PROPOSED COEGA WIND ENERGY PROJECT, EASTERN CAPE PROVINCE OF SOUTH AFRICA

ENVIRONMENTAL IMPACT ASSESSMENT
VOLUME 2: SPECIALIST REPORTS

Prepared for:	Prepared by:
InnoWind (Pty) Limited	**Coastal & Environmental Services**
P.O. Box 1116 Port Elizabeth, 6000	P.O. Box 934 Grahamstown, 6140
South Africa	South Africa

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REPORTS PRODUCED AS PART OF THIS EIA:

Volume 1:	Scoping and Terms of Reference Report
Volume 2:	**Specialist Reports**
Volume 3:	Environmental Impact Assessment Report
Volume 4:	Environmental Management Plan

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AMSL:	Above mean sea level
BBBEE:	Broad Based Black Economic Empowerment
BCRM:	Blue Crane Route Municipality
BID:	Background Information Document
BPEO:	Best Practice Environmental Option
CAR:	Co-ordinated Avifaunal Road counts
CARA	Conservation of Agricultural Resources Act
CES:	Coastal and Environmental Services
CITES:	Committee for International Trade in Endangered Species
CR	Critically Endangered
DEA:	Department of Environmental Affairs
DEAT:	Department of Environmental Affairs and Tourism
DEM	Digital Elevation Model
DMS:	Degrees, Minutes, Seconds
DSR:	Draft Scoping Report
DTM:	Digital Terrain Model
DWAF:	Department of Water Affairs and Forestry
DWEA:	Department of Water and Environmental Affairs
EAP:	Environmental Assessment Practitioner
EC:	Eastern Cape
ECDC:	Eastern Cape Development Corporation
ECO:	Environmental Control Officer
EIA:	Environmental Impact Assessment
EIR:	Environmental Impact Report
EMP:	Environmental Management Plan
EN:	Endangered
ENPAT:	Environmental Potential Atlas
ESA:	Early Stone Age
EWEA:	European Wind Energy Association
EWT:	Endangered Wildlife Trust
FSR:	Final Scoping Report
GIS:	Geographic Information System
GLVIA;	Guideline for Involving Visual and Aesthetic Specialists in EIA Processes
GNR:	Government Notice Regulation
ha:	Hectare
HIA:	Heritage Impact Assessment
I&APs:	Interested and Affected Parties
IDP:	Integrated Development Plan
IPP:	Independent Power Producer
IUCN:	International Union for Conservation of Nature
Kv:	Kilovolt
Ltd:	Limited
LSA:	Late Stone Age
Ma	Million years ago
MAP	Mean Annual Precipitation
MSA:	Middle Stone Age
MW:	Mega Watts
NASA	National Aeronautics and Space Administration
NEMA:	National Environmental Management Act 107 of 1998 as amended in 2006

NERSA:	National Energy Regulator of South Africa
NHRA:	National Heritage Resources Act 25 of 1999
NT	Near Threatened
NWCC	National Wind Coordinating Committee
PoS:	Plan of Study
PPA:	Power Purchase Agreement
PPP:	Public Participation Process
PPWRA	Altamont Pass Wind Resource Area
QDS:	Quarter Degree Square
RDB:	Red Data Book
REFIT:	Renewable Feed In Tariff
REPA:	Renewable Energy Purchasing Agency
RPM	Repetitions per minutes
SABAP2	Southern Africa Bird Atlas Project 2
SAHRA:	South African Heritage Resources Agency
SANBI:	South African National Biodiversity Institute
SARDB	South African Red Data Book
SDF	Spatial Development Framework
SSC:	Species of Special Concern
STEP	Subtropical Thicket Ecosystem Planning project
ToR:	Terms of Reference
VIA	Visual Impact Assessment
VU	Vulnerable
WEF:	Wind Energy facility
WfW	Working for Water
WPDA:	World database on Protected Areas
WT:	Wind Turbine
ZTV	Zone of Theoretical Visibility
ZVI	Zone of Visual Influence

1 INTRODUCTION

1.1 Background to the study

InnoWind (Pty) Limited - a renewable energy generator that develops, finances, builds, operates and maintains commercial wind powered electricity generation facilities, plans to develop a wind energy facility (often referred to as a „wind farm") on a portion of Zone 14 of the Coega Industrial Development Zone (IDZ), as well as on two parcels of Pretoria Portland Cement (PPC) property immediately north of Zone 14.

The IDZ is situated in the Nelson Mandela Bay Metropolitan Municipality (NMBMM) in the Eastern Cape Province of South Africa, approximately 15km north-east of Port Elizabeth. Portions of the adjacent PPC properties (located on the Farms Grassridge 223, 190 and 227 and Doornkom 229) to the north and north-west of Zone 14 are currently mined for limestone ore for the production of cement.

Potential environmental impact limitations not withstanding, the proposed project is planned to host up to seventy (70) turbines, each with a nominal power output ranging between 2-3 Mega Watts (MW). The total potential output of the wind farm will be approximately 210 MW. In accordance with the requirements of the National Environmental Management Act (Act No 107 of 1998) (NEMA), and the relevant regulations (GNR. 543) set out the procedures and criteria for the submission, processing and consideration of and decisions on applications for the environmental authorisation of activities. Three lists of activities, published on 02 August 2010, as Government Notice Numbers R.544 to 546, define the activities that require, respectively, a Basic Assessment (applies to activities with limited environmental impacts or within a prescribed geographical area - province), or a Scoping and Environmental Impact Assessment (applies to activities which are significant in extent and duration).

Coastal & Environmental Services (CES) have been appointed by Innowind (Pty) Limited as Environmental Assessment Practitioner (EAP) to conduct the EIA. Under Regulation 32 of GNR 543, specialist studies have to be undertaken as part of the detailed EIA Phase, the objectives of which are discussed in detail in Section 1.2 below.

1.2 Objectives of the Specialist Studies

The primary objective of the baseline specialist studies is to generate sufficient factual information on which to assess the significance and severity of environmental impacts. In order to achieve this, and in accordance with Regulation 32 of GNR 543:

1. An applicant or EAP managing an application may appoint a person who is independent to carry out a specialist study or specialised process.
2. The person referred to in sub-regulation (1) must comply with the requirements of regulation 17.
3. A specialist report or a report on a specialised 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 specialised study or process;
    b. A declaration that the person is independent in a form as may be specified by the competent authority;
    c. An indication of the scope of, and the purpose for which, the report was prepared;
    d. A description of the methodology adopted in preparing the report or carrying out the specialised process;
    e. A description of any assumptions made and any uncertainties or gaps in knowledge;
    f. A 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. A description of any consultation process that was undertaken during the course of carrying out the study;
i. A summary of the copies of any comments that were received during any consultation process, and;
j. Any other information requested by the competent authority.

The following Specialist Studies were undertaken for the EIA

- Ecological (encompassing fauna and flora)
- Avifauna
- Visual
- Noise
- Palaeontological

The specific Terms of Reference (ToR) for each of the above-mentioned studies, which outline the information required from each of the specialists, are provided in the relevant specialist volumes and the methodology used for assessing the significance of impacts and alternatives is described in Chapter 3. Specialists were also required to address issues raised by Interested and Affected Parties (I&APs) in their reports (see Appendix A -: individual specialist volumes).

1.3 Structure of the report

This volume presents the findings of the four specialist studies undertaken in the detailed EIA phase of the proposed development and the structure of the report is therefore as follows:

Chapter 1- Introduction: Provides brief background information on the proposed project as well as the objectives of the specialist studies. This Chapter also provides details on the structure of this report.

Chapter 2 – Project Description: Provides a detailed description of the proposed project based on the latest project plans provided by InnoWind (Pty) Ltd.

Chapter 3 – The Specialist Study Process: Provides details of the specialists that undertook each of the studies including their expertise, as well as a declaration of their independence. This Chapter also provides a detailed description of the methodology used by the specialists when evaluating the significance of impacts.

Chapter 4 – Ecological Specialist Report

Chapter 5 – Avifauna Specialist Report

Chapter 6 – Visual Specialist Report

Chapter 7 – Noise Specialist Report

Chapter 8 – Palaeontological Specialist Report

2 PROJECT DESCRIPTION

This chapter identifies the location and size of the site of the proposed Coega Wind Energy Project, and provides a description of its various components and arrangements on the site.

2.1 Location and Site Description of the Proposed Development

The proposed Coega wind energy project is to be constructed on a portion of Zone 14 of the Coega Industrial Development Zone (IDZ) situated in the Nelson Mandela Bay Metropolitan Municipality (NMBMM) in the Eastern Cape Province of South Africa, approximately 15km north-east of Port Elizabeth. The total area of all 3 study area portions is approximately 4367 hectares of which a minor portion of this total extent will be utilised for the proposed facility. The location of the relevant portion of Zone 14 within the IDZ, as well as the relevant PPC property portions is depicted in Figure 2-1. During the Scoping process the 3 property portions comprising the study area were for reporting purposes designated at follows:

1. Zone 14 IDZ (Farm Bontrug 301): 2338 ha in extent
2. PPC East (Farms Grassridge 225, 226 and 227, Farm Geluksdal 590): 1550 ha in extent
3. PPC West (Farms Grassridge 190 and 227 and Doornkom 229): 479 ha in extent

Zone 14

Zone 14 is situated in the north-western portion of the IDZ. The northern boundary of Zone 14 is defined by the Eskom Grassridge Substation and associated 400kV powerline servitude. The zone is currently undeveloped.

PPC East

The PPC East study area property portion is currently not subject to extensive mining operations as is the case with the PPC West portion. The rail siding that is used to load the mined limestone onto rail carriages for transport to PPC"s cement manufacturing works in Port Elizabeth is located in this portion of the study area.

PPC West

The PPC West property is currently mined by PPC. The associated plant and crushing works is situated on this portion with all prepared limestone or transported via the existing haul road to the rail siding on the PPC East portion for shipment to Port Elizabeth. It is anticipated that within the next 5 years PPC will be relocating its plant and crusher works to the PPC East portion once mining activity increases on this portion, with the PPC West portion no longer subject to mining activity once this occurs.

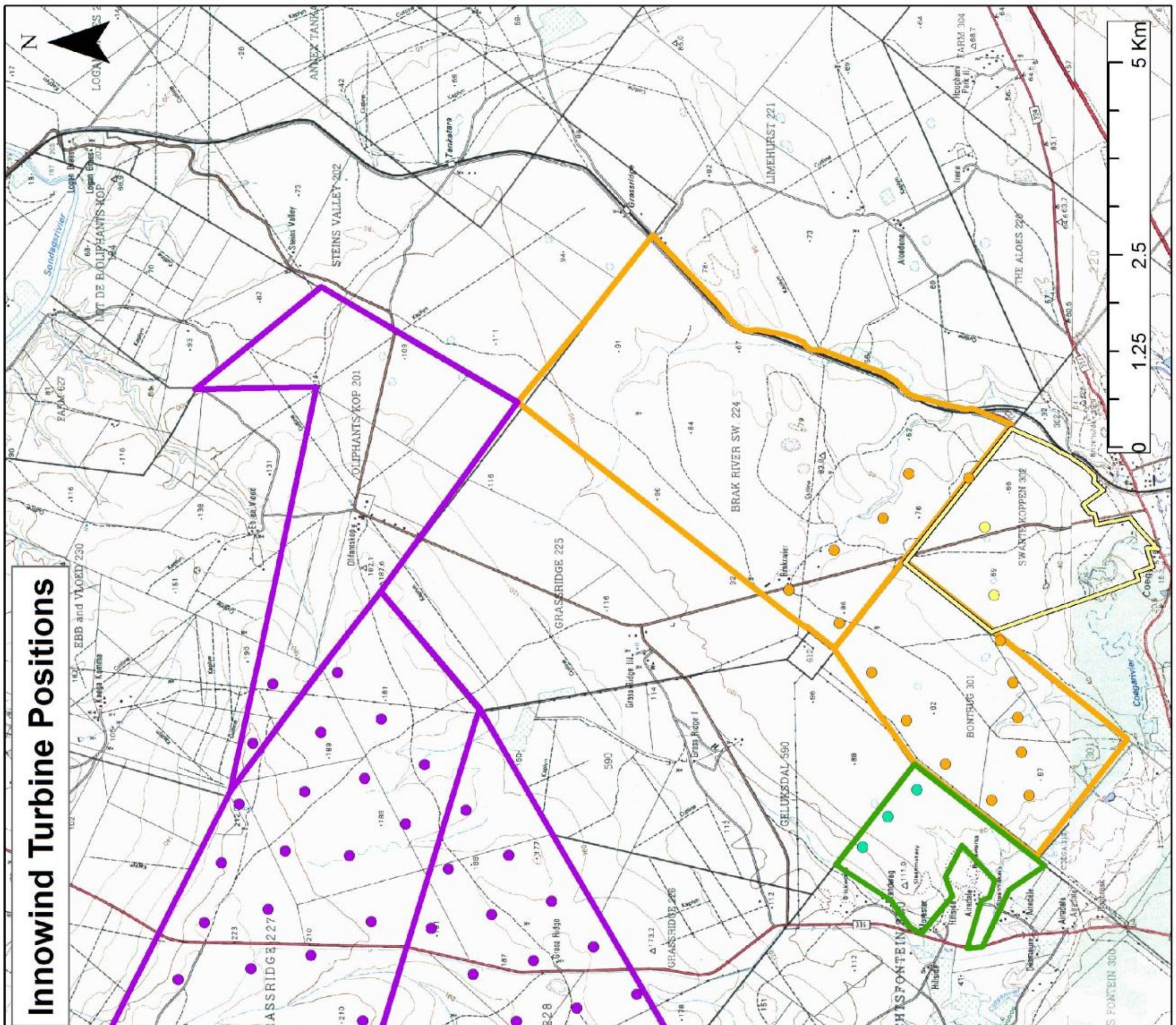

Figure 2-1: Locality map indicating the revised location of proposed Coega Wind Energy Project. Turbines are represented by the coloured dots.

2.2 Detailed description of the proposed Coega Wind Energy Project

2.2.1 Roads

During construction, it will be necessary to transport large turbine components (including blades each with a length of 49 meters) to the site and, as such, there are specific requirements for the roads. The general requirement is that all roads should have a width of approximately 5 meters with 8 meters horizontal clearance. However, Innowind expects that a road width of 4 meters will be sufficient.

2.2.2 Machinery and cables

Wind energy is a form of renewable energy. Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth. Wind flow patterns are modified by the earth's terrain, bodies of water, and vegetation. This wind flow or motion energy (kinetic energy) can be used for generating electricity. The term "wind energy" describes the process by which wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power and a generator can then be used to convert this mechanical power into electricity. Typical wind turbine subsystems include (also refer to Figure 2-2):-

- *A rotor, or blades*, which are the portion of the wind turbine that collect energy from the wind and convert the wind's energy into rotational shaft energy to turn the generator. The speed of rotation of the blades is controlled by the nacelle, which can turn the blades to face into the wind („yaw control), and change the angle of the blades („pitch control") to make the most use of the available wind;
- *A nacelle (enclosure)* containing a drive train, usually including a gearbox (some turbines do not require a gearbox) and a generator. The generator is what converts the turning motion of a wind turbine"s blades (mechanical energy) into electricity. Inside this component, coils of wire are rotated in a magnetic field to produce electricity. The nacelle is also fitted with brakes, so that the turbine can be switched off during very high winds, such as during storm events. This prevents the turbine from being damaged. All this information is recorded by computers and is transmitted to a control centre, which means that operators don't have to visit the turbine very often, but only occasionally for a mechanical check;
- *A tower*, to support the rotor and drive train; The tower on which a wind turbine is mounted is not only a support structure, but it also raises the wind turbine so that its blades safely clear the ground and so can reach the stronger winds at higher elevations. The tower must also be strong enough to support the wind turbine and to sustain vibration, wind loading, and the overall weather elements for the life time of the turbine, and;
- *Electronic equipment* such as controls, electrical cables, ground support equipment, and interconnection equipment.

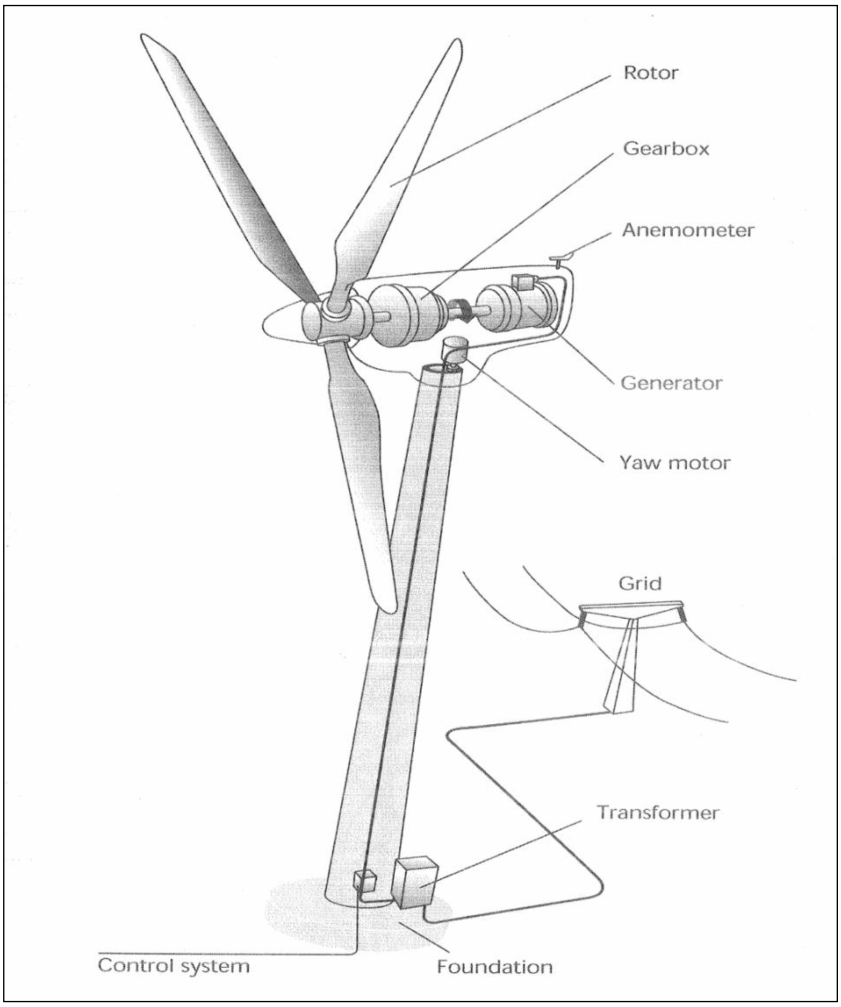

Figure 2-2: Illustration of the main components of a typical wind turbine - P.S: Note that the transformer in the figure above would normally be inside the tower (probably at the base).

A wind turbine obtains its power input by converting the force of the wind into torque (turning force) acting on the rotor blades. The wind then turns the rotor blades, which spin a shaft, which connects to a generator and makes electricity. The amount of energy which the wind transfers to the rotor depends on the density of the air (the heavier the air, the more energy received by the turbine), the rotor area (the bigger the rotor diameter, the more energy received by the turbine), and the wind speed (the faster the wind, the more energy received by the turbine).

Provided in the sections that follow is a detailed discussion on the various components of the proposed Coega Wind Energy Project.

2.2.3 Construction of a typical wind farm

Typically, building a wind farm is divided into three phases namely:-

- Preliminary civil works
- Construction
- Operation

Each of the above-mentioned phases is described in detail in sections 2.2.4.1 – 2.2.4.3 that follow.

2.2.4.1. Preliminary civil works

A temporary area of 35m*25m needs to be established during the preliminary phase of the wind farm for access to the site during the construction phase by machines (bulldozers, trucks, cranes etc). The access roads need to have a minimum internal turning circle of 26-27m.

2.2.4.2. Construction Phase

This phase comprises of the following sub-phases:-

(a) Geotechnical studies and foundation works
A geotechnical study of the area is usually undertaken for safety purposes. This comprises of drilling, penetration and pressure assessments. For the purpose of the foundations, $500m^3$ would need to be excavated for each turbine. These excavations are then filled with steel-reinforced concrete (typically 13 tons of steel rods per turbine). The foundations can vary according to the quality of the soil. The main dimensions for the foundation of a 3MW/100m high wind turbine are shown in the Figure 2-4 with underground foundation, tower base, above ground foundation, and ground level.

Innowind (Pty) Ltd will undertake a geotechnical study upon receipt of a positive environmental authorization from the Department. Geotechnical studies are costly and the risk of commissioning a geotechnical study prior to environmental authorization being received is a large risk, time- and cost-wise.

(b) Foundation Works
The turbine foundations can vary according to the quality of the soil. The main dimensions for the foundation of a 3MW/100m high wind turbine are shown in the Figure 2-3.

(c) Electrical cabling
As discussed above, electrical and communication cables are run approximately 1m deep, under or immediately alongside the access roads.

(d) Turbine erection
The process is quick (around 3 days per turbine) if the weather conditions permit. This phase is the most complex and costly.

2.2.4.3. Electrical connection

Each turbine is fitted with its own transformer that steps up the voltage usually to 22kv or 33kv. The entire wind farm is then connected through a series of connections to the “point of interconnection” which is the electrical boundary between the wind farm and the municipal or national grid. The national grid might need to be extended to accommodate and evacuate power from the wind energy facility. Most of the off site grid works will be carried out by Eskom or its sub contractor (line upgrade, connection to the sub-station, burial of the cables etc.).

2.2.4.4. Timing estimation

The implementation of a wind farm of these approximate dimensions would require:-

- Preliminary phase = 13 weeks (including 8 weeks to let the foundation concrete dry)
- Wind turbines erection = 4 weeks (in good low wind weather conditions)
- Commissioning and electrical connection = 4 weeks

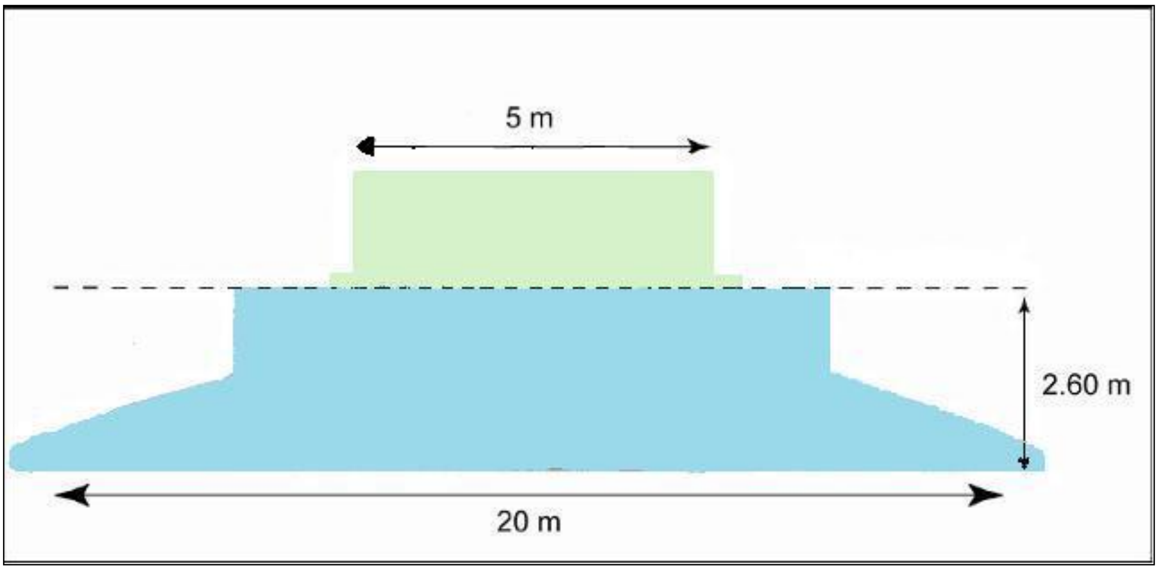

Figure 2-3: The main typical dimensions for the foundation of a 2.5MW/80-100m high wind turbine. * Note: Blue area is underground and green area is above ground

2.2.4.5. Operational phase

During the period when the turbines are up and running, on-site human activity drops to a minimum, and includes routine maintenance requiring only light vehicles to access the site. Only major breakdowns would necessitate the use of cranes and trucks.

2.2.4.6. Refurbishment and rehabilitation of the site after operation

Current wind turbines are designed to last for over 25 years and this is the figure that has been used to plan the life span of a modern wind farm. If refurbishment is economical, the facility life span could be expanded by another 25 years.

Decommissioning of the wind energy facility at the end of its useful life will be undertaken in agreement with the landowners and according to the land use agreement. The intention of the project proponent is to ensure that the usable land and visible images would be removed and restored to their original condition.

2.3 The Affected Environment

2.3.1 Climate

Rainfall in the Coega area averages approximately 620mm per annum, with peaks in spring and autumn. Average daily temperature ranges from 25ºC in summer to 12ºC in winter. Strong winds can be expected from the west and west-south-west all year round, while easterly winds blow from October to March.

2.3.2 Geology and Soils

The geology of the study area is characterised by coastal limestone overlaid by calcareous sands blown onshore. Soils in the IDZ are relatively deep, red, lime-rich sandy clay loams. In areas where the limestone is visible, the geology and soils are a typical habitat for Bontveld vegetation.

2.3.3 Surface and groundwater

The Coega River, the most significant surface water feature between the Zwartkops and Sundays rivers, is adjacent to the study area, but it is highly unlikely that the wind energy facility would impact on this. It is a relatively small river, but has formed a floodplain valley between 400m and 1 000m wide. The southern part of the study area is underlain by an artesian aquifer formed by sandstones and quartzites of the Table Mountain Group, confined by a succession of Cretaceous formations of the Uitenhage group up to 1 200m thick.

2.3.4 Vegetation

During vegetation survey conducted in November 2009 and February 2010 it was established that the site proposed for development of the facility made up of Coega Bontveld and Sundays Thicket. When comparing the two vegetation units, although the Coega Bontveld is sensitive in nature, it pales in comparison to the sensitivity of the Sundays Thicket unit i.e. even though the Sundays Thicket Unit is lower in species richness; it is of greater ecological significance due to the high number of additional species that it supports.

2.3.5 Fauna

Lack of pristine terrestrial habitat in the Coega region, particularly due to loss of natural vegetation caused by human activity, has impacted on the terrestrial fauna. Large mammals are absent from the area, and the remaining mammals are small and medium sized. Two terrestrial mammals – the blue duiker (Vulnerable) and the honey badger (Near Threatened) - are of conservation concern in the region.

More than half of the Eastern Cape"s endemic reptile species occur in the Algoa Bay area, and the majority of these are found in Mesic Succulent Thicket (Sundays Thicket) and riverine habitats. The list of reptiles of special concern includes five endemic species, eight CITES-listed species and one rare species.

Knowledge of amphibian species diversity in the Coega region is limited, but it is estimated that as many as 17 species may occur, none of which are endemic or of conservation concern.

The Coega region has a diverse avifauna, with over 150 species being resident or common visitors to the region. Most diversity occurs in the thicket clumps. A number of terrestrial birds are of conservation concern, some of which (Damara Tern, African Black Oystercatcher, Spotted Thicknee and Kelp Gull) have been observed within the coastal region in the vicinity of the study area.

Terrestrial invertebrates of conservation concern include two rare butterflies of the Lycaenidae family, which have distributions that include the Coega area.

2.3.6 Socio-economic profile

According to the Nelson Mandela Bay Metropolitan Municipality (NMBMM) Integrated Development Plan (IDP) 2008, Nelson Mandela Bay has a population of about 1.1 million people, 52 percent of whom are female and 37 per cent are below the age of 20. The unemployment rate among the economically active sector of the community is approximately 28 percent (IDP, 2008) and although the unemployment rate in Nelson Mandela Bay has shown a steady decline since 1994, led by the manufacturing sector; it remains higher than the national average for South Africa.

2.4 Key Findings of the Specialist Studies

2.4.1 Ecological Specialist Study

The vegetation on the proposed wind energy facility site is mostly in fair condition. There are a few invader species along with some degraded vegetation, both of which could potentially result in further degradation of the site in the future. As the site forms part of the Coega IDZ, there is an existing Open Space Management Plan that provides for the conservation and upkeep of some of the land within the Coega IDZ.

Because of the very nature of a wind farm, it is suspected that many of the impacts will be reduced with effective management of the site as well as the utilization of rehabilitation after construction. For the plant species of special concern, it is recommended that any of these species are identified and rescued before building commences. In addition to this, any extra land needed for the construction phase of the development that will not be used during the operation phase of the development should be rehabilitated after construction is completed.

Overall, the impacts of the overall development will be negative, mainly due to a loss of vegetation. This loss of vegetation is also important for fauna as it constitutes habitat loss. Positive impacts include the active management of the alien vegetation on the site.

2.4.2 Avifauna Specialist Study

The proposed facility has the potential to significantly impact on avifauna in the area, although our confidence in this assessment is low, due to the lack of operation experience of commercial scale wind farms in South Africa. It is recommended that the management of these potential impacts be approached through a rigorous monitoring programme as set out in this report.

2.4.3 Visual Specialist Study

The wind farm proposed by Innowind is quite large at 75 turbines and there will be few areas in the region that will not have views on a turbine or at least a moving blade on the horizon. A number of turbines will fall within the Coega IDZ, but most of them will be adjacent to the IDZ. The land outside the IDZ is owned by PPC, some of which is being mined in a large open cast mine, and the rest which will be mined in future.

The Draft Scoping Report indicates that visual impact is not one of the issues highlighted by the public participation process. This is perhaps due to the fact that the landscape here is in close proximity to large industrial and urban centres, and that industrial type structures, quarries and construction sites are familiar features of the landscape. Most people in South Africa seem to associate wind turbines with industrial landscapes. As such this should be an acceptable landscape for the proposed wind farm.

2.4.4 Noise Specialist Study

During the construction phase, all operations should only occur during daylight hours if possible. This may not be practical if continuous pouring of the turbine base has to occur. There should be no construction piling occuring at night. Piling should only occur during the hottest part of the day to take advantage of unstable atmospheric conditions. Construction staff should receive “noise sensitivity” training.

The noise impact from the wind turbine generators during the operational phase should be measured during the operational phase, to ensure that the impact is within the recommended limits. WTG 1 should be moved further away from NSA 8 and WTG 40 should be moved further away from NSA 9 to meet the minimum setback criteria.

2.4.5 Palaeontological Specialist Study

The overall impact on palaeontological heritage of the proposed wind farm project is of low significance. Accordingly further specialist palaeontological mitigation for this project is not recommended unless wind turbines or ancillary developments are sited over the Sundays River Formation (mainly escarpment areas); or deep excavations penetrate through the limestone capping into Sundays River sediments below.

In these two cases, mitigation by a professional palaeontologist is recommended during the construction phase of the wind farm. It is important that the opportunity to mitigate is given while the bedrock excavations are fresh and before they are infilled, covered over or degraded by weathering and plant growth. Before development starts a realistic programme of mitigation should therefore be negotiated between the developer and the palaeontologist contracted for the project to maximize the scientific and conservation benefits of the work while minimizing disruption of the construction programme. The palaeontologist involved will need to obtain a fossil collection permit from SAHRA and make arrangements with an approved repository (*e.g.* museum, university) to store and curate any fossil material collected.

2.5 Summary of the potential Impacts of the proposed Coega Wind Energy Project

Tables 2.1a and 2.1b provide a summary of the impacts associated with the proposed Coega Wind Energy Project as a whole, with and without mitigation. Please note that a comparative assessment of the various alternative layouts is discussed at a later stage.

2.5.1 Construction Phase

During the construction phase, the proposed Coega Wind Energy Project will have a moderate visual impact with regards to the intrusion of large and highly visible construction activity in an industrial area. This is mainly because the height of the features that will be built, and the siting on ridges will expose construction activities against the skyline. Even with the incorporation of mitigation measures, this impact will remain moderate.

The Loss of plant Species of Special Concern (SSC) including *Sideroxylon inerme L.*, *Aloe africana Mill., Boophone disticha*., *Euphorbia obesa*. and the Mesembryanthemaceae family during the construction phase of the proposed Coega Wind Energy Project is of concern – this is discussed in the comparative assessment below as it is dependant on the alternative layouts.

Half of the other impacts associated with the proposed project during the construction phase before mitigation are of low significance and the other half are moderate, and the significance of all of these impacts with the exception of the loss of plant SSC during the construction phase – discussed in the comparative assessment below, and the loss of bird habitat due to vegetation clearing, after the incorporation of appropriate mitigation measures, can be reduced to Low else Moderate positive significance.

The No-Go Option will have four moderate benefical/positive impacts with regards to the following:-

- Bontveld
- Sundays thicket
- Plant Species of Special Concern
- Loss of habitat

And the No-Go Option will have two highly beneficial/ positive impacts with regard to the following:-

- Loss of faunal biodiversity
- Loss of Species of Special Concern

However, the introduction of alien species will be of High negative significance with the No-Go Option (i.e. No development).

Table 2-1a: Summary of the construction impacts associated with the proposed Coega Wind Energy Project

CONSTRUCTION PHASE						
			Significance			
			Without mitigation		With mitigation	
Impact Study	Impact #	Impact type		No-go		No-go
Ecological		**Flora and Vegetation**				
	1	Loss of Bontveld	MOD –ve	MOD +ve	LOW –ve	N/A
	2	Loss of Sundays Thicket	MOD –ve	MOD +ve	LOW –ve	N/A
	3	Loss of Plant Species of Special Concern	MOD –ve	MOD +ve	MOD –ve	N/A
	4	Introduction of alien plant species	MOD –ve	HIGH –ve	MOD +ve	N/A
		Fauna				
	5	Loss of faunal biodiversity	MOD –ve	HIGH +ve	LOW –ve	N/A
	6	Loss of species of special concern	LOW –ve	HIGH +ve	N/A	N/A
	7	Disturbance displacement of bats	LOW –ve	LOW +ve	LOW –ve	N/A
	8	Loss of bat habitat	LOW –ve	MOD +ve	LOW –ve	N/A
	9	Bat mortalities	N/A	N/A	N/A	N/A
		Cumulative impacts				
	10	Fragmentation of vegetation types	LOW –ve	N/A	LOW –ve	N/A
Avifauna	1	Impact of habitat destruction during the construction phase	MOD –ve	N/A	MOD –ve	N/A
	2	Impact of disturbance during the construction phase	LOW –ve	N/A	LOW –ve	N/A
Visual	1	Intrusion of large and highly visible construction activity on sensitive viewers	MOD –ve	N/A	MOD –ve	N/A
Noise	1	Impact of the construction noise on the surrounding environment	LOW –ve	N/A	N/A	N/A
Paleaontological	1	Impact from disturbance of due to construction activity	LOW –ve	N/A	MOD +ve	N/A

2.5.2 Operational Phase

During the operational phase, the proposed Coega Wind Energy Project will have a moderate visual impact with regards to the intrusion of large wind turbines on the existing views of sensitive visual receptors. Regardless of the incorporation of mitigation measures, this impact will remain moderate.

As discussed above, bat fatalities as a result of the proposed project will be of moderate negative significance without mitigation, but as no studies have been conducted with regard to bat fatalities from wind turbines in South Africa, this impact would remain moderate. It is important to note however, that there is currently no information available on bat fatalities, and their causes at windfarms in South Africa, therefore this EIA assumes a precautionary approach.

The introduction of alien species will also be of high negative significance with the proposed project as well as the No-Go option. However, if alien invader species are consistently managed over the entire operation phase of the project, and an alien eradication program implemented (in terms of the No-Go option), the significance of this impact can be reduced to beneficially moderate significance.

Noise during the operational phase of the proposed Coega Wind Energy Project will be of moderate significance and can be mitigated to low significance by moving WTG-1 and 40 further from the affected noise sensitive areas.

The majority of the other impacts associated with the proposed project during the operational phase before mitigation were regarded as being of moderate significance, and the significance of all of these impacts with the exception of the following (impact of noise on surrounding environment is reduced to Low, and introduction of alien plant species is reduced to moderately beneficial after mitigation) can, after the incorporation of appropriate mitigation measures can be reduced to Moderate –„ve

Table 2-1b: Summary of the operation impacts associated with the proposed Coega Wind Energy Project

OPERATION PHASE						
			Significance			
			Without mitigation		With mitigation	
Impact Study	Impact #	Impact type		No-go		No-go
Ecological		**Flora and Vegetation**				
	1	Loss of Bontveld	N/A	MOD +ve	N/A	N/A
	2	Loss of Sundays Thicket	N/A	MOD +ve	N/A	N/A
	3	Loss of Plant Species of Special Concern	N/A	MOD +ve	N/A	N/A
	4	Introduction of alien plant species	HIGH -ve	HIGH –ve	MOD +ve	N/A
		Fauna				
	5	Loss of faunal biodiversity	N/A	HIGH +ve	N/A	N/A
	6	Loss of species of special concern	N/A	HIGH +ve	N/A	N/A
	7	Disturbance displacement of bats	MOD -ve	LOW +ve	MOD -ve	N/A
	8	Loss of bat habitat	MOD –ve	MOD +ve	MOD -ve	N/A
	9	Bat mortalities	MOD -ve	N/A	MOD -ve	N/A
		Cumulative impacts				
	10	Fragmentation of vegetation types	N/A	N/A	N/A	N/A
Avifauna	1	Impact of bird collisions with turbines during the operational phase	HIGH -ve	N/A	MOD -ve	N/A
	2	Impact of disturbance during the operational phase	MOD -ve	N/A	MOD -ve	N/A
	3	Impact of disruption in local bird movement patterns during operation.	MOD -ve	N/A	MOD -ve	N/A
	4	Impact of collision and electrocution of birds on associated power line.	MOD -ve	N/A	MOD -ve	N/A
Visual	1	Intrusion of large highly visible wind turbines on the existing views of sensitive visual receptors	MOD –ve	N/A	MOD –ve	N/A
	2	Impact of night lights on existing nightscape	MOD –ve	N/A	MOD –ve	N/A
	3	Impact of shadow flicker on residents in close proximity to wind turbines	MOD –ve	N/A	MOD –ve	N/A
	4	Impact of introducing highly visible wind turbines into an industrial landscape	MOD –ve	N/A	MOD –ve	N/A
Noise	1	Impact of the operational noise on the surrounding environment (NSA 8 & 9)	MOD –ve	N/A	LOW –ve	N/A

3 THE SPECIALIST PROCESS

3.1 Study Team

The team of specialists was drawn from many sources, including universities and private consulting companies. Table 3-1 indicates the specialists involved in the proposed Coega Wind Energy Project EIA and provides their contact details. Appendix B-1 provides short *Curriculum Vitae* (CVs) of each of these specialists detailing their expertise to undertake these studies.

Table 3-1: The Specialists involved in the Proposed Coega Wind Energy Project EIA

Specialist Study	Affiliation	Name of Lead Specialist(s)	Contact Details
Noise	Safetech	Mr. Brett Williams	P.O. Box 27607, Greenacres, Port Elizabeth 6056
Avifauna	Mr Jon Smallie	Endangered Wildlife Trust	Private Bag X11, Parkview 2122
Visual	MapThis	Mr. Henry Holland	8 Cathcart Street, Grahamstown 6139
Ecological	Coastal and Environmental Services	Prof. Roy Lubke Ms. Leigh-Ann De Wet	67 African Street, Grahamstown 6139
Palaeontological	Natura Viva CC	Dr John Almond	P.O. Box 12410 Mill St. Cape Town 8010

In addition to the above, this specialist volume incorporating each of the above-mentioned specialist reports was compiled by Mr. Hylton Newcombe and reviewed by Mr Marc Hardy both of Coastal and Environmental Services (See short CVs in Appendix B-2).

3.2 Declaration of Independence

Appendix B-3 provides signatures of each of the specialists involved in the proposed Coega Wind Energy Project EIA indicating a declaration of their independence.

3.3 Methodology

The exact methodology used in each of the specialist studies is provided in detail in the relevant attached specialist Chapters. However, although the specialists were given free reign on how they conducted their research and obtained their information, they were required to provide the reports in a specific layout and structure, so that a uniform specialist report volume could be produced. Consequently, the specialists were given details on how their reports should be laid out, and considerable time has been spent ensuring that the reports are of the highest standard possible. In addition to the above, in order to ensure that a direct comparison could be made between the various specialist studies, a set methodology was used by all the specialists when evaluating the significance of impacts. This methodology is discussed in detail in section 3.3.1 below.

3.3.1 Evaluating the significance of impacts

To ensure that a direct comparison between the various specialist studies was possible, five factors were considered when assessing the significance of impacts, namely –

1. Relationship of the impact to **temporal** scales - the temporal scale defines the significance of the impact at various time scales, as an indication of the duration of the impact.

2. Relationship of the impact to **spatial** scales - the spatial scale defines the physical extent of the impact.

3. The severity of the impact - the **severity/beneficial** scale was used in order to scientifically evaluate how severe negative impacts would be, or how beneficial positive impacts would be on a particular affected system (for ecological impacts) or a particular affected party.

   The severity of impacts can be evaluated with and without mitigation in order to demonstrate how serious the impact is when nothing is done about it. The word „mitigation" means not just „compensation", but also the ideas of containment and remedy. For beneficial impacts, optimization means anything that can enhance the benefits. However, mitigation or optimization must be practical, technically feasible and economically viable.

4. The **likelihood** of the impact occurring - the likelihood of impacts taking place as a result of project actions differs between potential impacts. There is no doubt that some impacts would occur (e.g. loss of vegetation), but other impacts are not as likely to occur (e.g. vehicle accident), and may or may not result from the proposed development. Although some impacts may have a severe effect, the likelihood of them occurring may affect their overall significance.

5. Each criterion is ranked with scores assigned as presented in Table 3-2 to determine the overall **significance** of an activity. The criterion is then considered in two categories, viz. effect of the activity and the likelihood of the impact. The total scores recorded for the effect and likelihood are then read off the matrix presented in Table 3-3, and the overall significance of the impact is determined according to Table 3-4. The overall significance is either negative or positive.

The ***environmental significance*** scale is an attempt to evaluate the importance of a particular impact. This evaluation needs to be undertaken in the relevant context, as an impact can either be ecological or social, or both. The evaluation of the significance of an impact relies heavily on the values of the person making the judgment. For this reason, impacts of especially a social nature need to reflect the values of the affected society.

Cumulative Impacts
Cumulative Impacts affect the significance ranking of an impact because it considers the impact in terms of both on-site and off-site sources. For example, the noise generated by an activity (on-site) may result in a value which is within the World Bank Noise Standards for residential areas. Activities in the surrounding area may also create noise, resulting in levels also within the World Bank Standards. If both on-site and off-site activities take place simultaneously, the total noise level at the specified receptor may exceed the World Bank Standards. For this reason it is important to consider impacts in terms of their cumulative nature.

Seasonality
Although seasonality is not considered in the ranking of the significance, if may influence the evaluation during various times of year. As seasonality will only influence certain impacts, it will only be considered for these, with management measures being imposed accordingly (i.e. dust suppression measures being implemented during the dry season).

Prioritising
The evaluation of the impacts, as described above is used to prioritise which impacts require mitigation measures.

Negative impacts that are ranked as being of "**VERY HIGH**" and "**HIGH**" significance will be investigated further to determine how the impact can be minimised or what alternative activities or mitigation measures can be implemented. These impacts may also assist decision makers i.e. lots of **HIGH** negative impacts may bring about a negative decision.

For impacts identified as having a negative impact of "**MODERATE**" significance, it is standard practice to investigate alternate activities and/or mitigation measures. The most effective and practical mitigations measures will then be proposed.

For impacts ranked as "**LOW**" significance, no investigations or alternatives will be considered. Possible management measures will be investigated to ensure that the impacts remain of low significance.

Table 3-2: Ranking of Evaluation Criteria

EFFECT	**Temporal scale**			**Score**
	Short term	Less than 5 years		1
	Medium term	Between 5 and 20 years		2
	Long term	Between 20 and 40 years (a generation) and from a human perspective almost permanent.		3
	Permanent	Over 40 years and resulting in a permanent and lasting change that will always be there		4
	Spatial Scale			
	Localised	At localised scale and a few hectares in extent		1
	Study area	The proposed site and its immediate environs		2
	Regional	District and Provincial level		3
	National	Country		3
	International	Internationally		4
	*	**Severity**	**Benefit**	
	Slight / Slight Beneficial	Slight impacts on the affected system(s) or party(ies).	Slightly beneficial to the affected system(s) or party(ies).	1
	Moderate / Moderate Beneficial	Moderate impacts on the affected system(s) or party (ies).	An impact of real benefit to the affected system(s) or party(ies).	2
	Severe / Beneficial	Severe impacts on the affected system(s) or party(ies).	A substantial benefit to the affected system(s) or party(ies).	4
	Very Severe / Very Beneficial	Very severe change to the affected system(s) or party (ies).	A very substantial benefit to the affected system(s) or party(ies).	8
LIKELIHOOD	**Likelihood**			
	Unlikely	The likelihood of these impacts occurring is slight		1
	May Occur	The likelihood of these impacts occurring is possible		2
	Probable	The likelihood of these impacts occurring is probable		3
	Definite	The likelihood is that this impact will definitely occur		4

** In certain cases it may not be possible to determine the severity of an impact thus it may be determined: Don't know/Can't know*

Table 3-3: Matrix used to determine the overall significance of the impact based on the likelihood and effect of the impact.

		Effect													
		3	4	5	6	7	8	9	10	11	12	13	14	15	16
Likelihood	1	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	2	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	3	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	4	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Table 3-4: Description of Environmental Significance Ratings and associated range of scores

Significance	Description	Score
Low	Ac acceptable impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in either positive or negative medium to short term effects on the social and/or natural environment.	4-7
Moderate	An important impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in either a positive or negative medium to long-term effect on the social and/or natural environment.	8-11
High	A serious impact, if not mitigated, may prevent the implementation of the project (if it is a negative impact). These impacts would be considered by society as constituting a major and usually a long-term change to the (natural &/or social) environment and result in severe effects or beneficial effects.	12-15
Very High	A very serious impact which, if negative, may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects, or very beneficial effects.	16-20

APPENDICES

APPENDIX A:	**INDIVIDUAL SPECIALIST REPORTS**
APPENDIX A-1:	ECOLOGICAL SPECIALIST REPORT
APPENDIX A-2:	AVIFAUNA SPECIALIST REPORT
APPENDIX A-3:	VISUAL SPECIALIST REPORT
APPENDIX A-4:	NOISE SPECIALIST REPORT
APPENDIX A-5:	PALAEONTOLOGICAL SPECIALIST REPORT
APPENDIX B:	**THE SPECIALIST STUDY PROCESS**
APPENDIX B-1:	SHORT CURRICULUM VITAE OF EACH OF THE SPECIALISTS INVOLVED IN THE PROPOSED COEGA WIND ENERGY PROJECT EIA
APPENDIX B-2	APPENDIX B-2: SHORT *CURRICULUM VITAE* OF THE PERSONS WHO COMPILED AND REVIEWED THIS SPECIALIST VOLUME
APPENDIX C:	**NOISE SPECIALIST CERTIFICATION**
APPENDIX C-1:	AIA CERTIFICATE
APPENDIX C-2:	CALIBRATION CERTIFICATE

APPENDIX A-1: ECOLOGICAL REPORT

ECOLOGICAL ASSESSMENT: PROPOSED COEGA WINDFARM, NELSON MANDELA BAY MUNICIPALITY, EASTERN CAPE PROVINCE

SPECIALIST REPORTS
VOLUME 2: ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Prepared for:	Prepared by:
InnoWind (Pty) Limited	Coastal & Environmental Services
P.O. Box 1116 Port Elizabeth, 6000	P.O. Box 934 Grahamstown, 6140
South Africa	South Africa

FEBRUARY 2011

This Report should be sited as follows: L. de Wet. Coastal & Environmental Services, February 2011: *Ecological report: Proposed Coega/PPC Wind energy facility*, CES, Grahamstown.

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EXECUTIVE SUMMARY

InnoWind (Pty) Limited - a Franco-South African Independent Power Producer that develops, finances, builds, operates and maintains commercial wind powered electricity generation facilities, plans to develop a wind energy facility (often referred to as a „wind farm‟) on a portion of Zone 14 of the Coega Industrial Development Zone (IDZ), two property portions adjacent to Zone 14, and on Pretoria Portland Cement (PPC) property immediately north of Zone 14. The IDZ is situated in the Nelson Mandela Bay Metropolitan Municipality (NMBMM) in the Eastern Cape Province of South Africa, approximately 15km north-east of Port Elizabeth. The PPC portion of the study area is currently mined for limestone ore for the production of cement.

The Eastern Cape exists at the confluence of several climatic regimes and thus has a complex climate. Temperature, rainfall and wind patterns vary widely. Port Elizabeth has a bimodal rainfall pattern with peaks in spring and autumn. The Coega area specifically is subject to strong gradient winds that occur mainly during the day. The site of the proposed wind energy facility was visited in order to accurately describe what is there, especially in terms of the state of the vegetation and identifying species of special concern, both animals and plants. Two different vegetation types were found on site, these included Bontveld and Sundays Thicket.

112 plant species were identified on site but it is predicted that with an additional sampling session in spring or autumn, additional species would be identified. Plant Species of Special Concern included *Sideroxylon inerme*, *Aloe Africana, Boophone disticha* and various Mesembranthemaceae species. Alien species identified included *Opuntia fiicus-indica* and *Acacia* species that, though were not taking over the site, are likely to with the introduction of disturbance. Both species require removal by law.

Bontveld is characterized by the presence of a mixture of fynbos, grassland, succulent karoo as well as thicket element bushclumps. Contains many localized endemics often in the form of small succulents and geophytes. According to Mucina and Rutherford (2006), Bontveld is described as “least threatened” and by STEP “currently not vulnerable”. Bontveld is included in the Coega Open Space Management Plan (OSMP) but is not well-represented overall in conservation areas. Sundays Thicket is an extremely dense, impenetrable thicket in the coastal areas of the Eastern Cape. Also not well conserved in formal conservation areas but included in the Coega OSMP. Sundays Valley Thicket is also described as “least threatened” by Mucina and Rutherford (2006) and “currently not vulnerable” by STEP.

Lack of pristine terrestrial habitat in the Coega region, particularly due to loss of natural vegetation caused by human activity, has impacted on terrestrial fauna. Large mammals are absent from the area, and the remaining mammals are small and medium sized. Two terrestrial mammals – the Vulnerable Black-footed Cat (*Felis nigripes*) and the Endangered White-tailed Mouse (*Mystromys albicaudatus*) - are of conservation concern in the region. More than half of the Eastern Cape‟s endemic reptile species occur in the Algoa Bay area, and the majority of these are found in Mesic Succulent Thicket and riverine habitats. The list of reptiles of special concern includes five endemic species, eight CITES-listed species and one rare species. Knowledge of amphibian species diversity in the Coega region is limited, but it is estimated that as many as 17 species may occur, none of which are endemic or of conservation concern. Terrestrial invertebrates of conservation concern include two rare butterflies of the Lycaenidae family, both of which have distributions that include the Coega area.

Fifteen bat species are found within the Port Elizabeth areas, two of which are listed by the IUCN as Near Threatened. The lack of studies on the effects of wind farms on bats in the South African context make monitoring of bat impacts imperative, especially as studies that have been conducted in America and elsewhere have determined that bat fatalities are one of the most significant impacts of wind energy facilities.

Sensitivity assessment showed that areas of Bontveld in very good condition have a high sensitivity. Less sensitive areas include areas degraded due to grazing as well as road construction which are of a medium sensitivity. Only areas containing large numbers of alien invasive species and degraded vegetation are of a low sensitivity.

A summary of the impacts of the proposed development on the site are given in Table 1 below. Most impacts in the construction phase with mitigation are low, with only the loss of plant species of special concern scoring a moderate negative overall significance. Impacts are higher for the operation phase of the development, with most scoring a moderate negative overall significance. Three of these moderate impacts relate to the effect of the wind turbines on bats and it is recommended that the impact on bats is carefully monitored during the operation phase of the development.

Alien species should be strictly controlled throughout the construction and operation phases of the proposed development, and any necessary destruction resulting from the construction phase but not needed for the operation phase should be carefully restored.

Table 1: Summary of potential impacts from the proposed Coega wind energy facility.

Impacts	Without mitigation			With mitigation		
	Construction phase	Operation phase	No-Go	Construction phase	Operation phase	No-Go
Flora and Vegetation						
1: Loss of Bontveld	MOD -	N/A	MOD +	LOW -	N/A	N/A
2: Loss of Sundays Thicket	MOD -	N/A	MOD +	LOW -	N/A	N/A
4: Loss of Plant Species of Special Concern	MOD -	N/A	MOD +	MOD -	N/A	N/A
5: Introduction of alien plant species	MOD -	HIGH -	HIGH -	MOD +	MOD +	N/A
Fauna						
6: Loss of faunal biodiversity	MOD -	N/A	HIGH +	LOW -	N/A	N/A
7: Loss of species of special concern	LOW -	N/A	HIGH +	N/A	N/A	N/A
8: Disturbance displacement of bats	LOW -	MOD -	LOW +	LOW -	MOD -	N/A
9: Loss of bat habitat	LOW -	N/A	MOD +	LOW -	N/A	N/A
10: Bat mortalities	N/A	MOD -	N/A	N/A	MOD -	N/A
Cumulative Impacts						
11: Fragmentation of vegetation types	LOW -	N/A	MOD +	LOW -	N/A	N/A

SPECIALIST PRACTITIONER DECLARATION OF INDEPENDENCE

ECOLOGICAL ASSESSMENT: PROPOSED COEGA WIND ENERGY FACILITY, NELSON MANDELA BAY MUNICIPALITY, EASTERN CAPE

Visual specialist

I Leigh Anne De Wet declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Coega Wind Energy Project, application or appeal in respect of which I 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 my performing such work.

SIGNATURE: 

1 INTRODUCTION

1.1 Background

InnoWind (Pty) Limited - Franco-South African Independent Power Producer that develops, finances, builds, operates and maintains commercial wind powered electricity generation facilities, plans to develop a wind energy facility (often referred to as a „wind farm") on a portion of Zone 14 of the Coega Industrial Development Zone (IDZ), two property portions adjacent to Zone 14, and on Pretoria Portland Cement (PPC) property immediately north of Zone 14. The IDZ is situated in the Nelson Mandela Bay Metropolitan Municipality (NMBMM) in the Eastern Cape Province of South Africa, approximately 15km north-east of Port Elizabeth. The PPC portion of the study area is currently mined for limestone ore for the production of cement.

The wind farm will be spread over three adjacent property portions in the Coega/Grassridge area. The three land portions are planned to host up to seventy five (75) turbines, each with a nominal power output ranging between 2-3 Mega Watts (MW). The total potential output of the wind farm would be approximately 225 MW, which will serve to further support the regional and national power balance. Provisionally, the 75 turbines have been allocated to the respective property portions as follows:

1. Zone 14 IDZ (Farms Bontrug 301 and Brak River SW 224): 15 turbines
2. PPC (Farms Grassridge 190, 227 and 228, Oliphants Kop 201): 55 turbines
3. Swarte Koppen 302: 2 turbines
4. Welbedachtsfontein 300: 3 turbines

The final number of turbines and there placement will be further informed by EIA phase specialist study and assessment. The ultimate size of the wind turbines will depend on further technical assessments but will typically consist of rotor turbines (3 x50m length blades) with rotor diameters of around 100 meters mounted atop a 80 - 100 meter high steel (or hybrid steel/concrete) tower. Other infrastructure components associated with the proposed wind energy facility are *inter alia*:

- Concrete foundations to support the wind turbine towers;
- Approximately 4 meter wide internal access roads to each turbine
- Underground electricity reticulation cables connecting the wind turbines to one another
- Overhead power lines linking the site to the Grassridge or/and Motherwell Substation (to be confirmed)
- The necessary upgrades to the Eskom substation that may be required, additional line bays and transformers, busbars etc.

The impacts of the proposed wind energy facility on the flora and fauna on the site are issues of concern. Therefore, as part of the detailed Environmental Impact Assessment (EIA) Phase for the proposed facility, it was necessary to conduct a specialist ecological study. This report therefore aims to address potential ecological impacts of both the construction and operation phases of the proposed wind energy facility. The specific terms of reference for this specialist study are detailed below.

1.2 Terms of Reference

The assessment will follow on from the initial study, which included a site visit conducted during the scoping phase, and will address any key issues raised by interested and affected parties. A considerable body of information on the flora and fauna of the Coega area and its environs has been assembled in the reports on previous studies of the area in general. Accordingly the study will comprise a desktop study of all available relevant literature.

However, a detailed survey of the site will be undertaken to determine the possibility of there being listed threatened or protected ecosystems and species on the proposed project site. If any of these are found, the Environmental Management Plan will include recommended measures to remove or otherwise protect plant species found on the site that are afforded protection under the National Environmental Management: Biodiversity Act during construction. This specialist study will therefore include but will not be limited to –

1. A detailed description of the ecological (fauna and flora) environment within and immediately surrounding the footprint of the proposed development and will consider terrestrial fauna and flora. Fauna include mammals, reptiles, amphibians, and insects but not avifauna as these will be the subject of a separate specialist study. This aspect of the report will specifically include the identification of -
   - Areas of high biodiversity;
   - The presence of species of special concern, including sensitive, endemic and protected species;
   - Habitat associations and conservation status of the identified fauna and flora;
   - The presence of areas sensitive to invasion by alien species; and
   - The presence of conservation areas and sensitive habitats where disturbance should be avoided or minimised.
2. Review relevant legislation, policies, guidelines and standards.
3. An assessment of the potential direct and indirect impacts resulting from the proposed development (including the wind turbines, associated infrastructure e.g. access road), both on the footprint and the immediate surrounding area during construction and operation;
4. A detailed description of appropriate mitigation measures that can be adopted to reduce negative impacts for each phase of the project, where required; and
5. Checklists of faunal groups identified in the region to date, highlighting sensitive species and their possible areas of distribution.

1.3 The study team

Ms Leigh-Ann de Wet (Botanical and Ecological Specialist)
Leigh-Ann holds a BSc (Botany and Entomology) as well as a BSc (Hons) and MSc in Botany from Rhodes University. She conducts vegetation sensitivity assessments including vegetation and sensitivity mapping, to guide developments and thereby minimising their impacts sensitive vegetation. Her experience ranges from local Eastern Cape Projects to those in different provinces including but not limited to Kwa-Zulu Natal, Western Cape and Mpumalanga. She has experience in many different vegetation types as well as different levels of vegetation degradation. Leigh-Ann has also worked on numerous international projects for the mining sector, the most recent of which was a botanical study for First Quantum Minerals in Zambia.

1.4 Relevant legislation

1.4.1 The National Environment Management: Biodiversity Act (10 of 2004)

This Act provides for the management and conservation of South Africa‟s biodiversity within the framework of the National Environmental Management Act 107 of 1998. In terms of the Biodiversity Act, the developer has a responsibility for:

1. 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).
2. Application of appropriate environmental management tools in order to ensure integrated environmental management of activities thereby ensuring that all developments within the area are in line with ecological sustainable development and protection of biodiversity.
3. Limit further loss of biodiversity and conserve endangered ecosystems.

The objectives of this Act are –

- To provide, within the framework of the National Environmental Management Act, for –
  - The management and conservation of biological diversity within the Republic;

- The use of indigenous biological resources in a sustainable manner.

The Act"s permit system is further regulated in the Act"s Threatened or Protected Species Regulations, which were promulgated in February 2007.

Relevance of the act to the proposed Wind Energy Project:

- The proposed development must conserve endangered ecosystems and protect and promote biodiversity;
- Must assess the impacts of the proposed development on endangered ecosystems;
- No protected species may be removed or damaged without a permit;
- The proposed site must be cleared of alien vegetation using appropriate means

1.4.2 The National Forests Act (84 of 1998)

The objective of this Act is to monitor and manage the sustainable use of forests. In terms of Section 12 (1) (d) of this Act and GN No. 1012 (promulgated under the National Forests Act), no person may, except under licence:

- Cut, disturb, damage or destroy a protected tree; or
- Possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree or any forest product derived from a protected tree.
- of any protected tree or any forest product derived from a protected tree.

Relevance of the act to the proposed Wind Energy Project:

- If any protected trees in terms of this Act occur on site, the developer will require a licence from the DWAF to perform any of the above-listed activities.

1.5 Study area

The proposed Coega wind energy project is to be constructed on a portion of Zone 14 of the Coega Industrial Development Zone (IDZ), two property portions adjacent to Zone 14, and on Pretoria Portland Cement (PPC) property immediately north of Zone 14. the study area is situated in the Nelson Mandela Bay Metropolitan Municipality (NMBMM) in the Eastern Cape Province of South Africa, approximately 15km north-east of the city of Port Elizabeth (Figure 1-1). The total area of all study area portions is approximately 9584 hectares. The location of the relevant study area property portions and preliminary turbine layout is depicted in Figure 1-1. During the Scoping process the various property portions comprising the study area were designated as follows:

4. Zone 14 IDZ (Farms Bontrug 301 and Brak River SW 224): 2180 ha in extent
5. PPC (Farms Grassridge 190, 227 and 228, Oliphants Kop 201): 6678 ha in extent
6. Swarte Koppen 302: 460 ha in extent
7. Welbedachtsfontein 300: 266 ha in extent

It must be noted that the cumulative development footprint for the project will only be a minor portion of this total extent.

1.5.1 Zone 14

Zone 14 is situated in the north-western portion of the IDZ. The northern boundary of Zone 14 is defined by the Eskom Grassridge Substation and associated 400kV powerline servitude. The zone is currently undeveloped. Due to the CDC requirement that turbines only be placed on the zone boundaries so as not to sterilise the land portion for any future industrial development within it, the preliminary layout is restricted to the periphery thereof.

1.5.2 Swarte Koppen 302

This property portion is currently privately owned land immediately adjacent to Zone 14 that is in the process of being acquired by the CDC for incorporation into the IDZ, The site is currently undeveloped.

1.5.3 Welbedachtsfontein 300

This portion of the study area is privately owned land immediately adjacent to Zone 14 that is currently the location of a brick-making facility and quarry area.

1.5.4 PPC

The PPC study area property portions are currently subject to extensive mining operations. The associated plant and crushing works is situated on the western portion of these properties, with all prepared limestone transported via the existing haul road to the rail siding on the eastern portion of these properties for shipment to their factory in Port Elizabeth. It is anticipated that within the next 5 years PPC will be relocating its plant and crusher works to the eastern portion once mining activity increases in this locality, with the PPC West portion no longer subject to mining operations once this occurs.

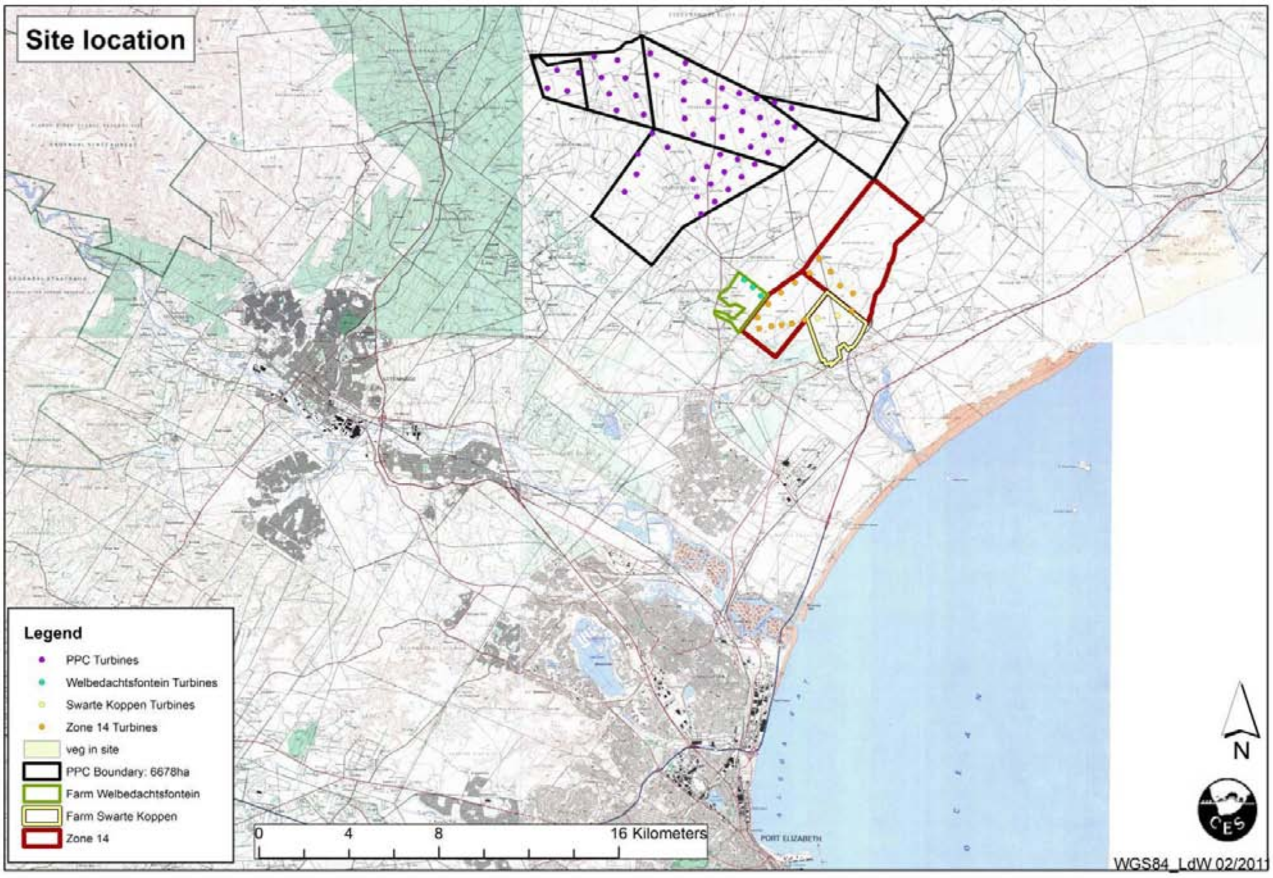

Figure 1-1: Locality map of the proposed wind energy facility

1.6 Approach to Ecological Study

1.6.1 Study area field assessment

During November 2010, the proposed Coega/PPC Wind Farm site was visited and the vegetation sampled in relevés (sample plots) within all vegetation types that are present on site (Bontveld and, Mesic Succulent Thicket). All species recorded are listed in Appendix A-1. An analysis of the flora of the study site and the greater region has been carried out from this species list in terms of the dominant families and the different life forms of the species. Unusual species were collected and pressed to be identified at a later stage in Selmar Schonland Herbarium, Grahamstown.

Using satellite imagery the vegetation was mapped showing the extent of all plant communities, and sensitive sites, which are important in order to reduce the area of impact and disturbance of the wind energy facility on sensitive plant communities, habitats and plant and animal species.

A brief vegetation survey of the proposed site of the manganese smelter was undertaken to provide some insight into the vegetation type(s) present on the site, some indication of how disturbed the site is, as well as an indication of the presence of Species of Special Concern (SSC). Existing literature sources on the vegetation of the region were also examined.

1.6.2 Impact rating methodology

To ensure a balanced and fair means of assessing the significance of potential impacts a standardised rating scale was adopted in the EIA phase. This rating scale will also be used to allow the direct comparison of specialist studies.

This rating scale adopts four key factors that are generally recommended as best practice around the world that include:

1. **Temporal Scale**: This scale defines the duration of any given impact over time. This may extend from the short- term (less than 5 years or the construction phase) to permanent. Generally the longer the impact occurs the more significance it is.
2. **Spatial Scale:** This scale defines the spatial extent of any given impact. This may extend from the local area to an impact that crosses international boundaries. The wider the impact extends the more significant it is considered.
3. **Severity/Benefits Scale:** This scale defines how severe negative impacts would be, or how beneficial positive impacts would be. This negative/positive scale is critical in determining the overall significance of any impacts.
   The Severity/Benefits Scale is used to assess the potential significance of impacts prior to and after mitigation in order to determine the overall effectiveness of any mitigations measures.
4. **Likelihood Scale:** This scale defines the risk or chance of any given impact occurring. While many impacts generally do occur, there is considerable uncertainty in terms of others. The scale varies from unlikely to definite, with the overall impact significance increasing as the likelihood increases.

These four scales are ranked and assigned a score, as presented in Table 1-1 to determine the overall impact significance. The total score is combined and considered against Table 1-2 to determine the overall impact significance.

1.7 Assumptions and Limitations

The following limitations are inherent in the rating methodology:

1.7.1 Value Judgements

This scale attempts to provide a balance and rigor to assessing the significance of impacts. However, the evaluation of the significance of an impact relies heavily on the values of the person making the judgment. For this reason, impacts of especially a social nature need to reflect the values of the affected society.

1.7.2 Cumulative Impacts

Cumulative impacts affect the significance ranking of an impact because it considers the impact in terms of both on-site and off-site sources. This is particularly problematic in terms of impacts beyond the scope of the proposed development and the EIA. For this reason it is important to consider impacts in terms of their cumulative nature.

1.7.3 Seasonality

Certain impacts will vary in significance based on seasonal change thus it is difficult to provide a static assessment. Seasonality will need to be implicit in the temporal scale and, with management measures being imposed accordingly (i.e. dust suppression measures being implemented during the dry season).

Table 1-1: Ranking of Evaluation Criteria

EFFECT	**Temporal scale**			**Score**
	Short term	Less than 5 years		**1**
	Medium term	Between 5 and 20 years		**2**
	Long term	Between 20 and 40 years (a generation) and from a human perspective almost permanent.		**3**
	Permanent	Over 40 years and resulting in a permanent and lasting change that will always be there		**4**
	Spatial Scale			
	Localised	At localised scale and a few hectares in extent		**1**
	Study area	The proposed site and its immediate environs		**2**
	Regional	District and Provincial level		**3**
	National	Country		**3**
	International	Internationally		**4**
	*	**Severity**	**Benefit**	
	Slight / Slight Beneficial	Slight impacts on the affected system(s) or party(ies).	Slightly beneficial to the affected system(s) or party(ies).	**1**
	Moderate / Moderate Beneficial	Moderate impacts on the affected system(s) or party (ies).	An impact of real benefit to the affected system(s) or party(ies).	**2**
	Severe / Beneficial	Severe impacts on the affected system(s) or party(ies).	A substantial benefit to the affected system(s) or party(ies).	**4**
	Very Severe / Very Beneficial	Very severe change to the affected system(s) or party (ies).	A very substantial benefit to the affected system(s) or party(ies).	**8**
LIKELIHOOD	**Likelihood**			
	Unlikely	The likelihood of these impacts occurring is slight		**1**
	May Occur	The likelihood of these impacts occurring is possible		**2**
	Probable	The likelihood of these impacts occurring is probable		**3**
	Definite	The likelihood is that this impact will definitely occur		**4**

Table 1-2: Ranking matrix to provide an Environmental Significance

Environmental Significance		Positive	Negative
LOW	An acceptable impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent development. These impacts will result in either positive or negative medium to short term effects on the social and/or natural environment	4-7	4-7
MODERATE	An important impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which, in conjunction with other impacts may prevent its implementation. These impacts will usually result in either positive or negative medium to long term effect on the social and/or natural environment.	8-11	8-11
HIGH	A serious impact which, if not mitigated, may prevent the implementation of the project. These impacts would be considered by society as constituting a major and usually long term change to the natural and/or social environment and result in severe negative or beneficial effects.	12-15	12-15
VERY HIGH	A very serious impact which may be sufficient by itself to prevent the implementation of the project. The impact may result in permanent change. Very often these impacts are unmitigable and usually result in very severe effects or very beneficial effects.	16-20	16-20

Example of an Impact Significance Statement - Impact 1: Impact of noise on human health

Cause and Comment
The noise associated with Heavy Goods Vehicles (HGVs) has the potential to impact on human health. A recommendation for the movement of large vehicles at night may impact on the sleep patterns of local communities.

Mitigation and Management
There are standard mitigation measures to ensure that vehicle noise is kept within acceptable limits. Vehicles should be kept in good repair; they should use standard exhaust and silencing equipment. Drivers should stick to designated speed limits. Roads should be kept in good condition.

Significance Statement

RATING		Temporal Scale		Spatial Scale		Severity of Impact		Risk or Likelihood		Total
	Without Mitigation	Short term	1	Localised	1	Moderate	2	Definite	4	8
	With Mitigation	Short term	1	Localised	1	Slight	1	Unlikely	1	5
Overall Significance without mitigation										**MODERATE**
Overall Significance with mitigation										**LOW**

1.8 Sensitivity assessment methodology

This section of the report explains the approach to determining the ecological sensitivity of the study area on a broad scale. The approach identifies zones of very high, high, moderate and low sensitivity according to a system developed by CES and used in numerous proposed development studies (CES 2002). It must be noted that the sensitivity zonings in this study are based solely on ecological (primarily vegetation) characteristics and social and economic factors have not been taken into consideration. The sensitivity analysis described here is based on 10 criteria which are considered to be of importance in determining ecosystem and landscape sensitivity, and have been used in past studies (e.g. CES 2002 – N2 Toll Road Study). The method predominantly involves identifying sensitive vegetation or habitat types, topography and land transformation (Table 1-3).

The study area was zoned into areas which were homogenous in terms of vegetation types. Alternatively topography and drainage areas were used as boundaries for homogenous zones. Once the study area had been zoned, the sensitivity criteria described in Table 1-3 were applied to each zone and scored as HIGH (3), MODERATE (2) or LOW (1). A total score for each zone was then calculated and the overall ecological sensitivity was determined using the following percentage scale:

- 0 - 33.3% : LOW ecological sensitivity
- 33.4 – 64.9% : MODERATE ecological sensitivity
- 65 – 85% : HIGH ecological sensitivity
- 85.1 – 100%: VERY HIGH ecological sensitivity.

Although very simple, this method of analysis provides a good, yet conservative and precautionary assessment of the ecological sensitivity.

Table 1-3: Criteria used for the analysis of the sensitivity of the area

CRITERIA		LOW SENSITIVITY - 1	MODERATE SENSITIVITY - 5	HIGH SENSITIVITY - 10
1	**Topography**	Level, or even	Undulating; fairly steep slopes	Complex and uneven with steep slopes
2	**Vegetation -** Extent or habitat type in the region	Extensive	Restricted to a particular region/zone	Restricted to a specific locality / site
3	**Conservation status** of fauna/ flora or habitats	Well conserved independent of conservation value	Not well conserved, moderate conservation value	Not conserved - has a high conservation value
4	**Species of special concern** - Presence and number	None, although occasional regional endemics	No endangered or vulnerable species, some indeterminate or rare endemics	One or more endangered and vulnerable species, or more than 2 endemics or rare species
5	**Habitat fragmentation** leading to loss of viable populations	Extensive areas of preferred habitat present elsewhere in region not susceptible to fragmentation	Reasonably extensive areas of preferred habitat elsewhere and habitat susceptible to fragmentation	Limited areas of this habitat, susceptible to fragmentation
6	**Biodiversity** contribution	Low diversity, or species richness	Moderate diversity, and moderately high species richness	High species diversity, complex plant and animal

CRITERIA		LOW SENSITIVITY - 1	MODERATE SENSITIVITY - 5	HIGH SENSITIVITY - 10
				communities
7	**Visibility** of the site or landscape from other vantage points	Site is hidden or barely visible from any vantage points with the exception in some cases from the sea.	Site is visible from some or a few vantage points but is not obtrusive or very conspicuous.	Site is visible from many or all angles or vantage points.
8	**Erosion potential** or instability of the region	Very stable and an area not subjected to erosion.	Some possibility of erosion or change due to episodic events.	Large possibility of erosion, change to the site or destruction due to climatic or other factors.
9	**Rehabilitation** potential of the area or region	Site is easily rehabilitated.	There is some degree of difficulty in rehabilitation of the site.	Site is difficult to rehabilitate due to the terrain, type of habitat or species required to reintroduce.
10	**Disturbance** due to human habitation or other influences (Alien invasives)	Site is very disturbed or degraded.	There is some degree of disturbance of the site.	The site is hardly or very slightly impacted upon by human disturbance.

A Global Information System (GIS) map was drawn up and with the aid of a satellite image from which the sensitive regions and vegetation types could be plotted. The description of the relevés, helped to map the vegetation and these descriptions as well as sensitivity ratings were illustrated in the form of the resultant maps.

1.9 Structure of the Report

This report describes the ecology of the proposed site as well as assesses the potential impacts on the ecology of the proposed site. It consists of a further 4 sections.

The first section outlines the assessment criteria used to identify impacts and sensitivity, as well as describing the proposed site.

Section 2 describes the physical environment and Section 3 reviews the biological environment including flora, vegetation and fauna as well as assessing the sensitivity of the site.

Section 4 identifies and assesses the ecological impacts of both the construction and operation of the development and finally, Section 5 makes conclusions and recommendations based on the impacts described in Section 4.

2 DESCRIPTION OF THE PHYSICAL ENVIRONMENT

2.1 Climate

Due to its location at the confluence of several climatic regimes, the most important of which are temperate and subtropical, the Eastern Cape has a complex climate. There are wide variations in temperature, rainfall and wind patterns, largely as a result of movements of air masses, altitude, mountain orientation and distance from the Indian Ocean (Stone 1988). Exceptionally high temperatures may be experienced during berg wind conditions, which occur frequently during winter, with maximums of well over 30°C. Extreme temperatures also occur during summer, with little accompanying wind. Areas close to the coast experience cooling due to onshore sea breezes (Burger and Scorgie 1998).

Algoa Bay is situated near the junction of temperate (winter rainfall) and subtropical (summer rainfall) climate regimes and experiences a warm temperate climate. The Port Elizabeth area has a bimodal rainfall pattern, with peaks in spring and autumn. Rainfall ranges from 400- 800mm per year in the region, but the Coega area falls at the low end of the range, averaging at 400mm per year (Coetzee *et al.* 1997). The Coega area is subject to strong gradient winds with a strong prevalence from the west and west-south-west (41% combined frequency) all year round, and east (15%) from October through to March. These winds occur mainly during the day and generate a significant amount of fugitive dust (CSIR 1997). In addition to seasonal shifts in the wind field, diurnal variations in the wind regime occur. These diurnal variations are due to the influence of land-sea breeze circulation on the airflow of the region. Land-sea circulation arises due to the differential heating and cooling of land and water surfaces. During the day, the land is heated more rapidly than the sea, which results in a pressure gradient that generates a sea breeze (onshore wind). During the night, the land cools more quickly than the sea, which results in an offshore wind (Burger and Scorgie 1998).

2.2 Geology and landform

The geology of the Eastern Cape coastal belt is complex, with a number of strata and rock formations of different ages being evident (CES 1997). Most of the Eastern Cape rock formations are sedimentary, with rock types such as sandstone, mudstone, limestone, conglomerate and tillite being relatively common (CEN 1997). The metropole of Port Elizabeth is situated on Peninsula Sandstone Formation of the Table Mountain Group (a member of the Cape Super Group). This formation consists of course-grained super-mature sandstone and is relatively resistant to erosion. It forms the bedrock of Algoa Bay and emerges as outcrops in the bay as the islands of St Croix, Jahleel, Bird and Brenton, and on land as Coega Kop.

The geology of the Coega River is mainly of marine or estuarine origin. The pre-Cretaceous basement comprises Table Mountain Group quartzites and shales of the Bokkeveld Group, forming a trough into which the Cretaceous deposit of the Uitenhage Group was deposited. Tertiary to recent deposits overlay this group. The Coega Fault extends from west of Groendal Dam eastwards towards the coast just to the west of the Coega River mouth, dipping at between 30° and 60° for about 120km. It is a normal tensional fault, with a vertical southward throw of 500m to 100m; an offset that places basement sandstones to the north in lateral contact with Cretaceous shales, siltstones and sandstones to the south. The fault is seismically active (SRK 1999).

2.3 Soils

In the south-eastern coastal region, sandy soils with variable depth and deep red sandy clay loams overlying limestone are common. The southern coastal belt is characterised by coastal sands, and sandy soils, lime containing lithosols and weakly developed soils on rock. Coega area and the IDZ are characterized by relatively deep, red, lime-rich sandy clay loams (CEN 1997). Shallower soils with high limestone content define the Bontveld (Mucina and Rutherford 2006).

2.4 Hydrology

2.4.1 Catchment Drainage

The Coega catchment (tertiary catchment M30) is approximately 45km long, 15km wide and has a total area of about 563km^2. Current land use in the catchment area is mainly agricultural with a fair amount of natural subtropical thicket vegetation. The total annual runoff will, however, not increase appreciably because the area lies within a region of high evaporation (CSIR 1997). Various authors indicate that recharge of underground aquifers in areas where Table Mountain Group rocks are exposed at the surface may be 15% of mean annual precipitation.

2.4.2 Surface Water

The Coega River valley represents the only major incision into the coastal landform in the area between the Swartkops and Sundays rivers. It is a relatively small sand-bed river, and is the most significant surface water feature associated with the proposed wind energy facility. At its lower end, the river is currently used by a commercial salt works for industrial purposes. The incised river valley forms a natural route through which a transportation corridor can be constructed in the future, linking the port with the industrial hinterland. It also provides a location for a harbour basin with reduced earthworks and dredging costs. The Coega River has been canalised around the north side of the salt works and runs through the area of the Port of Ngqura into the sea. The Coega River is regarded as a sensitive system and is vulnerable to contamination (African Environmental Solutions 1996).

3 DESCRIPTION OF THE BIOLOGICAL ENVIRONMENT

3.1 Flora and Vegetation

3.1.1 Flora

The Coega IDZ and PPC properties fall within the Albany Centre of Floristic Endemism; also know as the Albany Hotspot which is shown in Figure 3-1. This is an important centre for plant taxa, and, according to van Wyk and Smith (2001), contains approximately 4000 vascular plant species with approximately 15% either endemic or near-endemic (Victor and Dold, 2003). This area was delimited as the „region bounded in the west by the upper reaches of the Sundays and Great Fish River basins, in the east by the Indian Ocean, in the south by the Gamtoos–Groot River basin and in the north by the Kei River basin" (Victor & Dold, 2003). Species endemic to the area are described by Mucina and Rutherford (2006) these are shown in Table 3-1. In addition to the endemic taxa found in the study area, there are also a number of species expected to be found in the study area, some of which are listed as protected by Victor and Dold (2003). These are given in Table 3-2. Importantly, the list given by Victor and Dold is not complete as little is known about many species. These taxa with many data deficient species include specifically the Mesembranthemaceae family, which Victor and Dold (2003) estimate would have 72 species that should, but do not, occur on the list. Thus any members of the family are included as Species of Special Concern. Victor and Dold (2003) also include a number of other taxa as important; these include members of the Amaryllidaceae (Amaryllids), Iridaceae (Irises), Orchidaceae (Orchids) and Apocynaceae (Lianas), as well as members of the genus *Aloe*.

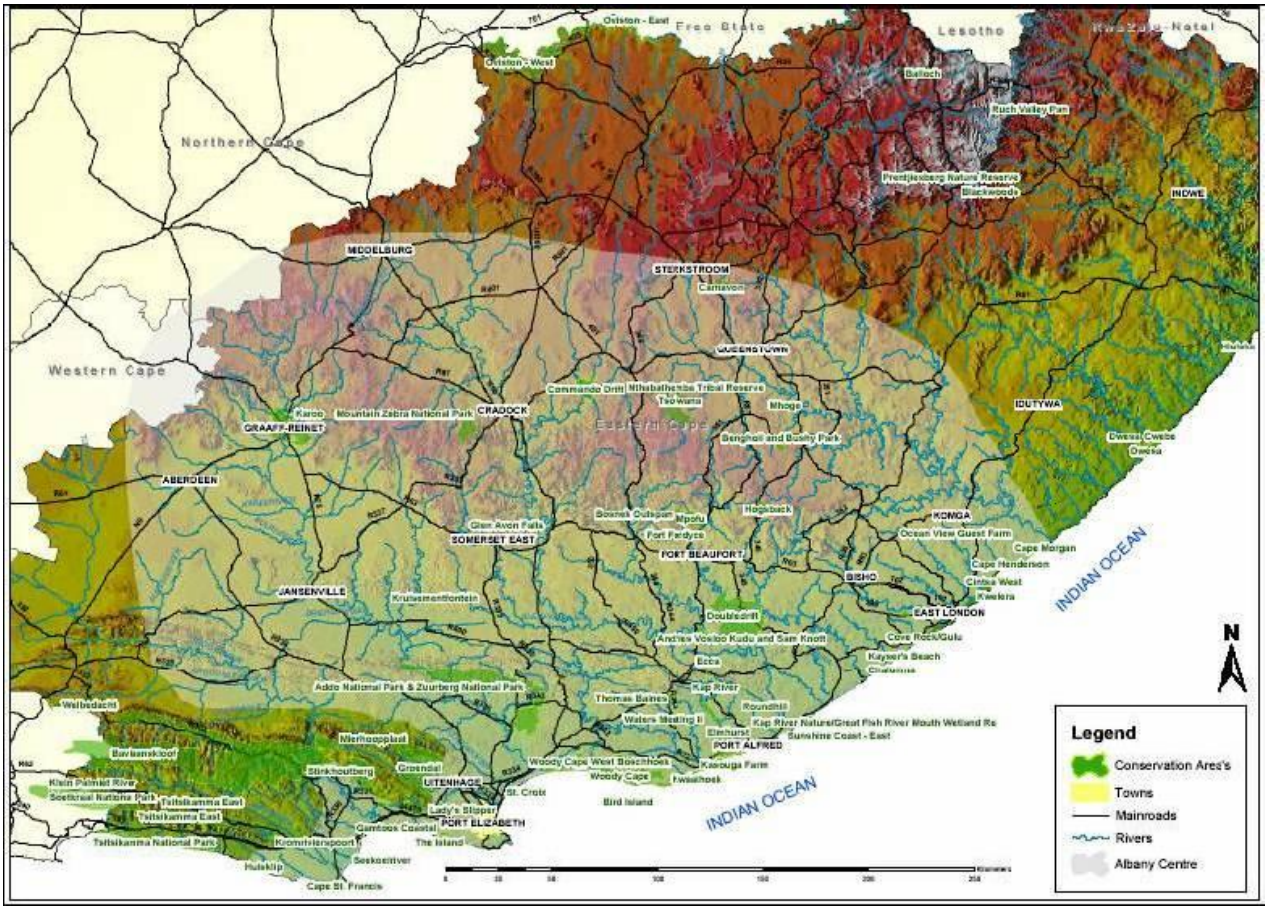

Figure 3-1: The Albany Centre of Endemism, also known as the „Albany Hotspot", has long been recognised as an important centre of plant species diversity and endemism (From van Wyk and Smith 2001).

Table 3-1: Species endemic to the vegetation types found in the study area for the proposed wind energy facility.

Vegetation Type	Species	Protection	Status
Sundays Thicket	*Encephalartos horridus*	IUCN	Endangered (EN)
	Aloe bowiea	IUCN	Endangered (EN)
	Aloe gracilis	-	-
	Bergeranthus addoensis	IUCN	Near Threatened (NT)
	Glottiphyllum grandiflorum	-	-
	Orthopterum coegana	IUCN	Critically endangered (CR)
	Ruschia aristata	-	-
	Ceropegia dubia	IUCN	Data Deficient (DD)
	Haworthia arachnoidea var. *xiphiophylla*	-	-
	Haworthia aristata	-	-
	Huernia longii subsp. *Longii*	IUCN	Rare (R)
	Brachystelma cummingii	IUCN	Endangered (EN)
	Brachystelma schoenlandianum	-	-
	Brachystelma tabularium	-	-
	Pelargonium ochroleucum	-	-
	Strelitzia juncea	IUCN	Near Threatened (NT)
	Tritonia dubia	-	-
	Arctosis hispidula	-	-
	Argyrolobium crassifolium	-	-
	Lessertia carnosa	IUCN	Rare (R)
	Lotonosis monophylla	IUCN	Vulnerable (VU)
	Senecio scaposus var. *addoensis*	IUCN	Vulnerable (VU)
	Wahlenbergia oocarpa	IUCN	Data Deficient (DD)
Coega Bontveld	*Euphorbia globulosa*	IUCN	Endangered (EN)
	Rhombophyllum rhomboideum	-	-
	Anginon rugosum	-	-
	Ledebouria sp. Nov. („*coriacea*“ S. Venter ined.)	IUCN	Endangered (EN)

Table 3-2: Species expected to be found in the proximity of the proposed wind energy facility, which are listed as protected (but are not endemic).

Vegetation Type	Species	Protection	Status
Sundays Thicket	*Aloe Africana*	Nature Conservation Ordinance Schedule 4	Protected
	Encephalartos lehmannii	IUCN	Near Threatened (NT)
	Sideroxylon inerme	Forest Act 2002	Protected
	Euphorbia ledienii	IUCN	Data Deficient (DD)
	Freesia corymbosa	IUCN	Least Concern (LC)
Coega Bontveld	*Sideroxylon inerme*	Forest Act 2002	Protected
	Aloe arborescens	Nature Conservation Ordinance Schedule 4	Protected
	Pentaschistis pallida	IUCN	Least Concern (LC)

More than 30 Eastern Cape endemic species have been found in the proposed IDZ area. The most important of these are the endangered *Orthopterum coegana* and *Aloe bowiea*, a small endangered grass aloe known from only a few sites in the region (see table 3-1). Much of the vegetation of the area is therefore of high conservation importance. However, the presence of areas of lower conservation importance, such as areas that are already impacted by agriculture, development and alien plants, means that there are areas suitable for development that do not deplete or reduce the integrity of the natural vegetation (CSIR 1997).

Plant species recorded during the site investigation are listed in Appendix A-1. One hundred and twelve species were identified on site. The floristic data (Appendix A -1 and Table 3-3) gives a clear picture of the nature of the plants in the vegetation sampled. There were high numbers of species from:

- Grass family (Poaceae – 12 species), had a strong presence primarily within the Bontveld.
- Daisy family (Asteraceae – 14 species) was well represented throughout the site form of shrubs and herbs. This family is typically prevalent within all the communities found on site.
- Staff vine family (Celastraceae – 6 species) was well represented both within the thicket clumps of the Bontveld as well as the Sunday"s Thicket.

The high prevalence of thicket species, shrubs such as *Rhus* spp. and *Asparagus* spp., and grasses such as *Eragrostis* spp are important components of this vegetation, consisting of areas of Sunday"s Thicket and the thicket clumps of the Bontveld. Of the 112 species that were recorded in the area, many of these were woody plants most of these were distributed within thickets and the bush clumps of the Bontveld. Graminoids and succulents are well-represented with in the site and herbs form the second largest group.

Plant species of special concern

Many of the SSC are small succulent plants and geophytes that are inconspicuous, especially during periods of dormancy, and sometimes present only in small numbers. Details of some of the SSC found during this survey include –

- ***Sideroxylon inerme* L.** is an occasional tree in the Mesic Succulent Thicket (MST) at Coega. It is a widespread species occurring in many vegetation types in South Africa. It is protected according to the Forestry Schedule A list.
- ***Aloe africana* Mill.** (Plate 3-1) is a leaf-succulent tree that is present throughout the MST and other desiccation tolerant areas of Coega, including the bushclumps. The species is endemic to thicket vegetation between the Baviaanskloof, Port Elizabeth, Grahamstown and Port Alfred, and it is often locally very abundant. It is not accorded any threatened status by Everard (1988) or Hilton-Taylor (1996). Johnson (1998) recorded it from Addo Elephant National Park, and several other protected areas in the Eastern Cape. As with most species of *Aloe* in the Eastern Cape, *A. africana* is a PNCO Schedule 4 protected species.
- ***Boophone disticha*.** (Plate 3-1) is a geophyte usually occurring in Bontveld, it is a PNCO Schedule 4 protected plant.
- ***Euphorbia obesa*.** (Plate 3-1) is a succulent occurring occasionally in both Bontveld and MST and is protected in terms of PNCO Schedule 4.
- The **Mesembryanthemaceae** family is also protected in terms of PNCO schedule list.

Species of Special Concern recorded during previous studies (Phillipson, 2002a; 2002b) within the same vegetation type and within the Coega IDZ, and which could be expected to be found on the site, are listed in Appendix A-2. As can be seen when comparing the list of SSC compiled by Phillipson, (2002a; 2002b), with regard to the Coega Bontveld species, there are many SSC which were not recorded during the on-site investigation. Possible reasons for these variations are that different vegetation occurs on the site, or many of the plants were currently dormant and so were not detected during the site visit.

Alien species

The on-site investigation noted the presence of a number of *Opuntia ficus-indica*, *Acacia cyclops* and *Acacia mearnsii* individuals on the site. These species are highly invasive, and pose a threat to the indigenous vegetation. However, at present they have not penetrated significantly into the natural vegetation of the site, and the population numbers are not sufficiently high to be considered as a significant impact on the biodiversity of the site. They are likely to have an impact in the future, especially considering their categories according to the Conservation of Agricultural Resources Act (CARA) (2001), *Opuntia ficus-indica* is a category 1 invader and *Acacia meansii* and *Acacia cyclops* are category 2 weeds. Additional to these invasive species, some blue bush (*Pteronia incana*) is present on the site. Though not an invader, blue bush indicates degraded vegetation

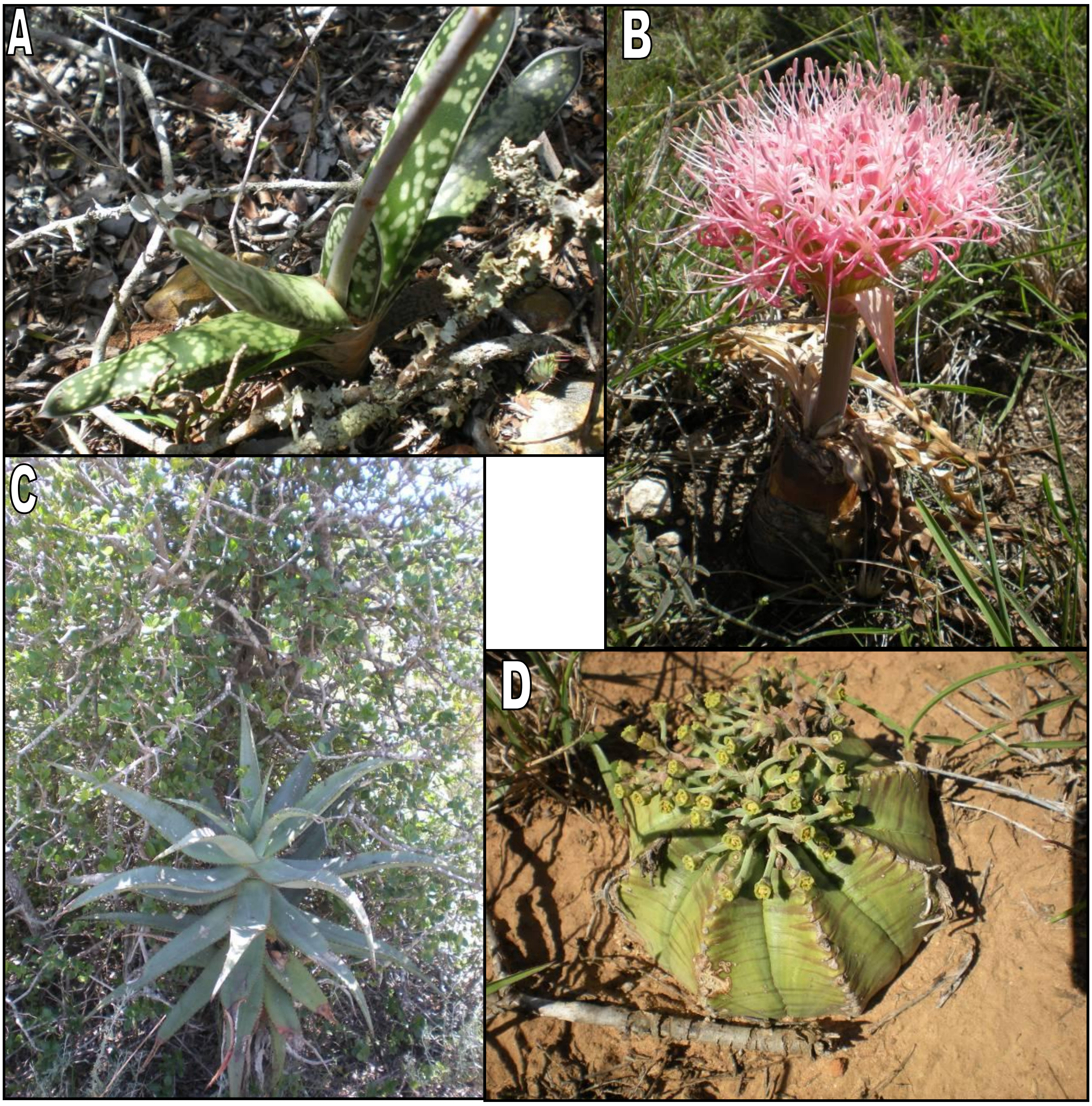

Plate 3-1: Protected species within the proposed wind energy facility site. A: Gasteria bicolor (Although not protected, occurs rarely throughout the site). B: Boophone disticha. C: Aloe Africana and D: Euphorbia obesa.

According to CARA, legislation for category 1 and 2 declared plants are as follows:

Category 1 declared plants (Section 15A of the amended act)

- may not occur on any land or inland water surface other than in biological control reserves.
- must be controlled by the land user on whose land or inland water such plants are growing.
- may not be planted or propagated.
- may not be imported or sold; and
- may not be acquired.
- can be exempted from the above regulations through written exemption from "the executive officer", provided there is a good reason for it.

Category 2 declared plants (Section 15B of the amended act):

- may not occur on any land or inland water surface other than a demarcated area or a biological control reserve. However, the "executive officer" may on application in writing demarcate an area where category 2 plants may occur, be established and be maintained. Demarcated areas include areas where a water use license for stream flow reduction activities has been issued. Otherwise, a demarcated areas will be established only if:
    - o the Category 2 plants are cultivated under controlled circumstances;
    - o the land user has been authorised to use water in terms of the National Water Act No. 36 of 1998
    - o the Category 2 plants are demonstrated to serve a commercial purpose
    - o all reasonable steps are taken to curtail the spreading of propagating material of the category 2 plants outside the demarcated areas.
    - o no-one sells propagating material of category 2 plants or any category 2 plants to another person unless such other person is a land user of a demarcated area or of a biological control reserve.
    - o the land user is prepared to comply with further conditions as set down by the "executive officer".
    - o the land user does not allow Category 2 plants to grow within 30 metres of the 1:50 year flood line of a river, stream, or anyother sort of water body, unless authorised to do so in terms of the National Water Act, No. 36 of 1998
- must be controlled by the land user if in areas that are not demarcated areas or biological control reserves.
- may not be acquired unless such acquired material is for propagation in a demarcated area or biological control reserve.
- may only be imported or sold in accordance with the provisions of the Plant Improvement Act, No. 53 of 1976, the Agricultural Pests Act, No. 36 of 1983 and the environment conservation regulations.
- can be exempted from the above regulations through written exemption from "the executive officer", provided there is a good reason for it.

3.1.2 Vegetation

The climate and topography of the region give rise to the great diversity of vegetation types and habitats. The site falls within the Albany Thicket Biome The vegetation type Coega Bontveld and Sunday"s Thicket. Coega Bontveld (known as Grass Ridge Bontveld by Vlok and Euston-Brown (2002)) (Mucina and Rutherford 2006) is characterised by the presence of a mixture of Fynbos, Grassland, Succulent Karoo, and as well as Thicket element bushclumps. Sunday"s Thicket comprises typical thicket elements. Eighteen relevés were sampled within the study site in order to determine the presence of species and to inform vegetation type maps as well as sensitivity maps of the study area. Figure 3-3 shows the vegetation found on the proposed wind energy facility site.

Bontveld

Mucina and Rutherford (2006) refer to this type of vegetation as Coega Bontveld (Figure 3-2), while the STEP (Figure 3-3) and the NM MOSS refer to it as Grass Ridge Bontveld. This vegetation type occurs in the Eastern Cape Province, northeast of Port Elizabeth just inland of Algoa Bay; mainly around Coega, but also in small patches in Addo, at altitudes of between 0–400 m. This vegetation type is often found on moderating undulating plains and is characterised by the presence of a mixture of Fynbos (*Acmadenia obtusata, Euryops ericifolius*), Grassland (*Themeda triandra, Eustachys paspaloides*), Succulent Karoo (*Pteronia incana*), and as well as Thicket element bushclumps. The distribution of this vegetation type is restricted to shallow stony soils strongly influenced by an underlyng calcareous substrate (Watson 2001; Pierce and Mader 2006). The Coega Bontveld contains many highly localized endemics and has many SSC, often in the form of small succulents and geophytes. Furthermore the geophytes are often dormant for a large part of the year, and therefore effectively undetectable.

Watson (2001) distinguished four separate vegetation communities within the Grassridge Bontveld, namely bushclumps, miniclumps, grassveld and succulent patches:

- **Bushclumps**: The average clump size varies greatly with an average of 214 ± 127m^2 and it ranges in height from 2-3m tall, with *Scutia myrtina* and *Hippobromus pauciflorus* being indicative of bushclumps. Bushclumps are comprised of 74 species from 37 families.

- **Miniclumps**: Miniclumps are distinguished (physiognomically and phytosociologically) from bushclumps and are considerably smaller (7±4m^2). The miniclumps vary between 50 – 150cm in height, with aloes usually being the tallest species. The presence of *Rhus pallens* is indicative of miniclumps, which is comprised of 63 species from 31 families.

- **Grassveld**: The grassveld within the Bontveld comprises 43 species from 18 families, with *Themeda triandra* and *Merxmeulera disticha* indicative of Bontveld grassland.

- **Succulent patches**: The succulent patches occur over small areas (average of 4m^2) with bare ground constituting over 50% of the total area. This vegetation type comprises 36 species from 22 families, with *Lampranthus productus* indicative of the succulent patches.

Watson (2001) stated that Bontveld differed from Thicket in that the Thicket flora was predominately of a Subtropical origin, while the Bontveld had a large proportion of widespread flora. Consequently there is an abundance of calcareous Grassland and thicket Bushclumps. The Bushclumps have a species composition similar to that of the Mesic Succulent thicket, but the Calcareous Grassland is very diverse with an abundance of graminoides, herbs and small shrubs characteristic of the plant community. Dwarf shrubs usually include *Nylandtia spinosa, Muraltia squarrosa, Acmadenia obtusata* and common graminoids are *Themeda triandra, Ficinia truncata* with some herbs and succulents (CES 2001).

Where breaks in the calcareous substrate are evident thicket vegetation is present, forming distinct bushclumps. The bushclump species composition has caused previous scientists to speculate that this vegetation type only existed as a secondary thicket vegetation type form, as a result of previous disturbances to the original thicket vegetation type. However, Campbell, (1996) proved this was not the case, and thus the Coega Bontveld Vegetation type was reclassified to include these bushclumps.

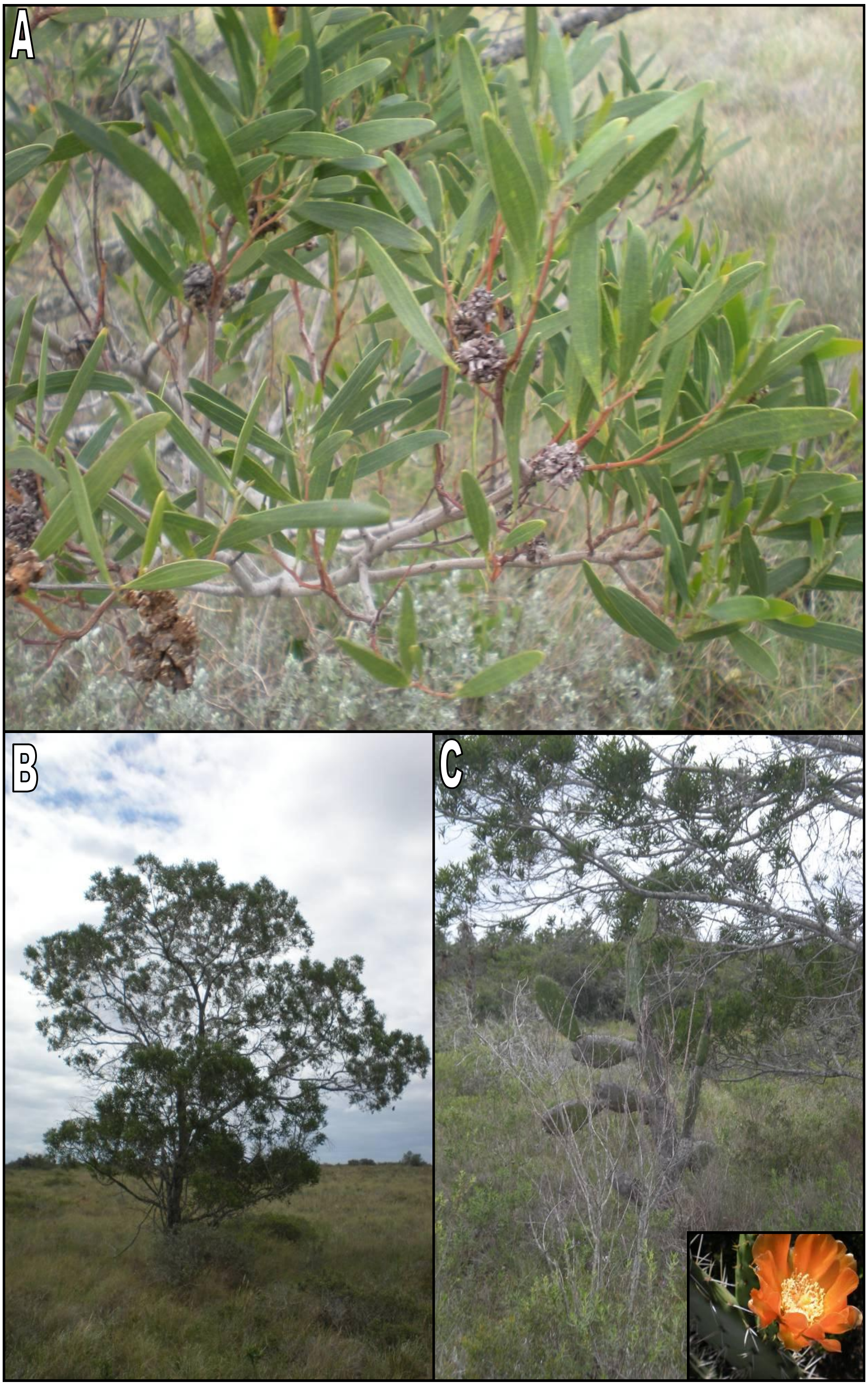

Plate 3-2: Alien invasive species present on site. A: Acacia cyclops. B: Acacia meansii. C: Opuntia ficus-indica (flower shown in inset) beneath an Acacia meansii plant

The Thicket bushclumps which occur within Bontveld are about 2.5 m high and have about 90% cover. They consist mostly of spinescent shrubs and woody creepers with many succulents. Diversity is high and the characteristic woody species include *Sideroxlyon inerme, Gymnosporia procumbens* and *Polygala myrtifolia*. Succulent species such as *Aloe africana, Aloe ferox, Euphorbia ledienii* and *Euphorbia grandidens* also occur. Numerous SSC occur in this vegetation type in the form of small succulents and geophytes, which are often well-hidden under the larger plants and therefore inconspicuous.Two protected species (*Sideroxylon inerme* L and *Aloe africana* Mill), together with members of the protected Mesembryanthemaceae family, were identified during a survey of the site, and the presence of one invasive species (*Opuntia ficus-indica*) was also noted.

Mucina and Rutherford (2006) classify this vegetation type as “Least Threatened”, while at the same time the protection status of this vegetation type is said to be “Poor”. Various biodiversity planning guidelines have also covered the area. Most significantly the STEP, (Vlok and Euston-Brown, 2004), which classed the site as “Currently not vulnerable”. Coega Bontveld has been given a conservation target of 19% by Mucina and Rutherford (2006), with 14 % currently protected in the Greater Addo Elephant National Park as well as the privately-owned Grassridge Nature Reserve. 6 % of this vegetation type has been transformed. The development of the Coega IDZ and associated infrastructure has encroached on this vegetation type and constitutes a severe threat (Mucina and Rutherford, 2006).

Plate 3-3 shows an example of the Coega Bontveld vegetation type on the site of the proposed wind energy facility, including thicket bushclumps.

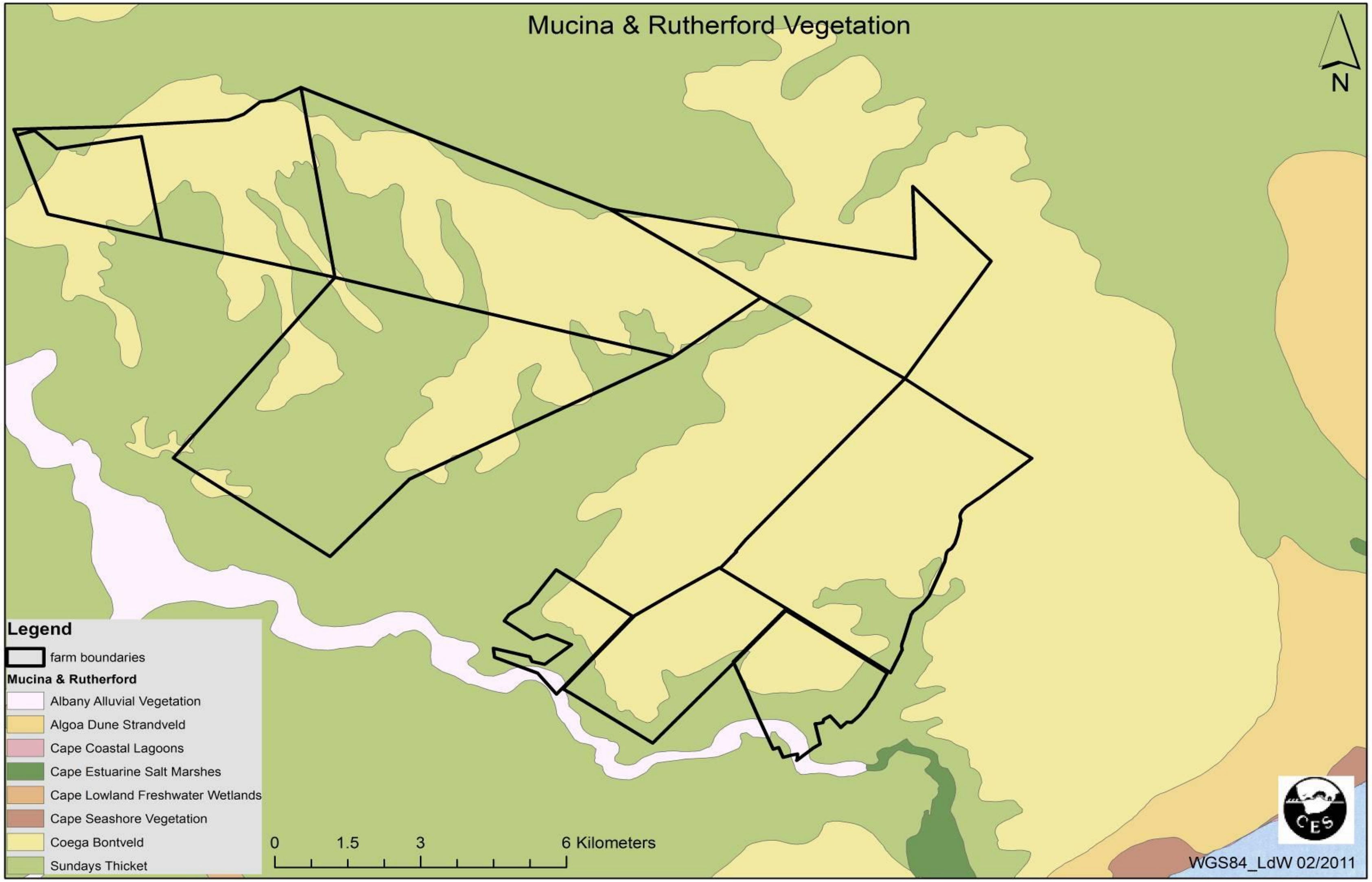

Figure 3-2: Map showing the Mucina and Rutherford (2006) Vegetation classification of the site.

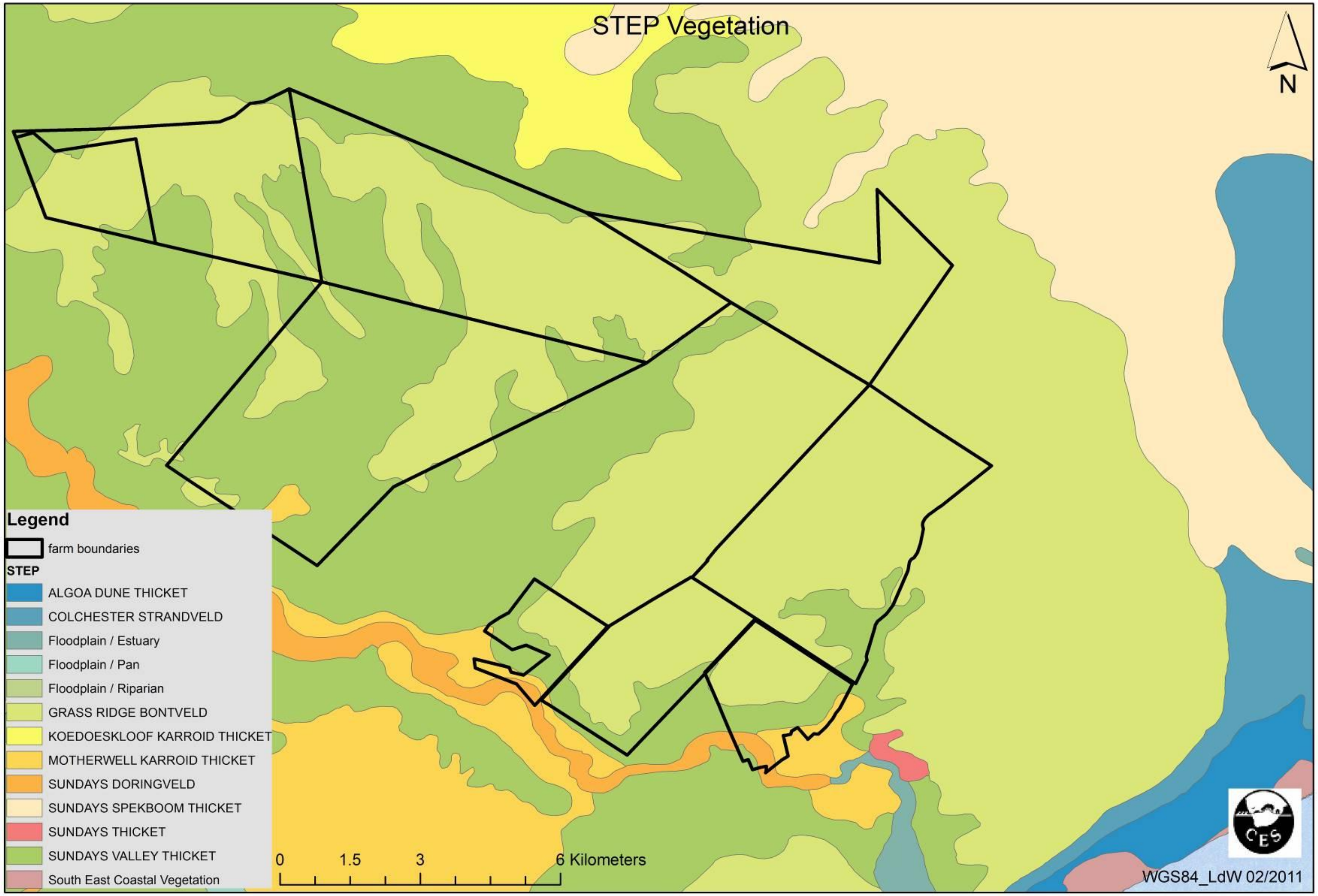

Figure 3-3: Map showing the STEP classification of the vegetation on the site

Plate 3-3: Coega Bontveld on the wind energy facility site - Campbell (1996) reclassified this vegetation type, whose typical herbaceous-like structure is shown in the foreground of the plate, to include the thicket bushclumps, whose typical shrub-like structure is shown in the background of the plate, present in the same locality.

Sunday‟s MST

Sundays Mesic Succulent Thicket, Or Sunday‟s Thicket is restricted to the Eastern Cape region from the Sundays River in the east to the Gamtoos River in the west. This type of vegetation is restricted to the Eastern Cape Province and extends from Port Elizabeth in the South to the Zuurberg Mountains in the north, and from the Groot Winterhoek Mountains on the West to east of Colchester in the East (Mucina and Rutherford, 2006). The thicket is usually impenetrable with a variety of succulent and tree species that are usually spinescent.

Presence of the species *Portulacaria afra* occurs in varying densities depending on geographical location. Succulent thicket is extensive along the coastal region stretching inland towards Uitenhage and Addo (CEN 1997). This succulent type is an extremely dense, impenetrable thicket in the coastal areas. Dense Mesic Succulent thicket is common along the Coega estuary and is mostly found as patches inland along the Coega River.

Mesic Succulent Thicket Mosaic is evident in linear bands in the DZ, which appear to indicate slight depression areas where denser and taller-growing thicket occurs. Denser and taller thicket occurs more often in valleys and open Bontveld occurs on the crests or plateau‟s (CSIR 1997). Boerboon (*Schotia afra)* and Gwarrie (*Euclea undulata)* trees dominate this vegetation type while suurnoors (*Euphorbia ledienii)* and Uitenhage aalwyn (*Aloe africana)* are reliable indicator species (STEP).

Around 51% of MST has been transformed and only 5.3% is formerly conserved. This coupled with the fact that it has a high proportion of endangered species and is reportedly threatened by various forms of development result in it being of conservation importance. Dold (2003) reported 70 plant species, of which 18 are protected in terms of the National Forest Act and the Provincial Nature Conservation Ordinance (PNCO).

Three species are endemic to the Albany Centre of Endemism (Victor & Dold 2003). These are generally small succulent plants and geophytes (plants with storage organs below ground and often only visible during the growing period). Consequently they are inconspicuous, especially during periods of dormancy and could be present in small numbers.

Sundays Thicket is described as Least Threatened by Mucina and Rutherfod (2006), with a conservation target of 19% identified. Much of this vegetation type is protected in national conservation areas, most importantly the Greater Addo Elephant National Park, as well as in private conservation areas. As much as 6% of Sundays Thicket is transformed, and much is degraded, mostly through cattle grazing. Degradation of the Sundays Thicket leads to a serious reduction in the number of important species as well as invasion by exotic weeds (Mucina and Rutherford, 2006).

Plate 3-4: Sunday's Thicket with typical succulent and shrub species.

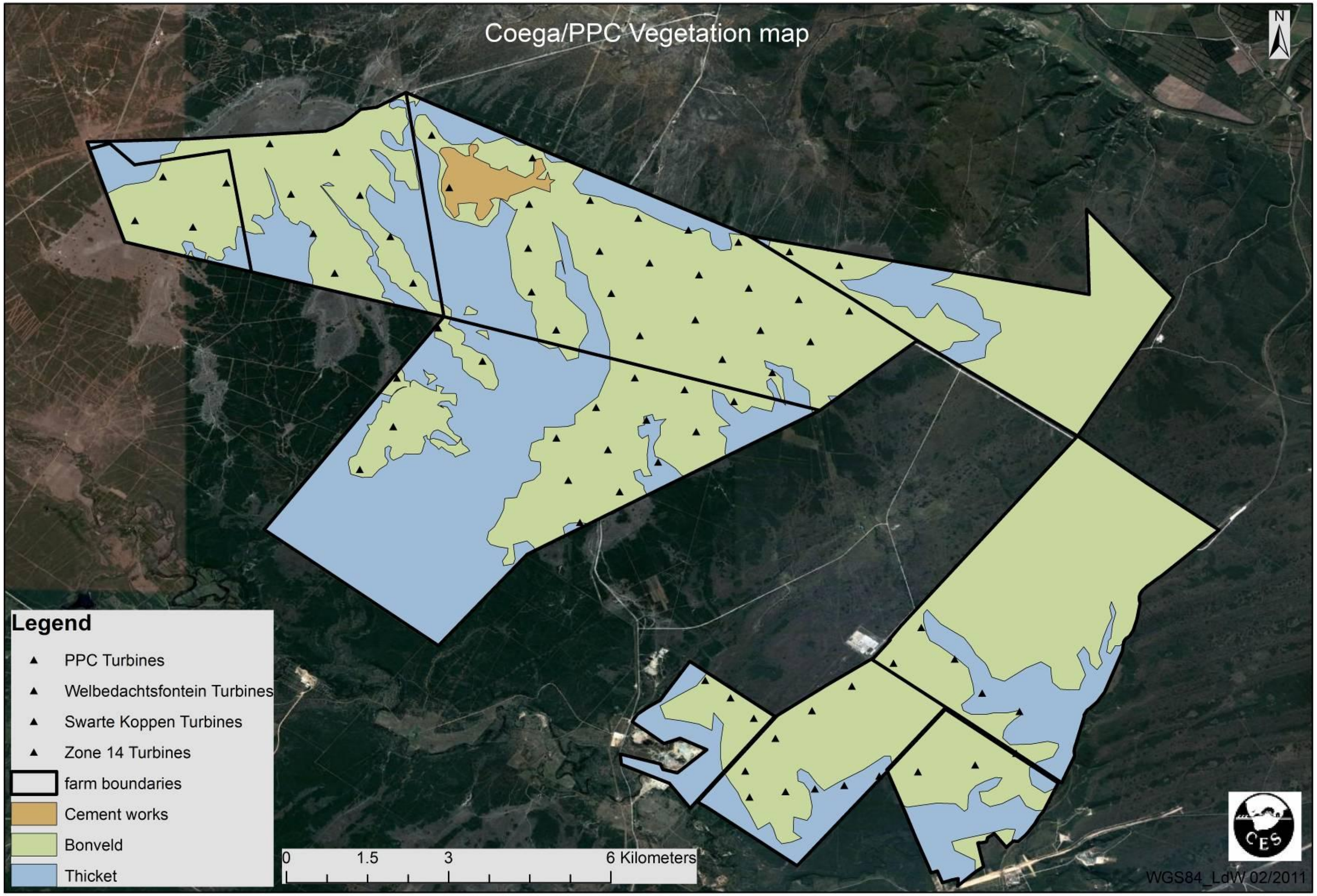

Figure 3-4: Vegetation map of the site showing the different vegetation types present on the site

3.2 Fauna

3.2.1 Habitats

Lack of pristine terrestrial habitat in the Coega region, particularly due to loss of natural vegetation caused by human activity, has impacted on terrestrial fauna. Large mammals are absent from the area, and the remaining mammals are small and medium sized. Two terrestrial mammals – the Vulnerable Black-footed Cat (*Felis nigripes*) and the Endangered White-tailed Mouse (*Mystromys albicaudatus*) - are of conservation concern in the region. More than half of the Eastern Cape"s endemic reptile species occur in the Algoa Bay area, and the majority of these are found in Mesic Succulent Thicket and riverine habitats. The list of reptiles of special concern includes five endemic species, eight CITES-listed species and one rare species. Knowledge of amphibian species diversity in the Coega region is limited, but it is estimated that as many as 17 species may occur, none of which are endemic or of conservation concern.

The Coega region has a diverse avifauna, with over 150 species being resident or common visitors to the region. Most diversity occurs in the thicket clumps. A number of terrestrial birds are of conservation concern, some of which – Damara Tern, African Oystercatcher, Spotted Thicknee and Kelp Gull - have been observed within the coastal region in the vicinity of the study area. Terrestrial invertebrates of conservation concern include two rare butterflies of the Lycaenidae family, both of which have distributions that include the Coega area. There is a general lack of pristine terrestrial habitats in the Coega region. This means that some components of the terrestrial fauna have been severely impacted by previous human activity, particularly the loss of vegetation, invasion of alien vegetation, local extinction of large mammals, and varied industrial developments.

3.2.2 Invertebrates

The distribution of the terrestrial invertebrates found along the coast depends to a large degree on the extent and composition of the natural vegetation. One grasshopper species (*Acrotylos hirtus*) is endemic to the dunefields, but these areas do not form part of the study site. Of nearly 650 butterfly species recorded within the borders of South Africa, 102 are considered of conservation concern and are listed in the South African Red Data Book for Butterflies. Two have become extinct, whilst three rare butterflies are known from a number of scattered localities in the Coega region.

The Coega region has a diverse butterfly fauna. More butterflies are linked to Mesic Succulent Thicket (MST) than Bontveld. However, sensitive butterflies are associated with Bontveld grasslands. Ant-associated lycaenid butterflies are most at risk. They form a co-adapted complex with a host ant and food plant. The small blue lycaenid butterfly *Lepidochrysops bacchus* is known from four localities in the Eastern Cape. One of these is reported to occur in the "general area" of the Coega IDZ, but not within the port area. Another rare small copper lycaenid, *Poecilimitis pyroeis*, has a similar distribution to *Lepidochrysops bacchus*, extending from the southwestern Cape to Little Namaqualand. An isolated eastern race, P.p. hersaleki, was described from Witteklip Mountain (Lady"s Slipper) to the west of Port Elizabeth. It has also been recorded from St Albans and from the Baviaanskloof Mountains. There is currently no evidence that this rare butterfly occurs in the Coega area, or that a suitable habitat for the eastern race exists in the port area (CES 1997).

3.2.3 Vertebrates

Amphibians

Amphibians are an important and often neglected component of terrestrial vertebrate faunas. They are well represented in sub-Saharan Africa, from which approximately 600 species have been recorded (Frost 1985). Currently amphibians are of increasing scientific concern as global reports of declining amphibian populations continue to appear (Phillips 1994). Although there is no consensus on a single cause for this phenomenon, there is general agreement that the declines in many areas, even in pristine protected parks, are significant and do not represent simple cyclic events. Frogs have been aptly called bioindicator species, whose abundance and diversity is a poignant reflection of the general health and well-being of aquatic ecosystems. They are important components of wetland systems, particularly ephemeral systems from which fish are either excluded or of minor importance. In these habitats, they are dominant predators of invertebrates, many of which may impact significantly on humans (e.g. as vectors of disease).

Amphibians are well represented in sub-Saharan Africa, from which approximately 600 species have been recorded. A relatively rich amphibian fauna occurs in the Eastern Cape, where a total of 32 species and sub-species occur. This represents almost a third of the species known from South Africa. Knowledge of amphibian species diversity in the Coega region is limited and based on collections housed in national and provincial museums. It is estimated that as many as 17 species may occur. However, none of these species are endemic or of conservation concern.

Reptiles

The Eastern Cape is home to 133 reptile species including 21 snakes, 27 lizards and eight chelonians (tortoises and turtles). More than half of the Eastern Cape‟s endemic reptile species occur in the Algoa Bay area, giving the region a high conservation value (Branch 1988). The majority of these are found in Mesic Succulent Thicket and riverine habitats. Reptile diversity in the Coega region is high, with 60 species (27 snakes, 29 lizards, and 4 chelonians) likely to occur. One highly threatened reptile, the Albany dwarf adder (*Bitis albanica*), which is Globally Critically Endangered, may occur. Three other endemic reptiles and six CITES-listed (Appendix II) reptiles are found. All are common and occur in existing conserved areas. The list of reptiles of special concern is very significant since it includes five endemic species (two of which are endangered), eight CITES-listed species banned from International Trade in Endangered Species, one rare species and four species at the periphery of their range (Table 3-3). More than a third of the species are described as relatively tolerant of disturbed environments, provided migration corridors of suitable habitat are maintained to link pristine habitats.

Reptile species which have been recorded in the Coega Bontveld (CES 2009) which are listed on Appendix II of CITES (all Testudinidae spp. are listed on Appendix II of CITES), include the:

- Leopard or Mountain Tortoise (*Geochelone pardalis*),
- Angulate Tortoise (*Chersina angulata*), and
- Karoo or Boulenger's Padloper (*Homopus boulengeri*)

Table 3-3: Reptile species in the Coega region that are listed in the International Red Data Book of Reptiles and Amphibians.

Species	Common Name	Status
Cordylus tasmani	Tasman‟s girdled lizard	Endemic *
Scelotes anguineus	Dwarf burrowing skink	Endemic *
Acontias (meleagris) orientalis	Eastern legless skink	Endemic *
Pachydactylus sp. (St Croix Island)	St Croix thicktoed gecko	Endemic/Endangered *
Bitis albanica	Albany dwarf adder	Endemic/Endangered *
Bradypodion ventrale	Southern dwarf chameleon	CITES Appendix II *
Cordylus cordylus	Cape girdled lizard	CITES Appendix II *
Pseudocordylus microlepidotus	Cape crag lizard	CITES Appendix II
Varanus niloticus	White-throated monitor	CITES Appendix II *
Varanus albigularis	Nile monitor	CITES Appendix II *
Geochelone pardalis	Leopard tortoise	CITES Appendix II *
Homopus areolatus	Parrot-beaked tortoise	CITES Appendix II *
Cherisina angulata	Angulate tortoise	CITES Appendix II *
Dermochelys coriacea	Leatherback sea turtle	Endangered #

Species	Common Name	Status
Chelonia mydas	Green sea turtle	Endangered #
Eretmochelys imbricata	Hawksbill sea turtle	Endangered #
Caretta caretta	Loggerhead sea turtle	Vulnerable #
Lamprophis fuscus	Yellowbellied house snake	Rare
Mabuya varia	Variable skink	Peripheral *
Scelotes caffer	Cape dwarf skink	Peripheral
Nucras taeniolata	Albany sandveld lizard	Peripheral
Philothamnus semivariegatus	Spotted bush snake	Peripheral *

Mammals

Large game makes up less than 15% of the mammal species in South Africa and a much smaller percentage in numbers and biomass. In developed and farming areas, this percentage is greatly reduced, with the vast majority of mammals present being small or medium-sized. Of the 62 mammal species known or expected to occur in the area, none are now considered endemic to the coastal region. The conservation status of South African mammals has recently been re-assessed. The conservation status of some has been downgraded, with the African wild cat, Aardvark, Blue duiker, and Honey badger are no longer considered threatened. The White-tailed rat (*Mystromys albicaudatus*) has not been recorded from the Coega region, whilst Duthie"s golden mole (Vulnerable) is not known from east of the Swartkops River. No subspecies are recognised of the Hairy-footed gerbil (*Gerbillurus paeba*) which is also unthreatened. The conservation status of two species remains indeterminate (Data Deficient). The Black-footed Cat (*Felis nigripes*) is listed as Vulnerable, and White-tailed Mouse (*Mystromys albicaudatus*) is listed as Endangered. The study site falls within the distribution range of both (IUCN 2008). However, it is unlikely that the Black-footed cat occurs in the area, due to the rarity of the species. It is also unlikely that the White-tailed Mouse would occur on site, because the study site falls on the edge of the species" distribution range. Of specific importance for wind farm developments are the presence of bats in the area; A confounding number of bat fatalities have been found at the bases of wind turbines throughout the world. Echolocating bats should be able to detect moving objects better than stationary ones, which begs the question, why are bats killed by wind turbines (Baerwald *et al*.). Table 3-4 lists the species of bats likely to occur in Coega and surrounds, and thus will be affected by the proposed development.

Table 3-4: Bat species that occur in the Port Elizabeth area which are likely to be affected by the wind turbines.

Order: Chiroptera		
Common Name	Species Name	SSC
Straw-coloured fruit bat	*Eidolon helvum*	Near Threatened
Egyptian fruit bat	*Rousettus aegypticus*	
Geoffrey's horseshoe bat	*Rhinolophus clivosus*	Least Concern
Cape horseshoe bat	*Rhinolophus capensis*	Least Concern
Temminck's hairy bat	*Myotis tricolor*	Least Concern
Cape serotine bat	*Eptesicus capensis*	Least Concern
Common slit-faced bat	*Nycteris thebaica*	Least Concern
Giant yellow house bat	*Scotophilus nigrita*	Least Concern
Schreiber's long-fingered bat	*Miniopterus schreibersi*	Near Threatened
Tomb bat	*Taphozous mauritianus*	Least Concern
Angola free-tailed bat	*Tadarida condylura*	Least Concern
Wahlberg's epaulated bat	*Epomophorus wahlbergi*	Least concern
Banana bat	*Pipistrellus nanus*	Least Concern
Egyptian free-tailed bat	*Tadarida aegyptiaca*	Least Concern
Lesser woolly bat	*Kerivoula lanosa*	Least Concern

Bat fatalities at wind power facilities are highly variable throughout the year, but there are many more bat fatalities than bird fatalities at wind farms (Brinkman *et al*. 2006). Importantly, bat studies have been done in Europe and the United States of America, but none in South Africa. These studies have found that even a few deaths can be seriously detrimental to bat populations, and is thus cause for concern (Hotker *et al*. 2006). Most bats are struck during periods of migration or dispersal (Hotker *et al*. 2006, Johnson *et al* 2003).

Horn *et al*. (2008) conducted a study on the behavioural responses of bats to wind turbines and discovered the following:

- Bats actively forage near operating turbines
- Bats approach both rotating and non-rotating blades
- Bats followed or were trapped in blade-tip vortices
- Bats investigated the various parts of the turbine with repeated fly-bys
- Bats were struck directly by rotating blades

These behavioural responses of bats to wind turbines explains why many of them are killed, however, there are additional explanations for this behaviour. There are several reasons proposed for the number of bat fatalities, one is that the turbines attract insects, and thus foraging insect-eating bats (Ahlen 2003, Kunz *et al*. 2007). Alternatively, bats may mistake turbines for trees when they are looking for a roost, or be acoustically attracted to the wind turbines (Kunz *et al*. 2007). The cause of death is not entirely explained by collision with turbine blades, but instead is caused by internal haemorrhaging. Most bats are killed by barotrauma, which is "caused by rapid air-pressure reduction near many turbine blades" (Baerwald *et al*.). Barotrauma "involves tissue damage to air-containing structures caused by rapid or excessive pressure change" (Baerwald *et al*.).

Possible mitigation measures

In a study conducted to determine the effects of turbine size on bat fatalities, Barclay *et al*. (2007) discovered that the diameter of the rotor had no effect on bat fatalities. Height of the turbines, however, though having no effect on bird fatalities, bat fatalities increased exponentially with an increase in turbine height (Barclay *et al*. 2007). There are, as a result, a few mitigation measures that have been suggested to reduce bat fatalities, these are:

- Ultrasound broadcast can deter bats from flying into wind turbines. (Szewczak and Arnett 2007)
- Minimizing turbine height will help to reduce bat fatalities (Barclay *et al*. 2007).
- Turbine sites on ridges should be avoided (Brinkman *et al*. 2006).
- Wind turbine operating times should be restricted during times when bat activity is high (Brinkman *et al*. 2006). Bats are at higher risk of fatality on nights with low wind speeds (Horn *et al*. 2008).

3.2.4 Animal species of special concern

The following terrestrial invertebrates are of conservation concern:

- Small blue lycaenid butterfly (*Lepidochrysops bacchus*)
- Small copper lycaenid, (*Poecilimitis pyroeis*),

The following reptile species which are relevant to the study site are of conservation concern:

- Endemic:
  - Tasman‟s girdled lizard (*Cordylus tasmani*)
  - Dwarf burrowing skink (*Scelotes anguineus*)
  - Eastern legless skink (*Acontias (meleagris) orientalis*)
- Endemic and Endangered

  - Albany dwarf adder (*Bitis albanica*
- CITES Appendix II
  - Southern dwarf chameleon (*Bradypodion ventrale*)
  - Cape girdled lizard (*Cordylus cordylus*)
  - Cape crag lizard (*Pseudocordylus microlepidotus*)
  - White-throated monitor (*Varanus niloticus*)
  - Nile monitor (*Varanus albigularis*)
  - Leopard or Mountain Tortoise (*Geochelone pardalis*),
  - Angulate Tortoise (*Chersina angulata*), and
  - Parrot-beaked tortoise (*Homopus areolatus*)

The following mammals which may occur in the study area are of conservation concern:

- Vulnerable; Black-footed Cat (Felis nigripes)
- Endangered; White-tailed Mouse (Mystromys albicaudatus)

3.2.5 Effect of low frequency sound and vibration on animals

The „pitch" of a sound is defined by varying frequencies, which is measured in cycles per second (or Hertz (Hz)). Low frequency pressure vibrations are typically categorized as low frequency sound when they can be heard near the bottom of human perception (10-200 Hz) (Williams 2010), while Infrasound is sound that is lower in frequency than 20 Hz (Hertz) or cycles per second, the normal limit of human hearing (Williams 2010; Bowles 1995; O"neal *et al.* 2009).

Animals use sound to navigate, defend, communicate, and find food (Bowles 1995). In the context of windfarms, turbines create infrasound and vibrations that could potentially alter the behaviour of animals or interfere with their normal functioning, and these possible negative and/or positive effects need to be acknowledged. Amongst other impacts, the low-frequency (infrasound) produced by turbines can potentially cause changes to behaviour, reproductive patterns, feeding behaviour, distribution, habitat use and survivorship of animals (Bowles, 1995).

As a result of the substantial increase in size and number of applications for potential windfarms in South Africa in recent years, concerns over the potential negative impacts of noise and vibrations on animal receptors have risen. However, an extensive literature review has revealed that very little research has been conducted on the subject.

Literature appears to confirm that certain animals communicate, sometimes over long distances, using vibrations and low-frequency calls. For example, Langbauer *et al* (1991) estimated that elephants communicate via low-frequency sound over distances of up to 4 kilometers. Arnason *et al*. (1998) later quantified the propogation of vibrations in the substrate caused by elephant vocalisations and found them to carry over a distance of 120 meters. However, no literature could be found that documents studies on the impact of noise or vibrations from wind turbines on these animals.

Hill (2001) provides a comprehensive review of the use of vibration-based communication by members of the animal Kingdom including certain mammals, reptiles, amphibians and invertebrates. Again, no reliable scientific evidence could be found in the literature that addresses the impact of vibrations from wind turbines on animal communication. Although it is not possible to completely rule out impacts of vibrations and low-frequency noise from wind turbines on animal communication, it is important to note that both low-frequency sound and vibrations are produced from numerous sources, including vehicle movement.

Given the close proximity of the proposed site to the Coega IDZ, it would therefore be reasonable to assume that if vibrations and low-frequency noise did have a significant negative impact on animal communications that this impact would already be in effect. Furthermore, it may be argued that the additional impact associated with the limited vibrations and low-frequency noise from the modern turbines at the proposed Coega/PPC wind farm would be slight.

3.3 Conservation in the Coega IDZ

There are two important conservation plans for the Coega area. These are designed to retain some indigenous vegetation with a view to maintaining corridors to avoid restricting animal movement as well as retaining the vegetation. These are the Subtropical Thicket Ecosystem Planning (STEP) Project and the Coega Open Space Management Plan (OSMP). In addition to these conservation plans, on the National Level is the National Spatial Biodiversity Assessment (NSBA), and on a provincial level the Eastern Cape Biodiversity Conservation Plan (ECBCP).

3.3.1 National Spatial Biodiversity Assessment (NSBA)

The National Spatial Biodiversity Assessment (NSBA) is a national assessment of priority areas for conservation action (Driver *et al* 2005). It takes into account terrestrial, river, estuarine and marine ecosystems. The NSBA has mapped several different aspects including biodiversity features, existing protected areas, current patterns of land and resource use and likely future patterns of land and resource use. This information is then analysed to give geographical priority areas. The approach used by the NSBA for biodiversity planning is one of systematic biodiversity planning, which is based on three key principles.

1) “The need to conserve a representative sample of biodiversity pattern, such as species and habitats (the principle of representation)
2) The need to conserve the ecological and evolutionary processes that allow biodiversity to persist over time (the principle of persistence).
3) The need to set quantitative biodiversity targets that tell us how much of each biodiversity feature should be conserved in order to maintain functioning landscapes and seascapes. These biodiversity targets should ideally be based on best available science, rather than on arbitrarily defined thresholds (such as 10% of all features)”

There are protected areas near the study site (Figure 3-5). Of these, the Addo Elephant National Park is listed as a Type 1 protected area, Tregathlyn Game Reserve as a Type 2 protected area and Grassridge Private Nature Reserve as a Type 3 protected area. The classification of these protected areas is as follows:

- Type1 protected areas include National Parks, Provincial Nature Reserves, Local Authority Nature Reserves and DWAF Forest Nature Reserves.
- Type 2 protected areas include wildlife management areas, private nature reserves, National Heritage Sites, SANDF property, bird sanctuaries, botanical gardens, state land, mountain catchment areas and DWAF Forest Areas
- Type 3 protected areas include game farms, other conservation areas (such as conservancies), and game reserves. (These are not considered formal protected areas, and were not included in the analyses. However, it is useful to map them because they could provide a basis for future conservation action should they fall within biodiversity priority areas.)

The study area is listed at Poorly Protected by the NSBA although it is also Least Threatened. Least Threatened vegetation has more than 80% of their extent untransformed, with little or no disruption to ecosystem functioning. Most vegetation types in the country are Poorly Protected with only 6% of land in the country formally protected. A status of Poorly Protected means that very little of the vegetation type is conserved in Type 1 Protected Areas.

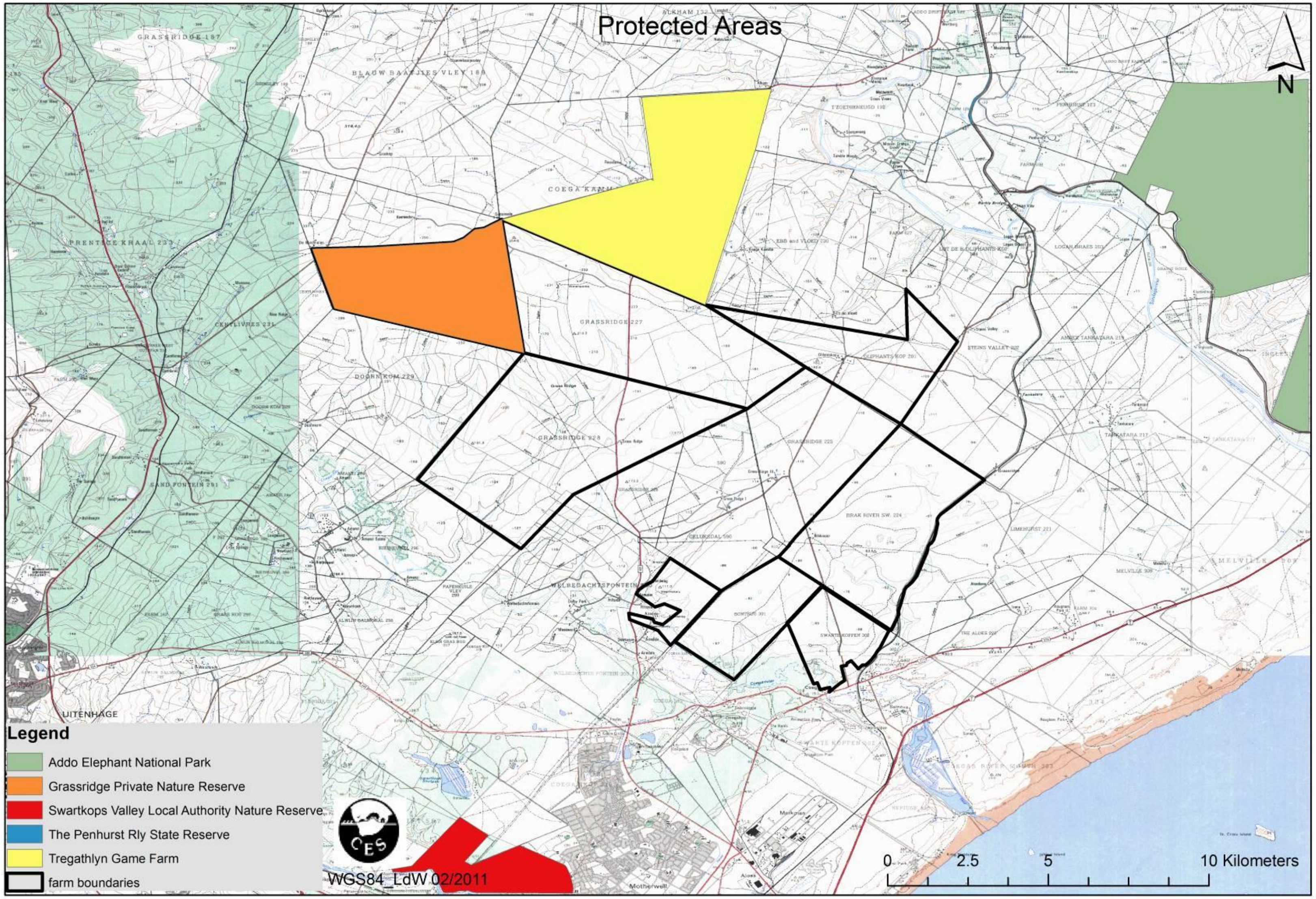

Figure 3-5: Protected areas in the study area and surrounds (NSBA)

3.3.2 Eastern Cape Biodiversity Conservation Plan (ECBCP)

The Eastern Cape Biodiversity Conservation Plan (ECBCP) is responsible for mapping areas that are priorities for conservation in the province, as well as assigning land use categories to the existing land depending on the state that it is in (Berliner et al. 2007).

Critical Biodiversity Areas (CBAs) are defined by Berliner et al. (2007) as: "CBAs are terrestrial and aquatic features in the landscape that are critical for conserving biodiversity and maintaining ecosystem functioning". Biodiversity Land Management Classes (BLMCs) are also used in the plan: "Each BLMC sets out the desired ecological state that an area should be kept in to ensure biodiversity persistence. For example, BLMC 1 refers to areas which are critical for biodiversity persistence and ecosystem functioning, and which should be kept in as natural a condition as possible". Table 3-4 shows how the BLMCs relate to the CBAs.

Table 3-4: Terrestrial Critical biodiversity Areas and Biodiversity Land Management Classes as described by the Eastern Cape Biodiversity Conservation Plan.

CBA map category	Code	BLMC	
Terrestrial CBAs and BLMCs:			
Protected areas	PA1	BLMC 1	Natural landscapes
	PA2		
Terrestrial CBA 1 (not degraded)	T1		
Terrestrial CBA 1 (degraded)	T1	BLMC 2	Near-natural landscapes
Terrestrial CBA 2	T2		
	C1		
	C2		
Other natural areas	ONA T3	BLMC 3	Functional landscapes
	ONA		
Transformed areas	TF	BLMC 4	Transformed landscapes

Table 3-5: Terrestrial BLMCs and Land Use Objectives

BLMC	Recommended land use objective
BLMC 1: Natural landscapes	Maintain biodiversity in as natural state as possible. Manage for no biodiversity loss.
BLMC 2: Near natural landscapes	Maintain biodiversity in near natural state with minimal loss of ecosystem integrity. No transformation of natural habitat should be permitted.
BLMC 3: Functional landscapes	Manage for sustainable development, keeping natural habitat intact in wetlands (including wwtalnd buffers) and riparian zones. Environmental authorisations should support ecosystem integrity.
BLMC 4: Transformed landscapes	Manage for sustainable development.

As can be seen from figure 3-7, much of the study site occurs in a corridor area. Importantly, wind farms, if managed properly, have a low impact on the vegetation and these corridor areas are unlikely to be negatively affected by the construction and operation of the wind farm, thus leaving them intact. Figure 3-6 shows the CBAs in and around the study area. The majority of the study area does not fall within a CBA.

Ten principles of land use planning for biodiversity persistence

1) Avoid land use that results in vegetation loss in critical biodiversity areas.
2) Maintain large intact natural patches – try to minimise habitat fragmentation in critical biodiversity areas.

3) Maintain landscape connections (ecological corridors) that connect critical biodiversity areas.
4) Maintain ecological processes at all scales, and avoid or compensate for any effects of land uses on ecological processes.
5) Plan for long-term change and unexpected events, in particular those predicted for global climate change.
6) Plan for cumulative impacts and knock-on effects.
7) Minimise the introduction and spread of non-native species.
8) Minimize land use types that reduce ecological resilience (ability to adapt to change), particularly at the level of water catchments.
9) Implement land use and land management practices that are compatible with the natural potential of the area.
10) Balance opportunity for human and economic development with the requirements for biodiversity persistence.

The proposed development, if managed properly, subscribes to these guidelines.

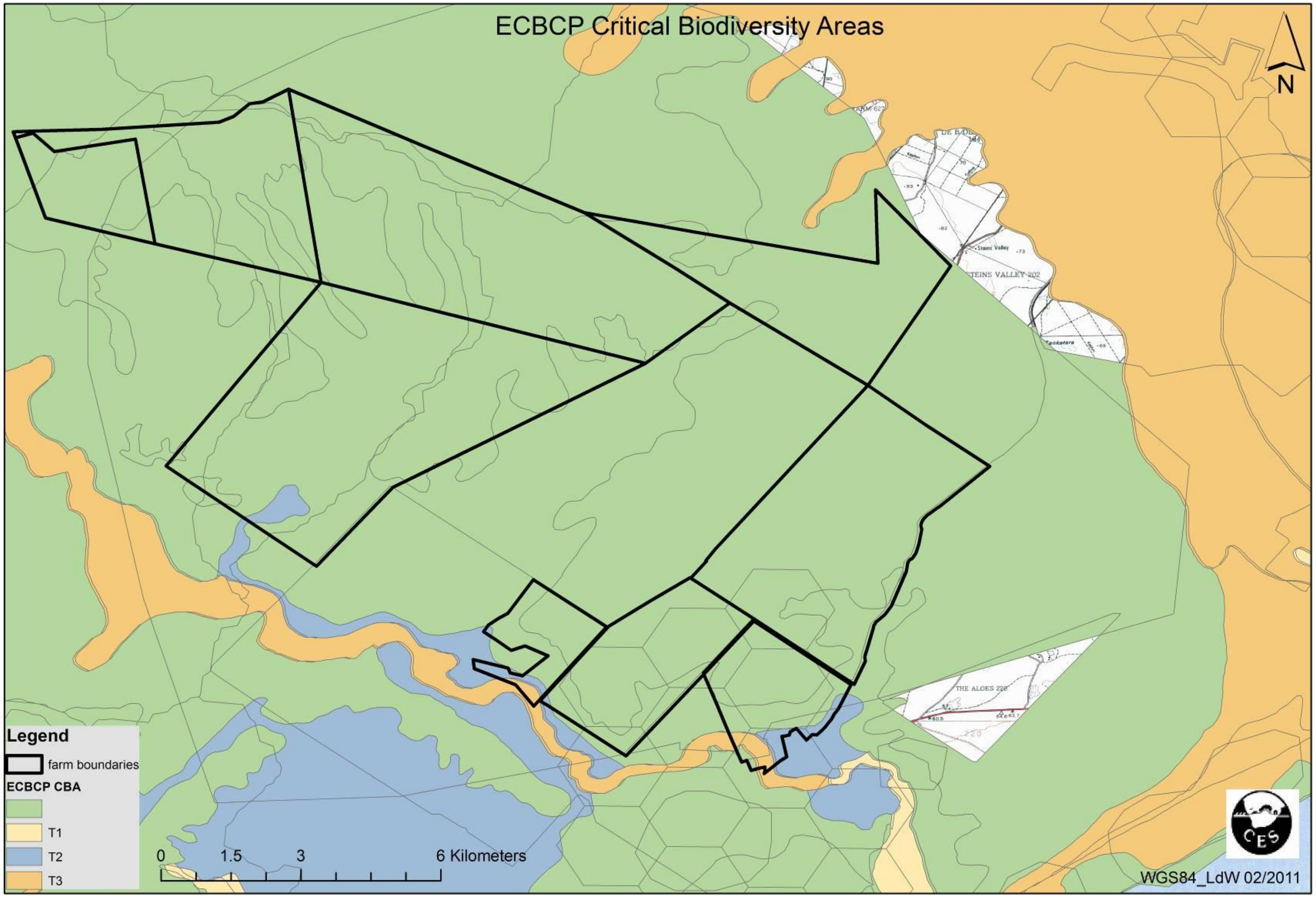

Figure 3-6: Critical Biodiversity Areas

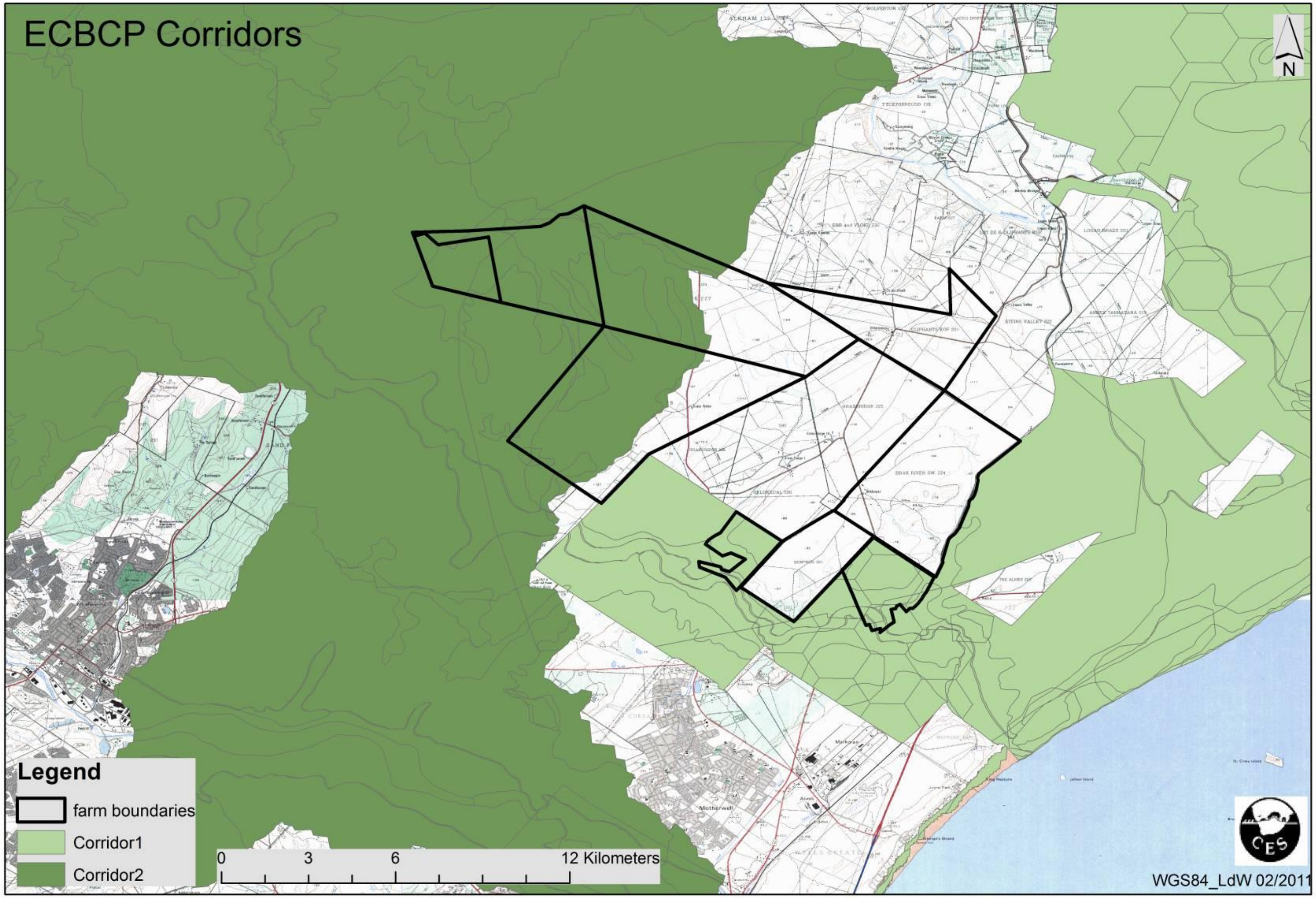

Figure 3-7: Corridors.

3.3.3 Subtropical Thicket Ecosystem Planning (STEP) Project

The STEP Project covers the south-eastern Cape region, which extends from the Kei River to Riversdale. The project area covers the unique, indigenous vegetation type known as thicket, with the aim being to assess the region‟s biodiversity. The assessment measured how much of the thicket vegetation had been damaged or destroyed through anthropogenic impacts and determined the degree to which biodiversity is endangered in different areas. The project aims to guide the necessary but destructive development away from areas of endangered biodiversity and promote sustainable land use.

The study area is classified as a “Currently not vulnerable” (Figure 3-8), which implies an ecosystem that covers most of its original extent and which is mostly undamaged, healthy and functioning. Depending on other factors, such an ecosystem may be able to withstand some loss of natural area through disturbance or development (Pierce and Mader 2006). The STEP Mapbook also outlines several procedures, restrictions and opportunities for use by municipal decision-makers, which can guide future development within the STEP Region. These are discussed below in the context of the study area.

In terms of STEP (2004), a feature that has much more extant habitat than is needed to meet its target, is considered Currently Not Vulnerable.

For Currently Not Vulnerable vegetation, STEP recommends three Land use management procedures, these include:

1. Proposed disturbance or developments should preferably take place on portions which have already undergone disturbance or impacts rather than on portions that are undisturbed or unspoilt by impacts.
2. In response to an application for a non-listed activity which will have severe or large-scale disturbance on a relatively undisturbed site (unspoilt by impacts), the Municipality should first seek the opinion of the local conservation authority.
3. For a proposed “listed activity”, EIA authorisation is required by law.

From a Spatial planning (forward planning – SDF‟s) point of view, for Currently Not Vulnerable vegetation, STEP presents two restrictions and gives examples of opportunities. The two spatial planning restrictions are as follows:

1. Proposed disturbance or developments should preferably take place on portions which have already undergone disturbance or impacts rather than on portions that are undisturbed.
2. In general, Class IV land can withstand loss of disturbance to natural areas through human activities and developments.

Opportunities depend on constraints (such as avoidance of spoiling scenery or wilderness, or infra-structure limitations) Class IV land can withstand loss of, or disturbance to, natural areas. Within the constraints, this class may be suitable for a wide range of activities (e.g. extensive urban development, cultivation, tourist accommodation, ecotourism and game faming).

Table 3-6: Summary of the STEP Project conservation priorities, classifications and general rules (Pierce, 2003)

Conservation priority	Classification	Brief Description	General Rule
IV	Currently not vulnerable area	Ecosystems which cover most of their original extent and which are mostly intact, healthy and functioning	Depending on other factors, this land can withstand loss of natural area through disturbance or development
III	Vulnerable area	Ecosystems which cover much of their original extent but where further disturbance or destruction could harm their health and functioning	This land can withstand limited loss of area through disturbance or development
II	Endangered area	Ecosystems whose original extent has been severely reduced, and whose health, functioning and existence is endangered	This land can withstand minimal loss of natural area through disturbance or development
I Highest Priority	Critically endangered area	Ecosystems whose original extent has been so reduced that they are under threat of collapse or disappearance. Included here are special ecosystems such as wetlands and natural forests	This Class I land can NOT withstand loss of natural area through disturbance or development. Any further impacts on these areas must be avoided. Only biodiversity-friendly activities must be permitted.
High Priority	Network Area	A system of natural pathways e.g. for plants and animals, which if safeguarded, will ensure not only their existence, but also their future survival.	Land in Network can only withstand minimal loss of natural area through disturbance and developments
Highest Priority	Process Area	Area where selected natural processes function e.g. river courses, including their streams and riverbanks, interfaces between solid thicket and other vegetation types and sand corridors	Process area can NOT withstand loss of natural area through disturbance and developments
	Municipal reserve, nature reserve, national parks	Protected areas managed for nature conservation by local authorities, province or SA National Parks	No loss of natural areas and no further impacts allowed
Dependant on degree on existing impacts	Impacted Area	Areas severely disturbed or destroyed by human activities, including cultivation, urban development and rural settlements, mines and quarries, forestry plantations and severe overgrazing in solid thicket.	Ability for this land to endure further disturbance of loss of natural area will depend on the land"s classification before impacts, and the position, type and severity of the impacts

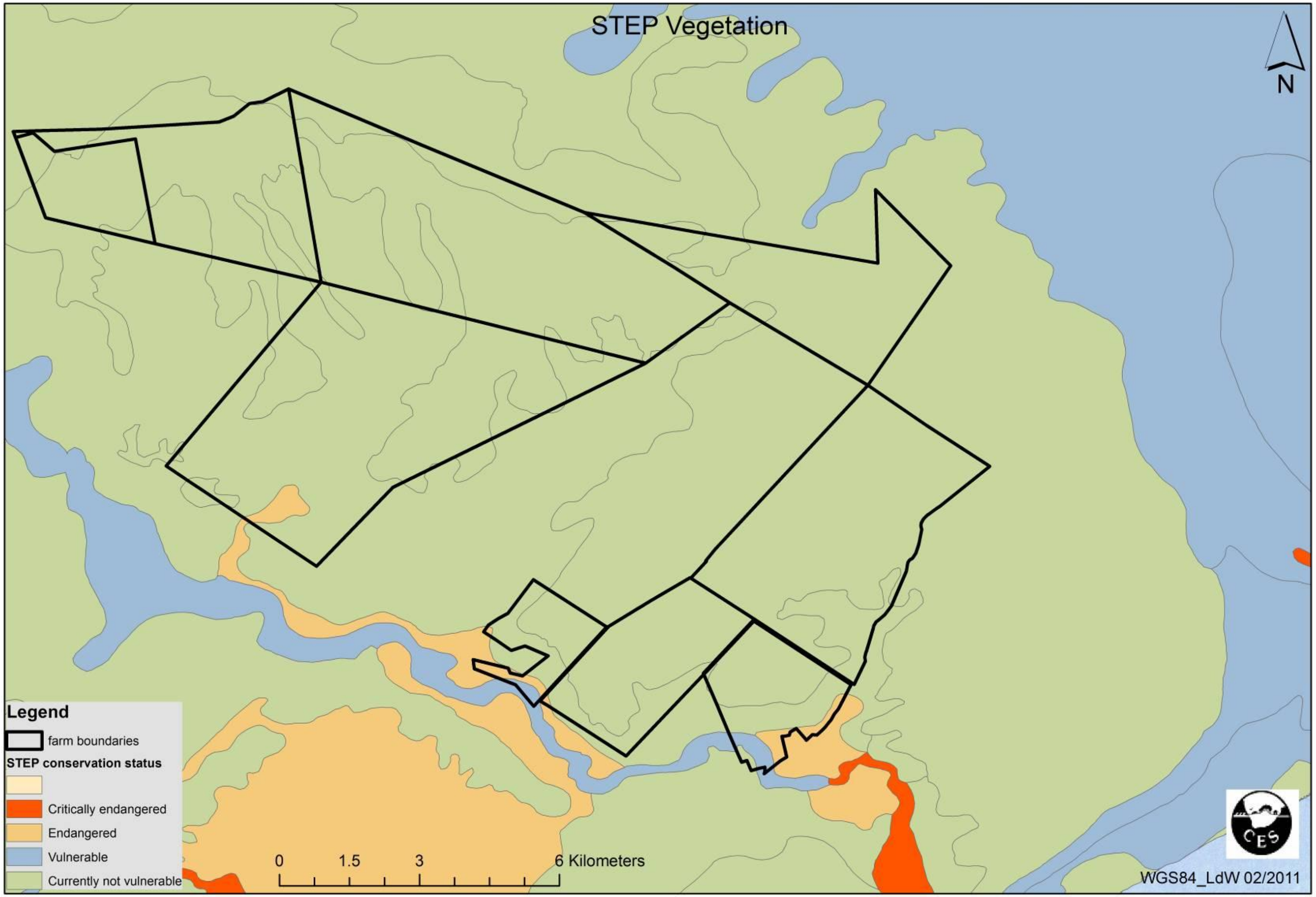

Figure 3-8: STEP Conservation status.

3.3.4 Coega Open Space Management Plan (OSMP)

The preparation of the **Open Space Management Plan (OSMP)** for the Coega Industrial Development Zone (IDZ) was initiated and commissioned by the Coega Development Corporation (CDC) in order to fulfil CDC"s own stated intent to determine and manage its open spaces. The OSMP aimed to achieve the following goals within the IDZ:

- Promote preservation of the environment where systems and/ or specific habitats require it.
- Meet recreation space demands as well as provide for the IDZ working population.
- Address the social & cultural needs of workers and families if and where desired.
- Promote educational opportunities within the IDZ to inform the public of the IDZ as well as to enhance the level of environmental awareness of the workers within the IDZ.
- Ensure positive visual opportunities from within as well as from outside the IDZ.
- Improve environmental quality by means of development guidelines to ensure the IDZ can compete with other alternative locations on global scale.

These goals were achieved by means of a broad classification system of all the sensitive areas within the IDZ. This classification system aims to guide the CDC in terms of fulfilling its fore mentioned objectives and its various Open Space areas have in turn been classed into Primary, Secondary and Tertiary Networks.

- **Primary Network**
  Refers mainly to the natural areas where emphasis is on conservation of areas to protect special vegetation types, as well as preserve ecological processes. These areas will attract interest from persons from throughout the Metropolitan area and even beyond, and can be divided into Core Conservation Areas and Ecological Process Areas

- **Secondary Network**
  Refers mainly to recreational and visually attractive open space areas provided not for their conservation value per se, but for relief in the built environment, screening off industrial buildings and softening the impact of developed areas for bulk infrastructure within the IDZ. The scale of development in the secondary network is such that facilities provided will attract usage from people all over the IDZ. It also includes the major transportation and service servitude routes, providing physical and visual linkages between different open spaces and other uses.

- **Tertiary Network**
  Refers mainly to the man-made facilities provided close to the Coega Open Space whose main purpose is to compliment open space activities in the secondary and primary network systems. These facilities will mainly attract localised interest but can be of significance on a Metropolitan Scale. It also includes areas for limited development in specific localities to serve as attractions and/or provide areas for development in close proximity to the open space system and this requires special consideration.

The final documentation for the **Coega Open Space Management Plan** (version 10), consists of two components namely:

Part 1: The Open Space Plan for Coega IDZ indicating permitted activities

Part 2: The Management Guidelines for the open space network

Currently the OSMP is been revised into a version 11, of which the major changes include the realignment of the Bontveld Corridor of Zone 8 and the allocation of developable land in Zone 10, as well as various minor changes to the rest of the OSMP. The proposed wind energy facility site is not situated on any primary networks.

3.4 Sensitivity Assessment

The results of the sensitivity assessment have been summarised into one habitat sensitivity map for the study area (Figure 3-9). The vegetation sample sites within the study area were identified and assessed in terms of the sensitivity criteria presented in Section 1.3. Areas containing alien invader species, which include in this site *Opuntia ficus-indica* and *Acacia* species, have a low sensitivity. Areas close to roads and those degraded by grazing were also given a low sensitivity score. A medium level of sensitivity is given to most of the Bontveld and thicket, which contains fewer Species of Special Concern and a lower overall biodiversity than the Bontveld in very good condition in restricted areas of the site, which was given a high sensitivity.

Low sensitivity

Low sensitivity areas were given this rating primarily because of the presence of alien invasive species, as well as the level of degradation of the vegetation. Previous land use as a grazing area as well as current land use at the PPC site (mainly the building of roads) has led to degradation of the vegetation. This degradation means that there exist few species of special concern in the area and species growing in these areas tend to be ubiquitous throughout the vegetation type.

Medium sensitivity

Medium sensitivity areas are not as degraded as those given a low ecological sensitivity score and have some species of special concern as well as fewer alien invasive species. These areas also tend to be easier to rehabilitate than areas of high sensitivity because of the topography and available habitats. Careful attention should be placed on having as little impact as possible on these areas as they may still form a valuable role in ecosystem functioning.

High sensitivity

High sensitivity areas are restricted in their distribution as these are areas that tend to be little impacted by previous or current land use. Topography tends to be complex, allowing for a variety of different habitats for rare and location-specific species to establish. These areas are difficult to rehabilitate as they contain no alien invasive species, and are in extremely good condition. They also have a greater presence of Species of Special Concern. Areas of high sensitivity should be avoided completely when micro-siting turbines as they are very important for ecosystem integrity and functioning.

As wind farms have very little impact on the vegetation post construction, it may be possible to retain the areas of moderate sensitivity as corridor areas and avoid doing any damage to the areas of high ecological sensitivity.

It should be noted that the presiding sensitivity was based on the flora and vegetation as the vegetation units, representing habitats, and show varying degrees of ecological integrity and that these values directly influenced the impact rating scores.

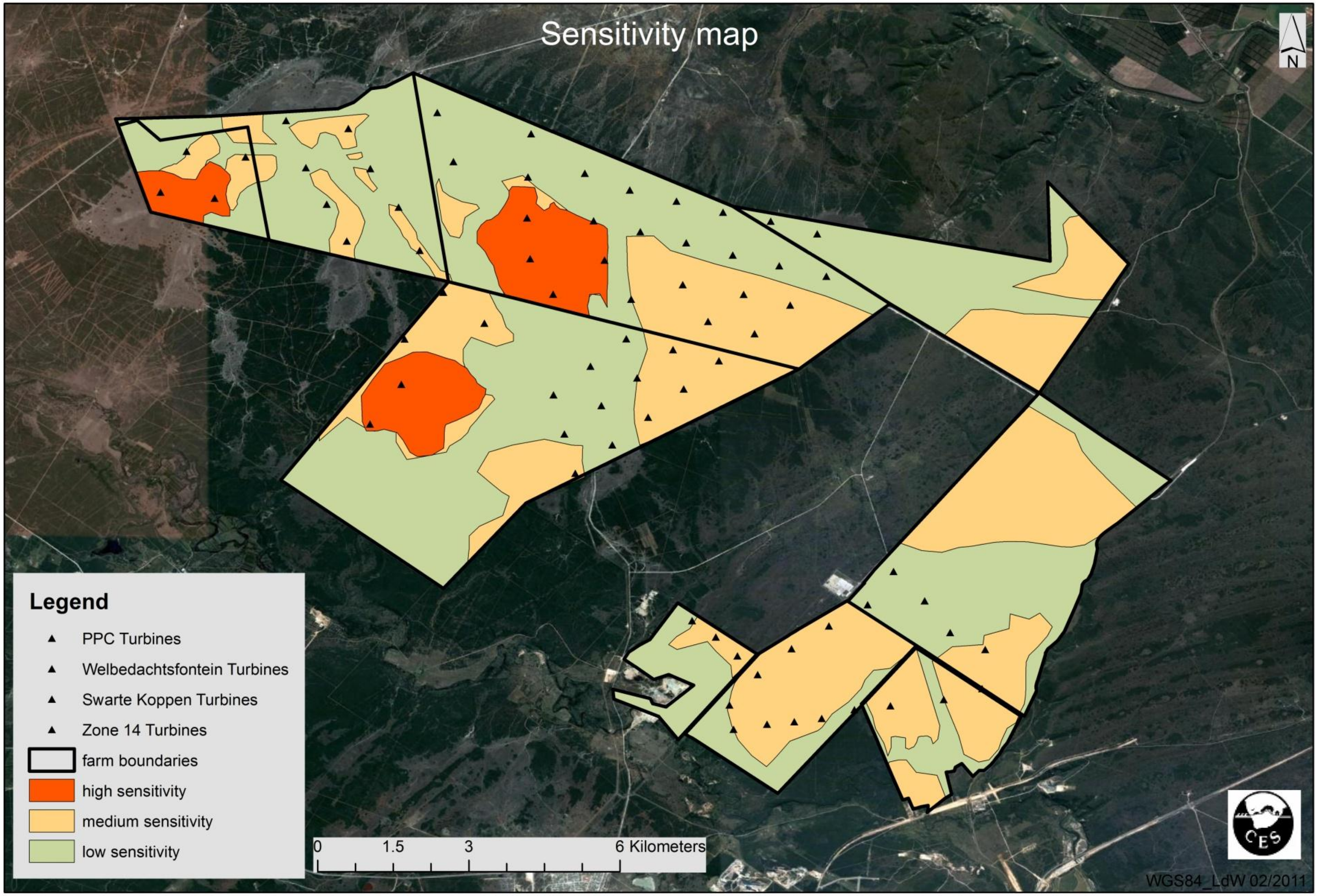

Figure 3-9: Map of the proposed Coega/PPC wind energy facility site showing sensitivity of the vegetation on the site.

4 IMPACTS IDENTIFIED AND ASSESSED

The proposed development will inevitably result in a loss of vegetation and habitat, as is detailed in the section below. Importantly, every effort should be made to avoid the species of special concern. Although much of the site has a moderate or high ecological sensitivity, positioning of turbines occurs mostly in moderate to low areas of ecological sensitivity and turbine footprints are small, resulting in minimal destruction of the vegetation.

4.1 Flora and Vegetation

Issue 1: Destruction of vegetation

Impact 1: Loss of Bontveld

Cause and Comment
Construction of the wind farm will result in loss of the Bontveld on the site. This loss will occur as a result of trampling of the vegetation as well as extra clearing needed for construction. Mitigation measures can be used in order to reduce the trampling and rehabilitate the vegetation respectively.

If nothing were built on the site, the overall significance would be positive. This would be due to the continuation of the current lad use. On the Coega site, this would be nothing and on the PPC site, the vast majority will be conservation, resulting in the regrowth of vegetation and the rehabilitation of ecological integrity and corridors.

Mitigation and management
Mitigation measures include the following: Keep removal of vegetation to a minimum. Do not remove vegetation in areas set aside for conservation within the site (should an area be set aside for conservation).

Without mitigation:
In the construction phase of this development, the impact will be permanent, localised, may occur and will be a slight severity. The overall Significance of the impact will thus be a moderate negative. This impact was assessed with a high level of confidence.

With mitigation:
With mitigation, in the construction phase of the development, with mitigation the impact is reduced to an overall significance of low negative.

Significance statement

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Without mitigation	Permanent	4	Localised	1	Slight	1	May Occur	2	**8**	**MODERATE -**
With mitigation	Permanent	4	Localised	1	Slight	1	Unlikely	1	**7**	**LOW -**
Operation phase										
Without mitigation	N/A		N/A		N/A		N/A			**N/A**
With mitigation	N/A		N/A		N/A		N/A			**N/A**
No-Go										
Without mitigation	Long term	3	Study area	2	Moderate	2	Probable	3	**10**	**MODERATE +**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

Impact 2: Loss of Sunday‟s Thicket

Cause and Comment

Construction of the wind farm will result in a loss of the Sunday‟s Thicket on the site. This loss will occur as a result of trampling of the vegetation as well as extra clearing needed for construction. Mitigation measures can be used in order to reduce the trampling and rehabilitate the vegetation respectively.

If nothing were built on the site, the overall significance would be positive. This would be due to the continuation of the current lad use. On the Coega site, this would be nothing and on the PPC site, the vast majority will be conservation, resulting in the regrowth of vegetation and the rehabilitation of ecological integrity and corridors.

Mitigation and management

Mitigation measures include the following: Keep removal of vegetation to a minimum. Do not remove vegetation in areas set aside for conservation within the site (should an area be set aside for conservation).

Without mitigation:

In the construction phase of this development, the impact will be permanent, localised, may occur and will be a slight severity. The overall Significance of the impact will thus be a moderate negative. This impact was assessed with a high level of confidence.

With mitigation:

With mitigation, in the construction phase of the development, with mitigation the impact is reduced to an overall significance of low negative.

Significance statement

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Without mitigation	Permanent	4	Localised	1	Slight	1	May Occur	2	**8**	**MODERATE -**
With mitigation	Permanent	4	Localised	1	Slight	1	Unlikely	1	**7**	**LOW -**
Operation phase										
Without mitigation	N/A		N/A		N/A		N/A			**N/A**
With mitigation	N/A		N/A		N/A		N/A			**N/A**
No-Go										
Without mitigation	Long term	3	Study area	2	Moderate	2	Probable	3	**10**	**MODERATE +**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

Impact 3: Loss of plant species of special concern

Cause and Comment

There are, on the study site, three species of special concern. These include *Aloe africana*, *Sideroxylon inerme, Euphorbia obesa, Boophone disticha* and *Mesembyanthemaceae.* There may be many additional species of special concern that will be found on site during construction that were not found during this study. These should be relocated of they need to be removed, and the required permits obtained in order to do so.

If nothing was built on the site the overall impact would be positive. This would be due to the continuation of the current lad use. On the Coega site, this would be nothing and on the PPC site, the vast majority will be conservation, resulting in the regrowth of vegetation and the rehabilitation of ecological integrity and corridors.

Mitigation and management
It is recommended that areas containing species of special concern be noted and every effort made to reduce the impacts of construction on these sections of vegetation. SSC in any area to be cleared should be identified and rescued. Some SSC will not transplant. These individuals should, as far as possible, be left untouched.

Without mitigation:
Without mitigation in the construction phase of the project the impact will be restricted to the study area, long term and definite with a moderate impact, resulting in an overall significance of moderate negative. This impact was assessed with a high level of confidence.

With mitigation:
With mitigation the severity of the impact is decreased from moderate to slight, but the overall significance of the impact remains moderate negative.

Significance statement

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Without mitigation	Long term	3	Study area	2	Moderate	2	Definite	4	**11**	**MODERATE -**
With mitigation	Long term	3	Study area	2	Slight	1	Definite	4	**10**	**MODERATE -**
Operation phase										
Without mitigation	N/A		N/A		N/A		N/A			**N/A**
With mitigation	N/A		N/A		N/A		N/A			**N/A**
No-Go										
Without mitigation	Long term	3	Study area	2	Moderate	2	Probable	3	**10**	**MODERATE +**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

Issue 2: Alien Vegetation

Impact 4: Introduction of alien plant species

Cause and Comment
As with all building operations, the introduction of alien and invader species is inevitable; with disturbance comes the influx of aliens. Alien invader species need to be consistently managed over the entire operation phase of the project.

Mitigation and management
Mitigation measures to reduce the impact of the introduction of alien invaders, as well as mitigation against alien invaders that have already been recorded on the site should be actively maintained throughout both the construction and operation phases. Removal of existing alien species should be consistently done. Also, rehabilitation of disturbed areas after the construction of the wind energy facility should be done as soon as possible after construction is completed. Invasive plant species are most likely to enter the site carried in the form of seeds by construction vehicles and staff; these should be cleaned before entering the site to prevent alien infestation.

Without mitigation:
In the construction phase of the development, the impact will be short-term, restricted to the study area and definite, with a severe severity. The impact will have an overall significance of moderate negative. In the operation phase of the project, the impact will be permanent, restricted to the study area, definite and with a severe severity. Overall significance would be a high negative. Should the proposed development not go ahead (the No-Go option), the impact would be permanent, definite and restricted to the study area with a severity of moderate and an overall significance of high negative. This impact was assessed with a high level of confidence.

With mitigation:
In the construction phase of development, mitigation measures will result in an overall positive impact. For the operation phase of development; mitigation measures will result in an overall positive impact.

Significance statement

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Without mitigation	Short-term	1	Study area	2	Severe	4	Definite	4	**11**	**MODERATE -**
With mitigation	Short-term	1	Study area	2	Beneficial	4	Probable	3	**10**	**MODERATE +**
Operation phase										
Without mitigation	Permanent	4	Study area	2	Severe	4	Definite	4	**14**	**HIGH -**
With mitigation	Medium-term	2	Study area	2	Beneficial	4	Probable	3	**11**	**MODERATE +**
No-Go										
Without mitigation	Permanent	4	Study area	2	Moderate	2	Definite	4	**12**	**HIGH -**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

4.2 Fauna

Issue 3: Loss of Fauna

Impact 5: Loss of faunal biodiversity

Cause and Comment
Loss of faunal diversity will occur mainly as a result of habitat destruction and resultant restriction in animal movement will reduce the fauna on the site. In addition, workers trapping animals will have an effect on the faunal populations.

If nothing was built on the site the overall impact would be a high positive. This would be due to the continuation of the current lad use. On the Coega site, this would be nothing and on the PPC site, the vast majority will be conservation, resulting in the regrowth of vegetation and the rehabilitation of ecological integrity and corridors.

Mitigation and management
If any fencing is to be done; the fences should have enough space between wires for small animals to move across them uninhibited. Workers should also be educated on conservation and should not be allowed to trap animals on site.

Without mitigation:
Without mitigation in the construction phase of the development, the impact will be long-term, restricted to the study area and probably will occur. Severity of the impact is moderate with an overall significance of moderate negative. This impact was assessed with a medium level of confidence.

With mitigation:
With mitigation likelihood is decreased to unlikely and severity of impact is reduced to slight. The overall significance is thus a low negative.

Significance statement

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Without mitigation	Long-term	3	Study area	2	Moderate	2	Probable	3	**10**	**MODERATE -**
With mitigation	Long-term	3	Study area	2	Slight	1	Unlikely	1	**7**	**LOW -**
Operation phase										
Without mitigation	N/A		N/A		N/A		N/A			**N/A**
With mitigation	N/A		N/A		N/A		N/A			**N/A**
No-Go										
Without mitigation	Permanent	4	Localised	1	Beneficial	4	definite	4	**14**	**HIGH +**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

Impact 6: Loss of species of special concern

Cause and Comment
There are a number of species of special concern that occur within the study site. This development is unlikely to affect any of these as few are restricted to the site specifically. For the No-Go option, the impact will be positive. This would be due to the continuation of the current lad use. On the Coega site, this would be nothing and on the PPC site, the vast majority will be conservation, resulting in the regrowth of vegetation and the rehabilitation of ecological integrity and corridors.

Mitigation and management
Mitigation measures include those described for loss of faunal biodiversity. The impact is likely to be low, however and thus these mitigation measures not required for this impact.

Without mitigation:
Without mitigation in the construction phase of the development, the impact will be permanent, localised and unlikely with a severity of slight and an overall significance of low negative. This impact was assessed with a high level of confidence.

With mitigation:
Mitigation measures for this impact are unnecessary as the impact is low negative.

Significance statement

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Without mitigation	Permanent	4	Localised	1	Slight	1	Unlikely	1	**7**	**LOW -**
With mitigation	N/A		N/A		N/A		N/A			**N/A**
Operation phase										
Without mitigation	N/A		N/A		N/A		N/A			**N/A**
With mitigation	N/A		N/A		N/A		N/A			**N/A**
No-Go										
Without mitigation	Permanent	4	Localised	1	Beneficial	4	definite	4	**14**	**HIGH +**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

4.3 Bat impacts

Issue 4: Displacement

Impact 7: Disturbance and displacement of bats

Cause and Comment
Disturbance displacement from around the turbines may result in reduced breeding productivity or reduced survival if bats are displaced from preferred habitat and are unable to find suitable alternatives. Disturbance may be caused by the presence of turbines, and/or by maintenance vehicles and people, as well as during the construction of the turbines.

In the No-Go option, the impact will be positive. This would be due to the continuation of the current lad use. On the Coega site, this would be nothing and on the PPC site, the vast majority will be conservation, resulting in the regrowth of vegetation and the rehabilitation of ecological integrity and corridors.

Mitigation and Management
Not a great deal can be done to minimise the effects of disturbance displacement from construction activities. However, within reason noise must be kept to a minimum when constructing the wind energy facility.

Without mitigation
In the construction phase without mitigation the impact will occur over the short term, be restricted to the study area and probable with a slight severity. Overall significance is Low Negative. In the operation phase without mitigation the impact will occur over the long term, be restricted to the study area, is probable and moderate with an overall significance of Moderate Negative

With mitigation
In the construction phase with mitigation, the severity is still slight, resulting in an overall significance of Low Negative. In the operation phase with mitigation (continual monitoring and application of new mitigation measures), the severity is likely to be reduced to slight, resulting in an overall impact of Moderate Negative.

Significance Statement

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Without mitigation	Short term	1	Study area	2	Slight	1	Probable	3	**7**	**LOW -**
With mitigation	Short term	1	Study Area	2	Slight	1	Probable	3	**7**	**LOW -**
Operation phase										
Without mitigation	Long term	3	Study Area	2	Moderate	2	Probable	3	**10**	**MODERATE -**
With mitigation	Long term	3	Study Area	2	Slight	1	Probable	3	**9**	**MODERATE -**
No-Go										
Without mitigation	Long term	3	Localised	1	Slight	1	May occur	2	**7**	**LOW +**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

Issue 5: Habitat

Impact 8: Loss of bat habitat due to vegetation clearing

Cause and Comment
Change to or loss of habitat due to wind turbines and associated infrastructure. A relatively small area of habitat for bats will be completely destroyed in the construction process.

For the No-Go option, the impact will be positive. This would be due to the continuation of the current lad use. On the Coega site, this would be nothing and on the PPC site, the vast majority will be conservation, resulting in the regrowth of vegetation and the rehabilitation of ecological integrity and corridors.

Mitigation and Management
The following mitigation measures can be used to minimise the effects of loss of habitat:

- The wind turbines should not be placed on the tops of ridges.
- Every effort should be made to rehabilitate the damaged vegetation to minimise the habitat losses to resident bat species.

Without mitigation
For the construction phase without mitigation the impact will occur in the long term, will be restricted to the study area and is probable with a severity of slight and an overall significance of Moderate Negative.

With mitigation
For the construction phase with mitigation the risk is slight and the overall significance is a Moderate Negative.

Significance Statement

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Without mitigation	Long term	3	Study area	2	Slight	1	Probable	3	**9**	**MODERATE -**
With mitigation	Long term	3	Study area	2	Slight	1	May occur	2	**8**	**MODERATE -**
Operation phase										
Without mitigation	N/A		N/A		N/A		N/A			**N/A**
With mitigation	N/A		N/A		N/A		N/A			**N/A**
No-Go										
Without mitigation	Long term	3	Study area	2	Slight	1	May occur	2	**8**	**MODERATE +**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

Issue 6: Bat collisions

Impact 9: Bat mortalities from colliding with turbine blades, tower, and/or associated infrastructure

Cause and Comment
This impact is most probably the most crucial impact associated with the wind farm in terms of this study. Collision with the moving turbine blades, with the turbine tower or associated infrastructure such as overhead powerlines, or the wake behind the rotors can cause injury, leading to direct mortality of bats.

Mitigation and Management
The tops of ridges should be avoided for placement of turbines, turbines should also be shut off during times when bats are active, low wind speeds at night is the best time (and when little electricity is being generated by the turbines).

The lower the turbines the less bat fatalities there are likely to be. If cut-in speed is set at 6 metres per second, bat fatalities can be halved. It is recommended that bat fatalities, and their causes at the wind farm are monitored, as there is no information available for wind farms in South Africa. More applicable mitigation measures can be applied when there is more information. Bats should be continually be monitored.

Without mitigation
This impact applies only to the operation phase of the development. Without mitigation the impact is probable, is restricted to the study area, over the long term with a moderate severity and an overall significance of Moderate Negative.

With mitigation
With mitigation the likelihood is reduced to may occur but the overall significance remains Moderate Negative.

Significance Statement

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Without mitigation	N/A		N/A		N/A		N/A			**N/A**
With mitigation	N/A		N/A		N/A		N/A			**N/A**
Operation phase										
Without mitigation	Long term	3	Study area	2	Moderate	2	Probable	3	**10**	**MODERATE -**
With mitigation	Long term	3	Study area	2	Moderate	2	May occur	2	**9**	**MODERATE -**
No-Go										
Without mitigation	N/A		N/A		N/A		N/A			**N/A**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

4.4 Cumulative impacts

Issue 7: Fragmentation

Impact 10: Effect of fragmenting Vegetation types

Cause and Comment

This impact is unlikely to occur if the development is managed effectively. Considering the nature of wind turbines, it is unlikely that fragmentation will occur if the natural vegetation is left beneath them and the building of roads kept to a minimum.

Mitigation and management

As mentioned above, fragmentation is unlikely to occur due to the nature of the development. However, it is important to make sure all fences have wide enough mesh to let small animals through, and that large areas of vegetation are not cleared, especially for roads.

For the No-Go option, the impact will be positive. This would be due to the continuation of the current lad use. On the Coega site, this would be nothing and on the PPC site, the vast majority will be conservation, resulting in the regrowth of vegetation and the rehabilitation of ecological integrity and corridors.

Without mitigation:

Without mitigation the impact will be unlikely, in the long term and restricted to the study area and slight. Overall significance will be a low negative.

With mitigation:

With mitigation the temporal scale would be reduced from long term to short term, thus the overall significance remains a low negative. This impact was assessed with a high level of confidence.

Significance statement

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Without mitigation	Long term	3	Study area	2	Slight	1	Unlikely	1	**7**	**LOW -**
With mitigation	Short term	1	Study area	2	Slight	1	Unlikely	1	**5**	**LOW -**
Operation phase										
Without mitigation	N/A		N/A		N/A		N/A			**N/A**
With mitigation	N/A		N/A		N/A		N/A			**N/A**
No-Go										
Without mitigation	Long-term	3	Study area	2	Slightly beneficial	1	May Occur	2	**8**	**MODERATE +**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Current status

The vegetation on the proposed wind energy facility site is mostly in fair condition. There are a few invader species along with some degraded vegetation, both of which could potentially result in further degradation of the site in the future. As the site forms part of the Coega IDZ, there is an existing Open Space Management Plan that provides for the conservation and upkeep of some of the land within the Coega IDZ.

5.2 Comparison of impacts

Because of the very nature of a wind farm, it is suspected that many of the impacts will be reduced with effective management of the site as well as the utilization of rehabilitation after construction. For the plant species of special concern, it is recommended that any of these species are identified and rescued before building commences.

In addition to this, any extra land needed for the construction phase of the development that will not be used during the operation phase of the development should be rehabilitated after construction is completed. Table 6-1 below outlines the impacts.

Table 6-1: Summary table of all 11 impacts on flora and vegetation and fauna in the Coega/PPC wind farm site along with cumulative impacts.

Impacts	Without mitigation			With mitigation		
	Construction phase	Operation phase	No-Go	Construction phase	Operation phase	No-Go
Flora and Vegetation						
1: Loss of Bontveld	MOD -	N/A	MOD +	LOW -	N/A	N/A
2: Loss of Sundays Thicket	MOD -	N/A	MOD +	LOW -	N/A	N/A
4: Loss of Plant Species of Special Concern	MOD -	N/A	MOD +	MOD -	N/A	N/A
5: Introduction of alien plant species	MOD -	HIGH -	HIGH -	MOD +	MOD +	N/A
Fauna						
6: Loss of faunal biodiversity	MOD -	N/A	HIGH +	LOW -	N/A	N/A
7: Loss of species of special concern	LOW -	N/A	HIGH +	N/A	N/A	N/A
8: Disturbance displacement of bats	LOW -	MOD -	LOW +	LOW -	MOD -	N/A
9: Loss of bat habitat	LOW -	N/A	MOD +	LOW -	N/A	N/A
10: Bat mortalities	N/A	MOD -	N/A	N/A	MOD -	N/A
Cumulative Impacts						
11: Fragmentation of vegetation types	LOW -	N/A	MOD +	LOW -	N/A	N/A

Overall, the impacts of the overall development will be negative, mainly due to a loss of vegetation. This loss of vegetation is also important for fauna as it constitutes habitat loss. Positive impacts include the active management of the alien vegetation on the site.

5.3 Plant removal\rehabilitation

It is recommended that a botanist/ecologist is on site to determine if any of the species of special concern or protected species occurs where the turbines and associated infrastructure are positioned. Before the clearing of the site is authorised, the appropriate permission must be obtained from the Department of Water Affairs (DWA) for plants listed in the National Forests Act, and from the Department of Economic Development and Environmental Affairs (DEDEA) for the destruction of the Provincial Nature Conservation Ordinance (PNCO) Schedule 4 protected species.

In order to acquire a permit to destroy or remove plant species that fall under the National Forest Act an application form will need to be submitted to DWA. A letter needs to be drafted and sent to DEDEA prior to the destruction\removal of any PNCO Schedule 4 species: This letter must list the species that will be removed or destroyed and the reason for their removal or destruction.

These permits may be subject to certain conditions, for example allowing various nurseries to collect plants before vegetation clearance commences; the removal of certain species for rehabilitation purposes, etc. The plants can also be removed and placed in the Coega IDZ nursery for use in the Coega IDZ and for rehabilitation purposes. If a species is identified for relocation, individuals of the species will need to be located within the proposed site, before vegetation clearing commences, and carefully uprooted and removed by a skilled horticulturist. Prior to removal, however, suitable relocation areas need to be identified, either within the site or in other disturbed areas on the property. Individual plants that cannot be relocated at the time of removal should be moved to the Coega IDZ nursery. It should be noted that many critical SSC are plants that will not be able to be successfully uprooted and replanted at all (Phillipson, 2002), or at best may have a low survival rate. In all cases the species will require very careful treatment to give them the best chances of survival, and specialist horticultural knowledge will be needed.

5.4 Invasion of alien species

Any form of disturbance to the natural vegetation provides a gateway for alien species to invade the site of disturbance. In this regard, it is recommended that a strict monitoring plan be implemented to prevent the additional spread and the continued removal of alien species such as those of *Opuntia ficus-indica* and *Acacia* species, which are already present on site.

5.5 Micro-siting of turbines

Turbine micro-siting should be done bearing in mind the impacts and ecological sensitivity of the proposed location of the turbines. In areas of low sensitivity, turbines can be located as their impact will be low and the control of alien invasive species and any rehabilitation will have a comparatively positive impact. Turbines places in areas of medium sensitivity should be carefully positioned and built so that they have as little impact as possible, as areas of medium sensitivity are valuable for ecosystem functioning. Areas of high sensitivity should be avoided completely when micro-siting turbines as they are very important for ecosystem integrity and functioning and are usually restricted in size, lending them great importance. It should also be noted that turbines should not be places in drainage regions or within rivers as these are process areas and their functioning should not be effected in any way.

5.6 Operational phase recommendations

- Continued monitoring of the site for potential alien invasion, especially of plant species already established.
- Continued monitoring of impacts on bats with a view to determining baseline information on the impacts of wind farms on bats in South Africa as well as determining which mitigation measures are best used.

Maintenance of areas set aside within the site for conservation to make sure these are not being impacted further in any way.

ECOLOGICAL APPENDIX - A: SPECIES RECORDED DURING THE ON-SITE INVESTIGATION, NOVEMBER 2010

ACANTHACEAE
Hypoestes aristata (Vahl) Sol. ex Roem. & Schult. var. *aristata*

AIZOACEAE
*Aizoon rigidum*L.f

AMARYLLIDACEAE
Boophone disticha (L.f.) Herb.

ANACARDIACEAE
Rhus glauca Thunb.
Rhus incisa L.f. var. *incise*
Rhus longispina Eckl. & Zeyh.
Rhus pallens Eckl. & Zeyh.

APIACEAE
Centella asiatica (L.) Urb.

APOCYNACEAE
Carissa bispinosa (L.) Desf. ex Brenan
Pachypodium bispinosum (L.f.) A.DC.
Sarcostemma viminale subsp. Indet

ARALIACEAE
Cussonia spicata Thunb.

ASPARAGACEAE
Asparagus africanus Lam.
Asparagus densiflorus (Kinth) Jessop
Asparagus striatus (L.f.) Thunb.

ASPHODELACEAE
Aloe africana Mill.
Aloe ferox Mill.
Gasteria bicolor Haw.

ASTERACEAE
Athanasia sp. L.
Berkheya sp.
Brachylaena elliptica (Thumb.) DC.
Conyza canadensis (L.) Cronquist
Chrysanthemoides monilifera (L.) Norl.
Chrysocoma ciliata L.
Eriocephalus ericoides (L.f.) Druce
Filicia muricata (Thunb.) Nees subsp *muricata*
Gazania sp
*Helichrysum anomalum*Less.
Metalasia muricata (L.) D.Don
Pteronia incana (Burm.) DC.
Pentzia incana (Thunb.) Kuntze
Senecio radicans (L.f.) Sch.Bip.

BORAGINACEAE
Ehretia rigida (Thunb.) Druce subsp *nervifolia* Retief & A.E. van Wyk

BRASSICACEAE
Lepidium africanum (Burm.f.) DC.

CACTACEAE
Opuntia ficus-indica (L.) Mill.

CAPPARACEAE
Cappparis sepiaria L. var. *citrifolia* (Lam.) Tolken
Cadaba aphylla (Thunb.) Wild

CELASTRACEAE
Gymnosporia arenicola M.Jordaan
Pterocelastrus tricuspidatus (Lam.) Walp.
Putterlickia pyracantha (L.) Szyszyl.
Gymnosporia buxifolia (L.) Szyszyl.
Gymnosporia polyacantha (Sond.) Szyszyl. Subsp. *Polyacantha*
Maytenus undata (Thunb.) Blakelock

COMMELINACEAE
Commelina sp.
Commelina benghalensis L.

CRASSULACEAE
Crassula ericoides Haw.
Crassula perfoliata L.
Cotyledon orbiculata L. var. indet
Kalanchoe Adans sp

CYPERACEAE
Eleocharis limosa (Schrad.) Shult.Ficinia sp
Kyllinga erecta Schumach. Var. *erecta*
Scirpus sp.

DRACAENACEAE
Sansevieria hyacinthoides (L.) Druce

EBENACEAE
Euclea undulata Thunb.
Diospyros lycioides De Winter

ELATINACEAE
Bergia glomerata L.f.

EUPHORIBIACEAE
Clutia sp. L.
Euphorbia burmannii E.Mey. Ex Boiss.
Euphorbia triangularis Desf.

FABACEAE
Psoralea sp. L.
Schotia afra var indet
Acacia cyclops A.Cunn. Ex G.Don
Acacia karroo Hayne
Indigofera L. sp.

GERANIACEAE
Geranium incanum Burm. F.

Pelargonium capitatum (L.) L'Her.
Pelargonium sp. L'Her.

HYACINTHACEAE
Ledebouria sp.

HYPOXIDACEAE
Hypoxis hemerocallidea Fisch.Mey. & Ave-Lall.
Spiloxene sp

LAMIACEAE
Plectranthus ecklonii Benth
Plectranthus sp.

LOBELIACEAE
Cyphia sp. P.J. Bergius

MESEMBRYANTHEMACEAE
Lampranthus sp.
Delosperma sp. N.E.Br. Emend. Lavis

OLEACEAE
Olea europaeae L. supbsp. *Africana*(Mill.) P.S. Green

OXALIDACEAE
Oxalis smithiana Eckl. & Zeyh.
Oxalis sp L.

POACEAE
Aristida congesta Roem. & Schult.
Cynodon dactylon (L.) Pers.
Digitaria eriantha Steud.
Eragrostis curvula (Schrad.) Nees
Eragrostis plana Nees
Eragrostisobtusa Munro ex Ficalho & Hiern
Hemarthria altissima (Poir.) Stapf & C.E.Hubb.
Hyparrhenia hirta (L.) Stapf
Merxmuellera distica (Nees) Conert
Panicum deustum Thunb.
Panicum maximum Jacq.
Panicum repens L.

PORTULACACEAE
Portulacaria afra Jacq.

RANUNCULACEAE
Clematis brachiata Thunb.

RESEDACEAE
Reseda sp. L.

RHAMNACEAE
Scutia myrtina (Burm.f.) Kurz

SALVADORACEAE
Azima tetracantha Lam.

SANTALACEAE
Osyris compressa (P.J. Bergius) A.DC.

SAPINDACEAE
Hippobromus pauciflorus (L.f.) Radlk.
Pappea capensis Eckl. & Zeyh

SAPOTACEAE
Sideroxylon inerme L. subsp. *Inerme*

SCORPHULARIACEAE
Selago corymbosa L.
Jamesbrittenia sp. Kuntze

SOLANACEAE
Lycium oxycarpum Dunal
Lycium afrum L.

STERCULIACEAE
Hermannia amoena Dinter ex Friedr.-Holzh.
Hermannia althaeoides Link
Hermnnia flammea Jacq.

THYMELAEACEAE
Passerina sp.

TILIACEAE
Grewia robustai Burch.

VISCACEAE
Viscum obovatum Thunb.
Viscum rotundifolium L.f.

VITACEAE
Rhoicissus digitata (L.f.) Gilg & M.Brandt
Rhoicissus tridentata

ECOLOGICAL APPENDIX B: SCC RECORDED DURING PREVIOUS STUDIES (PHILLIPSON, 2002A; 2002B), WITHIN THE SAME VEGETATION TYPE WITHIN THE COEGA IDZ

ACANTHACEAE
Blepharis procumbens (L. f.) Pers.

AMARYLLIDACEAE
Apodolirion macowanii Bak.
Cyrtanthus clavatus (L'Hérit.) R.A. Dyer
Haemanthus albiflos Jacq.
Haemanthus coccineus L.
Strumaria gemmata Ker-Gawl

APOCYNACEAE
Pachypodium bispinosum (L. f.) A. DC.
Pachypodium succulentum (L. f.) Sweet

ASCLEPIADACEAE
Brachystelma sp.
Duvalia caespitosa (Mass.) Haw.

ASPHODELACEAE
Aloe striata Haw. subsp. striata
Trachyandra ciliata (L. f.) Kunth

ASTERACEAE
Berkheya heterophylla (Thunb.) O. Hoffm. var. *heterophylla*
Gibbaria scabra (Thunb.) T. Norl.
Euryops ericifolius (Belang.) B. Nord.

CELASTRACEAE
Lauridia reticulata Eckl. & Zeyh. (listed as *Cassine reticulate)*

CRASSULACEAE
Adromischus cristatus (Haw.) Lem.
Crassula perfoliata L. var. *coccinea* (Sweet) Rowley
Cotyledon velutina Hook. f.

ERIOSPERMACEAE
Eriospermum dregei Schonl.

EUPHORBIACEAE
Euphorbia clava Jacq.
Euphorbia fimbriata Scop.
Euphorbia ledienii Berger var. *ledienii*
Euphorbia meloformis Ait.
Euphorbia stellata Willd.

GERANIACEAE
Pelargonium pulverulentum Colv. ex Sweet

HYACINTHACEAE
Ledebouria coriacea S.Venter ined.
Ledebouria ensifolia (Eckl.) S.Venter ined.
Massonia echinata L. f.

IRIDACEAE
Babiana patersoniae L. Bol.

MESEMBRYANTHEMACEAE
Bergeranthus addoensis L. Bol
Lampranthus hollandii (L. Bol.) L. Bol.
Platythyra haeckeliana (Berger) N.E. Br.
Rhombophyllum rhomboideum (Salm-Dyck) Schwant.

ORCHIDACEAE
Acrolophia micrantha (Lindl.) Schltr. & H. Bol.

OXALIDACEAE
Oxalis algoensis Eckl. & Zeyh.
Ophioglossum polyphyllum A. Br. in Seub.

RHAMNACEAE
Phylica axillaris Lam. var. *microphylla* (Eckl. & Zeyh.) Pillans

SANTALACEAE
Thesium scandens Sond.

SOLANACEAE
Lycium horridum Thunb.

STERCULIACEAE
Hermannia saccifera (Turcz.) K. Schum.

APPENDIX A-2: AVIFAUNA REPORT

AVIFAUNA IMPACT ASSESSMENT: PROPOSED COEGA WINDFARM, NELSON MANDELA BAY MUNICIPALITY, EASTERN CAPE PROVINCE

SPECIALIST REPORTS
VOLUME 2: ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Prepared for:	Prepared by:	Prepared by:
InnoWind (Pty) Limited	Coastal & Environmental Services	Endangered Wildlife Trust
P.O. Box 1116 Port Elizabeth, 6000	P.O. Box 934 Grahamstown, 6140	Private bag X11 Parkview 2122
South Africa	South Africa	South Africa

FEBRUARY 2011

<u>This report should be cited as follows</u>: Smallie, J.J. Endangered Wildlife Trust, February 2011. *Proposed Coega Wind Energy Project: Avifaunal Specialist Sudy Impact Assessment, Endangered Wildlife Trust*, Johannesburg, South Africa

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EXECUTIVE SUMMARY

InnoWind (Pty) Ltd is proposing to develop a wind energy facility named "Coega Wind Energy Facility", near the port of Coega in the Eastern Cape.

The Endangered Wildlife Trust‟s Wildlife and Energy Programme was appointed by Coastal Environmental Services (CES) to conduct the avifaunal specialist studies for this project.

The most important potential impacts of the proposed development will be collision of certain bird species with the turbine blades, and collision of birds with the associated power lines that will be built. Habitat destruction and disturbance of birds is likely to be of lower significance due to the relatively disturbed nature of the site and habitat. With respect to the impact of power line collision, the EWT has an excellent understanding of this interaction, and believes mitigation is relatively straight forward to achieve through optimal routing, and identification of high risk sections of line during the site specific environmental management plan that has been recommended. However, with respect to collision with turbines, our confidence is much lower, due to a lack of operational turbines in South Africa to date. A number of species which are: considered likely to be vulnerable to turbine collisions based on theory and international experience; have proven vulnerable to power line collisions; are Red Listed; and are abundant on or close to site, have been identified by this study. These species include the Blue Crane, Denham‟s Bustard, Secretarybird, Greater Flamingo, Lanner Falcon, White Stork, Great White Pelican, and assorted waterfowl and waders. The Greater Flamingo is of particular concern. However, the extent to which collision of the target species, and any other species, occurs at the proposed turbines is dependant on their flight movements and behaviour. In other words with respect to collision specifically, there could be large numbers of a species on or close to site, but if they do not fly frequently enough, at the relevant rotor zone height and in the relevant areas, collisions will not occur.

Given this uncertainty, and the belief that in broad environmental terms, renewable energy options such as wind energy should be supported, the EWT is of the opinion that this project should go ahead. The broader area and site is subject to significant development of various forms, and is in many respects the type of site that should in the EWT‟s opinion be targeted by wind energy facilities. The main reason for uncertainty with regard to the above aspects is the lack of operational wind farms in South Africa, and without building any wind farms we cannot begin to gather the data required to eliminate or reduce this uncertainty.

We believe that it is critical to obtain the best possible data on bird movement on site as soon as possible, so as to develop an understanding of, and manage, the issues at hand. This can be achieved through the implementation of a comprehensive pre and post construction monitoring programme. A methodology for this monitoring programme has been compiled and included as Appendix A. It is recommended that a suitable avifaunal specialist be appointed by InnoWind to supervise the full monitoring programme, ideally with a local person doing the field work. It is important that pre construction monitoring begins early enough in order to facilitate at least 12 months of data collection.
If the post construction monitoring reveals significant numbers of bird collisions, the developer will need to take reasonable measures to mitigate for these collisions. Likely options for this mitigation have been detailed in this report.

We also believe that avifaunal input into the final site specific EMP, and micro siting of infrastructure is essential.

SPECIALIST PRACTITIONER DECLARATION OF INDEPENDENCE

AVIFAUNA IMPACT ASSESSMENT: PROPOSED COEGA WIND ENERGY FACILITY, NELSON MANDELA BAY MUNICIPALITY, EASTERN CAPE

Avifauna specialist

I Jon Smallie declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Coega Wind Energy Project, application or appeal in respect of which I 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 my performing such work.

SIGNATURE:

LIST OF ABBREVIATIONS

CAR:	Co-ordinated Avifaunal Road counts
CES:	Coastal and Environmental Services
DSR:	Draft Scoping Report
EMP:	Environmental Management Plan
EWT:	Endangered Wildlife Trust
QDS:	Quarter Degree Square
SABAP:	South African Bird Atlas Project
WEF:	Wind Energy Facility

1 INTRODUCTION

1.1 Overview

InnoWind Pty (Ltd) is proposing to develop a wind energy facility named “Coega Wind Energy Facility”, near the port of Coega in the Eastern Cape.

Coastal Environmental Services (CES) has been appointed to undertake the environmental studies as required by legislation. The Endangered Wildlife Trust has been appointed by CES to conduct the avifaunal specialist studies for the project. A site visit was conducted in late November, and a second site visit in February 2011, to examine the sites and available conditions first hand.

Typically a development of this type could be expected to impact on birds through destruction and alteration of habitat, disturbance of birds and barrier effects, collision of birds with turbine blades, and impacts of associated infrastructure.

1.2 Terms of reference

The assessment will include:

- A desk-top review of existing literature. The review will seek: Previous means of predicting bird mortality (and other impacts) of wind turbines affecting birds in groups similar to those in the study area; accounts of mortality at wind turbines; information on the status, in Coega, Eastern Cape, South Africa and globally, of bird groups most likely to be affected
- A site visit to identify species of special concern and assess the likely impacts of the construction and operational phases on the avifauna of the site
- Conduct a review of international literature and experience relating to operational wind farms; including state-of-the-art plants around the world;
- Contextualize the literature and experience and relate it to the Eastern Cape scenario and local avifauna;
- Map sensitive areas in and around the proposed project site(s);
- Describe the affected environment and determine the status quo in terms of avifauna;
- Indicate how an avifaunal resource or community will be affected by the proposed project;
- Discuss gaps in the baseline data with respect to avifauna and relevant habitats;
- List and describe the expected impacts;
- Assess and evaluate the anticipated impacts, and
- Make recommendations for relevant mitigation measures which will allow the reduction of negative impacts and the maximization of the benefits associated with any identified positive impacts.
- Although the avifauna specialist will assess avian collision risk and provide detailed explanations and ratings of the likelihood of collisions of various species, detailed avian collision modellingi.e quantitatively assessing the collision risk potential (i.e. birds directly colliding with rotor blades and turbine towers) of the proposed wind farm cannot be undertaken. This is because the extent to which this can formally be modeled and quantified to arrive at predicted numbers of collisions, would depend largely on the primary data collection related to flight frequencies and species, but it is unlikely that even the best possible data collection within the framework of current EIA practice in SA would provide much confidence in such a model, as it would require more representative data collection across a range of conditions/seasons etc.

1.3 Structure of the report

This report is structured as follows:

- Literature review of the existing knowledge of avifaunal interactions with wind energy
- Description of the avifaunal environment

- Bird presence in the study area
- Impacts
- Comparison of alternatives
- Conclusions and recommendations

1.4 The study team

Jon Smallie (Pri. Sci. Nat)
Jon Smallie is employed by the Endangered Wildlife Trust"s Wildlife and Energy Programme as a specialist investigator for conducting avifaunal specific specialist reports. Jon has a BSc (hon) degree and has experience with numerous electrical infrastructure projects, including wind energy facilities. Jon is registered with the South African Council for Natural Scientific Professions (registration number: 400020/06).

1.5 Methodology

1.5.1 Data collection

This study followed the following steps:

- An extensive review of available international literature, pertaining to bird interactions with wind energy facilities was undertaken in order to fully understand the issues involved and the current level of knowledge in this field. Care was taken to adapt the international knowledge to local conditions and species wherever necessary
- The various data sets listed below were obtained and examined
- The potential impacts of the proposed facility were described and evaluated
- Sensitive areas within the proposed site were identified using various GIS layers and Google Earth
- A site visit was conducted to investigate these sensitive areas more fully as well as to get an idea of what micro-habitats occur in the area

1.5.2 Data sources used

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

- The South African Bird Atlas Project (SABAP) data (Harrison et al 1997) for the quarter degree square covering the sites
- The Important Bird Areas report (Barnes 1998) was consulted for data on the area
- Conservation status of species occurring in the study areas was determined using Barnes (2000)
- The bird specialist report for the original Klipheuwel demonstration facility (van Rooyen 2001)
- The report to Eskom Peaking Generation on the monitoring of bird mortalities at the demonstration facility at Klipheuwel (Kuyler 2004 – obtained from Eskom Peaking Generation)
- International literature on avian interactions with wind energy facilities
- Coordinated Waterbird Counts (CWAC) (Taylor, Navarro, Wren-Sargent, Harrison &Kieswetter, 1999) from the nearby site of: Krom River Mouth. Although the original report was compiled in 1999 and is referenced here, more up to date data available online has been used for this study.

1.5.3 Assumptions and limitations

Any inaccuracies in the above sources of information could limit this study. In particular, the Bird Atlas data is now thirteen years old (Harrison et al 1997), but no reliable more recent data on bird species presence and abundance in the study area exists.

2 INTERACTIONS BETWEEN AVIFAUNA AND WIND ENERGY FACILITIES

2.1 Background

The following section provides a background to avifauna - wind energy facility interactions. It is critical to understand the various issues and factors at play, before an accurate assessment of the impacts of the proposed wind energy facility on the birds of the area can be conducted.

By necessity, the following description is based almost entirely on international literature, primarily from the United States. In reality the South African experience of wind energy generation has been extremely limited to date. Most of the principles that have been learnt internationally can, to a certain extent, be applied locally.

However, care needs to be taken to adapt existing international knowledge to local bird species and conditions. Much of the work cited below has also been published in proceedings of meetings and conferences, not in formal peer reviewed journals. The information therefore needs to be used with some degree of caution, particularly when drawing comparisons, as the methodologies used were not always as scientific as desired.

This section focuses largely on the impact of bird collisions with wind turbines. Wind energy facilities also impact on birds through disturbance and habitat destruction, and by means of their associated infrastructure. This has received less attention in the literature, probably because they are less direct (and less emotive) impacts. In spite of the focus of this section on turbine collisions, this study will assess all possible interactions between avifauna and the proposed facility.

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

Concern for the avian impacts of wind energy facilities first arose in the 1980"s when raptor mortalities were detected in California (Altamont Pass - US) and at Tarifa (Spain). The Altamont Pass and Tarifa sites were the sites of some extremely high levels of bird mortalities. These mortalities focused attention on the impact of wind energy on birds and subsequently a large amount of monitoring at various sites has been undertaken.

Naturally, as more monitoring was conducted at different sites, a need arose for a standard means of expressing the levels of bird mortalities – in this case the number of mortalities per turbine per year. The following is a brief summary of some data that has emerged internationally.

It is important to note that searcher efficiency (and independence) and scavenger removal rates need to be accounted for. Searcher efficiency refers to the percentage of bird mortalities that are detected by searchers and searcher independence refers to whether the person monitoring has certain objectives of their own which may influence the results of monitoring.

Additionally, although the rates may appear relatively low, it is important to note that it is the cumulative effect of a wind farm that is really important. In other words, the absolute number of birds killed by a wind farm in a year is far more meaningful than an average per turbine. In addition, for some species, even a minute increase in mortality rates could be significant (long lived, slow reproducing species such as many of the South African Red Listed species).

Table 2-1: Summary of international bird collision rates

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

South Africa

To date, only eight wind turbines have been constructed, 1 at Coega in July 2010, 3 at a demonstration facility at Klipheuwel in the Western Cape in 2002 and 2003, and 4 at a site near Darling (although access to these for the purpose of monitoring bird impacts has been restricted to the knowledge of the EWT).

A monitoring program, conducted by Jacque Kuyler (2004), was put in place once the Klipheuwel turbines were operational. This report was obtained from Eskom Peaking Generation. The monitoring involved site visits twice a month to monitor birds flying in the vicinity of the site in order to detect bird mortalities. Important findings of this monitoring conducted from June 2003 to January 2004 are as follows:

- Between 9% and 57% of birds observed within 500m of the turbines were at blade height – there was great variation between months.
- Between 0% and 32% of birds sighted were close to the turbines defined as “between turbines or within outer router arc” and again showed great variation between months.
- Five bird carcasses were found on the site during this 8 month period. Two of these, a Helmeted Guineafowl and a Spotted Dikkop were determined to be killed by predators. A Horus Swift and a Thick-billed Lark were determined to have been killed by collision with turbine blades. A Cattle Egret was found with no visible injuries and was allocated to natural causes.
- Given that these two mortalities occurred in an eight month period are expressed as # of mortalities/turbine/year (using the three turbines at Klipheuwel), the result is 1.00 mortality per turbine per year.
- Experimental assessment of the searcher efficiency revealed that 7 out of 9 (77%) of carcasses placed in the study area were detected by the searcher.
- These nine carcasses were scavenged at between 12 and 117 days after their placement.

2.1.1 Factors influencing bird collisions with turbines

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

Bird related information

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

It is important to understand that not all birds that fly through the rotor zone automatically collide with blades. In fact avoidance rates for certain species have proven to be extremely high. In a radar study of the movement of ducks and geese in the vicinity of an off-shore wind facility in Denmark, less than 1% of bird flights were close enough to the turbines to be at risk. This is graphically shown in Figure 1-1, where black lines represent bird flights, and red dots represent the position of turbines. It is clear that the birds avoided the turbines effectively (Desholm&Kahlert, 2005).

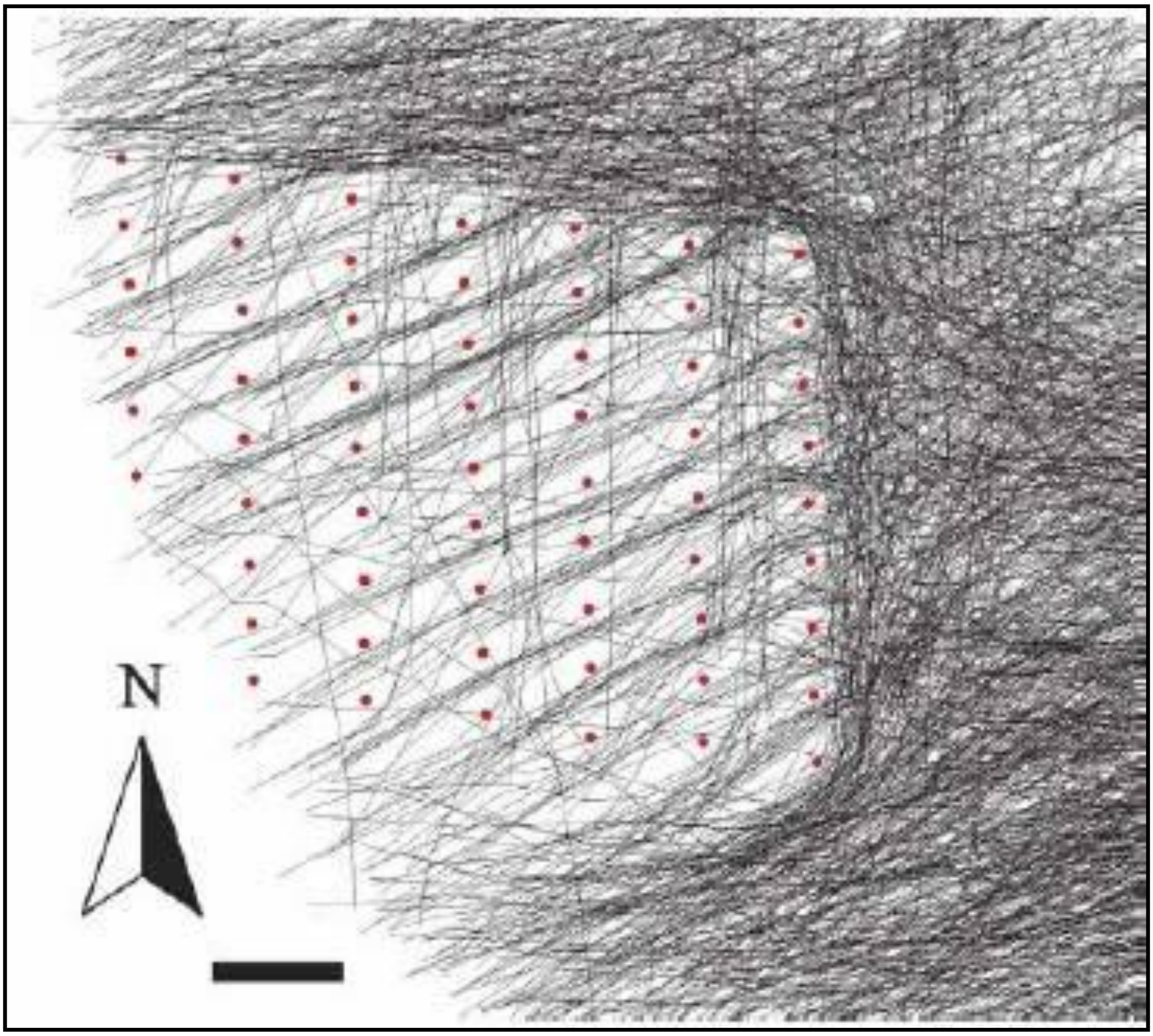

Figure 2-1: Radar tracked movement of ducks and geese relative to an offshore wind facility in Denmark Desholm&Kahlert, 2005)

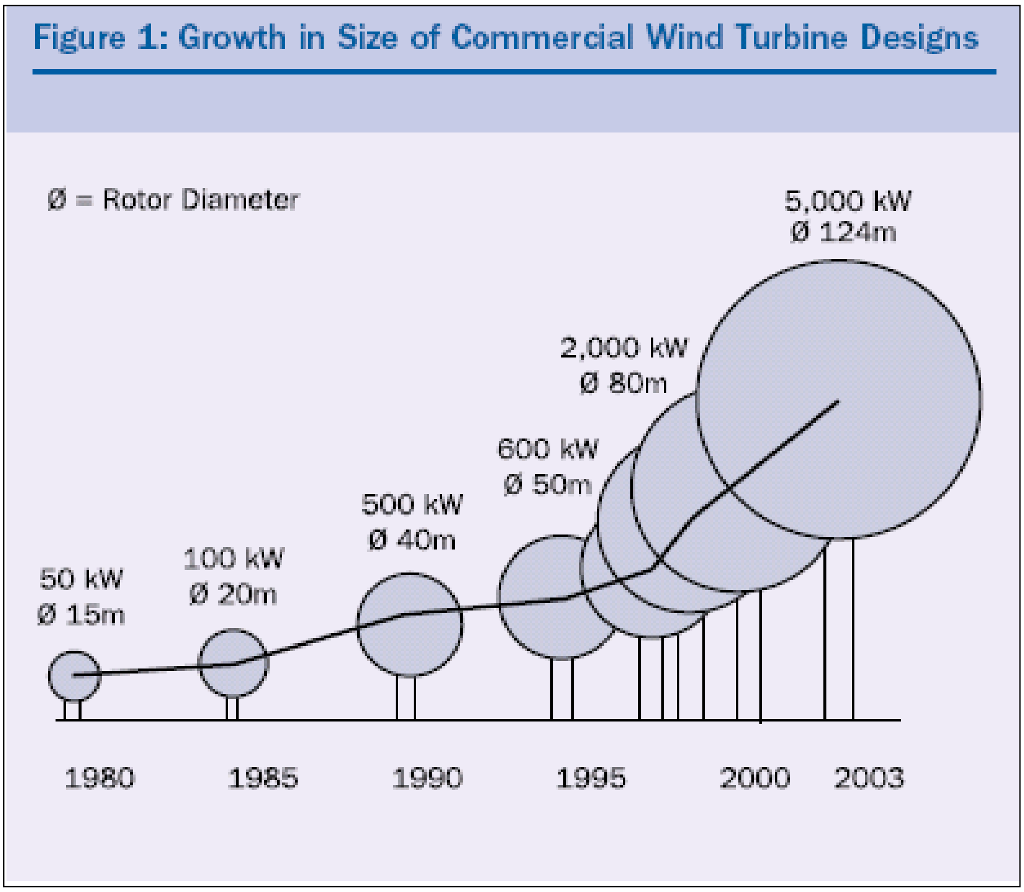

Figure 2-2: The development of turbine size since the 1980's – European Wind Energy Association (EWEA)

Site information

Landscape features can potentially channel or funnel birds towards a certain area, and in the case of raptors, influence their flight and foraging behaviour. Elevation, ridges and slopes are all important factors in determining the extent to which an area is used by birds in flight. High levels of prey will attract raptors, increasing the time spent hunting, and as a result reducing the time spent being observant. At Mountaineer Wind Energy Centre in Tucker County (USA), 30 songbirds collided unexpectedly with a turbine during thick fog conditions in May 2003 (Cumberland Times).

Very few collisions had been recorded prior to this weather incident. Birds fly lower during strong headwinds (Hanowski&Hawrot, 2000; Richardson, 2000; pers.obs.). This means that, when the turbines are functioning at their maximum speed, birds are likely to be flying at their lowest – a perilous combination.

Facility information

According to Kingsley &Whittam (2005), "More turbines will result in more collisions". Although only two mortalities have been recorded at Klipheuwel, the difference between the 3 turbines at Klipheuwel and a potential 72 turbines at the proposed Coega Wind energy facility is significant. Larger facilities also have greater potential for disturbance and habitat destruction.To date, it has been shown that large turbines kill the same number of birds as smaller ones (Howell 1995, Erickson et al, 1999). With newer technology and larger turbines, fewer turbines are needed for the same quantity of power generation, possibly resulting in less mortalities per kW of power produced (Erickson et al, 1999). Figure 1-2 shows the development of turbine size over the years.

Certain turbine tower structures may provide suitable perching space to certain bird species, thereby increasing the chances of collisions as birds leave or enter the perch. These lattice structure designs have since been abandonedand it is anticipated that tubular towers (which have limited perching potential) will be used for the Coega Wind energy facility.

Lighting of turbines and other infrastructure has the potential to attract birds, thereby increasing the risk of collisions with turbines. In Sweden a large number of collisions were recorded with one turbine in one night. The turbine was not operational, but was lit (Karlsson, 1983: in Winkelman, 1995). At the Mountaineer site mentioned above, all collisions occurred on the three turbines closest to the substation (which was lit with a solid white light). No collisions occurred on any of the other 12 turbines which were lit with red strobe lights. The theory behind the relationship between lights and the number of collisions is that nocturnal migrants navigate using stars and mistake lights for stars (Kemper, 1964).

Another partial explanation may be that lights attract insects which in turn attract birds. Changing constant lighting to intermittent lighting has been shown to reduce attraction (Richardson 2000) and mortality (APLIC, 1994; Jaroslow, 1979; Weir, 1976) and changing white flood light to red flood light resulted in an 80% reduction in mortality (Weir, 1976). Erickson *et al* (2001) suggest that lighting is the single most critical attractant leading to collisions with tall structures. As this is the case, mitigatory means by the investigation of reducing or cancelling the usage of lights on wind turbines will be investigated, possibly using transpondeur technology *inter alias*.

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

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

Infrastructure associated with the facility often also impacts on birds. The minimal use of overhead power lines used only to connect the WEF to the substation are likely to pose a collision and possibly an electrocution threat to certain bird species. Furthermore, the construction and maintenance of the power lines will result in some disturbance and habitat destruction. New access roads constructed will also have a disturbance and habitat destruction impact.

Collisions are one of the biggest single threats posed by overhead power lines to birds in southern Africa (van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes and various species of water birds. These species are mostly heavy-bodied birds with limited maneuverability, which makes it difficult for them to take the necessary evasive action to avoid colliding with power lines (van Rooyen 2004, Anderson 2001). Unfortunately, many of the collision-sensitive species are considered threatened in southern Africa.

The Red Listed species vulnerable to power line collisions are generally long living, slow reproducing species under natural conditions. Some require very specific conditions for breeding, resulting in very few successful breeding attempts, or breeding might be restricted to very small areas. These species have not evolved to cope with high adult mortality, with the result that consistent high adult mortality over an extensive period could have a serious effect on a population"s ability to sustain itself in the long or even medium term.

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004).

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

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

2.1.2 Potential explanations for collisions of birds with turbines

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

- An inability to divide attention between prey and obstacles. This seems an unlikely explanation as birds have been found to maintain good acuity in the peripheral vision; have different foveal regions in the eye for frontal and ground vision; and have various other optical methods for keeping objects at different distances simultaneously in focus.
- The phenomenon of motion smear or retinal blur, whereby rapidly moving objects become less visible the closer the eye is to them. The retinal image can only be processed up to a certain speed, after which the image cannot be perceived. Hence the plausible reasoning why rotors with lower rotational speeds are less prone to collision.
- The angle of approach. If a bird approaches from side on to the turbine, the blades present a very small profile and are even more difficult to detect.

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

2.1.3 Mitigation measures

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

Turbine design

Several different modern turbine designs exist, apart from the conventional three blade design, and are potentially of less impact to avifauna. Some of these turbines turn in the wind on the same plane as the tower, as opposed to the three bladed design, which turns at right angles to the tower. Another important aspect is that some of these designs are a solid mass and thus by not having the gaps between the blades, should be more visible to birds and hence result in fewer collisions. South Africaisonly beginning to set up a wind energy industry and are likely to be technology followers not leaders in this regard.

Painting turbines

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

- Acuity of kestrels appears superior when objects are viewed at a distance, suggesting that the birds may view nearby objects with one visual field and objects further away with another.
- Moderate motion of the stimulus significantly influences kestrel acuity. Kestrels may be unable to resolve all portions of turbine blades under some conditions such as blade rotation, low contrast of blade with background and dim illumination.
- Results suggest that careful selection of blade pattern will increase conspicuity. Blade patterns that were proven to be conspicuous to humans also proved to be conspicuous to kestrels. Patterns across the blade produce better conspicuity in humans and kestrels than patterns down the length of blades. These authors recommend a pattern of square wave black and white components that run across the blade width.

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

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

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

Anti perching devices

Perching on turbines has been implicated in increasing collision rates, although this was predominantly on lattice type towers which have almost disappeared from use,and not tubular towers. It is highly unlikely that any significant amount of perching will occur on the tubular type turbines.

Curtailment

This involves the shutdown of high risk turbines during high risk periods. In certain cases, where collision risk occurs in very specific conditions or at very specific times, this can be a feasible option.

Blade adjustment

This involves shortening the blade to accommodate the predominant flight height of a particular species, so that safe flight may occur below the rotor zone.

2.1.4 Summary of literature review

Summary of the main points from the above literature review:

- With a few exceptions (such as at Altamont Pass and Tarifa), studies have found low numbers of bird mortalities at wind energy facilities.
- There is a huge variance in mortality between sites, and even between individual turbines within sites.
- The majority of collisions seem to involve raptors and/or songbirds.
- At the Klipheuwel site in South Africa, monitoring for 8 months revealed two mortalities, i.e. a Horus Swift and a Thick-billed Lark (now named Large-billed Lark). The lark mortality is in accordance with literature which states that grassland species with aerial courtship displays (such as larks, many of which perform aerial displays) are particularly vulnerable to collisions.
- Factors affecting the number of mortalities at a facility include: bird species present, prey abundance, landscape features, weather, number of turbines, turbine size, turbine spacing and facility lighting.
- Associated infrastructure such as power lines, etc also impact on birds.
- It appears that intermittent lighting may be less attractive than continuous lighting, and that possibly red light is less attractive than white light.
- The primary explanation for collisions appears to be the phenomenon of motion smear or retinal blur. Mitigation measures should therefore focus on reducing motion smear effects.
- In laboratory testing, two studies have found that painting turbine blades increases their visibility to American Kestrels. The most visible patterns appear to be black stripes across the blade, in different positions on each blade so as to reduce retinal blur or motion smear or more simply a single solid black blade with two solid white blades. Unfortunately these tests confirm only that the blades will be more visible if painted. They do not test what the psychological response of birds to the blades will be. Birds may be scared and repelled from the blades or may be curious and be attracted closer. Only field testing can confirm these responses. We are not aware of any field testing of these blades to date.

2.2 Description of the proposed wind energy facility

The Coega wind energy facility is located near the port of Coega in the Eastern Cape, and will consist of the following:

- Approximately 75 turbines;
- Electrical substation/s;
- Each turbine will have a hub height of 90 – 105m, with blades between 45 and 56m long.
- 22 to 33kV underground power line/s interlinking the wind turbines, and 22 to 33kV underground or overhead power lines linking the facility to the existing Eskom/ Municipal grid;
- Access roads; and
- Maintenance /control building.

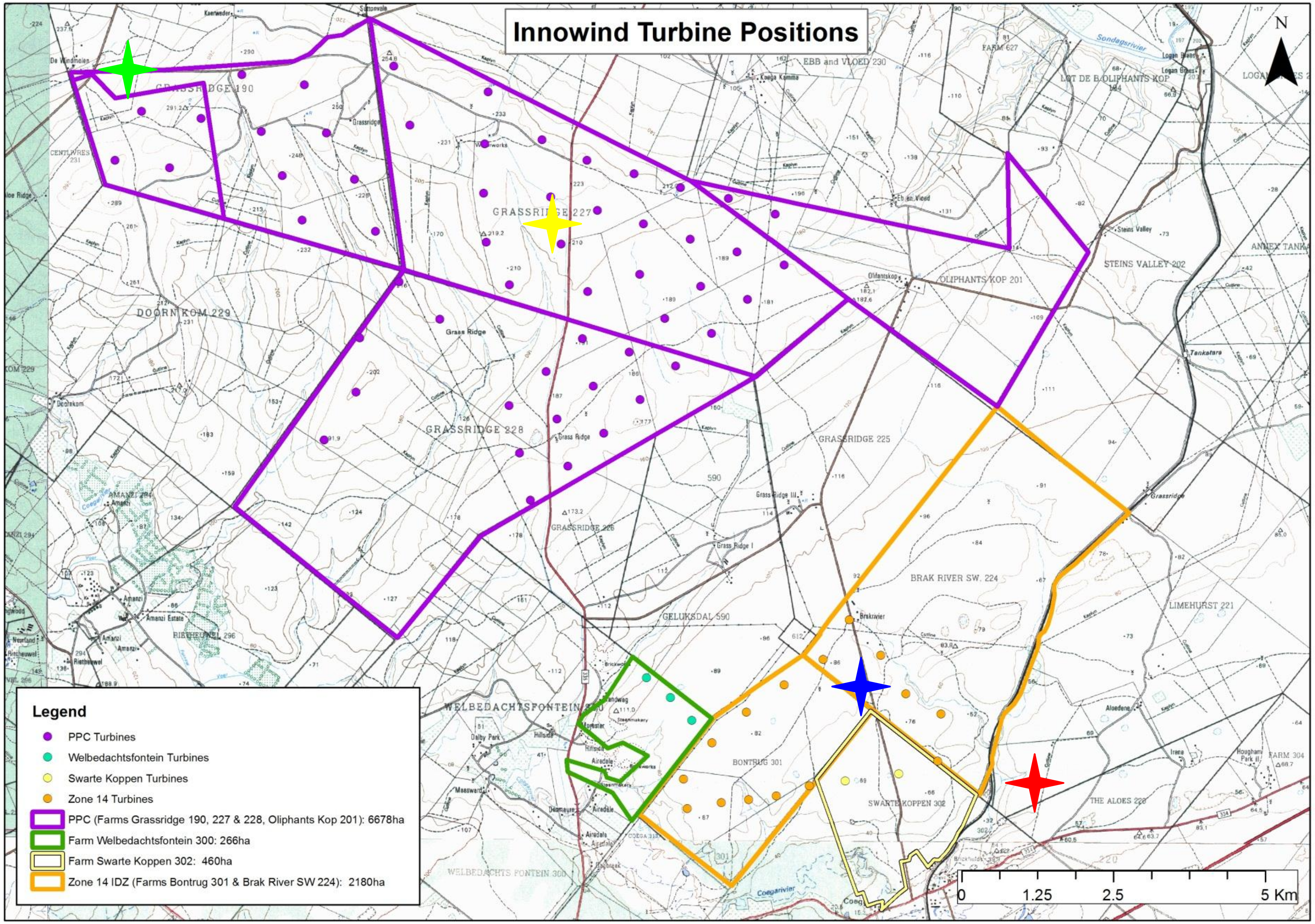

Figure 2-3: Layout of the proposed site for the Coega wind energy facility and associated infrastructure. Stars indicate vantage points from which observational data was collected.

3 DESCRIPTION OF THE AVIFAUNA ENVIRONMENT

3.1 General area

The site is situated several kilometers from the Coega Industrial Development Zone, near Port Elizabeth in the Eastern Cape. The broader area is already relatively intruded upon by developments such as roads, power lines, electrical substations, cement/lime mines and of course the port of Coega and associated development zone.

3.1.1 Land use and vegetation of the study area

While this report is an avifaunal specialist report, vegetation and micro habitats are very important in determining avifaunal abundances and likelihood of occurrences. As such, a map has been produced below (Figure 1-4) showing the vegetation classification of the area (Mucina& Rutherford 2005). It is clear that nearly all turbine positions are situated in „Coega Bontveld", with a few in or close to „Sundays thicket".

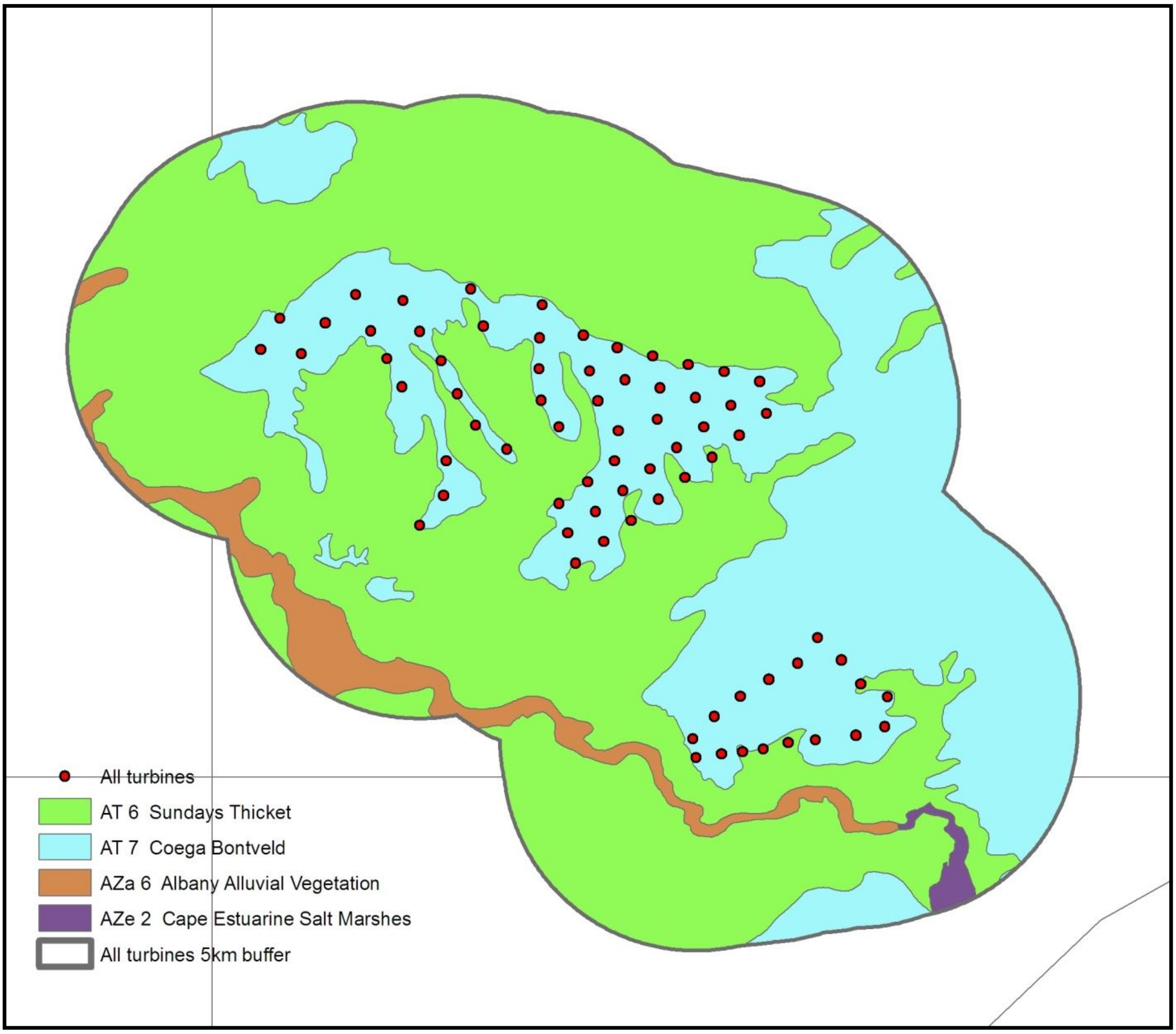

Figure 3-1: Vegetation classification for the study area (Mucina& Rutherford 2005)

3.1.2 Sensitive micro habitats for avifauna

Although the vegetation types are useful in determining the suitability of habitat for bird species, the „micro habitats" available to birds on site are far more informative. Micro habitats can be created by a combination of vegetation type, and anthropogenic factors. Also, it is widely understood that vegetation structure is more important in determining bird species occurrence than vegetation species composition.

The site itself is relatively uniform and consists really of only one micro habitat type (with the exception of several small arable lands), a low valley bushveld vegetation as pictured below (Plates 3-1- to 3-4). In some cases this vegetation is more open, effectively grassland. This micro habitat is not particularly sensitive in terms of avifauna. The Red listed species likely to make use of the area are shown in Table 3-1.

Plate3-1: A typical view of the vegetation on site

Plate 3-2: A typical view of the vegetation on site

Plate 3-3: A typical view of the vegetation on site

Plate 3-4: A small arable land in the study area

3.1.3 Bird presence in the study area

Southern African Bird Atlas Project data

Table 1-2 lists the total number of recorded species, and the abundances of Red Listed bird species recorded in the quarter degree squares covering the study area by the Southern African Bird Atlas Project (Harrison *et al*, 1997). Although the entire project site falls within the square 3325DA, broader landscape level information is relevant for a facility of this type, and so data from two additional adjacent squares have been considered for the purpose of this study.

The total number of bird species recorded ranged from 149 to 325 across the 3 squares, and of these, 35 are Red Listed (Barnes 2000). These comprise 1 „Critically endangered", two „endangered", eight „vulnerable" and 24 „near-threatened". In addition the White Stork is included in Table 3-1 as it is protected internationally under the "Bonn Convention on migratory species". Of these Red Listed species, a number can be excluded from consideration immediately due to their marine nature, leaving those in bold in Table 3-1 that are likely to occur on site, or fly in close vicinity to the turbines.

Of these, the Blue Crane, Denham"s Bustard, Greater and Lesser Flamingo"s, Secretarybird, Lanner Falcon and White Stork are species with relatively high recorded abundance in the area. These species have all proven vulnerable to collision with other obstacles such as power lines.

The Southern African Bird Atlas Project 2 data was also consulted as this is a more recent source. The pentads which are closest to covering the turbine positions are 3340 2540 and 3340 2535, examination of the data from these pentads showed that most of the above important species have in fact been recorded in the pentads recently.

Coordinated Water bird count data (CWAC)

Six official sites that fall under the CWAC project are relevant to this study: the Coega saltpans; Perseverance vleis; Bar None saltpan; Redhouse saltpan; Chatty saltpans; PE Power station pans; Zwartkops River Estuary. Collectively these sites are important as breeding sites for several species such as Grey-headed Gull, Swift Tern, Caspian Tern, Chestnut-banded Plover, and African Sacred Ibis. Species which frequent these areas in high numbers include Greater Flamingo, Lesser Flamingo to a far lesser extent, gulls, waders, dabchicks, cormorants, ducks. Black-necked Grebe, Cape Teal, Red-billed Teal, African Sacred Ibis, and African Spoonbill. The Great White Pelican also occurs in the area, albeit at low densities. The position of these sites relative to the proposed turbines can be seen in Figure 3-2

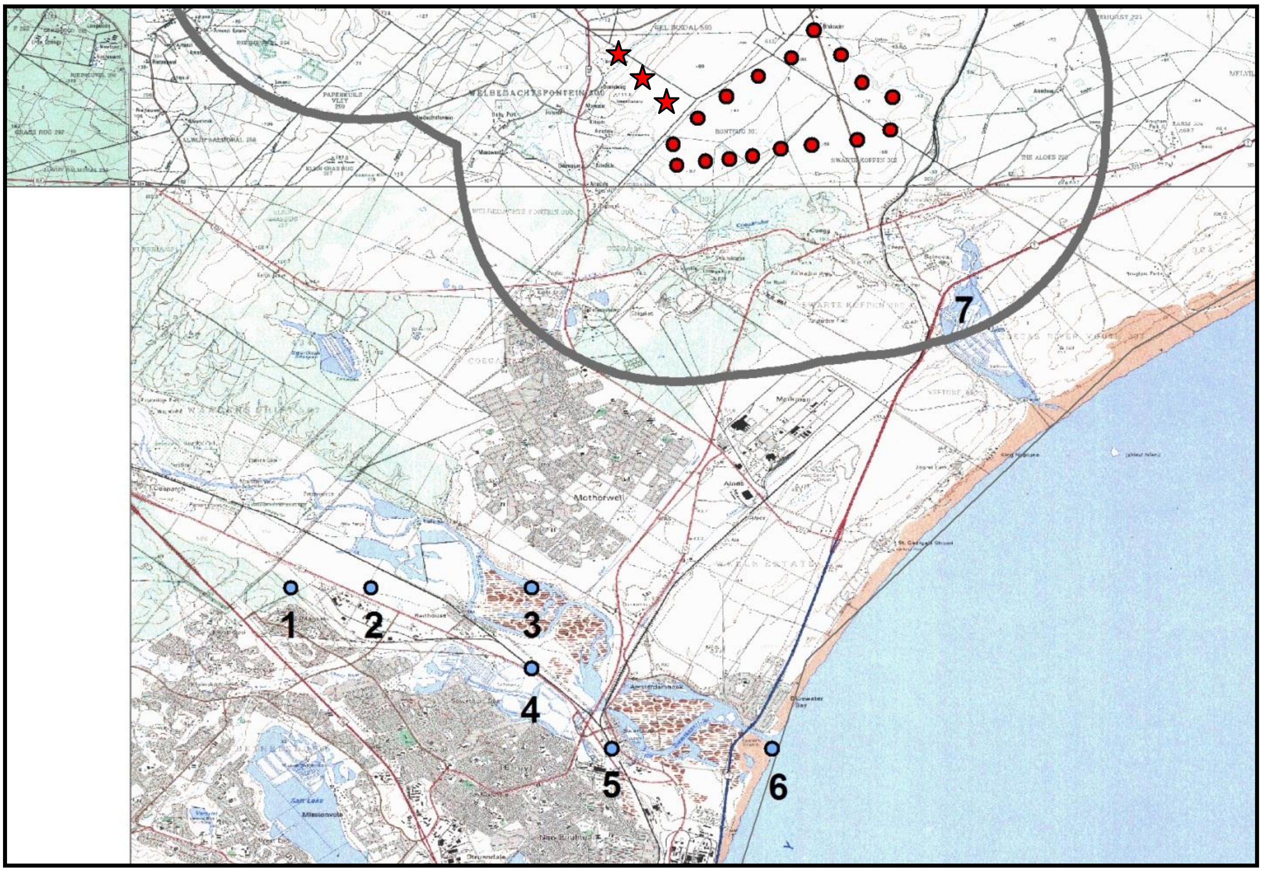

Figure 3-2: Position of the Coordinated Waterbird Count sites to the turbines. 1-Perseverance Pans, 2 Bar None Saltpans, 3 – Redhouse Saltpans, 4- Chatty Saltpans, PE Power Station Saltpans, 6 – Zwartkops River Estuary, 7 – Coega Saltpans. Grey line is 5km buffer from turbines.

The below mentioned species typically move frequently between these sites. Fortunately these sites are all south of the proposed turbines. There are no similar estuaries or salt pans to the west, or north of the turbines that would cause these species to regularly commute through the turbine zone.

Table 3-1: Red Listed species recorded in the quarter degree squares covering the study area (Harrison et al 1997)

Species	Conservation Status	Report rate (%)			Preferred micro habitat
		3325 CB	3325 DA	3325 DC	
Total species		228	149	325	
# cards submitted		137	250	843	
Spectacled Petrel	CE	-	-	2	Marine
Roseate Tern	EN	-	-	3	Marine
Damara Tern	EN	-	-	1	Marine
Atlantic Yellow-nosed Albatross	VU	-	-	1	Marine
Shy Albatross	VU	-	-	1	Marine
Cape Gannet	VU	-	-	18	Marine
Cape Vulture	**VU**	**-**	**-**	**0**	**Grassland, short vegetation**
Martial Eagle	**VU**	**1**	**2**	**0**	**Grassland, woodland**
African Marsh-Harrier	**VU**	**-**	**2**	**2**	**Grassland, wetland**
Blue Crane	**VU**	**1**	**6**	**2**	**Grassland, arable land**
Denham's Bustard	**VU**	**1**	**8**	**-**	**Grassland, short vegetation**
Black-browed Albatross	NT	-	-	0	Marine
Northern Giant-Petrel	NT	-	-	0	Marine
White-chinned Petrel	NT	-	-	2	Marine
Great White Pelican	**NT**	**-**	**-**	**0**	**Wetland, dam, estuary**
Cape Cormorant	NT	-	-	26	Marine, estuary
Black Stork	**NT**	**4**	**1**	**8**	**Riverine**
Yellow-billed Stork	**NT**	**-**	**1**	**2**	**Wetland, dam, estuary**
Greater Flamingo	**NT**	**1**	**-**	**22**	**Wetland, dam, estuary**
Lesser Flamingo	**NT**	**-**	**-**	**14**	**Wetland, dam, estuary**
Secretarybird	**NT**	**1**	**5**	**1**	**Woodland, grassland**
African Crowned Eagle	**NT**	**7**	**-**	**-**	**Indigenous forest**
Black Harrier	**NT**	**-**	**1**	**1**	**Grassland, wetland**
Peregrine Falcon	**NT**	**-**	**-**	**3**	**Grassland, short vegetation**
African Penguin	**NT**	**-**	**-**	**5**	**Marine**
Lanner Falcon	**NT**	**-**	**5**	**10**	**Grassland, short vegetation**
Greater Painted-snipe	**NT**	**-**	**-**	**0**	**Wetland**
African Black Oystercatcher	NT	-	-	29	Marine
Chestnut-banded Plover	**NT**	**-**	**-**	**1**	**Estuary**
Black-winged Lapwing	**NT**	**-**	**2**	**0**	**Short grassland**
Black-tailed Godwit	**NT**	**-**	**-**	**1**	**Wetland, grassland**
Caspian Tern	**NT**	**1**	**7**	**19**	**Wetland**
Half-collared Kingfisher	**NT**	**1**	**5**	**5**	**Riverine**
Knysna Woodpecker	**NT**	**3**	**3**	**5**	**Indigenous forest**
Bush Blackcap	**NT**	**-**	**-**	**0**	**Indigenous forest**
White Stork	**Bonn**	**-**	**5**	**2**	**Wetland, grassland, arable land**

CE = Critically endangered, E = Endangered, VU = Vulnerable, NT = Near threatened, Bonn = Protected internationally under the “Bonn Convention on Migratory Species”. Report rates are essentially percentages of the number of times a species was recorded in the square, divided by the number of times that square was counted. It is important to note that these species were recorded in the entire quarter degree square in each case and may not actually have been recorded on the proposed site for this study.

Important Bird Areas project (IBA)

The Swartkops Estuary & Chatty Saltpans (SA096) Important Bird Area (Barnes 1998) lies approximately 10km south-east of proposed site. This area holds large numbers of various bird species, including notably the second largest breeding colony of White-breasted Cormorant in southern Africa and the second largest breeding colony of Caspian Tern in South Africa. Grey-headed Gull and African Sacred Ibis also have regionally important breeding populations here. Other species important to this study include Greater Flamingo, and assorted waterfowl.

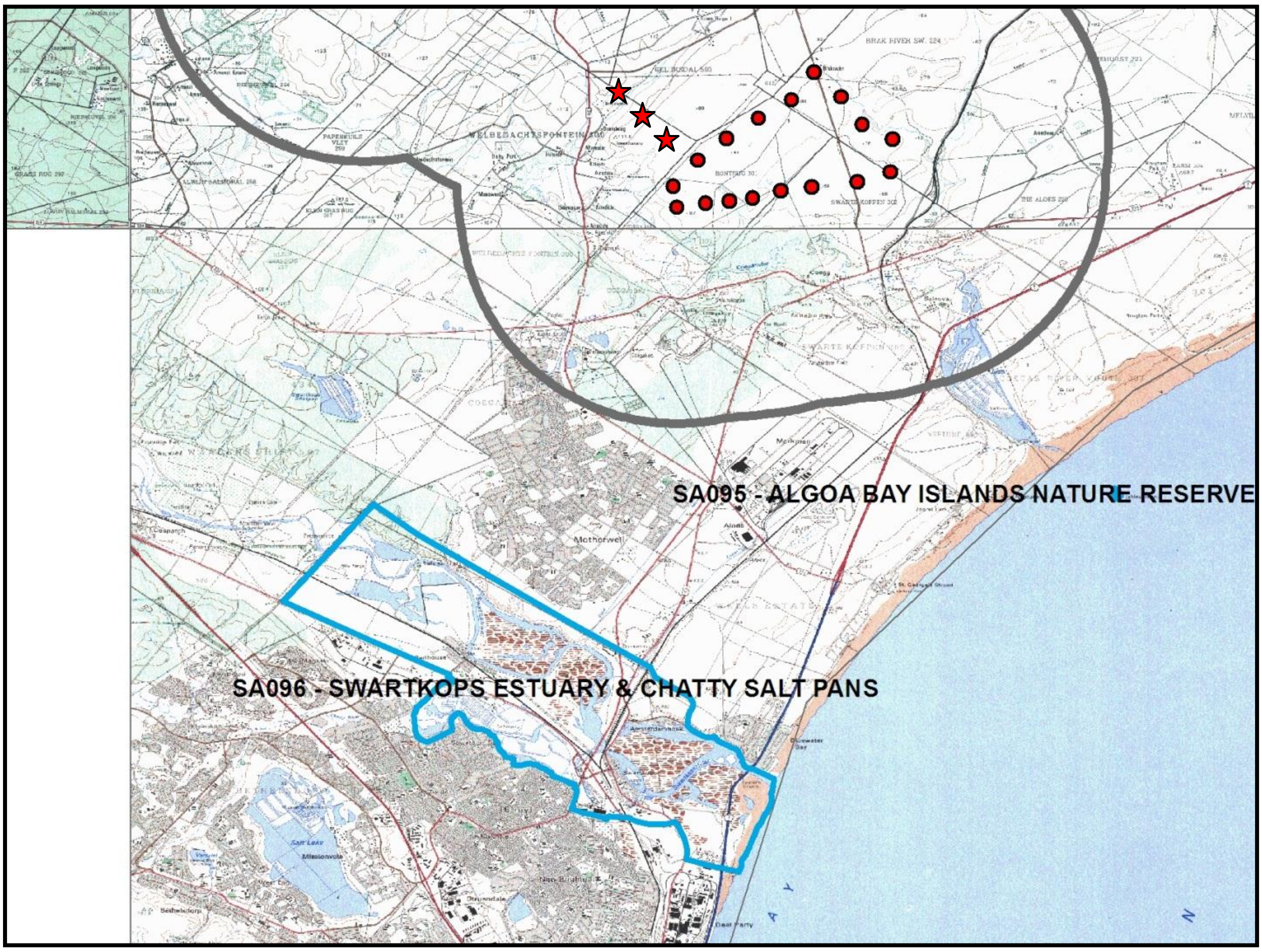

Figure 3-3: Position of the Important Bird Area SA096 – Swartkops Estuary & Chatty Saltpans. Grey line is 5km buffer from turbines

The data from these counts needs to be used with caution. Conducting counts over such a short period, in one season, and in fairly similar weather conditions cannot be taken as a true indication of the abundance of bird species in the area. In particular, the target species for this study are threatened, rare species, so the likelihood of seeing one during a 30 minute period is limited. This study has therefore attached far more weight to the secondary data sources such as the bird atlas project (Harrison et al, 1997, which collected data over a far longer period, and more diverse conditions.

Target species for this study

Determining the target species for this study, i.e. the most important species to be considered, is a three step process. The above data represents the first step, i.e. which species occur in the area at significant abundances. Secondly, the recent document “A briefing document on best practice for pre-construction assessment of the impacts of onshore wind farms on birds” (Jordan & Smallie, 2010) was consulted to determine which groups of species could possibly be impacted on by wind farms. This document summarises which taxonomic groups of species have been found to be vulnerable to collision with wind turbines in the USA, UK, EU, Australia and Canada.

The taxonomic groups that have been found to be vulnerable in two or more of these regions are as follows: Pelicaniformes (pelicans, gannets, cormorants); Ciconiiformes (storks, herons, ibises, spoonbills); Anseriformes (swans, ducks, geese); Falconiformes (birds of prey); Charadriiformes (gulls, terns, waders); Strigiformes (owls); Caprimulgiformes (nightjars); Gruiformes (cranes, bustards, rails); Galliformes (pheasants, grouse, francolins); and Passeriformes (songbirds).

The third step is to consider the species conservation status or other reasons for protecting the species. This involved primarily consulting the Red List bird species (Barnes 2000) as presented in Table 3-1.

The resultant list of „target species" for this study is as follows: the Blue Crane, Denham"s Bustard, Secretarybird, Greater Flamingo, Lanner Falcon, White Stork, Great White Pelican, and assorted waterfowl, and waders. In some cases, these species serve as surrogates for other similar species, examples being Lanner for Peregrine Falcon, and Greater for Lesser Flamingo.

As discussed elsewhere in this report, the impact of most concern for these species is that of collision with turbines. Of these species, the Greater Flamingo is perhaps of most concern, not only in terms of collision with turbines, but also the less direct impact resulting from the wind farm clusters forming barriers to the birds movement within this area. Flamingos are nocturnal fliers, and as such extremely vulnerable to collision with vertical obstacles in their flight paths.

The key question is how frequently do species such as this fly to the north of the complex of salt pans and estuary to the south of the proposed WEF. It is our opinion that there is little reason for these species to venture north, and hence cross the proposed site, since there are no more similar habitats to the north. However, this is speculation, and in the case of a species such as Greater Flamingo it is well know that it sometimes flies off course during the night or in poor weather.

Assorted more common species will also be relevant to this study, but it is believed that the above target species will to a large extent serve as surrogates for these in terms of impact assessment and management.

Study area sensitivity

The actual site itself has little in the way of sensitive features. The vegetation and habitat is relatively uniform, and apart from a few small drainage lines, there does not appear to be any surface water. The areas of medium sensitivity have therefore been identified based on drainage lines (Figure 3-5). One turbine currently lies within the medium sensitivity area and should be repositioned.

However, at a landscape level, there are a number of sensitive features which, although off site, would certainly influence the movement of birds in the broader area and hence the likelihood of bird collisions with the turbines. A map has been compiled showing these features (Figure 3-4).

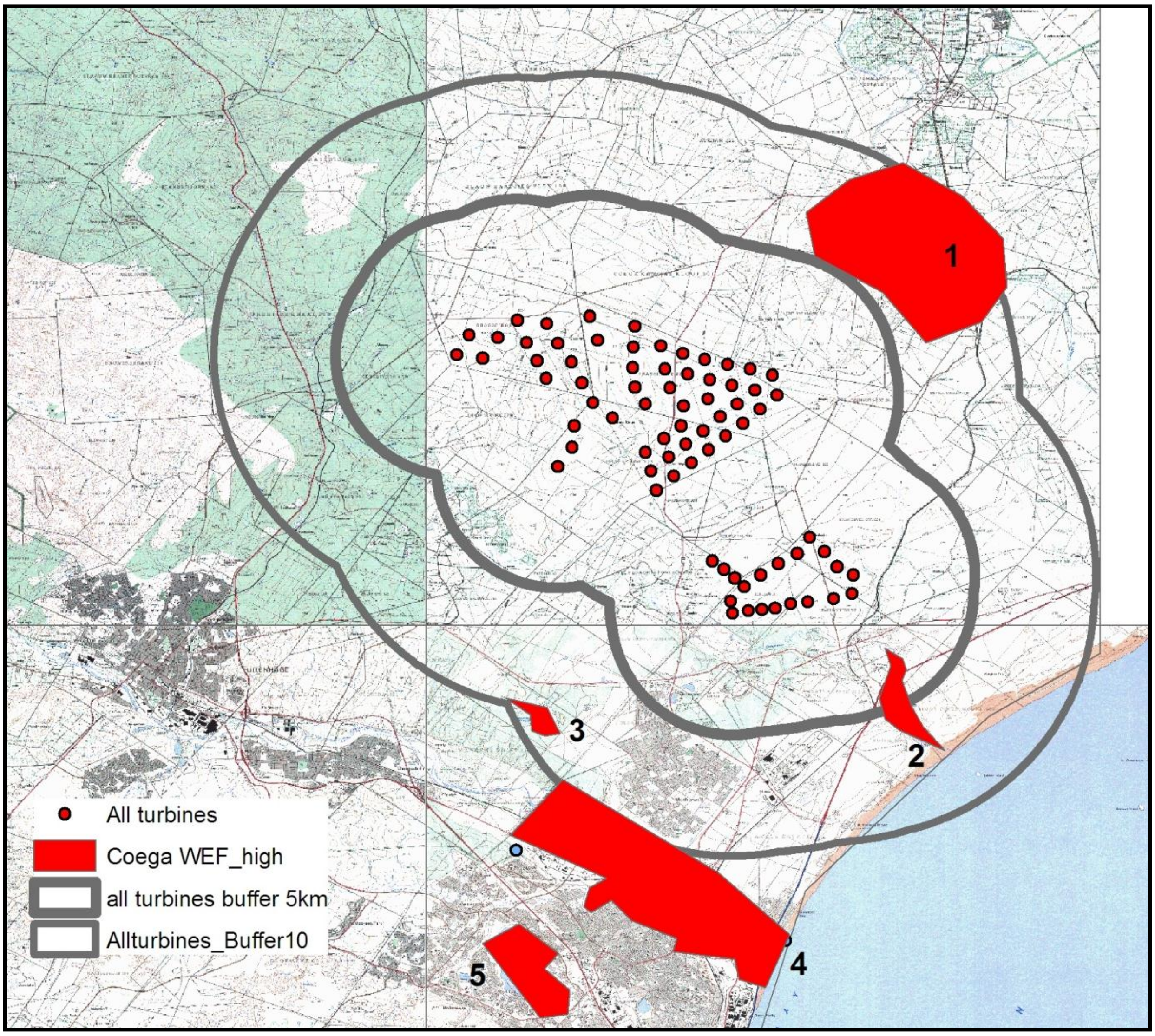

Figure 3-4: Position of sensitive avifaunal features in the landscape relevant to the proposed site. Grey lines represent 5km and 10km buffers from the turbines. 1-an area of irrigated arable land; 2-Coega saltpans; 3-Swartkops saltpan; 4-Swartkops estuary; 5-Mission saltworks.

The sensitivity categories were assigned using the following factors:

High sensitivity: There are no high sensitivity zones in this study area, but several exist in the broader landscape and will influence bird movement in the area.

Medium Sensitivity: The medium sensitivity zones are the areas where drainage lines or streams exist. These will be natural flight paths and attractive habitat for various species. Turbines and other infrastructure should not be built within these areas. One turbine is in fact positioned within these areas and should be moved if possible.

Low Sensitivity: These are the remaining areas, where construction can take place.

It is essential that avifaunal input be provided once all project information has been finalised, most importantly exact turbine positions. This avifaunal input could be in the form of a site specific avifaunal EMP or input into the overall EMP.

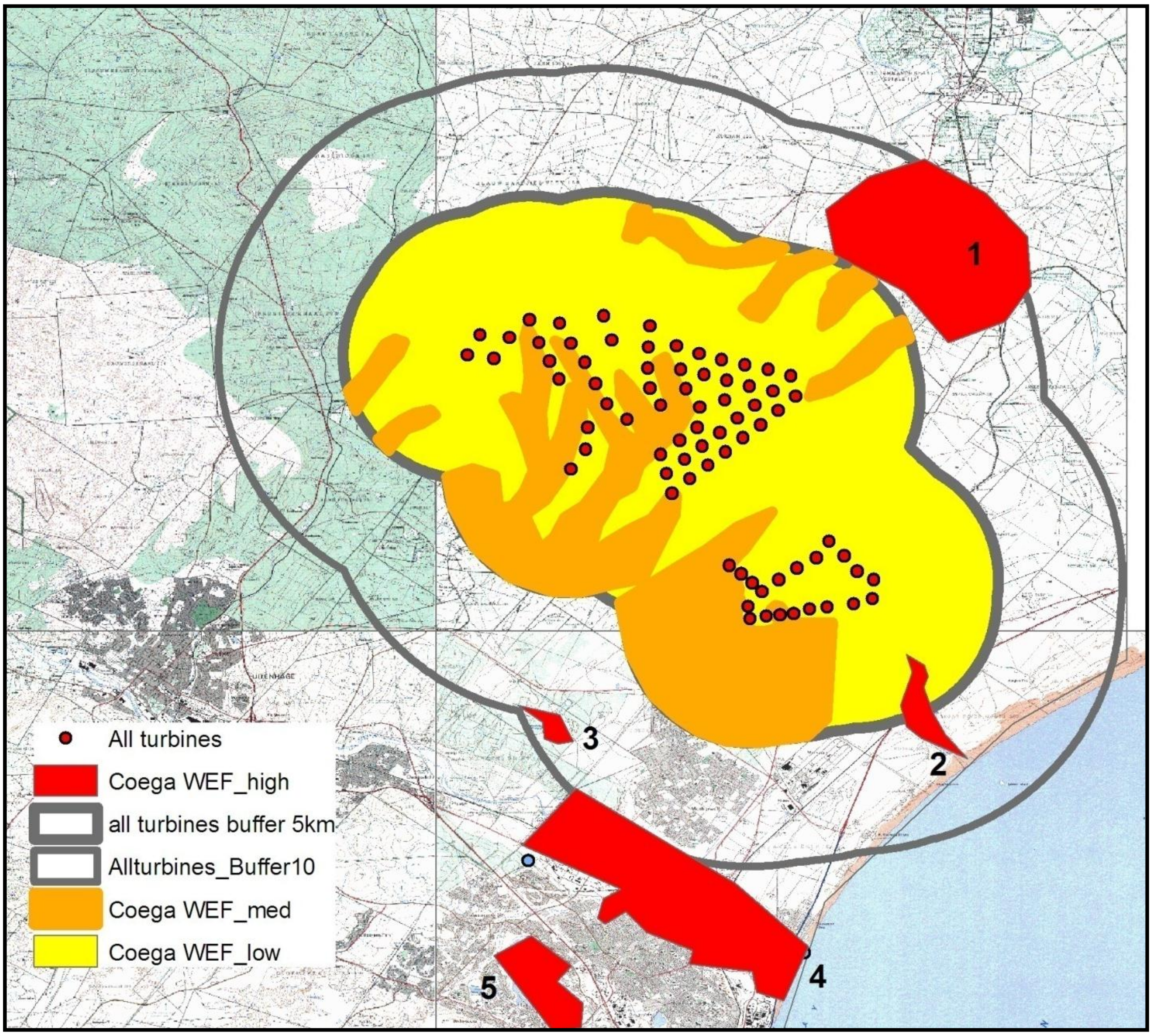

Figure 3-5: Sensitivity analysis of the study area (turbines buffered by 5km. Red areas are high sensitivity, as explained in this report. Orange area areas are medium sensitivity, based on small drainage lines. Yellow areas are low sensitivity.

4 ASSESSMENT AND MITIGATION OF IMPACTS

4.1 Construction phase

4.1.1 Impact 1: Habitat destruction

Cause and Comment

During construction a certain amount of habitat destruction will take place. This will be from the actual footprint of each turbine as well as associated infrastructure such as roads, crane pads, batching plants, labour camps, power lines, substations and machinery and equipment storage. From an avifaunal perspective this habitat destruction will result in a potential loss in habitat for many bird species.

Mitigation and Management

On a project such as this the possibility for mitigating the impact of habitat destruction is low. The scale of the project means that it is inevitable that habitat destruction will take place. The mitigation for this impact will be to only affect the minimum amount of habitat possible. This means that where possible existing roads must be used and batching plants, labour camps, equipment storage, etc should be situated in areas that are already disturbed. A full site specific EMP must also be compiled to specify all of the impacts and mitigation measures and provide a step by step programme to follow for the ECO on site. Specialist avifaunal input must be included into the EMP and this will focus on breeding sensitive species and their locations and the mitigation for this impact.

Significance Statement: Habitat destruction is rated as a low significance impact.

Table 4-1: Impact of habitat destruction during the construction phase

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
OPTION 1										
Without Mitigation	Permanent	4	Study Area	1	Low	1	Probable	3	**9**	**Moderate**
With Mitigation	Permanent	4	Study Area	1	Low	1	May Occur	2	**8**	**Moderate**
NO-GO OPTION										
Without Mitigation	None	0	None	0	None	0	None	0	**0**	**None**
With Mitigation	None	0	None	0	None	0	None	0	**0**	**None**

4.1.2 Impact 2: Disturbance and displacement of birds

Cause and Comment

During construction, disturbance of avifauna during all of the construction activities has the ability to negatively affect avifauna. This is especially true during breeding of sensitive species. The impact can cause sensitive species to abandon their nest or chicks and as such these species can lose this important recruitment to their populations.

Mitigation and Management

Mitigation for disturbance is the same as for habitat destruction. In general terms all construction activities should result in as little disturbance as possible. This will be detailed in the site specific EMP and will be enforced and overseen by the ECO for the project. During the EMP the avifaunal specialist must identify any breeding sensitive bird species in close proximity to specified turbine and associated infrastructure positions. Specific recommendations must be provided for each case and these must be strictly enforced and followed.

Significance Statement: Disturbance is rated as low significance, however mitigation must still be implemented to keep it this way and make sure that sensitive bird species are not affected.

Table 4-2: Impact of disturbance during the construction phase

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
OPTION 1										
Without Mitigation	Short Term	1	Study Area	2	Moderate	2	May Occur	2	**7**	**Low**
With Mitigation	Short Term	1	Study Area	2	Slight	1	May Occur	2	**6**	**Low**
NO-GO OPTION										
Without Mitigation	None	0	None	0	None	0	None	0	**0**	**None**
With Mitigation	None	0	None	0	None	0	None	0	**0**	**None**

4.2 Operational phase

4.2.1 Impact 3: Collision of birds with the turbines

Cause and Comment

The cause of birds colliding with the turbines has been explained in this report and the various theories presented. In general, the main cause will be the positioning of the turbines in or close to important bird flight paths. This impact of collisions is seen as the most significant possible impact on avifauna for this project and as such the one that requires the most careful management and mitigation.

Mitigation and Management

We have established that there are high abundances of certain target species on site and in the general area. However, the extent to which collision of the target species, and any others, occurs at the proposed turbines is dependent on their flight movements and behaviour. In other words with respect to collision specifically, there could be large numbers of a species in the area, but if they do not fly frequently enough, at the relevant altitude (estimated at approximately 45m to 155m above ground) and in the relevant areas, collisions will not occur.

Once frequency and height of flight information is established for the target species, there is still the issue of avoidance rates, i.e. one cannot assume that every bird flying towards a turbine will collide with it. In fact avoidance rates established for other species in the UK are approximately 99%.

Given this uncertainty, i.e. how frequently birds will be exposed to collision, and how many of these birds will actually collide with turbines, the EWT does not consider it reasonable to recommend that this project should not go ahead. The main reason for uncertainty with regard to the above aspects is the lack of operational wind farms in South Africa, and without building any wind farms we cannot begin to gather the data required to eliminate or reduce this uncertainty. We believe that a more reasonable approach is to obtain the best possible data on bird movement on site as soon as possible, in consultation with the developer.

We also believe that in general environmental terms, this site is favourable for a wind energy facility. It is therefore recommended that a site specific avifaunal environmental management plan be compiled, which includes the development of a detailed pre and post construction monitoring methodology.

Since the actual site does not contain any particularly sensitive features, siting of turbines within the site will have little effect on this impact. Most available or potential mitigation options therefore would need to be employed once the turbines are already operational, if monitoring reveals significant impacts. Some mitigation options that can be employed if monitoring reveals significant numbers of collisions, include: that one blade be painted black, in order to provide an alternating image for the bird in flight; curtailment, i.e. shutting down certain turbines at certain times; radar monitoring; manipulation of blade height to accommodate predominant bird flight height, and any others that may be identified as our understanding of the impacts progresses.

The cumulative impact of bird collisions in the area is likely to be significant. Many of the target species for this study are species that are in all likelihood already significantly impacted upon by collisions with overhead cables in the area. An additional mortality factor such as collision with turbines may prove detrimental to local populations of these species.

Significance Statement: The impact of collisions is a moderate impact and must be mitigated to reduce the impact. The site specific EMP will, to a large extent, tighten up and further define the mitigation measures required in order to do this, including a rigorous pre and post construction monitoring programme.

Table 4-3: Impact of bird collisions with turbines during the operational phase

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
OPTION 1										
Without Mitigation	Long Term	3	Study Area	2	Severe	4	Probable	3	**12**	**High**
With Mitigation	Long Term	3	Study Area	2	Moderate	2	May Occur	2	**9**	**Moderate**
NO-GO OPTION										
Without Mitigation	None	0	None	0	None	0	None	0	**0**	**None**
With Mitigation	None	0	None	0	None	0	None	0	**0**	**None**

4.2.2 Impact 4: Disturbance

Cause and Comment

During operation the wind turbines will disturb avifauna on or close to site. This disturbance is likely to result in shy and sensitive species leaving the area. Habitat fragmentation and barrier effects are also likely, although the extent of these is not well understood.

Mitigation and Management

No mitigation is required, as it is unlikely that any measures that are feasible will reduce the impact of this disturbance to an extent where the shy and sensitive species will remain. In comparison to the other impacts, this impact is relatively minor.

Significance Statement: While the Table below shows that this impact has been rated as moderate, this is misleading as the temporal scale and risk of likelihood push this impact score up. The significance should rather be seen as low.

Table 4-4: Impact of disturbance during the operational phase

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
OPTION 1										
Without Mitigation	Long Term	3	Study Area	2	Slight	1	Probable	3	**9**	**Moderate**
With Mitigation	Long Term	3	Study Area	2	Slight	1	Probable	3	**9**	**Moderate**
NO-GO OPTION										
Without Mitigation	None	0	None	0	None	0	None	0	**0**	**None**
With Mitigation	None	0	None	0	None	0	None	0	**0**	**None**

4.2.3 Impact 5: Disruption in local bird movement patterns

Cause and Comment

Large scale wind energy facilities will no doubt be a huge obstacle for birds to avoid and this avoidance behaviour may lead to increased energy costs to the bird as they expend more energy flying from one point to another. This in turn may result in decreased breeding productivity and ultimately population level impacts. Of particular concern is the cumulative impact of multiple wind energy facilities in one area (as could be the case here).

Mitigation and Management

This impact is not yet well understood, and not possible to mitigate for.

Significance statement

The significance of this impact has been rated as moderate both with and without mitigation.

Table 4-5: Impact of disruption in local bird movement patterns during operation.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
OPTION 1										
Without Mitigation	Long Term	3	Study Area	2	Moderate	2	Definite	4	**11**	**Moderate**
With Mitigation	Long Term	3	Study Area	2	Slight	1	Probable	3	**9**	**Moderate**
NO-GO OPTION										
Without Mitigation	None	0	None	0	None	0	None	0	**0**	**None**
With Mitigation	None	0	None	0	None	0	None	0	**0**	**None**

4.2.4 Impact 6: Collision and electrocution of birds with/on power lines and substations

Cause and Comment

Collisions are one of the biggest single threats posed by overhead power lines to birds in southern

Africa (van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes and various species of water birds. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with power lines. Depending on the routes and amount of overhead power line required to link this project into the grid, this could have a serious impact on avifauna.Electrocutions of birds in the substation yards and on the power line poles could also have a significant effect depending on the design of the infrastructure.

Mitigation and Management
The high risk sections of line will need to be identified during the site specific EMP, and marked with a suitable anti-collision marking device. The pole design in Figure 4-1 should be used in order to prevent electrocutions.

Significance statement: The significance of this impact has been rated as moderate, but low with mitigation.

Table 4-6: Impact of collision and electrocution of birds on associated power line.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
OPTION 1										
Without Mitigation	Long Term	3	Study Area	2	Moderate	2	Definite	4	**11**	**Moderate**
With Mitigation	Long Term	3	Study Area	2	Slight	1	May Occur	2	**8**	**Moderate**
NO-GO OPTION										
Without Mitigation	None	0	None	0	None	0	None	0	**0**	**None**
With Mitigation	None	0	None	0	None	0	None	0	**0**	**None**

4.2.5 Comparison of alternatives

The only alternatives provided in this case are to develop the project as proposed, or the no-go option. No site alternatives have been provided. These two alternatives have been considered in the assessment of impacts.

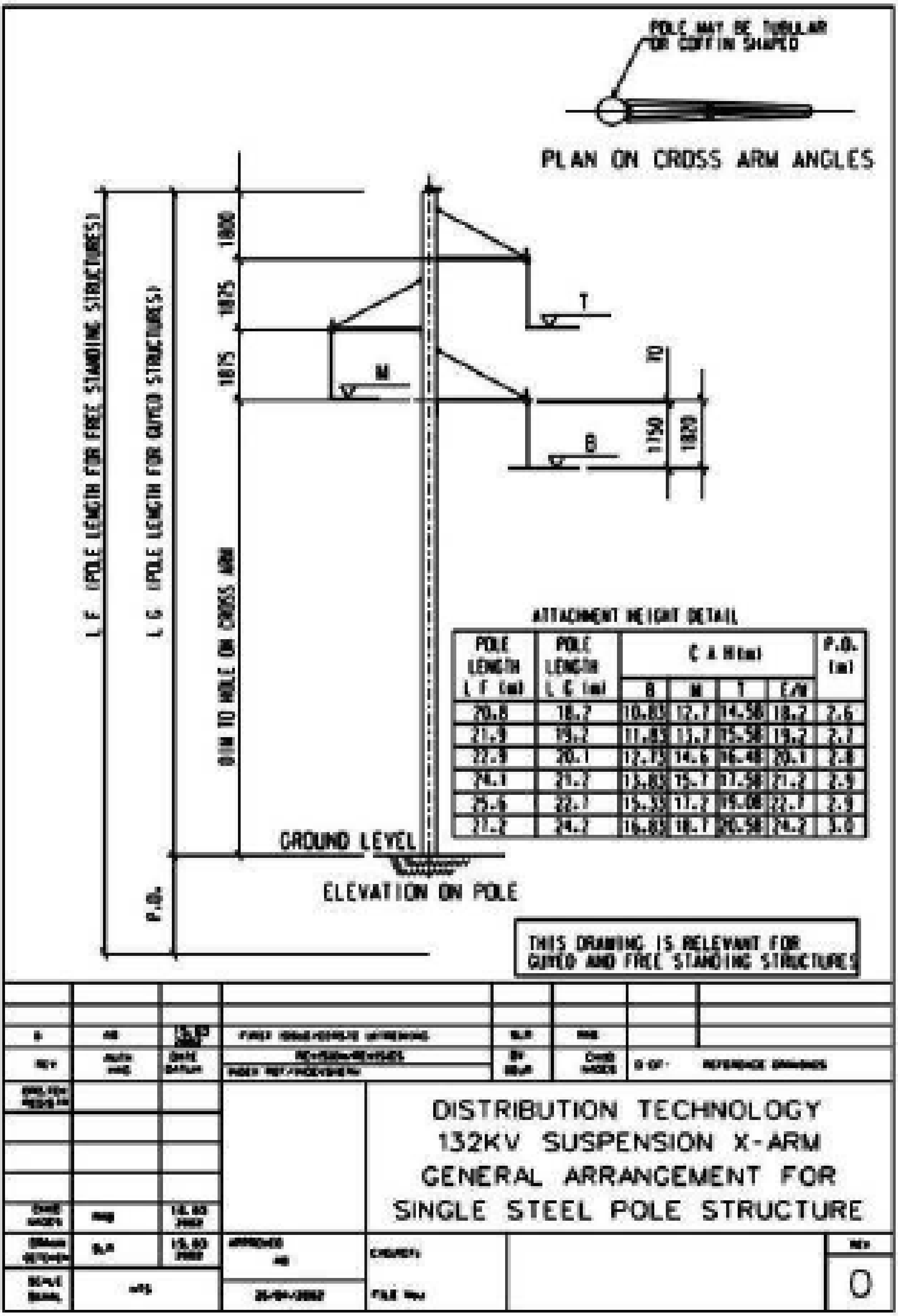

Figure 4-1: Structure of the proposed 132KV steel mono- pole for use in the project

5 CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the proposed facility has the potential to significantly impact on avifauna in the area, although our confidence in this assessment is low, due to the lack of operation experience of commercial scale wind farms in South Africa. It is recommended that the management of these potential impacts be approached through a rigorous monitoring programme as set out in this report.

AVIFAUNA APPENDIX 1: PRELIMINARY AVIFAUNAL PRE AND POST CONSTRUCTION MONITORING PLAN

The above study states that it is essential that a comprehensive monitoring programme be implemented at this site. This section of the report provides details of how to go about this monitoring. This detail has been provided from the "Birds and Wind Energy Specialist Group" (BAWESG) draft guidelines on the monitoring of wind farms in SA, by Chris van Rooyen and Andrew Jenkins, 2011.

The EWT believe that the ideal model through which to implement the monitoring programme is as follows:

- A suitably qualified avifaunal specialist should supervise the monitoring programme, train the necessary observers, collate, analyse, report and publish data.
- This specialist should be contracted by the developer
- The first step for the appointed specialist will be to identify the key information required in the protocol below (highlighted in yellow). This will be best done through a short site visit, which will also serve to train the identified observers and generally iron out any teething problems with the methodologies.
- The bulk of the actual work involved should be done by trained observers, under the guidance and supervision of a qualified and experienced ornithologist. This role could be filled by a number of people or entities, but will need to be the same entity for the duration of the programme.
- The specialist could advise the developer on available options to source observers

Specific challenges in a southern African context

The monitoring protocols that are available from Europe and the USA are mostly aimed at estimating population densities of small passerines in a relatively small study area. In southern Africa, the majority of priority species are large species that are relatively thinly distributed. Specific challenges in a local context are the following:

- Some priority species are sparely distributed with large territories, e.g. many of the large raptors and cranes. These species could easily be missed during surveys.
- Some priority species are nomadic with fluctuating densities related to habitat conditions, particularly rainfall, e.g. bustards. To cover all possible conditions in the study area would require an effort which will be impractical, both in terms of resources and length of monitoring time.
- Some of the sites are extremely remote and access restricted. This means that sample size will be determined by what is practically possible, introducing bias towards areas within the study area which are accessible, and potentially missing important habitat. This is fortunately not the case at the Coega site.
- Limited availability of suitably experienced individuals that can do monitoring.

The suggested monitoring protocol is an attempt to address the challenges listed above whilst still maintaining a measure of practical realism as to what is possible with limited resources.

Aims of monitoring:

1. To estimate an abundance index for all the priority species within the wind farm area as a baseline to measure potential **displacement** due to the construction and operation of the wind farm.
2. To estimate the risk of priority species **colliding** with the wind turbines by recording flight behaviour. Recommended method is **vantage point observations**.

A) Pre-construction monitoring

1. Displacement due to the construction and operation of the wind farm:

*1.1 Methodology for calculating an abundance index using line **transects**:*

- Establish boundaries for the wind farm area (including buffer zones), taking into account the priority species likely to be present, for the area to be surveyed (hereafter referred to as the wind farm area). The experience of the ornithologist will be priority in establishing the buffer zones,**the decision to include an area will depend on the priority species that are likely to be present in the wind farm area.** It is important that this is done realistically and objectively, taking into account the potential impacts of the wind farm and the availability of resources to conduct the monitoring.
- Identify, delineate and calculate the percentage of each distinct habitat type from a priority species perspective in the wind farm area using a combination of satellite imagery (Google Earth) and GIS tools e.g. agricultural land, ridges, fynbos, woodland.
- Within the study area, selection of transects will largely depend on practical factors e.g. access, but ideally transects should cover as much as possible of the study area, and be as representative as possible of all the habitat types. However, it must be accepted that site variance will be unavoidable given varying capacity, time and access. Standardization of monitoring protocols should however always be attempted across studies, especially in the same regions e.g. the Overberg, West Coast, Karoo etc. in order for results to be extrapolated for comparison purposes, with some degree of confidence.
- Line transects should be counted in summer (from November to March) and in winter (May to August). Transects should be counted at least four times per season. A proposed practical method is for the observer to drive very slowly with a vehicle and stop every 250m and scan the surrounding habitat with binoculars in a 360° radius. All priority species must be recorded. The following data must be recorded:
    - Date of count
    - Number of count (each count must be numbered individually)
    - Duration of count i.e. the time it has taken to travel the transect (s)
    - Species
    - Weather conditions
    - Habitat type where the bird is recorded - overflying birds should be noted as such and not linked to a habitat type. In this respect the judgment of the observer will be crucial e.g. a bird that is foraging on the wing in a specific habitat type (e.g. a Black Harrier quartering in fynbos) should be distinguished from a bird that is obviously passing through.
- Ideally a similar exercise should be conducted for a control site of similar habitat composition and size, to make post-construction comparisons meaningful. **There may be merit in use of shared control or reference sites for several wind farms in a well-defined geographical area.** Control sites should have the following characteristics:
    - Host a similar mix of bird species present on the wind farm development site.
    - Be similar in size to the wind farm area.
    - Be located on ground with a similar mix of habitats and similar topography and aspect.
    - Be as closely matched as possible to the wind farm site, the main difference being the absence of wind turbines from the control.
    - Be situated as close as possible to the wind farm area without its bird populations being so close as to be affected by wind farm operations.
- It is important to record information on priority species occurrence from secondary sources, for example CAR counts or local bird watchers as well. Although this information cannot be analyzed as part of the formal protocol, it is nonetheless important, especially if the source is reliable. Typical examples would be if the existence of nesting sites on the property which is known to the landowner. This should be incorporated into the final report.

1.2 Output:

- The main output of the transect monitoring is an abundance index for priority species expressed as species/km for both the wind farm area and the control area. This information will feed into the avifaunal specialist report for the EIA study.

2. Collision risk

*2.1 Methodology for estimating collision risk using **vantage point (VP) observations**:*

- Vantage point (VP) observations are a means of quantifying flight activity of priority species that take place within the wind farm area, with the principal aim of determining the likely collision risk.
- The purposes of vantage point watches are to collect data on priority species that will enable estimates to be made of:
  - The time spent flying over the defined survey area;
  - The relative use of different parts of the defined survey area;
  - The proportion of flying time spent within the upper and lower height limits as determined by the rotor diameter and rotor hub height.
  - The flight activity of other species - secondary species using the defined survey area.
- When selecting VPs, the aim should be to cover all of the survey area such that no point is greater than 2km from a VP, but this is not always feasible.
- It is very important that VPs are chosen in order to achieve maximum visibility with the minimum number of points.
- Typically, a site measuring 1000ha will require at least 2 VP"s.
- As acuity of observations will decrease with distance, VPs should be located as close to the survey boundary as possible.
- VPs should not be located near to the nest site of target species and observers should try to position themselves inconspicuously so as to minimise their effects on bird movements.
- Coordinates of VPs must be recorded using a GPS. Observers should take care to re-use the exact VP location in successive watches.
- VP observations should be conducted in summer (November to March) and in winter (May to August). A total of 18 hours (two days) of vantage point (VP) observations pre- and post-construction per season per VP should be conducted. VP watches should be conducted in three hour shifts, to account for different levels of bird activity:
  - Shift 1: starting one hour before dawn sunrise?
  - Shift 2: starting noon
  - Shift 3: starting two hours before sunset until visibility becomes too low
- The following data must be recorded at the start of the watch:
  - Watch number
  - Date
  - Start time
  - Wind strength (light, moderate, strong)
  - Wind direction
  - Flight activity for priority species must be recorded in the following manner (number each flying bout consecutively), the use of markers on laminated maps are strongly recommended:
    Species
    Flight duration (starting at time of detection until bird disappears from view)
    Flight height (below the rotor arc; within the rotor arc; above the upper rotor arc - recorded at 15 second intervals until bird disappears from sight)
    Flight direction recorded at 15 second intervals until bird disappears from sight.
    Flight mode recorded at 15 second intervals until bird disappears from site (soaring, gliding, flapping)
- Estimation of predicted collision mortality can be undertaken with a model such as that developed by SNH (Scottish Natural Heritage 2000b). Band et al (2007) provide further details, worked examples and discussion. The model leads to an initial estimate of collision risk based on the theoretical assumption that birds take no avoiding action. It is then necessary to build in a more realistic expectation that a high proportion of birds are likely to take avoiding action successfully (see SNH 2000a). Limited information on avoidance rates is available for some species, based on experience at actual wind farms (see SNH 2004). With time, avoidance rates for SA species will need to be established.

B) Post-construction monitoring

Aims:

- To compare the abundance index for all the priority species within the development area after construction against the pre-construction baseline to measure actual **displacement** due to the construction and operation of the wind farm. Recommended survey method is **linetransect counts (see A above).**
- To estimate the risk of priority species **colliding** with the wind turbines by recording actual collisions and comparing post-construction flight patterns with pre-construction baseline data. Recommended methods are **carcass searches and VP watches (see A above)**.

1. Displacement due to the construction and operation of the wind farm:

*1.1 Methodology for calculating abundance index using **linetransects**:*

- Methodology has been fully covered under A above.
- Ideally, surveys should be conducted in two seasons of years 1, 2, 3, 5, 10 and 15; after the wind farm becomes operational. Bird responses to wind farms may operate over very long periods of time, and that monitoring needs to take this into account, as results from short term observational studies are unlikely to be representative.

2. Collision risk

*2.1 Methodology for estimating actual collision rates using **carcass searches**:*

Carcass searches are the most direct way of estimating the number of collisions and hence the likely impact on species of conservation importance. Measures of the number of collisions can also help to quantify avoidance rates (as used in collision risk modelling calculations), and, when collisions can be ascribed to a particular time, contribute to an understanding of environmental conditions and behaviours that increase collision risk.

The value of surveying the area for collision victims only holds if some measure of the accuracy of the survey method is developed. To do this, a sample of suitable bird carcasses (of similar size and colour to the priority species – e.g. Egyptian Goose *Alopochenaegyptiacus*, 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 carcasses 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. 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.

The area within a radius of at least 50 m of each of the turbines (from the outer edge of rotor zone) at the facility should be checked regularly for bird casualties. 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).

2.2. *Methodology for comparing post-construction flight patterns with pre-construction baseline data using **Vantage point watches***

- Methodology has been fully covered under A above.

In addition to the above monitoring, which will take place largely „on site", there is a need to do off site counts of Greater Flamingo at the nearby estuaries and salt pans identified by this study. More details on this will be developed by the appointed avifaunal specialist.

APPENDIX A-3: VISUAL REPORT

VISUAL IMPACT ASSESSMENT: PROPOSED COEGA WINDFARM, NELSON MANDELA BAY MUNICIPALITY, EASTERN CAPE PROVINCE

SPECIALIST REPORTS
VOLUME 2: ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Prepared for:	Prepared by:	Prepared by:
InnoWind (Pty) Limited	**Coastal & Environmental Services**	**MapThis**
P.O. Box 1116 Port Elizabeth, 6000	P.O. Box 934 Grahamstown, 6140	8 Cathcart Street Grahamstown, 6139
South Africa	South Africa	South Africa

NOVEMBER 2010

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EXECUTIVE SUMMARY

CES has appointed Henry Holland of map(this); to conduct a visual impact assessment (VIA) of the proposed wind energy facility in the Coega IDZ and adjacent areas.

The landscape character of the region is a mixture of industrial and urban development, and agricultural land. The proposed wind farm is located in a low landscape character sensitivity area and surrounded by landscapes of low to moderate sensitivity to change brought on by the introduction of a wind farm. The visual absorption capacity for the development is low due to the size and height of the wind farm.

There is only one turbine located closer than 500m to farm buildings, which may potentially be a shadow flicker risk for these buildings, and they may experience more than 30h/a of shadow flicker. Sections of the R335 may experience the shadow flicker effect of turbines closer than 500m.

Table 1: Visual impact criteria

Criteria	Impact
Viewer Sensitivity	• Residents of urban areas – Highly sensitive to changes in their views. • Residents on surrounding farms – Highly sensitive • Scenic viewpoints and protected areas – Highly sensitive – there are no recognised viewpoints protected for their scenic quality in the region. • Motorists – Low sensitivity due to short exposure time and the fact that their focus on landscape is reduced.
Visibility of Development	• High due to the tall structures and their position in the topography.
Visual Exposure	• Residents of surrounding urban areas – Residents of a couple of nearby settlements such as Motherwell and Wells Estate will have a high visual exposure to the development due to their proximity to the wind farm. • Residents on surrounding farms – high visual exposure for a number of farm residences or buildings. • Protected areas – high visual exposure is expected for the Swartkops Valley Local Nature Reserve. The GAENP and three islands off CoegaRiver mouth will have a low visual exposure. • Motorists – high for sections of the N2, R334, R335 and R102.
Visual Intrusion	• Residents of surrounding urban areas – moderate to low due to the low quality and complexity of their existing views in this region. • Protected areas – Low for GAENP (distance) and SwartkopsLNR (complexity of current views). Low for other protected areas such as The Springs Resort and Groendal Wilderness Area. • Residents on surrounding farms – moderate to low due to complexity of views in an industrial and metropolitan area. • Motorists – High for a short time when in close proximity.

The significance of the landscape impact according to the rating methodology is expected to be moderate due to the long duration, the regional extent and the slight severity of the impact.

The significance of the visual impact on sensitive viewers during the construction phase is moderate in terms of the suggested rating methodology, due to the regional extent of highly visible construction activity, even though the severity is expected to be slight. Not all of the construction phase will necessarily have a negative visual impact since the construction of wind turbines is an incredible engineering feat and viewers are likely to find it fascinating to observe.

The overall significance of the visual impact on sensitive viewers during the operational phase is moderate due to the regional extent, long term and low severity of the impact.

The significance of the impact of lighting of the turbines according to aviation regulations is expected to be moderate for farmers living in close proximity, but low overall due to the existing levels of sky glow in the area.

The landscape into which the wind farm will be introduced is in close proximity to large industrial and urban centres. Wind turbines will not be out of place in such a metropolitan setting.

SPECIALIST PRACTITIONER DECLARATION OF INDEPENDENCE

VISUAL IMPACT ASSESSMENT: PROPOSED WINDFARMS ON GRASSRIDGE 190, GELUKSDAL 590 AND BONTRUG 301, NELSON MANDELA BAY MUNICIPALITY, EASTERN CAPE

Visual specialist

I Henry Holland declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Coega Wind Energy Project, application or appeal in respect of which I 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 my performing such work.

SIGNATURE:

LIST OF ABBREVIATIONS

AMSL	Above mean sea level
DEM	Digital Elevation Model
DTM	Digital Terrain Model
EIA	Environmental Impact Assessment
ENPAT	Environmental Potential Atlas
EWEA	European Wind Energy Association
GIS	Geographic Information System
GLVIA	Guideline for Involving Visual and Aesthetic Specialists in EIA Processes
IDP	Integrated Development Plan
IUCN	International Union for Conservation of Nature
I&APs	Interested and Affected Parties
SANBI	South African National Biodiversity Institute
STEP	Subtropical Thicket Ecosystem Project
ToR	Terms of Reference
VIA	Visual Impact Assessment
WPDA	World Database on Protected Areas
ZTV	Zone of Theoretical Visibility
ZVI	Zone of Visual Influence

GLOSSARY OF TERMS

Cumulative viewshed A viewshed which indicates in some way how much of a development is visible from a particular viewpoint. In a raster based cumulative viewshed each pixel value will indicate how many points within the development area are visible. A power line development could, for example, use pylons as points to generate a cumulative viewshed for the development. Each pixel value in the viewshed will be a count (accumulation) of the number of pylons that will potentially be visible from that pixel.

Digital Elevation Model (DEM) A digital or computer representation of the topography of an area.

Landscape baseline A description of the existing elements, features, characteristics, character, quality and extent of the landscape (GLVIA, 2002).

Landscape character The distinct and recognisable pattern of elements that occurs consistently in a particular type of landscape, and how this is perceived by people. It reflects particular combinations of geology, landform, soils, vegetation, land use and human settlement. It creates the particular sense of place of different areas of the landscape (GLVIA, 2002).

Landscape character sensitivity This provides an indication of the ability of a landscape to absorb change from the proposed development without changing character. A pristine landscape prized for its natural beauty, or a landscape of high cultural value will have high sensitivity to changes brought about by new developments.

Landscape impacts Change in the elements, characteristics, character and qualities of the landscape as the result of development (GLVIA, 2002). These effects can be positive or negative, and result from removal of existing landscape elements, addition of new elements, or the alteration of existing elements.

Memorability	The quality of being worth remembering; "continuous change results in lack of memorability"; "true memorability of phrase"
Nature-based tourism	Tourism that involves travelling to relatively undisturbed natural areas with the specific objective of studying, admiring and enjoying the scenery, fauna and flora, either directly or in conjunction with activities such as trekking, canoeing, mountain biking, hunting and fishing (Turpie et al. 2005)
Principal representative viewpoints	Principal representative viewpoints are identified during the visual baseline desk study and field survey. They should be representative of the visual amenity of the area and include walking public footpaths and visiting areas of open public access. A comprehensive photographic record of these points supports the visual impact assessment (GLVIA, 2002)
Receptor	An element or assemblage of elements that will be directly or indirectly affected by the proposed development.
Sense of place	That distinctive quality that makes a particular place memorable to the visitor, which can be interpreted in terms of the visual character of the landscape. The unique quality or character of a place, whether natural, rural or urban. Relates to uniqueness, distinctiveness or strong identity (Oberholzer 2005).
Viewer sensitivity	The assessment of the receptivity of viewer groups to the visible landscape elements and visual character and their perception of visual quality and value. The sensitivity of viewer groups depends on their activity and awareness within the affected landscape, their preferences, preconceptions and their opinions.
Viewshed	A viewshed is an area of land, water, and other environmental elements that is visible from a fixed vantage point. In digital imaging, a viewshed is a binary raster indicating the visibility of a viewpoint for an area of interest. A pixel with a value of unity indicates that the viewpoint is visible from that pixel, while a value of zero indicates that the viewpoint is not visible from the pixel.
Visibility of Project	The geographic area from which the project will be visible, or view catchment area. (The actual zone of visual influence of the project may be smaller because of screening by existing trees and buildings). This also relates to the number of receptors affected (Oberholzer 2005)
Visual absorption capacity (VAC)	Visual Absorption Capacity signifies the ability of the landscape to accept additional human intervention without serious loss of character and visual quality or value. VAC is founded on the characteristics of the physical environment such as vegetative screening, diversity of colours and patterns and topographic variability. It also relates to the type of project in terms of its vertical and horizontal scale, colours and patterns. A high VAC rating implies a high ability to absorb visual impacts while a low VAC implies a low ability to absorb or conceal visual impacts.
Visual amenity	The value of a particular area or view in terms of what is seen. (GLVIA, 2002)

Visual baseline	A description of the extent and nature of existing views of the site from representative viewpoints, and the nature and characteristics of the visual amenity of the potentially sensitive visual receptors (GLVIA, 2002)
Visual envelope	The approximate extent within which the development can be seen. The extent is often limited to a distance from the development within which views of the development are expected to be of concern.
Visual exposure	Visual exposure refers to the relative visibility of a project or feature in the landscape (Oberholzer, 2005). Exposure and visual impact tend to diminish exponentially with distance.
Visual impact	Changes to the visual character of available views resulting from the development that include: obstruction of existing views; removal of screening elements thereby exposing viewers to unsightly views; the introduction of new elements into the viewshed experienced by visual receptors and intrusion of foreign elements into the viewshed of landscape features thereby detracting from the visual amenity of the area.
Visual impact assessment	A specialist study to determine the visual effects of a proposed development on the surrounding environment. The primary goal of this specialist study is to identify potential risk sources resulting from the project that may impact on the visual environment of the study area, and to assess their significance. These impacts include landscape impacts and visual impacts.
Visual intrusion	Visual intrusion indicates the level of compatibility or congruence of the project with the particular qualities of the area – its 'sense of place'. This is related to the idea of context and maintaining the integrity of the landscape (Oberholzer 2005).
Visual quality	An assessment of the aesthetic excellence of the visual resources of an area. This should not be confused with the value of these resources where an area of low visual quality may still be accorded a high value. Typical indicators used to assess visual quality are vividness, intactness and unity. For more descriptive assessments of visual quality attributes such as variety, coherence, uniqueness, harmony, and pattern can be referred to.
Visual receptors	Visual receptors include viewer groups such as the local community, residents, workers, the broader public and visitors to the area, as well as public or community areas from which the development is visible.
Visual resource	Visual resource is an encompassing term relating to the visible landscape and its recognisable elements which, through their coexistence, result in a particular landscape and visual character
Zone of visual influence (ZVI)	The extent of the area from which the most elevated structures of the proposed development could be seen and may be considered to be of interest (see visual envelope or viewshed).
Zone of Theoretical Visibility (ZVT)	The area over which a development can theoretically be seen (also known as a Zone of Visual Influence, visual envelope and viewshed). (Horner, MacLennan and Envision 2006)

1 INTRODUCTION

1.1 Background information

Coastal and Environmental Services (CES) has been appointed by InnoWind (Pty) Ltd. as independent environmental assessment practitioners to undertake an environmental impact assessment (EIA) of the proposed wind energy facility in the Coega IDZ. CES has, in turn, appointed Henry Holland of map(this); to conduct a visual impact assessment (VIA) of the proposed development. This VIA is based on guidelines for visual assessment specialist studies as set out by South Africa‟s Western Cape Department of Environmental Affairs and Development Planning (DEA&DP) (Oberholzer 2005) as well as guidelines provided by the Landscape Institute of the UK (GLVIA 2002). The DEA&DP guideline recommends that a visual impact assessment consider the following specific concepts (from Oberholzer 2005):

- An awareness that 'visual' implies the full range of visual, aesthetic, cultural and spiritual aspects of the environment that contribute to the area's sense of place.
- The considerations of both the natural and cultural landscape, and their interrelatedness.
- The identification of all scenic resources, protected areas and sites of special interest, together with their relative importance in the region.
- An understanding of the landscape processes, including geological, vegetation and settlement patterns, which give the landscape its particular character or scenic attributes.
- The need to include both quantitative criteria, such as 'visibility', and qualitative criteria, such as aesthetic value or sense of place.
- The need to include visual input as an integral part of the project planning and design process, so that the findings and recommended mitigation measures can inform the final design, and hopefully the quality of the project.
- The need to determine the value of visual/aesthetic resources through public involvement.

1.2 Terms of reference

The specific Terms of Reference (Coastal & Environmental Services 2010) for the Visual and Landscape Impact Assessment will include:

- Conduct a site reconnaissance visit and photographic survey of the proposed project site.
- Conduct a desk top mapping exercise to establish visual sensitivity:-
- Describe and rate the scenic character and sense of place of the area and site.
- Establish extent of visibility by mapping the view-sheds and zones of visual influence
- Establish visual exposure to viewpoints
- Establish the inherent visual sensitivity of the site by mapping slope grades, landforms, vegetation, special features and land use and overlaying all relevant above map layers to assimilate a visual sensitivity map.
- Review relevant legislation, policies, guidelines and standards.

Preparation of a draft Visual Baseline/Sensitivity report:

- Assessing visual sensitivity criteria such as extent of visibility, the sites inherent sensitivity, visual sensitivity of the receptor‟s, visual absorption capacity of the area and visual intrusion on the character of the area
- Prepare photomontages of the proposed development
- Conduct shadow flickering modelling
- Assess the proposed project against the visual impact criteria (visibility, visual exposure, sensitivity of site and receptor, visual absorption capacity and visual intrusion) for the site.

- Assess impacts based on a synthesis of criteria for each site (criteria = nature of impact, extent, duration, intensity, probability and significance)
- Establish mitigation measures/recommendations with regards to minimizing visual risk areas

1.2.1 Visual triggers

Oberholzer (2005) identifies visual triggers which are used to determine the approach and scope of an impact study. The following triggers, related to the receiving environment, are potentially applicable to this project:

- Areas with protection status, such as national parks or nature reserves;
- Areas with important vistas or scenic corridors;
- Areas with visually prominent ridge lines or skylines;
- Areas of important tourism or recreational value.

Triggers related to the nature of the project:

- A significant change to the fabric and character of the area;
- Possible visual intrusion in the landscape.

1.2.2 Information base

- Documentation supplied by the client and CES and the client;
- ToR for the visual specialist;
- Digital topocadastral data at 1:50 000 scale from the Surveyor General: Surveys and Mapping;
- South African digital land cover dataset of 2002 (Majeke et al. 2002);
- SPOT satellite image mosaic (2007)
- 1:250000 Geology map sheets covering the region;
- Wind turbine model by Pete Young hosted in the Google 3D Warehouse (http://sketchup.google.com/3dwarehouse/details?mid=cc036208d537d6f98967f3aa7f40c33&prevstart=0).
- Google Earth software and data.
- IUCN database of protected areas (http://www.wdpa.org/Download.aspx)
- STEP vegetation and conservation status data from the South African National Biodiversity Institute (http://bgis.sanbi.org/STEP/project.asp)
- Data from the draft conservation assessment plan (SRK Consulting 2007)

1.2.3 Assumptions and limitations

Spatial Data Accuracy

Spatial data used for visibility analysis originate from various sources and scales. Inaccuracy and errors are therefore inevitable. Where relevant these will be highlighted in the report. Every effort was made to minimize their effect.

Viewshed calculations

Calculation of the viewsheds does not take into account the potential screening effect of vegetation and buildings. Due to the size and height of the wind turbines, and the relatively low vegetation cover in the region, the screening potential of vegetation is likely to be minimal over most distances.

Simulated views and Photomontages

In this report a *simulated view* will be defined as a view generated by using 3D computer software using an elevation model and aerial photography. A *photomontage* is a landscape photograph onto which images of the wind turbines are placed using software which maintains the accurate spatial positions of the turbines and their scale in relation to their distance from the point at which the photograph was taken. The photomontage images used in this report were compiled using landscape photographs taken specifically for this purpose. Simulated views were produced using 3D modelling software (Visual Nature Studio 3 from 3D Nature - http://3dnature.com/), and a digital elevation model (DEM) interpolated from 1:50000 contours.

1.3 Details and expertise of the environmental assessment practitioner

Mr Henry Holland*(Visual Specialist)*

Henry Holland is a Grahamstown-based GIS Specialist/Programmer with extensive spatial software skills. He holds an MSc in geologically related GIS applications from Rhodes University. His experience includes the following software applications, languages and operating systems: Software applications – TNTMips, Manifold System, Eclipse IDE, Microsoft Access, Postgresql (Cygwin), Visual Studio, Text Pad and VIM; Languages – Java, Visual C^{++}, COM, HTML, Ruby and SQL; Operating Systems – Microsoft and Linux (Red Hat). Henry has been involved in a number of wind farm and other Visual Impact Assessments, modelled the distribution of wetlands (i.e. Baviaanskloof catchment) using GIS, contributed towards or developed databases (e.g. developed a diamond exploration database), and conducted the remote sensing task for the Corridor Sands Monitoring Programme. He has used Postgresql (Cygwin) to host spatial data.

2 METHODOLOGY

2.1.1 Issues raised by I&APs

Visual impact has not been raised by I&APs as a specific issue (Coastal & Environmental Services 2010).

2.1.2 Site visit and photographic survey

The field survey (conducted on 10 and 11 October 2010) provided an opportunity to:

- Determine the actual or practical extent of potential visibility of the proposed development, by assessing the screening effect of landscape features;
- Conduct a photographic survey of the landscape surrounding the development;
- Take photos for use in photomontage images;
- Identify sensitive landscape and visual receptors.

Viewpoints were chosen using the following criteria:

- High visibility – sites from where most of the wind farm will be visible.
- High visual exposure – sites at various distances from the proposed site.
- Sensitive areas and viewpoints such as nature reserves and game farms from which turbines will potentially be seen.

Additionally, photo sites were chosen to aid in describing the landscape surrounding, and potentially affected by, the proposed development.

2.1.3 Landscape description

A desktop study was conducted to establish and describe the landscape character of the receiving environment. A combination of Geographic Information System (GIS), literature review and photographic survey was used to analyse land cover, landforms and land use in order to gain an understanding of the current landscape within which the development will take place (GLVIA, 2002). Landscape features of special interest were identified and mapped, as were landscape elements that may potentially be affected by the development.

2.1.4 Visual impact assessment

A GIS was used to calculate viewsheds for various components of the proposed development. The viewsheds and information gathered during the field survey were used to define criteria such as visibility, viewer sensitivity, visual exposure and visual intrusion for the proposed development. These criteria are, in turn, used to determine the intensity of potential visual impacts on sensitive viewers. All information and knowledge acquired as part of the assessment process were then used to determine the potential significance of the impacts according to the standardised rating methodology as described in the Terms of Reference document (and in section **Error! Reference source not found.** of this document).

3 PROJECT DESCRIPTION

3.1 Overview of project

The wind farm which will be spread over three adjacent property portions in the Coega/Grassridge area. The three land portions are planned to host up to seventy five (75) turbines, each with a nominal power output ranging between 2-3 Mega Watts (MW). The total potential output of the wind farm would be approximately 225 MW, which will serve to further support the regional and national power balance. Provisionally, the 75 turbines have been allocated to the respective property portions as follows:

1. Zone 14 IDZ (Farms Bontrug 301 and Brak River SW 224): 15 turbines
2. PPC (Farms Grassridge 190, 227 and 228, Oliphants Kop 201): 55 turbines
3. SwarteKoppen 302: 2 turbines
4. Welbedachtsfontein 300: 3 turbines

The farm portions north of the IDZ belong to PPC and are either being mined, or will be mined in future.

3.2 Project components and activities

3.2.1 Construction

The following main components related to construction activity will potentially cause visual impacts:

- Clearing of land for a construction compound and laydown area. An area will be required to temporarily store up to 225 blades, each 40 to 60m in length, as well as other large turbine components.
- A site compound for contractors.
- Borrow pits.
- Tall cranes will be required to lift turbine components into position.
- Large trucks will be required to haul turbine components from Port Ngqura to the site.
- Heavy equipment such as bulldozers, graders, trenching machines and concrete trucks may be required.
- Stable platforms for the cranes need to be constructed.
- Existing roads connecting the N2 with site may need to be upgraded.
- Internal access roads to connect platforms will need to be established.
- A transformer station might have to be build either on the wind farm site, or adjacent to the existing substation. The construction of it will depend on Eskom‟s final connection requirements."

3.2.2 Operational wind farm

- Hub heights are between 60m and 120m high (depending on the model chosen), and rotors are 35 to 60m long. The maximum height at blade tip is therefore potentially 180m high.
- Operations and maintenance building.
- Access roads will follow road alignments as contained in the CDC Master Plans or existing roads where possible.
- Internal access roads to individual turbines.
- Overhead power lines linking the site to substations (internal power lines will be underground).
- Existing substations (Grassridge or Motherwell) will be used to connect the WEF to the grid.

4 DESCRIPTION OF RECEIVING ENVIRONMENT

4.1 Landscape baseline

The landscape baseline is a description of the existing elements, features, characteristics, character, quality and extent of the landscape (GLVIA, 2002).

4.1.1 Topography

Figure 4-1 provides a map of the topography of the region into which the wind farm will be introduced. A number of topographic profiles (indicated on the map) through the wind farm is shown in Figure 4-2.

From the beach near the Coega River mouth the land rises sharply at first onto a palaeo-marine bench (Coega Platform) which is mostly flat and on which most of the Coega IDZ is located. Beyond the IDZ the land rises more steeply again onto a second palaeo-marine bench (Grassridge Platform). The Grassridge Platform is not as flat since it contains the remnants of a palaeo-dune system. This platform gives way to foothills of the Groot Winterhoek Mountains near The Springs resort.

The two platforms or terraces are dissected by the Coega, Sundays and Swartkops River systems. The Sundays and Swartkops river floodplains are broad and form major landforms in the study area. The Coega River floodplain bisects the IDZ and the mouth of the river is the location of the Port of Ngqura. The two major terraces are readily seen in the SE-NW profile (Figure 4-2c) while the SW-NE profile shows the effect of the three major rivers and their floodplains on the local topography (Figure 4-2d). The wind turbines in the IDZ will be located on the Coega Platform, while the rest will be spread across the Grassridge Platform.

4.1.2 Geology

Alluvium/Sand

The three major river floodplains are filled with sediment (alluvium) derived from extensive drainage basins (especially that of the Sundays River), and provides fertile soils for agricultural development. Dunes of the Alexandria coastal dune field extends along the coast from Cannonvale at the Sundays River mouth eastwards to Woody Cape. The dune field forms when a strong dominant wind blows onshore along a long sandy beach, and it is known as an accretionary sheet dune field(Illenberger&Burkinshaw 2008).

Algoa Group

The *Nanaga Formation* represents coastal palaeo dune fields. It consists mostly of calcareous sandstone which weathers to form surficial calcrete or red, clayey soil (Roberts et al. 2006). These palaeo dunes form high beach ridges and rolling hills, with crests up to 100m above the valleys between dunes and are seen in the landscape east of Colchester (Illenberger&Burkinshaw 2008).

The *Alexandria Formation* underlies the Nanaga Formation in the Algoa Group and represents marine deposits formed during a series of marine transgression/regression cycles (rising and falling sea-level) which was caused by a succession of ice ages (McCarthy &Rubidge 2006). The formation comprises layers of conglomerate, oyster shells and calcareous sandstones. This layer forms the marine terraces or platforms mentioned in section **Error! Reference source not found.** on the topography of the study area. The wind turbines will mostly be underlain by Alexandria Formation rocks (Figure 4-3).

Grahamstown Formation

The Grahamstown Formation consists of silcrete which is a combination of sand and pebbles cemented in a matrix of hard siliceous material (Partridge et al. 2006). It formed through deep weathering of rocks during a warm humid period in the Cretaceous. These deposits are erosion resistant and will generally produce positive relief. A few small outcrops occur within the study area.

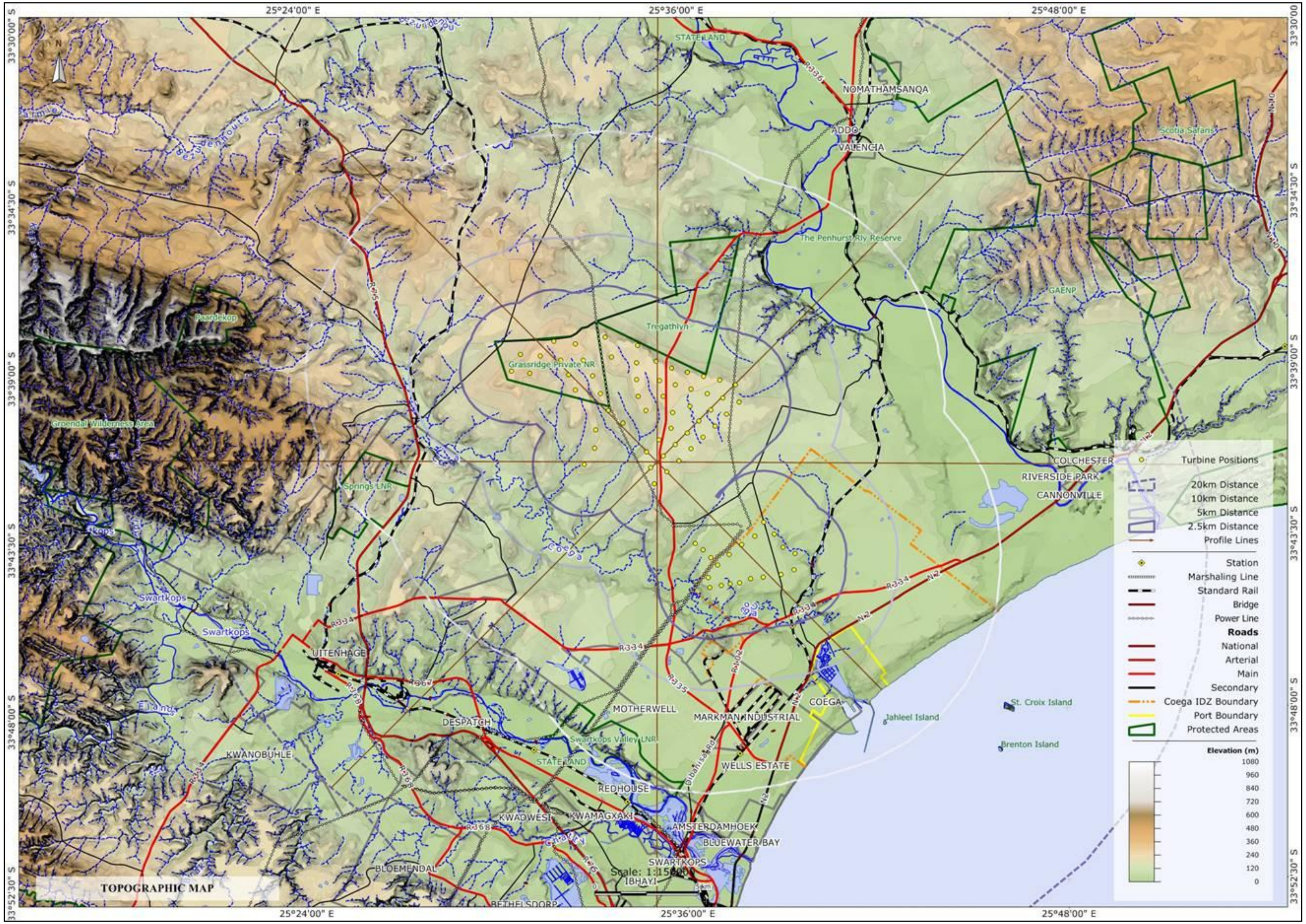

Figure 4-1 a-d: Topographic map showing wind farm area in relation to surrounding settlements and protected areas. Distances of 2.5km, 5km, 10km and 20km from turbines are indicated, as well as topographic profile lines.

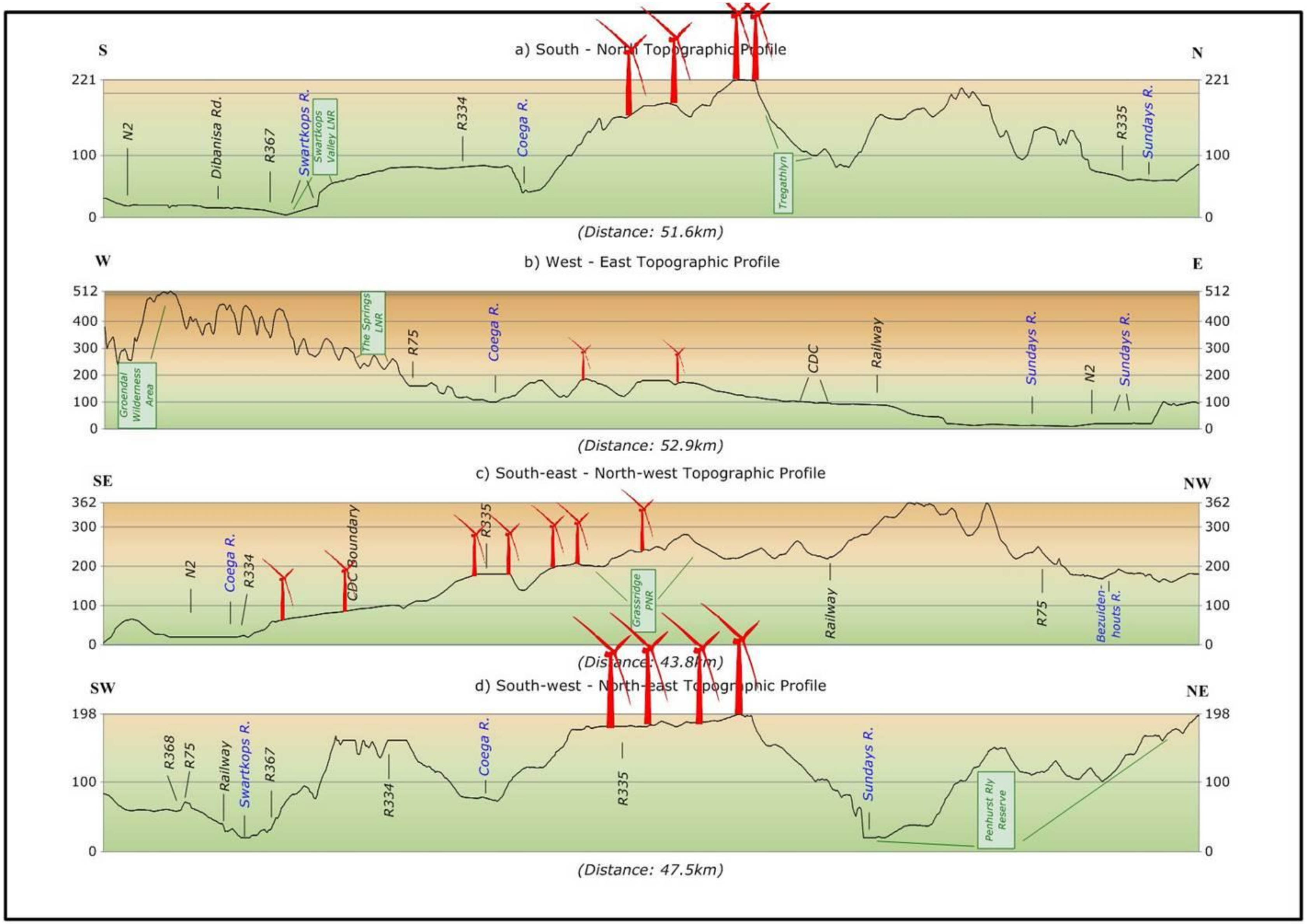

Figure 4-2: Topographic profiles across the region. Vertical scale exaggerated and different for each profile. Wind turbines (red) in scale in terms of height, not size. See topographic map (Figure 4-1) for profile line positions.

Uitenhage Group

The Enon, Kirkwood and Sundays River Formations represent the Uitenhage Group in this region. Rocks from this group were deposited in basins formed along the southern margin of Africa during the break-up of Gondwana. The *Enon Formation*, the lower most layer, consists mainly of conglomerate with large pebbles and cobbles and were deposited under high energy conditions, generally attributed to initiation of the extensional tectonics prevalent at the time. Above this lie sandstones and mudstones of the *Kirkwood Formation* which were deposited in rivers further from the basin scarps. Rocks of the *Sundays River Formation* represent shallow marine environments such as estuaries and lagoons and comprise thin layers of sandstone, siltstones and mudstones (Shone 2006; McCarthy &Rubidge 2006). The conglomerates of the Enon Formation were therefore deposited at the steep scarps at the edge of the developing Algoa Basin, while the Kirkwood formation represents lower energy river systems inside the basin, and the Sundays River Formation indicate the coastal boundary of the basin (which gradually moved inland as water from the ocean filled the expanding basin).

Suurberg Group

The Suurberg volcanic rocks were extruded during the extensional tectonics of the Gondwana break-up. It consists of basalt, tuff (volcanic ash) and breccia.

Cape Supergroup

The *Peninsula Formation* and *Nardouw Subgroup* (Table Mountain Group) consist of a sequence of relatively pure sandstone (arenite) layers deposited in shallow seas and fluvial braided plains. Later the sedimentary rocks were altered by compressional tectonic forces and heat to produce hard, erosion resistant metamorphic rocks known as quartzites. The *Ceres Subgroup* (Bokkeveld Group) was deposited in numerous deltas, and consists of finer grained material in layers of mudstone and arenite. Overlying the Ceres Subgroup are rocks of the Traka Subgroup (Bokkeveld Group) which consists of layers representative of deeper marine environments at the front of deltas. Mudstones and siltstones are the main rock types with some sandstone layers. These rocks tend to weather quicker relative to the harder quartzites and often form valleys between quartzite ridges or mountains. The *Weltevrede Formation* is the basal layer of the Witteberg Subgroup in the Eastern Cape. It consists of alternating layers of shale, sandstone and siltstone and represents fluvial and deltaic deposits. The Zuurberg mountain range north of Addo Elephant National Park is made up of Witteberg Subgroup rocks.

Gamtoos Inlier

Rocks of the Gamtoos Group are exposed along the northern flank of the Algoa Basin (Uitenhage Group). These layers were deposited in pre-Cambrian times and imprints of a number of tectonic events obscure accurate interpretation of their origins (Gresse et al. 2006).

Geological History

A number of tectonic events produced the topography of the study area. After deposition of the Cape Supergroup rocks, a subduction zone formed along the southern margin of Gondwana. The sediments (Cape Supergroup) on the seafloor were compressed and buckled, and a mountain range similar to that of the Andes was formed (Cape Fold Belt). The break-up of Gondwana occurred during the late Jurassic and Cretaceous Periods along the southern African boundary. Most sedimentation during this time occurred either off-shore (in the Atlantic and Indian Oceans), or in small inland basins caused by extensional tectonics.

The Algoa Basin is an example of one of these basins, and it was filled with sediments of the Uitenhage Group. As Gondwana continued to break up the sea flooded into these basins and the southern African continental shelf was developed. Differential erosion of the softer Bokkeveld Group rocks created longitudinal valleys between the mountain ridges formed by harder quartzites of the Table Mountain Group. Various ice-ages subsequent to the establishment of the continental shelf caused changes in sea level which produced marine and fluvial terraces along the coast. In particular, two major continental uplift events in the last 20 million years caused major terracing and drainage rejuvenation. Marine terraces were deeply incised during regression of sea level as stream erosion was renewed.

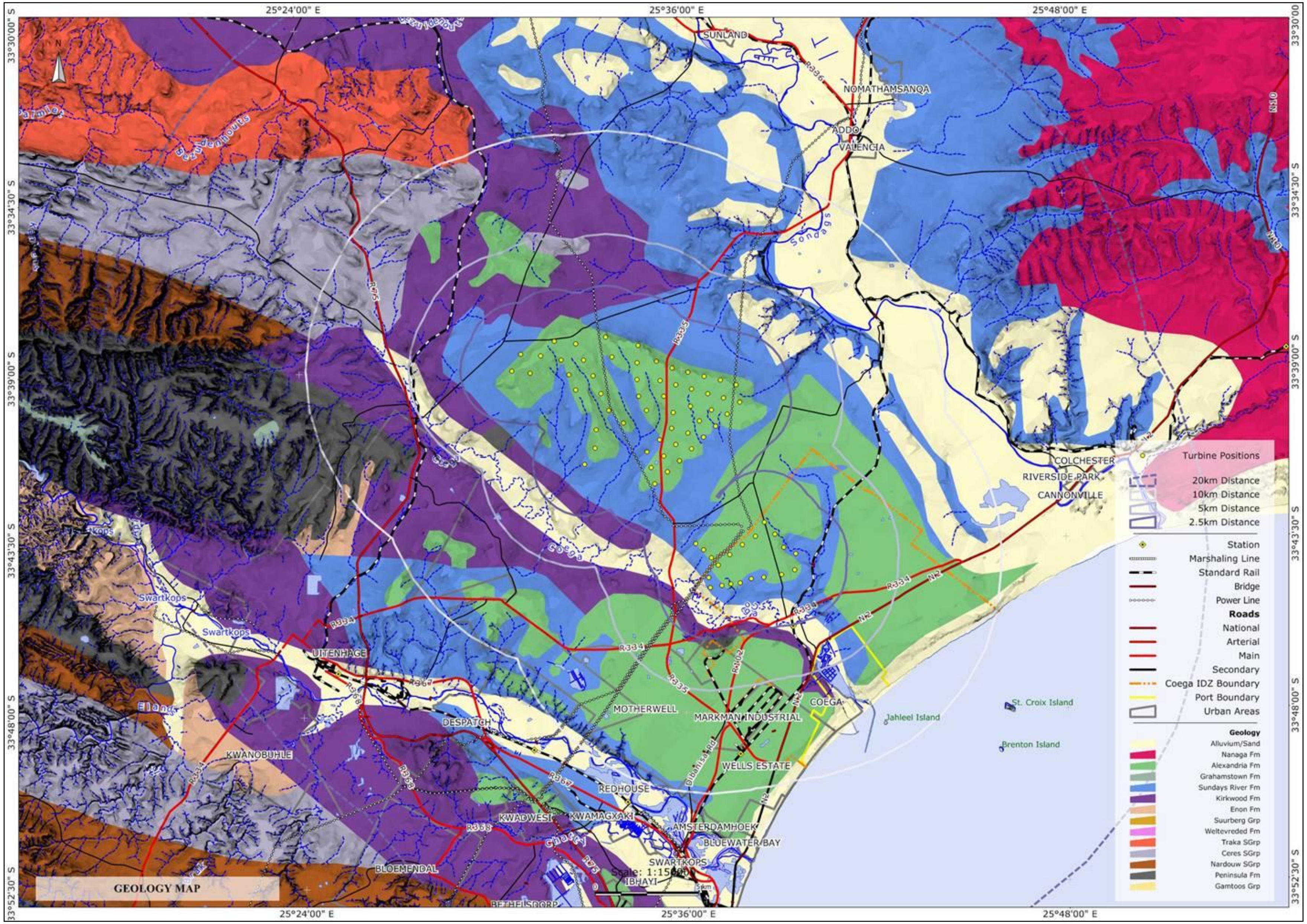

Figure 4-3: Geology of the region. (Fm - formation; SGrp - subgroup; Grp - group)

4.1.3 Landcover

Part of the WEF will be installed in the Coega IDZ (Figure 4-4). This is currently an area that is under intense development and many projects are in the construction phase, while others have not yet started. South and west of the IDZ are formal and informal urban areas and further industrial zones. Among the urban settlements are coastal resorts such as Bluewater Bay, and rapidly expanding townships such as Motherwell and Kwanobuhle. Suburbs of Port Elizabeth are also within the study area, as are Uitenhage and Despatch. West and north-west of the IDZ is agricultural land with crops, livestock and game farming (or private nature reserves). The remainder of the wind farm is located on land previously used for grazing and which is now owned by PPC, some of which is mined in an open cast operation. Further to the west, beyond The Springs, lies the Groendal Wilderness Area which is valued for its scenic landscapes. The floodplain of the Sundays River is under irrigated cultivation. There are numerous opencast mining operations and quarries in the surrounding landscape. Much of the land north of Colchester is now protected and is part of the Greater Addo Elephant National Park, as are the dune fields east of the Sundays River mouth. The three islands off Coega River mouth are also designated protected areas.

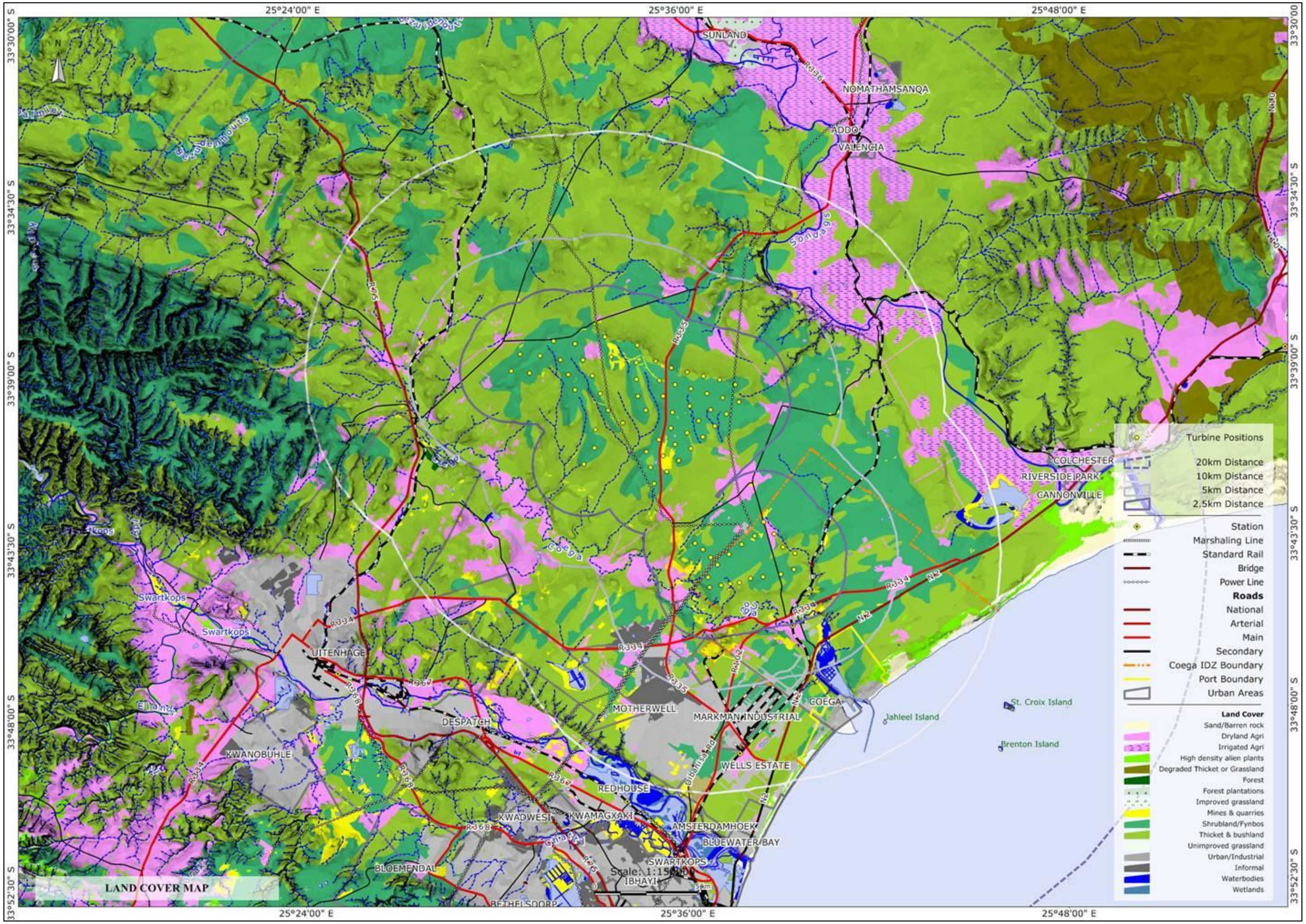

Figure 4-4: Map of land cover for the region. The map represents a conflation of the South African land cover data set and the set produced by SRK for the Nelson Mandela Bay Metropolitan Municipality in 2007.

4.1.4 Built environment

The Coega IDZ falls within the Nelson Mandela Bay Municipal Metropole and is surrounded by formal and informal settlements and industrial areas (Figure 4-5). Port Elizabeth, Uitenhage and Despatch are the main industrial centres, and numerous other urban areas have developed around these. Colchester, Cannonvale and Bluewater Bay are coastal resorts with some seasonal flux in population. Addo and Kirkwood developed as service centres for the Sundays River floodplain agricultural communities. A network of major roads surrounds and dissects the WEF and IDZ, and two major railway lines pass through the area. Various high voltage power lines and substations are common features of the landscape, as are large buildings and structures. The nearby deep water port of Ngqura contains cranes and other tall structures comparable in size with wind turbines.

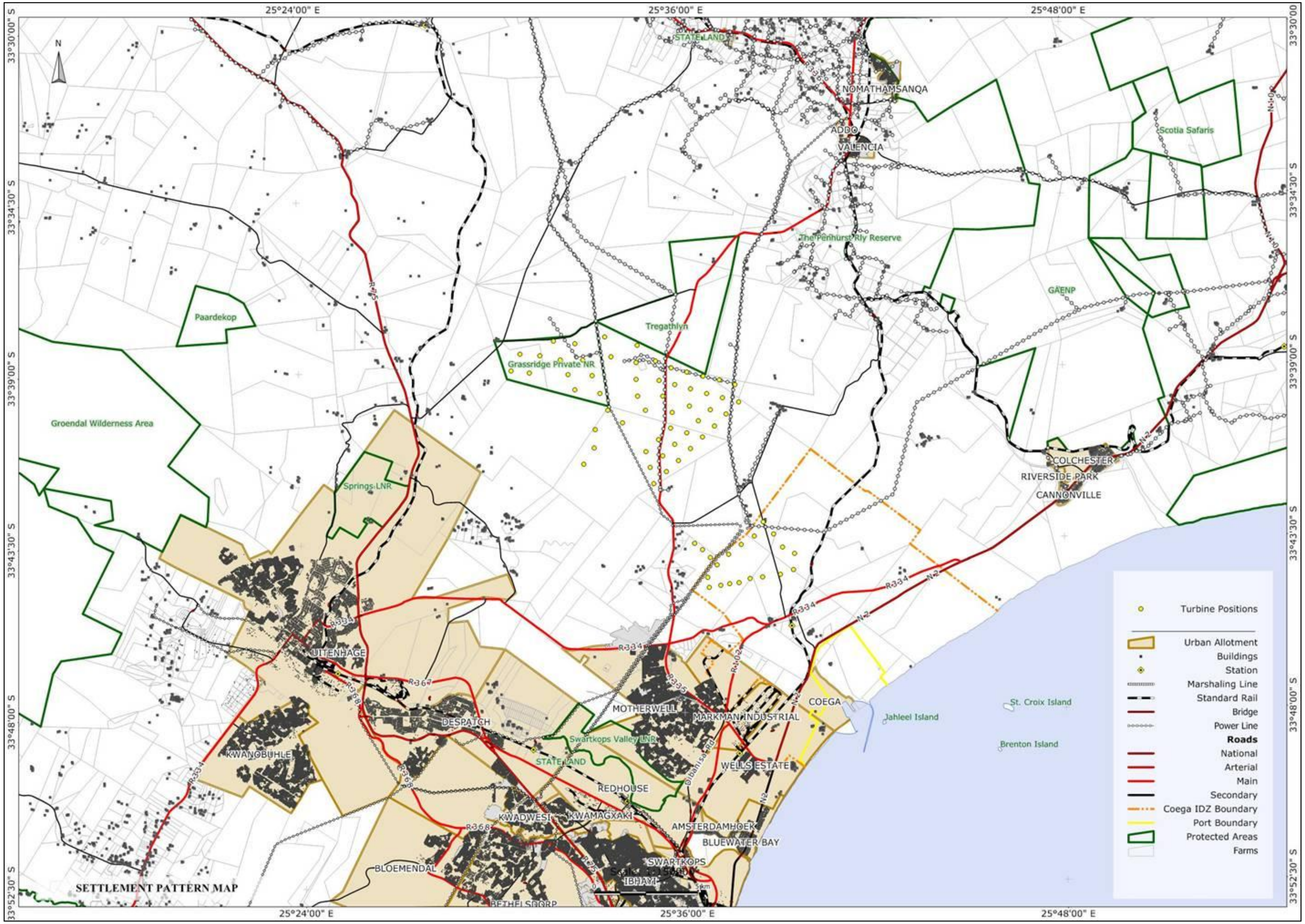

Figure 4-5: Settlement pattern and large man-made structures in the regional landscape.

4.2 Landscape character

Landscape character is the distinct and recognisable pattern of elements that occurs consistently in a particular type of landscape, and how this is perceived by people. It reflects particular combinations of geology, landform, soils, vegetation, land use and human settlement. It creates the particular sense of place of different areas of the landscape (GLVIA, 2002). Considering the landscape elements discussed above it is possible to identify five major landscape character types that may potentially be affected by the proposed wind farm:

- High population density urban and industrial areas south of the wind farm area;
- Agricultural land on the plateaus west and northwest of the IDZ;
- Agricultural land on the Sundays River floodplain;
- Coastal dune fields from the Sundays River mouth eastwards (GAENP);
- Protected areas on the plateau north of Colchester (Addo Elephant National Park);
- Protected areas in the Groot Winterhoek Mountains (Groendal Wilderness Area).

4.3 Landscape character sensitivity

Landscape character sensitivityprovides an indication of the ability of a landscape to absorb change from the proposed development without changing character. A pristine landscape prized for its natural beauty, or a landscape of high cultural value will have high sensitivity to changes brought about by new developments.

4.3.1 Urban and industrial areas

The WEF will be installed in an industrial landscape with some urban elements surrounding it. The sensitivity to the proposed wind farm for this landscape character type is expected to be **low** since the wind turbine structures are seen as congruent with industrial landscapes, and this is clearly not a pristine landscape. It is constantly changing and large industrial type activities and structures are expected in this landscape type. The urban areas that will be affected are surrounded by industrial developments and activities.

4.3.2 Agricultural landscape

The agricultural land west of the IDZ will have a **moderate to low** sensitivity to the wind farm development since it is surrounded and encroached on by urban, peri-urban and industrial developments. High voltage power lines cross the landscape and are often visible against the skyline. There are also a number of open cast mining operations in the area. A network of major roads dissects the landscape. It is a landscape that is rapidly changing. Elsewhere in the world wind farms are considered congruent with agricultural landscapes.

4.3.3 River floodplain agriculture

A **moderate to low** sensitivity to wind farm developments is expected since this landscape is under intense cultivation and large structures such as warehouses and irrigation equipment are visible in the landscape. Very little pristine landscape remains and the introduction of wind turbines is unlikely to change this landscape character type.

4.3.4 Coastal dune fields

The coastal dune fields east of Colchester are relatively devoid of man-made structures and other signs of human activity. It is also a protected area and the potential for pristine landscapes exist. A **high** sensitivity to the development is therefore expected.

4.3.5 Protected areas in the mountains

It is likely that if views from these areas contain wind turbines that they will also include other structures in the region (settlements, roads, quarries, power lines, chicken broiler housing, etc.). The landscape character type is therefore unlikely to change due to the introduction of the wind farm and a **moderate** sensitivity is predicted.

4.4 Visual absorption capacity

Visual absorption capacity (VAC is the capacity for the landscape to conceal the proposed development. The VAC of a landscape depends on its topography and on the type of vegetation that naturally occurs in the landscape. The size and type of the development also plays a role.

The VAC for this project is low due to the size of the project and the height of its components, as well as the fact that the turbines will be located on land that is relatively elevated. Vegetation will seldom conceal the development although high thicket and bush close to roads and viewpoints will provide some screening. High trees surrounding farmsteads will also reduce the visibility of the wind farm (as well as any shadow flicker effect from the turbines).

5 ASSESSMENT AND MITIGATION OF IMPACTS

5.1 Visual impact concepts and assessment criteria

The assessment and mitigation of impacts is conducted in the following steps:

- Identification of visual impact criteria (key theoretical concepts).
- Conducting a visibility analysis.
- Assessment of impacts of the project on the landscape and on receptors (viewers) taking into consideration factors such as sensitive viewers and viewpoints, visual exposure and visual intrusion.

5.1.1 Visual assessment criteria used in assessing magnitude and significance

The potential visual impact of the proposed wind farm is assessed using a number of criteria which provide the means to measure the magnitude and determine the significance of the potential impact (Oberholzer 2005). The **visibility** (Section 5.1.3) of the project is an indication of where in the region the development will potentially be visible from. The rating is based on viewshed size only and is an indication of how much of a region will potentially be affected visually by the development. A high visibility rating does not necessarily signify a high visual impact, although it can if the region is densely populated with sensitive visual receptors. **Viewer (or visual receptor) sensitivity** (Section 5.1.4) is a measure of how sensitive potential viewers of the development are to changes in their views. Visual receptors are identified by looking at the development viewshed, and include scenic viewpoints, residents, motorists and recreational users of facilities within the viewshed. A large number of highly sensitive visual receptors can be a predictor of a high **intensity/magnitude** visual impact although their distance from the development (measured as **visual exposure** – Section 5.1.5) and the current composition of their views (measured as **visual intrusion** – Section 5.1.6) will have an influence on the significance of the impact.

5.1.2 Impact rating methodology

Although specialists will be given relatively free rein on how they conduct their research and obtain information, they will be required to provide their reports to the EAP in a specific layout and structure, so that a uniform specialist report volume can be produced (Coastal & Environmental Services 2010).

To ensure a direct comparison between various specialist studies, a standard rating scale has been defined and will be used to assess and quantify the identified impacts. This is necessary since impacts have a number of parameters that need to be assessed. Five factors need to be considered when assessing the significance of impacts, namely:

- Relationship of the impact to temporal scales - the temporal scale defines the significance of the impact at various time scales, as an indication of the duration of the impact.
- Relationship of the impact to spatial scales - the spatial scale defines the physical extent of the impact.
- The severity of the impact - the severity/beneficial scale is used in order to scientifically evaluate how severe negative impacts would be, or how beneficial positive impacts would be on a particular affected system (for ecological impacts) or a particular affected party.
- The severity of impacts can be evaluated with and without mitigation in order to demonstrate how serious the impact is when nothing is done about it. The word „mitigation" means not just „compensation", but also the ideas of containment and remedy. For beneficial impacts, optimization means anything that can enhance the benefits. However, mitigation or optimization must be practical, technically feasible and economically viable.
- The likelihood of the impact occurring - the likelihood of impacts taking place as a result of project actions differs between potential impacts. There is no doubt that some impacts would occur (e.g. loss of vegetation), but other impacts are not as likely to occur (e.g.

vehicle accident), and may or may not result from the proposed development. Although some impacts may have a severe effect, the likelihood of them occurring may affect their overall significance.

Each criterion is ranked with scores assigned as presented in Table 5-1 to determine the overall **significance** of an activity. The criterion is then considered in two categories, viz. effect of the activity and the likelihood of the impact. The total scores recorded for the effect and likelihood are then read off the matrix presented in Table 5-2, to determine the overall significance of the impact (Table 5-3). The overall significance is either negative or positive.

The ***environmental significance*** scale is an attempt to evaluatethe importance of a particular impact. This evaluation needs to be undertaken in the relevant context, as an impact can either be ecological or social, or both. The evaluation of the significance of an impact relies heavily on the values of the person making the judgment. For this reason, impacts of especially a social nature need to reflect the values of the affected society.

Negative impacts that are ranked as being of "**VERY HIGH**" and "**HIGH**" significance will be investigated further to determine how the impact can be minimised or what alternative activities or mitigation measures can be implemented. These impacts may also assist decision makers i.e. lots of **HIGH** negative impacts may bring about a negative decision.

For impacts identified as having a negative impact of "**MODERATE**" significance, it is standard practice to investigate alternate activities and/or mitigation measures. The most effective and practical mitigations measures will then be proposed.

For impacts ranked as "**LOW**" significance, no investigations or alternatives will be considered. Possible management measures will be investigated to ensure that the impacts remain of low significance

Table 5-3: Criterion used to rate the significance of an impact

EFFECT	**Temporal scale**			**Score**
	Short term	Less than 5 years		**1**
	Medium term	Between 5 and 20 years		**2**
	Long term	Between 20 and 40 years (a generation) and from a human perspective almost permanent.		**3**
	Permanent	Over 40 years and resulting in a permanent and lasting change that will always be there		**4**
	Spatial Scale			
	Localised	At localised scale and a few hectares in extent		**1**
	Study area	The proposed site and its immediate environs		**2**
	Regional	District and Provincial level		**3**
	National	Country		**3**
	International	Internationally		**4**
	Severity		**Benefit**	
	Slight / Slightly Beneficial	Slight impacts on the affected system(s) or party (ies)	Slightly beneficial to the affected system(s) or party (ies)	**1**
	Moderate / Moderately Beneficial	Moderate impacts on the affected system(s) or party(ies)	An impact of real benefit to the affected system(s) or party (ies)	**2**
	Severe / Beneficial	Severe impacts on the affected system(s) or party (ies)	A substantial benefit to the affected system(s) or party (ies)	**4**
	Very Severe / Very Beneficial	Very severe change to the affected system(s) or party(ies)	A very substantial benefit to the affected system(s) or party (ies)	**8**
LIKELIHOOD	**Likelihood**			
	Unlikely	The likelihood of these impacts occurring is slight		**1**
	May Occur	The likelihood of these impacts occurring is possible		**2**
	Probable	The likelihood of these impacts occurring is probable		**3**
	Definite	The likelihood is that this impact will definitely occur		**4**

Table 5-4: The matrix that will be used for the impacts and their likelihood of occurrence

		Effect													
Likelihood		**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
	1	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	2	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	3	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	4	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Table 5-5: The significance rating scale

Significance	Description	Score
Low	An acceptable impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in either positive or negative medium to short term effects on the social and/or natural environment.	4-7
Moderate	An important impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in either a positive or negative medium to long-term effect on the social and/or natural environment.	8-11
High	A serious impact, if not mitigated, may prevent the implementation of the project (if it is a negative impact). These impacts would be considered by society as constituting a major and usually a long-term change to the (natural &/or social) environment and result in severe effects or beneficial effects.	12-15
Very High	A very serious impact which, if negative, may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are unmitigatable and usually result in very severe effects, or very beneficial effects.	16-20

5.1.3 Visibility

Visibility of Project	The geographic area from which the project will be visible, or view catchment area. (The actual zone of visual influence of the project may be smaller because of screening by existing trees and buildings). This also relates to the number of receptors affected (Oberholzer 2005). • *High visibility* - visible from a large area (e.g. several square kilometres). • *Moderate visibility* – visible from an intermediate area (e.g. several hectares). • *Low visibility* – visible from a small area around the project site.

In this report there is also another sense in which 'visibility' is used. Cumulative viewsheds indicate not only where a feature is visible from (the meaning of visibility as used in the definition above), but also how much of the feature will be visible from that point or area.

As expected the visibility is **high** in terms of area due to the turbine heights and their location on relatively elevated land. The map in **Figure 5-** shows the spatial extent of areas with views on the wind farm. Due to the proximity of the wind farm to urban areas it is also clear that there are many visual receptors which will potentially be affected.

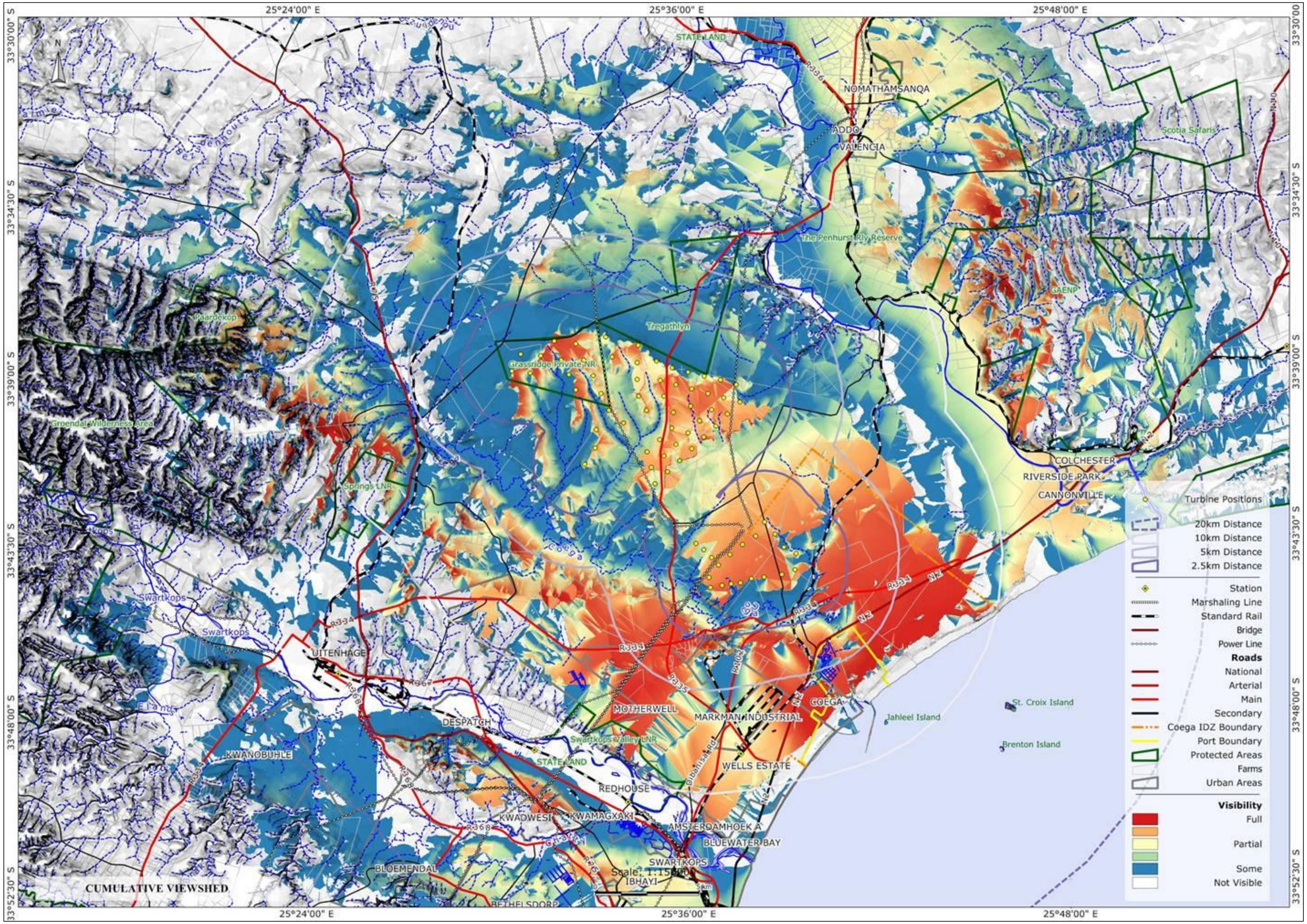

Figure 5-1: Map showing the cumulative viewshed calculated for 75 wind turbines. Red indicates areas where views of the wind farm will contain most of the wind turbines (potentially all the turbines). Green lines on the map show positions of protected areas. The viewshed calculation does not take into account distance from the wind farm, which will be discussed in the section on visual exposure, and is not a direct reflection of visual impact.

5.1.4 Sensitive viewers and viewpoints

Viewer sensitivity is the assessment of the receptivity of viewer groups to the visible landscape elements and visual character and their perception of visual quality and value. The sensitivity of viewer groups depends on their activity and awareness within the affected landscape, their preferences, preconceptions and their opinions.

A rating system provided by the Landscape Institute of the United Kingdom was used to determine viewer sensitivity:

Definition (GLVIA 2002)	
Exceptional	• Views from major tourist or recreational attractions or viewpoints promoted for or related to appreciation of the landscape, or from important landscape features.
High	• Users of all outdoor recreational facilities including public and local roads or tourist routes whose attention may be focussed on the landscape; • Communities where the development results in changes in the landscape setting or valued views enjoyed by the community; • Residents with views affected by the development.
Moderate	• People engaged in outdoor sport or recreation (other than appreciation of the landscape).
Low	• People at their place of work or focussed on other work or activity; • Views from urbanised areas, commercial buildings or industrial zones; • People travelling through or passing the affected landscape on transport routes
Negligible (uncommon)	• Views from heavily industrialised or blighted areas.

The following sensitive viewers or viewpoints were identified:

- Residents of surrounding urban areas;
- Residents of coastal resorts;
- Viewpoints in surrounding protected areas;
- Tourists and visitors to protected areas;
- Residents on surrounding farms (including residents in the wind farm area);
- Workers in the industrial areas;
- Motorists using the N2 and other main roads in the region.

Residents of resort towns
Residents are seen as highly sensitive to changes in their views since they have an interest in the landscape that surrounds them. The wind farm is more than 5km away from Cannonvale and Colchester, but residents may have some of their current views altered by wind turbines.

Residents of surrounding urban areas
There are large urban centres as well as informal settlements adjacent to the IDZ and residents living there are likely to have their existing views altered by the wind farm development.

Residents of surrounding farms
Residents" views will be affected according to their visual exposure to the wind farm and the quality of their existing views.

Scenic viewpoints
Viewpoints on farms in the surrounding landscape with scenic views can potentially be affected by the wind farm.

Protected areas
There are a number of protected areas in the region which can potentially be affected by the wind farm. Among these are the Addo Elephant National Park, The Springs Local Nature Reserve and the Swartkops Valley Nature Reserve. The islands off the coast at the Coega River mouth will also be affected. The Groendal Wilderness Area may also be affected.

Workers in IDZ and surrounding industry
Viewers in the IDZ are likely to have views of wind turbines from their places of work. There are many other large industrial developments in Uitenhage and Despatch and the existing views of workers will potentially be altered by the turbines. Workers are seen as low sensitivity visual receptors since their attention will generally not be focussed on the landscape.

Motorists
There are a number of major roads that pass near wind turbines and motorists travelling on these will have close views of many of the wind turbines. The roads include the N2, a major tourist route connecting Port Elizabeth Airport with popular tourist areas further north and along the coast, the R75, R334, R335 and R102. Secondary and other roads connecting these major routes will also be affected. Motorists are normally seen as low sensitivity visual receptors, but they may include tourists who will have more interest in the landscape they are driving through.

5.1.5 Visual exposure

Visual exposure refers to the relative Visibility of a project or feature in the landscape (Oberholzer, 2005). Exposure and visual impact tend to diminish exponentially with distance. The exposure is classified as follows:

- High exposure – dominant or clearly noticeable;
- Moderate exposure – recognisable to the viewer;
- Low exposure – not particularly noticeable to the viewer

The European Wind Energy Association (EWEA) also suggests zones of theoretical visibility (ZTV) as follows (EWEA 2009):

- Zone I – Visually dominant: turbines are perceived as large scale and movement of blades is obvious. The immediate landscape is altered. Distance up to 2km.
- Zone II – Visually intrusive: the turbines are important elements on the landscape and are clearly perceived. Blades movement is clearly visible and can attract the eye. Turbines not necessarily dominant points in the view. Distance between 1 and 4.5 km in good visibility conditions.
- Zone III – Noticeable: the turbines are clearly visible but not intrusive. The wind farm is noticeable as an element in the landscape. Movement of blades is visible in good visibility conditions but the turbines appear small in the overall view. Distance between 2 and 8 km depending on weather conditions.
- Zone IV – Element within distant landscape: the apparent size of the turbines is very small. Turbines are like any other element in the landscape. Movement of blades is generally indiscernible. Distance of over 7 km.

The zones overlap due to the fact that they attempt to incorporate atmospheric or weather conditions. The maps in this section do not show these zones but distance buffers are included to enable readers to apply the EWEA nomenclature.

Visual exposure was calculated using visibility (i.e. how much of the wind farm will be visible) and distance from the nearest wind turbine

Residents of surrounding urban areas
There are a number of urban centres within 20km from the wind farm and those which may have medium to high visual exposure to the project are listed in Table 5-4. All these settlements are surrounded by industrial developments and views from them towards the wind farm will be complex with many tall structures and large buildings in them. It is clear from the map that there are more settlements where residents will potentially be able to see wind turbines, but their exposure to the wind farms will be low due to their distance from the site and how much of the wind farm will be visible to them.

Table 5-4: Visual exposure ratings for settlements potentially affected by the WEF.

URBAN AREA	MIN DIST (km)	VISUAL EXPOSURE
WELLS ESTATE	2.36	High
MOTHERWELL	3.37	High
COEGA	4.79	High
MARKMAN INDUSTRIAL	5.00	High
AMSTERDAMHOEK A	10.60	Medium

Protected Areas and Scenic Viewpoints
The southern section of the Greater Addo Elephant National Park (GAENP) will potentially have views of the wind farm from the plateau above Colchester. However, there are no designated viewpoints in this area that will have views on the turbines. One short section of the road from the northern part of the park as one approaches the southern gate from the plateau has a view of the existing wind turbine at Coega, and may provide a view of a few of the proposed wind turbines. However, this point is more than 15km from the nearest wind turbine and it would require a clear day to see. Areas indicated on the map as having views on the wind farm are not accessible by the public and the high thicket will reduce the viewshed considerably.

Some areas in the northern part of the Swartkops Valley LNR will potentially have views on many of the turbines, which results in high visual exposure ratings even though the reserve is quite far from the wind farm. Other elements in these views will include houses in Motherwell, many high voltage power lines and pylons and other industrial structures between the reserve and the wind farm. Some of the wind turbines will be located in the Grassridge Private Nature Reserve (PPC owned) and it is therefore likely that the owners of the reserve realise and accept that the visual impact on the reserve will be high. The status of the Tregathlyn reserve (STEP Type 3) is unclear and a chicken broiler housing development on the site was approved by DEAET (pers. comm. Sandy Wren 2010).

The Groendal Wilderness Area is more than 15km from the wind farm and visual exposure to the development is low. Views from the three islands (Jahleel, Brenton and St Croix) off Coega River mouth will only contain parts of some of the turbines. Their visual exposure to the wind farm will be low.

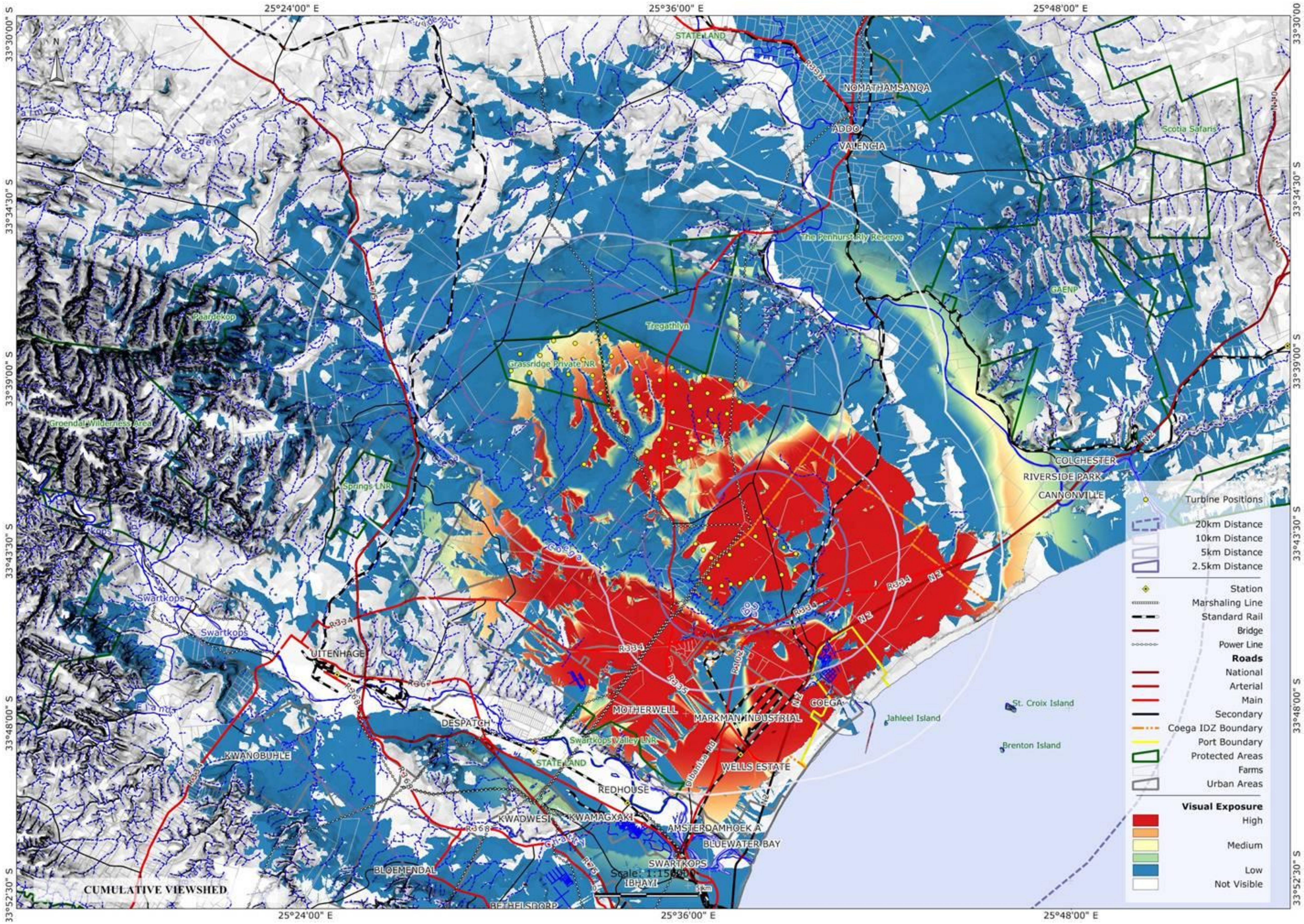

Figure 5-2: Visual exposure calculated from visibility and distance from nearest turbine.

Table 5-5: Protected area types as defined by STEP (from Lombard et al. 2003)

STEP PROTECTED AREA TYPE	TYPE DESCRIPTION
Type 1	A protected area owned and run by the State, Province or a local authority. Conservation legislation is strong.
Type 2	Public or private land managed for conservation and other land uses. Conservation legislation is weak or non-existent.
Type 3	Areas potentially available for conservation, owing to the existence of a structure for communication between conservation planners and landowners.

Table 5-6: Protected areas that may be affected by the wind farm development.

PROTECTED AREA	STEP TYPE	MIN DIST (km)	VISUAL EXPOSURE
Grassridge Private NR	2	0.00	High
Tregathlyn	3	0.14	Medium
Springs LNR	1	7.26	Low
Swartkops Valley LNR	1	7.94	High
The Penhurst Rly Reserve	2	8.23	Low
Jahleel Island	1	8.53	Low
Addo Elephant NP	1	10.14	Low
St. Croix Island	1	12.04	Low
Paardekop	3	12.60	Low
Brenton Island	1	13.17	Low
Groendal Wilderness Area	1	15.32	Low
Citruslandgoed	3	19.90	Low
Voetpadskloof	3	21.66	Low
Scotia Safaris	3	22.45	Low

Residents on farms

Appendix 1 at the end of this document lists buildings on farms on or surrounding the WEF high visual exposure ratings. Many of these are either within the IDZ or are surrounded by industrial developments (

Figure 5-). There are three buildings within 500m of a wind turbine and these visual receptors may be affected by shadow flicker.

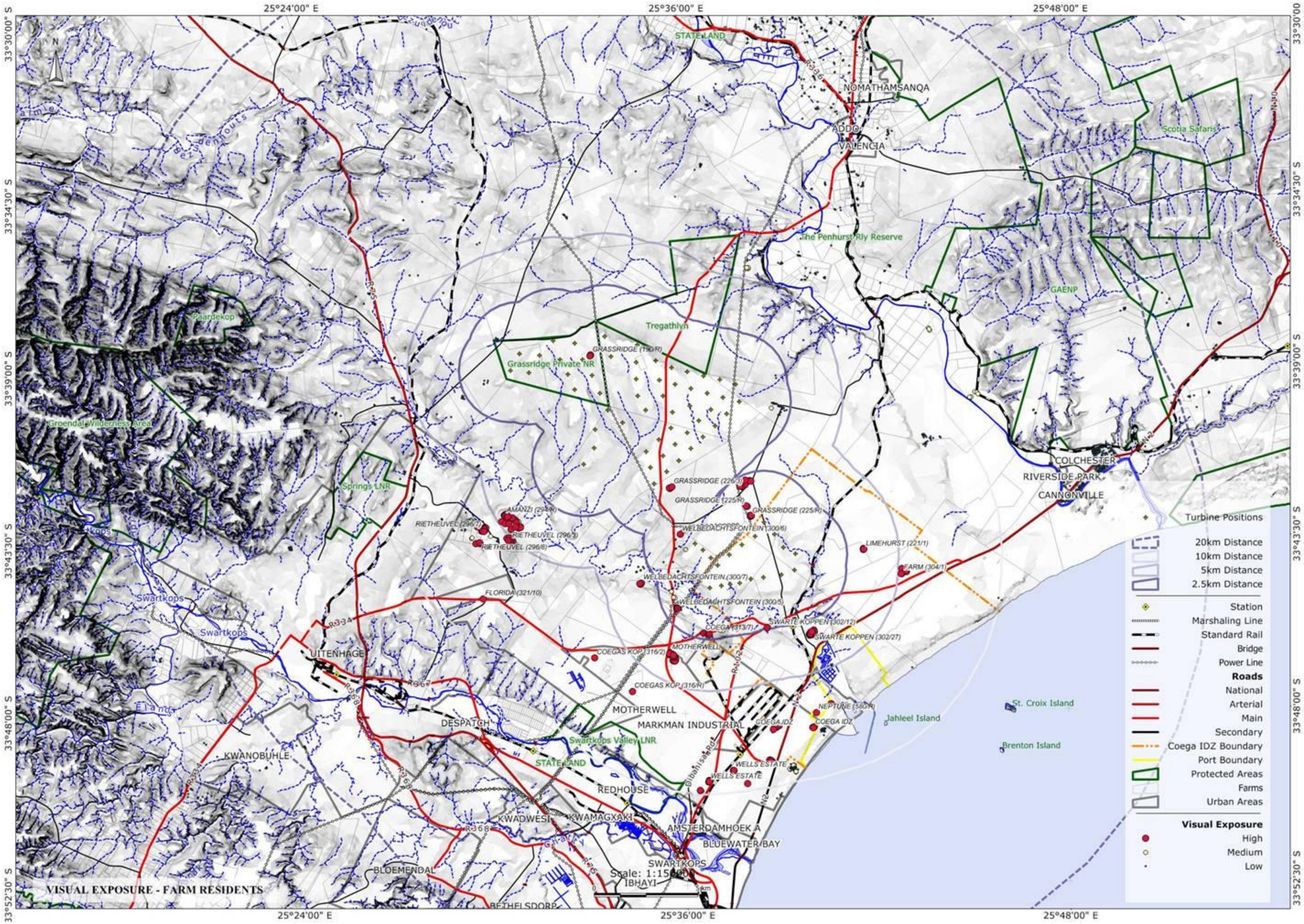

Figure 5-3: Potential visual exposure for buildings on farms surrounding wind turbines.

Motorists

Sections of the N2, R334, R335 and R102 will be highly exposed to the wind farm. Motorists on these and other connecting secondary roads in the region will have close views of a number of wind turbines at a time. The R335 will be particularly affected since motorists will drive among wind turbines for a part of this road.

5.1.6 Visual intrusion

Visual intrusion indicates the level of compatibility or congruence of the project with the particular qualities of the area – its sense of place. This is related to the idea of context and maintaining the integrity of the landscape (Oberholzer 2005). It can be ranked as follows:

- High – results in a noticeable change or is discordant with the surroundings;
- Moderate – partially fits into the surroundings, but is clearly noticeable;
- Low – minimal change or blends in well with the surroundings.

Sense of place is defined by (Oberholzer 2005) as: 'The unique quality or character of a place... relates to uniqueness, distinctiveness or strong identity.' It describes the distinct quality of an area that makes it memorable to the observer.

The map in
Figure 5- shows the locality of sites visited during the photographic survey.

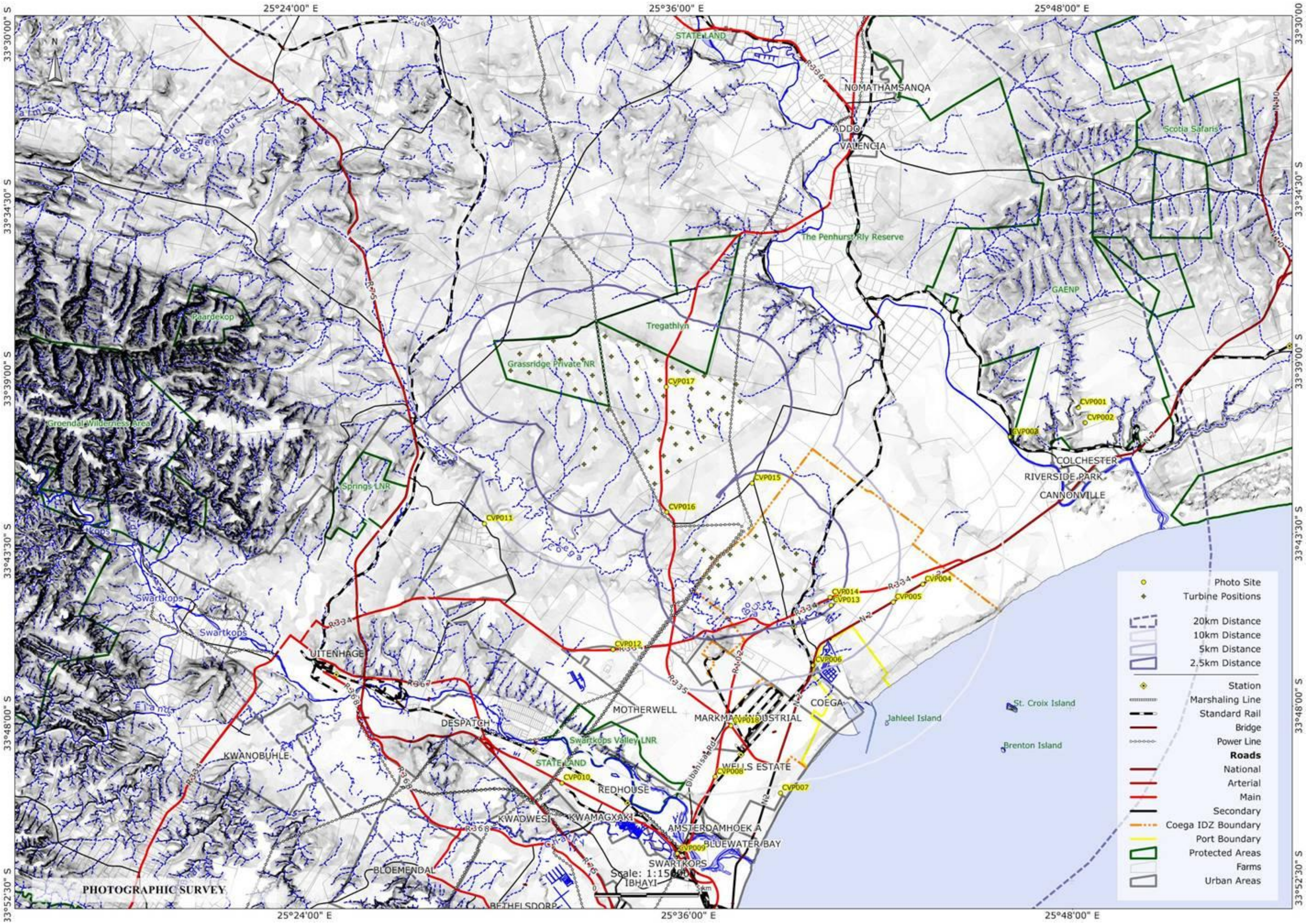

Figure 5-4: Map showing sites from where photos were taken during the photographic survey. These sites are referred to in the text and figure captions below.

Residents of surrounding urban areas
Settlements with high visual exposure ratings are all in close proximity to industrial developments. Those residents with views on turbines will also have views on other large industrial type structures such as high voltage power lines, towers, cranes and tall large buildings (Plate 5-1 to Plate 5-3). Views are likely to be very complex with high contrast. Many of these settlements are also expanding at a high rate and the existing views of residents are therefore not constant. Visual intrusion for residents of urban areas with high visual exposure ratings is expected to be moderate to low.

Plate 5-1: View of large power line pylons from photo site CVP009. In the background are several quarries against the hills.

Plate 5-2: View on some of the structures that residents of the area will have in their views. This view from CVP008 towards Motherwell

Plate 5-3: Tall power line pylons and street lamps in view at photo site CVP018 near Motherwell.

Protected Areas and Scenic Viewpoints

Visual intrusion for the GAENP will be low due to its low visual exposure and the fact that there are very few areas in the park from which the public will see any wind turbines (Plate 5). It is unlikely that the Swartkops Valley LNR has any viewpoints prized for their natural scenic beauty since most potential views with turbines in them will also include high voltage power lines, substations, industrial buildings and warehouses and formal and informal settlements (Plate 5-5). Its distance from the wind farm and locality indicates a low visual intrusion rating. Visual intrusion for the three islands will be low since views from these islands will also be complex and will include structures in the port such as many tall cranes and buildings. Views from protected areas further away to the west such as The Springs Resort and Groendal Wilderness Area are far from the wind farm and views with turbines in them will also have many other elements of the landscape in them, such as open cast mines, power lines, major roads, towers and cut-lines in the thicket (Plate 5-6).

Plate 5-4: View from within the GAENP on the road (CVP002) towards the southern gate. The arrow points to the existing wind turbine in the IDZ. It can just be made out in the haze.

Plate 5-5: View from viewpoint CVP010 towards the Swarkops River Valley LNR. The power line bisects the reserve.

Plate 5-6: Panoramic view towards the Coega IDZ from a viewpoint in the Springs Resort.

Residents on farms

These viewers are in a similar situation to residents in urban areas as discussed above. Views are often complex, composed of highly contrasting elements. Residents living in high visual exposure areas will also have their views encroached upon by many large structures associated with industrial developments and large urban or metropolitan centres (Plate 5). A few existing views contain less man-made features, but these do not occur often and are normally not far removed from larger structures

The views in Plate 5 are from the Amanzi farmstead and show elements in the landscape that are currently in view for the region west and north-west of the IDZ. A moderate to low visual intrusion is therefore expected for most of these visual receptors, depending on their distance from turbines.

Plate 5-7: A substation as seen from the R335, site CVP016.

Plate 5-8: Communications towers as seen from site CVP017 at the PPC mine entrance.

Plate 5-9: View on distant hills where turbines will be installed, from near the Amanzi farm entrance (site CVP011). There are few man-made elements in this view, but large chicken broiler housing buildings are located not far from here and a cellphone tower is also visible not far from this site.

Plate 5-10: Chicken broiler housing and other farm buildings and elements in view from the main Amanzi farmstead.

Motorists

A large network of roads will be affected by the wind farm, but most of these roads will have a low visual intrusion rating due to all the other elements that will also be in the views of motorists. Plates 5-11 to 5-15 provide an indication of existing views along the major roads.

Plate 5-11: View in the direction of the Ngqura Port from the main Amanzi farmstead. The white building in the distance is the new CerebosSaltworks building. Large brickwork developments are also visible in the middle ground.

Plate 5-12: View onto Ngqura Port and its large cranes as seen from the R335 (photo site CVP016). Tall power line pylons are also visible in this view.

Plate 5-13: Large brickworks along the R335.

Plate 5-14: Large quarry as seen from R335.

Plate 5-15: View towards the existing turbine (indicated by the arrow) in the IDZ from the R334 between Motherwell and the IDZ. Photo site CVP012 (10km from turbine).

Shadow Flicker

Turbine IWT42 is closer than 500m to buildings according to available data sets (see Appendix 1). Table 5- lists turbines that are within 500m to a road and these are labelled on the map in Figure 5-5. The turbines listed have a potential to affect motorists and residents by causing the shadow flicker effect. However, it is unlikely to be a major issue for motorists since they will spend a very short time on the section of road that may be affected by shadow flicker. The buildings in question are between 420m and 460m from IWT42 and it is unlikely that shadow flicker will affect them for more than 30 hours per year (an internationally accepted threshold for shadow flicker hours, above which it is recommended that the turbine be moved).

Table 5-7: Turbines closer than 500m to a building or a road.

TURBINE	MIN DIST M	LONGITUDE	LATITUDE
IWT70	22.02	25.6421	-33.7173
IWT42	59.92	25.5488	-33.6454
IWT43	82.43	25.5373	-33.6452
IWT55	88.54	25.5337	-33.6368
IWT51	104.94	25.5870	-33.6463
IWT01	117.66	25.6511	-33.7401
IWT27	137.10	25.5906	-33.6617
IWT57	142.28	25.5607	-33.6354
IWT11	148.36	25.5880	-33.6807
IWT07	149.02	25.5900	-33.6877
IWT52	203.12	25.5769	-33.6469
IWT40	203.90	25.5210	-33.6507
IWT50	260.34	25.5950	-33.6492
IWT04	306.92	25.5919	-33.6947
IWT14	312.68	25.5944	-33.6758
IWT17	316.29	25.5953	-33.6687

TURBINE	MIN DIST M	LONGITUDE	LATITUDE
IWT03	323.08	25.5853	-33.6998
IWT69	324.60	25.6477	-33.7225
IWT36	329.40	25.5886	-33.6547
IWT56	401.95	25.5774	-33.6392
IWT54	409.06	25.5448	-33.6383
IWT71	430.77	25.6375	-33.7232
IWT35	444.11	25.5969	-33.6567
IWT05	479.27	25.5834	-33.6928

Table 5-8: Summary of visual impact criteria

Criteria	Impact
Viewer Sensitivity	• Residents of urban areas – Highly sensitive to changes in their views. • Residents on surrounding farms – Highly sensitive • Scenic viewpoints and protected areas – Highly sensitive – there are no recognised viewpoints protected for their scenic quality in the region. • Motorists – Low sensitivity due to short exposure time and the fact that their focus on landscape is reduced.
Visibility of Development	• High due to the tall structures and their position in the topography.
Visual Exposure	• Residents of surrounding urban areas – Residents of a couple of nearby settlements such as Motherwell and Wells Estate will have a high visual exposure to the development due to their proximity to the wind farm. • Residents on surrounding farms – high visual exposure for a number of farm residences or buildings. • Protected areas – high visual exposure is expected for the Swartkops Valley Local Nature Reserve. The GAENP and three islands off Coega River mouth will have a low visual exposure. • Motorists – high for sections of the N2, R334, R335 and R102.
Visual Intrusion	• Residents of surrounding urban areas – moderate to low due to the low quality and complexity of their existing views in this region. • Protected areas – Low for GAENP (distance) and SwartkopsLNR (complexity of current views). Low for other protected areas such as The Springs Resort and Groendal Wilderness Area. • Residents on surrounding farms – moderate to low due to complexity of views in an industrial and metropolitan area. • Motorists – High for a short time when in close proximity.

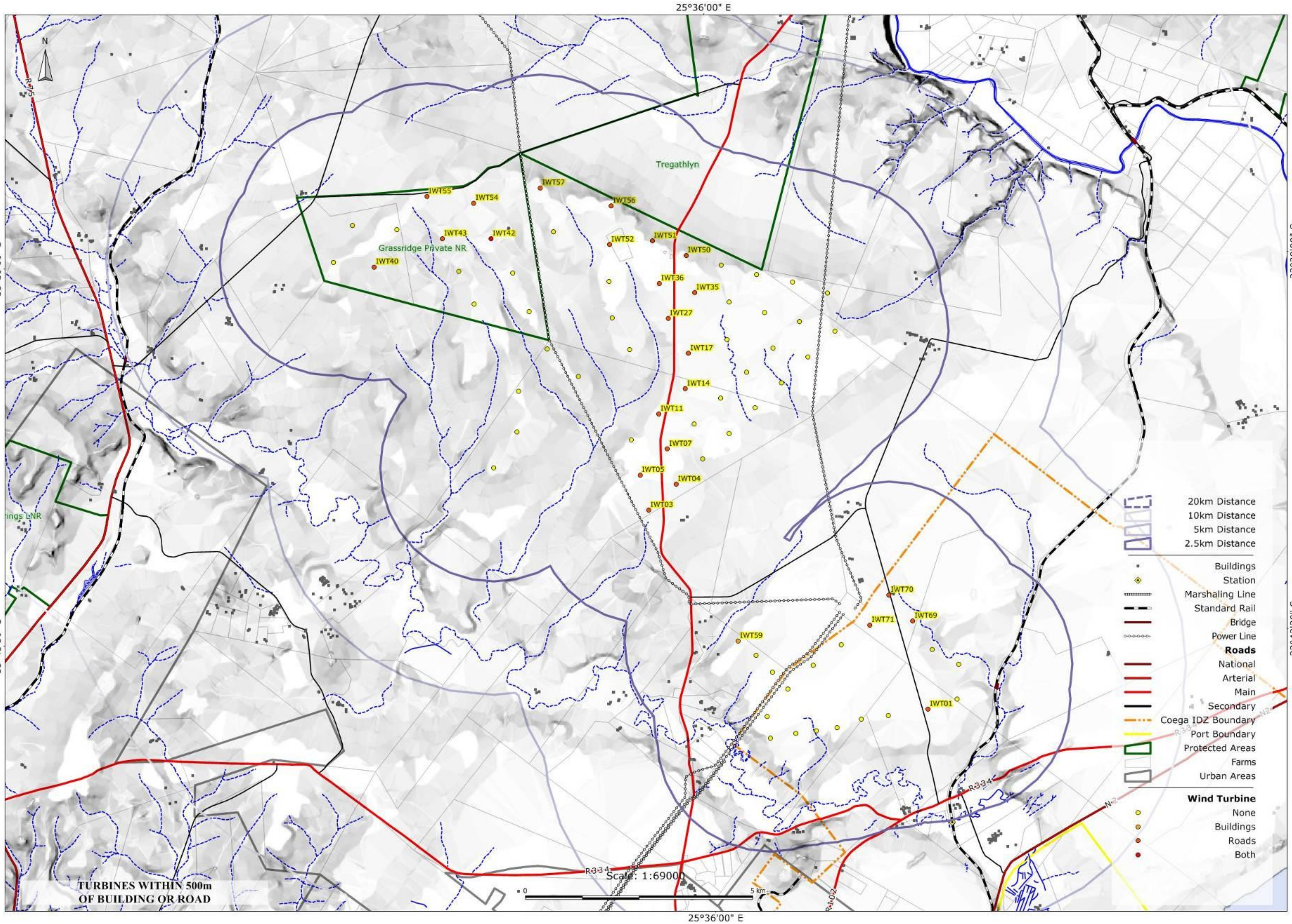

Figure 5-5: Map of wind turbines which are close enough to buildings or roads to potentially affect sensitive viewers through shadow flicker.

5.2 Significance of visual impact on the landscape

Landscape impacts are the resultant change in the elements, characteristics, character and qualities of the landscape as the result of development (GLVIA, 2002). These effects can be positive or negative, and result from removal of existing landscape elements, addition of new elements, or the alteration of existing elements.

5.2.1 Impact 1: Impact of introducing highly visible wind turbines into an industrial landscape

Cause and Comment
The existing landscape character type (industrial and peri-urban agricultural) sensitivity is low – introduction of a WEF is unlikely to change the character type. Other landscape character types surrounding the Coega IDZ will also be affected due to the high visibility of the turbines. As discussed in Section **Error! Reference source not found.** the sensitivity of these landscape character types range from moderate to low for agricultural, floodplain agricultural and protected areas above Colchester, to high for the coastal dune fields east of Colchester.

Mitigation Measures
There are no mitigation measures that will change the significance of the landscape impact other than avoiding the site entirely. A reduction in wind turbine numbers are unlikely to have an appreciable effect since even a few wind turbines will still have high visibility.

Significance Statement
The duration of the impact is long term (3) (and not permanent) since the turbines can be removed from the landscape after their life span has been reached. The extent is regional (3) due to the visibility and size of the project. The severity of the impact is expected to be slight (1) since the landscape character sensitivity is low, and visual exposure in the high sensitivity landscape character type (coastal dune fields) is expected to be low, resulting in an overall significance of 7 (see**Error! Reference source not found.**).

The likelihood of the impact occurring is probable (3) due to the size of the wind farm and its components, and their high visibility. The significance of the landscape impact according to the rating methodology is therefore expected to be moderate (10) due to the long duration and the extent of the impact. The status of the impact should be positive since it is clear that wind farms are needed to supplement the existing electricity production in a sustainable and environmentally acceptable way, and that wind farms are perceived by many to be industrial type developments. Internationally, wind farms are a common feature in agricultural landscapes. However, their high visibility in most landscapes may still be met with some resistance.

Table 5-9: Significance of impact on an industrial/peri-urban/agricultural landscape caused by introduction of a wind farm.

Impact (Operation Phase Only)	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
All Alternatives										
Without Mitigation	Long Term	3	Regional	3	Slight	1	Probable	3	10	Moderate
With Mitigation	Long Term	3	Regional	3	Slight	1	Probable	3	10	Moderate

5.3 Significance of visual impact on viewers

Visual impacts are the resultant changes to the visual character of available views resulting from the development that include: obstruction of existing views; removal of screening elements thereby exposing viewers to unsightly views; the introduction of new elements into the viewshed experienced by visual receptors and intrusion of foreign elements into the viewshed of landscape features thereby detracting from the visual amenity of the area

5.3.1 Impact 2: Intrusion of large and highly visible construction activity on sensitive viewers

Cause and Comment

The height of the features being built and the siting on the flat landscape is likely to expose construction activities against the skyline (Plate 5-16). Large, abnormal freight vehicles and equipment will be visible. Traffic may be disrupted while large turbine components are moved along public roads. Activity at night is also probable since transport of large turbine components may occur after work hours to minimise disruption of traffic on main roads. Construction sites and activity within the Coega IDZ is currently a familiar occurrence and the construction phase will not seem out of place, and construction activities and large vehicles on busy roads in the region outside the IDZ also common.

Plate 5-16: Construction of the existing Coega wind turbine (2km away).

Mitigation Measures

The most obvious causes of impact cannot be mitigated for since the turbines are so tall and they are to be installed on the top of ridges close to settlements and busy roads. The duration of the impact is short, though, and there are a number of mitigation measures that will curtail the intensity to some extent:

- New road construction should be minimised and existing roads should be used where possible.

- The contractor should maintain good housekeeping on site to avoid litter and minimise waste.
- Clearance of indigenous vegetation should be minimised and rehabilitation of cleared areas should start as soon as possible.
- Erosion risks should be assessed and minimised as erosion scarring can create areas of strong visual contrast with the thicket, which can often be seen from long distances (as can be seen in the cut-lines and quarries in the region).
- Laydown areas and stockyards should be located in low visibility areas (e.g. valleys between ridges) and existing vegetation should be used to screen them from views where possible.
- Night lighting of the construction sites should be minimised within requirements of safety and efficiency. See section on lighting for more specific measures.
- Fires and fire hazards need to be managed appropriately.

Significance Statement

The duration of the impact is *short term (1)* (while construction lasts). The extent is *regional (3)* due to the nature of the development (height of towers and siting on ridges and higher ground) and construction activities will be visible over long distances. The severity of the visual impact will be *slight (1)* due to the low visual intrusion expected for most highly sensitive viewers who may be affected by the development. The effect of the impact is 5. The likelihood of the impact occurring is *definite (4)* since construction of the turbines will be outlined against the skyline and is likely to be viewed with some curiosity. The mitigation measures are there to contain the severity of the impact and if adhered to are likely to keep it at moderate. The significance of the impact is **moderate (9)** in terms of the suggested rating methodology, due to the regional extent of highly visible construction activity. Construction will last approximately 18 months, of which 12 weeks is spent erecting the turbines (under favourable weather conditions) – potentially the most visible activity as it will most probably be exposed against the skyline. It is also worth noting that the visual impact of at least some of the construction phase is likely to be positive, especially during assembly of the turbine towers. The construction engineering feat of lifting and attaching components weighing more than 50 tons a piece in a highly visible area is bound to be spectacular (see for example Degraw 2009 or filmsfromyes2wind 2010).

Table 5-10: Significance of construction activities on sensitive viewers

Impact (Construction Phase Only)	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Wind Farm										
Without Mitigation	Short Term	1	Regional	3	Slight	1	Definite	4	9	Moderate
With Mitigation	Short Term	1	Regional	3	Slight	1	Definite	4	9	Moderate

5.3.2 Impact 3: Intrusion of large highly visible wind turbines on the existing views of sensitive visual receptors

Cause and Comment

The Coega IDZ is within a metropolitan area and there are large residential and peri-urban areas within 25km of the proposed wind farm site. Many of the turbines are to be located in an agricultural landscape adjacent to these urban areas. Residents are seen as highly sensitive to changes in their existing views. However, the current views of most of the potentially affected residents are very complex and contain highly varied elements from adjacent and surrounding industrial areas. The introduction of wind turbines into their views is unlikely to change them appreciably even considering the size of the structures. Visual intrusion for most viewers is low.

Mitigation Measures

There are no mitigation measures that can reduce the impact significantly unless the site is avoided but there are a number of measures that can enhance the positive aspects of the impact. It has been shown that uncluttered sites are preferred for wind farms (Gipe 1995; Stanton 1996; Vissering 2005). In view of this the following mitigation measures and suggestions may enhance the positive visual aspects of the development:

- Ensure that there are no wind turbines closer than 500m to a residence.
- Maintenance of the turbines is important. A spinning rotor is perceived as being useful. If a rotor is stationary when the wind is blowing it is seen as not fulfilling its purpose and a negative impression is created (Gipe 1995).
- Signs near wind turbines should be avoided unless they serve to inform the public about wind turbines and their function. Advertising billboards should be avoided.
- According to the Aviation Act, 1962, Thirteenth Amendment of the Civil Aviation Regulations, 1997: "Wind turbines shall be painted bright white to provide maximum daytime conspicuousness. The colours grey, blue and darker shades of white should be avoided altogether. If such colours have been used, the wind turbines shall be supplemented with daytime lighting, as required."
- Lighting should be designed to minimise light pollution without compromising safety. Investigate using motion sensitive lights for security lighting. Turbines are to be lit according to Civil Aviation regulations (see impact 4, section Error! Reference source not found.).
- An information kiosk (provided that the kiosk and parking area is located in a low visibility area) and trails along the wind farm can enhance the project by educating the public about the need and benefits of wind power. „Engaging school groups can also assist the wind farm proponent, as energy education is paramount in developing good public relations over the long term. Instilling the concept of sustainability, and creating awareness of the need for wind farm developments, is an important process that can engage the entire community‟ (Johnston 2001).

Significance Statement

The duration for the impact is *long term (3)* since the life span of a wind turbine can be up to 40 years after which it can be dismantled, or upgraded. The extent of the impact is *regional (3)* since the turbines will be visible from more than 20km away on clear days. Due to the low visual intrusion that is expected on most views, the severity of the impact is expected to be *slight (1)* (resulting in an effect of 7). The status of the impact is beneficial for turbines located within the IDZ since most people view wind turbines to be structures that are congruent with industrial zones, and energy generation using wind turbines are seen to be in line with current environmental concerns. The impact should also be seen as beneficial for those turbines outside the IDZ since the landscape is already severely compromised by peri-urban and industrial elements such as power lines and large quarries. It is even possible that the turbines will take viewers‟ attention away from these elements. However, the status in this case will depend on the viewer‟s opinion on the aesthetic appeal of wind turbines. It is p*robable (3)* that the impact will occur due to the high visibility of the turbines and the number of sensitive viewers who will be affected. The overall significance of the visual impact on sensitive viewers is **moderate (10)** due to the regional extent and the long term effect of the impact (although the impact is likely to diminish with time).

Table 5-11: Significance of the visual impact of the proposed wind farm on sensitive viewers

Impact (Operation Phase Only)	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
All Alternatives										
Without Mitigation	Long Term	3	Regional	3	Slight	1	Probable	3	10	Moderate
With Mitigation	Long Term	3	Regional	3	Slight	1	Probable	3	10	Moderate

5.3.3 Impact 4: Impact of night lights on existing nightscape

Cause and Comment

Wind farms are required by law to be lit at night as they represent hazards to aircraft due to the height of the turbines. Marking of turbines depends on wind farm layout and not all turbines need to be lit. Marking consists of a red flashing light of medium intensity (2000 candela). The conceptual layout of the wind farm is a combination of „cluster" and „linear" in terms of the lighting specification (Minister of Transport 1997) and it is not clear how many turbines will need to be lighted, but at least 56 can be expected to have lights.

Mitigation Measures

The aviation standards have to be followed and no mitigation measures are applicable in terms of marking the turbines. Lighting of ancillary buildings and structures should be designed to minimise light pollution without compromising safety. Motion sensitive lighting can be used for security purposes.

Significance Statement

Views towards the south, south-east and east will have considerable sky glow as a backdrop at night due to the urban and industrial centres in that direction. Views from these centres towards the wind farm will have less light as a backdrop, but will obviously contain the lights which are causing the sky glow. It is therefore expected that only some farm residents along the Coega River west of the IDZ will be affected by the turbine lights. The severity of the impact is therefore expected to be *moderate (2)* (for a few farm residents) to *slight (1)*. Extent is difficult to determine and since these are medium intensity lights the extent of the impact is expected to be *local (1)* even though they may be visible over a longer distance – the urban and industrial lighting as backdrop will reduce the extent of the impact. Duration is *long term (3)*. Likelihood is *probable (3)* for farmers living close to the wind farm and having views of turbines and *unlikely (1)* for other viewers. The significance of the impact is **low (7)** to **moderate (10)** due to its long term development.

Table 5-6: Significance of the impact of night lighting of the wind farm on sensitive viewers

Impact (Operation Phase Only)	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
All Alternatives										
Without Mitigation	Long Term	3	Localised	1	Moderate to Slight	2 to 1	Unlikely or probable	1 or 3	7 or 10	Low to Moderate
With Mitigation	Long Term	3	Localised	1	Moderate to Slight	2 to 1	Unlikely or probable	1 or 3	7 or 10	Low to Moderate

5.3.4 Impact 5: Impact of shadow flicker on residence in close proximity to wind turbines

Cause and Comment

The impact of shadow flicker caused by wind turbines appears to be a minor issue in most countries where wind farms are common. There are no official set of regulations governing the levels of exposure to shadow flicker and it is unclear what the health risks are. Most reports on shadow flicker suggest that the threshold for a significant impact is 30 hours per year or more and many countries have adopted this as an informal regulation, following a court judgement made in Germany (EDR 2009). According to the data sets available to the author there are a few buildings within 500m of a wind turbine. Sections of the R335 will be within 500m of wind turbines and may potentially experience the shadow flicker effect.

Mitigation Measures

The following measures are proposed:

- Shadow flicker modelling should be used to identify potentially vulnerable buildings and roads and it may then be possible to adjust the layout of the wind farm to lower the number of residents potentially affected by it.
- Trees are an effective measure against shadow flicker and if residents are willing trees can be planted to reduce the flicker effect.
- Alternatively, a sensor can be installed at homes potentially affected by shadow flicker which shuts down the turbine on the rare occasion that the conditions are such that shadow flicker can occur (Portwain 2008).

6 CONCLUSIONS AND RECOMMENDATIONS

The wind farm proposed by Innowind is quite large at 75 turbines and there will be few areas in the region that will not have views on a turbine or at least a moving blade on the horizon. A number of turbines will fall within the Coega IDZ, but most of them will be adjacent to the IDZ. The land outside the IDZ is owned by PPC, some of which is being mined in a large open cast mine, and the rest which will be mined in future.

The Draft Scoping Report indicates that visual impact is not one of the issues highlighted by the public participation process. This is perhaps due to the fact that the landscape here is in close proximity to large industrial and urban centres, and that industrial type structures, quarries and construction sites are familiar features of the landscape. Most people in South Africa seem to associate wind turbines with industrial landscapes. As such this should be an acceptable landscape for the proposed wind farm.

VISUAL APPENDIX 1: BUILDINGS ON FARMS SURROUNDING WIND TURBINES WITH HIGH VISUAL EXPOSURE RATINGS

BUILDING	URBAN AREA	MIN DIST (m)	VISUAL EXPOSURE	LONGITUDE	LATITUDE
GRASSRIDGE (190/R)		423.33	High	25.5529	-33.6438
GRASSRIDGE (190/R)		454.16	High	25.5531	-33.6435
GRASSRIDGE (190/R)		457.41	High	25.5530	-33.6433
GRASSRIDGE (225/R)		665.88	High	25.6358	-33.7144
GRASSRIDGE (225/R)		686.11	High	25.6356	-33.7143
GRASSRIDGE (225/R)		688.49	High	25.6357	-33.7141
GRASSRIDGE (225/R)		699.02	High	25.6355	-33.7143
GRASSRIDGE (225/R)		700.88	High	25.6354	-33.7144
GRASSRIDGE (225/R)		709.59	High	25.6352	-33.7146
GRASSRIDGE (225/R)		734.93	High	25.6351	-33.7142
GRASSRIDGE (226/3)		752.63	High	25.5931	-33.7018
GRASSRIDGE (226/3)		766.01	High	25.5944	-33.7013
GRASSRIDGE (226/3)		797.37	High	25.5936	-33.7019
WELBEDACHTSFONTEIN (300/6)		843.50	High	25.5985	-33.7220
GRASSRIDGE (225/R)		1129.08	High	25.6335	-33.7101
GRASSRIDGE (225/R)		1170.90	High	25.6330	-33.7100
WELBEDACHTSFONTEIN (300/5)		1846.43	High	25.5966	-33.7542
WELBEDACHTSFONTEIN (300/5)		1848.63	High	25.5964	-33.7540
WELBEDACHTSFONTEIN (300/5)		1872.84	High	25.5960	-33.7539
GRASSRIDGE (225/R)		2001.81	High	25.6312	-33.7017
GRASSRIDGE (225/R)		2030.83	High	25.6326	-33.7008
GRASSRIDGE (225/R)		2047.62	High	25.6307	-33.7015
GRASSRIDGE (225/R)		2056.85	High	25.6324	-33.7006
GRASSRIDGE (225/R)		2065.43	High	25.6320	-33.7007
GRASSRIDGE (225/R)		2077.64	High	25.6299	-33.7016
GRASSRIDGE (225/R)		2085.78	High	25.6356	-33.6993
GRASSRIDGE (225/R)		2128.13	High	25.6351	-33.6990
GRASSRIDGE (225/R)		2138.65	High	25.6348	-33.6990
COEGA (313/7)		2219.12	High	25.6099	-33.7652
GRASSRIDGE (225/R)		2232.86	High	25.6326	-33.6988
COEGAKOP (314/R)		2248.32	High	25.6125	-33.7657

COEGAKOP (314/R)		2257.31	High	25.6129	-33.7658
SWARTEKOPPEN (302/12)	COEGA IDZ	2447.05	High	25.6433	-33.7633
SWARTEKOPPEN (302/27)	COEGA IDZ	3048.02	High	25.6675	-33.7645
SWARTEKOPPEN (302/27)	COEGA IDZ	3086.90	High	25.6666	-33.7651
SWARTEKOPPEN (302/27)	COEGA IDZ	3100.54	High	25.6659	-33.7653
SWARTEKOPPEN (302/27)	COEGA IDZ	3117.71	High	25.6680	-33.7650
SWARTEKOPPEN (302/27)	COEGA IDZ	3124.65	High	25.6668	-33.7654
SWARTEKOPPEN (302/27)	COEGA IDZ	3135.31	High	25.6673	-33.7654
SWARTEKOPPEN (302/27)	COEGA IDZ	3149.87	High	25.6669	-33.7656
SWARTEKOPPEN (302/27)	COEGA IDZ	3164.31	High	25.6652	-33.7661
SWARTEKOPPEN (302/27)	COEGA IDZ	3167.79	High	25.6663	-33.7659
SWARTEKOPPEN (302/27)	COEGA IDZ	3169.38	High	25.6651	-33.7662
SWARTEKOPPEN (302/27)	COEGA IDZ	3176.12	High	25.6658	-33.7661
SWARTEKOPPEN (302/27)	COEGA IDZ	3189.44	High	25.6668	-33.7660
SWARTEKOPPEN (302/27)	COEGA IDZ	3189.94	High	25.6656	-33.7662
SWARTEKOPPEN (302/27)	COEGA IDZ	3208.12	High	25.6662	-33.7663
WELBEDACHTSFONTEIN (300/7)		3216.08	High	25.5779	-33.7429
SWARTEKOPPEN (302/27)	COEGA IDZ	3225.92	High	25.6657	-33.7665
SWARTEKOPPEN (302/27)	COEGA IDZ	3230.94	High	25.6667	-33.7664
SWARTEKOPPEN (302/27)	COEGA IDZ	3237.21	High	25.6653	-33.7668
WELBEDACHTSFONTEIN (300/7)		3247.21	High	25.5777	-33.7432
LIMEHURST (221/1)	COEGA IDZ	3283.27	High	25.6939	-33.7297
WELBEDACHTSFONTEIN (300/7)		3292.14	High	25.5774	-33.7435
LIMEHURST (221/1)	COEGA IDZ	3299.59	High	25.6940	-33.7293
WELBEDACHTSFONTEIN (300/7)		3302.01	High	25.5771	-33.7433
LIMEHURST (221/1)	COEGA IDZ	3316.65	High	25.6942	-33.7295
SWARTEKOPPEN (302/27)	COEGA IDZ	3434.79	High	25.6695	-33.7676
SWARTEKOPPEN (302/27)	COEGA IDZ	3460.72	High	25.6715	-33.7673
MOTHERWELL	MOTHERWELL	3668.75	High	25.5925	-33.7735
MOTHERWELL	MOTHERWELL	3682.33	High	25.5943	-33.7745
MOTHERWELL	MOTHERWELL	3684.79	High	25.5927	-33.7738
MOTHERWELL	MOTHERWELL	3690.97	High	25.5939	-33.7744
MOTHERWELL	MOTHERWELL	3697.94	High	25.5925	-33.7738
MOTHERWELL	MOTHERWELL	3700.84	High	25.5929	-33.7740
MOTHERWELL	MOTHERWELL	3713.26	High	25.5948	-33.7751

MOTHERWELL	MOTHERWELL	3716.66	High	25.5942	-33.7748
MOTHERWELL	MOTHERWELL	3716.84	High	25.5938	-33.7746
MOTHERWELL	MOTHERWELL	3720.42	High	25.5922	-33.7739
MOTHERWELL	MOTHERWELL	3734.36	High	25.5920	-33.7739
MOTHERWELL	MOTHERWELL	3746.18	High	25.5935	-33.7748
MOTHERWELL	MOTHERWELL	3747.78	High	25.5940	-33.7750
MOTHERWELL	MOTHERWELL	3749.28	High	25.5943	-33.7752
MOTHERWELL	MOTHERWELL	3750.87	High	25.5925	-33.7743
MOTHERWELL	MOTHERWELL	3757.11	High	25.5950	-33.7756
MOTHERWELL	MOTHERWELL	3771.54	High	25.5919	-33.7743
MOTHERWELL	MOTHERWELL	3848.60	High	25.5951	-33.7766
MOTHERWELL	MOTHERWELL	3899.47	High	25.5950	-33.7770
MOTHERWELL	MOTHERWELL	3920.30	High	25.5946	-33.7771
MOTHERWELL	MOTHERWELL	3926.84	High	25.5938	-33.7768
MOTHERWELL	MOTHERWELL	3933.59	High	25.5944	-33.7771
RIETHEUVEL (296/4)		4265.77	High	25.5126	-33.7148
RIETHEUVEL (296/4)		4277.73	High	25.5129	-33.7153
RIETHEUVEL (296/4)		4277.99	High	25.5132	-33.7156
AMANZI (294/R)		4304.37	High	25.5113	-33.7140
RIETHEUVEL (296/4)		4317.39	High	25.5153	-33.7181
AMANZI (294/R)		4329.46	High	25.5111	-33.7141
RIETHEUVEL (296/4)		4365.73	High	25.5142	-33.7178
RIETHEUVEL (296/4)		4377.25	High	25.5145	-33.7182
RIETHEUVEL (296/4)		4399.54	High	25.5142	-33.7182
AMANZI (294/R)		4429.28	High	25.5089	-33.7131
RIETHEUVEL (296/4)		4440.44	High	25.5130	-33.7176
AMANZI (294/R)		4443.78	High	25.5086	-33.7129
AMANZI (294/R)		4457.10	High	25.5081	-33.7125
AMANZI (294/R)		4461.41	High	25.5091	-33.7139
AMANZI (294/R)		4463.28	High	25.5079	-33.7124
AMANZI (294/R)		4465.57	High	25.5077	-33.7122
AMANZI (294/R)		4473.54	High	25.5085	-33.7134
AMANZI (294/R)		4476.48	High	25.5084	-33.7132
AMANZI (294/R)		4490.53	High	25.5079	-33.7128
AMANZI (294/R)		4503.01	High	25.5076	-33.7126

AMANZI (294/R)		4508.84	High	25.5074	-33.7124
AMANZI (294/R)		4510.92	High	25.5082	-33.7135
AMANZI (294/R)		4515.60	High	25.5080	-33.7133
AMANZI (294/R)		4526.02	High	25.5076	-33.7130
AMANZI (294/R)		4538.25	High	25.5073	-33.7128
AMANZI (294/R)		4539.03	High	25.5072	-33.7127
AMANZI (294/R)		4545.29	High	25.5070	-33.7126
AMANZI (294/R)		4549.06	High	25.5079	-33.7138
RIETHEUVEL (296/4)		4598.08	High	25.5094	-33.7163
RIETHEUVEL (296/4)		4602.08	High	25.5095	-33.7164
RIETHEUVEL (296/4)		4701.21	High	25.5104	-33.7188
AMANZI (294/R)		4756.47	High	25.5073	-33.7163
AMANZI (294/R)		4846.33	High	25.5054	-33.7155
RIETHEUVEL (296/3)		5053.56	High	25.5095	-33.7226
RIETHEUVEL (296/3)		5062.87	High	25.5110	-33.7240
RIETHEUVEL (296/3)		5119.76	High	25.5099	-33.7239
FARM (304/1)	COEGA IDZ	5139.50	High	25.7133	-33.7403
RIETHEUVEL (296/3)		5151.95	High	25.5081	-33.7227
RIETHEUVEL (296/3)		5158.38	High	25.5090	-33.7236
RIETHEUVEL (296/3)		5170.41	High	25.5095	-33.7241
FARM (304/1)	COEGA IDZ	5179.63	High	25.7138	-33.7382
FARM (304/1)	COEGA IDZ	5188.17	High	25.7139	-33.7401
FARM (304/1)	COEGA IDZ	5188.71	High	25.7138	-33.7405
FARM (304/1)	COEGA IDZ	5390.04	High	25.7161	-33.7390
FARM (304/1)	COEGA IDZ	5410.24	High	25.7163	-33.7395
RIETHEUVEL (296/7)		5624.84	High	25.4974	-33.7180
RIETHEUVEL (296/7)		5647.13	High	25.4968	-33.7177
RIETHEUVEL (296/7)		5674.64	High	25.4966	-33.7179
RIETHEUVEL (296/7)		5692.38	High	25.4968	-33.7184
RIETHEUVEL (296/7)		5701.42	High	25.4965	-33.7181
RIETHEUVEL (296/7)		5740.37	High	25.4961	-33.7183
RIETHEUVEL (296/7)		5746.30	High	25.4967	-33.7192
RIETHEUVEL (296/7)		5755.68	High	25.4962	-33.7186
RIETHEUVEL (296/7)		5775.90	High	25.4961	-33.7189
RIETHEUVEL (296/7)		5793.26	High	25.4960	-33.7191

RIETHEUVEL (296/7)		5825.83	High	25.4960	-33.7196
RIETHEUVEL (296/7)		5832.52	High	25.4954	-33.7189
RIETHEUVEL (296/7)		5837.74	High	25.4956	-33.7193
RIETHEUVEL (296/7)		5865.26	High	25.4952	-33.7192
RIETHEUVEL (296/7)		5871.81	High	25.4952	-33.7193
RIETHEUVEL (296/7)		5889.53	High	25.4951	-33.7195
LONGWOOD (295/3)		5958.01	High	25.4928	-33.7176
COEGAS KOP (316/R)	MOTHERWELL	6241.09	High	25.5725	-33.7901
RIETHEUVEL (296/8)		6299.99	High	25.4937	-33.7244
RIETHEUVEL (296/8)		6301.67	High	25.4940	-33.7248
RIETHEUVEL (296/8)		6473.13	High	25.4919	-33.7249
COEGAS KOP (316/2)	MOTHERWELL	6495.70	High	25.5531	-33.7752
NEPTUNE (580/R)	COEGA IDZ	6680.20	High	25.6763	-33.7966
NEPTUNE (580/R)	COEGA IDZ	6862.58	High	25.6684	-33.8003
COEGA IDZ	COEGA IDZ	7143.35	High	25.6487	-33.8059
COEGA IDZ	COEGA IDZ	7180.51	High	25.6475	-33.8065
COEGA IDZ	COEGA IDZ	7190.57	High	25.6476	-33.8065
COEGA IDZ	COEGA IDZ	7205.25	High	25.6463	-33.8069
COEGA IDZ	COEGA IDZ	7252.75	High	25.6458	-33.8075
COEGA IDZ	COEGA IDZ	7523.75	High	25.6664	-33.8067
COEGA IDZ	COEGA IDZ	7524.23	High	25.6671	-33.8066
COEGA IDZ	COEGA IDZ	7549.31	High	25.6666	-33.8070
FLORIDA (321/10)		8100.23	High	25.4954	-33.7489
COEGA IDZ	COEGA IDZ	8664.13	High	25.6437	-33.8207
COEGA IDZ	COEGA IDZ	8709.70	High	25.6445	-33.8210
COEGA IDZ	COEGA IDZ	8725.82	High	25.6437	-33.8213
COEGA IDZ	COEGA IDZ	8738.72	High	25.6442	-33.8213
COEGA IDZ	COEGA IDZ	8757.78	High	25.6451	-33.8214
COEGA IDZ	COEGA IDZ	8767.19	High	25.6436	-33.8217
WELLS ESTATE	WELLS ESTATE	8882.68	High	25.6247	-33.8250
WELLS ESTATE	WELLS ESTATE	8890.12	High	25.6247	-33.8251
WELLS ESTATE	WELLS ESTATE	8897.53	High	25.6248	-33.8251
WELLS ESTATE	WELLS ESTATE	8904.99	High	25.6249	-33.8252
WELLS ESTATE	WELLS ESTATE	8912.41	High	25.6250	-33.8253
WELLS ESTATE	WELLS ESTATE	9297.75	High	25.6377	-33.8272

WELLS ESTATE	WELLS ESTATE	9298.57	High	25.6375	-33.8272
WELLS ESTATE	WELLS ESTATE	9302.49	High	25.6379	-33.8272
WELLS ESTATE	WELLS ESTATE	9307.89	High	25.6125	-33.8294
WELLS ESTATE	WELLS ESTATE	9308.16	High	25.6379	-33.8273
WELLS ESTATE	WELLS ESTATE	9311.49	High	25.6121	-33.8294
WELLS ESTATE	WELLS ESTATE	9313.57	High	25.6381	-33.8273
WELLS ESTATE	WELLS ESTATE	9337.92	High	25.6376	-33.8276
WELLS ESTATE	WELLS ESTATE	9339.15	High	25.6377	-33.8276
WELLS ESTATE	WELLS ESTATE	9340.59	High	25.6378	-33.8276
WELLS ESTATE	WELLS ESTATE	9341.18	High	25.6121	-33.8297
WELLS ESTATE	WELLS ESTATE	9345.76	High	25.6380	-33.8276
WELLS ESTATE	WELLS ESTATE	9348.78	High	25.6381	-33.8276
WELLS ESTATE	WELLS ESTATE	9374.27	High	25.6117	-33.8300
WELLS ESTATE	WELLS ESTATE	9622.19	High	25.6320	-33.8309
WELLS ESTATE	WELLS ESTATE	9789.35	High	25.6073	-33.8336

APPENDIX A-4: NOISE REPORT

NOISE IMPACT ASSESSMENT: PROPOSED COEGA WINDFARM, NELSON MANDELA BAY MUNICIPALITY, EASTERN CAPE PROVINCE

SPECIALIST REPORTS
VOLUME 2: ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Prepared for:	Prepared by:	Prepared by:
InnoWind (Pty) Limited	Coastal & Environmental Services	SAFETECH
P.O. Box 1116 Port Elizabeth, 6000	P.O. Box 934 Grahamstown, 6140	P.O.Box 27607, Greenacres, Port Elizabteh, 6057
South Africa	South Africa	South Africa

FEBRUARY 2011

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EXECUTIVE SUMMARY

Safetech were appointed to conduct a specialist study for an environmental impact assessment for construction of the Coega Wind Energy Project situated outside Port Elizabeth in the Eastern Cape. The project will generate electricity and will be operated by InnoWind (Pty) Ltd.

The study considered the site location as described in the Final Scoping Report (CES, November 2010: Final Scoping Report: Proposed Coega Wind Energy Project in the Eastern Cape. CES, Grahamstown). A literature review and desktop modelling was conducted. Baseline monitoring was done of the ambient noise levels at and adjacent to the site.

The results of the study indicate that the following conclusions can be drawn:

a) There will be a short term increase in noise in the vicinity of the site during the construction phase as the ambient level will be exceeded. The impact during the construction phase will be difficult to mitigate.
b) The impact of low frequency noise and infra sound will be negligible and there is no evidence to suggest that adverse health effects will occur as the sound power levels generated in the low frequency range are not high enough to cause physiological effects.
c) The noise produced by the wind turbines will exceed the 45dB(A) day/night limit at NSA 8 and 9 (above 8m/s wind speed). Furthermore WTG 40 is too close to NSA 9 and does not meet the 500m setback distance. As the wind speed increases, the ambient noise also increases and masks the wind turbine noise. The critical wind speeds are thus between 4-6m/s when there is a possibility of little masking at ground level. Above 8m/s the wind speed is such that it is highly unlikely that the turbine noise will be heard.

The following is recommended:

Planning and design activities

a) WTG 1 should be moved further away from NSA 8.
b) WTG 40 should be moved further away from NSA 9

Construction Activities

a) All construction operations should only occur during daylight hours if possible.
b) No construction piling should occur at night. Piling should only occur during the hottest part of the day to take advantage of unstable atmospheric conditions.
c) Construction staff should receive “noise sensitivity” training.

Operational Activities

The following general recommendation is made for the operational phase:

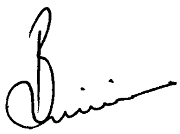
The noise impact from the wind turbine generators should be measured during the operational phase, to ensure that the impact is within the recommended limits.

SPECIALIST PRACTITIONER DECLARATION OF INDEPENDENCE

NOISE IMPACT ASSESSMENT: PROPOSED WINDFARMS ON GRASSRIDGE 190, GELUKSDAL 590 AND BONTRUG 301, NELSON MANDELA BAY MUNICIPALITY, EASTERN CAPE

Visual specialist

I Brett Williams declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Coega Wind Energy Project, application or appeal in respect of which I 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 my performing such work.

SIGNATURE: 

GLOSSARY OF TERMS AND ABBREVIATIONS

Ambient noise	Totally encompassing sound in a given situation at a given time, and usually composed of sound from many sources, both near and far. **Note:** Ambient noise includes the noise from the noise source under investigation.
Annoyance	General negative reaction of the community or person to a condition creating displeasure or interference with specific activities
A-weighted sound pressure level (L_{pA} and $L_{Aeq,T}$)	A-weighted sound level L_{pA} which is the sound pressure level at specific frequencies and is given using the following equation: $L_{pA} = 10\text{Log}\left(\frac{P_A}{P_O}\right)^2$ **Where:** *PA* = is the root-mean-square sound pressure, using the frequency weighting network A *PO* = is the reference sound pressure (*PO* = 20 μPa). A-weighted sound pressure level is expressed in decibels dBA **Note:** For clarity in this study L_{pA} shall equal $L_{Aeq,T}$
dBA	The decibel is the unit used to measure sound pressure levels. The human ear does not perceive all sound pressures equally at all frequencies. The "A" weighted scale adjusts the measurement to approximate a human ear response.
Equivalent continuous day/night rating level ($L_{R,dn}$)	Equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$) during a reference time interval of 24 h, plus specified adjustments for tonal character, impulsiveness of the sound and the time of day; and derived from the following equation: $L_{R,dn} = 10Log\left[\left(\frac{d}{24}\right)10^{L_{Req,d}/10} + \left(\frac{24-d}{24}\right)10^{L_{Req,n+k_n}/10}\right]$dB **Where:** $L_{R,dn}$ is the equivalent continuous day/night rating level; *d* is the number of daytime hours; $L_{Req,d}$ is the rating level for daytime; $L_{Req,n}$ is the rating level for night-time; K_n is the adjustment of 10 dB added to the night-time rating level.
High-energy impulsive sound	Sound from one of the following categories of sound sources: quarry and mining explosions, sonic booms, demolition and industrial processes that use high explosives, explosive industrial circuit breakers, military ordnance (e.g. armour, artillery, mortar fire, bombs, explosive ignition of rockets and missiles), or any other explosive source where the equivalent mass of TNT exceeds 25 g, or a sound with comparable characteristics and degree of intrusiveness
Highly impulsive sound	sound from one of the following categories of sound sources: small arms fire, metal hammering, wood hammering, drop-hammer pile driver, drop forging, pneumatic hammering, pavement breaking, or metal impacts of rail yard shunting operations, or sound with comparable characteristics and degree of intrusiveness
Infra sound	Sound which predominantly contains sound energy at frequencies below 10 Hz
Low frequency noise	Sound which predominantly contains sound energy at frequencies below 100 Hz
MW	Mega Watt of electricity (1000 kilowatts)
Reference time interval	Representative duration of time periods that are regarded as typical for sound exposure of the community within a period of 24 h: – Daytime: 06:00 to 22:00 – Night-time: 22:00 to 06:00

Residual noise	Totally encompassing sound in a given situation at a given time, and usually composed of sound from many sources, both near and far, excluding the noise under investigation
Specific noise	Component of the ambient noise which can be specifically identified by acoustical means and which may be associated with a specific source **Note:** Complaints about noise usually arise as a result of one or more specific noises.

1 INTRODUCTION AND METHODOLOGY

1.1 Introduction

InnoWind (Pty) Ltd plans to develop a wind power generation facility on the following properties:

- Zone 14 IDZ (Farms Bontrug 301 and Brak River SW 224): 15 turbines
- PPC (Farms Grassridge 190, 227 and 228, Oliphants Kop 201): 55 turbines
- Swarte Koppen 302: 2 turbines
- Welbedachtsfontein 300: 3 turbines

The project is situated near Coega in the Eastern Cape Province of South Africa. The proposed project is planned to host 75 turbines, each with a nominal power output of 2-3 megawatts (MW).

1.2 Methodology

The methodology used in the study consisted of two approaches to determine the noise impact from the proposed project and associated infrastructure:

- A desktop study to model the likely noise emissions from the site;
- Field measurements of the existing ambient noise at different locations in the vicinity of the project.

1.2.1 Desktop study and methodology

The desktop study was done using the available literature on noise impacts as well as numerical calculations using EMD WindPro Software Version 2.7 which is specifically developed for wind turbine noise. The method described in SANS 10357:2004 version 2.1 (The calculation of sound propagation by the Concawe method) was used a reference for further calculations where required.

WindPro uses the methods described in ISO 9613-2 (Acoustics – Attenuation of sound during propagation outdoors. Part 2 – General method of calculation). This method is very comparable to SANS 10357:2004.

The numerical results were then used to produce a noise map that visually indicates the extent of the noise emissions from the site. The noise emissions were modelled for various wind speeds. The direction of the wind is not taken into consideration as the wind could blow from any direction at the speeds that were modelled. The noise model allows for the manual input of meteorological absorption (sound attenuation) of up to 2 decibels. A conservative approach was used and a 0dB atmospheric attenuation was selected. Furthermore the model automatically calculates the noise emission for 10^{o}C and 70% humidity to take into account the worst case conditions.

1.2.2 Field study – Proposed site

A field study to the proposed sites was conducted on the 17th November 2010.

Four ambient monitoring points were chosen in the Coega area based on their proximity to sensitive receptors as well as the location of the proposed wind turbines. The location of the ambient measurement positions are as follows:

Table 7.1: Measurement Point Positions

Test Point	East	South
1	25°37'0.67"	33°39'45.77"
2	25°34'49.02"	33°38'41.85"
3	25°31'53.86"	33°38'16.77"
4	25°35'43.09"	33°44'43.62"

The test environment contained the following noise sources:

- Vehicular traffic that included trucks and cars.
- Farm animals.
- Wind noise.

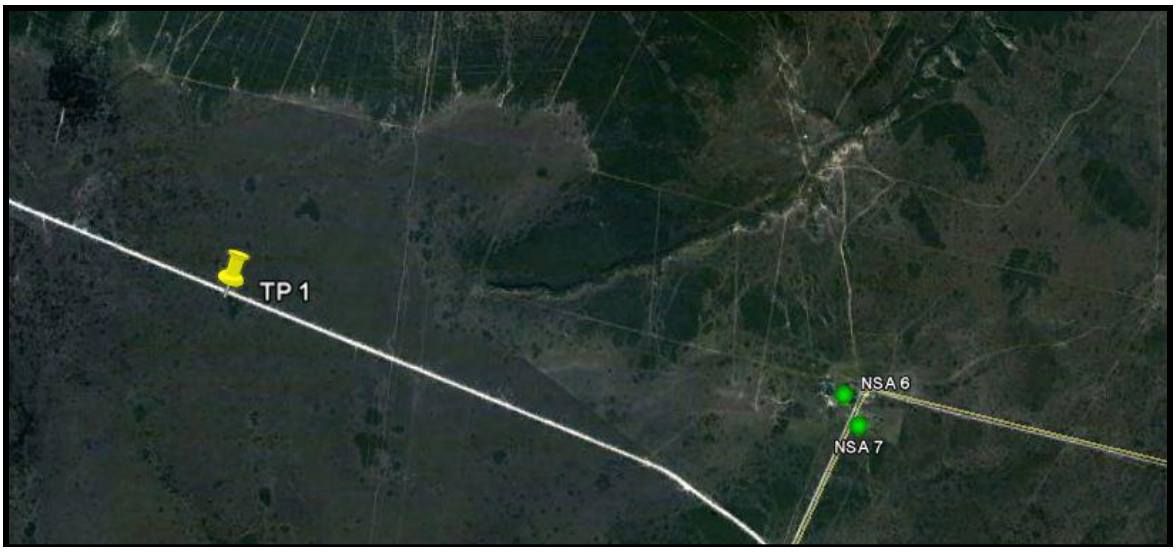


Figure 6.1 - Test Point 1

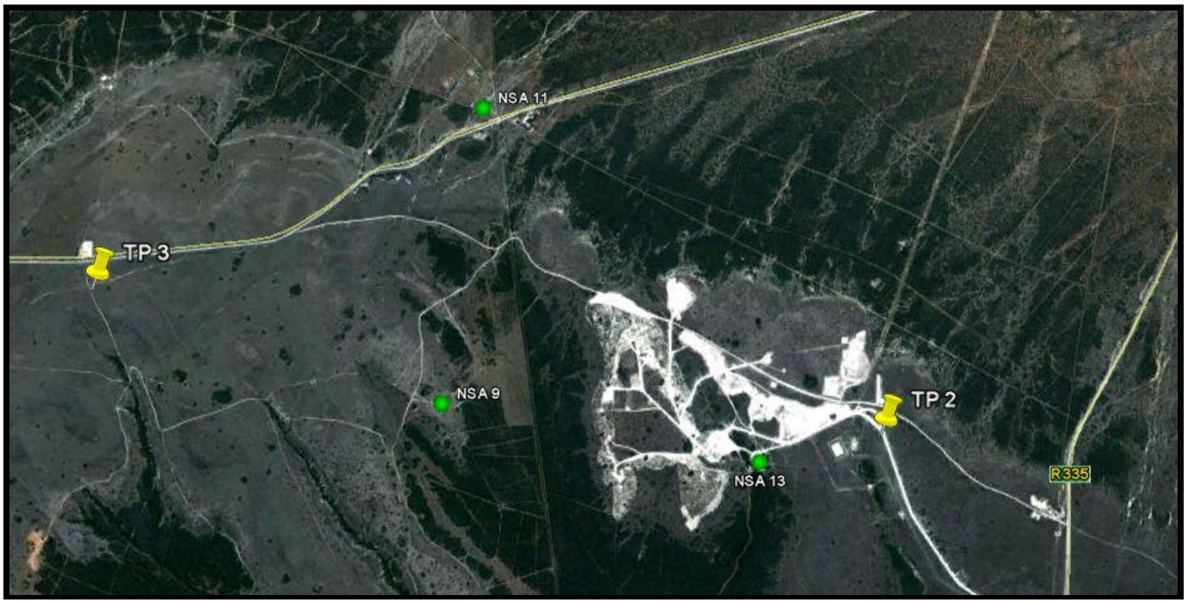


Figure 1.7 - Test Point 2 and 3

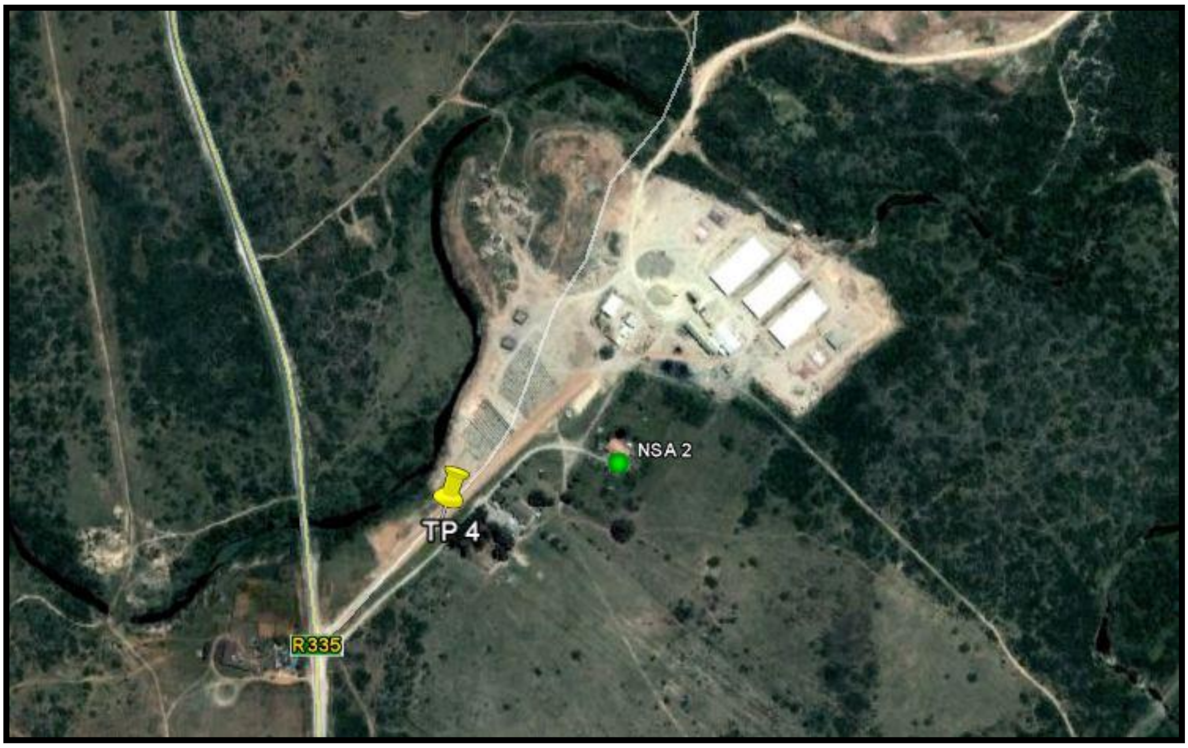


Figure 1.8 - Test Point 4 A number of measurements were taken by placing the noise meter on a tripod and ensuring that it was at least 1.2m from floor level and 3.5m from any large flat reflecting surface.

All measurement periods were at least over 10 minutes, except where indicated. The noise meter was calibrated before and after the survey. At no time was the difference more than one decibel (If the difference is more than 1 decibel the meter is not calibrated properly and the measurement is discarded). The weighting used was on the A scale and the meter placed on impulse correction, which is the preferred method as per Section 5 of SANS 10103:2008. No tonal correction was added to the data. Measurements were taken during the day and night-time. The meter was fitted with a windscreen, which is supplied by the manufacturer. The screen is designed so as to reduce wind noise around the microphone and not bias the measurements.

The instrumentation that was used to conduct the study is as follows:

- Rion Precision Sound Level Meter (NL32) with 1/3 Octave Band Analyzer.
- Serial No. 00151075
- Microphone (UC-53A) Serial No. 307806
- Preamplifier (NH-21) Serial No. 13814

All equipment was calibrated in January 2010 (see Appendix C-2)

1.3 Introduction to noise

1.3.1 Sound propagation

Noise is defined as any unwanted sound and is measured in decibels. Sounds are characterized by their magnitude (loudness) and frequency. There can be loud low frequency sounds, soft high frequency sounds and loud sounds that include a range of frequencies. The human ear can detect a very wide range of both sound levels and frequencies, but it is more sensitive to some frequencies than others.

Sound frequency denotes the "pitch" of the sound and, in many cases, corresponds to notes on the musical scale (Middle C is 262Hz). An octave is a frequency range between a sound with one frequency and one with twice that frequency, a concept often used to define ranges of sound frequency values. The frequency range of human hearing is quite wide, generally ranging from about 20Hz to 20kHz (about 10 octaves). Sounds experienced in daily life are usually not a single frequency, but are formed from a mixture of numerous frequencies, from numerous sources (See Noise - Appendix A)

Concerns about environmental noise depend on:

- the level of intensity, frequency, frequency distribution and patterns of the noise source;
- background sound levels;
- the terrain between the emitter and receptor
- the nature of the receptor; and
- the attitude of the receptor about the emitter.

In general, the effects of noise on people can be classified into three general categories:

- Subjective effects including annoyance, nuisance, dissatisfaction
- Interference with activities such as speech, sleep, and learning
- Physiological effects such as anxiety, tinnitus, or hearing loss.

It is important to distinguish between the various measures of the magnitude of sounds, namely sound power level and sound pressure level. Sound power level is the power per unit area of the sound pressure wave; it is a property of the source of the sound and it gives the total acoustic power emitted by the source. Sound pressure is a property of sound at a given observer location and can be measured there by a microphone.

In order to predict the sound pressure level at a distance from source with a known power level, one must determine how the sound waves propagate. In general, as sound propagates without obstruction from a point source, the sound pressure level decreases. The initial energy in the sound is distributed over a larger and larger area as the distance from the source increases. Thus, assuming spherical propagation, the same energy that is distributed over a square meter at a distance of one meter from a source is distributed over 10,000 m2 at a distance of 100 meters away from the source. With spherical propagation, the sound pressure level is reduced by 6 dB per doubling of distance.

This simple model of spherical propagation must be modified in the presence of reflective surfaces and other disruptive effects. For example, if the source is on a perfectly flat and reflecting surface, then hemispherical spreading has to be assumed, which also leads to a 6 dB reduction per doubling of distance, but the sound level would be 3 dB higher at a given distance than with spherical spreading.

Sound propagation is generally influenced by the following factors:

- Source characteristics (e.g., directivity, height, etc.)
- Distance of the source from the observer
- Air absorption, which depends on frequency
- Ground effects (i.e., reflection and absorption of sound on the ground, dependent on source height, terrain cover, ground properties, frequency, etc.)
- Blocking of sound by obstructions and uneven terrain
- Weather effects (i.e., wind speed, change of wind speed or temperature with height). The prevailing wind direction can cause differences in sound pressure levels between upwind and downwind positions.
- Shape of the land; certain land forms can also focus sound

1.3.2 Sources of wind turbine noise

The sources of sounds emitted from operating wind turbines can be divided into two categories, firstly mechanical sounds, from the interaction of turbine components, and secondly aerodynamic sounds, produced by the flow of air over the blades.

Mechanical Sounds

Mechanical sounds originate from the relative motion of mechanical components and the dynamic response among them. Sources of such sounds include:

- Gearbox
- Generator
- Yaw Drives
- Cooling Fans
- Auxiliary Equipment (such as hydraulics)

Since the emitted sound is associated with the rotation of mechanical and electrical equipment, it tends to be tonal (of a common frequency), although it may have a broadband component. For example, pure tones can be emitted at the rotational frequencies of shafts and generators, and the meshing frequencies of the gears.

In addition, the hub, rotor, and tower may act as loudspeakers, transmitting the mechanical sound and radiating it. The transmission path of the sound can be air-borne or structure-borne. Air-borne means that the sound is directly propagated from the component surface or interior into the air. Structure-borne sound is transmitted along other structural components before it is radiated into the air.

Figure 1.4 shows the type of transmission path and the sound power levels for the individual components for a 2MW wind turbine.

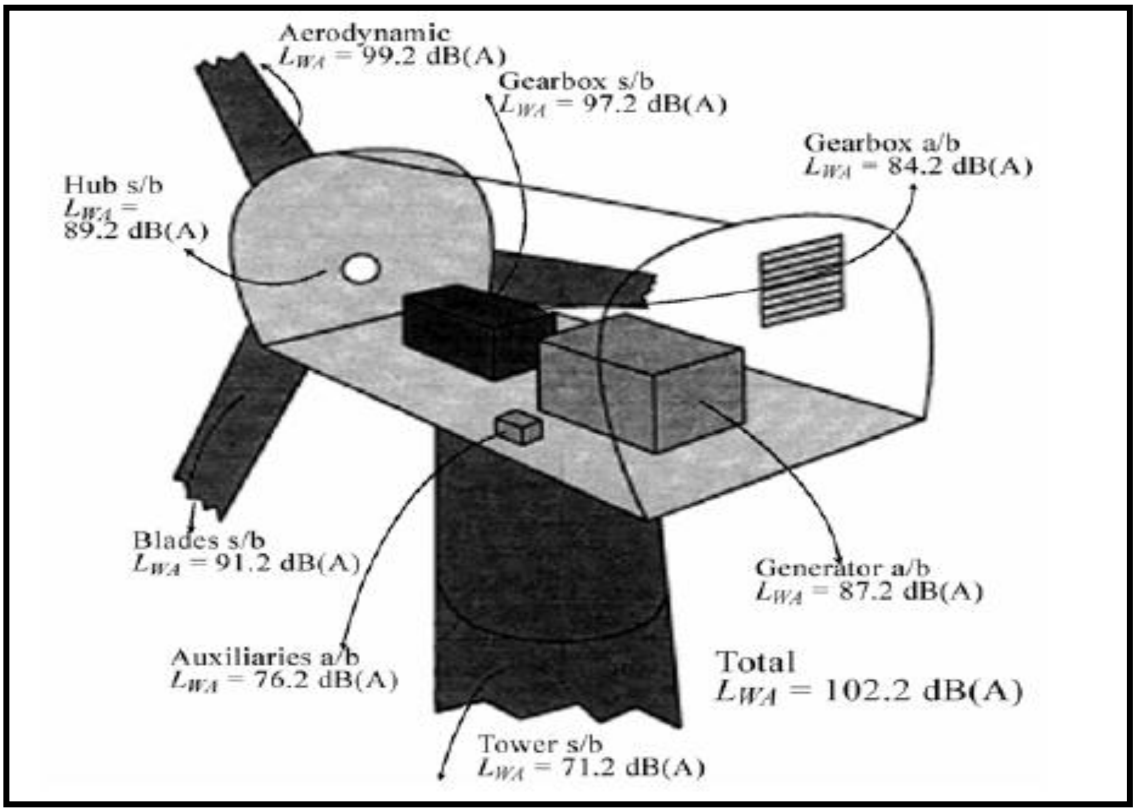


Figure 1.4 - Typical Sound Power Levels of a 2MW Turbine

Aerodynamic Sound

Aerodynamic broadband sound is typically the largest component of wind turbine acoustic emissions. It originates from the flow of air around the blades. As shown in Figure 1.3, a large number of complex flow phenomena occur, each of which might generate some sound. Aerodynamic sound generally increases with rotor speed. The various aerodynamic sound generation mechanisms that have to be considered are divided into three groups:

- *Low Frequency Sound*: Sound in the low frequency part of the sound spectrum is generated when the rotating blade encounters localized flow deficiencies due to the flow around a tower, wind speed changes, or wakes shed from other blades.
- *Inflow Turbulence Sound*: Depends on the amount of atmospheric turbulence. The atmospheric turbulence results in local force or local pressure fluctuations around the blade.
- *Airfoil Self Noise*: This group includes the sound generated by the air flow right along the surface of the airfoil. This type of sound is typically of a broadband nature, but tonal components may occur due to blunt trailing edges, or flow over slits and holes.

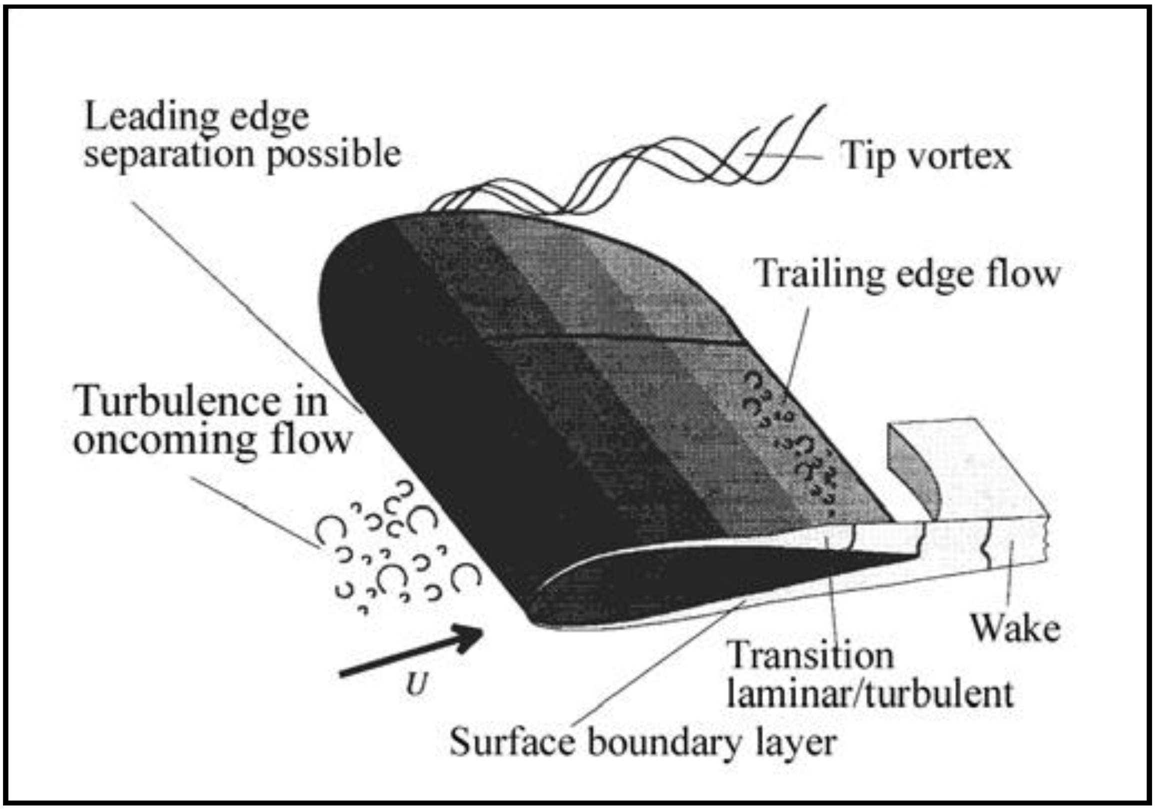


Figure 1.9 - Sources of Aerodynamic Noise

Modern airfoil design takes all of the above factors into account and is generally much quieter that the first generation of blade design.

1.3.3 Ambient sound and wind speed

The ability to hear a wind turbine in a given installation depends on the ambient sound level. When the background sounds and wind turbine sounds are of the same magnitude, the wind turbine sound gets lost in the background. Both the wind turbine sound power level and the ambient sound pressure level will be functions of wind speed. Thus whether a wind turbine exceeds the background sound level will depend on how each of these varies with wind speed.

The most likely sources of wind-generated sounds are interactions between wind and vegetation. A number of factors affect the sound generated by wind flowing over vegetation. For example, the total magnitude of wind-generated sound depends more on the size of the windward surface of the vegetation than the foliage density or volume.

The sound level and frequency content of wind generated sound also depends on the type of vegetation. For example, sounds from deciduous trees tend to be slightly lower and more broadband than that from conifers, which generate more sounds at specific frequencies. The equivalent A-weighted broadband sound pressure generated by wind in foliage has been shown to be approximately proportional to the base 10 logarithm of wind speed.

Sound levels from large modern wind turbines during constant speed operation tend to increase more slowly with increasing wind speed than ambient wind generated sound. As a result, wind turbine noise is more commonly a concern at lower wind speeds and it is often difficult to measure sound from modern wind turbines above wind speeds of 8m/s because the background wind-generated sound masks the wind turbine sound above 8m/s.

It should be remembered that average sound pressure measurements might not indicate when a sound is detectable by a listener. Just as a dog‟s barking can be heard through other sounds, sounds with particular frequencies or an identifiable pattern may be heard through background sounds that is otherwise loud enough to mask those sounds. Sound emissions from wind turbines will also vary as the turbulence in the wind through the rotor changes. Turbulence in the ground level winds will also affect a listener‟s ability to hear other sounds. Because fluctuations in ground level wind speeds will not exactly correlate with those at the height of the turbine, a listener might find moments when the wind turbine could be heard over the ambient sound.

1.3.4 Low frequency noise and infrasound

Infrasound was a characteristic of some wind turbine models that has been attributed to early designs in which turbine blades were downwind of the main tower. The effect was generated as the blades cut through the turbulence generated around the downwind side of the tower. Modern designs generally have the blades upwind of the tower. Wind conditions around the blades and improved blade design minimise the generation of the effect.

Low frequency pressure vibrations are typically categorized as low frequency sound when they can be heard near the bottom of human perception (10-200 Hz), and infrasound when they are below the common limit of human perception. Sound below 20Hz is generally considered infrasound, even though there may be some human perception in that range. Because these ranges overlap in these ranges, it is important to understand how the terms are intended in a given context.

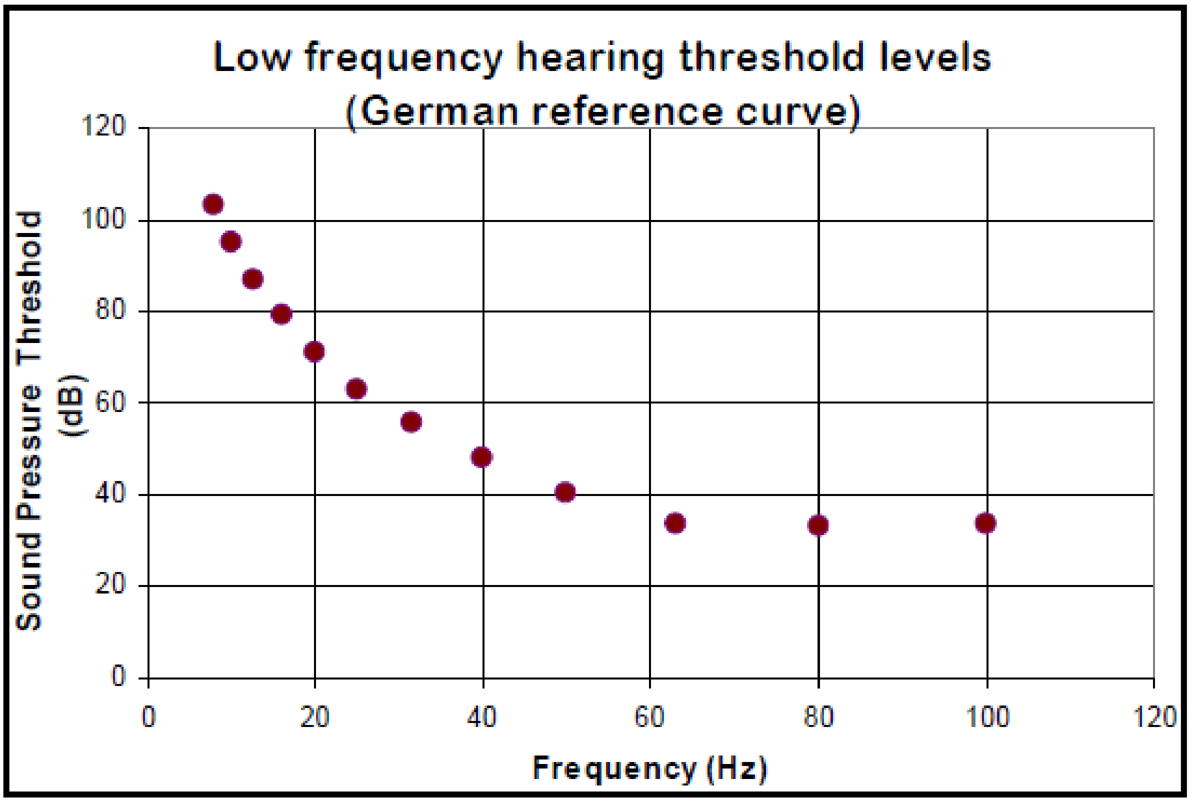


Figure 1.10 - Low frequency Hearing Threshold Levels

Infrasound is always present in the environment and stems from many sources including ambient air turbulence, ventilation units, waves on the seashore, distant explosions, traffic, aircraft, and other machinery. Infrasound propagates farther (i.e. with lower levels of dissipation) than higher frequencies. To place infrasound in perspective, when a child is swinging high on a swing, the pressure change on its ears, from top to bottom of the swing, is nearly 120dB at a frequency of around 1Hz.

Some characteristics of the human perception of infrasound and low frequency sound are:

- Low frequency sound and infrasound (2-100 Hz) are perceived as a mixture of auditory and tactile sensations.
- Lower frequencies must be of a higher magnitude (dB) to be perceived, e.g. the threshold of hearing at 10Hz is around 100dB; see Figure 1.4 above.
- Tonality cannot be perceived below around 18Hz
- Infrasound may not appear to be coming from a specific location, because of its long wavelengths.

The primary human response to perceived infrasound is annoyance, with resulting secondary effects. Annoyance levels typically depend on other characteristics of the infrasound, including intensity, variations with time, such as impulses, loudest sound, periodicity, etc. Infrasound has three annoyance mechanisms:

- A feeling of static pressure
- Periodic masking effects in medium and higher frequencies
- Rattling of doors, windows, etc. from strong low frequency components

Human effects vary by the intensity of the perceived infrasound, which can be grouped into these approximate ranges:

- 90dB and below: No evidence of adverse effects
- 115dB: Fatigue, apathy, abdominal symptoms, hypertension in some humans
- 120dB: Approximate threshold of pain at 10Hz
- 120 – 130dB and above: Exposure for 24 hours causes physiological damage

There is no reliable evidence that infrasound below the perception threshold produces physiological or psychological effects.

The typical range of sound power level for wind turbine generators is in the range of 100 to 105dBA – a much lower sound power level (10dB or more) than the majority of construction machinery such as dozers. In order for infrasound to be audible even to a person with the most sensitive hearing at a distance of, say, 300m would require a sound power level of at least 140dB at 10Hz and even higher emission levels than this at lower frequencies and at greater distances. There is no information available to indicate that wind turbine generators emit infrasound anywhere near this intensity[(2)].

Several studies have confirmed that there are no physiological effects from low frequency or infrasound from wind turbines [(2),(4),(5),(9),(15),(16),(17)].

2 PROJECT DESCRIPTION

The proposed wind energy project is planned to host 75 turbines, each with a nominal power output of up to 3MW. This study only modelled the Vestas V80 2MW unit and the WinWinD WWD 3MW unit. Two alternative layouts for the WTG"s are proposed based on the two alternative turbine choices.

2.1 Site location

The location and position of the various wind turbines are contained in the table and figures below.

Table 8.1: Wind Turbine co-ordinates for the site

Wind turbine	East	South
1	25°35'07.19"	33°41'59.26"
2	25°35'30.95"	33°41'40.95"
3	25°35'00.18"	33°41'34.01"
4	25°35'54.01"	33°41'23.25"
5	25°35'23.94"	33°41'15.70"
6	25°34'53.18"	33°41'08.76"
7	25°36'16.90"	33°41'05.09"
8	25°35'47.01"	33°40'58.00"
9	25°35'16.94"	33°40'50.45"
10	25°36'39.47"	33°40'46.93"
11	25°36'09.90"	33°40'39.84"
12	25°35'40.01"	33°40'32.75"
13	25°37'02.36"	33°40'29.59"
14	25°36'32.46"	33°40'21.68"
15	25°35'43.14"	33°40'07.44"
16	25°34'52.99"	33°40'04.14"
17	25°32'55.34"	33°41'27.59"
18	25°33'15.36"	33°41'02.05"
19	25°33'17.60"	33°40'32.93"
20	25°34'08.86"	33°40'22.76"
21	25°33'42.47"	33°40'02.94"
22	25°37'25.26"	33°40'11.15"
23	25°36'55.36"	33°40'04.34"
24	25°36'16.25"	33°39'58.07"
25	25°35'26.00"	33°39'42.25"
26	25°34'38.21"	33°39'41.41"
27	25°33'27.26"	33°39'36.00"
28	25°32'40.35"	33°39'30.06"
29	25°37'48.49"	33°39'52.71"

Wind turbine	East	South
30	25°37'18.26"	33°39'45.90"
31	25°36'48.36"	33°39'39.09"
32	25°36'18.46"	33°39'31.18"
33	25°35'48.90"	33°39'24.09"
34	25°35'19.00"	33°39'17.00"
35	25°34'36.22"	33°39'15.21"
36	25°33'13.70"	33°39'08.24"
37	25°32'27.57"	33°39'06.40"
38	25°31'15.48"	33°39'02.52"
39	25°30'40.74"	33°38'58.71"
40	25°32'55.54"	33°38'43.49"
41	25°32'14.13"	33°38'42.85"
42	25°31'35.44"	33°38'36.07"
43	25°30'57.48"	33°38'32.39"
44	25°37'42.64"	33°39'25.47"
45	25°37'12.74"	33°39'17.29"
46	25°36'42.10"	33°39'11.58"
47	25°36'12.20"	33°39'04.42"
48	25°35'42.15"	33°38'57.26"
49	25°35'13.31"	33°38'46.54"
50	25°34'36.87"	33°38'48.87"
51	25°33'48.97"	33°38'38.99"
52	25°32'41.44"	33°38'17.73"
53	25°32'01.46"	33°38'12.61"
54	25°34'38.78"	33°38'21.11"
55	25°33'38.50"	33°38'07.58"
56	25°39'03.85"	33°44'24.44"
57	25°38'29.64"	33°44'28.48"
58	25°36'37.41"	33°43'44.31"
59	25°36'22.19"	33°43'33.83"
60	25°36'51.32"	33°43'56.44"
61	25°36'48.79"	33°44'43.68"
62	25°37'10.32"	33°44'40.41"
63	25°37'27.90"	33°44'38.72"
64	25°37'45.49"	33°44'36.63"
65	25°38'06.53"	33°44'31.03"
66	25°39'28.48"	33°44'17.50"
67	25°39'30.51"	33°43'52.38"

Wind turbine	East	South
68	25°39'08.05"	33°43'41.51"
69	25°38'51.69"	33°43'21.06"
70	25°38'31.66"	33°43'02.24"
71	25°38'14.94"	33°43'23.55"
72	25°37'04.29"	33°44'08.51"
73	25°36'46.20"	33°44'28.00"
74	25°37'26.12"	33°43'51.92"
75	25°37'50.06"	33°43'37.25"

Figure 2.1 - NSA's & wind turbine locations

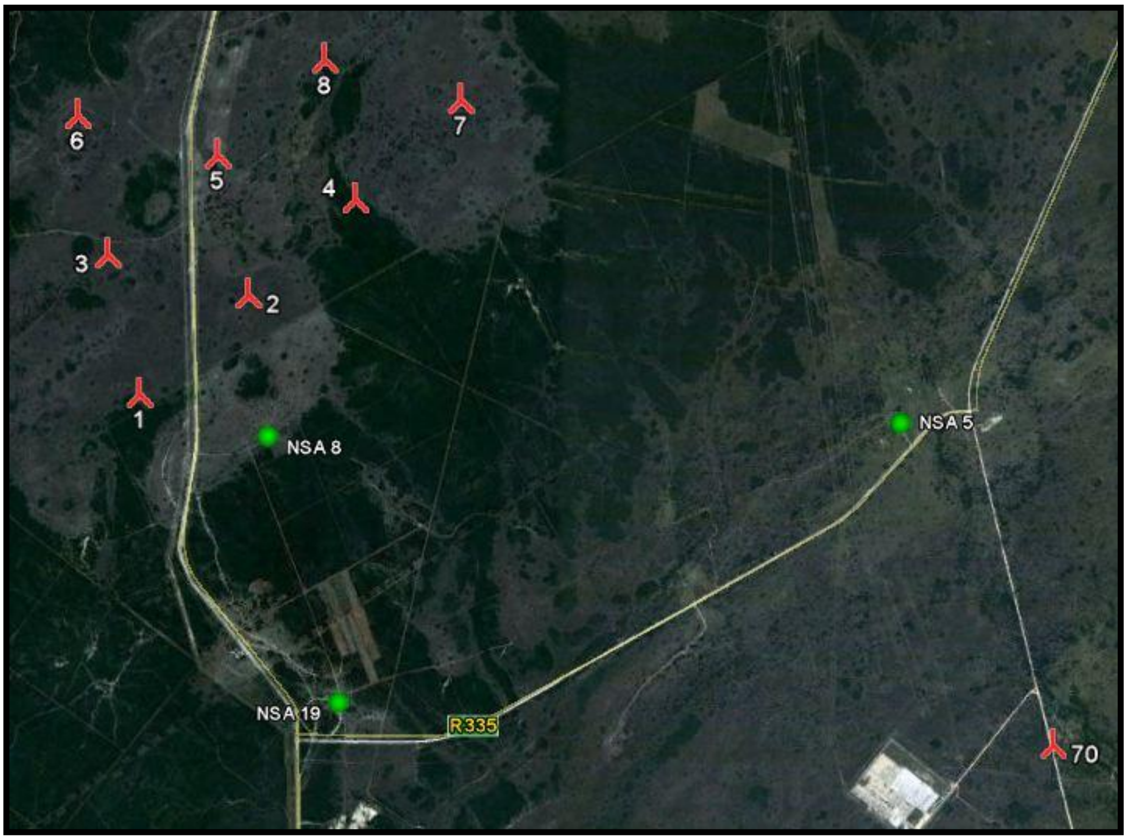


Figure 2.2 - NSA's & wind turbine locations

Figure 2.3 - NSA's & wind turbine locations

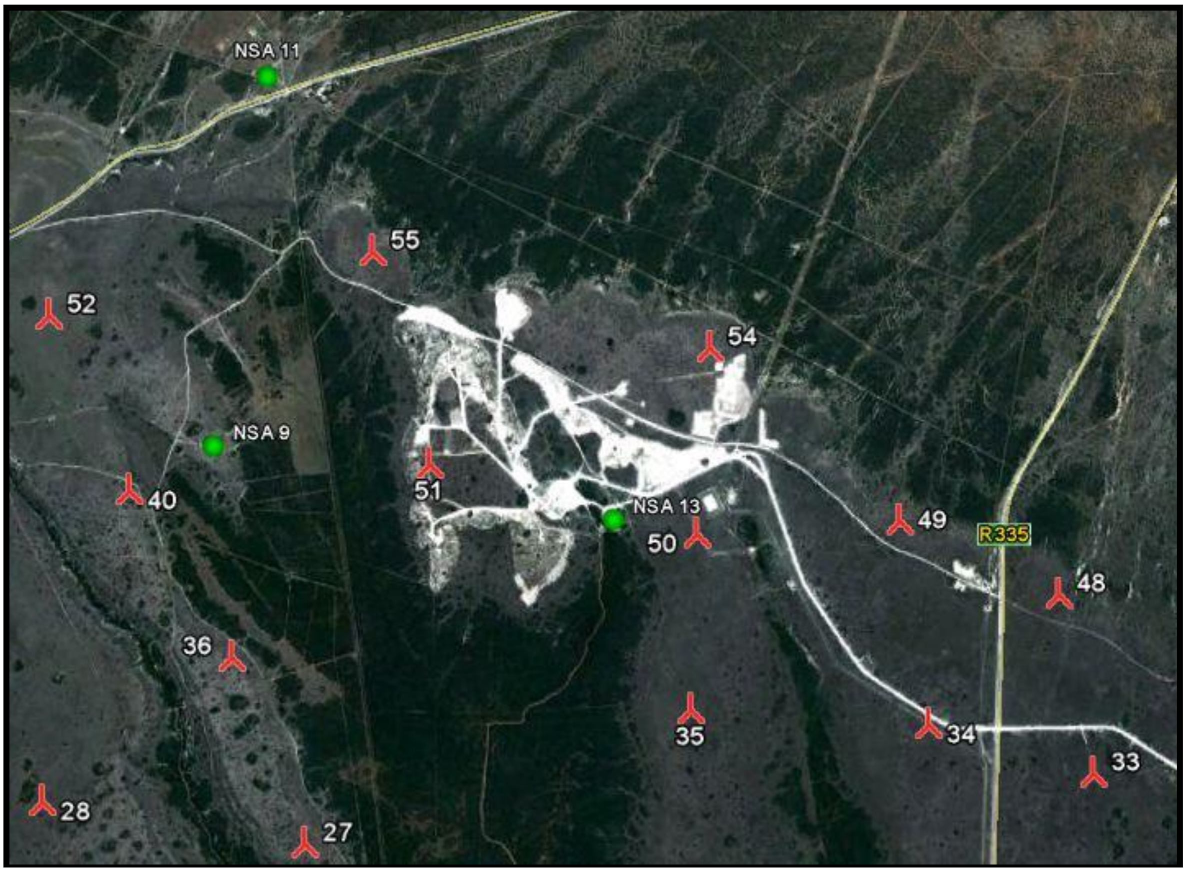


Figure 2.4 - NSA's & wind turbine locations

Figure 2.5 - NSA's & wind turbine locations

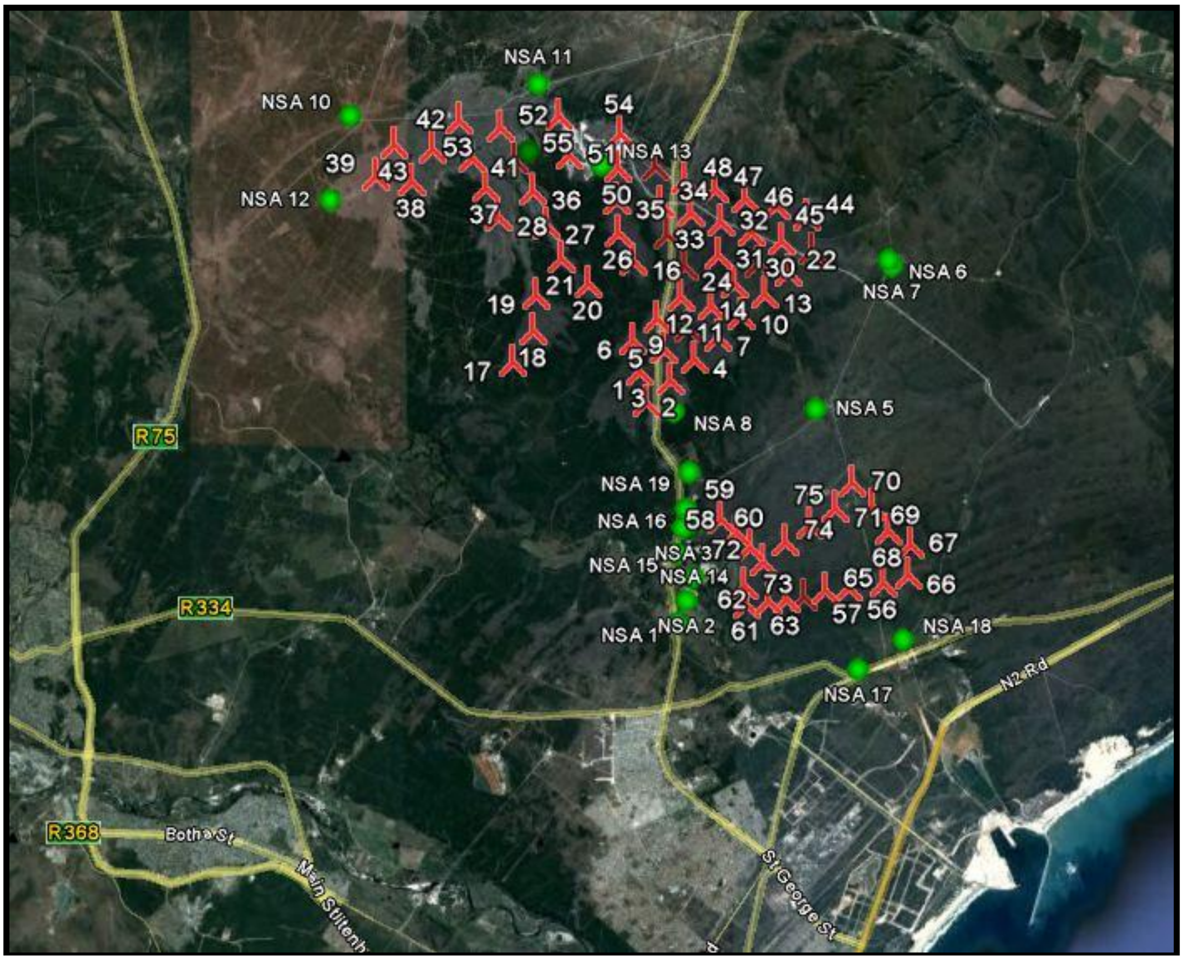


Figure 2.6 - NSA's & wind turbine locations (all turbines)

2.2 Potential noise sources – Construction phase

Noise pollution will be generated during the construction phase as well as the operational phase.

2.2.1 Potential noise sources (general equipment and vehicles)

The construction phase could generate noise during different activities such as:

- Site preparation and earthworks to gain access using bulldozers, trucks etc.
- Foundation construction using mobile equipment, cranes, concrete mixing and pile driving equipment (if needed).
- Heavy vehicle use to deliver construction material and the turbines.

The number and frequency of use of the various types of vehicles has not been determined but an indication of the type and level of noise generated are presented in table 2.2 below.

Table 2.2 – Typical types of vehicles and equipment to be used on site (Construction Phase)

Type	Description	Typical Sound Power Level (dB)
Passenger Vehicle	Passenger vehicle or light delivery vehicle such as bakkies	85
Trucks	10 ton capacity	95
Cranes	Overhead and mobile	109
Mobile Construction Vehicles	Front end loaders	100
Mobile Construction Vehicles	Excavators	108
Mobile Construction Vehicles	Bull Dozer	111
Mobile Construction Vehicles	Dump Truck	107
Mobile Construction Vehicles	Grader	98
Mobile Construction Vehicles	Water Tanker	95
Stationary Construction Equipment	Concrete mixers	110
Compressor	Air compressor	100
Compactor	Vibratory compactor	110
Pile Driver	Piling machine (mobile)	115

Source: GCDA 2006

2.3 Potential noise sources – Operational phase

The project will install 75 wind turbine generators that are manufactured by WinWinD. The most likely model to be installed is the WWD-3 or similar. The general characteristics of the model are as follows:

The WTG is usually a pitch regulated upwind wind turbine with active yaw and three blade rotor. The turbine consists of three main parts:

Rotor

- 3 blades and hub, electrical pitch control

Integrated power unit

- roller bearing, planetary gear and variable speed
- generator with permanent magnets

Nacelle

- frequency converter, transformer and accessories

The technical specifications are contained in table 2.3 below.

Table 2.3 - WWD-3 Wind Turbine Technical Specifications

Type	3 blades, up-wind
Power control	Pitch, variable speed
Rated power	3000 kW (grid side)
Rotor diameter	90 and 100 m
Cut-in wind speed	4 m/s
Rated wind speed	12,5 m/s (100 m hub) 13 m/s (90 m hub)
Cut-out wind speed	20 m/s (100 m hub) 25 m/s (90 m hub)
Design maximum	59,5 m/s (hub height)
Rotor speed	5-16 rpm
Frequency converter	Located in nacelle
Transformer	Transformer located in nacelle
Hub heights	80 -100 m

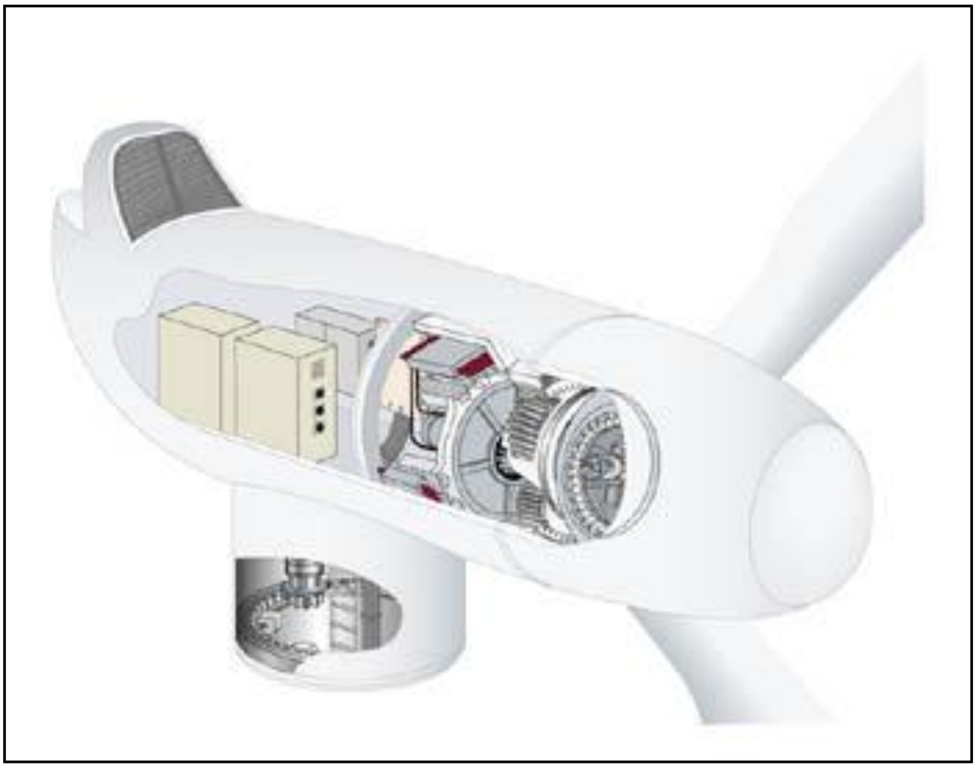


Figure 2.7 - Nacelle details of WWD-3

3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The potential sensitive receptors are discussed below. The main noise sensitive receptors that could be impacted by noise pollution are the terrestrial fauna, the avifauna and human receptors.

3.1 Sensitive receptors

3.1.1 Human sensitive receptors

The project is situated in a farming community as well as an industrial zone.. Several businesses and homesteads are located on the properties where the turbines will be erected. There also neighbouring farms outside of the proposed site that could be affected.

The locations of the various human sensitive receptors are indicated in Figures 2.1-2.6 above. The identified Noise sensitive areas are described in the Table 3.1 below.

Table 3.1 - Identified Nosie Sensitive Areas

NSA	East	South	Type
NSA 1	25°35'41.88"	33°45'00.29"	Rural Homestead
NSA 2	25°35'50.25"	33°44'41.57"	Rural Homestead
NSA 3	25°35'45.92"	33°43'41.75"	Rural Homestead
NSA 4	25°35'52.75"	33°43'40.70"	Rural Homestead
NSA 5	25°37'55.88"	33°42'02.57"	Rural Homestead
NSA 6	25°39'05.35"	33°40'00.10"	Rural Homestead
NSA 7	25°39'08.59"	33°40'05.28"	Rural Homestead
NSA 8	25°35'35.69"	33°42'06.64"	Rural Homestead
NSA 9	25°33'10.67"	33°38'36.71"	Rural Homestead
NSA 10	25°30'14.26"	33°38'08.84"	Rural Homestead
NSA 11	25°33'18.37"	33°37'40.98"	Rural Homestead
NSA 12	25°29'56.28"	33°39'18.11"	Rural Homestead
NSA 13	25°34'22.07"	33°38'46.93"	Industrial Premises
NSA 14	25°35'57.20"	33°44'22.50"	Industrial Premises
NSA 15	25°35'40.49"	33°44'02.78"	Industrial Premises
NSA 16	25°35'48.52"	33°43'26.38"	Industrial Premises
NSA 17	25°38'41.79"	33°45'36.49"	Rural Homestead
NSA 18	25°39'25.89"	33°45'11.39"	Rural Homestead
NSA 19	25°35'51.43"	33°42'55.75"	Rural Homestead

3.1.2 Natural environment receptors

The fauna includes bats, birds, commercial livestock and a variety of buck. The impacts on the fauna and avifauna are dealt with in separate studies.

3.2 Results of the field study

3.2.1 Ambient noise at proposed sites

The ambient noise was measured at four locations as described in the above methodology and the results thereof are contained in tables 3.2 and 3.3 below.

The weather conditions at the time of the daytime survey were as follows:

- Windspeed 7m/s
- Temperature 20.2oC
- Relative humidity 54%

Table 3.2 - Ambient Noise Results – (Day)

Location	Start Time	Duration (minutes)	$L_{Req.T}$ dB(A)	Comments
TP1 – 2.5 km from Crossing (right)	12:35	13	61.5	• 4 Trucks passed by • Wind noise • Birds singing
TP2 – Main road at fork	12:00	10	58.5	• Wind noise • Birds singing • 2 trucks passed by and hooted
TP3 – East from PPC Plant	13:05	10	44.7	• Wind blowing • Vehicles passing on dirt road
TP 4 – South of Brickfield	14:00	10	49.9	• Vehicles passing on dirt road

The weather conditions at the time of the night survey was as follows:

- Windspeed 10.5m/s
- Temperature 17.3oC
- Relative humidity 74%

Table 3.3 - Ambient Noise Results – (Night)

Location	Start Time	Duration (minutes)	$L_{Req.T}$ dB(A)	Comments
TP1 – 2.5 km from Crossing (right)	22:00	11	39.5	• Wind noise • Insect noise
TP2 – Main road at fork	22:35	12	42.8	• Wind noise • Cars in distance passing on dirt road
TP3 – East from PPC Plant	23:10	10	41.8	• Wind blowing
TP 4 – South of Brickfield	23:40	10	43.3	• Wind blowing

The general ambient noise at each location varies substantially as the ambient sound is influenced by human activities, vehicles and animal sounds. It is thus extremely difficult to isolate just the wind component.

4 IDENTIFICATION OF KEY ISSUES

The key issues regarding the noise impact are as follows:

- What is the current ambient noise in the vicinity of the proposed project?
- What is the likely noise impact during construction and operation of the site and associated infrastructure?
- Where are local sensitive human receptors located and how is the noise going to affect them?
- Will low frequency sound and infra sound be a problem?

5 APPLICABLE LEGISLATION AND STANDARDS

South Africa has applicable noise legislation or standards that could be applied to the project. The draft scoping report has identified that the applicable environmental legislation places a general onus on the developer to ensure that the environment is not affected negatively by the development.

The following legislation and standards have been used to aid the study and guide the decision making process with regards noise pollution:

- South Africa - GNR.154 of January 1992: Noise control regulations in terms of section 25 of the Environment Conservation Act (ECA), 1989 (Act No. 73 of 1989).
- South Africa - GNR.155 of 10 January 1992: Application of noise control regulations made under section 25 of the Environment Conservation Act, 1989 (Act No. 73 of 1989).
- South Africa - SANS 10103:2008 Version 6 - The measurement and rating of environmental noise with respect to annoyance and to speech communication.
- South Africa - SANS 10210:2004 Edition 2.2 – Calculating and predicting road traffic noise.
- South Africa - SANS 10357:2004 Version 2.1 - The calculation of sound propagation by the Concawe method.

- International Finance Corporation – 2007 General EHS Guidelines: Environmental Noise.

SANS 10103:2008 provides typical rating levels for noise in various types of districts, as described in Table 5.1 below. Two types of districts are applicable to the study, namely rural districts and industrial districts.

Table 5.1 - Typical rating levels for noise in various types of districts

Type of District	Equivalent Continuous Rating Level, LReq.T for Noise					
	• Outdoors (dB(A))			• Indoors, with open windows (dB(A))		
	• Day-night	• Daytime	• Night-time	• Day-night	• Daytime	• Night-time
• **Rural Districts**	**45**	**45**	**35**	**35**	**35**	**25**
• Suburban districts with little road traffic	• 50	• 50	• 40	• 40	• 40	• 30
• Urban districts	• 55	• 55	• 45	• 45	• 45	• 35
• Urban districts with one or more of the following: Workshops; business premises and main roads	• 60	• 60	• 50	• 50	• 50	• 40
• Central business districts	• 65	• 65	• 55	• 55	• 55	• 45
• **Industrial districts**	• **70**	• **70**	• **60**	• **60**	• **60**	• **50**

SANS 10103:2008 defines Daytime as 06:00 to 22:00 hours and night time as 22:00 to 06:00 hours. The rating levels in the table above indicate that in rural districts the ambient noise should not exceed 35 dB(A) at night and 45 dB(A) during the day. These levels can thus be seen as the target levels for any noise pollution sources.

Furthermore the South African noise control regulations describe a disturbing noise as **any** noise that exceeds the ambient noise by more than 7dB. This difference is usually measured at the complainants location should a noise complaint arise. Therefore, if a new noise source is introduced into the environment, irrespective of the current noise levels, and the new source is louder than the existing ambient environmental noise by more than 7dB, the complainant will have a legitimate complaint.

SANS 10103: 2004 also provides a guideline for expected community responses to excess environmental noise above the ambient noise. These are reflected in table 5.2 below.

Table 5.2 - Categories of environmental community / group response (SANS 10103:2008)

EXCESS Lr dB (A)	ESTIMATED COMMUNITY/GROUP RESPONSE	
	CATEGORY	DESCRIPTION
0 - 10	Little	Sporadic complaints
5 - 15	Medium	Widespread complaints
10 - 20	Strong	Threats of community / group action
> 15	Very Strong	Vigorous community / group action

International Standards

There are various international criteria levels for ambient sound from wind turbines. These are listed below:

- New Zealand – 40dB(A)
- Denmark – 40dB(A)
- United Kingdom (L_{A90}) 35 - 40dB(A)

Australia has set the following limits that wind turbine noise should not exceed:

- 35dB(A) at relevant receivers in localities which are primarily intended for rural living, or
- 40dB(A) at relevant receivers in localities in other zones, or
- the background noise (L_{A90}) by more than 5dB(A)

Germany has set the following standards

- Purely residential areas with no commercial developments 50 dBA (Day) and 35 dBA (Night)
- Areas with hospitals, health resorts, etc. 45 dBA (Day) 35 dBA (Night)

The rationale behind the criteria levels is that the design limit should be 5 dB below the natural ambient limit. This corresponds well with the South African guideline limit of 45 dB for rural districts.

There are no legislated setback distance guidelines for wind turbines in South Africa. A 500m setback distance is recommended for the rural residences as this is approximately the distance that the author noted in France that the wind turbines could not be heard. This distance is chosen subjectively, but in the absence of legislated requirements, it could be considered as an option. As far as a setback distance for the industrial sites is concerned, a setback of 100m is provisionally recommended. This is entirely subjective as it is approximately the blade diameter. The author has seen sites in Europe where wind turbines are located even closer in industrial complexes.

6 NOISE IMPACT ASSESSMENT

6.1 Predicted noise levels for the construction phase

The construction noise at the various sites will have a local impact. Safetech has conducted noise tests at various sites in South Africa and has recorded the noise emissions of various pieces of construction equipment. The results are presented in the Table 6.1 below.

Table 6.1 – Typical Construction Noise

Type of Equipment	$L_{Req.T}$ dB(A)
CAT 320D Excavator measured at approximately 50 m.	67.9
Mobile crane measured at approximately 70 m	69.6
Drilling rig measured at approximately 70 m	72.6

The impact of the construction noise that can be expected at the proposed site can be extrapolated from Table 2.3. As an example, if a number of pieces of equipment are used simultaneously, the noise levels can be added logarithmically and then calculated at various distances from the site to determine the distance at which the ambient level will be reached.

Table 6.2 - Combining Different Construction Noise Sources – High Impacts (Worst Case)

Description	Typical Sound Power Level (dB)
Overhead and mobile cranes	109
Front end loaders	100
Excavators	108
Bull Dozer	111
Piling machine (mobile)	115
Total*	**117**

*The total is a logarithmic total and not a sum of the values.

Table 6.3 - Combining Different Construction Noise Sources – Low Impacts

Description	Typical Sound Power Level (dB)
Front end loaders	100
Excavators	108
Truck	95
Total	**111**

The information in the tables above can now be used to calculate the attenuation by distance. Noise will also be attenuated by topography and atmospheric conditions such as temperature, humidity, wind speed and direction etc. but for this is ignored for this purpose. Therefore, the distance calculated below would be representative of maximum distances to reach ambient noise levels.

The table below gives an illustration of attenuation by distance for a noise of 117dB (sound power) at the source.

Table 6.4 – Attenuation by distance for the construction phase (worst case)

Distance from noise source (metres)	Sound Pressure Level dB(A)
10	89
20	83
40	77
80	71
160	65
320	59
640	53
1280	47

What can be inferred from the above table is that if the ambient noise level is at 45dB(A), the construction noise will be similar to the ambient level at approximately 1280m from the noise source, if the noise characteristics are similar. Beyond this distance, the noise level will be below the ambient noise and will therefore have little impact. The above only applies to the construction noise and light wind conditions. In all likelihood, the construction noise will have little impact on the surrounding community as it will most likely occur during the day when the ambient noise is louder and there are unstable atmospheric conditions.

6.2 Predicted noise levels for the operational phase

The effects of low frequency noise include sleep disturbance, nausea, vertigo etc. These effects are unlikely to impact upon residents due to the distance between the plant and the nearest communities. Sources of low frequency noise also include wind, train movements and vehicular traffic, which are all sources that are closer to the residential areas.

6.2.1 Predicted noise levels for wind turbine generators

The tables and figures below indicate the noise generated by the turbines at wind speeds from 4m/s to 12m/s. The areas shaded red in the tables indicate where the day / night 45dB(A) recommended limit is exceeded. ***It should be noted that NSA's 13, 14, 15 and 16 are industrial zones and therefore the rating level is higher as per SANS 10103:2008.***

Table 6.5 - Results of the modelling for the various NSA's

NSA 1				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1796m from WTG 61	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	24.6	22.2	Yes
6	45	33.4	29.8	Yes
8	45	35.2	35.7	Yes
10	45	33.9	37.1	Yes
12	45	35.1	38.5	Yes

NSA 2				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1499m from WTG 73	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	27.0	24.6	Yes
6	45	35.8	32.2	Yes
8	45	37.6	38.1	Yes
10	45	36.3	39.5	Yes
12	45	37.5	40.9	Yes

NSA 3				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 965m from WTG 59	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	29.0	26.5	Yes
6	45	37.7	34.1	Yes
8	45	39.5	40.0	Yes
10	45	38.2	41.4	Yes
12	45	39.4	42.8	Yes

NSA 4				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 787m from WTG 59	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	30.4	27.9	Yes
6	45	39.1	35.5	Yes
8	45	40.9	41.4	Yes
10	45	39.6	42.8	Yes
12	45	40.8	44.2	Yes

NSA 5				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 2056m from WTG 70	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	24.8	22.3	Yes
6	45	33.5	29.9	Yes
8	45	35.3	35.8	Yes
10	45	34.0	37.2	Yes
12	45	35.2	38.6	Yes

NSA 6				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1993m from WTG 29	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	23.3	20.8	Yes
6	45	32.0	28.4	Yes
8	45	33.8	34.3	Yes
10	45	32.5	35.7	Yes
12	45	33.7	37.1	Yes

NSA 7				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 2099m from WTG 29	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	22.8	20.3	Yes
6	45	31.5	27.9	Yes
8	45	33.3	33.8	Yes
10	45	32.0	35.2	Yes
12	45	33.2	36.6	Yes

NSA 8				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 768m from WTG 1	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	32.4	29.9	Yes
6	45	41.1	37.5	Yes
8	45	42.9	43.4	Yes
10	45	41.6	44.8	Yes
12	45	42.8	46.2	No

NSA 9				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 442m from WTG 40	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	35.7	33.2	Yes
6	45	44.4	40.8	Yes
8	45	46.2	46.7	No
10	45	44.9	48.1	No
12	45	46.1	49.5	No

NSA 10				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1329m from WTG 43	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	25.4	23.0	Yes
6	45	34.1	30.6	Yes
8	45	36.0	36.5	Yes
10	45	34.7	37.9	Yes
12	45	35.9	39.3	Yes

NSA 11				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 970m from WTG 55	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	28.8	26.3	Yes
6	45	37.5	33.9	Yes
8	45	39.3	39.8	Yes
10	45	38.0	41.2	Yes
12	45	39.2	42.6	Yes

NSA 12				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1292m from WTG 39	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	24.7	22.3	Yes
6	45	33.4	29.9	Yes
8	45	35.3	35.8	Yes
10	45	34.0	37.2	Yes
12	45	35.2	38.6	Yes

NSA 13				
Distance to Nearest WTG[m] - min 100m			Nearest WTG 386m from WTG 50	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	70	36.5	34.0	Yes
6	70	45.2	41.6	Yes
8	70	47.0	47.5	Yes
10	70	45.7	48.9	Yes
12	70	46.9	50.3	Yes

NSA 14				
Distance to Nearest WTG[m] - min 100m			Nearest WTG 1272m from WTG 73	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	70	29.0	26.5	Yes
6	70	37.7	34.1	Yes
8	70	39.5	40.0	Yes
10	70	38.2	41.4	Yes
12	70	39.4	42.8	Yes

NSA 15				
Distance to Nearest WTG[m] - min 100m			Nearest WTG 1396m from WTG 59	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	70	27.4	24.9	Yes
6	70	36.1	32.5	Yes
8	70	37.9	38.4	Yes
10	70	36.6	39.8	Yes
12	70	37.8	41.2	Yes

NSA 16				
Distance to Nearest WTG[m] - min 100m			Nearest WTG 897m from WTG 59	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	70	29.1	26.6	Yes
6	70	37.8	34.2	Yes
8	70	39.6	40.1	Yes
10	70	38.3	41.5	Yes
12	70	39.5	42.9	Yes

NSA 17				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 2118m from WTG 57	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	24.3	21.8	Yes
6	45	33.0	29.4	Yes
8	45	34.8	35.3	Yes
10	45	33.5	36.7	Yes
12	45	34.7	38.1	Yes

NSA 18				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1554m from WTG 56	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	25.9	23.4	Yes
6	45	34.6	31.0	Yes
8	45	36.4	36.9	Yes
10	45	35.1	38.3	Yes
12	45	36.3	39.7	Yes

NSA 19				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1415m from WTG 59	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V80 2MW	WinWinD WWD 3 3MW	Noise Demand Fulfilled?
4	45	26.9	24.4	Yes
6	45	35.6	32.0	Yes
8	45	37.4	37.9	Yes
10	45	36.1	39.3	Yes
12	45	37.3	40.7	Yes

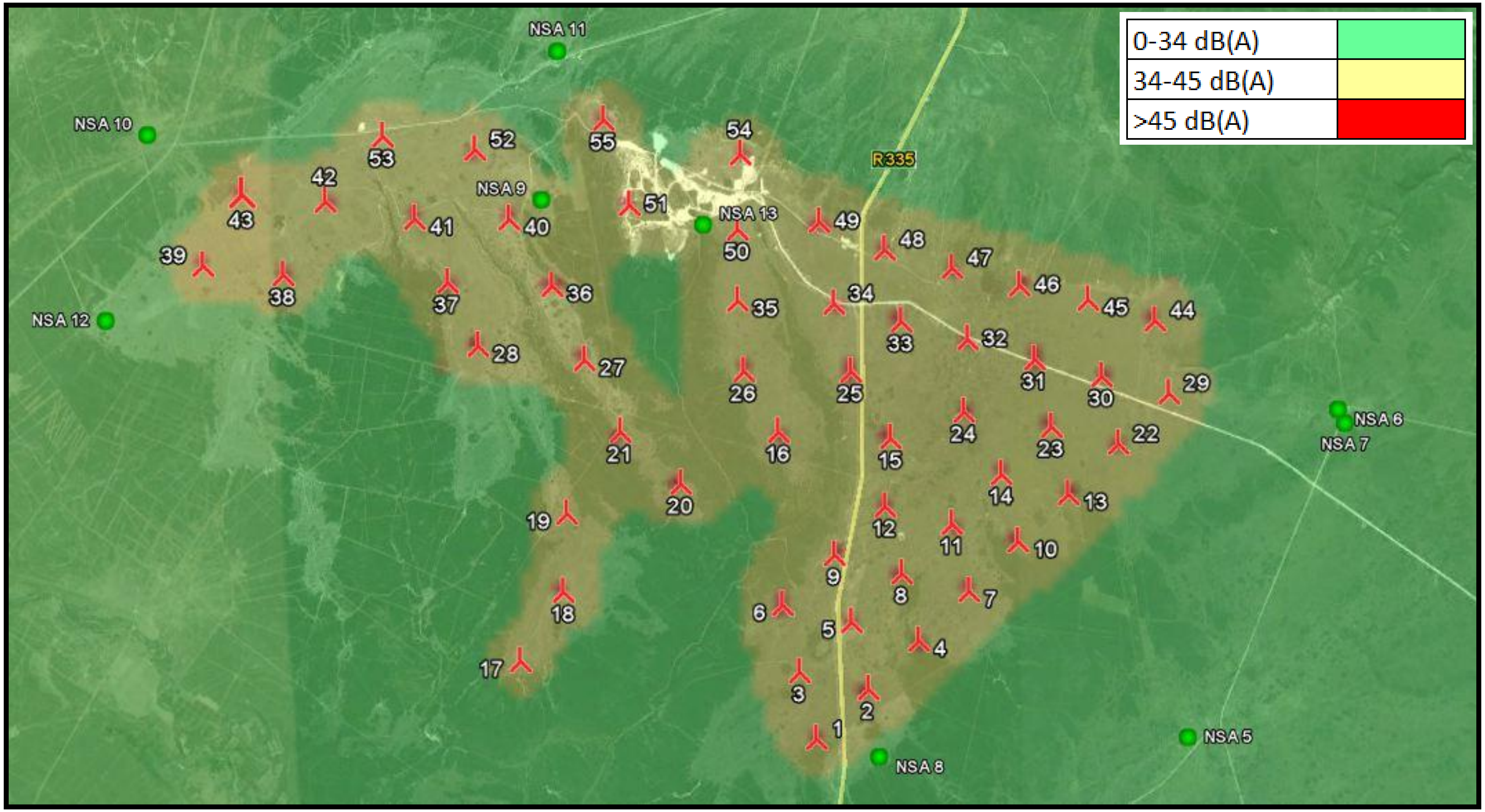


Figure 6.1 - Raster Image of Result (Vestas V80 4m/s North) - Note: NSA 13 is classed as an industrial district and the rating limit is 70dBA

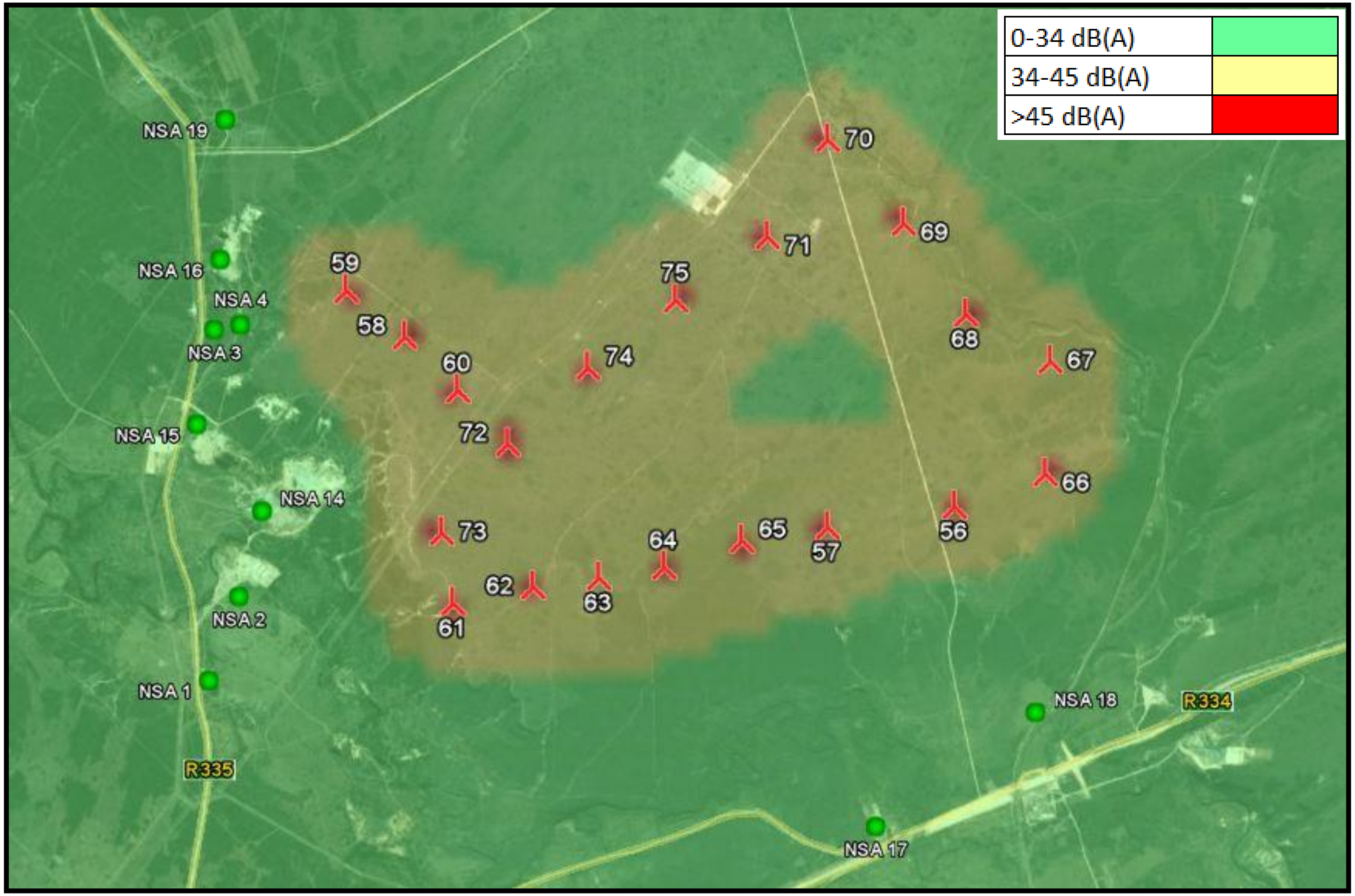


Figure 6.2 - Raster Image of Result (Vestas V80 4m/s South) - Note: NSA 14, 15 & 16 are classed as an industrial district and the rating limit is 70dBA

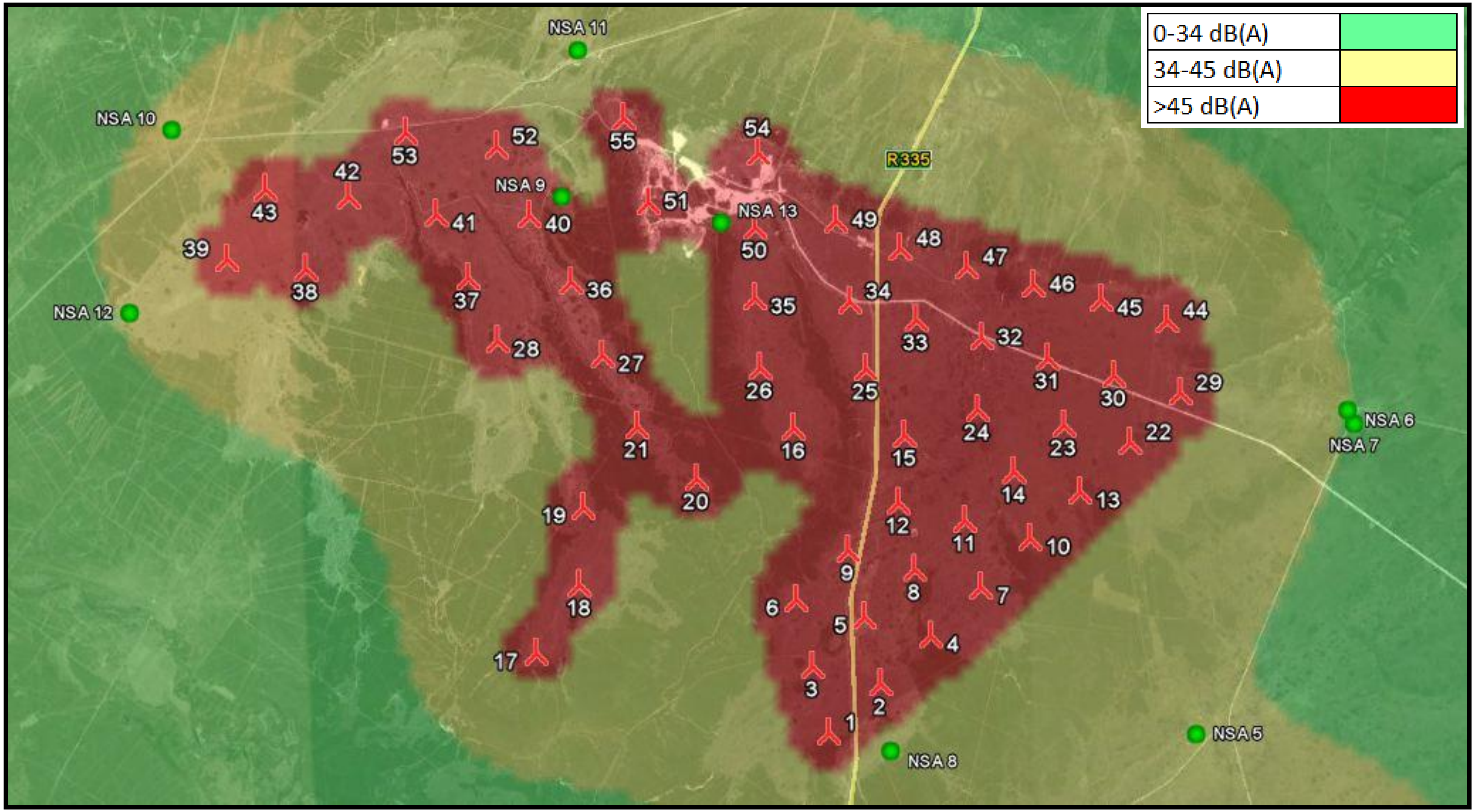


Figure 6.3 - Raster Image of Result (Vestas V80 8m/s North) - Note: NSA 13 is classed as an industrial district and the rating limit is 70dBA

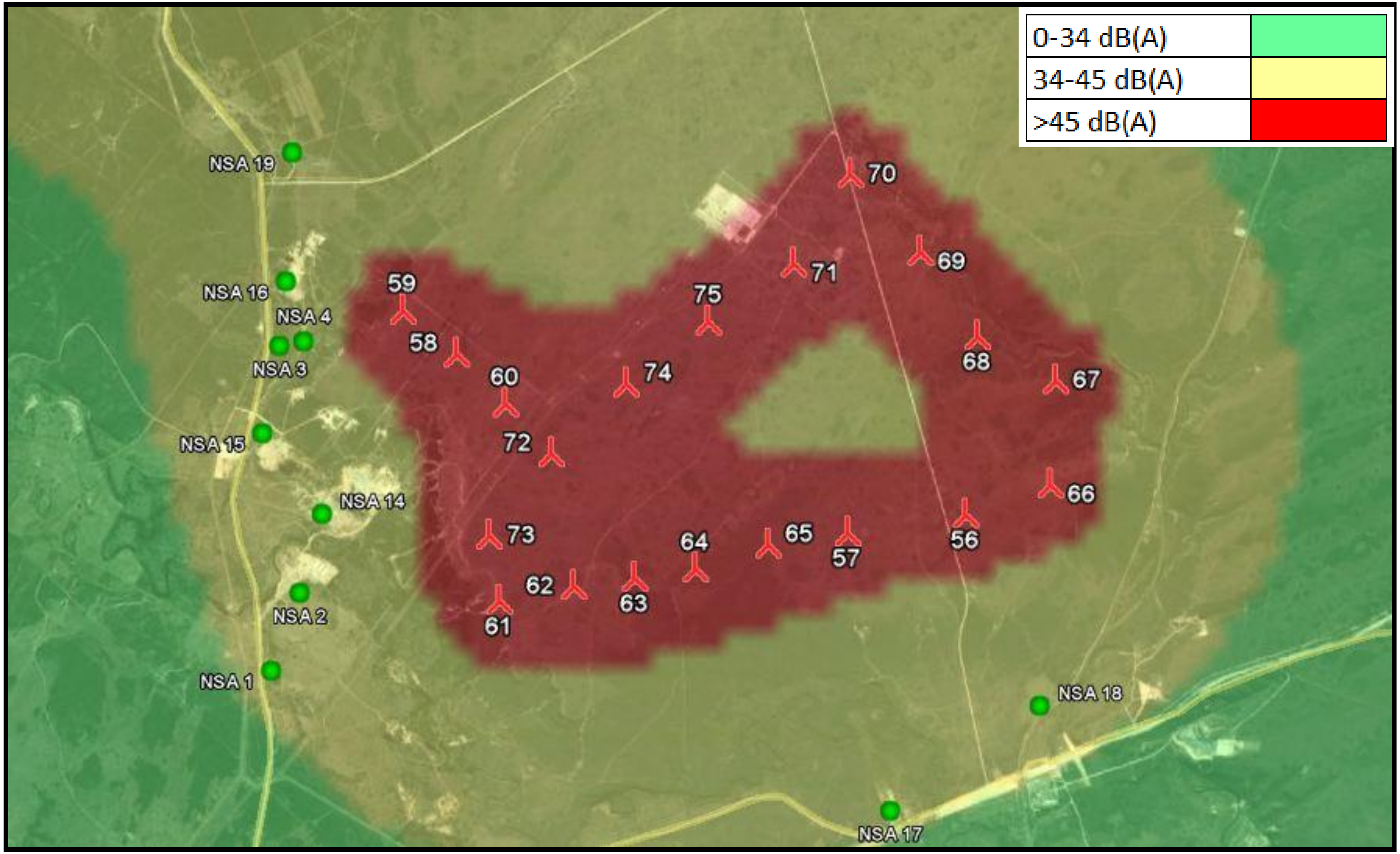


Figure 6.4 - Raster Image of Result (Vestas V80 8m/s South) - Note: NSA 14, 15 & 16 are classed as an industrial district and the rating limit is 70dBA

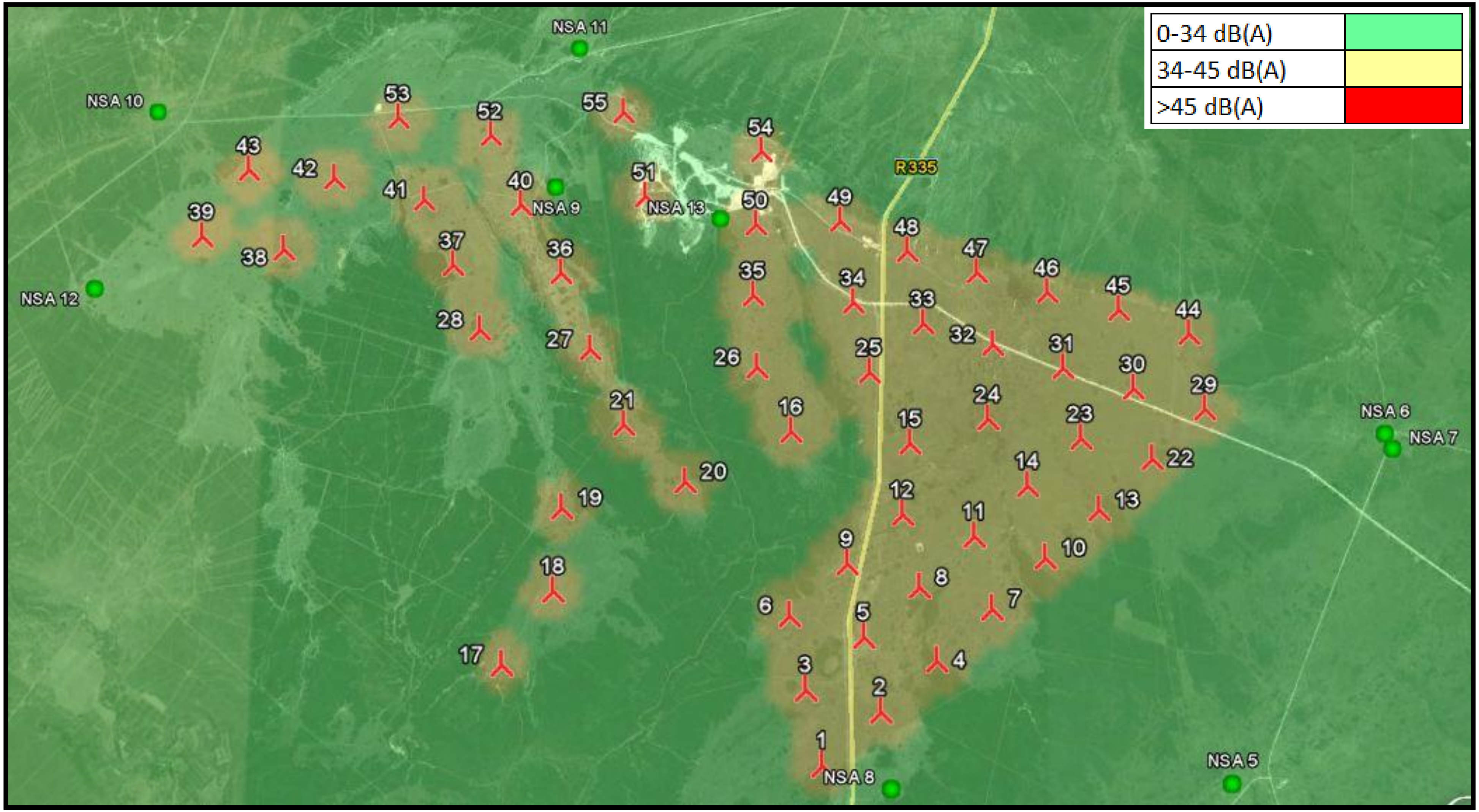


Figure 6.5 - Raster Image of Result (WinWinD WWD3 4m/s (North) - Note: NSA 13 is classed as an industrial district and the rating limit is 70dBA

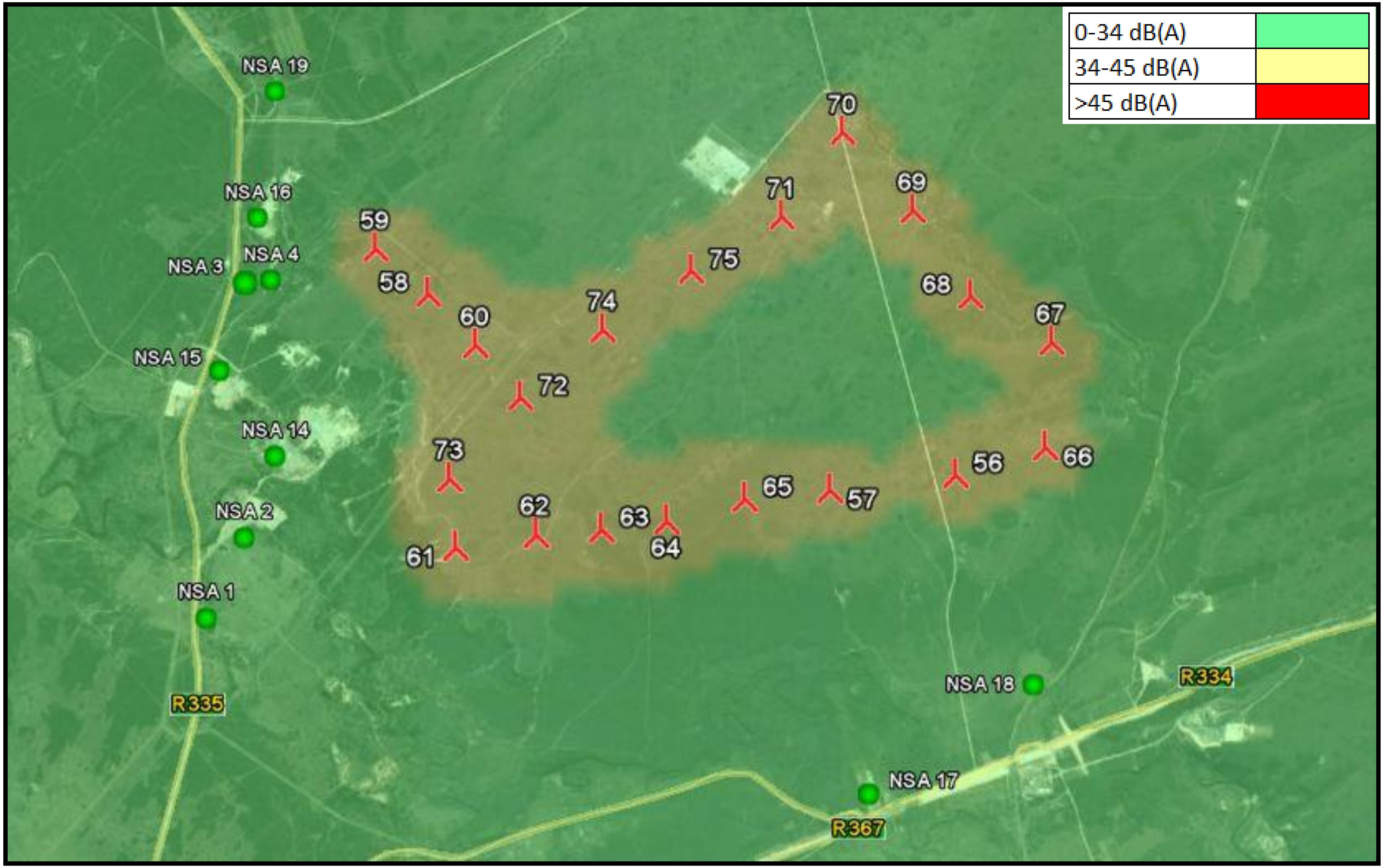


Figure 6.6 - Raster Image of Result (WinWinD WWD3 4m/s (South) - Note: NSA 14, 15 & 16 are classed as an industrial district and the rating limit is 70dBA

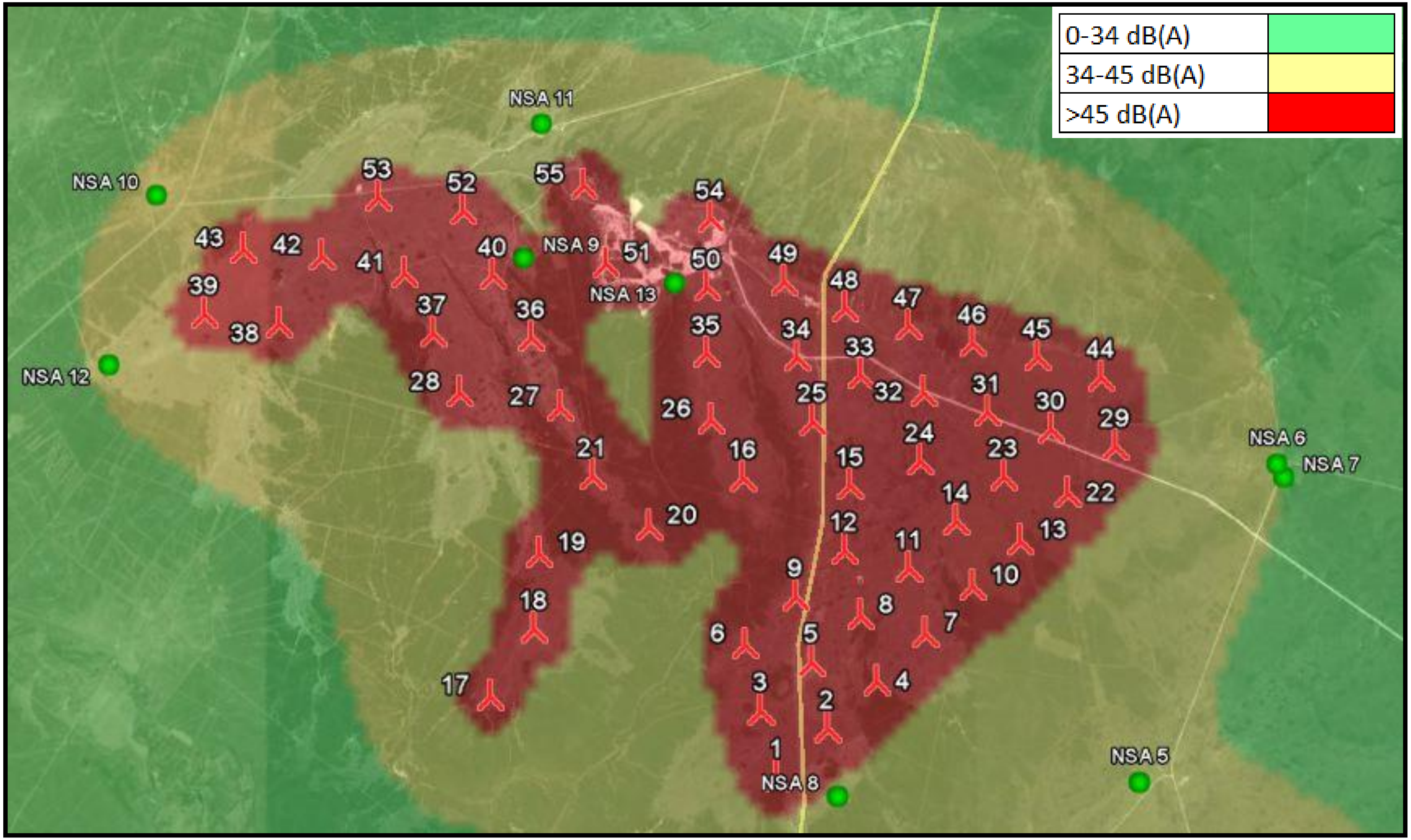


Figure 6.7 - Raster Image of Result (WinWinD WWD3 8m/s (North) - Note: NSA 13 is classed as an industrial district and the rating limit is 70dBA

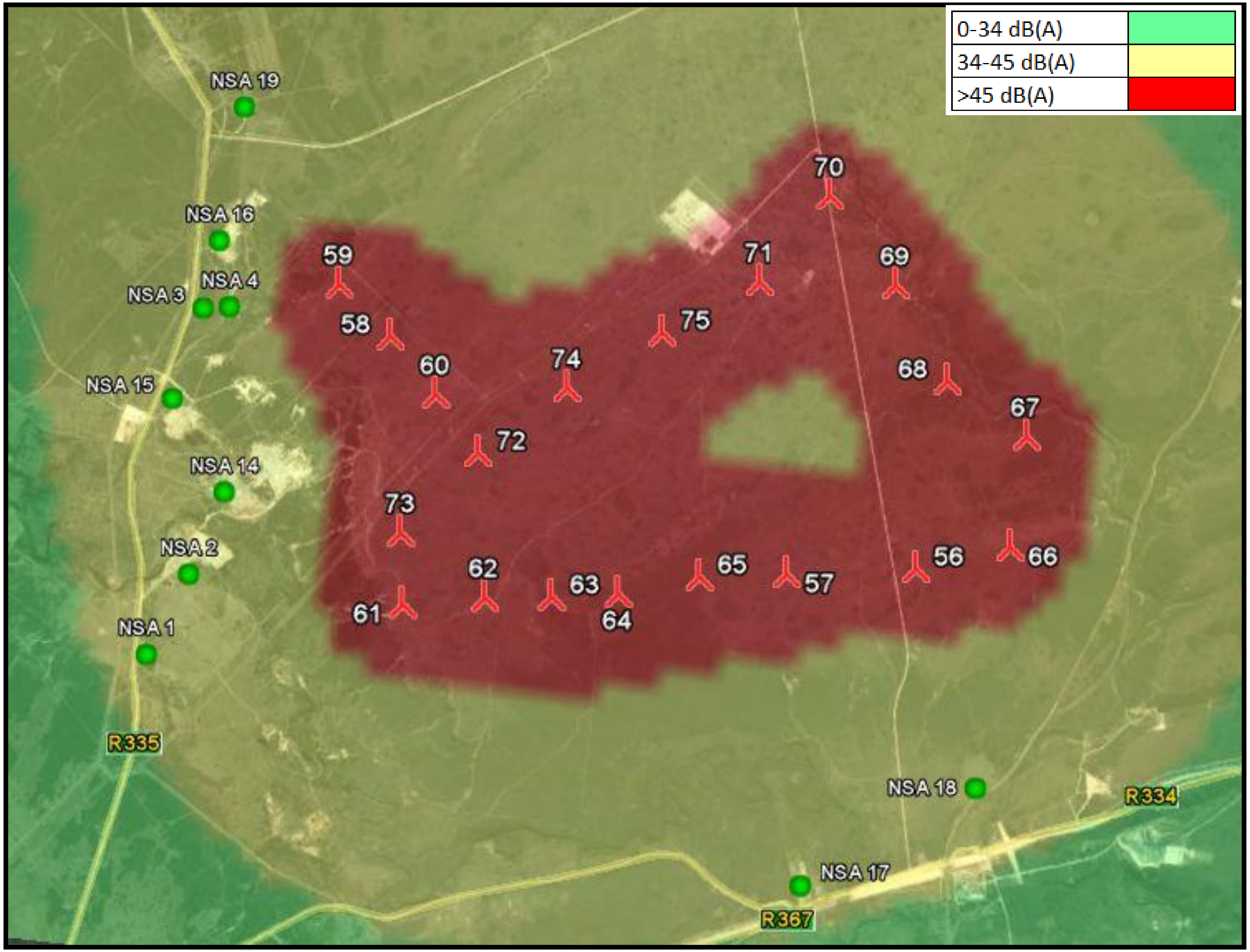


Figure 6.8 - Raster Image of Result (WinWinD WWD3 8m/s (South)

6.3 Noise impact assessment summary

The impact of the noise pollution that can be expected from the site during the construction and operational phase will largely depend on the climatic conditions at the site. The ambient noise increases as the wind speed increases. In summary the noise rating limits used are 45 dB(A) for the rural homesteads and 70dB(A) for the industrial sites. The recommended setback distances are 500m for the rural homesteads and 100m for the industrial sites.

The results indicate the following:

Operational Phase

Table 6.6 - Summary of noise impacts on NSA's at various wind speeds (Vestas V80)

	NSA Type	4m/s	6m/s	8m/s	10m/s	12m/s	Turbine setback distance criteria met
1	Rural Homestead	✓	✓	✓	✓	✓	Yes
2	Rural Homestead	✓	✓	✓	✓	✓	Yes
3	Rural Homestead	✓	✓	✓	✓	✓	Yes
4	Rural Homestead	✓	✓	✓	✓	✓	Yes
5	Rural Homestead	✓	✓	✓	✓	✓	Yes
6	Rural Homestead	✓	✓	✓	✓	✓	Yes
7	Rural Homestead	✓	✓	✓	✓	✓	Yes
8	Rural Homestead	✓	✓	✓	✓	✓	Yes
9	Rural Homestead	✓	✓	X	✓	X	No
10	Rural Homestead	✓	✓	✓	✓	✓	Yes
11	Rural Homestead	✓	✓	✓	✓	✓	Yes
12	Rural Homestead	✓	✓	✓	✓	✓	Yes
13	Industrial Site	✓	✓	✓	✓	✓	Yes
14	Industrial Site	✓	✓	✓	✓	✓	Yes
15	Industrial Site	✓	✓	✓	✓	✓	Yes
16	Industrial Site	✓	✓	✓	✓	✓	Yes
17	Rural Homestead	✓	✓	✓	✓	✓	Yes
18	Rural Homestead	✓	✓	✓	✓	✓	Yes
19	Rural Homestead	✓	✓	✓	✓	✓	Yes

✓ = Within Recommended Limit
X = Exceeds Recommended Limit

Table 6.7 - Summary of noise impacts on NSA's at various wind speeds (WinWinD WWD3)

	NSA Type	4m/s	6m/s	8m/s	10m/s	12m/s	Turbine setback distance criteria met
1	Rural Homestead	✓	✓	✓	✓	✓	Yes
2	Rural Homestead	✓	✓	✓	✓	✓	Yes
3	Rural Homestead	✓	✓	✓	✓	✓	Yes
4	Rural Homestead	✓	✓	✓	✓	✓	Yes
5	Rural Homestead	✓	✓	✓	✓	✓	Yes
6	Rural Homestead	✓	✓	✓	✓	✓	Yes
7	Rural Homestead	✓	✓	✓	✓	✓	Yes
8	Rural Homestead	✓	✓	✓	✓	X	Yes
9	Rural Homestead	✓	✓	X	X	X	No
10	Rural Homestead	✓	✓	✓	✓	✓	Yes
11	Rural Homestead	✓	✓	✓	✓	✓	Yes
12	Rural Homestead	✓	✓	✓	✓	✓	Yes
13	Industrial Site	✓	✓	✓	✓	✓	Yes
14	Industrial Site	✓	✓	✓	✓	✓	Yes
15	Industrial Site	✓	✓	✓	✓	✓	Yes
16	Industrial Site	✓	✓	✓	✓	✓	Yes
17	Rural Homestead	✓	✓	✓	✓	✓	Yes
18	Rural Homestead	✓	✓	✓	✓	✓	Yes
19	Rural Homestead	✓	✓	✓	✓	✓	Yes

✓ = Within Recommended Limit
X = Exceeds Recommended Limit

The noise produced by the wind turbines will exceed the 45dB(A) day/night limit at the following noise sensitive areas for two turbine options:

Vestas V80 2MW Unit - NSA 9 (Rural Homestead) at 8 and 12m/s wind speed. The location of the wind turbine generators did not meet the 500m minimum setback distance at NSA 9 as it is 442m from the farmhouse.

WinWinD WWD3 3MW Unit - NSA 8 (Rural Homestead) at 12m/s wind speed and NSA 9 (Rural Homestead) at 8, 10 and 12m/s wind speed. The location of the wind turbine generators did not meet the 500m minimum setback distance at NSA 9 as it is 442m from the farmhouse.
s the wind speed increases, the ambient noise also increases and masks the wind turbine noise. The critical wind speeds are thus between 4-6m/s when there is a possibility of little masking. At 12m/s the wind speed is such that it is highly unlikely that the turbine noise will be heard.

Construction Phase

There will be an impact on the immediate surrounding environment from the construction activities, especially if pile driving is to be done. This however will only occur if the underlying geological structure requires this.

The area surrounding the construction site will be affected for a short periods of time in all directions, should a several pieces of construction equipment be used simultaneously.

The number of construction vehicles that will be used in the project will add to the existing ambient levels and will most likely cause a short term disturbing noise.

The noise impact assessment tables are presented below:

Table 6.8- Noise impact rating table – No Mitigation

Nature of impact	Status (Negative or positive)	Temporal Scale	Spatial Scale	Severity	Likelihood	Impact Rating
Impact of the construction noise on the surrounding environment	Negative	Short Term (1)	Local (1)	Moderate (2)	Probable (3)	**Low (7)**
Impact of the operational noise on the surrounding environment (NSA 8 & 9)	Negative	Long Term (3)	Local (1)	Moderate (2)	Definite (4)	**Moderate (10)**

Table 6.9- Noise impact rating table – With Mitigation

Nature of impact	Status (Negative or positive)	Temporal Scale	Spatial Scale	Severity	Likelihood	Impact Rating
Impact of the operational noise on the surrounding environment (NSA 8 & 9) **Mitigation:** Move WTG 1 and 40 further from the affected NSA"s	Negative	Long Term (3)	Local (1)	Slight (1)	May Occur (2)	**Low (7)**

7 RECOMMENDATIONS AND CONCLUSIONS

The following is recommended:

7.1 Construction activities

a) All construction operations should only occur during daylight hours if possible. This may not be practical if continuous pouring of the turbine base has to occur.
b) No construction piling should occur at night. Piling should only occur during the hottest part of the day to take advantage of unstable atmospheric conditions.
c) Construction staff should receive “noise sensitivity” training.

7.2 Operational activities

The following general recommendation is made for the operational phase:

a) The noise impact from the wind turbine generators should be measured during the operational phase, to ensure that the impact is within the recommended limits.
b) WTG 1 should be moved further away from NSA 8 and WTG 40 should be moved further away from NSA 9 to meet the minimum setback criteria.

NOISE APPENDIX A: TYPICAL SOUND POWER AND SOUND PRESSURE LEVELS

Acoustic Power	Degree		Pressure Level	Source
32 GW	Deafening		225 dB	12" Cannon @ 12ft in front and below
25 to 40 MW			195 dB	Saturn Rocket
100 Kw			170 dB	Turbojet engine with afterburner
10 Kw			160 dB	Turbojet engine, 7000lb thrust
1 kW			150 dB	4 Propeller Airliner
100 W			140 dB	Artillery Fire
10 W	Threshold of pain		130 dB	Pneumatic Rock Drill
				130 dB causes immediate ear damage
3 W			125 dB	Small aircraft engine
1.0 W			120 dB	Thunder
100 Mw			110 dB	Close to train
10 mW	Very Loud		100 dB	Home lawn mower
1 mW			90 dB	Symphony or a Band
				85 dB regularly can cause ear damage
100 uW	Loud		80 dB	Police whistle
10 uW			70 dB	Average radio
1 uW	Moderate		60 dB	Normal conversational voice
100 nW			50 dB	Quiet stream
10 nW	Faint		40 dB	Quiet conversation
1 nW			30 dB	Very soft whisper
100 pW	Very faint		20 dB	Ticking of a watch
10 pW	Threshold of hearing		10 dB	
1 pW			0 dB	Absolute silence

Sound Perception

Change in Sound Level	Perception
3 dB	Barely perceptible
5 dB	Clearly perceptible
10 dB	Twice as loud

APPENDIX A-5: PALAEONTOLOGICAL REPORT

PALAEONTOLOGICAL IMPACT ASSESSMENT: PROPOSED WINDFARM ON GRASSRIDGE 190, 227 AND 228, OLIFANTS KOP 201, BONTRUG 301, BRAK RIVER SW 224, SWARTE KOPPEN 302 AND WELBEDACHTSFONTEIN 300, NELSON MANDELA BAY MUNICIPALITY, EASTERN CAPE PROVINCE

SPECIALIST REPORTS
VOLUME 2: ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Prepared for:	Prepared by:	Prepared by:
InnoWind		***NATURA VIVA cc***
InnoWind (Pty) Limited	**Coastal & Environmental Services**	**Natura Viva cc**
P.O. Box 1116 Port Elizabeth, 6000	P.O. Box 934 Grahamstown, 6140	P.O. Box 12410 Mill St. Cape Town 8010
South Africa	South Africa	South Africa

FEBRUARY 2011

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EXECUTIVE SUMMARY

The Coega Wind Energy Projectproposed by Innowind (Pty) Ltd will take place on a number of sites located on the coastal plain to the northeast of Uitenhage, close to or within the Coega IDZ (Industrial Development Zone), Nelson Bay Municipality, Eastern Cape Province. These sites arePretoria Portland Cement (PPC) property (Farms Grassridge 190, 227 and 228, Oliphants Kop 201) and Zone 14 ofCoega Industrial Development Zone (IDZ)(Farms Bontrug 301, Brak River SW 224, Swarte Koppen 302) as well as farm Welbedachtsfontein 300. All these sites are underlain by a broadly similar geological foundation, viz. marine mudrocks and sandstones of the Sundays River Formation (Mesozoic Uitenhage Group) capped by shallow coastal limestones of the Alexandria Formation (Late Caenozoic Algoa Group). The Alexandria limestones are locally mantled by pebbly residual weathering deposits known informally as the “Bluewater Bay Formation” as well as relict patches of Pliocene to Pleistocene dune sands of the Nanaga Formation (Algoa Group).

The palaeontological sensitivity of the Sundays River Formation is high due to its rich fossil record of marine invertebrates as well as very rare marine reptiles (plesiosaurs). The potential for important new fossil finds in these beds is considerable, as demonstrated by the first records of scaphopod molluscs (tusk shells) from this formation made during the present field study. However, the proposed wind turbine positions are largely concentrated on the limestone plateaux areas, so there should be little or no direct impact on the Sundays River Formation that generally underlies sloping escarpment zones.

The Alexandria Formation that underlies most of the flat-lying areas that are likely to be targeted for wind turbines is also known to be richly fossiliferous. However, field evidence suggests that much of this lime-rich succession here has been altered by post-depositional leaching and calcretization so that most new excavations expose few or no fossils of value. Specialist palaeontological mitigation of excavations into the Alexandria Formation – i.e. the majority of those envisaged for this project - is not warranted unless rich fossil concentrations are exposed.

The palaeontological sensitivity of the “Blue Water Bay Formation” residual deposits and the Nanaga aeolian sandstones above the Alexandria limestones is generally very low. No specialist palaeontological mitigation is recommended here unless rich fossil concentrations are exposed during excavations.

In conclusion, the overall impact on palaeontological heritage of the proposed Coega Wind Energy Project is of low significance.Potential negative impacts are generally slight and will only take place during the construction phase. Further specialist palaeontological mitigation is therefore not recommended for this development*unless*:

a) Wind turbines or ancillary developments are sited over the Sundays River Formation (mainly escarpment areas); or
b) deep excavations penetrate through the limestone capping into Sundays River sediments below.

Where fresh Sundays River Formation rocks are extensively exposed during construction, mitigation by a qualified palaeontologist should entail:

a) The field examination of new bedrock excavations;
b) the recording of sedimentological and palaeontological data; and
c) the judicious sampling of fossil material and
d) recommendations for any further action required to safeguard fossil heritage.

It is important that the opportunity to mitigate is given while the bedrock excavations are fresh and before they are infilled, covered over or degraded by weathering and plant growth. Before development starts a realistic programme of mitigation should therefore be negotiated between the developer and the palaeontologist contracted for the project to maximize the scientific and conservation benefits of the work while minimizing disruption of the construction programme. The palaeontologist involved will need to obtain a fossil collection permit from SAHRA and make arrangements with an approved repository (e.g. museum, university) to store and curate any fossil material collected.

Environmental control officers responsible for developments within the Coega IDZ should:

a) Be alerted to the palaeontological sensitivity of several geological units in the area;
b) familiarize themselves with the sort of fossils that might be encountered during development through museum displays and using illustrated reports such as the present one as well as the Coega IDZ palaeontological heritage report by Almond (2010); and
c) alert SAHRA and a professional palaeontologist as soon as possible should significant fossil remains be exposed during excavations. These fossils should be safeguarded, preferentially *in situ*, until appropriate mitigation measures can be undertaken.

These requirements must be incorporated in the Construction Phase Environmental Management Plan (EMP).

SPECIALIST PRACTITIONER DECLARATION OF INDEPENDENCE

PALAEONTOLOGICAL IMPACT ASSESSMENT: PROPOSED WINDFARM ON GRASSRIDGE 190, 227 AND 228, OLIFANTS KOP 201, BONTRUG 301, BRAK RIVER SW 224, SWARTE KOPPEN 302 AND WELBEDACHTSFONTEIN 300, NELSON MANDELA BAY MUNICIPALITY, EASTERN CAPE PROVINCE	
Palaeontological specialist	I John E. Almond declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Innowind Coega Wind Energy Project, application or appeal in respect of which I 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 my performing such work. **SIGNATURE:**

LIST OF ABBREVIATIONS AND ACRONYMS

IDZ: Industrial Development Zone
Ma: million years ago
amsl above mean sea level

1 INTRODUCTION

1.1 Background information

The proposed Innowind (Pty) Limited Coega Wind Energy is a wind farm development sited to the northeast of Uitenhage, Nelson Bay Municipality in the Eastern Cape Province. The study area isPretoria Portland Cement (PPC) property (Farms Grassridge 190, 227 and 228, Oliphants Kop 201) and Zone 14 ofCoega Industrial Development Zone (IDZ)(Farms Bontrug 301, Brak River SW 224, Swarte Koppen 302) as well as farm Welbedachtsfontein 300 outside the Coega IDZ. The location and extent of the study areas are shown below in Figure 1-1 below.

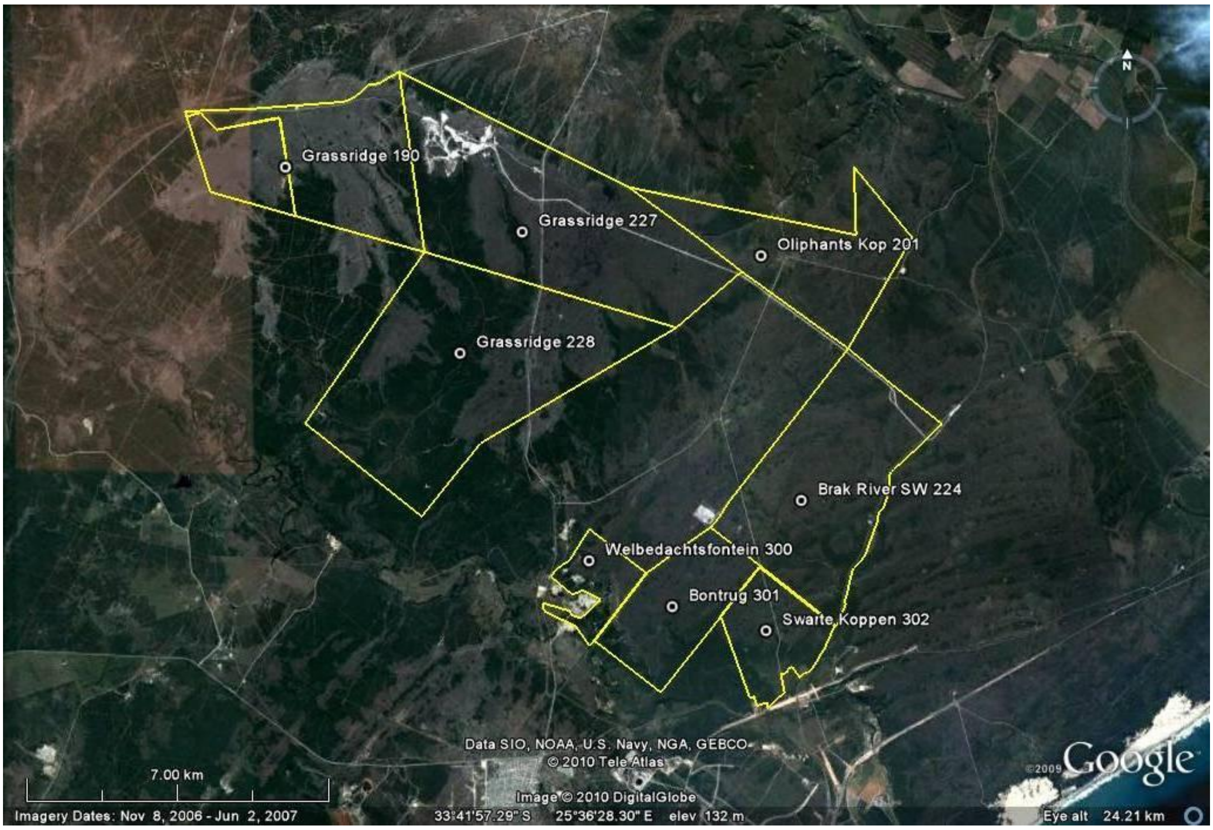

Figure 1-1: Google satellite image showing location of the proposed Coega wind farm study areas

Since the farms concerned overlie potentially fossiliferous sediments of the Mesozoic Uitenhage and Late Caenozoic Algoa Groups, a palaeontological impact assessment for the project was commissioned by Coastal and Environmental Services, Grahamstown in accordance with the requirements of the National Heritage Resources Act, 1999.

Proposed wind turbine positions within each sector of the Coega Wind Energy Project are shown in Figure 1-2 below.

1.2 Terms of reference

The terms of reference for this specialist palaeontological impact study were to:

- Determine the likelihood of palaeontological resources of significance in the proposed site;
- Identify and map (where applicable) the location of any significant palaeontological remains;

- Assess the sensitivity and significance of palaeontological remains in the site; and
- Identify mitigatory measures to protect and maintain any valuable palaeontological sites and remains that may exist within the proposed site.

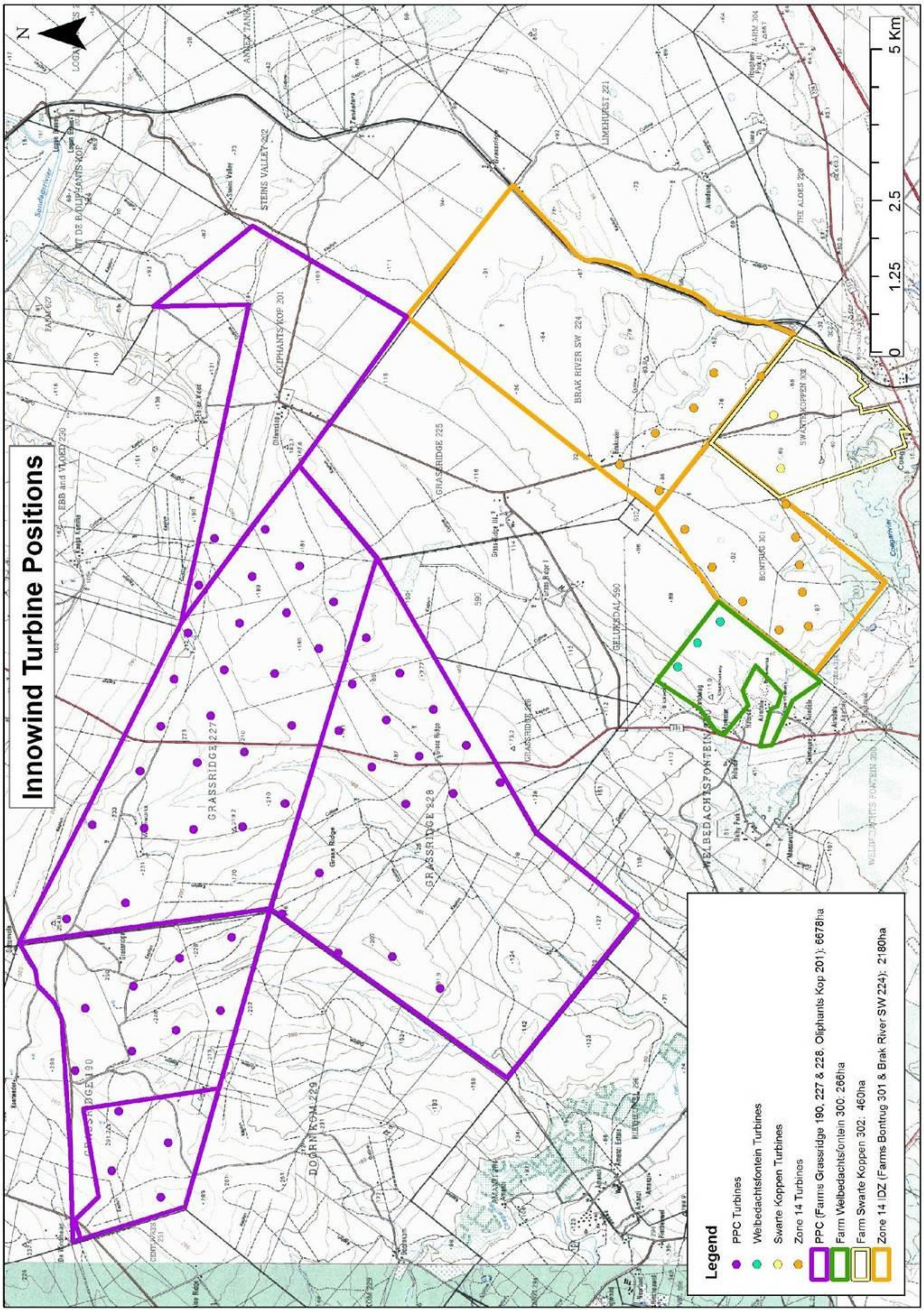

Figure 1-2: Proposed wind turbine positions for the Coega Wind Energy Project

1.3 Structure of the report

This report is structured as follows:

Section 1: Provides some background information on the proposed project as well as an indication of the scope of, and the purpose for which, this specialist report was prepared. This section also outlines the specific terms of reference for this specialist study and provides the details and expertise of the specialist who prepared this report.

Section 2: Outlines the geological context of the study areas and summarizes the palaeontological heritage that is already known from the various sedimentary formations represented here on the basis of the scientific literature,.

Section 3: Presents the geological and palaeontological observations made during fieldwork for the present impact study and data from related desktop studies. The necessity for specialist palaeontological mitigation for each of the study areas is also evaluated.

Section 4: Expresses the significance of the envisaged impacts on palaeontological heritage in tabular form. The sensitivity of all major rocks units represented within the study area is also summarized.

Section 5: Briefly summarizes when and where specialist palaeontological mitigation is recommended for this project and outlines what form this mitigation should take.

Section 6: Acknowledges colleagues and others who have contributed to the completion of this impact study.

Section 7: Provides full references to publications and reports relevant to the present study.

Palaeontological Appendix 1: Tabulates GPS data for all localities mentioned in the text.

1.4 Details and expertise of the environmental assessment practitioner

Dr John Almond*(Palaeontological Specialist)*

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA.

Since 2002 Dr Almond has also carried out palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape under the aegis of his Cape Town-based company *Natura Viva* cc. He is a long-standing member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHAP (Association of Professional Heritage Assessment Practitioners – Western Cape).

1.5 Relevant legislation, policies and guidelines

The extent of the proposed development (over 5000 m^2) falls within the requirements for a heritage impact assessment as required by Section 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999). The various categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act include, among others:

- geological sites of scientific or cultural importance
- palaeontological sites
- palaeontological objects and material, meteorites and rare geological specimens

This report provides an assessment of palaeontological heritage within the study areas with recommendations for mitigation, where considered necessary, within the framework of a comprehensive heritage impact assessment.

Miminum standards for the palaeontological component of impact assessment reports are currently being developed by SAHRA. The latest version of the SAHRA guidelines is dated May 2007.

2 METHODOLOGY

The following methodology for palaeontological impact assessments has been applied during the preparation of this report:

Phase 1 – desktop study

Preparation of desktop study on fossil heritage of study area based on:

- review of all relevant palaeontological and geological literature, including geological maps, previous reports
- location and examination of fossil collections from study area (*e.g.* museums)
- data on proposed development provided by the developer (*e.g.* location of footprint, depth and volume of bedrock excavation envisaged)

Phase 2 – fieldwork

- detailed field examination of representative natural and artificial exposures of potentially fossil-bearing sediments (rock outcrops, quarries, roadcuts *etc*)
- recording of observed fossils and associated sedimentological features of palaeontological relevance (photos, maps, aerial or satellite images, gps co-ordinates, stratigraphic columns)
- judicious sampling of fossil material, where warranted

Phase 3 – curation & analysis

- curation of any fossil material collected in an approved respository (usually museum of geological survey collection)
- photography and provisional identification of fossils
- analysis of stratigraphy, age and depositional setting of fossil-bearing units

Phase 4 – final report & feedback

- illustrated, fully-referenced review of palaeontological heritage within study area based on desktop study and new data from fieldwork and analysis
- identification and ranking of highlights and sensitivities to development of fossil heritage within study area
- specific recommendations for further palaeontological mitigation (if any)
- recommendations and suggestions regarding fossil heritage management on site, including conservation measures as well as promotion of local fossil heritage (*e.g.* for public education, schools)

2.1 Data collection

Fieldwork at the principal Coega study sites was spread over three days in February / March 2010.

Assumptions and Limitations

Published geological maps of the study areas are used to determine which geological units (*e.g.* sedimentary formations) are represented both at the surface and below the surface within the study area. The preparation of these maps usually involves extensive extrapolation from limited areas of bedrock exposure (*e.g.* natural rocky outcrops, artificial road and railway cuttings, quarries and pits) since a high fraction of the outcrop area of any formation is generally obscured by surface deposits (*e.g.* soil, alluvium) and vegetation cover. For the purposes of palaeontological impact studies the maps are taken to be substantially correct. Later fieldwork, such as the examination of recent excavations during the impact study, may suggest necessary corrections to the geological maps, but these changes are generally small.

Most fossil heritage is buried below the surface of the ground and can only be sampled and assessed from occasional sites where bedrock is well exposed, as listed above. Extrapolation from the palaeontological record at these recorded sites is used to infer the nature and density of fossil remains that may well be exposed in the study area during development, mainly through new excavations in the construction phase. It is often assumed for practical purposes that the palaeontological heritage within a given formation is fairly evenly distributed within the entire outcrop area of the sedimentary unit, although experience shows that this is in fact often not the case. A more accurate picture of the variety and distribution of fossil heritage within the study area can only be obtained through monitoring of excavations during construction.

Note that some farms were not visited during the field assessment stage. Relevant data for these areas has been obtained from geological maps, previous impact reports and the scientific literature.

3 GEOLOGICAL AND PALAEONTOLOGICAL ENVIRONMENT

3.1 Geological background

The geology of the study region is outlined on the 1: 250 000 geological map 3324 Port Elizabeth (Council for Geoscience, Pretoria; Toerien & Hill 1989) (Figure 3-1). This has been improved and updated on the more recent 1: 50 000 sheet 3325DC & DD, 3425BA Port Elizabeth (Le Roux 2000; see also Engelbrecht *et al.* 1962) (Figures 3-5, 3-6, 3-7, 3-9, 3-11 and 3-14). Other relevant geological reports are those for the Coega IDZ compiled by Goedhart and Hattingh (1997) and Almond (2010).

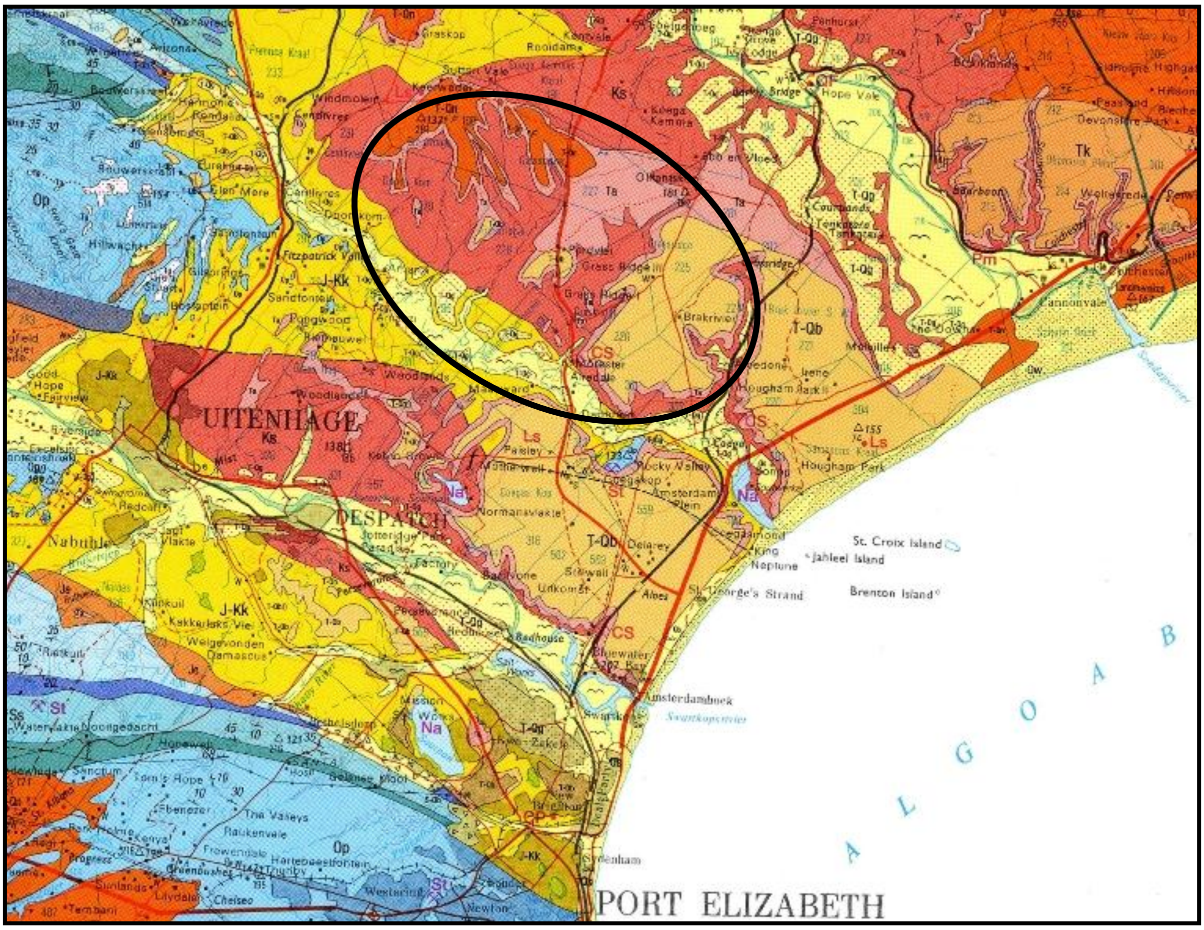

Figure 3-1: Extract from 1: 250 000 geological map 3324 Port Elizabeth (Council for Geoscience, Pretoria) showing approximate location of the Coega wind farm study area to the northeast of Uitenhage, Eastern Cape Province (black oval).

The proposed wind farm sites are all situated on a low-lying, stepped coastal plateau that is incised by the Coega River to the southwest and the Sundays River to the northeast (Figure 3-2). The seaward portion of this stepped surface is termed the Coega Plateau and the higher, landward portion is called the Grassridge Plateau (Goedhart & Hattingh 1997). The coastal plateau as a whole is largely built of fine-grained fluvial, estuarine and marine shelf sediments of the Early Cretaceous **Uitenhage Group** and is capped by a thin veneer (usually *c.* 10 or less) of lime-rich Neogene to Recent sediments of the **Algoa Group**. The flatter plateau areas are largely covered by scrubby vegetation with isolated thicket patches (Coega Bontveld) while the valley slopes as well as the slope break between the Grassridge and Coega Plateaux are clothed in dense Sundays Thicket (Mucina & Rutherford 2006). Bedrock exposure is mainly limited to the artificial excavations associated with roads, storm water drainage and sewage systems, active and abandoned quarries and electricity substations. However, steeper scarps along river valleys feature numerous small donga exposures into the softer Uitenhage Group sediments while the tougher "coastal limestone" Alexandria Formation forms a thin krans or cliff at the plateau edge.

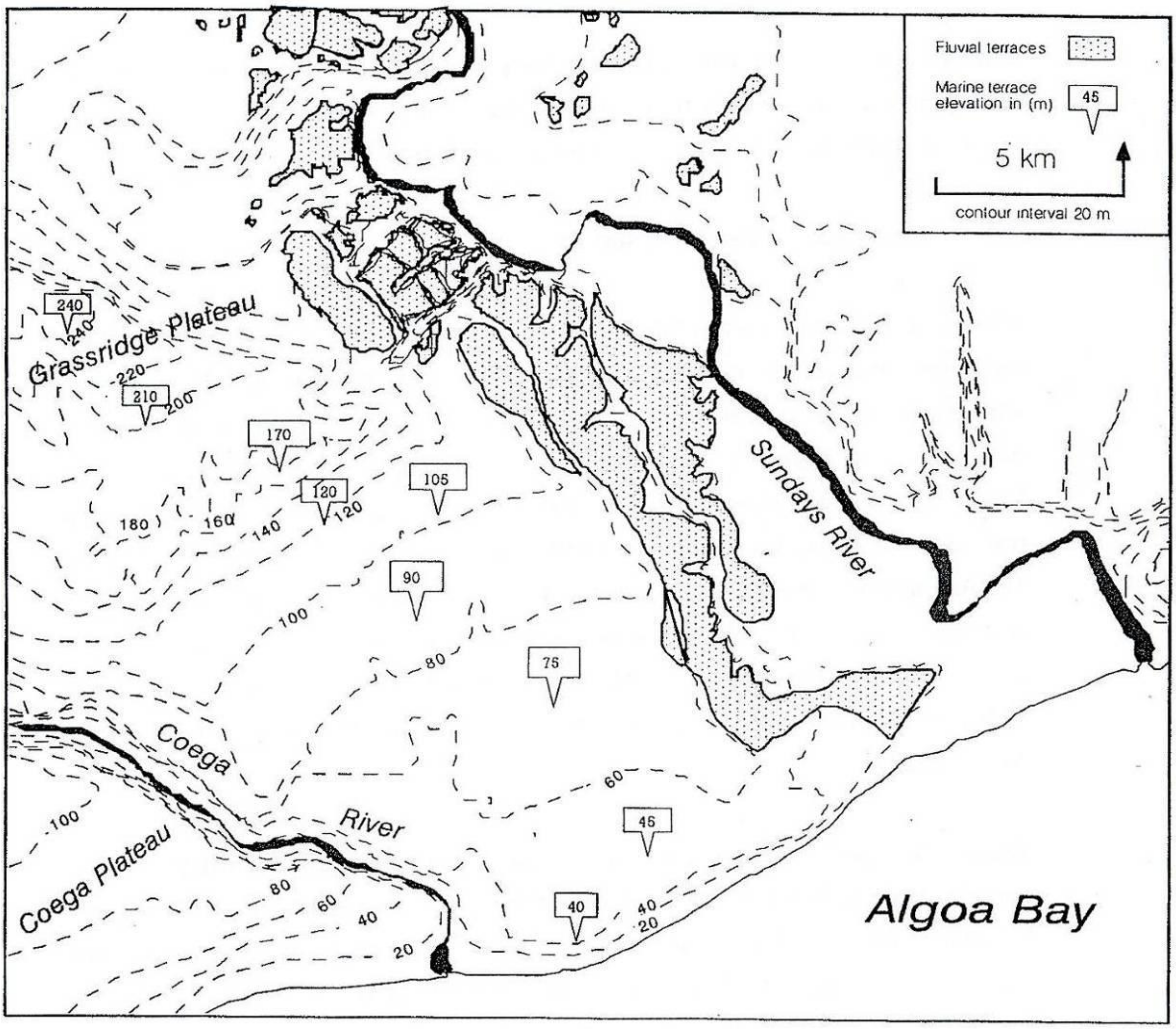

Figure 3-2: Contour map of the coastal area between the Coega and Sundays Rivers showing the high inland Grassridge Plateau and the lower coastal Coega Plateau separated by a steeper break in slope (From Goedhart & Hatting 1997).

In the study area the coastal plateau is largely built of fine-grained estuarine and marine shelf sediments of the Early Cretaceous **Sundays River Formation** (**Uitenhage Group**, **Ks**). These readily-weathered rocks are capped by a thin (10m or less), limestone-dominated shallow marine to coastal succession, the **Alexandria Formation** (**Algoa Group**, **Ta**) of Neogene (Late Tertiary) age. In some areas the Alexandria Formation is extensively blanketed in pebbly, reddish-brown residual soils. These were previously (1: 250 000 map, Figure 3-1) assigned to a separate **Bluewater Bay Formation** (**T-Qb**) but are now incorporated into the Alexandria Formation (1: 50 000 map). Relict patches of Pleistocene aeolianites (dune sands) of the **Nanaga Formation** (Algoa Group) are scattered across the interior coastal plateau. These sands are often rubified (reddened) through weathering of metal-rich impurities. Small outcrop areas of the Early Cretaceous **Kirkwood Formation** (**J-Kk**) as well as Quaternary to Recent **alluvium** (**T-Qk**) occur on the floor of the Coega River Valley. Since these rock units will not be directly impacted by the proposed wind farm development, they are not considered further here.

Sundays River Formation (Ks)

The Sundays River Formation is of Early Cretaceous (Valanginian-Hauterivian) age, *i.e*around 136 Ma (million years old). It comprises a thick (up to 2km) succession of thin-bedded grey sandstones, siltstones and finer-grained mudrocks that are often highly fossiliferous (Shone 2006). Depositional settings range from estuarine through littoral (shoreline) to marine outer shelf (McMillan 2003). These beds are differentiated from the older Kirkwood Formation of the Uitenhage group by (a) the absence of reddish-hued mudrocks, (b) the presence of prominent-weathering calcareous sandstones, and (c) the frequent occurrence of fossil marine shells. These last are commonly, but not invariably, associated with the thin, calcareous sandstone beds, many of which are tempestites (*i.e.* storm deposits). Key geological accounts of the Sundays River Formation include those by Du Toit (1954), Rigassi & Dixon (1972), Winter (1973), McLachlan & McMillan (1976), Tankard *et al.* (1982), Dingle *et al.,* (1983), McMillan (2003) and Shone (1976, 2006). For the study area the geological sheet explanations by Haughton (1928), Engelbrecht *et al.* (1962), Toerien and Hill (1989) and Le Roux (2000) are most relevant.

Alexandria Formation (Ta)

This estuarine to coastal marine formation consists of a basal conglomerate rich in oyster shells overlain by calcareous sandstones, shelly coquinas and thin conglomerates. It represents a composite product of several marine transgression (invasion) / regression (retreat) cycles across the Algoa coastal plain in Late Miocene-Pliocene times, *i.e.* roughly around 7-5 Ma ago (Maud & Botha 2000, Roberts *et al.* 2006). The Alexandria Formation overlies a series of marine terraces incised into older (mainly Cretaceous) rocks in the hinterland of the Algoa Basin - the lower seawards Coega Plateau and the higher, landwards Grassridge Plateau (Ruddock 1968, Goedhart and Hattingh (1997). The Alexandria Bay Formation ranges from three to 13m in thickness, with an average of 9 to 10m (Le Roux 1987b, Goedhart and Hattingh, 1997). It reaches its greatest thickness between the Swartkops and Sundays Rivers. Maud & Botha (2000) record a maximum thickness of 18m.

The "Bluewater Bay Formation" (T-Qb)

Geologically recent karstic (*i.e.* solution) weathering of the lime-rich Alexandria Formation has led to the development of pebbly, reddish-brown residual soils over much of the inland outcrop area of the Alexandria Formation (Maud & Botha 2000). This was formerly identified as a separate, bipartite *fluvial* unit of Plio-Pleistocene age with calcrete horizons that was named the Bluewater Bay Formation (Le Roux 1987c, 1989). This unit is mapped as such (T-Qb) on the 1: 250 000 Port Elizabeth geology sheet but not on the later 1:50 000 scale geological maps where it is indicated as pedogenic gravels overlying the Alexandria Formation (circular symbols). Incised "channels" cutting into the Alexandria Formation and infilled with cross-bedded coarse "Bluewater Bay" gravels are illustrated by Le Roux (1989). Maud and Botha (2000) suggest that these surface deposits comprise a composite of *in situ* karstic weathering products (including coarse solution-hollow infills) as well as fluvial sediments of late Neogene age. Goedhart and Hattingh (1997) have developed an explanatory scheme showing how residual pebbly and sandy weathering products of the Alexandria Formation infill solution cavities within the calcretised limestones following periods of humid climate leaching. The superficial "Bluewater Bay" deposits average 1.2m in thickness, but this varies greatly due to the presence of numerous incised channel-fill and solution pipe structures up to 7m deep (Le Roux 1987c, 1989, 2000).

The most prominent and widely occurring solution structures in the Alexandria Formation outcrop area are *dolines*. They stand out clearly on aerial and satellite images as rounded or oval grassy patches within darker zones of thicket. These shallow but large depressions are caused by karstic solution of the underlying limestone and may reach diameters of 100m or more. Centripetal drainage causes the build-up of fine-grained sediment and pebbles within the doline. The surface depression often develops into a pan where rainwater may accumulate unless the doline is drained by a subsurface outlet (*i.e.* swallow hole). The distribution of dolines in the Coega area has been mapped in detail by Goedhart and Hattingh (1997) who note that they generally occur in well-defined NE-SW zones that correspond to furrows between fossil beach ridges developed in the underlying shallow marine Alexandria Formation.

Nanaga Formation (T-Qn)

Coastal aeolianites (ancient, wind-blown dune sands) of the Nanaga Formation of Pliocene to Early Pleistocene age crop out extensively to the west and east of Port Elizabeth (Le Roux 1992). They have recently been mapped along the coast of the Coega region (not shown in earlier 1: 250 000 maps, Figure 3-1). The Nanaga beds comprise calcareous sandstones and sandy limestones that often display large scale aeolian cross-bedding - well seen, for example, in deep N2 roadcuts between Colchester and Grahamstown. They may reach thicknesses of 150m or more (Maud & Botha 2000). The Nanaga aeolianites are normally partially to well-consolidated, although unconsolidated sands also occur west of Port Elizabeth (Le Roux 2000). The upper surface of the aeolianites weathers to calcrete and red, clay-rich soil, and the dune sands themselves may be profoundly reddened. The age of the palaeodunes decreases towards the modern coastline, reflecting marine regression (relative sea level fall) during the period of deposition. The oldest outcrops located furthest from the modern coast are the most elevated, having experienced some 30m of uplift in the Pliocene, and may even be Miocene in age (Roberts *et al.*, 2006). Typically the ancient dunes are preserved as undulating ridges of rounded hills trending parallel to the modern shoreline (Le Roux 1992).

3.2 Outline of recorded palaeontological heritage

The known palaeontological heritage within each of the three main geological units represented in all three of the study areas is outlined here. This information is largely abstracted from the recent unpublished report by Almond (2010). As mentioned earlier, rock units such as the Kirkwood Formation and Coega River alluvium are not considered here since they will not be directly impacted by the proposed development.

Palaeontological record of the Sundays River Formation

In palaeontological terms the Sundays River Formation contains one of the most prolific and scientifically important marine biotas of Mesozoic age in southern Africa. Fossils have been recorded from the Sundays River beds in the Algoa Basin since the early nineteenth century (1837). Cooper (1981) provides a good review of the earlier literature. Important collections were made, for example, by the famous Eastern Cape geologists W.G. Atherstone and A.G. Bain (see Sharpe 1856) and there has been a long history of palaeontological publications dealing with the Sundays River fauna since then. Among the key papers are those by Sharpe (1856), Kitchin (1908), Spath (1930), Du Toit (1954), Engelbrecht *et al*. (1962), Haughton (1969), McLachlan & McMillan (1976, 1979), Klinger & Kennedy (1979), Cooper (1981, 1991), Dingle *et al*. (1983), McMillan (2003) and Shone (1986, 2006). An accessible, well-illustrated account of Sundays River fossils has recently been given by MacRae (1999). The ammonites and microfossils are of particular biostratigraphic (rock dating) importance, while the foraminiferans (a group of protozoans) are useful for palaeoenvironmental analysis (See extensive discussion in McMillan 2003).

The main invertebrate macrofossils recorded from the Sundays River Formation are a rich variety of molluscs. These include several cephalopod subgroups - mainly ammonites, *plus* much rarer nautiloids and belemnites. The cephalopod fauna has been revised recently by Cooper (1981, 1983) and is dominated by a series (14 spp.) of strongly ribbed, coiled ammonites of the Genus *Olcostephanus* (Plate 3-1), also well known from Early Cretaceous marine faunas elsewhere in the world. Interestingly, clear examples of well-developed sexual dimorphism (male and female shells of different size and form) are shown in this genus. Much rarer partially coiled ammonites (*Distoloceras*) and straight-shelled, obliquely ribbed forms (*Bochianites*) also occur.

The Sundays River molluscs include a number of mainly small-bodied gastropods (*c*. 6 genera, including limpets), and over forty genera of bivalves (mussels, clams *etc*). In terms of abundance as well as biodiversity the bivalve molluscs are also the dominant group. The commonest form is the thick-shelled "Devil"s toenail" oyster *Aetostreon* (previously known as *Exogyra* or *Gryphaea*) which is often preserved in dense *coquinas* (shell beds) at the base of storm sandstones (Plate 3-2). Some of the other bivalves, such as the strongly–ribbed or knobbed trigoniids (eleven species in seven genera, recently revised by Cooper, 1979, 1991) and the elongate-shelled *Gervillella* – all shallow infaunal forms - are also quite substantial (20-30cm long or more) with robust shells (Plate 3-27). Encrusting oysters cemented onto shells, rocks or hardgrounds are common. Dense storm-transported accumulations of scaphopod molluscs (tusk shells) have been discovered during the present field scoping study in the Sundays River Formation (Plate 3-19). Most of these South African fossils are badly in need of taxonomic and palaeobiological revision along the lines of recent work on similar-aged South America molluscs by Lazo (2007 and earlier papers).

Plate3-1: Well-preserved specimen of the ammonite Olcostephanus from the Sundays River Formation (Albany Museum, Grahamstown). This is a macroconch (female) and c. 25cm across.

Plate 3-2: Well-preserved specimen ("Devil's toenail") of the common free-living oyster Aetostreon from the Sundays River Formation, main brick pit at Coega.

More minor invertebrates – including stenohaline as well as euryhaline taxa - from the Sundays River Formation are solitary and branching colonial corals, tube-dwelling serpulid polychaetes, bryozoans, echinoderms (usually fragmentary crinoids or sea lilies, ophiuroids or brittle stars, sea cucumbers, regular echinoids) and shrimp-like crustaceans. However, more intensive collecting from these beds is likely to reveal further invertebrate taxa. This is suggested by the recent discovery of two new crustaceans (including several specimens of strongly tuberculate crabs) within Sundays River concretions (Dr Billy de Klerk, pers. comm., 2010), the scaphopods or tusk shells mentioned earlier, and recent new records of beetle remains south of Addo (Mostovski & Muller 2010). Sundays River trace fossils are poorly studied, but are locally abundant. They range from dense banks of cylindrical intrasediment burrows to a range of borings into wood, shells and hardgrounds (*i.e.* cemented substrata on the sea floor including, for example, exhumed early diagenetic concretions). A spectrum of microfossils from this stratigraphic unit include foraminiferans, ostracods, dinoflagellates and land-derived pollens and spores (Dingle *et al*., 1983, McMillan 2003). Among the rarer microfossil groups recorded are radiolarians, shrimps, and fragments of echinoderms (ossicles of crinoids, ophiuroids, holothurians and echinoids).

The Sundays River beds contain sparse, often unidentifiable plant fossils such as fragments of driftwood (sometimes insect- or perhaps mollusc-bored), leaf and twig debris, amber (fossil resin), lignite, charcoal and the reproductive structures of charophyte algae (stoneworts). Fossil vertebrates from the Sundays River Formation are very rare indeed. The best-known example is the partial skeleton of a 3m-long plesiosaur (an extinct group of large marine reptiles), *Leptocleidus capensis* (Plate 3-3). This comes from the famous, but poorly-localized, site of Picnic Bush on the Swartkops River near Port Elizabeth (Andrews 1910; see MacRae 1999 for good illustrations). Isolated dinosaur bones and teeth have also been mentioned, though several earlier records probably stem from the older Kirkwood Formation.

Plate 3-3: Artist's reconstruction of a Cretaceous plesiosaur hunting ammonites.

Despite the long history of palaeontological work on Sundays River fossils, there has been little systematic collection of fossils – especially macrofossils - from these beds in recent decades and most taxa remain poorly studied (*e.g.*most invertebrate groups, apart from the ammonites, trigoniid bivalves and foraminiferans). The valleys of the Swartkops River and Coega River been sampled extensively by palaeontological groups over the years for micro- and macrofossil remains. Invertebrate fossil groups recorded close to the study area by McLachlan and McMillan (1976) and Cooper (1981) include ammonites, bivalves and gastropods. Much further research remains to be done here, however, and a lot of palaeontologically valuable material is undoubtedly being destroyed in the currently active brick pits in the region.

Palaeontological record of the Alexandria Formation

The Alexandria Formation limestones as a whole are highly fossiliferous. However, good exposures in the interior are usually limited by cover of younger sediments of the Algoa Group (*e.g.* Nanaga Formation aeolianites), weathered surface material of the "Bluewater Bay" facies, extensive development of surface calcretes and thicket vegetation. A wide range of shelly marine fossils are recorded from the Alexandria Formation (Newton 1913, Du Toit 1954, Barnard 1962, Engelbrecht *et al*. 1962, King 1973, Dingle *et al*., 1983, Le Roux 1987a, 1987b, 1990b, 1993, McMillan 1990). These are mainly molluscs (bivalves, gastropods, scaphopods), but also include serpulid worm tubes, sea urchins (the "sea pansy" *Echinodiscus*), solitary and colonial corals, bryozoans, brachiopods, barnacles and crab claws and benthic foraminifera. Sharks" teeth and rare fish vertebrae are also known. Robert Gess (undated heritage report for Coega development) mentions mammal bones found in this unit but this may be a reference to the later, Pleistocene fauna briefly described by W. H. Gess (1951/1952) from Aloes. Diverse trace fossil assemblages (*e.g.* pellet-walled burrows of *Ophiomorpha*, bivalve borings *Gastrochaeonolites*, and a wide range of shell borings) occur in the Alexandria sediments but have not yet been described in detail in the palaeontological literature (W.J. De Klerk *et al*., work in progress).

Palaeontological record of the "Bluewater Bay Formation"

The "Bluewater Bay" residual soils are largely unfossiliferous, although they may be expected to contain occasional robust marine shells weathered-out from the underlying Alexandria Formation bedrock with an admixture of younger terrestrial snail shells. Le Roux (1989) records sparse freshwater mussels as well as land snails from these sediments. Doline infill sediments might likewise contain the bones and teeth of mammals and other animals attracted to intermittently wet, grassy microhabitats, but these have not yet been observed.

Palaeontological record of the Nanaga Formation

The sparse palaeontological record of the Pliocene to Early Pleistocene Nanaga Formation is summarised by Le Roux (1992) and Almond (2010). The fossil biota consists of fragmentary marine shells, foraminifera (shelled protozoans *cf* McMillan 1990), and a small range of terrestrial snails (*e.g. Achatina, Tropidophora, Trigonephrus, Natalina*). Dense arrays of calcretised rhizoliths (root casts) commonly occur in these and contemporary Plio-Pleistocene aeolianites along the southern and southwestern coast (Roberts *et al*., 2009, Almond 2010). A wider range of terrestrial fossils might be found here in future, albeit only rarely due to extensive post-depositional diagenesis (*e.g.* solution and re-preciptation of carbonate by groundwater). They might include mammal remains from hyaena lairs, such as are recorded from contemporary Langebaan Formation aeolianites in the SW Cape (Roberts *et al*., 2006 and refs therein).

3.3 Observations from desktop and field scoping studies

Please note that GPS data for the localities mentioned in the text below are provided in Appendix 1. All GPS readings were taken using a hand-held Garmin GPSmap 60CSx instrument. The datum used is WGS 84.

3.3.1 PPC development area on Grassridge Plateau (Farms Grassridge 190, 227, 228 and Olifants Kop 190)

Four adjacent farms on the elevated Grassridge Plateau spanning the R335 between Coega and Addo are concerned in this windfarm project: Grassridge 190, 227, 228 and Oliphants Kop 201 (Figure 3-3). These farms share a broadly similar geology and palaeontology. Detailed field observations made on farm Grassridge 190 are extrapolated here to adjacent areas on the Grassridge Plateau.

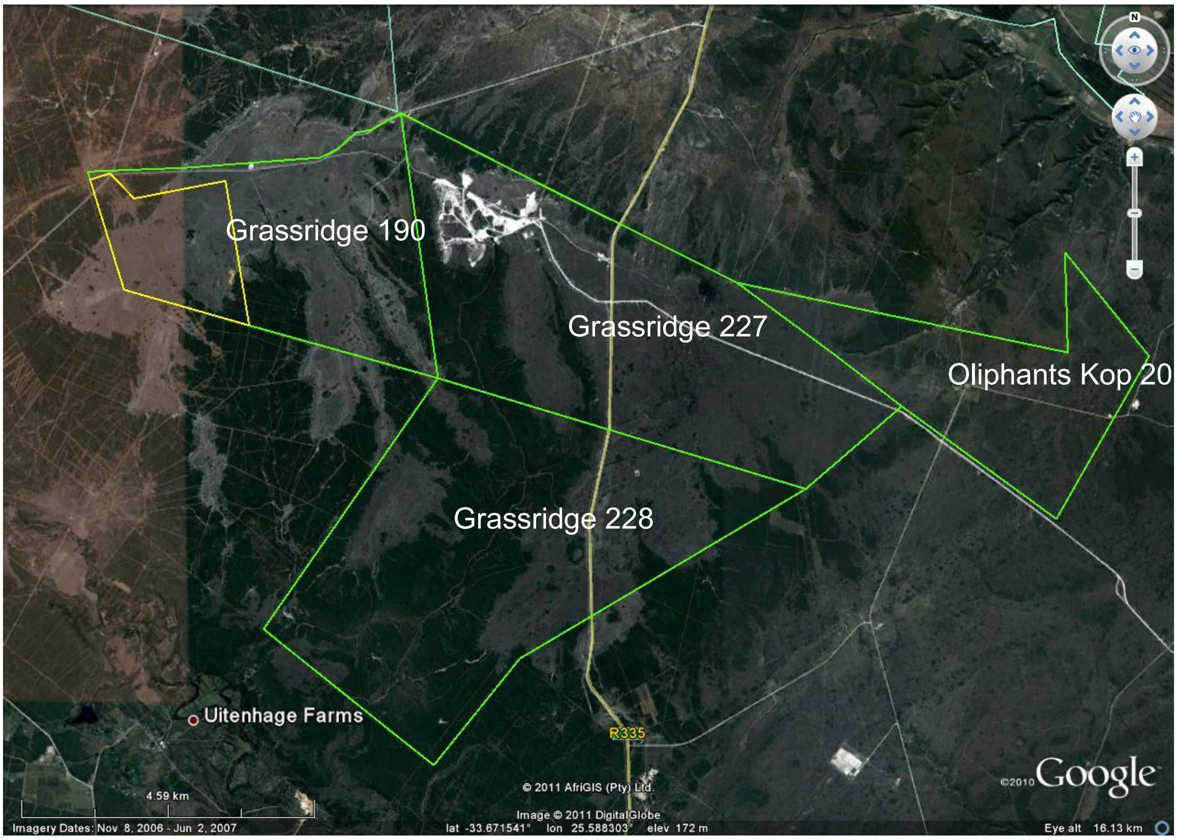

Figure 3-3: Google satellite image of the Innowind study sites in the Grassridge Plateau region. Portions of four adjacent farms spanning the R335 from Coega to Addo are concerned here (Figure provided by CES, Grahamstown).

Grassridge 190

The PPC West wind farm site is situated on Farm Grassridge 190 some 10 km northeast of Uitenhage (Figures 1-1 and 3-4). Here a dissected plateau of Algoa Group sediments at 230 to 290m amsl forms part of the Grassridge Plateau of Goedhart and Hattingh (1997). The plateau is underlain by limestones of the Alexandria Formation that are extensively mantled away from the plateau edge by Pleistocene aeolianites of the Nanaga Formation (Figure 3-5). Fine-grained marine sediments of the Sundays River Formation form the gentle slopes and valleys surrounding and incising the Grassridge Plateau but these readily-weathering rocks are very rarely exposed due to a cover of superficial drift deposits and dense mesic thicket vegetation.

The best exposures of the **Sundays River Formation** in this area observed are at Loc. 124 along the northern escarpment. Here greenish-brown, weathered Cretaceous mudrocks with beds and loose blocks of darker, more prominent-weathering calcareous sandstone are seen (Plate 3-4). Several blocks contain shelly fossil remains, principally robust trigoniid bivalves together with abundant shell fragments, and were probably deposited as *tempestites* (storm event beds) (Plate3-5). Cross-sections of some beds show multiple thin shelly coquinas, suggesting a composite origin. Secondary mineralization of the more porous sandstones by iron and manganese minerals is probably responsible for their darker hues. The contact between the Sundays River Formation and the overlying Algoa Group is generally obscured by limestone talus and surface wash. An artifical stormwater trench close to the offices at the PPC limestone works has cut down through the Alexandria limestones into the underlying Sundays River mudrocks. No Cretaceous fossils were seen here, however.

The **Alexandria Formation** is exposed in cliffs of four meters height or more around the plateau edge as well as in several deep and extensive excavations in the northern part of the property where the limestone is being exploited by PPC. Typical basal conglomerates of this formation containing well-rounded pebbles and cobbles of Table Mountain quartzite are seen at Loc. 116 south of the farmstead (Plate 3-10). The quartzite clasts weather out to form a pebbly surface veneer ("Blue Water Bay Formation"). Freshly quarried faces show a range of limestone lithologies. These include occasional floating blocks and boulders of greyish Sundays River mudrocks and sandstones as well as breccio-congomerates of reworked, ochreous-coloured calcrete clasts that indicate a polycyclic origin for the Alexandria beds.

Natural cliff exposures (Plate 3-6) as well as quarry and trench faces (Plates 3-8 and 3-9) show that the limestones have been extensively calcretized, with leaching and re-precipitation of calcium carbonate. In most cases this resulted in massive, amorphous "chalky" white limestones with occasional harder bands of dense pinkish-buff limestone and has obliterated the original shelly and trace fossils. Casts of broken shelly material (coquinites) and isolated, robust oyster shells are preserved locally, however (Plate 3-7). Dumps of quarried limestone at the PPC limestone works were examined for fossils without success. In the north-eastern escarpment zone (Loc. 123) a road cutting exposes greyish-green sandy sediment containing impersistent, lenticular conglomeratic lenticles overlain by pale limestones (Plate 3-13). The stratigraphic position of these beds is unclear – they may lie within the lower Alexandria Formation and represent colluvial (reworked slope) deposits.

Reddish-orange weathered aeolianites of the **Nanaga Formation** typically form undulating, often grassy landscapes with red-hued termitaria over the interior coastal plain (Le Roux 2000). The fine Nanaga dune sands can be seen directly overlying the karstified (solution-corroded) upper surface of the Alexandria limestones in the area of at Loc. 117 (Plates 3-11 and 3-12). The irregular *palaeokarst* surface here has been "case hardened" with calcrete and is hollowed by irregular channels and pits infilled with younger wind-blown Nanaga sediments as well as occasional thin breccias of rubbly reworked calcrete with occasional quartzite pebbles. The Nanaga sands have been extensively weathered (decalcified, rubified) and do not contain obvious land snails or trace fossils here. Karst hollows (*e.g.* small caves and overhangs within cliffs) may have been occupied by predators such as hyaenas in the distant past, so there is the possibility of rich mammalian bone accumulations being preserved here, as seen at Swartklip along the False Bay coast.

Figure 3-4: Google satellite image of PPC West site on farm Grassridge 190. The irregular pale area is a dissected limestone plateau. The dark area is mesic thicket overlying the Sundays River Formation. Note extensive limestone quarrying operations by PPC (white) (Figure provided by CES, Grahamstown).

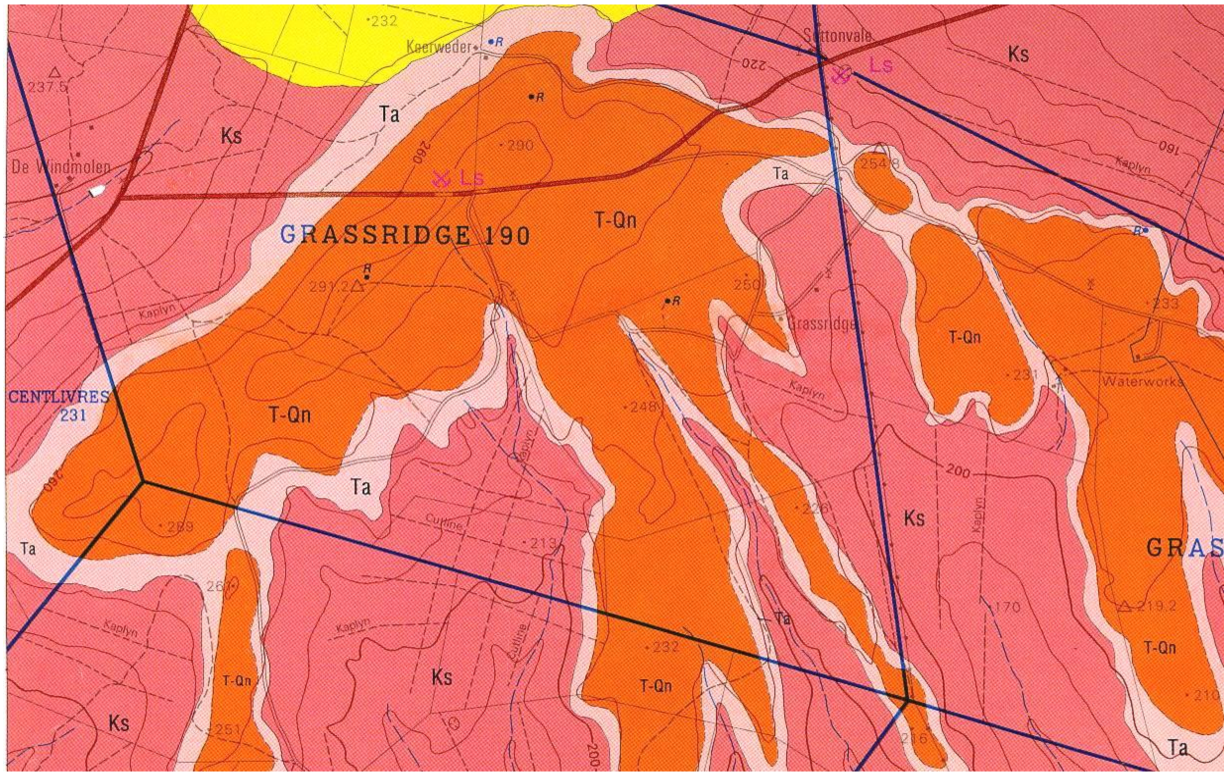

Figure 3-5: Extract from 1: 50 000 geological map 3325DA Addo (Council for Geoscience, Pretoria) showing farm Grassridge 190 (PPC West study area). Ks = Sundays River Formation Ta = Alexandria Formation T-Qn = Nanaga Formation

Plate 3-4: Weathered Sundays River Formation mudrocks and sandstones along northeastern escarpment on Grassridge 190 (Loc. 124). Note dark blocks of calcareous sandstone which are highly fossiliferous.

Plate 3-5: Detail of calcareous sandstone block from locality illustrated above, showing abundant shelly remains – mainly bivalves such as *trigoniids* here (Scale = 15 cm).

Plate 3-6: Cliff of calcretized, cavernous-weathering lower Alexandria Formation conglomeratic limestone along northern escarpment, Grassridge 190 (Loc 120) (Hammer = 30cm).

Plate 3-7: Detail of sparsely pebbly, decalcified bench of Alexandria Formation limestone along northeastern escarpment. Numerous cavities within limestone are moulds of fossil shells and shelly debris (Loc. 124) (Hammer = 30cm).

Plate 3-8: Deep trench into extensively calcretized Alexandria Formation limestones close to northeastern escarpment (Loc. 121). These weathered and altered limestones are largely unfossiliferous.

Plate 3-9: Detail of calcretized Alexandria limestones showing ferruginous reworked intraclasts (brown) and harder layers of fine-grained secondary limestone (pinkish). Field of view is *c.* 40 cm across.

Plate 3-10: Upper surface of Alexandria Formation in southern part of Grassridge 190 (Loc. 116) showing incipient development of pebbly residual deposits of the Bluewater Bay facies derived from weathering of the conglomeratic lower part of the Alexandria Formation.

Plate 3-11: Orange-hued Plio-Pleistocene aeolianites of the Nanaga Formation overlying irregular, karstified surface of the Alexandria Formation, southern part of Grassridge 190 (Loc. 117).

Plate 3-12: Nanaga Formation aeolian sandstones overlying karstified Alexandria Formation limestones, Grassridge 190 (Loc. 117).

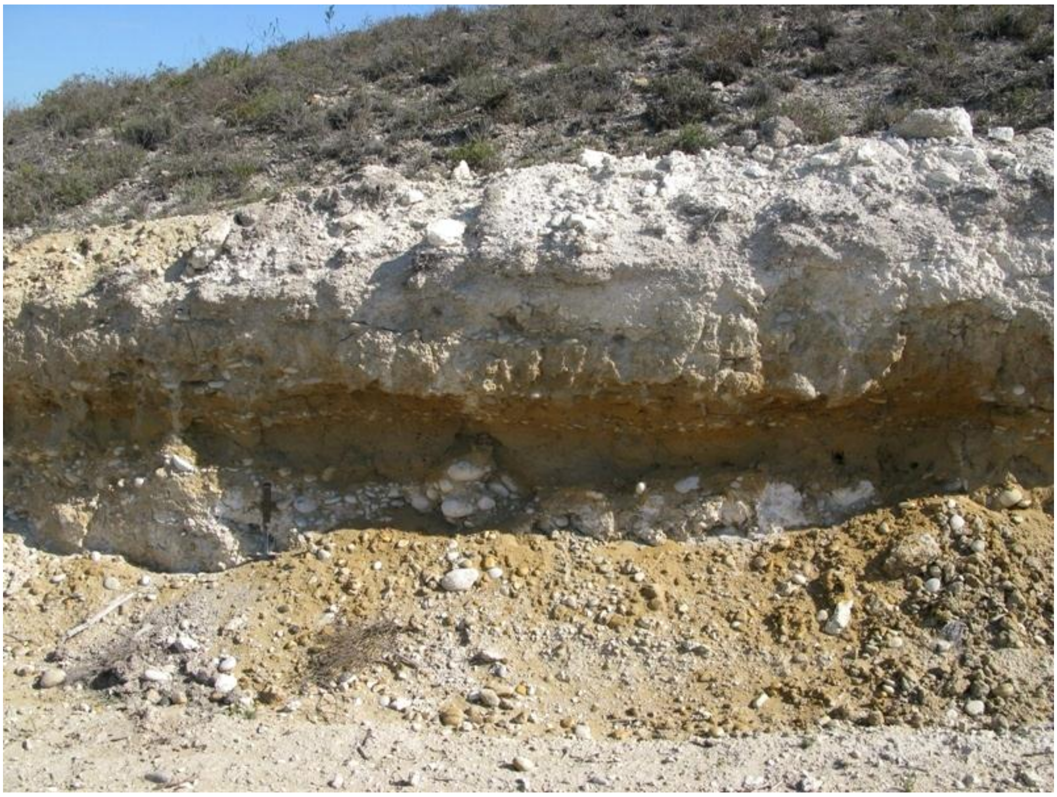

Plate 3-13: Roadcutting along northeastern escarpment on Grassridge 190 showing greenish-grey sandy sediments with pebbly lenticles overlain by pale limestone. These sediments may all belong to the Alexandria Formation or younger colluvial deposits (Loc. 123).

Grassridge 228

Farm Grassridge 228 is situated to the southeast of Grassridge 190, on the northeastern side of the Coega River valley (Figure 3-3). Wind turbines here are to be situated on deeply dissected upland plateau areas above *c*. 180m amsl in the northwestern and eastern parts of the farm (Figure 1-2). These areas are underlain by Alexandria Formation limestones and associated weathering products ("Bluewater Bay Formation") that are locally capped by Miocene / Pliocene to Early Pleistocene aeolianites of the Nanaga Formation (Figure 3-6). The intervening valley slopes are underlain by recessive-weathering Cretaceous Sundays River beds, but judging from satellite images bedrock exposure here is very limited indeed. Small outcrop areas of the Early Cretaceous fluvial sediments of the slightly older Kirkwood Formation occur along the western edge of the farm; here these beds are largely blanketed by Quaternary to Recent alluvium on the floor of the Coega River Valley.

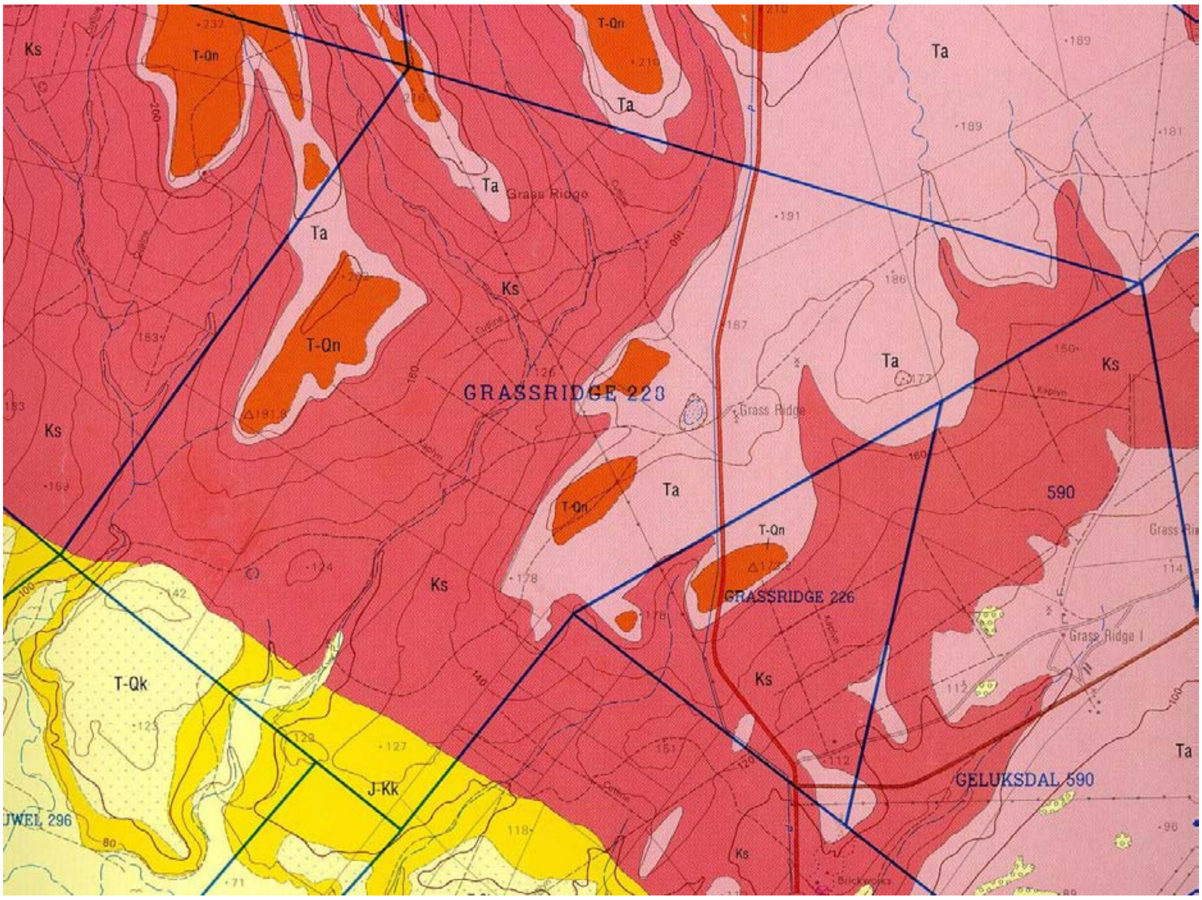

Figure 3-6: Extract from 1: 50 000 geological map 3325DA Addo (Council for Geoscience, Pretoria) showing the geology of the Innowind study area on Grassridge 228. J-Kk = Kirkwood Formation Ks = Sundays River Formation Ta = Alexandria Formation T-Qn = Nanaga Formation Pale yellow areas = Quaternary to recent alluvium

Grassridge 227

Farm Grassridge 227, situated on both sides of the R335, features an extensive, marginally dissected portion of the Grassridge Plateau spanning elevations of 180 to 250m amsl. (Figure 3-3). Proposed wind turbine positions in the eastern half of the property, east of the R335, are underlain by Alexandria Formation limestones and their weathering products while those in the west mostly overlie a veneer of Nanaga Formation aeolianites (Figures 1-2, 3-7).

Olifants Kop 201

The small number of turbine positions within the tapering western tip of farm Olifants Kop 201 are emplaced on Alexandria Formation limestones at 180-190m amsl. (Figures 1-2, 3-3, 3-7). These are generally of low palaeontological sensitivity, as discussed below.

Wind turbine construction on the elevated plateau areas on farms Grassridge 227, 228 and Olifants Kop 201 will largely impact the Late Caenozoic Alexandria and Nanaga Formations. Both these stratigraphic units are both generally of low palaeontological sensitivity and to the author‟s knowledge there are no published records of fossils from these farms. However, local concentrations of marine shells may occur within the former - notably banks of thick-shelled oysters that are recorded from the basal Alexandria Formation of the Grassridge Plateau area by Le Roux 2000 - while terrestrial snails and impressive megarhizoliths (fossilized plant root casts) are recorded from the Nanaga Formation closer to the modern coastline (Almond 2010). The palaeontologically sensitive Sundays River and Kirkwood Formation beds on the Grassridge Plateau farms are unlikely to be directly affected by the proposed windfarm development. No specialist palaeontological mitigation is therefore recommended for the Grassridge 227, 228 and Olifants kop study areas as far as the Innowind windfarm development is concerned.

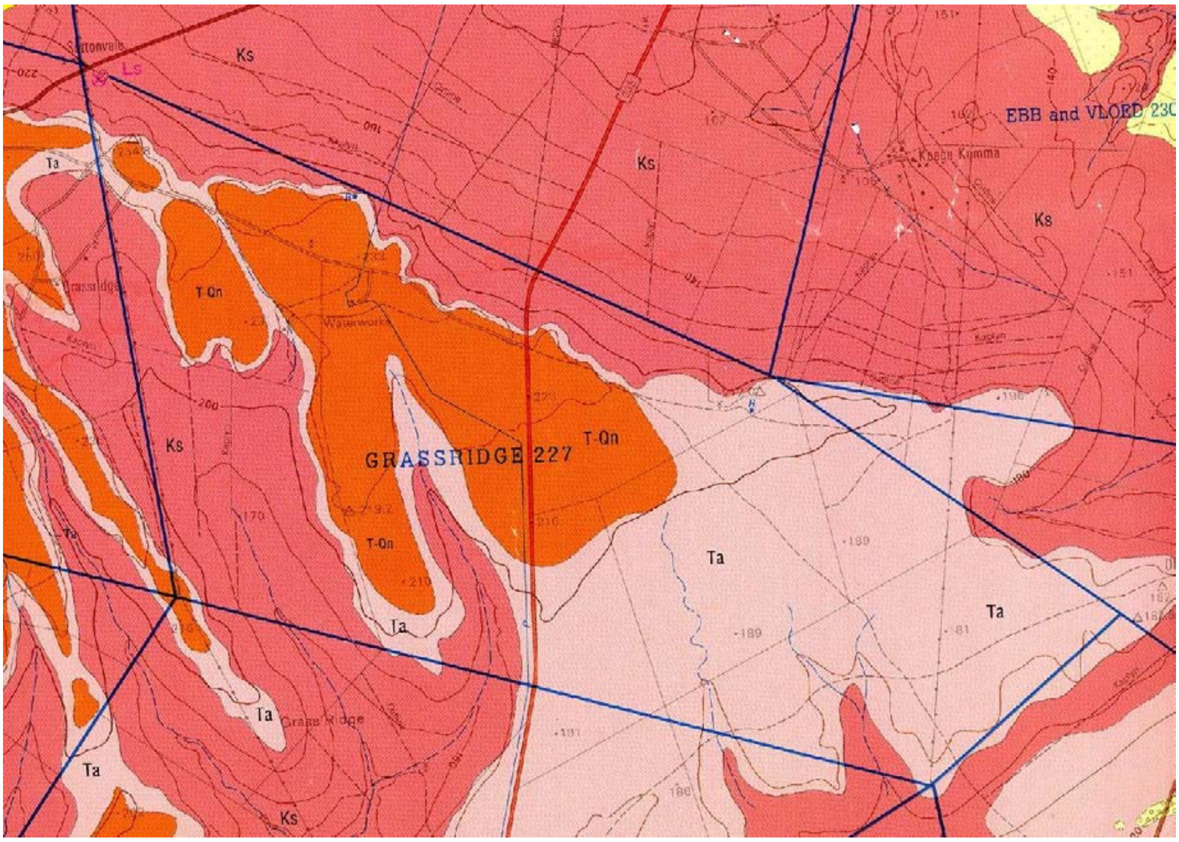

Figure 3-7: Extract from 1: 50 000 geological map 3325DA Addo (Council for Geoscience, Pretoria) showing the geology of the Innowind study areas on Grassridge 227 and the tapering western tip of Oliphants Kop 201. Ks = Sundays River Formation Ta = Alexandria Formation T-Qn = Nanaga Formation

3.3.2 Coega IDZ Zone 14 (Farms Bontrug 310, Brak River SW 224 and Swarte Koppen 302)

The southernmost wind turbines for the Innowind wind farm near Coega are to be located on a cluster of three farms situated within the borders of the Coega IDZ - Bontrug 301, Brak River SW 224 and Swarte Koppen 302 (Figures 1-1, 1-2). These farms mainly lie within IDZ Zone 14 (but also in parts of Zones 12 and 13) and include some private (Offit) land as well. The palaeontological heritage of the Coega IDZ as a whole has been reviewed by Almond (2010) and much of the data presented here has been abstracted from that study during which known or potential fossil sites on all three farms were visited.

Bontrug 301

The Bontrug 301 wind farm site is situated within Zone 14 of the Coega Industrial Development Zone close to the Grassridge Substation. The study area lies on the eastern side of the Coega Valley on the low-lying Coega Plateau (Figure 1-1 and 3-8). Shallow marine limestones of the Alexandria Formation, with occasional patches of Bluewater Bay pebbly residual soils, underlie most of the farm (Figure 3-9).

Several dongas incising the southwestern escarpment, facing the Coega River, expose softer-weathering sediments of the Sundays River Formation capped by a thin *krans* of Alexandria limestone. In the southernmost portion of the farm lies the inferred contact between the Kirkwood and Sundays River Formations, but this area will not be affected by the proposed windfarm development and is not considered further here.

Bedrock outcrop within the study area is very limited; most of the limestone plateau area is covered with Coega Bontveld while dense mesic thicket overlies Uitenhage Group mudrocks on the escarpment slopes. A brief (10pp, illustrations excised) palaeontological impact assessment for the Grassridge Substation is available on the Eskom Website (author unknown).

Figure 3-8: Google satellite image of Coega IDZ Zone 14 on Farm Bontrug 310. Pale areas on the left are brick pits excavated into Sundays River Formation on the eastern flanks of the Coega Valley. Dongas with important Early Cretaceous fossils are outlined by the white dotted circle (Figure provided by CES, Grahamstown).

Greyish-green weathered mudrocks with occasional thin, often ochreous (ferruginised) or blackened, calcareous sandstones of the **Sundays River Formation** are exposed in the walls of several elongate dongas (and possible small abandoned quarries) along the southwestern escarpment (Figure 3-8 and Plate 3-15).

Calcareous sandstones and pale, dense early diagenetic concretions at Loc. 104 are encrusted with small, flattish oysters that are typically much smaller than the Neogene oyster shells of the overlying Alexandria Formation (Plate 3-16). The sandstones often display well-developed wavy lamination and lenticular bedding with possible hummocky cross-stratification suggesting a tempestite (storm) origin.

Thin (3-5 cm) dark calcareous sandstones cropping out on either side of the narrow donga at Locs. 105, 106 and 132 display dense concentrations of small, usually intact bivalves (mainly nuculids but also small oysters *plus* other unidentified forms) as well as rare gastropods on their flat bedding planes (Plates 3-17 and 3-18). These bivalves have probably been concentrated by storm currents and may represent winnowed-out, re-exhumed (*i.e.* already dead-and-buried) shells in many cases. Others may reflect events of mass mortality of mollusc communities on the sea bed, perhaps due to episodes of bottom anoxia (catastrophic oxygen depletion). Several thin, shell-rich layers may be present within a single sandstone block. While intact molluscs predominate at some levels, other bedding planes show an abundance of finely comminuted shell hash. The dark colour of the sandstones is probably due to reduced iron and managanese minerals. Diagenetic calcareous nodules within the sandstones also contain well-preserved bivalves.

A 20cm-thick lenticular, fining-upwards, ripple laminated calcareous sandstone at Loc. 108 contains at its base a unique concentration of curved, tapering shells of scaphopod molluscs ("tusk shells") (Plate 3-19). This curious invertebrate group has not been previously recorded from the Sundays River Formation. The fossil tusk shells are associated with bivalve shell debris and show a degree of preferential orientation that was probably current-generated.

Thicker, blackened calcareous sandstones with wavy laminatation and lenticular concretions are exposed in a donga at Loc.107. "Devil"s toenail" type free-living oysters (*Aetostreon*; Almond 2010), normally the commonest shelly fossils associated with Sundays River Formation sandstones, are notably absent here. A few meters lower in the succession (Loc. 133) is a peculiar, 30 cm-thick bed of breccio-conglomerate containing intraclasts of mudrock, possible fossil wood fragments as well as locally abundant fragments of branching corals (otherwise a fairly rare group within Sundays River Formation) (Plates 3-20 to 3-22). The bed must be the result of an unusually energetic erosive event (probably a major storm or tsunami) that ripped up lumps of already consolidated mud from the sea bed, disrupted reef patches of delicate branching corals and deposited the entrained debris as a dense slurry on the sea floor.

The **Alexandria Formation** on Bontrug 310 is poorly exposed over most of the plateau. Extensive surface calcretization is evident in shallow roadcuts. Vertical sections through the Alexandria limestone capping are well seen along the southwestern escarpment where this varies from a couple of meters to 6m of more thick. The Alexandria / Sundays River contact is often obscured by scree, limy sheet wash or even downslope collapse of limestone blocks.

At Loc. 105 the dense vuggy limestone shows abundant cavities representing the moulds of intact or broken shells (especially oysters, *Glycimeris*, with rarer gastropods) that have been dissolved away during diagenesis. Relict bedding within the limestone succession is picked out by pebbly lenticles. The uppermost limestones are chalky and secondarily calcretized, lacking any obvious fossils. Elsewhere (Loc. 124) typical pebbly Alexandria Formation conglomerates are notable for the density of well-preserved oyster shells (Plate 3-24). Basal conglomerates consisting largely of oyster shells have been previously noted on the Grassridge Plateau by Le Roux (2000). Scree deposits below the limestone *krans* contain abundant disarticulated oyster shells (Plate 3-25).

Reddish-brown sandy soils and termitaria as well as subdued, undulating surface topography in some areas indicate relict patches of **Nanaga Formation** Pleistocene aeolianites (These are not indicated on the 1: 50 000 map, however). **Bluewater Bay** pebbly residual soils are developed locally on top of the Alexandria surface limestones, (*e.g.* Loc. 129. *N.B.* Small areas of these residual deposits are mapped on the 1: 50 000 geology sheet but in many cases the patches shown appear to coincide rather with thicket vegetation rather than well-developed residual soils). Elsewhere on the limestone plateau the soils and termitaria overlying Alexandria calcretes are greyish-brown. Reddish Nanaga-like soils are seen overlying pebbly Bluewater Bay residual deposits and Sundays River sediments exposed in the walls of dongas in the southwestern escarpment area.

Several well-developed *dolines* (solution hollows) are clearly visible on satellite images in in the study area as pale rounded patches 30m to 100m or more across (Figure 3-8). On the ground they are very shallow (1-2m deep) bowl-shaped depressions covered with short grass and sedges that constrast with the surrounding shrubby thicket vegetation. Soils on the dolines are silty, greyish rather than red, and often contain abundant brownish quartzite pebbles that have weathered out of the Alexandria Formation (**Bluewater Bay facies**), *e.g.* Locs. 129-130 (Plate 3-26).

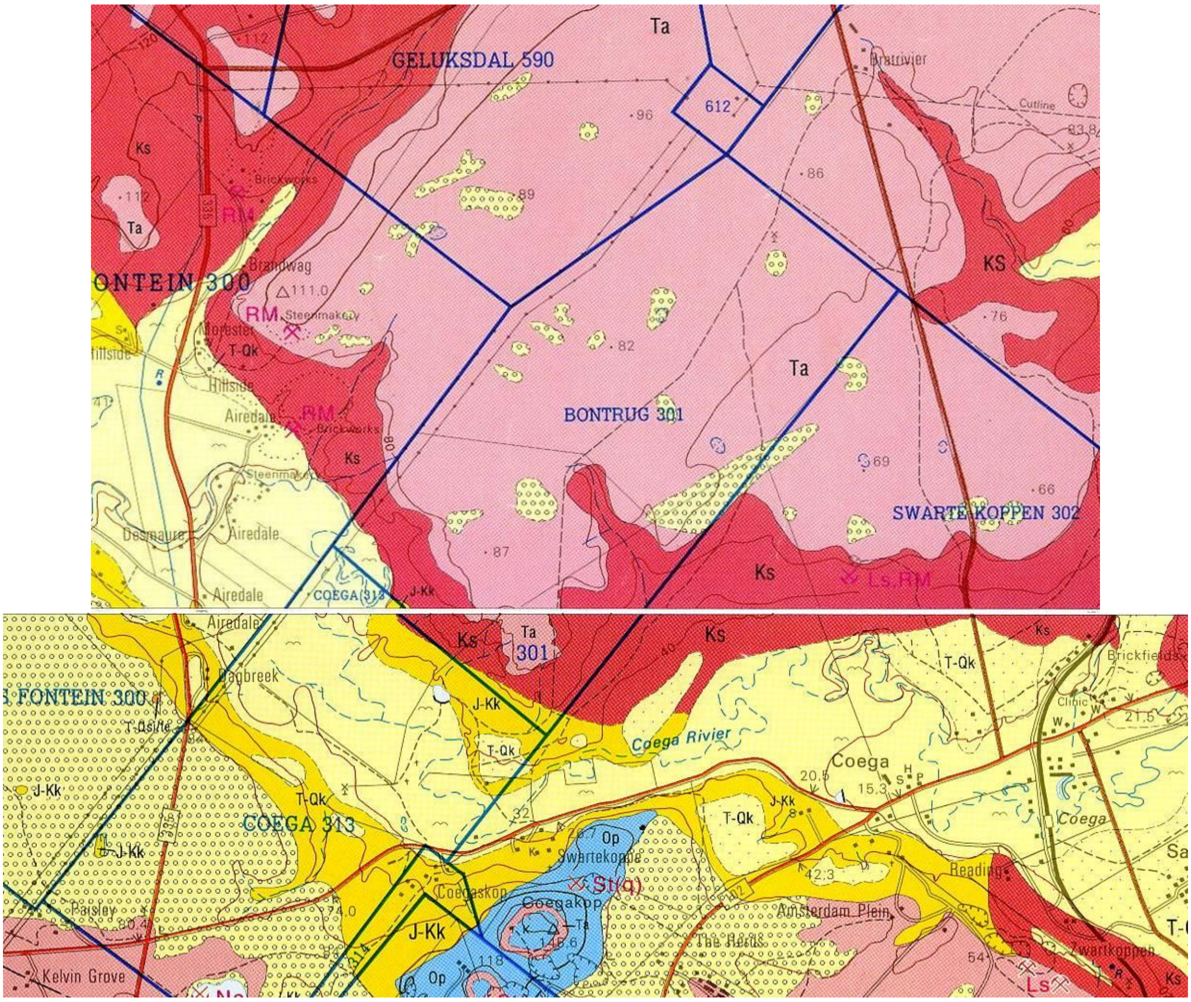

Figure 3-9: Composite geological map of the farm Bontrug 301 (Coega IDZ Zone 14) extracted from 1: 50 000 sheets 3325DA (above) and 3325DC (below). Note small patches of supposed Bluewater Bay residual deposits (pale yellow with circles) overlying Alexandria Formation limestones (Ta). Important shelly fossil sites occur here within the Sundays River Formation (Ks).

Plate 3-15: Exposure of weathered Sundays River mudrocks and calcareous sandstones along the southwestern escarpment on Bontrug 301 (Loc. 104). Note thin capping of pale Alexandria Formation limestones in background.

Plate 3-16: Encrusting oysters (possibly Genus *Amphidonte*) attached to cemented calcareous sandstones of the Sundays River Formation, Bontrug 301 (Loc. 104).

Plate 3-17: Donga exposure of Sundays River Formation on Bontrug 301 (Loc. 105). Dark-hued sandstones at level of hammer contain dense assemblages of fossil bivalves (see following figure).

Plate 3-18: Bedding plane in calcareous sandstone exposing dense carpets of small bivalve shells and shell fragments, Bontrug 301 (Loc. 106) (Scale in cm). The shell-rich layers may have been winnowed and concentrated by storms, but might also reflect episodes of mass mortality of bottom-dwelling invertebrates.

Plate 3-19: Small slab of Sundays River Formation sandstone showing aligned scaphopods or "tusk shells" (*c.* 1.5cm long). These represent a new mollusc group for this formation and were first discovered in the Coega IDZ (Bontrug 301, Loc 108).

Plate 3-20: Prominent-weathering, 30cm thick bed of intraformational breccio-conglomerate, Sundays River Formation, Bontrug 301 (Loc. 133). Fossils found within this unusual sedimentary layer are illustrated in the following two figures.

Plate 3-21: Fragments of rare, branching coral colonies from an intraformational breccio-conglomerate bed in the Sundays River Formation, Bontrug 301 (Loc. 133) Colony braches are *c*. 1cm wide (See also Plate 3-20).

Plate 3-22: Probable fragment (*c*. 3 cm wide) of petrified wood embedded within an intraformational breccio-conglomerate bed in the Sundays River Formation, Bontrug 301 (Loc 133) (See Plate3-20).

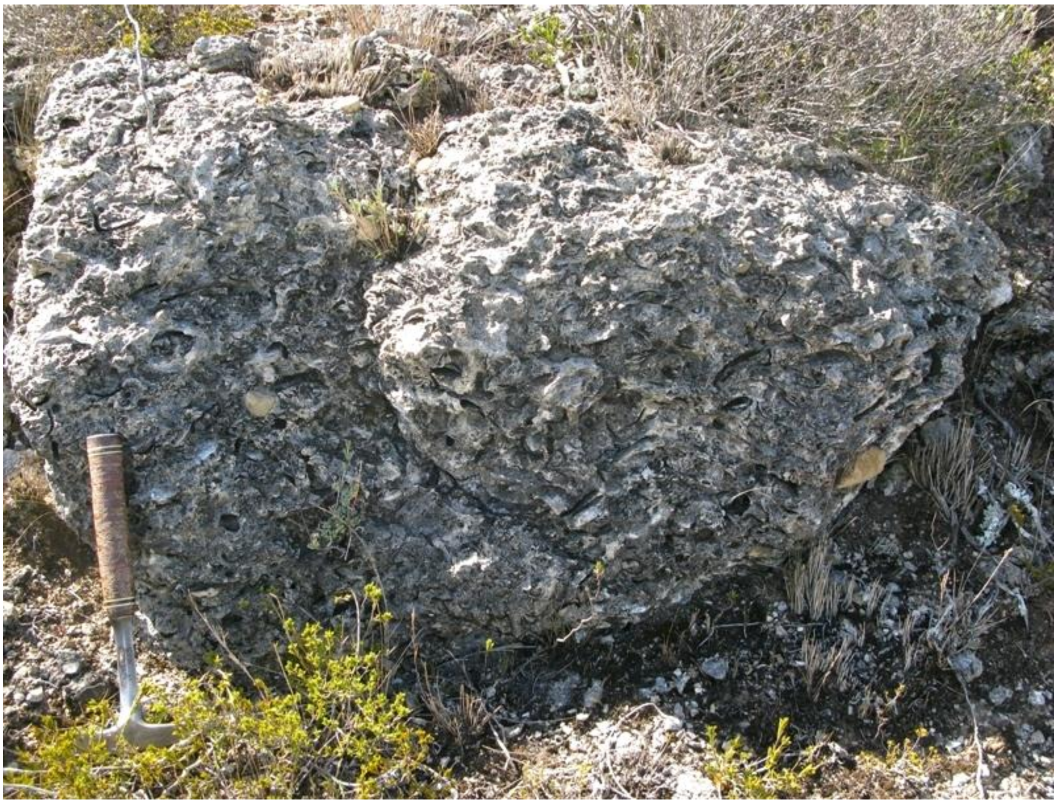

Plate 3-23: Leached Alexandria Formation limestones, Loc. 105, Bontrug 103 (Hammer = 30cm). Numerous hollows represent moulds of shallow marine mollusc shells, including oysters and *Glycimeris*.

Plate 3-24: Typical oyster-rich, pebbly basal conglomerate of the Alexandria Formation in the Grassridge area, Loc. 104, Bontrug 301 (Hammer = 30cm).

Plate 3-25: Robust-shelled Miocene to Pliocene oyster shells from the basal Alexandria Formation, Loc. 104, Bontrug 301 (Scale in cm).

Plate 3-26: View across a shallow doline (solution depression) overlying Alexandria Formation limestones (Loc. 130, Bontrug 301). Note surface concentration of brown quartzitic pebbles and cobbles that have weathered out of the Alexandria conglomerates and been concentrated by sheet wash into surface depressions.

Zwartekoppen 302

The farm Zwartekoppen 302 straddles the coastal plateau at *c*. 60m amsl in the north, a well-vegetated escarpment zone, and the Coega River Valley lowlands in the south (Figure 3-10). It is bisected by a dust road from Coega in the south to the Grassridge area to the north. The 1: 50 000 geological map (Figure 3-11) shows that the coastal plateau area is underlain by Alexandria Formation limestones with small patches of "Bluewater Bay" residual weathering deposits, including prominent rounded dolines that are clearly visible on satellite images (Figure 1-2). All the proposed Innowind wind turbine sites are located in this higher-lying plateau region. Le Roux (1987, his fig. 1.1, Loc. 7) recorded significant Miocene – Pliocene marine fossils from a limestone quarry at the Butterfly Reserve on this farm, just east of the Coega – Grassridge dust road. This locality was revisited by Almond (2010) who reported that the quarry is now largely overgrown and partially infilled. Shelly basal conglomerates of the Alexandria Formation exposed here contain abundant robust-shelled mollusks such as oysters and the large extinct cowrie *Cypraea zietsmani* (Plate 3-28).

Marine mudrocks of the Sundays River Formation underlie the escarpment zone to the south. Small brick clay quarries here have yielded shelly marine fossils in the past, including ammonites (Cooper 1981, his map fig. 1, locs. F3, F5). While revisiting the larger of these abandoned quarries, Almond (2010) reported rich, winnowed concentrations of mollusks shells associated with certain sandstone horizons. These included thick-shelled bivalves such as *Gervillella* and trigoniids as well as free-living and encrusting oysters (Plate 3-27). In addition the sharp, channeled contact between the Sundays River beds and the overlying Alexandria Formation limestones is very well exposed here. Almond proposed that the larger Offit quarry be protected as a geosite.

The southern, low-lying portion of Zwartekoppen 302 is largely mantled by Quaternary to recent alluvium of the Coega River. The Sundays River and Coega alluvial sediments will not be directly impacted by the proposed wind turbine development on the coastal plateau. Given the generally low palaeontological sensitivity on the Alexandria Formation limestones and Bluewater Bay residual deposits on the plateau, no specialist palaeontological mitigation is recommended for the Zwartekoppen 302 study area as far as the Innowind windfarm development is concerned. However, as shown by Le Roux (1987), important Miocene – Pliocene marine fossils do occur at least locally within the Alexandria Formation in this area, and any substantial fossil remains exposed during construction should be safeguarded by the ECO and reported to SAHRA.

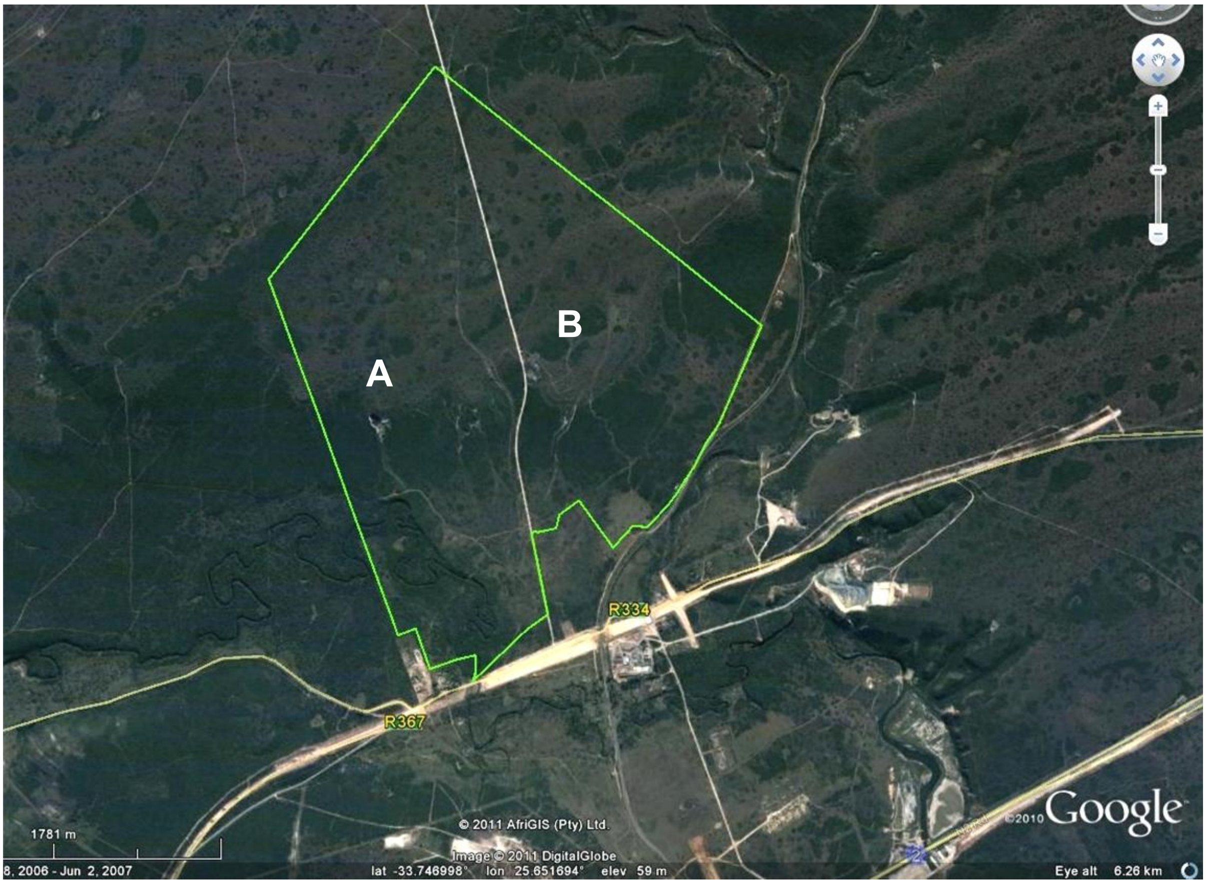

Figure 3-10: Google satellite image of the Innowind study site on the farm Zwarte Koppen 302 (Figure provided by CES, Grahamstown). A small number of wind turbine positions are located on the limestone-capped coastal plateau in the north. An abandoned brick clay quarry at A in the escarpment zone contains impressive winnowed concentrations of Cretaceous mollusks. Important collections of Tertiary marine mollusks have been recorded from a small roadside quarry at B.

Plate 3-27. Dense, winnowed and perhaps down-wasted concentration of mollusk shells, including *Gervillella* and *Steinmanella*, at the top of a storm sandstone, Offit brick pit, Swarte Koppen 302 .

Plate 3-28: Two-knobbed shells of an extinct cowrie species (*Cypraea zietsmani*) from the Alexandria Formation of the Coega area (scale in cm). These rare shells are recorded from an abandoned limestone quarry on Swarte Koppen 302.

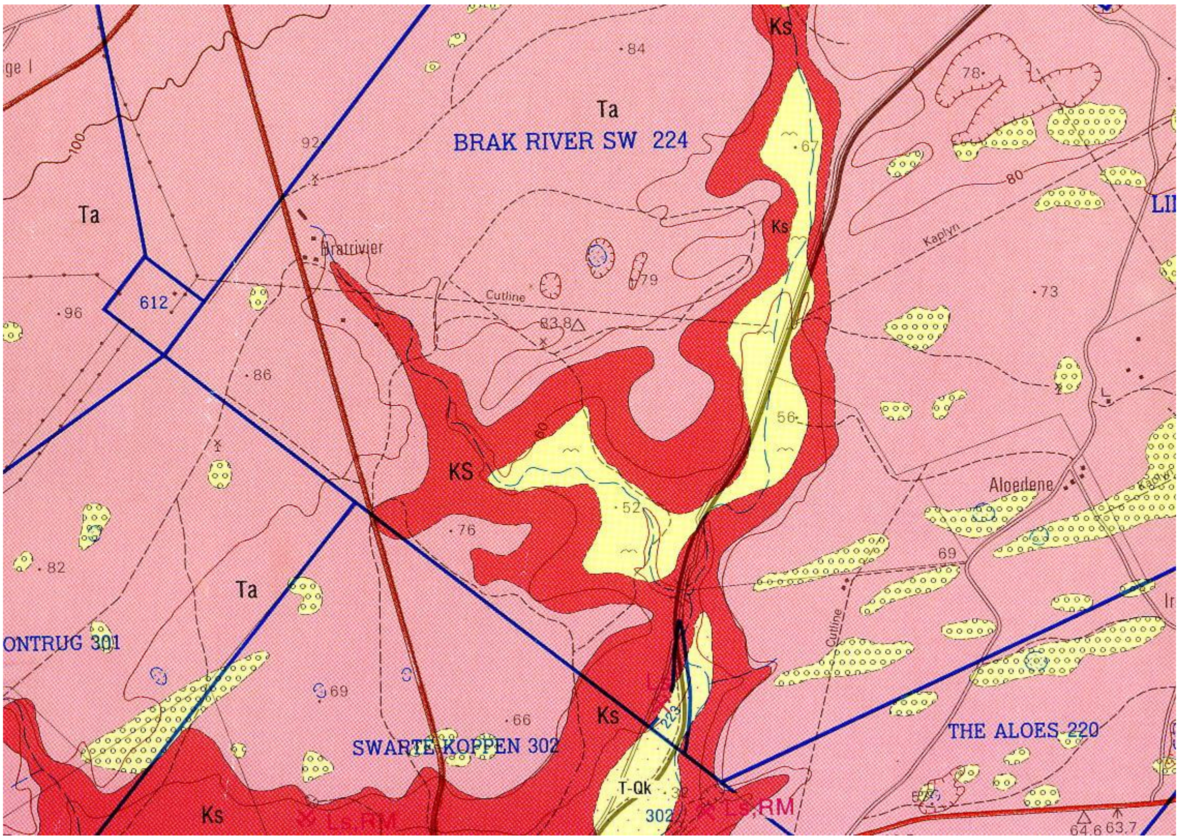

Figure 3-11: Extract from 1: 50 000 geological map 3325DA Addo (Council for Geoscience, Pretoria) showing the geology of the Innowind study areas in the northern sector of farm Swarte Koppen 302 and the south-western portion of Brak River SW 224. J-Kk = Kirkwood Formation Ks = Sundays River Formation Ta = Alexandria Formation T-Qk = Quaternary to Recent alluvium Pale yellow dotted areas = "Bluewater Bay" residual deposits.

Brak River SW 224

A small number of Innowind wind turbine positions are situated along the southwestern margin of the farm Brak River SW 224 (Figure 1-2), mainly to the southeast of the Grassridge Substation (white rectangle in Figure 3-12) and southwest of the prominent stream valley that runs across the farm here. Due to limited accessibility and dense vegetation within the valley itself, this area was not surveyed in detail by Almond (2010) or for the present impact study.

The proposed turbine positions are all situated on the Coega plateau at *c*. 70 to 90m amsl. and are underlain by coastal limestones of the Alexandria Formation (Figure 3-11). A number of small rounded topographic depressions are indicated to the east of Brakrivier homestead on the 1: 50 000 scale geological and topographic maps (3325DA Addo). These may be limestone quarries or doline solution hollows; satellite images suggest the latter. A well-developed series of parallel, arcuate palaeobeach ridges within the Alexandria Formation cover rocks are well seen on satellite images to the east of the study area (Figure 3-12). The intervening swales are picked out by bands of Bluewater Bay residual deposits on the geological map (Figure 3-11).

The slopes of the Brakrivier valley are clothed in dense vegetation and underlain by marine mudrocks of the Sundays River Formation, but Cretaceous bedrock exposures are probably very limited to almost non-existent here. To the author"s knowledge, there are no records of fossil collections from either the Sundays River or overlying Alexandria beds on this farm.

Given the generally low palaeontological sensitivity on the Alexandria Formation limestones and Bluewater Bay residual deposits on the Coega plateau, no specialist palaeontological mitigation is recommended for the Brak River SW 224 study area as far as the Innowind windfarm development is concerned.

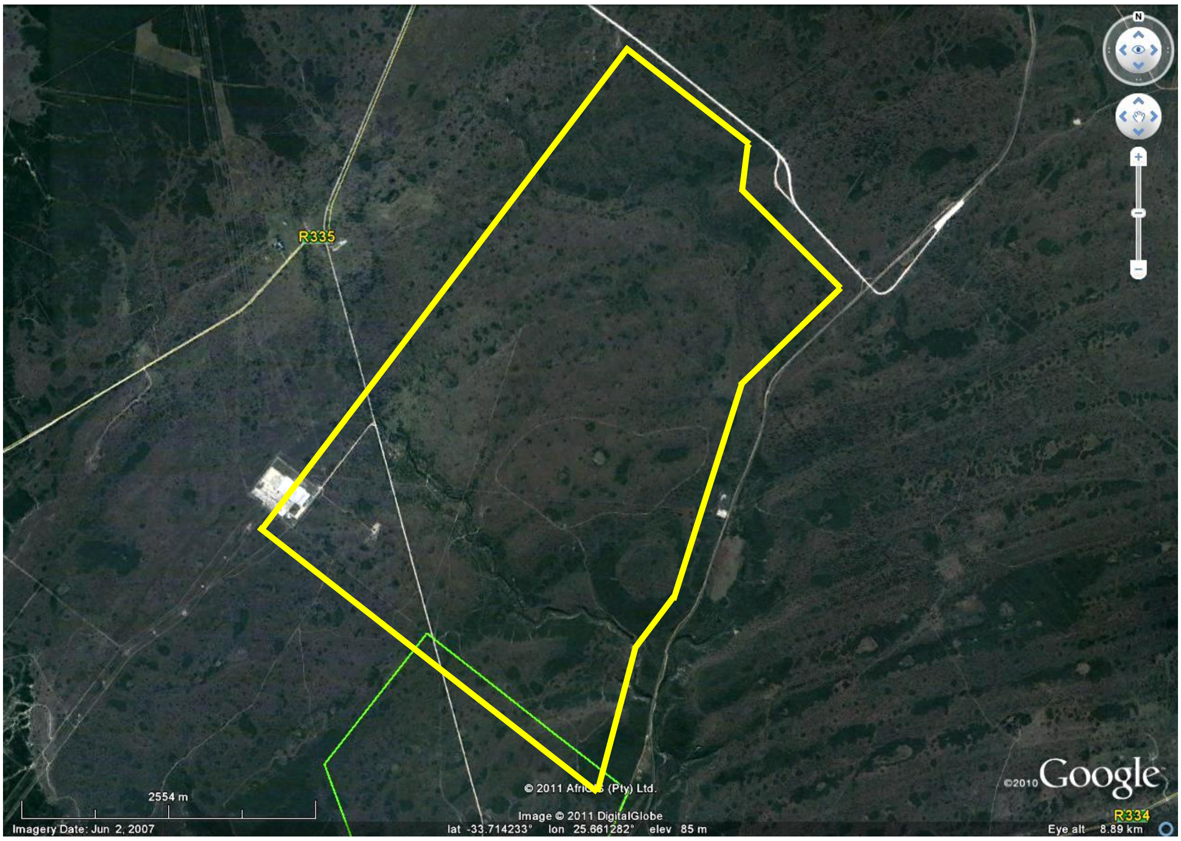

Figure 3-12: Google satellite image of the Innowind study site on the farm Brak River SW 224. A small number of wind turbine positions are located on the limestone-capped coastal plateau to the southwest of the prominent Brakrivier stream valley, southeast of the Grassridge Substation (white rectangle).

3.3.3 Welbedachtsfontein 300

The proposed Innowind development area here, which was not surveyed during fieldwork for this project, is situated towards the eastern corner of the farm Welbedachtsfontein 300, lying to the east of the R335 from Port Elizabeth to Addo (1: 50 000 topo map 3325DA). This area lies outside the Coega IDZ but borders Zone 14 of the IDZ to the southeast (Farm Bontrug 301) (Figure 3-13).

The critical sector along the northeastern edge of the study area, where the proposed wind turbines are to be situated, lies up on the coastal plateau at *c*. 80-100m amsl. (Figure 1-2). This area is entirely underlain by limestones of the Alexandria Formation that are locally mantled with small patches of pebbly “Bluewater Bay” residual weathering deposits. Obvious rounded depressions outside but close to the study site are solution hollows or *dolines* infilled with fine, organic-rich clays and pebbles (Almond 2010). Le Roux (1987) listed the brickworks at Welbedachtsfontein among his key fossil sites within the Alexandria Formation (his fig. 1.1, Loc. 6).

To the west the prominent, well-vegetated escarpment zone bordering the coastal plateau is underlain by mudrocks of the Sundays River Formation which are extensively exploited for brick clay on Welbedachtsfontein 300; several brick pits are clearly visible on satellite images. Cooper (1981, his map fig. 1) records the occurrence of ammonites in this part of the escarpment and these are undoubtedly accompanied by other groups of shelly marine invertebrate fossils. The westernmost portion of the study area extends onto the floor of the Coega River Valley and is mantled by Quaternary to Recent alluvial deposits that cover Kirkwood Formation sediments at depth (Figure 3-14).

The palaeontologically sensitive Sundays River beds of the escarpment zone will not be directly impacted by the proposed Innowind development. It is noted that ongoing exploitation of these Cretaceous fossiliferous sediments in the vicinity for brick making undoubtedly entails the destruction of vast quantities of marine fossils but no mitigation measures are in place to limit loss of palaeontological heritage here.

Given the generally low palaeontological sensitivity on the Alexandria Formation limestones and Bluewaterbay residual deposits on the coastal plateau, no specialist palaeontological mitigation is recommended for the Welbedachtsfointein study area as far as the Innowind windfarm development is concerned. However, as recorded by Le Roux (1987), important Miocene – Pliocene marine fossils do occur at least locally within the Alexandria Formation in the Welbedachtsfontein area, and any substantial fossil remains exposed during construction should be safeguarded by the ECO and reported to SAHRA.

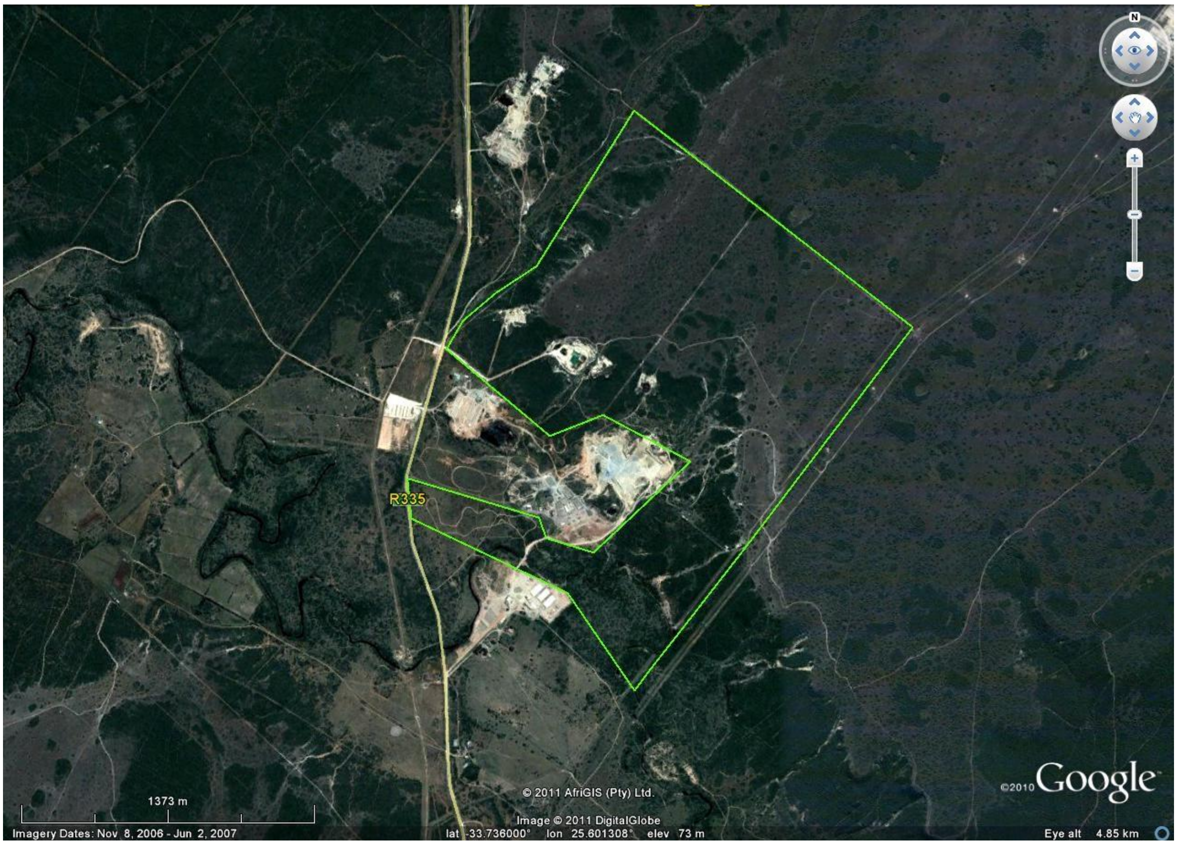

Figure 3-13: Google satellite image of the Innowind study site on the farm Welbedachtsfontein 300 (Figure provided by CES, Grahamstown). A small number of wind turbine positions are located on the limestone-capped coastal plateau along the northeastern margin of the site. Note extensive mining for brick clay from the Sundays River Formation along the vegetated escarpment zone (dark).

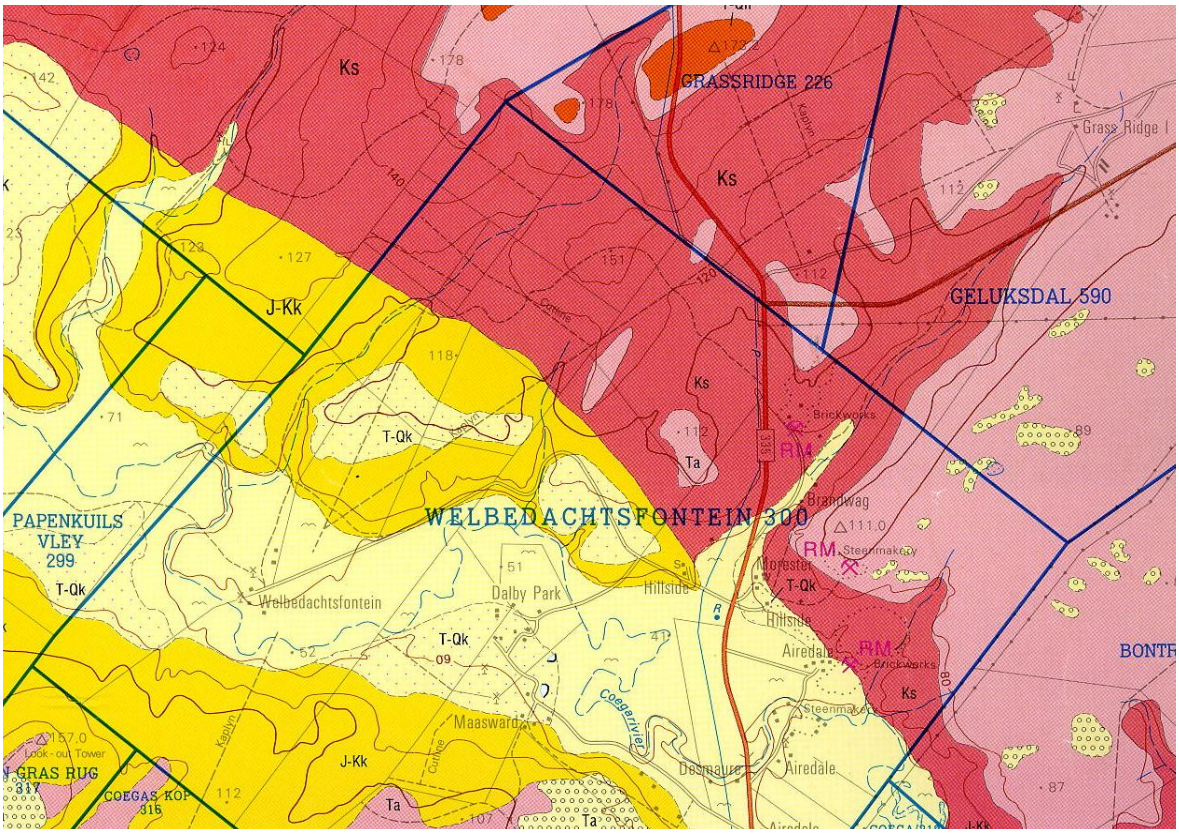

Figure 3-14: Extract from 1: 50 000 geological map 3325DA Addo (Council for Geoscience, Pretoria) showing the geology of the Innowind study area in the eastern corner of farm Welbedachtsfontein 300. J-Kk = Kirkwood Formation Ks = Sundays River Formation Ta = Alexandria Formation T-Qk = Quaternary to Recent alluvium Pale yellow dotted areas = "Bluewater Bay" residual deposits.

4 POTENTIAL PALAEONTOLOGICAL IMPACTS

4.1 Construction phase impacts

Excavations made during the course of building the Innowind (Pty) wind farm and associated developments (*e.g.* roads, powerlines) will expose potentially fossiliferous sediments that are currently buried beneath the land surface or mantled by dense vegetation. Where rich or unusual fossil remains are likely to be exposed within these rocks, study and sampling of the sediments and their enclosed fossils by a qualified palaeontologist while they are still exposed is necessary, before they are permanently sealed in by further development and thereby lost to science. If appropriate mitigation is carried out, as outlined below, this will usefully contribute to our understanding of the rich palaeontological heritage of the Coega region.

The fossil record and inferred palaeontological sensitivity of the sixprincipal sedimentary rock units represented in the study region are summarized in Table 1 (Based on Almond *et al*., 2008, Almond 2010).

The palaeontological sensitivity of the Sundays River Formation – and especially the prominent-weathering calcareous sandstones therein – is ranked as high to very high due to its rich fossil record of marine invertebrates as well as very rare marine reptiles (plesiosaurs). The potential for important new fossil finds here is considerable, as demonstrated by the first records of scaphopod molluscs from this formation made during the present field study. However, it is likely that the proposed wind farm developments will be mainly concentrated on the limestone plateaux areas, so there should be little direct impact on the Sundays River Formation that generally underlies sloping escarpment zones. For the same reason, it is considered unlikely that the construction of the Coega Wind Energy Project will have a direct impact on the Kirkwood Formation and Late Caenozoic alluvial deposits that crop out on the floor of the Coega River Valley.

The Alexandria Formation that underlies most of the flat-lying areas that are likely to be targeted for wind turbines is also known to be richly fossiliferous. A substantial number of the key fossil localities within this unit are situated in the Algoa Bay region, including a few within the broader development footprint of the Coega Wind Energy Project. However, field evidence within the Coega IDZ and neighbouring areas suggests that much of this lime-rich succession here has been diagenetically altered (*e.g.* by post-depositional leaching and calcretization) so that the majority of new excavations expose few or no fossils of value. This is demonstrated by the apparent absence of fossils in most of the extensive excavations into Alexandria limestones made in the PPC quarry area on Grassridge 190. It is concluded that specialist palaeontological mitigation of excavations into the Alexandria Formation is not warranted unless rich fossil concentrations are exposed.

The palaeontological sensitivity of the “Bluewater Bay Formation” residual deposits and the Nanaga aeolian sandstones above the Alexandria limestones is generally very low. No specialist palaeontological mitigation is recommended here unless, as before, rich fossil concentrations are exposed during excavations.

Table 4-1: Sensitivity of fossil heritage of sedimentary formations occurring within the Coega study area

(For use with 1: 50 000 scale geological maps)			
FORMATION & AGE	**FOSSIL HERITAGE**	**PALAEONTOLOGICAL SENSITIVITY**	**RECOMMENDED MITIGATION**
RIVER TERRACE GRAVELS (T-Qk) & ALLUVIUM Miocene to Recent river deposits	possibly rare rolled bones, freshwater molluscs, plant remains	LOW	mitigation not required - *unless* rich fossil accumulations exposed during excavation
NANAGA FORMATION (T-Qn) Pliocene – Early Pleistocenecalcareous dune sands	common land snails, calcretised root casts, possible termitaria	LOW	not required - *unless* rich fossil accumulations exposed during excavation
BLUEWATER BAY FORMATION Pos - Pliocene weathering product of Alexandria Fm	rare fossil shells weathered out from underlying limestones *plus* land snails, freshwater mussels	LOW	not required - *unless* rich fossil accumulations exposed during excavation
ALEXANDRIA FORMATION(Ta) Miocene – Pliocene shallow marine to estuarine sediments	very rich shelly invertebrate faunas, especially molluscs but also several other groups, sharks teeth, possible rare vertebrate bones	LOW TO HIGH Rich shelly faunas only found at some localities fossil shells often destroyed by deep weathering & calcrete formation, especially in near-surface sections	recommended - if rich fossil accumulations are exposed during excavation
SUNDAYS RIVER FORMATION (Ks) Early Cretaceous marine to estuarine / intertidal mudrocks and sandstones	rich variety of marine molluscs (bivalves, ammonites *etc*) and other invertebrates v. rare marine reptiles (plesiosaurs)	MODERATE TO HIGH most shelly fossils are associated with thin sandstones rather than the mudrocks	substantial (high volume) excavations to be examined and sampled by professional palaeontologist while fresh bedrock is still exposed
KIRKWOOD FORMATION (J-Kk) Early Cretaceous fluvial to estuarine mudrocks and sandstones	rare dinosaurs, petrified wood, plants (esp. gymnosperms), charcoal, freshwater crustaceans & molluscs	MODERATE TO HIGH fossils generally sparse but may be concentrated at certain horizons (*eg* ancient soils, flood deposits)	substantial (high volume) excavations to be examined and sampled by professional palaeontologist while fresh bedrock is still exposed

4.1.1 Significance statement

The inferred significance of the proposed wind farm developments in the construction and operational phases, contrasted with the no-go option, is estimated in Table 4-2 below using the CES rating system. Note that as far as palaeontological heritage is concerned, significant impacts are generally restricted to the construction phase of development alone, with little or no further impacts anticipated in the operational or decommissioning phases of the wind farm.

According to the CES significance rating scheme the overall impact of the proposed Coegawind farm development on palaeontological heritage is assessed as LOW. This is mainly because most of the sedimentary rocks directly affected have a low palaeontological sensitivity, and even where this is not the case (*e.g.*any excavations into the Sundays River Formation) the small scale of excavations envisaged is unlikely to seriously reduce the regional stock of fossils embedded underground. Where significant fossils are encountered during construction and the recommended specialised palaeontological mitigation is followed through, this is likely to have a moderately positive impact through enhancing our general understanding of palaeontological heritage in the region.

Failure to mitigate will probably result inthe modest loss of local fossil heritage, while mitigation will probably provide new palaeontological datathat is of regional significance (a moderately beneficial outcome). The no-go option will have a lownegative impact compared with construction of the wind farm accompanied by recommendedspecialist mitigation since the opportunity to collect further palaeontological data will be lost for thetime being.In this respect, the No-Go Option, in which no wind farms are constructed, can be considered to have a higher negative impact than any of the alternatives in so far as buried fossils remain inaccessible for research.

Table 4-2: Impact table of inferred significance of the proposed windfarm developments in the construction and operational phases.

Impact	**Effect**						**Risk or Likelihood**		**Total Score**	**Overall Significance**
	Temporal Scale		**Spatial Scale**		**Severity of Impact**					
Coega Wind Energy Project (construction phase)										
Without Mitigation	Permanent	4	Localised	1	Slight	1	Unlikely	1	**7**	Low -
With Mitigation	Permanent	4	Localised	1	Moderately beneficial	2	Unlikely	1	**8**	Moderate +
Coega Wind Energy Project (operational phase)										
Without Mitigation	n/a									Zero
With Mitigation	n/a									Zero
No-Go Option										
Without Mitigation	Permanent	4	Localised	1	Slight	1	Unlikely	1	**7**	Low -
With Mitigation	n/a									

5 CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the overall impact on palaeontological heritage of the proposed wind farm project is of low significance.Accordingly further specialist palaeontological mitigation for this project is not recommended unless:

a) Wind turbines or ancillary developments are sited over the Sundays River Formation (mainly escarpment areas); or
b) deep excavations penetrate through the limestone capping into Sundays River sediments below.

In these two cases, mitigation by a professional palaeontologist is recommended during the construction phase of the wind farm, as outlined in the previous section.

Where it is specifically recommended above, mitigation by a qualified palaeontologist should entail:

a) The field examination of new bedrock excavations;
b) the recording of sedimentological and palaeontological data; and
c) the judicious sampling of fossil material and
d) recommendations for any further action required to safeguard fossil heritage.

It is important that the opportunity to mitigate is given while the bedrock excavations are fresh and before they are infilled, covered over or degraded by weathering and plant growth. Before development starts a realistic programme of mitigation should therefore be negotiated between the developer and the palaeontologist contracted for the project to maximize the scientific and conservation benefits of the work while minimizing disruption of the construction programme. The palaeontologist involved will need to obtain a fossil collection permit from SAHRA and make arrangements with an approved repository (*e.g.* museum, university) to store and curate any fossil material collected.

Environmental control officers responsible for developments within the Coega IDZ should:

a) Be alerted to the palaeontological sensitivity of several geological units in the area;
b) familiarize themselves with the sort of fossils that might be encountered during development through museum displays and using illustrated reports such as the present one as well as the Coega IDZ palaeontology report by Almond (2010); and
c) alert SAHRA and a professional palaeontologist as soon as possible should significant fossil remains be exposed during excavations.

These requirements must be incorporated in the Construction Phase Environmental Management Plan (EMP).

6 CONCLUSIONS AND RECOMMENDATIONS

Marc Hardy, Principal Environmental Consultant for Coastal and Environmental Services, Grahamstown, is thanked for commissioning this study, for kindly providing the necessary background information and for editorial assistance. Mr Jackie Erasmus is assisted with access to PPC land and Mr Kapp introduced me to the Grassridge 190 property and limestone quarry. Andrea von Holdt (Operations Project Manager, Coega Development Corporation) is warmly thanked for facilitating the comprehensive heritage assessment for the Coega IDZ.

PALAEONTOLOGICAL APPENDIX 1: GPS LOCALITY DATA – GRASSRIDGE-COEGA REGION, EASTERN CAPE PROVINCE

Loc	Degrees East	Degrees South	Formation	Locality	Palaeontology
99	25,63462	-33,72337	Alexandria + ?Nanaga	Zone 14 surface topography, soils	
100	25,62859	-33,73239	doline	Zone 14	
101	25,61634	-33,74665	soils	Zone 14, modern termitaria	
102	25,61313	-33,74727	Alexandria	escarpment, Zone 14	shell-rich lower Ta
103	25,61262	-33,74693	Sundays River	dongas at escarpment foot, Zone 14	
104	25,61258	-33,74625	Sundays R + Alex	gulley in escarpment	oysters in Ks sst and basal Ta
105	25,61429	-33,74865	Sundays River	gulley in escarpment	abundant molluscs in Ks sst
106	25,61387	-33,74890	Sundays River	gulley in escarpment	abundant molluscs in Ks sst
107	25,61317	-33,74971	Sundays River	calc sst step in gulley	
108	25,61337	-33,74951	Sundays River	gulley in escarpment	scaphopod-rich coquinas
109	25,63624	-33,72490	doline	SW of Grassridge substation	
+116	25,55094	-33,64905	Alexandria	PPC Grassridge property	
117	25,52819	-33,65098	Alexandria + Nanaga?	PPC Grassridge property	
118	25,53540	-33,64731	Alexandria	PPC Grassridge property	
119	25,56836	-33,63772	Alexandria	limestone quarry, PPC Grassridge	
120	25,56713	-33,63674	Sundays River + Alexandria	escarpment edge, PPC, Grassridge	shell moulds in Ta
121	25,57351	-33,63849	Alexandria	deep trench, PPC, Grassridge	
122	25,57209	-33,63685	Alexandria	escarpment edge, PPC, Grassridge	
123	25,57924	-33,63839	Alexandria	roadcut	
124	25,58161	-33,64060	Sundays River + Alexandria	escarpment edge, PPC, Grassridge	shells in Ks sst, moulds in Ta
125	25,56904	-33,64580	Alexandria	PPC quarry dump	
126	25,62611	-33,66998	doline	PPC wind farm S area	
127	25,62462	-33,68148	viewpoint	PPC wind farm S area, N plateau edge	
128	25,61458	-33,71740	viewpoint	PPC wind farm S area, S plateau edge	
129	25,63575	-33,73867	BWB	Zone 14 wind farm	
130	25,63232	-33,74006	doline	Zone 14 wind farm	
131	25,61275	-33,74627	Sundays River + Alexandria	gulley in escarpment	oysters in Ks sst and basal Ta
132	25,61388	-33,74885	Sundays River	gulley in escarpment	abundant molluscs in Ks sst
133	25,61306	-33,74991	Sundays River	conglomerate bed in gulley	coquina of branching corals, ?wood

All GPS readings were taken using a hand-held Garmin GPSmap 60CSx instrument.The datum used is WGS 84.

REFERENCES

4 SPECIALIST REPORTS

4.1 Ecological Report

African Environmental Solutions. (1996). Proposed Eastern Cape zinc refinery and associated phosphoric acid plant. Supplementary report. Vol. 1. African Environmental Solutions (Pty) Ltd, Cape Town.

Ahlen I (2003). Wind turbines and bats – A pilot study. Swedish National Energy Administration.

Arnason, B.T., O‟Connell, L.E. and Hart, L.A. (1998). Long range seismic characteristics of Asian elephant (*Elephus maximus*) vocalizations and locomotion. Journal of the Acoustical Society of America, **104:** 1810.

Baerwald EF, D‟Amours GH, Klug BJ and Barclay RMR (2008). Barotrauma is a significant cause of bat fatalities at wind turbines. Current Biology 18(16): R695 - R696.

Barclay RMR, Baerwald EF and Cruver JC (2007). Variation in bat and bird fatalities at wind energy facilities: assessing the effects of rotor size and tower height. Canadian Journal of Zoology. 85: 381-387.

Berliner D, Desmet P and Hayes R (2007). Eastern Cape Biodiversity Conservation Plan Handbook. Department of Water Affairs and Forestry Project No 2005-012, King Williams Town. ISBN: 978-0-620-39423-9.

Branch, W.R. 1988. Terrestrial reptiles and amphibians. In: *A Field Guide to the Eastern Cape Coas*t, R. A. Lubke, F. W. Gess and M. N. Bruton (eds.), Grahamstown Centre for the Wildlife Soc. S. Afr., 251-264.

Brinkman R, Schauer-Weisshahn H and Bontadina F (2006). Survey of possible operational impacts on bats by wind facilities in Southern Germany. Final Report submitted by the Administrative District of Freiburg, Department of Conservation and Landscape management and supported by the foundation Naturschutzfonds Baden-Wurttemberg. Brinkmann Ecological Consultancy, Gundelfingen/Freiburg, Germany.

Burger, L.W. and Scorgie, Y. (1998). Assessment of potential deposition of contaminants at Coega saltworks due to future industry and development of a model for emission limit estimation. Environmental Management Services cc. Wierdapark 0149.

Bowles, A.E. 1995. (*eds* Knight, R.L., Gutzwiller, K.J.). *Responses of Wildlife to Noise* in: Wildlife and Recreationists: Co-existence through management and Research, Island Press,

Cape Nature and Environmental Conservation Ordinance (1997). Ordinance
No. 19 of 1974, Schedule **4**, 11–18.

Coastal & Environmental Services, April 2009: *Tankatara Farm Ecological Baseline Assessment*, CES, Grahamstown.

Coastal & Environmental Services (CES), April 2001: The distribution and extent of Bontveld within the Eastern Cape, South Africa, CES, Grahamstown.

Coastal & Environmental Services (CES). 1997. Strategic Environmental Assessment of the Coega IDZ – Terrestrial Ecology Specialist Report. Coastal Environmental Services, Grahamstown

CEN. 1997. Feasibility study. Environmental impact report on a proposed harbour in the vicinity of Coega, Port Elizabeth. CEN Integrated Environmental Management Unit, Port Elizabeth.

Coetzee, J.C., Adams, J.B and Bates, G.C. (1997) A botanical importance rating of selected Cape estuaries. *Water SA* 23 (1): 81 - 93.

CSIR, 1997. Strategic Environmental Assessment for the Proposed Industrial Development Zone and Harbour at Coega. CSIR Report No. ENV-S-C 97025. CSIR, Stellenbosch

Driver, A, Maze, K, Rouget, M, Lombard, AT, Nel, J, Turpie, JK, Cowling RM, Desmet, P, Goodman, P, Harris J, Jonas, Z, Reyers, B, Sink, K and Strauss, T (2005). National Spatial Biodiversity Assessment 2004: priorities for biodiversity conservation in South Africa. *Stelitzia* 17. South African National Biodiversity Institute, Pretoria.

Hill, P.S.M. 2001. Vibration and animal communication: a review. American Zoology. 41: 1135 – 1142.

Hotker H, Thomsen K-M and Jeromin H (2006). Impacts on biodiversity of exploitation of renewable energy sources: the example of birds and bats – facts, gaps in knowledge, demands for further research, and ornithological guidelines for the development of renewable energy exploitation. Michael-Otoo-Institut im NABU, Bergenhusen.

Horn JW, Arnett EB and Kunz TH (2008). Behavioral Responses of Bats to Operating Wind Turbines. Journal of Wildlife Management 72(1): 123- 132.
IUCN (2009). Red List of Threatened Species. IUCN Species Survival Commission, Cambridge Available: http://www.iucnredlist.org/ (Accessed 12/10/2009).

IUCN (2008). Red List of Threatened Species. IUCN Species Survival Commission, Cambridge Available: http://www.iucnredlist.org/ (Accessed 07/04/2009).

Johnson GD, Erickson WP, Strickland MD, Shepherd MF, Shepherd DA and Sarappo SA (2003). Mortality of Bats at a Large-scale Wind Power Development at Buffalo Ridge, Minnesota. American Midland Naturalist. 150: 332 – 342.

Kunz TH, Arnett EB, Erickson WP, Hoar AR, Johnson GD, Larkin RP, Strickland MD, Thusher RW and Tuttle MD. (2007). Ecological Impacts of wind energy development on bats: questions, research needs, and hypotheses. Frontiers in Ecology and the Environment. 5(6): 315 – 324.

Langbauer, W.R., Payne, K.B., Charif, R.A., Rapaport, L. and Osborn, F. 1991. African elephants respond to distant playbacks of low-frequency conspecific calls. Journal of Experimental Biology. 157: 35 – 46.

Mucina, L. and Rutherford, M.C. (Eds.) 2006. The Vegetetion of South Africa, Leshto and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.
Johnson, C.F. 1998. Vulnerability, Irreplaceability and Reserve Selection for the Elephant-impacted Flora of the Addo Elephant National Park, Eastern Cape, South Africa. MSc Thesis, Rhodes University.

O‟Neal, R.D.; Hellweg, R.D.; Lampeter, R.M. 2009. A study of low Frequency Noise and Infrasound from Wind Turbines. *NextEra Enery Resources, LLC*
Szewczak JM and Arnett EB (2007). Field test results of a potential acoustic deterrent to reduce bat mortality from wind turbines.

Phillipson, P.B. 2002a. *Plant Relocation Survey: Neptune Road Coega.* Unpublished report for Coega Development Zone Corporation. Coastal and Environmental Services, Grahamstown.

Phillipson, P.B. 2002b. *Plant Survey: Haul Road Coega.* Unpublished report for National Port

Authority. Rhodes University, Grahamstown.

Pierce, S. M. and Mader, A. D. 2006. The STEP Handbook. Integrating the natural environment into land use decisions at the municipal level: towards sustainable development. Centre for African Conservation Ecology (ACE). Report Number 47 (Second Edition). Nelson Mandela Metropolitan University, South Africa.

Rouget, M., Reyers, B., Jonas, Z., Desmet, P., Driver, A., Maze, K., Egoh, B., Cowling, R.M., Mucina, L. & Rutherford, M.C. 2004. *South African National Spatial Biodiversity Assessment 2004: Technical Report. Volume 1: Terrestrial Component.* South African National Biodiversity Institute, Pretoria

Stone, A.W. (1988). Climate and weather. In: A field guide to the eastern Cape coast. Eds: Lubke, R.A., Gess, F.W. and Bruton, M. The Grahamstown Centre of the Wildlife Society of Southern Africa.

SRK Consulting Engineers and Scientists. (1999). Groundwater impact study: Coega quarry. SRK Consulting, Port Elizabeth.

Szewczak JM and Arnett EB (2007). Field test results of a potential acoustic deterrent to reduce bat mortality from wind turbines.

Van Wyk, A.E. & Smith, G.F. (2001). *Regions of Floristic Endemism in Southern Africa. A Review with Emphasis on Succulents*. Pretoria: Umdaus Press.

Victor, J. & Dold, A. (2003) *Threatened plants of the Albany Centre of Floristic Diversity, South Africa*. Biodiversity & Conservation

Vlok JHJ & Euston-Brown DIW 2002. *The patterns within, and the ecological processes that sustain, the Subtropical Thicket Vegetation in the planning domain for the Subtropical Thicket Ecosystem Planning (Step) Project* . Terrestrial Ecology Research Unit, University of Port Elizabeth, Port Elizabeth. Report No. 40

Watson, J. J. 2001. Bontveld ecosystem functioning and rehabilitation after strip mining. PhD Thesis, University of Port Elizabeth.

4.2 Avifauna Report

Acha, A. 1997.Negative impact of wind generators on the Eurasian Griffon Gyps fulvus in Tarifa, Spain. Vulture News 38:10-18

Acocks, J.P.H. 1953. *Veld types of South Africa*. Memoirs of the Botanical Society of South Africa 28, pp 1-192.

Anderson, M.D. 2001. *The effectiveness of two different marking devices to reduce large terrestrial bird collisions with overhead electricity cables in the eastern Karoo, South Africa*. Draft report to Eskom Resources and Strategy Division. Johannesburg. South Africa.

Australian Wind Energy Associationwww.auswea.com.au (accessed 25/04/07)

Avian Literature Database – National Renewable Energy Laboratory – www.nrel.gov

Avian Powerline Interation Committee (APLIC). 1994. Mitigating bird collisions with power lines: the state of the art in 1994. Edison Electric Institute. Washington DC.

Barnes, K.N. (ed.) 1998. *The Important Bird Areas of southern Africa*. BirdLife South Africa: Johannesburg.

Barnes, K.N. (ed.) 2000. The Eskom Red Listed Book of Birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg.

Cade, T.J. 1994. Industry research: KenetechWindpower. In Proceedings of the National Avian-Wind Power Planning Meeting, 1994.

Colson & associates 1995. Avian interaction with wind energy facilities: a summary. Prepared for the American Wind Energy Association. Washington DC

Crockford, N.J. 1992. A review of the possible impacts of wind farms on birds and other wildlife. Joint Nature Conservation Committee. JNCC Report number 27. Peterborough. United Kingdom

Curry &Kerlinger, LCCwww.currykerlinger.com (accessed 27/04/07)

Curry, R.C., &Kerlinger, P. 2000. Avian mitigation plan: Kenetech model wind turbines, Altamont Pass WRA, California. In Proceedings of the National Avian-Wind Power Planning Meeting III, San Diego California, May 1998.

Desholm, M. &Kahlert, J. 2005.Avian collision risk at an offshore wind farm. Biology Letters (2005) 1. 296-298.

Erickson, W.P., Johnson, G.D., Strickland, M.D., Kronner, K., &Bekker, P.S. 1999. Baseline avian use and behaviour at the CARES wind plant site, Klickitatcounty, Washington. Final Report.Prepared for the National Renewable Energy Laboratory.

Erickson, W.P., Johnson, G.D., Strickland, M.D., Young, D.P., Sernka, K.J., Good, R.E. 2001. Avian collisions with wind turbines: a summary of existing studies and comparison to other sources of avian collision mortality in the United States. National Wind Co-ordinating Committee Resource Document.

Erickson, W.P., Johnson, G.D., Strickland, M.D., Young, Good, R., Bourassa, M., & Bay, K. 2002.Synthesis and comparison of baseline avian and bat use, raptor nesting and mortality from proposed ans existing wind developments.Prepared for Bonneville Power Administration.

European Wind Energy Association www.ewea.org (accessed 27/04/07)

Everaert, J. 2003. Wind turbines and birds in Flanders: Preliminary study results and recommendations. Natuur.Oriolus 69 (4): 145-155

German Wind Energy Association – www.wind-energie.de

Gill, J.P., Townsley, M. &Mudge, G.P. 1996. Review of the impact of wind farms and other aerial structures upon birds. Scottish Natural Heritage Review.Number 21.

Hanowski, J.M., &Hawrot, R.Y. 2000. Avian issues in development of wind energy in western Minnesota. In Proceedings of the National Avian-Wind Power Planning Meeting III, San Diego California, May 1998.

Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V & Brown, C.J. (eds). 1997. The atlas of southern African birds. Vol. 1&2.BirdLife South Africa, Johannesburg.

Hockey, P.A.R., Dean, W.R.J., Ryan, P.G. (Eds) 2005. Roberts – Birds of Southern Africa, VIIthed. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

Hodos, W. 2002. Minimization of motion smear: Reducing avian collisions with turbines. Unpublished subcontractor report to the National Renewable Energy Laboratory. NREL/SR 500-33249

Howell, J.A. Noone, J. 1992. Examination of avian use and mortality at a US Windpower wind energy development site, Montezuma Hills, Solano County, California.Final report.Prepared for Solano County Department of Environmental Management, Fairfield, California.

Howell, J.A. 1995. Avian mortality at rotor sweep areas equivalents Altamont Pass and Montezuma Hills, California. Prepared for Kenetech Wind Power, San Francisco, California. http://www.wave- guide.org/archives/waveguide_3/birdkill.html.

Hunt, W.G. 2002. Golden Eagles in a perilous landscape: predicting the effects of migration for wind turbine blade strike mortality. Report to the California Energy Commission. Pier grant number 500-97-4033 to the University of California.

Janss, G. 2000. Bird behaviour in and near a wind farm at Tarifa, Spain: Management considerations. In Proceedings of National Avian-Wind Power Planning Meeting III, San Diego California, May 1998

Jaroslow, B. 1979. A review of factors involved in bird-tower kills, and mitigation procedures. In G.A. Swanson (Tech co-ord).The Mitigation symposium.A national workshop on mitigation losses of Fish and Wildlife Habitats.US Forest Service General Technical Report. RM-65

Karlsson. 1983. as cited in Winkelman 1995.

Kemper, C.A. 1964. A tower for TV: 30 000 dead birds. Audubon Magazine 66 (1): 86-90

Kerlinger, P. 2001. Avian issues and potential impacts associated with wind power development of near shore waters of Long Island, New York. Prepared for Bruce Bailey, AWS Scientific.

Kerlinger, P. 2003. Addendum to the Phase I avian risk assessment for the Flat Rock Wind Power Project, Lewis County, New York: Phase One and Phase Two. March 31, 2003. Report to Flat Rock Wind Power, L.L.C

Kerlinger, P. &Dowdell, J. 2003.Breeding bird survey for the Flat Rock wind power project, Lewis County, New York.Prepared for Atlantic Renewable Energy Corporation.

Kingsley, A &Whittam, B. 2005. Wind turbines and birds – A background review for environmental assessment. Unpublished report for Environment Canada/Canadina Wildlife Service.

Kuyler, E.J. 2004. The impact of the Eskom Wind Energy Demonstration Facility on local avifauna – Results from the monitoring programme for the time period June 2003 to Jan 2004. Unpublished report to Eskom Peaking Generation.

Low, A.B. &Robelo, A.G. (eds). 1996. *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism: Pretoria.

McIsaac, H.P. 2001.Raptor acuity and wind turbine blade conspicuity. Pp. 59-87. National Avian-Wind Power Planning Meeting IV, Proceedings. Prepared by Resolve, Inc., Washington DC

National Wind Co-ordinating Committee. 2004. Wind turbine interactions with birds and bats: A summary of research results and remaining questions. Fact Sheet Second Edition.

New Zealand Wind Energy Associationwww.windenergy.org.nz (accessed 25/04/07)

Orloff, S., & Flannery, A. 1992. Wind turbine effects on avian activity, habitat use and mortality in Altamont Pass and Solano County Wind Resource Areas, 1989-1991. Prepared by Biosystems Analysis Inc, Tiburon, California. Prepared for the California Energy Commission, Sacramento, Grant 990-89-003.

Richardson, W.J. 2000. Bird migration and wind turbines: Migration timing, flight behaviour and collision risk. In Proceedings of the National Avian-wind Power Planning Meeting III, San Diego, California, May 1998.

Smit, I. 2007. Personal communication.Eskom Research and Innovation Department, Eskom Resources and Strategy Group.

Taylor, P.B., Navarro, R.A., Wren-Sargent, M., Harrison, J.A., &Kieswetter, S.L. 1999. TOTAL CWAC Report: Coordinated Waterbird Counts in South Africa, 1992 – 1997. Avian Demography Unit, Cape Town.

Thelander, C.G., and Rugge, L. 2001. Examining relationships between bird risk behaviours and fatalities at the Altamont Wind Resource Area: a second years progress report In: Schwartz, S.S. (Ed), Proceedings of the National Avian – Wind Power Planning Meeting 4 Carmel, CA, May 16-17 2000.

Van Rooyen, C. 2001. Bird Impact Assessment Study – Eskom Wind Energy Demonstration Facility, Western Cape South Africa.Prepared for Eskom Enterprises, TSI Division.

Van Rooyen, C.S. 2004a. The Management of Wildlife Interactions with overhead lines. In The fundamentals and practice of Overhead Line Maintenance (132KV and above), pp217-245. Eskom Technology, Services International, Johannesburg.

Van Rooyen, C.S. 2004b. Investigations into vulture electrocutions on the Edwardsdam-Mareetsane88KV feeder, Unpublished report, Endangered Wildlife Trust, Johannesburg.

Weir, R. D. 1976. Annotated bibliography of bird kills at manmade obstacles: a review of the state of the art and solutions. Canadian Wildlife Services, Ontario Region, Ottawa.

Winkelman, J.E. 1995. Bird/wind turbine investigations in Europe. In Proceedings of the National Avian- wind Power Planning Meeting 1994.

Young, D.J., Harrison, J.A., Navarro, R.A., Anderson, M.D., &Colahan, B.D. (Eds). 2003. Big Birds on Farms: Mazda CAR report 1993-2001. Avian Demography Unit, Cape Town.

4.3 Visual Report

Coastal & Environmental Services, 2010. Draft Environmental Scoping Report: Proposed Coega Wind Energy Project, Grahamstown, South Africa: CES.

Degraw, S., 2009. Giant Wind Turbine. World's Toughest Fixes. Available at: http://channel.nationalgeographic.com/series/worlds-toughest-fixes/4218/Overview [Accessed February 1, 2010].

EDR, 2009. Shadow flicker modeling report for the Steuben Wind Project, Towns of Hartsville and Hornellsville, Steuben County, New York, Steuben County, New York: Environmental Design and Research, Landscape Architecture, Planning, Environmental Services, Engineering and Surveying, P. C. (EDR). http://www.eon.com/en/downloads/Appendix_M_Shadow_Flicker_Modeling_Report.pdf [Accessed October 17, 2009].

EWEA ed., 2009. Wind Energy - The Facts: A guide to the technology, economics and future of wind power, Earthscan. Available at: http://www.wind-energy-the-facts.org/.

filmsfromyes2wind, 2010. Delivery and assembly of a wind turbine, Available at: http://www.youtube.com/watch?v=r0DZUDQyw_0&feature=youtube_gdata_player [Accessed September 26, 2010].

Gipe, P., 1995. Design as if People Matter: Aesthetic Guidelines for the Wind Industry. Design as if People Matter: Aesthetic Guidelines for the Wind Industry. Available at: http://www.wind-works.org/articles/design.html [Accessed September 22, 2008].

GLVIA, 2002. Guidelines for Landscape and Visual Impact Assessment 2nd ed., United Kingdom: Spon Press.

Gresse, P.G., Von Veh, M.W. & Frimmel, H.E., 2006. Namibian (Neoproterozoic) to early Cambrian successions. In The Geology of South Africa. pp. 395-420.

Horner, MacLennan and Envision, 2006. Visual representation of windfarms, good practice guidance, Scotland: Scottish Natural Heritage.

Illenberger, W.K. & Burkinshaw, J.R., 2008. Coastal dunes and dunefields. In Geomorphology of the Eastern Cape: South Africa. Grahamstown, South Africa: NISC South Africa, pp. 85-106.

Johnston, A., 2001. Wind Energy Projects in SA. Environment South Australia. Available at: http://www.ccsa.asn.au/esa/wind.htm [Accessed September 4, 2008].

Majeke, B. et al., 2002. Updated National Land-Cover Database of South Africa. In Proceedings of Map Africa 2006. Map Africa 2006. Johannesburg, South Africa: CSIR. Available at: http://www.gisdevelopment.net/technology/survey/maf06_19abs.htm [Accessed May 24, 2010].

McCarthy, T. & Rubidge, B., 2006. The Story Of Earth & Life: A Southern African Perspective on a 4.6-Billion-Year Journey, Struik Publishers.

Minister of Transport, 1997. Aviation Act, 1962 (Act no 74 of 1962) Thirteenth Amendment of the Civil Aviation Regulations (CAR's),

Oberholzer, B., 2005. Guideline for involving visual & aesthetic specialists in EIA processes, Cape Town: CSIR, Provincial Government of the Western Cape, Department of Environmental Affairs & Development.
http://www.capegateway.gov.za/Text/2005/10/5_deadp_visual_guideline_june05.pdf.

Partridge, T.C., Botha, G.A. & Haddon, I.G., 2006. Cenozoic deposits of the interior. In The Geology of South Africa. pp. 585-604.

Portwain, V., 2008. Wind Energy Questions - What is Wind Turbine Shadow Flicker? Wind Energy Planning. Available at: http://www.windenergyplanning.com/wind-energy-questions-what-is-wind-turbine-shadow-flicker/ [Accessed October 17, 2009].

Roberts, D.L. et al., 2006. Coastal Cenozoic deposits. In The Geology of South Africa. pp. 605-628.

Shone, R.W., 2006. Onshore Post-Karoo Mesozoic Deposits. In The Geology of South Africa. Geological Society of South Africa, Johannesburg/Council of Geoscience, Pretoria, pp. 541-552.

SRK Consulting, 2007. Draft Conservation Assessment and Plan for the Nelson Mandela Bay Municipality, Nelson Mandela Bay: Nelson Mandela Bay Metropolitan Municipality.
http://www.srk.co.za/publicDocuments/365595-3%20-%20NMBM%20-%20Draft%20Conservation%20Assessment%20and%20Plan%20for%20the%20Nelson%20Mandela%20Bay%20Municipality%20-%20161107.pdf [Accessed August 19, 2008].

Stanton, C., 1996. The Landscape Impact and Visual Design of Windfarms, Edinburgh College of Art.

Vissering, J., 2005. Wind Energy and Vermont"s Scenic Landscape, Vermont. Available at: http://publicservice.vermont.gov/energy-efficiency/ee_files/wind/vissering_report.pdf [Accessed September 4, 2008].

4.4 Noise Report

1)	Australia Environmental Protect Agency - **Wind farms - environmental noise guidelines**. July 2009.
2)	Bell Acoustic Consulting. **Low frequency noise and infrasound from Wind turbine generators: A literature review.** George Bellhouse. June 2004.
3)	Coastal & Environmental Services, 2010: **Proposed Chaba Energy Facility, Eastern Cape Province of South Africa, East London**
4)	DEFRA – United Kingdom **A Review of Published Research on Low Frequency Noise and its Effects.** Geoff Leventhall. 2003
5)	DTI – United Kingdom **The measurement of low frequency noise at 3 UK Wind Farms**. Hayes Mackenzie. 2006
6)	Gold Coast Desalination Alliance (GCDA) – **2006 Environmental Impact Assessment Queensland Desalination Plant** (Chapter 11).
7)	International Finance Corporation – 2007 **General EHS Guidelines: Environmental Noise.**
8)	ISO 9613-2 - **Acoustics – Attenuation of sound during propagation outdoors**. Part 2 – General method of calculation.
9)	Renewable Energy Research Laboratory - Department of Mechanical and Industrial Engineering. University of Massachusetts at Amherst. **A White Paper on Wind Turbine Acoustic Noise.** Authors: Anthony L. Rogers, Ph.D. James F. Manwell, Ph.D. Sally Wright. Amended January 2006
10)	South Africa - GNR.154 of January 1992: **Noise control regulations** in terms of section 25 of the Environment Conservation Act (ECA), 1989 (Act No. 73 of 1989)
11)	South Africa - GNR.155 of 10 January 1992: **Application of noise control regulations** made under section 25 of the Environment Conservation Act, 1989 (Act No. 73 of 1989)
12)	South Africa - SANS 10210:2004 Edition 2.2 – **Calculating and predicting road traffic noise**
13)	South Africa - SANS 10357:2004 Version 2.1 - **The calculation of sound propagation by the Concawe method**
14)	South Africa - SANS 10103:2008 Version 6 - **The measurement and rating of environmental noise with respect to annoyance and to speech communication**.
15)	Swedish Environmental Protection Agency – **Noise Annoyance from Wind Turbines – a Review.** Authors: Eja Pedersen, Högskolan i Halmstad. August 2003.
16)	University of Groningen - **11th International Meeting on Low Frequency Noise and Vibration and its Control. Do wind turbines produce significant low frequency sound levels?** GP. van den Berg. September 2003.
17)	World Health Organization – **Guidelines for Community Noise**. 1999

4.5 Palaeontological Report

ALMOND, J.E. 2010. Palaeontological heritage assessment of the Coega IDZ, Eastern Cape Province, 112 pp. plus appendix. Natura Viva cc, Cape Town.

ALMOND, J.E., DE KLERK, W.J. & GESS, R. 2008. Palaeontological heritage of the Eastern Cape. Interim technical report for SAHRA, 25 pp.

ANDERSON, J.M. & ANDERSON, H.M. 1985. Palaeoflora of southern Africa. Prodromus of South African megafloras, Devonian to Lower Cretaceous, 423 pp, 226 pls. Botanical Research Institute, Pretoria & Balkema, Rotterdam.

ANDREWS, C.W. 1910. Description of a new plesiosaur (Plesiosaurus capensis sp. nov.) from the Uitenhage beds of Cape Colony. Annals of the South African Museum 7, 309-323, pl. 18, 4 textfigs.

ANON. 2001. Palaeontological assessment, Section 12, pp 102-112 in Environmental Scoping Report: Proposed Transmission Line between Poseidon Substation and Grassridge Substation, Eastern Cape. Eskom Website.

ATHERSTONE, W.G. 1857. Geology of Uitenhage. The Eastern Province Monthly Magazine 1, 518-532 and 580 -595.

BAMFORD, M.K. 1986. Aspects of the palaeoflora of the Kirkwood and Sundays River Formations, Algoa Basin, South Africa. Unpublished M.Sc. Thesis, Univ. Witwatersrand, 160pp.

BARNARD, K.H. 1962. Revised list of South African Late Tertiary and Pleistocene marine molluscs. Transactions of the Royal Society of South Africa 36, 179-196.

BROOM, R. 1904. On the occurrence of an opisthocoelian dinosaur (Algoasaurus bauri) in the Cretaceous beds of South Africa. Geological Magazine 5:445-447.

BROWN, J.T. 1977a. The morphology and taxonomy of Cycadolepis jenkinsiana and Zamites recta from the Lower Cretaceous of South Africa. Palaeontologia africana 20, 43-46.

BROWN, J.T. 1977b. On Araucarites rogersii Seward from the Lower Cretaceous Kirkwood Formation of the Algoa Basin, Cape Province, South Africa. Palaeontologia africana 20, 47-51.

COOPER, M.R. 1979. A new species of Myophorella (Bivalvia, Trigoniidae) from the Sunday"s River Formation, South Africa. Annals of the South African Museum 78 (3), 21-27.

COOPER, M.R. 1981. Revision of the Late Valanginian Cephalopoda from the Sundays River Formation of South Africa, with special reference to the Genus Olcostephanus. Annals of the South African Museum 83: 147-366, 206 figs.

COOPER, M.R. 1983. The ammonite genus Umgazaniceras in the Sundays River Formation. Transactions of the Geological Society of South Africa 86(1):63-64.

COOPER, M.R. 1991. Lower Cretaceous Trigonioida (Mollusca, Bivalvia) from the Algoa Basin, with a revised classification of the order. Annals of the South African Museum 100:1-52.

DINGLE, R.V., SIESSER, W.G. & NEWTON, A.R. 1983. Mesozoic and Tertiary geology of southern Africa. viii + 375 pp. Balkema, Rotterdam.

DU TOIT, A.L. 1954. The geology of South Africa (3rd edition). 611 pp, 41 pls, geological map insert.

ENGELBRECHT, L.N.J., COERTZE, F.J. & SNYMAN, A.A. 1962. Die geologie van die gebied tussen Port Elizabeth en Alexandria, Kaapprovinsie. Explanation to geology sheet 3325 D Port Elizabeth, 3326 C Alexandria and 3425 B, 54pp., 8 pls. Geological Survey of South Africa / Council for Geosciences, Pretoria.

GESS, R. W. (undated). Palaeontological heritage report for proposed Chlor-Alkali and Salt Plant at Coega, 4 pp.

GESS, W.H.R. 1951/1952. Excavation of a Pleistocene bone deposit at Aloes near Port Elizabeth. South African Archaeological Bulletin 24, 31-32.

GOEDHART, M.L. & HATTINGH, J. 1997. The geology of the Coega river mouth and proposed adjacent industrial development zone, Eastern Cape. Report No. 1997-0008, 1-6 pp including appendices, maps. Council for Geoscience, Pretoria.

HATTINGH, J. & GOEDHART, M.L. 1997. Neotectonic control on drainage evolution in the Algoa Basin, Eastern Cape. South African Journal of Geology 100, 43-52.

HAUGHTON, S.H. 1928. The geology of the country between Grahamstown and Port Elizabeth. An explanation of Cape Sheet No. 9 (Port Elizabeth), 45 pp. Geological Survey / Council for Geoscience, Pretoria.

HAUGHTON, S.H. 1935. The geology of portion of the country east of Steytlerville, Cape Province. An explanation of Sheet No. 150 (Sundays River), 35 pp. Geological Survey / Council for Geoscience, Pretoria.

HAUGHTON, S.H. 1969. Geological history of southern Africa, 535 pp. Geological Society of South Africa, Johannesburg.

KING, L.C. 1973. Pliocene marine fossils from the Alexandria Formation in the Paterson District, Eastern Cape Province, and their geomorphic significance. Transactions of the Geological Society of South Africa 75: 159-160.

KITCHIN, F.L. 1908. The invertebrate fauna and palaeontological relationships of the Uitenhage Series. Annals of the South African Museum 7(2):21-250, pls. 2-11.

KLINGER, H.C. & KENNEDY, W.J. 1979. Cretaceous faunas from southern Africa: Lower Cretaceous ammonites, including a new bochianitid genus from Umgazana, Transkei. Annals of the South African Museum 78: 11-19.

LAZO, D.G. 2007. Early Cretaceous bivalves of the Neuquén Basin, west-central Argentinia: notes on taxonomy, palaeobiogeography and palaeoecology. Geological Journal 42, 127-142.

LE ROUX, F.G. 1987a. Tertiary macrofossils of the Alexandria Formation - a supplementary list. Annals of the Geological Survey of South Africa 21: 65-74.

LE ROUX, F.G. 1987b. Lithostratigraphy of the Alexandria Formation. Lithostratigraphic Series, South African Committee for Stratigraphy, 1, 18 pp. Council for Geoscience, Pretoria.

LE ROUX, F.G. 1987c. Note on fluvial deposits overlying the Tertiary Alexandria Formation in the Algoa Basin. Annals of the Geological Survey of South Africa 21, 77-81.

LE ROUX, F.G. 1989a. Lithostratigraphy of the Bluewater Bay Formation. Lithostratigraphic Series, South African Committee for Stratigraphy, 10, 9 pp. Council for Geoscience, Pretoria.

LE ROUX, F.G. 1990a. Algoa Group. In: Johnson, M.R. (Ed.) Catalogue of South African Lithostratigraphic Units, 2, 1-2. South African Committee for Stratigraphy. Council for Geoscience, Pretoria.

LE ROUX, F.G. 1990b. Palaeontological correlation of Cenozoic marine deposits of the southeastern, southern and western coasts, Cape Province. South African Journal of Geology 93: 514-518.

LE ROUX, F.G. 1992. Lithostratigraphy of the Nanaga Formation (Algoa Group). Lithostratigraphic Series, South African Committee for Stratigraphy, 15, 9 pp. Council for Geoscience, Pretoria.

LE ROUX, F.G. 1993. Updated macrofossil checklists for Cenozoic marine deposits along the south-eastern and southern Cape coasts, South Africa. South African Journal of Science 89: 375 – 386.

LE ROUX, F.G. 2000. The geology of the Port Elizabeth – Uitenhage area. Explanation of 1: 50 000 geology Sheets 3325 DC and DD, 3425 BA Port Elizabeth, 3325 CD and 3425 AB Uitenhage, 3325 CB Uitenhage Noord and 3325 DA Addo, 55pp. Council for Geoscience, Pretoria.

MACRAE, C. 1999. Life etched in stone. Fossils of South Africa. 305pp. The Geological Society of South Africa, Johannesburg.

MAUD, R.R. & BOTHA, G.A. 2000. Deposits of the South Eastern and Southern Coasts. Pp. 19-32 in Partridge, T.C. & Maud, R.R. (Eds.) The Cenozoic of Southern Africa. Oxford Monographs on Geology and Geophysics No 40. Oxford University Press. Oxford, New York.

McLACHLAN, I.R. & McMILLAN, I.K. 1976. Review and stratigraphic significance of southern Cape Mesozoic palaeontology. Transactions of the Geological Society of South Africa. 79: 197-212.

McLACHLAN, I.R. & McMILLAN, I.K. 1979. Microfaunal biostratigraphy, chronostratigraphy and history of Mesozoic and Cenozoic deposits on the coastal margin of South Africa. In: Anderson, A.M. & Van Biljon, W.J. (Eds.) Some sedimentary basins and associated ore deposits of South Africa. Special Publication of the Geological Society of South Africa 6, 161-181.

McMILLAN, I.K. 1990. A foraminiferal biostratigraphy and chronostratigraphy for the Pliocene to Pleistocene upper Algoa Group, Eastern Cape, South Africa. South African Journal of Geology 93: 622-644.

McMILLAN, I. K., 2003. The Foraminifera of the Late Valanginian to Hauterivian (Early Cretaceous) Sundays River Formation of the Algoa Basin, Eastern Cape Province, South Africa. Annals of the South Africa Museum 106:1-274, 84 figs, 4 tables.

MOSTOVSKI, M. & MULLER, B. 2010. [Untitled article on fossil insects from the Sundays River and Kirkwood Formations]. PalNews 17 (3), 9-10.

MUCINA, L. & RUTHERFORD, M.C. (Eds.) 2006. The vegetation of South Africa, Lesotho and Swaziland. Streliztia 19, 807 pp. South African National Biodiversity Institute, Pretoria.

NEWTON, R.B. 1913. On some Cainozoic shells from South Africa. Records of the Albany Museum 2: 315-352.

RAATH, M., HILLER, N. & BAMFORD, M. 1998. Palaeontology, pp. 27-40 in Lubke, R. & De Moor, I. Field guide to the eastern and southern Cape coast. University of Cape Town Press, Cape Town, xxx + 561 pp, 49 pls.

RIGASSI, D.A. & DIXON, G.E. 1972. Cretaceous of the Cape Province, Republic of South Africa. Proceedings, Conference on African geology, Ibadan Dec. 1970, pp. 513-527.

ROBERTS, D.L., BOTHA, G.A., MAUD, R.R. & PETHER, J. 2006. Coastal Cenozoic deposits. Pp. 605 – 628 in Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa. Geological Society of South Africa, Johannesburg & Council for Geoscience, Pretoria.

ROBERTS, D.L., BATEMAN, M.D., MURRAY-WALLACE, C.V., CARR, A.C. & HOLMES, P.J. 2009. West coast dune plumes: climate driven contrasts in dunefield morphogenesis along the western and southern South African coasts. Palaeogeography, Palaeoclimatology, Palaeoecology 271, 24-38.

RUDDOCK, A. 1968. Cainozoic sea-levels and diastrophism in a region bordering Algoa Bay. Transactions of the Geological Society of South Africa 71, 209-233.

SEWARD, A.C. 1903. Fossil floras of Cape Colony. Annals of the South African Museum 4, 1-122. CHECK PLS

SHARPE, D. 1856. Description of fossils from the secondary rocks of Sundays River and Zwartkops River, South Africa, collected by Dr. Atherstone and A. G. Bain, Esq. Transactions of the Geological Society, London (2nd Series) 7(4):193-203.

SHONE, R.W. 1976. The sedimentology of the Mesozoic Algoa Basin. Unpublished MSc thesis, University of Port Elizabeth, 48 pp.

SHONE, R.W. 1986. A new ophiuroid from the Sundays River Formation (Lower Cretaceous), South Africa. Journal of Paleontology 60, 904-910.

SHONE, R.W. 2006. Onshore post-Karoo Mesozoic deposits. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 541-552. Geological Society of South Africa, Marshalltown.

SPATH, L. F. 1930. On the Cephalopoda of the Uitenhage beds. Annals of the South African Museum 28(2):131-157, pls. 13-15, 1 text fig.

TANKARD, A.J., JACKSON, M.P.A., ERIKSSON, K.A., HOBDAY, D.K., HUNTER, D.R. & MINTER, W.E.L. 1982. Crustal evolution of southern Africa – 3.8 billion years of Earth history, xv + 523 pp., pls. Springer Verlag, New York.

TATE, R. 1867. On some secondary fossils from South Africa. Proceedings of the Quarterly Journal of the Geological Society of London 23, 139-175.
TOERIEN, D.K. & HILL, R.S. 1989. The geology of the Port Elizabeth area. Explanation to 1: 250 000 geology Sheet 3324 Port Elizabeth, 35 pp. Council for Geoscience. Pretoria.

WINTER, H. DE LA R. 1973. Geology of the Algoa Basin, South Africa. In: Blant, G. (Ed.) Sedimentary basins of the African coast. Part, 2 South and East Coast, pp. 17-48. Association of African Geological Surveys, Paris.

APPENDIX B

APPENDIX B-1: SHORT *CURRICULUM VITAE* OF EACH OF THE LEAD SPECIALISTS INVOLVED IN THE PROPOSED COEGA WIND ENERGY PROJECT EIA

<table>
<tr><th>SPECIALIST STUDY</th><th>NAME OF SPECIALIST</th><th>DETAILS OF EXPERTISE (SHORT CV)</th></tr>
<tr><td>ECOLOGICAL</td><td>PROF ROY LUBKE</td><td>CURRICULUM VITAE - PROF ROY ALLEN LUBKE

Date of birth: 22 July 1940

QUALIFICATIONS

BSc (Hons.) (Rhodes), M.Sc. (University of Keele), PhD (Univ. Western Ontario)

ASSOCIATIONS

• Member of the South African Institute of Ecologists
• Registered with the S.A. Council of Natural Scientists
• South African Association for Advancement of Science (since 1962)
• International Association of Plant Taxonomy (since 1966)
• Association for the Taxonomic Study of the Flora of Tropical Africa (since 1970)
• South African Association of Botanists (since 1970)
• Botanical Society of Southern Africa (since 1975)
• South African Institute of Ecologists and Environmental Scientists
    o (Founder Member since 1980)
• European Union for Coastal Conservation (since 1991)

PROFESSIONAL EXPERIENCE

1964 - 1968: Laboratory/Tutorial Asst (P/T): University of Western Ontario
1970 - 1974: Lecturer: University of Witwatersrand
1975 - 1976: Lecturer: Rhodes University
1977 - 1983: Senior Lecturer: Rhodes University
1984 -1999: Associate Professor: Rhodes University
2000 – present: Associate Professor and Head of Department of Botany:
Rhodes University
1990 – present: Director of Coastal & Environmental Services

RESEARCH INTERESTS

Over the last 25 years, Professor Roy Lubke has been involved in the study and research of coastal dune systems in the Cape, specialising in stabilisation and rehabilitation of dune systems. He has worked along coasts from Western Cape through eastern South Africa to Mozambique and Kenya and has a fuller understanding of Southern and East African coastal systems. These studies include availability of plant pathogens and vesicular-arbuscular mycorrhiza in dune systems and on dune plants; plant succession and dynamics of dune systems; the effects of potentially invasive species on dune systems and stabilisation and restoration of dune environments. Professor</td></tr>
</table>

Lubke has held CSIR and FRD national programme funded projects in South Africa, and is currently managing a European Union-funded project on marram grass, in association with colleagues from the Netherlands, the United Kingdom and Botswana. He has travelled widely in Europe and North America and visited and consulted on similar projects in the USA and the Netherlands.

POST GRADUATE STUDENT SUPERVISION TO DATE

30 Honours students, 16 MSc students and 8 PhD students.

CONSULTING EXPERIENCE

Project management experience includes:

Principal consultant for the specialist studies for the Environmental Impact Assessments of proposed dune mining on the Eastern Shores of Lake St Lucia.

Project manager for a five-year rehabilitation programme of Samancor"s Chemfos mine on the West Coast.

Other projects and studies include:

Ecological specialist reports for Billiton"s TiGen mineral sand mining EIA in Mozambique.

A position paper on the current ecological knowledge of the Eastern Cape Provincial Coastline: implications for planning and research.

Ecological specialist report for the Coega Industrial Development Zone Strategic Environmental Assessment.

Numerous small-scale Environmental Impact Assessments along the South African coastline.

A pre-feasibility Environmental Impact Assessment of Gencor"s mineral sand mining project in Mozambique

Ecological baseline survey of the Cuango River area, Angola for NSR Environmental, Australia.

Initial Environmental assessment and drafting Terms of Reference of a mineral sand mine along the Kenyan coast for Tiomin Resources, Canada.

The vegetation and floristics of the habitat of the Brenton Blue butterfly, for Endangered Wildlife Trust.

Numerous vegetation surveys in South Africa.

COMMUNITY INVOLVEMENT

Albany Museum

Board of Trustees: Member 1976-1999

Chairman of Natural History sub-committee: 1979-81; 1985

Deputy Chairman of the Board: 1982-84

Wildlife Society of Southern Africa - Grahamstown Branch

Vice-chairman 1981-1981 and 1982-1983

Chairman 1981-1982

Chairman: Publications Committee 1982 - present

Co-ordinating Council for Nature Conservation in the Eastern Cape

Representative of Rhodes University Biological Sciences since 1979

Chairman 1982-1985

		School Science Convention Committee Member 1983 - 1997 Chairman 1991 - 1997 **SELECTED RECENT PUBLICATIONS** Lubke, R.A. and Avis, A.M. (1998) A review of the concepts and application of rehabilitation following heavy mineral dune mining. *Marine Pollution Bulletin* 37: 8-12 Hertling, UM and Lubke, R.A. (1999) Indigenous and *Ammophila arenaria* – dominated dune vegetation in the South African Cape Coast. *Applied Vegetation Science* 2: 157 - 168 Lubke, R.A., Avis, A.M., Steinke, T.D. & Bowker, C.B. (1998) Coastal vegetation. In: Cowling, R.M. & D. Richardson (Eds.) *Vegetation of South Africa*. Cambridge University Press, Cape Town. Lubke, R.A. and de Moor, I. (Eds.) (1998) Field Guide to Eastern and Southern Cape Coasts. Wildlife Society and UCT Press, Cape Town.
	MS. LEIGH-ANN DEWET	LEIGH-ANN ROBYNNE DE WET Date of birth: 01 September 1982 QUALIFICATIONS 2004 - BSc (Botany and Entomology) Rhodes University 2005 – BSc (Hons) with Distinction (Botany) Rhodes University 2007 – MSc (Botany) Rhodes University **THESIS** Pollinator mediated selection in *Pelargonium reniforme* Curtis (Geraniaceae): patterns and processes. **PROFESSIONAL EXPERIENCE** 2007 - 2009: NERC Research Assistant, Rhodes University, Grahamstown The position involved the set-up, maintenance and conducting of a large common or garden experiment determining the effects of global climate change and specifically drought, on grasses. **NOTABLE ACHEIVEMENTS** - SRC representative on the Rhodes University Environmental Committee (2006) - Group Leader of the youth branch of the Jane Goodall Institute, Roots & Shoots (2005 – 2006) - Best young botanist second prize for a presentation entitled: “Population biology and effects of harvesting on *Pelargonium reniforme* (Geraniaceae) in Grahamstown and surrounding areas” at the SAAB conference (2005) -The Putterill Prize for conservation in the Eastern Cape SELECTED PRESENTATIONS

South African Association of Botanists (SAAB) conference, Bloemfontein. 10-14 January 2005

- Population biology and effects of harvesting on *Pelargonium reniforme* (Geraniaceae) in Grahamstown and surrounding areas, Eastern Cape, South Africa.

Thicket Forum, Grahamstown, May 2005

- Harvesting of *Pelargonium reniforme* in Grahamstown; what are the implications for populations of the plant?

South African Association of Botanists (SAAB) conference, Port Elizabeth 16-19 January 2006

- Pollinator-mediated selection in *Pelargonium reniforme* as described by Inter Simple Sequence Repeat markers.

Southern African Society for Systematic Biology (SASSB)

conference, Kruger National Park 14 - 17 July

- Pollinator-mediated selection of *Pelargonium reniforme* and two floral morphs described by inter simple sequence repeat markers.

Population biology of *Pelargonium reniforme*. Annual general meeting. Botanical Society of South Africa, Albany branch. 17th July 2004

Harvesting of *Pelargonium reniforme* in Grahamstown; what are the implications for populations of the plant? Annual general meeting Botanical society of South Africa, Albany branch. 30th July 2005

SELECTED PUBLICATIONS

L. de Wet. (2005). Is *Pelargonium reniforme* in danger? The effects of harvesting on *Pelargonium reniforme*. Veld & Flora. December. 182-184.

L. de Wet, NP Barker and CI Peter (2006). Beetles and Bobartia: an interesting herbivore-plant relationship. Veld & Flora. September. 150-151.

de Wet LR and Botha CEJ. Resistance or tolerance: An examination of aphid (*Sitobion yakini)* phloem feeding on Betta and Betta-Dn wheat (*Triticum aestivum* L.) (2007). South African Journal of Botany 73(1): 35-39.

Ripley BS, de Wet L and Hill MP (2008). Herbivory-induced reduction in photosynthetic productivity of water hyacinth, *Eichhornia crassipes* (Martius) Solms-Laubach (Pontederiaceae), is not directly related to reduction in photosynthetic leaf area. African Entomology 16(1): 140-142.

de Wet LR, Barker NP and Peter CI (2008). The long and the short of gene flow and reproductive isolation: Inter-Simple Sequence Repeat (ISSR) markers support the recognition of two floral forms in *Pelargonium reniforme* (Geraniaceae). Biochemical Systematics and Ecology 36: 684-690.

AVIFAUNA	**Mr. Jon Smallie**	**Date of birth:** 20 October1975 **Qualifications**: BSC –Agriculture (Hons) University of Natal- Pietermaritzburg Pri. Sci.Nat **Occupation:** Field Biologist – Endangered Wildlife Trust – Wildlife and Energy Interaction group) **Duties**: Conduct investigations, impact assessments, studies, research on wildlife interactions with power line infrastructure and wind energy facilities. **1) Wildlife interactions with power lines** *Transmission lines* • Mercury Perseus 400kV • Eros Neptune Grassridge 400kV • Kudu Juno 400kV • Garona Aries 400kV • Perseus Hydra 765kV • Tabor Witkop 275kV • Tabor Spencer 400kV • Moropule Orapa 220kV (Botswana) • Coega Electrification • Majuba Venus 765kV • Gamma Grassridge 765kV • Gourikwa Proteus 400KV • Koeberg Strengthening 400kV • Ariadne Eros 400kV *Transmission lines* • Kanoneiland 22KV • Hydra Gamma 765kV • Komani Manzana 132kV • Rockdale Middelburg 132kV • Irenedale 132 kV • Zandfontein 132kV • Venulu Makonde 132 kV • Spencer Makonde 132 kV • Dalkeith Jackal Creek 132kV • Glen Austin 88kV • Bulgerivier 132kV • Ottawa Tongaat 132kV • Disselfontein 132kV • Voorspoed Mine 132kV • Wonderfontein 132kV • Kabokweni Hlau Hlau 132kV • Hazyview Kiepersol 132kV • Mayfern Delta 132kV • VAAL Vresap 88kV • Arthursview Modderkuil 88kV • Orapa, AK6, Lethakane substations and 66kV lines (Botswana) • Dagbreek Hermon 66kV • Uitkoms Majuba 88kV • Pilanesberg Spitskop 132kV

		• Qumbu PG Bison 132kV • Louis Trichardt Venetia 132kV • Rockdale Middelburg Ferrochrome 132kV • New Continental Cement 132KV • Hillside 88kV • Marathon Delta 132kV • Malelane Boulder 132kV • Nondela Strengthening 132kV • Spitskop Northern Plats 132kV • West Acres Mataffin 132kV • Westgate Tarlton Kromdraai 132kV • Sappi Elliot Ugie 132kV • Melkhout Thyspunt 132kV *Electricity Generation projects* • Eskom Concentrated Solar Power Plant • West Coast Wind Energy Facility • Hopefield Wind Energy Facility • PE Wind Energy Facility • Exxaro West Coast Wind Monitoring Mast – Basic Assessment • Kouga Wind Energy Facility • Coega Wind Energy Facility • Bronkhorstspruit Solar Photovoltaic Plant • Cookhouse Wind Energy Facility *Electricity Generation projects* Hydra-Droerivier 1,2 & 3 400kV; Hydra-Poseidon 1,2 400kV; Butterworth Ncora 66kV; Nieu-Bethesda 22kV; Maclear 22kV (Joelshoek Valley Project); Wodehouse 22kV (Dordrecht district); Burgersdorp Aliwal North Jamestown 22kV; Cradock 22kV; colesberg area 22kV; Loxton self build 11kV; Kanoneiland 22kV; Stutterheim Municipality 22kV; Majuba-Venus 400kV; Chivelston-Mersey 400kV; Marathon-Prairie 275kV; Delphi-Neptune 400kV; Ingagane – Bloukrans 275kV; Ingagane – Danskraal 275kV; Danskraal – Bloukrans 275kV *Avifaunal "walk through" (EMP"s)* • Beta Delphi 400kV • Mercury Perseus 765kV • Perseus 765kV Substation • Beta Turn 765kV in lines • Spencer Tabor 400kV line • Kabokweni Hlau Hlau 132kV • Mayfern Delta 132kV • Eros Mtata 400kV *Strategic Environmental Assessments for Master Electrification Plans* • Northern Johannesburg area • Southern KZN and Northern Eastern Cape • Northern Pretoria • Western Cape Peninsula *Other specialist studies:*

<table>
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Bird Impact Assessment for Lizzard Point Golf Estate - Vaaldam
Bird Impact Assessment for Lever Creek Estates housing development
Investigation into rotating Bird Flapper saga – Aberdeen 22kV
Investigation of in excess of 80 separate incidents of bird mortalities on power line networks from August 1999 to present
Investigation of bird mortalities at 3 separate substations
Special investigation into faulting on Ariadne-Eros 132kV
Special investigation into Bald Ibis faulting on Tutuka Pegasus 275kV
Special investigation into bird related faulting on 22kV Geluk Hendrina line
Special investigation into bird related faulting on Camden Chivelston 400kV line

Specialist risk assessments for wildlife airport hazards:

Kigali International Airport - Rwanda
Port Elizabeth Airport – specialist study as part of the EIA for the proposed Madiba Bay Leisure Park
Manzini International Airport (Swaziland)
Polokwane International Airport
Mafekeng International Airport
Lanseria Airport

Conferences attended:

September 2000: 5th World Conference on Birds of Prey in Seville, Spain.
2003: Presented a talk on “Birds & Power lines” at the 2003 AGM of the Amalgamated Municipal Electrical Unions – in Stutterheim - Eastern Cape
May 2005: International Bird Strike Committee 27th meeting – Athens, Greece. Presented a paper entitled Bird Strike Data analysis at SA airports 1999 to 2004.
June 2005: IASTED Conference at Benalmadena, Spain – presented a paper entitled “Impact of bird streamers on quality of supply on transmission lines: a case study”
March 27 – 30 2006: International Conference on Overhead Lines, Design, Construction, Inspection & Maintenance, Fort Collins Colorado USA. Presented a paper entitled “Assessing the power line network in the Kwa-Zulu Natal Province of South Africa from a vulture interaction perspective”.
May 2010 - Wind Power Africa 2010. Presented on wind energy and birds
September 2010 – Raptor Research Foundation conference, Fort Collins, Colorado. Presented on the use of camera traps to investigate Cape Vulture roosting behaviour on transmission lines

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</tr>
<tr>
<td>VISUAL
NOISE</td>
<td>MR. HENRY HOLLAND</td>
<td>
HENRY JAMES HOLLAND
Date of birth: 26 December 1968
QUALIFICATIONS
BSc (Hons.) (UOFS), MSc (Rhodes)
</td>
</tr>
</table>

PROFESSIONAL EXPERIENCE

2005-present:	GIS Consultant, Map (this) GIS Consultancy
2000-2004:	GIS Consultant, Self employed
1996-1999:	GIS Manager, SDM

CONSULTING EXPERIENCE

I have consulted in South Africa and Mozambique. Environmental consulting experience, in no particular order, includes:

Remote Sensing

- Established a baseline for monitoring effects of mining activities on vegetation using change detection techniques on multi-temporal SPOT satellite imagery, Corridor Sands Limitada, Mozambique

Visual Impact Assessment

- Kouga Windfarm VIA, Jeffreysbay
- Boschfontein VIA, Chicken Broiler Housing, Uitenhage
- Telkom tower replacement, Elarduspark, Pretoria
- Loerie VIA, Chicken Broiler Housing

GIS Coordinator

- Kromme River Analysis
- Amahlathi SEA
- Ngqushwa SEA
- Madiba Bay Leisure Resort
- WMA12 SEA

Cartographic Support

- Amahlathi AWRM Phase II
- Elitheni Coal Mining EMP Phase 3A
- Numerous Geotechnical Projects
- Mentorskraal Estate Scoping, Eastern Cape
- Amahlathi AWRM
- Izizwe AWRM
- Amanzi Estate ERA
- Madiba Bay EIA
- Hunters Development, Knysna, Eastern Cape
- Environmental Plan for Prospecting Rights - Guba Hoek, Eastern Cape
- Wells Estate Water Pipeline, Eastern Cape
- Pierpoint Development, Knysna, Eastern Cape 2004
- Simola Phase II, Eastern Cape
- Kelvin Jones Wastewater Treatment Plant, Port Elizabeth, Eastern Cape
- Cola Beach ERA, Sedgefield, Eastern Cape
- Various maps for publication in journals, Department of Statistics, Rhodes University

Visibility Analysis

- Krommensee Visibility Study (Site Selection)
- Seaview EIA Site selection
- Hydra Gamma project
- Coffee Bay Site selection
- Eskom Breyten strengthening project
- Eskom Eiland project
- Eskom Everest - Simplon project
- Eskom Matimba - Witkop No 2 400 kV Transmission line

		- December 2003 alternative alignment • Eskom Matimba - Witkop No 2 400 kV Transmission line – alternative alignment • Eskom Ikaros project • Eskom Matimba - Witkop project • Eskom Coega - Grassridge project • N2 Wild Coast Toll Road Project **Other GIS projects** • River bank migration rate and erosion study - Ingleside Estate, Eastern Cape • River bank migration rate and erosion study - Colchester, Eastern Cape • Ridge/dune migration and erosion study - Sedgefield, Eastern Cape • GreatKei SEA, Eastern Cape 2003 • Baviaanskloof Wetland Identification Project
NOISE	**MR. BRETT WILLIAMS**	**BRETT WILLIAMS** **Born:** April, 21, 1963 **Nationality:** South African **Identity Number, SA:** 6304215081084 **Work:** Managing Member, Safetech, PO Box 27607, Greenacres 6057, Mobile: 0825502137, brett.williams@safetechsa.co.za Brett Williams has been involved in Health Safety and Environmental Management since 1987, and has been measuring noise related impacts since 1996. Brett is the owner of Safetech who have offices in Pretoria and Port Elizabeth. He has consulted to many different industries including, mining, chemical, automotive, food production etc. He is registered with the Department of Labour and Chamber of Mines to measure environmental stressors, which include chemical monitoring, noise and other physical stresses. He has also been trained by the United States Environmental Protection Agency on air pollution measurement and dispersion modelling. He has submitted a doctoral thesis through the University of Pretoria for examination on the relationship between polluting organisations and the receiving community. **TERTIARY EDUCATION** • National Diploma Health & Safety Management • Bachelor of Arts (UPE) • United States EPA Pollution Measurement course conducted at the University Of Cincinnati (EPA Training Centre) • US EPA Air Dispersion Modelling Training Course • Master of Business Administration (University of Wales) with dissertation on environmental reporting in South Africa. • PhD - Currently registered at University of Pretoria. The thesis has been submitted for external examination and graduation is possible in 2009. • Various Health & Safety Courses. • Environmental Auditor (ISO 14001:2004)

<table>
<tr><td></td><td></td><td>KEY EXPERIENCE

The Table below presents an abridged list of Brett Williams" project experience relevant to this proposal:

• Crown Chickens – The independent report review of a noise specialist report conducted as part of an EIA to establish a new broiler farm
• BMW – The evaluation of the impact of the Rosslyn production facilities on the surrounding community.
• Victory Race Track - Specialist noise report conducted as part of an EIA to establish a new stock car racing track.
• Continental Tyre - The evaluation of the impact of production facilities on the surrounding community.
• Media 24 – The measurement portion of an investigation on the impact of a printing press on a local community. The main study was conducted by the University of Stellenbosch.
• Zwartebosh Quarry - Specialist noise report conducted as part of an EIA to establish a new quarry.
• Milo Granite - Specialist noise report conducted as part of an EIA to establish a new quarry.
• Dunlop Tyres - The evaluation of the impact of production facilities on the surrounding community.
• Sasol Secunda - Independent report review of a noise specialist report conducted to determine the impact of production facilities on the surrounding community.
• Barlow World Coatings - The evaluation of the impact of production facilities on the surrounding community.
• Western Platinum Refinery - The evaluation of the impact of production facilities on the surrounding community.
• CSIR – Noise Impact Study of Namwater Desalination Plant
• CSIR - Kouga Wind Turbine Project – Background Noise Measurements</td></tr>
<tr><td>PALAEONTOLOGICAL</td><td>DR. JOHN E. ALMOND</td><td>DR. JOHN E. ALMOND

• Honours Degree in Natural Sciences (Zoology), University of Cambridge, UK (1980).

• PhD in Earth Sciences (Palaeontology), University of Cambridge, UK (1986).

• Post-doctoral Research Fellowships at University of Cambridge, UK and Tübingen University, Germany (Humboldt Research Fellow).

• Visiting Scientist at various research institutions in Europe, North America, South Africa and fieldwork experience in all these areas, as well as in North Africa.

• Scientific Officer, Council for Geoscience, RSA (1990-1998) – palaeontological research and fieldwork – especially in western RSA and Namibia.

• Managing Member, Natura Viva cc – a Cape Town-based company specialising in broad-based natural history education, tourism and research – especially in</td></tr>
</table>

		the Arid West of Southern Africa (2000 onwards). *Natura Viva* cc produces **technical reports** on palaeontology, geology, botany and other aspects of natural history for public and private nature reserves. • **Current palaeontological research** focuses on fossil record of the Precambrian / Cambrian boundary (especially trace fossils), and the Cape Supergroup of South Africa. Also **reviews of fossil records** relating to new 1: 250 000 geological maps published by the Council for Geoscience (Geological Survey of SA) – *e.g.* Clanwilliam, Loeriesfontein, Alexander Bay sheets. • **Registered Field Guide** for **South Africa** and **Namibia** • **Member of the A-team, Botanical Society of SA** (Kirstenbosch Branch) – involved in teaching and training leaders for botanical excursions. Invited leader of annual Botanical Society excursions (Kirstenbosch Branch) to Little Karoo, Cederberg, Namaqualand and other areas since 2005. • **Professional training of Western and Eastern Cape Field Guides** (FGASA Level 1 & 2, in conjunction with *The Gloriosa Nature Company*) and of Tourist Guides in various aspects of natural history. • Involved in **extra-mural teaching in natural history** since the early 1980s. Extensive experience in **public lecturing**, running **intensive courses** and leading **field excursions for professional academics as well as enthusiastic amateurs** (*e.g.* Geological Society / Archaeological Society / Friends of the SA Museum / Cape Natural History Club / Mineral Club / Botanical Society of South Africa / SA Museum Summer & Winter School Programmes / UCT Summer School) • **Development of palaeontological teaching materials** (textbooks, teachers guides, palaeontological displays) and **teacher training** for the new school science curriculum (GET, FET). • **Palaeontological impact assessments** for developments in the Western, Eastern and Northern Cape. Member of **Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC)**. Advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA (APM Permit Committees for both organisations). Compilation of **technical reports on provincial palaeontological heritage of Western, Northern and Eastern Cape** for SAHRA and HWC. Accredited member of PSSA and APHAP (Association of Professional Heritage Assessment Practitioners).

APPENDIX B-2: SHORT *CURRICULUM VITAE* OF THE PERSONS WHO COMPILED AND REVIEWED THIS SPECIALIST VOLUME

<table>
<tr><th>ROLE</th><th>NAME OF PERSON</th><th>DETAILS OF EXPERTISE (SHORT CV)</th></tr>
<tr><td>PROJECT LEADER AND REPORT REVIEWER</td><td>MR MARC HARDY</td><td>MR. MARC RICHARD HARDY

Born: 04 May 1972
Phone: 046 622 2364
Nationality: South African
Email: m.hardy@cesnet.co.za

ACADEMIC QUALIFICATIONS

2009 M.Phil Environmental Management (Stellenbosch University).
2002 B.Soc.Sci. (Hons) Environmental & Geographical Science (University of Cape Town).
2001 B.Soc.Sci. Environmental & Geographical Science (University of Cape Town).

EMPLOYMENT HISTORY

November 2009 – Present: Principal Environmental Consultant: Coastal and Environmental Services (Grahamstown)

January 2008 – October 2009: Senior Environmental Consultant: Bohlweki-SSI Environmental (Johannesburg)

January 2006 – December 2007: Principal Environmental Officer/Assistant Director: Gauteng Provincial Department of Agriculture, Conservation and Environment – GDACE (Environmental Planning and Impact Assessment Directorate - Johannesburg)

January 2003 – December 2005: Environmental Consultant/Research Assistant: Various research organisations and institutions (Cape Town)

June – November 2004: Temporary Lecturer: Department of Environmental and Geographical Science (University of Cape Town)

1999 – 2002: Full time studies: University of Cape Town.

1992 – 1998: Commercial Diver/Unit Supervisor: Commercial diving and marine diamond recovery industries off the west coasts of South Africa, Namibia and Angola.

1990 – 1991: Learner Official: Mining engineering graduate training programme (Welkom).

COURSES ATTENDED

• IEMA Certificate course in ISO 14001 EMS and Auditing, 2007
• Certificate course in Project Management, Graduate School</td></tr>
</table>

of Business - University of Cape Town, 2009

RESEARCH & CONSULTING EXPERIENCE

Research:

Marc been involved in numerous projects for the Department of Marine and Coastal Management (MCM) pertaining to various fisheries along the South African coast as a research team member -

- On-board monitoring of rock lobster fishing vessels in the Hangklip concession area, False Bay as part of the Marine and Coastal Management fishery monitoring program, Cape Town (Research Assistant);
- Compilation of a fishery permit holder database and implementation of a community-based catch monitoring system for the Cape South Coast oyster picking fishery for the department of Marine and Coastal Management (Research Assistant);
- The identification and development of potential additional livelihood options, key intervention strategies, as well as the implementation of a community-based catch monitoring system for the Olifants River subsistence fisher community for the Environmental Evaluation Unit - UCT, Cape West Coast (Research Assistant).

Consulting:

Marc has been project manager/team member for the following projects –

- Appointed to various steering committees tasked with developing Spatial Development Frameworks, Integrated Development Plan‟s, Urban Edge Policy and Environmental Management Frameworks for local/ provincial government while employed by GDACE;
- The Dinokeng Project Environmental Management Framework (EMF), Gauteng Province;
- The Tlokwe (Potchefstroom) EMF, North West Province;
- New Vaal Colliery EMPR Audit, Vereeniging, Gauteng Province (EMPPAR);
- Gauteng Freeway Improvement Project environmental compliance audits;
- Usutu Forests Due Diligence audit, Swaziland
- Due Diligence audit, Cerebos salt works Port Elizabeth, Eastern Cape Province
- The upgrade of the Ashwater Return Process at Arnot Power Station, Mpumalanga Province (Basic Assessment);
- Multi products fuel transport infrastructure (rail and pipeline) from Milnerton refinery to Atlantis OCGT power station (Full EIA), Cape Town;
- Matla Power Station-Jupiter B-Sebenza 400KV overhead powerlines and Substations, Mpumalanga and Gauteng Provinces (Full EIA);
- Johannesburg East electricity supply strengthening project:

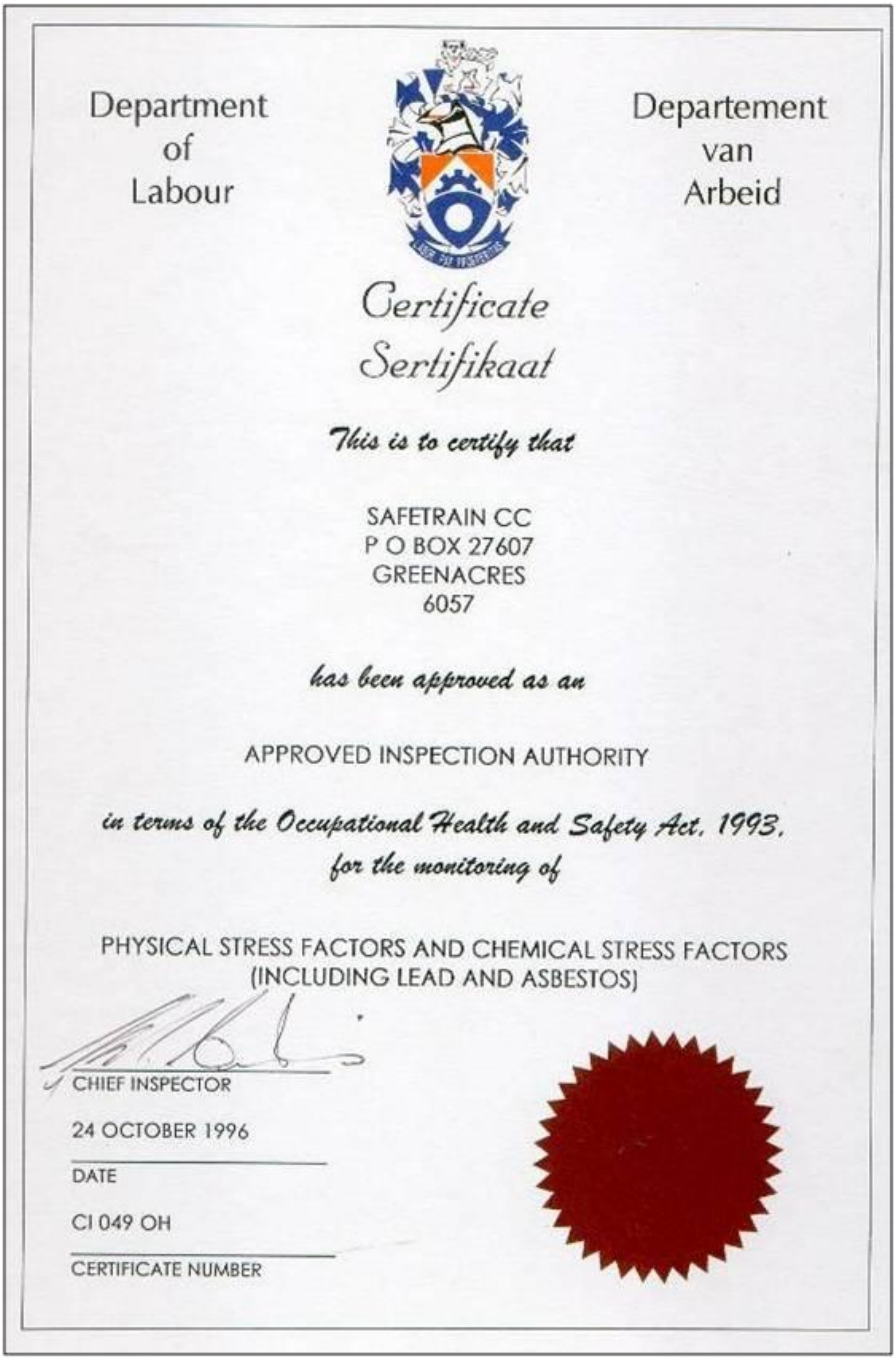
		400/132KV overhead powerlines and Substations, Gauteng Provinces (Full EIA); • Witkloof Thuli 132KV overhead power line, Mpumalanga Province (Full EIA); • Vryburg 400/132KV Substation and loop in lines North-West Province (Full EIA); • Komati Power Station EMP compliance audits, Mpumalanga Province; • Camden Power Station EMP compliance audits, Mpumalanga Province; • Grootvlei Power Station EMP compliance audits, Mpumalanga Province; • Boulders Malelane 132KV overhead power line, Mpumalanga Province (Full EIA); • Tarlton Magaliesburg 132KV overhead power line, North-West Province (Full EIA); • Watershed Sephaku 132KV overhead power line, North-West Province (Full EIA); • Ingagane Power Station Waste landfill closure, KZN Province (Basic Assessment and landfill closure permit); • Terra Wind Energy Cookhouse Project, Eastern Cape Province (Full EIA); • Grahamstown wind energy project, Eastern Cape Province (Full EIA); • Thomas River and Chaba wind energy project, Eastern Cape Province (Full EIA); • Coega/Grassridge wind energy project, Eastern Cape Province (Full EIA); • Coega IDZ (St Georges Interchange) filling stations, Eastern Cape Province (Full EIA); • Numerous meteorological monitoring masts for wind energy projects (Basic Assessment); • Various Water Use Licence Applications (WULA‟s) for Rand Water, Gauteng Province; • Regional Hazardous Waste Disposal Facility for the Coega IDZ, Eastern Cape Province (Full EIA and Permit Application Report - PAR); • Various pipeline applications for Rand Water (Basic Assessments); • Xstrata Ferrochrome bag filter plant upgrades, North-West Province (Basic Assessment); • Addax Bioenergy sugarcane to ethanol biofuel project, Sierra Leone (Full ESIA); • Lokomasama oil palm plantation and biofuel project, Port Loko, Sierra Leone (Full ESIA) **SKILLS** Development, planning and management of projects; management of research teams and support staff; preparation and management of budgets in excess of R1 million; EIA reporting and EMP development for linear, energy and bulk infrastructure projects; environmental and due diligence auditing, compliance monitoring; strategic policy planning and reporting.

		PROFESSIONAL MEMBERSHIP • International Association for Impact Assessment (IAIAsa – Member No: 2416)
REPORT COMPILATION	**MR HYLTON NEWCOMBE**	**HYLTON NEWCOMBE** Date of Birth: 14 May Languages: English **QUALIFICATIONS** • B.Sc. [Ichthyology, Zoology and Environmental Science] – Rhodes University, 2005 • B.Sc. Honours [Ichthyology] – Rhodes University, 2006 • MSc [Fish **EMPLOYMENT EXPERIENCE** • Junior Environmental Consultant, Coastal & Environmental Services (January2010 – present) Assisting on numerous environmental projects in the broad fields of Environmental Impact Assessment and Environmental Management, including but not limited to basic assessments, scoping and EIA studies, and baseline surveys, as well as having administrative duties. My responsibilities include being part of and/or leading a project team, as well as co-ordinating and allocating tasks and budgets to team members. I have organised and been part of numerous field (site) visits, and have demonstrated efficiency and professionalism in client and authority liason. I am experienced in the public participation process (maintenance of a database of Interested & Affected parties, public meetings, responding to public comments and concerns), and have the ability and skills to assist with and/or manage a wide range of projects. Working as a consultant, I have learnt that extreme flexibility, an ability to cope with intense time pressures and being able to multi-task are key for a successful working environment. **CES PROJECT INVOLVEMENT** **Listed from date of employment to current** • Two wind farm EIAs in the Eastern Cape, Western Cape for Terra Wind Energy (Pty) Ltd • Two wind farm BAs in the Eastern Cape and Western Cape for Terra Power (Pty) Ltd • Two wind farm BAs in the Eastern Cape for Innowind (Pty) Ltd • Sama Valley Eco-Estate EIA – Port Edward, for DN Labtrust • Kenmare Moma long-term marine monitoring

		programme, for Kenmare Moma (Mauritius) Pty Ltd. • ADDAX Biofuel ESIA, for ADDAX Bioenergy, SA, Genève • Knysna Estuary Management Plan • Boundary survey and demarcation of indigenous state forests in the Wild Coast

APPENDIX C: NOISE CERIFICATION

APPENDIX C-1: AIA Certificate



Department of Labour

Departement van Arbeid

Certificate

Sertifikaat

This is to certify that

SAFETRAIN CC
P O BOX 27607
GREENACRES
6057

has been approved as an

APPROVED INSPECTION AUTHORITY

in terms of the Occupational Health and Safety Act, 1993, for the monitoring of

PHYSICAL STRESS FACTORS AND CHEMICAL STRESS FACTORS (INCLUDING LEAD AND ASBESTOS)

CHIEF INSPECTOR

24 OCTOBER 1996

DATE

CI 049 OH

CERTIFICATE NUMBER

APPENDIX C-2: Calibration certificate

SANAS

ACCREDITED
LABORATORY
146 1382

De Beer Calibration Services

De Beer Calibration Services cc
Registration No. 2000/0[illegible]852/23
VAT No. [illegible]
East Dale Pavilion
C/o Hans Strydom and Jacqueline Drives
Garsfontein, Pretoria East
P.O. Box 905-654, Garsfontein [illegible]
Tel Int. +27 12 998 2172
Fax Int. +27 12 998 2173

CERTIFICATE OF CALIBRATION

CERTIFICATE NUMBER	2009-035
ORGANISATION	SAFE-TECH
CALIBRATION OF	INTEGRATING SOUND LEVEL METER complete with ½" MICROPHONE and ⅓-OCTAVE/OCTAVE FILTER
CALIBRATED BY	M.W. DE BEER
MANUFACTURER	RION
MODEL NUMBERS	NL-32, UC-53 A and NX-22RT
SERIAL NUMBERS	00151075, 307806 and 00150957 V2.2
DATE OF CALIBRATION	5 JANUARY 2009
RECOMMENDED DUE DATE	JANUARY 2010
PAGE NUMBER	PAGE 1 OF 4

This certificate is issued in accordance with the conditions of approval granted by the South African National Accreditation System (SANAS). This Certificate may not be reproduced without the written approval of SANAS and De Beer Calibration Services.

Calibrations performed by this laboratory are in terms of standards, the accuracies of which are traceable to national measuring standards as maintained by the NMISA.

The measurement results recorded in this certificate were correct at the time of calibration. The subsequent accuracy will depend on factors such as care, handling, frequency of use and the amount of different users. It is recommended that re-calibration should be performed at an interval, which will ensure that the instrument remains within the desired limits and/or manufacturer's specifications.

The South African National Accreditation System (SANAS) is member of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). This arrangement allows for mutual recognition of technical test and calibration data by member accreditation bodies worldwide. For more information on the arrangement please consult www.ilac.org

M.W. DE BEER (SANAS AUTHORIZED SIGNATORY)

8 January 2009
DATE OF ISSUE

Director: M.W. de Beer