PROPOSED TERRA WIND ENERGY GOLDEN VALLEY PROJECT
BLUE CRANE ROUTE LOCAL MUNICIPALITY, COOKHOUSE
EASTERN CAPE PROVINCE OF SOUTH AFRICA

ENVIRONMENTAL IMPACT ASSESSMENT
VOLUME 2: SPECIALIST REPORTS

Prepared for:	Prepared by:
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South Africa	South Africa

October 2010

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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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

LIST OF ACRONYMS

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 Institue
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

Terra Power Solutions (Pty) Limited (TPS), a renewable energy company, and General Electric International (Benelux) B.V. the largest wind turbine manufacturer in the world, have formed a joint development company, Terra Wind Energy Golden Valley (Pty) Ltd, which plans to develop a wind powered electricity generation facility (known as a ‘wind farm’) on the eleven farms: Olive Wood Estate, Olive Fonteyn, Quaggas Kuyl, Lushof, Kroonkop, Oude Smoor Drift, Maatjiesfontein, Leuwe Drift, Gedagtenis, Varkens Kuyl and Wagenaarsdrift, all found around the town of Cookhouse, located in the Blue Crane Route Local Municipality (BCRM) in the Eastern Cape Province of South Africa.

As per the Background Information Document (BID) and Newspaper Adverts, the proposed project had originally been planned to host between 150-200 turbines, each with a nominal power output ranging between 1.5-2.5 Mega Watts (MW). The total potential output of the wind farm would have been 300MW with the wind farm covering an area of approximately 29400 hectares (ha). Please note that the proposed project is now planned to host 214 turbines (as per the *Final Scoping Report: Proposed Terra Wind Energy Golden Valley Project, Blue Crane Route Local Municipality*. CES, Grahamstown dated December 2009), each with a nominal power output of 2.5 Mega Watts (MW). The total potential output of the wind farm will therefore be 500MW but the wind farm will still cover the same area.

In accordance with the requirements of the National Environmental Management Act (Act No 107 of 1998) (NEMA), and relevant EIA regulations made in terms of this Act and promulgated in April 2006 (Government Notice No 385), and listed activities under (Government Notice Nos 386 and 387), the proposed project requires a full Scoping and Environmental Impact Assessment (EIA). Coastal & Environmental Services (CES) have been appointed by Terra Power Solution (Pty) Limited as Environmental Assessment Practitioner (EAP) to conduct the EIA. Under Regulation 33 of GNR 385, 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 33 of GNR 385:

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. 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.

A Plan of Study (PoS) for the EIA Phase which outlined the specialist studies that would be undertaken for the proposed project was submitted together with the Final Scoping Report (FSR) for review and comment on 8 December 2010 to the competent authority that must consider and decide on the application for authorisation in respect of the listed activities triggered by the proposed Terra Wind Energy Golden Valley Project who in this case is the Department of Environmental Affairs (DEA), formerly the Department of Environmental Affairs and Tourism (DEAT). DEA approved the PoS and advised the EAP in terms of Regulation 31(1) (a) to, "*proceed with the tasks contemplated in the PoS for environmental impact assessment*" i.e. the detailed EIA Phase. The following Specialist Studies were therefore undertaken –

- Ecological (encompassing fauna and flora)
- Avifauna
- Noise
- Visual
- Heritage
- 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 Chapters of this volume (Chapters 4-7) 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).

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 Terra Power Solutions (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 – Heritage Specialist Report

Chapter 9 – Palaeontological Specialist Report

2 PROJECT DESCRIPTION

This chapter identifies the location and size of the site of the proposed Terra Wind Energy Golden Valley 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 Terra Wind Energy Golden Valley Project is to be constructed on 29,400 hectares (ha)(total area of the development and not the actual physical footprint of the turbines) encompassing the eleven farms Olive Wood Estate, Olive Fonteyn, Quaggas Kuyl, Lushof, Kroonkop, Oude Smoor Drift, Maatjiesstontein, Leuwe Drift, Gedagtenis, Varkens Kuyl and Wagenaarsdrift all found around Cookhouse (refer to Table 2-1 for details of the portions/erf numbers that comprise these farms), located in the Blue Crane Route Municipality (BCRM) in the Eastern Cape Province of South Africa (Figure 2-1 and Figure 2-2). Table 2-2 provides the coordinates of the proposed project site including the preliminary location of each wind turbine.

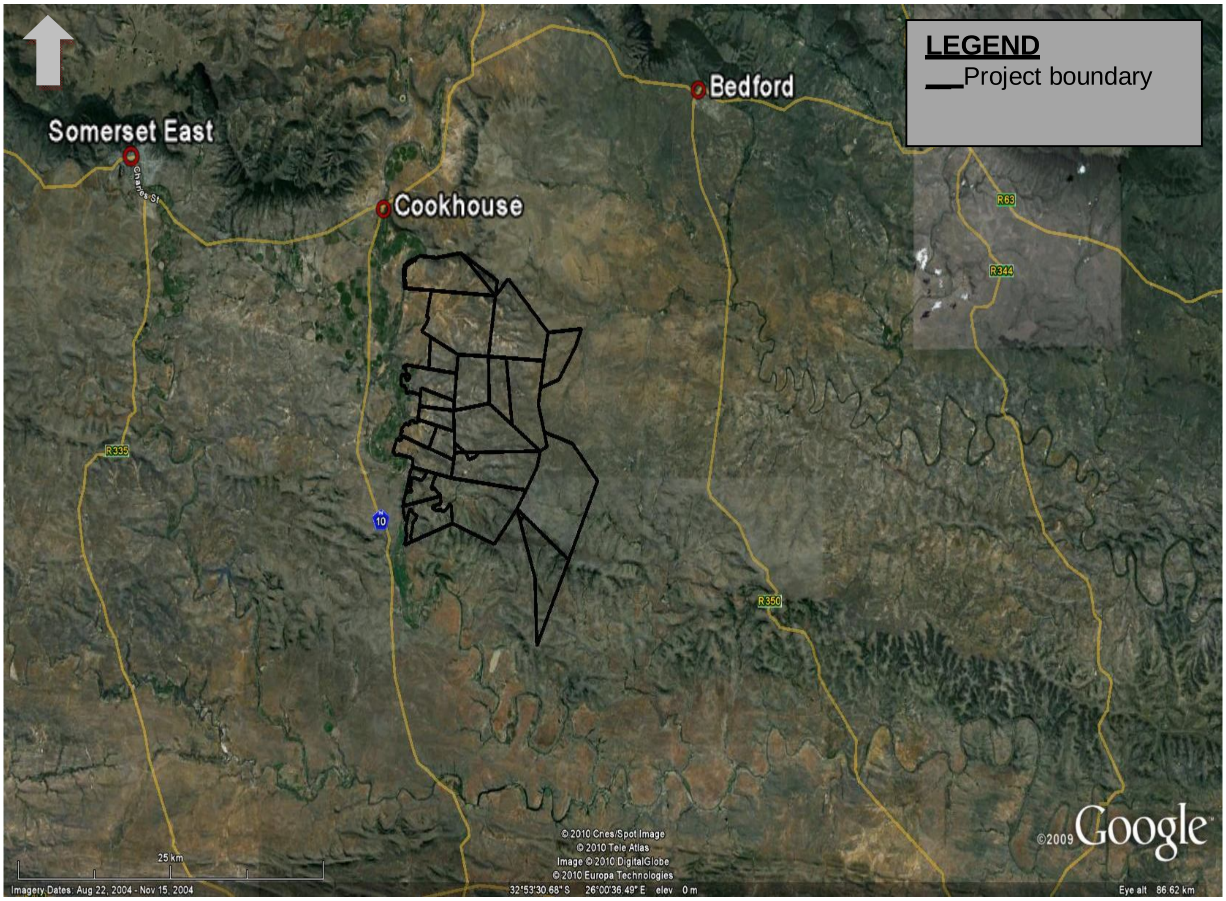

Figure 2-1: Locality map of the proposed Terra Wind Energy Golden Valley Project, showing the boundary of the project site in relation to surrounding towns.

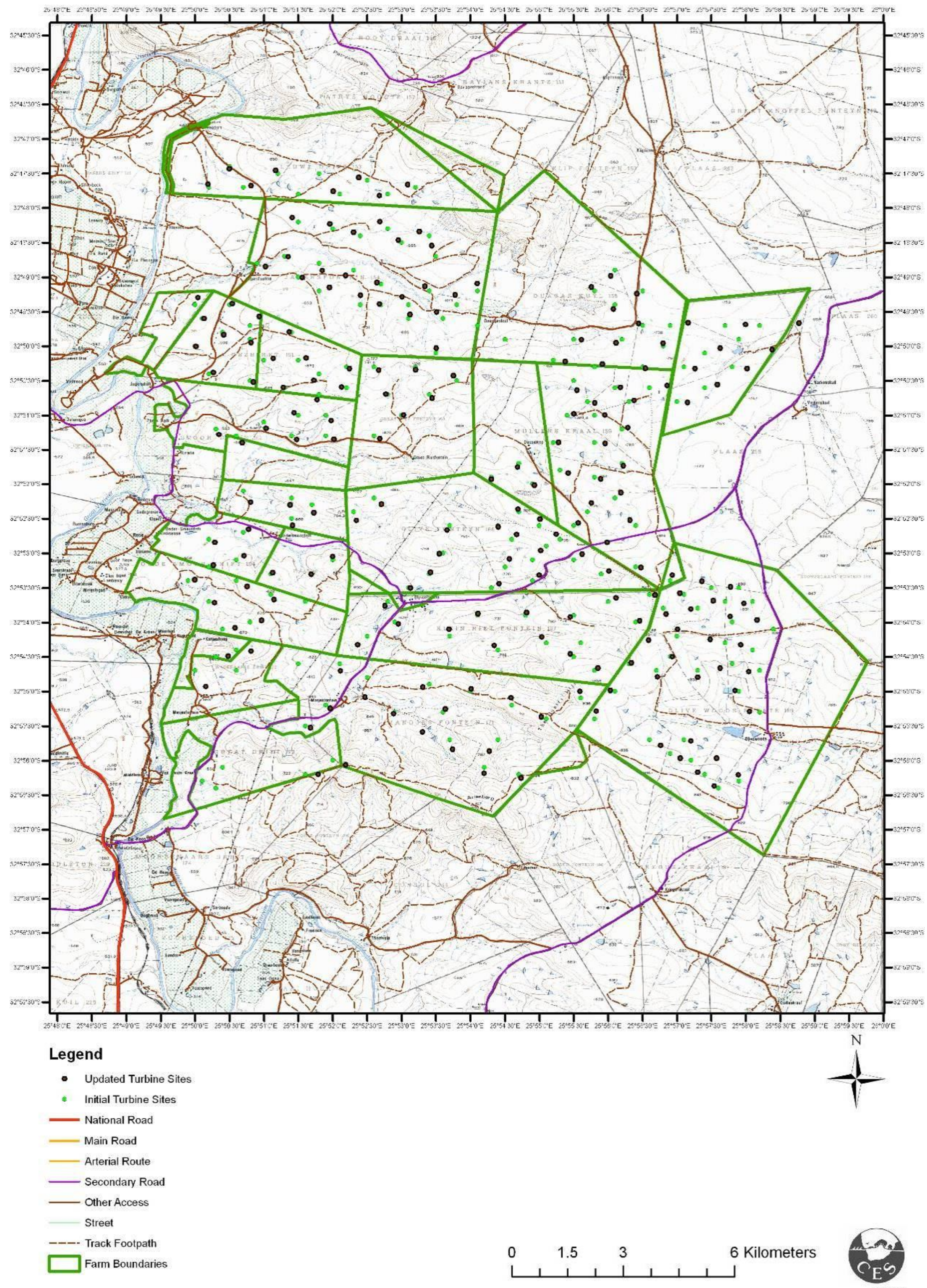

Figure 2-2: Site Layout Plan indicating the initial and revised location of proposed Terra Wind Energy Golden Valley Project. Turbines are represented by the black dots.

Table 2-1: Portions/erf numbers the study area farms

FARM NAME	ERF NUMBERS
Olive Wood Estate	• Portion 2 of the consolidated Farm Olive Woods No. 169, Bedford, in the Nxuba Municipality, Division of Bedford, Eastern Cape Province
Olive Fonteyn	• The Farm Olive Fonteyn No. 166, situated as below • Remainder of the Farm Mullerskraal No. 159, Bedford, in the Nxuba Municipality, Division of Bedford, Eastern Cape Province • The Farm Klien Rietfontein No. 167, situated as above
Quaggas Kuyl	• The Farm Quaggas Kuyl No. 155, Bedford, in the Nxuba Municipality, Division of Bedford, Eastern Cape Province • The Farm Jagersfontein No. 154, situated as above • Portion 10 of the Farm Gezhiret No. 161, situated as above • Portion 17 of the Farm Smoor Drift No. 162, as situated as above • The Farm Great Riet Fonteyn No. 160, situated as above
Lushof	• Portion 24 of the Farm Oude Smoor Drift No. 164, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province • Portion 37 of the Farm Oude Smoor Drift No. 164, as situate above. • Portion 47 of the Farm Oude Smoor Drift No. 164, as situate above. • Portion 14 of the Farm Smoor Drift No. 162, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province
Kroonkop	• Portion 3 of the Farm Oude Smoor Drift No. 164, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province • Portion 7 of the Farm Oude Smoor Drift No. 164, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province • Portion 16 of the Farm Oude Smoor Drift No. 164, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province • Portion 1 of the Farm Mullerskraal No. 159, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province
Ondersmoordrift	• Portion 40 of the Farm Oude Smoor Drift No. 164 • Portion 42 of the Farm Oude Smoor Drift No. 164
Matjiesfontein	• Portion 1 of the Farm Creguskraal No. 181, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province • The Farm No. 283 Matjiesfontein, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province
Leuwe Drift	• Remainder extent of the Farm 153, Leuwe Drift, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province • Portion 1 of the Farm Bavians Krantz No. 151, situated as above
Gedagtenis	• Portion 14 of the Farm 164, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province • Portion 34 of the Farm 164, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province • Portion 35 of the Farm 164, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province • Portion 36 of the Farm 164, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province • Portion 38 of the Farm 164, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province
Varkens Kuyl	• Portion 1 of the Farm Varkens Kuyl No. 158, Bedford, in the Nxuba Municipality, Division of Bedford, Eastern Cape Province
Wagenaarsdrift	• The Farm No. 172, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province • Portion 2 of the Farm No. 172, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province • Portion 2 of the Farm No. 173, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province • The Farm No. 284, Bedford, in the Blue Crane Route Municipality, Division of Bedford, Eastern Cape Province

Table 2-2: Revised coordinates of the turbines for the proposed Terra Wind Energy Golden Valley Project (Decimal Degrees) - Note: 214 turbines are proposed for the Terra Wind Energy Golden Valley Project. 204 turbines are shown in this table as a preliminary turbine layout.

Turbine Number (Also refer to Figure 2-1)	Coordinates (DD)		Wind Turbine Number	Coordinates (DD)		Wind Turbine Number	Coordinates (DD)		Wind Turbine Number	Coordinates (DD)	
	SOUTH	EAST		SOUTH	EAST		SOUTH	EAST		SOUTH	EAST
Turbine 1	-32.82768	25.95267	Turbine 56	-32.83697	25.92292	Turbine 111	-32.89174	25.88544	Turbine 166	-32.93619	25.95503
Turbine 2	-32.79456	25.84688	Turbine 57	-32.84392	25.92580	Turbine 112	-32.89600	25.87935	Turbine 167	-32.93952	25.95900
Turbine 3	-32.82667	25.83547	Turbine 58	-32.84329	25.93627	Turbine 113	-32.90041	25.88258	Turbine 168	-32.92865	25.95335
Turbine 4	-32.79050	25.84156	Turbine 59	-32.84279	25.94759	Turbine 114	-32.89955	25.84940	Turbine 169	-32.92970	25.94599
Turbine 5	-32.79421	25.83646	Turbine 60	-32.84256	25.95980	Turbine 115	-32.89447	25.85243	Turbine 170	-32.91319	25.94525
Turbine 6	-32.79085	25.85288	Turbine 61	-32.84684	25.95259	Turbine 116	-32.88801	25.85213	Turbine 171	-32.91636	25.93388
Turbine 7	-32.79588	25.86674	Turbine 62	-32.84638	25.93960	Turbine 117	-32.88840	25.86150	Turbine 172	-32.90972	25.93887
Turbine 8	-32.79701	25.87800	Turbine 63	-32.84691	25.93010	Turbine 118	-32.88419	25.86663	Turbine 173	-32.90425	25.94310
Turbine 9	-32.79256	25.87292	Turbine 64	-32.84995	25.93254	Turbine 119	-32.89532	25.83803	Turbine 174	-32.90759	25.92417
Turbine 10	-32.79427	25.88485	Turbine 65	-32.84963	25.92495	Turbine 120	-32.89132	25.84590	Turbine 175	-32.91102	25.93079
Turbine 11	-32.80325	25.87809	Turbine 66	-32.85299	25.93813	Turbine 121	-32.88975	25.83320	Turbine 176	-32.90357	25.91721
Turbine 12	-32.80767	25.88257	Turbine 67	-32.85657	25.92126	Turbine 122	-32.88622	25.83772	Turbine 177	-32.90563	25.90576
Turbine 13	-32.80562	25.88762	Turbine 68	-32.85685	25.93258	Turbine 123	-32.88394	25.84521	Turbine 178	-32.90169	25.89476
Turbine 14	-32.80901	25.89066	Turbine 69	-32.86223	25.93703	Turbine 124	-32.88073	25.83809	Turbine 179	-32.91669	25.92653
Turbine 15	-32.80583	25.87166	Turbine 70	-32.86535	25.93156	Turbine 125	-32.87658	25.85696	Turbine 180	-32.92140	25.93048
Turbine 16	-32.80381	25.86599	Turbine 71	-32.86402	25.92366	Turbine 126	-32.87760	25.84631	Turbine 181	-32.92278	25.91720
Turbine 17	-32.80230	25.85685	Turbine 72	-32.86688	25.91542	Turbine 127	-32.87150	25.87843	Turbine 182	-32.91816	25.90976
Turbine 18	-32.81677	25.85931	Turbine 73	-32.86262	25.91139	Turbine 128	-32.87356	25.86207	Turbine 183	-32.91608	25.90023
Turbine 19	-32.81169	25.85585	Turbine 74	-32.86545	25.90500	Turbine 129	-32.87165	25.85629	Turbine 184	-32.91556	25.88846
Turbine 20	-32.81410	25.85036	Turbine 75	-32.87270	25.91155	Turbine 130	-32.87104	25.84684	Turbine 185	-32.92093	25.89391
Turbine 21	-32.81504	25.86418	Turbine 76	-32.87123	25.92932	Turbine 131	-32.83970	25.83769	Turbine 186	-32.92650	25.88838
Turbine 22	-32.81622	25.86985	Turbine 77	-32.86872	25.93643	Turbine 132	-32.84190	25.84747	Turbine 187	-32.93645	25.90334
Turbine 23	-32.81796	25.87735	Turbine 78	-32.87507	25.91682	Turbine 133	-32.83623	25.85225	Turbine 188	-32.93059	25.89571

Turbine Number (Also refer to Figure 2-1)	Coordinates (DD)		Wind Turbine Number	Coordinates (DD)		Wind Turbine Number	Coordinates (DD)		Wind Turbine Number	Coordinates (DD)	
	SOUTH	EAST		SOUTH	EAST		SOUTH	EAST		SOUTH	EAST
Turbine 24	-32.81630	25.93396	Turbine 79	-32.87692	25.90672	Turbine 134	-32.83614	25.86017	Turbine 189	-32.93104	25.90462
Turbine 25	-32.83339	25.83347	Turbine 80	-32.87881	25.91112	Turbine 135	-32.84329	25.85475	Turbine 190	-32.93754	25.91222
Turbine 26	-32.83243	25.84686	Turbine 81	-32.87880	25.92079	Turbine 136	-32.83870	25.87067	Turbine 191	-32.92204	25.88139
Turbine 27	-32.82613	25.84892	Turbine 82	-32.87603	25.92602	Turbine 137	-32.84321	25.86879	Turbine 192	-32.91800	25.87450
Turbine 28	-32.83052	25.84028	Turbine 83	-32.88352	25.92705	Turbine 138	-32.83902	25.87785	Turbine 193	-32.90542	25.87266
Turbine 29	-32.82992	25.85619	Turbine 84	-32.88272	25.91700	Turbine 139	-32.84491	25.87953	Turbine 194	-32.91176	25.86853
Turbine 30	-32.82158	25.83410	Turbine 85	-32.88076	25.93311	Turbine 140	-32.83893	25.88668	Turbine 195	-32.92069	25.86600
Turbine 31	-32.82309	25.84232	Turbine 86	-32.87777	25.89439	Turbine 141	-32.83376	25.89177	Turbine 196	-32.92536	25.86131
Turbine 32	-32.81909	25.86588	Turbine 87	-32.88339	25.89247	Turbine 142	-32.84036	25.89583	Turbine 197	-32.93441	25.86978
Turbine 33	-32.82101	25.87340	Turbine 88	-32.88795	25.89027	Turbine 143	-32.84579	25.89074	Turbine 198	-32.93669	25.86314
Turbine 34	-32.82310	25.87802	Turbine 89	-32.88472	25.90947	Turbine 144	-32.84995	25.88380	Turbine 199	-32.90132	25.84308
Turbine 35	-32.82143	25.88345	Turbine 90	-32.88863	25.91660	Turbine 145	-32.85564	25.87811	Turbine 200	-32.90693	25.84692
Turbine 36	-32.81883	25.88892	Turbine 91	-32.89067	25.90692	Turbine 146	-32.85129	25.86629	Turbine 201	-32.90815	25.84132
Turbine 37	-32.82090	25.89632	Turbine 92	-32.89790	25.90179	Turbine 147	-32.84940	25.85736	Turbine 202	-32.91548	25.83590
Turbine 38	-32.81816	25.90165	Turbine 93	-32.89763	25.91354	Turbine 148	-32.85471	25.83904	Turbine 203	-32.84625	25.86291
Turbine 39	-32.82569	25.88532	Turbine 94	-32.89868	25.92415	Turbine 149	-32.85664	25.84474	Turbine 204	-32.84157	25.86205
Turbine 40	-32.82507	25.89183	Turbine 95	-32.88762	25.93352	Turbine 150	-32.85312	25.85054	Turbine 205	To be confirmed on final micro-siting of turbines	
Turbine 41	-32.81905	25.92925	Turbine 96	-32.89412	25.93526	Turbine 151	-32.85593	25.85792	Turbine 206		
Turbine 42	-32.82428	25.93458	Turbine 97	-32.87536	25.93864	Turbine 152	-32.85584	25.86693	Turbine 207		
Turbine 43	-32.82067	25.94029	Turbine 98	-32.88675	25.94126	Turbine 153	-32.87541	25.87245	Turbine 208		
Turbine 44	-32.83248	25.93520	Turbine 99	-32.89344	25.94462	Turbine 154	-32.91647	25.96403	Turbine 209		
Turbine 45	-32.82778	25.94071	Turbine 100	-32.89962	25.94099	Turbine 155	-32.93681	25.96484	Turbine 210		
Turbine 46	-32.83262	25.94663	Turbine 101	-32.89802	25.94732	Turbine 156	-32.90543	25.96538	Turbine 211		
Turbine 47	-32.82806	25.96661	Turbine 102	-32.88867	25.94886	Turbine 157	-32.91192	25.96744	Turbine 212		
Turbine 48	-32.82768	25.97951	Turbine 103	-32.89009	25.95605	Turbine 158	-32.92155	25.96755	Turbine 213		
Turbine 49	-32.83371	25.96045	Turbine 104	-32.89683	25.95335	Turbine 159	-32.90168	25.95012	Turbine 214		

Turbine Number (Also refer to Figure 2-1)	Coordinates (DD)		Wind Turbine Number	Coordinates (DD)		Wind Turbine Number	Coordinates (DD)		Wind Turbine Number	Coordinates (DD)	
	SOUTH	EAST		SOUTH	EAST		SOUTH	EAST		SOUTH	EAST
Turbine 50	-32.83408	25.97307	Turbine 105	-32.89299	25.95064	Turbine 160	-32.90827	25.94893			
Turbine 51	-32.83869	25.95437	Turbine 106	-32.89478	25.95879	Turbine 161	-32.90413	25.95806			
Turbine 52	-32.83865	25.96693	Turbine 107	-32.89863	25.96290	Turbine 162	-32.91100	25.96043			
Turbine 53	-32.83856	25.94235	Turbine 108	-32.89146	25.96303	Turbine 163	-32.91328	25.95500			
Turbine 54	-32.83765	25.93187	Turbine 109	-32.89550	25.96619	Turbine 164	-32.93276	25.95076			
Turbine 55	-32.83175	25.92684	Turbine 110	-32.89942	25.96939	Turbine 165	-32.93279	25.95957			

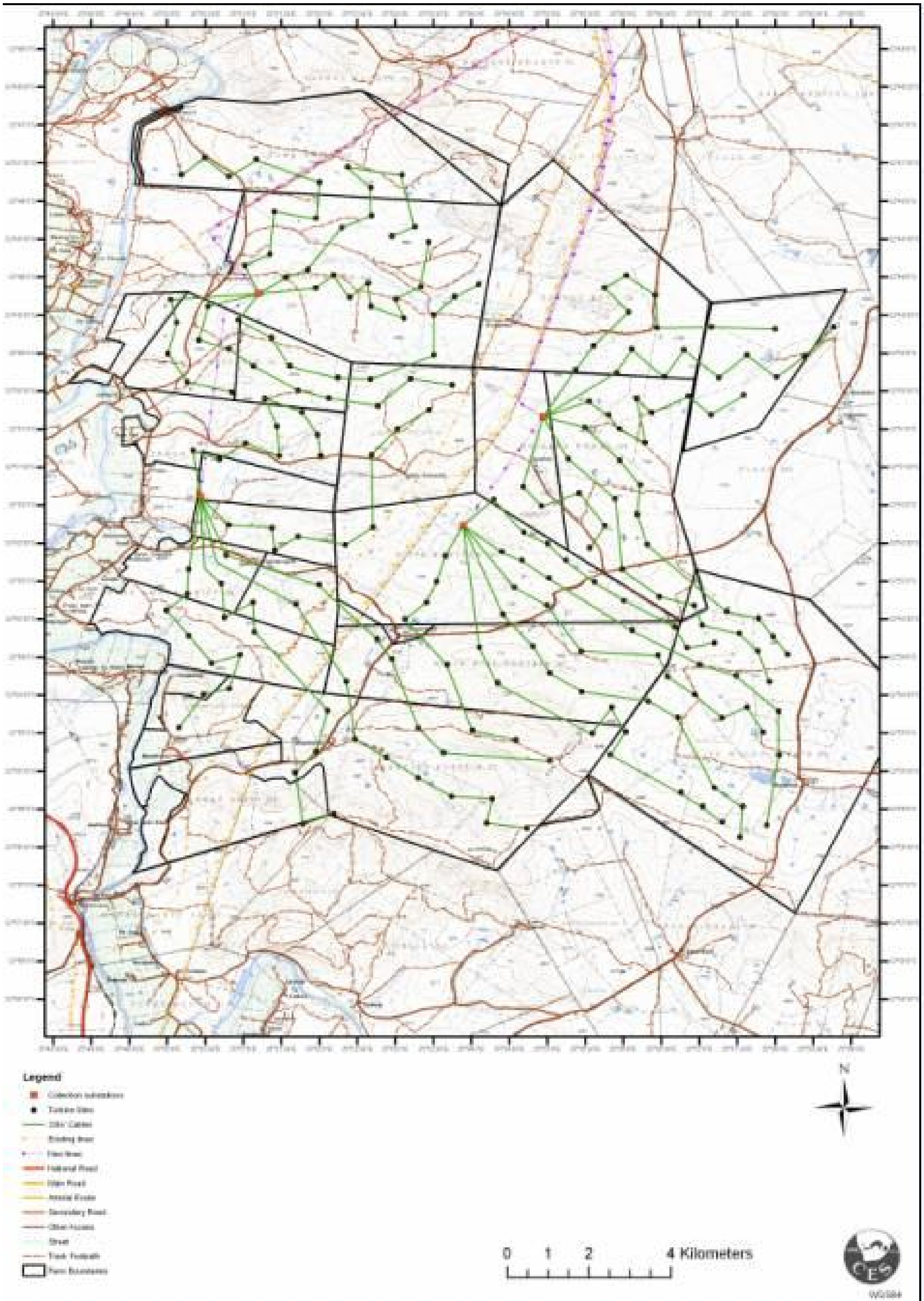

Figure 2-3: Locality map indicating the electrical cable, road hub, access road and sub-station layout of the proposed Terra Wind Energy Golden Valley Project. Turbines are represented by the black dots.

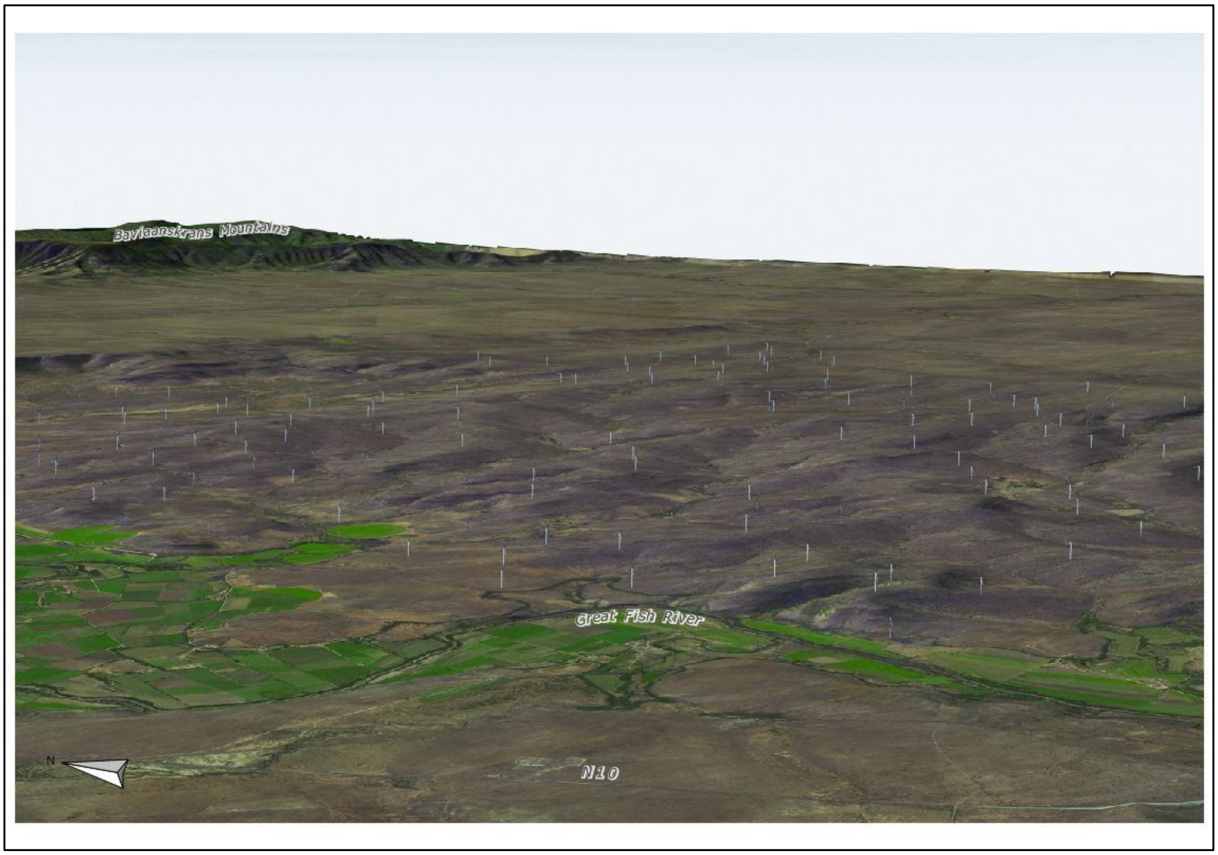

Figure 2-4: Proposed Terra Wind Energy Golden Valley Project in relation to recognisable features in the landscape: N10, Great Fish River and Baviaanskrans Mountains in the background.

Figure 2-5: View south-east from Cookhouse with wind turbines super-imposed in the background. The closest wind turbine is 6km away.

Figure 2-6: View west from Olyvenfontein residence with turbine super-imposed in the photo. The turbine is 500m away.

Figure 2-7: A potential scenic view from the ridge north of the wind farm site. The view is towards the south-west with the Baviaanskrans farmstead just below this site and to the left of the photograph. The farm house has a view down onto the wind farm, but the house faces west and is surrounded by high trees, particularly in the direction of this view. The turbines have been super-imposed into the photo.

Figure 2-8: Current view north-east on the N10 with wind turbines super-imposed in the background.

2.2 Detailed description of the proposed Terra Wind Energy Golden Valley Project

2.2.1 Roads

Figure 2-9 indicates the proposed location of the roads associated with the proposed Terra Wind Energy Golden Valley Project. 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, Terra Power Solution expect 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 2-10):-

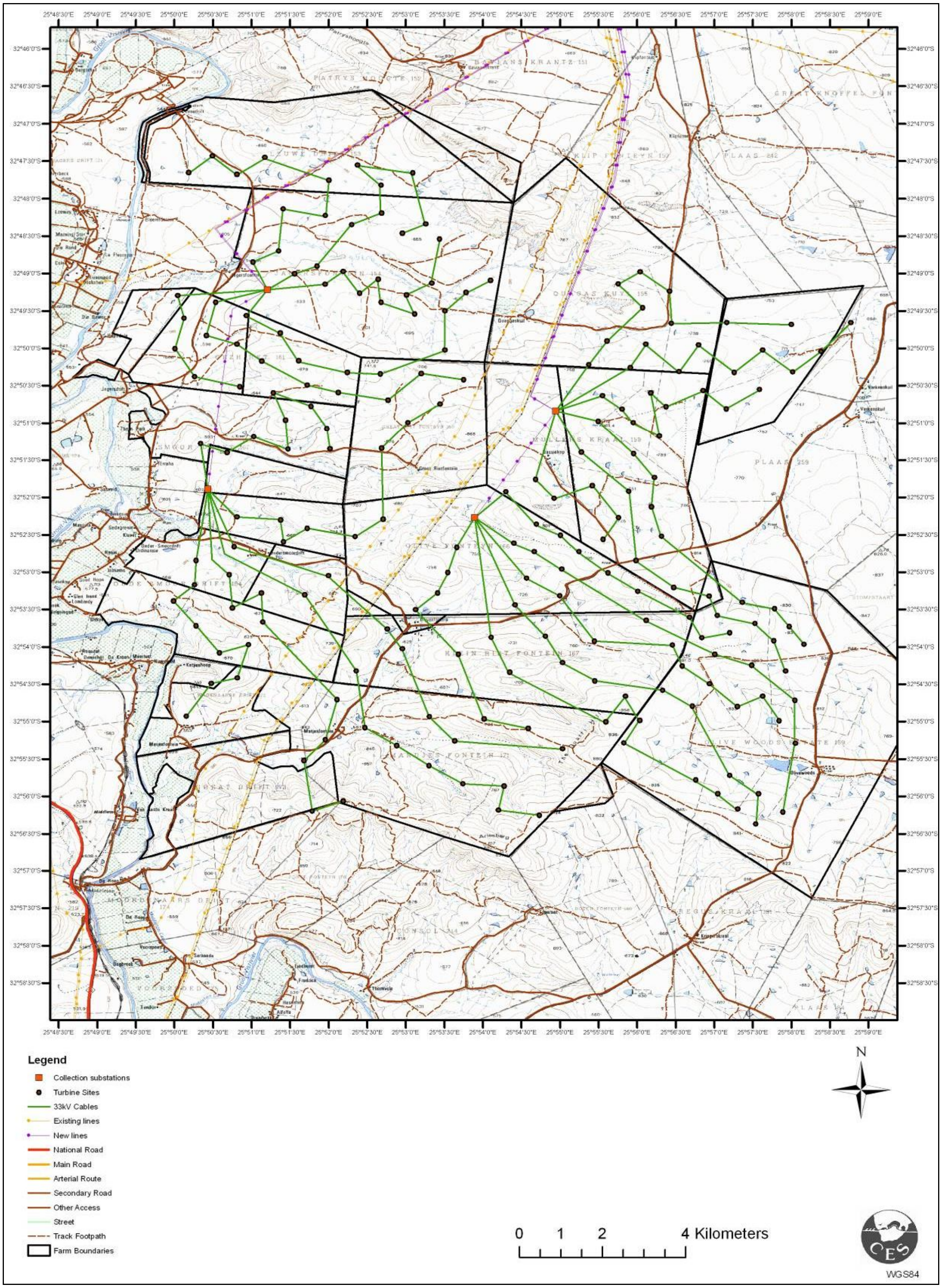

Figure 2-9: Roads associated with the proposed Terra Wind Energy Golden Valley Project. Note that the purple line represents the expected routing of the 33kV underground cable to the sub-station.

- *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.

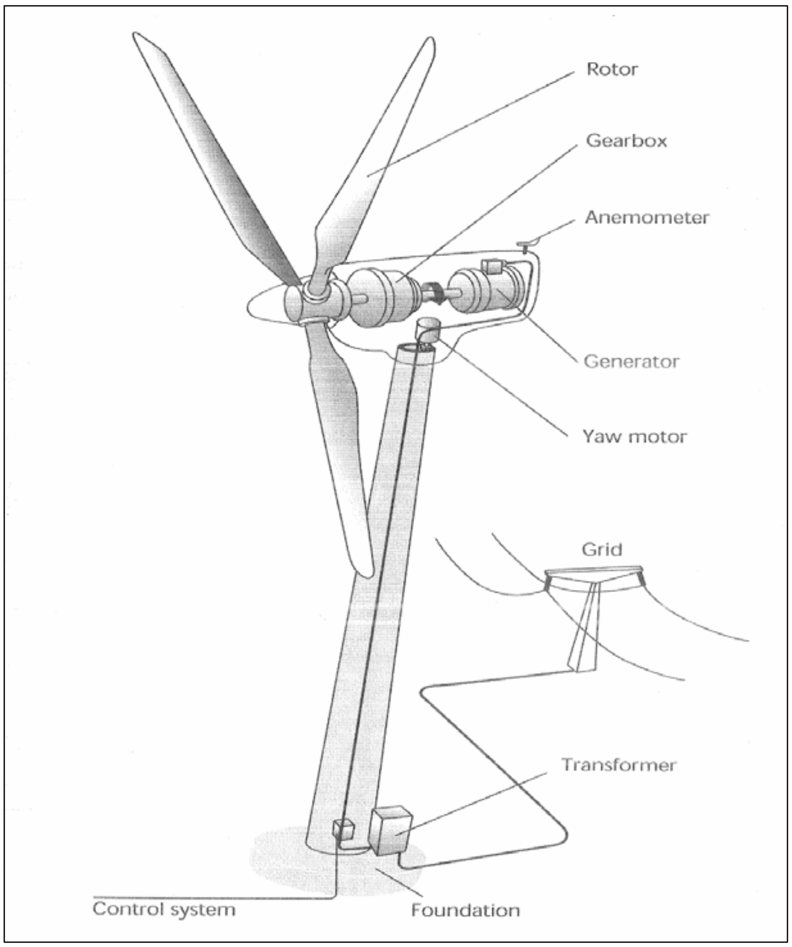

Figure 2-10: Illustration of the main components of a typical wind turbine
P.S: Note that the transformer in the figure above would normally be <u>inside</u> the tower (probably at the base).
Source: Terra Power Solution (Pty) Limited

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 Terra Wind Energy Golden Valley Project.

2.2.3 Measurement mast

On 17 February 2010, the competent authority, who in this case was the Department of Environmental Affairs (DEA) – formerly the Department of Environmental Affairs and Tourism (DEAT) granted the environmental authorisation (Authorisation Register Number: 12/12/20/1715) for Terra Power Solution (Pty) Limited to erect four temporary 80m measurement masts on the farms Quaggaskuil, Smoorsdrift, Varkenskuil and Olive Wood Estate to gather wind speed data and correlate these measurements with other meteorological data in order to produce a final wind model of the above-mentioned farms.

It is necessary to erect wind measurement masts to gather wind speed data and correlate these measurements with other meteorological data in order to produce a final wind model of the proposed project site. A measurement campaign of <u>no less than</u> 18 months duration is necessary to ensure that a bankable wind resource study can be produced as well as to validate the initial wind turbine mapping.

The four proposed 80-meter masts are a highly versatile meteorological tower designed specifically for wind resource measurements (see Figure 2-11). It is ice-rated for extreme climates, and exceeds EIA-222-F Standards (http://www.nrgsystems.com/sitecore/content/Products/4042.aspx). Superior design and sturdy galvanized steel tube construction make the tower reliable and easy to transport to remote sites. Tower tube sections slide together, then tilt up from the ground using a ginpole and winch. No cranes or concrete foundations are required for installation. The tower will be supported with aircraft cable guy wires and anchored with standard screw-in anchors (although depending on soil conditions, another type of the anchor might be used). The mast will have to be 'marked' as per the requirements of the Civil Aviation Authority.

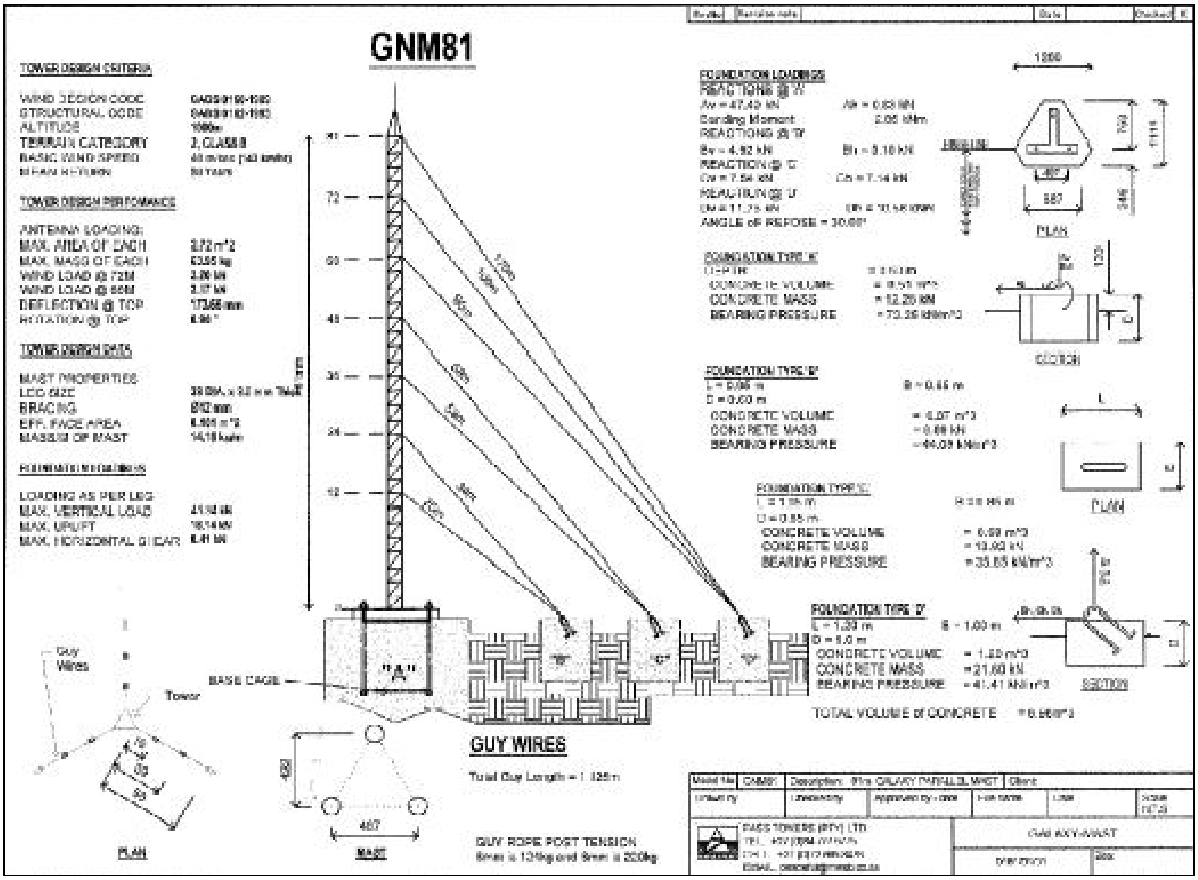

Figure 2-12: Typical measurement mast that will be erected to gather wind speed data with other meteorological data to produce a final wind model of the proposed project site prior to the establishment of a wind farm.

2.2.4 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 2-12 with underground foundation, tower base, above ground foundation, and ground level.

Terra Power Solution (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 2-12.

(c) Electrical cabling

As discussed above, electrical and communication cables are run approximately 1m deep, under or immediately alongside the access roads. The routing of these roads is shown in Figure 2-9.

(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

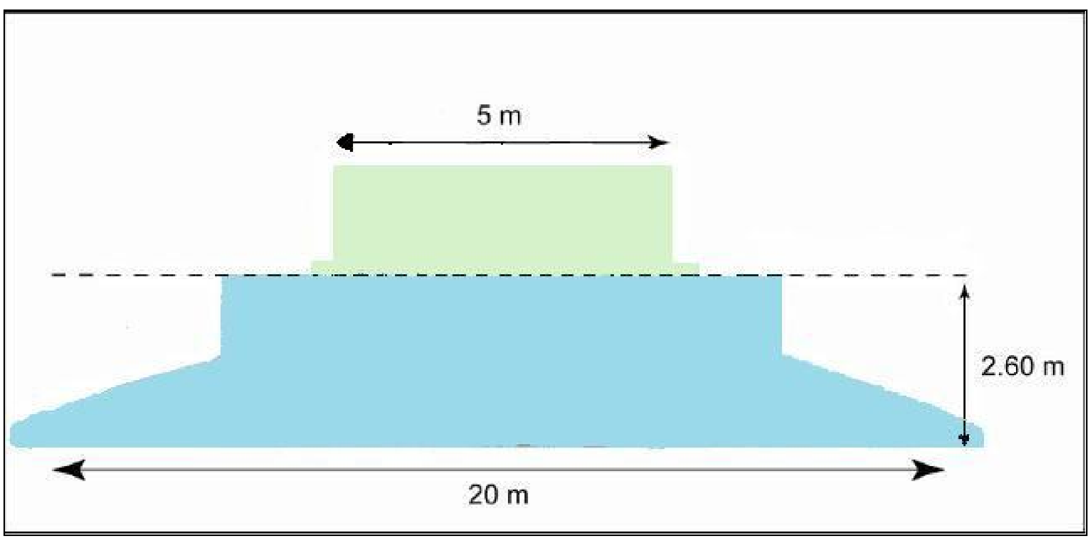

Figure 2-13: The main typical dimensions for the foundation of a 2.5MW/80-100m high wind turbine.

*** 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.

3 THE SPECIALIST STUDY 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 Terra Wind Energy Golden Valley 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 Terra Wind Energy Golden Valley 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 Luke Strugnell	Endangered Wildlife Trust	Private Bag X11, Parkview 2122
Visual	MapThis	Mr. Henry Holland	8 Cathcart Street, Grahamstown 6139
Heritage	ACO Associates CC	Dr. Tim Hart	8 Jacobs Ladder St James 7945
		Dr. Lita Webley	
Ecological	Coastal and Environmental Services	Prof. Roy Lubke	67 African Street, Grahamstown 6139
		Ms. Leigh-Ann De Wet	
		Mr. Colin Fordham	
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 Ms. Samantha Bodill 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 Terra Wind Energy Golden Valley 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 specialist Chapters that follow. 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.

Likelihood	Effect: 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 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

4 ECOLOGICAL SPECIALIST REPORT

Prepared for:	Prepared by:
Terra Power Solution (Pty) Limited PO Box 68063 Bryanston, 2021 South Africa	**Coastal & Environmental Services** GRAHAMSTOWN P.O. Box 934, Grahamstown, 6140 Also in EAST LONDON South Africa

<u>This report should be cited as</u>:

Lubke, R and DeWet, L., January 2010. *Proposed Terra Wind Energy Golden Valley Project: Ecological Assessment.* CES, Cookhouse.

4.1 Introduction

4.1.1 Background Information

This specialist study was undertaken to describe the ecological environment of the proposed Terra Wind Energy Golden Valley Project site and to determine the impact of the proposed facility on the surrounding ecological environment. This report does not assess the potential impacts on avi-fauna as this is addressed in a separate specialist study (Chapter 5 of this specialist volume).

4.1.2 Terms of Reference

This assessment will follow on from the initial study conducted during the scoping report and will address any key issues raised by the interested and affected parties. The specialist study will include but will not be limited to:

A detailed description of the ecology within and immediately surrounding the footprint of the proposed development will consider terrestrial fauna (mammals, reptiles, amphibians, and insects) and flora. This report will specifically:

- Identify areas of high biodiversity on the site;
- Note the presence of species of special concern, including sensitive, endemic and protected species;
- Record habitat associations and conservation status of the identified fauna and flora;
- Note the presence of areas sensitive to invasion by alien species; and
- Map conservation areas and sensitive habitats where disturbance should be avoided or minimised.

An assessment of the potential direct and indirect impacts resulting from the proposed development and associated infrastructure, both on the footprint and the immediate surrounding area during construction and operation;
A detailed description of appropriate mitigation measures that can be adopted to reduce negative impacts for each phase of the project, where required.

4.1.3 Relevant Legislation

4.1.3.1 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 Terra Wind Energy Golden Valley 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

4.1.3.4 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 Terra Wind Energy Golden Valley 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.

4.1.4 Structure of the Report

This report describes the ecology of the proposed development site and assesses the potential impacts on the ecology of the site. Section 4.2 outlines the assessment criteria used to identify impacts and sensitivity, as well as describing the proposed site. Section 4.3 provides a description of the physical environment and biological environment of the proposed project site including flora, vegetation and fauna. The sensitivity of the site is also assessed in this section. Section 4.4 identifies and assesses the ecological impacts of both the construction and operation of the development and finally, Section 4.5 provides conclusions and recommendations based on the impacts described in Section 4.4.

4.1.5 Assumptions and limitations

Limitations of the study included the timing of the field study, which occurred in February, which, though included much of the summer-flowering plants, could have missed much of what could be flowering at other times of the year.

4.1.6 The specialist study team

Prof R. Lubke has been involved with the study and research of the vegetation in the Eastern Cape over the last 30 years, specialising in coastal systems. He has also worked in the Western Cape and Kwa-Zulu Natal and thus has a fuller understanding of South African coastal vegetation and systems. He has also worked on Environmental Impact assessments in Mozambique, Kenya and Madagascar and has consulting experience in Malawi and Angola. Professor Lubke has had extensive experience in environmental projects especially ecological impacts and sensitivity of the environment, due to biodiversity and species rarity and vegetation and habitat sensitivity.

Miss L. de Wet holds an MSc in Botany from Rhodes University. She also holds a B.Sc degree majoring in Botany and Entomology and a B.Sc (Hons) degree in Botany. Leigh-Ann is a botanical specialist with consulting experience in botanical specialist studies. She conducts vegetation assessments for potential developments.

Mr. Colin Fordham

Colin is an Environmental Consultant\Botanical Specialist with CES. He completed his BSc in Botany and Biochemistry as well as his BSc Botany Honours degree, specializing in Environmental Management at NMMU. His honours project focused on riverine work and he also presented a seminar on the use of constructed wetlands and their efficiency with regard to wastewater

4.2 Methodology

4.2.1 Study area field assessment

During February 2010, the proposed Cookhouse wind farm site was visited and the vegetation sampled in relevés (sample plots) within all vegetation types that are present on site (thicket and grassland). All species recorded are listed in Appendix C-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 turbines on sensitive plant communities, habitats and plant and animal species. A brief vegetation survey of the proposed site of the wind farm 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.

4.2.2 Impact rating methodology

The CES impact rating methodology was used to rate the potential ecological impacts that could occur as a result of the proposed Terra Wind Energy Golden Valley Project. This methodology is discussed extensively in Section 3.3 in Chapter 3 above and will therefore not be repeated here.

4.2.3 Sensitivity assessment methodology

This section of the report explains the approach to determining the ecological sensitivity of the proposed project 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 – Wild Coast N2 Toll Road Study). The method predominantly involves identifying sensitive vegetation or habitat types, topography and land transformation (Table 4-1). The proposed project 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 area had been zoned, the sensitivity criteria described in Table 4-1 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 4-1: 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 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 developed with the aid of a satellite image from which the sensitive regions and vegetation types could be plotted. The description of the relevés assisted in mapping the vegetation and these descriptions, as well as sensitivity ratings, are illustrated in the resultant maps.

4.3 Description of the environment

4.3.1 Physical Environment

4.3.1.1. Climate and Hydrology

Due to the location of the study area at the confluence of several climatic regimes, namely temperate and subtropical, the Eastern Cape Province of South Africa has a complex climate. There are wide variations in temperature, rainfall and wind patterns, mainly as a result of movements of air masses, altitude, mountain orientation and the proximity of the Indian Ocean.

There is data available for climatic conditions in Somerset East, which is close to the study site. The annual mean rainfall is 570mm (ranging from 278mm to 994mm), with a March high of 84mm and a June low of 21mm. The mean annual daily temperature is 17.2^{o}C with a mean monthly daily temperature high in January of 22.2^{o}C and low in June and July of 12.6^{o}C.

4.3.1.2. Geology and Landform

The Eastern Cape Province contains a wide variety of landscapes, from the stark Karoo (the semi-desert region of the central interior) to mountain ranges and gentle hills rolling down to the sea. The climate and topography give rise to the great diversity of vegetation types and habitats found in the region. The mountainous area on the northern border forms part of the Great Escarpment.Another part of the escarpment lies just north of Bisho, Somerset East and Graaff-Reinet. In the south of the province, the Cape Folded Mountains start between East London and Port Elizabeth and continue westward into the Western Cape. As is the situation in KwaZulu-Natal, the Eastern Cape is characterised by a large number of short, deeply incised rivers flowing parallel to each other.

Cookhouse and the surrounding areas (including Somerset East) occur in the Karoo Supergroup and comprise mainly of the Beaufort Group with some Karoo Dolerite (Rust, 1998). The Beaufort group overlays the Ecca Group and was deposited on land through alluvial processes. It is characterised by reddish-purple and mottled, greenish, mudstone beds, interbedded with lenticular, creamy and buff coloured sandstone beds. The mudstone beds are a diagnostic feature of the Beaufort Group. A couple of long Dolerite outcrops occur in the area (Rust, 1998). The Adelaide subgroup occurs as a subgroup of the Beaufort Group, and forms most of the geology of the area. The Adelaide subgroup comprises the Middleton Formation and the Balfour Formation which are made up of layers of a greenish-grey mudstone, shale and sandstone (Mucina and Rutherford, 2006). Plates 4-1 to 4-3 provide an idea of the topography of the proposed Terra Wind Energy Golden Valley Project site.

Plate 4-1: The undulating hills of the site proposed for the location of the Terra Wind Energy Golden Valley Project

Plate 4-2: The undulating hills of the site proposed for the location of the Terra Wind Energy Golden Valley Project. Note the escarpment in the distance

Plate 4-3: Some very flat areas found on the site proposed for the location of the Terra Wind Energy Golden Valley Project. The escarpment can be seen in the background

Mucina and Rutherford (2006) describe the geology and soil for each of the vegetation types in the region (Table 4-2).

Table 4-2: Geology and soils of each of the vegetation types of the study area

Vegetation Type	Geology and Soils
Albany Broken Veld	Mainly shales and some sandstones of various stratigraphic units within the Witteberg Group of the Cape Supergroup and the Beaufort, Ecca and Dwyka Groups of the Karoo Supergroup. Mainly Glenrosa and/or Mispah soils (Fc land type) with some red-yellow, apedal, drained soils, with a high base status, generally <300 mm deep, typical of Ag land type.
Bedford Dry Grassland	Loam or clay-loam soils typical of Fc (most of the region) as well as Db and Fb land types on the mudstones and sandstones of the Adelaide Subgroup (Beaufort Group, Karoo Supergroup).
Great Fish Thicket	Mostly on shallow (< 1 m) clay soils (Glenrosa and Mispah) derived from the Adelaide and Estcourt Formations (Beaufort Group, Karoo Supergroup) mudstone and arenite. Half the area falls within the Fc land type, with Fb the only other one of some importance.
Eastern Cape Escarpment Thicket	Mudstones and arenite of the Adelaide Subgroup of the Karoo Supergroup as well as Jurassic dolerite intrusions. The soils derived from these rocks are fine-grained, nutrient-poor silts or more nutrient-rich red clays. Soils are often shallow, on moderate to steep slopes and the surface rock cover is high. The major land types are Fc as well as Ib and Fb.
Southern Karoo Riviere	Recent sandy-clayey alluvial deposits rich in salt occurring on mudrocks and sandstones of the Adelaide Subgroup (Beaufort Group of the Karoo Supergroup) that support soils typical of land type.

Source: Mucina & Rutherford (2006)

Plate 4-4 below provides a general indication of the rocks around the proposed development area.

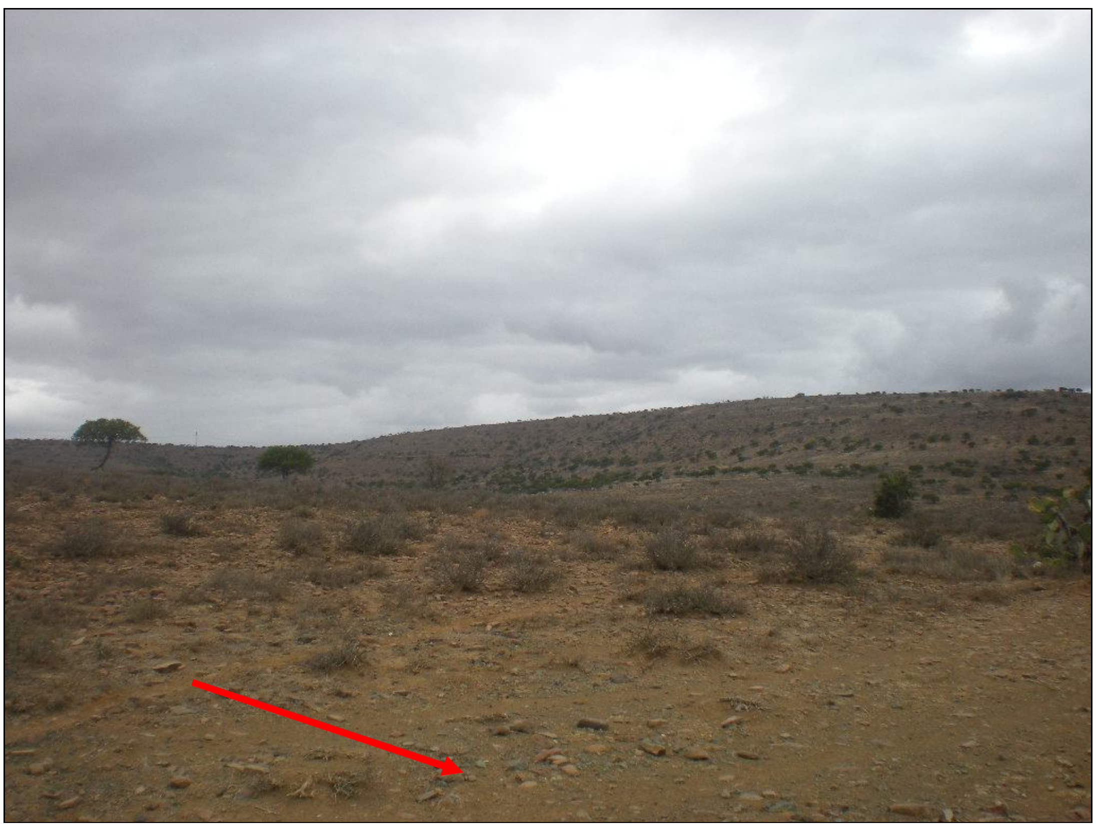

Plate 4-4: The reddish mudstones of the Beaufort Group of Cookhouse and the surrounding areas

4.3.2 Biological environment

When the impacts of developments are compared between fauna and flora, it is noted that the impacts on flora are much more notable than the effects developments have on fauna populations and communities. This can simply be attributed to the fact that where possible fauna can migrate out of the immediate area and away from the disturbance, circumstances permitting.

This does appear to be the case with this development; hence greater focus has been allocated to the floral aspects of the area as this is where a greater impact would be noted. Another reason why floral components are the centre of most biotic environmental studies is that should any impacts on the floral aspects of a project be well mitigated for and possibly well conserved, then due to the conservation of habitat faunal aspects would more than likely return to their previous state before the development.

4.3.2.1. Flora and Vegetation

Flora

The vegetation of the Eastern Cape is complex and is transitional between the Cape and subtropical floras and many taxa of diverse phytogeographical affinities reach the limits of their distribution in this region. The region is best described as a tension zone where four major biomes converge and overlap (Lubke et al. 1988).

The dominant vegetation is Succulent Thicket (Spekboomveld or Valley Bushveld), a dense spiny vegetation type unique to this region. While species in the canopy are of subtropical affinities, and generally widespread species, the succulents and geophytes that comprise the understorey are of karroid affinities and are often localised endemics.

Cookhouse falls within the Albany Centre of Floristic Endemism; also known as the Albany Hotspot (Figure 4-1). 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 south by the Indian Ocean, in the east by the Gamtoos–Groot River basin and in the north by the Kei River basin'* (Victor & Dold, 2003)

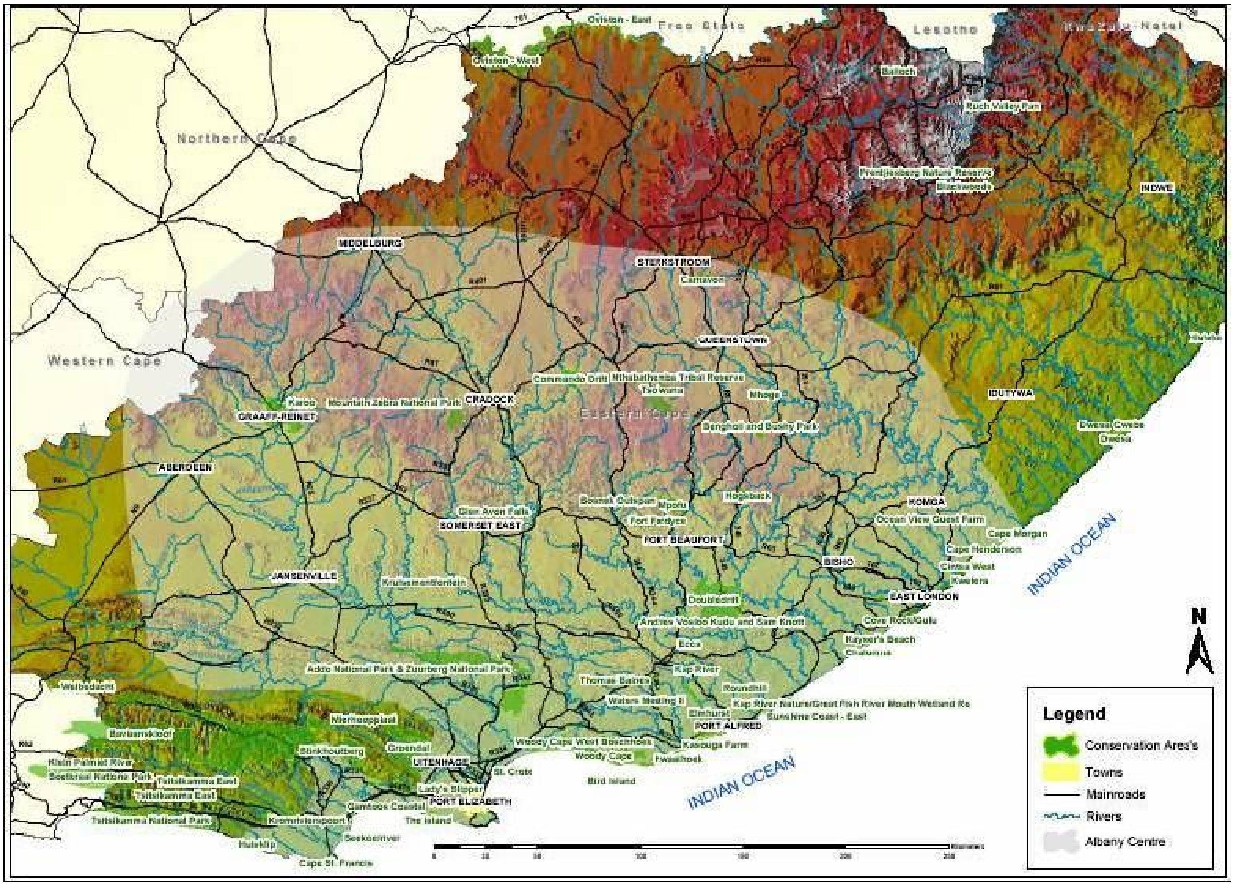

Figure 4-1: The Albany Centre of Endemism, also known as the 'Albany Hotspot', has long been recognised as an important centre of plant species diversity and endemism
Source: van Wyk and Smith (2001)

Mucina and Rutherford (2006) described the species endemic to the area (Table 4-3). In addition to the endemic taxa found in the study area, there are also a number of species which are listed as protected by Victor and Dold (2003) that are expected to be found in the study area. 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 (SSC). Victor and Dold (2003) also list 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 (*see Plate 4-5*)*.

Table 4-3: Species endemic to the vegetation types found in the study area and Cookhouse surrounds.

Vegetation Type	Species	Protection	Status
Bedford Dry Grassland	No endemics	-	-
Great Fish Thicket	*Euphorbia cumulate*	-	-
	Euryops gracilipes	IUCN	Vulnerable
	Haworthia aungustifolia var. *pauciflora*	PNCO 4	Protected
	Haworthia cummingii	PNCO 4	Protected
	Haworthia cymbiformis var. *incurvula*	PNCO 4	Protected
	Haworthia cymbiformis var. *ramose*	PNCO 4	Protected
	Zaluzianskya vallispiscis	-	-
Southern Karoo Riviere	*Isolepis expallescens*	-	-
Eastern Cape Escarpment thicket	No endemics	-	-
Albany Broken Veld	*Brachystelma huttonii*	-	-
	Ornithogalum britteniae	IUCN	Vulnerable
	Ornothogalum perdurans	IUCN	Vulnerable
	Haworthia cymbiformis var. *obtuse*	-	-
	Ceropegia fimbriata subsp. *fimbriata*	IUCN	Vulnerable
	Euphorbia inermis var. *huttoniae*	-	-
	Rhombophyllum albanense	-	-
	Rhombophyllum dyeri	-	-

Table 4-4: Species expected to be found in the study area and surrounds which are listed as protected (but are not endemic).

Vegetation Type	Species	Protection	Status
Bedford Dry Grassland	*Cotyledon orbiculata*	IUCN	Near Threatened
	Pelargonium sidoides	IUCN	Declining
Great Fish Thicket	*Delosperma ecklonii*	IUCN	Rare
	Tetradenia barberae	IUCN	Rare
	Boscia albitruscia	Protected Trees	Protected
	Aloe tenuior	PNCO	Protected
Albany Broken Veld	*Ceropegia fimbriata*	IUCN	Vulnerable
	Euphorbia meloformis	IUCN/ PNCO 4	Near Threatened/ Protected
	Faucaria tigrina	IUCN	Endangered
	Ornithogalum britteniae	IUCN	Vulnerable
	Ornithogalum perdurans	IUCN	Vulnerable
Eastern Cape Escarpment Thicket	*Crassula obovata*	IUCN	Vulnerable
Southern Karoo Riviere	*Amphiglossa callunoides*	IUCN	Near Threatened

Plate 4-5: One of the many Aloe (*Aloe striatus*) plants found in the study area. All species of Aloe (except for *Aloe ferox*) are protected by the PNCO Schedule 4.

Alien species

Alien species recorded from the study site included *Opuntia ficus-indica*, prickly pear (Plate 4-6), *Opuntia lindheimeri* (Plate 4-7), *Opuntia aurantiaca*, jointed cactus (Plate 4-8), *Agave americana*, *Conyza canadensis.*. These invaders are required to be removed by law, as they are each Category 1: declared weeds. Biological control agents are present on the site on each of these species. The most recent legislation makes the following recommendations regarding category 1 plants:

Combating of category 1 plants (section 15A)

1) Category 1 plants may not occur on any land or inland water surface other than in biological control reserves.
2) A land user shall control any category 1 plants that occur on any land or inland water surface in contravention of the provisions of sub-regulation (1) by means of the methods prescribed in regulation 15E.
3) No person shall, except in or for purposes of a biological control reserve –
    a. establish, plant, maintain, multiply or propagate category 1 plants;
    b. import or sell propagating material of category 1 plants or any category 1 plants;
    c. acquire propagating material of category 1 plants or any category 1 plants.
4) The executive officer may, on good cause shown in writing by the land user, grant written exemption from compliance with the requirements of sub-regulation (1) on such conditions as the executive officer may determine in each case.

Plate 4-6: ***Opuntia ficus-indica*** **recorded on the farm Quagas Kuil.**

Plate 4-7: ***Opuntia lindheimeri*** **recorded on the farm Smoordrift**

Plate 4-8: Opuntia aurantiaca recorded throughout the proposed Cookhouse Wind Energy site.

Vegetation

There are two main vegetation classifications for the area. These are Mucina and Rutherford (2006) and the Subtropical Thicket Ecosystem Project (STEP). There are five Mucina and Rutherford (2006) and four STEP Vegetation types for the general Cookhouse area (Table 4-5). Plate 4-9, 4-10 and 4-11 show the vegetation in the study area. Much is degraded due to grazing by livestock and comprises sparse grassland with scattered low shrubs, *Acacia karroo* plants and alien invader species.

Table 4-5: Mucina & Rutherford and STEP vegetation types in the Cookhouse area

Mucina & Rutherford		STEP
Code	**Vegetation Type**	**Vegetation type**
AT11	Great Fish Thicket	Hartebeest Karroid Thicket
		Fish Spekboom Thicket
Gs18	Bedford Dry Grassland	-
AT13	Eastern Cape Escarpment Thicket	Escarpment Thicket
NK14	Albany Broken Veld	Saltaire Karroid Thicket
Azi6	Southern Karoo Riviere	-

Plate 4-9: Sparse grassland with low shrubs and a few stunted trees

Plate 4-10: Sparse grassland with scattered Acacia karroo plants as well as a few Opuntia ficus-indica invaders

Plate 4-11: Grassland with a few *Opuntia lindheimeri* individuals

Vegetation Types

Mucina and Rutherford (2006) define the following vegetation types (Figure 4.2) from which source these descriptions are derived:

(a) Great Fish Thicket

Great Fish Thicket occurs in the Eastern Cape quite extensively in and around the lower Great Fish River and Keiskamma River Valleys. Succulent thicket occurs in steep slopes. Thicket is dominated by *Portulacaria afra* which becomes less dominant and replaced by *Euphoria bothae* with increasing aridity. With increasing moisture *P. afra* is replaced by *Euphorbia tetragona* and *E. triangularis.* The vegetation tends to be clumped. This vegetation type is classified as Least Threatened. The conservation target is 19%, with 6% conserved and 4% transformed (3% cultivation, 1% urbanization).

(b) Bedford Dry Grassland

This grassland type is widespread in the Eastern Cape. It occurs on gently undulating plains and is open, dry grassland interspersed with *Acacia karroo* woodland. The grasses dominating are by *Digitaria argyrograpta, Tragus koelerioides, Eragrostis curvula* and *Cymbopogon caesius*. It is classified as Least Threatened, with a conservation target of 23%. No part of this vegetation type is statutorily conserved and only 1% privately conserved. 3% has been transformed for cultivation. Erosion is high in 25% of this vegetation type.

(c) Eastern Cape Escarpment Thicket

This thicket is restricted to the Eastern Cape along steeply sloping escarpment and mountain slopes, hills and lowlands of the region. It is a semi-open to closed thicket with dominant shrubs being *Olea europaeae* and *Acacia natalitia*. The conservation target for this vegetation type is 19%. 7% is conserved both privately and statutorily. This vegetation type has been permanently altered through various means including cultivation and urbanization.

(d) Albany Broken Veld

Named for the Albany District where it is found, this veld type only occurs in the Eastern Cape and extends from the Zuurberg Mountains, around the confluence of the Great and Little Fish Rivers extending eastwards on low mountain ridges and hills. It is an open grassy karroid dwarf shrubland with scattered low trees (*Boscia oleoides, Euclea undulate, Pappea capensis, Schotia afra*), dwarf shrubs (*Becium burchellianum, Chrysocoma ciliata*) and grasses (*Eragrostis obtusa*). It is classified as Least Threatened with a conservation target of 16%, with 12% privately conserved. About 3% has been transformed for cultivation.

(e) Southern Karoo Riviere

This karroid vegetation occurs in both the Eastern and Western Cape, is associated with rivers and is embedded in several vegetation types. It is found in riverine flats with a complex of *Acacia karroo* or *Tamarix usneoides* thickets and edged by *Salsola* dominated shrubland. It type is listed as Least Threatened , with a conservation target of 24%. Only 1.5% is statutorily and privately conserved, 12% has been transformed for cultivation and building of dams.

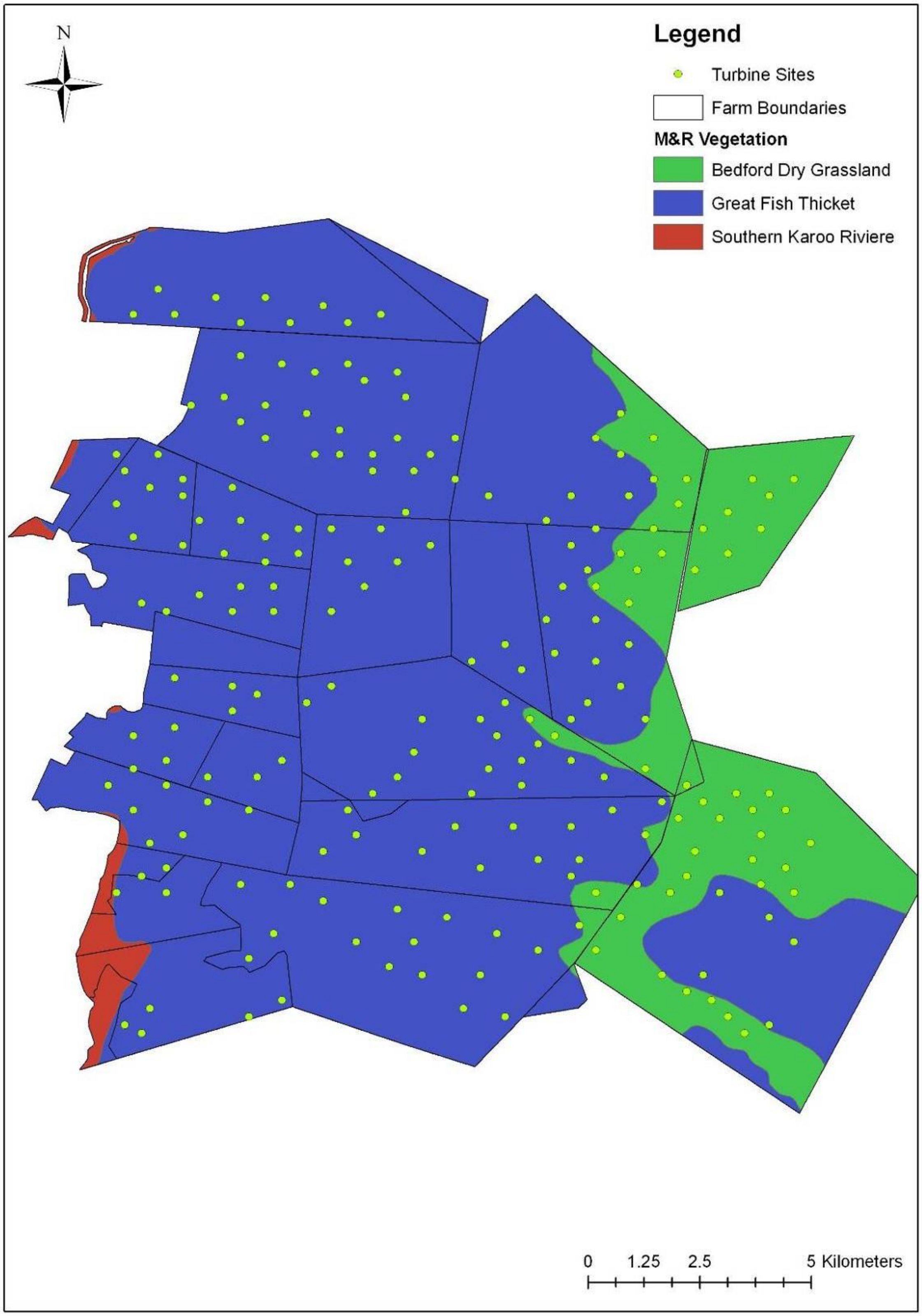

Figure 4-2: Mucina and Rutherford (2006) Vegetation map of the study area, with the location of the proposed turbines as green dots.

The *Subtropical Thicket Ecosystem Planning (STEP) Project* identifies four vegetation types in this region and Pierce & Mader (2006) describe these as follows:

(a) Hartebeeste Karroid Thicket

This Thicket is listed as Least Threatened. and comprises fragmented thicket clumps comprising species typical of Fish Valley Thicket. Trees of Fish Valley Thicket include doppruim (*Pappea capensis*) and gwarrie (*Euclea undulate*) as well as shrubs such as needlebush (*Azima tetracantha*). The Nama-karoo matrix is dominated by kankerkaroo (*Pentzia incana*) and *Becium burchellianum*is a characteristic species.

(b) Escarpment Thicket

Escarpment Thicket is classified as Vulnerable with dominant species of this vegetation type including wild olive (*Olea europapeae* subsp. *africana*) and kruisbessie (*Grewia occidentalis*). Also abundant are saffron (*Elaeodendron croceum*) and buffalo-thorn (*Ziziphus mucronata*).

(c) Fish Spekboom Thicket

Fish Spekboom Thicket, which forms part of the Thicket Biome and the Valley Thicket vegetation type is classified as Vulnerable. Valley Thicket grows in areas with relatively intermediate rainfall for Thicket. It can be impenetrable when in pristine condition but overgrazing results in a savanna-like vegetation with occasional trees. Ubiquitous thicket tree/shrub species include: *Pappea cappensis*, *Azima tetracantha* and *Rhus longispina*. Succulent species of *Crassula* and *Aloe* as well as spekboom (*Portulacaria afra), Euphorbia grandidens* and *Euphorbia tetragonal* are the most common.

Fish Spekboom Thicket, specifically is a variable thicket type with tree euphorbias (*Euphorbia curvirama, Euphorbia grandidens* and *Euphorbia tetragonal*) as well as spekboom (*Portulacaria afra*). In addition, there are also woody tree and shrub species present including: *Pappea capensis, Schotia afra* and *Rhigozum obobvatum*.

(d) Aliwal North Dry Grassland

Aliwal North Dry Grassland, which forms part of the Grassland Biome, consists mainly of grasses, with very few trees or shrubs and is classified as Least Threatened. It. If present trees cover less than 10% (Pierce & Mader 2006). Aliwal North Dry Grassland is pure grassland of sweet grass: *Themeda triandra, Digitaria eriantha, Sporobolus fimbriatus* and *Eragrostis chloromelas*.

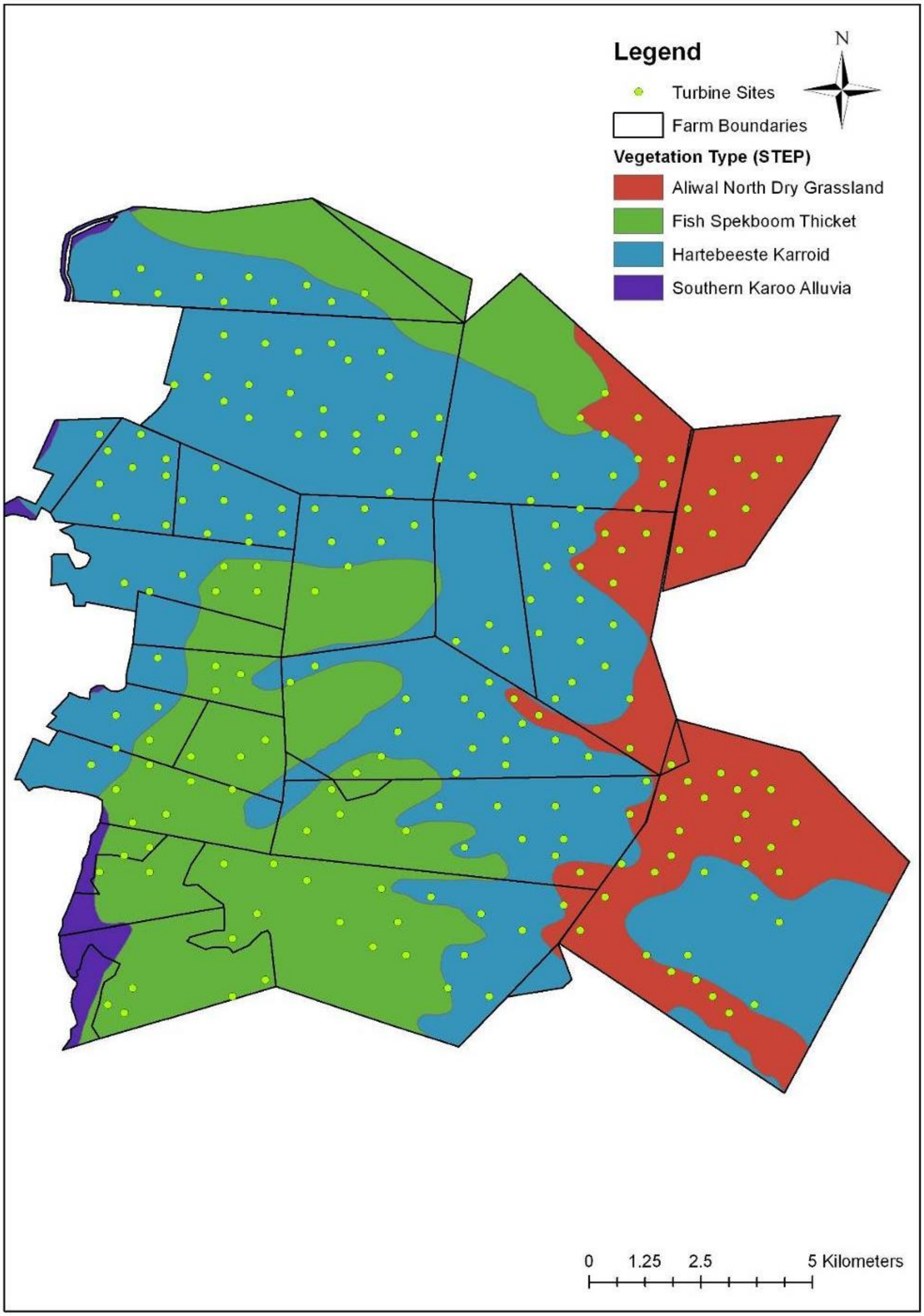

Figure 4-3: STEP vegetation map of the study area with the locations of the proposed turbines in green (from Pierce & Mader, 2006)

STEP vegetation classes

STEP provides management recommendations for each of the classes given to vegetation types. As the study area contains vegetation types listed as Least Threatened (Currently Not Vulnerable), and Vulnerable by STEP, recommendations for these classes are provided below and summarised in Table 4-6.

Currently Not Vulnerable (Class IV)

A vegetation type that has much more extant habitat than is needed to meet its conservation target, is considered Currently Not Vulnerable, or Least Threatened

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.

Table 4-6: 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

Conservation priority	Classification	Brief Description	General Rule
	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

From a Spatial planning (forward planning – Spatial Development Framework (SDF)) 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 due to disturbance of 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).

Vulnerable (III)

Vulnerable ecosystems are those where further disturbance or destruction could harm their health and functioning.

For Vulnerable vegetation, STEP recommends four Land use management procedures, these include:

1. As a rule, developments with limited area or impacts should be allowed on Class III land.
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. Proposed disturbance or developments should preferably take place on sites which have undergone disturbance or impacts rather than on sites that are undisturbed.
4. For a proposed "listed activity", EIA authorisation is required by law.

From a Spatial planning (forward planning – Spatial Development Frameworks (SDF)) point of view, for Vulnerable vegetation, STEP presents three restrictions and gives examples of opportunities. The three spatial planning restrictions are as follows:

1. In general, Class III land can withstand only limited loss of natural area or limited disturbance through human activities and developments.
2. Proposed disturbance or developments should preferably take place on sites which have undergone disturbance or impacts rather than on sites that are undisturbed.
3. In general, Class IV land should be developed in preference to Class III land.

Depending on constraints (such as avoidance of spoiling scenery or wilderness, or infra-structure limitations), Class III land can withstand a limited loss of, or disturbance to, natural areas. Within the constraints, this class may be suitable for a moderate range of activities that are either compatible with the natural environment (e.g. sustainable stock-farming, ecotourism, game farming and wilderness) or of limited extent (e.g. small-scale housing or urban development, small-scale cultivation).

General Floristics of the site

Plant species recorded during the site investigation are listed in Appendix C-1.
One hundred and nineteen (119) species were identified on site.
The floristic data (Appendix C-1 and Table 4-7) gives a clear picture of the nature of the plants in the vegetation sampled. There were high numbers of species from:

- Daisy family (Asteraceae – 11 species) was well represented throughout the site form of shrubs and herbs. This family is typically prevalent within all the communities found on site.
- Grass family (Poaceae – 15 species), had a strong presence within the grassland communities.

The high number of grass (Poaceae) species is typical of the Bedford Dry Grassland. In addition, the large numbers of shrubs form an essential part of the thicket.

A breakdown of the life forms is given in Table 4-8.

Of the 119 species that were recorded in the area, many of these were woody plants (33% trees and shrubs). Small shrubs tend to occur within the Bedford Dry Grassland as well as degraded thicket sites whilst most of the tree species were also found in thicket.

Graminoids and geophytes are well-represented within the site 16 and 4 % respectively and herbs form the second largest group, forming 30% of the vegetation.

Table 4-7: Summary of the flora of the study area and the number of species in each taxon.

Taxon (Higher Group or Family)	**Species Recorded**
Dicotyledons	81
Monocotyledons	38
Total	**119**
Major Families	**Species**
Asteraceae	11
Asphodelaceae	6
Poaceae	15
Major Genera	**Species**
Euphorbia	5
Lycium	5

Table 4-8: Life Forms of the species found in the study area

Life Form	**No of Species**	**Percentage of Total**
Trees	3	2.5
Shrubs	36	30
Graminoids	19	16
Succulents	21	18
Geophytes	4	3.5
Herbs	36	30
TOTAL	**119**	100

Plant species of special concern

From the site visit, several plant species of special concern were recorded. These include *Aloe striatus* (Plate 4-12) and *Aloe teniour* (Plate 4-13), among others listed in table 4-9. All species of the genus *Aloe* excluding *Aloe ferox* are protected by the Provincial Nature Conservation Ordinance 4. It is recommended that no *Aloe striatus* plants be removed during the construction of the turbines. If this is impossible, they should be relocated to ensure their survival.

Table 4-9: Plant species of special concern for the proposed Cookhouse wind farm site.

Species	Protection	Status
Pachypodium bispinosum	PNCO	Protected
Pelargonium sidoides	IUCN	Declining
Crassula perfoliata	PNCO	Protected
Euphorbia globosa	IUCN/PNCO	Endangered/ Protected
Euphorbia meloformis	IUCN/PNCO	Vulnerable/ Protected
Aloe tenuior	PNCO	Protected
Anacampseros sp.	PNCO	Protected
Euphorbia meloformis	IUCN/ PNCO 4	Near Threatened/ Protected
Tritonia sp.	PNCO	Protected
Watsonia sp.	PNCO	Protected
Drosanthemum sp.	PNCO	Protected
Psilocaulon sp.	PNCO	Protected
Trichodiadema sp.	PNCO	Protected

Plate 4-12: An *Aloe tenuior* individual found abundantly in the North West of the study site.

Plate 4-13: An *Aloe striat*a plant. These Aloes are found all over the site and are very widespread.

Field Assessment

The field assessment of the study site showed the existence of four different vegetation types. Most of the site was heavily degraded due to its primary use as a grazing area. As a result, no Southern Karoo Alluvia (STEP) or Southern Karoo Riviere (Mucina & Rutherford) remains within the study site but has been taken over by irrigated cultivation (Figure 4-4). Most of the study site is covered with a low sensitivity scrub grassland with scattered rocky outcrops.

This vegetation type is comprised mostly out of the same grass species as the Bedford Dry Grassland but with scattered thicket elements and is thus determined to be degraded thicket. Some patches of karroid thicket remain but these are also degraded. Bedford Dry Grassland (Mucina & Rutherford) or Aliwal North Dry Grassland (STEP) exisits towards the east of the site and is more extensive than the vegetation maps suggest. This vegetation type has also been degraded by grazing. There are a few small patches of remnant thicket, also somewhat degraded (Figure 4-5). The proposed placement of turbines is throughout the site in the degraded vegetation.

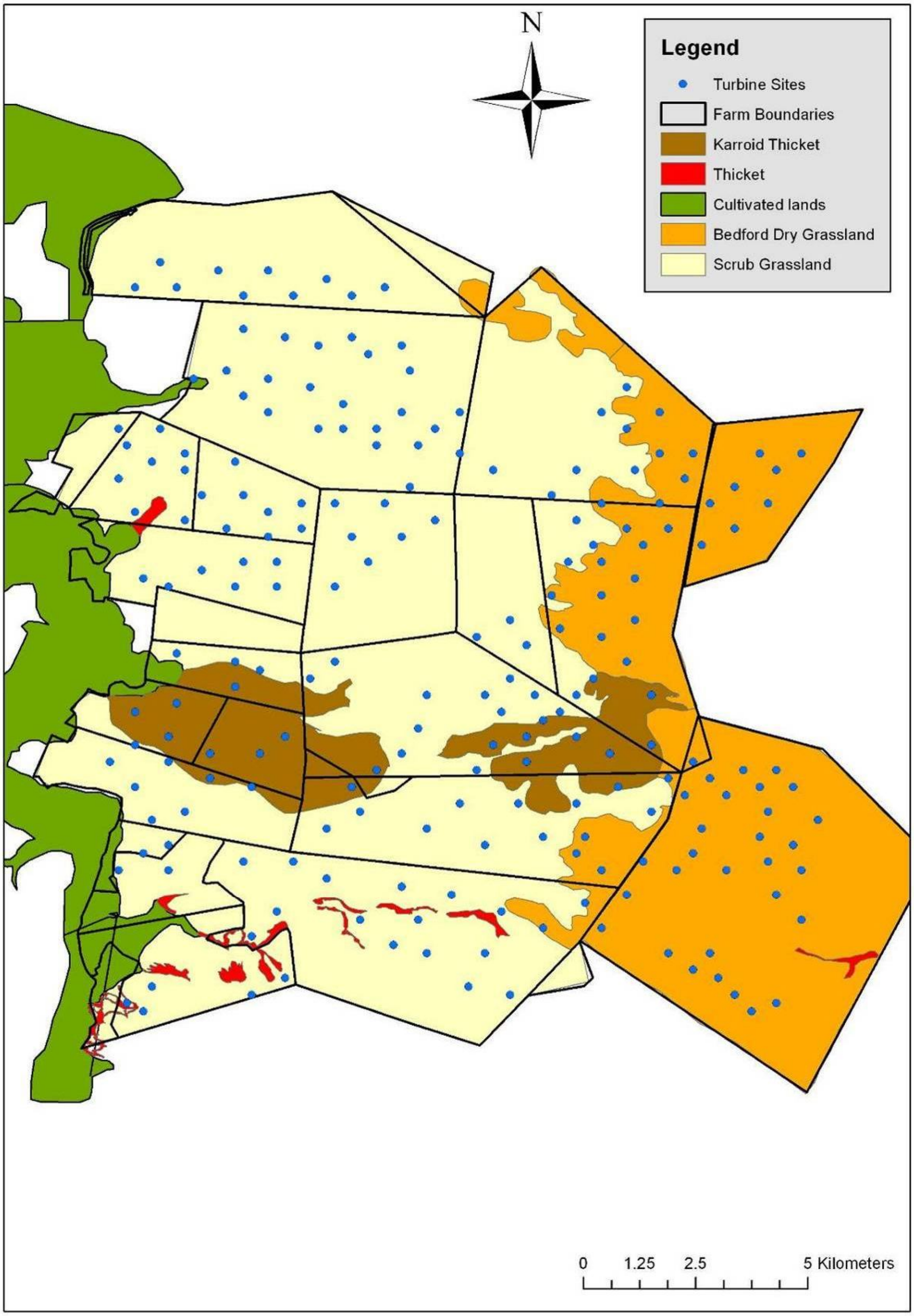

Figure 4-4: Vegetation map of the study site showing the positions of each of the wind turbines and their relationships to the vegetation types existing on the study area

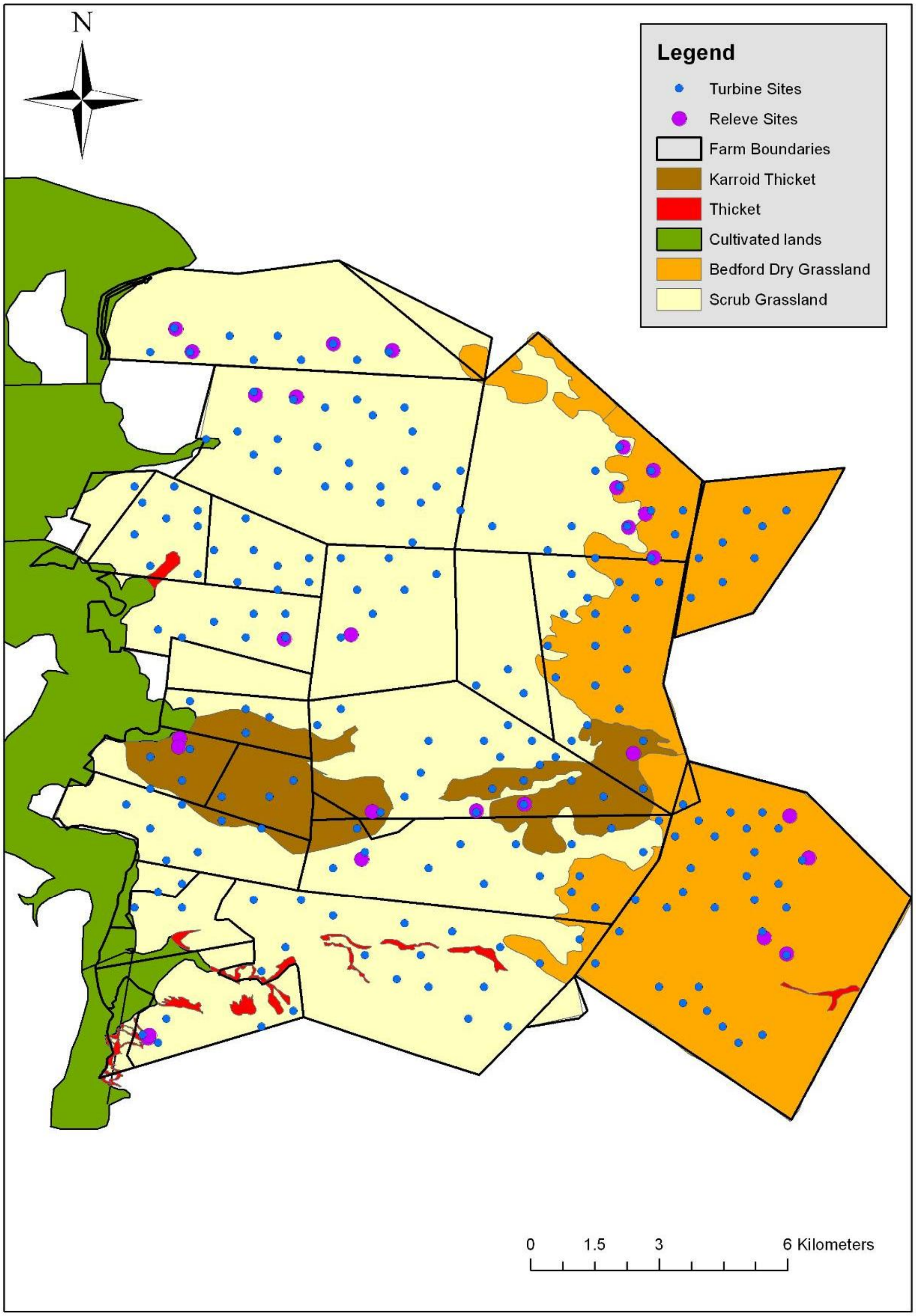

Figure 4-5: Vegetation map of the study area showing the location of each of the study releves (shown in purple) compared to the location of each of the proposed turbine sites (shown in blue).

Fauna

Reptiles

The Eastern Cape is home to 133 reptile species including 21 snakes, 27 lizards and eight chelonians (tortoises and turtles) (Plate 4-14). The majority of these are found in Mesic Succulent Thicket and riverine habitats. Table 4-10 provides an indication of the threatened and endemic reptile species with distribution ranges that include the Cookhouse area.

The list of reptiles of special concern is very significant since it includes five endemic species (two of which are endangered), eight CITES (Committee for International Trade in Endangered Species) listed species, one rare species and four species at the periphery of their range. 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.

Plate 4-14: An Angulate tortoise (*Chersina angulata*) found in the Cookhouse area.

Table 4-10: Threatened and endemic reptiles likely to occur in the Cookhouse region (Source: CSIR, 2004)

Latin name	Notes
Acontias meleagris orientalis	Eastern Cape endemic
Nucras taeniolata	
Tropidosaura Montana subp. *rangeri*	Eastern Cape Endemic
Bradypodion ventrali	Eastern Cape Endemic
Afroedura karroica	Eastern Cape Endemic
Afroedura tembulica	Eastern Cape Endemic
Goggia essexi	Eastern Cape Endemic

Amphibians

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 Cookhouse region is limited and based on collections housed in national and provincial museums. It is estimated that as many as 17 species may occur. Table 4-11 lists species of frogs that are endemic or of conservation concern, and occur in the Cookhouse region.

Table 4-11: Threatened and endemic frogs likely to occur in the Cookhouse area (Source: CSIR, 2004)

Latin name	Notes
Anhydrophryne rattrayi	Endangered (Eastern Cape endemic)
Bufo amatolicus	Endangered (Eastern Cape endemic)
Bufo pardalis	Eastern Cape endemic

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, such as Cookhouse, this percentage is greatly reduced, with the vast majority of mammals present being small or medium-sized. Except where reintroduced into protected areas, lions, black wildebeest, red hartebeest, buffalo, black rhinoceros, elephant, hippopotamus and reedbuck are extinct. Cheetah and hunting dog are no longer found in the area and hyenas, leopard, ratel and vaal ribbok are almost extinct (Skead, 1974b).

The antelope that are abundant in the thick bush (thicket or bushclump savanna) are bushbuck, duicker, steenbok and kudu (Plate 4-15) (the most abundant antelope of the valley thicket). Blesbok (Plate 4-16), bontebok and gemsbok have been reintroduced on some farms.

Of the cat species, the lynx (caracal) and black-footed cat are found. Jackal and bat-eared foxes are also found as is the aardwolf, but it is not abundant.

Vervet monkeys are common and baboons are found in appropriate sites in kloofs and valleys. Rock dassies are common, but tree dassies are only found inland in forests along larger rivers. Genet and mongoose species are also common. Aardvark also occur in the region (Plate 4-17) Twenty-three rodent species are found in the area and include rats and mice, the cane rat, springhare and porcupine. A number of species of bat also occur. Table 4-12 lists large and medium sized mammals on the IUCN Red Data List that occur in the Eastern Cape Province.

Plate 4-15: Kudu is present on farms in the Proposed Cookhouse Windfarm area

Plate 4-16: Blesbok (*Damaliscus pygarus phillipsi*), has been introduced into some of the farms in the Proposed Cookhouse Windfarm area

Plate 4-17: Typical excavations made by the Aardvark (*Orycteropus afer*), which, though rarely seen, occurs in the area

Table 4-12: Threatened large to medium-sized mammals in the Eastern Cape Province (Source: Smithers, 1986)

Common name	Latin name	Conservation Status
Wild dog	*Lycaon pictus*	Endangered
Brown Hyaena	*Hyaena brunnea*	Rare
Aardwolf	*Proteles cristatus*	Rare
Black-footed cat	*Felis nigripes*	Rare
Serval	*Felis serval*	Rare
Leopard	*Panthera pardus*	Rare
Blue Duiker	*Philantomba monticola*	Rare
Honey Badger	*Mellivora capensis*	Vulnerable
African Wild Cat	*Felis lybica*	Vulnerable
Aardvark	*Orcteropus afer*	Vulnerable
Cape Mountain Zebra	*Equus zebra*	Vulnerable
Black Rhinoceros	*Diceros bicornis*	Vulnerable
Oribi	*Ourebia ourebi*	Vulnerable
Pangolin	*Manis temminckii*	Vulnerable
Small-spotted cat	*Felis nigripes nigripes*	Rare

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 4-13 lists the species of bats likely to occur in Cookhouse and surrounds, and thus will be affected by the proposed development.

Table 4-13: Bat species that occur in the Cookhouse 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 Sates 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).

Terrestrial Invertebrates

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 (RDB) for Butterflies. Two have become extinct, whilst three rare butterflies are known from a number of scattered localities in the Cookhouse region.

According to the most recent IUCN red data list there are no members of the Athropoda (insects, arachnids and crustaceans) Phylum in the area that can be defined as SSC. One of the most important insects of the study area is the dung beetle (Plate 4-18), there are over 780 species in Southern Africa.

Plate 4-18: Perhaps one of the most important invertebrates of the region is the family Scarabaeidea, which contains the dung beetles (Picker et al. 2002). This picture shows one of the species of the region (there are over 780 species in Southern Africa) (Scholtz & Holm 1996)

4.4 Sensitivity Assessment

Sensitivity of the site is primarily low, with most of the vegetation quite degraded due to both alien invasion as well as sheep (Plate 4-19) and cattle (Plate 4-20) grazing. Sensitivity of the entire site is thus low, with only a couple of isolated instances where the vegetation is of a medium sensitivity. These are shown in Figure 4-6.

Plate 4-19: Land use is primarily sheep farming, resulting in the modified state of most of the vegetation of the proposed wind facility.

Plate 4-20: Land is also used for cattle grazing and dairy cows and is heavily infested with alien invader plants, resulting in the degraded state of most of the vegetation of the proposed wind facility.

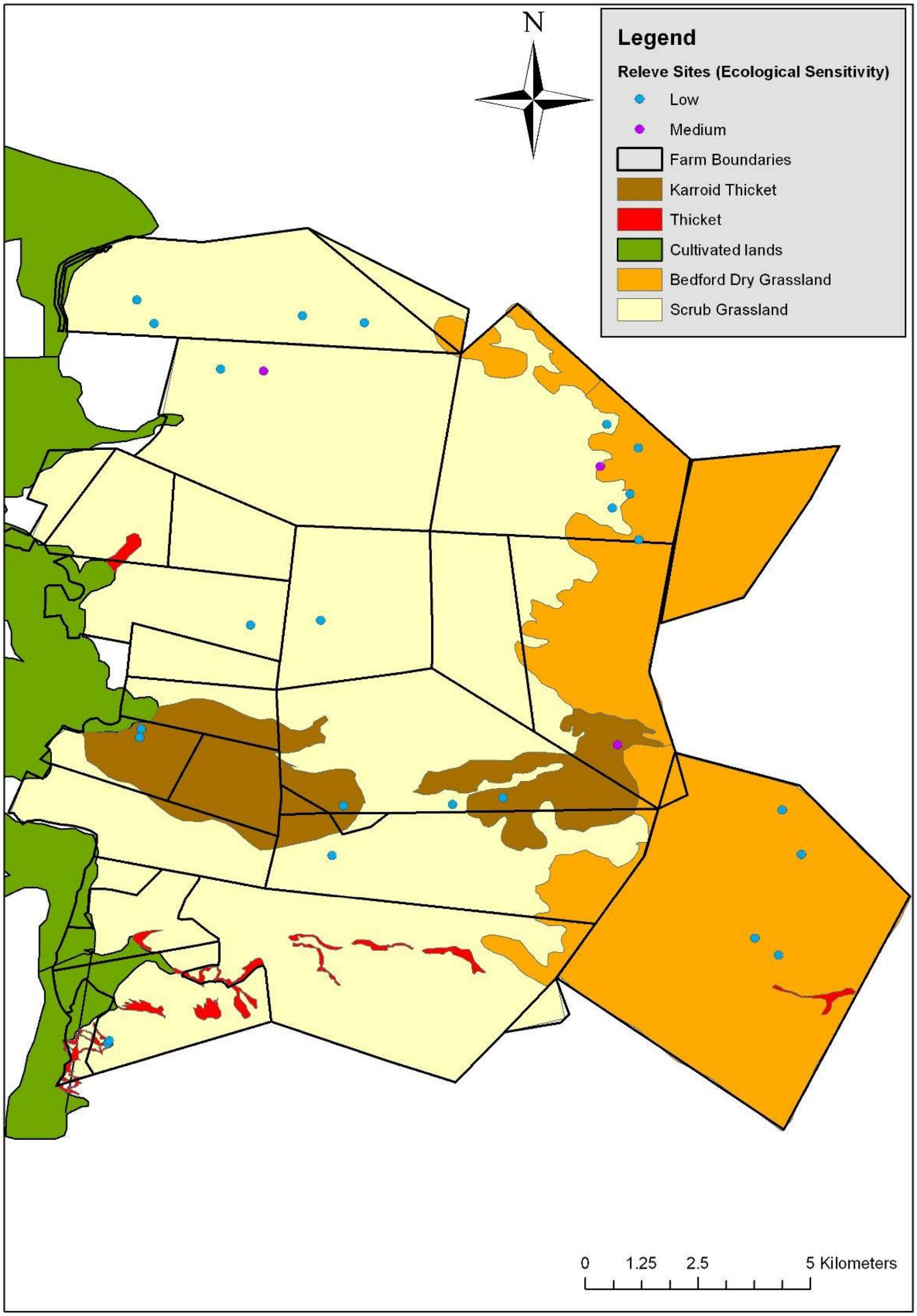

Figure 4-6: Vegetation map of the study area showing the location of each of the study releves and the sensitivity of these sites. There are two isolated areas with a medium sensitivity (purple), while the rest of the study sites had a low sensitivity (blue).

Land use and the 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 (CBA) 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 4-14 shows how the BLMCs relate to the CBAs.

Table 4-14: Terrestrial Critical biodiversity Areas and Biodiversity Land Management Classes as described by the Eastern Cape Biodiversity Conservation Plan.

<table>
<tr><th>CBA map category</th><th>Code</th><th colspan="2">BLMC</th></tr>
<tr><td colspan="4">Terrestrial CBAs and BLMCs:</td></tr>
<tr><td rowspan="2">Protected areas</td><td>PA1</td><td rowspan="3">BLMC 1</td><td rowspan="3">Natural landscapes</td></tr>
<tr><td>PA2</td></tr>
<tr><td>Terrestrial CBA 1 (not degraded)</td><td>T1</td></tr>
<tr><td>Terrestrial CBA 1 (degraded)</td><td>T1</td><td rowspan="4">BLMC 2</td><td rowspan="4">Near-natural landscapes</td></tr>
<tr><td rowspan="3">Terrestrial CBA 2</td><td>T2</td></tr>
<tr><td>C1</td></tr>
<tr><td>C2</td></tr>
<tr><td rowspan="2">Other natural areas</td><td>ONA T3</td><td rowspan="2">BLMC 3</td><td rowspan="2">Functional landscapes</td></tr>
<tr><td>ONA</td></tr>
<tr><td>Transformed areas</td><td>TF</td><td>BLMC 4</td><td>Transformed landscapes</td></tr>
</table>

Table 4-15: Terrestrial BLMCs and Land Use Objectives (source: Berliner et al. 2007)

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 4-7, the majority 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 4-8 shows the CBAs in and around the study area. The majority of the study area is CBA T2.CBA T2 areas were mapped based on the following:

- Endangered vegetation types identified through the ECBCP systematic conservation assessment
- Endangered vegetation types from STEP
- Endangered forest patches in terms of the National Forest Assessment

- All expert-mapped areas less than 25 000ha in size (includes expert data from this project, STEP birds, SKEP, Wild Coast, Ponondoland and marine studies)
- All other forest clusters (includes 500m buffers)
- 1km coastal buffer strip

This rest of the study site comprises CBA T3, which are areas already transformed. Ground assessments of the area show most of the study site to be transformed as it is used as grazing land and is thus somewhat degraded.

As CBA T2 ideally should comprise corridors as it is semi-natural landscape, the proposed development poses no threat to this functionality as the wind turbines will not result in any habitat fragmentation and minimal impacts on the existing flora and fauna of the study site. The land use planning principles designed by the ECBCP are reproduced here:

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. As can be seen by the more detailed Figure 4-9, much of the site is transformed; the rest of the site is formed by natural landscapes. However, as previously mentioned these natural areas are heavily impacted by current land uses and thus are not valuable as conservation areas unless a great deal of rehabilitation is undertaken. The land use will remain the same, fragmentation kept to a minimum and impacts to the existing near-natural landscape including both flora and fauna will be limited.

4.5 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. As most of the site has a low ecological sensitivity, location of the turbines is not a problem.

4.5.1 Flora and Vegetation

Issue 1: Destruction of vegetation

<u>Impact 1: Loss of thicket</u>

Cause and Comment

Construction of the wind farm will result in a small amount of loss of the limited areas of 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.

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. Proposed turbine sites are not situated within the few remaining patches of thicket. If any turbines are located in or nearby thicket, they should be moved.

Significance statement

Without mitigation:
In the construction phase of this development, the impact will be long term, localised, may occur and will be a slight severity. The overall Significance of the impact will thus be a slight negative. In the operation phase of the development, the impact will be permanent, localised, may occur and slight, resulting in an overall significance of 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 not reduced and remains an overall significance of low negative. In the operation phase of the development, severity of the impact is not reduced and remains an overall significance of low negative.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Construction phase										
Without mitigation	Long term	3	Localised	1	Slight	1	May Occur	2	**7**	**LOW -**
With mitigation	Medium term	2	Localised	1	Slight	1	May Occur	2	**6**	**LOW -**
Operation phase										
Without mitigation	Permanent	4	Localised	1	Slight	2	May Occur	2	**9**	**MODERATE -**
With mitigation	Permanent	4	Localised	1	Slight	1	Unlikely	1	**7**	**LOW -**
No-Go										
Without mitigation	Permanent	4	Localised	1	Beneficial	1	May Occur	2	**8**	**MODERATE +**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

<u>Impact 2: Loss of Bedford dry grasses</u>

Cause and Comment
Construction of the wind farm will result in loss of Bedford Dry Grassland 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

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.

Significance statement

Without mitigation:
In the construction phase of this development, the impact will be long term, occurring within the study area, probably and will be a slight impact. The overall Significance of the impact will thus be a moderate negative. In the operation phase of the development, the impact will be permanent, restricted to the study are, probable and slight, resulting in an overall significance of moderate negative. This impact was assessed with a high level of confidence.

With mitigation:
With mitigation, the loss of Bedford Dry Grassland due to trampling and other construction impacts can be reduced, however, for the operation of the development, some Bedford Dry Grassland will have to be permanently removed, In the construction phase of the development, with mitigation the impact is reduced to medium term, with a low severity and an overall significance of low negative. In the operation phase of the development, only the severity of the impact is reduced, resulting in an unchanged overall significance of moderate negative.

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	Medium term	2	Study area	2	Slight	1	May Occur	2	**7**	**LOW -**
Operation phase										
Without mitigation	Permanent	4	Study area	2	Moderate	2	Probable	3	**11**	**MODERATE -**
With mitigation	Permanent	4	Study area	2	Low	1	Probable	3	**10**	**MODERATE -**
No-Go										
Without mitigation	Permanent	4	Study area	2	Beneficial	1	definite	4	**11**	**MODERATE +**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

Impact 3: Loss of Karroid Thicket

Cause and comment
Construction of the wind farm will result in loss of Karroid 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 a positive.

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.

Significance Statement

Without mitigation:
In the construction phase of this development, the impact will be long term, occurring within the study area, probably and will be a moderate impact. The overall Significance of the impact will thus be a moderate negative. In the operation phase of the development, the impact will be permanent, restricted to the study are, probable and moderate, resulting in an overall significance of 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 medium term, with a low severity and an overall significance of low negative. In the operation phase of the development, only the severity of the impact is reduced, resulting in an unchanged overall significance of moderate negative.

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	Medium term	2	Study area	2	Low	1	May Occur	2	**7**	**LOW -**
Operation phase										
Without mitigation	Permanent	4	Study area	2	Moderate	2	Probable	3	**11**	**MODERATE -**
With mitigation	Permanent	4	Study area	2	Low	1	Probable	3	**10**	**MODERATE -**
No-Go										
Without mitigation	Permanent	4	Study area	2	Beneficial	1	definite	4	**11**	**MODERATE +**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

<u>Impact 4: Loss of Scrub Grassland</u>

Cause and Comment

Construction of the wind farm will result in loss of Scrub Grassland 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.

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.

Significance Statement

Without mitigation:

In the construction phase of this development, the impact will be long term, occurring within the study area, probably and will be a moderate impact. The overall Significance of the impact will thus be a moderate negative.

In the operation phase of the development, the impact will be permanent, restricted to the study are, probable and moderate, resulting in an overall significance of 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 medium term, with a low severity and an overall significance of low negative.

In the operation phase of the development, only the severity of the impact is reduced, resulting in an unchanged overall significance of moderate negative.

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	Medium term	2	Study area	2	Low	1	May Occur	2	**7**	**LOW -**
Operation phase										
Without mitigation	Permanent	4	Study area	2	Moderate	2	Probable	3	**11**	**MODERATE -**
With mitigation	Permanent	4	Study area	2	Low	1	Probable	3	**10**	**MODERATE -**
No-Go										
Without mitigation	Permanent	4	Study area	2	Beneficial	1	definite	4	**11**	**MODERATE +**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

Impact 5: Loss of plant species of special concern

Cause and Comment

There are, on the study site, thirteen species of special concern. These are *Pachypodium bispinosum, Pelargonium sidoides, Crassula perfoliata, Euphorbia globosa, Euphorbia meloformis, Aloe tenuior, Anacampestros* sp, *Euphorbia meloformis, Tritonia* sp, *Watsonia* sp, *Drosanthemum* sp, *Psilocaulon* sp and *Trichodiadema* sp. There may be mnay 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 a high positive, assuming the area is well-managed, and grazing kept to a minimum.

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.

Significance statement

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.

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	Moderately Beneficial	2	Probable	3	**10**	**MODERATE +**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

Issue 2: Alien Vegetation

Impact 6: Introduction of alien 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 existed 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.

Significance Statement

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 reduce both the likelihood and severity of the impact to ‘may occur’ and slight respectively. Overall significance of the impact is thus reduced from moderate negative to low negative. For the operation phase of development; temporal scale is reduced to medium-term, severity of impact to slight and likelihood to may occur, thus reducing the overall significance from high negative to low negative. Alien invasion is just as likely to occur if no development takes place and mitigation measures for the No-Go option will reduce temporal scale, severity and likelihood as well, giving an overall significance of low negative.

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	Slight	1	May Occur	2	**6**	**LOW -**
Operation phase										
Without mitigation	Permanent	4	Study area	2	Severe	4	Definite	4	**14**	**HIGH -**
With mitigation	Medium-term	2	Study area	2	Slight	1	May Occur	2	**7**	**LOW -**
No-Go										
Without mitigation	Permanent	4	Study area	2	Moderate	2	Definite	4	**12**	**HIGH -**
With mitigation	Medium-term	2	Study area	2	Slight	1	May Occur	2	**7**	**LOW -**

4.5.2 Fauna

Issue 3: Loss of Fauna

Impact 7: 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.

Mitigation and management
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.

Significance Statement

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 8: Loss of faunal 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.

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.

Significance Statement

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.

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**

Bats

Issue 4: Displacement

Impact 9: Disturbance 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.

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.

Significance Statement
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. With mitigation, the severity is still slight, resulting in an overall significance of 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. 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.

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

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.

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.

Significance Statement

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. With mitigation, the severity is still slight, resulting in an overall significance of 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. 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.

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

Issue 5: Habitat

<u>Impact 10: Loss of bat habitat due to vegetation clearing</u>

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.

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.

Significance Statement

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

In the operation phase without mitigation the impact occurs over the long term, is restricted to the study area, is probable and has a slight severity giving an overall significance of Moderate Negative. With mitigation the overall significance remains Moderate Negative.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Cookhouse site (Turbine sites)										
Construction phase										
Without mitigation	Short term	1	Study area	2	Slight	1	Probable	3	**7**	**LOW NEGATIVE**
With mitigation	Short term	1	Study area	2	Slight	1	May occur	2	**6**	**LOW NEGATIVE**
Operation phase										
Without mitigation	Long term	3	Study area	2	Slight	1	Probable	3	**9**	**MODERATE NEGATIVE**
With mitigation	Long term	3	Study area	2	Slight	1	May occur	2	**8**	**MODERATE NEGATIVE**
No-Go										
Without mitigation	Long term	3	Study area	2	Slight	1	May occur	2	**8**	**MODERATE POSITIVE**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

Issue 6: Bat collisions

Impact 11: 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. The lack of bat feeding and roosting sites in the area suggest that there are not many bats (Prof Bernard, pers comm.), however, bats should be continually be monitored.

Significance Statement

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

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Cookhouse site										
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 NEGATIVE**
With mitigation	Long term	3	Study area	2	Moderate	2	May occur	2	**9**	**MODERATE NEGATIVE**
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**

Issue 7: Fragmentation (Cumulative Impact)

<u>Impact 12: Effect of fragmenting Vegetation types</u>

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
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.

Significance statement

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.

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	N/A		N/A		N/A		N/A			**N/A**
With mitigation	N/A		N/A		N/A		N/A			**N/A**

4.6 Conclusions and recommendations

4.6.1 Current status

The vegetation on the study site is mostly in a poor condition due to heavy grazing as well as alien plant infestation. There are many invader species along with some degraded grassland and thicket sites, both of which could potentially result in further degradation of the site in the future. Where possible it is recommended that areas within the study site be set aside for conservation allowing the vegetation to reach its natural state free from grazing pressure and alien infestation. The most important and long term impact is likely to be the introduction and infestation of alien plant species. This should be managed effectively to prevent huge impacts on the study area.

4.6.2 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 4-16 below outlines the impacts.

Table 4-16: Summary table of all 14 impacts on flora and vegetation and fauna in the Cookhouse 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 Thicket	LOW -	MOD -	MOD +	LOW -	LOW -	N/A
2: Loss of Bedford Dry Grassland	MOD -	MOD -	MOD +	LOW -	MOD -	N/A
3: Loss of Karroid Thicket	MOD -	MOD -	MOD +	LOW -	MOD -	N/A
4: Loss of Scrub Grassland	MOD -	MOD -	MOD +	LOW -	MOD -	N/A
5: Loss of Plant Species of Special Concern	MOD -	N/A	MOD +	MOD -	N/A	N/A
6: Introduction of alien plant species	MOD -	HIGH -	HIGH -	LOW -	LOW -	LOW -
Fauna						
7: Loss of faunal biodiversity	MOD -	N/A	HIGH +	LOW -	N/A	N/A
8: Loss of species of special concern	LOW -	N/A	HIGH +	N/A	N/A	N/A
9: Disturbance displacement of bats	LOW -	MOD -	LOW +	LOW -	MOD -	N/A
10: Loss of bat habitat	LOW -	MOD -	MOD +	LOW -	MOD -	N/A
11: Bat mortalities	N/A	MOD -	N/A	N/A	MOD -	N/A
Cumulative Impacts						
6: Fragmentation of vegetation types	LOW -	N/A	N/A	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.

4.6.3 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 occur 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 Eastern Cape Department of Economic Development and Environment 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 a nursery for use 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 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.

4.6.4 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* and *Agave* species, which are already present on site. Sterilization of vehicles entering the construction site should be considered as this would reduce alien infestation in the long term as well as dramatically decreasing future control costs.

4.6.5 Impacts on bats

As there is little bat research applicable to South Africa, and, more specifically, the Eastern Cape the impacts on bats should be very carefully monitored and any available mitigation measures employed, and their success or failure also monitored.

4.7 Operational phase recommendations

- Continued monitoring of the site for potential alien invasion, especially of plant species already
- Careful monitoring of the effects of the wind turbines on bat populations, especially mortality as a direct result of the turbines and associated infrastructure. Recent research, especially that applicable to wind farms in South Africa and the Eastern Cape should be regularly consulted and every effort should be made to use recommended mitigation measures.
- Maintenance of areas set aside within the site for conservation to make sure these are not being impacted further in any way.

5 AVIFAUNA SPECIALIST REPORT

Prepared by:	**Prepared for:**	**On behalf of:**
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<u>This report should be cited as</u>:

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5.1 Introduction

5.1.1 Background

The Endangered Wildlife Trust's Wildlife and Energy Programme was appointed by CES as independent avifaunal specialists to conduct the avifaunal specialist assessment of the proposed wind energy facility in the Cookhouse region of South Africa.

A site visit was conducted during the week of the 8th – 12th February 2010 during which data was collected and the site was extensively examined from an avifaunal perspective.

Typically, a wind energy project of this nature can be expected to impact on avifauna as follows: disturbance of birds, habitat destruction during construction and maintenance; collision of birds with turbines during operation and the collision and electrocution of birds on associated electrical infrastructure. This report approached the study in the following ways:

- A review of current information relating to wind energy
- Sensitivity mapping using GIS
- A site visit to examine the area with particular emphasis on bird microhabitats and to collect first hand avifaunal data
- Description and rating of impacts from our professional knowledge andexperience
- Suggestions on how to mitigate the impacts

5.1.2 Terms of Reference

The specific terms of reference (TOR) for the avifauna specialist study as drawn up in the Plan of Study incorporated in the Final Scoping Report (FSR) for the proposed project (CES, November 2009) were as follows:-

- Undertake a desk-top review of existing literature. The literature 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 Cookhouse, BCRM, Eastern Cape, South Africa, and globally, of bird groups most likely to be affected

- A site visit to identify Species of Special Concern (SSC) and assess the likely impacts of the construction and operational phases on the avifauna of the site.

Surveys will be conducted on at least two days at sites at either end and in the middle of the proposed turbine corridor and survey sites will be selected to reflect variation in local habitat and terrain

During daylight in each survey 2 x 15 minutes of visual scans of birds crossing the proposed turbine corridor (with appraisal of flight height above the ground) as well as 2 x 10 minutes circular point surveys, will be conducted

In addition, it will be necessary to:

- 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;

- 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;
- List and describe the expected impacts;
- Discuss gaps in the baseline data with respect to avifauna and relevant habitats;
- 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 modelling* i.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 modelled 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 between now and mid 2010 would provide much confidence in such a model, as it would require more representative data collection across a range of conditions/seasons etc. In addition, very often the worst bird collision 'events' at wind farms around the world have been found to have occurred in extreme weather conditions, when flight behavior etc is abnormal.

5.1.3 The study team

The project team consisted of:-

Mr Luke Strugnell (*Pri.Sci.Nat)*, is employed by the Endangered Wildlife Trust's Wildlife and Energy Programme as a specialist investigator for conducting avifaunal specific specialist reports. Luke has a BSc (hon) degree and has experience with over 20 Eskom distribution projects as well as 10 Eskom transmission projects. Furthermore Luke has conducted avifaunal specialist studies for 3 South African wind energy facilities. Luke is registered with the South African Council for Natural Scientific Professions (registration number: 400181/09).

5.2 Methodology

5.2.1 Approach

This study included the following:

- 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

5.2.2 Data sources

- 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
- Co-ordinated Avifaunal Road counts were used to supplement the SABAP data

5.2.3 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.

5.3 Background on the Interaction between Avifauna and Wind Energy

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 Volume 2: EIA Specialist Volume – Avifaunal Specialist Study Coastal & Environmental Services 9 Terra Wind Energy Golden Valley Project 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 site of some extremely high levels of bird mortalities. These mortalities focused attention on the impact of wind energy on birds and subsequently a large amount of monitoring at various sites has been undertaken. Naturally, as more monitoring was conducted at different sites, a need arose for a standard means of expressing the levels of bird mortalities – in this case, number of mortalities per turbine per year. The following is a brief summary of some data that has emerged internationally (Table 5-1). It is important to note that searcher efficiency (and independence) and scavenger removal rates need to be accounted for. Searcher efficiency refers to the percentage of bird mortalities that are detected by searchers, searcher independence refers to whether the person monitoring has certain objectives of their own which may influence the results of monitoring. Additionally, although the rates may appear relatively low it is important to note that it is the cumulative effect of a wind farm that is really important. In other words, the absolute number of birds killed by a wind farm in a year is far more meaningful than an average per turbine. In addition, for some species, even a minute increase in mortality rates could be significant (long lived, slow reproducing species such as many of the South African Red Data species).

Table 5-1: Summary of Wind energy and collision rates from overseas.

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

<u>South Africa</u>

To date, only three wind turbines have been constructed at a demonstration facility at Klipheuwel in the Western Cape, in 2002 and 2003. (Although four turbines have been constructed privately at a site near Darling, access to these for the purpose of monitoring bird impacts has been restricted). A monitoring program, conducted by Jacque Kuyler (2004), was put in place once the Klipheuwel turbines were operational. This report was obtained from Eskom Peaking Generation. The monitoring involved site visits twice a month to monitor birds flying in the vicinity of the site and 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.
- If these two mortalities in eight months are expressed as #mortalities/turbine/year (using the three turbines at Klipheuwel), the result is 1.00 mortalities per turbine per year.
- Experimental assessment of the searcher efficiency revealed that 7 out of 9 77%) carcasses placed in the study area were detected by the searcher.
- These nine carcasses were scavenged at between 12 and 117 days after their placement.

5.3.1 Factors influencing bird collisions with turbines

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

Bird related information

Although only one study has so far shown a direct relationship between numbers of birds present in an area and number of collisions (Everaert, 2003, 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 to notice infrastructure. There may also be seasonal and temporal differences in behaviour, for example breeding males displaying may be particularly at risk. These factors can all influence the birds' vulnerability.

A controlled experiment with homing pigeons was undertaken by Cade (1994) to examine their flight behaviour in the proximity of turbines. Pigeons released near turbines clearly recognised the turbines and adjusted their flight as required. Of about 2270 pigeon flights near turbines, three collisions occurred. In a radar study of the movement of ducks and geese in the vicinity of an off-shore wind facility in Denmark, less than 1% of bird flights were close enough to the turbines to be at risk. This is graphically shown in Figure 5-1, 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).

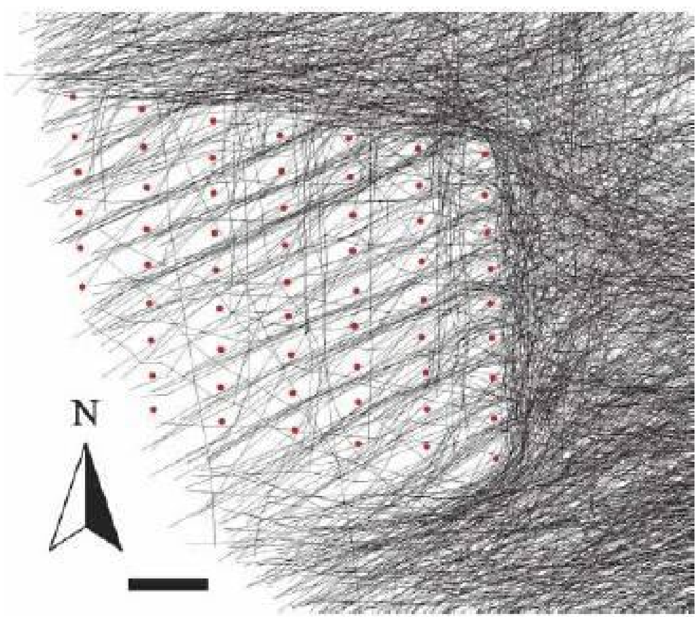

Figure 5-1: Radar tracked movement of ducks and geese relative to an offshore wind facility in Denmark (Desholm & Kahlert, 2005) Scale bar = 1000m

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 (US), 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 400 turbines at the proposed Cookhouse 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 5-2 below shows the development of turbine size Over the years

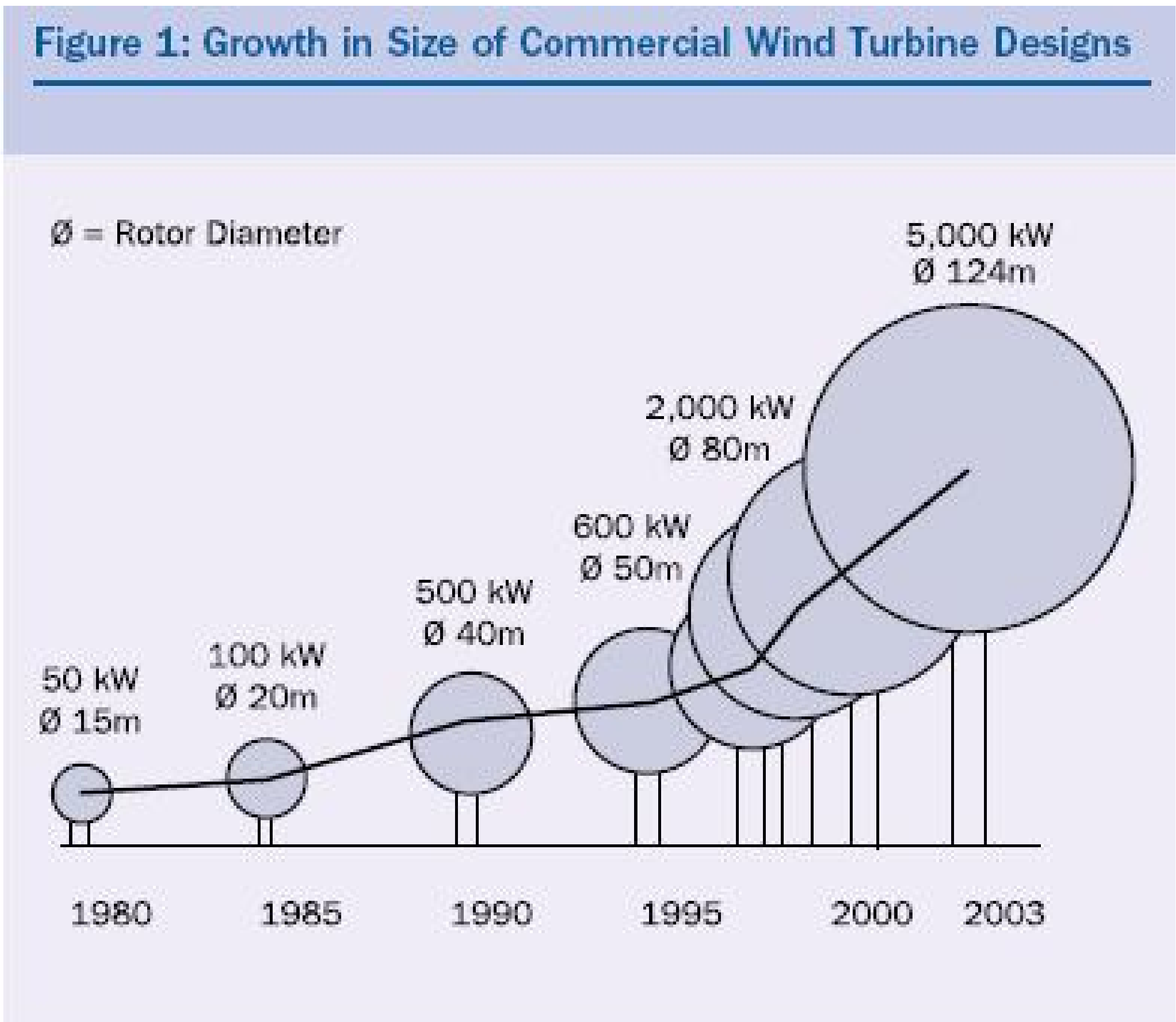

Figure 5-2: The development of turbine size since the 1980's – European Wind Energy Association (EWEA)

Certain turbine tower structures may provide suitable perching space to certain bird species, thereby increasing the chances of collisions as birds leave or enter the perch. It is anticipated that tubular towers will be used for the Cookhouse 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.

One of the reasons suggested for bird collisions with turbine blades is 'motion smear'stal & Eor retinal blur, terms used to describe the phenomenon whereby rapidly moving objects become less visible the closer the eye is to them. The retinal image can only be processed up to a certain speed, after which the image cannot be perceived. It stands to reason then that the slower the blades move, the less motion smear – and this should translate into less collisions. Interestingly, it is believed that at night there is no difference between a moving blade and a stationary one in terms of number of collisions (Kingsley & Whittam, 2005).

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

Collisions are one of the biggest single threats posed by overhead power lines to birds in southern Africa (van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds. These species are mostly heavy-bodied birds with limited manoeuvrability, 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 Data species vulnerable to power line collisions are generally long living, slow reproducing species under natural conditions. Some require very specific conditions for breeding, resulting in very few successful breeding attempts, or breeding might be restricted to very small areas. These species have not evolved to cope with high adult mortality, with the result that consistent high adult mortality over an extensive period could have a serious effect on a population's ability to sustain itself in the long or even medium term.

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

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

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

Spacing between turbines at a wind facility can have an effect on the number of collisions. Some authors have suggested that paths need to be left between turbines so that birds can move along these paths. For optimal wind generation, relatively large spaces are generally required between turbines in order to avoid wake and turbulence effects in the case of the proposed Wind Energy Facility, turbines will be spaced more than 300m apart.

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).*

5.3.2 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 region in the eye for frontal and ground vision and they have various other optical methods for keeping objects at different distances simultaneously in focus
- The phenomenon of motion smear or retinal blur, explained earlier in this report
- The angle of approach. If a bird approaches from side on to the turbine, the blades present a very small profile and are even more difficult to detect

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

5.3.3 Mitigation measures

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

<u>*Turbine design*</u>

Several different turbine designs exist, apart from the conventional 3 blade design, and are potentially of less impact to avifauna. These turbines turn in the wind on the same plane as the tower as opposed to the three bladed design which turns at right angles to the tower. Another important aspect is that some of these designs are a solid mass and thus not having the gaps between the blades should be more visible to birds and hence result in fewer collisions.

Example of a potentially safe design can be seen below:

Plate 5-1: The bird friendly Helix wind turbine

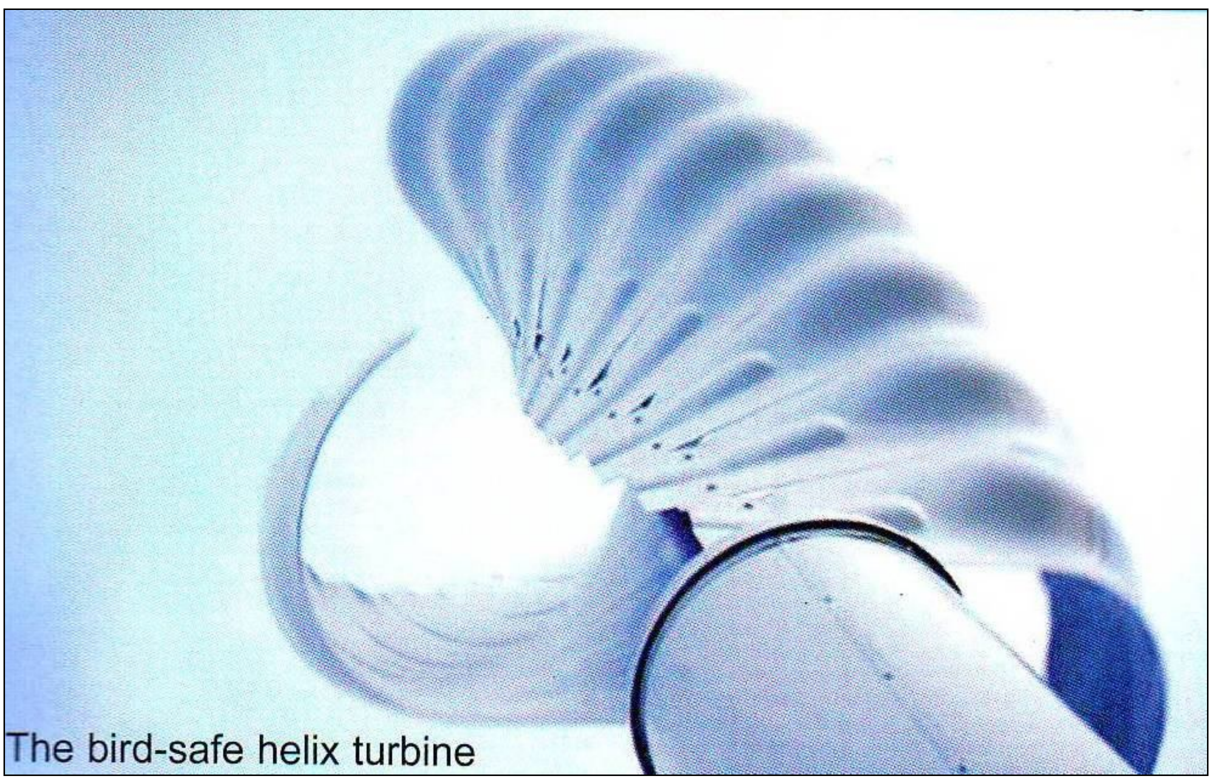

Plate 5-2: Close up view of the bird friendly Helix wind turbine

Painting turbines

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

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

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 patterns across the widest variety of backgrounds were the single black blade pattern and the black thin stripe pattern staggered across the three blades. Since the single black blade pattern has the advantage of being easier and cheaper to implement, it is recommended for use by Hodos (2002)

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

Anti perching devices

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

Construction of pylons

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

Provided below is a summary of the key points identified in the above literature review on birds and wind farms:

- With a few exceptions (such as at Altamont Pass and Tarifa), studies have found low numbers of bird mortalities at wind facilities
- There is a huge variance in mortality between sites, and even between individual turbines within sites
- The majority of collisions seem to involve raptors and/or songbirds
- At the Klipheuwel site, monitoring for 8 months revealed two mortalities, a Horus Swift and a Thick-billed Lark (now named Large-billed Lark). The lark mortality is in accordance with literature which states that grassland species with aerial courtship displays (such as larks, many of which perform aerial displays) are particularly vulnerable to collisions
- Factors affecting the number of mortalities at a facility include: bird species present, prey abundance, landscape features, weather, number of turbines, turbine size, turbine spacing and facility lighting
- Associated infrastructure such as power lines etc also impact on birds
- It appears that intermittent lighting may be less attractive than continuous lighting, and that possibly red light is less attractive than white light
- The primary explanation for collisions appears to be the phenomenon of motion smear or retinal blur. Mitigation measures should therefore focus on reducing motion smear effects

In laboratory testing, two studies have found that painting turbine blades increases their visibility to American Kestrels. The most visible patterns appear to be black stripes across the blade, in different positions on each blade so as to reduce retinal blur or motion smear or more simply a single solid black blade with two solid white blades. Unfortunately these tests confirm only that the blades will be more visible if painted. They do not test what the psychological response of birds to the blades will be. Birds may be scared and repelled from the blades, or may be curious and be attracted closer. Only field testing can confirm these responses. We are not aware of any field testing of these blades to date

Plate 5-3: An early wind farm in the Tehachapi Mountains of California.
Source: Wikipedia 2010

5.4 Description of the affected environment

5.4.1 General Area

The below map (Figure 5-3) shows the general receiving environment with existing power lines, canals and the river. The CAR (Co-ordinated Avifaunal Road counts) routes are also shown.

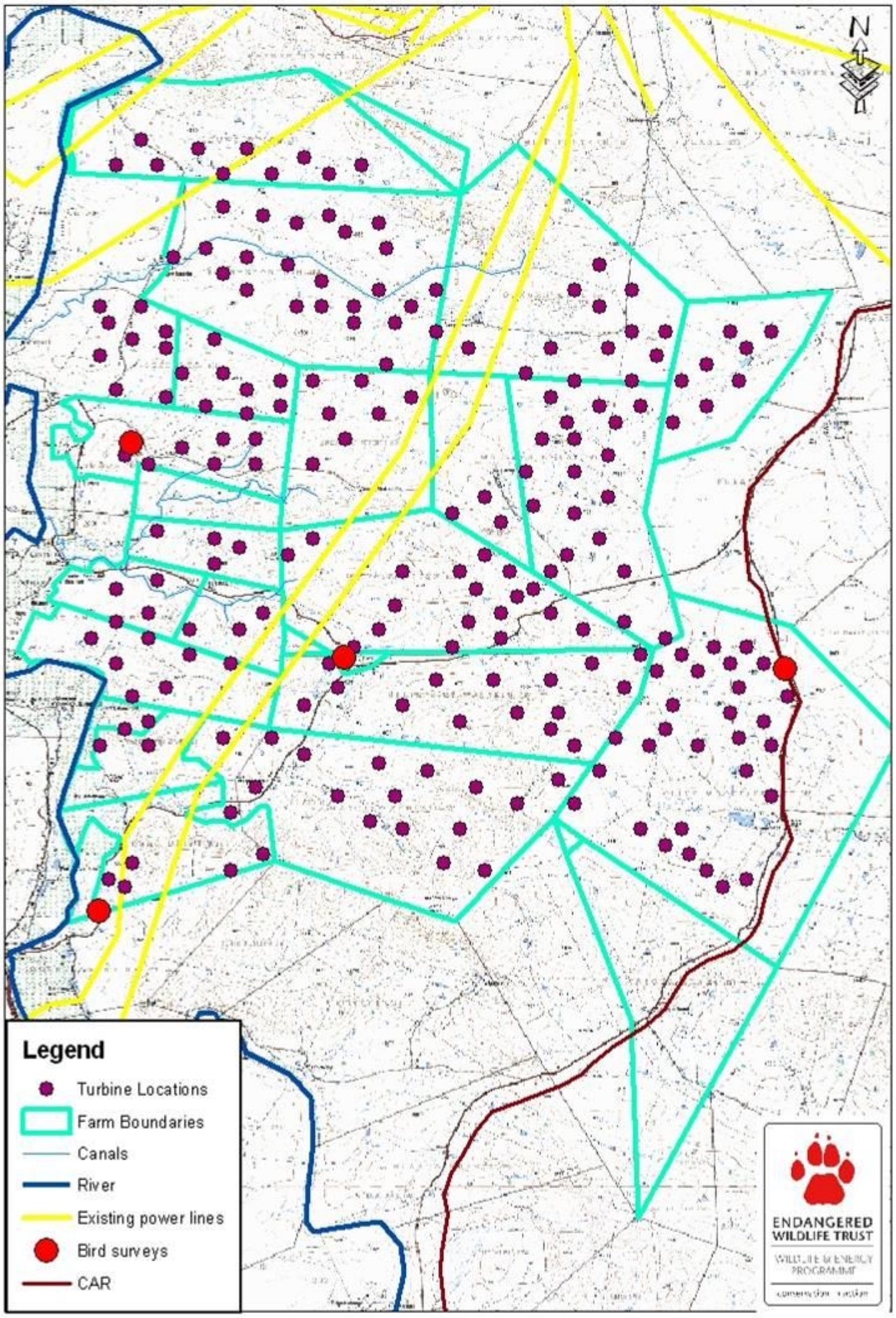

Figure 5-3: General layout of the study area with turbine positions (CAR= Co-ordinated Avifaunal Road counts).

5.4.2 Land use and vegetation

The land use and vegetation maps were produced and are presented below in Figure 5-4 and 5-5.

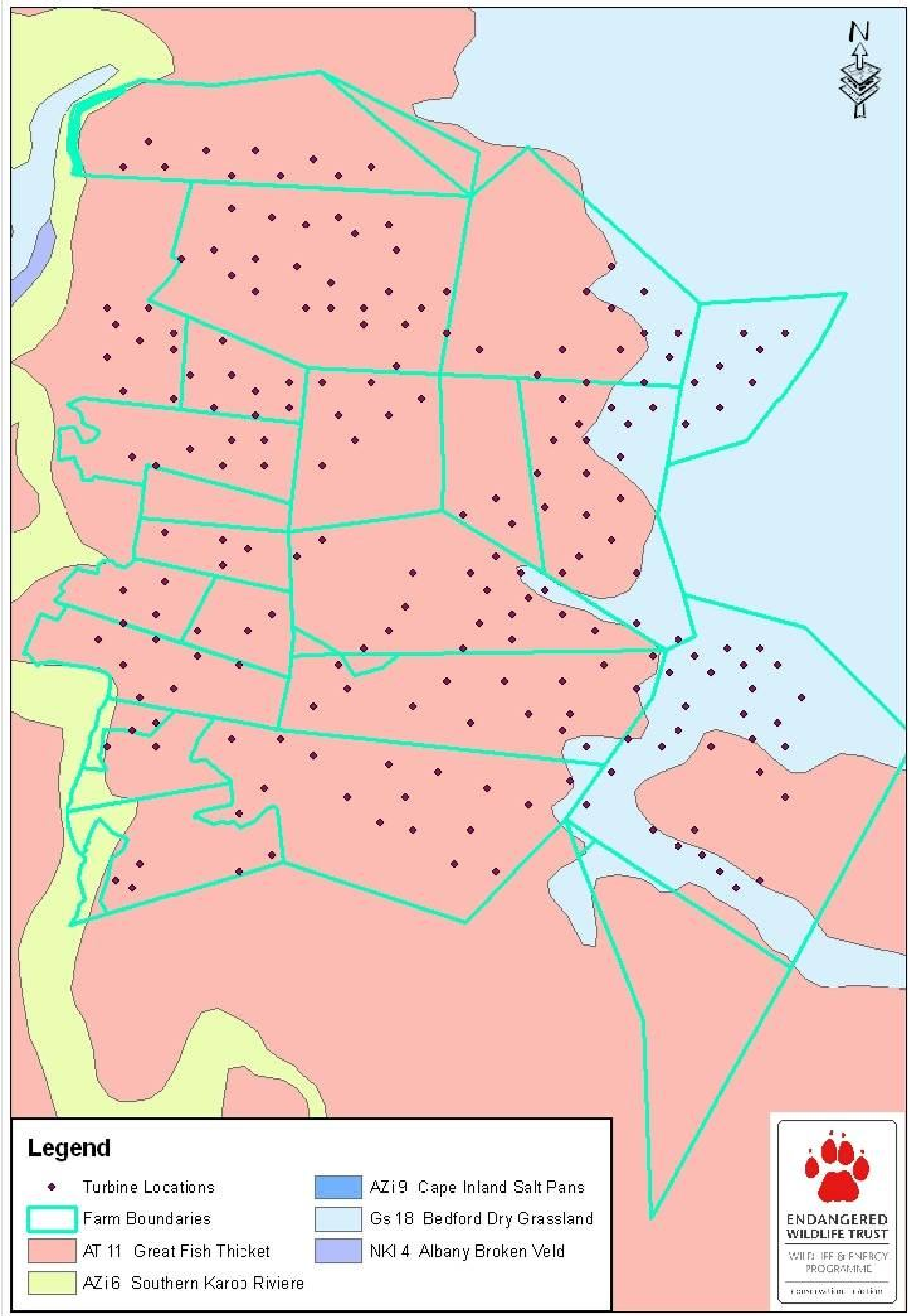

Figure 5-4: Vegetation of the study area.

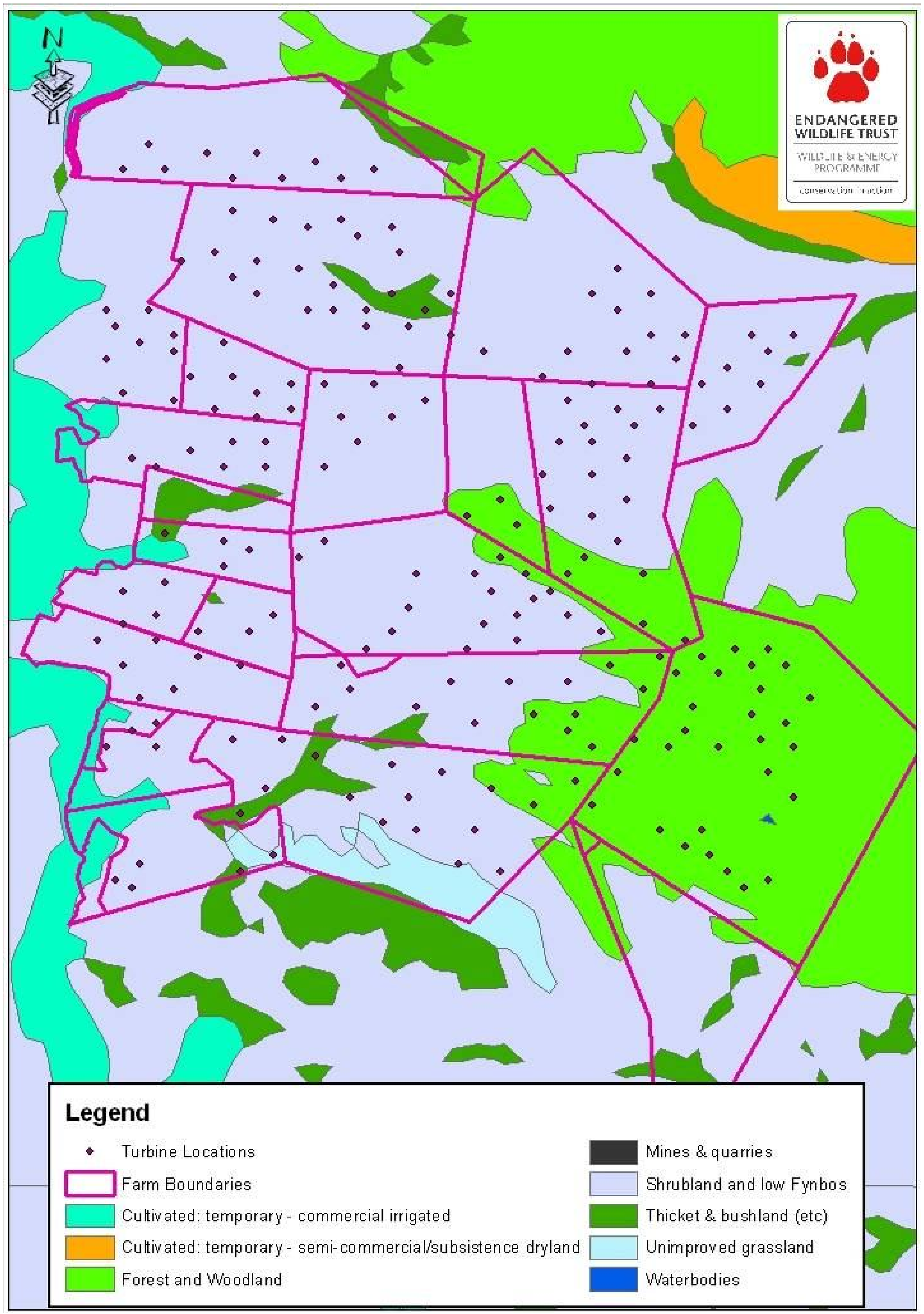

Figure 5-5: Land use of the study area.

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 above (Figure 5-5) showing the vegetation classification of the area (Mucina & Rutherford 2005).

The three main vegetation types identified on the map below are: *Great Fish Thicket; Bedford Dry Grassland and Southern Karoo Riviere.*

Great Fish Thicket: "Steep slopes of deeply dissected rivers supporting short, medium and tall thicket types (Palmer 1981, Palmer *et al* 1988, Evans *et al* 1997), where both the woody trees and shrubs and the succulent component are well developed, with many spinescent shrubs. There is distinct clumping of the vegetation, which is linked to zoogenic mounds, formed principally by termites, earthworms, mole rats, and aardvarks" (Mucina & Rutherford 2005).

Bedford Dry Grassland: "Gently undulating plains supporting open, dry grassland interspersed with Acacia Karoo woodland vegetation. The grassland is relatively short (10-100cm). It contains a dwarf shrubby component of karroid origin in the southern and southwestern parts of its range" (Mucina & Rutherford 2005).

Southern Karoo Riviere: "Narrow riverine flats supporting a complex of Acacia Karoo or Tamarix usneoides thickets (up to 5m tall), and fringed by tall Salsola-dominated shrub land, especially on heavier soils on very broad alluvia "(Mucina & Rutherford 2005).

It is important to note that the vegetation classification shows that the area is comprised mainly of shrubs and "grassland" and that few large trees are present. We would thus expect more terrestrial species in the area. The Atlas of Southern African Birds suggests that the following sensitive species that may be collision sensitive would be expected to be found in this area:

- Blue Crane
- Secretarybird
- Denhams Bustard
- White Stork

The vegetation data is also useful in predicting the likelihood of occurrence of certain species presented in the SABAP data below (Table 5-2). The vegetation characteristics help us to assess what the predominant habitat type is and as such, when correlated to each species preferred habitat, its likelihood of occurrence.

The land use map (Figure 5-5) above shows that the area is predominantly shrubland and low fynbos, as well as some thicket and bushland, forest and woodland, unimproved grassland and commercially irrigated cultivated land. The commercially irrigated cultivated land is found on the western side of the site following the Fish river. Irrigated land is generally attractive to a wide variety of avifauna and this is one of the sensitive micro-habitats discussed further below.

5.4.3 Sensitive micro-habitats for avifauna

The above vegetation description partially describes the species likely to occur in the study area. However, more detail is required in order to understand exactly where within the study area certain species will occur. These "micro" habitats are formed by a combination of factors such as vegetation, land use, and others. These micro habitats will be critically important in siting the proposed turbines within the affected farms. The following micro habitats were observed from the site visit. The species most likely to use each micro habitat within this study area are shown in Table 5-2.

Natural grassland (Plate 5-4): This is the dominant micro habitat available to birds in the study area. The dominant plants in this biome are grass species, with geophytes and herbs also well represented (Low & Rebelo 1996). Grasslands are maintained mainly by a combination of the following factors: relatively high summer rainfall; frequent fires; frost and grazing. These factors generally preclude the growth of trees and shrubs. This biome has been largely transformed in SA already through various land uses such as afforestation and crop cultivation. Sweet grassland is generally found in the lower rainfall areas. Vegetation is taller and sparser, and nutrients are retained in the leaves during winter. Relatively few bird species favour sweet grassland over sour or mixed grassland. Sour grassland generally occurs in the higher rainfall areas on leached soils. Vegetation is shorter and denser, and nutrients are withdrawn from the leaves during the winter months. Many grassland bird species show a preference for sour grassland over sweet or mixed. These include many Red Data species which clearly confirms the status of grassland in SA, as one of the least conserved or most transformed biome. Mixed grassland is a combination or a transition between sweet and sour grassland as described below.

Plate 5-4: Grassland in the study area, note the Blue Cranes.

Rivers, drainage lines and canals (Plate 5-5): A number of rivers, drainage lines and canals bisect the affected farms. Most rivers in southern Africa are in the east and extreme south, in the higher rainfall areas. Thirteen species of water bird are mostly restricted to riverine habitat in southern Africa. The map distribution of these species correlates with the river courses in southern Africa.

In the study area although many of these water courses seldom contain water, these systems are important, as they have a different vegetation composition to the remainder of the plains, often including woody species such as Acacia Karoo. Furthermore any river, stream or drainage line represents an important flight path for many bird species.

Plate 5-5: Fish River on the north and west of the study area

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

Woodland (Plate 5-6): The woodland biome covers most of the northern and eastern parts of southern Africa and is defined as having a grassy under-storey and a woody upper-storey of trees and shrubs. Woodland can be divided into two types: the fine leaved arid, often Acacia dominated woodlands in the drier parts of the country, and the predominantly broadleaved woodlands in the wetter regions. The Woodland bird community is the most species rich community in southern Africa. Complex differences in bird species distribution and abundance are seen between the different woodland types. Relatively small amounts of woodland exist in this study area, mainly on the escarpment slopes, and in the valleys and drainage lines.

Plate 5-6: Typical woodland in the study area

Arable or cultivated land (Plate 5-7)**:** These areas represent significant feeding areas for many bird species in any landscape for the following reasons: through opening up the soil surface, land preparation makes many insects, seeds, bulbs and other food sources suddenly accessible to birds and other predators; the crop or pasture plants cultivated are often eaten themselves by birds, or attract insects which are in turn eaten by birds; during the dry season arable lands often represent the only green or attractive food sources in an otherwise dry landscape. In this study area arable lands are not found within the project development footprint, but are present in the broader landscape and are therefore relevant to this study.

Many of these lands are irrigated and as such most definitely represent almost the only source of "green" and moisture in this landscape for much of the year. This attracts certain species as shown in Table 5-2. In particular the White Stork has a high affinity with arable lands, with 86% of sightings in South Africa recorded on arable lands (Allan 1985, Allan 1989, Allan 1997 in Hockey, Dean & Ryan 2005).

Plate 5-7: Cultivated land in the study area

Ridges: Ridges represent important habitat for a number of species. Most relevant to this study are the aerial species such as raptors and swifts/swallows – which favour flying along ridges where there are favourable air currents, termed 'ridge lift' (or orographic lift). Wind that is perpendicular to the ridge line is forced upwards when it meets the ridge, thereby creating lift, long continuous ridges resulting in greater lift. In addition, the air is heated differently by the sun on either side of a ridge, resulting in thermal lift. Birds use this lift to gain altitude, forage or move between locations – all with less effort than would be required elsewhere. Larger soaring species such as storks and vultures will also circle over ridges as they gain height and exploit the conditions. On the lee side of the ridge, several 'waves' may form. Whilst these waves can potentially also favour bird flight, it is probably more likely that the turbulence in this area would be detrimental to birds and probably avoided, particularly by smaller species. Various studies internationally have found higher wind turbine bird mortality rates close to steep ground (including Orloff & Flannery 1992; Howell & Noone, 1992; Thelander & Rugge, 2001). The increased wind speed in these ridge areas may also mean that birds have less control of their own flight and are less able to adjust to avoid obstacles such as wind turbines.

5.4.4 Bird Presence in the study area

Table 5-2: lists the Red Data bird species recorded in the quarter degree square covering the study area by the Southern African Bird Atlas Project (Harrison *et al*, 1997), i.e.3225DD. The total number of all species recorded and the number of cards (counts) submitted per square is also shown. In total 6 Red Data species were recorded across the square, comprising 2 Vulnerable and 3 Near-threatened species. In addition, the White Stork was included here as it is afforded protection 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.

Table 5-2: Sensitive bird species in the effected quarter degree square.

Total Cards		35		
Total Species		156		
Total Breeding Species		19		
Name	**Conservation status**	**3225DD**	**Habitat**	**Likelihood of occurrence**
Blue Crane	VU	20	Midland and highland grassveld, edge of karoo, cultivated land, edges of vleis	Likely
Denham's (Stanley's) Bustard	VU	9	Montane and highland grassveld, savanna, karoo scrub	Likely
Black Stork	NT	3	Feeds in or around marshes, dams, rivers and estuaries; breeds in mountainous regions	Possible
Secretarybird	NT	14	Semidesert, grassland, savanna, open woodland, farmland, mountain slopes	Likely
Melodious (Latakoo) Lark	NT	6	Open climax grassland, especially Red Grass (Rooigras) *Themeda triandra* and species of *Eragrostis* and Russet Grass *Loudetia simplex* , sometimes with rocky outcrops, termite mounds or sparse bushes; also cultivated fields of Teff *Eragrostis tef* ; in KwaZulu-Natal at 550-1750 m elevation, rainfall 400-800 mm/year; moves into e Karoo after good rains.	Possible
White Stork	Bonn	20	Highveld grasslands, mountain meadows, cultivated lands, marshes, karoo	Likely

VU = Vulnerable

NT = Near-threatened

Bonn = Protected under the Bonn Convention on migratory species

Table 5-3- CAR data for the EG02 route, data is numbers of birds per 100km. (Young, D.J, et al, 2003)

Species	Summer	Winter
Blue Crane	7.63	15.97
Kori Bustard	-	0.7
Ludwigs Bustard	-	2.1
White Stork	18.03	-
Secretarybird	5.6	6.97
Black Korhann	9.03	4.2
Whitebellied Khoraan	-	2.1
Spurwinged Goose	0.7	1.4
Blackheaded Heron	7	2.8
Total	48	36.23

As can be seen in the two tables above, large terrestrial birds are present in the study area. These larger species are the species of particular concern for us as they are known to be more collision sensitive with power lines (EWT central incident register) and as such we suspect that they will also be more collision sensitive with wind turbines. A lack of data on avifaunal interactions with wind turbines in South Africa is of concern and as such the precautionary principle has been applied to this assessment due to the lack of knowledge and experience on wind energy in South Africa.

As well as the above two datasets, surveys were conducted at 4 locations. These locations can be seen in the map above (Figure 5-3). At each site the following was done:

- Surveys will be conducted on at least two days at sites at either end, and in the middle of the proposed turbine corridor and Survey sites will be selected to reflect variation in local habitat and terrain.

- During daylight in each survey 2 x 15 minutes of visual scans of birds crossing the proposed turbine corridor (with appraisal of flight height above the ground) as well as 2 x 10 minutes circular point surveys will be conducted.

- Flight height was recorded as either: Below Turbine Height; Turbine Height; or Above Turbine Height.

The data that was collected can be seen below in the tables (Table 5-4 to 5-7).

Table 5-4: First Bird survey conducted at 17:05 on the 8/2/2010

Species	Flight Height
Barn Swallow	Below Turbine Height
Red-faced Mousebird	Below Turbine Height
Southern Glossy Starling	Below Turbine Height
Southern clapper Lark	Below Turbine Height

Table 5-5: Second Bird survey conducted at 05:48 on the 9/2/2010

Species	Flight Height
Red-eyed Dove	Below Turbine Height
Barn Swallow	Below Turbine Height
Turtle Dove	Below Turbine Height
Deidricks Cuckoo	Below Turbine Height

Table 5-6: Third Bird Survey conducted at 16:18 on the 9/2/2010

Species	Flight Height
Pied Starling	Below Turbine Height
Deidricks Cuckoo	Below Turbine Height
Turtle Dove	Below Turbine Height
Southern Glossy Starling	Below Turbine Height
Southern Clapper Lark	Below Turbine Height
Barn Swallow	Turbine Height
White Storks	Below Turbine Height

Table 5-7- Fourth Bird Survey conducted at 05:35 on the 10/2/2010

Species	Flight Height
Egyptian Goose	Below Turbine Height
Barn Swallow	Below Turbine Height
Southern Glossy Starling	Below Turbine Height
Red-eyed Dove	Below Turbine Height
Fork-tailed Drongo	Below Turbine Height
Cape Sparrow	Below Turbine Height
Sacred Ibis	Below Turbine Height

As can be seen above the bird surveys did not really add much in terms of sensitive species but it was a worthwhile exercise to assess the height the birds are flying at, at various locations within the study area. As can be seen in the four tables above only one incident of birds flying at turbine height was recorded and these were Barn swallows. Having said this, however, the scope for first hand data collection within the current EIA process in South Africa is severely lacking.

It would be far better to have 1 years worth of data from many more localities within this site to have a real idea of bird flight paths and to be able to model this with any degree of accuracy. Unfortunately this is not feasible in the current EIA process and as such second hand sources are relied on far more heavily than the limited first hand observation data that was collected.

5.5 Impact Assessment

This section will assess the significance of impacts as a result of the proposed Terra Wind Energy Golden Valley Project on the surrounding avifaunal environment. The significance of each impact was identified and evaluated using the CES impacts rating scale (Section 3.3 in Chapter 3 above).

5.5.1 Construction phase

Impact 1: Habitat destruction

Cause and comment

During construction a large 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, batching plants, labour camps, power lines, substations and machinery and equipment storage. From an avifaunal perspective this habitat destruction will result in a loss in habitat for many bird species. Of particular concern is the river and any natural habitat surrounding the river. This is, however, mostly transformed and used for large scale commercial agriculture. As mentioned above, in the micro-habitats section, agricultural lands can be an important habitat for birds and as such should not be discounted simply because the natural vegetation does no longer exist. Of particular concern would be breeding bird species and all care should be taken to avoid habitat destruction and disturbance in the vicinity of any breeding sensitive species.

Mitigation and Management

On a project such as this the possibility for mitigating the impact of habitat destruction is very low. The scale of the project means that it is inevitable that large amounts of habitat destruction will take place. The mitigation for this impact will be to only effect 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 conducted 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 moderate impact and will require mitigation for the project to proceed.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
OPTION 1										
Without Mitigation	Permanent	4	Study Area	2	Moderate	2	Probable	3	**11**	**Moderate**
With Mitigation	Permanent	4	Study Area	2	Moderate	2	May Occur	2	**10**	**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**

Impact 2: Disturbance

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 these important additions to many endangered, vulnerable or near threatened populations.

Mitigation and Management

Mitigation for disturbance is much the same as for habitat destruction. In general terms all construction activities should result in the minimum amount of 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.

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**

5.5.2 Operational phase

Impact 1: Collisions 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 largest impact on avifauna for this project and as such the one that requires the most mitigation.

Mitigation and Management
The most important mitigation activity will be positioning the turbines away from sensitive avifaunal sites. These sites include the Fish river and the associated agriculture as well as the canals, dams and pans etc. A map has been produced taking all of these sensitive sites into account and the map can be seen below in figure 5-6.

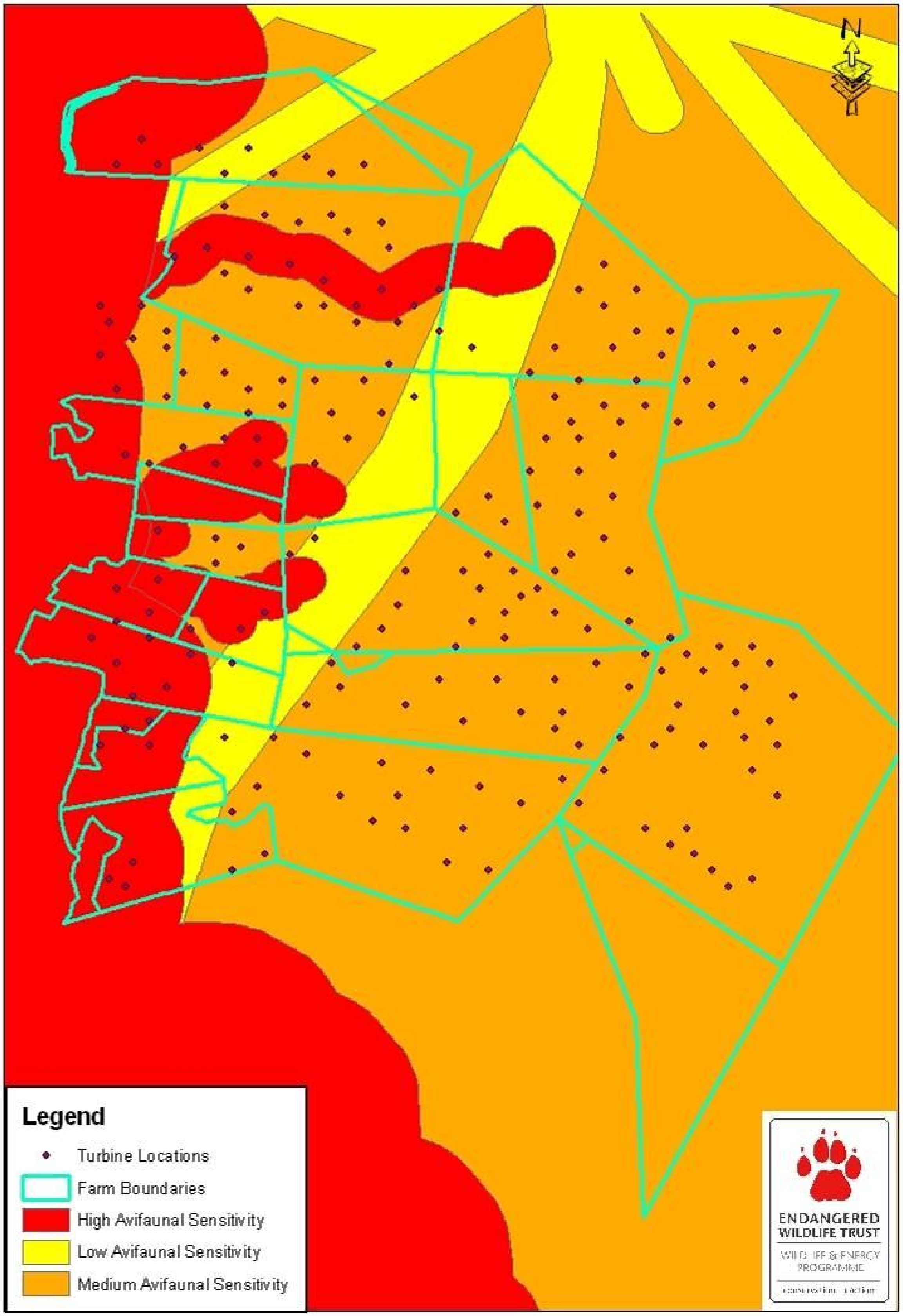

Figure 5-6- Avifaunal sensitivity map for the proposed project.

The sensitivity categories were assigned using the following factors:

High sensitivity:

- Fish River buffered by 2 kilometres
- Canals and smaller streams buffered by 500 meters on either side.

Medium Sensitivity:

- The medium sensitivity was the entire study site that was not high or low sensitivity.

Low Sensitivity:

- The existing transmission power lines in the area buffered by 500 meters on either side.

The sensitivity map has been presented to guide the placing of turbines during this phase of the project. High sensitivity should not be seen as a no go area but rather an area that will need more focus during the site specific EMP for the project. During this phase turbines falling inside this high sensitivity zone need to all be visited and their positions assessed. Should it be found that the site is suitable, the map will be adapted to indicate this.

On the other hand the low avifaunal sensitivity zones can be used as much as possible. The rationale for the low sensitivity around the transmission lines is that it will be beneficial from an avifaunal perspective to place infrastructure as close together as possible. It is likely that a line of wind turbines next to or close to the transmission lines will be a much larger group of infrastructure than if they are placed apart and thus easier for a bird to see and avoid. An additional advantage is that the turbines may shield the power lines from bird collisions and from a cumulative impact point of view this will be advantageous for avifauna. There will be little or no need for specific site assessment during the EMP.

The rest of the study area that has been classified as medium will be subject to further assessment during the site specific EMP, however this will be done in less detail when compared to the turbines falling in the high sensitivity zone.

Additional mitigation for collisions will include painting or marking two of the three turbine blades as specified in this report above, to reduce the chances of retina blur and thus mitigate for collision. It is acknowledged that there is little or no data from a South African perspective as to whether this is feasible or in fact effective but due to this lack of data the precautionary principle has been used and as such this recommendation has been made.
Lighting may also become an issue for avifauna and as such, the turbines should remain unlit as far as possible. Should it be necessary for lights to be placed on turbines, these must only be red strobe lights.

Since wind energy in South Africa is so new, it is difficult to rate the impacts of collisions just on international experience. As such, we have been very cautious when compiling this report. It is suggested that a monitoring program be seriously considered on this facility after it is constructed to assess and collect data on bird collisions with turbines in South Africa.

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.

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	**11**	**Moderate**
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**

Impact 2: Disturbance

Cause and Comment
During operation the disturbance caused by the noise and visual movement of the wind turbines will disturb avifauna. This disturbance is likely to result in shy and sensitive species leaving the area and should a suitable new area be found, they will stay in this new area.

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.

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**

Impact 3: 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 decreased fitness as birds expend more energy flying from one point to another.

Of particular concern is the cumulative impact of multiple wind energy facilities in one area (as will be the case here).

Mitigation and Management
The following mitigation measures can be used to minimise the effects of barriers caused by the wind energy facility:

- Corridors must be left between turbines to allow birds to fly safely from one side of the site to the other.

Significance statement: The significance of this impact has been rated as moderate both with and without mitigation. The mitigation for this impact should not be seen as solving the problem as it is uncertain as to whether birds will use corridors between turbines and if they do how much increased risk they will face from collisions.

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**

Impact 4: Collisions and electrocutions of birds with 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 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 in this project, 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 large effect depending on the design of the infrastructure.

The map below (Figure 5-7) shows the electrical infrastructure including the underground 33KV cabling that will link the different turbines, the location of the collecting substations as well as the routes of the 132KV power lines that will connect the wind energy facility to the ESKOM grid.various species of water birds. These species are mostly heavy-bodied birds with limited

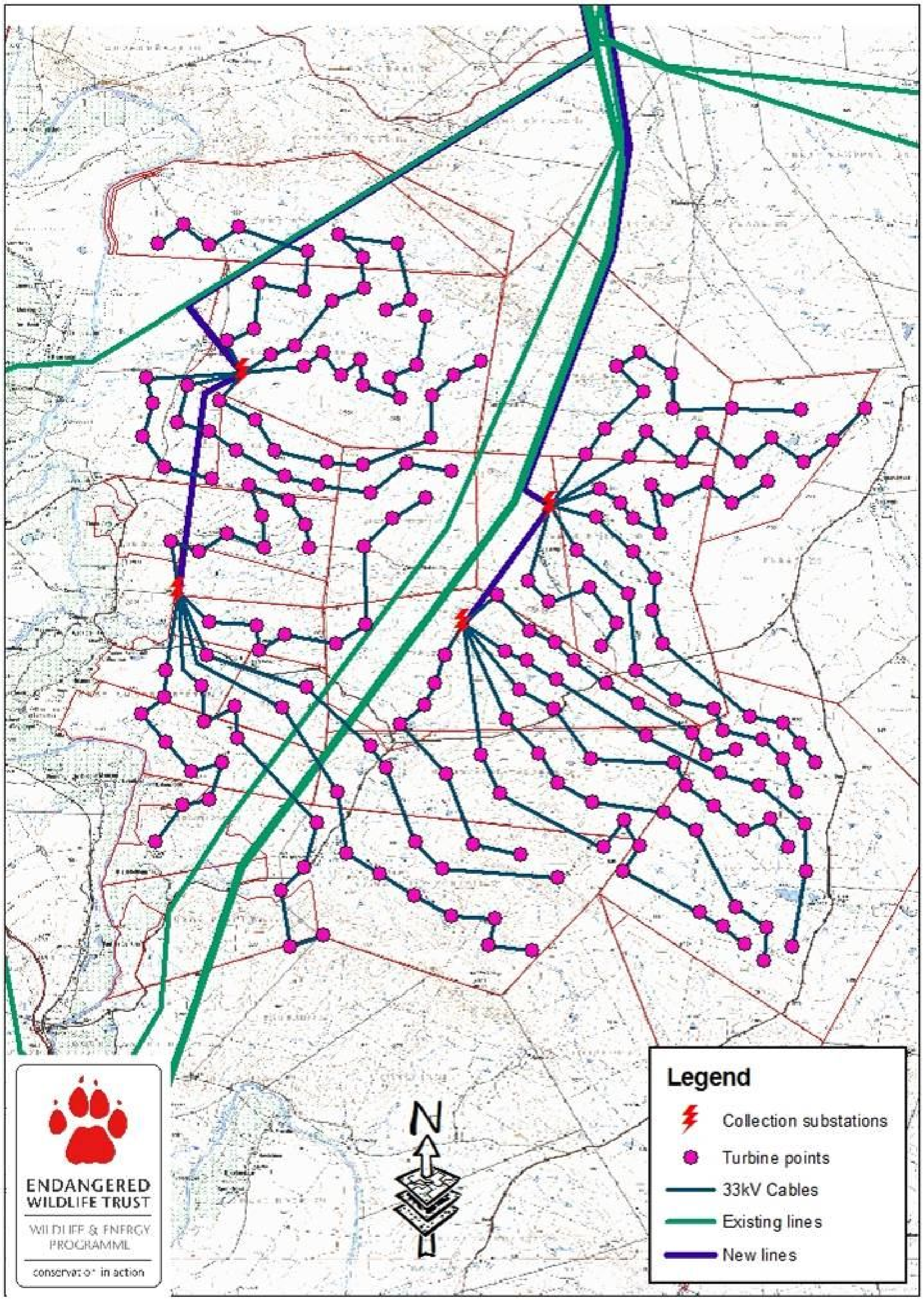

Figure 5-7: Location and routes of the power lines and substations.

Mitigation and Management
Mitigation for the impact of the electrical infrastructure will include the following:

Electrocutions - It is highly recommended that the steel monopole design be used for the 132KV power line poles. This design is generally very safe for birds as the clearances between live phases and earth phases is greater than 1.8 meters, which is the length of the largest species wingspan. The steel monopole must also have the standard bird perch fitted, which will allow raptors a safe area to perch on the pole.

Electrocutions in the substation yards should not be significant as the sensitive species are not known to use these sites for perching or roosting. If problems are picked up during operation they can be mitigated reactively using insulation.

Collisions - The significance of the short power lines that will service this facility in relation to the collision risk of birds with the turbines is very small. In addition the 132KV lines will, for the most part, follow existing transmission lines. This will help to mitigate for the impact of collision as power lines grouped together are more visible to birds while in flight.

The power line routes must be walked during the site specific EMP and any sections of collision concern should be marked with standard anti-collision marking devices to mitigate for the impact of collision.

Significance Statement
The significance has been rated as moderate, however should the steel monopole design be used for the power line and sensitive areas marked for collisions during the EMP this can rather be viewed as a low impact.

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	May occur	2	**9**	**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**

5.6 Comparison of Alternative

The alternatives on this project can be split up into:

- Construction of the wind energy facility on the proposed land with turbines in the positions as specified in the maps.
- No Go - No construction of the wind energy facility.

- Construction of the wind energy facility with slight modification in terms of turbine position.

The preferred alternative from an avifaunal perspective is the third option as it is very unlikely that this project will not proceed. There is no avifaunal fatal flaw and as such the most preferred option is for the project to proceed but with certain turbines to be shifted to accommodate avifaunal impacts. These affected turbines can be seen in the sensitivity map and will be the subject of the avifaunal specific EMP. With modification in terms of site selection and mitigation of all of the impacts, it is expected that the project will have an acceptable impact on avifauna.

There will also be alternatives from a power line routing perspective and once these are available, this can be discussed further.

5.7 Conclusions and Recommendations

In conclusion, the proposed project has been assessed from an avifaunal perspective and no fatal flaws have been found. The impact of collision is expected to be the greatest and this can be mitigated by the correct placing of turbines, painting the turbine blades as specified in this report and the use of no or red strobe lights on the turbines. As mentioned in the report, there is a lack of experience and knowledge on wind energy in South Africa and as such, this report has been dealt with using our best scientific knowledge and experience from other fields and from international studies that are available. We have applied the precautionary principle throughout, and this may mean that some impacts have been rated higher and some areas have been identified as more sensitive than they really are.

It must be noted here that there is some concern regarding the cumulative impact of multiple wind energy facilities on avifauna. This facilities site is located just south of another proposed wind energy facility. This means that in this particular area, there is the possibility of approximately 700 wind turbines and the associated infrastructure. This will obviously have a much larger effect on avifauna and no study has been done on this cumulative impact. While both facilities have been subject to EIA studies, there has been little thought for the cumulative impact. This should not be seen as the fault of the developer but rather a gap in the environmental process that needs to be filled with a more strategic assessment of wind energy in South Africa.

A site specific avifaunal EMP is seen as a critical next step to refine the sensitivity map and to strengthen the mitigation measures in order to have the least impact possible on avifauna in the area.

6 VISUAL SPECIALIST REPORT

Prepared by:	Prepared for:	On behalf of:
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<u>This report should be cited as</u>:

Holland, H., March 2010. *Proposed Terra Wind Energy Golden Valley Project: Visual Assessment.* MapThis, Cookhouse.

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)

6.1 Introduction

CES has been appointed by TerraPower Solution (Pty) Limited as the independent environmental assessment practitioners to undertake an environmental impact assessment (EIA) of the proposed wind farm near Cookhouse. 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.

6.1.1 Scope of the Specialist Study

6.1.1.1. Terms of Reference

The specific Terms of Reference for the Visual and Landscape Impact Assessment will include:-

1. Conduct a site reconnaissance visit and photographic survey of the proposed project site.
2. 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.
3. Review relevant legislation, policies, guidelines and standards.
4. 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

6.1.1.2. 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 change in land use from the prevailing use;
- A significant change to the fabric and character of the area;
- Possible visual intrusion in the landscape.

6.1.1.3. Information Base

- Documentation supplied by the client and CES;
- ToR for the visual specialist;
- Digital topocadastral data at 1:50 000 scale from the Surveyor General: Surveys and Mapping;
- South African land cover dataset of 2006;
- 1:250000 Geology map sheet 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)

6.1.2 Assumptions and Limitations

6.1.2.1. 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.

6.1.2.2. 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 turbine, and the relative low thicket cover in the region, the screening potential of vegetation is likely to be minimal over most distances.

6.1.2.3. 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*, for the purposes of this report, 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 done 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.

6.1.2.4. Shadow flicker modelling

The following standard assumptions are made when modelling shadow flicker:

- The sky is 100% clear with no allowance for mist, fog, cloud etc.;
- Turbines are always rotating;
- The rotor of the turbine is always orientated such that it is facing the receptor;
- There is a 2 km limit to the human perception of shadow flicker;
- The sun can be represented as a point light source;
- With exception to the consideration of terrain there exists a clear line of site between sun, turbine and receptor. No allowance is made for any obstructions such as vegetation or buildings;
- The sun must be 3 degrees above the horizon.

This model is conservative and the impact from shadow flicker is normally lower than predicted by current models (Nielsen 2003).

6.1.3 The specialist study team

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 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.

6.2 Methodology

6.2.1 Issues raised by I&APs

The main issue raised by I&APs in relation to visual impact is that of the potential visual impact on tourism development in the area:

- “The Blue Crane Municipality thinks it is great for the economy and very positive for the area but our biggest concern is the visual impact, especially in terms of its affect on tourism.”
- “Perhaps the municipality should restrict wind farms to a certain area to avoid huge visual impacts.”

These issues will be addressed throughout this report.

6.2.2 Site Visit and Photographic Survey

The field survey (conducted on 10 and 11 February 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;
- 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.

Additionally, photo sites were chosen to aid in describing the landscape surrounding, and potentially affected by, the proposed development (Figure 6-1).

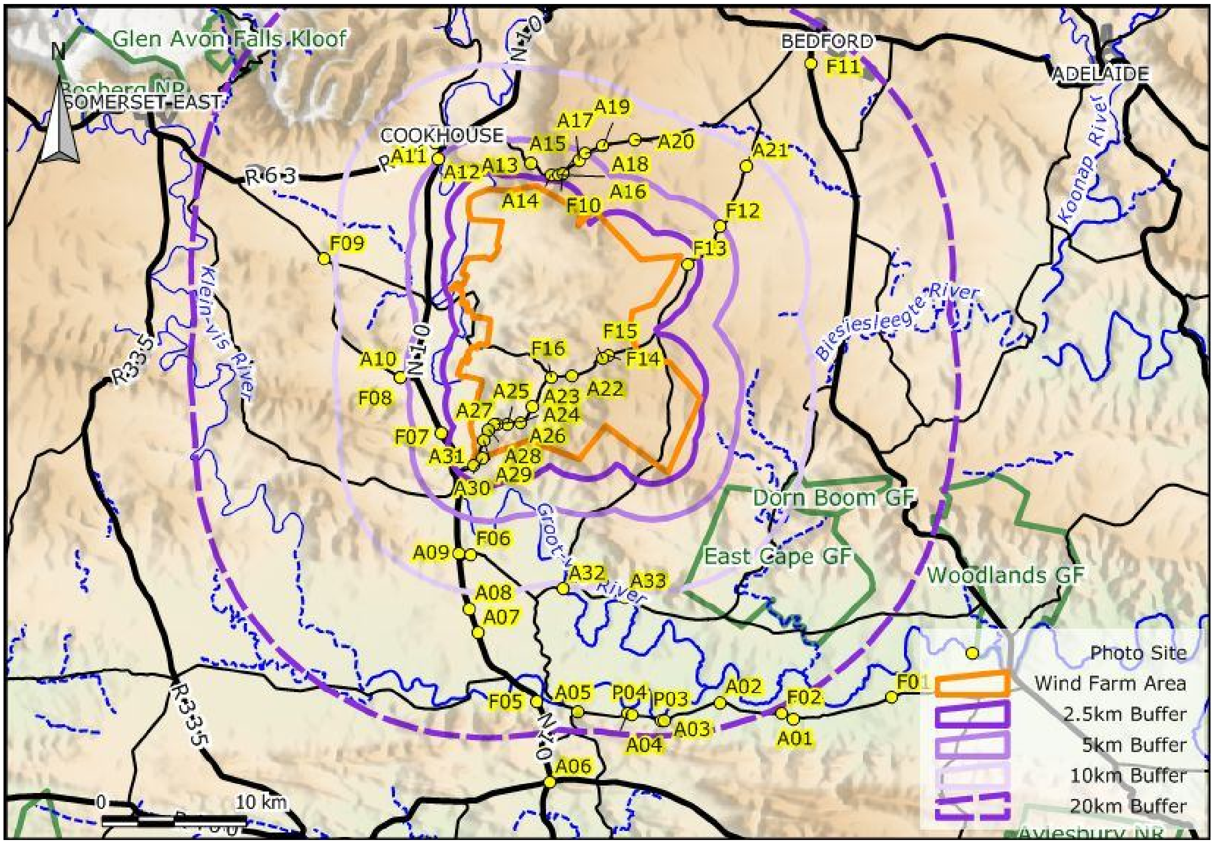

Figure 6-1: Localities from which photos for the photographic survey were taken. Reference to photo sites on this map is made throughout the report. Areas indicated in green are protected areas from the IUCN database. Most of these in the study area are of Type 3 and are game farms (GF).

6.2.3 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.

6.2.4 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 CES rating methodology as described in the Terms of Reference document (and in section 0 of this document).

6.3 Proposed project site

6.3.1 Overview of project

Figure 6-2 shows the proposed wind farm in relation to recognisable landscape features such as the Great Fish River and the N10. The project is described in the Draft Scoping Report (Coastal & Environmental Services 2009) as follows:

> *"..the proposed project is now planned to host 214 turbines, each with a nominal power output of 2.5 Mega Watts (MW). The total potential output of the wind farm will therefore be 500MW but the wind farm will still cover the same area."*

The provisional layout of the wind farm is shown in Figure 6-3.

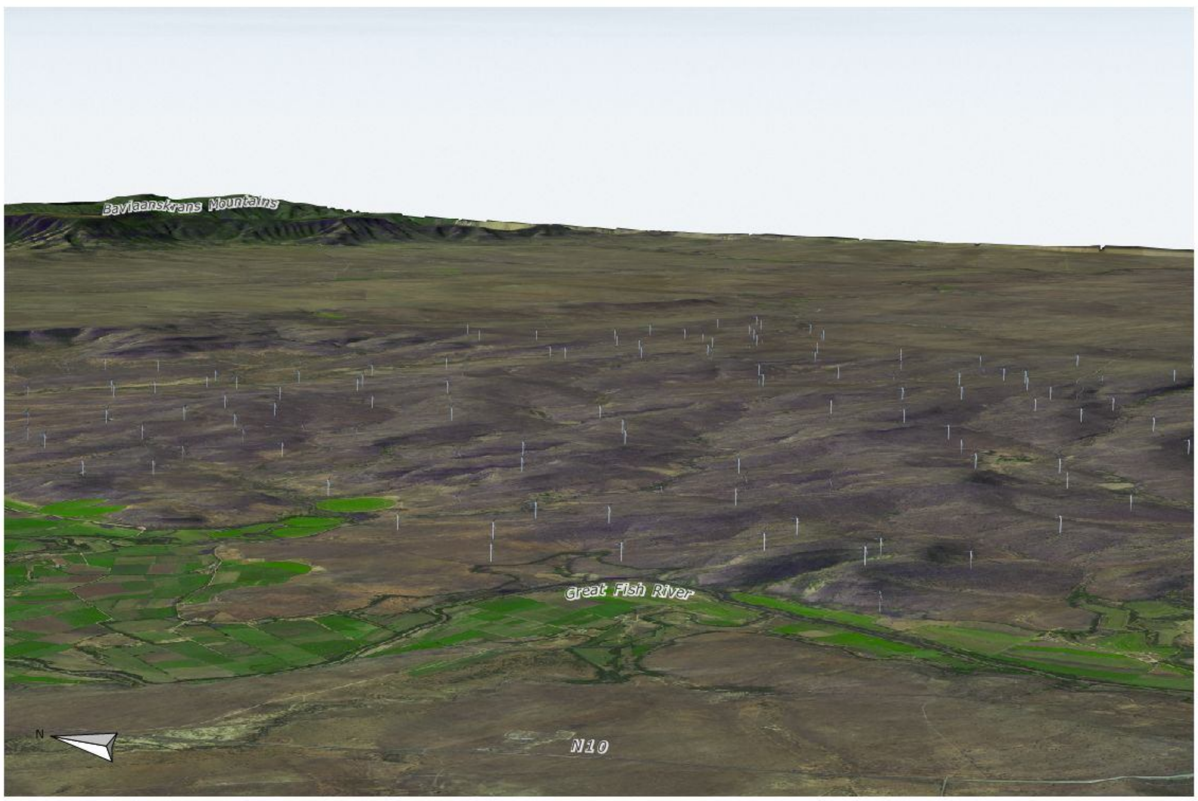

Figure 6-2: Proposed wind farm in relation to recognisable features in the landscape.

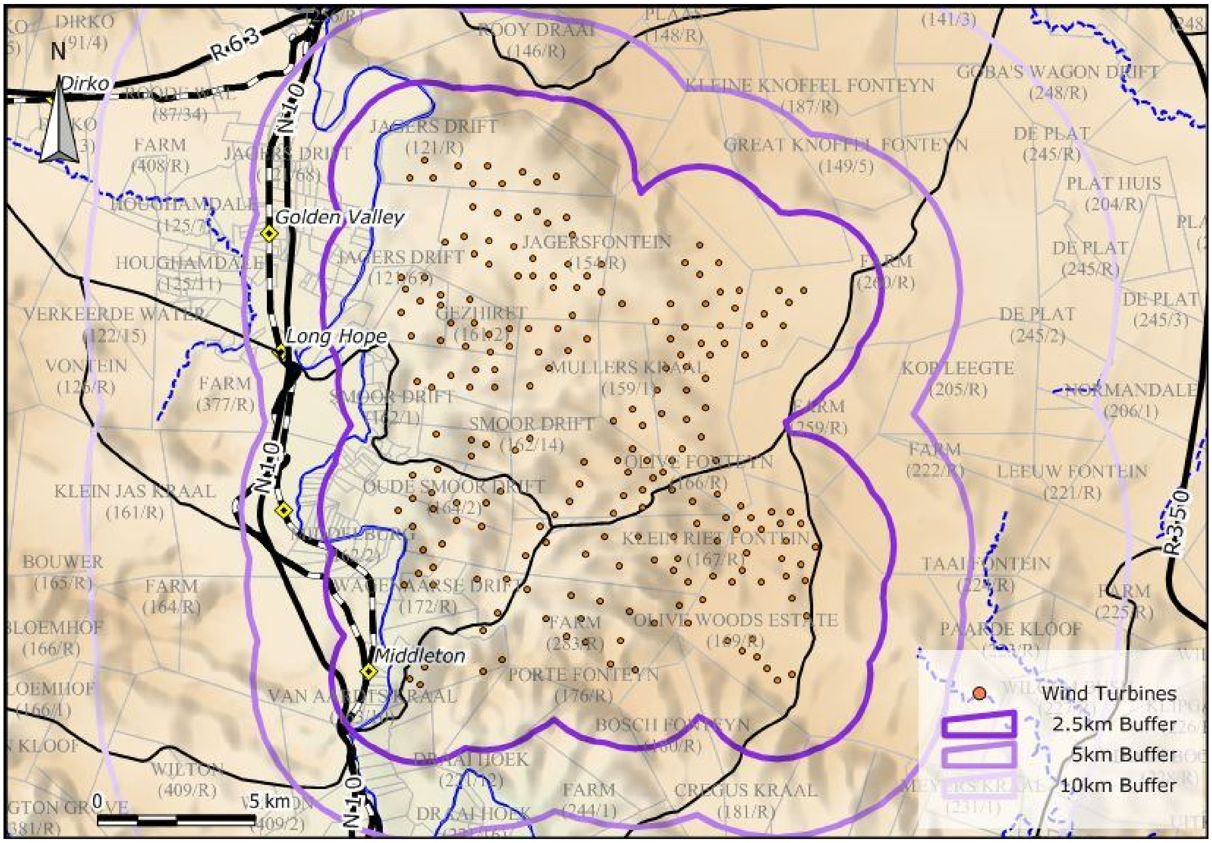

Figure 6-3: Provisional layout of the Cookhouse wind farm.

6.3.2 Project Components and Activities

6.3.2.1. 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 over 600 blades, each 40m in length, as well as other large turbine components.
- Tall cranes will be required to lift turbine components into position.
- Large trucks will be required to haul turbine components from Port Elizabeth on the N10.
- Heavy equipment such as bulldozers, graders, trenching machines and concrete trucks will be required.
- Stable platforms for the cranes need to be constructed.
- Existing roads connecting the N10 with site will need to be upgraded.
- Internal access roads to connect platforms will need to be established.

6.3.2.2. Operation

- Hub heights are between 80m and 100m high (depending on the model chosen), and rotors are 50m long. The maximum height at blade tip is therefore potentially 150m high.
- 132kV overhead power line connecting the site to the Poseidon Sub-station and/or the existing power lines traversing the site.
- Two sub-stations to receive generated power.
- Maintenance of access roads.
- A building to house control instrumentation and backup power support.
- Store room for maintenance equipment.

6.4 Description of Receiving Environment

6.4.1 Landscape Baseline

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

6.4.1.1. Topography

The topography of the study area is dominated by the Fish River floodplain and the Winterberg mountains (and their extension to the east) north of Somerset East, Cookhouse and Bedford (Figure 6-4). Towards the south most views will have the Suurberg Mountains and its foothills as distant backdrop. A ridge extending roughly west to east forms a topographic boundary south of the wind farm, while a slight escarp forms a clear boundary in the north (Figure 6-5a). From west to east the wind farm site rises more gradually from the Fish River floodplain to the plateau south of Bedford (Figure 6-5a to d). The lowest points (approximately 450m AMSL) in the region are found in the Little and Great Fish River (Klein- and Groot-Vis) floodplains south of the site, while the highest are found in the mountains north of Somerset East (approximately 1250m AMSL). The wind farm will therefore be located in on hills and ridges within a locally lower area within the regional landscape and will be almost completely surrounded by elevated land. An implication of this is that most distant views (>2km away) of the wind farm are not likely to contain wind turbines exposed against the skyline.

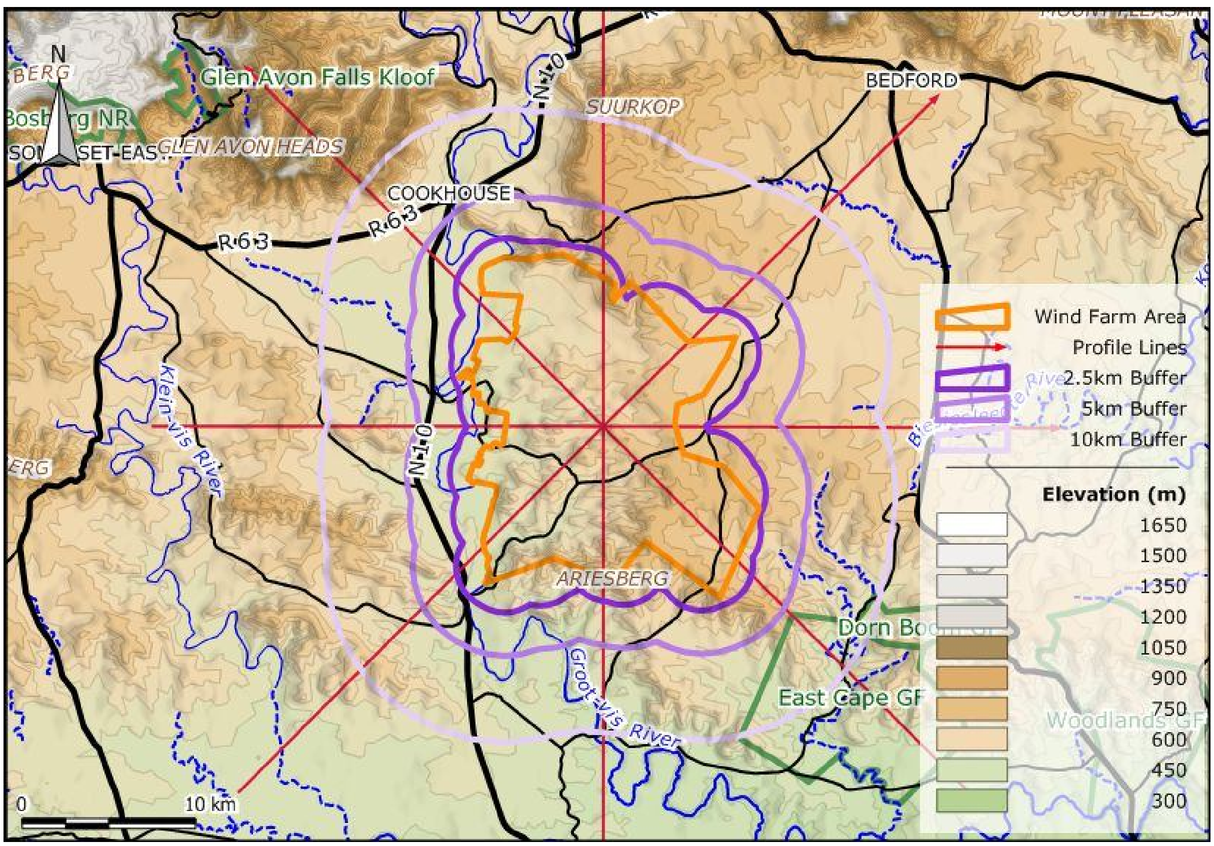

Figure 6-4: Topographic map showing wind farm area in relation to surrounding settlements and protected areas. Distances of 2.5km, 5km and 10km from turbines are indicated, as well as topographic profile lines.

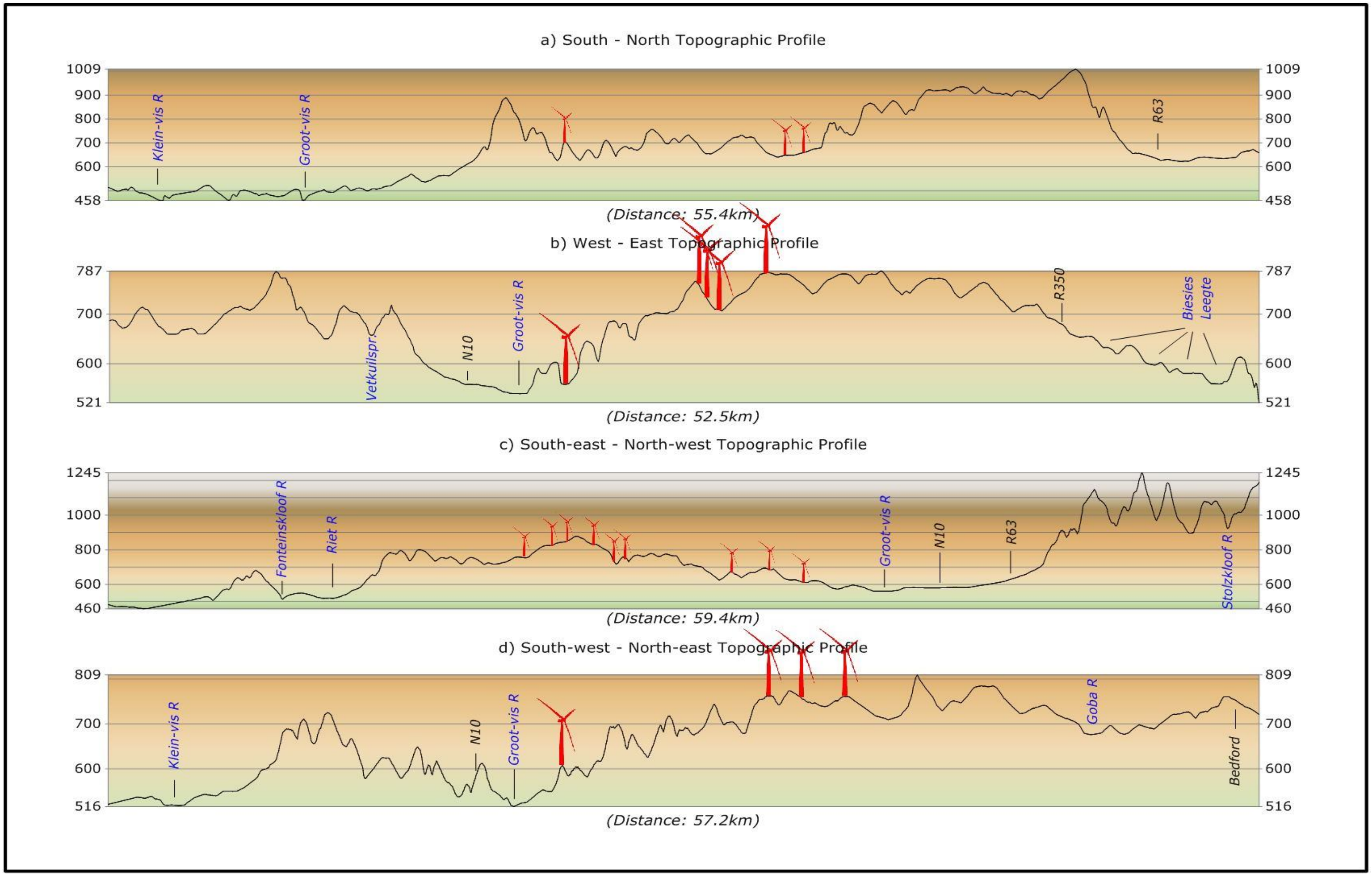

Figure 6-5a-d: Topographic profiles across the region. Vertical scale exaggerated and different for each profile. Wind turbines (red) in scale in terms of height. See topographic map for profile line positions.

6.4.1.2. Landform

The geomorphology of the region is a product of the erosive forces of the Great Fish River and its tributaries working on the underlying, almost horizontal, layers of shale and sandstone. Irregular plains with low to moderate hills dominate the landscape with ridges of high hills cutting across them in a roughly east-west direction (Figure 6-6). North of the wind farm site the relief is considerably more pronounced and low mountains form a constant background of views to the north.

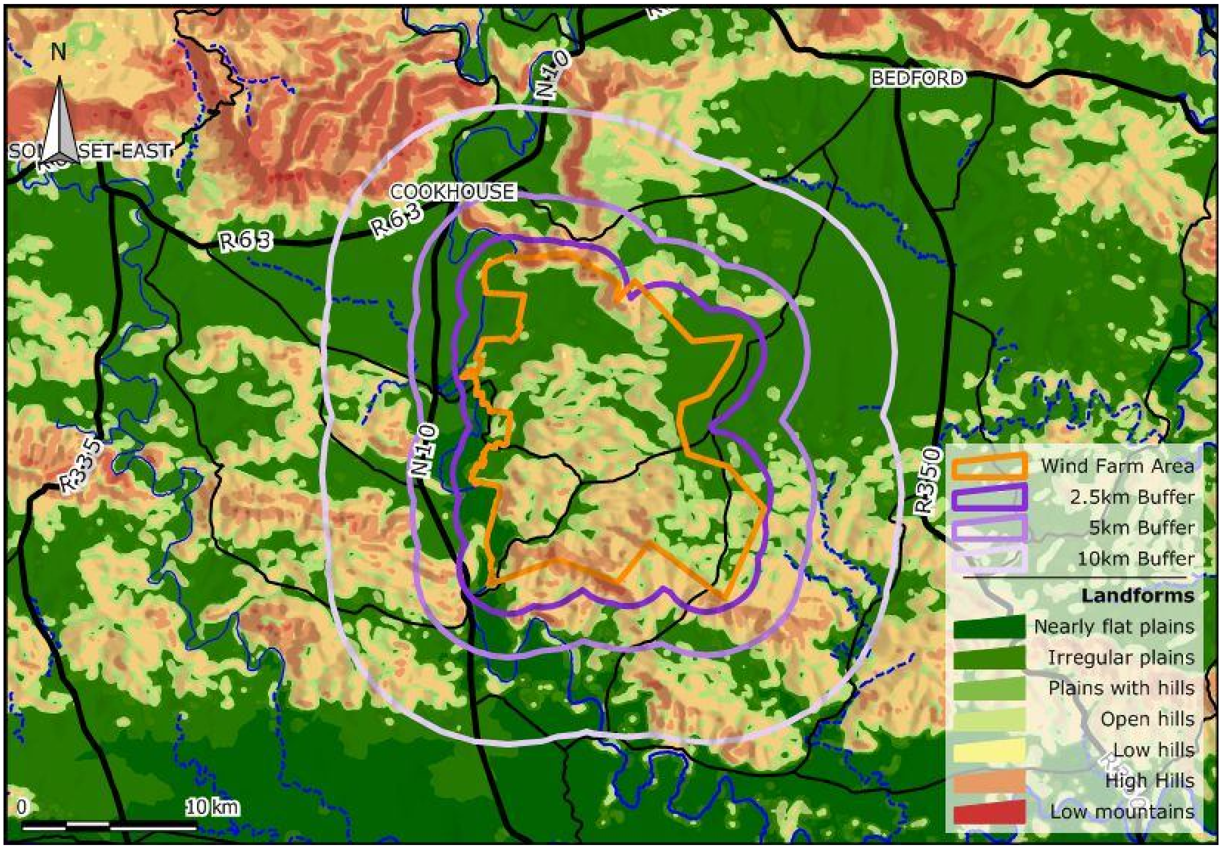

Figure 6-6: Landform classification of the region. Flatter areas are shaded in green while higher relief is indicated by yellow to red colours.

6.4.1.3. Geology

The wind farm site, and most of the study area, is underlain by rocks of the Beaufort Group (Koonap, Middleton and Balfour Formations) (Figure 6-7). These formations consist mostly of mudrock and shale layers interspersed with relatively thin sandstones (Johnson et al. 2006). The Karoo dolerites are igneous rocks which intruded the Karoo layers (e.g. Beaufort Group) during the break-up of the Gondwana supercontinent and formed sills (horizontal sheets between layers of sedimentary rocks) and dykes (vertical sheets exploiting joints and faults in the sedimentary layers). These rocks are weather resistant and are normally responsible for landforms with a positive relief in the landscape. The relatively softer rocks of the Beaufort Group were therefore eroded away by the Fish River and its tributaries, leaving the more resistant dolerite ridges as high hills (west-east extending ridge along the south of the wind farm site) and low mountains (north of Somerset East, Cookhouse and Bedford).

Alluvium, indicated in Figure 6-7, delineate floodplains of the major rivers in the region, such as the Great and Little Fish River, where sediment (derived from the bedrock higher up) are deposited and continuously reworked as the rivers migrate across their floodplains.

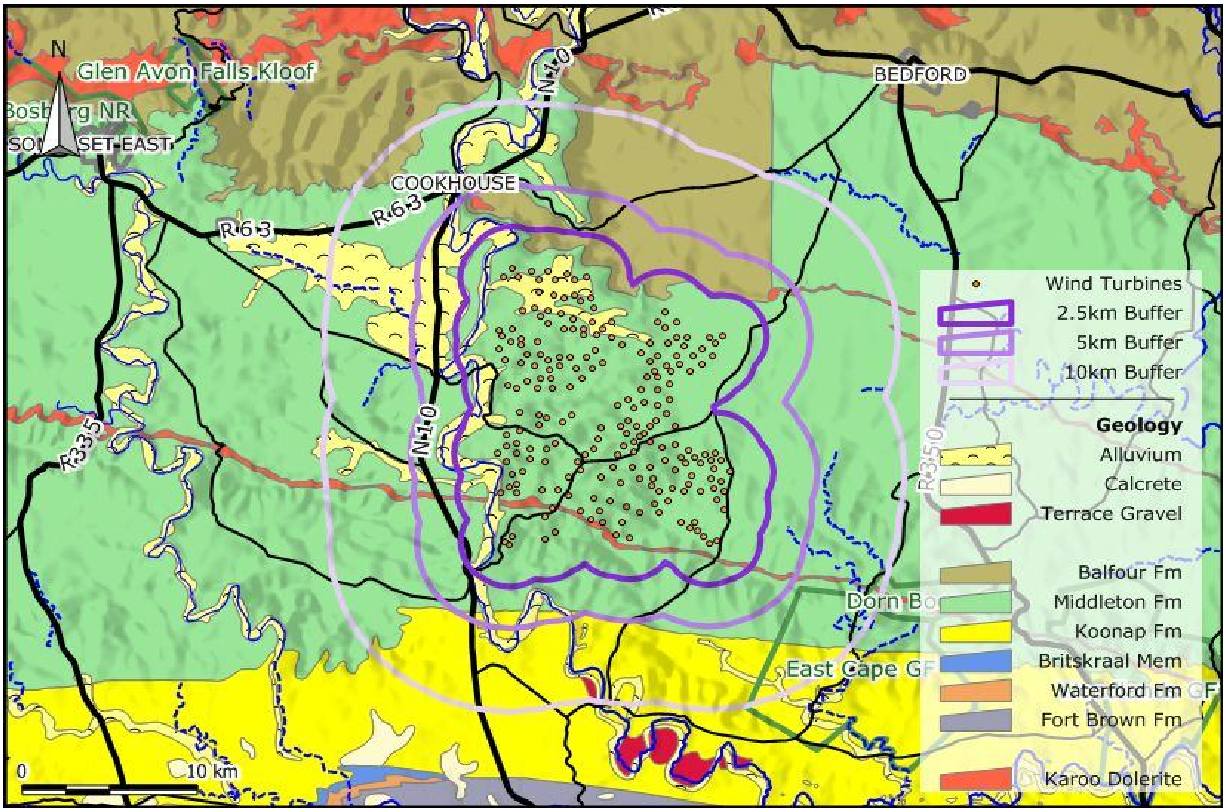

Figure 6-7: Geology of the study area

Further south some outcrops of Ecca Supergroup rocks can be seen on the map (Britskraal Member, and Waterford and Fort Brown Formations). These consist mostly of shales and will form landforms of negative relief (compare Figure 6-6).

6.4.1.4 Land Cover

The map in

Figure 6-8 shows most of the wind farm site to be covered in shrubland and thicket. Much of this natural vegetation is degraded and transformed by agricultural practises (presumably by overgrazing which consists mostly of commercial livestock farming in the regions outside the river floodplains. Irrigated cultivation exploits water from the major rivers as well as the rich alluvium of their floodplains (see section 6.4.1.3).

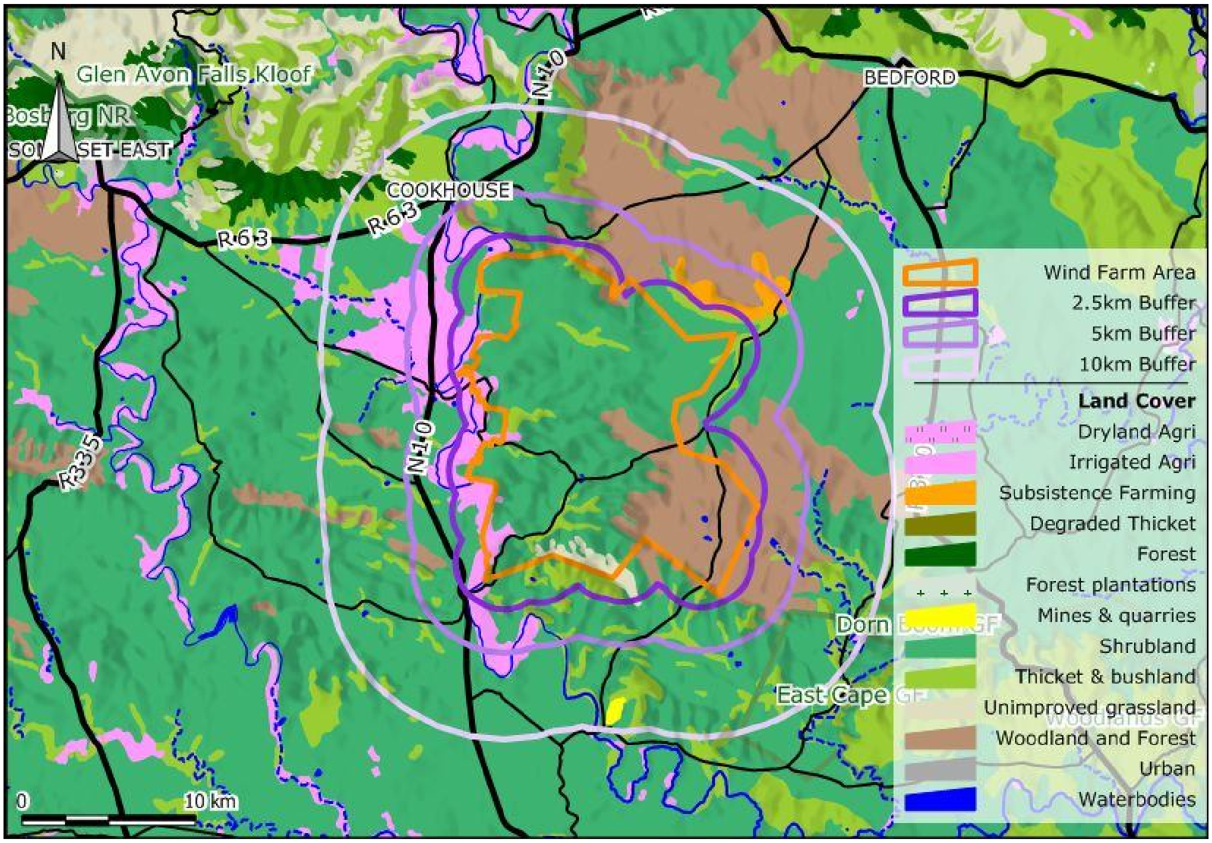

Figure 6-8: Land cover map showing the major features of the region, such as vegetation, agriculture and settlements. From the field visit it is clear that much of the shrubland and thicket indicated on the map is degraded and transformed by grazing

6.4.1.5 Built Environment

The major settlements in the area are Somerset East, Cookhouse and Bedford. These towns developed as service centres for the surrounding farms and no heavy industrial complexes are present. The Poseidon Substation is located on the plateau north of the wind farm site (Figure 6-9). A number of high voltage power lines radiate from it and several cross and dissect the landscape such that most views of the wind farm will also include large power line pylons and wires (Plate 6-1 and 6-2)[1].

The N10 between Port Elizabeth and Cradock (via Cookhouse) passes very close by the wind farm site. Other major roads in the landscape include the R63 between Cookhouse and Somerset East and the R350 between Grahamstown and Bedford. Several large gravel roads cross the wind farm site. A railway line runs parallel to the N10.

The commercial irrigated agricultural lands on the Fish River floodplain is the most obvious other human related feature in the landscape. This is due to the high concentration of buildings, irrigation equipment and cultivated fields which contrast strongly with the muted colours of the surrounding vegetation (Plate 6-3). Once outside the river valley buildings and human made features are sporadic only and, apart from the power lines, the rural areas have a sense of remoteness

[1] A farmer when informally interviewed by the author at Photo Site A10 said that the potential for scenic viewpoints on farms in the region is very low due to the high voltage power lines crossing the countryside.

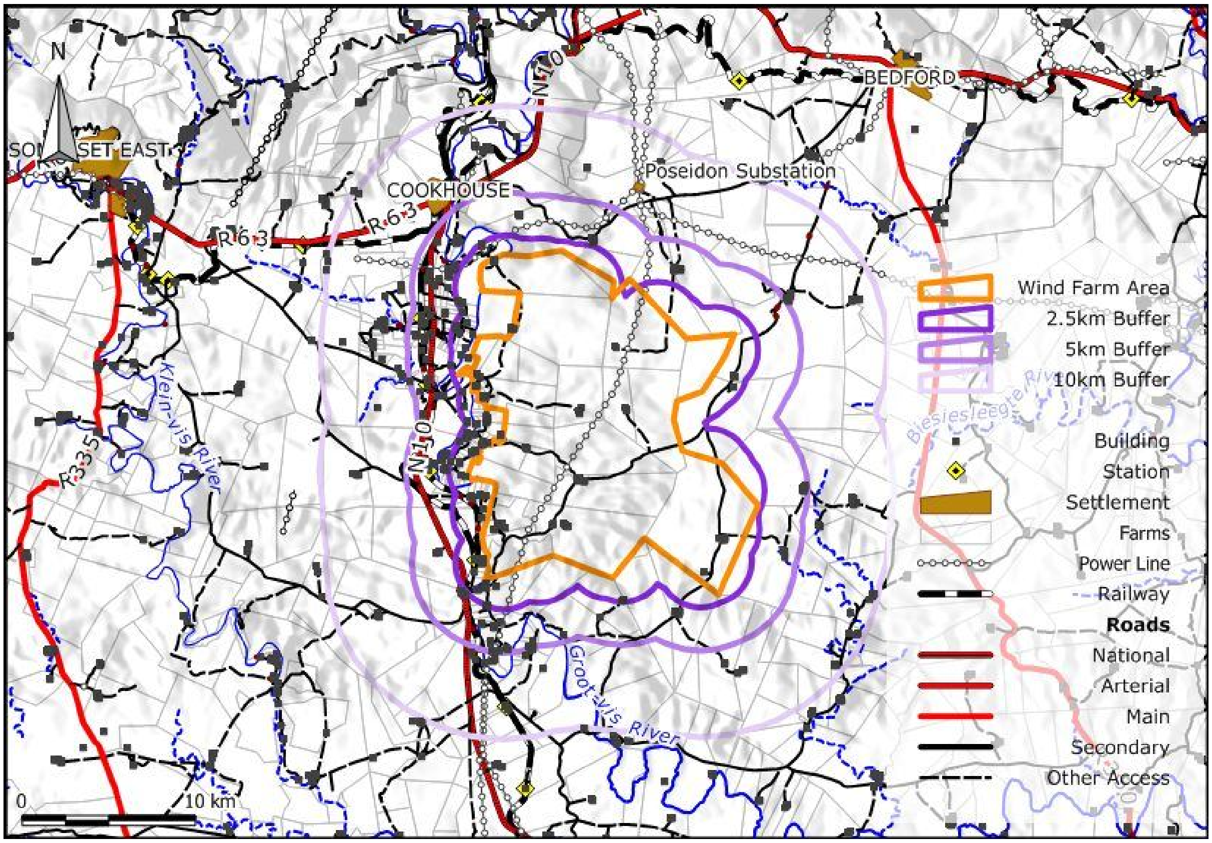

Figure 6-9: Settlement patterns and large structures in the landscape

Plate 6-1: Power lines exposed against the skyline as seen from Photo Site F16. Many views in the study area include power lines exposed against the skyline.

Plate 6-2: High voltage power lines crossing cultivated lands in the Great Fish River floodplain. View north-east from photo site F06.

Plate 6-3: Cultivated lands in the Great Fish River floodplain.

6.4.2 Landscape Character

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).

The landscape character of the region is one of commercial agriculture dominated by stock farming in areas outside the Great Fish River floodplain and irrigated cultivation in the floodplain. The natural thicket and grassland have been transformed by grazing and most of the floodplain vegetation has been replaced with cultivated lands.

The settlements in the region developed as service centres for the agricultural concerns. Several large roads dissect the region with the N10 a particularly busy route connecting Port Elizabeth with Gauteng. A network of high voltage power lines with large pylons radiate from the Poseidon Substation just north of the site and across the region.

6.4.3 Landscape Character Sensitivity

A map showing scenic sensitivity of the region around the proposed wind farm site was prepared using the various landscape data layers discussed above (Figure 6-10). The map provides only an indication of scenic sensitivity for discussing the landscape character sensitivity, and is broadly consistent with observations during the field visit. It is clear from the map and descriptions of the landscape above that the landscape is not pristine. There are areas within the study area that has scenic value, but overall the potential for scenic views are low to moderate (assuming that pristine views of nature have the highest potential).

A wind farm of this magnitude will alter the landscape character but the fact that large structures related to electricity already exists in the landscape (and has had a considerable influence on the aesthetic value of the landscape) makes it less sensitive to this change. It is also expected that current agricultural practises (i.e. stock farming) will be able to continue as before. The area has a **low** sensitivity to change in its character for this development type.

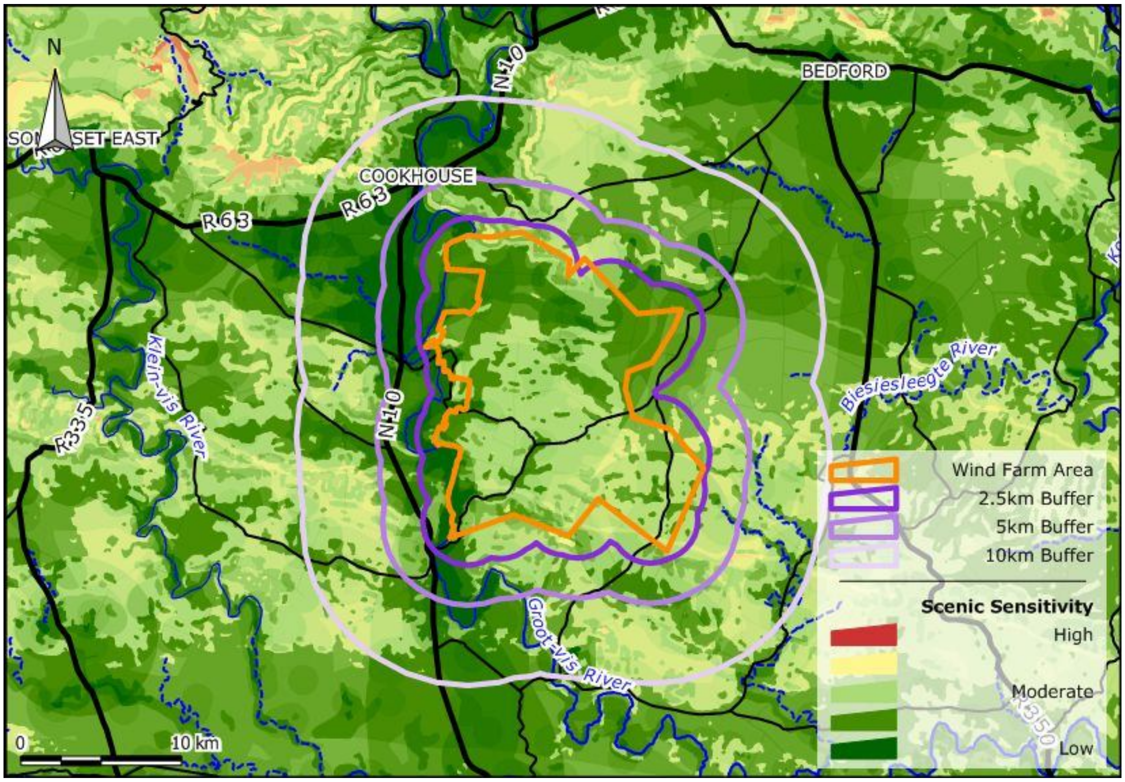

Figure 6-10: Scenic sensitivity of the landscape based on its 'naturalness'.

6.4.4 Visual Absorption Capacity

Visual absorption capacity (VAC)	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. The wind farm area will be developed in a low area within the broader region, which means that views from far away are unlikely to have wind turbines against the skyline (there will be mountains or higher ridges in the background). However, viewpoints closer to the wind farm (<2.5km) will have turbines or parts of turbines exposed against the sky, since they are mostly located on hills and are up to 150m high. Vegetation is seldom going to form a screen to conceal the development although high thicket and woodland trees close to roads 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).

6.5 Assessment and Mitigation of Impacts

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.

6.5.1 Visual Impact Concepts and assessment Criteria

6.5.1.1. 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 6.5.1.3.) 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 6.5.1.4.) 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 6.5.1.5) and the current composition of their views (measured as **visual intrusion** – Section 6.5.1.6) will have an influence on the significance of the impact.

6.5.1.2. Impact Rating Methodology

The CES impacting rating methodology described in Section 3.3 in Chapter 3 above, was used to rate the significance of potential visual impacts.

6.5.1.3. 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 specialist 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.

Table 6-1 shows the areas in hectares which will have views on the wind farm for a region with a radius of 20km around the wind farm area. As expected the visibility is high due to the number of wind turbines and their heights. It is a rural/agricultural region and it is unlikely to have many viewers.

Table 6-1 Summary of viewshed analysis for the proposed Cookhouse wind farm

Visibility	Area (ha)	Total Area
Some	84 387.01	33.52%
	27 408.27	10.89%
Partial	9 579.43	3.80%
	9 968.41	3.96%
Full	8 505.00	3.38%

The map in Figure 6-11 shows the spatial extent of areas with views on the wind farm. Some areas west of Cookhouse and the N10 with views on the wind farm are likely to see most of the turbines (although they will be more than 5km away). The 10-15km section of N10 road just south of Cookhouse will provide views of large parts of the wind farm (depending on road side vegetation). Generally, viewers further away from the wind farm site will see a higher number of turbines and more of the structure both in number of visible turbines as well as how much of each turbine will be visible. Their visual exposure to the wind farm and its intrusion on their views will tend to be lower due to the distance (see section 6.5.3.5).

The topography of the landscape in the area where the wind farm is to be located is such that many viewers within the wind farm area will see only a few turbines at a time relative to viewers outside the area and west of Cookhouse. This is due to the fact that the wind farm will be located in an area with irregular relief and which is lower than most of the surrounding region (refer to section 6.4.1.1 and 6.4.1.2).

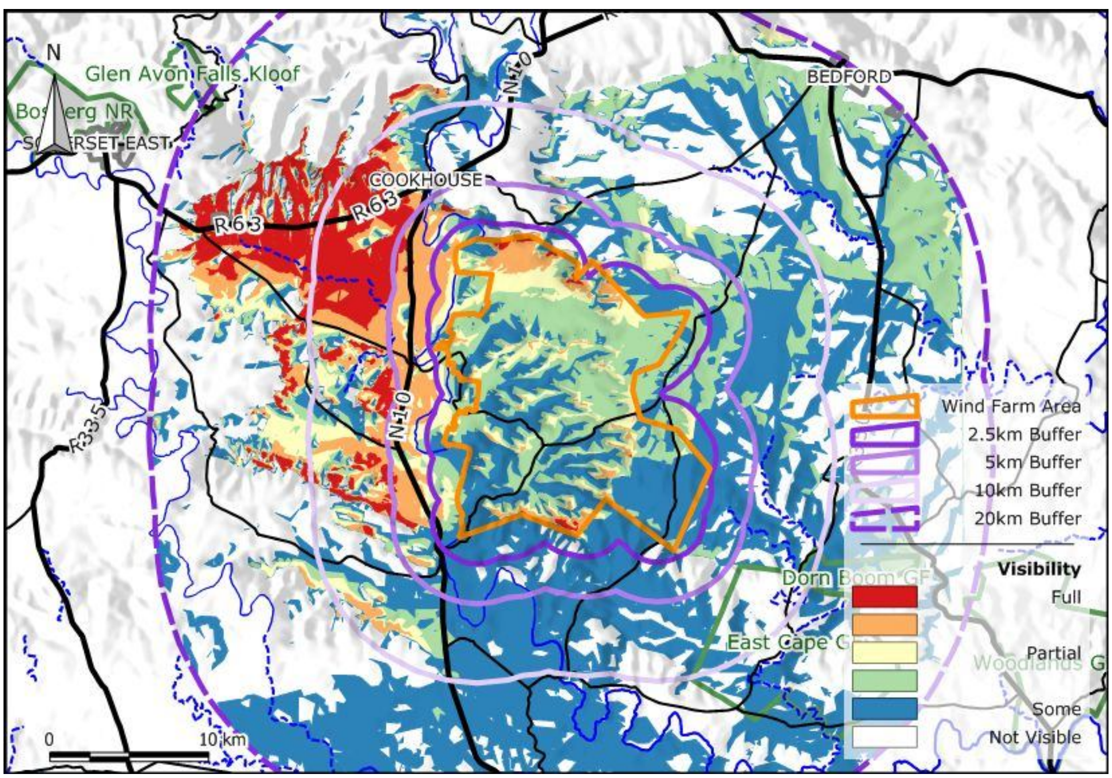

Figure 6-11: Map showing the cumulative viewshed calculated for 215 wind turbines.

6.5.1.4. Sensitive Viewers and Viewpoints

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.

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 Cookhouse and its suburbs;
- Viewpoints in surrounding nature reserves and game farms;
- Residents on surrounding farms (including residents in the wind farm area);
- Motorists using the N10 and other main roads in the region.

Each of these is discussed in more detail below.

Residents of Cookhouse

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 the town, though, and although there are residents who will potentially have views of many turbines it is unlikely that their views will be significantly altered.

Residents on surrounding farms

Residents on farms surrounding the site (including those farms on which the wind turbines will be built) will be highly sensitive to changes in their views. Many existing views will be altered by introduction of the wind farm into the landscape, especially those of residents in close proximity to the wind farms.

Scenic viewpoints

There are few viewpoints in the region with views on the wind farm which will not also include power lines and major roads. The Glen Avon Falls Natural Heritage Site is approximately 20km north-west of the nearest wind turbine and it's unlikely that any viewpoints will have views of the wind farm (see Figure 6.14).

Protected areas

There are no protected areas of Type 1 or 2 as defined by STEP, and only two game farms (Type 3) within 20km of the wind farm area. The two game farms, Dorn Boom and East Cape, are further than 5km away and show only low visibility in Figure 6-12.

Motorists

Views from the N10 towards the wind farm will be affected and some views (especially close to Cookhouse) will include many turbines. The other major roads in the area will be much less affected.

6.5.1.5. Visual Exposure

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) suggests zones of theoretical visibility (ZTV) as follows (EWEA 2009):

1 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.

2 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.

3 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.

4 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.

Cookhouse Residents

The map in Figure 6-12 indicates that it will be possible to see some part of the wind farm from anywhere in Cookhouse. This is obviously unlikely since buildings and vegetation in and around Cookhouse will have some influence on the actual visibility. However it is clear that some current views of Cookhouse residents are likely to be altered by the wind farm. The town is more than 5km from the nearest wind turbine and so the wind farm will constitute only a small part of views towards the site. The visual exposure that most residents of Cookhouse will have to the wind farm (assuming they can see it at all) will be **medium** to **low** (Figure 6-14).

Residents on Farms

The exposure was calculated as a combination of high visibility and minimum distance from a wind turbine position. Buildings (houses, residences and other farm buildings) were identified on Google Earth and SPOT satellite imagery for the area. Visibility values (from the cumulative viewshed as seen in Figure **Error! Reference source not found.**6.11 above) were transferred/attached to each building (maximum value for a 100m buffer around the building) and its distance to the nearest wind turbine position was calculated using a Geographical Information System (GIS). A high visibility value and close proximity (< 2km) to a wind turbine indicates a potentially **high** visual exposure to the wind farm.

Figure 6-15 shows buildings that will experience high visual exposure to the wind farm due to their proximity to wind turbines as well as the extent of the wind farm that will be visible to them. The map also provides an index to maps in
Figure 6-16 and Figure 6-17 which provide more detailed views on these potentially sensitive viewers (including their proximity to wind turbines). Table 6-2 lists the farm names and coordinates of buildings with potentially high visual exposure levels. Most of these buildings are on the farms which will rent land for the wind farm although a number are outside of the area, especially just west of the wind farm area. It should also be noted that not all the buildings are residences.

Table 6-2: Buildings with potentially high visual exposure to the wind farm. The first four are closer than 500m to a wind turbine.

FARM NAME	MINIMUM DISTANCE	LONGITUDE	LATITUDE
KLEIN RIET FONTEIN (167/1)	322.85	25.884770	-32.895023
FARM (283/R)	346.35	25.873459	-32.919221
WELTEVREDE (292/R)	354.57	25.845132	-32.816215
MULLERS KRAAL (159/1)	425.91	25.914541	-32.858723
OUDE SMOOR DRIFT (164/40)	515.21	25.852741	-32.878613
OLIVE WOODS ESTATE (169/R)	543.31	25.973016	-32.926642
QUAGAS KUYL (155/R)	562.88	25.908846	-32.826314
KLEIN RIET FONTEIN (167/R)	571.51	25.888494	-32.895983
WAGENAARSE DRIFT (172/R)	645.45	25.835601	-32.920256
VAN AARDTS KRAAL (163/2)	720.10	25.825309	-32.912126
OUDE SMOOR DRIFT (164/37)	762.18	25.837111	-32.871241
OUDE SMOOR DRIFT (164/43)	863.04	25.828901	-32.875798
VAN AARDTS KRAAL (163/3)	878.16	25.823827	-32.936239
GREAT RIET FONTEYN (160/R)	916.06	25.886269	-32.859162
VAN AARDTS KRAAL (163/9)	922.67	25.824817	-32.938188
SMOOR DRIFT (162/12)	986.46	25.827325	-32.851746
OUDE SMOOR DRIFT (164/33)	995.82	25.827571	-32.875335
MIDDELBURG (162/4)	1072.20	25.827873	-32.903164
OUDE SMOOR DRIFT (164/17)	1075.62	25.825826	-32.875984
SMOOR DRIFT (162/16)	1088.59	25.825110	-32.841104
OUDE SMOOR DRIFT (164/18)	1103.30	25.826480	-32.874986
GEZHIRET (161/6)	1178.90	25.823022	-32.839438
LEUWE DRIFT (153/R)	1199.68	25.835190	-32.780664
MOORDENAARS DRIFT (174/1)	1210.68	25.827656	-32.951000
LEUWE DRIFT (153/4)	1252.91	25.834246	-32.780501
MIDDELBURG (162/2)	1270.83	25.821918	-32.903750
JAGERS DRIFT (121/46)	1273.46	25.820583	-32.819332
SMOOR DRIFT (162/1)	1323.94	25.829013	-32.863251
OUDE SMOOR DRIFT (164/11)	1376.85	25.821950	-32.880085
VAN AARDTS KRAAL (163/16)	1380.71	25.820074	-32.938955
SMOOR DRIFT (162/7)	1422.18	25.822592	-32.845681
OUDE SMOOR DRIFT (164/5)	1440.19	25.821050	-32.879434
SMOOR DRIFT (162/9)	1457.43	25.822462	-32.845386
GEZHIRET (161/4)	1472.31	25.817631	-32.831022
MIDDELBURG (162/5)	1539.20	25.820009	-32.903518
OUDE SMOOR DRIFT (164/2)	1556.98	25.819052	-32.880657
OUDE SMOOR DRIFT (164/24)	1566.49	25.815260	-32.892830
SMOOR DRIFT (UNDER) (163/1)	1582.82	25.825538	-32.865405
VERKEERDE WATER (122/19)	1598.56	25.816449	-32.825486
MIDDELBURG (162/3)	1683.66	25.818221	-32.903343
OUDE SMOOR DRIFT (164/7)	1774.45	25.812889	-32.892266
FARM (260/R)	1777.28	25.982219	-32.842188
OUDE SMOOR DRIFT (164/29)	1797.19	25.820147	-32.870969
JAGERS DRIFT (121/30)	1890.73	25.817418	-32.812835
OUDE SMOOR DRIFT (164/16)	1897.57	25.811774	-32.885649
ALTONA (340/R)	1914.74	25.813292	-32.829876
FARM (259/R)	1957.18	25.981006	-32.847770

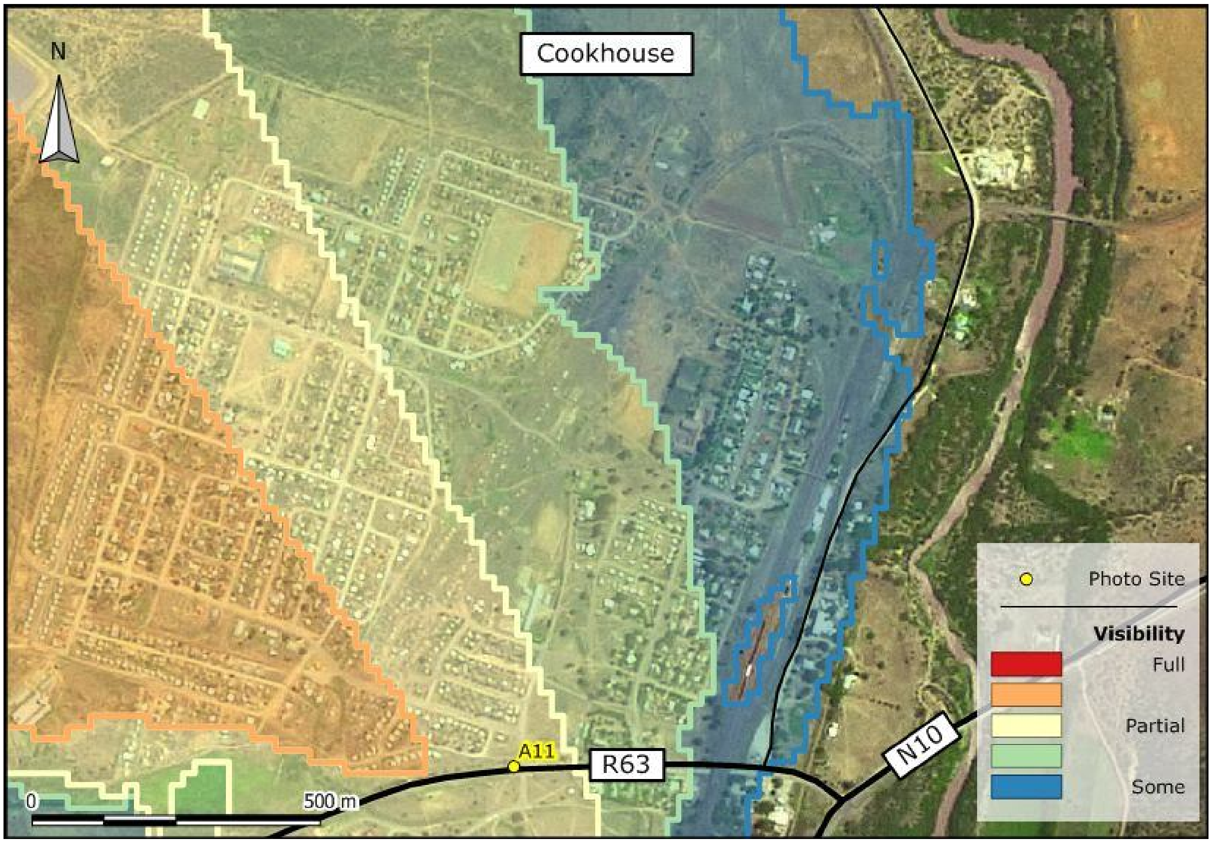

Figure 6-12: Visibility of the wind farm from Cookhouse. Some areas in town will potentially have views of a large part of the wind farm.

Figure 6-13: View south-east from Photo Site A11 towards the wind farm. This was the only point along the R63 near Cookhouse that the site was visible at all due to high trees bordering the road. Conditions were not good for viewing the site which is in haze in the background.

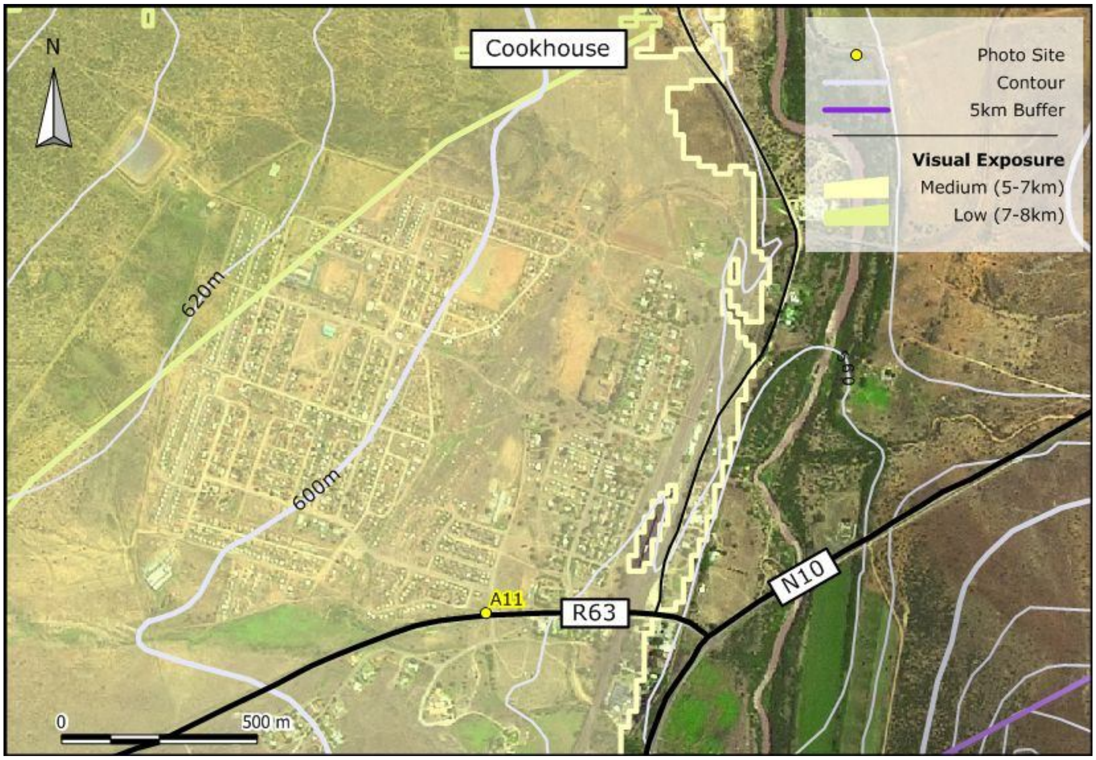

Figure 6-14: Visual exposure residents of Cookhouse will have to the proposed wind farm

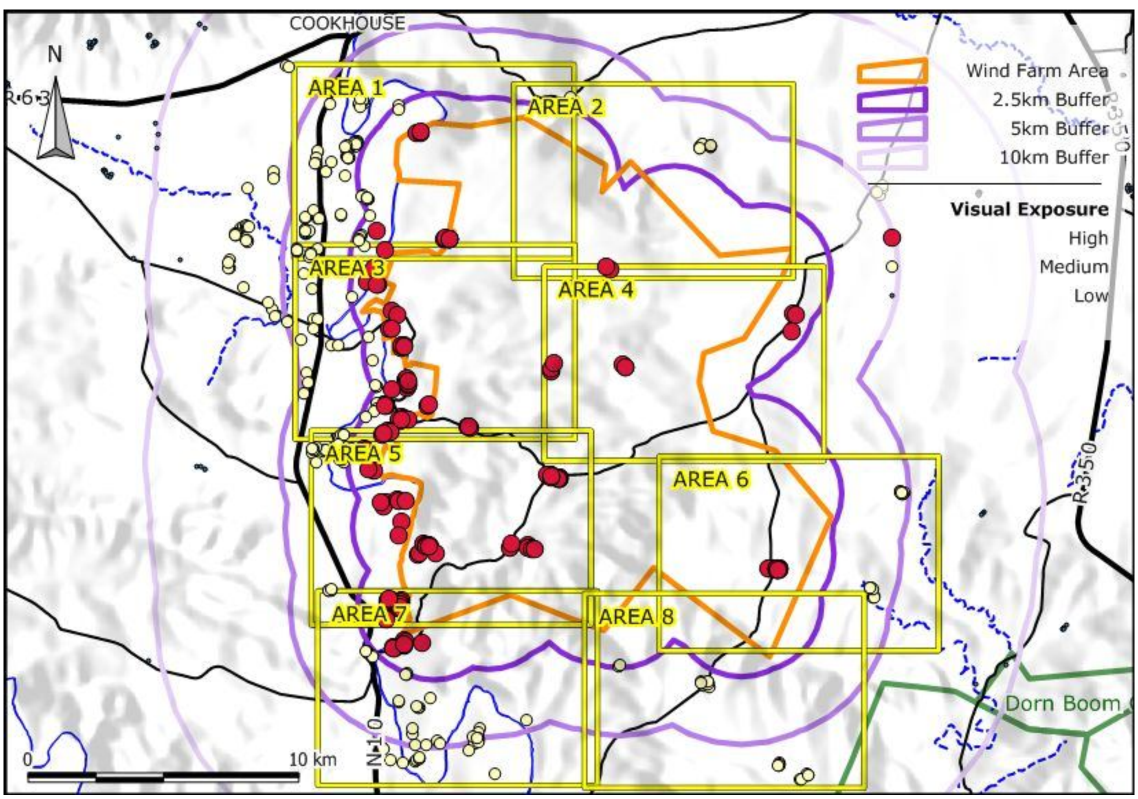

Figure 6-15: Buildings on farms on or surrounding the wind farm site with there potential visual exposure indicated. Visual exposure is a measure of the visibility of the wind farm and the distance of the viewer from the nearest wind turbine. Close-up views of the yellow areas can be seen in the maps below.

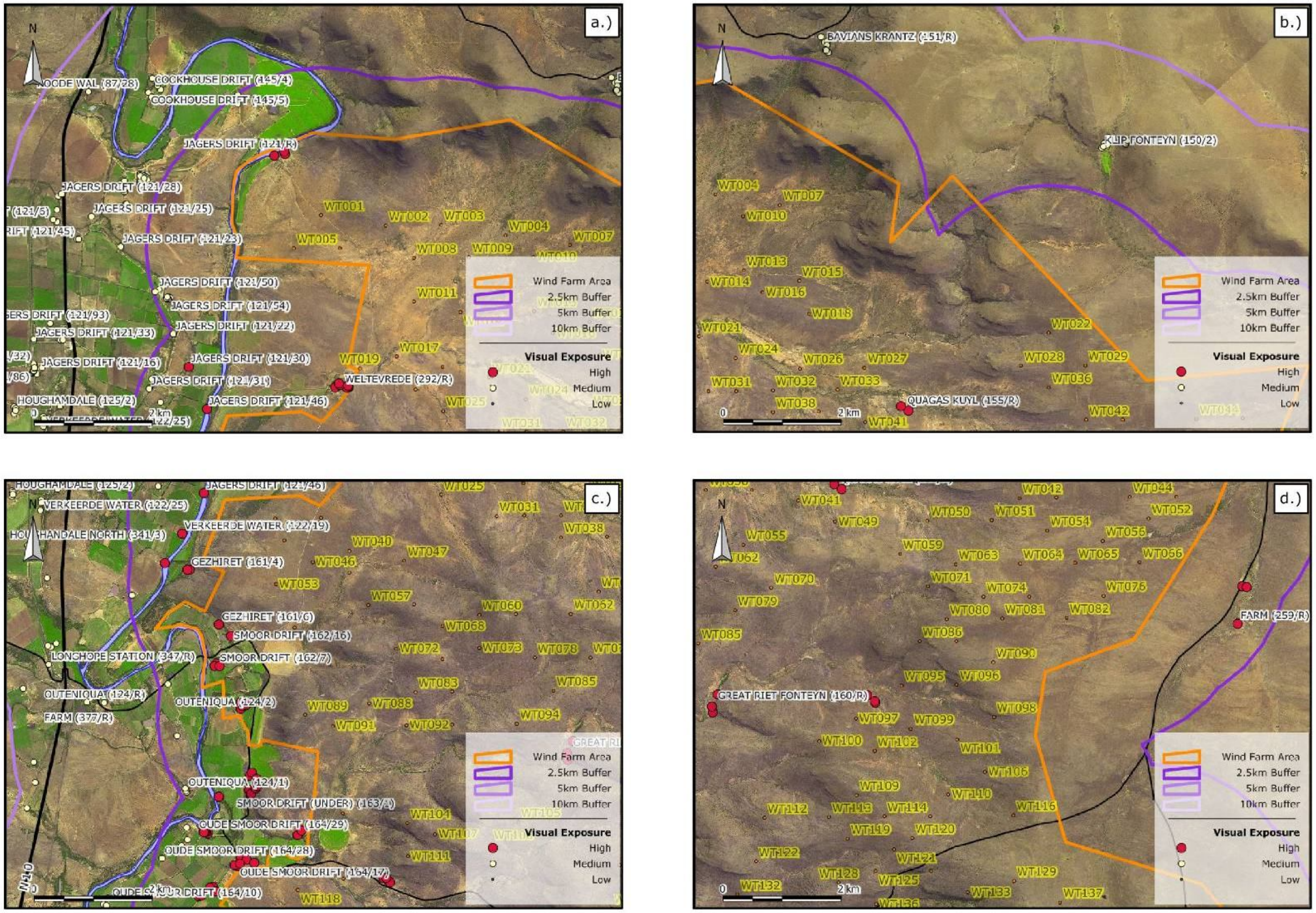

Figure 6-16: Sensitive viewers who will experience high visual exposure to the wind farm. a.) Area 1, b.) Area 2, c.) Area 3 and d.) Area 4 corresponding to areas in Figure 6.18.

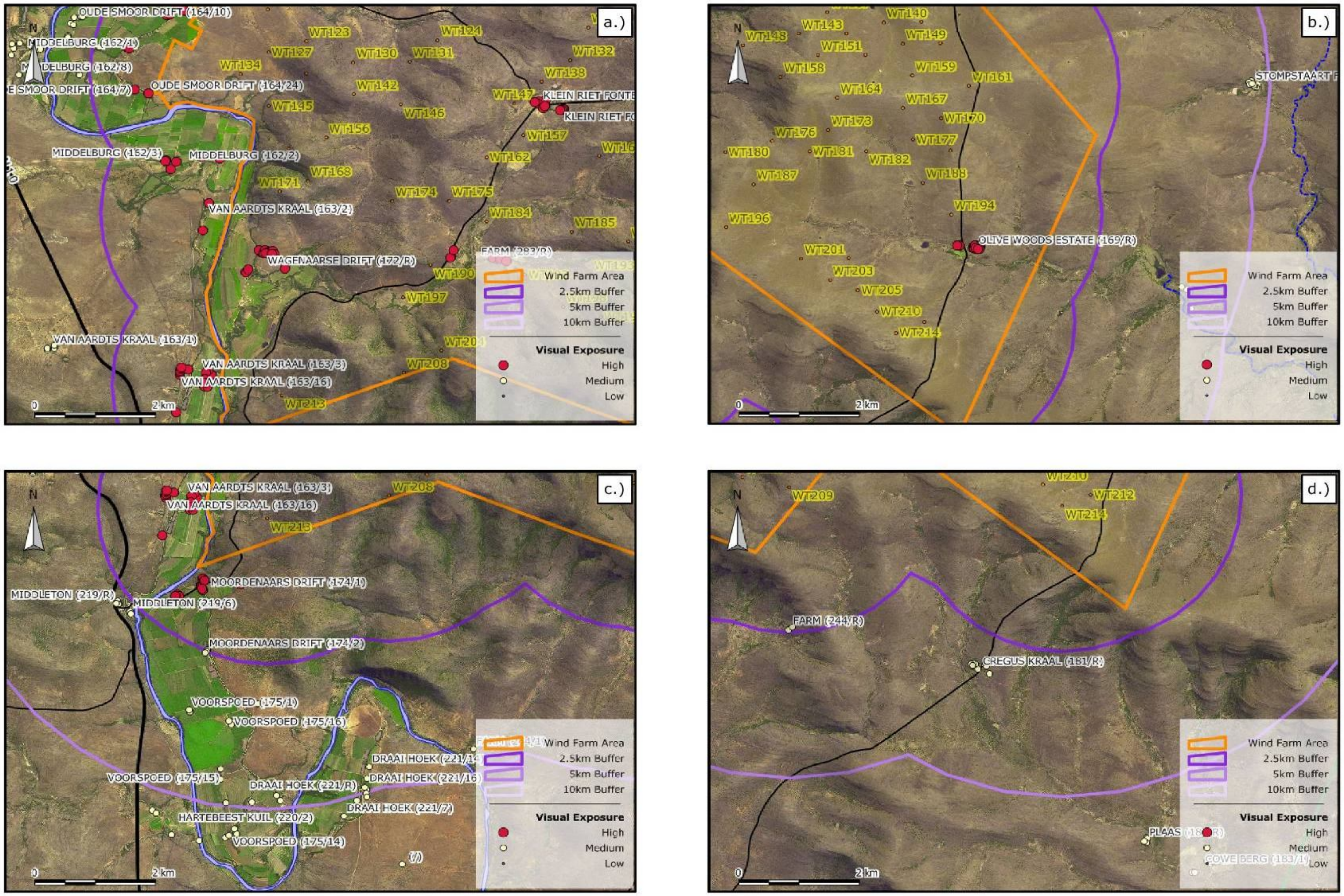

Figure 6-17: More sensitive viewers who will experience high visual exposure to the wind farm. a.) Area 5, b.) Area 6, c.) Area 7 and d.) Area 8 corresponding to areas in Figure 6.18.

Protected Areas and Scenic Viewpoints

The only areas currently recognised by STEP and IUCN as protected areas within 20km of the nearest wind turbine are the East Cape and Dorn Boom game farms. Visual exposure ratings are mostly **low** for these two Figure 6-18). For areas in East Cape game farm within medium visual exposure levels, the topography is such that few areas will have a view of the wind farm (Not Visible category on the map). No buildings, as traced from 2007 SPOT imagery, showed higher than low levels of exposure, if at all.

There are areas along the ridge just north of the wind farm site where the potential for scenic views are high in terms of topography. The visual exposure along this ridge is **moderate** to **high**. Similarly, any potential scenic views along the ridge bordering the wind farm site to the south will also have a moderate to high visual exposure rating for the wind farm due to its proximity.

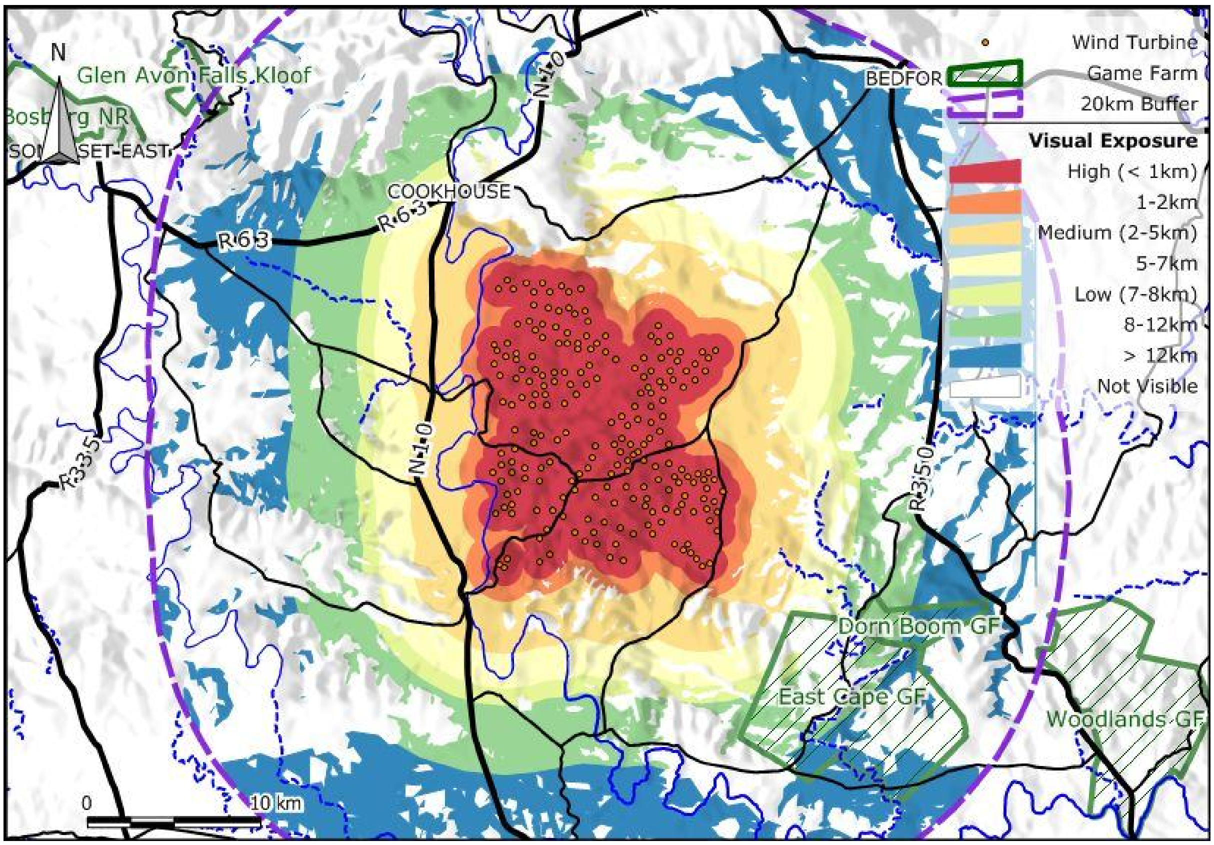

Figure 6-18: Visual exposure ratings for the region (an area within 20km of the nearest wind turbine).

Motorists

The wind farm will be potentially visible on the N10 from just north of the N10/R400 junction up to the turn-off to Cookhouse (R63 junction). For approximately 30km motorists will experience **medium** visual exposure to the wind farm where the road is within 2km of the wind farm site along the western bank of the Great Fish River (Figure 6-18). The R63 between Cookhouse and Somerset East will also offer views on the wind farm and exposure ratings for some parts will be medium. In the sections of the R63 where visual exposure ratings are medium views will include large parts of the wind farm (Figure 6-11). However the road here is often bordered by high trees and bush which will reduce the actual visibility envelope considerably. The R350 between Grahamstown and Bedford will have sporadic views of the wind farm, but it doesn't get closer than 10km from the wind farm and visual exposure ratings are low. Gravel/farm roads crossing the wind farm area will have very close views of many turbines in places. Here the visual exposure will be very high.

6.5.1.6. Visual Intrusion

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...[It] relates to uniqueness, distinctiveness or strong identity.*' It describes the distinct quality of an area that makes it memorable to the observer.

<u>Cookhouse Residents</u>

Cookhouse is a small town which provides a service centre for surrounding agricultural concerns. There are no large scale industrial complexes in the region and few large buildings. However, sensitive viewers will be used to having large and complex structures such as high-voltage power lines, major roads and large scale irrigation systems in at least some of their views. The distance from the site also means that the wind farm will only constitute a small part of any view. Buildings and trees will provide considerable screening. Plate 6-4 and 6-19 show the current view and the same view with wind turbines from just outside Cookhouse on the R63. The visual intrusion is **low** due to the distance and the complexity of the view which includes trees, buildings and pylons. Views from within Cookhouse will be more complex since more buildings, roads and vehicles will be included.

<u>Residents on Surrounding Farms</u>

The region in which the wind farm will be developed is not pristine and the natural vegetation has been transformed by agricultural practises and a network of high-voltage power lines traverses, and is visible from, most farms in the area. There are few viewpoints with potential for pristine scenic views. However, the size of the development and its highly visible components are likely to be intrusive in most existing views within the wind farm area and in views from neighbouring farms. Sensitive viewers with high visual exposure ratings will also have **highly** visual intrusion ratings. There is nothing in the current landscape that compares with the scale of this development. An indication of the size of a wind turbine is shown for a site next to the farmstead of Olyvenfontein (photo site F16) in Figure 6-20 and Plate 6-4. Compare the turbine with the power lines in the background as well as the buildings in the foreground. There are other residences/buildings which will be surrounded by several turbines of this size and proximity (500m) (refer to Table 6-2).

<u>Protected Areas and Scenic Views</u>

The protected areas in the region are all more than 10km from the nearest wind turbine and the wind farm will constitute only a small part of views in its direction if it is visible at all. Most of these views will also include power lines and roads in closer proximity. Visual intrusion ratings for protected areas are therefore expected to be **low**.

There are few areas in the region with potential scenic views in close proximity to the wind farm site. The ridge just north of the site provides opportunities for such views towards the south over the area proposed for the wind farm. The visual exposure map (Figure 6.11) shows that this ridge has a moderate exposure rating, and that there are not many areas along the road here where the wind farm will be visible from. Plate 6-5 shows a view from one of these areas near the farmstead Baviaanskrans. The scenic potential of the view here is marred somewhat by high voltage power lines and large pylons, but it is a channelled view which opens up onto the Great Fish River valley with distant hills/mountains in the background. The same view is shown in Figure 6-20 with the wind turbines super-imposed to provide an indication of the effect the proposed wind farm will have on views in this area. In this case there is a farmstead just below the road on the photo and it is clear that the views of residents here will be affected by the wind farm. The farmstead is surrounded by high trees and faces west (in other words, not towards this particular view), so that it is doubtful that views from the house will be affected. There are also large pylons and power lines passing over the ridge and behind the house. Visual intrusion for scenic views in the region are seen as **low** due to their distance from the wind farm as well as the low potential for scenic views in the study area. Scenic views from the mountains north of Somerset East and Bedford are too far away to be intruded upon beyond a low level.

Plate 6-4: Current view south-east from Photo Site A11 in Cookhouse.

Plate 6-5: Current view west from Photo Site F16 (Olyvenfontein residence).

Figure 6-19: View west from Photo Site F16 with wind turbine super-imposed. The wind turbine is 500m away.

Plate 6-6: A potential scenic view from the ridge north of the wind farm site. The view is towards the south-west from photo site F10. The Baviaanskrans farmstead is just below this site and to the left of the photograph and it potentially has a view down onto the wind farm, but the house faces west and is surrounded by high trees, particularly in the direction of this view.

Figure 6-20: The same view as above with wind turbines super-imposed.

Motorists

Views from the N10 within the study area will have **moderate** visual intrusion ratings due to the size of the development, its visibility and proximity to the road. The development is not entirely incongruent with the landscape as seen from this road due to the existence of the large power line pylons, the road itself which is a major feature in this landscape, and clear signs of the proximity of the settlement of Cookhouse, although initially the novelty aspect of the wind farm will increase this incongruence. A view from the N10 with and without the wind turbines is shown in Plate 6-7 and Figure 6.21.

Other major roads in the region will have low visual intrusion ratings. There are areas along farm roads within the wind farm area where motorists will be surrounded by many wind turbines in close proximity to the road. However, these roads are not busy and it is unlikely to have many sensitive viewers.

Plate 6-7: Current view north-east from Photo Site F07 on the N10.

Figure 6-21: View north-east from Photo Site F07 on the N10 with wind turbines super-imposed.

6.5.1.7. Shadow Flicker

At the time of this writing a full shadow flicker analysis is not available. A number of buildings have been identified which are within 500m of a wind turbine and so will potentially be affected by shadow flicker. These are shown in Figure 6.22 and in more detail in Figure 6.23 (refer also toTable 6-3). Few of the buildings seem to be surrounded by trees and if the shadow flicker hours per year for these are higher than 30 then a significant impact is likely (also assuming these buildings are residences which is not always clear from the SPOT satellite image).

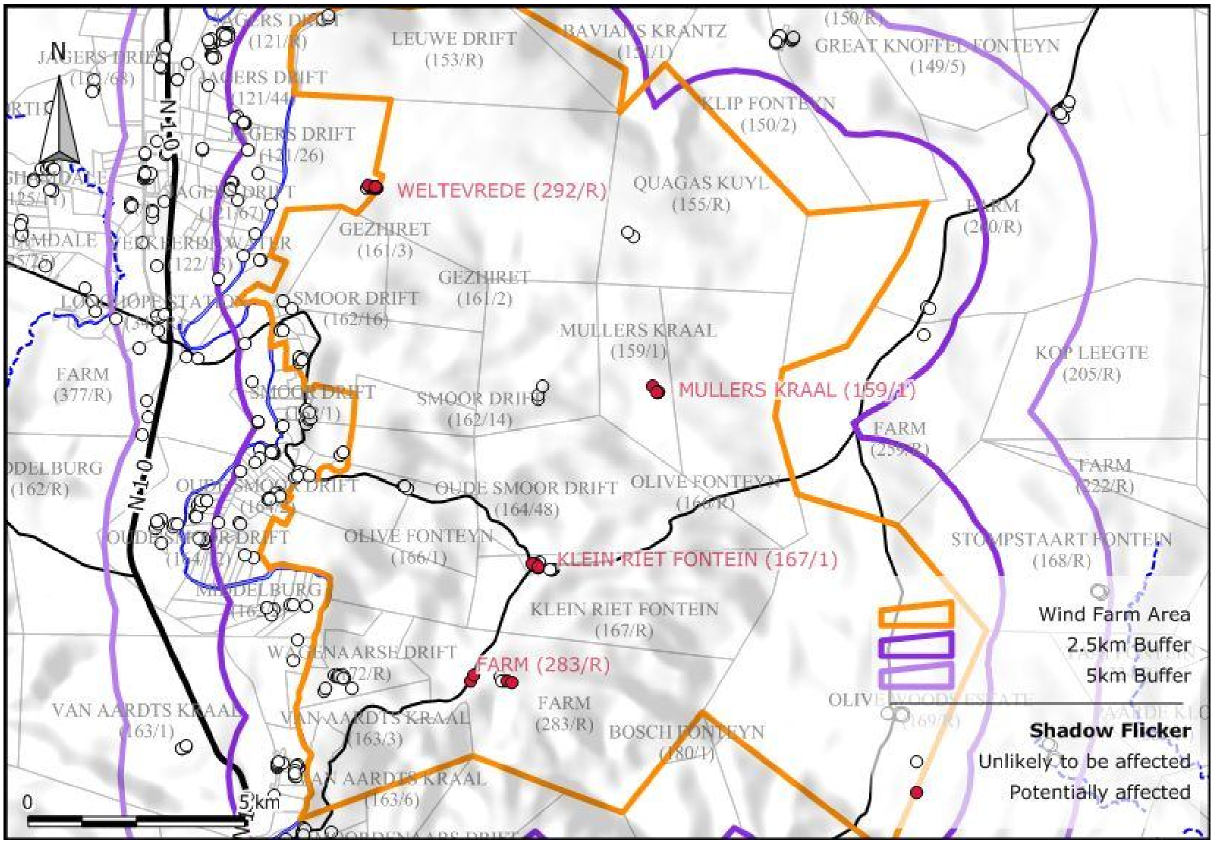

Figure 6-22: Buildings potentially affected by shadow flicker due to their proximity to wind turbines (<500m) - indicated in red circles and labels. See maps in following figure for more detailed views of these buildings.

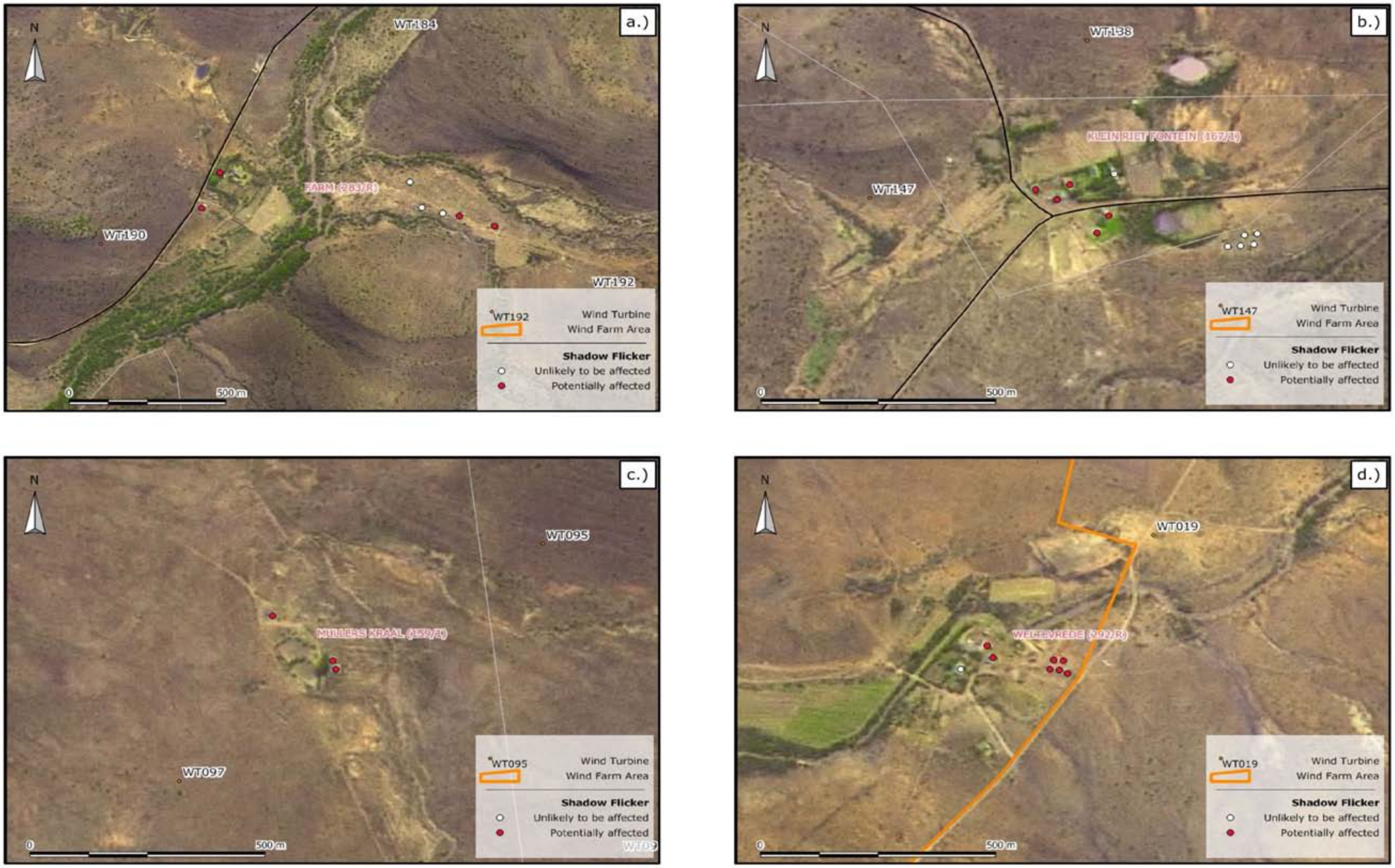

Figure 6-23: Maps showing buildings potentially affected by shadow flicker due to their proximity to wind turbines. These maps focus on buildings identified in the previous map. a.) Buildings on Farm 283/R, b.) Klein Riet Fontein 167/1, c.) Mullers Kraal 159/1 and d.) Weltevrede 292/R

Table 6-3 Summary of visual impact criteria

Criteria	*Impact*
Viewer Sensitivity	Residents of Cookhouse – Highly sensitive to changes in their views. Residents on surrounding farms – Highly sensitive Scenic viewpoints and protected areas – Highly sensitive Motorists – Low sensitivity due to short exposure time and the fact that their focus on landscape is reduced.
Visibility of Development	High
Visual Exposure	Residents of Cookhouse – Medium to low (more than 5km away). Residents of surrounding farms – High for residents in the wind farm area and a couple of residents just outside since they live within 2km of the nearest wind turbine. Scenic viewpoints – high on ridges near turbines (e.g. ridges on northern and southern boundary of wind farm area). Protected areas – low due to their distance from the wind farm. Motorists – medium for N10 and parts of R63, low for other major roads.
Visual Intrusion	Residents of Cookhouse – Low due to their distance from the wind farm. Residents on surrounding farms – High for some due to their proximity to the wind farm. Scenic viewpoints – low due to their distances from the wind farm. Protected areas – Low due to their distances from the wind farm. Motorists – Moderate for motorists on the N10 and low for motorists on other major roads.

6.5.2 Significance of visual impact on the landscape

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.

Impact 1: Impact of a change in the agricultural landscape as a result of establishing a wind farm

Cause and Comment
The current landscape character is that of commercial stock and irrigated farming. The landscape character has a low sensitivity to the change that will be caused by introduction of a wind farm (see section 6.4.3 for a discussion). It is expected that stock farming will not be altered by introduction of wind turbines in the area. However, this is a large wind farm and the landscape will be affected, especially initially when the wind farm is still a new feature in the landscape.

Mitigation and Management
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 (not permanent) since the turbines can be removed from the landscape after their life span of 40 years has been reached. The spatial scale is regional due to the visibility and size of the project. The severity of the impact is expected to be moderate since the landscape character sensitivity is low but the wind farm is particularly large. The likelihood of the impact occurring is probable (and not definite) since it is not yet known what the impact of a

wind farm on an agricultural landscape will be in South Africa. The significance of the landscape impact is therefore expected to be **moderate.**

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	Moderate	2	Probable	3	11	Moderate
With Mitigation	Long Term	3	Regional	3	Moderate	2	Probable	3	11	Moderate

6.5.3 Significance of Visual Impact on Viewers

Visual impacts	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

Impact 1: Intrusion of large and highly visible construction activity on sensitive views

Cause and Comment

The height of the features being built and the siting on ridges is likely to expose construction activities against the skyline. Large construction vehicles and equipment will be highly visible. An increase in activity, vehicles and workers in an otherwise quiet area will affect views. Traffic will 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 of power lines and pylons in the region was observed during the photographic survey and considering the number of power lines in the region this is probably a common sight (Plate 6-8). Plate 6-9 provides another example along the N10.

Plate 6-8: Construction of a high voltage power line pylon exposed against the skyline. View from photo site A24.

Plate 6-9: Power line pylon construction just off the N10 at photo site A08. Notice also the number of high voltage lines extending across the landscape.

Mitigation and Management

The most obvious causes of this impact cannot be mitigated since the turbines are so tall and they are to be installed on the top of ridges. 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 contrast which can be seen from long distances.
- Laydown areas and stockyards should be located in low visibility areas (e.g. valley between the ridges) and existing vegetation should be used to screen them from views.
- 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 (while construction lasts). The extent is regional due to the nature of the development (height of towers and siting on ridges) and construction activities will be visible over long distances. The visual impact will be moderate to severe due to the high visual exposure that highly sensitive viewers (residents in or close to the wind farm area, and others in close proximity to the site) will experience during the construction phase. The high voltage power line network which traverses the study area is somewhat similar in scale to the wind farm and construction activity is often exposed against the skyline.

However, the individual components of the wind turbines are very large and heavy compared with that of the power line pylons. Laydown areas, access roads, transport vehicles and construction equipment will be much larger and more visible. 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 remains **high** in terms of the suggested rating methodology, although the short duration of the impact should perhaps have more of an effect on the significance rating. Construction will last approximately 14 months, of which 4 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)). Further, most of the sensitive viewers living in close proximity to the turbines have agreed to have turbines on their properties and are presumably informed on the effect of the construction phase on their views (*pers.comm.*CES).

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	Severe	4	Definite	4	12	High
With Mitigation	Short Term	1	Regional	3	Moderate	2	Definite	4	10	Moderate

Impact 2: Intrusion of large wind turbines on the existing views of sensitive visual receptors

Cause and Comment

Most of the viewers/viewpoints identified in this report are highly sensitive to changes in their views (as determined and discussed in section 6.5.3.4). However, the region has a low population density and the proposed site is far removed from visually sensitive areas such as pristine wilderness sites and protected areas. A large network of high voltage power lines radiates across most of the study area and pylons are visible from most viewpoints. The wind farm will alter a number of views due to its size (spatial extent and the height of the turbines) and visibility (located on ridges). There are a few visual receptors (viewers and viewpoints) for which the visual intrusion will be very high (residents living on or close to the wind farm area), although many of these have agreed to have turbines on their properties.

Mitigation and Management

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 or farm building.
- Maintenance of the turbine 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.
- 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 benefits of wind power. 'Engaging school groups can also assist the wind farm proponent, as 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 a process that can engage the entire community' (Johnston 2001).

Significance Statement

The duration for the impact is long term 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 since residents and other sensitive viewers will potentially view the wind farm from different areas in the region. Many existing views will be altered by the wind farm. It is not clear whether the change will be perceived as positive (i.e. as a symbol of sustainable and environmentally less harmful energy harvesting) or negative since opinions on the visual aesthetics of wind farms differ widely. It is expected that the severity of the impact will be high for a number of residents who live on or very close to the wind farm area (many of whom presumably are in favour of the wind farm). For most of the other sensitive viewers discussed above the severity will be moderate to low. The impact will definitely occur and overall significance on sensitive viewers is therefore **high**.

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	Moderate	2	Definite	4	12	High
With Mitigation	Long Term	3	Regional	3	Moderate	2	Definite	4	12	High

Impact 3: Impact of shadow flicker on residents 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).

Mitigation and Management

- Trees are an effective measure against shadow flicker and if residents are willing trees can be planted to reduce flickering.
- 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). It is unclear how practical this is as a solution but it should be investigated.
- Adjust layout of the wind farm to lower the number of residents affected by shadow flicker.

6.6 Conclusions and Recommendations

Wind turbines are enormous structures. They are highly visible due to their height, siting on ridges and the movement of their rotating blades. The wind farm proposed for this project will contain over 200 wind turbines spread over a large area. In order for wind generated power to become viable as a replacement, or even to supplement, current power generation schemes a large number of wind farms of comparable size will be required. This means that large tracts of land in areas compatible with wind energy generation will have to be made available to wind farms.

A standard guideline for wind farms is to locate them as far away from sensitive viewers and scenic landscapes as possible. The proposed site for this project adheres to this principle as the landscape has relatively low scenic potential and a low population density.

Tourism in the study area is unlikely to depend on scenic views. If all other parameters indicate that the project is feasible then this area is ideal for a wind energy facility of this size.

7 NOISE SPECIALIST REPORT

Prepared by:	**Prepared for:**	**On behalf of:**
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<u>This report should be cited as</u>:

Brett W., March 2010. *Proposed Terra Wind Energy Golden Valley Project: Noise Assessment.* Safetech, Port Elizabeth.

GLOSSARY OF TERMS AND DEFINITIONS

GLOSSARY OF TERMS & DEFINITIONS	
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: $L_{R,dn} = 10Log\left[\left(\frac{d}{24}\right)10^{\frac{L_{Req,d}}{10}} + \left(\frac{24-d}{24}\right)10^{\frac{L_{Req,n}+K_n}{10}}\right]$ 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

GLOSSARY OF TERMS & DEFINITIONS	
Low frequency noise	Sound which predominantly contains sound energy at frequencies below 100 Hz
m/s	Metres per second
MW	Mega Watt of electricity (1000 kilowatts)
NSA	Noise Sensitive Area
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.
WTG	Wind Turbine Generator

7.1 Introduction

Terra Power Solution (Pty) Ltd is intending to construct a wind energy electricity generation project on several farms in the Cookhouse district. The site falls within the Blue Crane Route Municipality in the Eastern Cape. As per the Scoping Report, it is proposed that the project will consist of 214 wind turbines. This study only addresses the noise impact from the proposed site. The study was requested by Coastal and Environmental Services (CES) as part of the overall Environmental Impact Assessment for the project. CES therefore appointed Brett Williams of Safetech (Appendix D-1); to conduct a noise impact assessment of the proposed development in the detailed EIR Phase.

7.1.1 Terms of Reference

The specific Terms of Reference for the noise impact assessment were:-

1. Determine the land use zoning and identify all potential noise sensitive sites that could be impacted upon by activities relating to the construction and operation of the proposed wind energy facility.
2. Identify all noise sources relating to the activities of the facility during the construction and operation phases that could potentially result in a noise impact at the identified noise sensitive sites.
3. Determine the sound emission, operating cycle and nature of the sound emission from each of the identified noise sources.
4. Calculate the combined sound power level due to the sound emissions of the individual noise sources.
5. Calculate the expected rating level of sound at the identified noise sensitive sites from the combined sound power level emanating from identified noise sources.
6. Display the rating level of sound emitted by the noise sources in the form of noise contours superimposed on the map of the study area.
7. Determine the existing ambient levels of noise at identified noise sensitive sites by conducting representative sound measurements.
8. Determine the acceptable rating level for noise at the identified noise sensitive sites.
9. Calculate the noise impact at identified noise sensitive sites.
10. Assess the noise impact at identified noise sensitive sites in terms of:-
    - SANS 101 SANS 10103 for “The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication”.
    - Noise Control Regulations.
    - World Health Organsation - Guidelines for Community Noise.
    - World Bank - Environmental Guidelines.
11. Investigate alternative noise mitigation procedures, if required, in collaboration with the design engineers of the facility and estimate the impact of noise upon implementation of such procedures.
12. Prepare and submit a full environmental noise impact report containing detailed procedures and findings of the investigation including recommended noise mitigation procedures, if relevant.

7.2 Methodology

The methodology used in this specialist 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.

7.2.1 Desktop study

The desktop study was done using the available literature on noise impacts from wind turbines as well as numerical calculations of the possible noise emissions. A Danish modelling program, EMD WindPro Software Version 2.7 was used and is specifically developed for wind turbine noise. This program is used extensively worldwide and has been developed and validated in Denmark. 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 and is used worldwide for modelling noise from various sources including wind turbine generators (WTG's).

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 from 4m/s to 12m/s. 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 modelling is thus for worst case scenarios and takes the topography around the turbine and noise sensitive area (NSA) into account. The site elevation data was sourced from NASA and imported into WindPro. A comparison was done using the digital elevation data and the contour heights from a 1:50 000 topographical map. The comparison showed that the digital data and the map corresponded well and provided a better resolution.

7.2.2 Field Study

7.2.2.1. Proposed project site

A field study to the proposed site was conducted on the 8th and 9th February 2010. Seven ambient monitoring points were chosen based on their proximity to noise sensitive receptors as well as the location of the proposed wind turbines (Figure 7-1). The access to some of the proposed locations was hampered as there are no access roads at present. This also influenced where the ambient monitoring occurred.

The location of the ambient measurement positions are as follows (Table 7-1):

A number of measurements were taken by placing the noise meter on a tripod and ensuring that it was at least 1.2 m from floor level and 3.5 m 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. Notonal 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 test environment contained the following noise sources:

- Vehicular traffic that included trucks and cars.
- Birds and insects
- Farm animals
- Water flow
- Wind noise

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 E-2)

7.2.2.2. InnoVent France

A field trip was undertaken to France in November 2009 by the author. The field study was done to specifically measure firsthand the noise at different frequencies from various sizes of turbines. Measurements were taken at Valhuon and Hescamps in northern France.

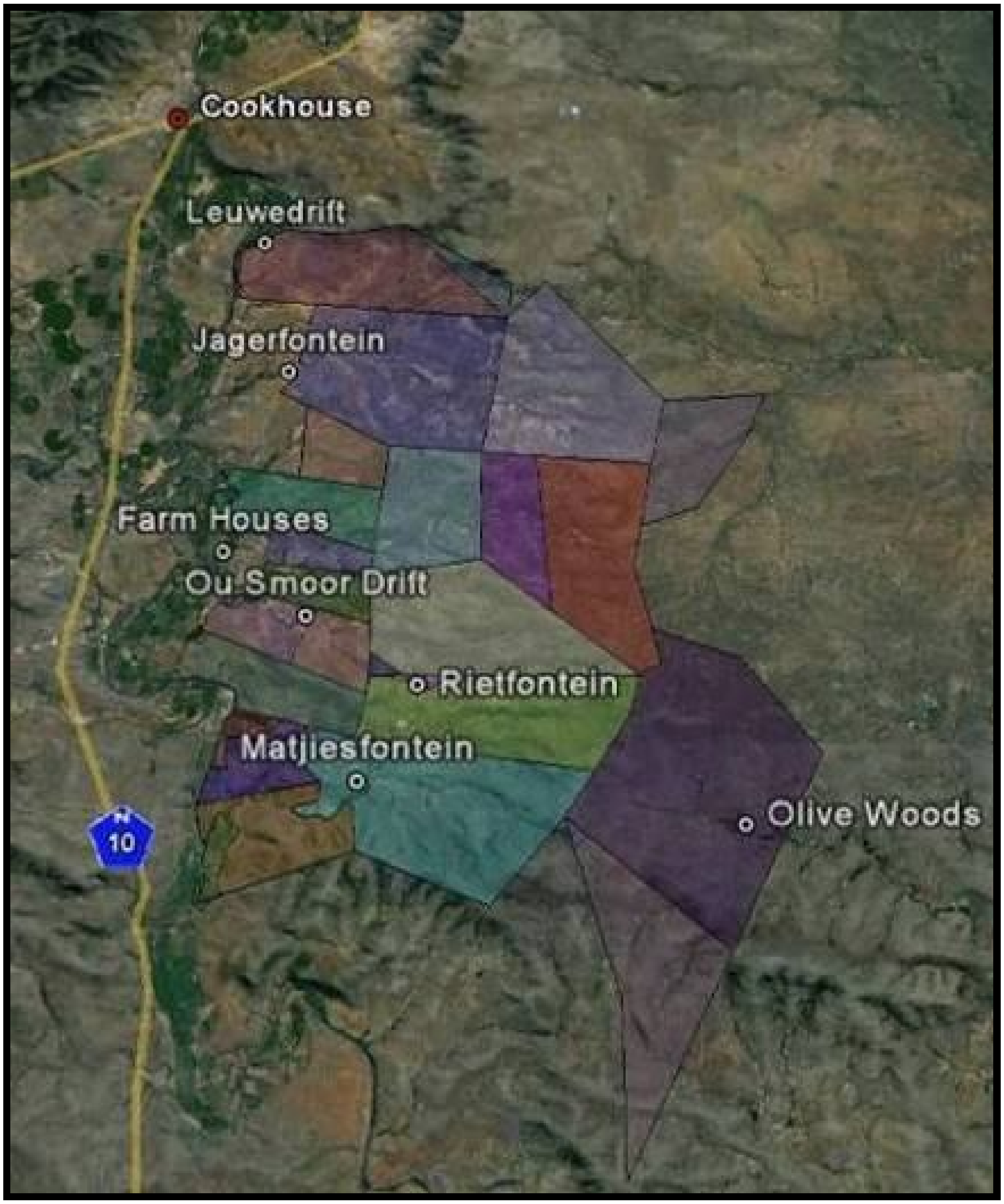

Figure 7-1: -Locations of Test Points 1-7

Table 7-1: Measurement Point Positions

Test Point #	Location Description	Position (at microphone height)
Point 1	Leuwedrift Farm House	32°46.8733'S 25°50.0829'E
Point 2	Jagersfontein Farm House	32°48.9713'S 25°50.7686'E
Point 3	Farm Houses	32°52.4450'S 25°49.5245'E
Point 4	Ou Smoor Drift Farm House	32°52.7229'S 25°51.0873'E
Point 5	Rietfontein Farm House	32°53.6918'S 25°53.0703'E
Point 6	Olive Woods Farm House	32°55.600'S 25°58.330'E
Point 7	Matjiesfontein Farm House	32°55.0333'S 25°52.0978'E

7.3 Introduction to Noise

7.3.1 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 262 Hz).

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 20 to 20 kHz (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 Appendix D-3 and D-4).

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 m^2 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

7.3.2 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.

7.3.2.1. Mechanical Sounds

Mechanical sounds originates 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 (e.g., 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 7-2 shows the type of transmission path and the sound power levels for the individual components for a 2 MW wind turbine.

7.3.2.2. 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 7-3, 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.

Modern airfoil design takes all of the above factors into account and is generally much quieter that the first generation of blade design.

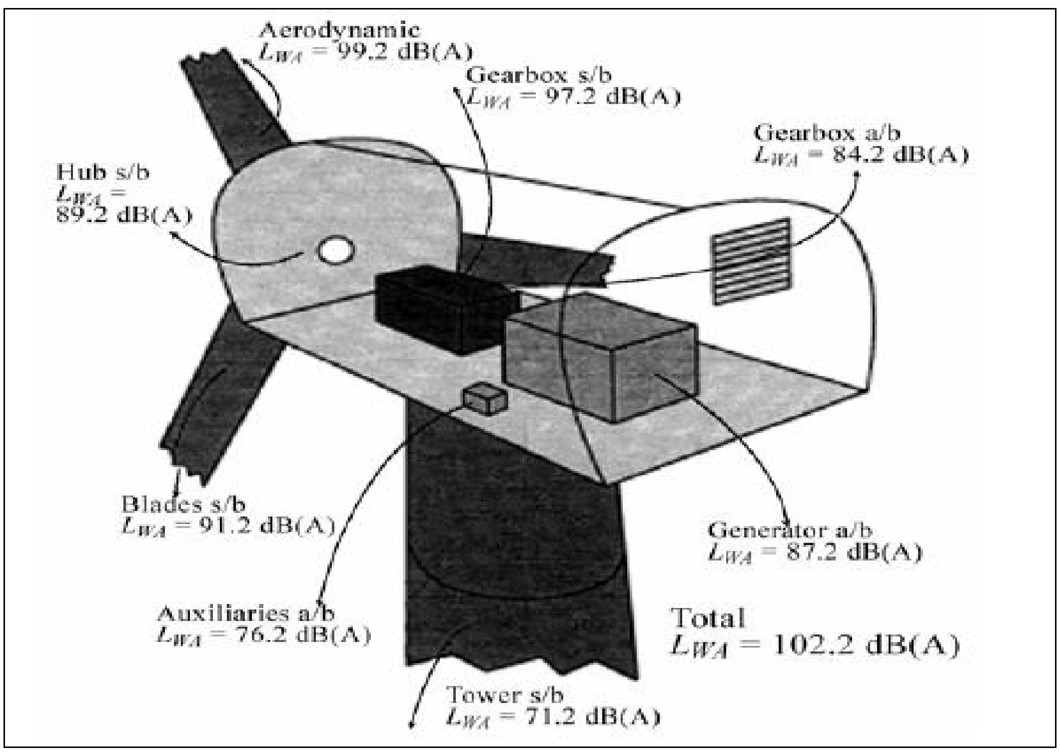

Figure 7-2: Typical Sound Power Levels of a 2MW Turbine

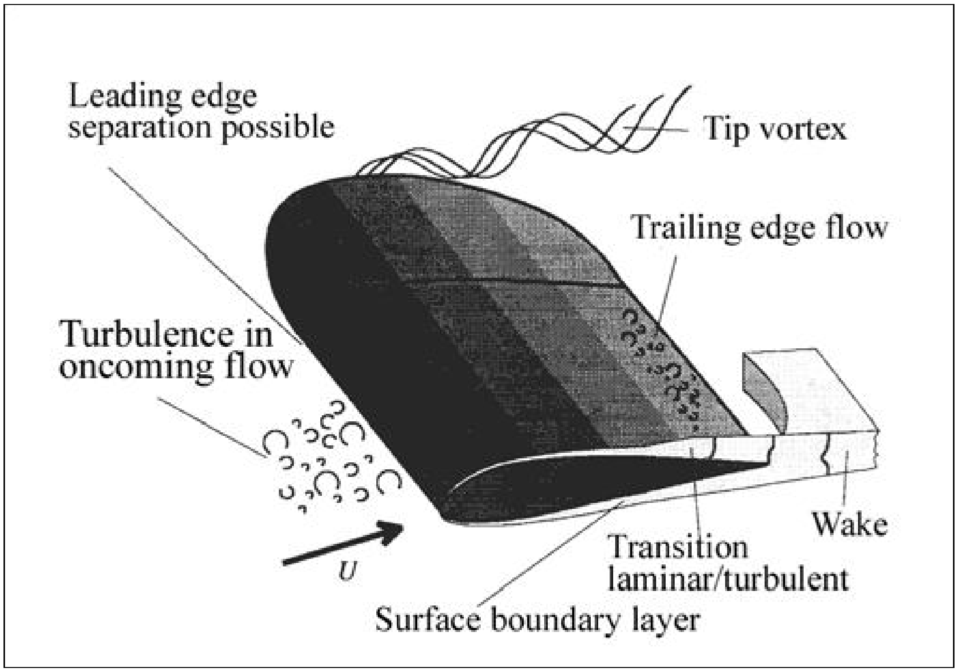

Figure7-3: Sources of Aerodynamic Noise

7.3.2.3. Ambient Sound & 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 8 m/s because the background wind-generated sound masks the wind turbine sound above 8 m/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.

7.3.2.4. 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 (Figure 7-4). Sound below 20 Hz 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.

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 120 dB at a frequency of around 1 Hz.

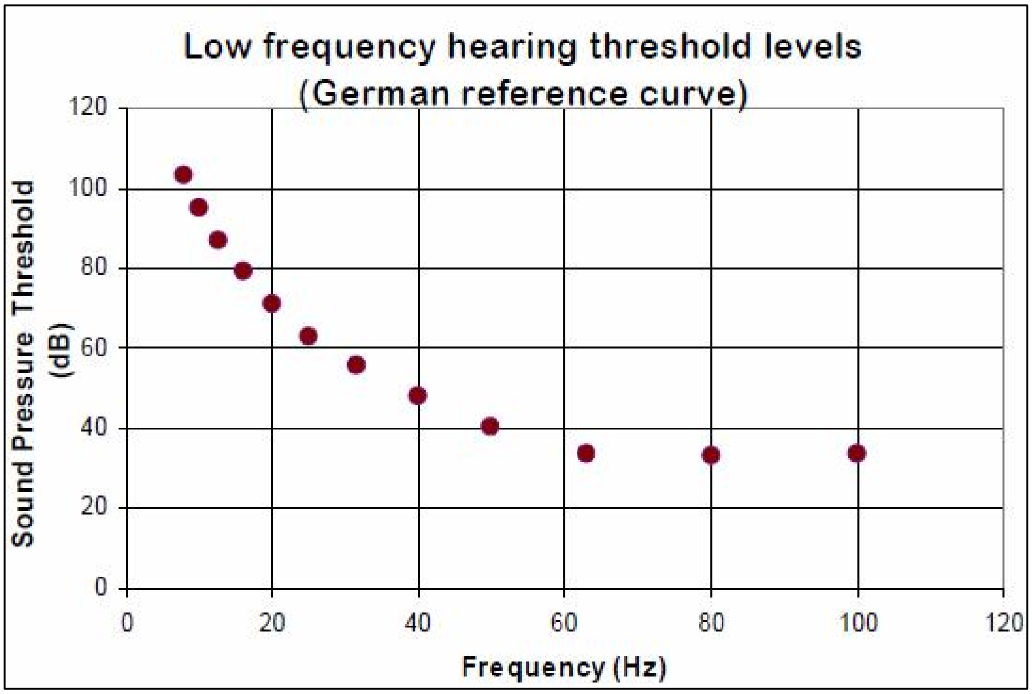

Figure 7-4: Low frequency Hearing Threshold Levels

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 10 Hz is around 100 dB; see Figure 7-4 above.
- Tonality cannot be perceived below around 18 Hz
- 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:

- 90 dB and below: No evidence of adverse effects
- 115 dB: Fatigue, apathy, abdominal symptoms, hypertension in some humans
- 120 dB: Approximate threshold of pain at 10 Hz
- 120 – 130 dB 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 below 90dB from low frequency or infrasound from wind turbines 2,4,5,9,15,16,17.

7.3.3 Potential Noise Sources as a result of the proposed CookhouseWind Energy

Noise pollution will be generated during the construction phase as well as the operational phase.

7.3.3.1. Construction Phase

<u>General Equipment and Vehicles</u>

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 is presented in Table 7-2.

Table 7-2: Typical types of vehicles and equipment to be used on site (Construction Phase)
Source: GCDA 2006

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

7.3.3.2. Operational Phase

The project will install approximately 214 wind turbine generators that are manufactured by General Electric. The general characteristics of the model are as follows:

The GE 2.5 MW is 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 the Table 7-3 and Figure 7-5 provides an illustration of the nacelle details.

Table 7-3: 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	75 -100 m

7.4 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.

7.4.1 Sensitive Receptors

7.4.1.1. Human Sensitive Receptors

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The proposed Terra Wind Energy Golden Valley Project site is situated in a farming community. Several homesteads are located on the properties where the turbines will be erected as well as on neighbouring farms. The local prison and the associated staff housing complex are situated to the north west of the proposed site.

The sensitive noise receptors have been recorded in Table 7-4 and the locations of the various human sensitive receptors are indicated in Figure 7-6 that follows.

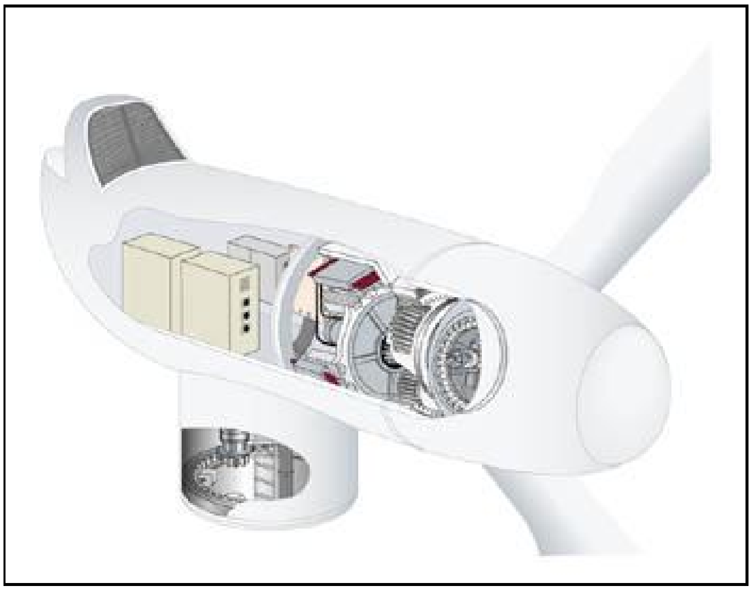

Figure 7-5: Nacelle details of WWD-3

Table 7-4: Sensitive Noise Receptors

Label	Location Description	Position
NSA 1	Leuwedrift Farm House	32°46.8733'S 25°50.0829'E
NSA 2	Ou Smoor Drift Farm House	32°52.7229'S 25°51.0873'E
NSA 3	Matjesfontein Farm House	32°55.0333'S 25°52.0978'E
NSA 4	Jagersfontein Farm House	32°48.9713'S 25°50.7686'E
NSA 5	Olive Woods Farm House	32°55.600'S 25°58.4941'E
NSA 6	Rietfontein Farm House	32°53.6918'S 25°53.0703'E
NSA 7	School	32°56.995'S 25°49.580'E
NSA 8	Thorn Park Farm House	32°51.1086'S 25°49.6574'E
NSA 9	Barn and Farm Workers Houses	32°50.5531'S 25°49.3851'E
NSA 10	Farm House	32°51.923'S 25°49.6973'E
NSA 11	Farm Houses on Longhope Road	32°52.4840'S 25°49.5793'E
NSA 12	Varkenskuil Farm House	32°50.8699'S 25°58.8663'E
NSA 13	Abandoned Building	32°51.6258'S 25°53.1636'E

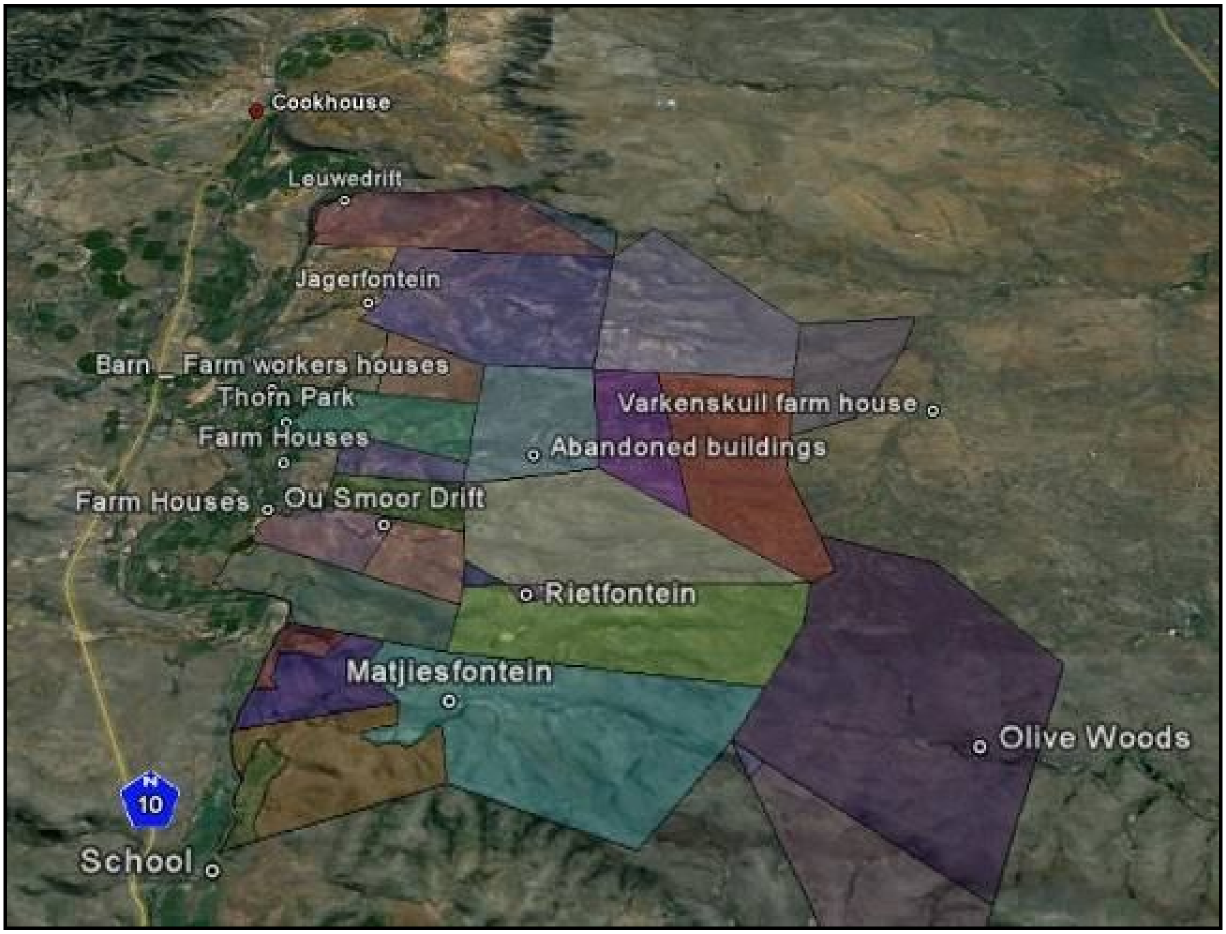

Figure 7-6: Nearby sensitive human receptors in relation to the wind turbines

7.4.1.2. Natural Environment Receptors

The vegetation around the site is characterised by thicket and grasslands. The fauna includes bats, birds, commercial livestock and a variety of buck. The impacts on the faun and avifauna are dealt with in separate studies.

7.4.2 Results of the Field Study

7.4.2.1. Ambient Noise at the proposed project site

The ambient noise was measured at seven locations as described above (Section 7.2.2.1) and results thereof are contained in Tables 7-5.

Table 7-5: Ambient Noise Results - 8th and 9th February 2010 (Extremely hot ambient conditions)

Location	Start Time	Duration (minutes)	Wind (m/s) *(At Microphone)	Temperature (° Celsius) *(At Microphone)	$L_{Req.T}$ dB(A)	Comments / Noise Sources
Point 1	14:00	10	3.8	42.6	42.9	• Wind • Waterflow • Car/truck
Point 2	14:40	10	3.8	43.3	34.9	• Wind • Thunder • Radio in background • Car in background • People's voices • Cicadas • Dog barking • Banging on roof
Point 3	10:03	10	1.4	34.8	60.3	• Insects • Wind • Birds • Cicadas
Point 4	10:40	10	2.2	37.3	35.1	• Wind in trees • Flies • Birds
Point 5	15:20	10	2.9	33.8	34.5	• Birds • Cows • Wind in trees • Flies • Voices in distance
Point 6	13:10	10	2.6	32.7	40	• Metal banging • Insects • People in background • Truck on gravel road • Birds • Slight breeze in nearby trees
Point 7	05:45	10	0	22.2	34.7	• Pigeon • Birds • Large flying insects • Flies

Location	Start Time	Duration (minutes)	Wind (m/s) *(At Microphone)	Temperature (° Celsius) *(At Microphone)	$L_{Req.T}$ dB(A)	Comments / Noise Sources
Point 7	15:55	10	1.0	36.6	36.5	• Wind in trees • Birds • Flies

*Author measurements of wind speed and temperature at microphone height.

The results indicate that the ambient noise is approximately between 34 and 60 dB(A) depending on the wind speed. The general ambient noise at each location varies substantially as the ambient sound is influenced by human activities as well as vehicles and animal sounds. It is thus extremely difficult to isolate just the wind component.

7.4.2.2. Noise Study at InnoVent France

The author did note that the Winwind 1 MW unit made a distinct sound when the blade passed the nacelle as the static and lightning discharge coupling made contact. The author was informed that on subsequent models this design has been revised. These units will not be installed in South Africa.

The results of the field study showed that at no time did the sound level below 20 hertz exceed 25 decibels. This correlates well with the literature review as there are no proven health effects from infrasound below 90dB.

The total noise emitted by the turbines at 500m was approximately 45dB. This level would correspond to the SANS 10103 recommended ambient limit for rural areas. The sound above the infrasound range does not indicate specific tonal qualities except at 1600hertz, but this is explained above as a turbine design flaw.

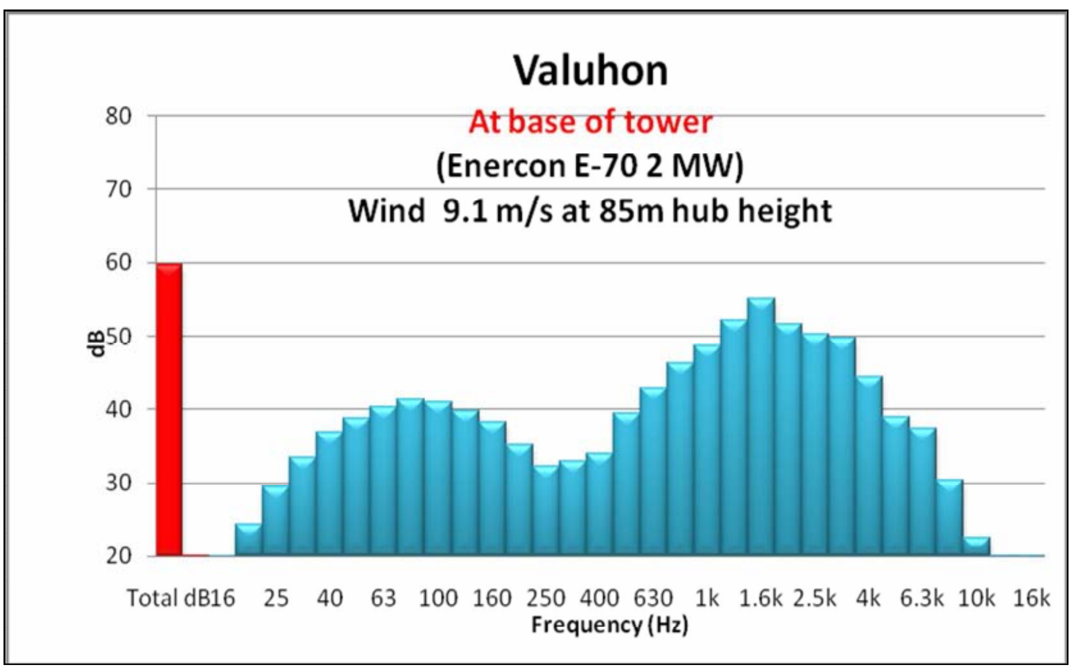

Figure 7-7: Frequency analysis 2MW WTG - At base of tower

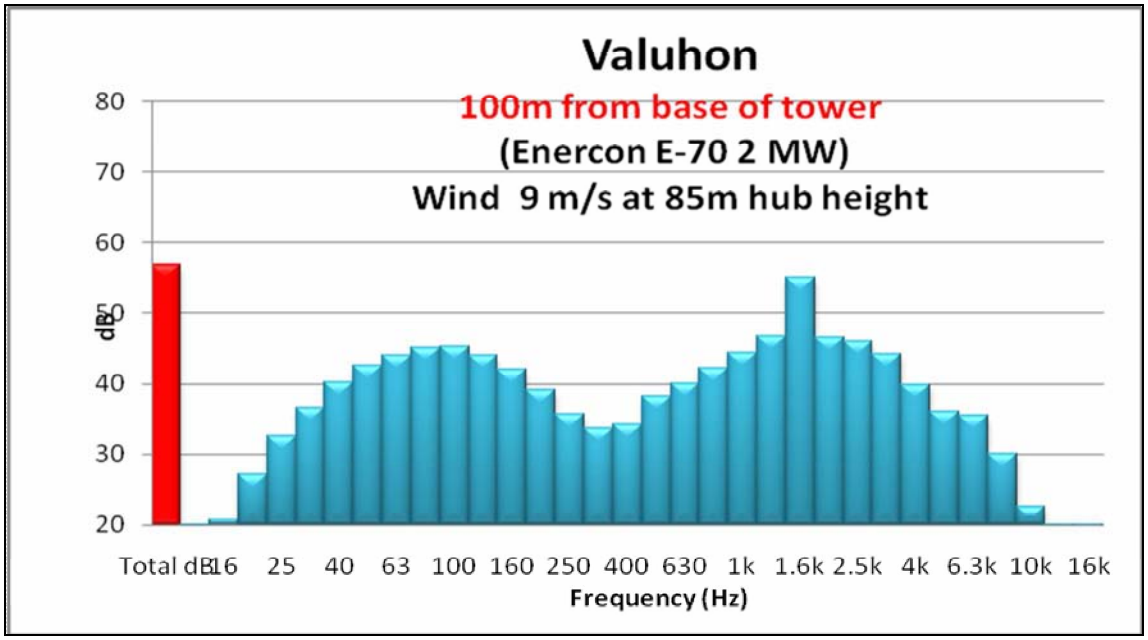

Figure 7-8: Frequency analysis 2MW WTG – 100m from tower

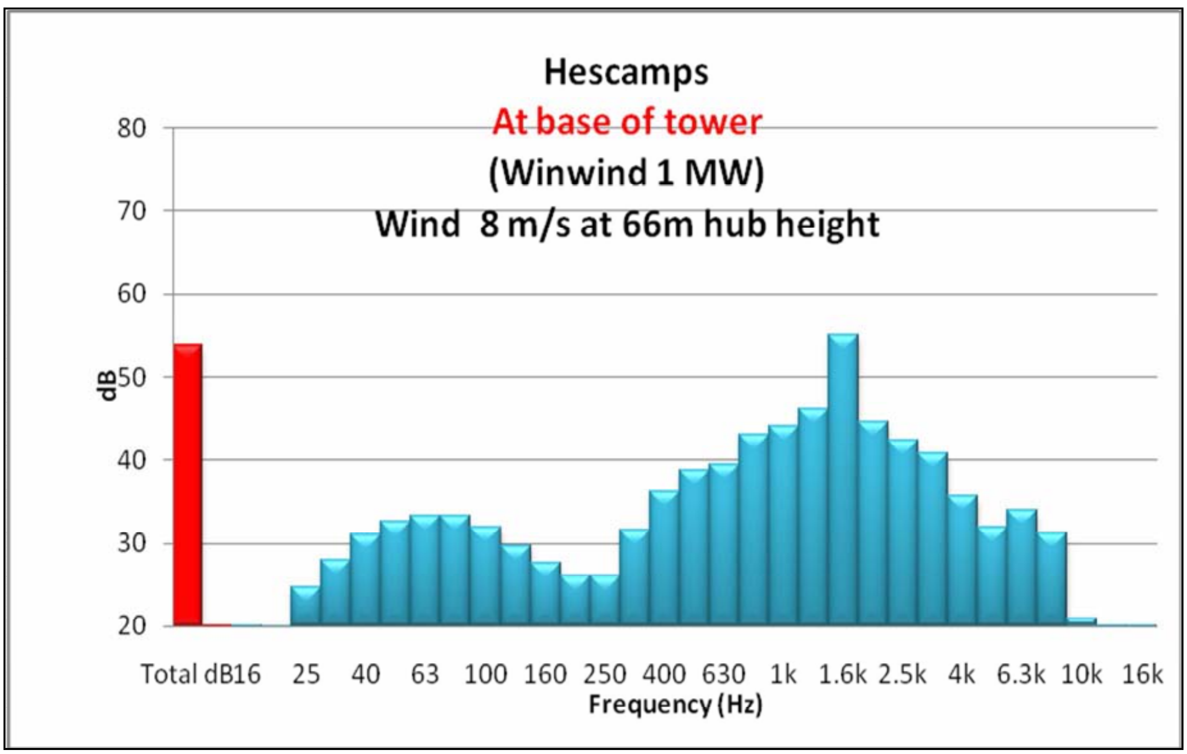

Figure 7-9: Frequency analysis 1MW WTG – At base of tower

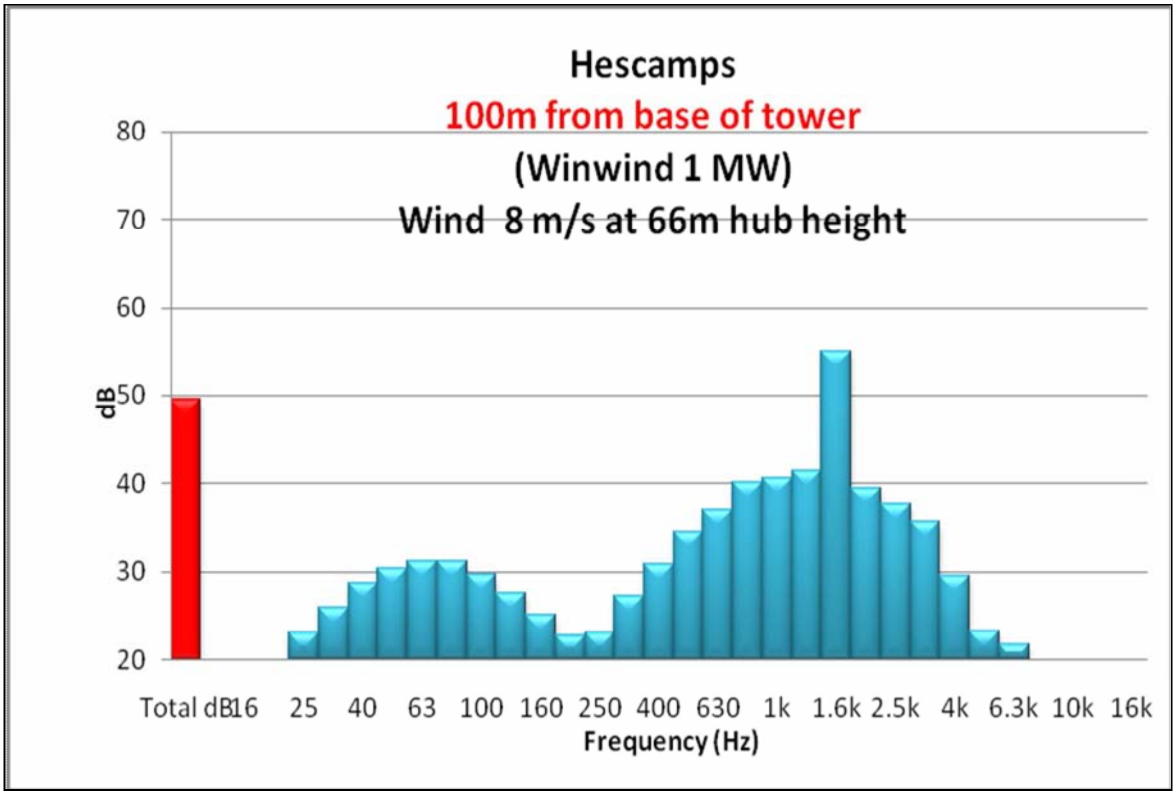

Figure 7-10: Frequency analysis 1MW WTG – 100m from tower

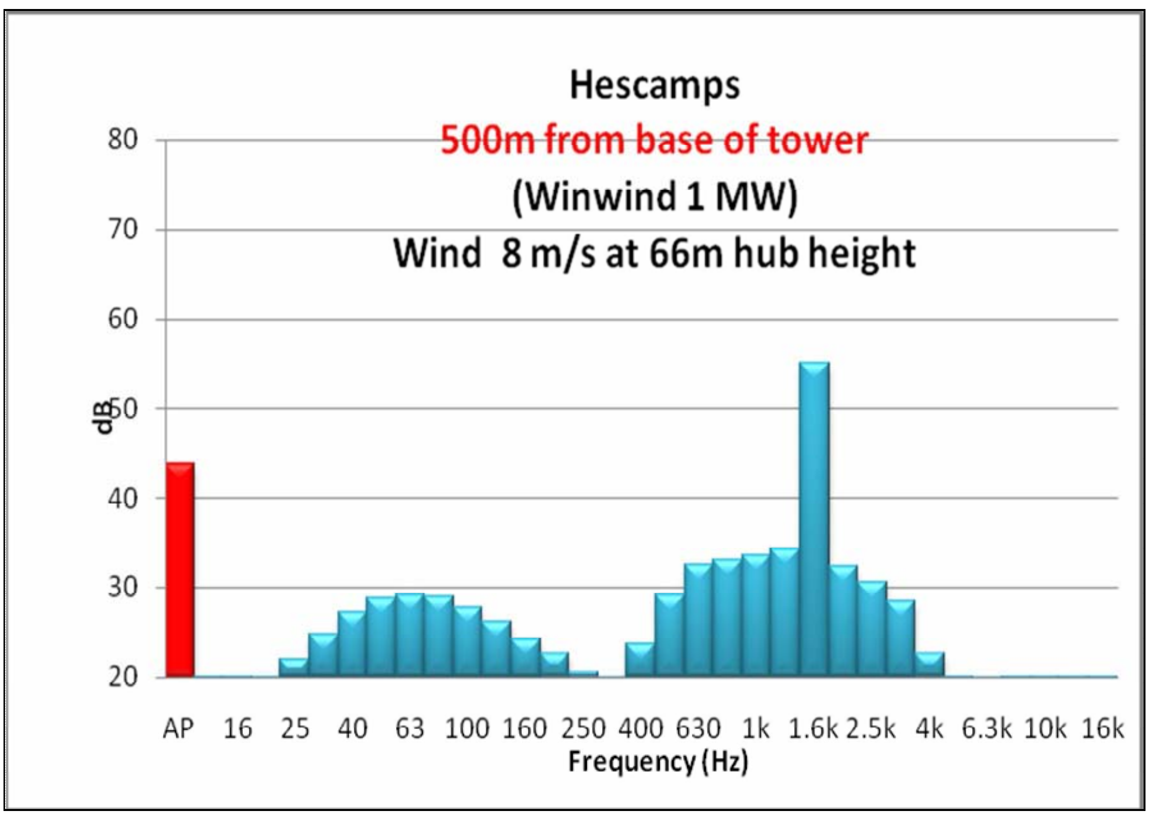

Figure 7-11: Frequency analysis 1MW WTG – 500m from tower

7.5 Identification of key issues

The key issues regarding the noise impact are as follows:

- What is the current noise 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 pose an unacceptable impact?

7.6 Applicable legislaltion 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 7-6.

Table 7-6: 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:	60	60	50	50	50	40

Workshops; business premises and main roads						
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 Table 7-6 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.

It is doubtful that the ambient noise levels will be below 40 dB(A) when the wind is strong enough for the turbines to run. The noise generated from the wind itself will be higher than the night time level of 35 dB(A) as the turbine minimum cut in speed is 4m/s. It is thus possible to take 45dB(A) as the noise limit when the turbines are operational. The author found from the field study results that the noise at 500m was in the region of 45 dB(A). Furthermore, the operator of the turbines can limit the turbine rotational speed under unfavourable night conditions to ensure that the sensitive receptors are not affected.

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 7-7.

Table 7-7: 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

7.6.1 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 (LA90) 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 (LA90) 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(A) for rural districts during the day. The South Africa night time limit of 35 dB(A) will in all likelihood not be exceeded as the, when the night time wind speed exceeds 4m/s which is the turbine cut-in speed, the ambient limit will be above 35 dB(A). A guideline limit of 45 dB(A) is thus chosen as the design limit for the wind turbine noise at sensitive noise receptors.

There are no legislated setback distance guidelines for wind turbines in South Africa. A 500m setback distance is recommended 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.

7.7 Noise Impact Assessment

7.7.1 Predicted Noise Levels for the Construction Phase

Cause and Comment

The construction noise at the various sites will have a local impact. Safetech has conducted noise tests at various sites in Southern Africa and have recorded the noise emissions of various pieces of construction equipment. The results are presented in Table 7-8 to 7.10.

Table 7-8: 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 7-2. 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 distance the ambient level will be reached.

Table 7-9: 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 7-10: 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 Tables 7-9 and 7-10 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 this is ignored for this purpose. Therefore, the distance calculated below would be representative of maximum distances to reach ambient noise levels.

Table 7-11 below gives an illustration of attenuation by distance from a noise of 117dB measured from the source.

Table 7-11: 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 1300m 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. The construction noise will be transient in nature and in all likelihood not constant for extended periods as the construction team will move from site to site.

7.7.2 Predicted noise levels for the Operational Phase

The impact of the noise pollution that can be expected from the site during the operational phase will largely depend on the climatic conditions at the site. The ambient noise increases as the wind speed increases. Under very stable atmospheric conditions, a temperature inversion or a light wind the turbines will not be operational as the cut-in speed is 4m/s.

Cause and Comment

The effects of low frequency noise could include sleep disturbance, nausea, vertigo etc. These effects are unlikely to impact upon residents due to the distance between the turbines and the nearest communities as the sound power levels from the turbines are low. Sources of low frequency noise other than the turbines include wind noise, train movements (at very infrequent times) and vehicular traffic.

Predicted noise levels for 9 Wind Turbines Generators

The tables and figures below indicate the isopleths for 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 45dB(A) recommended limit is exceeded.

NSA 1			
Distance to Nearest WTG[m] - min 500m			1081m (WTG 1)
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	WTG Noise [dB(A)]	Noise Demand Fulfilled?
4	45	31.8	Yes
5	45	32.8	Yes
6	45	33.8	Yes
7	45	34.8	Yes
8	45	35.8	Yes
9	45	36.8	Yes
10	45	37.8	Yes
11	45	38.8	Yes
12	45	39.8	Yes

Table 7-12: NSA 1 Results - Leuwedrift Farm House

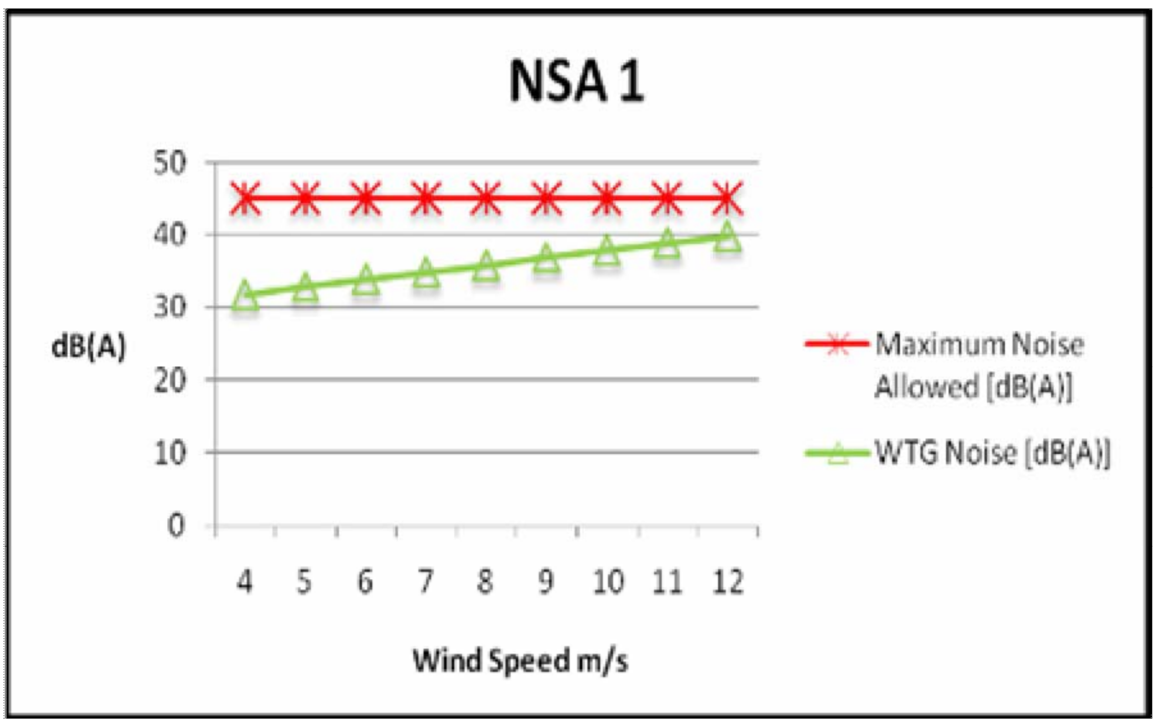

Figure 7-12: NSA 1 Results - Leuwedrift Farm House

Table 7-13: NSA 2 Results Ou Smoor Drift Farm House

NSA 2			
Distance to Nearest WTG[m] - min 500m			462m (WTG 117)
Wind Speed [m/s]	Maximum Noise Demand [dB(A)]	WTG Noise [dB(A)]	Noise Demand Fulfilled?
4	45	40.1	Yes
5	45	41.1	Yes
6	45	42.1	Yes
7	45	43.1	Yes
8	45	44.1	Yes
9	45	45.1	No
10	45	46.1	No
11	45	47.1	No
12	45	48.1	No

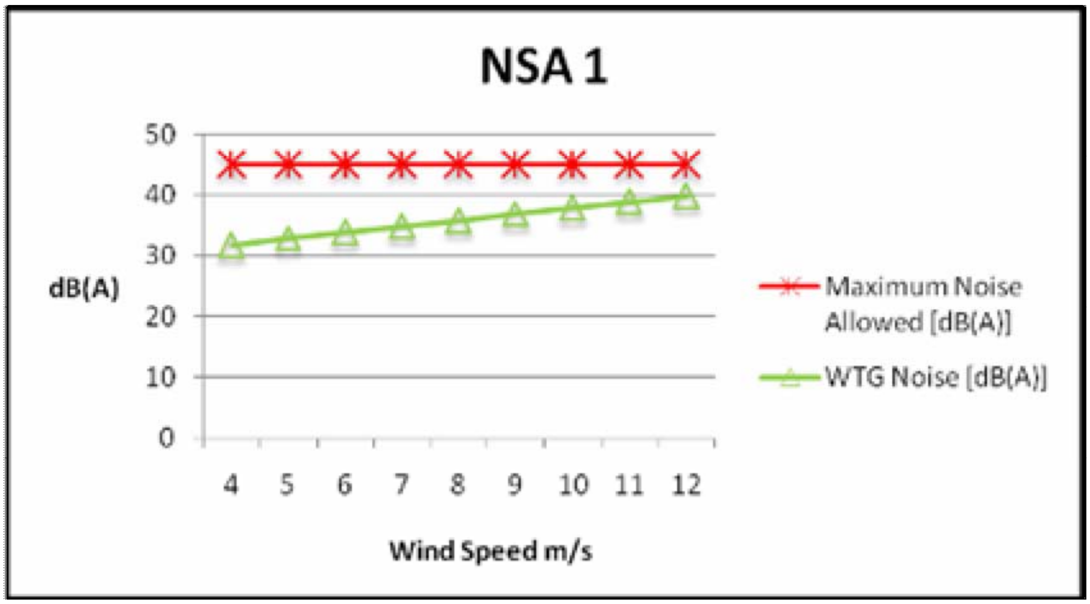

Figure 7-13: NSA 2 Results Ou Smoor Drift Farm House

Table 7-14: NSA 3 Results Matjesfontein Farm House

NSA 3			
Distance to Nearest WTG[m] - min 500m			385m (WTG 190)
Wind Speed [m/s]	Maximum Noise Demand [dB(A)]	WTG Noise [dB(A)]	Noise Demand Fulfilled?
4	45	40.5	Yes
5	45	41.4	Yes
6	45	42.4	Yes
7	45	43.5	Yes
8	45	44.5	Yes
9	45	45.4	No
10	45	46.4	No
11	45	47.4	No
12	45	48.5	No

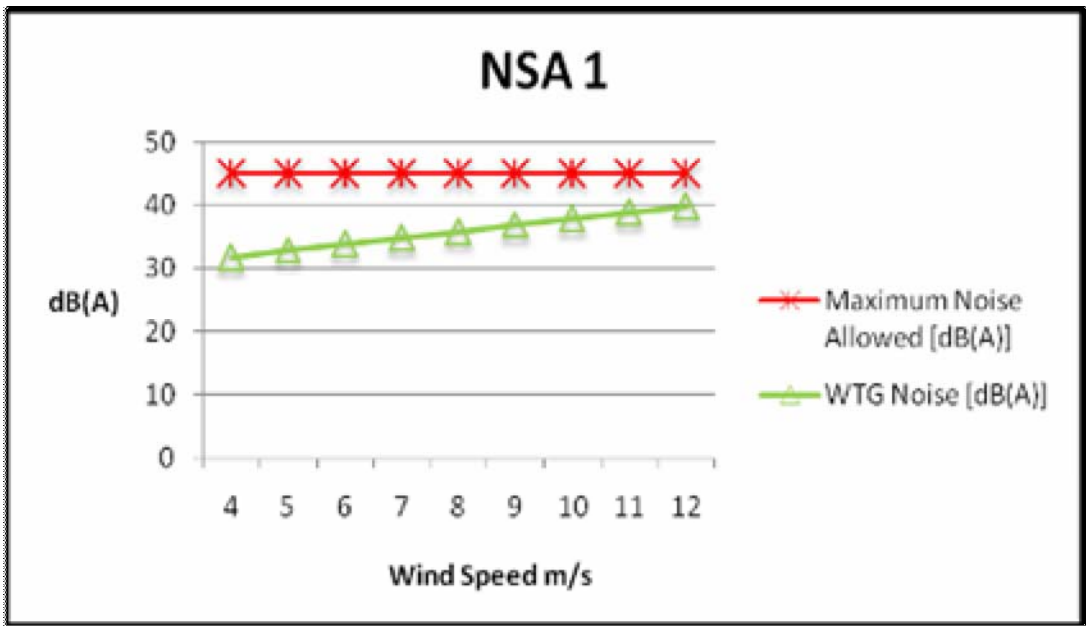

Figure 7-14: NSA 3 Results Matjesfontein Farm House

Table 7-15: NSA 4 Results Jagersfontein Farm House

NSA 4			
Distance to Nearest WTG[m] - min 500m			269m (WTG 19)
Wind Speed [m/s]	Maximum Noise Demand [dB(A)]	WTG Noise [dB(A)]	Noise Demand Fulfilled?
4	45	43	Yes
5	45	44	Yes
6	45	45.0	No
7	45	46.0	No
8	45	47.0	No
9	45	48.0	No
10	45	49.0	No
11	45	50.0	No
12	45	51.0	No

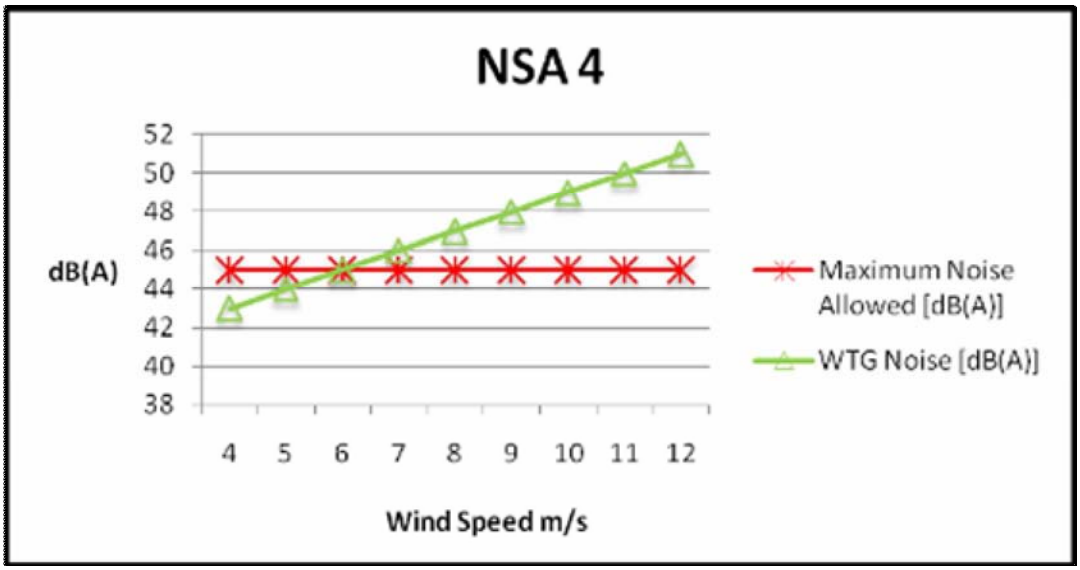

Figure 7-15: NSA 4 Results Jagersfontein Farm House

Table 7-16: NSA 5 Results Olive Woods Farm House

NSA 5			
Distance to Nearest WTG[m] - min 500m			611m (WTG 194)
Wind Speed [m/s]	Maximum Noise Demand [dB(A)]	WTG Noise [dB(A)]	Noise Demand Fulfilled?
4	45	36.1	Yes
5	45	37.1	Yes
6	45	38.1	Yes
7	45	39.1	Yes
8	45	40.1	Yes
9	45	41.1	Yes
10	45	42.1	Yes
11	45	43.1	Yes
12	45	44.1	Yes

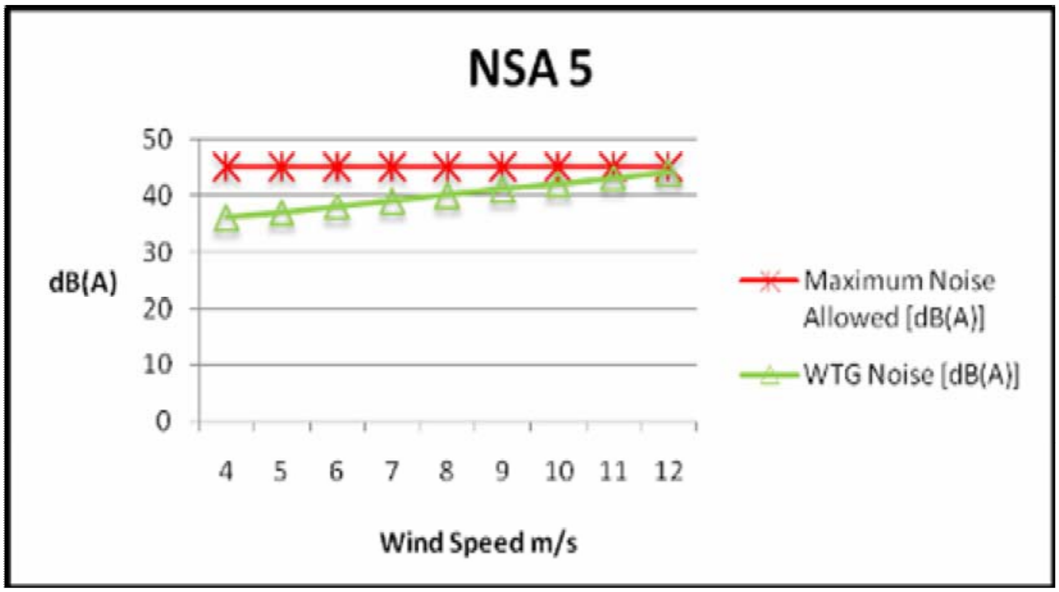

Figure 7-16: NSA 5 Results Olive Woods Farm House

Table 7-17: NSA 6 Results Rietfontein Farm House

NSA 6			
Distance to Nearest WTG[m] - min 500m			245m (WTG 147)
Wind Speed [m/s]	Maximum Noise Demand [dB(A)]	WTG Noise [dB(A)]	Noise Demand Fulfilled?
4	45	44.6	Yes
5	45	45.6	No
6	45	46.6	No
7	45	47.6	No
8	45	48.6	No
9	45	49.6	No
10	45	50.6	No
11	45	51.6	No
12	45	52.6	No

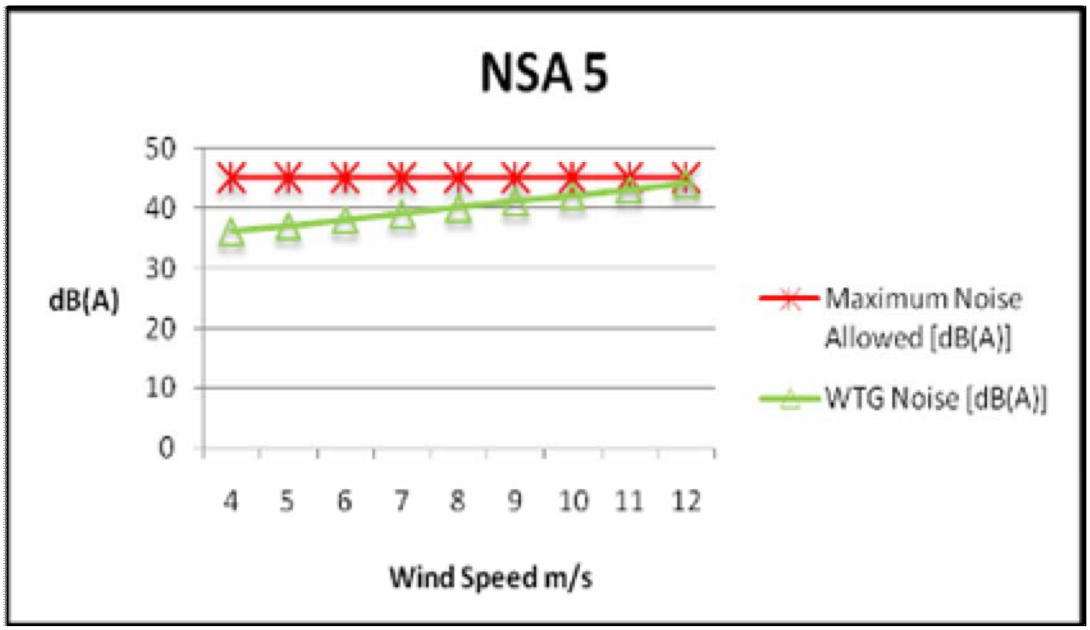

Figure 7-17: NSA 6 Results Rietfontein Farm House

Table 7-18: NSA 7 Results School

NSA 7			
Distance to Nearest WTG[m] - min 500m			1483m (WTG 211)
Wind Speed [m/s]	Maximum Noise Demand [dB(A)]	WTG Noise [dB(A)]	Noise Demand Fulfilled?
4	45	29.3	Yes
5	45	30.3	Yes
6	45	31.3	Yes
7	45	32.3	Yes
8	45	33.3	Yes
9	45	34.3	Yes
10	45	35.3	Yes
11	45	36.3	Yes
12	45	37.3	Yes

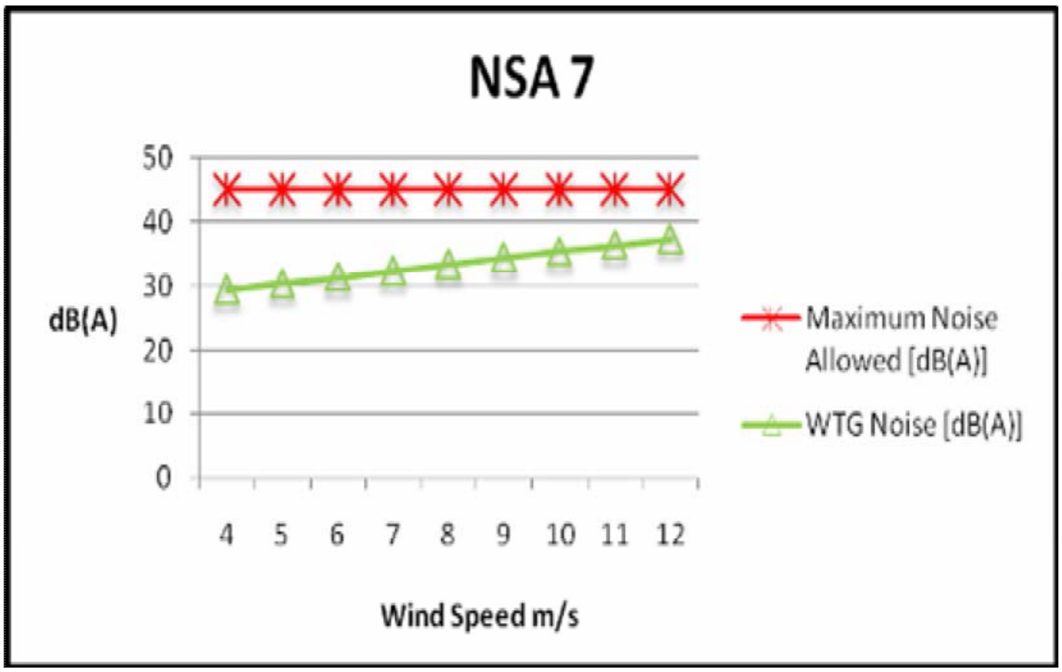

Figure 7-18: NSA 7 Results School

Table 7-19: NSA 8 Results Thorn Park Farm House

NSA 8			
Distance to Nearest WTG[m] - min 500m			922m (WTG 89)
Wind Speed [m/s]	Maximum Noise Demand [dB(A)]	WTG Noise [dB(A)]	Noise Demand Fulfilled?
4	45	34.5	Yes
5	45	35.5	Yes
6	45	36.5	Yes
7	45	37.5	Yes
8	45	38.5	Yes
9	45	39.5	Yes
10	45	40.5	Yes
11	45	41.5	Yes
12	45	42.5	Yes

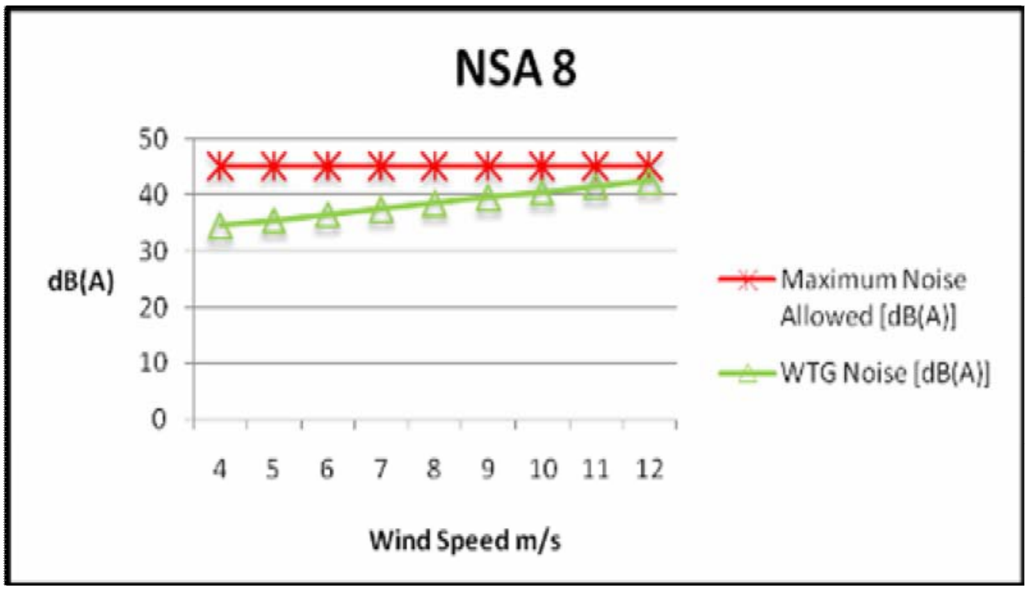

Figure 7-19: NSA 8 Results Thorn Park Farm House

Table 7-20: NSA 9 Results Barn and Farm Workers Houses

NSA 9			
Distance to Nearest WTG[m] - min 500m			1202m (WTG 67)
Wind Speed [m/s]	Maximum Noise Demand [dB(A)]	WTG Noise [dB(A)]	Noise Demand Fulfilled?
4	45	33.5	Yes
5	45	34.5	Yes
6	45	35.5	Yes
7	45	36.5	Yes
8	45	37.5	Yes
9	45	38.5	Yes
10	45	39.5	Yes
11	45	40.5	Yes
12	45	41.5	Yes

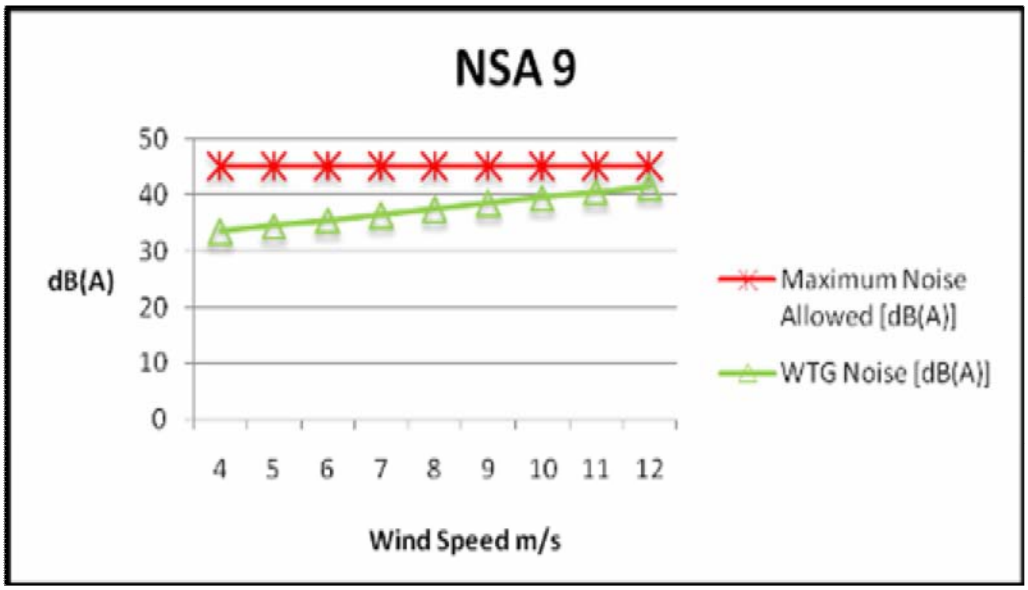

Figure 7-20: NSA 9 Results Barn and Farm Workers Houses

Table 7-21: NSA 10 Results Farm House

NSA 10			
Distance to Nearest WTG[m] - min 500m			1458m (WTG 103)
Wind Speed [m/s]	Maximum Noise Demand [dB(A)]	WTG Noise [dB(A)]	Noise Demand Fulfilled?
4	45	33.3	Yes
5	45	34.3	Yes
6	45	35.3	Yes
7	45	36.3	Yes
8	45	37.3	Yes
9	45	38.3	Yes
10	45	39.3	Yes
11	45	40.3	Yes
12	45	41.3	Yes

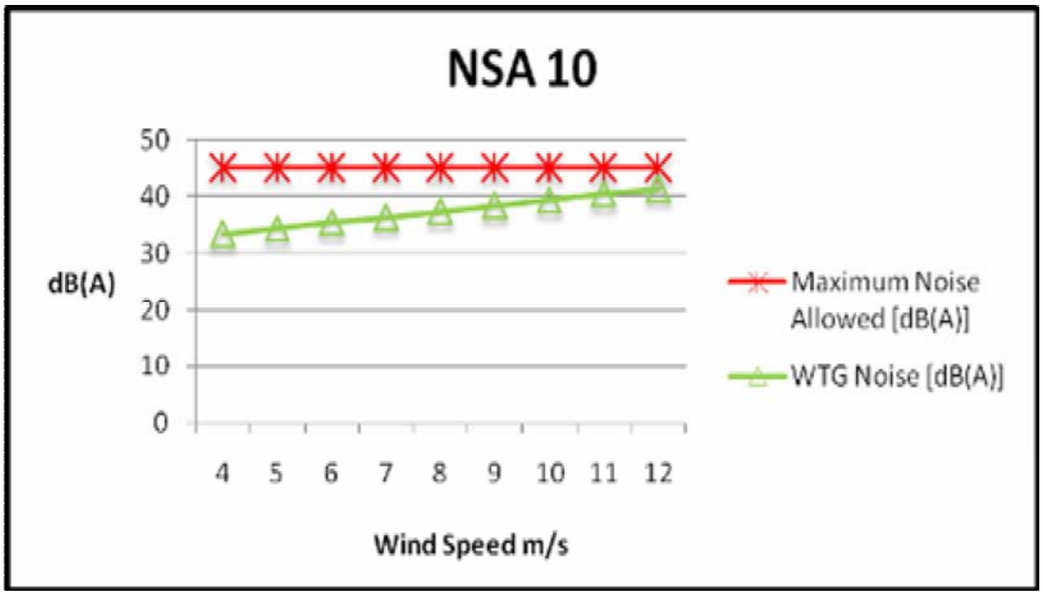

Figure 7-21: NSA 10 Results Farm House

Table 7-22: NSA 11 Results Farm Houses on Longhope Road

NSA 11			
Distance to Nearest WTG[m] - min 500m			1033m (WTG 118)
Wind Speed [m/s]	Maximum Noise Demand [dB(A)]	WTG Noise [dB(A)]	Noise Demand Fulfilled?
4	45	33.9	Yes
5	45	34.9	Yes
6	45	35.9	Yes
7	45	36.9	Yes
8	45	37.9	Yes
9	45	38.9	Yes
10	45	39.9	Yes
11	45	40.9	Yes
12	45	41.9	Yes

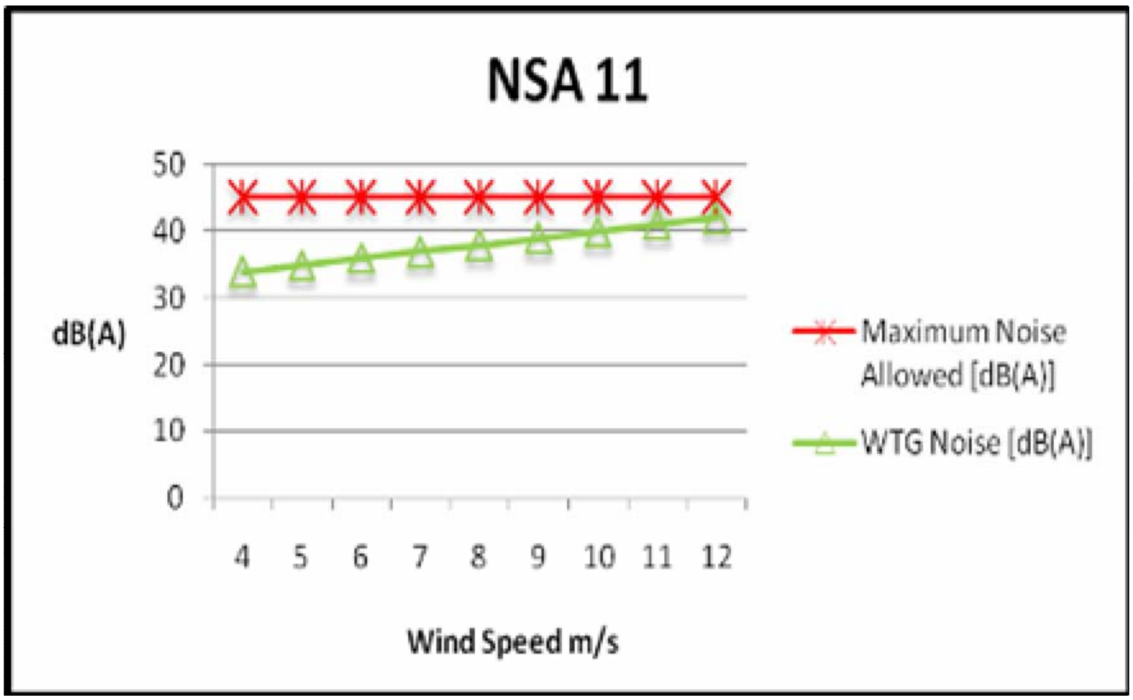

Figure 7-22: NSA 11 Results Farm Houses on Longhope Road

Table 7-23: NSA 12 Results Varkenskuil Farm House

NSA 12			
Distance to Nearest WTG[m] - min 500m			1863m (WTG 66)
Wind Speed [m/s]	Maximum Noise Demand [dB(A)]	WTG Noise [dB(A)]	Noise Demand Fulfilled?
4	45	30.6	Yes
5	45	31.6	Yes
6	45	32.6	Yes
7	45	33.6	Yes
8	45	34.6	Yes
9	45	35.6	Yes
10	45	36.6	Yes
11	45	37.6	Yes
12	45	38.6	Yes

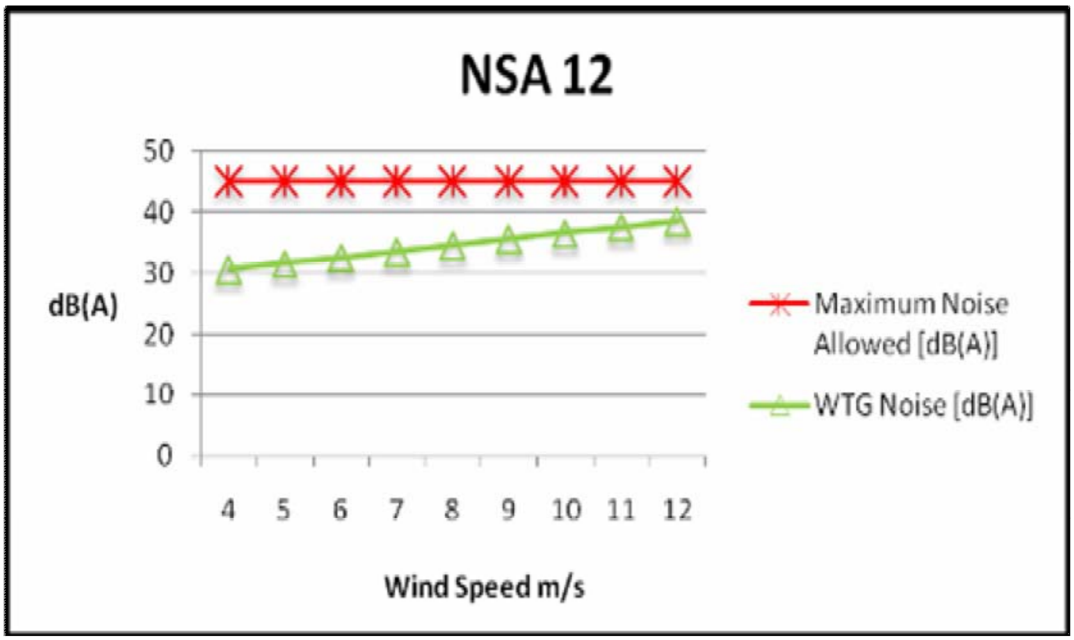

Figure 7-23: NSA 12 Results Varkenskuil Farm House

Table 7-24: NSA 13 Results Abandoned Building

NSA 13			
Distance to Nearest WTG[m] - min 500m		1034m (WTG 94)	
Wind Speed [m/s]	Maximum Noise Demand [dB(A)]	WTG Noise [dB(A)]	Noise Demand Fulfilled?
4	45	36.3	Yes
5	45	37.3	Yes
6	45	38.3	Yes
7	45	39.3	Yes
8	45	40.3	Yes
9	45	41.3	Yes
10	45	42.3	Yes
11	45	43.3	Yes
12	45	44.3	Yes

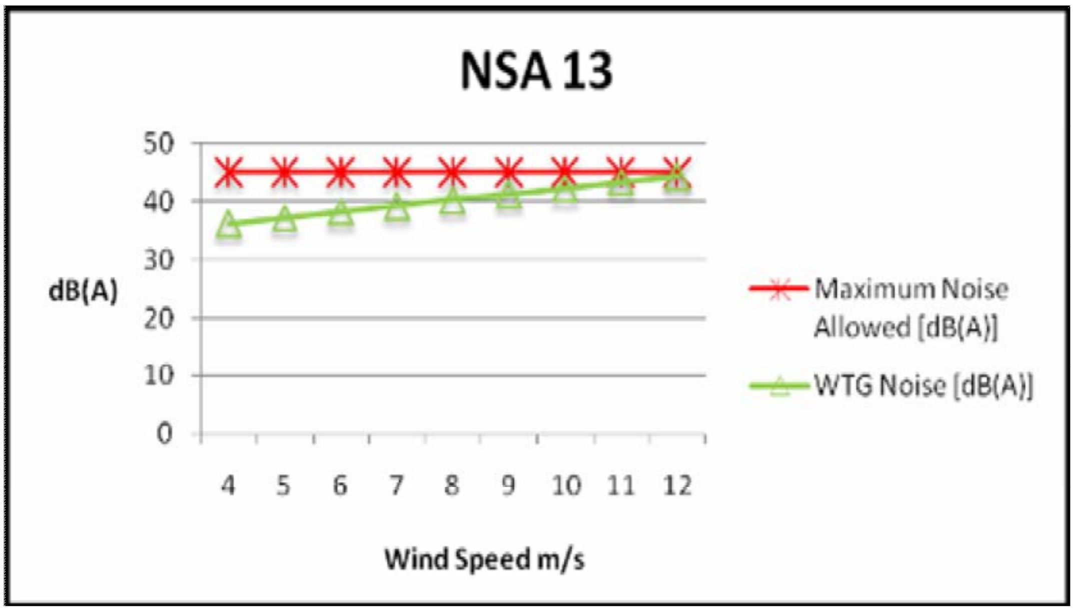

Figure 7-24: NSA 13 Results Abandoned Building

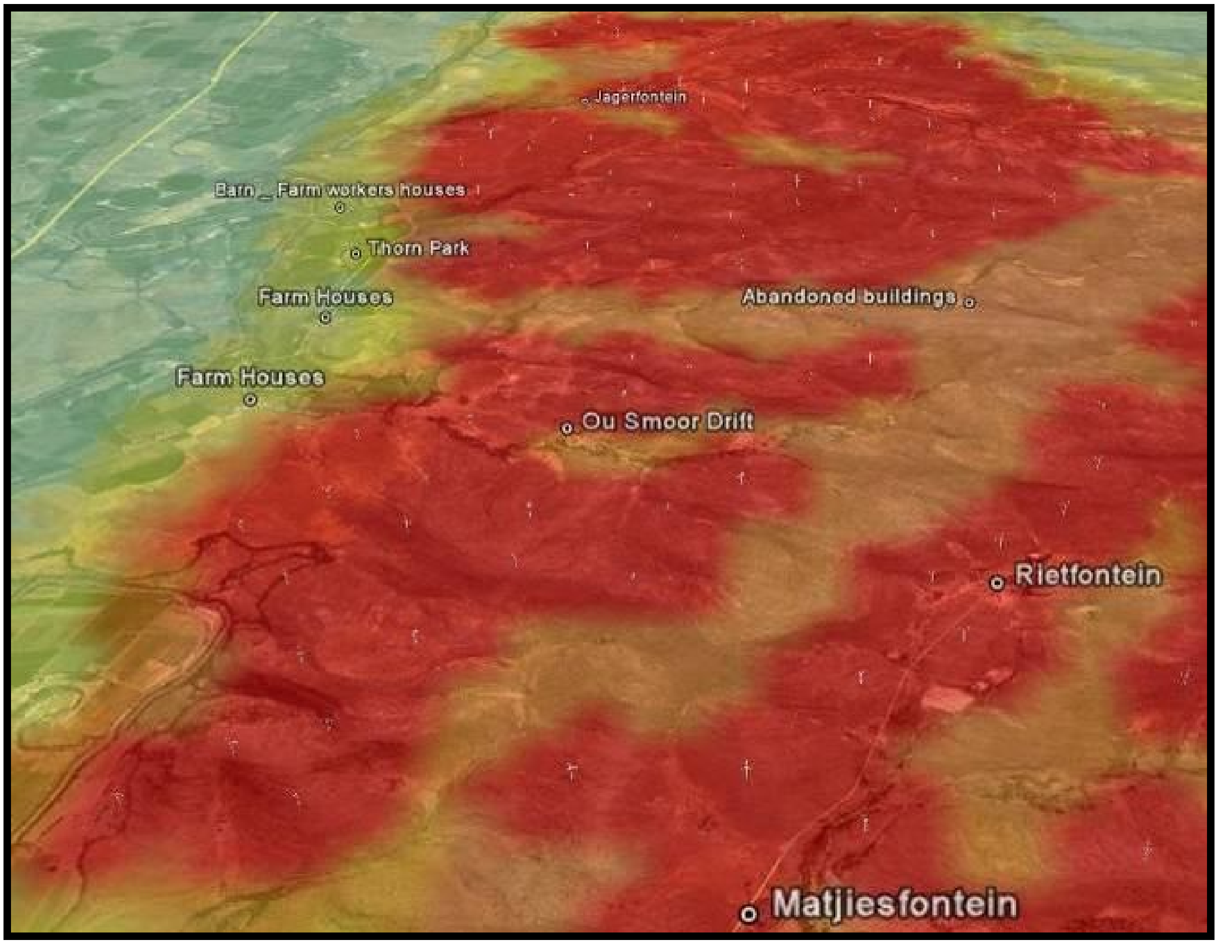

Figure 7-25: Raster Image of Isopleths & NSA's (Image1)

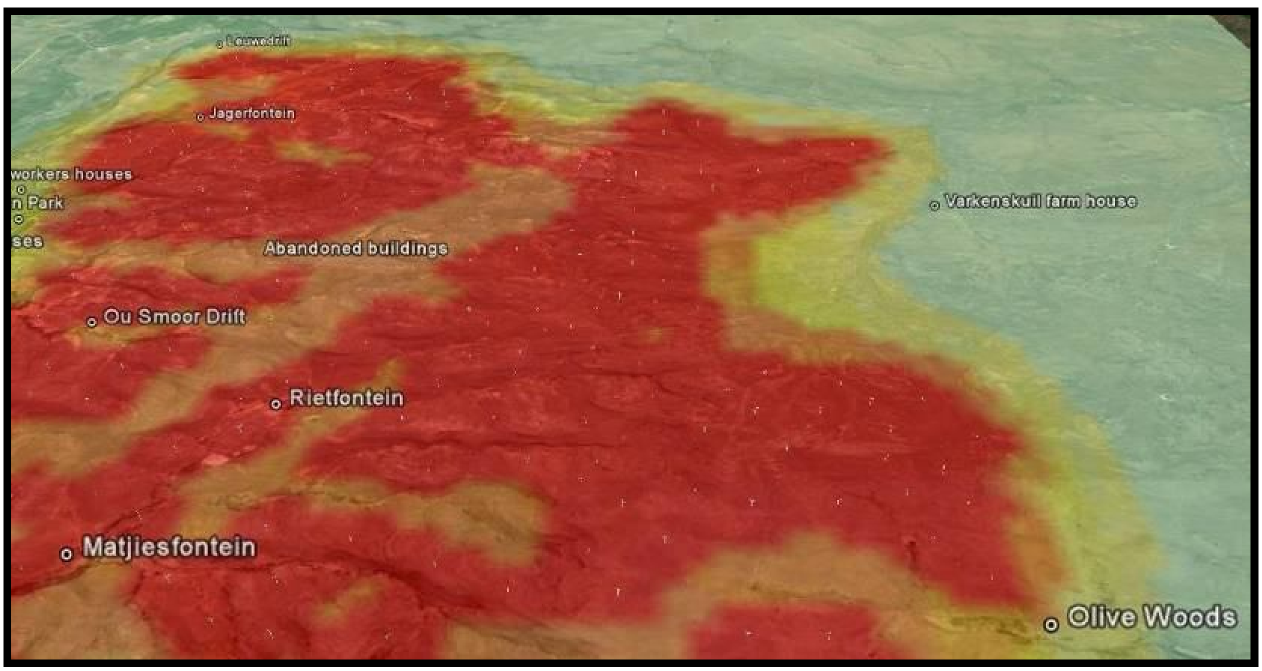

Figure 7-26: Raster Image of Isopleths & NSA's (Image2)

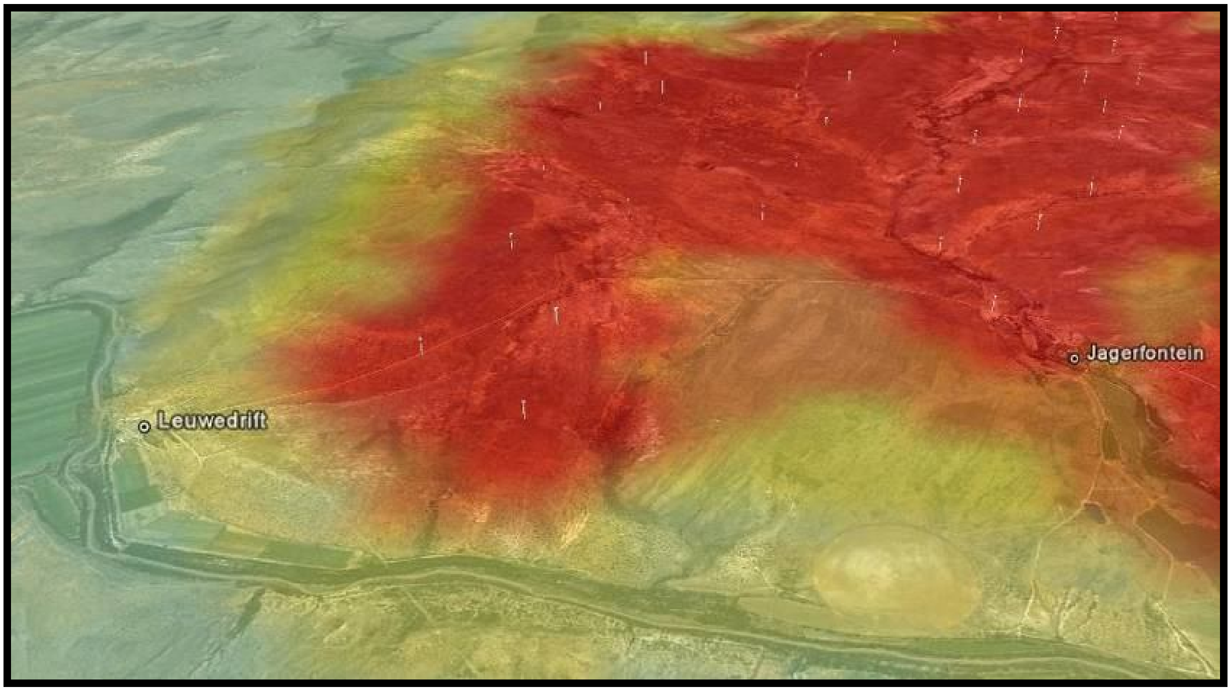

Figure 7-27: Raster Image of Isopleths & NSA's (Image 3)

7.8 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. Under very stable atmospheric conditions, a temperature inversion or a light wind the turbines will not be operational as the cut-in speed is 4m/s. As the wind speed increases above the cut-in speed the ambient noise will also increase.

Operational Phase

Table 7-25: Summary of Noise Impacts on Various Receptors

Wind Speed	NSA 1	NSA 2*	NSA 3*	NSA 4*	NSA 5	NSA 6*	NSA 7	NSA 8	NSA 9	NSA 10	NSA 11	NSA 12	NSA 13
4m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5m/s	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	✓
6m/s	✓	✓	✓	X	✓	X	✓	✓	✓	✓	✓	✓	✓
7m/s	✓	✓	✓	X	✓	X	✓	✓	✓	✓	✓	✓	✓
8m/s	✓	✓	✓	X	✓	X	✓	✓	✓	✓	✓	✓	✓
9m/s	✓	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓
10m/s	✓	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓
12m/s	✓	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓
12m/s	✓	X	X	X	✓	X	✓	✓	✓	✓	✓	✓	✓

NSA = Noise Sensitive Area
✓ = Within Recommended Noise Limit
X = Exceeds 45dB (A) Recommended Limit
* = Turbines to Close to Noise Sensitive Area

The results for of the modelling were found to be unacceptable at four noise sensitive areas as the impacts would result in a noise level exceeding 45 dB(A), which is regarded as the ambient noise limit. The affected areas are:

- Ou Smoor Drift Farm House (NSA 2) – The wind turbine generator is too close to the dwelling (WTG 117 – 462m). This is resulting in the noise exceeding the recommended limit from 9m/s.
- Matjesfontein Farm House (NSA 3) – The wind turbine generator is too close to the dwelling (WTG 190 – 385m). This is resulting in the noise exceeding the recommended limit from 9m/s.
- Jagersfontein Farm House (NSA 4) – The wind turbine generator is too close to the dwelling (WTG 19 – 269m). This is resulting in the noise exceeding the recommended limit from 6m/s.
- Rietfontein Farm House (NSA 6) – The wind turbine generator is too close to the dwelling (WTG 147 – 245m). This is resulting in the noise exceeding the recommended limit from 5m/s.

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 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 disturbing noise, albeit for a short period of time.

The noise impact assessment tables are presented below:

Table 7-26: Noise Impact Rating – 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 1,5, 7,8,9,10,11,12 & 13)	Negative	Long Term (3)	Local (1)	Slight (1)	May Occur (2)	**Low (7)**
Impact of the operational noise on the surrounding environment (NSA 2,3,4 & 6)	Negative	Long Term (3)	Local (1)	Severe (4)	Definite (4)	**High (12)**

Table 7-27: Noise Impact Rating – 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 2,3,4 & 6) **Mitigation:** Move WTG 117,190,19 & 147 further than 500m from a NSA	Negative	Long Term (3)	Local (1)	Slight (1)	May Occur (2)	**Low (7)**

7.9 Conclusions and Recommendations

The results of the noise specialist study indicate that the following conclusions can be drawn:

The results of the study indicate that the following conclusions can be drawn:

- 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 difficult to mitigate.
- The noise level at four noise sensitive areas during the operational phase is unacceptable.
- The impact of low frequency noise and infra sound will be negligible as 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 (i.e. are well below 90 dB) to cause physiological effects.

The following mitigation measures are recommended:

7.9.1 Construction Activities

- All construction operations should only occur during daylight hours if possible.
- 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.
- Construction staff should be given "noise sensitivity" training in order to mitigate the noise impacts caused during construction.

7.9.2 Operational Activities

The following recommendations are made for the operational phase:

- WTG 117 should be moved to distance exceeding 500m from Ou Smoor Drift Farm House.
- WTG 190 should be moved to distance exceeding 500m from Matjesfontein Farm House.
- WTG 19 should be moved to distance exceeding 500m from Jagersfontein Farm House.
- WTG 147 should be moved to distance exceeding 500m from Rietfontein Farm House.

7.9.3 No-Go Option

The no-go option of *not* proceeding with the project is not recommended for the following reasons:

- The noise impacts associated with the project can be mitigated by applying set back distances as well relocating turbines, albeit that they may be in less efficient locations for electricity generation.

- There are a number of the farm owners whose property the turbines are on and who are enthusiastic about contributing to the environment in a positive way.
- The economic and environmental benefits of the project outweigh the cost of mitigation measure that are needed to ensure that the sensitive noise receptors are not adversely affected.

8 HERITAGE SPECIALIST REPORT

Prepared by:	Prepared for:	On behalf of:
ACO Associates CC	**Coastal & Environmental Services**	**Terra Power Solutions (Pty) Ltd**
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South Africa	South Africa	South Africa

<u>**This report should be cited as**</u>:

Hart, TJG and Webley, LE. 2010 ACO Associates, June 2010. *Proposed Terra Wind Energy Golden Valley Project, Blue Crane Route Local Municipality: Heritage Impact Assessment, ACO Associates*, Cape Town

8.1 Introduction

Coastal and Environmental Services (CES) in Grahamstown on behalf of Terra Power Solutions (Pty) Limited requested that ACO Associates cc conduct a Phase 1 Archaeological Impact Assessment for the proposed Terra Wind Energy Golden Valley Project.

The aim of this specialist study is to locate and map archaeological heritage sites and remains that may be negatively impacted by the planning, construction and implementation of the proposed project, to assess the significance of the potential impacts and to propose measures to mitigate against the impacts.

The extent of the proposed development (>12ha) falls within the requirements for an archaeological impact assessment as required by Section 38 of the South African Heritage Resources Act (No. 25 of 1999).

8.1.1 Terms of Reference

The terms of reference for the archaeological heritage study were to:

- Determine the likelihood of archaeological remains of significance in the proposed site(s);
- Identify and map (where applicable) the location of any significant archaeological remains;
- Assess the sensitivity and significance of archaeological remains in the site(s); and
- Identify mitigatory measures to protect and maintain any valuable archaeological sites and remains that may exist within the proposed site(s).

8.2 Study Approach

The extent of the proposed development falls within the requirements for an archaeological impact assessment as required by Section 38 of the South African Heritage Resources Act (No. 25 of 1999).

8.2.1 Relevant legislation, Policies and guidelines

The basis for all heritage impact assessment is the National Heritage Resources Act (NHRA) 25 of 1999, which in turn prescribes the manner in which heritage is assessed and managed

Loosely defined, *heritage is that which is inherited*. The National Heritage Resources Act 25 of 1999 has defined certain kinds of heritage as being worthy of protection, by either specific or general protection mechanisms. In South Africa the law is directed towards the protection of human made heritage, although places and objects of scientific importance are covered. The National Heritage Resources Act also protects intangible heritage such as traditional activities, oral histories and places where significant events happened. Generally protected heritage which must be considered in any heritage assessment includes:

- Cultural landscapes and intangible heritage associated with them
- Buildings and structures (greater than 60 years of age)
- Archaeological sites (greater than 100 years of age)
- Palaeontological sites and specimens
- Shipwrecks and aircraft wrecks
- Graves and grave yards.

Section 38 of the NHRA requires that Heritage Impact Assessments (HIA's) are required for certain kinds of development such as rezoning of land greater than 10 000 sq m in extent or exceeding 3 or more sub-divisions, or for any activity that will alter the character or landscape of a site greater than 5000 sq m. "Standalone HIA's" are not required where an EIA is carried out as long as the EIA contains an adequate HIA component that fulfils Section 38 provisions.

The Eastern Cape Provincial Heritage Authority is responsible for the management and protection of all provincial heritage sites (grade 2), built environment and structures (grade 3a-grade 3c) in the Eastern Cape. SAHRA Archaeology Unit based in Cape Town is responsible for the management of all archaeological and palaoentological sites in the Eastern Cape. In terms of this particular project both the Eastern Cape Heritage Authority and SAHRA are important commenting authorities but are not responsible for final compliance as this study forms part of an EIA process for which the Department of Environment Affairs and Development Planning is the compliance authority (in terms of section 38.10 of the National Heritage Resources Act).

Wind energy policy and heritage: A pilot study commissioned by the Provincial Government of the Western Cape "Towards a Regional Methodology for Wind Energy Site Selection in the West Coast region" (May 2006) is the only locally available policy guideline. The study considered landscape character rather than the "cultural landscape or heritage" but they concluded that wind energy facilities can have a profound impact on the surrounding landscape in terms of the natural qualities of places. In terms of landscapes and heritage, there are no pro-active detailed local regional studies that can be consulted, however the Western Cape pilot study recognizes that severe impacts can occur and suggests a buffer zone of 500 m from heritage sites. Neither SAHRA nor any other heritage compliance organization has developed a specific policy with respect to heritage and renewable energy, although the issue has received considerable attention in European countries (Joberta Laborgneb and Mimberg 2007, Clark 2009)

8.2.2 Methodology

8.2.2.1. Desktop study

A review of available information was carried out which is based on mainly published sources. This office has also been involved in two other similar assessments in the immediate area which have provided valuable insights into the distribution of archaeological sites in this previously un-described site (Hart and Webley 2008, Halkett and Webley 2009).

8.2.2.2. Ground survey

A physical survey of the study area was completed involved travelling to the site and spending 5 days travelling to as many different landscapes within the study area as possible (May 27 – June 1).

Data collection took place mainly during the physical site inspection. This involved making contact with landowners in the area who were asked about the possible whereabouts of heritage on their property (old buildings, cemeteries, settlement, San (bushman) rock paintings and archaeological sites). The proposed locations of as many turbines as possible were inspected on foot, large areas of landscape were traversed and every accessible track was driven with an off-road vehicle.

Farm buildings were visited and assessed for heritage significance; archaeological sites were recorded, mapped and photographed. Each team member was equipped with a Garmin GPSmap C60cxs gps unit loaded with 1:50 000 topographic maps of the area. No archaeological material was removed from the study area, but recorded and photographed *in situ*.

8.2.2.3. Data Analysis

Data analysis involving mainly the assessment of the spatial distribution of archaeological sites on the landscape to determine which areas held the highest potential for heritage material. Indications are that strong trends exist in the study area. The analysis of archaeological material on individual sites is based upon the experience of the team members who are familiar with the standard classification systems for artefactual material in use to the degree that they can roughly date and characterise an archaeological site based on its content. Built environment is considered in terms of the grading system for structures that is presently employed by a number of SAHRA offices and some provincial compliance offices.

8.2.2.4. Assumptions and Limitations

The physical survey of the study area proved difficult. Much time was spent finding landowners and negotiating access to property. Organised hunting had been scheduled on certain land portions which meant that less time was spent in certain areas than was desirable. The proposal is for some 214 wind turbines. While ideally each turbine site should have been inspected, this was not possible due to the considerable amount of time it took to reach many of the localities which were very remote (if one hour was dedicated to each locality, the study would require 3 weeks of survey time). Locked gates, jackal and kudu fences all contributed to the physical difficulty of the work.

The proposed locations of turbines provided by the proponent are preliminary and not field-tested. It is highly likely that turbine positions will change through the course of the proposed project.
The proposed turbine localities will each require an access road. Given the rugged topography of the study area, this will involve considerable road works to create gradient suitable for transportation of abnormal loads. No information with respect to proposed roads was provided by the proponent, which meant that a potential source of significant impact in heritage terms could not be fully assessed for the purposes of this EIA.

Given the low level of detail at this stage of the project, the ACO team focussed on carrying out a general survey of the study area focussing on determining the general density of heritage/archaeological occurrences and the relative sensitivity of the range of topography.

8.2.3 Description of the Heritage Concept

8.2.3.1. Pre-colonial heritage

The pre-colonial heritage of the study area has not been academically described, although there are anecdotal references to finds of stone artefacts in the area. Albany Museum, which is the official repository of all site record forms and archaeological information in the Eastern Cape has no records from the area at all (J. Binneman pers comm.). This however is not an indication that there is no pre-colonial heritage in the area, but rather refers to the fact that no studies have taken place. Areas of the Great Karoo (the catchment of the Zeekoe Valley) have been subject to a lifetime of study by Prof Garth Sampson of Southern Methodist University (Sampson 1992) and his various post-graduate students with the result that there is a comprehensive body of information which we may "borrow from" in terms of predicting the pre-colonial sensitivity of the area.

It is anticipated that the study area will contain artefactual material dating to the Early Stone Age and Middle Stone Age of the Pleistocene epoch (*3 million – 20 000 years ago)*. This material is often noted in eroded areas, or on terraces in river valleys. Under very rare circumstances it is found in undisturbed contexts in association with fossil bone. Such sites enjoy massively high status in research terms as they have the potential to produce significant information about early human behaviour.

Later Stone Age sites attributable to the ancestors of the San people and Khoekhoen pastoralists (after 2000 years ago) are a certainty within the study area. The San frequented the Karoo and the coastal plains before 2000 years ago. Their legacy includes numerous open sites while traces of their presence can be found in most large rock shelters, often in the form of rock art. They frequently settled a short distance from permanent water sources (springs or waterholes) and made use of natural shelters such as rock outcrops or large boulders. In the Great Karoo natural elevated features such as dolerite dykes and ridges played a significant role in San settlement patterns. The introduction of pastoralism (sheep and goats, later cattle) roughly 2000 years along with the arrival of the Khoekhoen was a significant event that broke the ancient tradition of hunting and gathering that had been the method of human subsistence for thousands of years. Before colonisation of the Eastern Cape by the British in the early 19th century, Khoekhoen herders formed powerful transhumant communities (herding cattle and sheep) throughout the coastal plain and from time to time into the Great Karoo (Hart 1987). They enjoyed dominance as far as the Great Fish

River where they shared a loose border with farming communities (Xhosa's) to the East. The San retreated to the Great Karoo where although they were subject to periodic incursions of the Khoekhoen they continued their traditional hunting and gathering existence. The arrival of *Trekboer* farmers in the mid-18th century started what has come to be known as the "Bushman War" which continued for almost 60 years. Eventually the *kommandos* which were dispatched from regional centers such as Graaf Reinet prevailed, and the "wild bushman" of the karoo were rendered extinct by the early 19th century (Hart 1987).

Prior to the arrival of Europeans, the Fish River was a loose divider between large Khoekhoen groups who followed a mainly pastoralist lifestyle on the coastal plains, and the most easterly of the Xhosa communities who practiced settled agriculture in the summer rainfall areas. While the history of the interaction between the Khoekhoen and the Xhosa's was never committed to paper, linguistic borrowings and Khoekhoen name places (which extend into the Ciskei) attest to a long history of interaction. Even before European settlers arrived, the Fish River formed a divide between two groups of people – one practicing transhumant pastoralism (Khoekhoen) and the Xhosa who practiced settled agriculture.

European farmers (*Trekboere*) were the vanguard of formal colonisation and accelerated granting of land by the British Colonial Government. It is interesting to note that most of the farms that make up the study area were granted to Dutch speaking farmers between 1820 and 1825. The implication of this is that the farmers (who were probably *trekboers*) had by that time already informally occupied the land, the deeds of which were made official by the British Colonial Government. Land which was viewed as a shared resource by the Khoekhoen was no longer available to them. The Fish River became a frontier zone between the colony of the Cape Province and the Xhosa nation, who for much of the 19th century did their utmost to drive out the settlers. Coetzee (undated) has documented more than a hundred small forts, outposts and fortified farms which are testimony to the years of attrition that took place on the Fish River frontier.

8.2.3.2. The colonial period

Skead (2007) calls this zone the sub-coastal interior, and it includes the districts of Somerset East, Bedford, Adelaide and Fort Beaufort. In the past this area was traversed by a number of early European travellers who described what they saw. The historic road seems to have followed quite closely the route of the railway line or the N10 but meandered more towards Somerset East rather than Cookhouse after breaking into the Karoo at Kommadaggaskop. The landscape is described by Skead as having been open Karoo veld in parts, but mostly vast plains of sweet grassland. Early travelers noted the presence of large games animals on the coastal plains, as well as hippos in the Fish River. Very little comment was made on the human inhabitants of the area. In these game rich areas, claims Skead, the Xhosa had not settled in strength. They had infiltrated as wandering hunters in an advance guard of future occupation and permanent residence by a population moving westwards under pressure from the already settled areas behind them. Here they encountered eastward-moving Whites. The confrontation between the Eastward moving Europeans and the Xhosa is well reflected in history (Mostert 1992).

Cookhouse, however seems to have played a minor role in those early years seldom receiving mention. The area derived its name from an early British military camp kitchen, however indication are that little physical evidence exists today. The closest and oldest military post close to the study area was a small fortified outpost known as the Kaka Post that was built at the foot of the Kaka Berg just to the west of the town of Bedford. Built in 1824 on Landrost Stockenstrom's farm "Maasstrom" it appears that very little of the outpost has survived (Coetzee undated). The study area itself does not appear to have played any significant roles in the region, however settlement of the area took place largely in the 19th century.

8.2.4 Results and Discussion

None of the sites described below are will be directly impacted by the proposed activity in terms of the information that has been provided.

The heritage survey revealed that the heritage of the study area is characterised byarchaeological sites spanning the Early, Middle and Late stone ages. The position of the finds are indicated on figure 8-1. Also see Appendix E-1 for a summary of archaeological observations.

Early Stone Age material was located at a single locality.

1) A scatter of early Early Stone age material situated on the lower slopes of the hilltop referred to “Onder Smoorsdrift” on the farm Bygevoegt 164 (plates 8-1 and 8-2). The site which contains fine examples of Achaeulian bifaces, regular and irregular cores is (moderately) scattered over a wide but definable area on a gentle gradient above a river. The site is significant in that it is the only example of its kind found in the study area so far. Suggested grade: Locally significant 3b.

Middle Stone Age material was found thinly scattered throughout the study area, however definable archaeological sites could not be easily identified. The material may be described as “ancient litter” containing occasional flakes and blades. Like the Late Stone Age material it is more common on alluvial fans around dongas, sandy flat area and is even occasionally seen on remote hilltops and steep slopes. Relatively dense scatters were identified:

2) An eroded scatter of MSA material, mostly informal flakes, blades and large cores made from *hornfels* on a valley bottom cut through by a deep donga. This is one of very few instances where MSA material is noticeably denser than anywhere else. Suggested grade: low local significance grade 3c.
3) An eroded scatter of mostly MSA material found along the banks of a shallow stream bed (plate 8-3).
4) MSA material thinly associated with a dammed donga on the farm Olivewoods (plate 8-4).

	
Plate 8-1: This gently sloping area on Bygevoegd 164 in the Fish River Valley contains the only ESA site found in the study area	**Plate 8-2: ESA bifaces found on a large ESA site on a gently sloping hill side**
	
Plate 8-3: Site 3. A stream bed in a sandy valley where a mixed scatter of mostly MSA material was noted.	**Plate 8-4: Site 4. MSA cores found in an eroded valley on farm Olivewoods**

Late Stone Age material was limited to two recorded occurrences (see figure 8-2)

5) A scatter of ceramics strewn over along the edges of an erosion gully which has cut into an alluvial fan (Farm Great Drift 173). The site is unusual as only ceramics in the style of Cape Coastal Pottery and a stone cairn were noted (plates 8-5 and 8-6) Pottery of this kind is associated with the period after 2000 years ago when pre-historic pastoralists entered the Cape bringing with them domestic stock and the knowledge of working clay into pottery. Suggested grade locally significant 3b.
6) A large assortment of informal artefacts scattered widely over a large alluvial fan area on the farm Bijgevoegd 164 (plates 8-7 and 8-8). The site which lies on sandy land is cut through by a very large erosion gulley. The presence of up to 20 upper and lower grinding stones is a possible indication that there may be prehistoric graves here as such artefacts were used as grave markers or ornaments. No human remains were noted at the time of inspection. The raw material used was *Hornfels* and *Siltstone*. Suggested grade: moderately locally significant 3b.

	
Plate 8-5: Site 5 Stone cairn found close to LSA ceramic period site.	**Plate 8-6: Site 5 Eroded landscape on valley bottoms and alluvial fans contain the most archaeological material**
	
Plate 8-7: Site 6. is situated on an alluvial fan cut through by a deep erosion gully. The site abounds with informal artefacts and may grinding surfaces.	**Plate 8-8: Site 6. An example of the many grindstones found on a large eroded alluvial fan**

Historical archaeology: A single occurrence was recorded.

There is a single disused set of farm buildings situated at Groot Rietfontein. The farm house which was originally a rectangular cottage built from home-made bricks and mud mortar. Apart from one end-wall (plate 8-9), it has collapsed completely. Indications are that the structure is of late 19th century origin judging by the proportions of the last remaining window opening. Other features of the site are a corrugated outbuilding, stone wire kraal as well as various enclosures. There is a wind pump and a corrugated iron out-building. No historical artefactual material greater than 100 years of age was noted.

General Built environment

Farm Houses and buildings (within the study area were inspected for their heritage significance. While almost every farm house has elements which are greater than 60 years of age, none of them may be considered particularly unique or typical of their type. Virtually all of them have late 19th or early 20th century origins; however they are lived-in working homes with the inevitable result that they have been considerably altered. Characteristically the main houses take on the form of rectangular bungalows with large front *stoeps*. In almost every instances the curvilinear *stoep* roofs and cast iron work has been removed and replaced with modern brick and glass (winter weather in the area can be bracing). Prevailing security concerns have also taken their toll on the exterior of structures. None of the buildings are worth more than a 3b-c grading (in terms of SAHRA's criteria). It was noted that many of the out buildings and kraals associated with the farms are carefully executed stone structures and are aesthetically pleasing. In particular reference is made to *Olywenfontein* situated at a road junction where its stone kraals and buildings are an important "place maker" (plate 8-10). Farm grave yards were noted at *Olywenfontein* and *The Olives* (plates 8-11 and 8-12) which also has a spectacular arrangement of stone kraals.

Cultural landscape

The cultural landscape qualities of the study area are difficult to define in that the area is typically a mixed agricultural area that was first farmed after 1820. For obvious reasons human settlement has focussed mainly on the flood plains of the Great Fish River on the edge of the study area. The canal provides farms with permanent water and the ability to irrigate pastureland and cultivate various crops. Away from the river within the study area, the scenario is different. The land is used for stock grazing only, hence each farm is divided into large camps, which apart from a few tracks and wind pumps has strong wilderness qualities. The environment however is not pristine. There are dense stands of invasive cactus in places, while the valley bushveld has in effect been sculpted by human hand in that lands have been cleared from grazing over the years. The cultural landscape qualities of the place cannot be defined geographically within the study area apart from the fact the area consists of a mosaic of farms incorporating in part relict patches of natural/prehistoric landscape together later layers of cultivation along the rivers and open grazing lands on the more gently sloping inclines. It is a typical slice of the Bedford – Cookhouse – Somerset east area.

Plate 8-9: Site 7. The last remaining wall of the farm "Rietfontein".

Plate 8-10: Early 20th century home: Olyvenfontein

Plate 8-11: Stone kraal complex at Olive Woods

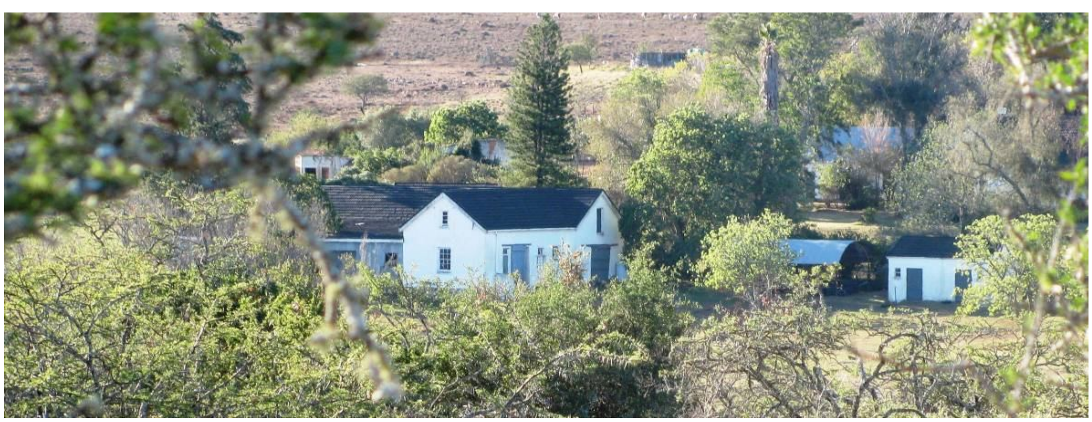

Plate 8-12: Olive Woods farm house, late 19th – early 20th century.

Plate 8-13: Hills and bushy thicket typical of the western side of the proposed site.

Plate 8-14: Rolling grasslands on the eastern side of the study area

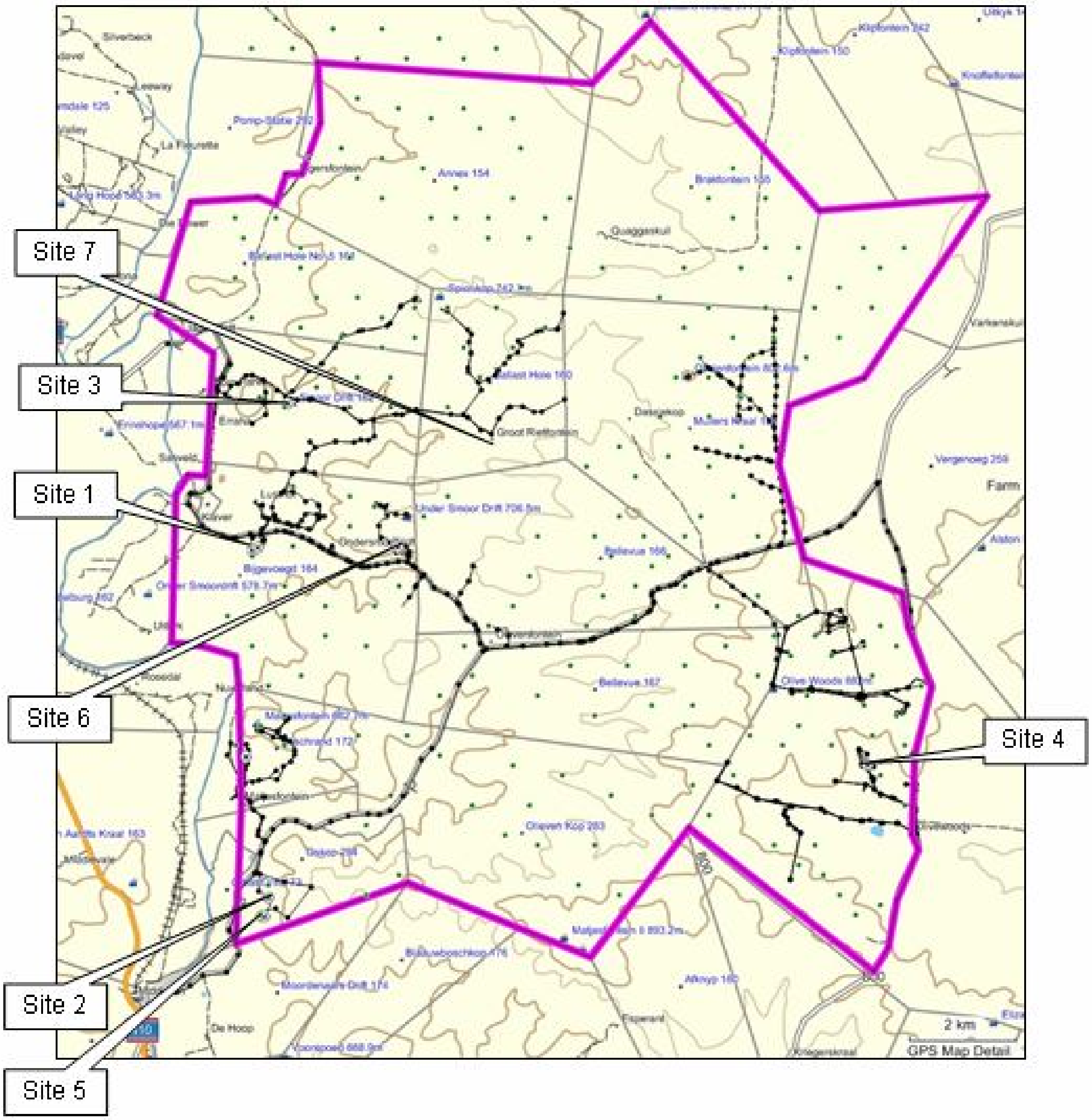

Figure 8-1: Locations of archaeological sites identified in the study area. Track logs are indicated by dark dotted lines.

8.3 Impact Assessment

8.3.1 Construction phase

8.3.1.1. Impact on Heritage Resources

Cause and Comment

Wind energy facilities are big developments that can produce a wide range of impacts that will affect the heritage qualities of an area. Typically each turbine can be up to 100m high with blades/rotors up to 50m in radius. Each turbine site needs road access that can be negotiated by a heavy lift crane(s) which means that in undulating topography (such as in the study area) deep cuttings and contoured roads will have to be cut into the landscape to create workable gradients.

During the construction phase each of the turbine sites will have to be leveled off to create a solid platform for cranes as well as a lay-down area for materials. This will involve earthmoving and road construction, followed by the bringing in of materials and plant. The actual construction of the turbines will involve excavation into the land surface to a depth of 3m and over an area of $400m^2$ for the concrete base. The pre-fabricated steel tower is bolted on to the base and erected in segments. The nacelle containing the generator is finally attached followed by the rotors. The turbines are connected to underground cables to sub-station (positioned to be determined) where after the generated current will be fed to the nearby Poseidon substation via a 132kV transmission line.

Option 1 – Construction of the wind farm.

During the construction phase the following physical impacts to the landscape and any heritage that lies on it can be expected:

- Bulldozing of roads to turbines sites with a possibility of cut and fill operations in places.
- Upgrading of existing farm tracks
- Creation of working and lay-down areas close to each turbine site
- Excavation of foundations for each tower
- Excavation of many kilometers of linear trenches for cables
- Erection of a 132 kV power line (pole design or route not finalised)
- Construction of electrical infra-structure in the form of one or more sub-stations.

In terms of impacts to heritage, archaeological sites which are highly context sensitive are most vulnerable to the alteration of the land surface. The survey undertaken to inform this assessment has revealed that archaeological sites are very sparse on the landscape which is consistent with earlier work carried out on another proposed wind farm in the area (Halkett and Webley 2009). This means that generally the impacts to archaeological heritage are likely to be of low significance. The clear patterning of archaeological sites in valley bottoms and alluvial plains contrasts with the requirement to erect wind turbines in windy exposed areas such as ridge tops and hill slopes which is in itself a factor that is likely to mitigate damage.

Mitigation and Management

The best way to manage impacts to archaeological material is to avoid impacting them. This means micro-adjusting turbine positions where feasible, or routing access roads around sensitive areas. If primary avoidance of the heritage resource is not possible some degree of mitigation can be achieved by systematically removing the archaeological material form the landscape. This is generally considered a second best approach as the process that has to be used is exacting and time-consuming, and therefore expensive. Furthermore the NHRA requires that archaeological material is stored indefinitely which has cost implications and places an undue burden on the limited museum storage space available in the province.

Although indications are that impacts to archaeological material are likely to be of low significance, it must be noted that it has not been possible to assess the potential impacts of road construction on archaeological sites. Furthermore, turbine positions provided are preliminary.It is recommended that the following mitigation measures are implemented:

- Existing farm tracks must be re-used or upgraded to minimise the amount of change to un-transformed landscape.
- In general terms, construction of turbines and roads in valley bottoms should be kept to a minimum.
- During the detailed planning phase, drawings of proposed road alignments, infrastructure and near-final turbine positions should be submitted to an archaeologist for review and field-proofing. Micro-adjustment of alignments and turbine positions is likeley to be sufficient to achieve adequate mitigation.

Significance Statement
The significance of impacts during the construction phase to physical heritage such as archaeological material and built environment is likely to be low as the landscape contains a sparse distribution of sites.

The no-go alternative. Not implementing the proposal will result in no impacts to heritage, apart from those impacts caused by natural forces such as erosion**.**

Impact	Effect								Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact		Risk or Likelihood			
OPTION 1										
Without Mitigation	Permanent	4	Local	1	Moderate negative	2	May Occur	2	**9**	**Moderate**
With Mitigation	Short	1	Local	1	Slight	1	Slight	1	**4**	**Low**
NO-GO OPTION										
Without Mitigation	No impact								**0**	
With Mitigation	No Impact								**0**	

8.3.2 Operational Phase

Option 1 – Operation of the wind farm

During the operational life of the wind farm, it is expected that physical impacts to heritage will diminish or cease. Impacts to intangible heritage are expected to occur. Such impacts relate to changes to the feel, atmosphere and identity of a place or landscape. Such changes are evoked by visual intrusion, noise, changes in land use and population density. In the case of this project, impacts to remote and rural landscape and wilderness qualities are of concern.

The point at which a wind turbine may be perceived as being “intrusive” from a given visual reference point is a subjective judgment, however it can be anticipated that the presence of such facilities close to (for example) wilderness and heritage areas will destroy many of the intangible and aesthetic qualities for which an area is valued. The characteristics of wind turbines that invoke these impacts are listed below.

- Due to the size of the turbines the visual impacts are largely immitigable (they are easily visible from 10 km) in virtually all landscapes (personal observations), however indications are (PGWC 2006) that they are perceived to aesthetically/artistically more acceptable in agricultural or manicured landscapes.
- Shadow flicker – an impact particular to wind turbines is very large moving shadows created by the giant blades when the sun is low on the horizon. Such shadows can extend a considerable distance from the turbine. Continuous shadow flicker will have a serious impact on the sense of place of a heritage site.
- Visual impact of road cuttings into the sides of slopes will affect the cultural, natural and wilderness qualities of the area.
- Residual impacts can occur after the cessation of operations. The large concrete base will remain buried in the ground indefinitely. Bankruptcy of, or neglect by a wind energy company can result in turbines standing derelict for years creating a long term eyesore.

Mitigation and Management

The amount size and placement of turbines will influence the degree to which they impact on the intangible qualities of an area. Mitigation of visual impacts is not feasible; however some measures can be taken to avoid impacts to the farm houses and their surrounds. Almost all the farm houses in the study area rest with the general protections of the NHRA and therefore the act applies to the aesthetic and intangible elements of each structure that is more than 60 years old.

It is recommended that the following mitigation measures are implemented.

- Turbines must be positioned in such a way that they are at least 500m away from farm complexes.
- Turbines must be positioned in such a way that shadow flicker does not affect any farm complexes.
- Road alignments must be planned in such a way that the minimum of cut and fill operations are required.
- Guarantees for demolition of turbines after their useful life must be in place as a condition of approval.

Significance Statement

Implementation of the proposed activity will change the character of the study area and its surrounds. This is specially the case in terms of accumulative impacts given the fact the together with two similar proposals adjacent to the study area, which if authorized will create one of the biggest clusters of wind farms in the world (http://en.wikipedia.org/wiki/List_of_large_wind_farms). This change is likely to have a knock-on effect in terms of changes to the identity and associations of the towns of Bedford and Cookhouse. The rural and wilderness qualities of the study area will change for the long term and take on a more industrial character in places. It is predicted that at first the presence of the wind turbines will be perceived as a novelty and evoke some interest in the area, however as this kind of industry gains pace in South Africa, the novelty value will fall away and the perceived visual impacts will increase.

In summary the way the landscape looks will change, its wilderness qualities will diminish. Given that there are no heritage sites on the landscape that are of any particular importance, the overall impact to cultural landscape is moderate. The impact on wilderness qualities of the site will be high, however the natural element of cultural heritage is only protected under the NHRA if it can be associated with an area of exceptional biodiversity in terms of the definition of cultural significance.

The no-go alternative. Not implementing the proposal will result in no impacts to heritage, apart from those impacts caused by natural forces such as erosion.

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
OPTION 1										
Without Mitigation	Permanent	4	Study area	2	High	4	Definite	4	**14**	**High**
With Mitigation	Permanent	4	Study area	2	Moderate	3	Probable	3	**14**	**High**
NO-GO OPTION										
Without Mitigation	No Impact								**0**	
With Mitigation	No Impact								**0**	

8.4 Comparison of alternatives

Given the energy crisis faced by South Africa and the nation's restricted options in terms of conventional generating capacity, the proposal is likely to have social and economic benefits. There will be a sacrifice to be made in terms of landscape heritage as wind farms are visually "greedy" and require vast tracks of land to create a facility capable of producing significant power. Exercising of the no-go option will not have any immediate affects on heritage apart from the usual process of incremental change to buildings by their owners, the gradual alteration of landscape by farming activities and the natural erosion or burial of archaeological sites by wind or water. The impacts on heritage that have been identified in this study are not sufficient to warrant exercising of the no-go option.

8.5 Conclusion and Recommendations

While wind farms certainly represent clean energy which much needed in South Africa, they are not without impacts that are particular to this form of development. In heritage terms these relate to the size of the turbines and the requirement for massive expanses of landscape. Under most circumstances it would be unthinkable to erect a 25 story tower block (let alone hundreds of them) in a natural area, yet all round the world the wind energy industry has been successful at gaining the acceptance of individuals and authorities alike. Unfortunately this form of development is gathering significant momentum in South Africa before such time that the nation has developed adequate baseline information or adequate policy for the protection of its landscapes.

While this report can offer no abjection to the proposed activity that is under consideration on heritage grounds, the accumulative impact on wind farms on the "South African Experience" are perhaps is perhaps greater than the impact of individual facilities. South Africa is internationally known for its scenic landscapes, its wilderness qualities and vast horizons. This national identity is one of the nation's greatest heritage assets, tourism draw-cards and as such is reflected in the National Anthem. Wind farms proliferating across the South African landscape is a direct threat to these almost intangible qualities.

Given that this study has taken place prior to the development of a draft layout for the wind farm infrastructure, the impacts that we have identified are of a general nature, which means that it will be necessary to review further information as it becomes available so that where necessary, archaeological sites can be mitigated. The following recommendations are offered.

- Turbines must be positioned in such a way that they are at least 500m away from farm complexes, most of which have a moderate degree of heritage significance.
- Turbines must be positioned in such a way that shadow flicker does not affect any farm complexes.
- Guarantees for demolition of turbines after their useful life must be in place as a condition of approval.
- Road alignments must be planned in such a way that the minimum of cut and fill operations are required.
- Existing farm tracks must be re-used or upgraded to minimise the amount of change to un-transformed landscape.
- In general terms, construction of turbines and roads in valley bottoms should be kept to a minimum.
- During the detailed planning phase, drawings of proposed road alignments, infrastructure and near-final turbine positions should be submitted to an archaeologist for review and field-proofing. Micro-adjustment of alignments and turbine positions is likely to be sufficient to achieve adequate mitigation.

9 PALAEONTOLOGICAL SPECIALIST REPORT

Prepared for:	Prepared by:	Prepared by: ***NATURA VIVA* CC**
Terra Power Solution (Pty) Limited	**Coastal & Environmental Services**	***Natura Viva* cc**
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<u>This report should be cited as</u>:

Almond, J.E. Natura Viva cc, July 2010. *Proposed Terra Wind Energy Golden Valley Project, Blue Crane Route Local Municipality: Palaeontological Impact Assessment,* Natura Viva cc, Cape Town, South Africa

9.1 Introduction

in accordance with the requirements of the National Heritage Resources Act, 1999, Coastal and Environmental Services (CES) in Grahamstown on behalf of Terra Power Solutions (Pty) Limited requested that Natura Viva CC conduct a Palaeontological Assessment for the proposed Terra Wind Energy Golden Valley Project.

9.1.1 Terms of Reference

The terms of reference for the Phase 1 palaeontological impact study are to:

- Provide a summary of the relevant legislation;
- Conduct a site inspection as required by national legislation;
- Determine the likelihood of palaeontological remains 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;
- Assess the significance of direct and cumulative impacts of the proposed development and viable alternatives on palaeontological resources;
- Identify mitigatory measures to protect and maintain any valuable palaeontological sites and remains that may exist within the proposed site;
- Prepare and submit any permit applications to relative authorities;
- Preparation of a draft and final specialist report.

9.2 Structure of 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, summarizes the palaeontological heritage that is already known from the various rock formations represented here on the basis of the scientific literature, and presents the geological and palaeontological observations made during fieldwork for the present impact study.

Section 3: Summarises the fossil heritage and its inferred sensitivity for each major rock unit represented in the study area. The significance of the envisaged impacts on palaeontological heritage are assessed in tabular form. The necessity for specialist palaeontological mitigation for the proposed wind farm project is also evaluated. Recommendations are made as to when and where specialist palaeontological mitigation for this project should be undertaken, and the form this mitigation should take is outlined.

Section 4: Briefly summarises the sensitivity of palaeontological heritage in the study area, the likely impact of the proposed development on this heritage, and recommendations for specialist mitigation.

Section 5: Acknowledges colleagues and others who have contributed to the completion of this impact study.

Appendix 1: Tabulates GPS data for all localities mentioned in the text.

9.3 The Study Team

Dr John Almond, the team leader, 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).

Dr Almond was assisted in the field by Ms Hedi Stummer (previously a Karoo fossil preparator and field assistant at Iziko Museums, Cape Town), Mr E. Stummer and Ms Madelon Tusenius (MA in Archaeology and Postgraduate Diploma in Museology, University of Stellenbosch). All three assistants have extensive experience with Karoo field palaeontology.

9.4 Relevant Legislation, Policies and Guidelines

The extent of the proposed development (over 5000 m^2) falls within the requirements for a Heritage Impact Assessment (HIA) 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

Minimum standards for the palaeontological component of heritage impact assessment reports are currently being developed by SAHRA. The latest version of the SAHRA guidelines is dated May 2007.

9.5 Methodology

9.5.1 General approach used for palaeontological impact scoping studies

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations *etc*) represented within the study area are determined from geological maps. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author's field experience (Consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to development (Provisional tabulations of palaeontological sensitivity of all formations in the Western, Eastern and Northern Cape have already been compiled by J. Almond and colleagues; *e.g.* Almond *et al.,* 2008). The likely impact of the proposed development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature of the development itself, most notably the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a field scoping study by a professional palaeontologist is usually warranted.

The focus of palaeontological scoping work is *not* simply to survey the development footprint or even the development area as a whole (*e.g.* farms or other parcels of land concerned in the development). Rather, the palaeontologist seeks to assess or predict the diversity, density and distribution of fossils within and beneath the study area, as well as their heritage or scientific interest. This is primarily achieved through a careful field examination of one or more representative exposures of all the sedimentary rock units present (*N.B.* Metamorphic and igneous rocks rarely contain fossils). The best rock exposures are generally those that are easily accessible, extensive, fresh (*i.e.* unweathered) and include a large fraction of the stratigraphic unit concerned (*e.g.* formation). These exposures may be natural or artificial and include, for example, rocky outcrops in stream or river banks, cliffs, quarries, dams, dongas, open building excavations or road and railway cuttings. Uncemented superficial deposits, such as alluvium, scree or wind-blown sands, may occasionally contain fossils and should also be included in the scoping study where they are well-represented in the study area. It is normal practice for impact palaeontologists to collect representative, well-localized (*e.g.* GPS and stratigraphic data) samples of fossil material during scoping studies. All fossil material collected must be properly curated within an approved repository (usually a museum or university collection).

Note that while fossil localities recorded during scoping work within the study area itself are obviously highly relevant, most fossil heritage here is embedded within rocks beneath the land surface or obscured by surface deposits (soil, alluvium *etc*) and by vegetation cover. In many cases where levels of fresh (*i.e.* unweathered) bedrock exposure are low, the hidden fossil resources have to be *inferred* from palaeontological observations made from better exposures of the same formations elsewhere in the region but outside the immediate study area. Therefore a palaeontologist might reasonably spend far *more* time examining road cuts and borrow pits close to, but outside, the study area than within the study area itself. Field data from localities even further afield (*e.g.* an adjacent province) may also be adduced to build up a realistic picture of the likely fossil heritage within the study area.

9.5.2 Approach used for this Palaeontological study

This report provides an assessment of the observed or inferred palaeontological heritage within the study area near Cookhouse, with recommendations for any specialist palaeontological mitigation where this is considered necessary. The report is based on a review of the relevant scientific literature, geological maps, a previous palaeontological heritage assessment relevant to the Cookhouse region of the Great Karoo (Almond 2009) as well as on a four-day field scoping study by the author and a team of three assistants that was carried out on 26-29 April, 2010.

The following general 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 or 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)

9.6 Data Collection

The palaeontological fieldwork for the Cookhouse wind farm impact study was carried out over four days, *viz*. 26-29 April, 2010. The search for fossil remains focused especially on fresh exposures of Beaufort Group bedrocks, especially the overbank mudrocks (*e.g.* palaeosols with calcrete nodules) but also on conglomeratic facies at the bases of channel sandstones. Levels of bedrock exposure within the study area were fairly poor overall, largely due to cover by superficial drift deposits (alluvium, colluvium, calcrete *etc*) and to relatively dense thicket vegetation over much of the study area, especially on steeper slopes and in valleys (The local vegetation type is known as Great Fish Thicket).

The best outcrops of fresh bedrock were seen in numerous roadcuts along the N10 south of Cookhouse (Loc. 349-361, just west of the study area), along the banks of the Great Fish River (*e.g.* at Middleton, Jagersdrift), an excellent cliff section on Great Rietfontein 160, Farm 283 (Loc.320), erosional gullies into hillsides (Locs. 325, 332, 336), and several dams or borrow pits along the eastern margin of the study area (Locs. 343-348). For comparative purposes, the excellent roadcut exposures of channel sandstones and mudrocks of the Middleton Formation along the Bruintjieshoogte Pass between Somerset East and Pearston were also examined. However, although the well-exposed N10 road sections are of considerable sedimentological interest, no fossil were found here. Deep railway cuttings into Beaufort Group bedrocks are also present west of the study area and close to the N10 but they were not examined here for reasons of safety.

Field localities and their GPS co-ordinates are listed in the Appendix. All GPS readings were taken in the field using a hand-held Garmin GPSmap 60CSx instrument. The datum used is WGS 84. Fossil material collected in this study will be deposited at Iziko: South African Museum, Cape Town.

9.7 Assumptions and Limitations

Published geological maps of the study area 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 intensive field collection as well as monitoring of excavations during construction.

9.8 Description of the Geological and Palaeontological Environment

9.8.1 Geological Environment

As shown on the relevant 1: 250 000 geological map, Sheet 3224 Graaff-Reinet published by the Council for Geoscience (Figure 9-1), the study area is largely underlain by Late Permian continental sediments of the Lower Beaufort Group (Adelaide Subgroup, Karoo Supergroup). In particular the Karoo sediments belong to the Middleton Formation (Pm) (Hill 1993, Cole et al. 2004, Johnson et al., 2006). In the southern part of the study area the Middleton Formation is intruded by a major, narrow, WNW-ESE trending intrusion of the Karoo Dolerite Suite (Jd) of Early Jurassic age (c. 183 Ma). Dips of the Beaufort Group sediments recorded on the geological map in the study region are generally shallow (5 to 10°), with small-scale E-W fold axes to the south and east of Cookhouse, so low levels of tectonic deformation and cleavage development are expected. However, as outlined below, frequent small-scale faults, including low-angle thrusts and normal faults, are very evident where outcrop is good. These structural features are most clearly seen where they affect sandstone bodies in roadcuts. They can be related to both the Permo-Triassic Cape Orogeny (mountain-building event) as well as later stretching of the continental crust prior to the break-up of Western Gondwana during the Cretaceous Period.

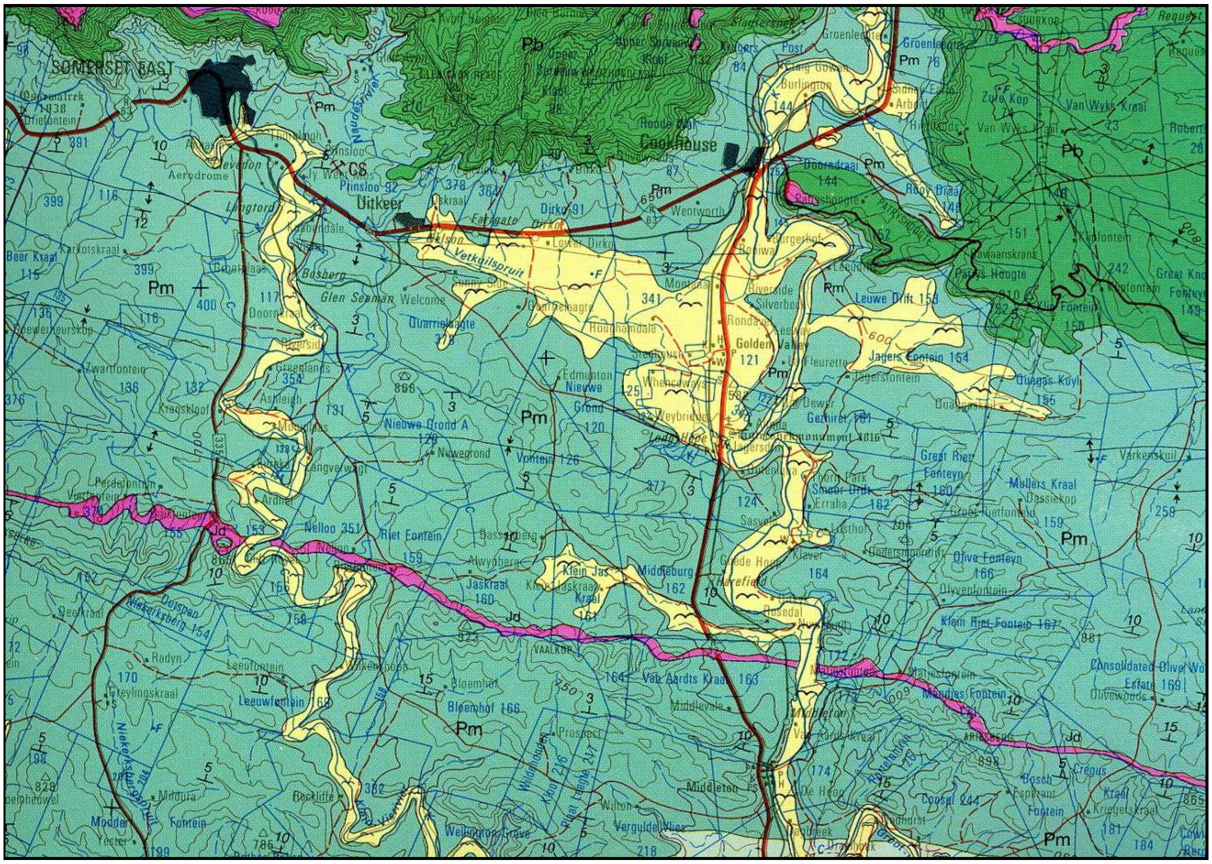

Figure 9-1: Extract from eastern edge of 1: 250 000 geological sheet 3224 Graaff-Reinet (Council for Geoscience, Pretoria) showing approximate extent of study area east of Cookhouse (black rectangle). Pm (blue-green) = Middleton Formation Pb (green) = Balfour Formation Jd (pink) = Jurassic dolerite intrusions yellow = Caenozoic alluvium of the Little and Great Fish Rivers and their tributaries

9.8.1.1 Middleton Formation

This formation forms the middle portion of the Adelaide Subgroup east of 24°E, including the Graaff-Reinet sheet area (Hill 1993, Johnson *et al*., 2006). The fluvial Middleton succession comprises greenish-grey to reddish overbank mudrocks with subordinate resistant-weathering, fine-grained channel sandstones deposited by large meandering river systems. Because of the dominance of recessive-weathering mudrocks, the Middleton Formation erodes readily to form low-lying *vlaktes* and hilly terrain at the base of the Escarpment near Cookhouse and extensive exposures of fresh (unweathered) bedrock are rare.

The Middleton Formation succession in the study area is dominated by blue-grey, hackly-weathering mudrocks. These are mainly silty but also muddy, variously massive (unbedded) to well-bedded, often showing clearly developed fining-upwards and thinning-upward cycles within the succession (Plate 9-1 & 9-2). Olive-grey, maroon to purple-brown and mottled maroon / grey mudrocks occur less frequently but are not uncommon.

Plate 9-1:. Steep riverbank exposure of blue-grey and purple-brown overbank mudrocks of the Middleton Formation at the Middleton bridge across the Great Fish River. Note several meter-thick section through silty alluvium overlying the gently N-dipping Beaufort Group bedrocks.

Plate 9-2: Roadcut section through the Middleton Formation along the N10 south of Cookhouse showing well-bedded, thinning- and fining-upwards overbank mudrocks (blue-grey) capped by a sheet-like crevasse splay sandstone (buff) that itself fines upwards into mudrock (Loc. 357) (Hammer = 30cm).

Palaeosol (fossil soil) horizons characterized by bands of oblate to irregular calcrete nodules are fairly common within the overbank mudrock facies (Plate 9-3, Plate 9-21) and are often associated with fossil remains in the *Cistecephalus* Assemblage Zone (Smith & Keyser 1995). Various types of pedogenic to diagenetic nodules were observed. Many are pale and micritic, others bluish-grey with a pearly "phosphatic" tinge, or rusty-coloured and ferruginous. Some nodules are septarian concretions with internal patterns of radiating cracks infilled with sparry calcite. At Loc. 357 some pale grey micritic nodules have an outer rind speckled with euhedric golden pyrite cubes indicating formation under anoxic conditions (perhaps groundwater-saturated soils in boggy areas on the floodplain).

Plate 9-3: Large oblate, rust-coloured concretions of ferruginous calcrete within blue-grey overbank mudrocks (Loc.337) (Hammer = 30cm). These palaeosol horizons are occasionally associated with fossil vertebrates.

Thin, flat-based sheets of fine-sandstones interbedded with the mudrocks are attributed to episodic crevasse splays (Plate 9-2). Fine-grained sheet sandstones with arrays of small-scale wave ripples, as seen at Loc. 325 and 336 (Plate 9-4) are probably playa lake deposits on the distal floodplain. These shallow pond sediments are often associated with wrinkled microbial mat textures, sand-infilled mudcracks as well as a variety of trace fossils (Plate 9-22).

The best vertical sections seen through the Middleton Formation within the study area occur on the southern banks of a small riverbed *c*. 1km WSW of the Groot Rietfontein homestead (Loc. 340, farm Great Rietfontein 160, Plate 9-5). The lower part of the section is dominated by massive to well-bedded blue-grey mudrocks, while a series of closely-spaced broad, thin channel sandstones and mudrock-infilled abandoned channels is seen higher up. Despite the excellent levels of exposure, no fossils were found here in in riverbed exposures nearby.

Plate 9-4: Fine-scale ladderback wave ripples on sandstone bedding plane, probably generated by wind action over a shallow playa lake on the Late Permian flood plain (Loc. 336, Smoorsdrift 162).

Plate 9-5: Thick riverbank cliff section through the Middleton Formation at Groot Rietfontein (Loc. 340), showing concentration of closely-spaced channel sandstones in the middle of the succession seen here. View towards the south.

Good horizontal and vertical sections through lenticular to sheet-like channel sandstones are also seen in several good roadcuts along the N10. The sandstones are typically well-sorted, fine-grained and buff-coloured, sometimes mottled and containing sparse mudrock intraclasts. Thick (to 3m), massive lithofeldspathic speckled sandstones are seen in thicker channel bodies. Numerous interesting sedimentological features seen here include laterally migrating point bar sandstones, current cross-bedding, ripple drift and climbing ripple cross-lamination, soft-sediment deformation (convolute lamination, loading, ball-and-pillow structures), heavy mineral lamination, and basal channel breccio-conglomerates. Palaeocurrent indicators suggest river flow towards the north or northeast. Channel bases are usually sharp and sometimes clearly erosional, but usually devoid of coarse-grained gravels. Larger intraclasts within the few basal channel breccio-conglomerates seen consist predominantly of reworked angular mudflakes (Plate 9-6, Plate 9-7). No transported fossil bones, teeth or plant debris were observed in the erosional channel bases.

Plate 9-6: Flat base of *c*. 30cm-thick, current-ripple cross-laminated sandstone showing local concentrations of pinkish (possibly silicified) mudrock or calcrete intraclasts (Loc. 360).

Plate 9-7: Erosive base of major channel sandstone showing concentration of angular, flaky mudrock intraclasts (Loc. 360). These basal breccio-conglomerates are searched for transported fossil remains (*e.g.* bones, teeth, plant debris).

Plate 9-8: Clearly erosive-based channel sandstone within the Middleton Formation, Bruintjieshoogte Pass. Large lumps of mudrock eroded from channel banks upstream are often incorporated into the base of the sandstone channel infill here.

The Beaufort Group sediments show moderate to low levels of tectonic deformation in the Cookhouse area. The succession dips gently towards the north; closely-spaced, east-west trending fold axes and gentle northward dips of 5-15˚ are shown the geological map (Figure 9-1). However, roadcuts along the N10 show numerous small-scale faults and thrusts that have caused tectonic reduplication, distortion and thickening of sandstone bodies. Contacts between channel sandstones and mudrocks are frequently tectonically modified. Reverse fault planes are sometimes associated with quartz veining, mineral lineation and zones or wedges of brecciated country rock up to 50cm or more thick (Plate 9-9 & Plate 9-10).

Faulting may also be responsible for mudrock flame structures and small sandstone injection dykes, while thicker sandstones are often highly jointed, and mudrocks locally cleaved. Complex outcrops with unconformable packages of bedded Beaufort rocks probably have a tectonic rather than soft sediment deformation (*e.g.* gravity slumping) origin (*e.g.* Loc. 330, north of Matjesfontein). Steep normal faults cutting the Beaufort succession (e.g. Loc. 358) may be associated with Gondwana fragmentation in the Cretaceous Period.

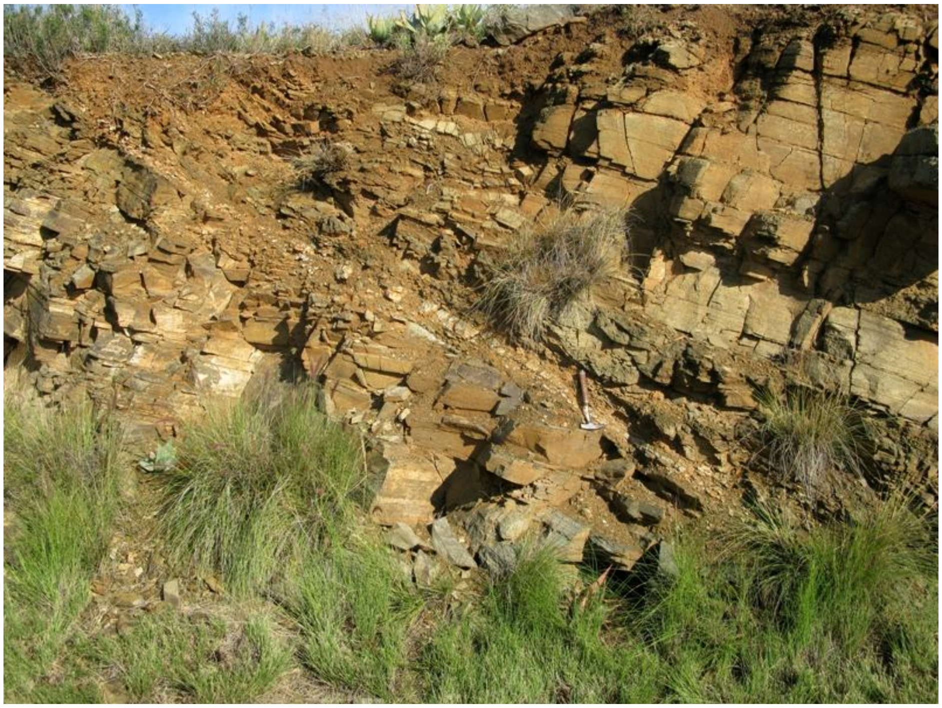

Plate 9-9: East-facing roadcut along the N10 south of Cookhouse showing package of tabular-bedded, horizontally-laminated channel sandstones cut by N-dipping reverse fault that is associated with quartz mineralization and brecciation (above hammer) (Loc. 353) (Hammer = 30cm).

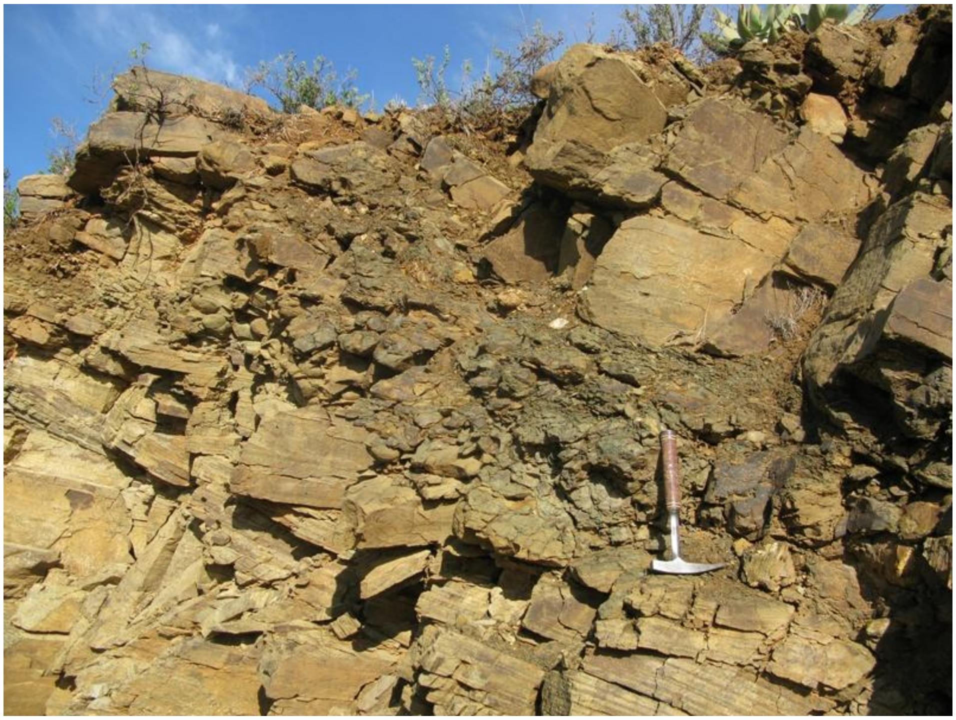

Plate 9-10: Thin, fault-related breccia (adjacent to hammer) consisting of chaotic blocks of laminated sandstone, mudrock and calcrete nodules that cuts across a well-bedded, locally brecciated channel sandstone (N10 roadcut, Loc. 353) (Hammer = 30cm).

9.8.1.2 Karroo Dolerite Suite

Igneous intrusions intruding the Beaufort Group in the vicinity of the Great Escarpment are referred to the Karoo Dolerite Suite of Early Jurassic age (c. 182 Ma; Duncan & Marsh 2006). According to Hill (1993) the southernmost dolerites in the Graaff-Reinet sheet area take the form of "crescentic dykes and transgressive sheets with easterly strikes and dipping towards the north". This description applies well to the thin band of Karoo dolerite outcrop running ESE-WNW across the Beaufort Group close to the southern edge of the study area (Figure 9-1). On the 1:250 000 geological map this band can be traced westwards past Pearston and beyond. Typical bouldery dolerite outcrops (pillows or corestones) are visible on Farm 283 (Matjesfontein) where they form a ridge culminating in the plateau of Ariesberg at 897m asl (Plate 9-11). An extensive area of Beaufort Group outcrop to either side of the intrusion is mantled in rubbly doleritic colluvium that is often cemented with calcrete to form a resistant, concrete-like near-surface pan

Plate 9-11: Typical bouldery outcrop of Karoo dolerite on north-facing hillslope, Farm 283 southeast of Matjesfontein homestead (Loc. 319).

9.8.1.3 Caenozoic superficial deposits ("drift")

Various types of superficial deposits ("drift") of Late Caenozoic (Miocene / Pliocene to Recent) age occur widely throughout the Karoo study region. They include pedocretes (*e.g*..calcretes), colluvial slope deposits (dolerite scree *etc*), river alluvium, as well as spring and pan sediments (*cf* Partridge *et al*. 2006). As a result, surface exposure of fresh Beaufort Group rocks within the development footprint itself is generally poor, apart from stream beds, dongas and steeper hillslopes ands artificial exposures in road and railway cuttings. The hill slopes are typically mantled with a thin layer of **colluvium** or slope deposits (*e.g.* sandstone scree). Thicker accumulations of sandy, gravelly and bouldery **alluvium** of Late Caenozoic age (< 5Ma) are found in stream and river beds, such as along the western edge of the study area, adjacent to the Great Fish River. These colluvial and alluvial deposits may be extensively calcretised (*ie* cemented with soil limestone or calcrete), especially in the neighbourhood of dolerite intrusions.

Thick, silty alluvium of the ancient Fish River drainage system overlies riverside cliffs and banks in the study area, even where the river is incised quite deeply into Beaufort Group bedrock (Plate 9-3). Good exposures of silty alluvium are also seen in the neighbourhood of Cookhouse and extensive portions of western study area along the Fish River (mainly agricultural lands) are mantled with fertile alluvium (yellow areas on geological map, Figure 9-1). The Fish River was probably a major drainage conduit in Tertiary times, cutting a wide meandering valley. Subsequent regional uplift and aridification in Late Tertiary (Miocene /Pliocene) times has reduced its flow and caused the river to cut a narrower course down though its older alluvium and into the underlying bedrock, while headwards erosion has driven its tributaries to cut well back into the Great Escarpment zone as far as Cradock (De Wit *et al*., 2000).

Coarse, blocky sandstone colluvium on hillslopes has been generated by gravity processes as well as *in situ* downwasting (Plate 9-12). Extensive areas of sandstone surface are exposed here, but no fossils were seen.

Plate 9-12: Coarse, angular colluvium of channel sandstone blocks (much of it generated by *in situ* weathering), Ondersmoorsdrift (Loc. 324).

Remarkably thick (7-8m) deposits of silty and gravely colluvium and sheet wash are seen on the northern slopes of the Ariesberg ridge (Farm 283, Matjesfontein) where they are incised by recent donga erosion (Plate 9-13). Beaufort Group and Karoo Dolerite bedrocks are exposed in floor of the dongas. Crude bedding picked out by thin layers of angular gravels is seen here.

Plate 9-13: Thick accumulations of silty and gravelly colluvium overlying dolerite bedrock exposed within a donga on Farm 283 (Loc.318).

Well-developed pedogenic calcretes of Late Caenozoic (probably Pleistocene) age directly overlie Beaufort Group sediments or cement a thick cover of silty alluvium in several parts of the study area (*e.g*. Loc. 343, Plate 9-14, Loc. 344 at Varkenskuil). Some of the subsurface rounded calcrete bodies seen here might be centred on ancient termitaria, although unequivocal termite nest structures (*e.g.* sponge-like gallery systems, tunnels, shelves or walls) were not seen. *In situ* calcretized termitaria are well known within superficial deposits in the fossil record of the Western Cape, for example in the Little Karoo (Almond *in* Rubidge *et al.* 2008). Many areas of the hilly veld east and west of Cookhouse (*e.g.* towards Bedford) are today dotted with amazingly dense concentrations of domical termitaria. Subterranean nests may have become preferentially calcretized during past semi-arid climatic episodes.

Plate 9-14: Thick silty alluvial sediment overlying Beaufort group bedrock and impregnated with nodular to diffuse calcrete (pedogenic limestone), probably during than one semi-arid climatic phase. Note development of continuous calcrete hard pan near soil surface and rounded to irregular calcrete concentrations subsurface (Hammer = 30cm) ("Diggings" at Loc. 343, Farm 259).

9.8.2 Palaeontological heritage within the study area

In the section of the report the known fossil heritage within each of the major rock units represented within the study area is summarized and new palaeontological data from the scoping fieldwork is briefly outlined.

9.8.2.1 Fossil heritage within the Middleton Formation

The overall palaeontological sensitivity of the Beaufort Group sediments is high (Rubidge 1995, Almond *et al*. 2008). These continental sediments have yielded one of the richest fossil records of land-dwelling plants and animals of Permo-Triassic age anywhere in the world. A chronological series of mappable fossil biozones or assemblage zones (AZ), defined mainly on their characteristic tetrapod faunas, has been established for the Main Karoo Basin of South Africa (Rubidge 1995). Maps showing the distribution of the Beaufort assemblage zones within the Main Karoo Basin have been provided by Keyser and Smith (1979) and Rubidge (1995), and for the Graaff-Reinet sheet area they are available in Hill (1993).

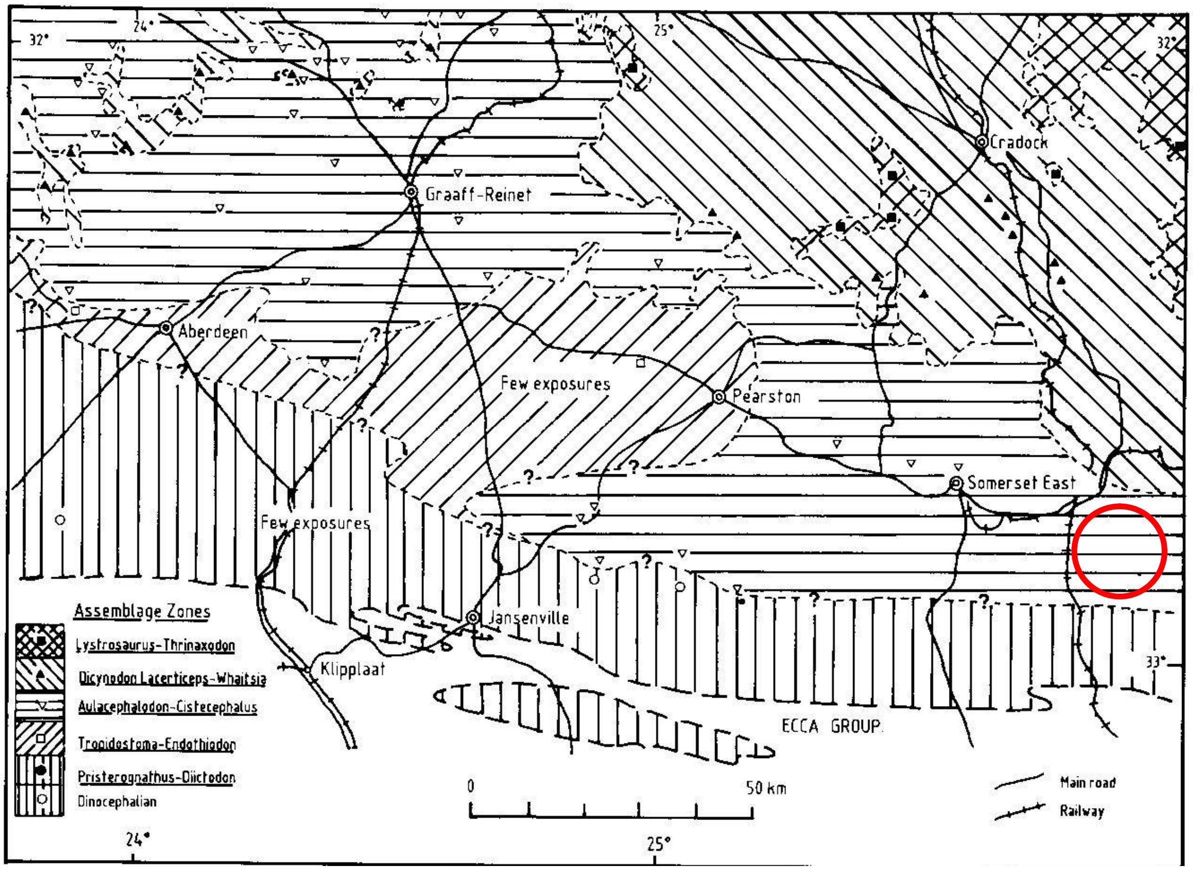

Figure 9-2: Distribution of Beaufort Group fossil assemblage zones in the Graaff-Reinet sheet area (After Keyser & Smith 1977-78). The location of study area near Cookhouse within the Cistecephalus Assemblage Zone (previously known as the Aulacephalodon – Cistecephalus Zone) is indicated by the red circle. Note the comparative paucity of fossil records from this particular area of the eastern Great Karoo.

The Middleton Formation comprises portions of three successive Beaufort Group fossil assemblage zones (AZ) that are largely based on the occurrence of specific genera and species of fossil therapsids. These are, in order of decreasing age, the *Pristerognathus*, *Tropidostoma* and *Cistecephalus* Assemblage Zones (Rubidge 1995). The three biozones have been assigned to the Wuchiapingian Stage of the Late Permian Period, with an approximate age range of 260-254 million years (Rubidge 2005). According to published maps showing the distribution of the Beaufort assemblage zones within the Main Karoo Basin (Keyser & Smith 1977-78, Hill 1993, Rubidge 1995), the Middleton Formation succession to the southeast of Cookhouse lies within the ***Cistecephalus* Assemblage Zone** (= upper *Cistecephalus* Biozone or *Aulacephalodon-Cistecephalus* Assemblage Zone of earlier authors; see Fig. 18 above).

The following major categories of fossils might be expected within *Cistecephalus* AZ sediments in the study area (Kitching 1977, Keyser & Smith 1977-78, Anderson & Anderson 1985, Hill 1993, Smith & Keyser *in* Rubidge 1995, MacRae 1999, Cole *et al*., 2004, Almond *et al*. 2008; see also Figure 9-3 and Figure 9-4 herein):

- isolated petrified bones as well as rare articulated skeletons of **terrestrial vertebrates** such as true **reptiles** (notably large herbivorous pareiasaurs, small insectivorous owenettids) and **therapsids** or "mammal-like reptiles" (*e.g.* diverse herbivorous dicynodonts, flesh-eating gorgonopsians, and insectivorous therocephalians)

- aquatic vertebrates such as large **temnospondyl amphibians** (*Rhinesuchus*, usually disarticulated), and **palaeoniscoid bony fish** (*Atherstonia*, *Namaichthys*; these are often represented by scattered scales rather than intact fish)

- freshwater **bivalves** (*Palaeomutela*)

- **trace fossils** such as worm, arthropod and tetrapod burrows and trackways, coprolites (fossil droppings), plant roots

- **vascular plant remains** including leaves, twigs, roots and silicified woods ("*Dadoxylon*") of the *Glossopteris* Flora, especially glossopterid trees and arthrophytes (horsetails). Plant remains are usually sparse and fragmentary.

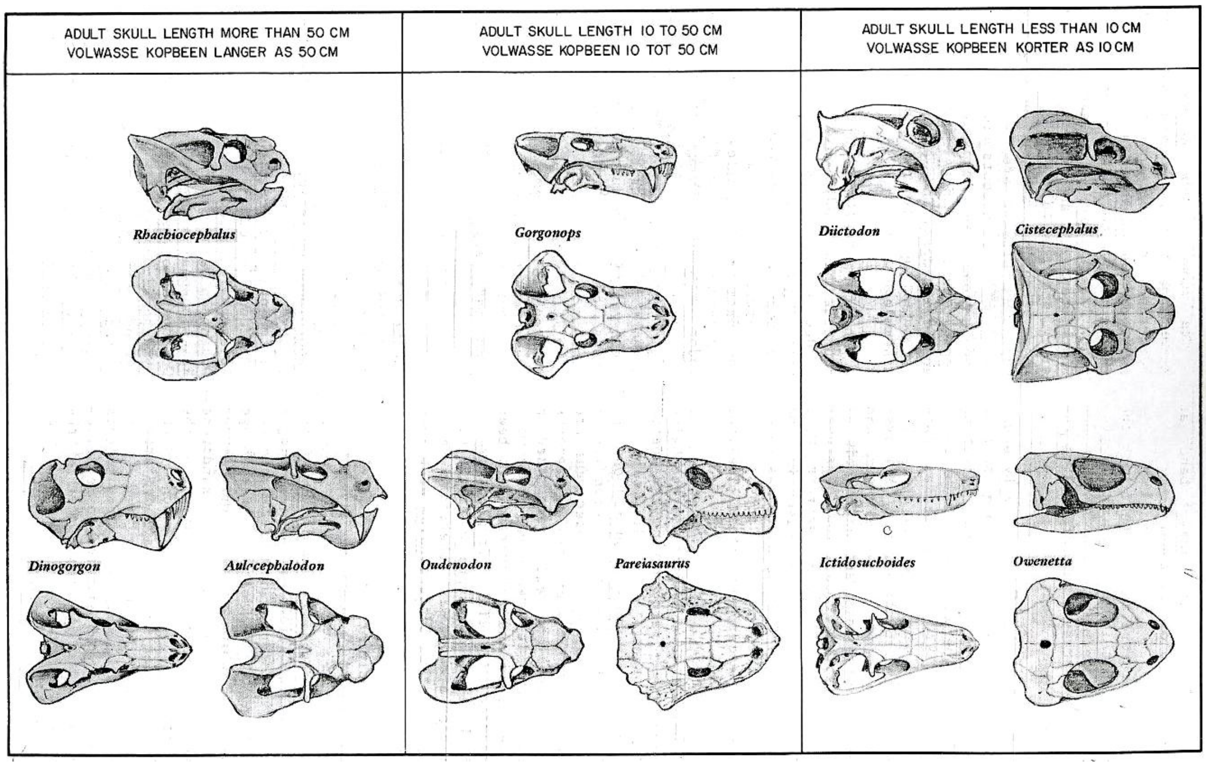

Figure 9-3: Skulls of characteristic fossil vertebrates from the Cistecephalus Assemblage Zone (From Keyser & Smith 1977-78). Pareiasaurus, a large herbivore, and Owenetta, a small insectivore, are true reptiles. The remainder are therapsids or "mammal-like reptiles". Of these, Gorgonops and Dinogorgon are large flesh-eating gorgonopsians, Ictidosuchoides is an insectivorous therocephalian, while the remainder are small to large-bodied herbivorous dicynodonts.

Authoritative lists of vertebrate genera and species recorded so far from the Cistecephalus Assemblage Zone are given by Smith and Keyser (1995).

As far as the biostratigraphically important tetrapod remains are concerned, the best fossil material is generally found within overbank mudrocks. In contrst, fossils preserved within channel sandstones (e.g. channel lag breccio-conglomerates of reworked mudflakes and calcrete nodules) tend to be fragmentary and water-worn (Smith & Keyser 1995, Smith 1993). Many fossils are found in association with ancient soils (palaeosol horizons) that can usually be recognised by bedding-parallel concentrations of calcrete nodules. The fossil bones are isolated and disarticulated for the most part, and are typically permineralised and encrusted in a mantle of calcrete (often brown-weathering). Fossil bone embedded in mudrocks adjacent to major dolerite intrusions may be modified by thermal metamorphism; for example, bones in the Graaff-Reinet

District may acquire a smooth, white "porcellanite" pallor, while bones recorded near Bedford, just east of the study area, may be black (Smith & Keyser 1995).

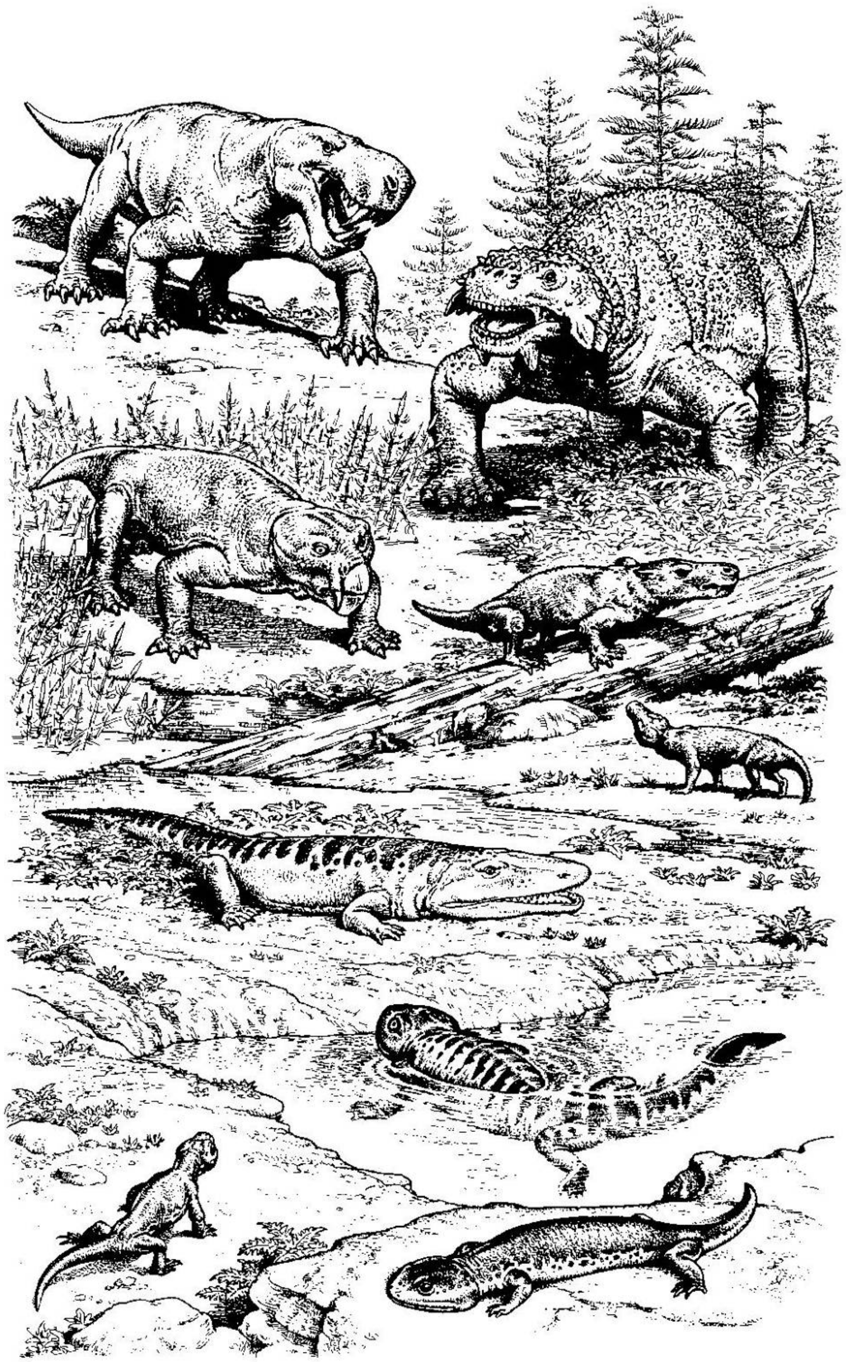

Figure 9-4: Reconstruction of a typical Late Permian continental biota (From Benton 2003). TOP: predatory gorgonopsian (left), rhino-sized herbivorous pareiasaur (right). MIDDLE: herbivorous, two-tusked dicynodont (left), carnivorous therapsids, including a therocephalian and small cynodont (right, below). BOTTOM: predatory amphibians with a procolophonid – a small insectivorous reptile (bottom left). N.B. Not all of these animals were present in the Cistecephalus Assemblage Zone.

Fossil vertebrate remains appear to be surprisingly rare in the Lower Beaufort Group outcrop near Cookhouse compared to similar-aged deposits further west within the Great Karoo (Figure 9-2)(Apparently, a team of experienced palaeontologists working in this area several years ago for about a week failed to find any substantial fossil remains). The important compendium of Karoo fossil faunas by Kitching (1977) lists numerous finds from the *Cistecephalus* Assemblage Zone near Pearston, some 75km to the WNW of the study area. A few therapsid genera - the dicynodonts *Emydops* and *Cistecephalus plus* the therocephalian *Ictidosuchoides* – are reported from Bruintjieshoogte, between Pearston and Somerset East, although fossils are recorded as rare even here, despite the excellent level of exposure. Sparse dicynodonts are also mentioned from Bedford, *c*. 30km to the east of Cookhouse. The most relevant fossil record for the present study, however, is that of the small, communal burrowing dicynodont *Diictodon* from Slachtersnek to the south of Somerset East (precise location not provided, Kitching 1977, p. 66). The very few fossil specimens recorded during the present scoping study southeast of Cookhouse were, as expected, found where extensive, gentle hillside exposures of overbank mudrocks with numerous calcretized palaeosol horizons are present.

The reason for the comparative scarcity of fossil material within the Beaufort beds near Cookhouse is unknown. It might be related to the area's southern, high palaeolatitudinal position within the N-S orientated Main Karoo Basin. The comparative scarcity of calcretized pedogenic horizons and maroon mudrocks may suggest colder, wetter climates here. The paucity of coarse clastic material, the rarity of deeply erosive channel bases within the river systems, the soft-sediment deformation seen at some channel sandstone bases, and the high proportion of ferruginous and pyritic calcrete nodules possibly suggest distal, swampy environments that may have been less conducive to terrestrial wildlife. This is all highly speculative, however!

The most palaeontologically productive sites in the study area were gentler slopes of well-exposed mudrocks with numerous palaeosols rich in calcrete nodules that were examined on Smoorsdrift 162 (Loc. 338) and Farm 283 (Locs. 321). Small bone fragments embedded within blue-grey mudrock or as surface float were found at Loc. 324 (Oudesmoorsdrif 164), Loc. 332 (Farm 283, Matjesfontein) and Loc. 336-338 (Smoorsdrift 162). In most cases the disarticulated bone fragments were encrusted with a thick mantle of micritic calcrete. The Matjesfontein bones occur in association with pedogenic calcrete and are often tinged pink or lilac (The discoloration may be related to the nearby dolerite intrusion). They belong to the post-cranial skeleton of a medium-sized animal that is still partially embedded in mudrock (Plate 9-15).

Plate 9-15: Fragments of fossil bone float together with an embedded rib of a medium-sized tetrapod (probably therapsid), Loc. 332, Farm 283 (Matjesfontein) (Rib fragment seen here is 8cm long, for scale).

The important Smoorsdrift 162 vertebrate fossils were found on an extensive N-facing exposure of Middleton Formation mudrocks just south and north of the farm track to Groot Rietfontein. The mudrocks here contain thin crevasse splay sandstones, wave-rippled playa lake sediments, and an extensive horizon of large, irregular, isolated to confluent ferruginous calcrete nodules (Plate 9-18). The disarticulated bones are embedded in calcrete or indurated grey mudrock and include two moderately well-preserved therapsid skulls (Plate 9-16 & 9-17) as well as fragments of a couple of other skulls *plus* fragmentary postcranial remains.

According to palaeontologist Dr Roger Smith (Iziko: South African Museums, Cape Town) the medium-sized (*c*. 18cm long), tusk-bearing dicynodont skull shown in Plate 9-16 bears a broad resemblance to the genus *Robertia* which is only recorded, however, from the significantly older *Tapinocephalus* Assemblage Zone of the Lower Beaufort Group (Rubidge 1995). The second dicynodont skull shown in Plate 9-17 is tuskless and may be a female specimen of the long-ranging small dicynodont *Diictodon*. It should be emphasized that these identifications are *provisional*, based on an examination of photos rather than the original material, and that further preparation of the specimens – especially in the palatal region – is necessary before firm conclusions can be drawn. These skulls are, to the author's knowledge, among the first identifiable fossil vertebrate remains recorded so far from the Cookhouse area and are therefore of considerable scientific importance for biostratigraphic purposes.

The Smoorsdrift site may well yield further valuable vertebrate remains when intensively searched, so further mitigation before construction of the proposed wind farm is suggested here.

Plate 9-16: Dorsal view of fossil skull of a medium-sized dicynodont preserved within a ferruginous calcrete nodule (Scale = 16cm) (Smoorsdrift 162, Loc. 338).

Plate 9-17: Dorsal view of second fossil skull of a small dicynodont preserved within a calcrete nodule (Scale = 16cm) (Smoorsdrift 162, Loc. 338). The skull apparently lacks canine tusks.

Plate 9-18: Extensive zone of large ferruginous calcrete nodules marking an ancient soil horizon at Loc. 338. The skulls found at this locality may have weathered out from the same or a similar horizon (Hammer = 30cm).

Plate 9-19: Overbank mudrocks penetrated by vague, cross-cutting horizontal burrows (Loc.346, Olive Woods Estate) (Hammer = 30cm).

Trace fossils found within or close to the study area include the vaguely striated or annulated horizontal burrows seen at Loc. 346 (Plate 9-19). These are attributable to an unknown invertebrate and may have been generated subaquesously or in wet shoreline sediments associated with a shallow playa lake system. Other vague epichnial furrows and wash-out sole traces (possibly including the arthropod burrow *Scoyenia*) were recorded in association with thin sandstone beds at Loc. 326.

The only plant fossils recorded during this study were locally abundant, transported stem fragments of sphenophytes or "horsetails" (Plate 9-20) that are preserved as internal casts within scraped up blocks of mudrock *c*. 2km east of Middleton (Loc. 334). These reed-like plants probably belong to the common fern genus *Phyllotheca* that characterized boggy riverine and lakeside habitats of the Late Permian in Gondwana (*Glossopteris* Flora; Anderson & Anderson 1985).

Plate 9-20: Internal cast of longitudinally-ribbed, "segmented" stem of a sphenophyte ("horsetail" fern). The stem fragment shown is 10cm long. Rubbish-filled borrow pit west of Middleton (Loc. 334).

9.8.2.2 Fossil heritage within the Karoo Dolerite Suite

The dolerite outcrops in the northern part of the study area are in themselves of no palaeontological significance since these are high temperature igneous rocks emplaced at depth within the Earth's crust. However, as a consequence of their proximity to large dolerite intrusions in the Great Escarpment zone, the Beaufort Group sediments nearby may well have been thermally metamorphosed or "baked" (*ie*. recrystallised, impregnated with secondary minerals). Embedded fossil material of phosphatic composition, such as bones and teeth, is frequently altered by baking – bones may become blackened, for example (as seen near Bedford to the east of the study area) - and can be very difficult to extract from the hard matrix by mechanical preparation (Smith & Keyser, p. 23 *in* Rubidge 1995). Thermal metamorphism by dolerite intrusions therefore tends to reduce the palaeontological heritage potential of adjacent Beaufort Group sediments.

9.8.2.3 Fossil heritage within the superficial deposits ('drift')

Karoo drift deposits have been comparatively neglected in palaeontological terms for the most part. However, they may occasionally contain important fossil biotas, notably the bones, teeth and horn cores of mammals (e.g. Skead 1980, Klein 1984, MacRae 1999, Partridge & Scott 2000). Other late Caenozoic fossil biotas from these superficial deposits include non-marine molluscs (bivalves, gastropods, rhizoliths), ostrich egg shells, trace fossils (e.g. calcretised termitaria, coprolites), and plant remains such as peats or palynomorphs (pollens) in organic-rich alluvial horizons.

Drift deposits including silty alluvium along the banks of the Fish River, near-surface calcretes, and various colluvial (slope) deposits were briefly examined for Caenozoic fossil remains, but without success. Calcretized termitaria may be present in some thicker drift successions in the eastern sector of the study region (See Section 9.8.1.3. and Plate 9-14).

9.9 Impact Assessment

9.9.1 Construction Phase

Cause and Comment

Significant impacts on palaeontological heritage normally occur during the construction phase and not in the operational phase of any development. Excavations made during the course of installing the proposed wind farm turbines and associated developments (*e.g.* roads, powerlines) may well expose, damage, disturb or permanently seal-in scientifically valuable fossil heritage that is currently buried beneath the land surface or mantled by dense vegetation.

The fossil record and inferred palaeontological sensitivity of the three main rock units represented in the study region are summarized in Table 9-1 (Based on Almond *et al*., 2008).

Bedrock excavations made during construction of the proposed wind energy facility east of Cookhouse will primarily affect continental sediments of the Middleton Formations of the Late Permian Beaufort Group. These sediments underlie the great majority of the study area and are renowned for their rich fossil heritage of terrestrial vertebrates (most notably mammal-like reptiles or therapsids), as well as fish, amphibians, molluscs, trace fossils (*e.g.* trackways) and plants (*e.g.* petrified wood). Caenozoic surface sediments in the study area (*e.g.* alluvium, colluvium) are generally of low palaeontological sensitivity, while the Karoo dolerite intrusions do not contain fossil remains at all.

Although the direct impact of the proposed project will be local, fossils within the Beaufort Group are of importance to national as well as international research projects on the fossil biota of the ancient Karoo and the end-Permian mass extinction.

Table 9-1: Sensitivity of Fossil Heritage of Rock Units represented within Cookhouse study area

TABLE 9-1: SENSITIVITY OF FOSSIL HERITAGE OF ROCK UNITS REPRESENTED WITHIN COOKHOUSE STUDY AREA (For use with 1: 50 000 scale geological maps)			
FORMATION & AGE	**FOSSIL HERITAGE**	**PALAEON-TOLOGICAL SENSITIVITY**	**RECOMMENDED MITIGATION FOR NEW DEVELOPMENTS**
Superficial deposits (colluvium, alluvium *etc*) **Late Caenozoic**	**Sparse remains of vertebrates (*e.g.* mammalian bones, teeth), trace fossils (calcretized termitaria, rhizoliths), freshwater molluscs, microfossils (*e.g.* palynomorphs)**	**LOW**	**None**
Karoo Dolerite Suite **Early Jurassic**	**None (igneous intrusions)**	**ZERO**	**None**
Middleton Formation (Lower Beaufort Group) **Late Permian**	**Rich continental biota of reptiles, therapsids, amphibians, fish, molluscs, petrified wood and plant debris & trace fossils**	**HIGH TO LOCALLY VERY HIGH**	**Intensive recording and collection of fossil material within designated high sensitivity areas demarcated on map (Fig. ** below)**

Mitigation and Management

Where rich or unusual fossil remains are likely to be present within the Beaufort Group rocks, study and judicious sampling of the sediments and their enclosed fossils by a qualified palaeontologist *before* construction starts is usually recommended. However, the greater part of the proposed wind farm development at Cookhouse is not considered as posing a serious risk to local fossil heritage because:

- deep or voluminous bedrock excavations are unlikely to be required for the installation of wind turbines, electricity powerlines and ancillary developments, with the possible exception of any borrow pits;
- an extensive, and often thick, mantle of comparatively unfossiliferous drift deposits (alluvium, colluvium) covers the more sensitive Beaufort Group rocks over much of the region;
- fossil remains are apparently much scarcer within the Beaufort Group succession in the study area compared with similar-aged outcrops further west within the Great Karoo (as borne out by this and a previous, independent palaeontological field study).
- the Beaufort Group in the study region has been extensively affected by Permotriassic tectonism (folding, faulting, some cleavage development) and locally by thermal metamorphism due to Jurassic dolerite intrusion, perhaps reducing the palaeontological sensitivity of these rocks (*N.B.* These last effects may not be very significant in practice).

Nevertheless, it is recommended that specialist palaeontological mitigation be carried out at least within the two small areas demarcated in the satellite image Figure 9-5 below. The red circle here includes our localities 336-338 on the farm Smoorsdrift 162 which yielded several important fossil skull specimens during a relatively brief visit (Plate 9-16 and Plate 9-17). The dashed ellipse indicates a comparable sloping outcrop area of Beaufort Group mudrocks on the farm Gezhiret 161 just to the northwest (unvisited). This second area may be affected by the proposed windfarm and may well also yield useful fossil material. Note that the Slachtersnek area just to the west has yielded some of the very few (perhaps only) fossil remains previously recorded from the Cookhouse region (Kitching 1977, p. 66).

The proposed specialist mitigation should involve the intense recording and judicious collection of fossil material within the designated two areas, as well as the recording of pertinent geological data (e.g. sedimentological information). Note that the palaeontologist involved will be required to obtain beforehand a palaeontological collection permit from SAHRA and to arrange a suitable respository for any fossils collected (*e.g.* Albany Museum, Grahamstown, BPI, Wits University, Johannesburg or Iziko: South African Museums, Cape Town).

Should substantial fossil remains, such as vertebrate bones, teeth or petrified wood, be found or exposed anywhere within the study area during construction of the Cookhouse wind farm, the responsible ECO should safeguard these – *in situ*, if feasible – and alert SAHRA as soon as possible so that appropriate mitigation can be undertaken by a professional palaeontologist at the developer's expense.

Note that *providing* appropriate mitigation is carried out, as outlined here, the Cookhouse windfarm development should usefully contribute to our understanding of the rich palaeontological heritage of the Great Karoo region.

Figure 9-5: Google Earth® satellite image of part of the study area southeast of Cookhouse showing area (red circle) where good slope exposures of Middleton Formation mudrocks and palaeosols on farm Smoorsdrift 162 yielded several well-preserved therapsid ("mammal-like reptile") skulls during this field scoping study.

Small dicynodont remains have previously been reported from Slachtersnek in this area (Kitching 1977) (See yellow triangle that marks the historical Slachtersnek Monument site). Intensive recording and collection of fossil remains within the two areas demarcated here by the red circle and ellipse is recommended before construction of the wind farm commences.

Significance Statement

According to the CES significance rating scheme the overall impact of the proposed Cookhouse wind farm on palaeontological heritage is assessed as LOW. This accords with "an acceptable impact for which mitigation is desirable but not essential". Failure to mitigate will probably result in the loss of local fossil heritage, while mitigation will probably provide new palaeontological data that is of regional significance (a moderately beneficial outcome). The no-go option will have a low negative impact compared with construction of the wind farm accompanied by recommended specialist mitigation, since the opportunity to collect further palaeontological data will be lost for the time being.

Impact	**Effect**						**Risk or Likelihood**		**Total Score**	**Overall Significance**
	Temporal Scale		**Spatial Scale**		**Severity of Impact**					
OPTION 1										
Without Mitigation	Permanent	4	Local	1	Moderate	2	Probable	3	**10**	**Low**
With Mitigation	Permanent	4	Regional	3	Moderately beneficial	2	Probable	3	**12**	**Moderate**
NO-GO OPTION										
Without Mitigation	Long term	3	Study area	2	Moderate	2	Probable	3	**13**	**Low**

9.10 Conclusions and Recommendations

The proposed Cookhouse wind farm study area is largely underlain by Late Permian continental sediments of the Middleton Formation (Lower Beaufort Group, Karoo Supergroup) that are potentially highly fossiliferous. However, field scoping and the accompanying desktop study have shown that (a) much of the Beaufort Group outcrop is mantled by relatively unfossiliferous superficial deposits – principally Late Caenozoic alluvium and colluvium; (b) the Beaufort Group is sparsely fossiliferous in this region; (c) the palaeontological sensitivity of these rocks may have been partially compromised by tectonism (*e.g.* folding, faulting) and thermal metamorphism. The likely impact of the proposed development on local palaeontological heritage is therefore inferred to be low (negative), if no mitigation takes place beforehand.

Focused specialist palaeontological mitigation to take place before construction starts is recommended in two small areas of Lower Beaufort outcrop on the farms Smoorsdrift 162 and Gheziret 161 because several scientifically useful fossil skulls have already been collected here (including during the current scoping study), or in the neighbourhood. This mitigation should involve the intensive recording and collection of fossil heritage within the two areas, as well as the recording of pertinent geological data.

Should substantial fossil remains, such as vertebrate bones, teeth or petrified wood, be found or exposed here or anywhere else within the study area during construction of the Cookhouse wind farm, the responsible ECO should safeguard these – *in situ*, if feasible – and alert SAHRA as soon as possible so that appropriate mitigation can be undertaken by a professional palaeontologist at the developer's expense.

9.11 Acknowledgements

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APPENDICES

APPENDIX A: ISSUES AND RESPONSE TRAIL PRIOR TO THE RELEASE OF THE DSR AND RELEVANT TO THE SPECIALIST STUDIES AS OBTAINED DURING THE SCOPING PHASE OF THE EIA

Record of issues and responses raised prior to release of the Draft Scoping Report for Public Review

Raised By:	Event & Date	Issue, Concern, Comment	Response
Electricity Supply Issues			
BCDA	Focus group meeting 29.09.09	How will we be getting the electricity?	The wind farm will sell the electricity to Eskom national grid and they will distribute it.
BCDA	Focus group meeting 29.09.09	Will the electricity always be coming from the wind farm for the local system?	Most of the time, yes. The wind is almost always blowing.
BCDA	Focus group meeting 29.09.09	There is a problem with the electricity from Eskom and the Blue Crane Municipality will support the project so long as Terra Power Solutions puts pressure on Eskom to lift the current NVA (?) from 15 to 20 or 25.	We will try to do so.
BCDA	Focus group meeting 29.09.09	Will there be enough energy for development of the municipality as it has been our limiting factor in the past.	Yes, that will be the least of your worries.
J. Louw	Public meeting 22.09.09	What is happening with Eskom Power Purchasing Agreement and how will it affect this project?	It has not been finalised yet and it has just been put for public review and we have made our inputs in the process.
Visual Issues			
BCDA	Focus group meeting 29.09.09	The Blue Crane Municipality thinks it is great for the economy and very positive for the area but our biggest concern is the visual impact, especially in terms of its affect on tourism.	There are three major concerns for the wind farm there are: 1) visual impact, 2) noise impact, 3) the impact on migrating birds all of which will have to be managed. In terms of the visual impact, studies have been done indicating that watching the turbines spin is relaxing. You need to consider the other options, would you like a coal or nuclear power station rather? Their visual impact is much higher. It is essentially a trade-off: yes, the turbines will have a visual impact but wind turbines are so much better than the alternatives.

Raised By:	Event & Date	Issue, Concern, Comment	Response
			There will be a visual impact assessment conducted in the EIA phase. The assessment will include a photomontage that will give you a better idea of the visual impact the wind farm is likely to have.
BCDA	Focus group meeting 29.09.09	Perhaps the municipality should restrict wind farms to a certain area to avoid huge visual impacts.	This farm shouldn't be a problem in terms of visual impacts as it is not near the tourism areas.
Construction Issues			
BCDA	Focus group meeting 29.09.09	There is a problem getting materials in this area. The Blue Crane Municipality knows where to get all the materials and are happy to help in sourcing material.	Thank you very much.
BCDA	Focus group meeting 29.09.09	Will you be building a line from the farms to Poseidon?	It depends. Eskom will make the choice of how to connect; for example, using three circuits to Poseidon.
Financial Issues			
J. Louw	Public meeting 22.09.09	If the wind measurement data proves that there is enough wind for the wind farm, are you sure about finances to start the project?	Yes as mentioned in the presentation a number of local and international finance institutions have been contacted to present the idea and they showed a lot of interest in the project.
Other Issues			
BCDA	Focus group meeting 29.09.09	Can we please have clarification of which authorities the application will be sent to?	The EIA application and reports will be submitted to the DWEA (formerly termed DEAT)
Site Issues			
BCDA	Focus group meeting 29.09.09	Is there enough wind?	Yes, preliminary measurements show that there is - the valley and plateau winds will be used to drive the turbines. We need to measure based on the 80m met masts to get a more feasible study.
BCDA	Focus group meeting 29.09.09	Does the map in the BID show the entire area, are the farms in the centre of the group included?	Yes, it does and yes, they are.
BCDA	Focus group meeting 29.09.09	Which are the farms that border on the right?	Olive Woods Estate is the last of the farms.
BCDA	Focus group meeting	The municipality has no problem with this wind	Well, you will see it, as discussed, it is a trade-off.

Raised By:	Event & Date	Issue, Concern, Comment	Response
	29.09.09	farm, but is concerned that there are so many popping up in the area.	
General Issues			
BCDA	Focus group meeting 29.09.09	What are the options for people working together (will you be happy to work with the municipality)?	That is not a problem, there is definitely room for Terra Power and the municipality to work together. Terra Power Solutions also wants to support local projects.
BCDA	Focus group meeting 29.09.09	What about wind farms with problems, there is at least one in the Western Cape where the turbines are standing still.	This wind farm should be fine, that one had issues with the company that will not happen to Terra Power Solutions.
CES	Focus group meeting 29.09.09	Do you have any suggestions on locations where CES should put the report when it comes out for public review so as to make it as accessible to the public as much as is possible?	Yes, in Middleton as well as the Golden Valley Co-op.
Terra Power Solution	Focus group meeting 29.09.09	How does the Blue Crane Development Agency fall in with the municipality, and how do we liaise with the municipality?	The BCDA is the development section arm of the BCRM and are pro-development and will assist as much as is possible. For permits and similar necessities you will deal with the infrastructure department who we can put you in contact with

Record of Issues and Response relevant to the specialist studies as obtained during the release of the DSR, EIR and EMP for public review

Raised By:	Event & Date	Issue, Concern, Comment	Response
Visual Issues			
Dr Paul Martin	06.09.2010 via email	Similarly the cumulative visual impacts of all the wind farms proposed for an area need to be assessed, not just on an individual project basis.	Noted. The cumulative visual impacts of the proposed project will be reported in the final EIA report.
Avifaunal Issues			
Dr Paul Martin	06.09.2010 via email	The cumulative impacts of all proposed wind farms in an area need to be assessed. The large number of wind farms proposed for the Cookhouse area will result in the sterilization of large areas of land for the larger bird species such as Blue Cranes, Denham's Bustards and Secretary birds as they are expected to avoid the areas where the turbines are located. This is expected to have a large negative impact on their populations via loss of useable habitat.	Noted. These avifaunal and vegetation considerations have been taken into account in the EIA and the cumulative impacts thereof will be reported in the final EIA report.

APPENDIX B: THE SPECIALIST STUDY PROCESS

APPENDIX B-1: SHORT *CURRICULUM VITAE* OF EACH OF THE LEAD SPECIALISTS INVOLVED IN THE PROPOSED TERRA WIND ENERGY GOLDEN VALLEY 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
</td></tr>
</table>

stabilisation and restoration of dune environments. Professor 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.

	Mr. Colin Fordham	**COLIN FORDHAM**
		
		Date of Birth: 08 December 1982
		Languages: English, Afrikaans, Xhosa
		
		QUALIFICATIONS
		
		• B.Sc. [Natural Sciences] – Nelson Mandela Metropolitan University, 2007
		
		• B.Sc. Honours [Botany - Environmental Management] - Nelson Mandela Metropolitan University, 2008
		
		EMPLOYMENT EXPERIENCE
		
		• Environmental Consultant, Coastal & Environmental Service (March 2008 – February 2010) – Botanical Specialist and Ecologist.
		  ▪ Assistance with regard to the compilation of Environmental Impact Assessment (EIA) and Botanical Survey reports.
		  ▪ Assisting with specialist faunal and floral studies, with specific reference to estuaries, riparian zones, wetlands, coastal forests, grasslands and savannas.
		  ▪ Compilation\assisting with regard to the compilation of the following reports\studies; Environmental Impact Assessments (EIA), Basic Assessments, Scoping Reports, Environmental Management Plans, Baseline Surveys and Botanical Surveys.
		  ▪ Compilation of maps using GIS systems and analysis of data, using GIS systems
		  ▪ Also general assistance with regard to administration, co-ordination, project management and report production activities related to CES projects.
		
		• Dept of Botany, NMMU, 2005-2007
		  ▪ Assisted in the undertaking of an EIA, for the augmentation of a water supply for Nieu Bethesda, including; the construction of a pump station and two water reservoirs. Was directly responsible for the compilation of a botanical species list from samples taken from the site.
		
		CES PROJECT INVOLVEMENT
		
		Listed from date of appointment to current.
		
		• Hollingrove Share Block Development BA, project ecological specialist.
		• Knysna Expert Witness Botanical Specialist Review.
		• Port Durnford Ecological Specialist Report, vegetation\GIS specialist.

		• Dutch Jatropha Biodiesel, vegetation\GIS specialist. • Centani Drill Survey, vegetation\GIS specialist. • Kalagadi Manganese Smelter Scoping Report, vegetation specialist. • Kalagadi Manganese Smelter EIA, vegetation specialist. • Exxaro Smelter Scoping - vegetation\GIS specialist • Kasouga Ridge EIA, vegetation\GIS specialist. • Sidbury Cricket Club - vegetation\GIS specialist • Wildcoast Meander Road, vegetation\GIS specialist • Cobbay BA - vegetation\GIS specialist • Rent – A- Store – BA - vegetation\GIS specialist • Aston Bay Dune\Remainder Site vegetation\GIS specialist • Laguna Bay Prefeasibility Assessment vegetation\GIS specialist • Peregrine Dunes Scoping Report vegetation\GIS specialist. • Coega Open Space Management Report Version 11 – Project Management and vegetation\GIS specialist • Nooitgedagt Pipeline Vegetation Assessment - Vegetation\GIS specialist • EC Parks Board Wild Coast Forest Boundary Survey, Project Manager and vegetation\GIS specialist. **PUBLICATIONS** Presentations and Posters: • Constructed wetlands and their efficiency for wastewater treatment, Nelson Mandela Metropolitan University. March, 2006
AVIFAUNA	**Mr. Luke Strugnell**	**Date of birth:** 19 March 1982 **Qualifications**: BSC –Zoology (Hons) Rhodes University- Grahamstown Pri. Sci.Nat (Zoology- 400181/09) **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** *Bird Impact Assessment Studies for Electrical infrastructure:* • Johannesburg Strengthening 400KV Power lines • Appollo- Verwoerdburg 400KV Power line • Phoebus- Kwagga 400KV Power line • Ariadne-Eros 400KV Power line • Mogwase- 400KV Power line • Venus Sigma-765KV Power line • Malelane- Boulders 132KV Power line • Nondabuyo-Ndumo 132KV Power line • Randfontein 132KV Power line • Sasol Intergration 132KV Power line • Marathon- Kiepersol 132KV Power line

		• Dumasi- 132KV Power line • Invubu-Melmoth 132KV Power Line • NMPP Electrical Infrastructure • Madadeni 132KV Power line • Randfontein Strategic Servitude • Kuka ropeway review • Ubertas Substation • Graceview- Slagment 88KV Power line • Graceview- Eyestone 88KV Power line • Honingklip 88KV Power line • Randjiesfontein 88KV Power line • Delmas 44KV Power line • Cookhouse Wind Energy facility 1 • Cookhouse Wind Energy facility 2 • Port Elizabeth Wind Energy facility • Suurplaats Wind Energy facility *Avifaunal "walk thoughs" (EMP's):* • Zeus- Mercury 765KV EMP • Bravo-132KV EMP • Grassridge Poseidon 400KV EMP • Mercury –Ferrum 400KV EMP *Research projects:* • Rhino and Lion Park camera risk assessment • Carcass detection using dogs under power lines
HERITAGE	**MR. Tim Hart**	**Date of Birth** 29 July 1960 **Qualifications** • Bachelor of Arts in Archaeology and Psychology • BA Honours in archaeology • MA in Archaeology • Professional member (no 50) Association of Southern African Professional Archaeologists (ASAPA) • Principal Investigator, cultural resources management section (ASAPA) • Professional member in specialist and generalist categories Association of Heritage Assessment Professionals **Membership of Professional Institutions** • Founder member of Association of Heritage Assessment Professionals • Founder member and secretary CRM section ASAPA (1995) • Council member (1995 – 2000 and current) ASAPA • Built environment and landscape committee member, Heritage Western Cape 2003 -2007 (provincial compliance authority for heritage) • Archaeology, Palaeontology and Meteorites committee (Heritage Western Cape)

		• Honorary member of 2 historical associations. Personal
		• Amateur artist • Life partnership with Elisabet Schietecatte, 1 daughter aged 3 years old. Tim Hart has a Masters degree in Archaeology which he obtained after an extended period of fieldwork study Late Stone Age Archaeology in the Great Karoo. Since 1987 in professional practise he has been involved in a wide rage of heritage related projects ranging from excavation of fossil and stone age sites to the conservation of historic buildings, places and industrial structures. To date he has led and completed with the ACO team over 1000 projects throughout the country ranging from minor assessments to participating as a specialist in a number of substantial EIA's as well as international research projects. Together with his colleague Dave Halkett he has been involved in heritage policy development, development of the profession, the establishment of 2 professional bodies and development of professional practice standards. Notable projects he has been involved with are the development of a heritage management plan and ongoing annual mitigation for the De Beers Namaqualand Mines Division, heritage management for Namakwa Sands and other west coast and Northern Cape mining firms. Locally, Tim Hart was responsible for the discovery of the "Battery Chavonnes" at the V&A Waterfront (now a conserved as a museum), the discovery of a massive paupers burial ground in Green Point (now a National Heritage Site), the fossil deposit which is now the subject of a public display at the West Coast Fossil Park as well as participating in the development of the Robben Island Museum world heritage site (ongoing). A recent significant appointment is to assist with the development of a conservation policy for the Houses of Parliament. Tim Hart has teaching experience within a university setting and has given many public lectures on archaeology and general heritage related matters. In the forthcoming years he will be running a NLF funded project (R1.2m) to research the burial grounds of Green Point.
		Relevant recent Project Experience: • Specialist Specialist consultant – Eskom's Kudu Integration project (identifying transmission line routes across Namaqualand) • Specialist consultant – Eskom's Atantis Open Cycle Gas Turbine project, upgrade and power lines • Specilaist consultant – Eskom's Mossel Bay Open Cycle Gas Turbine project, substations and power lines • Specialist consultant – Eskom's Koeberg Plant proposed training campus • Contracted by University of Stanford to set up and participate in Duinefontein Archaeological Research project, Koeberg Nuclear Power Station • Specialist consultant – Eskoms proposed Omega sub-station • Specialist consultant – Eskoms Nuclear 1 programme • Specialist consultant – Eskoms PBMR programme • Specialist consultant – Department of Water Affairs raising of Clanwilliam Dam project • Specialist consultant to De Beers Namaqualand Mines (multiple projects since 1995) • Specialist consultant – Saldanha Ore Handling Facility phase

		2 upgrade • Three years of involvement in Late Stone Age projects in the Central Great Karoo • Wind Energy systems: Koekenaap, Hopefield, Darling, Vredendal, Bedford, Sutherland, Caledon • Bantamsklip Nuclear 1 TX lines • Koeberg Nuclear 1 TX lines • Karoo uranium prospecting various sites • HIA Houses of Parliament
	Dr. Lita Webbley	I have a MA cum laude (Archaeology) from the University of Stellenbosch (1984) and a PhD (Archaeology) from the University of Cape Town (1992) with the title: **The history and archaeology of pastoralist and hunter-gatherer settlement in the north-western Cape, South Africa**. **Archaeological Excavation experience**: Since 1977 I have participated in and/or directed archaeological excavations at over 50 sites in South Africa. These have included Middle and Later Stone Age sites in the Western Cape, Northern Cape and Eastern Cape. I have also excavated a number of historical sites in the Western Cape, Kwa-Zulu Natal and Eastern Cape. I also have limited experience on Iron Age sites. In addition to fieldwork, I have lectured in archaeology at a number of tertiary institutions and published numerous scientific papers on archaeology. **Anthropological Experience:** I have been actively engaged in ethnographic fieldwork among descendants of Nama-speaking peoples in the Northern Cape since 1981. This has involved collecting oral histories from local communities in the Leliefontein, Steinkopf and Richtersveld Reserves. **Consultancy work:** I have conducted at least 35 consultancy reports on the impact of development on heritage sites, since 1995. Three of the biggest consultancy contracts have involved work for the South African National Parks Board and I have surveyed the Richtersveld National Park, the Namaqua National Park and the Addo Elephant National Park for heritage sites, interviewed people around heritage, and set up an MS Access database. **Professional Status**: I am registered as professional archaeologist with the CRM section of the Association of Southern African Professional Archaeologists (ASAPA). I am registered as a Principal Investigator in the fields of Stone Age Archaeology, Shell Middens, Historical Archaeology and Ethno-archaeology. **Employment:** From 1979 to 1987 I lectured in archaeology at a number of universities, including UNISA, Fort Hare, Stellenbosch and Cape Town. Between 1988 and 1997 I was the archaeologist, first at the Natal Museum Services in Pietermaritzburg, and then at the Albany Museum in Grahamstown. In 1997 I was appointed Assistant Director of the Albany Museum, and from 1999 I have been the Head (Director) of the Museum.
VISUAL	**MR. HENRY HOLLAND**	**HENRY JAMES HOLLAND** Date of birth: 26 December 1968

QUALIFICATIONS

BSc (Hons.) (UOFS), MSc (Rhodes)

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.

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Environmental Auditor (ISO 14001:2004)
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

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<tr><td>PALAEONTOLOGICAL</td><td>DR. JOHN E. ALMOND</td><td>
<u>DR. JOHN E. ALMOND</u>

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

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		(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 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

ROLE	NAME OF PERSON	DETAILS OF EXPERTISE (SHORT CV)
PROJECT LEADER AND REPORT REVIEWER	**MR MARC HARDY**	**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 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 Golden Valley 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)

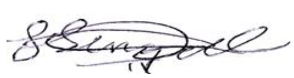
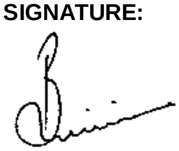
SKILLS

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	**MS. SAMANTHA BODILL**	**SAMANTHA BODILL** Date of Birth: 28 November Langauges: English **QUALIFICATIONS** • B.Sc. [Ichthyology and Zoology] – Rhodes University, 2007 • B.Sc. Honours [Zoology] – Rhodes University, 2008 **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. • Assistant to Lodge Management, Kwanza Lodge, Angola (March 09 – October09) Overseeing staff, housekeeping, menu planning, handling of safe transactions and bulk supply purchases. I demonstrated a willingness and ability to be extremely flexible, which was key in Angola, as more often that not unforeseen circumstances presented themselves. I have enormous respect, appreciation and acceptance of different cultures and am able to work with many different types of people as our guests came from many different backgrounds– French, Portuguese, Italian, Dutch, German, Brazilian, etc. • Demonstrator Cell Biology Practicals (January-December 2008) My responsibilities included pre-practical preparation including

		set up of laboratory and preparation of marking sheet template; grading of practicals; responsibility of providing link between students and lecturers – linking theoretical lectures to practical sessions; assisting during and later assess the practical sessions. **CES PROJECT INVOLVEMENT** **Listed from date of employment to current** • Hollingrove Share Block Development Basic Assessement - *project report production* • Pruim Plaas, Peninsula, and Wellington Grove Basic Assessment, Eastern Cape (wind energy project) – *project manager (report production, public participation specialist, authority and client liason)* • Remaining extent of Farm Doorntjies 172 (Hilton Farm) Basic Assessment, Eastern Cape (wind energy project) - *project manager (report production, public participation specialist, authority and client liason)* • Portion 4 of Haverfontein 7 Basic Assessment, Mpumalanga (wind energy project) – *report production, public participation specialist, authority and client liason* • Pretoria Portland Cement (PPC) Property Basic Assessment, Coega (wind energy project) - *report production, public participation specialist, authority and client liason* • Waainek Basic Assessment, Eastern Cape (wind energy project) - *report production, public participation specialist, authority and client liason* • Cookhouse specialist volume (wind energy project) Environmental Impact Assessment – *report production* • Middleton EIA (wind energy project) - *report production, public participation specialist, authority and client liason* • Haverfontein EIA (wind energy project) - *report production, public participation specialist, authority and client liason* **SELECTED PRESENTATIONS** South African Wildlife Management Association, Mpekweni Beach Resort, Port Alfred, 16-19 September 2008 - Poster Presentation: Differences in the Feeding Behaviour of Male and Female Giraffe at Amakhala Game Reserve, Eastern Cape Province of South Africa

APPENDIX B-3: DECLARATIONS BY SPECIALISTS

Specialist	Declaration of independence
Ecological Specialist	I **LEIGH-ANN DE WET** declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Terra Wind Energy Golden Valley Project, in the Eastern Cape Province of South Africa, 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:** 
	I **PROF ROY LUBKE** declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Terra Wind Energy Golden Valley Project, in the Eastern Cape Province of South Africa, 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:** 
Avifaunal Specialist	I **LUKE STRUGNELL** declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Terra Wind Energy Golden Valley Project, in the Eastern Cape Province of South Africa, 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:** 
Noise Specialist	I **BRETT WILLIAMS** declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Terra Wind Energy Golden Valley Project, in the Eastern Cape Province of South Africa, 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:** 

Visual Specialist	**I HENRY HOLLAND** declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Terra Wind Energy Golden Valley Project, in the Eastern Cape Province of South Africa, 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:** 
Heritage Specialist	I TIMOTHY JAMES GRAHAM HART declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Terra Wind Energy Golden Valley 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:** 
Paleontological Specialist	I JOHN ALMOND declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Terra Wind Energy Golden Valley 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:** 

(For official use only)

File Reference Number:						
Application Number:						
Date Received:						

APPENDIX C: ECOLOGICAL

Appendix C-1: Plant species list for the proposed Terra Wind Energy Golden Valley Project site.

Assemblage	Family	Species Name
Dicotyledon	FABACEAE	*Acacia karroo* Hayne
Monocotyledon	AGAVACEAE	*Agave americana* L. subsp. *americana* var. *americana*
Monocotyledon	HYACINTHACEAE	*Albuca maxima* Burm.f.
Monocotyledon	ASPHODELACEAE	*Aloe ferox* Mill.
Monocotyledon	ASPHODELACEAE	*Aloe striata* Haw.
Monocotyledon	ASPHODELACEAE	*Aloe tenuior* Haw.
Dicotyledon	PORTULACACEAE	*Anacampseros* sp. L.
Monocotyledon	POACEAE	*Andropogon* sp. L.
Monocotyledon	POACEAE	*Aristida congesta* Roem. & Schult.
Monocotyledon	POACEAE	*Aristida diffusa*
Monocotyledon	ASPARAGACEAE	*Asparagus africanus* Lam.
Monocotyledon	ASPARAGACEAE	*Asparagus* sp L.
Dicotyledon	ASPARAGACEAE	*Asparagus striatus* (L.f.) Thunb.
Monocotyledon	ASPARAGACEAE	*Asparagus suaveolens* Burch.
Dicotyledon	SALVADORACEAE	*Azima tetracantha* Lam.
Dicotyledon	ACANTHACEAE	*Barleria* sp. L.
Dicotyledon	ASTERACEAE	*Berkheya* sp.
Dicotyledon	ACANTHACEAE	*Blepharis* sp Juss.
Dicotyledon	ASTERACEAE	*Brachylaena discolor* DC.
Monocotyledon	ASPHODELACEAE	*Bulbine frutescens* (L.) Willd.
Dicotyledon	APOCYNACEAE	*Carissa bispinosa* (L.) Desf. ex Brenan
Dicotyledon	ASTERACEAE	*Chrysocoma ciliata* L.
Monocotyledon	COMMELINACEAE	*Commelina* sp.
Dicotyledon	ASTERACEAE	*Conyza canadensis* (L.) Cronquist
Dicotyledon	CRASSULACEAE	*Crassula expansa* Dryand.
Dicotyledon	CRASSULACEAE	*Crassula muscosa* L.
Dicotyledon	CRASSULACEAE	*Crassula perfoliata* L.
Dicotyledon	CRASSULACEAE	*Crassula* sp. L.
Dicotyledon	ARALIACEAE	*Cussonia spicata* Thunb.
Monocotyledon	COMMELINACEAE	*Cyanotis speciosa* (L.f.) Hassk.
Monocotyledon	POACEAE	*Cynodon dactylon* (L.) Pers.
Monocotyledon	CYPERACEAE	*Cyperus rotundus* L.
Monocotyledon	CYPERACEAE	*Cyperus semitrifidus* Schrad.
Monocotyledon	CYPERACEAE	*Cyperus* sp. L.
Dicotyledon	CARYOPHYLLACEAE	*Dianthus* sp. L.
Monocotyledon	POACEAE	*Digitaria eriantha* Steud.
Dicotyledon	EBENACEAE	*Diospyros austro-africana* De Winter
Dicotyledon	FABACEAE	*Dolichos* sp. L.
Dicotyledon	MESEMBRYSANTHEMACEAE	*Drosanthemum* sp. Schwantes
Dicotyledon	BORAGINACEAE	*Ehretia rigida* (Thunb.) Druce.
Monocotyledon	POACEAE	*Eragrostis capensis* (Thunb.) Trin.
Monocotyledon	POACEAE	*Eragrostis curvula* (Schrad.) Nees.
Monocotyledon	POACEAE	*Eragrostis obtusa* Munro ex. Ficalho & Hiern
Monocotyledon	POACEAE	*Eragrostis* sp.
Dicotyledon	ASTERACEAE	*Eriochephalus* sp. L.
Dicotyledon	FABACEAE	*Eriosema dregei* E.Mey.
Monocotyledon	ERIOSPERMACEAE	*Eriospermum* sp. Jacq. Ex Willd.

Dicotyledon	EBENACEAE	*Euclea undulata* Thunb.
Dicotyledon	EUPHORBIACEAE	*Euphorbia burmannii* E.Mey. Ex Boiss.
Dicotyledon	EUPHORBIACEAE	*Euphorbia caput-medusae* L.
Dicotyledon	EUPHORBIACEAE	*Euphorbia globosa* (Haw.) Sims
Monocotyledon	EUPHORBIACEAE	*Euphorbia meloformis*
Dicotyledon	EUPHORBIACEAE	*Euphorbia tetragona* Haw.
Dicotyledon	ASTERACEAE	*Felicia echinata* (Thunb.) Nees
Dicotyledon	ASTERACEAE	*Gazania krebsiana*
Dicotyledon	TILIACEAE	*Grewia robustai* Burch.
Dicotyledon	CELASTRACEAE	*Gymnosporia* sp. (Wight & Arn.) Hook.f.
Dicotyledon	STERCULIACEAE	*Hermannia althaeoides* Link
Dicotyledon	MALVACEAE	*Hibiscus pusillus* Thunb.
Dicotyledon	APOCYNACEAE	*Huernia hystrix* (Hook.f.) N.E.r.
Dicotyledon	FABACEAE	*Indigofera* sp. L.
Dicotyledon	CONVOLVULACEAE	*Ipomoea* sp. L
Dicotyledon	CRASSULACEAE	*Kalanchoe rotundifolia* (Haw.) Haw.
Dicotyledon	CUCURBITACEAE	*Kedrostis foetidissima* (Jacq.) Cogn.
Dicotyledon	HYACINTHACEAE	*Ledebouria* sp.
Dicotyledon	LAMIACEAE	*Leucas capensis* (Benth.) Engl.
Dicotyledon	FABACEAE	*Lotononis* sp. (DC.) Eckl. & Zeyh.
Dicotyledon	SOLANACEAE	*Lycium amoenum* Dammer
Dicotyledon	SOLANACEAE	*Lycium ferocissimum* Miers
Dicotyledon	SOLANACEAE	*Lycium hirsutum* Dunal.
Dicotyledon	SOLANACEAE	*Lycium oxycarpum* Dunal
Dicotyledon	SOLANACEAE	*Lycium* sp. L.
Monocotyledon	CYPERACEAE	*Mariscus* sp. Vahl.
Monocotyledon	POACEAE	*Merxmuellera distica* (Nees) Conert
Dicotyledon	RUBIACEAE	*Nenax microphylla* (Sond.) Salter
Dicotyledon	OLEACEAE	*Olea europaeae* L. supbsp. *Africana*(Mill.) P.S. Green
Dicotyledon	CACTACEAE	*Opuntia aurantiaca* Lindl.
Dicotyledon	CACTACEAE	*Opuntia ficus-indica* (L.) Mill.
Dicotyledon	CACTACEAE	*Opuntia linheimeri* Engelm.
Dicotyledon	ASTERACEAE	*Osteospermum* sp L.
Dicotyledon	OXALIDACEAE	*Oxalis smithiana* Eckl. & Zeyh.
Dicotyledon	APOCYNACEAE	*Pachypodium bispinosum* (L.f.) A.DC.
Monocotyledon	POACEAE	*Panicum maximum* Jacq.
Monocotyledon	POACEAE	*Panicum* sp. L.
Dicotyledon	SAPINDACEAE	*Pappea capensis* Eckl. & Zeyh
Dicotyledon	GERANIACAE	*Pelargonium sidoides* DC.
Dicotyledon	GERANIACAE	*Pelargonium* sp. L'Her.
Dicotyledon	ASTERACEAE	*Pentzia* sp. Thunb.
Dicotyledon	PLUMBAGINACEAE	*Plumbago* sp. L
Dicotyledon	POLYGALACEAE	*Polygala* sp. L
Dicotyledon	PORTULACACEAE	*Portulacaria afra* Jacq.
Dicotyledon	MESEMBRYSANTHEMACEAE	*Psilocaulon* N.E.Br.
Dicotyledon	CELASTRACEAE	*Putterlickia pyracantha* (L.) Szyszyl.
Dicotyledon	VITACEAE	*Rhoicissus* sp. Planch.
Dicotyledon	ANACARDIACEAE	*Rhus lancea* L.f.
Dicotyledon	ANACARDIACEAE	*Rhus longispina* Eckl. & Zeyh.
Dicotyledon	DRACAENACEAE	*Sansevieria hyacinthoides* (L.) Druce
Dicotyledon	GERANIACAE	*Sarcocaulon vanderietiae* L.Bolus
Dicotyledon	APOCYNACEAE	*Sarcostemma viminale* subsp. indet
Dicotyledon	FABACEAE	*Schotia afra* var indet
Dicotyledon	SCROPHULARIACEAE	*Selago corymbosa*L.

Dicotyledon	SCROPHULARIACEAE	*Selago* sp L.
Dicotyledon	ASTERACEAE	*Senecio pterophorus* DC.
Dicotyledon	ASTERACEAE	*Senecio radicans* (L.f.) Sch.Bip.
Dicotyledon	ASTERACEAE	*Senecio* sp.L.
Monocotyledon	POACEAE	*Setaria* sp. P. Beauv.
Monocotyledon	POACEAE	*Sporobolis* sp. R.Br.
Monocotyledon	POACEAE	*Themeda triandra* Forssk
Monocotyledon	ASPHODELACEAE	*Trachyandra asperata* Knuth.
Monocotyledon	ASPHODELACEAE	*Trachyandra* sp. Kunth.
Monocotyledon	COMMELINACEAE	*Tradescantia fluminensis* Vell.
Monocotyledon	POACEAE	*Tragus* sp Haller
Dicotyledon	MESEMBRYSANTHEMACEAE	*Trichodiadema* sp. Schwantes
Monocotyledon	IRIDACEAE	*Tritonia* sp. Ker Gawl.
Dicotyledon	VISCACEAE	*Viscum obovatum* Thunb.
Dicotyledon	VISCACEAE	*Viscum rotundifolium* L.f.
Dicotyledon	CAMPANULACEAE	*Wahlenbergia* sp. Schrad. Ex Roth
Monocotyledon	IRIDACEAE	*Watsonia* sp. Mill.
Dicotyledon	RHAMNACEAE	*Ziziphus mucronata* Willd.

Appendix C-2: IUCN Categories (Source: www.iucnredlist.org)

EXTINCT (EX)
A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

EXTINCT IN THE WILD (EW)
A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR)
A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.

ENDANGERED (EN)
A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.

VULNERABLE (VU)
A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.

NEAR THREATENED (NT)
A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

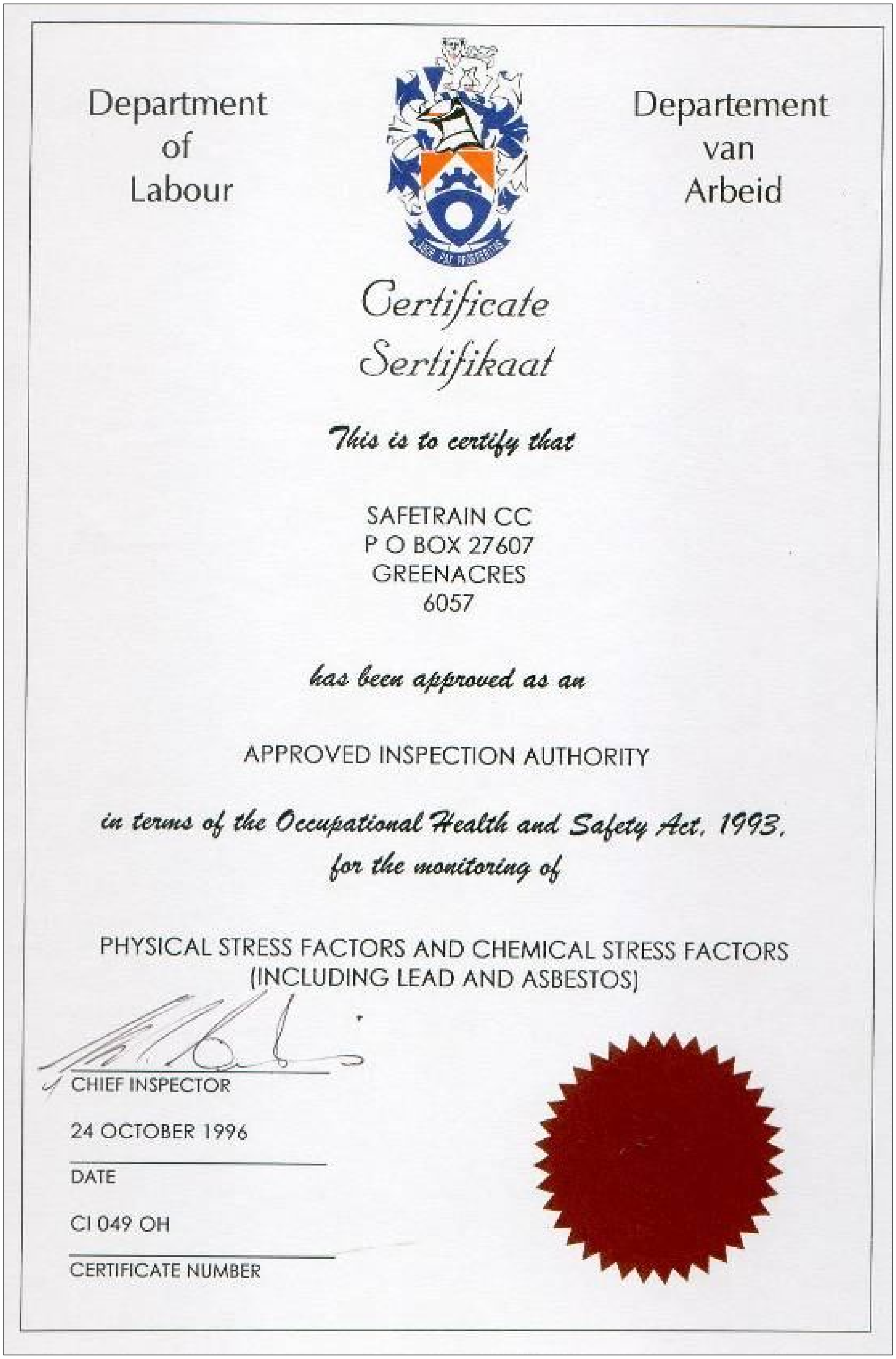
LEAST 1CONCERN (LC)
A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

DATA DEFICIENT (DD)
A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED (NE)
A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

APPENDIX D: NOISE

APPENDIX D-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 D-2: Calibration Certificate

SANAS

ACCREDITED LABORATORY

1492 1382

De Beer Calibration Services

De Beer Calibration Services cc
Registration No. 2000/057858/23
VAT No. 4860181787
East Dale Pavilion
C/o Hans Strydom and Jacqueline Drives
Garsfontein, Pretoria East
P.O. Box 905-654, Garsfontein X8, 0042
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

APPENDIX D-3: 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

APPENDIX D-4: Sound Perception

Change in Sound Level	Perception
3 dB	Barely perceptible
5 dB	Clearly perceptible
10 dB	Twice as loud

APPENDIX E: HERITAGE AND PALAEONTOLOGY

APPENDIX E-1: Summary of archaeological observations

1) S32.94039 E25.83906. A scatter of early Early Stone age material situated on the lower slopes of the hilltop referred to "Onder Smoorsdrift" on the farm Bygevoegt 164. The site which contains fine examples of Achaeulian bifaces, regular and irregular cores is (moderately) scattered over a wide but definable area on a gentle gradient above a river. The site is significant in that it is the only example of its kind found in the study area so far. Suggested grade: Locally significant 3b.
2) S32.93721 E25.83998. An eroded scatter of MSA material, mostly informal flakes, blades and large cores made from *hornfels* on a valley bottom cut through by a deep donga. This is one of very few instances where MSA material is noticeably denser than anywhere else. Suggested grade: low local significance grade 3c.
3) S32.85439 E25.84399. An eroded scatter of mostly MSA material found along the banks of a shallow stream bed. Low significance grade 3c
4) S32.91494 E25.96231. MSA material thinly associated with a dam and donga on the farm Olivewoods. Low local significance grade 3c.
5) S32.94035 E25.83911. A scatter of ceramics strewn over along the edges of an erosion gully which has cut into an alluvial fan (Farm Great Drift 173). The site is unusual as only ceramics in the style of Cape Coastal Pottery were noted. Pottery of this kind is associated with the period after 2000 years ago when pre-historic pastoralists entered the Cape bringing with them domestic stock and the knowledge o f working clay into pottery. Suggested grade locally significant 3b.
6) S32.87769 E25.86610. A large assortment of informal artefacts scattered widely over a large alluvial fan area on the farm Bijgevoegd 164. The site which lies on sandy land is cut through by a very large erosion gulley. The presence of up to 20 upper and lower grinding stones is a possible indication that there may be prehistoric graves here as such artefacts were used as grave markers or ornaments. No human remains were noted at the time of inspection. The raw material used was *Hornfels* and *Siltstone*. Suggested grade: moderately locally significant 3b.
7) S32.86062 E25.88585. There is a single disused set of farm buildings situated atGroot Rietfontein. The farm house which was originally a rectangular cottage built from home-made bricks and mud mortar. Apart from one end-wall, it has collapsed completely. Indications are that the structure is of late 19th century origin judging by the proportions of the last remaining window opening. Other features of the site are a corrugated outbuilding, stone wire kraal as well as various enclosures. There is a wind pump and a corrugated iron out-building. No historical artefactual material greater than 100 years of age was noted. Low local significance grade 3c.

APPENDIX E-2: Palaeontology GPS locality data

LOC.NO.	SOUTH			EAST			FEATURE
	DEG.	MIN.	SEC.	DEG.	MIN.	SEC.	
318	32	55	27.8	25	53	17.5	thick colluvial deposits
319	32	55	44.2	25	53	21.4	dolerite outcrop
320	32	55	13.6	25	54	14.4	cliff of Middleton Fm
321	32	54	54.6	25	53	40.2	mudrocks with disarticulated bones
322	32	50	39.2	25	49	15.3	mudrocks with calcrete nodules
323	32	52	39.2	25	51	09.9	sandstone colluvium
324	32	52	51.4	25	52	11.3	small bone fragment
325	32	53	11.1	25	52	31.0	quarry and donga in Middleton Fm
326	32	53	19.0	25	52	36.8	excavated mudrocks beneath pylons
327	32	53	19.4	25	52	44.8	mudrocks with pedogenic nodules
328	32	53	20.0	25	52	49.8	ditto
329	32	53	26.8	25	52	46.2	ditto
330	32	54	39.4	25	52	29.4	deformed Middleton Fm in riverbanks
331	32	54	53.3	25	53	36.7	calcrete nodules
332	32	54	50.9	25	53	33.2	mudrocks with disarticulated bones
333	32	54	52.6	25	53	01.8	donga exposure of mudrocks
334	32	56	58.2	25	49	40.5	fossil plants in roadside pit
335	32	50	56.0	25	47	56.0	Middleton F, sandstones
336	32	51	00.0	25	50	06.4	wave rippled sandstones
337	32	50	59.3	25	50	09.6	small disarticulated bones
338	32	50	58.6	25	50	11.0	fossil skulls, postcrania
339	32	51	21.6	25	52	00.7	streambed exposure of mudrocks
340	32	51	43.3	25	52	57.2	thick cliff section of Middleton Fm
341	32	51	35.5	25	53	02.1	riverine exposure of Middleton Fm
342	32	53	03.9	25	55	21.2	roadside mudrock exposure
343	32	52	16.6	25	57	37.4	“diggings” with calcretes
344	32	50	29.3	25	58	53.9	roadside quarry with calcretes
345	32	51	03.1	25	58	21.8	roadside quarry
346	32	52	28.1	25	57	54.2	roadside quarry
347	32	54	12.9	25	58	27.3	roadside quarry, vague trace fossils
348	32	56	39.3	25	57	57.7	roadside quarry
349	33	00	27.2	25	48	57.8	N10 roadcutting
350	32	59	00.6	25	48	52.8	N10 roadside cliff section
351	32	58	28.0	25	48	55.2	N10 roadcutting
352	32	58	09.8	25	48	58.0	N10 roadcutting
353	32	58	09.3	25	48	58.1	N10 roadcutting
354	32	58	04.4	25	48	57.6	N10 roadcutting
355	32	57	45.9	25	48	52.9	N10 roadcutting
356	32	57	45.0	25	48	52.5	N10 roadcutting
357	32	57	32.2	25	48	51.4	N10 roadcutting
358	32	56	46.3	25	48	46.9	N10 roadcutting
359	32	56	06.6	25	48	26.9	N10 roadcutting
360	32	52	27.3	25	47	18.9	N10 roadcutting
361	32	50	56.9	25	47	42.0	N10 roadcutting

All GPS readings were taken in the field using a hand-held Garmin GPSmap 60CSx instrument. The datum used is WGS 84.

Localities mentioned refer to exposures of the Middleton Formation (Beaufort Group) unless otherwise specified.