site

The footprint associated with the wind turbines and associated on-site infrastructure will occupy only a fraction of the WEF site. Continued utilisation of the remainder of the site for existing land uses and agri-residential purposes is envisaged. Restrictions on the erection of permanent structures within the 132 kV servitudes will apply, but continuation of existing land uses would otherwise be possible.

2.7 DECOMISSIONING PHASE

The turbine infrastructure is anticipated to have a lifespan of approximately 25-30 years. It is likely that turbines will be replaced with more modern ones at the end of their lifespan. Disassembling and replacement activities will require the transport of abnormal loads (cranes, new turbine components, removal of decommissioned components) to and within the Rheboksfontein site.

Decommissioned components will be removed from the Rheboksfontein site, and reused, recycled or disposed of in accordance with regulatory requirements. With the exception of the turbine blades, all turbine components can currently be reused or recycled. According to current legislation, infrastructure will have to be removed and the site rehabilitated once final decommissioning has occurred. According to current legislation, infrastructure will have to be removed and the site rehabilitated once final decommissioning has occurred.

2.8 OTHER WEF PROPOSALS IN THE AREA

At least one other (small) WEF development is currently being proposed in the vicinity of the Rheboksfontein site. The Oelsner Group is proposing to add an addition 16 turbines to the existing 4 x 1.3 MW turbine Darling Wind Demonstration Farm (operational since 2008). The capacity of the existing WEF will be increased to from 5.3 MW to 20.8 MW. The proposed Kerrie Fontein/ Darling project would consist of 6 turbines on the existing Darling Wind Farm site (Slangkop 552), and an additional 10 turbines on the adjacent Kerrie Fontein (Farm 555). The proposed Kerrie Fontein/ Darling site is located adjacent (to the north and west) to the proposed Rheboksfontein WEF.

Nordex N60 turbines, with tower heights of approximately 60m, are proposed. The development includes the establishment of one 33/132 kV substation on the site. Access to the site would be off the R27 (West Coast Road). It is anticipated that, pending approval, construction would commence in mid-2011 (EEU, 2010).

Figure 2.5 indicate the approximately location of the existing 4 wind turbines (red dots) and additional proposed 16 turbines (blue dots) in relation to the proposed Rheboksfontein WEF site (pink outline; proposed turbine locations indicated as pink circles).

Figure 2.5. Location of existing and proposed Kerrie Fontein/ Darling WEF wind turbines relative to Rheboksfontein site

SECTION 3: OVERVIEW OF THE STUDY AREA

3.1 INTRODUCTION

Section 3 provides a broad overview of the socio-economic environment affected by the proposed Rheboksfontein WEF, and includes:

- Overview of the study area, including the administrative context and road network;
- Overview of the land use and settlement patterns in the study area;
- Overview of the local socio-economic environment;
- Overview of potentially affected land uses in the study area.

3.2 STUDY AREA CONTEXT

3.2.1 Administrative context

The proposed Rheboksfontein WEF is located within the Swartland Local Municipality (LM) (WC015), and is one of five constituent B-Municipalities that make up the West Coast District Municipality (WCDM) (DC1). The Swartland LM is divided into 10 wards and consists largely of agricultural land and. A portion of the town of Darling falls under Ward 4. The remainder of Darling (including Nuwedorp), the town of Yzerfontein, and the coastal settlements of Jakkalsfontein, Grotto Bay and Ganzekraal fall under Ward 5. Ward 5 also includes the rural area around the relevant settlements. The Rheboksfontein WEF site is also located within the Ward 5 area.

Malmesbury (administrative seat of Swartland LM), Moorreesburg (administrative seat of the West Coast DM) and Darling are the most significant settlements in the area. Other settlements in the Swartland include Koringberg, Yzerfontein, Abbotsdale, Chatsworth and Kalbaskraal. The majority of settlements and the majority of the Swartland's population are concentrated in the southern part of municipal area (bordering onto the City of Cape Town (CCT).

A section of the proposed 132 kV line associated with the WEF is located within the extreme north-western portion of the CCT (Blaauwberg Planning District). The relevant section of the line portion follows an existing 400 kV transmission line corridor (Aurora-Atlantis line), which is aligned across a rural area to the north of the township of Atlantis, before cutting across a built up section of Atlantis.

3.2.2 Road network

Figure 3.1 illustrates the road network of the Swartland LM. The star indicates the approximate location of the Rheboksfontein WEF site.

Figure 3.1: Swartland Municipality Road Network

As indicated in Figure 3.1, the major roads in the study area include:

North-South aligned roads

- R27 (West Coast Road), linking Cape Town in the south to Saldanhna and Velddrif in the north. The R27 is located immediately to the west of the site and is a proclaimed scenic route;
- R307 (Old Darling Road), linking Darling in the north to Atlantis in the south (and from Atlantis, via the R304, to the M19 (Melkbosstrand-N7));
- N7 to the east of the site, which runs from Cape Town in the south to the South Africa-Namibia border in the north.

East-west aligned roads

- R315, linking Yzerfontein in the west, via Darling and Malmesbury, to the Riebeeck Valley in the east.

The northern section of the proposed Rheboksfontein WEF is traversed by the R315. The R315 serves as the main conduit for traffic between Darling and Malmesbury, and (via the R27) these towns and the high-growth profile towns of Saldanha and Vredenburg to the north, and the CCT to the south. The road also provides access to the coastal town of Yzerfontein.

3.3 LAND USES AND SETTLEMENT PATTERNS

3.3.1 Area in and around Rheboksfontein WEF site

The Rheboksfontein site is located in a rural area that falls within the Darling Hills. This picturesque landscape is dominated by gentle, rolling hills and broad valleys, punctuated by granite outcrops. With the exception of its extreme south-western portion, the Rheboksfontein site consists of land which has been used for agricultural purposes for well over two centuries (Photograph 3.1). Small remnants of natural renosterveld are limited to drainage lines, steep slopes and the small granite outcrops. However, the majority of the natural vegetation has been cleared to accommodate wheat and livestock farming (diary cattle and sheep). Many of the slopes in the area have been contoured as part of the wheat farming activities. In recent years vineyards (Rheboksfontein and Wildschutsvlei) and olive plantations have been established in the area (adjacent Alexanderfontein farm).

The settlement pattern essentially consists of farmsteads spaced at 2-4 km intervals to the north and south of the R315. Large trees in the landscape are limited to farmsteads, windbreaks, and lanes leading up to farmsteads. The majority of farmers in the area live on their farms. The labourers housing typically consists of clusters of structures located in close proximity to the farmsteads. The implementation of ESTA legislation[2] has however seen many farm labourer families relocated to Darling.

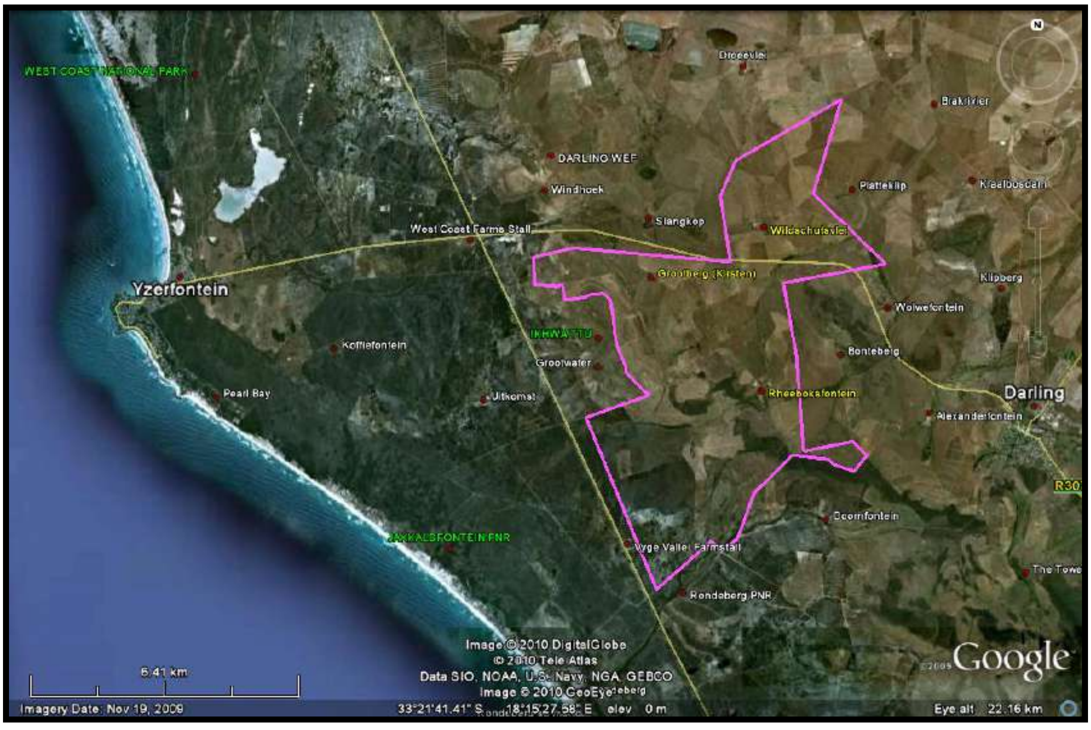

Figure 3.2. Farmsteads on and in the vicinity of the Rheboksfontein site

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[2] The Extension of Security of Tenure Act (Act 62 of 1997). The intention of the Act was to secure tenure for farm labourer families. In practice, implementation of the Act lead to shedding of farm workers not meeting the relevant qualifications. Urbanised farm workers are generally unprepared to compete in the semi-skilled and skilled urban job markets, and consequently unemployment and poverty levels are very high amongst these urban newcomers.

Photograph 3.1: View south from the R315 towards the farmstead on Alexanderfontein farm.

The area to the east and north-east of the site is relatively flat, and marks a transition into the Swartland, the region traditionally renowned as the "bread basket of the Western Cape". The landscape has been transformed by centuries of continuous cultivation. Wheat fields and pasturage still dominate the landscape in this area. In some areas, wheat farming is being replaced by viticulture.

The area towards the south and east of the site forms part of the Darling Hills (Photograph 3.4). Land use on the relevant adjacent farms, Doornfontein and Rondeberg, consists of conservation and livestock farming. Rondeberg is a Private Nature Reserve, and the owner has made a substantial investment in rehabilitating the veld and conserving the natural fynbos vegetation. Doornfontein is currently being developed as a private game reserve, potentially with châlets and other tourist facilities. The owners of both farms reside on the properties. The existing 400 kV Aurora-Atlantis transmission corridor traverses a small portion of Doornfontein, but is essentially located to the east of the property, while a cell phone tower is located on Rondeberg. A quarry established to provide aggregate for the construction of the R27 is located on the south-western portion of Rondeberg Hill. The quarry is clearly visible from the R27.

Photograph 3.4: Darling Hills area to the south of the WEF site.

The area to the west of the site, between the site boundary and the R27, makes up the western slopes of the Darling Hills. The area to the west of the R27 consists of low, lying sandy terrain associated with the coastal plain. The agricultural potential of the land in the sandy, coastal plain area is low.

The key land uses to the west of the site that stand to be affected by the proposed Rehboksfontein WEF include the Jakkalsfontein residential eco-estate and the !Khwa ttu San cultural and training facility. The Jakkalsfontein eco-estate is located along the coast to the west of the R27 and consists of approximately 100 up-market residential units. The estate forms part of the Jakkalsfontein private nature reserve, which covers an area of approximately 1700 ha. The !Khwa ttu San cultural and training facility is located on the farm Grootwater which is located between the R27, to the west, and the eastern boundary of the proposed Rehboksfontein WEF. The farm Grootwater covers an area of approximately 850 ha. The !Khwa ttu San cultural and training facility includes a restaurant and conference facility and also caters for game drives. Overnight accommodation is also provided for visitors.

Slangkop and Windhoek Farms are located to the north of the R315 and west of the R27. The settlement patterns on these on these farms are similar to those on the WEF site described above. In terms land uses, ostriches are farmed on Slangkop, while four wind turbines associated with the Darling Demonstration Wind Farm are located on Windhoek Farm (Photograph 3.5). The turbines are visible along stretches of the R315 and R27, as well as from the coastal settlement of Yzerfontein to the west. Established in 2008, these turbines represent some of the first wind turbines in

South Africa. Due to their novelty, the turbines have become a distinctive landmark in the Darling area.

Two farm stall complexes located off the R27 to the west of the Rheboksfontein site, namely Vygevallei (adjacent to the R27 opposite the turn-off to Jakkalsfontein) and the West Coast Farms Stall (at the R27/ R315 intersection). A number of agricultural smallholdings are also located on either side of the R315, west of the R27, towards Yzerfontein.

Photograph 3.5: View north-west from Slangkop towards existing Darling WEF on Windhoek Farm.

3.3.2 Coastal settlements

The coastal town of Yzerfontein is located approximately 8 km to the west of the WEF site at the western terminus of the R315. The town has also become a popular retirement destination and has grown rapidly over the past ten to fifteen years. Development is mainly along the coast towards the south. The upmarket Pearl Bay and Pearl Bay Heights development currently form the southernmost extension of the town. The popularity of the town is strongly linked to its proximity to Cape Town and towns in the Swartland and Boland.

A number of residential estates are located to the south of Yzerfontein. These include, from north to south, Tygerfontein, Jakkalsfontein Estate and Grotto Bay. Tygerfontein and Jakkalsfontein are located directly to the west of the R27 west of the Rheeboksfontein site. Grotto Bay is located approximately 11 km south-west of the Rheeboksfontein site. Ganzekraal Resort is located approximately 2 km further to the south.

Jakkalsfontein Estate, one of the first eco-estates in the country, consists of approximately 100 residential units located in a private nature reserve. Units are located in linear clusters set back behind coastal dunes. The Estate land consists of approximately 1700 ha of restored coastal fynbos, and offers unobstructed views from the residential units onto the Darling Hills (Photograph 3.6). Approximately 30-40% of units are occupied throughout the year. Peak occupancy is over summer (80-100%). Property prices in Jakkelsfontein range upwards from ~R5 million (Marais – pers. comm).

Photograph 3.6: View east onto the Rheboksfontein site (hilly area) from residential area on Jakkalsfontein Estate.

3.3.3 Darling

Darling, founded in 1853, is a quaint Swartland town, and nationally and internationally renowned for its spectacular spring wildflower displays. Views from the town towards the west and south-west are onto the Darling Hills, while the vistas to the north and east are take in the gently rolling plains of the Swartland (Photograph 3.7).

Photogrpah 3.7: View looking north towards town of Darling

The town clearly reflects the legacy of Apartheid planning, with the historical, “White” part of town located to the south of the Cape Town – Hopefield railway line, and the newer, “Coloured” Nuwedorp and the industrial part of town located to the north of the railway line.

The older part of town is laid out in a grid-pattern around the Dutch Reformed Church. A number of Victorian houses are located in the older part of town. Over the last 10-15 years the town has gained a reputation as popular destination for artists and people wanting to get away from the hustle and bustle of city life. Despite this the town has managed to retain a small town atmosphere. Houses are set on generously proportioned erven along broad streets, and high, impermeable walls around properties are the exception.

The town continues to function as an agricultural service centre for the well-established and productive agricultural sector in its hinterland. Manufacturing (textiles and agri-processing), which has traditionally provided employment opportunities to a significant number of townsfolk, have in the past decade declined or stagnated. However, the tourism sector of the town has developed significantly over the last 10 or so years.

3.4 SOCIO-ECONOMIC CONTEXT

3.4.1 Demographic

The data for Darling is based on data from the last Census count (Census 2001). Data includes the surrounding rural area.

Population

According to Census 2001 data, the total population of Darling (including surrounding rural area) was 7 544. As indicated in Table 3.1, the Coloured population group was overwhelmingly dominant (85%), with the White and Black groups only contributing 9% and 6% to the total respectively. Census 2001 data indicated that 92% of the population spoke Afrikaans as first language.

Table 3.1: Population for Darling (town and surrounding rural area)

Population Group	Darling	
	Number	%
Black African	432	6
Coloured	6 426	85
Indian or Asian	15	-
White	671	9
Total	7 544	100

Source: Census 2001

Education levels

As indicated in Table 3.2, according to Census data, approximately 29.5% of the study area population aged 20 years and older was estimated to be functionally illiterate/ innumerate in 2001. Given the strong correlation between education and skills levels, it may be assumed that a significant portion of the study area's working age population have only sufficient skills for elementary jobs.

Table 3.2: Darling education levels (20 years+)

Description	%
No schooling	8.5
Some primary	21
[% functional illiteracy/ innumeracy][3]	[29.5]
Complete primary	12
Some secondary	35.5
Std 10/Grade 12	16
Higher	7

[3] In the South African context, having obtained a primary qualification (i.e. having successfully passed Grade 7) is generally held as the absolute minimum requirement for functional literacy/ numeracy. The National Department of Education's ABET (Adult Basic Education and Training) programme provides education and training up to the equivalent of Grade 9. In this more onerous definition, Grade 9 is required as the minimum qualification for having obtained a basic education (www.abet.co.za).

Source: Census 2001

Employment levels

The employment statistics presented in Table 3.3 indicate that in 2001 55% of the study area population was employed. The unemployment rate was relatively low, viz. 8%. (The recorded Provincial average for 2001 was 17%). Given the agricultural context, seasonal unemployment is likely to be significant.

Table 3.3: Darling employment levels (15 – 64 age group)

Description	%
Employed[4]	55
Unemployed	8
Not Economically Active[5]	37

Source: Census 2001

Household income

Census data for 2001, presented in Table 3.4, indicated that a significant portion of households were living below the R1 600/ month minimum subsistence level (35.5%). Only 14.5% of households were earning more than R6400 per month.

Table 3.4: Darling Household income (by head of household)

Income per month	%
No formal income	7
R 1 – R 400	1.5
R 401 – R 800	9
R 801 - R 1 600	18
[% households below minimum subsistence level]	[35.5]
R1 601 - R 3 200	28
R 3 201 – R 6 400	22
R 6 401 – R 12 800	10
R 12 801 – R 25 600	4
R 25 601 and higher	0.5

Source: Census 2001

Sectoral employment

Table 3.5 provides an overview of proportional employment per economic sector by head of household for the relevant settlements. According to the data, most of the population was employed in the manufacturing sector (28%). Based on the authors knowledge of the area, it would be reasonable to assume that significant portion of associated employment opportunities are located in Malmesbury. Agriculture (15.5%) and Retail (15%) were the second and third greatest providers of

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[4] Census 2001 official definition of *an unemployed person*: "A person between the ages of 15 and 65 with responses as follows: 'No, did not have work'; 'Could not find work'; 'Have taken active steps to find employment'; 'Could start within one week, if offered work'." (www.statssa.gov.za).

[5] The term "not economically active" refers to people of working age not actively participating in the economy, such as early retirees, students, the disabled and home-makers.

employment opportunities. It may be assumed that both manufacturing and retail have strong links to the agricultural sector in the study area.

Table 3.5: Sectoral contribution to employment

Description	%
Agriculture, hunting, forestry and fishing	15.5
Mining and quarrying	-
Manufacturing	28.5
Electricity, gas and water supply	2.5
Construction	10.5
Wholesale and retail trade	15
Transport. Storage and communication	2.5
Fin., real estate and bus. Services	3.5
Community, social and personal services	15
Other and not adequately defined	-
Private households[6]	7

Source: Derived from Census 2001

3.4.2 Agriculture

Darling is located at the western extreme of the Swartland region and the area is an established productive commercial farming area. The Rheboksfontein site is located in the transition zone between the fertile soils of the Swartland, to the east, and the sandy soils of the coastal plain, to the west. Established agricultural activities in the Darling area include cereals, stock, vineyards and fodder crops. The large Lentefris diary is located in Darling.

Wheat and stock farming are the traditional agricultural activities in the region. However, wine grapes and olives have become increasingly important in recent years. In this regard the Darling Wine Route was established in 2004, and currently involves has 5 estates and wineries. Livestock farming with cattle is still undertaken on a number of farms (including large dairy herds on Grootberg and Wildschutsvlei). Stock theft in the area is largely restricted to sheep. While flocks continue to exist on most farms, the general trend is towards the gradual phasing out of sheep. Cultivation of marginal lands to the west of the Rheboksfontein site has essentially ceased. Limited stock farming continues, but agricultural activities have been replaced by conservation (Jakkalsfontein, Grootwater) and rural-residential land uses.

3.4.3 Tourism

Tourism forms a cornerstone of the Darling economy. The seasonal wildflower displays and the town's scenic setting at the foothills of the Darling Hills are the town's major assets. The Darling Tourism Association (serving the town and hinterland) currently has 60 registered members, including accommodation facilities

[6] This category mainly comprises domestic workers and gardeners.

such as guest houses, B&B's, self-catering facilities, guest farms, and a number of restaurants. The Darling area is best known for its seasonal wildflower displays (mid-July to mid-October), but also boasts of a number of well-established non-seasonal attractions such as "Evita se Perron" and the Duckitt orchid nursery. Peak tourist season in the Darling area coincides with the flower season. Five wildflower reserves are located in close proximity to Darling. Perhaps the best known of these, the Tienie Versfeld Reserve, which consists of a 10 ha area sandwiched between the R315 and the Rheboksfontein WEF site. The Tienie Versfeld is renowned for its flowering geophytes. The tourism sector has also been enhanced by a number of well attended events, such as the annual wildflower show, the annual orchid show, the "Rocking the Daisies" music festival and the ABSA off-road rally. The attraction of the town is also linked to its proximity to Cape Town (+- 80km).

The Darling Wine Route, the first certified "Biodiverse Wine Route" in the country, draws visitors throughout the year. The route is located from Darling towards the south and east, and thus does not traverse the Rheboksfontein site.

The R27 functions as an important tourism route in the West Coast region, linking Cape Town in the south to a number of important tourist destinations within the West Coast. These include a number of resorts, the West Coast National Park (north of Yzerfontein), and the seaside settlements and towns of Yzerfontein, Langebaan, destinations on the Vredenburg Peninsula (Paternoster), and Velddrif. Tourist flows into the Darling area appear to be split approximately 50/50 between those accessing the town from the R27/ R315 and those accessing the town from the R27/ R307. Tourist flows from the eastern portion of the Swartland (Riebeeck Valley) appear limited at this stage (le Roux – pers. comm). The Rheboksfontein WEF site is located at one of the gateways to the town, namely the R27/ R315.

The !Khwa tuu San culture and training centre is located on the farm Grootwater off the R27, adjacent to the Grootberg portion of the Rheboksfontein site.!Khwa tuu provides a range of tourism-orientated activities (guided walks, game viewing) and facilities (50 bed accommodation, a restaurant, shop and interpretative centre). !Khwa tuu receives approximately 15 000 visitors per year, and provides permanent employment to 25 people. Revenue from tourist plays an important role covering the operating costs of the centre.

3.4 POTENTIALLY AFFECTED LAND USES

A description of the study area, including dominant land use and settlement patterns was provided under Section 3.3 above. This section provides specific information with regards to the properties constituting the Rheboksfontein WEF site and the proposed 132 kV line alignment.

3.4.4 Rheboksfontein WEF site

A summary of ownership, land use, associated employment and tenure for the relevant properties is provided in Table 3.6 below.

Table 3.6. Overview of WEF site properties

Landowner	Property [7]	Land uses	Owner resident	Dedicated Labour / associated tenure
Basson, Mr. Theo	Rheboksfontein; Wildschutsvlei	• Vineyard (250 ha); • Dairy cattle (700); • Beef cattle; • Small stock; • Limited wheat and fodder crops	Yes, resident on Rheboksfontein	• 240 permanent employment opportunities; • Additional 60 seasonal opportunities; • 4 clusters of labourer's houses on two farms.
Kirsten, Mr. Johan	Grootberg	Mixed farming, mainly wheat and dairy cattle.	Yes	• 14 permanent employment opportunities; • 50/50 split between workers residing in Darling and on Grootberg.

3.4.5 132 kV line

As discussed in Section 2.3.3, the proposed 132 kV line is approximately 34 km in length, and largely follows the alignment of the existing Aurora-Atlantis 400 kV transmission line corridor. The corridor currently accommodates two 400 kV lines.

The initial ~4 km of the proposed alignment is relevance to the SIA. A short (~2 km) linking section between the Rheboksfontein WEF and the existing transmission line corridor traverses land on Bonteberg and Alexanderfontein Farms. Both farms belong to Mr. Nico Basson, and are farmed as part of a single mixed farming operation. Mr. Basson resides on Alexanderfontein. The relevant area which would be traversed by the relevant 132 kV line segment consists of high potential soils (T Basson –pers. comm). A further ~2 km section along the existing 400 kV corridor traverses established olive groves located on Alexanderfontein. South of Alexanderfontein, the alignment traverses a patchwork of land used for pasture and wheat farming, as well as natural veld located on the farms Smalpad, Groote Post and Klawervlei. The final 20 km of the proposed alignment is across the dune fields north of Atlantis and the periphery of Atlantis township.

[7] See: Section 2.2.1 for details regarding the relevant cadastral portions constituting the relevant Farms.

SECTION 4: POLICY AND PLANNING CONTEXT

4.1 INTRODUCTION

Legislation and policies reflect societal norms and values. The legislative and policy context therefore plays an important role in identifying and assessing the potential social impacts associated with a proposed development. In this regard a key component of the SIA process is to assess the proposed development in terms of its fit with key planning and policy documents. As such, if the findings of the study indicate that the proposed development in its current format does not conform to the spatial principles and guidelines contained in the relevant legislation and planning documents, and there are no significant or unique opportunities created by the development, the development cannot be supported.

This section provides an overview of the most pertinently significant policy documents of relevance to the proposed Rheboksfontein WEF, namely:

- The White Paper on Renewable Energy (2003);
- Climate Change Strategy and Action Plan for the Western Cape (2008);
- White Paper on Sustainable Energy for the Western Cape (Final Draft, 2008);
- Strategic Initiative to Introduce Commercial Land Based Wind Energy Development to the Western Cape. Towards a Regional Methodology for Wind Energy Site Selection (2006);
- The Western Cape Provincial Spatial Development Framework (2009);
- Guideline for the Management of Development on Mountains, Hills and Ridges in the Western Cape (2002);
- The Swartland Integrated Development Plan (IDP) (2007-2011);
- The Swartland Local Economic Development Strategy (2007).

Section 4.5 also provides a summary of some of the key social issues associated with wind farms based on international experience. The findings of the review concentrate on three documents, namely the National Wind Farm Development Guidelines produced by the Environment Protection and Heritage Council (EPHC) of Australia (Draft, July, 2010), recent research on wind energy development in Scotland undertaken by Warren and Birnie in 2009 (Warren, Charles R. and Birnie, Richard V. (2009) 'Re-powering Scotland: Wind Farms and the 'Energy or Environment?' Debate', and a review of the potential health impacts associated with wind farms undertaken by the Australian Health and Medical Research Council (July, 2010).

4.2 NATIONAL LEVEL ENERGY POLICY

4.2.1 The National White Paper on Renewable Energy

The White Paper on Renewable Energy (further referred to as the White Paper) supplements the *White Paper on Energy Policy*, which recognizes that the medium and long-term potential of renewable energy is significant. This Paper sets out

Government's vision, policy principles, strategic goals and objectives for promoting and implementing renewable energy in South Africa.

Apart from the reduction of greenhouse gas emissions, the promotion of renewable energy sources is aimed at ensuring energy security through the diversification of supply. Government's long-term goal is the establishment of a renewable energy industry producing modern energy carriers that will offer in future years a sustainable, fully non-subsidized alternative to fossil fuels. The medium-term (10-year) target set in the White Paper is:

10 000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar and small-scale hydro. This is approximately 4% (1667 MW) of the projected electricity demand for 2013 (41539 MW) (Executive Summary, ix).

4.3 PROVINCIAL LEVEL ENERGY AND SPATIAL POLICY

4.3.1 Climate Change Strategy and Action Plan for the Western Cape (2008)

The Climate Change Strategy and Action Plan (Final Draft, December 2008) was commissioned by the Western Cape Department of Environmental Affairs and Development Planning (DEA&DP). The document is aligned with the Western Cape Sustainable Development Strategy, and gives expression to Provincial Government of the Western Cape's (PGWC) acknowledgement that the Western Cape will inevitably be affected by climate change, and thus needs to timeously set in place a sound foundation for future climate change responses in the province.

The document consists of two sections. The first section examines climate change and socio-economic factors in the Western Cape, and establishes the need for a climate change response in the region. The second section outlines the key aspects of the Western Cape's response strategy.

Key points of specific relevance to the current Rheboksfontein WEF proposal are the following:

The need for a climate change response in the Western Cape

- South Africa is currently ranked as the 19th greatest emitter of greenhouse gasses (absolute terms) in the world;
- While the Western Cape's local direct emissions are relatively low, this is largely the result of the province importing most of its electricity (~90%), mainly from Mpumalanga;
- There is little doubt that the Western Cape will experience the effects of human-induced climate change in the near future, possibly as early as 2030. Current predictions indicate that the Western Cape will generally become hotter and drier. Predictions indicate a mean increase in temperature of at least 1 °C by 2050. Higher mean temperatures will have negative consequences for rainfall (frequency, amount) as well as the soil's ability to retain moisture. Periods of drought are anticipated to become more frequent and intense. Drier, hotter conditions will also increase the risk of more frequent, more severe fires;
- Predicted hotter and drier conditions hold significant risks to the Province's key economic sectors and associated livelihoods. Compromised growing conditions and less water available for irrigation will negatively affect the agricultural sector

– with massive negative implications for the regional economy, employment as well as regional food security. Increased sea surface temperatures will likely impact negatively on fish stocks. The tourism sector is likely to suffer from changes in the landscape amenity;

- For these reasons the province need to be committed to doing its share to stabilize or reverse the current trend in global warming;
- With regard to the current situation, the Western Cape's energy **infrastructure** has demonstrated its reduced capacity to sustain cumulative impacts. The failure in supply of high quality energy that the province relies on, has high social and economic costs, as most of it needs to be imported from coal-burning power stations over very long distances;
- In terms of the Kyoto Protocol, South Africa, as a developing nation, does not have to take active steps to mitigate its carbon emissions. However, valuable export markets in the European Union are already starting to impose carbon emission reduction targets on their suppliers. The Western Cape, whose important agricultural sector is to a large extent export-orientated (wine, fruit) stands to lose market share on agricultural goods, for example, if no attempt is to be made to achieve at least carbon neutrality (no net emission of carbon for a produced good).

The response strategy and action plan

- The Province's response strategy and associated action plan is based on two thrusts, namely adaptation and mitigation;
- Four programmes are prioritised. Of specific significance to the development of renewable energy resources, the reduction of the Province's carbon footprint is identified as the key mitigatory response. Associated strategies include promotion of energy efficiency (including demand management), the development of renewable and alternate sustainable energy resources, effective waste management strategies, and cleaner fuel programmes for households and transport;
- Solar and wind energy are identified as the most suitable renewable technologies for the Western Cape. No development targets are set.

4.3.2 White Paper on Sustainable Energy for the Western Cape

The White Paper on Sustainable Energy compliments the Climate Change Strategy and Action Plan, specifically by i.a. setting targets for renewable energy generation. The White Paper is currently in Final Draft form. Once approved by Provincial cabinet, it will constitute the formal Western Cape's policy document on which the Western Cape Sustainable Energy Facilitation Bill will be based. The purpose of the White Paper and the envisaged Bill is to create an enabling policy environment in the Western Cape in order to promote and facilitate energy generation from renewable sources, as well as efficient energy use technologies and initiatives.

The White Paper forms part of PGWC's strategy to aimed at removing a number of barriers (e.g. energy pricing, legal, institutional, low levels of investment confidence, insufficient knowledge) currently frustrating the province's energy goals by preventing the adoption and commercialization of clean energy (including electricity generation from renewable sources such as wind and solar) technologies and initiatives. The White Paper notes that, with regard to sources of renewable energy, wind and solar both represent commercially viable options in the province. The document proposes that special focus should be given to these renewables subsectors and specific associated technologies in particular in order to achieve critical mass of installation, and thus drive down establishment costs and ensure permanent employment opportunities.

In terms of targets, the PGWC agreed to targets for electricity from renewable sources and for energy efficiency to be achieved by 2014. Of these, two are of direct relevance to the proposed Rheboksfontein WEF:

- Target for electricity generated from renewable sources: *15% of the electricity consumed in the Western Cape will come from renewable energy sources in 2014, measured against the 2006 provincial electricity consumption* (p. 21)
- Target for reducing carbon emissions: *The carbon emissions are reduced by 10% by 2014 measured against the 2000 emission levels* (p. 23).

4.3.3 Western Cape Regional Methodology for Wind Energy Site Selection

The document focuses specifically on the siting of wind energy facilities. Some of the key findings and recommendations that have a bearing on the study are briefly summarized below.

Cumulative Impact Issues

The experience in Europe is that the very high cumulative impact of wind farms has resulted due to a policy of permitting small (wind) energy schemes in relatively close proximity to each other (only 2.5km in Denmark).

As a result the document recommends that:

- Large installations should be located extremely far apart (30 – 50km), and;
- Smaller installations should be encouraged in urban/ brownfield areas.

In this regard, it should be noted that an existing WEF, the Darling WEF, is located approximately 1-2 km to the north and west of the proposed Rheboksfontein site. The existing facility currently consists of 4 turbines; erection of an additional 16 is planned (see: Section 2.7).

Recommended Disturbed Landscape Focus

In addition to proposing that smaller facilities should be focused in urban/ brownfield areas, the proposed methodology further recommends focusing on existing disturbed rural landscapes, and in particular, those rural landscapes that have already been “vertically compromised” by the location, for example, of transmission lines, railway lines, and all phone towers. In this regard, the Rheboksfontein WEF site is flanked by the R27 the west, and traversed by the R315 in the north. Existing vertical disturbances to the landscape include 2 x 400 kV lines, which traverse a portion of the site from north to south, a cell phone tower on Rondeberg, a wind monitoring mast on Rheboksfontein, and 4 x existing wind turbines on Windhoek Farm. The general sense of place may however be described as rural/pastoral. Commercial farming and conservation land uses are currently located on and around the site.

Protecting Rural Landscape Values (put after "Urban Emphasis)

The document notes that in Europe in the past, a great degree of emphasis was given to quantifying views from residential locations. This policy emphasis has effectively led to pushing WEF projects into more "remote" rural locations. The study notes that in the SA context this policy would effectively "penalizing" rural areas, and compromising wilderness and touristic visual values. In this regard, the proposed Rheboksfontein site is located in rural area of significant scenic value, namely the Darling Hills.

The Western Cape Provincial Government is currently in the process of considering applicable zoning for solar and wind energy facilities, but as far as could be established, no directives have been finalized in this regard.

4.3.4 Western Cape Provincial Spatial Development Plan

The Western Cape Provincial Spatial Development Framework (PSDF)(2009) has statutory status. The PSDF is a long-term planning instrument, which is to be reviewed every five years. The next revision is due in 2014.

The PSDF, and specifically the objectives and directives contained in it, are aimed precisely at sustainable development guidance, as applicable to the spatial development situation prevailing in the Western Cape at present.

The following key objectives identified by the PSDF are of specific relevance to the proposed Rheboksfontein WEF development:

Objective 5: Conserve the sense of place of important landscapes

The PSDF notes the vital importance of tourism to the Provincial economy. The PSDF therefore stipulates that, with regard to the siting and design of future power lines and other visibly substantial infrastructural development, the relevant provincial guidelines should be followed, and proposals should include provision for environmental, visual and heritage impact assessments.

Two policy directives are of direct relevance to the proposed WEF:

Transmission lines and wind farms

HR26 *(...) transmission lines (...) should be aligned along existing and proposed transport corridors rather than along point to point cross-country routes.* (Mandatory directive)

With the exception of a short (~2 km) linking section, the proposed 132 kV power line corridor from the Rheboksfontein WEF to the Atlantis substation will follow the existing Aurora-Atlantis 400 kV corridor.

HR27 *Wind farms should be located where they will cause least visual impact, taking into consideration the viability of the project.* (Guiding directive)

The proposed Rheboksfontein site is located in an area that has wide expansive views that are of high scenic value. The R315, and especially the R27, carry high volumes of tourist traffic.

Objective 9: Minimize Consumption of Scarce Environmental Resources

In line with national government's Climate Change Response Strategy, the PSDF makes provisions for a strategy based on demand management and the development of renewable resources. The PSDF proposes that 25% of the Province's energy generation should consist of renewables by 2020.

4.3.5 Guideline for the Management of Development on Mountains, Hills and Ridges in the Western Cape

The key aspects reflected in the Guidelines that have a potential bearing on the proposed Rheboksfontein WEF development are listed below:

The aim of the Guideline is to provide a decision-making framework with regard to developments, which include listed activities in terms of NEMA Regulations, and which are proposed in an environment, which is characterised by mountains, hills and ridges.

The Guideline notes that mountains, hills and ridges are subject to a range of development pressures. A guiding framework is therefore needed to control development in these areas, they may generally be characterized as environmentally sensitive. Key reasons listed are:

- Provide catchment areas for valuable water resources;
- Often characterized by unique and sensitive ecosystems;
- Have aesthetic / scenic value;
- Provide “wilderness” experience opportunities.

The Guideline defines a mountain, hill or ridge as ‘a physical feature that is elevated above the surrounding landscape’.

The Guideline is divided into 2 sections. The second deals with key decision-making criteria, which need to be taken into account when adjudicating the suitability of developments in such areas. Key criteria, which are of specific relevance to the proposed Rheboksfontein WEF include:

- Development on the crest of a mountain, hill or ridge should be strongly discouraged;
- Avoid inappropriate development on mountains, hills and ridges, taking into account the character of the existing environment;
- Preserve landform features through ensuring that the siting of facilities is related to environmental resilience and visual screening capabilities of the landscape;
- Adopt the precautionary principle to decision making;
- Ensure that the scale, density and nature of the activities or developments are harmonious and in keeping with the sense of place and character of the area;
- The criteria used to assess developments in these areas include, amongst others, density of the development, aesthetics, location, value in terms of “sense of place”, character of adjacent land use, character of the general area, and cumulative impacts which may arise from other existing and planned developments in the area;
- Development on steep slopes (steeper than 1:4) will be strongly discouraged. As a general principle development should be located on lower-lying or gently sloping portions of the site.

It should be noted here that the proposed Rheboksfontein WEF and a portion of the associated 132 kV line is located in an area known as the Darling Hills. The scenic value of the area is widely recognised. A number of wind turbines are currently proposed on elevated portions of the Rheboksfontein WEF site.

4.4 MUNICIPAL LEVEL DEVELOPMENTAL AND SPATIAL POLICY

4.4.1 Swartland Integrated Development Plan (2007-2011)

The Swartland Integrated Development Plan (IDP) for 2007 – 2011 was finalized in May 2007. Discussion here is based on the “Strategic Summary” version of the IDP document.

The IDP document does not make any reference to renewable energy resources. The following aspects of the IDP are of particular relevance to the proposed Rheboksfontein WEF:

- **Darling not identified as future growth node**

  It is anticipated that medium to long term industrial growth and development in the Swartland will be focused along the Malmesbury-Cape town axis, and mainly along the N7 corridor. Lateral expansion of the N7 corridor is anticipated to be eastwards towards the R302, and westwards towards Atlantis. Darling is not identified as a significant future growth node or forming part of any potential development axes. Darling is identified as a third level priority (after Malmesbury and Moorrreesburg) node for industrial development in the Swartland. Specifically the promotion of light, mainly agriculturally-orientated development is recommended, on both upgraded existing premises as well as on new premises

- **Strategic importance of R315**

  The R 315 between Darling and Malmesbury carries significant traffic loads. The road also provides access to Darling, which has an important tourism sector. The R315 Riebeeck-Kasteel-Yzerfontein route has been identified as a primary scenic/tourism route. In this regard, the Rheboksfontein WEF site directly affects approximately 12km of the R 315.

- **R27 as regional transport corridor**

  The R27 West Coast road (Cape Town-Velddrif), along with the N7, are identified as the two regional transport corridors in the Swartland. The R27 serves as the major conduit for traffic between the high development profile towns in the adjacent Saldanha Bay Municipality (Saldanha, Langebaan and Vredenburg) and the southern portion of the Swartland, including Malmesbury. The R315 provides a directly link from the R27 to Darling. Access to the R27 from Malmesbury is via Darling.

- **Darling/ Yzerfontein area as significant tourism anchors**

  Together with the Riebeeck Valley area, Darling and Yzerfontein are identified as the primary tourism anchors within the Swartland. Darling’s attractiveness is identified as mainly socio-cultural, while that of Yzerfontein as natural. The IDP notes that, from a strategic perspective, these areas must be prioritized in terms of tourism development. Any future tourism development strategy should be based on strengthening existing tourism assets and attractions. Both the R27 and R315 are acknowledged as significant tourism conduits. Proper maintenance of these roads and the development of tourism infrastructure, including signage, are recommended along these routes.

- **HIV/Aids and TB**

  Basic health: HIV/ Aids and tuberculosis (TB) are identified as the two main health issues in the Swartland. Physical access to anti-retroviral (ARV) services is identified as a major constraint. Currently, the only available service for the Swartland is in Malmesbury.

- **Skills development and soft economic growth strategy for Darling area**

  The IDP identifies a focus on agri-tourism as the appropriate development strategy for the Darling area. The document notes that existing assets and attractions should be utilized, and that training and skilling strategies should focus on agri-tourism, arts and crafts and associated entrepreneurship. The document notes that tourism as an economic sector has a number of advantages. These include that it does not always require large capital investment to establish; that complementary attractions can be created relatively easily, and that, once a primary attraction has been established, it is a predominantly labour intensive industry.

  In addition, the supplementary development of metalworking, construction and carpentry skills should also be promoted within the context of the promotion of the light industrial sector in Darling.

4.4.2 Swartland Municipality Local Economic Development (LED) Strategy

The document notes that the Swartland is in direct competition with the CCT to attract new residents and industries, while maintaining existing residents and industries. As such it is imperative that the comparative advantages currently enjoyed by the Swartland be maintained. These include the quasi-rural sense of place, availability of land, road infrastructure linking the Swartland to the CCT and better value for money to prospective home-owners should not be jeopardized by inappropriate growth and development in the Swartland.

4.4.3 City of Cape Town First Draft Blaauwberg Planning SDP/ EMF

A segment of the proposed 132 kV line alignment is located within the north-westernmost portion of the City of Cape Town (CCT). The relevant segment follows an existing 400 kV transmission line corridor (Aurora-Atlantis line), which is aligned across a rural area north of the township of Atlantis, and across a portion of urban Atlantis. The relevant area is located within the CCT's Blaauwberg Planning District.

The Blaauwberg Planning District Draft Spatial Development Plan/ Environmental Management Framework (SDP/ EMF) is the most relevant planning document with regard to the relevant area. The document forms part of the CCT's Metro-wide SDF process (currently in progress). Only a First Draft (September 2009) version of the Blaauwberg SDP/ EMF is currently available.

The provisions of the SDP/ EMF are spatially expressed in a set of Zone Maps. The relevant Urban Uses and Utilities Zone Map (B6) indicates that the entire length of the relevant segment of the proposed 132 kV alignment coincides with a corridor reserved for the placement of electrical power lines.

4.5 INTERNATIONAL EXPERIENCE WITH WIND FARMS

4.5.1 Introduction

This section summarises some of the key social issues associated with wind farms based on international experience. The findings of the review concentrate on three documents.

The first is the National Wind Farm Development Guidelines produced by the Environment Protection and Heritage Council (EPHC) of Australia (Draft, July, 2010). The guidelines highlight the potential social and biophysical impacts associated with WEFs. Given the similarities between South Africa and Australia, such as large, unobstructed landscapes and climates, these guidelines are regarded as relevant to the South Africa situation.

The second relates to recent research on wind energy development in Scotland undertaken by Warren and Birnie in 2009 (Warren, Charles R. and Birnie, Richard V.(2009) 'Re-powering Scotland: Wind Farms and the 'Energy or Environment?' Debate'). The Scottish experience is also regarded as relevant to the South Africa context for a number of reasons. Firstly, installed wind power capacity has expanded rapidly in Scotland over the past decade. Before 1995 no wind farms existed. By late 2008, there were 59 operational onshore wind farms, 65 consented to or under construction and a further 103 in the planning process (BWEA, 2008). South Africa faces a similar situation, with a rush of applicants seeking approval for WEFs. Secondly, the impact on the landscape, specifically the Scottish Highlands, was one of the key concerns raised in Scotland. The impact on undeveloped, natural landscapes is also likely to become an issue of growing concern in South Africa. The key points raised in the article by Warren and Birnie that are relevant to South Africa are summarized below.

The third document is a review of the potential health impacts associated with wind farms undertaken by the Australian Health and Medical Research Council (July, 2010).

4.5.2 National Wind Farm Development Guidelines (Australia)

The Environment Protection and Heritage Council (EPHC) of Australia developed a set of guidelines for the establishment of Wind Farms (National Wind Farm Development Guidelines, DRAFT - July 2010). The section below summarises the key social issues listed in the guidelines.

Wind Turbine Noise
The guidelines note that excessive noise may cause annoyance, disturbance of activities such as watching TV, or sleep disturbance when received at a noise-sensitive location such as a dwelling. At higher levels, environmental noise has been linked to long-term health issues such as raised blood pressure and cardiovascular disease.

With regard to WEFs, the noise produced by wind turbines is associated with their internal operation and the movement of the turbine blades through the air. The noise levels associated with a WEF are dependant on a number of factors, including, the number of turbines operating, wind speed and direction. Noise levels diminish with distance from the wind farm. The guidelines also note that a unique characteristic of wind turbines is that while noise emission increase with increasing wind speed, this is also often, but not always, accompanied by an increase in the background noise environment. The background noise is associated with wind blowing past or through objects, such as trees or buildings. As a result, the background noise near a dwelling may be high enough to 'mask' the sound of the turbines.

Concerns have also been raised regarding the potential health impacts associated with low frequency noise (rumbling, thumping) and infrasound (noise below the normal frequency range of human hearing) from wind farms. The guidelines indicate that low frequency noise and infrasound levels generated by wind farms are normally at levels that are well below the uppermost levels required to cause any health effects. This issue is addressed in the review undertaken by the Australian Health and Medical Research Council (July, 2010).

Noise monitoring

With regards to monitoring, the guidelines recommend that the operational phase of the wind farm should include unattended post-construction noise monitoring for a sufficient period of time to demonstrate compliance with the noise criteria under expected worst-case conditions.

The Guidelines also recommend that a procedure should be developed, prior to construction activities commencing, to handle any complaints of construction noise. Similar procedures should concurrently be developed for implementation during operations and decommissioning stages. Complainants should be requested to keep a diary or sound log where they can note times of day and associated weather conditions when wind farm noise emission are found to be a problem. The sound log can also include a description of the type of sound heard. This information can then be used to help try and identify meteorological conditions, particularly wind speed and direction, where the wind farm noise emission is most problematic.

Landscape Impacts

The guidelines notes that due to the size and layout of wind turbine towers, the construction of WEFs will impact upon the landscape and its significance. Therefore, the significance of landscape values, and the extent of the impact, should be assessed. In this regard the impact of a wind farm on a landscape is not necessarily just visual – other 'values' can also be affected. Community values and perceptions of landscape may include associations, memories, knowledge and experiences or other cultural or natural values (National Wind Farm Development Guidelines, DRAFT - July 2010). Therefore, the assessment should consider the impact on landscape values in addition to considering the visual impacts.

The guidelines also note that landscapes change over time, both naturally and through human intervention. In addition, landscape values, being subjective, change not only with time, but also from person to person. As a result there are a wide variety of opinions of what is valued and what is not. The perceptions by which we value landscapes are influenced by a range of factors such as visual, cultural, spiritual, environmental, and based on memories or different aesthetics (National Wind Farm Development Guidelines, DRAFT - July 2010).

Shadow flicker

Shadow flicker is produced by wind turbine blades blocking the sun for short periods of time (less than 1 second) as the blades rotate causing a strobing effect. Since wind turbines are tall structures, shadow flicker can be observed at considerable distances but usually only occurs for brief times at any given location. The most common effect of shadow flicker is annoyance.

The likelihood of shadow flicker affecting people is dependant on the alignment of the wind turbine and the sun, and their distance from the wind turbine. The main risk associated with shadow flicker is the potential to disturb residents in the immediate vicinity. The Guidelines note that the investigations undertaken when developing the Guidelines indicated that the potential risk for epileptic seizures and distraction of drivers is negligible to people living, visiting or driving near a wind farm.

Mitigation measures
Where shadow flicker is an issue the following mitigation measures can be implemented.

- Plant screening vegetation between their property and the turbine(s);
- Install heavy blinds or shutters on affected windows.

The Guidelines also recommend that the issue of shadow flicker should be addressed in the design and layout of the wind farm.

Electromagnetic Interference (EMI)
Wind turbines can produce electromagnetic interference (EMI), in two ways. Firstly in the form of an electric and magnetic (electromagnetic) field that may interfere with radio communications services, and secondly, due to the obstruction of radio communications services by the physical structure of the wind turbines. Microwave, television, radar and radio transmissions are all examples of radio communication signals that may be impacted by the development of a wind farm.

Blade glint
Blade glint can be produced when the sun's light is reflected from the surface of wind turbine blades. Blade glint has potential to annoy people.

Cumulative impacts
The Guidelines note that the cumulative impact of multiple wind farm facilities in a region is likely to become an increasingly important issue for wind farm developments in Australia. This is also likely to be the case in South Africa. The assessment of cumulative impacts is also required for additional phases of existing or approved wind farms. The Scottish Natural Heritage (2005) describes a range of potential cumulative landscape impacts of wind farms on landscapes, including:

- Combined visibility (whether two or more wind farms will be visible from one location).
- Sequential visibility (e.g. the effect of seeing two or more wind farms along a single journey, e.g. road or walking trail).
- The visual compatibility of different wind farms in the same vicinity.
- Perceived or actual change in land use across a character type or region.
- Loss of a characteristic element (e.g. viewing type or feature) across a character type caused by developments across that character type.

The guidelines note that cumulative impacts need to be considered in relation to dynamic as well as static viewpoints. The experience of driving along a tourist road, for example, needs to be considered as a dynamic sequence of views and visual impacts, not just as the cumulative impact of several developments on one location. The viewer may only see one wind farm at a time, but if each successive stretch of the road is dominated by views of a wind farm, then that can be argued to be a cumulative visual impact (National Wind Farm Development Guidelines, DRAFT - July 2010).

Cumulative impacts may be visual and aesthetic, but they can also occur in relation to non-visual values about landscape. Non-visual values include sounds/noise, associations, memories, knowledge and experiences or other cultural or natural values. As an example, the Guidelines indicate that locating four wind farms in a valley previously best known for its historic wineries might change the balance of perception about the valley's associational character, irrespective of whether all four wind farms were sited in a single viewshed (National Wind Farm Development Guidelines, DRAFT - July 2010).

The Guidelines also note that the rapid expansion of wind energy sector also has the potential for consultation "fatigue", specifically in areas where more that one WEF is proposed. An abundance of community meetings, information sessions or materials about various developments, may result in community members tiring of attending local events or engaging in local discussions or activities.

Mitigation
The Guidelines indicate that mitigation measures for wind farms are very and therefore **general location** and **site selection** is of utmost importance.

4.5.3 Experience from Scotland and Europe

The information summarized below is based on research on wind farms undertaken by Warren, Charles R. and Birnie, Richard V published in the Scottish Geographical Journal in 2009.

Institutional capacity and strategic guidance
The research found that the rapid establishment of numerous large wind farms in Scotland has proved highly controversial. From around 2002, the potential negative impacts of wind farm developments have been the highest profile environmental issue in Scotland, generating extensive media coverage.

The experience in Scotland indicated that the speed of the wind power 'gold rush' took everyone by surprise – politicians, planners, scientists, land managers, conservationists and the public alike. As a result a severe burden was placed in officials and related planning and development control procedures. In addition, officials and planners had very few specific criteria for assessing proposals, notably because of the lack of overall strategic locational guidance. Basic data on most aspects of wind farm development, including environmental impacts, is limited and short term. As a result the debates regarding wind farms often degenerated into exchanges of claims and counter-claims that were typically long on assertion and short on evidence.

The potential for a similar situation to develop in South Africa is high. In addition, the lack of a National set of Guidelines for Wind Farms and spatial information on sensitive landscapes is a concern.

Landscape Impacts
In the Scottish case, the primary argument employed to oppose wind farms related to the impact on valued landscapes. As in the South African case, the visual impacts are exacerbated by the fact that the locations with the greatest wind resources are often precisely those exposed upland areas which are most valued for their scenic

qualities, and which are often ecologically sensitive. The establishment of wind farms together with the associated service roads and infrastructure, transforms landscapes which are perceived to be natural into 'landscapes of power' (Pasqualetti et al., 2002, p. 3).

Impacts on Tourism

In addition to the loss of amenity for those who live and work nearby, the concern was that wind farms would damage the Scottish tourist industry. The paper notes that Scotland's image as a country of magnificent, varied, unspoilt scenery is a major reason why tourists come here. The concern raised is that wind farms will cause tourists to stay away by tarnishing that image. The same argument could be applied to South Africa. However, the paper notes that, "so far, however, there is no clear evidence to support this assertion". In this regard far more visitors appeared to associate wind farms with clean energy than with landscape damage, suggesting that they could help to promote Scotland's reputation as an environmentally friendly country as long as they are sensitively sited (NFO System Three, 2002). In addition, some tourists may choose to avoid areas with wind farms, but on current (albeit limited) evidence, wind farms seem unlikely to have more than small, localised impacts on tourism. However, the paper notes that this could change as more are built.

The key lesson for South Africa is this regard is that wind farms should be located in areas that minimise the potential impact on landscapes and as such also reduce the potential impact on tourism. This highlights the need for spatial information on sensitive landscapes.

Noise impacts

The study found that early wind turbines were criticised for being noisy, and this reputation has stuck. However, the research found that modern designs are remarkably quiet, allowing normal conversation underneath a working turbine. The paper notes that at a distance of 350 m, wind farms generate a noise level of 35–45 decibels (dB) (cf. a busy office: 60 dB; a quiet bedroom: 35 dB), and this is often difficult to detect above normal background sounds such as the noise of the wind (SDC, 2005). Research by Krohn and Damborg (1999) indicated that turbine noise affected very few people, however, for those few the impact can be significant.

Explaining Public Perceptions of Wind Farms

Research found that the media coverage in Scotland relating to wind farms gives the impression that the majority of the public are strongly opposed to this form of renewable energy. However, every survey of public attitudes, from the earliest days of wind power onwards, has found just the opposite. Both in the UK and across Europe, large majorities (often around 80%) support renewable energy generally and wind power specifically (Krohn & Damborg, 1999; Devine-Wright, 2005a; SDC, 2005; Wolsink, 2007b). The research therefore found that the strong, consistent support is at odds with the widespread local opposition.

The research also found temporal and spatial patterns in attitudes. In this regard, attitudes to wind farms often followed a U-shaped progression over a period of time (Gipe, 1995; Wolsink, 2007a). The initial positive support of the concept (when no nearby schemes are planned) became more critical when a local wind farm was proposed. This opposition then shifted towards more positive attitudes once locals had experienced the wind farm in operation. In this regard several studies found that the strongest support for wind farms is amongst those who have personal experience of them (Fullilove, 2005) and/or those living closest to them (Braunholtz, 2003;

Elliott, 2003; SEI, 2003). Some of the opposition arose from exaggerated perceptions of the likely negative impacts, fears which are often not realised (Elliott, 1994; Braunholtz, 2003).

However, the research found that over and above all these interacting influences, two factors are of particular importance in determining whether people support or oppose specific wind farm proposals. One is their perception and evaluation of the landscape impact, and the other is whether they and their community have a personal stake in the development. Both of these factors are relevant to the South African situation.

The Influence of Landscape Perceptions on Attitudes

The paper notes that one of the few established empirical facts in the wind farm debate is that aesthetic perceptions, both positive and negative, are the strongest single influence on public attitudes (Pasqualetti et al., 2002; Warren et al., 2005; Wolsink, 2007b; Aitken et al., 2008). In addition, across Europe, the strength of anti-wind farm groups is strongly related to national attitudes to landscape protection; opposition is greatest in countries where landscapes are traditionally valued highly (Toke et al., 2008). In Scotland, the primary motivation of most opposition groups is the strong belief that wind farms despoil landscapes, whereas advocates of wind power typically perceive wind turbines as benign or positive features. The paper notes that given that aesthetic perceptions are a key determinant of people's attitudes, and that these perceptions are subjective, deeply felt and diametrically contrasting, it is not hard to understand why the arguments become so heated. Because landscapes are often an important part of people's sense of place, identity and heritage, perceived threats to familiar vistas have been fiercely resisted for centuries.

The paper identifies two other factors that important in shaping people's perceptions of wind farms' landscape impacts. The first is the cumulative impact of increasing numbers of wind farms (Campbell, 2008). If people regard a region as having 'enough' wind farms already, then they may oppose new proposals. The second factor is the cultural context. Whereas in Scotland the landscape effects of wind farms are often described in negative terms, in places such as Denmark wind turbines have become an integral part of the cultural landscape. Despite the widely varying perceptions, one of the few areas of consensus in the Scottish debate is that landscape issues are central, and that if wind farms are to be built, sensitive siting in the landscape is critical.

The impact on landscapes is also likely to be a key issue in South Africa, specifically given South African's strong attachment to the land and the growing number of wind farm applications.

The Influence of Ownership on Attitudes

The research found that the second influential factor related to the issue of ownership. Experience across Europe indicated that wind power became more socially acceptable when local communities were directly involved in, and benefited from the developments. In Denmark, Germany, the Netherlands and Sweden, where wind farms have typically been funded and controlled by local cooperatives, there has long been widespread support for wind power (Redlinger et al., 2002; Meyer, 2007; Szarka, 2007). However, in Britain where the favoured development approach has been the private developer/public subsidy model, many proposals have faced stiff local opposition.

These findings have potentially important implications for the future development of the wind energy sector in South Africa and the support from locally affected communities.

In conclusion the paper notes that despite being very acrimonious, the wind farm debate has helped to reintroduce energy issues to the arena of public debate. This is a significant positive benefit. For many years, most people have used electricity with little or no regard for the environmental costs of energy production. The high profile debates over wind farms and the potential impact on the Scottish Highlands have highlighted the fact that societies energy needs do have environmental implications.

4.5.4 Health impacts of wind farms

This section summarises the key findings of a literature review undertaken by the Australian Health and Medical Research Council published in July 2010.

Effects of Noise from Wind Turbines on Human Health
The health and well-being effects of noise on people can be classified into three broad categories:

- Subjective effects including annoyance, nuisance and dissatisfaction;
- Interference with activities such as speech, sleep and learning; and
- Physiological effects such as anxiety, tinnitus or hearing loss (Rogers, Manwell & Wright, 2006).

The findings of the literature review indicate that the measurement of health effects attributable to wind turbines is regarded as very complex. However, in summary the findings of the literature review indicated that:

- Sound from wind turbines does not pose a risk of hearing loss or any other adverse health effects in humans. Subaudible, low frequency sounds and infrasound from wind turbines do not present a risk to human health (Colby, et al 2009).
- 'There is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects' (Berglund & Lindvall 1995).
- Infrasound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to the health of a wind farm neighbour (DTI, 2006);
- There is no peer-reviewed scientific evidence indicating that wind turbines have an adverse impact on human health (CanWEA, 2009).
- Wind energy is associated with fewer health effects than other forms of traditional energy generation and in fact will have positive health benefits (WHO, 2004).

The overall conclusion of the review based on current evidence is that wind turbines do not pose a threat to health if planning guidelines are followed.

Effects of Shadow Flicker and Blade Glint on Human Health
The findings of the review found that the evidence on shadow flicker does not support a health concern (Chatham-Kent Public Health Unit, 2008) as the chance of conventional horizontal axis wind turbines causing an epileptic seizure for an individual experiencing shadow flicker is less than 1 in 10 million (EPHC, 2009). As with noise, the main impact associated with shadow flicker from wind turbines is annoyance.

With regard to blade glint, manufacturers of all major wind turbine blades coat their blades with a low reflectivity treatment, which prevents reflective glint from the surface of the blade. According to the Environment Protection and Heritage Council (EPHC) the risk of blade glint from modern wind turbines is considered to be very low (EPHC, 2009).

Effects of Electromagnetic Radiation and Interference from Wind Turbines on Human Health

Review found that Electromagnetic Fields (EMF) emanate from any wire carrying electricity and Australians are routinely exposed to these fields in their everyday lives. The same would apply to South Africans. In this regard the electromagnetic fields produced by the generation and export of electricity from a wind farm do not pose a threat to public health (Windrush Energy 2004). The closeness of the electrical cables between wind turbine generators to each other, and shielding with metal armour effectively eliminate any EMF (AusWEA, nd. b).

SECTION 5: KEY FINDINGS AND ASSESSMENT

5.1 INTRODUCTION

Section 5 provides an assessment of the key social issues identified during the study. The identification of key issues was based on:

- The Social Scoping Report prepared for the Scoping Report (Tony Barbour Consultants, 2010);
- Review of project related information, including other specialist studies;
- Interviews with key interested and affected parties;
- Experience of the authors with the area and local conditions;
- Experience with similar projects, including the Darling Wind Farm and Eskom Wind Energy Facility located north of the Olifants River on the West Coast of South Africa.

The assessment section is divided into:

- Assessment of compatibility with relevant policy and planning context ("planning fit";
- Assessment of social issues associated with the construction phase;
- Assessment of social issues associated with the operational phase;
- Assessment of social issues associated with the decommissioning phase.
- Assessment of the proposed 132 kV transmission line alignment;
- Assessment of the "no development" alternative;
- Assessment of cumulative impacts.

The section also comments on the potential health impacts associated with WEFs. This issue is addressed under the operational phase.

5.2 POLICY AND PLANNING FIT

The key findings from the review of relevant policy and planning documents presented in Section 4 are presented below. These findings are paired against discussions and key conclusions with regard to the Rheboksfontein WEF proposal.

The fit with planning is assessed in terms of:

- South Africa's policy with regards to renewable energy;
- Site related issues within the context of the Western Cape PSDF, Regional Methodology for Wind Energy Site Selection and Guidelines for development on Mountains, Hills and Ridges;
- Local planning context.

5.2.1 Energy policy

The development of renewable energy in South Africa is supported at both national and provincial (Western Cape) levels. In this regard, the National White Paper on Renewable Energy (2003) has set a target of 10 000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2013.

Similarly, the White Paper on Sustainable Energy for the Western Cape (2008) sets targets for both source replacement (15% of energy consumption - against 2006 values - from renewable sources by 2014) and for associated emission reductions (10% reduction - against 2000 values - by 2014). The 2009 Provincial Spatial Development Framework (PSDF) recommends an even more ambitious target of 25% from renewable energy by 2020.

Conclusion

The proposed Rheboksfontein WEF has the potential to provide up to 200 MW of wind-generated energy to the national grid, and will therefore make a contribution to achieving the stated national and provincial energy principles and associated targets. The proposed development is therefore supported by the relevant energy policy framework.

The proposed Rheboksfontein WEF development's contribution to clean, renewable energy is assessed below.

5.2.2 Site related aspects

A review of the Western Cape Regional Methodology for Wind Energy Site Selection (2006), the Western Cape PSDF (2009) and the Guideline for development on Mountains, Hills and Ridges (2003) indicates that the siting of WEFs and associated infrastructure should ideally adhere to the following principles:

- Large WEFs should be spaced at least 30-50 km apart (Regional Methodology);
- Preference should be given to disturbed rural landscapes, particularly vertically disturbed ones (Regional Methodology);
- Siting should be mindful of potential impacts on touristic visual and sense of place values (Regional Methodology);
- WEFs should be sited in locations where they have the least potential visual impact (PSDF);
- New power lines should follow existing transport or power line corridors in as far as possible, and point-to-point cross-country routes should be avoided (PSDF).
- Landform features should be preserved through ensuring that the siting of facilities is related to environmental resilience and visual screening capabilities of the landscape (Guideline);
- The scale, density and nature of the activities or developments should be harmonious and in keeping with the sense of place and character of the area (Guideline);
- Development on the crest of a mountain, hill or ridge should be strongly discouraged (Guideline);
- The precautionary principle should be adopted in decision making (Guideline);
- The criteria applicable to assessing developments in mountainous or hilly areas should include, amongst others, density of the development, aesthetics, location, value in terms of "sense of place", character of adjacent land use, character of

the general area, and cumulative impacts which may arise from other existing and planned developments in the area (Guideline);
- Development on steep slopes (steeper than 1:4) should be strongly discouraged. As a general principle development should be located on lower-lying or gently sloping portions of the site (Guideline).

In this regard, the proposed Rheboksfontein WEF:

- Is located in close proximity to a small WEF (4 x existing and 16 x proposed wind turbines) associated with the Kerriefontein/ Darling WEF;
- Is proposed on a site that has largely been transformed by historical and continued cropping and other agricultural activities. Vertical disturbance on the site currently consists of Telkom lines to some farms and 2 x 400 kV transmission lines across the north-eastern portion of the site. Four wind turbines associated with the Darling Demonstration WEF are located in close proximity to the site (2-3 km);
- Is located within the picturesque Darling Hills. Tourism plays an important role in the economy of the study area. The rural landscape, wildflower displays (Darling) and conservation-orientated land uses constitute key attractions/ land uses;
- Is located on a site that is visible from the R27 and R315 as well as a number of adjacent properties (mainly located towards the west). The R27 carries a significant amount of tourist traffic between the CCT and destinations in the West Coast region. The R315 serves as one of two main tourism gateways to Darling;
- Includes only a small linking section (~2 km) of the proposed 132 kV line which does not follow an existing power line corridor. The remainder (~32 km) is located along the existing Aurora-Atlantis 400 kV corridor;
- Is located in the scenic Darling Hills area;
- Includes a number of turbines that are located on or near the crest line of hills.

Conclusion

The proposed WEF is in conflict with a number of location-based principles contained in the Regional Methodology, PSDF and the Guideline for development on Mountains, Hills and Ridges. These relate largely to the development on hills, preference to disturbed landscapes, and the preservation of existing visual and sense of place values.

The SIA recognises that the location of the WEF is informed by the quality of the wind resource, which, in turn increases the WEF's potential to make a substantial contribution to the generation of renewable energy in South Africa. However, the impact of relatively large WEFs such as the Rheboksfontein WEF on the visual character of the area cannot be ignored. This is of pertinent relevance, as the economy of the study area is largely reliant on tourism. In this regard, the scenic landscape represents the key amenity. At least one significant tourism operation, !Khwa tuu, is located adjacent to the site, and would potentially be affected by the proposed placement of a number of turbines in close proximity to its boundary. In addition, the R27 is a scenic route and an important tourist route for visitors accessing the West Coast region is associated with the R27. The Swartland IDP alos identifies the R315 as the primary scenic/ tourism route in the Swartland. A number of turbines would be visible from both the R27 and R315. Changes to the scenic amenity would also potentially impact on established holiday and residential estates located in the vicinity of the proposed WEF, such as Jakkalsfontein Estate.

The impact of WEFs on rural landscapes is an issue that will need to be addressed by the relevant environmental authorities, specifically given the absence of specific spatial guidance in the face of the large number of applications for WEFs that have been submitted in the Western Cape and West Coast region over the past 12 months.

5.2.3 Local level development

A review of demographic data for the study area communities indicates that unemployment and poverty levels are high, while education and skills levels very low. The Swartland IDP indicates that the Darling/ Yzerfontein area, along with the Riebeeck Valley, represent key tourist attractions in the Swartland. In addition, the importance of the R27 as regional conduit is noted and the R315 is identified as the primary scenic/ tourism route in the Swartland. The IDP further identifies a focus on agri-tourism as the appropriate development strategy for the Darling area.

Conclusion

The lack of clear spatial guidance with regard to appropriate areas for the siting of WEFs currently presents a serious problem for local planning authorities. No provision for WEFs is currently made in the Swartland Zoning Scheme, and there are no policy guidelines relating to compatible land uses. The situation is exacerbated by the large number of WEF developments currently proposed in the WCDM coastal region, raising the concern of cumulative visual impacts on the landscape within the broader Swartland-SBLM-Bergrivier area (Kotze – pers. comm).

In this regard the WCDM planner has expressed specific reservations regarding the appropriateness of establishing WEFs on the Darling Hills and the area adjacent to the R27. This concern is linked to the importance of tourism in the area and the relatively undisturbed landscape of the Darling Hills (Kotze – pers. comm).

The overall sentiment appears to be that the Western Cape Provincial Planning Authorities should assist local authorities and provide clearer spatial guidance for the establishment of WEFs. Imposing a moratorium on processing applications for WEFs until such guidance was in place was mooted as a possible strategic intervention at this stage (D. Kotze – pers. comm).

5.3 SOCIAL IMPACTS ASSOCIATED WITH THE CONSTRUCTION PHASE

The key social issues associated with the construction phase are the following:

Potential positive impacts

- Creation of employment and business opportunities, and opportunity for skills development and on-site training.

Potential negative impacts

- Impacts associated with the presence of construction workers on local communities;
- Increased risks to stock, crops, grazing and farming infrastructure associated with the presence of construction workers;
- Impact of heavy vehicles on local roads;
- Loss of agricultural land associated with construction related activities.

Annexure C of this report contains the recommended Social inputs into the Environmental Management Plan (EMP).

5.3.1 Creation of local employment, training, and business opportunities

The total capital expenditure associated with the project is estimated at approximately R 4 billion (current 2010 value). The work associated with the construction phase will be undertaken by contractors and will include the establishment of access roads and services, the erection of the wind turbines and construction of power lines and substations.

Employment

Information provided by Moyeng Energy indicates that the project will provide approximately 120 direct employment opportunities for a period of 36 months. Construction is proposed in a single phase.

Moyeng Energy estimates that approximately 25% (or 30) of opportunities will be available to skilled personnel (engineers, technicians, management and supervisory), 35% (or 42) to semi-skilled personnel (drivers, equipment operators), and 40% (or 48) to low skilled personnel (construction labourers, security staff). The wage bill associated with the construction phase is estimated at R18.66 million per annum (current value). The total wage bill for the three-year construction phase will therefore be in the region of R55.98 million. The benefits to the local economy will however be confined to the construction period (36 months).

The majority of the employment opportunities are likely to be associated with the contactors appointed to construct the WEF and associated infrastructure. It is likely that civils contractors from the Cape Town and Malmesbury area will be appointed. Experience with large construction projects is that contractors typically make use of their own skilled and semi-skilled staff. The direct employment opportunities for members from the local community in Darling are therefore likely to be limited to low skilled opportunities, which account for approximately 48 jobs. The majority of these opportunities are likely to benefit Historically Disadvantaged (HD) members of the relevant communities.

Training

The contractors will provide on-site training and skills development opportunities. However, the majority of benefits are likely to accrue to personnel employed by the relevant contractors. In the absence of specific commitments from the developer and the contractors, the potential for meaningful skills development and training for members from the local communities are likely to be limited.

Business opportunities

The expenditure of R4 billion during the construction phase will create business opportunities for the regional and local economy. However, given the technical nature of the project, and the high import content associated with wind turbines and associated infrastructure, opportunities for the Swartland economy is likely to be largely limited. However, some opportunities may also accrue to local civil (construction of roads and associated infrastructure), engineering (production of components for the WEF, such as the base) and transport companies (movement of equipment and components onto site). Further opportunities may exist in the daily transport of staff onto and from site, the provision of after-hours site security, and catering for personnel on-site.

A number of the high skill/managerial workers are may reside in the study area, most likely in Darling and or Yzerfontein. This will create opportunities for local hotels, B&Bs, guest farms and people who want to rent out their houses. The injection of income into the area in the form of rental for accommodation and wages will create opportunities for local businesses (e.g. retail) in the study area. The hospitality industry in the local towns is also likely to benefit from the provision of accommodation and meals for professionals (engineers, quantity surveyors, project managers, product representatives etc.) and other (non construction) personnel involved on the project. Experience from other large construction projects indicates that the potential opportunities are not limited to on-site construction workers but also to consultants and product representatives associated with the project.

A percentage of the annual wage bill is also likely to be spent in the local towns, which will benefit local businesses.

Table 5.1: Assessment of local employment, training and business opportunities

Nature: Creation of local employment and business opportunities during the construction phase		
	Without Mitigation	**With Enhancement**
Extent	Local – Regional (2) (Rated as 2 due to potential opportunities for local communities and businesses)	Local – Regional (3) (Rated as 3 due to potential opportunities for local communities and businesses)
Duration	Short term (2)	Short term (2)
Magnitude	Low (4)	Low (4)
Probability	Highly probable (4)	Highly probable (4)
Significance	**Medium (32)**	**Medium (36)**
Status	Positive	Positive
Reversibility	N/A	N/A
Irreplaceable loss of resources?	N/A	N/A
Can impact be enhanced?	Yes	
Mitigation: See below		
Cumulative impacts: Opportunity to up-grade and improve skills levels in the area. However, due to relatively small number of local employment opportunities and limited skills range, this benefit is likely to be limited.		
Residual impacts: Improved pool of skills and experience in the local area. However, due to relatively small number of local employment and skills-transfer opportunities this benefit is likely to be limited.		

Assessment of No-Go option

There is no impact, as the current status quo will be maintained. The potential employment and economic benefits associated with the construction of the proposed

WEF would however be forgone. The potential opportunity costs in terms of local capital expenditure, employment, skills development and opportunities for local business are therefore regarded as a negative. Potential opportunity costs would be greatest with regards to the local service sector.

Recommended enhancement measures

In order to enhance local employment and business opportunities associated with the construction phase the following measures should be implemented:

Employment

- Where reasonable and practical, Moyeng Energy should appoint local contractors and implement a 'locals first' policy, especially for semi and low-skilled job categories;
- Prior to commencement of the construction phase, Moyeng Energy should meet with representatives from the Swartland Local Municipality (SLM) to establish the existence of skills and unemployment databases for the relevant municipal areas. If such databases exists, they should be made available to the appointed contractors;
- The local authorities, community representatives and organisations on the interested and affected party database should be informed of the final decision regarding the project and the potential job opportunities for locals and the employment procedures which Moyeng intends to implement during the construction phase;
- Where feasible, training and skills development programmes for locals should be initiated prior to the initiation of the construction phase.

Business

- Moyeng Energy should develop a database of local companies, specifically Historically Disadvantaged (HD) companies which qualify as potential service providers (e.g. construction companies, catering companies, waste collection companies, security companies etc.) prior to the commencement of the tender process for construction contractors. These companies should be notified of the tender process and invited to bid for project-related work;
- Where possible, Moyeng Energy should assist local HD companies to complete and submit the required tender forms and associated information;
- The SLM, in conjunction with representatives from the local hospitality and retail industries, should identify strategies aimed at maximising the potential benefits associated with the project.

Note that while preference to local employees and companies is recommended, it is recognised that a competitive tender process may not guarantee the employment of local labour for the construction phase.

5.3.2 Impact of construction workers on local communities

The presence of construction workers poses a potential risk to family structures and social networks. While the presence of construction workers does not in itself constitute a social impact, the manner in which construction workers conduct themselves can impact on local communities. The most significant negative impact is associated with the disruption of existing family structures and social networks. This risk is linked to potentially risky behaviour of male construction workers, including:

- An increase in alcohol and drug use;

- An increase in crime levels;
- The loss of girlfriends and or wives to construction workers;
- An increase in teenage and unwanted pregnancies;
- An increase in prostitution;
- An increase in sexually transmitted diseases (STDs).

The project will provide approximately 120 direct employment opportunities for a period of 36 months. As indicated above, the direct employment opportunities for members from the local Darling community is likely to be limited to low skilled opportunities, which account for approximately 48 jobs. Given the proximity of the site to the City of Cape Town and large towns in the Swartland (Malmesbury) and Boland (Paarl, Wellington), it is likely that contractors from the areas would be appointed.

Experience has shown that the potential social impacts associated with construction workers are typically associated with low-skilled workers and not the more skilled workers. However, given the relative proximity of the site to the Cape Town and other large towns in the Swartland and Boland, it would be relatively easy to transport workers to and from site on a daily basis. Some skilled and semi-skilled personnel may be accommodated in nearby towns such as Darling or Yzerfontein. In this regard Moyeng Energy has indicated that construction workers will be transported onto and off site on a daily basis. Exposure to farm workers and their families is therefore expected to be minimal.

As a result the potential impacts of construction workers on local communities is not likely to represent a significant issue. Employing local community members for the low skilled jobs can therefore assist to effectively mitigate the potential risks associated with construction workers in the area.

Table 5.2: Assessment of potential impacts of construction workers on local communities

Nature: Potential impacts on family structures and social networks associated with the presence of construction workers		
	Without Mitigation	**With Mitigation**
Extent	Local (2) (Rated as 2 due to potential severity of impact on local communities)	Local (1) (Rated as 1 due to potential severity of impact on local communities)
Duration	Short term for community as a whole (1) Long term-permanent for individuals who may be affected by STDs etc (5)	Short term for community as a whole (1) Long term-permanent for individuals who may be affected by STDs etc (5)
Magnitude	Low for the community as a whole (4) High-Very High for specific individuals who may be affected by STDs etc (10)	Low for community as a whole (4) High-Very High for specific individuals who may be affected by STDs etc (10)
Probability	Probable (3)	Probable (3)
Significance	Low for the community as a whole (21) Moderate-High for specific individuals who may be affected by STDs etc (51)	Low for the community as a whole (18) Moderate-High for specific individuals who may be affected by STDs etc (48)

Status	Negative	Negative
Reversibility	No in case of HIV	No in case of HIV
Irreplaceable loss of resources?	Yes, if people contract HIV/AIDS.	
Can impact be mitigated?	Yes, to some degree. However, the risk cannot be eliminated	
Mitigation: See below		
Cumulative impacts: Impacts on family and community relations that may, in some cases, persist for a long period of time. Where unplanned / unwanted pregnancies occur, or members of the community are infected by an STD, specifically HIV, the impacts may be permanent and have long term to permanent cumulative impacts on the affected individuals and/or their families and the community.		
Residual impacts: See cumulative impacts.		

Assessment of No-Go option

Potential risks to family structures and social networks of local urban communities will be avoided. On the other hand, potential positive impacts on the local economy associated with the additional spending by construction workers will be lost.

Recommended mitigation measures

The potential risks associated with construction workers can be mitigated. The detailed mitigation measures should be outlined in the Environmental Management Plan (EMP) for the Construction Phase. Aspects that should be covered include:

- Where reasonable and practical, Moyeng Energy should appoint local contractors and implement a 'locals first' policy, especially for semi and low-skilled job categories;
- Moyeng Energy should consider the establishment of a Monitoring Forum (MF) in order to monitor the construction phase and the implementation of the recommended mitigation measures. The MF should be established before the construction phase commences, and should include key stakeholders, including representatives from local communities, local Swartland councillors, farmers and the contractor(s). The MF should also be briefed on the potential risks to the local community associated with construction workers;
- Moyeng Energy and the contractor(s) should, in consultation with representatives from the MF, develop a code of conduct for the construction phase. The code should identify which types of behaviour and activities are not acceptable. Construction workers in breach of the code should be dismissed. All dismissals must comply with the South African labour legislation;
- Moyeng Energy and the contractor should implement an HIV/AIDS awareness programme for all construction workers at the outset of the construction phase;
- The movement of construction workers on and off the site should be closely managed and monitored by the contractors. In this regard the contractors should be responsible for making the necessary arrangements for transporting workers to and from site over weekends or after hours;
- The contractors should make the necessary arrangements for allowing workers from outside the area to return home over weekends and/ or on a regular basis. This would reduce the risk posed to local family structures and social networks.

5.3.3 Increased risk to stock, crops, pasture, game and farming infrastructure

The movement of construction workers on and off the site poses a potential threat to farm infrastructure, such as fences and gates, which may be damaged. Stock losses may also result from gates being left open and/or fences being damaged. Veld fires pose a potential risk to crops and pasture.

As discussed in Section 3.3.1 and 3.3.5, the proposed WEF site and adjacent area is primarily used for mixed commercial farming and conservation. All the properties affected by the proposed Rheboksfontein site farm sheep, which are vulnerable to stock theft. Sheep theft is currently problematic in the study area. The relevant properties are however not located in a secluded area, but in proximity to Darling, and border onto the R315. In addition, Moyeng Energy has indicated that construction workers will not be housed on-site. The potential threat in terms of stock theft posed by construction workers is therefore not regarded as significant.

The local fynbos vegetation is fire prone, especially over the hot, dry summer months. In addition, a number of properties are infested with alien vegetation (*Acacia* spp.), specifically some of the properties located to the west of the R27. The risk of veld fires therefore exists.

None of the site properties are used for conservation or game farming purposes, but conservation-orientated land uses are established on a number of properties in the study area. These include the !Khwa ttu, Rondebeg PNR and Doornfontein Farm. Stocked game only occurs on !Khwa ttu at this stage. Small buck (Steenbok, Greybuck) occur naturally in the study area. The potential for poaching does therefore exist, however, the significance of this issue is rated as low. In addition, no workers will be housed on site.

On-site infrastructure is limited due to dryland cropping activities (wheat, fodder crops and vineyard). Farm gates and fences are therefore probably the most vulnerable to damage. The implications may range from a nuisance to farmers, to actual stock losses. Overall, the risk potential to farms in the study area is not very significant.

Table 5.3: Assessment of potential risks to stock, crops, grazing, game and infrastructure

Nature: Potential loss of livestock, poaching and damage to farm infrastructure associated with the presence of construction workers on site		
	Without Mitigation	**With Mitigation**
Extent	Local (3) (Rated as 3 due to potential severity of impact on local farmers)	Local (2)
Duration	Short term (2)	Short term (2)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Low (27)**	**Low (24)**
Status	Negative	Negative
Reversibility	Yes, compensation paid for stock losses etc	Yes, compensation paid for stock losses etc

Irreplaceable loss of resources?	No	No
Can impact be mitigated?	Yes	
Mitigation: See below		
Cumulative impacts: None, provided that losses are adequately compensated for.		
Residual impacts: See cumulative impacts.		

Assessment of No-Go option

There is no impact as the current status quo is maintained. Potential negative impacts on commercial cropping and stock farming would be avoided.

Recommended mitigation measures

The detailed mitigation measures should be outlined in the EMP. Mitigation measures, which may be considered in order to address potential risks to livestock, crops and farm infrastructure include:

- Moyeng Energy should establish an MF (see above). The MF should include local farmers, and develop a Code of Conduct for construction workers. This committee should be established prior to commencement of the construction phase. The Code of Conduct should be signed by Moyeng Energy and all relevant contractors prior to the commencement of any on-site construction activities;
- Moyeng Energy should hold contractors liable for compensating farmers and communities in full for any stock losses and/or damage to farm infrastructure that can be linked to construction workers. This should be contained in the Code of Conduct, to be signed between Moyeng Energy, the contractors and neighbouring landowners. The agreement should also cover loses and costs associated with fires caused by construction workers or construction related activities (see below);
- A designated Control Officer should be appointed to monitor the conduct of staff. Affected landowners should have ongoing access to this Officer;
- The EMP must outline procedures for managing and storing waste (including arrangements for plastic waste etc) on site;
- Contractors must ensure that all workers are informed of the conditions contained on the Code of Conduct at the outset of the construction phase. The consequences of stock theft, poaching and trespassing on adjacent farms should be emphasised;
- Contractors must ensure that workers who are found guilty of stealing livestock, poaching and/or damaging farm infrastructure are dismissed and formally charged. This should be contained in the Code of Conduct. All dismissals must be in accordance with South African labour legislation;
- The contractor must ensure that open fires on the site for cooking or heating are not allowed except in designated areas;
- The contractor must ensure that construction related activities that pose a potential fire risk, such as welding, are properly managed and are confined to areas where the risk of fires has been reduced. Measures to reduce the risk of fires include clearing working areas and avoiding working in high wind conditions when the risk of fires is greater. In this regard special care should be taken during the high risk dry, windy summer months;
- The contractor must provide adequate fire fighting equipment on-site;

- The contractor must provide fire-fighting training to selected construction staff. This must take place before construction activities commence;
- As per the conditions of the Code of Good Conduct, in the advent of a fire being caused by construction workers and or construction activities, the appointed contractors must compensate farmers for any damage caused to their farms. The contractor should also compensate for the fire fighting costs borne by farmers and local authorities.
- Moyeng Energy should enter into legally binding arrangements with regard to compensation with all relevant property owners prior to the start of construction.

5.3.4 Impacts on local roads

Information provided by Moyeng Energy indicates that an estimated total 400 abnormal load trips are associated with the transport of turbine components onto site (i.e. 5 x trips per turbine). These will include abnormally long loads (associated with ~40-55 m rigid turbine blades), as well as abnormally heavy ones (associated with ~ 80 t nacelles). In addition, a crawler crane (~ 750 t) and assembly cranes will also need to be transported onto and off the sites. Other heavy equipment will include normal civil engineering construction equipment such as graders, excavators, cement trucks, etc.

Moyeng Energy proposes making use of the R315 to access both portions of the site (i.e. located on either side of the R315). Traffic movement is likely to be along the R27 (West Coast Road) either from Saldanha or Cape Town, and then along the R315 for ~7.5 km. Once on site, use will be made of existing and new internal roads to move components and equipment to the relevant construction locations.

The R315 constitutes one of two links to Darling from the R27 (the other being the R307). Both the R27 and R315 are major tarred roads, and important tourist routes.

Potential impacts are mainly associated with delays during the actual movement of construction traffic. Restricting construction traffic movements to weekdays, and reducing trips during the flower-season months of August and September can mitigate the severity of impacts on tourist traffic.

Overall, the impact potential on local road use is not likely to be very significant.

Table 5.4: **Assessment of impacts on local roads**

Nature: Potential impacts to road surfaces, tourist flows, property access and road safety associated with the movement of construction related traffic to and from the site		
	Without Mitigation	**With Mitigation**
Extent	Local (3) (Rated as 2 due to potential severity of impact on local farmers)	Local (2)
Duration	Short term (2)	Short term (2)
Magnitude	Low (4)	Minor (2)
Probability	Probable (3)	Probable (3)
Significance	**Low (27)**	**Low (18)**
Status	Negative	Negative
Reversibility	Yes	

Irreplaceable loss of resources?	No	No
Can impact be mitigated?	Yes	
Mitigation: See below		
Cumulative impacts: If damage to roads is not repaired then this will impact on the farming activities in the area and also result in higher maintenance costs for vehicles of local farmers and other road users. The costs will be borne by road users who were not responsible for the damage.		
Residual impacts: See cumulative impacts		

Assessment of No-Go option

There would be no impact as the current status quo is maintained. Potential negative impacts on local roads would be avoided.

Recommended mitigation measures

Potential impacts on roads can be effectively mitigated. Detailed mitigation measures should be outlined in the EMP, and should include:

- Movement of construction traffic should be limited to weekdays. In addition, the movement of heavy vehicles on the local roads, specifically the R27 and R315 should not be permitted after 13h00 on Friday afternoons and before 09h00 on Monday mornings as these are times that are likely to impact on weekend visitors are either travelling to or leaving Yzerfotein, Darling and West Coast;
- The contractor should inform local farmers and representatives from the Darling and Yzerfotein Local Authority and Tourism Sector of dates and times when abnormal loads will be undertaken;
- The contractor must ensure that damage caused to roads by the construction related activities, including heavy vehicles, is repaired before the completion of the construction phase. The costs associated with the repair must be borne by the developer;
- All vehicles must be road-worthy and drivers must be qualified and made aware of the potential road safety issues and need for strict speed limits.

5.3.5 Damage to farm land

Activities such as the establishment of access roads, the movement of heavy vehicles, the establishment of lay-down areas and foundations for the wind turbines, as well as the establishment of substations and power lines will potentially damage topsoils and vegetation. Moyeng Energy has indicated that workers will not be accommodated on site, so no construction camps will be established.

The compaction of soils associated with movement of heavy vehicles and other construction related activities does pose a potential threat to the productivity of the affected farms. However, mechanical ploughing and scarifying can mitigate the damage caused by compaction. Minimising the footprint of construction related activities could also mitigate the damage to farmland, and ensuring that disturbed areas are actively rehabilitated upon completion of the construction phase. The relevant farm owners also have indicated that construction activities and associated short-term damage to land can be factored into rotational planning and planting programmes for their crops.

The significance of this impact on the farming activities and livelihoods of the affected farmers is therefore likely to be low.

Table 5.5: Assessment of impact on farmland due to construction related activities

Nature: The activities associated with the construction phase, such as establishment of access/haul roads, the movement of heavy vehicles, the establishment of lay-down areas and foundations for the wind turbines, substations and power lines will potentially damage topsoils and vegetation and result in losses of the grazing resource.		
	Without Mitigation	**With Mitigation**
Extent	Local (2)	Local (1)
Duration	Long term-permanent if disturbed areas are not rehabilitated (5)	Short term if damaged areas are rehabilitated (1)
Magnitude	Low (4)	Minor (2)
Probability	Highly Probable (4)	Highly Probable (4)
Significance	**Medium (44)**	**Low (16)**
Status	Negative	Negative
Reversibility	Yes, but long period required	Yes, but long period required
Irreplaceable loss of resources?	No. Affected land can be restored, provided appropriate rehabilitation is implemented.	
Can impact be mitigated?	Yes, provided efficient site rehabilitation is carried out, and the movement of heavy loads on the site are strictly limited to designated on-site roads and construction areas.	
Mitigation: See below		
Cumulative impacts: The impacts would occur on land not currently affected by similar impacts. No additional impacts to the Rheboksfontein development are currently proposed on the relevant properties. No cumulative impacts are therefore associated with the development.		
Residual impacts: Potential localised deep soil computation resulting from the movement of abnormally heavy equipment and components.		

Assessment of No-Go option

There would be no impact as the current status quo is maintained. Potential negative impacts on local soils and vegetation would be avoided.

Recommended mitigation measures

With mitigation, the potential impacts on farming activities and livelihoods as a result of damage to and loss of farmland are assessed to be of low significance due to the relatively small portions of arable land likely to be affected. Impacts may be further reduced by the implementation of the following mitigation measures:

- The footprint associated with the construction related activities (access roads, turning circles, construction platforms, workshop etc) should be minimised;
- An Environmental Control Officer (ECO) should be appointed to monitor the entire duration of the construction phase;
- All areas disturbed by construction related activities, such as access roads, construction platforms, workshop area etc, should be rehabilitated at the end of the construction phase;

- The implementation of a rehabilitation programme should be included in the terms of reference for the contractor/s appointed to establish the WEF. The specifications for the rehabilitation programme should be drawn up the Environmental Consultants appointed to undertake the EIA (Savannah Environmental);
- The implementation of the Rehabilitation Programme should be monitored by the ECO;
- Compensation should be paid to farmers that suffer a permanent loss of land due to the establishment of the WEF. Compensation should be paid by Moyeng Energy, and based on accepted land values for the area.

In addition, Moyeng Energy needs to consult with affected property owners in a timeous fashion in order to enable them to factor construction activities into their rotational land use schedules.

5.4 SOCIAL IMPACTS ASSOCIATED WITH OPERATIONAL PHASE

The following key social issues are of relevance to the operational phase:

Potential positive impacts

- Creation of employment and business opportunities. The operational phase will also create opportunities for skills development and training;
- The promotion of clean energy as an alternative energy source and the establishment of a Cleaner Development Mechanism (CDM) project;

Potential negative impacts

- Potential impact on tourism;
- Impact of the proposed wind energy facility on the current farming activities;
- The visual impacts and associated impact on sense of place and landscapes.

Annexure C of this report contains the recommended social inputs into the Environmental Management Plan (EMP).

5.4.1 Creation of employment and business opportunities

Estimates provided by Moyeng Energy indicate that approximately 35 staff (administrative, management, monitoring and maintenance) will be employed during the operational lifespan of the Rheboksfontein facility (>25 years). Moyeng Energy estimates that approximately 25% of opportunities will be available to skilled personnel (forecasters, technicians, management and supervisory, etc), 35% to semi-skilled personnel (drivers, equipment operators), and 40% to low skilled personnel (road maintenance, security, etc). Given the requirement of specialised skills, and fact that the wind energy sector in South Africa is relatively new, it may be necessary to import some of the required operational and maintenance skills from other parts of South Africa or even overseas. However, it will be possible to increase the number of local employment opportunities through the implementation of a skills development and training programme linked to the operational phase. Such a programme would support the strategic goals of promoting local employment and skills development contained in the Swartland IDP.

At this stage it is unclear where the permanent staff will reside. However, a number of people are likely to be located in Darling or the coastal settlements in the study area. A percentage of permanent employees may purchase houses in one of these towns, while others may decide to rent. Both options would represent a positive economic benefit for the region. In addition, a percentage of the monthly wage bill earned by permanent staff would be spent in the regional and local economy. This will benefit local businesses in the relevant towns. The wage bill associated with the operational phase is estimated at R5.5 million per year (current value). The benefits to the local economy will extend over the anticipated 25-30 year operational lifespan of the project.

The local hospitality industry is also likely to benefit from the operational phase. These benefits are associated with site visits by company staff members and other professionals (engineers, technicians etc) who are involved in the company and the project but who are not linked to the day-to-day operations.

Research undertaken by Warren and Birnie (2009) also highlights the importance of addressing community benefits in the development and implementation of WEFs. The findings of the research found that wind farms in Europe became more socially acceptable when local communities were directly involved in, and benefited from the developments. In Denmark, Germany, the Netherlands and Sweden, where wind farms have typically been funded and controlled by local cooperatives, there has been widespread support for wind power. However, in Britain where the favoured development approach has been the private developer/public subsidy model, many proposals have faced stiff local opposition. This is an issue that should be addressed in the South African context.

Table 5.6: Impact assessment of employment and business creation opportunities

Nature: Creation of employment and business opportunities associated with the operational phase		
	Without Mitigation	**With Enhancement**
Extent	Local and Regional (1)	Local and Regional (2)
Duration	Long term (4)	Long term (4)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Low (27)**	**Medium (30)**
Status	Positive	Positive
Reversibility	N/A	
Irreplaceable loss of resources?	No	
Can impact be enhanced?	Yes	
Enhancement: See below		
Cumulative impacts: Creation of permanent employment and skills and development opportunities for members from the local community and creation of additional business and economic opportunities in the area		
Residual impacts: See cumulative impacts		

Assessment of No-Go option

There is no impact, as the current status quo will be maintained. The potential employment and economic benefits associated with the proposed WEF would however be forgone. The potential opportunity costs in terms of local capital expenditure, employment, skills development and opportunities for local business are therefore regarded as a negative.

Recommended enhancement measures

The enhancement measures listed in Section 5.3.1 to enhance local employment and business opportunities during the construction phase, also apply to the operational phase. In addition:

- Moyeng Energy should implement a training and skills development programme for locals during the first 5 years of the operational phase. The aim of the programme should be to maximise the number of people from local communities and the broader Swartland area employed during the operational phase of the project;
- Moyeng Energy, in consultation with the Swartland LM, should investigate the opportunities for establishing a Community Trust. The revenue for the trust should be derived from the income generated from the sale of energy from the WEF.

5.4.2 Development of infrastructure for the generation of clean, renewable energy

South Africa currently relies on coal-powered energy to meet more than 90% of its energy needs. Much of the coal used has a high sulphur content. As a result South Africa is the nineteenth largest per capita producer of carbon emissions in the world, and Eskom, as an energy utility, has been identified as the world's second largest producer carbon emissions.

The establishment of a clean, renewable energy facility will therefore reduce, albeit minimally, South Africa's reliance on coal-generated energy and the generation of carbon emissions into the atmosphere. As discussed under 5.2.1, the promotion of renewable energy sources is supported at national and provincial levels.

The overall contribution of the proposed Rheboksfontein WEF to South Africa's total energy requirements is small. However, the up to 200 MW produced will off-set the total carbon emissions associated with energy generation in South Africa. Given South Africa's reliance on Eskom as a power utility, the benefits associated with an IPP based on renewable energy are regarded as significant. It should however be noted that the current application is not unique. In this regard, a significant number of WEF developments are currently proposed in the Western and Eastern Cape. In addition, a smaller number of solar or solar/ wind-hybrid projects are also being proposed. The potential contribution of the Rheboksfontein facility should therefore be regarded as valuable, but should not be overestimated.

Table 5.7: Implementation of clean, renewable energy infrastructure

Nature: Development of infrastructure to generate clean, renewable energy		
	Without Mitigation	**With Mitigation**
Extent	Local, Regional and National (4)	Local, Regional and National (4)
Duration	Long term (4)	Long term (4)
Magnitude	High (8)	Very High (10)
Probability	Highly Probable (4)	Highly Probable (4)
Significance	**High (64)**	**High (72)**
Status	Positive	Positive
Reversibility	Yes	
Irreplaceable loss of resources?	Yes, impact of climate change on ecosystems	
Can impact be mitigated?	Yes	
Enhancement: See below		
Cumulative impacts: Potential contribution to establishing an economically viable commercial renewables generation sector in the Western Cape and South Africa.		
Residual impacts: See cumulative impacts		

Assessment of No-Go option

The No-Development option would represent a lost opportunity for South Africa to supplement its current energy needs with clean, renewable energy. This would represent a negative opportunity cost.

Recommended mitigation measures

The establishment of the WEF is a mitigation measure in itself. In order to maximise the benefits of the proposed project Moyeng Energy should:

- Use the project to promote and increase the contribution of renewable energy to the national energy supply;
- Implement a skills development and training programme aimed at maximizing the number of employment opportunities for local community members;
- Investigate the opportunities for establishing a Community Trust that would benefit local, disadvantaged and vulnerable communities.

5.4.3 Potential impacts on tourism

Potential negative impacts on tourism are largely linked to the visual impacts associated with the proposed Rheboksfontein WEF. The visual impacts are linked to the sites location relative to the R27 and R315, which are recognised scenic routes, and its location on the Darling Hills, which have a high scenic value. As indicated above, tourism is key component of the local economy of the towns of Darling and Yzerfontein. The R27 is also an important link between Cape Town in the south and the West Coast, including the West Coast National Park and the Langebaan Lagoon, in the north.

In addition the potential visual impact on passing traffic, the proposed WEF will also impact on the !Khwa tuu San culture and training centre is located on the farm Grootwater adjacent to the Grootberg portion of the Rheboksfontein site. !Khwa tuu receives approximately 15 000 visitors per year, and provides permanent employment to 25 people. A number of turbines are proposed on the ridgeline above the restaurant/ shop/ office complex at !Khwa tuu. The nearest turbine is proposed ~0.6 km from the complex. The relevant turbines would be very visible from the complex, and would adversely impact on the tourists' experience of being in a natural, undeveloped area.

The proposed location of a number of turbines on the ridgeline above Doornfontein Farm is also problematic. In this regard, the owners of Doornfontein Farm are in the process of converting the property to a game farm and are of the opinion that the presence of wind turbines along the skyline would detract from the visitor experience of a game farm.

The establishment of renewable energy infrastructure within the Swartland may in principle benefit public perception of the area as committed to clean, eco-friendly energy. In this regard research in Scotland undertaken by Warren and Birnie (2009) found that there appeared to be no clear evidence that tourists would be put off by the presence of wind farms in tourism areas. In this regard far more visitors appeared to associate wind farms with clean energy than with landscape damage, suggesting that they could help to promote an area's reputation as an environmentally friendly area, provided they are sensitively sited. However, the paper notes that this could change as more are built.

Given the large number of WEF developments currently proposed over large parts of the Western and Eastern Cape, the establishment of a WEF in the Swartland would not be unique. Care should therefore be taken not to overstate potential benefits from a perceived public association between "eco-tourist destination" and the development of WEFs in the area.

In addition the findings of the VIA (MetroGIS, September 2010) note that the construction and operation of the Rheboksfontein Wind Energy Facility and its associated infrastructure will have a visual impact on the natural scenic resources and rural character of this region. The rural and relatively unspoiled wide-open vistas surrounding the WEF will be transformed for the entire operational lifespan (approximately 30 years) of the plant. In this regard the facility will be visible for a large area that is generally seen as having a special landscape and tourism value (i.e. the Swartland). The facility would thus visually impact on various sensitive visual receptors that should ideally not be exposed to industrial style structures.

The key lesson for South Africa is this regard is that wind farms should be located in areas that minimise the potential impact on landscapes and as such also reduce the potential impact on tourism. In this regard reservations do exist with regard to the suitability of the Darling Hills area, and specifically the Rheboksfontein site due to its proximity to the R27. These reservations once again highlight the need for spatial guidance with regard to sensitive landscapes, as well as carrying capacities for suitable landscapes.

Table 5.8: Potential Impacts on tourism

Nature: Potential positive impact of the wind energy facility on local tourism		
	Without Mitigation	**With Enhancement**
Extent	Local – Regional (3) Due to potential impact on local tourism and adjacent activities	Local –Regional (2)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (39)** (Applies to both – and +)	**Medium (30)** (Applies to both – and +)
Status	Positive (Potential to attract people to the area) Negative (Potential to distract from the tourist experience of the area)	Positive (Potential to attract people to the area) Negative (Potential to distract from the tourist experience of the area)
Reversibility	Yes, turbines can be removed	Yes, turbines can be removed
Irreplaceable loss of resources?	No, turbines can be removed	No, turbines can be removed
Can impact be enhanced?	Yes	
Enhancement: See below		
Cumulative impacts: The proposed WEF is one of a number of WEFs proposed in the WCDM coastal area. While it should be noted that all proposals are currently at an application stage, the approval of a number of applications may potentially lead to an association of the relevant area(s) with the occurrence or even ubiquity of WEF developments.		
Residual impacts: See cumulative impacts		

Assessment of No-Go option

No-Development option would avoid the the risk of compromising the lanscape amenity in a recognised scenic area located in proximity to a major tourism route.

Recommended mitigation/ enhancement measures

- The recommendations contained in the VIA should be implemented;
- The siting of turbines should be undertaken so as to minimize the visual exposure from the R27 and R315;
- The owners of site-adjacent tourism-orientated operations such as !Khwa tuu and Doornfontein Farm should be consulted in order to determine acceptable locations for turbines which may otherwise affect views from their properties;
- Moyeng Energy should liaise with representatives from the WCDM, SBLM and local tourism representatives to raise awareness of the proposed wind energy facility;
- Moyeng Energy should establish a renewable energy interpretation centre on site or in Paternoster. A similar system is employed at Eskom's demonstration facility at Klipheuwel near Durbanville in the Western Cape.

- In order to maximise associated benefits, it is recommended that information be presented in the two main languages of the region, namely English and Afrikaans.

5.4.4 Impact on farming activities

This issue relates to the potential long-term impact of the WEF and associated infrastructure footprint on existing farming activities, specifically the loss of arable land for crops and grazing. This loss may, in turn, may impact on the viability of operations and the livelihoods of the affected farmers.

Experience with WEFs is that livestock farming is not significantly affected by operational WEFs. The final footprint lost to cultivation and grazing is relatively small and is linked to the foundation of the individual wind turbines, services roads, sub-stations and power lines. Consequently, the footprint lost to grazing will affect a relatively small portion of the site relative to its total extent. Underground 33 kV cables will be buried deep enough (~1 m) not to restrict cropping activities on the surface. Areas of high potential agricultural land should also be avoided. The significance of this impact on farming operations and livelihoods is therefore of low significance.

Table 5.9: Potential impacts on farming activities

Nature: Loss of land which may have been used for grazing by stock and game to WEF infrastructural footprint		
	Without Mitigation	**With Mitigation**
Extent	Local (2)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Minor (2)	Minor (2)
Probability	Probable (3)	Probable (3)
Significance	**Low (24)**	**Low (21)**
Status	Negative	Neutral
Reversibility	Yes. Land that is lost to footprint associated with wind energy facility (roads, turbines etc) and substation can be restored to farmland over time, provided appropriate rehabilitation is implemented. Due to the aridity of the area, effective rehabilitation may however take long to achieve, and may prove costly.	
Irreplaceable loss of resources?	No	
Can impact be mitigated?	Yes	
Enhancement: See below		
Cumulative impacts: Not applicable – the potential risk of losses in employment opportunities due to loss of productive grazing is minimal due to the comparatively small areas affected, coupled to the fact that no other developments are currently located or proposed on the relevant properties.		
Residual impacts: See cumulative impacts		

Assessment of No-Go option

There is no impact as the current status quo is maintained.

Recommended mitigation measures

Mitigation measures outlined in Section 5.3.6 apply.

5.4.5 Visual impact and impact on sense of place and landscape

The visual impacts are linked to the sites location relative to the R27 and R315, which are recognised scenic routes, and its location on the Darling Hills, which have a high scenic value. This picturesque landscape is dominated by rounded, rolling hills and broad valleys, punctuated by granite outcrops. The sense of place is of a landscape extensively used for commercial cropping (wheat, vineyards) pastoral (sheep and cattle) and conservation activities.

As indicated above, concerns have also been raised regarding the potential visual impact of the wind turbines on!Khwa tuu San culture and training centre (Grootwater Farm), Doornfontein Farm, and the Jakkalsfontein eco-estate.

The Australian National Wind Farm Development Guidelines (Draft, July 2010) indicate that the impact of a wind farm on a landscape is not necessarily just visual – other 'values' can also be affected. Community values and perceptions of landscape may include associations, memories, knowledge and experiences or other cultural or natural values.

The turbines associated with the proposed WEF will have a visual impact and, in so doing, impact on the rural sense of the place of the area and the landscape. While none of the local farmers interviewed identified visual impacts as a significant concern, this does not imply that the proposed WEF will not impact on the area's sense of place and the landscape. Experience from elsewhere, such as Australia and Scotland, indicates that impacts on the landscape represents one of the most significant concerns associated with wind farms. The parties who stand to be affected include residents of Darling and Yzerfontein, local farmers in the area, residential estates such as Jakkalsfontein, as well as motorists traveling along the R27 and R315.

The significance of the impact on the sense of place and landscape is linked to the location of the site in the scenic Darling Hills area and its proximity to the R27 and R315. In this regard the planner from the WCDM has raised concerns regarding the suitability of the Darling Hills for the establishment of WEFs. The concerns are largely linked to the visual impact of the proposed WEFs on the landscape character of the area. The potential for mitigating the impact on the area's sense of place and the landscape is low. In this regard the Australian National Wind Farm Development Guidelines stress the importance of **general location** and **site selection.**

The findings of the Visual Impact Assessment (VIA) (MetroGIS, September, 2010) indicate that the proposed facility will potentially be visible from the major roads (R27, R315 and R307) within the region. The R315 may have limited visual exposure to the WEF to the south east of the site and beyond Darling.

The town of Yzerfontein and to a lesser extent, the towns of Darling, Atlantis and Mamre will be affected visually by the WEF. In addition, various settlements / homesteads within the study area will be affected. The VIA goes on to state that it is envisaged that the structures would be easily and comfortably visible to observers (i.e. travelling along roads, residing at homesteads or visiting the WCNP), especially within a 10km radius of the WEF and would constitute a high visual prominence, potentially resulting in a high visual impact. While parts of the West Coast National Park are visually screened, sections remain exposed to high frequency of visual exposure. This includes the coastal interface and the shore of Langebaan Lagoon.

The key findings of the VIA (MetroGIS, September, 2010) are summarised below.

Potential visual impact on users of major roads (R27, R307 and R315) and secondary roads in close proximity of the proposed

Visual impacts on national/arterial/main roads are expected to **very high** for Arterial and secondary (local) roads within a 5km radius of the proposed development, and **high** for certain Arterial and secondary roads between 5km and 10km from the proposed development site.

Potential visual impact on residents of towns, settlements and homesteads in close proximity to the proposed WEF

The potential visual impact on residents of homesteads (the towns of Darling and Yzerfontein included) within a 10km radius of the proposed WEF is expected to be very high (within 5km radius) and high between 5km and 10km.

Potential visual impact on visitors to tourist destinations and entities of cultural and historical value in close proximity to the proposed WEF

The potential visual impact on tourist destinations and cultural and historical sites is expected to be moderate to high within a 10km radius of the WEF.

Potential visual impact on the West Coast National Park and on the private nature reserves and conservancies in close proximity to the proposed WEF

The visual impact of the facility on the West Coast National Park is expected to be moderate to low, as views will be longer distance views (i.e. beyond 10km). Visual impact on private nature reserves and conservancies within the West Coast Biospehere Reserve buffer area will be high within 5km of the WEF, and moderate to high between 5km and 10km from the proposed facility.

The VIA concludes that the construction and operation of the Rheboksfontein Wind Energy Facility and its associated infrastructure will have a visual impact on the natural scenic resources and rural character of this region. The rural and relatively unspoiled wide-open vistas surrounding the WEF will be transformed for the entire operational lifespan (approximately 30 years) of the plant. In this regard the facility will be visible for a large area that is generally seen as having a special landscape and tourism value (i.e. the Swartland). The facility would thus visually impact on various sensitive visual receptors that should ideally not be exposed to industrial style structures.

In addition, the conservation value of the region must not be overlooked, specifically the presence of the West Coast National Park, the context within the West Coast Biosphere Reserve and the proximity to Namaqualand further to the north. The VIA also states that there limited measures that can be taken to mitigate the visual impacts as no amount of vegetation screening or landscaping would be able to hide structures of these dimensions.

The key findings of the specialist Heritage Impact Assessment (ACO Associates, September, 2010) indicate that the most significant impacts will be to the cultural landscape and sense of place of the area. These impacts are broad and not limited to the WEF footprint. The cultural landscape is one of agriculture and livestock grazing, of which the latter component likely stretches back into pre-colonial times. The wind turbines will introduce a significant visual intrusion to this environment that may require some mitigation.

Table 5.10: Visual impact and impact on sense of place and the landscape

Nature: Visual impact associated with the proposed wind turbines and the potential impact on the area's rural sense of place and character of the landscape.		
	Without Mitigation	**With Mitigation**
Extent	Local and regional (4)	Local and regional (3)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Moderate (6)
Probability	Definite (5)	Definite (5)
Significance	**High (70)**	**High (65)**
Status	Negative	Negative
Reversibility	Yes. Wind turbines and other infrastructure can be removed.	
Irreplaceable loss of resources?	No	
Can impact be mitigated?	Yes	
Enhancement: See below		
Cumulative impacts: Potential impact on current rural sense of place and tourism in the area		
Residual impacts: See cumulative impacts		

Assessment of No-Go option

There is no impact as it maintains the current status quo.

Recommended mitigation measures

The recommendations contained in the Heritage Assessment and VIA should be implemented. In addition:

- Moyeng Energy should consult with the owners of !Khwa tuu San culture and training centre and Grootwater Farm with regard to siting of wind turbines along their boundaries;
- The siting of the wind turbines should seek to minimise the visual impact on the R27 and R315.

5.5 POTENTIAL HEALTH IMPACTS

The potential health impacts typically associated with WEFs include, noise, shadow flicker and electromagnetic radiation. As indicated in Section 4.5.5, the findings of a literature review undertaken by the Australian Health and Medical Research Council published in July 2010 indicate that there is no evidence of wind farms posing a threat to human health. The research also found that wind energy is associated with fewer health effects than other forms of traditional energy generation, and may therefore in fact result in the minimisation of adverse health impacts for the population as a whole (WHO, 2004).

Based on these findings it is assumed that the significance of the potential health risks posed by the proposed Rheboksfontein WEF are of low significance.

With regard to noise, the owner of Rondeberg Farm, Mr. Mark Duckitt, has indicated that noise generated by the movement of the turbines is a concern. In this regard he indicated that he can choose not to look at the wind turbines, but he cannot choose not to listen to them.

The noise produced by wind turbines is associated with their internal operation and the movement of the turbine blades through the air. The noise levels associated with a WEF are dependant on a number of factors, including, the number of turbines operating, wind speed and direction. Noise levels diminish with distance from the wind farm. However, while noise emissions increase with increasing wind speed, this is also often, but not always, accompanied by an increase in the background noise environment. The background noise is associated with wind blowing past or through objects, such as trees or buildings. As a result, the background noise near a dwelling may be high enough to 'mask' the sound of the turbines. This may not, however, always be the case.

Concerns have also been raised regarding the potential health impacts associated with low frequency noise (rumbling, thumping) and infrasound (noise below the normal frequency range of human hearing) from wind farms. Research undertaken in Australia indicates that low frequency noise and infrasound levels generated by wind farms are normally at levels that are well below the uppermost levels required to cause any health effects. However, this does not mean that the low, subliminal noise levels that are associated with WEFs do not impact on the psychological well being of affected parties.

With regard to the issue of noise, Mr. Duckitt has requested that Moyeng Energy determine the current ambient noise levels and implement a monitoring programme to monitor noise levels associated with the proposed Rheboksfontein WEF.

5.6 SOCIAL IMPACTS ASSOCIATED WITH DECOMISSIONING PHASE

Major social impacts associated with the decommissioning phase are typically linked to the loss of jobs and associated income. This has implications for the households who are directly affected, the communities within which they live, and the relevant local authorities.

However, in the case of the Rheboksfontein WEF, it is likely that the decommissioning phase will be indefinitely deferred, as it is envisaged that turbines will be disassembled and replaced with more modern technology at the end of their 25-30 year lifespan. All of the components of the wind turbine, with the exception of the turbine blades, can be reused or recycled. The decommissioning phase is therefore likely to create additional, construction type jobs.

When and if the wind turbine facility is finally decommissioned, the impacts are likely to be limited due to the relatively moderate number of permanent employees (35) affected. The potential impacts associated with the decommissioning phase can also be effectively managed with the implementation of a retrenchment and downscaling programme. With mitigation, the impacts are assessed to be Low (negative).

Recommended mitigation measures

The following mitigation measures are recommended:

- Moyeng Energy should investigate the option of relocating employees to other WEF when the Rheboksfontein WEF is decommissioned;
- Moyeng Energy should ensure that retrenchment packages are provided for all staff who stand to lose their jobs when the WEF is decommissioned;
- All structures and infrastructure associated with the Rheboksfontein WEF should be dismantled and transported off-site on decommissioning;
- Moyeng Energy should establish an Environmental Rehabilitation Trust Fund to cover the costs of decommissioning and rehabilitation of disturbed areas. The Trust Fund should be funded by a percentage of the revenue generated from the sale of energy to the national grid over the 25-30 year operational life of the facility.

5.7 PROPOSED POWER LINE ALIGNMENT

As discussed in Section 2.4.1, the proposed 132 kV line is approximately 34 km in length, and largely (~32 km) follows the alignment of the existing Aurora-Atlantis 400 kV transmission line corridor (two existing 400 kV lines). The existing 400 kV corridor traverses farmland for the majority of its length. The social impacts associated with this section of the alignment are therefore not regarded as significant and do not have bearing on the assessment.

From a social perspective, only the initial ~2 km section of the proposed alignment is of relevance. This short linking section between the Rheboksfontein WEF and the existing transmission line corridor traverses high potential land on Bonteberg and Alexanderfontein Farms. Vineyard and olive groves are established in the relevant area. Impacts would include loss of high potential land to pylon footprints, and more significantly, restricted movement of farming implements.

It is recommended that the possibility of siting the alignment along the Alexanderfontein-Doornfontein boundary should be investigated as an alternative for this segment. However, care should be taken to site the alignment towards the east of the relevant ridgeline in order to avoid visual impacts on Doornfontein. The proposed alignment for the relevant section is illustrated in Figure 5.1 below.

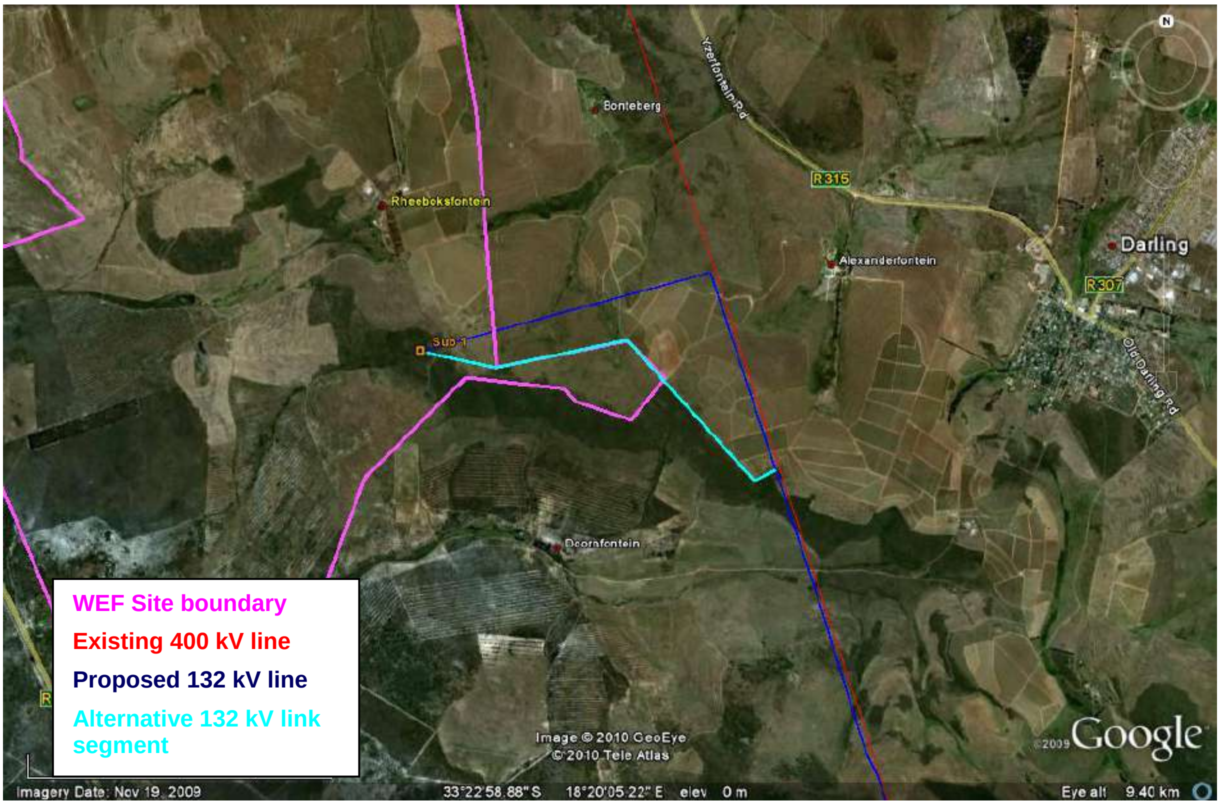

Figure 5.1. Alternative alignment of 132 kV linking segment

The recommendations contained in the VIA should be implemented. The measures listed above to address the potential impacts associated with the construction phase also apply to the construction of the power lines.

5.8 ASSESSMENT OF CUMULATIVE IMPACTS

The Australian Wind Farm Development Guidelines (Draft, July 2010) indicate that the cumulative impact of multiple wind farm facilities is likely to become an increasingly important issue for wind farm developments in Australia. This is also likely to be the case in South Africa. In terms of assessing cumulative impacts, the Scottish Natural Heritage (2005) describes a range of potential cumulative landscape impacts of wind farms on landscapes, including:

- Combined visibility (whether two or more wind farms will be visible from one location).
- Sequential visibility (e.g. the effect of seeing two or more wind farms along a single journey, e.g. road or walking trail).
- The visual compatibility of different wind farms in the same vicinity.
- Perceived or actual change in land use across a character type or region.
- Loss of a characteristic element (e.g. viewing type or feature) across a character type caused by developments across that character type.

The guidelines also note that cumulative impacts need to be considered in relation to dynamic as well as static viewpoints. The experience of driving along a tourist road, for example, needs to be considered as a dynamic sequence of views and visual impacts, not just as the cumulative impact of several developments on one location. The viewer may only see one wind farm at a time, but if each successive stretch of the road is dominated by views of a wind farm, then that can be argued to be a cumulative visual impact (National Wind Farm Development Guidelines, DRAFT - July 2010).

The visual and cumulative impacts on landscape character are highlighted in the research undertaken by Warren and Birnie (2009). The paper notes that given that aesthetic perceptions are a key determinant of people's attitudes, and that these perceptions are subjective, deeply felt and diametrically contrasting, it is not hard to understand why the arguments become so heated. Because landscapes are often an important part of people's sense of place, identity and heritage, perceived threats to familiar vistas have been fiercely resisted for centuries. The paper also identifies two factors that important in shaping people's perceptions of wind farms' landscape impacts. The first of these is the cumulative impact of increasing numbers of wind farms (Campbell, 2008). The research found that if people regard a region as having 'enough' wind farms already, then they may oppose new proposals. The second factor is the cultural context. This relates to people's perception and relationship with the landscape. In the South African context, the majority of South Africans have a strong connection with and affinity for the large, undisturbed open spaces that are characteristic of the South African landscape. The impact of WEFs on the landscape is therefore likely to be a key issue in South Africa, specifically given South African's strong attachment to the land and the growing number of wind farm applications.

The proximity of the existing and proposed Darling/ Kerriefontein WEF would probably result in the perception that the two WEFs as one facility. This, coupled to the relatively small scale of the Darling/ Kerriefontein (16 turbines) facility means that potential cumulative impacts are not a significant issue in the immediate area. A number of WEFs are however proposed further north along the R27, in the Saldanha Bay area. These include the 22 turbine Uyekraal WEF (~6 km south-east of Vredenburg) and the 98-129 turbine Mainstream Nooitgedacht facility (~4.5 km north-east of Vredenburg). This raises the potential for cumulative impacts associated with sequential visibility (e.g. the effect of seeing two or more wind farms along a single journey, e.g. road or walking trail).

The flood of applications and the impact on local planners is also a concern and appears to mirror the experience in Scotland. The research undertaken Warren and Birnie (2009), found that the wind energy 'gold rush' that took place in Scotland took everyone by surprise – politicians, planners, scientists, land managers, conservationists and the public alike. As a result a severe burden was placed in officials and related planning and development control procedures. In addition, officials and planners had very few specific criteria for assessing proposals, notably because of the lack of overall strategic locational guidance. Basic data on most aspects of wind farm development, including environmental impacts, is limited and short term. As a result the debates regarding wind farms often degenerated into exchanges of claims and counter-claims that were typically long on assertion and short on evidence. The potential for a similar situation to develop in South Africa is high. In addition, the lack of a National set of Guidelines for Wind Farms and spatial information on sensitive landscapes is a major concern.

The findings of the VIA (MetroGIS, September, 2010) indicate that the construction of 80 wind turbines together with the existing power line infrastructure and substation will increase the cumulative visual impact within the region. The possible development of other Wind Energy Facilities in the area (existing Darling WEF and potential Hopefield WEF) as well as the relatively slow construction schedule (i.e. the construction of 80 turbines at a rate of one turbine per week) may create the impression of a cumulative visual impact on uninformed observers (i.e. observers who are not aware of the total extent of the facility.

The findings of the HIA indicate that the establishment of additional WEFs in the area will escalate the erosion of context and sense of place. In this regard the significance of the impact on sense of place and the cultural landscape associated with the Rheboksfontein WEF is already rates as High Negative with mitigation (ACO Associates, September 2010).

The Australian Guidelines indicate that mitigation measures for wind farms are limited and **general location** and **site selection** is therefore of the utmost importance.

Table 5.11: Cumulative impacts on sense of place and the landscape

Nature: Visual impacts associated with the establishment of more than one WEF and the potential impact on the areas rural sense of place and character of the landscape.		
	Without Mitigation	**With Mitigation**
Extent	Local and regional (3)	Local and regional (2)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (6)
Probability	Highly Probable (4)	Highly Probable (4)
Significance	**Medium (52)**	**Medium (48)**
Status	Negative	Negative
Reversibility	Yes. Wind turbines and other infrastructure can be removed.	
Irreplaceable loss of resources?	No	
Can impact be mitigated?	Yes	
Enhancement: See below		
Cumulative impacts: Potential impact on current rural sense of place and landscape character of the area.		
Residual impacts: See cumulative impacts		

Assessment of No-Go option

There is no impact as it maintains the current status quo.

Recommended mitigation measures

The establishment of more than one, large WEF in the area is likely to have a significant negative cumulative impact on the area's sense of place and the landscape. Of specific concern is the impact on the scenic landscape important role of tourism in the study area economy. The visibility from the R27 and potential for sequential visibility is also a concern.

The absence of clear spatial guidance with regard to the appropriate siting of (proposed) WEFs and of the associated carrying capacities also constitute a significant concern for local and district municipal planners. This concern is exacerbated by large number of applications for WEFs in the area. In this regard the planner for the WCDM indicated that a moratorium on the adjudication of WEF applications should be declared until such time as a set of spatial guidelines are in place to guide the establishment of WEFs in the Western Cape.

5.9 ASSESSMENT OF NO-DEVELOPMENT OPTION

As indicated above, South Africa currently relies on coal-powered energy to meet more than 90% of its energy needs. As a result South Africa is one of the highest per capita producers of carbon emissions in the world and Eskom, as an energy utility, has been identified as the world's second largest producer carbon emissions. As discussed in 5.2.1, both national and the Western Cape provincial governments have set targets for renewables substitution. The No-Development option would represent a lost opportunity for South Africa to supplement is current energy needs with clean, renewable energy. Given South Africa's position as one of the highest per capita producer of carbon emissions in the world, this would represent a High negative social cost. However, it should be noted that the Rheboksfontein WEF development proposal is not unique. In that regard, a significant number of WEF developments are currently proposed in the Western and Eastern Cape Provinces. Foregoing the proposed Rheboksfontein WEF development would therefore not necessarily result in the end of the development of renewable energy facilities in the SBLM area, West Coast region, Western Cape or South Africa.

Table 5.12: Assessment of no-development option

Nature: The no-development option would result in the lost opportunity for South Africa to supplement is current energy needs with clean, renewable energy		
	Without Mitigation	**With Mitigation**
Extent	Local-International (5)	Local-International (5)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Moderate (6)
Probability	Highly Probable (4)	Highly Probable (4)
Significance	**High (60)**	**High (60)**
Status	Negative	Positive
Reversibility	Yes	
Irreplaceable loss of resources?	Yes, impact of climate change on ecosystems	
Can impact be mitigated?	Yes	
Enhancement: See below		
Cumulative impacts: The cumulative impacts associated with the proposed WEF include an increased awareness of role of renewable energy and the impact of on climate change associated with the reliance of fossil fuels.		
Residual impacts: See cumulative impacts		

Recommended mitigation measures

Mitigation would involve the development of the proposed WEF. However, as indicated above there are a number of concerns regarding the impact of the WEF on the sense of place and the landscape. These issues need to be taken into account by the relevant environmental and planning authorities before a final decision is taken with regard to Rheboksfontein WEF.

SECTION 6: KEY FINDINGS AND RECOMMENDATIONS

6.1 INTRODUCTION

Section 6 lists the key findings of the study and recommendations. These findings are based on:

- A review of the issues identified during the Scoping Process;
- A review of key planning and policy documents pertaining to the area;
- Semi-structured interviews with interested and affected parties;
- A review of social and economic issues associated with similar developments;
- A review of selected specialist studies undertaken as part of the EIA;
- A review of relevant literature on social and economic impacts;
- The experience of the authors with other wind energy projects in South Africa.

6.2 SUMMARY OF KEY FINDINGS

Section 6 provides an assessment of the key social issues identified during the study. The identification of key issues was based on:

- The Social Scoping Report prepared for the Scoping Report (Tony Barbour Consultants, 2010);
- Review of project related information, including other specialist studies;
- Interviews with key interested and affected parties;
- Experience of the authors with the area and local conditions;
- Experience with similar projects, including the Darling Wind Farm and Eskom Wind Energy Facility located north of the Olifants River on the West Coast of South Africa.

Section 6 provides an assessment of the key social issues identified during the study. The identification of key issues was based on:

The assessment section is divided into:

- Assessment of compatibility with relevant policy and planning context ("planning fit";
- Assessment of social issues associated with the construction phase;
- Assessment of social issues associated with the operational phase;
- Assessment of social issues associated with the decommissioning phase.
- Assessment of the "no development" alternative;
- Assessment of cumulative impacts.

The section also summarises the findings of the health impacts associated with WEFs.

6.2.1 Policy and planning issues

The key documents reviewed included:

- The White Paper on Renewable Energy (2003);
- Climate Change Strategy and Action Plan for the Western Cape (2008);
- White Paper on Sustainable Energy for the Western Cape (Final Draft, 2008);
- Strategic Initiative to Introduce Commercial Land Based Wind Energy Development to the Western Cape. Towards a Regional Methodology for Wind Energy Site Selection (2006);
- The Western Cape Provincial Spatial Development Framework (2009);
- Guideline for the Management of Development on Mountains, Hills and Ridges in the Western Cape (2002);
- The Swartland Integrated Development Plan (IDP) (2007-2011);
- The Swartland Local Economic Development Strategy (2007).

The findings of the review indicated that wind energy is strongly supported at a national and local level. At a national level the While Paper on Energy Policy (1998) notes:

- Renewable resources generally operate from an unlimited resource base and, as such, can increasingly contribute towards a long-term sustainable energy future;
- The support for renewable energy policy is guided by a rationale that South Africa has a very attractive range of renewable resources, particularly solar and ***wind*** and that renewable applications are in fact the least cost energy service in many cases; more so when social and environmental costs are taken into account.

In terms of the Western Cape Regional Methodology for Wind Energy Site Selection (2006), PSDF (2009) and Guidelines for development on Mountains, Hills and Ridges (2002), the findings of the review indicate that the proposed WEF and one of the power line options (Alternative 1) are in conflict with a number of location based principles. These relate to development on mountains, specifically the crest of hills and mountains, preference to disturbed landscapes and preservation of existing visual and sense of place values. The proposed 132 kV lines does, however, conform to the recommendations contained in the WCPSDF, in that it follows and an existing Eskom servitude.

The SIA recognises that the location of the WEF is informed by the quality of the wind resource, which, in turn, increases the WEF's potential to contribute to the generation of renewable energy in South Africa. However, the impact of large WEFs, such as the RHEBOKSFONTEIN WEF, on the visual and rural landscape character of the area cannot be ignored. This finding is supported by the findings of the VIA and the HIA. The impact of WEFs on rural landscapes is an issue that will need to be addressed by the relevant environmental and planning authorities, specifically given the large number of applications for WEFs that have been submitted in the Western Cape area over the last 12 months.

6.2.2 Construction phase

The key social issues associated with the construction phase include:

Potential positive impacts

- Creation of employment and business opportunities and opportunity for skills development and on-site training

Based on information provided by the developer the total estimated capital expenditure associated with the construction of 80 wind turbines is in the region of R 4 billion. The construction phase is expected to extend over a period of 3 years and create approximately 120 employment opportunities. Of this total, approximately 25% (or 30) of opportunities will be available to skilled personnel (engineers, technicians, management and supervisory), 35% (or 42) to semi-skilled personnel (drivers, equipment operators), and 40% (or 48) to low skilled personnel (construction labourers, security staff). The work associated with the construction phase will be undertaken by contractors and will include the establishment of the access roads and services and the erection of the wind turbines. Experience with large construction projects is that contractors typically make use of their own skilled and semi-skilled staff. The direct employment opportunities for members from the local communities of Darling and Yzerfontein are therefore likely to be limited to low skilled opportunities, which account for approximately 48 jobs. The majority of these opportunities are likely to benefit Historically Disadvantaged (HD) members of the community. However, the creation of local employment opportunities can be enhanced by the appointment of local contractors.

The wage bill associated with the construction phase is estimated at R18.66 million per annum (current value). The total wage bill for the three-year construction phase will therefore be in the region of R55.98 million. The benefits to the local economy will however be confined to the construction period (36 months).

The proposed development will also create an opportunity to provide on-site training and increase skills levels. However, the majority of these opportunities are likely to benefit the workers employed by the contractors and, as such may not benefit members of the local community. This issue can, however, be addressed through the implementation of effective enhancement measures.

In terms of business opportunities for local companies, the expenditure of in the region of R 4 billion during the construction phase will create business opportunities for the regional and local economy. However, given the technical nature of the project and the high import content associated with wind turbines the opportunities for the local Darling economy are likely to be limited. However, local engineering companies based in Cape Town, Malmesbury and Saldanha may be in a position to benefit from the construction of certain, less technical components of the wind turbines. The local service and hospitality sector is also likely to benefit from the development. These benefits would be linked to accommodation, catering, cleaning, transport and security, etc.

Potential negative impacts

- Impacts associated with the presence of construction workers on local communities;
- Increased risk of stock theft, poaching and damage to farm infrastructure associated with presence of construction workers on the site;
- Impact of heavy vehicles on local roads;
- Loss of agricultural land associated with construction related activities.

The significance of the all of the potential negative social impacts with mitigation was assessed to be of Low significance. All of the potential negative impacts can therefore be effectively mitigated if the recommended mitigation measures are implemented. However, the impact on individuals who are directly impacted on by construction workers (i.e. contract HIV/ AIDS) was assessed to be of Medium-High negative significance. Table 6.1 summarises the significance of the impacts associated with the construction phase.

Table 6.1: Summary of social impacts during construction phase

Impact	Significance No Mitigation	Significance With Mitigation
Creation of employment and business opportunities	Low (Positive impact)	Medium (Positive impact)
Presence of construction workers and potential impacts on family structures and social networks	Low (Negative impact for community as a whole) Medium-High (Negative impact of individuals)	Low (Negative impact for community as a whole) Medium-High (Negative impact of individuals)
Risk of stock theft, poaching and damage to farm infrastructure	Medium (Negative impact)	Low (Negative impact)
Impact of heavy vehicles on roads	Low (Negative impact)	Low (Negative impact)
Loss of farmland	High (Negative impact)	Low (Negative impact)

6.2.3 Operational phase

The key social issues affecting the operational phase include:

Potential positive impacts

- Creation of employment and business opportunities. The operational phase will also create opportunities for skills development and training;
- The development of clean energy as an alternative energy source and the establishment of a Cleaner Development Mechanism (CDM) project;
- Potential benefit for local tourism.

The proposed WEF will create employment of approximately 35 full time employees over a 25-year period. Of this total approximately 25% of opportunities will be available to skilled personnel (forecasters, technicians, management and supervisory, etc), 35% to semi-skilled personnel (drivers, equipment operators), and 40% to low skilled personnel (road maintenance, security, etc). Given that the wind energy sector in South Africa is relatively new it may be necessary to import the required operational and maintenance skills from other parts of South Africa or even overseas. To address this issue the developer should implement a skills development and mentorship programme for local candidates aimed at addressing this issue. This would support the strategic goals of promoting local employment and skills development contained in the Swartland Integrated Development Plan (IDP).

At this stage it is unclear where the permanent staff will reside. However, a number of people are likely to be located in Darling and possibly Yzerfontein. A percentage of permanent employees may purchase houses in one of these towns, while others may decide to rent. Both options would represent a positive economic benefit for the region. In addition, a percentage of the monthly wage bill earned by permanent staff would be spent in the regional and local economy. This will benefit local businesses in the relevant towns. The wage bill associated with the operational phase is estimated at R5.5 million per year (current value). The benefits to the local economy will extend over the anticipated 25-30 year operational lifespan of the project.

The local hospitality industry is also likely to benefit from the operational phase. These benefits are associated with site visits by company staff members and other professionals (engineers, technicians etc) who are involved in the company and the project but who are not linked to the day-to-day operations.

The proposed development also represents an investment in clean, renewable energy, which, given the challenges created by climate change, represents a positive social benefit for society as a whole.

Potential negative impacts

- Impact of the proposed wind energy facility on the current farming activities, specifically the potential loss of productive farm land;
- The visual impacts and associated impact on sense of place;

Of these impacts the impact on sense of place and the landscape represents a significant concern. The findings of the SIA indicate that while none of the local farmers interviewed identified visual impacts as a significant concern, this does not imply that proposed WEF will not impact on the areas sense of place and the landscape. Experience from elsewhere, such as Australia and Scotland, indicates that impacts on the landscape represent one of the most significant concerns associated with wind farms. The significance of the impact on the sense of place and landscape is linked to the location of the site in terms of the Darling Hills, visibility from the R27 and R315 (both of which are scenic routes), and the importance of tourism to the local economy. The potential for mitigating the impact on the areas sense of place and the landscape is low. The significance of this impact with mitigation is assessed to be High Negative. In addition, the lack of a National / Provincial set of Guidelines for Wind Farms and spatial information on sensitive landscapes is a major concern.

The significance of the impacts associated with the operational phase are summarised in Table 6.2.

Table 6.2: Summary of social impacts during operational phase

Impact	**Significance No Mitigation**	**Significance With Mitigation**
Creation of employment and business opportunities	Medium (Positive impact)	Medium (Positive impact)
Promotion of renewable energy projects	High (Positive impact)	High (Positive impact)
Impact on tourism	Low (Positive)	Medium (Positive)
Impact on farming	Low	Low

activities	(Negative impact)	(Neutral impact)
Visual impact and impact on sense of place	High (Negative impact)	High (Negative impact)

6.2.4 Power line options

The proposed 132 kV line is approximately 34 km in length, and largely (~32 km) follows the alignment of the existing Aurora-Atlantis 400 kV transmission line corridor (two existing 400 kV lines). The existing 400 kV corridor traverses farmland for the majority of its length. The social impacts associated with this section of the alignment are therefore not regarded as significant and do not have bearing on the assessment.

From a social perspective, only the initial ~2 km section of the proposed alignment is of relevance. This short linking section between the Rheboksfontein WEF and the existing transmission line corridor traverses high potential land on Bonteberg and Alexanderfontein Farms. Vineyard and olive groves are established in the relevant area. Impacts would include loss of high potential land to pylon footprints, and more significantly, restricted movement of farming implements.

It is recommended that the possibility of siting the alignment along the Alexanderfontein-Doornfontein boundary should be investigated as an alternative for this segment. However, care should be taken to site the alignment towards the east of the relevant ridgeline in order to avoid visual impacts on Doornfontein.

6.2.5 Cumulative impacts

At least one other WEF development is currently being proposed in the vicinity of the Rheboksfontein WEF site, namely the Darling/ Kerriefontein WEF, which consists of 16 wind turbines. Due to the relatively small scale of the (16 turbines) facility the potential cumulative impacts are not regarded as significant. However, a number of WEFs are proposed further north along the R27, in the Saldanha Bay area. These include the 22 turbine Uyekraal WEF (~6 km south-east of Vredenburg) and the 98-129 turbine Mainstream Nooitgedacht facility (~4.5 km north-east of Vredenburg). This raises the potential for cumulative impacts associated with sequential visibility (e.g. the effect of seeing two or more wind farms along a single journey, e.g. road or walking trail).

The findings of the SIA also indicate that the establishment of WEFs in the area conflicts with a number of key principles contained in the WCPSDF and the Guidelines for development on Mountains, Hills and Ridges. These impacts would be compounded by the development of more than one WEF in the area. Based on the findings of the VIA, HIA and SIA the establishment of more than one, large WEF in the area is therefore not supported.

6.2.6 Potential health impacts

The potential health impacts typically associated with WEFs include, noise, shadow flicker and electromagnetic radiation. As indicated in Section 4.5.5, the findings of a literature review undertaken by the Australian Health and Medical Research Council published in July 2010 indicate that there is no evidence of wind farms posing a threat to human health. The research also found that wind energy is associated with fewer health effects than other forms of traditional energy generation and in fact will have positive health benefits (WHO, 2004).

Based on these findings it is assumed that the significance of the potential health risks posed by the proposed Rheboksfontein WEF are of low negative significance. However, the owner of Rondeberg Farm, Mr. Mark Duckitt, has indicated that noise generated by the movement of the turbines is a concern. In this regard Mr. Duckitt has requested that Moyeng Energy determine the current ambient noise levels and implement a monitoring programme to monitor noise levels associated with the proposed Rheboksfontein WEF.

6.2.7 Assessment of no-development option

The No-Development option would represent a lost opportunity for South Africa to supplement is current energy needs with clean, renewable energy. Given South Africa's position as one of the highest per capita producer of carbon emissions in the world, this would represent a High negative social cost.

The no-development option also represents a lost opportunity in terms of the employment and business opportunities (construction and operational phase) associated with the WEF. This also represents a negative social cost. However, as indicated above, there are concerns related to the negative impact of the proposed WEF on the areas sense of place and the landscape.

6.2.8 Decommissioning phase

Typically, the major social impacts associated with the decommissioning phase are linked to the loss of jobs and associated income. This has implications for the households who are directly affected, the communities within which they live, and the relevant local authorities. However, in the case of the wind energy facility decommissioning phase is likely to involve the disassembly and replacement of the existing turbines with more modern technology. This is likely to take place in the 20-30 years post commissioning. All of the components of the wind turbine, with the exception of the turbine blades, can be reused or recycled. The decommissioning phase is therefore likely to create additional, construction type jobs, as opposed to the jobs losses typically associated with decommissioning.

The potential impacts associated with the decommissioning phase can also be effectively managed with the implementation of a retrenchment and downscaling programme. With mitigation, the impacts are assessed to be Low (negative).

Moyeng Energy should also establish an Environmental Rehabilitation Trust Fund to cover the costs of decommissioning and rehabilitation of disturbed areas. The Trust Fund should be funded by a percentage of the revenue generated from the sale of energy to the national grid over the 25-30 year operational life of the facility.

6.3 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of the SIA it would appear that none of the landowners who stand to be directly affected by the proposed Rheboksfontein WEF are opposed to the development. The findings of the SIA also indicate that the development will create employment and business opportunities for locals during both the construction and operational phase of the project. In order to enhance the local employment and business opportunities the mitigation measures listed in the report should be implemented. Moyeng, in consultation with the Swartland LM, should also investigate the opportunity of establishing a Community Trust. The revenue for the trust would be derived from the income generated from the sale of energy from the WEF. The mitigation measures listed in the report to address the potential negative impacts during the construction phase should also be implemented.

The proposed development also represents an investment in clean, renewable energy infrastructure, which, given the challenges created by climate change, represents a positive social benefit for society as a whole.

However, the impact of large WEFs, such as the Rheboksfontein WEF, on the visual and landscape character of the area cannot be ignored. The significance of the impact on the sense of place and landscape is linked to the location of the site in terms of the Darling Hills, visibility from the R27 and R315 (both of which are scenic routes), and the importance of tourism to the local economy. The impact of WEFs on rural landscapes is an issue that will need to be addressed by the relevant environmental and planning authorities, specifically given the large number of applications for WEFs in the area that have been submitted over the last 12 months.

The findings of the SIA also indicate that the establishment of WEFs in the area conflicts with a number of key principles contained in the WCPSDF and the Guidelines for development on Mountains, Hills and Ridges. These impacts would be compounded by the development of more than one WEF in the area. Based on the findings of the VIA, HIA and SIA the establishment of more than one, large WEF in the Darling Hills area is therefore not supported.

ANNEXURE A

INTERVIEWS

- Basson, Mr. Nico (telephonic – 31-08-10). Owner: Bonteberg and Alexander-fontein Farms, Darling.
- Basson, Mr. Theo (02-09-10). Owner: Rheeboksfontein and Wildschutsvlei Farms.
- Bosch, Mr. Alfred (03-09-10). Manager and co-owner: Slangkop Farm.
- Cleophas, Cllr. Harold (02-09-10). Swartland Municipality Ward 5 Councillor.
- Daiber, Mr. Micheal (02-09-10). CEO: !Khwa ttu San Culture and Education facility, Grootwater Farm.
- Duckitt, Mr. Mark (03-09-10). Owner: Rondeberg Farm/ Private Nature Reserve.
- Jansie, Mr. Harm (02-09-10). Chairman: Darling Tourism Association.
- Joubert, Mr Bennett (03-09-10). Owner: West Coast Farms Stall/ Restaurant; Doornfontein Farm.
- Kirsten, Mr. Johan (03-09-10). Owner: Grootberg Farm.
- Kotze, Ms. Dorothea (telephonic - 13-09-10). West Coast District Municipality: Head Planner.
- Le Roux, Ms. Diane (02-09-10). Manager: Darling Tourism Bureau (Swartland Municipality).
- Marais, Mr. Steyn (03-09-10). Reserve Manager: Jakkalsfontein Estate.
- Van Gent, Mr. Bodo (03-09-10). Manager: Doornfontein Farm.

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- Sanjit Mungroo (Moyeng Energy) to SIA study team re. envisaged construction and operational wage bills (23-07-10).

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ANNEXURE B

METHODOLOGY FOR THE ASSESSMENT OF POTENTIAL IMPACTS

Direct, indirect and cumulative impacts of the above issues, as well as all other issues identified will be assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, where it will be indicated whether the impact will be local (limited to the immediate area or site of development), regional, national or international. A score between 1 and 5 will be assigned as appropriate (with a score of 1 being low and a score of 5 being high).
- The **duration**, where it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3;
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5.
- The **magnitude**, quantified on a scale from 0-10, where a score is assigned:
  - 0 is small and will have no effect on the environment;
  - 2 is minor and will not result in an impact on processes;
  - 4 is low and will cause a slight impact on processes;
  - 6 is moderate and will result in processes continuing but in a modified way;
  - 8 is high (processes are altered to the extent that they temporarily cease); and
  - 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale, and a score assigned:
  - Assigned a score of 1–5, where 1 is very improbable (probably will not happen);
  - Assigned a score of 2 is improbable (some possibility, but low likelihood);
  - Assigned a score of 3 is probable (distinct possibility);
  - Assigned a score of 4 is highly probable (most likely); and
  - Assigned a score of 5 is definite (impact will occur regardless of any prevention measures).
- The **significance**, which shall be determined through a synthesis of the characteristics described above (refer formula below) and can be assessed as low, medium or high.
- The **status**, which will be described as either positive, negative or neutral.
- The *degree* to which the impact can be *reversed*.
- The *degree* to which the impact may cause *irreplaceable loss of res*ources.
- The *degree* to which the impact can be *mitigated.*

The **significance** is determined by combining the criteria in the following formula:

$S=(E+D+M)P$; where

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

ANNEXURE C:

ENVIRONMENTAL MANAGEMENT PLAN: SIA

CONSTRUCTION PHASE

Creation of employment and business opportunities

OBJECTIVE:

Maximise local employment and business opportunities associated with the construction phase.

Project component/s	Construction and establishment activities associated with the establishment of the wind energy facility, including infrastructure etc.
Potential Impact	The opportunities and benefits associated with the creation of local employment and business should be maximised.
Activity/risk source	The employment of outside contractors to undertake the work and who make use of their own labour will reduce the employment and business opportunities for locals. Employment of local labour will maximise local employment opportunities.
Mitigation: Target/Objective	Moyeng Energy ("Moyeng"), in consultation with the Swartland Municipality, should aim to employ a minimum of 80% of the low-skilled workers from the local area. This should also be made a requirement for all contractors. Moyeng should also develop a database of local BEE service providers

Mitigation: Action/control	Responsibility	Timeframe
• Ensure that a minimum of 80% of the low-skilled workers are sourced from the local area.	• Moyeng and contractors	• Employment and business policy document that sets out local employment targets to be in place before construction phase commences.
• Where required, implement appropriate training and skills development programmes prior to the initiation of the construction phase to ensure that 80% target is met.	• Moyeng	• Where required, training and skills development programmes to be initiated prior to the initiation of the construction phase.
• Skills audit to be undertaken to determine training and skills development requirements.	• Moyeng	• Skills audit to determine need for training and skills development programme undertaken within 1 month of commencement of

• Develop a database of local BEE service providers and ensure that they are informed of tenders and job opportunities; • Identify potential opportunities for local businesses.	• Moyeng • Moyeng	construction phase commences. • Database of potential local BEE services providers to be completed before construction phase commences.

Performance Indicator	• Employment and business policy document that sets out local employment and targets completed before construction phase commences; • 80 % of semi and unskilled labour locally sourced. • Database of potential local BEE services providers in place before construction phase commences. • Skills audit to determine need for training and skills development programme undertaken within 1 month of commencement of construction phase.
Monitoring	• Moyeng and or appointed ECO must monitor indicators listed above to ensure that they have been met for the construction phase.

Impact associated with presence of construction workers

OBJECTIVE:

Avoid the potential impacts on family structures and social networks associated with presence of construction workers from outside the area

Project component/s	Construction and establishment activities associated with the establishment of the wind energy facility, including infrastructure etc.
Potential Impact	The presence of construction workers who live outside the area and who are housed in local towns can impact on family structures and social networks.
Activity/risk source	The presence of construction workers can impact negatively on family structures and social networks, especially in small, rural communities.
Mitigation: Target/Objective	To avoid and or minimise the potential impact of construction workers on the local community. This can be achieved by maximising the number of locals employed during the construction phase and minimising the number of workers housed on the site.

Mitigation: Action/control	Responsibility	Timeframe
• Ensure that a minimum of 80% of the low-skilled workers are sourced from the local area. This should be included in the tender	• Moyeng and contractors	• Identify suitable local contractors prior to the tender process for the construction phase.

documents. Construction workers should be recruited from the local area in and around the town of Darling. • Construction workers should be able to provide proof of having lived in the area for five years or longer. • Identify local contractors who are qualified to undertaken the required work; • Establish a Monitoring Forum (MF) consisting of representatives from the local community, local police, local farming community and the contractor prior to the commencement of the construction phase; • Develop a Code of Conduct to cover the activities of the construction workers housed on the site; • Ensure that construction workers housed attend a brief session before they commence activities. The aim of the briefing session is to inform them of the rules and regulations governing activities on the site as set out in the Code of Conduct. • Ensure that all workers are informed at the outset of the construction phase of the conditions contained on the Code of Conduct; • Ensure that construction workers who are found guilty of breaching the Code of Conduct are dismissed. All dismissals must be in accordance with South African labour legislation. • Provide opportunities for workers to go home over weekends. The cost of transporting workers home over weekends and back to the site should be borne by the contractors.	• Moyeng • Moyeng • Moyeng • Moyeng and contractors • Moyeng and contractors and CLC • Contactors • Contractors • Contractors	• Tender documents for contractors include conditions set out in SIA, including transport of workers home over weekends, transportation of workers home on completion of construction phase, establishment of MF etc, • MF established before construction phase commences. • Code of Conduct drafted before construction phase commences. • Briefing session for construction workers held before they commence work on site.

• On completion of the construction phase all construction workers must be transported back to their place of origin within two days of their contract ending. The costs of transportation must be borne by the contractor.	• Contractors	

Performance Indicator	• Employment policy and tender documents that sets out local employment and targets completed before construction phase commences; • 80 % of semi and unskilled labour locally sourced; • Construction workers employed have proof that they have lived in the area for five years or longer; • Tender documents for contractors include recommendations for construction camp; • CLC set up prior to implementation of construction phase; • Code of Conduct drafted before commencement of construction phase; • Briefing session with construction workers held at outset of construction phase
Monitoring	• Moyeng and or appointed ECO must monitor indicators listed above to ensure that they have been met for the construction phase.

Safety, poaching, stock theft and damage to farm infrastructure

OBJECTIVE:

To avoid and or minimise the potential impact of the activities during the construction on the safety of local communities and the potential loss of stock and damage to farm infrastructure.

Project component/s	Construction and establishment activities associated with the establishment of the wind energy facility, including infrastructure etc.
Potential Impact	Impact on safety of farmers and communities (increased crime etc) and potential loss of livestock due to stock theft by construction workers and also damage to farm infrastructure, such as gates and fences.
Activity/risk source	The presence of construction workers on the site can pose a potential safety risk to local farmers and communities and may also result in stock thefts. The activities of construction workers may also result in damage to farm infrastructure.
Mitigation: Target/Objective	To avoid and or minimise the potential impact on local communities and their livelihoods.

Mitigation: Action/control	Responsibility	Timeframe

• The housing of construction workers on the site should be limited to security personnel; • Establish a MF with the adjacent farmers and develop a Code of Conduct for construction workers. • Inform all workers of the conditions contained in the Code of Conduct. • Dismiss all workers that do not adhere to the code of conduct for workers. All dismissals must be in accordance with South African labour legislation. • Compensate farmers / community members at full market related replacement cost for any losses, such as livestock, damage to infrastructure etc.	• Moyeng and contractors • Moyeng • Moyeng and contractor • Contractors • Contractors	• Establish MF before construction phase commences. • Develop Code of Conduct prior to commencement of construction phase. The Code of Conduct should be signed by Moyeng and the contractors before the contractors move onto site; • Inform all construction workers of Code of Conduct requirements before construction phase commences. • Compensate Farmers / community members within 1 month of claim being verified by Moyeng and or Contractor/s.

Performance Indicator	• Community MF in place before construction phase commences. • Code of Conduct developed and approved prior to commencement of construction phase. • All construction workers made aware of Code of Conduct within first week of being employed. • Compensation claims settled within 1 month of claim being verified by Community MF.
Monitoring	• Moyeng and or appointed ECO must monitor indicators listed above to ensure that they have been met for the construction phase.

Increased risk of veld fires

OBJECTIVE:

To avoid and or minimise the potential risk of increased veld fires during the construction phase.

Project component/s	Construction and establishment activities associated with the establishment of wind energy facility, including infrastructure etc.
Potential Impact	Veld fires can pose a personal safety risk to local farmers and communities, and their homes, crops, livestock and farm infrastructure, such as gates and fences.
Activity/risk source	The presence of construction workers and their activities on the site can increase the risk of veld fires.
Mitigation: Target/Objective	To avoid and or minimise the potential risk of veld fires on local communities and their livelihoods.

Mitigation: Action/control	Responsibility	Timeframe
• Ensure that open fires on the site for cooking or heating are not allowed except in designated areas. • Provide adequate fire fighting equipment onsite. • Provide fire-fighting training to selected construction staff. • Compensate farmers / community members at full market related replacement cost for any losses, such as livestock, damage to infrastructure etc.	• Moyeng and contractors • Moyeng and contractors • Contractors • Contractors	• Ensure that these conditions are included in the Construction Phase EMP. • Ensure that designated areas for fires are identified on site at the outset of the construction phase. • Ensure that fire fighting equipment and training is provided before the construction phase commences. • Compensate Farmers within 1 month of claim being verified by MF.

Performance Indicator	• Conditions contained in the Construction EMP. • Designated areas for fires identified on site at the outset of the construction phase. • Fire fighting equipment and training provided before the construction phase commences. • Compensation claims settled within 1 month of claim being verified by Community MF.
Monitoring	• Moyeng and or appointed ECO must monitor indicators listed above to ensure that they have been met for the construction phase.

Impact of dust and noise due to heavy vehicles and damage to roads

OBJECTIVE:

To avoid and or minimise the potential impacts of safety, noise and dust and damage to roads caused by construction vehicles during the construction phase.

Project component/s	Construction and establishment activities associated with the establishment of the wind energy facility, including infrastructure etc.
Potential Impact	Heavy vehicles can generate noise and dust impacts. Movement of heavy vehicles can also damage roads.
Activity/risk source	The movement of heavy vehicles and their activities on the site can result in noise and dust impacts and damage roads.
Mitigation: Target/Objective	To avoid and or minimise the potential noise and dust impacts associated with heavy vehicles, and also minimise damage to roads.

Mitigation: Action/control	Responsibility	Timeframe
• Implement dust suppression measures for heavy vehicles such as wetting roads on a	• Contractors	• Ensure that these conditions are included in the Construction Phase EMP.

regular basis and ensuring that vehicles used to transport sand and building materials are fitted with tarpaulins or covers. • Ensure that all vehicles are road-worthy, drivers are qualified and are made aware of the potential noise, dust and safety issues; • Ensure that drivers adhere to speed limits. Vehicles should be fitted with recorders to record when vehicles exceed the speed limit; • Ensure that damage to roads is repaired before completion of construction phase.	• Contractors • Contractors • Contractors	• Ensure that dust suppression measures are implemented for all heavy vehicles that require such measures during the construction phase commences. • Ensure that drivers are made aware of the potential safety issues and enforcement of strict speed limits when they are employed. • Fit all heavy vehicles with speed monitors before they are used in the construction phase. • Assess road worthy status of heavy vehicles at the outset of the construction phase and on a monthly basis thereafter; • Ensure that damage to roads is repaired before completion of construction phase.

Performance Indicator	• Conditions included in the Construction Phase EMP. • Dust suppression measures implemented for all heavy vehicles that require such measures during the construction phase commences. • Drivers made aware of the potential safety issues and enforcement of strict speed limits when they are employed. • All heavy vehicles equipped with speed monitors before they are used in the construction phase. • Road worthy certificates in place for all heavy vehicles at outset of construction phase and up-dated on a monthly basis.
Monitoring	• MOYENG and or appointed ECO must monitor indicators listed above to ensure that they have been met for the construction phase.

Impact on farming activities

OBJECTIVE:

To avoid and or minimise the potential impact on current and future farming activities during the construction phase.

Project component/s	Construction phase activities associated with the establishment of the wind energy facility and associated infrastructure.
Potential Impact	The footprint of the wind energy facility and associated infrastructure will result in a loss of land that will impact on farming activities on the site.
Activity/risk source	The footprint taken up by the wind energy facility and associated infrastructure.
Mitigation: Target/Objective	To minimise the loss of land taken up by the wind energy facility and associated infrastructure and to enable farming activities to continue where possible, specifically grazing.

Mitigation: Action/control	Responsibility	Timeframe
• Minimise the footprint of the wind energy facility and the associated infrastructure. • Rehabilitate disturbed areas on completion of the construction phase. Details of the rehabilitation programme should be contained in the EMP.	• Savannah Environmental and Moyeng • ECO and Contractors	• Footprint for wind energy facility should be defined in the Construction EMP before construction phase commences. • Rehabilitation should be on-going and completed within 3 months of the completion of the construction phase.
• Investigate the possibility of allowing farmers in the area to continue to use the site for grazing, or the option of leasing the land for grazing to other local farmers and possibly emerging farmers.	• Moyeng	• Meeting/s with local farmers to discuss lease options should take place during the construction phase.

Performance Indicator	• Footprint of wind energy facility included in the Construction Phase EMP. • Meeting/s held with farmers during construction phase.
Monitoring	• ECO must monitor indicators listed above to ensure that they have been met for the construction phase.

OPERATIONAL PHASE

Creation of employment and business opportunities

OBJECTIVE:

Maximise local employment and business opportunities associated with the operational phase.

Project component/s	Day to day operational activities associated with the wind energy facility including maintenance etc.	
Potential Impact	The opportunities and benefits associated with the creation of local employment and business should be maximised	
Activity/risk source	The operational phase of the wind energy facility will create approximately 30 full time employment opportunities.	
Mitigation: Target/Objective	In the medium to long term employ as many locals as possible to fill the 30 full time employment opportunities.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
• The workforce of approximately 100 permanent staff will be largely based in the local town of Darling. Moyeng Energy ("Moyeng") should commit to implementing a 5-year training and skills development and training programme. The initial local content target is 30%, however, after 5 years the objective is to have all the employment opportunities taken up by locals.	• Moyeng	• Develop 5 year training and skills development programme during the construction phase.
• Identify local members of the community who are suitably qualified or who have the potential to be employed full time.	• Moyeng	• Identify local members of the community who are suitably qualified or who have the potential to be employed full time during the construction phase.
Performance Indicator	• 5 year training and skills development programme developed and designed before construction phase completed; • Potential locals identified before construction phase completed.	
Monitoring	• Moyeng must monitor indicators listed above to ensure that they have been met for the operational phase.	

Impact on tourism / highlighting benefits of renewable energy

OBJECTIVE:

To maximise the potential tourism opportunities during the operational phase.
In addition, to highlight the benefits of renewable energy projects.

Project component/s	Operational phase of the project.
Potential Impact	The proposed wind energy facility has the potential to provide the Swartland Municipality with an attraction that would improve its attraction to tourists. The development also has the potential to promote the benefits of renewable energy projects.
Activity/risk source	The establishment of a wind energy facility has the potential to create and attraction for visitors to the area. The development also has the potential to promote the benefits of renewable energy projects.
Mitigation: Target/Objective	To enhance the potential tourism and renewable energy opportunities associated with the proposed wind energy facility.

Mitigation: Action/control	Responsibility	Timeframe
• Liaise with representatives from the Swartland Municipality and tourism organizations to raise awareness of the proposed wind energy facility.	• Moyeng	• Set up meetings with Swartland Municipality and local tourism organisations during the construction phase.
• Establish a renewable energy interpretation centre at the site. The centre should be equipped with information boards that provide visitors with information on the project and other relevant information. Information should also be provided on renewable energy and its benefits.	• Moyeng	• Establish interpretation centre at the outset of the construction phase. This will create and opportunity to provide tourists with information on both the construction and operational phases of the project.
• Information should presented in the two main languages in the Eastern Cape, namely English, and Xhosa.	• Moyeng	

Performance Indicator	• Meetings with Swartland Municipality and local tourism organisations during the construction phase. • Establishment of interpretation centre at the outset of the construction phase.
Monitoring	• Moyeng must monitor indicators listed above to ensure that they have been met for the operational phase.

DECOMMISSIONING PHASE

Impact of decommissioning

OBJECTIVE:

To avoid and or minimise the potential impacts associated with the decommissioning phase.

Project component/s	Decommissioning phase of the wind energy facility.
Potential Impact	Decommissioning will result in job losses, which in turn can result in a number of social impacts, such as reduced quality of life, stress, depression etc. However, the number of people affected (35) is relatively small. Decommissioning is also similar to the construction phase in that it will also create temporary employment opportunities.
Activity/risk source	Decommissioning of the wind energy facility.
Mitigation: Target/Objective	To avoid and or minimise the potential social impacts associated with decommissioning phase of the wind energy facility.

Mitigation: Action/control	Responsibility	Timeframe
• Retrenchments should comply with South African Labour legislation of the day.	• Moyeng	• When wind energy facility is decommissioned.

Performance Indicator	• South African Labour legislation relevant at the time.
Monitoring	• Moyeng and Department of Labour.

ADDENDUM TO SOCIAL IMPACT ASSESSMENT FOR RHEBOKSFONTEIN WIND ENERGY FACILITY (NEAR DARLING)

JUNE 2011

Prepared for

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TABLE OF CONTENTS

1. INTRODUCTION

The aim of this document is to comment on the revised layout for the proposed Rheboksfontein Wind Energy Facility located near the town of Darling in the Western Cape Province of South Africa. The focus of assessment is determine the implications of the proposed reduction from 80 wind turbines (Figure 1) to 48 turbines (Figure 2) on the findings of the initial Social Impact Assessment (SIA) undertaken by Tony Barbour Environmental Consulting and Research in September 2011.

The revised layout is in response to a letter received from the Department of Environmental Affairs dated 29 March 2011.

2. COMMENT ON KEY SOCIAL ISSUES

2.1 Fit with planning

The findings of the assessment of 80 wind turbines found that project was is conflict with a number of location based principles contained in the Western Cape Regional Methodology for Wind Energy Site Selection (2006), PSDF (2009) and Guidelines for development on Mountains, Hills and Ridges (2002). These relate to development on mountains, specifically the crest of hills and mountains, preference to disturbed landscapes and preservation of existing visual and sense of place values. The proposed 132 kV lines does, however, conform to the recommendations contained in the WCPSDF, in that it follows an existing Eskom servitude.

The SIA recognises that the location of the WEF is informed by the quality of the wind resource, which, in turn, increases the WEF's potential to contribute to the generation of renewable energy in South Africa. However, the impact of large WEFs, such as the Rheboksfontein WEF, on the visual and rural landscape character of the area cannot be ignored. This finding is supported by the findings of the VIA and the HIA. The impact of WEFs on rural landscapes is an issue that will need to be addressed by the relevant environmental and planning authorities, specifically given the large number of applications for WEFs that have been submitted in the Western Cape area over the last 12 months.

This finding still applies to the revised 48 turbine proposal. It should also be noted that the planner from the West Coast District Municipality (WCDM) raised concerns regarding the suitability of the Darling Hills for the establishment of WEFs.

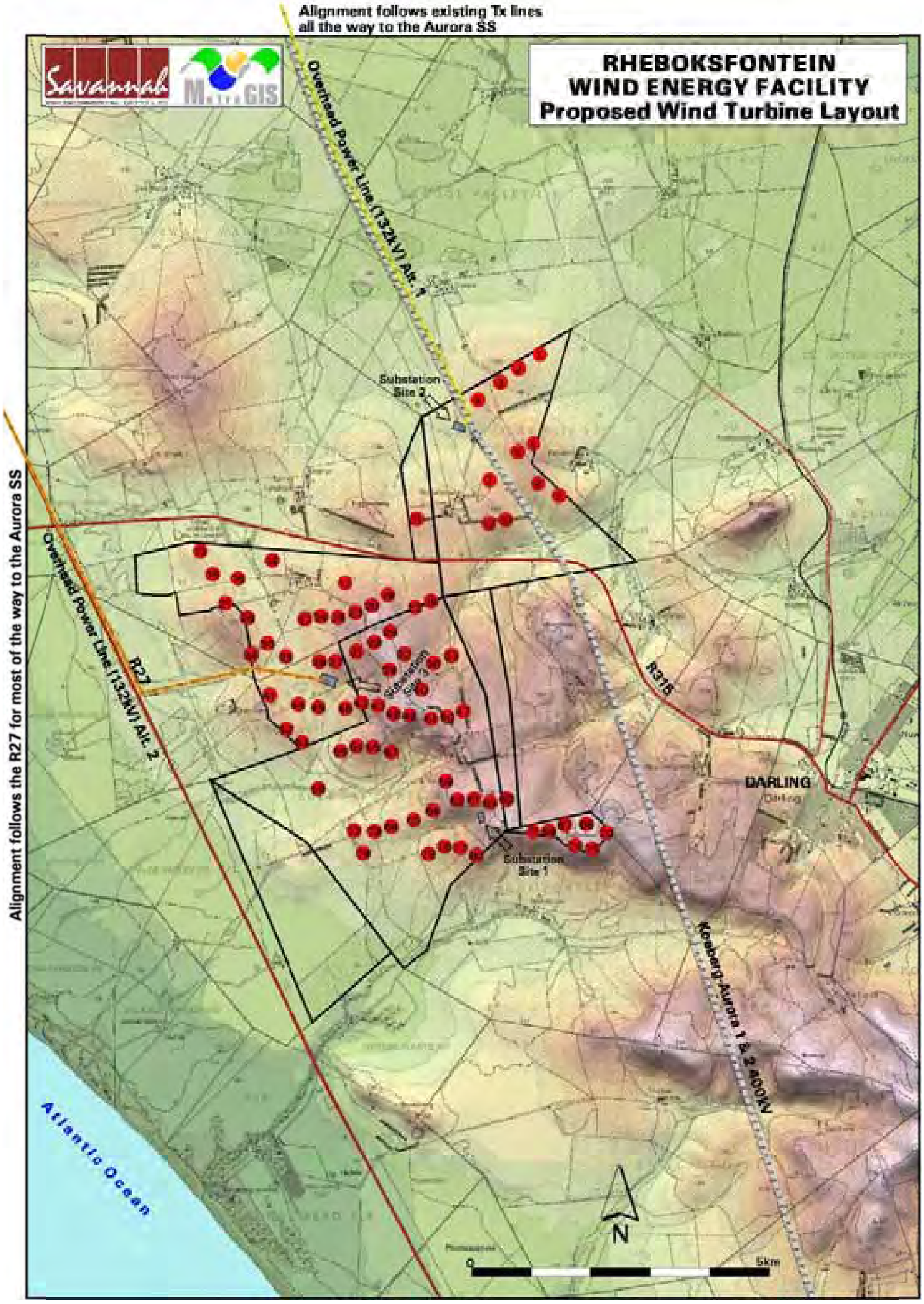
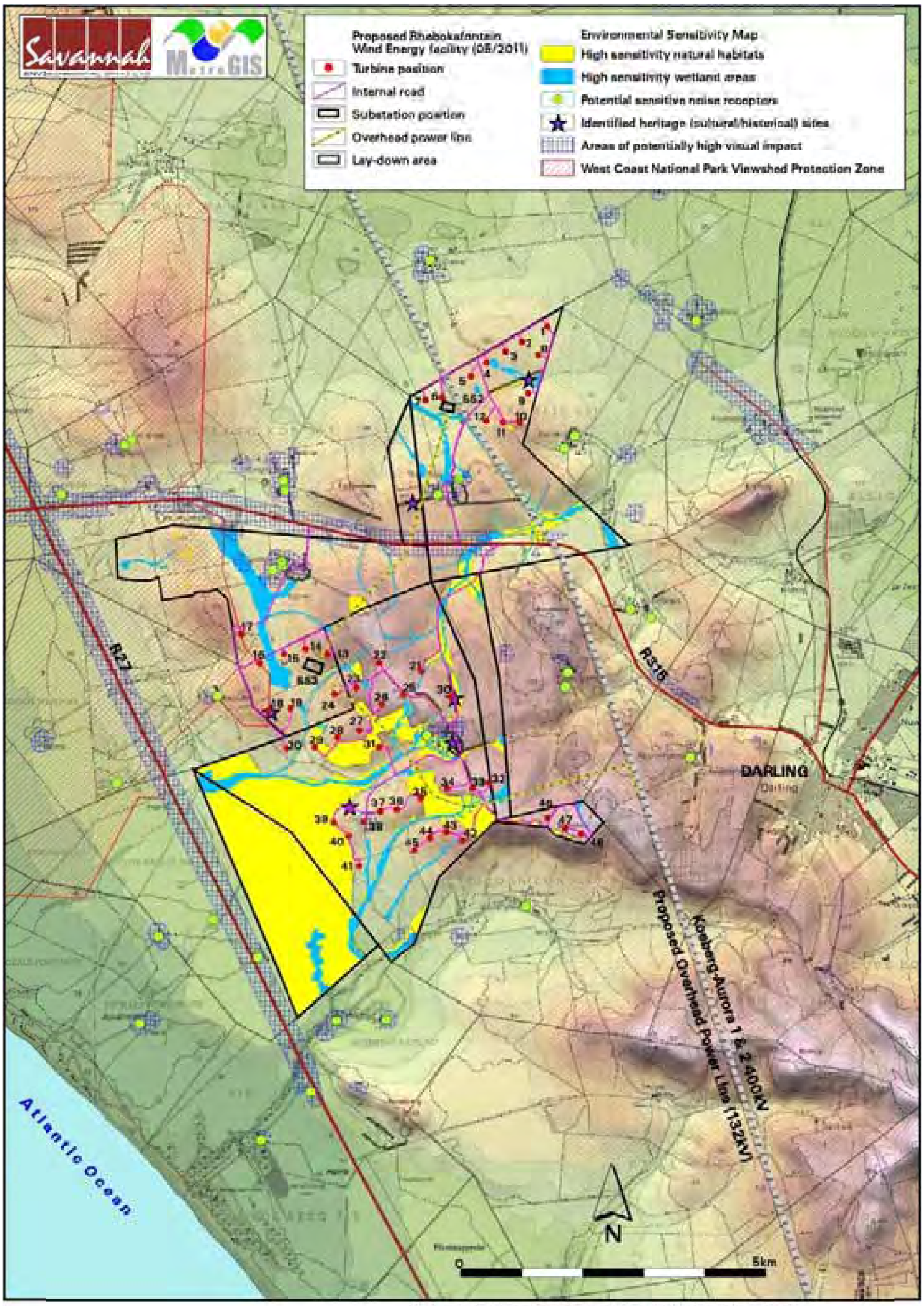


Figure 1: Original 80 turbine layout



Alignment follows existing Tx lines all the way to the Dassenberg SS

Figure 2: Revised 48 turbine layout

2.2 Visual impact and impact on sense of place and landscape

The visual impacts are linked to the sites location relative to the R27 and R315, which are recognised scenic routes, and its location on the Darling Hills, which have a high scenic value. Concerns were raised regarding the potential visual impact of the wind turbines on !Khwa tuu San culture and training centre (Grootwater Farm), Doornfontein Farm, and the Jakkalsfontein eco-estate.

The turbines associated with the proposed WEF will have a visual impact and, in so doing, impact on the rural sense of the place of the area and the landscape. While none of the local farmers interviewed identified visual impacts as a significant concern, this does not imply that the proposed WEF will not impact on the area's sense of place and the landscape. The parties who stand to be affected include residents of Darling and Yzerfontein, local farmers in the area, residential estates such as Jakkalsfontein, as well as motorists traveling along the R27 and R315.

The significance of the impact on the sense of place and landscape is linked to the location of the site in the scenic Darling Hills area and its proximity to the R27 and R315. In this regard the planner from the West Coast District Municipality (WCDM) has raised concerns regarding the suitability of the Darling Hills for the establishment of WEFs. The concerns are largely linked to the visual impact of the proposed WEFs on the landscape character of the area. The potential for mitigating the impact on the area's sense of place and the landscape is low.

The significance of the visual impact as a key issue is confirmed by the Visual Impact Assessment (VIA) (MetroGIS, September, 2010). The VIA concludes that the construction and operation of the Rheboksfontein Wind Energy Facility and its associated infrastructure will have a visual impact on the natural scenic resources and rural character of this region. The facility will be visible for a large area that is generally seen as having a special landscape and tourism value (i.e. the Swartland).

The findings of the addendum prepared by the heritage specialists (ACO Associates, June, 2010) also confirm that the most significant impacts will be to the cultural landscape and sense of place of the area. The report notes that while there may well be potential to construct a WEF in the proposed location but, owing to the nature of the topography and the very low absorption capacity, impacts of high to very high heritage significance will definitely occur. These impacts are primarily visual in nature and related to residents, tourists and the local scenic routes. The addendum prepared by the heritage specialist indicates that the site is located within a visually prominent landscape and stands in stark contrast to some of the far more remote, and hence more appropriate, locations that have been proposed for similar facilities in recent years. The addendum goes onto state that the site, from a heritage perspective, is generally unsuited to the type of development proposed.

Despite the reduced number, the establishment of 48 wind turbines is still expected to have a high negative impact on the the natural scenic resources and rural character of this region. The most directly affected parties will continue to be !Khwa tuu San culture and training centre (Grootwater Farm), Doornfontein Farm, and the Jakkalsfontein eco-estate. While the number of turbines associated with the original layout located on the ridgeline above !Khwa tuu complex have been moved, the majority of turbines associated with the revised layout will still be visible to visitors who take drives on the site, specifically drives to the scenic lookout point located on the high point to the north west of the restaurant and visitor centre. This will impact negatively on the visitor's experience of being in a natural, undeveloped area. In the case of Jakkalfontein eco-estate, while the number of turbines has been reduced, a large number will still remain visible.

2.3 Potential impact on tourism

The findings of the original SIA for 80 turbines indicated that the potential negative impacts on tourism are largely linked to the visual impacts associated with the proposed Rheboksfontein WEF. The visual impacts are linked to the sites location relative to the R27 and R315, which are recognised scenic routes, and its location on the Darling Hills, which have a high scenic value. The study found that tourism is key component of the local economy of the towns of Darling and Yzerfontein. The R27 is also an important link between Cape Town in the south and the West Coast, including the West Coast National Park and the Langebaan Lagoon, in the north.

In addition the potential visual impact on passing traffic, the proposed WEF will also impact on the !Khwa tuu San culture and training centre is located on the farm Grootwater adjacent to the Grootberg portion of the Rheboksfontein site. !Khwa tuu receives approximately 15 000 visitors per year, and provides permanent employment to 25 people. A number of turbines are proposed on the ridgeline above the restaurant/ shop/ office complex at !Khwa tuu. The nearest turbine is proposed ~0.6 km from the complex. The relevant turbines would be very visible from the complex, and would adversely impact on the tourists' experience of being in a natural, undeveloped area.

The proposed location of a number of turbines on the ridgeline above Doornfontein Farm is also problematic. In this regard, the owners of Doornfontein Farm are in the process of converting the property to a game farm and are of the opinion that the presence of wind turbines along the skyline would detract from the visitor experience of a game farm.

The findings of the VIA Addendum (MetroGIS, June 2011) indicate that the amended layout for the proposed Rheboksfontein Wind Energy Facility will result in a lower magnitude of visual impact overall, due to mainly to the reduced number of turbines and the inclusion of a buffer area along the R315. The facility will still be visible for a large area that is generally seen as having a special landscape and tourism value (i.e. the Swartland) and would visually impact on various sensitive visual receptors that should ideally not be exposed to industrial style structures. The author of the addendum to the VIA also indicates that in his opinion the study area is not ideally suited to the development of a WEF primarily due to its inherent and growing tourism value.

However, having said this the author goes onto state that the visual impacts associated with the WEF are likely to detract for the tourism appeal, numbers of tourists or tourism potential of the existing centres. This appears to contradict the earlier statement. This statement is not supported by the findings of the SIA. The findings of the SIA indicate that despite the reduced number of wind turbines, the establishment of 48 wind turbines is still expected to have a high negative impact on the the natural scenic resources and rural character of this region, which in turn will impact negatively on the tourist potential of the area. As indicated above, while the number of turbines associated with the original layout previously located on the ridgeline above !Khwa tuu complex have been moved, the majority of turbines will still be visible to visitors who take drives on the site, specifically drives to the scenic lookout point located on the high point to the north west of the restaurant and visitor centre. This will impact negatively on the visitor's experience of being in a natural, undeveloped area. The findings of the heritage specialist addendum also indicate that impacts of high to very high heritage significance will definitely occur. The addendum notes that these impacts are primarily visual in nature and related to residents, tourists and the local scenic routes (ACO Associates, June, 2010).

While the number of turbines on the ridgeline above Doornfontein Farm has been reduced (8 to 4), the remaining 4 will still in all likelihood be visible. The owners of Doornfontein Farm are in the process of converting the property to a game farm and are of the opinion that the presence of wind turbines along the skyline would detract from the visitor experience of a game farm. The impact on Doornfontein Farm therefore remains a concern.

In terms of impact on motorist, a large number of turbines will still be visible to motorists travelling along the R27 and R 315. A number of turbines will also still be visible from the coastal resort of Jakkalsfontein to the west of the site.

3. GENERAL COMMENT

Despite the reduction in the number of wind turbines from 80 to 48, reservations still exist with regard to the suitability of the Darling Hills area for the establishment of a WEF, specifically the Rheboksfontein site due to its proximity to and visibility from the R27 and R 315, and a number of well-established coastal settlements, including Jakaalsfontein. The R27 is also an important link between Cape Town in the south and the West Coast, including the West Coast National Park and the Langebaan Lagoon, in the north. Concerns regarding the suitability of the area for the establishment of a WEF have also been expressed by the authors of the VIA and the Heritage Assessment. The planner from the West Coast District Municipality (WCDM) has also raised concerns regarding the suitability of the Darling Hills for the establishment of WEFs. The reduction of the number of turbines from 80 to 48 does not address these concerns.

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REPORT

On contract research for

SAVANNAH ENVIRONMENTAL

SOIL INFORMATION FOR PROPOSED RHEBOKSFONTEIN WIND ENERGY FACILITY, NEAR DARLING, WESTERN CAPE

Section 2: SOIL PROFILES

By

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October 2010

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DECLARATION

I hereby declare that I am qualified to compile this report as a registered Natural Scientist, that I am independent of any of the parties involved and that I have compiled an impartial report, based solely on all the information available.

D G Paterson
October 2010

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1. TERMS OF REFERENCE

The ARC-Institute for Soil, Climate and Water (ARC-ISCW) was originally contracted by Savannah Environmental to undertake a desk-top soil investigation north of Cape Town, in Western Cape Province (Paterson, 2010). The purpose of the investigation was to contribute to the Environmental Impact assessment (EIA) process for a proposed wind energy facility. The objectives of the study were;

- To obtain all existing soil information and to produce a soil map of the specified area as well as

- To assess broad agricultural potential.

Despite the fact that the proposed wind turbines for the project would occupy a very small ground footprint, and that for most purposes, virtually all agricultural activities can continue in the immediate vicinity of such turbines, concern was raised by the Department of Agriculture: Western Cape as to the prevailing soil conditions and associated agricultural potential.

Consequently, a request was made to visit the site and obtain first-hand information concerning the soils occurring at certain of the turbine sites.

2. SITE CHARACTERISTICS

Location

The study area lies to the west of the town of Darling on parts of the farms Slangkop 552, Platklip 551, Slangkop 1199, Bonteberg 571, Rheboksfontein 5678, Doornfontein 574 and Nieuweplaats 567.

The area lies to the west of the R27 road, between 33^o 18" and 33^o 24' S and between 18^o 15' and 18^o 20' E. The position of the site is shown in the map in the Appendix.

All the other site characteristics were given in the original report (Paterson, 2010).

3. METHODOLOGY

The site was visited during September 2010 and a selection was made of all turbine sites occurring within the land type mapping units that were previously identified as containing soils of dominantly high potential. These points were located using a GPS and are shown by the **solid** white circles on the map (Appendix 1).

At each site, the soil was investigated using a hand-held soil auger to a maximum depth of 1 200 mm (or shallower, if a restricting layer was found). Information noted at each point included:

- Soil form and family; diagnostic horizons with clay content; effective depth and depth-limiting material; land use.

The soils were classified using the South African Soil Classification System (Soil Classification Working Group, 1991).

4. SOILS

The soils vary significantly, and the following soils were identified:

Cf1100 – Cartref form (“grey” E horizon, soft saprolite)
Cf2200 – Cartref form (“yellow” E horizon, hard saprolite)
Dr2000 – Dresden form (bleached A horizon on ferricrete)
Es1200 – Estcourt form (“grey” E horizon, non-black prismacutanic)
Fw1110 – Fernwood form (“grey” E horizon, no lamellae)
Gs2111 – Glenrosa form (bleached A horizon, soft saprolite, dry, no lime)
Gs2121 - Glenrosa form (bleached A horizon, soft saprolite, wet, no lime)
Hu2200 – Hutton form (moderately leached, luvic)
Kd1000 – Kroonstad form (“grey” E horizon)
Ms1100 – Mispah form (non-bleached A horizon, no lime, on rock)
Ms2100 – Mispah form (bleached A horizon, no lime, on rock)

Oa1110 – Oakleaf form (non-bleached A horizon, non-red, non-luvic)

Oa1210 – Oakleaf form (non-bleached A horizon, red, non-luvic)
Oa2120– Oakleaf form (bleached A horizon, non-red, non-luvic)
Oa2220– Oakleaf form (bleached A horizon, red, luvic)
Sw2121 – Swartland form (bleached A horizon, non-red, no lime)
Vf1120 – Vilafontes form (“grey” E, non-red, luvic)
Wa1000 - Wasbank form (“grey” E on ferricrete)

Due to the location of the observation sites, mainly on crests and upper midslopes, the average soil depth of soils varies between 100 - 800 mm onto underlying material that can differ from relict hard plinthite (weathering phases can varies from weak to strong weathering), and pre weathered granite.

The relevant soil information was recorded in a spread sheet, shown in Table 1 below.

Table 1 Soils

Point	Soil Form	Hor.	Horizon depth (mm)	Clay % plus Texture (est)	Depth limiting mat.	Eff. Depth	Land use	Perennial Crops		Annual Crops
								Limiting Factors	Suitability	Suitability
1R	Kd1000	A	300	0-6 coSa			Wheat	6,2,1	M-L	M
		E	650	0-6 coSa		650				
		G	850	35+ cl	Gleycutanic					
		R	850+							
2R	Cf1100	A	250	0-6 coSa			Disturbed land (old land)	6,2,4	M-L	M
		E	600	0-6 coSa		600				
		B	700+		Lithocutanic/neocutanic					
3R	Dr2000	A	300	0-6 coSa		300	Disturbed land (old land)	1,6	L	L-M
		B			Hard plinthite					
4R	Cf2200	A	250	10-15 fi-meSa			Wheat	2,4	M-L	M-H
		E	600	10-15 fi-meSa		600				
		R	700+		Rock					
5R	Cf1100	A	300	0-6 coSa			Disturbed land (old land)	6,2	L-M	M
		E1	700	0-6 coSa						
		E2	1400	0-6 coSa		1400				
		Cso	1500+		Deep weathered granite					
6R	Hu2200	A	250	6-8 meSa			Disturbed land (old land)	6,4	M-H	M-H
		B	600	20-25 fiSa		600				
		C	800	25-30 fiSa	lithocutanic					
		R	800+		Granite					
7R	Cf1100	A	300	6-8 coSa			Wheat	6,2,4	M	M
		E	600	6-8 coSa		600				
		Blc	850	35+						
		R	850+		Granite					
8R	Oa1210	A	250	8-10 meSa			Wheat	1,4	M-L	H
		B	450	10-15 meSa		450				

		Cso	500+		Weathered granite					
9R	Oa1210	A	200	8-10 meSa			Wheat	1,4	M-L	H
		B	450	10-15 meSa		450				
		R	500+							
10R	Cf1100	A	250	0-6 coSa			Disturbed land (old land)	6,2,4	M	M
		E	600	0-6 coSa		600				
		Blc	700	20-25 meSa						
		R	700+							
11R	Gs2111	A	300	6-8 coSa		300	Disturbed land (old land)	1,6	L	M-H
		Blc	600	25-30 fiSa						
		R	800+		Granite					
12R	Cf1100	A	250	0-6 coSa			Disturbed land (old land)	6,2	M	M
		E1	600	0-6 coSa						
		E2	900	0-6 coSa		900				
		B	1000	20-25 fiSa						
		R	1000+		Granite					
18R	Cf1100	A	200	0-6 coSa			Disturbed land (old land)	6,2,4	M	M
		E1	400	0-6 coSa						
		E2	600	0-6 coSa		600				
		B	800	10-15 coSa	lithocutanic/saprolitic					
		R	800+		Granite					
19R	Oa2220	A	250	10-15 fi-meSa			Vines	5,3	M-H	H
		B	500	30+ fiSa		500				
		C1	900	20-25 fiSa						
		C2	1100	20-25 fiSa						
		C3	1200+	30+ fiSa						
20R	Ms1100	A	300	6-8 me-coSa		300	Disturbed land (old land)	1	L	M-L
		R	300+		Granite					
22R	Oa2120	A	250	15-20 meSa			Vines	5,3	M-H	H
		B1	900	20+						
		B3	1100	20+		1100				
		R/stones?	1100+							

28R	Cf1100	A	300	3-6 me-coSa			Disturbed land (old land)	6,2,4	M	M
		E	700	0-6 coSa		700				
		Blc/so	900	20 fi-meSa						
		R	900+		Granite					
31R	Cf1100	A	350	0-6 coSa			Disturbed land (old land)	6,2,4	M	M
		E	700	0-6 coSa		700				
		Blc/so	900							
		R	900+		Granite					
32R	Kd1000	A	300	0-6 coSa			Disturbed land (old land)	2,6	M-L	M
		E	1000	0-6 coSa		1000				
		G	1100+	20-25 me - coSa						
33R	Kd1000	Aob	250	0-6 coSa			Grass (vleiland area)	2,6	M-L	M
		A	600	0-6 coSa						
		E	1200	0-6 coSa		1200				
		G	1500+	6 coSa						
36R	Cf1100	A	200	6-10 meSa			Disturbed land (old land)	2,1	M-L	M
		E	450	6-10 me- coSa		450				
		Blc/ne/pr?	700	35+						
		Cso	1100		Weathered granite					
		R	1200+							
40R	Kd1000	A	300	0-6 coSa			Disturbed land (old land)	2,6	M-L	M
		E	800	0-6 coSa		800				
		G	1000	6-8 fi - meSa						
		E	1200+	0-6 coSa						
47R	Vf1120	A	300	10-15 fi-meSa			Disturbed land (old land)	2	M	M-H
		E1	600	8-10 fi-meSa						
		E2	700	8-10 me-coSa		700				
		Bne/pr?	900+	35+						
50R	Wa1000	A	250	0-6 coSa			Disturbed land (old land)	2,6,1	L-M	M
		E	500	0-6 coSa		500				
		Bhp	500+							
51R	Kd1000	A	300	6+ me-coSa			Vines	2,6	M-L	M

		E1	600	3-6 coSa						
		E2	900	3-6 coSa		900				
		G	1100+	35+						
60R	Kd1000	A	300	0-6 meSa			Vines	2,6,1	L-M	M
		E	500	0-6 coSa		500				
		G	600+	40+ fiSa						
61R	Ms1100	A	300	10-15 fi-meSa			Oats	1	L	L-M
		R	300+		Granite	300				
62R	Gs2121	A	300	15 coSa			Oats	1,3	L	M-H
		Blc/so	900+	10-15 coSa						
63R	Sw2121	A	350	8-10 me-coSa			Oats	1,3	L-M	H
		B	600	30+ fiSa		350				
		Cso	700+	35+						
66R	Es1200	A	300	0-6 me-coSa			Oats	1,2	L-M	M
		E	400	0-6 coSa		300				
		Bpr	400+	35+						
67R	Fw1110	A	350	0-6 me-coSa			Oats	6,2	M-L	M
		E1	1000	0-6 coSa						
		E2	1500	0-6 coSa		1500				
69R	Oa1110	A	300	6-8 me-coSa			Oats - side of land	6	M-H	M-H
		B	800	10-15 meSa						
		B3	900	6-8 me-coSa		900				
		R	900+		Granite					
70R	Oa2120	A	250	10-15 fi-meSa			Oats	3,5	M-H	H
		B	500	20+ fiSa		500				
		Chp	500+							
71R	Cf2200	A	300	8-10 meSa			Oats - side of land	2,4	M	M
		E	500	6-8 me-coSa		500				
		R/stone?			Granite					
74R	Ms2100	A	300	10-15 meSa			Oats - side of land	1	L	L-M
		R	300+		Granite	300				
75R	Cf1100	A	350	6-8 me-coSa			Oats	6,2	M	M

		E	900	0-6 coSa						
		Blc	1000+	20+ coSa	Weathered granite					
76R	Sw2121	A	350	8-10 coSa			Oats harvested	1,3	L-M	H
		B	450	20+ fiSa		350				
		Clc	500	25+ fiSa						
		R	600+							

5. AGRICULTURAL POTENTIAL

Soil suitability

The suitability of a soil for successful crop production is dependant on the physical, morphological and chemical limitations that occur in that soil.

The suitability of the area, according to climate, for the cultivation of perennial crops such as dryland wine grapes and olives, is medium to high for the Darling area (Department of Agriculture, 1989a).

The annual crops included winter small grains, such as wheat and oats.

For annual winter small grain, the suitability rating according to climate is high for the Darling area (Department of Agriculture, 1989ba). The variation in the suitability rating of different soil types was fairly small. The reason for this small variation is the relatively shallow effective soil depth required by these crops for optimum production under winter rainfall conditions e.g. 30 – 35 cm for small grains. Only in localised small upland depressions and areas with sandy soils or where "heuweltjie" soils with calcrete/dorbank at <300 mm depth occurs, were the ratings low.

Limitations

The following limitations were taken into account during the field evaluation phase.

Limitation	Description	Symbol
Effective depth	This term refers to the depth to which plant roots will penetrate without any significant restrictions	1
Wetness	This refers to the presence of free water for shorter or longer periods at varying depths in a soil profile	2
Surface hard setting	Bleached topsoil, which is hard to very hard in the dry state. Possible loss of iron and clay	3
Weathering rock	Rock in different stages of weathering, from well weathered to unweathered, is present in many soils as a diagnostic or non-diagnostic horizon or material.	4
Hard plinthic horizons	Hardpan cemented primarily by iron in various degrees of cementation	5
Low clay content in top- and upper subsoils	Rapid loss of soil moisture during drier periods	6

These numerical symbols were only used as an identification number for each of the limitations and bear no value. However, the limitations are noted in a sequence of dominance. All the limitations noted per observation, are not always severe but should be mentioned (see Table 1).

Suitability classes

H – high few limitations which can be eliminated or prevented with standard soil preparation and fertilising practices

M – medium the elimination of one or more limitations is possible with the correct amelioration practices so that successful cultivation can take place

L – low severe limitations that prevent cultivation or need above-average management skills. Amelioration costs can be high

In summary, only eight of the 37 turbine sites investigated had an effective soil depth of 900 mm or more, while seven sites had shallow soils on rock. However, as previously stated, disturbance to an soils with a significant agricultural potential will be limited to the immediate area of the infrastructure, which would occupy a very small proportion of the landscape and not be limiting to dryland agriculture in the wider context in any way.

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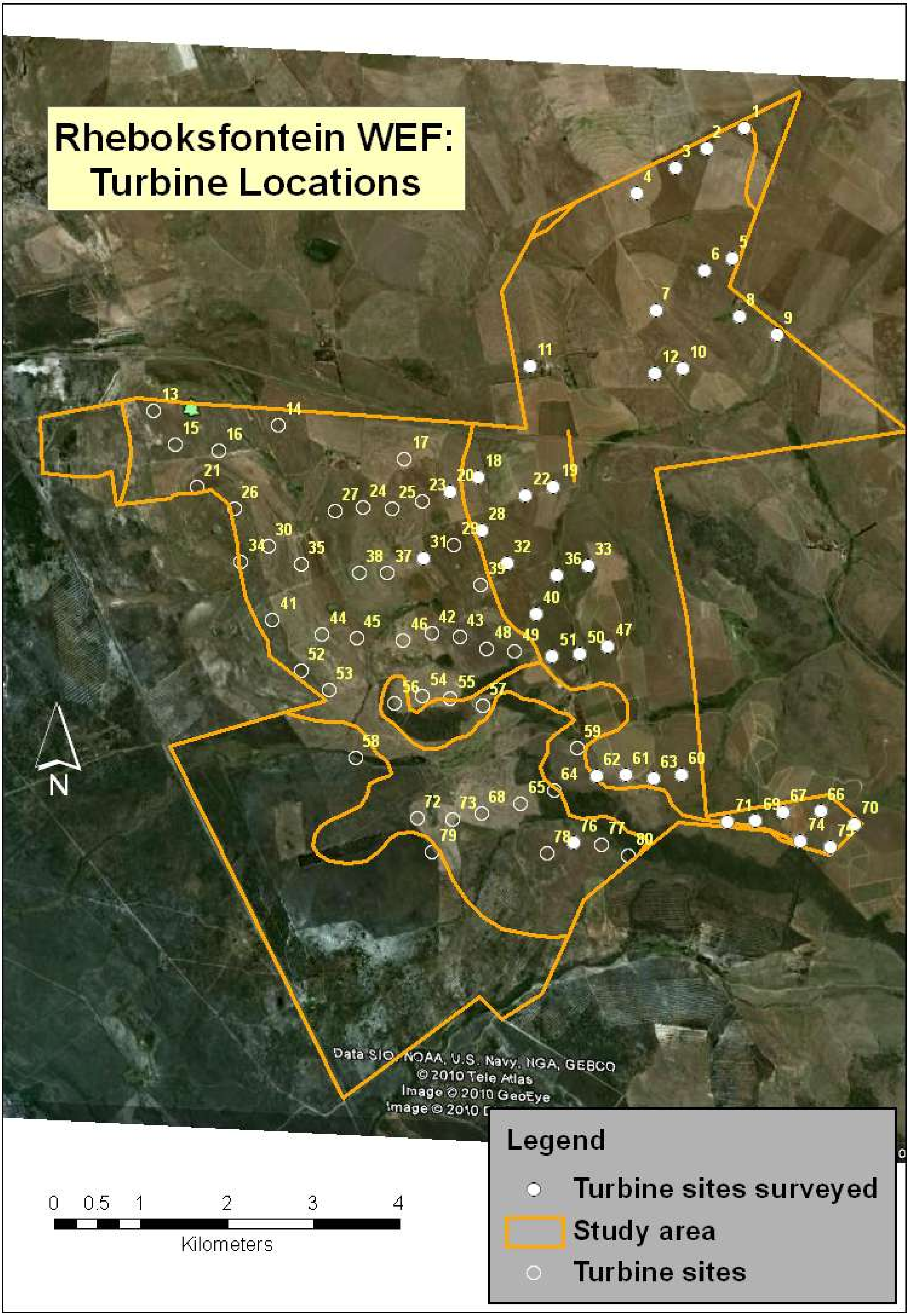
APPENDIX

MAP OF LAND TYPES


Rheboksfontein WEF:
Turbine Locations
N
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2010 Tele Atlas
Image © 2010 GeoEye
0 0.5 1 2 3 4
Kilometers
Legend
Turbine sites surveyed
Study area
Turbine sites

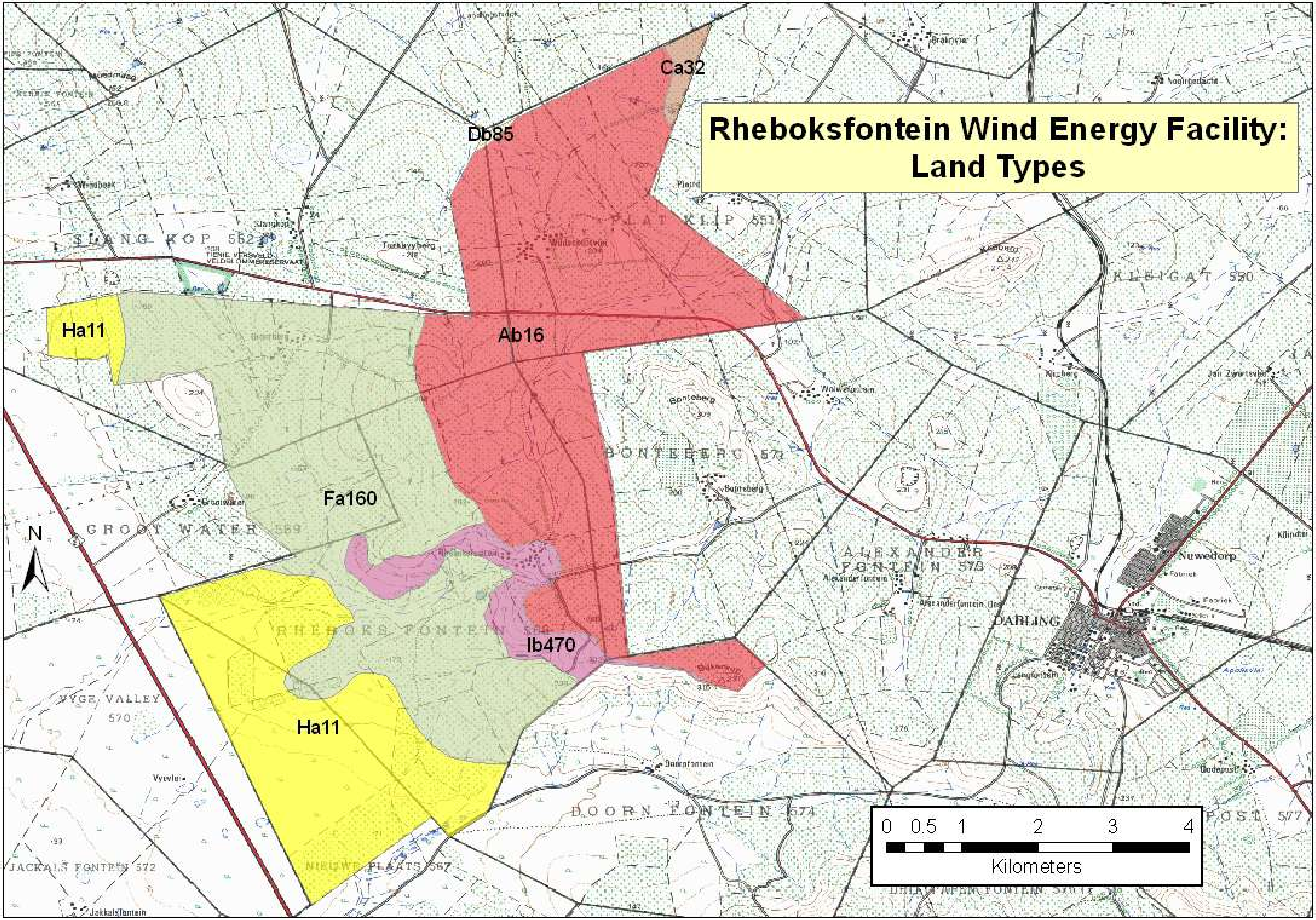
APPENDIX 2:

SOIL FORM DEFINITIONS

Soil Form	Abbr.	Topsoil	Subsoil 1	Subsoil 2	General Description	Notes
1. ORGANIC SOILS (Wetland Peat)						
Champagne	**Ch**	Organic	Gleyed material	-	Always wet	Cooler areas, often high-lying
2. HUMIC SOILS (Humus-rich topsoil)						
Kranskop	**Kp**	Humic	Yellow-brown apedal	Red apedal	Deep, structureless soil	Higher rainfall areas
Magwa	**Ma**	Humic	Yellow-brown apedal	-	Deep, structureless soil	Higher rainfall areas
Inanda	**Ia**	Humic	Red apedal	-	Deep, structureless soil	Higher rainfall areas
Lusiki	**Lu**	Humic	Pedocutanic	-	Deep, structured subsoil	Higher rainfall areas
Sweetwater	**Sw**	Humic	Neocutanic	-	Deep, structureless soil	Higher rainfall areas
Nomanci	**No**	Humic	Lithocutanic	(Usually rock)	Shallow, but often deeply weathered	Higher rainfall areas
3. VERTIC SOILS (Swelling clays)						
Arcadia	**Ar**	Vertic	-	-	Black turf soil, high clay content	On basic rocks; can be shallow
Rensburg	**Rg**	Vertic	Gleyed horizon	-	High clay content, often wet	On basic rocks
4. MELANIC SOILS (Dark, non-swelling clays)						
Willowbrook	**Wo**	Melanic	Gleyed horizon	-	High clay content, often wet	
Bonheim	**Bo**	Melanic	Pedocutanic	-	High clay contant	On basic rocks
Steendal	**Sn**	Melanic	Soft Carbonate	-	Often shallow	On basic rocks, dry
Immerpan	**Im**	Melanic	Hard Carbonate	-	Usually shallow	On basic rocks, dry
Mayo	**My**	Melanic	Lithocutanic	(Usually hard rock)	Dark, blocky topsoil	On basic rocks
Milkwood	**Mw**	Melanic	Rock	-	Dark, blocky topsoil	On basic rocks
Inhoek	**Ik**	Melanic	Alluvium/unspecified	-	Usually deep	
5. SILICIC SOILS (Silica enriched)						
Garies	**Gr**	Orthic	Red apedal	Dorbank	Structureless, variable depth	Occurs in driest areas
Oudtshoorn	**Ou**	Orthic	Neocutanic	Dorbank	Structureless, variable depth	Occurs in driest areas
Trawal	**Tr**	Orthic	Neocarbonate	Dorbank	Structureless, variable depth	Occurs in driest areas
Knersvlakte	**Kn**	Orthic	Dorbank	-	Structureless, usually shallow	Occurs in driest areas
6. CALCIC SOILS (Carbonate/gypsum enriched)						
Molopo	**Mp**	Orthic	Yellow-brown apedal	Soft carbonate	Structureless, variable depth	Occurs in dry areas
Askham	**Ak**	Orthic	Yellow-brown apedal	Hardpan carbonate	Structureless, variable depth	Occurs in dry areas
Kimberley	**Ky**	Orthic	Red apedal	Soft carbonate	Structureless, variable depth	Occurs in dry areas
Plooysburg	**Py**	Orthic	Red apedal	Hardpan carbonate	Structureless, variable depth	Occurs in dry areas
Etosha	**Et**	Orthic	Neocutanic	Soft carbonate	Structureless, variable depth	Occurs in dry areas
Gamoep	**Gm**	Orthic	Neocutanic	Hardpan carbonate	Structureless, variable depth	Occurs in dry areas

Addo	**Ad**	Orthic	Neocarbonate	Soft carbonate	Structureless, variable depth	Occurs in dry areas
Prieska	**Pr**	Orthic	Neocarbonate	Hardpan carbonate	Structureless, variable depth	Occurs in dry areas
Brandvlei	**Br**	Orthic	Soft carbonate	-	Structureless, usually shallow	Occurs in dry areas
Coega	**Cg**	Orthic	Hardpan carbonate	-	Structureless, usually shallow	Occurs in dry areas
7. DUPLEX SOILS (Sandy topsoil on structured clay)						
Estcourt	**Es**	Orthic	E Horizon	Prismacutanic	Sandy over structured, blocky subsoil	Very erodible if exposed
Klapmuts	**Km**	Orthic	E Horizon	Pedocutanic	Sandy over structured, blocky subsoil	Very erodible if exposed
Sterkspruit	**Ss**	Orthic	Prismacutanic	-	Sandy over structured, blocky subsoil	Very erodible if exposed
Sepane	**Se**	Orthic	Pedocutanic	Uncons., wet	Variable depth, structured soil	Often in lower positions
Valsrivier	**Va**	Orthic	Pedocutanic		Deep, structured clayey soil	Often on basic parent material
Swartland	**Sw**	Orthic	Pedocutanic	Saprolite	Variable depth, structured soil	Often on basic parent material
8. PODZOLS						
Tsitsikamma	**Ts**	Orthic	E Horizon	Podzol/Placic Pan	Often sandy, may be wet	Occurs in Southern & Western Cape
Lamotte	**Lt**	Orthic	E Horizon	Podzol	Deep, usually sandy	Occurs in Southern & Western Cape
Concordia	**Cc**	Orthic	E Horizon	Podzol/Unconsol.	Deep, usually sandy	Occurs in Southern & Western Cape
Houwhoek	**Hh**	Orthic	E Horizon	Podzol/Saprolite	Shallow, usually sandy	Occurs in Southern & Western Cape
Jonkersberg	**Jb**	Orthic	Podzol/Placic Pan	-	May be wet beneath	Occurs in Southern & Western Cape
Witfontein	**Wf**	Orthic	Podzol	Uncons., wet	Often sandy, wet beneath	Occurs in Southern & Western Cape
Pinegrove	**Pg**	Orthic	Podzol	Uncons., dry	Often sandy, depth will vary	Occurs in Southern & Western Cape
Groenkop	**Gk**	Orthic	Podzol	Saprolite	Often shallow	Occurs in Southern & Western Cape
9. PLINTHIC SOILS (Mottled, iron-rich subsoils)						
Longlands	**Lo**	Orthic	E Horizon	Soft plinthic	Often sandy and infertile	Depth to plinthic can vary
Westleigh	**We**	Orthic	Soft plinthic	(Usually gleyed)	Shallow soil on plinthic	Often close to wetlands
Avalon	**Av**	Orthic	Yellow-brown apedal	Soft plinthic	Moderately deep, structureless soil	Important maize soil in drier areas
Lichtenburg	**Li**	Orthic	Red apedal	Hard plinthic	Moderately deep, structureless soil	Important maize soil in drier areas
Bainsvlei	**Bv**	Orthic	Red apedal	Soft plinthic	Moderately deep, structureless soil	Important maize soil in drier areas
Wasbank	**Wa**	Orthic	E Horizon	Hard plinthic	Often sandy and infertile	Restricting if hard plinthic is shallow
Glencoe	**Gc**	Orthic	Yellow-brown apedal	Hard plinthic	Moderately deep, structureless soil	Restricting if hard plinthic is shallow
Dresden	**Dr**	Orthic	Hard plinthic	-	Shallow soil	Plinthite often outcrops at surface
10. OXIDIC SOILS (Iron-enriched)						
Pinedene	**Pn**	Orthic	Yellow-brown apedal	Gleycutanic	Moderately deep, structureless soil	Restricting if gleycutanic is shallow

Griffin	**Gf**	Orthic	Yellow-brown apedal	Red apedal	Often deep, structureless soil	Variation in texture and base status
Clovelly	**Cv**	Orthic	Yellow-brown apedal	-	Often deep, structureless soil	Variation in texture and base status
Bloemdal	**Bd**	Orthic	Red apedal	Unspecified, wet	Structureless soil, wetness beneath	May occur in lower positions
Hutton	**Hu**	Orthic	Red apedal	-	Often deep, structureless soil	Variation in texture and base status
Shortlands	**Sd**	Orthic	Red structured	-	Often deep, structured soil	Usually on basic parent material
Constantia	**Ct**	Orthic	E Horizon	Yellow-brown apedal	Deep, sandy soil	Common in W Cape flats
11. GLEYIC SOILS(Wet, mottled subsoils)						
Kroonstad	**Kd**	Orthic	E Horizon	Gleycutanic	Sandy over blocky subsoil	Very erodible if exposed
Katspruit	**Ka**	Orthic	Gleyed horizon	-	Usually clayey, always wet	Low-lying positions (wetland soil)
12. CUMULIC SOILS (Young deposits)						
Tukulu	**Tu**	Orthic	Neocutanic	Unspecified, wet	Usually deep, often alluvial	Often in lower positions
Oakleaf	**Oa**	Orthic	Neocutanic	-	Usually deep, often alluvial	Variety of colours and textures
Montagu	**Mu**	Orthic	Neocarbonate	Unspecified, wet	Usually deep, often alluvial	Often in lower positions
Augrabies	**Ag**	Orthic	Neocarbonate	-	Usually deep, often alluvial	Variety of colours and textures
Namib	**Nb**	Orthic	Regic sand	-	Sometimes calcareous	Often coastal dunes
Vilafontes	**Vf**	Orthic	E Horizon	Neocutanic	Deep soil, often sandy	
Kinkelbos	**Kk**	Orthic	E Horizon	Neocarbonate	Deep soil, often sandy	
Fernwood	**Fw**	Orthic	E Horizon	-	Deep, sandy soil	
Dundee	**Du**	Orthic	Stratified alluvium	-	Deep, alluvial soil	Usually on floodplains
13. LITHIC SOILS (Shallow and/or rocky)						
Glenrosa	**Gs**	Orthic	Lithocutanic	(Usually hard rock)	May be deeply weathered	May be very shallow
Mispah	**Ms**	Orthic	Hard rock	-	Shallow, non-arable	* Or calcrete, ferricrete, etc
Cartref	**Cf**	Orthic	E Horizon	Lithocutanic	Usually shallow, often stony	May be very shallow
14. ANTHROPIC SOILS (Man-affected)						
Witbank	**Wb**	Orthic	Man-made deposit	-	Very variable	Often very disturbed



Rheboksfontein Wind Energy Facility:
Land Types
Ca32
Db85
Ab16
Ha11
Fa160
Ib470
Ha11
N
0 0.5 1 2 3 4
Kilometers

PROPOSED RHEBOKSFONTEIN WIND ENERGY FACILITY
VISUAL IMPACT ASSESSMENT

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Moyeng Energy

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- September 2010 -

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Lourens du Plessis from MetroGIS (Pty) Ltd undertook the visual assessment in his capacity as a visual assessment and Geographic Information Systems specialist. Lourens has been involved in the application of Geographical Information Systems (GIS) in Environmental Planning and Management since 1990. He has extensive practical knowledge in spatial analysis, environmental modelling and digital mapping, and applies this knowledge in various scientific fields and disciplines. His GIS expertise are often utilised in Environmental Impact Assessments, State of the Environment Reports and Environmental Management Plans.

Lourens is familiar with the "Guidelines for Involving Visual and Aesthetic Specialists in EIA Processes" (Provincial Government of the Western Cape: Department of Environmental Affairs and Development Planning) and utilise the principles and recommendations stated therein to successfully undertake visual impact assessments.

Savannah Environmental (Pty) Ltd appointed MetroGIS (Pty) Ltd as an independent specialist consultant to undertake the visual impact assessment. Neither the author, nor MetroGIS will benefit from the outcome of the project decision-making.

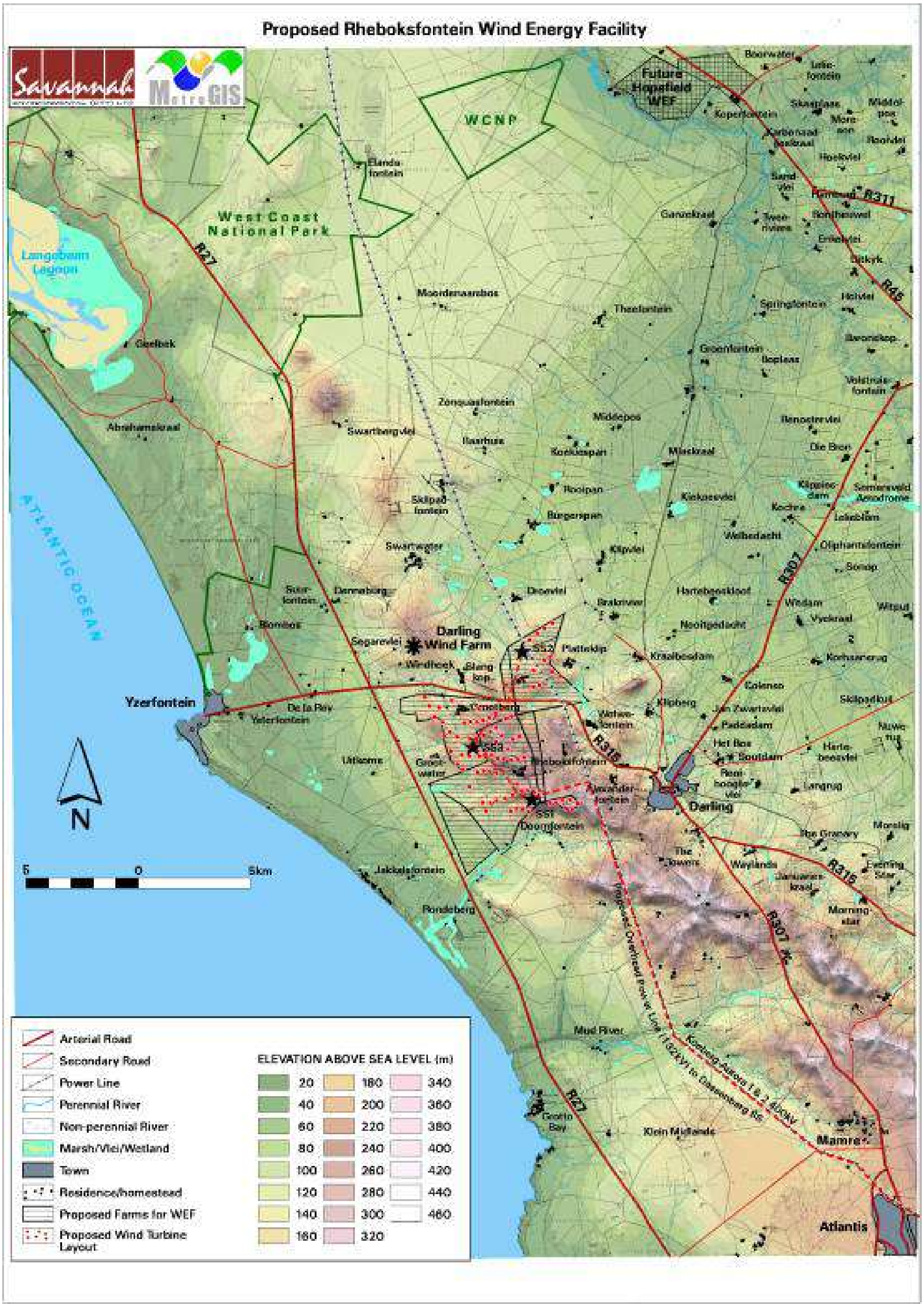
1. INTRODUCTION

Moyeng Energy identified the area north-west of Darling in the Western Cape Province as a potential location for the construction and operation of a Wind Energy Facility (WEF). The WEF generates electricity by means of wind turbines that harness the wind of the area as a renewable source of energy. Wind energy generation, or wind farming as it is commonly referred to, is generally considered to be an environmentally friendly electricity generation option.

The effectiveness of the WEF, or amount of power generated by the facility, is dependent on the number of wind turbines erected in the area as well as the careful placement of the turbines in relation to the topography and each other in order to optimise the use of the wind resource.

Moyeng Energy intends to construct up to eighty wind turbines over an identified area of 39km^2. The proposed layout of the WEF (wind turbine positions) is shown on **Map 1**.

Additional infrastructure would include 3 substations, a 132kV power line (proposed parallel to the Koeberg Aurora 1 & 2 400kV lines), internal access roads and a maintenance/control building.



Map 1: Proposed Rheboksfontein Wind Energy Facility layout (indicating the placement of 80 wind turbines and potential substation sites SS1, SS2 and SS3).

It is expected, from a visual impact perspective, that the wind turbines (80 in total) would constitute the highest potential visual impact of the WEF.

Each turbine is expected to consist of a concrete foundation, a steel tower, a hub (placed at approximately 82m above ground level) and three 55m long blades attached to the hub. Variations of the above dimensions may occur, depending on the preferred supplier or commercial availability of wind turbines at the time of construction.

The construction phase of the WEF is dependent on the number of turbines erected and is estimated at one week per turbine. The lifespan of the facility is approximated at 20 to 30 years.

This report sets out to identify and quantify the possible visual impacts related to the proposed Rheboksfontein Wind Energy facility and related infrastructure mentioned above, as well as offer potential mitigation measures, where required.

2. SCOPE OF WORK

The study area for the visual assessment encompasses a geographical area of 1,633km^2 and includes a minimum 20km buffer zone from the proposed development area. This study area includes the towns of Darling, Atlantis, Mamre and Yzerfontein as well as sections of the R27, R307, R315, R45 and R311 arterial/main roads and a number of secondary roads.

The scope of work includes the determination of the potential visual impacts in terms of nature, extent, duration, magnitude, probability and significance of the construction and operation of the proposed infrastructure. In this regard specific issues related to the visual impact were identified during a site visit to the affected environment. Issues related to the proposed Wind Energy Facility include:

- The visibility of the facility to, and potential visual impact on, observers travelling along major routes in the area (primarily the R27 arterial road, the R307 and R315 main roads and the major secondary roads within the study area).
- The visibility of the WEF to, and visual impact on, not only the larger built-up centres or populated places (primarily the towns of Darling and Yzerfontein) but also individual/isolated landowners/homesteads identified within the study area (some situated within close proximity of the proposed development site include: *Uitkoms, Segarevlei, Windhoek, Slangkop, Grootberg, Grootwater, Wildschutsvlei, Platteklip, Bonteberg, Rheboksfontein, Kraalbosdam, Wolwefontein, Klipberg, Alexanderfontein, Doornfontein, Smalpad, Jakkalsfontein,* etc.) .
- The potential visual exposure to and visual impact on structures/ settlements with high heritage value as identified by the Heritage Impact Assessment (HIA) report.
- The potential impact of the facility on the visual character or sense of place of the region, with special reference to the rural agricultural landscape and the R27 scenic road / tourist route.
- The visibility of the facility to, and potential visual impact on the West Coast National Park and the potential conflict with the South African National Parks (SANParks) planning zones (park interface zones).
- The visibility of the facility to, and potential visual impact on private nature reserves, conservancies and the West Coast biosphere reserve and the potential conflict with Cape Nature's conservation planning and envisaged land uses for the area.

- The potential visual impact of the construction of ancillary infrastructure (i.e. the substations at the facility, associated power line and internal access roads) on observers residing in close proximity of the facility.
- The potential visual impact of operational, safety and security lighting of the facility at night on observers residing in close proximity of the facility.
- Potential cumulative visual impacts (or alternately, consolidation of visual impacts) with special reference to the existing Darling WEF and the authorised Hopefield WEF.
- The visual absorption capacity of the natural vegetation (if applicable).
- Potential visual impacts associated with the construction phase.
- The potential to mitigate visual impacts.

3. METHODOLOGY

3.1. General

The study was undertaken using Geographic Information Systems (GIS) software as a tool to generate viewshed analyses and to apply relevant spatial criteria to the proposed facility. A detailed Digital Terrain Model (DTM) for the study area was created from 20m interval contours supplied by the Surveyor General.

Site visits were undertaken to source information regarding land use, vegetation cover, topography and general visual quality of the affected environment. It further served the purpose of verifying the results of the spatial analyses and to identify other possible mitigating/aggravating circumstances related to the potential visual impact.

The methodology utilised to identify issues related to the visual impact included the following activities:

- The creation of a detailed digital terrain model of the potentially affected environment.
- The sourcing of relevant spatial data. This included cadastral features, vegetation types, land use activities, topographical features, site placement, etc.
- The identification of sensitive environments upon which the proposed facility could have a potential impact.
- The creation of viewshed analyses from the proposed development area in order to determine the visual exposure and the topography's potential to absorb the potential visual impact. The viewshed analyses take into account the dimensions of the proposed structures.

3.2. Potential visual exposure

The visibility or visual exposure of any structure or activity is the point of departure for the visual impact assessment. It stands to reason that if the proposed infrastructure, or evidence thereof, weren't visible, no impact would occur.

Viewshed analysis of the proposed wind turbines, based on a 20m contour interval digital terrain model of the study area, indicates the potential visual exposure.

The visibility analysis was undertaken from each of the wind turbine positions (80 in total) at an offset of 82m (turbine hub height) above average ground level in order to simulate a worst-case scenario.

The viewshed analysis does not include the visual absorption capacity of the vegetation for the study area, as the natural vegetation cover, predominantly *Thicket, Bushland, Bush Clumps and High Fynbos* and *Shrubland and Low Fynbos*, is not expected to influence the results of the analysis significantly.

The result of the viewshed analysis for the proposed WEF's provisional layout is shown on **Map 2**. This viewshed analysis not only indicates areas from where the wind turbines would be visible (any number of turbines with a minimum of one turbine), but also indicate the potential frequency of visibility (i.e. how many turbines are exposed).

The visibility map clearly illustrates the influence of the topography and the placement of the wind turbines on the high ground, on the potential frequency of exposure. It is evident from the viewshed analyses that the proposed WEF would have a large area of potential visual exposure due to its elevated position in the landscape and the relatively tall wind turbine infrastructure.

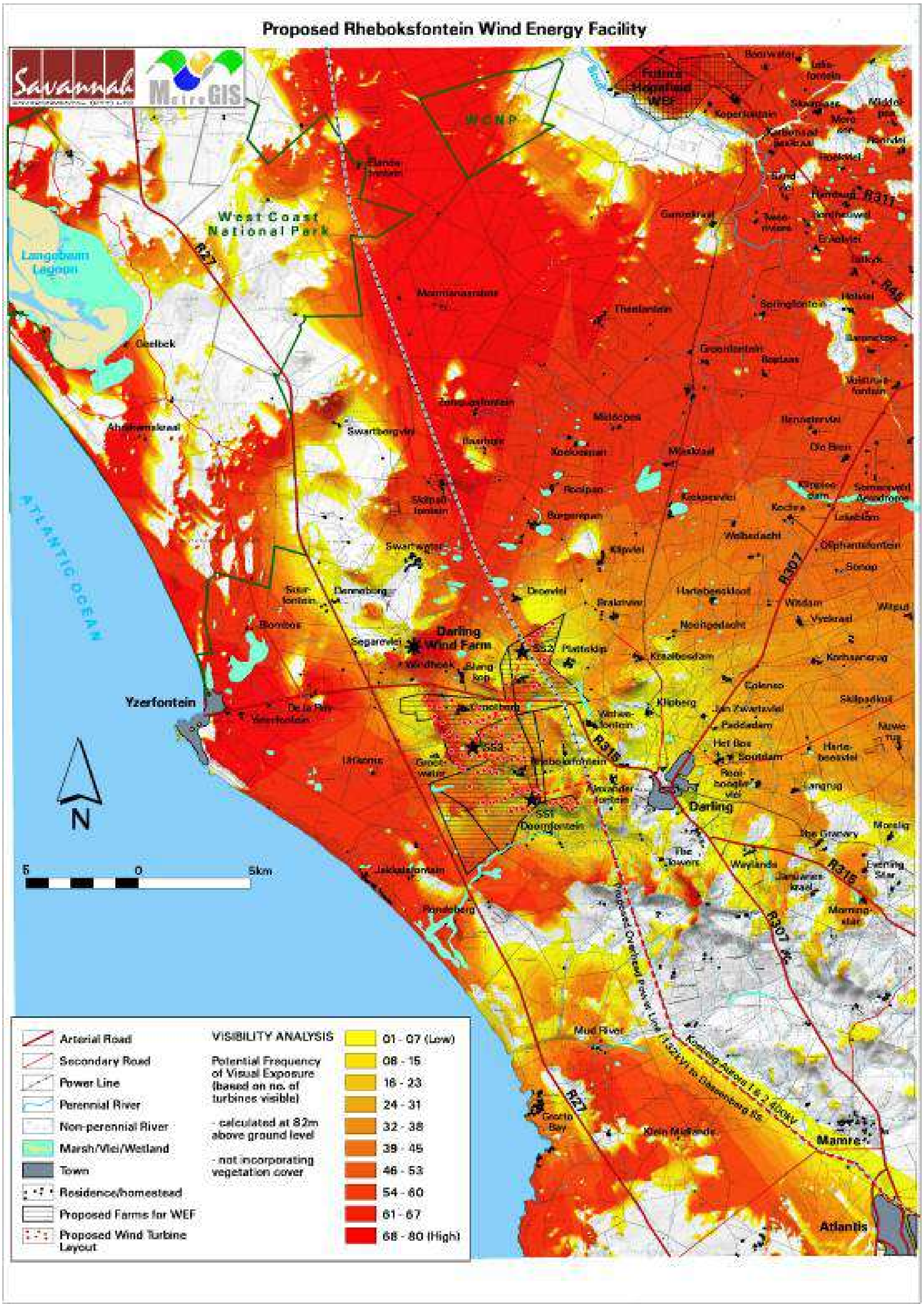
The proposed facility will potentially be visible from the major roads (R27, R315 and R307) within the region.

The R315 may have limited visual exposure to the WEF to the south east of the site and beyond Darling.

The town of Yzerfontein and to a lesser extent, the towns of Darling, Atlantis and Mamre will be affected visually by the WEF. In addition, various settlements / homesteads within the study area will be affected.

The visual exposure of the facility becomes interrupted to the north-west and south-east of the study area where the hilly terrain forms a visual barrier to the WEF. Parts of the West Coast National Park are visually screened, but sections remain exposed to high frequency of visual exposure. This includes the coastal interface and the shore of Langebaan Lagoon.

It is envisaged that the structures would be easily and comfortably visible to observers (i.e. travelling along roads, residing at homesteads or visiting the WCNP), especially within a 10km radius of the WEF and would constitute a high visual prominence, potentially resulting in a high visual impact.



Map 2: Potential visual exposure of the proposed Rheboksfontein WEF.

3.3. Visual distance / observer proximity to the Wind Energy Facility

The principle of reduced impact over distance is applied in order to determine the core area of visual influence for these types of structures. It is envisaged that the nature of the structures and the rural character of the study area would create a significant contrast that would make the facility visible and recognisable from a great distance.

The proximity radii for the proposed site were created in order to indicate the scale and viewing distance of the facility and to determine the prominence of the structures in relation to their environment.

The proximity radii (calculated from the boundary lines of the farms selected for the WEF), based on the dimensions of the proposed development area are indicated on **Map 3**, and include the following:

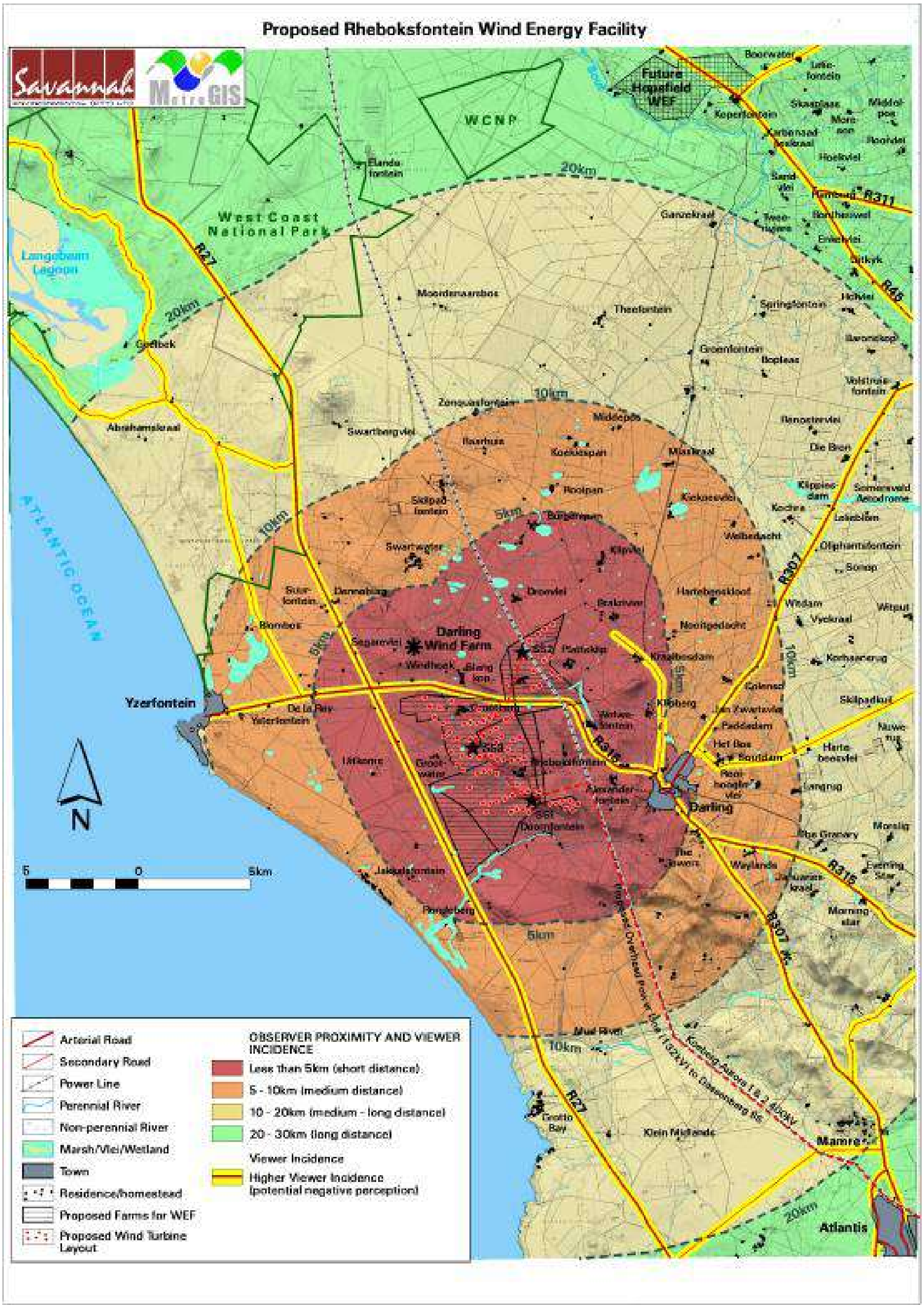
- 0 - 5km. Short distance view where the WEF would dominate the frame of vision and constitute a very high visual prominence.

- 5 - 10km. Medium distance view where the structures would be easily and comfortable visible and constitute a high visual prominence.

- 10 - 20km. Medium to longer distance view where the facility would become part of the visual environment, but would still be visible and recognisable. This zone constitutes a medium visual prominence.

- Greater than 20km. Long distance view of the facility could potentially still be visible though not as easily recognisable. This zone constitutes a medium to low visual prominence for the facility.

The visual distance theory and the observer's proximity to the facility are closely related, and especially relevant, when considered from areas with a high viewer incidence and a predominantly negative visual perception of the proposed facility.



Map 3: Observer proximity to the proposed Wind Energy Facility and areas of high viewer incidence.

3.4. Viewer incidence / viewer perception

The number of observers and their perception of a structure determine the concept of visual impact. If there are no observers or if the visual perception of the structure is favourable to all the observers, there would be no visual impact.

It is necessary to identify areas of high viewer incidence and to classify certain areas according to the observer's visual sensitivity towards the proposed wind energy facility and its related infrastructure. It would be impossible not to generalise the viewer incidence and sensitivity to some degree, as there are many variables when trying to determine the perception of the observer; regularity of sighting, cultural background, state of mind, purpose of sighting, etc. which would create a myriad of options.

Two areas of higher viewer incidence and potentially negative perception of the proposed WEF were identified for the study area.

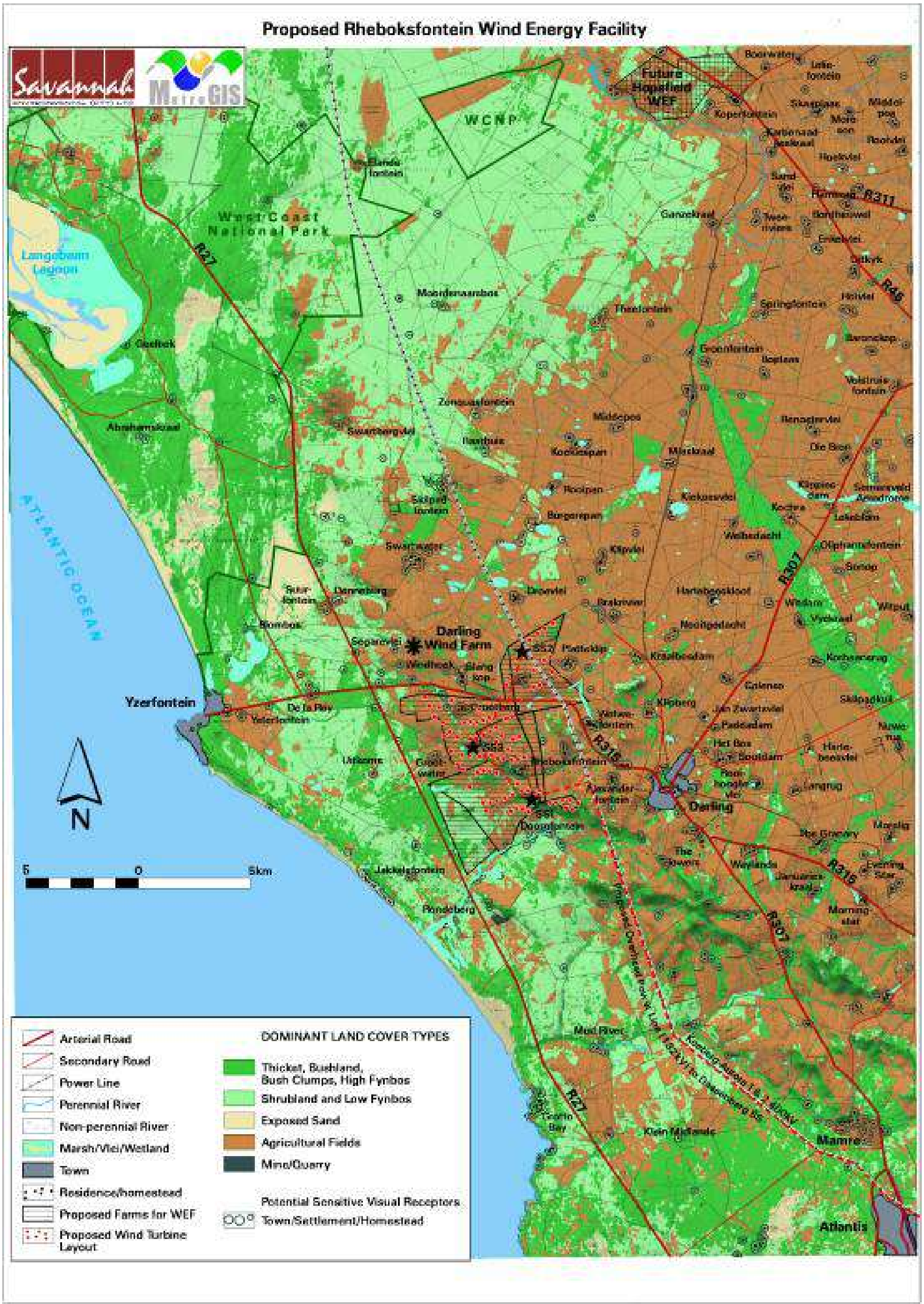
- The **first area** includes the town of Darling and a number of homesteads/farms (mainly to the north and west of Darling within an approximate radius of 4 to 5km of the proposed development site).

  Residents within this zone as well as tourists visiting or passing through the area are seen as potential sensitive visual receptors upon which the construction of the WEF could have a negative visual impact. See **Map 4** below.

- The **second area** includes a 200m buffer zone along the Main West Coast Road (R27), other proximal Arterial Roads (i.e. the R315 and R307) and Arterial Routes further afield (i.e. the R311 and R45). Limited secondary roads close to the development site will also be affected. The roads depicted within the afore-mentioned buffer zones are shown on **Map 3**.

The rest of the study area constitutes a fair population of random observers or sensitive visual receptors, but the severity of the visual impact on these receptors decreases with increased distance from the proposed facility.

The area to the immediate north, east and south-east of the WEF consists predominantly of lands used for agricultural purposes, while the remainder (concentrated to the far north, west and south) of the study area is largely made up of natural vegetation. The latter has a low occurrence of observers.



Map 4: Land cover/land use map indicating potential sensitive visual receptors.

3.5. Visual absorption capacity of the natural vegetation

It is has become apparent from site inspections that the visual absorption capacity of the natural vegetation (predominantly *Thicket, Bushland, Bush Clumps and High Fynbos* and *Shrubland and Low Fynbos*) would not influence the outcome of the visual impact assessment significantly. The vegetation types in question have a relatively low growth form and are on average less than 2m high.

3.6. Visual impact index

The results of all the above analyses (sections 3.2, 3.3, 3.4 and 3.5) were merged in order to determine where the areas of likely visual impact would occur. These areas were further analysed in terms of the previously mentioned issues (related to the visual impact) and in order to judge the severity of each impact. The Visual Impact Index is discussed in Chapter 5 (RESULTS).

4. THE AFFECTED ENVIRONMENT

The location of the proposed area for the development of the Wind Energy Facility includes portions (parts of) of the following farms:

- Remaining extent of Farm 568 (Rheboksfontein)
- Farm 567 (Nieuwe Plaats)
- Remaining extent of Farm 571 (Bonteberg)
- Portion 1 of Farm 574 (Doornfontein)
- Portion 1 of Farm 551 (Plat Klip)
- Farm 1199 (Groot Berg)
- Portion 2 of Farm 552 (Slang Kop)

These farms are located adjacent to the R27 and R315 Arterial Roads, approximately 3.5km (at the closest) west of the town of Darling and 8km east of Yzerfontein in the Western Cape Province. The proposed development site (total of all the farms listed above) encompasses a surface area of 39km^2.

Wheat and maize farming dominate the general land-use character of this region commonly (and affectionately) referred to as the *Boland* or *Swartland*. The small towns of Darling, Yzerfontein, Atlantis and Mamre account for the highest population concentration; within a region that has less than 50 people per km^2.

The dominant topographical unit or terrain type of the study area is described as *plains and hills*. The proposed development site spans across a number of hills located between Darling and Yzerfontein.

Existing infrastructure in this predominantly rural landscape includes the Eskom transmission power lines (Koeberg-Aurora 1 and 2) that traverse the north-eastern portion of the development site and the Darling WEF located on a hill (*Moedmaag*) just north west of the site. This facility currently includes four wind turbines, but will ultimately house 20 turbines. Another WEF is being planned south-east of Hopefield, located approximately 22.5km north of the proposed Rheboksfontein WEF. Refer to **Map 4** for reference to these areas.

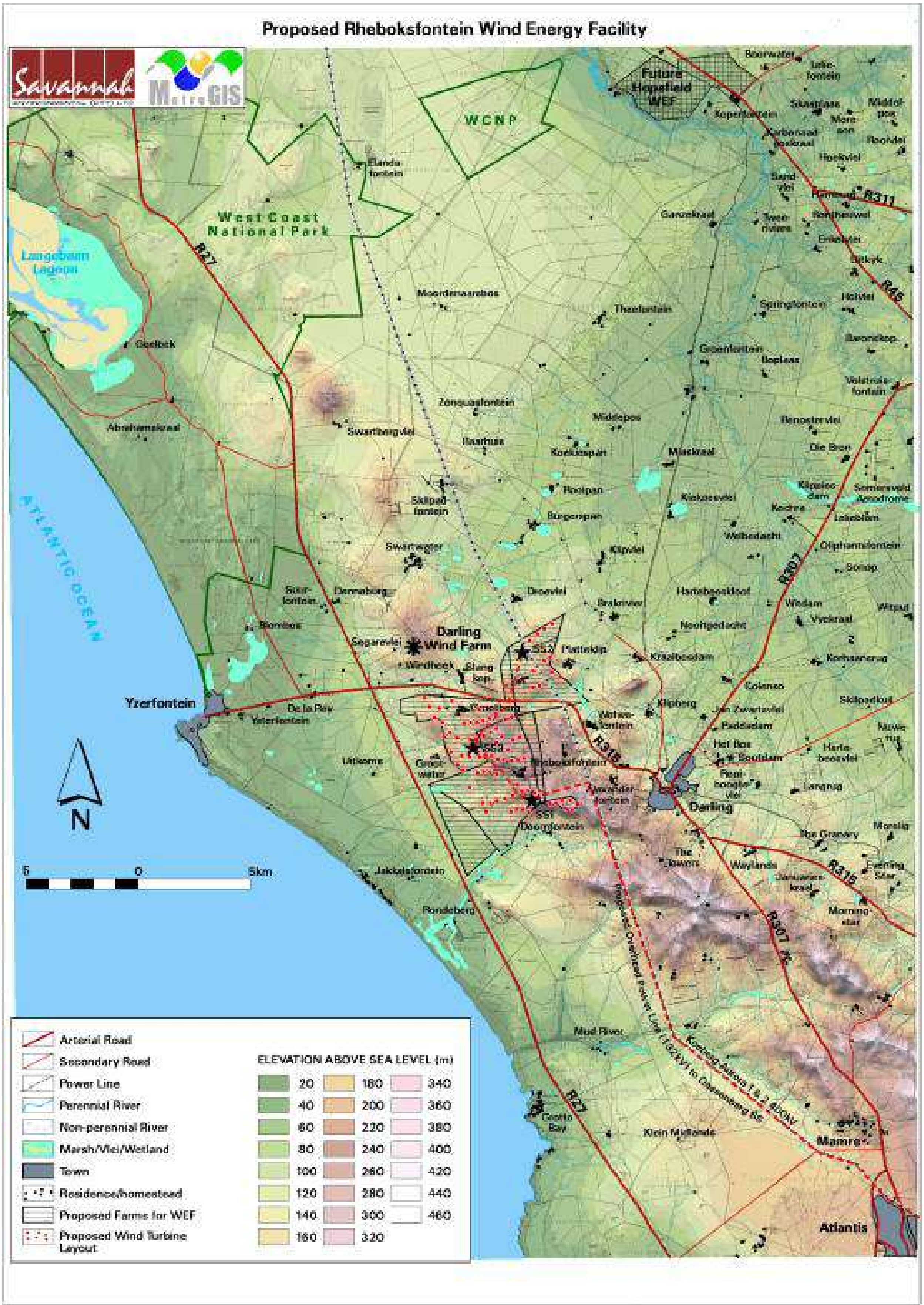
The region has a rural character with a number of farming homesteads/dwellings occurring within the study area. The natural vegetation type is *shrubland, low fynbos, thicket* and *bushland*. A large portion of the natural vegetation types in the study area have been removed to make way for agricultural fields. The proposed development site predominantly falls within existing agricultural land.

Figure 1: General environment within which the Rheboksfontein WEF is to be situated.

Figure 2: Natural vegetation cover to the north-west of the proposed Rheboksfontein WEF site.

Figure 3: Natural vegetation cover in the area of the proposed Rheboksfontein WEF site.

Figure 4: Natural vegetation cover in the area of the proposed Rheboksfontein WEF site (view looking north along the R27 towards the West Coast National Park).



Map 5: Shaded relief map (indicating topography and elevation above sea level)

The West Coast National Park (WCNP) is located approximately 8km (at the closest) north-west of the proposed WEF. This National Park's conservation planning zones are shown on **Map 6**, indicating the National Park itself, as well as adjacent areas of conservation significance, including Priority Natural Areas (earmarked for expansion of the protected area) as well as areas of Priority Catchment Protection. Overlaying these is the Viewshed Protection Zone (VPZ) for the National Park. A number of proposed wind turbine positions to the west of the facility falls within this zone. These include turbine positions 13, 15, 21, 34, 41 and potentially turbine positions 16 and 26.

Viewshed Protection Zones are *"... areas where developments could impact on the aesthetic quality of a visitors experience in a park. This zone is particularly concerned with visual impacts (both day and night), but could also include sound pollution".*[1]

These zones are part of SANParks planning policy to try to preserve the visual integrity of National Parks. Although there is no legislation that precludes development within the viewshed protection zone, it represents an area within which discernment should be exercised in terms of development.

The proposed WEF also falls within the West Coast Biosphere Reserve's buffer and transition zones as indicated on **Map 7**. This map also indicates a number of conservancies (Cape West Coast and Yzerfontein Conservancies) and private nature reserves (Jakkalsfontein, Rondeberg and Grotto Bay Nature Reserves) located south and west of the proposed WEF.

The West Coast Biosphere Reserve's buffer zone links two core areas within the study areas and is intended for: "*co-operative activities compatible with sound ecological practices, including environmental education, recreation, eco-tourism and applied and basic research*" as stated by Cape Nature Conservation.[2]

Sources: DEAT (ENPAT Eastern Cape and adapted for the Western Cape), NBI (Vegetation Map of South Africa, Lesotho and Swaziland) and NLC2000 (ARC/CSIR).

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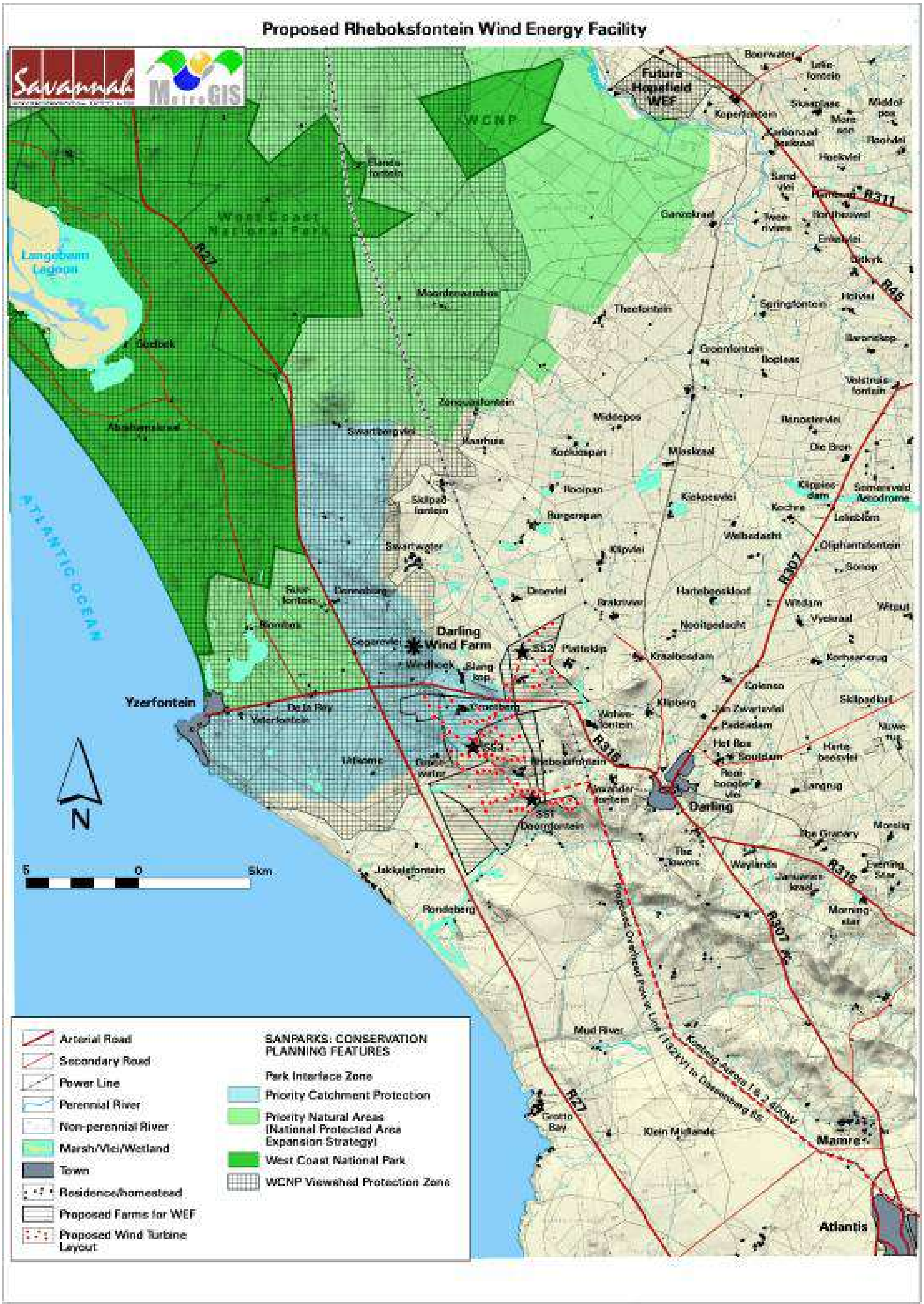
[1] *SANParks, 2008. West Coast National Park Zoning Plan. Unpublished.*

[2] *Cape Nature, 2008. (Joint statement by biosphere reserve managers/coordinators regarding developments within the core, buffer and transition areas).*



Map 6: SANParks protected areas and conservation planning features within the study area.

Map 7: Cape Nature conservation planning features (Biosphere Reserve Zones) and protected areas within the study area.

5. RESULTS

5.1. Visual impact indexes

The combined results of the visual exposure, viewer incidence/perception and visual distance of the proposed WEF and associated infrastructure (i.e. the 3 substations and the distribution power lines) are displayed on **Map 8** below. Here the weighted impact and the likely areas of impact are indicated as a visual impact index. Values have been assigned for each potential visual impact per data category and merged in order to calculate the visual impact index.

An area with short distance, high frequency visual exposure to the proposed facility, a high viewer incidence and a predominantly negative perception would therefore have a higher value (greater impact) on the index. This helps in focussing the attention to the critical areas of potential impact when evaluating the issues related to the visual impact.

The visual impact index map clearly indicates the core area of potentially **high** visual impact, within a 5km radius of the proposed WEF. This includes parts of the West Coast National Park Viewshed Protection Zone as well as significant portions of the West Coast Biosphere Reserve Buffer Area. Of specific relevance are the Jakkalsfontein and Rondeberg Private Nature Reserves and the Cape West Coast and Yzerfontein Conservancies.

Potential areas of **very high** to **high** visual impact occur within a 10km radius of the WEF and include most of the Arterial and secondary roads as well as homesteads/settlements (sensitive visual receptors) located within this zone.

Parts of the R315 and the R27, as well as secondary roads within a 5km radius of the site are expected to be exposed to **very high** visual impact due to the high frequency of observers, many of these tourists, travelling along these routes.

Further to this, sections of the R27, R307 and R315, as well as secondary roads between 5km and 20km from the development are expected to experience a **moderate** to **high** visual impact.

Farm settlements that can expect to be visually influenced (i.e. experience a potentially **high** to **very high** visual impact) by the proposed WEF, within a 5km radius of the development, include:

- Burgerspan
- Klipvlei
- Droevlei
- Brakrivier
- Platteklip
- Kraalbosdam
- Klipberg
- Wolwefontein
- Rheboksfontein
- Alexanderfontein
- Doornfontein
- The Towers
- Rondeberg
- Jakkalsfontein
- Grootwater
- Uitkoms
- Segarevlei
- Windhoek

- Slangkop
- Grootberg

Homesteads and settlements beyond 5km (roughly 5km to 10km) from the development that may experience **high** visual impacts include:

- Middepos
- Baarhuis
- Koekiespan
- Miaskraal
- Skilpadfontein
- Rooipan
- Kiekoesvlei
- Welbedacht
- Swartwater
- Hartebeeskloof
- Nooitgedacht
- Colenso
- Jan Zwartsvlei
- Paddadam
- Het Bos
- Soutriem
- Rooihoogtevlei
- Langrug
- Ysterfontein
- De la Rey
- Blombos

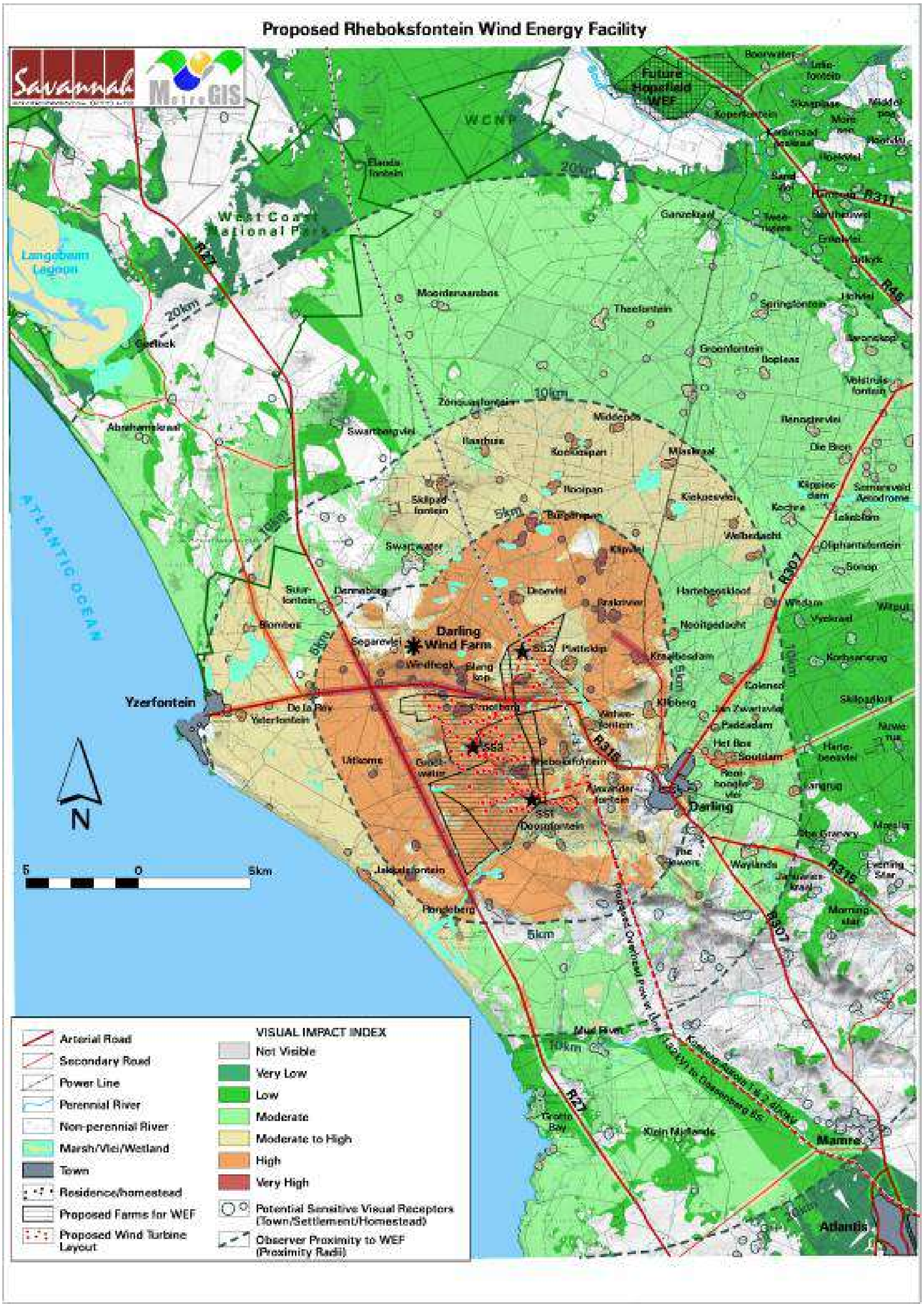
Roads and settlements/homesteads located within 10 to 20km of the WEF (e.g. the *Moordenaarsbos, Die Bron and Abrahamskraal*) may afford observers a clear, yet long distance (beyond 10km), view of the proposed development and may constitute **moderate** to **high** visual impact.

The towns of Darling, Yzerfontein and Mamre (built-up areas with existing structures and visual clutter) are not expected to experience a significant visual impact from the proposed development. Moreover the town of Yzerfontein focuses on the attraction of ocean and panoramic views, thus detracting from the possible visual impacts of the WEF. These areas may only have partial views of the wind farm from distances exceeding 5km, constituting a **low** potential visual impact.

Due to the presence of valuable and sensitive archaeological and historical entities within and in close proximity to the WEF, a number of concerns have led to the visual specialist flagging all homesteads and settlements within a 5km radius as having a potentially **high** to **moderate** visual sensitivity.

Additional to this is the inherent cultural and historic sense of place attached to the Swartland, not to mention its value as a tourism route and destination. The construction of the turbines in close proximity to areas that house this ambiance (such as the Tienie Versfeld Wild Flower Reserve) is likely to impact on the sense of place of a significant nature reserve as well as on a landscape of national cultural significance.

Lastly, sections of the two core areas of the West Coast Biosphere Reserve (including limited parts of the West Coast National Park) are expected to be exposed to clear, long distance (i.e. beyond 10km) views of the proposed WEF, constituting potentially **moderate**, **low** and **very low** visual impacts.



Map 8: Visual impact index of the proposed Rheboksfontein WEF.

5.2. Visual impact assessment

The previous section of the report identified specific areas where likely visual impacts would occur. This section will attempt to quantify these potential visual impacts in their respective geographical locations and in terms of the identified issues (see Chapter 2: SCOPE OF WORK) related to the visual impact.

The methodology for the assessment of potential visual impacts states the **nature** of the potential visual impact (e.g. the visual impact on users of major roads in the vicinity of the proposed WEF) and includes a table quantifying the potential visual impact according to the following criteria:

- **Extent** - site only (very high = 5), local (high = 4), regional (medium = 3), national (low = 2) or international (very low = 1)
- **Duration** - very short (0-1 yrs = 1), short (2-5 yrs = 2), medium (5-15 yrs = 3), long (>15 yrs = 4), and permanent (= 5)
- **Magnitude** - None (= 0), minor (= 1), low (= 2), medium/moderate (= 3), high (= 4) and very high (= 5)
- **Probability** - none (= 0), improbable (= 1), low probability (= 2), medium probability (= 3), high probability (= 4) and definite (= 5)
- **Status** (positive, negative or neutral)
- **Reversibility** - reversible (= 1), recoverable (= 3) and irreversible (= 5)
- **Significance** - low, medium or high.

The **significance** of the potential visual impact is equal to the **consequence** multiplied by the **probability** of the impact occurring, where the consequence is determined by the sum of the individual scores for magnitude, reversibility, duration and extent (i.e. **significance = consequence (magnitude + reversibility + duration + extent) x probability**).

The significance weighting for each potential visual impact (as calculated above) is as follows:

- <30 points: Low (where the impact would not have a direct influence on the decision to develop in the area)
- 31-60 points: Medium/moderate (where the impact could influence the decision to develop in the area)
- >60: High (where the impact must have an influence on the decision to develop in the area)

*Please note that due to the declining visual impact over distance, the **extent** (or spatial scale) rating is reversed (i.e. a localised visual impact has a higher value rating than a national or regional value rating). This implies that the visual impact is highly unlikely to have a national or international extent, but that the local or site-specific impact could be of high significance.*

No mitigation measures (e.g. painting the turbines a sky blue colour) are proposed as the colour scheme and lighting fixtures are legally required by the Civil Aviation Authority (see Chapter 5.4 below) and cannot be altered.

5.2.1 The WEF

Potential visual impact on users of major roads (R27, R307 and R315), secondary roads and tourist routes (R27) in close proximity of the proposed WEF

Visual impacts on national/arterial/main roads are expected to **very high** for Arterial and secondary (local) roads within a 5km radius of the proposed development, and **high** for certain Arterial and secondary roads between 5km and 10km from the proposed development site.

Table 1: Impact table summarising the significance of visual impacts

Nature of Impact: Potential visual impact on users of major roads, secondary roads and tourist routes in close proximity of the proposed WEF.	
Extent	Regional **(3)**
Duration	Long term **(4)**
Magnitude	Very high **(5)**
Probability	Definite **(5)**
Significance	High **(75)**
Status (positive or negative)	Negative
Reversibility	Recoverable **(3)**
Irreplaceable loss of resources?	No
Can impacts be mitigated during operational phase?	No
Mitigation: Decommissioning: removal of the wind turbines and ancillary infrastructure after 20 to 30 years.	
Cumulative impacts: The construction of 80 wind turbines together with the existing power line infrastructure and substations will increase the cumulative visual impact within the region. The possible development of other Wind Energy Facilities in the area (expansion of the existing Darling WEF and potential Hopefield WEF) as well as the relatively slow construction schedule (i.e. the construction of 80 turbines at a rate of one turbine per week) may create the impression of a cumulative visual impact on uninformed observers (i.e. observers who are not aware of the total extent of the facility).	
Residual impacts: None. The visual impact will be removed after decommissioning.	

Potential visual impact on residents of towns, settlements and homesteads in close proximity to the proposed WEF

The visual impact on the town of Mamre is expected to be negligible, and that on Atlantis low to very low. Neither of these towns is reflected in the table below.

The potential visual impact on residents of homesteads (the towns of Darling and Yzerfontein included) within a 10km radius of the proposed WEF is expected to be very high (within 5km radius) and high between 5km and 10km.

Table 2: Impact table summarising the significance of visual impacts

Nature of Impact: Potential visual impact on residents of towns, settlements and homesteads in close proximity to the proposed WEF.	
Extent	Local **(4)**
Duration	Long term **(4)**
Magnitude	Very high **(5)**
Probability	Definite **(5)**
Significance	High **(80)**
Status (positive or negative)	Negative
Reversibility	Recoverable **(3)**
Irreplaceable loss of resources?	No
Can impacts be	No

mitigated during operational phase?	
Mitigation: Decommissioning: removal of the wind turbines and ancillary infrastructure after 20 to 30 years.	
Cumulative impacts: The construction of 80 wind turbines together with the existing power line infrastructure and substations will increase the cumulative visual impact within the region. The possible development of other Wind Energy Facilities in the area (expansion of the existing Darling WEF and potential Hopefield WEF) as well as the relatively slow construction schedule (i.e. the construction of 80 turbines at a rate of one turbine per week) may create the impression of a cumulative visual impact on uninformed observers (i.e. observers who are not aware of the total extent of the facility).	
Residual impacts: None. The visual impact will be removed after decommissioning.	

Potential visual impact on visitors to tourist destinations and entities of cultural and historical value in close proximity to the proposed WEF

The potential visual impact on tourist destinations and cultural and historical sites is expected to be moderate to high within a 10km radius of the WEF.

Table 3: Impact table summarising the significance of visual impacts

Nature of Impact: Potential visual impact on visitors to tourist destinations and entities of cultural and historical value in close proximity to the proposed WEF.	
Extent	Local **(4)**
Duration	Long term **(4)**
Magnitude	High **(4)**
Probability	Definite **(5)**
Significance	High **(75)**
Status (positive or negative)	Negative
Reversibility	Recoverable **(3)**
Irreplaceable loss of resources?	No
Can impacts be mitigated during operational phase?	No
Mitigation: Decommissioning: removal of the wind turbines and ancillary infrastructure after 20 to 30 years.	
Cumulative impacts: The construction of 80 wind turbines together with the existing power line infrastructure and substations will increase the cumulative visual impact within the region. The possible development of other Wind Energy Facilities in the area (expansion of the existing Darling WEF and potential Hopefield WEF) as well as the relatively slow construction schedule (i.e. the construction of 80 turbines at a rate of one turbine per week) may create the impression of a cumulative visual impact on uninformed observers (i.e. observers who are not aware of the total extent of the facility).	
Residual impacts: None. The visual impact will be removed after decommissioning.	

Potential visual impact on the West Coast National Park and on the private nature reserves and conservancies in close proximity to the proposed WEF

The visual impact of the facility on the West Coast National Park is expected to be moderate to low, as views will be longer distance views (i.e. beyond 10km).

Visual impact on private nature reserves and conservancies within the West Coast Biosphere Reserve buffer area will be high within 5km of the WEF, and moderate to high between 5km and 10km from the proposed facility.

Table 4: Impact table summarising the significance of visual impacts

Nature of Impact: Potential visual impact on the West Coast National Park and on the private nature reserves and conservancies in close proximity to the proposed WEF.	
Extent	Local **(4)**
Duration	Long term **(4)**
Magnitude	Moderate **(3)**
Probability	Definite **(5)**
Significance	High **(70)**
Status (positive or negative)	Negative
Reversibility	Recoverable **(3)**
Irreplaceable loss of resources?	No
Can impacts be mitigated during operational phase?	No
Mitigation: Decommissioning: removal of the wind turbines and ancillary infrastructure after 20 to 30 years.	
Cumulative impacts: The construction of 80 wind turbines together with the existing power line infrastructure and substations will increase the cumulative visual impact within the region. The possible development of other Wind Energy Facilities in the area (expansion of the existing Darling WEF and potential Hopefield WEF) as well as the relatively slow construction schedule (i.e. the construction of 80 turbines at a rate of one turbine per week) may create the impression of a cumulative visual impact on uninformed observers (i.e. observers who are not aware of the total extent of the facility).	
Residual impacts: None. The visual impact will be removed after decommissioning.	

5.2.2 Ancillary infrastructure

- The 132kV distribution power line (linking the substations to the WEF and to the national grid), the 3 substations and the workshop area (placed within the facility) are not expected to be highly noticeable amidst the much taller wind turbines and are therefore not expected to pose a significant visual impact in their own right.

  A mitigating factor with regard to the power line is that the alignment is to run parallel to the existing Koeberg 400kV transmission line. This new alignment will therefore blend with an existing visual disturbance in the landscape. No sensitive visual receptors were identified along this route, so the localised visual impacts are not expected to be significant in comparison the construction of the wind turbines.

- Within the WEF footprint, access roads will be required, firstly to construct each turbine (construction phase), and secondly to maintain the turbines (operational phase). A network of roads will thus be constructed within the site footprint giving access to the turbines and other infrastructure. This network of roads has the potential of manifesting as a network of significant landscape scarring, and a potentially significant visual impact within the viewshed areas.

Lastly, if the road network is laid out indiscriminately, not taking cognisance of the topography, then both the roads themselves, and the graded slopes would be vulnerable to erosion over time. The effects of erosion also represent a potential visual impact to observers.

5.3. Secondary visual impacts

Lighting impacts

The area earmarked for the placement of the substations is within the Wind Energy Facility, and the surrounding area has a relatively small number of populated places (settlements and farmsteads). Although these are not densely populated areas, the light trespass and glare from the security and after-hours operational lighting (flood lights) for the substations will have some significance. Furthermore, the sense of place and cultural ambiance of the local area increases its sensitivity to such lighting intrusions.

Another source of glare light, albeit not as intense as flood lighting, is the aircraft warning lights mounted on top of the hub of the wind turbines. These lights are less aggravating due to the toned-down red colour, but have the potential to be visible from a great distance.

The Civil Aviation Authority (CAA) prescribes these warning lights and the potential to mitigate their visual impacts is low. The WEF is not required to have a light fitted to each turbine, but it is compulsory to have synchronous flashing lights on the turbines representing the outer perimeter of the facility. In this manner, less warning lights can be utilised to delineate the facility as one large obstruction, thereby lessening the potential visual impact.

The regulations for the CAA's *Marking of Obstacles* should be strictly adhered too, as the failure of complying with these guidelines may result in the developer being required to fit additional light fixtures at closer intervals thereby aggravating the visual impact.

Last is the potential lighting impact known as sky glow. Sky glow is the condition where the night sky is illuminated when light reflects off particles in the atmosphere such as moisture, dust or smog. The sky glow intensifies with the increase in the amount of light sources. Each new light source, especially upwardly directed lighting, contribute to the increase in sky glow. The WEF may contribute to the effect of sky glow in an otherwise dark environment.

Visual absorption capacity of the natural vegetation

The digital terrain model utilised in the calculation of the visual exposure of the facility does not incorporate the potential visual absorption capacity (VAC) of the natural vegetation of the region. It is therefore necessary to determine the VAC by means of the interpretation of the vegetation cover, supplemented with field observations.

The vegetation units (see Map 4), where present in the study area, range from 0.2m to 2m in height. This, coupled with the sparse distribution of the plant species and the dimensions of the facility, resulted in the conclusion that the VAC is low to negligible for most of the study area.

Potential visual impacts associated with the construction phase

The duration of the construction phase of the WEF is dependent on the number of turbines being constructed and is expected to take approximately 80 weeks to complete (a conservative estimation not taking natural weather conditions etc. into account). During this time there will be a noticeable increase in heavy vehicles utilising the roads to the development site that may cause, at the very least, a visual nuisance to other road users and land owners in the area.

Visual impacts associated with the construction phase, albeit temporary, should be managed according to the following principles:

- Reduce the construction period through careful planning and productive implementation of resources.
- Restrict the activities and movement of construction workers and vehicles to the immediate construction site.
- Ensure that the general appearance of construction activities, construction camps (if required) and lay-down areas are maintained by means of the timely removal of rubble and disused construction materials.
- Restrict construction activities to daylight hours (if possible) in order to negate or reduce the visual impacts associated with lighting.

The potential to mitigate visual impacts

- The primary visual impact, namely the appearance of the Wind Energy Facility (mainly the wind turbines) is not possible to mitigate. The functional design of the structures cannot be changed in order to reduce visual impacts.

  Alternative colour schemes (i.e. painting the turbines sky-blue, grey or darker shades of white) are not permissible as the CAA's *Marking of Obstacles* expressly states, "*Wind turbines shall be painted bright white to provide the maximum daytime conspicuousness*". Failure to adhere to the prescribed colour specifications will result in the fitting of supplementary daytime lighting to the wind turbines, once again aggravating the visual impact. The overall potential for mitigation is generally low or non-existent.

  The analysis of the potential visual exposure of the proposed turbine layout (as indicated in **Map 2**) reveals the fact that the placement of the turbines on top of prominent topographical features tends to increase the frequency of exposure to the north, north-east, west and the south, whilst the visual exposure of the facility becomes interrupted to the north-west and south-east of the study area where the hilly terrain forms a visual barrier to the WEF.

  The careful placement of the wind turbines in relation to the topography (in cases where the turbine layout has not yet been finalised) does however offer some opportunity for mitigation.

  This may, however, have an influence on the number of turbines that can ultimately be constructed and on the potential efficiency of the facility if wind conditions are different (i.e. if wind speeds are slower).

- The visual impact on the West Coast National Park may be somewhat mitigated by relocating the proposed turbines to be located within the defined Viewshed Protection Zone. These include turbine numbers 13, 15, 21, 34, 41, 16 and 26. This will not necessarily negate the visual impact of the WEF on the National Park, but will align the development of the facility with SANPark policy.

There is no mitigation to ameliorate the negative visual impacts anticipated for the private nature reserves and conservancies, and a definite land use conflict exists in this regard. This land use conflict extends to all parts of the West Coast Biosphere Reserve buffer area that lie within 10km of the proposed WEF (and which are exposed to visual impact), as the visual intrusion will impose some limitation on conservation based development and tourism opportunities in the future.

- Mitigation of lighting impacts includes the pro-active design, planning and specification lighting for the facility by a lighting engineer. The correct specification and placement of lighting and light fixtures for both the turbines and the ancillary infrastructure will go far to contain rather than spread the light. Additional measures include the following:

    - Shielding the sources of light by physical barriers (walls, vegetation, or the structure itself);
    - Limiting mounting heights of lighting fixtures, or alternatively using foot-lights or bollard level lights;
    - Making use of minimum lumen or wattage in fixtures;
    - Making use of down-lighters, or shielded fixtures;
    - Making use of Low Pressure Sodium lighting or other types of low impact lighting.
    - Making use of motion detectors on security lighting. This will allow the site to remain in relative darkness, until lighting is required for security or maintenance purposes.

- Mitigation of secondary visual impacts associated with the construction of roads include careful planning of the access road network, taking due cognisance of the topography. Roads should be laid out along the contour wherever possible, and should never traverse slopes at 90 degrees. Construction of roads should be undertaken properly, with adequate drainage structures in place to forego potential erosion problems.

  Also, the construction areas, including road servitudes and cut and fill slopes must be appropriately rehabilitated after construction. This rehabilitation must also be monitored and maintained in order to minimise the visual impact of the access roads.

- Visual impacts associated with the construction phase, albeit temporary, should be managed according to the following principles:
    - Reduce the construction period through careful planning and productive implementation of resources.
    - Restrict the activities and movement of construction workers and vehicles to the immediate construction site.
    - Ensure that the general appearance of construction activities, construction camps (if required) and lay-down areas are maintained by means of the timely removal of rubble and disused construction materials.
    - Restrict construction activities to daylight hours (if possible) in order to negate or reduce the visual impacts associated with lighting.

The possible mitigation of both primary and secondary visual impacts as listed above should be implemented and maintained on an ongoing basis.

6. PHOTO SIMULATIONS

Photo simulations were undertaken (in addition to the above spatial analyses) in order to illustrate the potential visual impact of the completed WEF (80 turbines) within the receiving environment.

The photo simulations indicate the visual significance of the alteration of the landscape from various sensitive visual receptors and over varying distances. The simulations are based on the wind turbine dimensions and layout as indicated on **Map 1**.

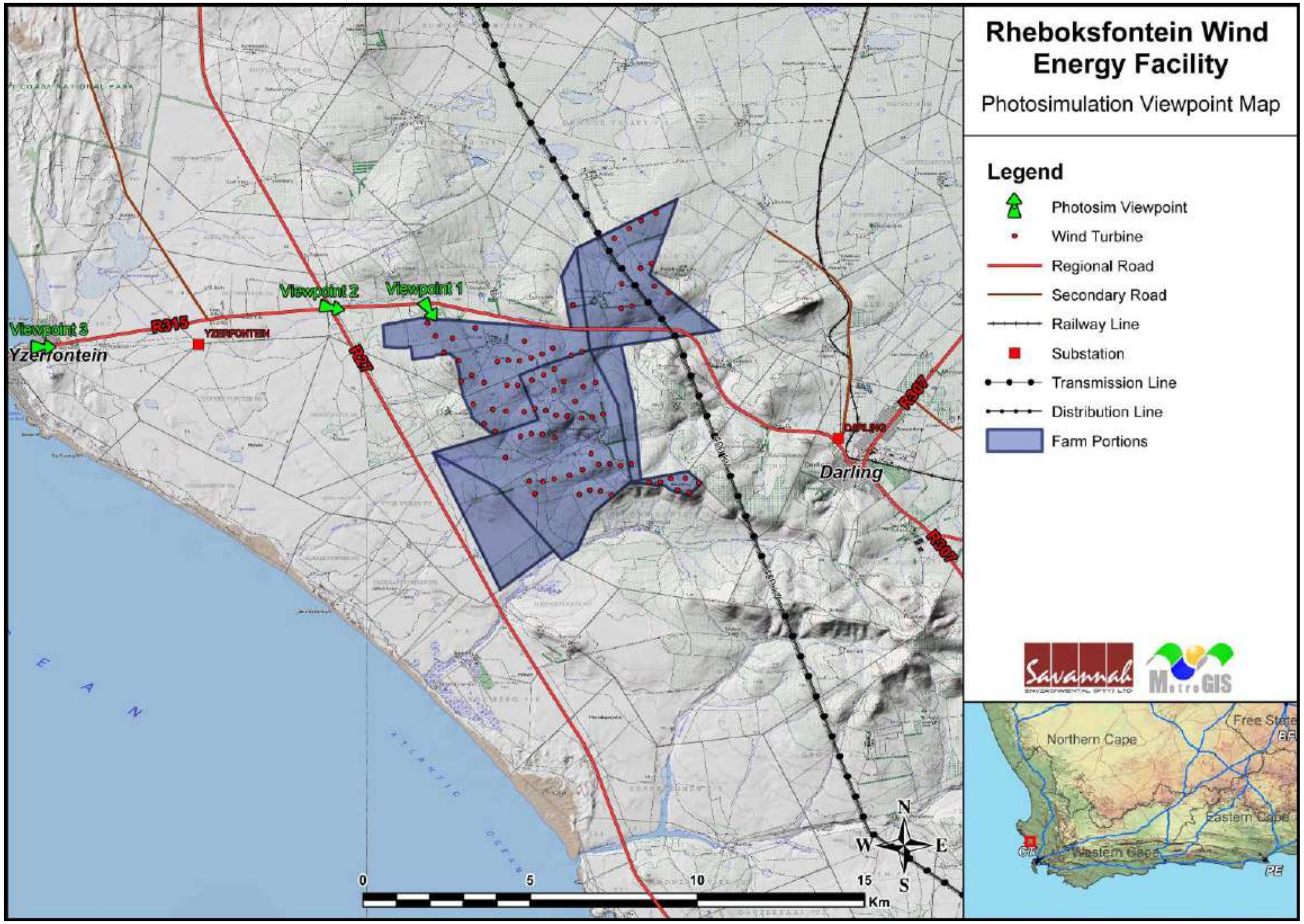
The simulated wind turbines, as shown on the photographs, were adapted to the atmospheric conditions present when the original photographs were taken. This implies that factors such as haze and solar glare were also simulated in order to realistically represent the observer's potential view of the facility.

The photograph positions are indicated on the map below and should be referenced with the photo simulation being viewed in order to place the observer in spatial context. The approximate viewing distances indicated were measured from the closest wind turbine(s) to the vantage point.

The simulated views show the placement of the wind turbines during the longer-term operational phase of the facility's lifespan. It is assumed that the necessary post-construction phase rehabilitation and mitigation measures, as proposed by the various specialists in the environmental impact assessment report, have been undertaken.

It is imperative that the natural vegetation be restored to its original (current) status for these simulated views to ultimately be realistic. These photographs can therefore be seen as an ideal operational scenario (from a visual impact point of view) that should be aspired to. The additional infrastructure (e.g. the proposed power lines, substations, access roads, etc.) associated with the facility is not included in the photo simulations as detailed layout and design information is not yet available.

Each photographic simulation is preceded by a panoramic overview of the landscape from the specified viewpoint being discussed. The panoramic overview allows for a more realistic viewer scale that would be representative of the distance over which the turbines are viewed. Each panoramic overview indicates the section that was enlarged to show a more detailed view of the WEF.



Map 9: Photograph positions.

6.1. South-south-easterly view

View 1 (short distance view)

Viewpoint 1 is located on the R315 road running from Darling to Yzerfontein on the northerly boundary of the southern section of the proposed facility. This position is very close to the closest turbines and is indicative of what will be seen from the lookout point within the Tienie Versveld Flower Reserve. The viewing direction is south-south-easterly and roughly 18 turbines may be fully to partially visible in the landscape. This view is representative of a short distance visual experience that travellers moving between Darling and the R27 (main west coast road) will have of the proposed turbines.

Figure 5a: Pre-construction panoramic overview from Viewpoint 1.

Figure 5b: Post-construction panoramic overview from Viewpoint 1 (showing photo sections).

Figure 5c: View 1a (enlarged photograph section from Viewpoint 1).

Figure 5d: View 1b (enlarged photograph section from Viewpoint 1).

6.2. Easterly view

View 2 (medium distance view)

Viewpoint 2 is located on the junction of the R315 and R27 roads situated to the north-west of the facility itself. This position is located about 2.5 km away from the closest turbine and is indicative of what will be seen by travellers moving along the R27, in either a northerly or southerly direction. This route forms the spine accessing most of the west coast attractions and destinations. The viewing direction is easterly and roughly 28 turbines may be fully to partially visible in the landscape. This does not include turbines (a total of 4 visible) from the Darling Wind Energy Facility that may also be visible from this point. This view is representative of a medium distance visual experience that travellers moving between along the R27 (main west coast road) will have of the proposed turbines.

Figure 6a: Pre-construction panoramic overview from Viewpoint 2.

Figure 6b: Post-construction panoramic overview from Viewpoint 2 (showing photo sections).

Figure 6c: View 2a (enlarged photograph section from Viewpoint 2).

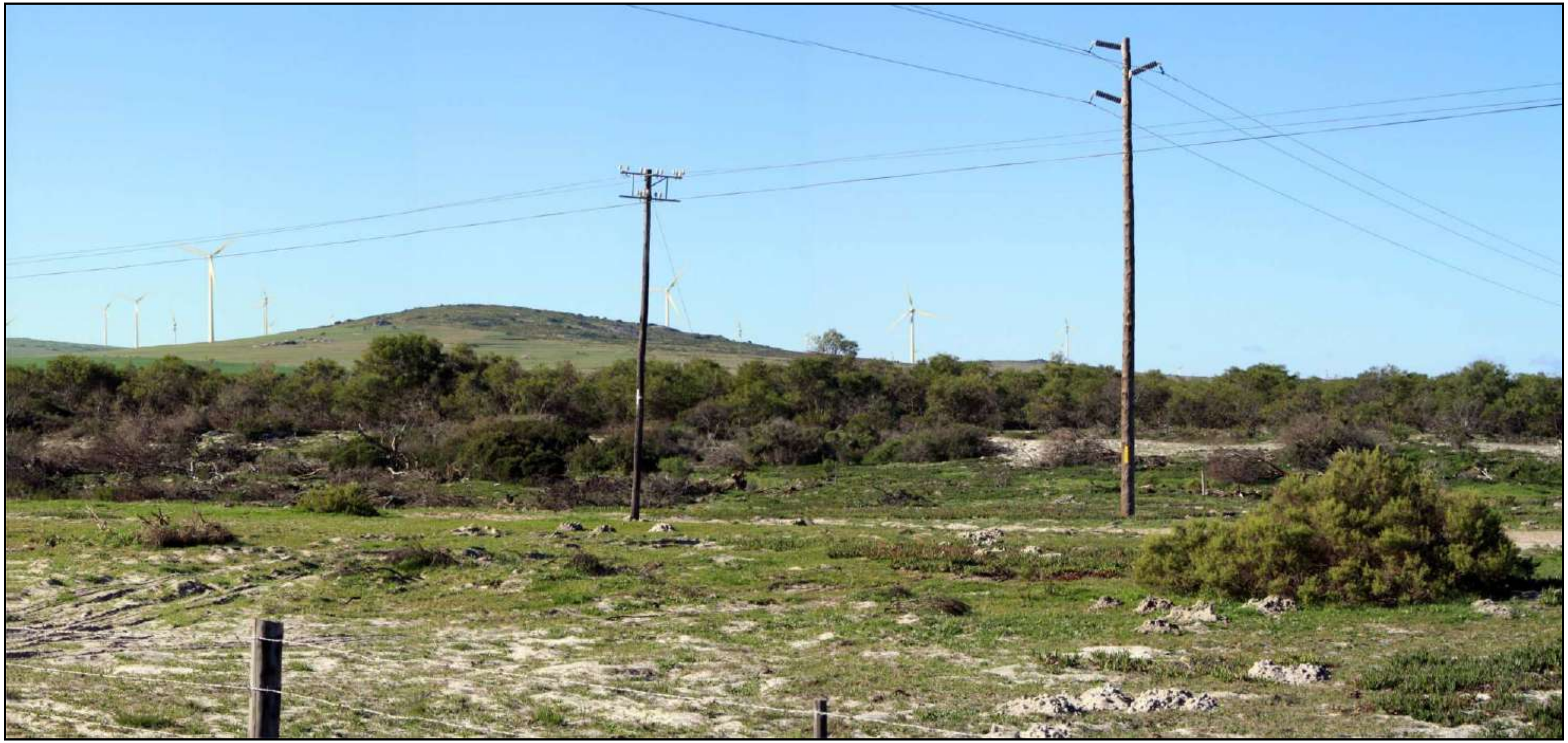


Figure 6d: View 2b (enlarged photograph section from Viewpoint 2).

6.3. Easterly view

View 3 (long distance view)

Viewpoint 3 is located in the outskirts of the town Yzerfontein on the R315 This position is located about 9.3 km away from the closest turbine and is indicative of what will be seen by travellers moving in an easterly direction when exiting the town of Yzerfontein. The viewing direction is easterly and roughly 60 turbines may be fully to partially visible in the landscape. This view is representative of a long distance visual experience that travellers moving away from Yzerfontein will have of the proposed turbines.

Figure 7a: Pre-construction panoramic overview from Viewpoint 3.

Figure 7b: Post-construction panoramic overview from Viewpoint 3 (showing photo sections).

Figure 7c: View 3a (enlarged photograph section from Viewpoint 3).

Figure 7d: View 3b (enlarged photograph section from Viewpoint 3).

7. CONCLUSION / RECOMMENDATIONS

The construction and operation of the Rheboksfontein Wind Energy Facility and its associated infrastructure will have a visual impact on the natural scenic resources and rural character of this region. The rural and relatively unspoilt wide-open vistas surrounding the WEF will be transformed for the entire operational lifespan (approximately 30 years) of the plant.

The author is of the opinion that the WEF has an advantage over other more conventional power generating plants (e.g. coal-fired power stations). The facility utilises a renewable source of energy (considered as an international priority) to generate power and is therefore generally perceived in a more favourable light. It does not emit any harmful by-products or pollutants and is therefore not negatively associated with possible health risks to observers.

The facility further has a generally unfamiliar novel and futuristic design that invokes a curiosity factor not generally present with other conventional power generating plants. The advantage being that the WEF can become an attraction or a landmark within the region that people would actually want to come and see. As it is impossible to hide the facility, the only option would be to promote it.

However, this opinion should not distract from the fact that the facility would be visible for a large area that is generally seen as having a special landscape and tourism value (i.e. the Swartland). The facility would thus visually impact on various sensitive visual receptors that should ideally not be exposed to industrial style structures.

In addition, the conservation value of the region must not be overlooked, specifically the presence of the West Coast National Park, the context within the West Coast Biosphere Reserve and the proximity to Namaqualand further to the north.

There are not also many option as to the mitigation of the visual impact of the core facility (besides the placement of the wind turbines on lower ground) as no amount of vegetation screening or landscaping would be able to hide structures of these dimensions.

Considering all factors, it is the opinion of the author that the study area is not ideally suited to the development of a WEF primarily due to its inherent and growing tourism value. The WEF will represent a visual impact, but this impact is not likely to detract for the tourism appeal, numbers of tourists or tourism potential of the existing centres. Those who will be most impacted upon visually, would be the users of the tourist routes (specifically the R27). This impact will, however be short lived, and is not likely to affect tourists once their destinations have been reached.

Therefore, the potential visual impact of the proposed WEF is not considered to be a fatal flaw for the development.

It is, however, recommended that the proposed turbines located within the National Park Viewshed Protection Zone be relocated to a more suitable position outside of this zone. These include turbine numbers 13, 15, 21, 34, 41, 16 and 26. This will not necessarily negate the visual impact of the WEF on the National Park, but will align the development of the facility with SANParks policy.

Furthermore, it is imperative that specific discussions be held with SANParks, Cape Nature and Private Reserve Owners regarding the potential future limitations on conservation based development and tourism opportunities within the West Coast Biosphere Reserve as a result of the visual impact of the WEF.

Ancillary infrastructure (distribution lines, substations, site office/workshop, access roads, etc.) be properly planned with due cognisance of the topography, that all disturbed areas be properly rehabilitated, and that all infrastructure and the general surrounds are maintained in a neat and appealing way.

The construction phase of the facility should be sensitive to potential observers in the vicinity of the construction site. The placement of lay-down areas and temporary construction camps should be carefully considered in order to not negatively influence the future perception of the facility.

Secondary visual impacts associated with the construction phase, such as the sight of construction vehicles, dust and construction litter must be managed to reduce visual impacts. The use of dust-suppression techniques on the access roads (where required), timely removal of rubble and litter, and the erection of temporary screening will assist in doing this.

A lighting engineer should be consulted to assist in the planning and placement of light fixtures in order to reduce visual impacts associated with glare and light trespass.

The facility should be dismantled upon decommissioning and the site and surrounding area should be rehabilitated to its original (current) visual status.

8. MANAGEMENT PLAN

The management plan tables aim to summarise the key findings of the visual impact report and to suggest possible management actions in order to mitigate the potential visual impacts. The management plan primarily focuses on the mitigation and management of potential secondary visual impacts, due to the fact that the primary visual impact (i.e. the wind turbines) has very low or limited mitigation potential.

Table 5: Management plan - Rheboksfontein Wind Energy Facility

OBJECTIVE: The mitigation and possible negation of the additional visual impacts associated with the construction and operation of the Rheboksfontein Wind Energy Facility.		
Project component/s	Rheboksfontein Wind Energy facility construction site, access roads, substations and distribution power lines.	
Potential Impact	The potential scarring of the landscape due to the creation of new access roads/tracks or the unnecessary removal of vegetation.	
Activity/risk source	The viewing of the abovementioned visual scarring by observers in the vicinity of the WEF or from the roads traversing the site.	
Mitigation: Target/Objective	Minimal disturbance to vegetation cover in close vicinity to the proposed WEF and its related infrastructure.	
Mitigation: Action/control	Responsibility	Timeframe
Implement an environmentally responsive planning approach to roads and infrastructure to limit cut and fill requirements.	MOYENG/contractors	During construction
Adopt responsible construction practices	MOYENG/contractors	During construction

aimed at containing the construction activities to specifically demarcated areas thereby limiting the removal of natural vegetation to the minimum.		
Limit access to the construction sites (during both construction and operational phases) along existing access roads.	MOYENG/contractors	Construction / operational phases
Rehabilitate all disturbed areas, including cut and fill slopes to acceptable visual standards.	MOYENG/contractors	Construction / operational phases
Maintain the general appearance of the facility in an aesthetically pleasing way.	MOYENG	Operational phase
Performance Indicator	Vegetation cover that remains intact with no new access roads or erosion scarring in close proximity of the WEF.	
Monitoring	Monitoring of vegetation clearing during the construction phase.	

Table 6: Management plan - 132kV distribution power lines

OBJECTIVE: The mitigation of potential visual impacts caused by the unnecessary removal (clearing) of vegetation cover for the power line servitude or the creation of new access roads during the construction phase.		
Project component/s	Distribution power line servitude.	
Potential Impact	The potential scarring of the landscape due to the creation of cleared cut-lines and new roads/tracks.	
Activity/risk source	The viewing of the abovementioned cut lines/roads by observers.	
Mitigation: Target/Objective	Minimal disturbance to vegetation cover in close vicinity to the proposed distribution power line.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Avoid the unnecessary removal of vegetation for the distribution power line servitudes and limit access to the servitudes (during both construction and operational phases) along existing access roads.	MOYENG	Construction/Operation.
Performance Indicator	Vegetation cover that remains intact with no visible cut lines, access roads or erosion scarring in and around the power line servitude.	
Monitoring	The monitoring of vegetation clearing during the construction and operational phases of the project.	

Table 7: Management plan - Rheboksfontein Wind Energy Facility (lighting impacts)

OBJECTIVE: The mitigation and possible negation of the potential visual impact of lighting at the WEF and substations.	
Project component/s	WEF and substations lighting fixtures.
Potential Impact	The potential night time visual impact of lighting fixtures on observers in proximity to the WEF.
Activity/risk source	The effects of glare and light trespass on motorists and observers.
Mitigation: Target/Objective	The containment of light emitted from the substations in order to eliminate the risk of additional night time visual impacts. Minimal usage of security and other lighting.

	Minimal usage of red warning lights – limit placement to outer structures but still adhere to CAA rules and regulations.		
Mitigation: Action/control		**Responsibility**	**Timeframe**
Ensure that proper planning is undertaken regarding the placement of lighting structures and that light fixtures only illuminate areas inside the substation sites. Undertake regular maintenance of light fixtures.		MOYENG/lighting engineer.	Construction/Operation.
Performance Indicator	The effective containment of the light to the substation site.		
Monitoring	The monitoring of the condition and functioning of the light fixtures during the operational phase of the project.		

9. REFERENCES / DATA SOURCES

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ADDENDUM TO VISUAL IMPACT ASSESSMENT

FOR THE PROPOSED RHEBOKSFONTEIN WIND ENERGY FACILITY

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- June 2011 -

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1. Introduction

A Visual Impact Assessment was undertaken for the Proposed Rheboksfontein Wind Energy Facility during September 2010, along with a number of other specialist studies in support of an EIA process.

In response to various recommendations and comments submitted during the process, the layout for the facility was amended in an effort to ameliorate anticipated negative environmental impacts.

This addendum discusses the relevant changes in the amended layout as these pertain to visual aspects. The addendum should not be read in isolation, but in conjunction with the Visual Impact Assessment (September 2010).

2. Amendments to the Layout

Relevant amendments to the layout for the proposed Rheboksfontein WEF include the following:

- A reduction in the number of turbines from 80 to 48;
- A change in layout of the turbines, allowing for a buffer on either side of the R315, the removal of turbines from the WCNP Viewshed Protection Zone and other minor changes;
- The omission of substation SS1 in the south of the site.

Access, supplementary infrastructure and power evacuation remains as per the original submission. Refer to **Map 1**.

3. The Affected Environment

The affected environment remains unchanged. The same farm portions are relevant, with the turbines occupying the same extent, although in a different configuration and reduced density. Refer to **Maps 4, 5 and 6**.

Of relevance is the fact that Jakkalsfontein Private Nature Reserve, located some 3km to the south west of the proposed WEF, houses a community of approximately 100 home owners, in addition to its status as a conservation area.

4. Potential visual exposure of the proposed WEF

Refer to **Map 2**. It is evident from this viewshed analysis that the amended layout of the WEF would still have a large area of potential visual exposure. The extent of this area is mostly unchanged when compared with the potential visual exposure of the original layout.

Of relevance, however, is the frequency of visual exposure, which is significantly reduced in the amended layout. This is due to the reduced number of turbines.

Low frequencies of visual exposure lie to the immediate east of the site. Areas to the west (along the coastline), to the north and to the south east are likely to be exposed to moderate frequencies of visual exposure.

There are no longer any areas where more than 48 turbines will be visible (i.e. high frequencies of visual exposure).

5. Visual distance / observer proximity

Refer to **Map 3**. Due to the unchanged site extents, the visual distance and observer proximity remains unchanged from the original layout. Of relevance again, is the Jakkalsfontein Nature Reserve, which lies partially within 5km of the proposed WEF (i.e. the eastern half) and partially beyond the 5km radius (i.e. the western half along the coast).

In the absence of any layout of this facility, it is assumed that the houses are mostly located along the coastline, in the western half of the reserve.

6. Viewer incidence / viewer perception

Refer to **Maps 4, 5 and 6**. Viewer incidence remains mostly unchanged, with the exception of the Jakkalsfontein Community, which represents an additional 100 households in close proximity of the proposed WEF. Perception of the proposed WEF by this community is negative.

7. Visual impact index

Refer to **Map 7**, which illustrates a core area of visual exposure of mainly **moderate-high** to **high** potential visual impact. When compared to the original layout, the areas of high visual exposure are reduced, and those of moderate visual exposure are increased. This is due to the lower number of turbines.

Areas of **very high** potential visual impact are similarly reduced, limited to shorter stretches of the R27 and R 315, and the following settlements, which are also reduced in number:

- Burgerspan
- Klipvlei
- Windhoek
- Slangkop
- Rheboksfontein
- Jakkalsfontein (east)
- Rondeberg
- Uitkoms
- Doornfontein

Those likely to experience potentially **high** visual impacts include the following:

- Droevlei
- Brakrivier
- Platteklip
- Kraalbosdam
- Wolwefontein
- Rheboksfontein
- Alexanderfontein
- Doornfontein
- The Towers
- Grootwater
- Grootberg
- Slangkop

Between the 5km and 10km radius, potential visual impacts are largely reduced to **moderate**. Exceptions are the main roads and settlements. The latter are likely to experience moderate-high to high visual impacts. Those likely to experience potentially **high** visual impacts are reduced in number and include the following:

- Middepos
- Miaskraal
- Koekiepan
- Rooipan
- Baarhuis
- Skilpadfontein
- Swartwater
- Blombos
- De la Rey
- Ysterfontein
- Jakkalsfontein (west)
- Welbedacht
- Kiekoesvlei

The figure below helps to place the above explanations in context, illustrating what scale a turbine structure will be perceived at different viewing distances.

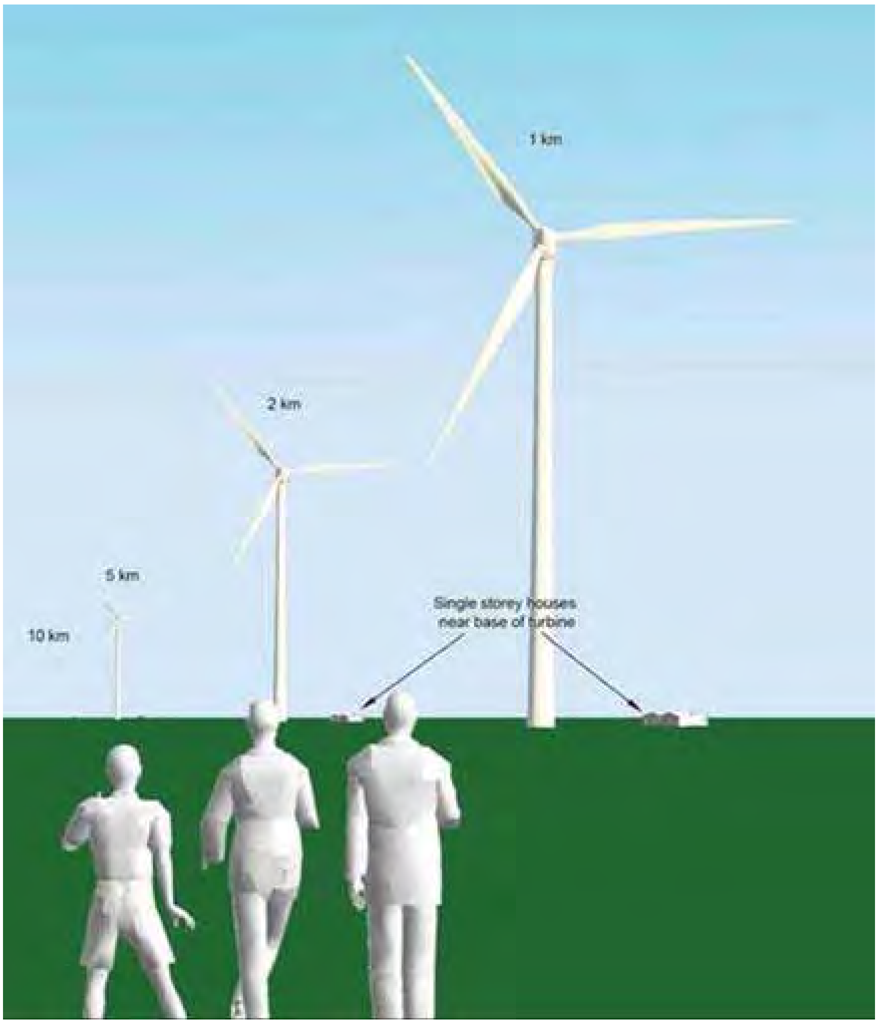


Figure 1: Visual experience of a wind turbine structure at a distance of 1km, 2km, 5km and 10km.

Other aspects of the Visual Impact Index remain largely unchanged when compared with the original layout. The magnitude of potential visual impacts is reduced overall due to the reduced number of turbines, but not to such an extent as to reduce the significance. This means that the results of the Visual Impact Assessment remain unchanged for the new layout.

8. Visual Exposure of Ancillary Infrastructure

Map 8 shows the potential visual exposure of the proposed substations and **Map 9** indicates area from which the proposed power line will be visible.

The viewshed of the proposed substations (calculated at a height of 15m) is expected to fall within that of the turbines. Visually exposed areas lie mostly within the site itself, to the south west of the site and to the north. Sensitive visual receptors include Jakkalsfontein and Rondeberg Nature Reserves along the coast south west of the site.

The viewshed of the proposed power line (calculated at a height of 20m) shows that almost the entire area within 5km on either side of the alignment will be exposed to potential visual impact. These areas also fall within the viewshed of the proposed turbines. Sensitive visual receptors include users of main and secondary roads, settlements and conservation areas (i.e. specifically Jakkalsfontein and Rondeberg Nature Reserves). The town of Darling is expected to be shielded from this visual impact.

Other conservation features impacted upon include the *West Coast National Park Viewshed Protection Zone* and the *West Coast Biosphere Reserve Core Area, Buffer Zone and Transition Zone*.

9. Conclusion

The amended layout for the proposed Rheboksfontein Wind Energy Facility will result in a lower magnitude of visual impact overall, due mainly to the reduced number of turbines and the inclusion of a buffer area along the R315.

Furthermore, the removal of turbines located within the *West Coast National Park Viewshed Protection Zone* aligns the development of the facility with SANParks policy.

However, these amendments do no negate potential visual impacts anticipated as a result of the proposed WEF and ancillary infrastructure. Although reduced in extent, the nature and significance of visual impacts remain unchanged for the amended layout.

The facility will still be visible for a large area that is generally seen as having a special landscape and tourism value (i.e. the Swartland) and would visually impact on various sensitive visual receptors that should ideally not be exposed to industrial style structures.

The study area is not considered ideally suited to the development of a WEF primarily due to its tourism value. However, the anticipated visual impact is not considered to be of such a nature and magnitude as to derail the tourism industry, especially in the existing centres.

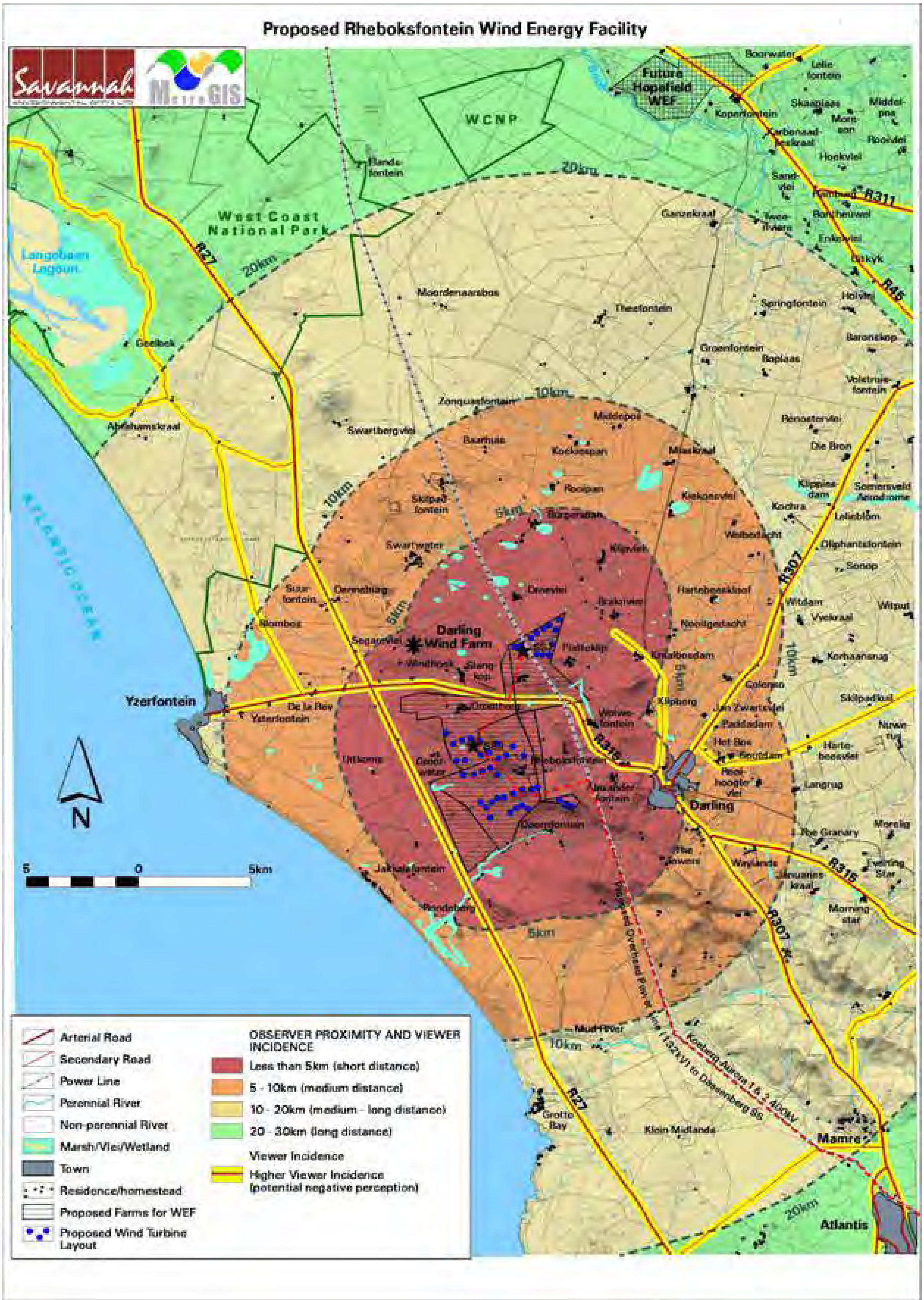
Other visual receptors of concern are the settlements in close proximity to the proposed WEF, especially the *Jakkalsfontein* community. In the absence of a layout for the Jakkalsfontein development, it is difficult to pinpoint what exactly the visual impact is likely to be on residents. Those facing the ocean will be less affected than those facing the north east.

Notwithstanding the above, the potential visual impact of the proposed WEF is not considered to be a fatal flaw for the development. It is therefore recommended that the development of the facility as proposed be supported, subject to the implementation of the recommended mitigation measures (see original report).

In addition, the amended layout is considered to be significantly more sensitive to visual indicators, and will result in a reduced Visual Impact overall. The amended layout is therefore considered to be preferable from a visual perspective, and is supported above the original layout.

Map 1: Proposed WEF layout indicating topography and elevation above sea level.

Map 2: Potential visual exposure of the proposed WEF.

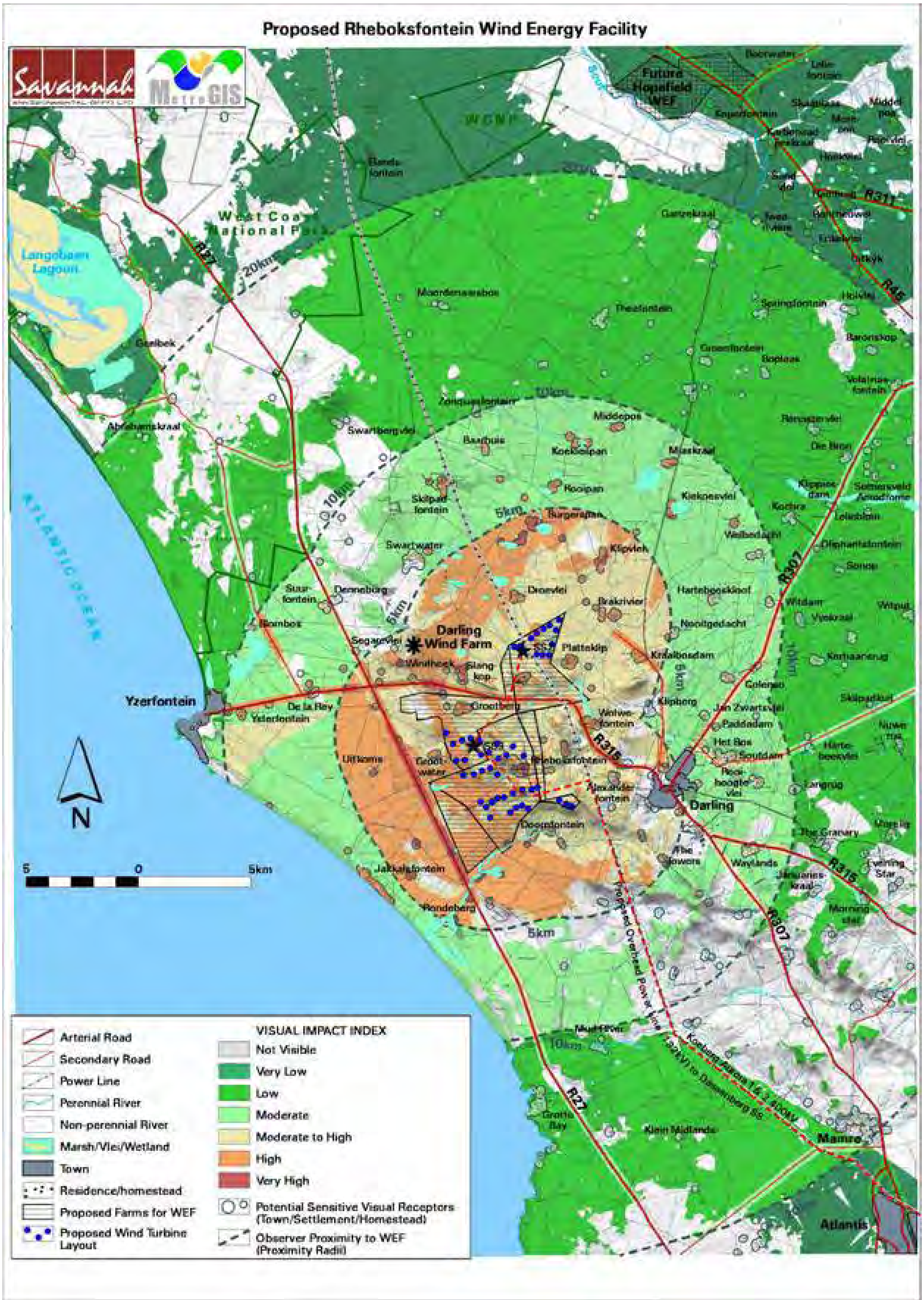


Map 3: Observer proximity to the proposed WEF and areas of high viewer incidence.

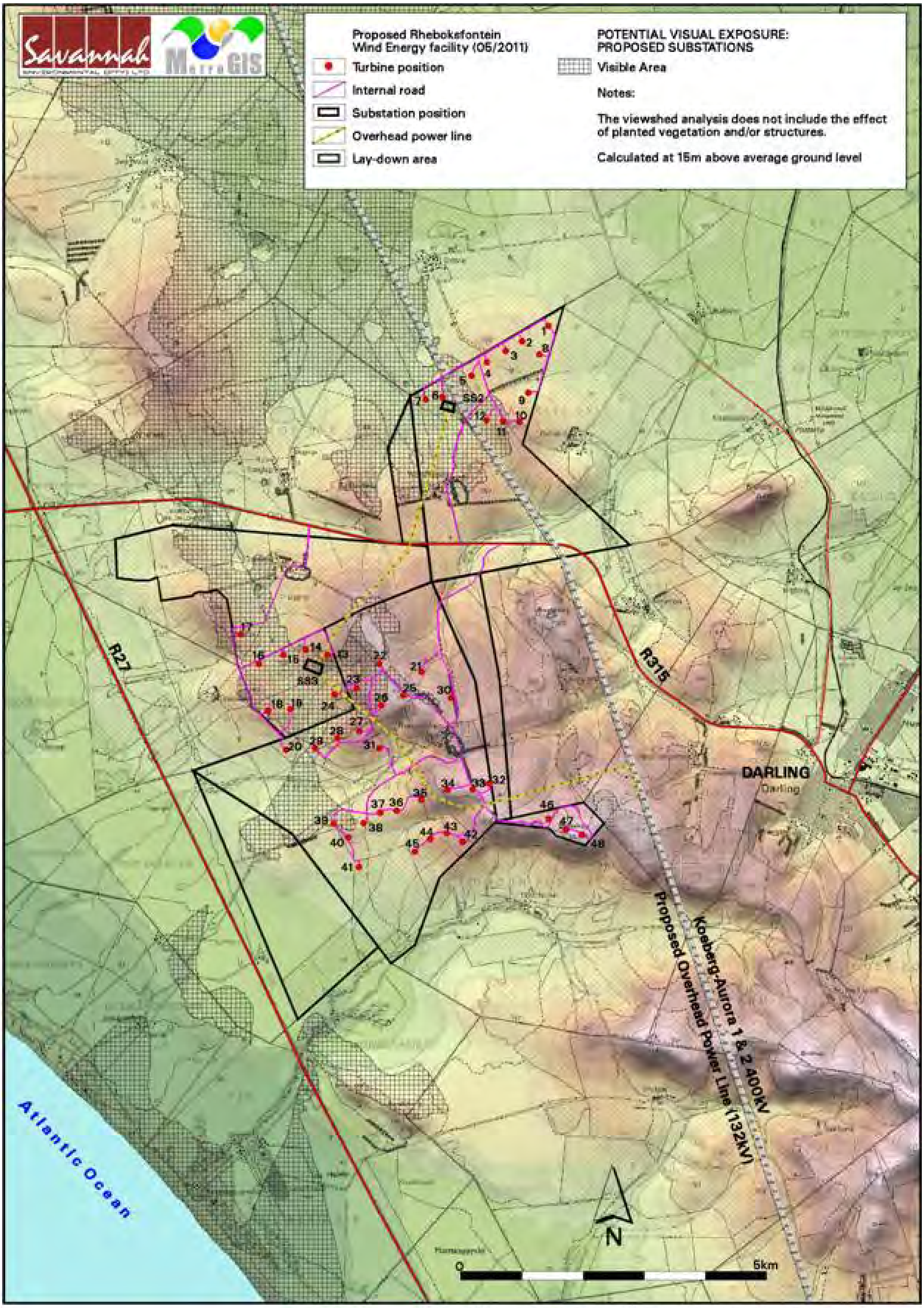
Map 4: Land cover/land use map indicating potential sensitive visual receptors.

Map 5: SANParks protected areas and conservation planning features within the study area.

Map 6: Cape Nature Conservation planning features (Biosphere Reserve Zones) and protected areas within the study area.



Map 7: Visual impact index of the proposed WEF.



Alignment follows existing Tx lines all the way to the Dassenberg SS

Map 8: Potential Visual Exposure of the proposed substations.

Map 9: Potential Visual Exposure of the proposed 132kV overhead power line.