Final Environmental Impact Report

Proposed Renewable Energy Facility at the Perdekraal Site 2, Western Cape
DEA Ref: 12/12/20/1783

Mainstream SA

Final Report

May 2012

www.erm.com

Delivering sustainable solutions in a more competitive world

ERM

Mainstream Renewable Power South Africa

Final Environmental Impact Report

Proposed Renewable Energy Facility at the Perdekraal Site 2, Western Cape

May 2012

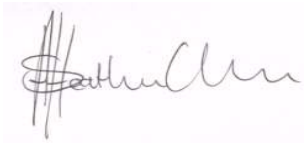
www.erm.com

DEA Reference: 12/12/20/1783
ERM Reference: 0108508

Prepared by: Tania Swanepoel and Lindsey Bungartz

For and on behalf of
Environmental Resources Management

Approved by: Stuart Heather-Clark

Signed: 

Position: Partner

Date: 02 May 2012

CONTENTS

ANNEXURES

Annex A: Maps and Figures
Annex B: Photographs
Annex C: Public Participation documentation
Annex D: DEA acceptance of Scoping
Annex E: Vegetation Specialist Report
Annex F: Ecology Specialist Report
Annex G: Bird Specialist Report
Annex H: Bat Specialist Report
Annex I: Noise Specialist Report
Annex J: Visual Specialist Report
Annex K: Heritage Specialist Report
Annex L: Environmental Management Plan

ACRONYMS

DEA	Department of Environmental Affairs
DEA&DP	Department of Environmental Affairs and Development Planning
DTS	Desk top study
EEZ	Exclusive Economic Zone
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EIR	Environmental Impact Assessment Report
EMP	Environmental Management Plan
EMS	Environmental Management Systems
ERM	Environmental Resources Management
I&APs	Interested & Affected Parties
IDP	Integrated Development Plan
NEMA	National Environmental Management Act
NGOs	Nongovernmental Organisations
SEP	Stakeholder Engagement Plan
REF	Renewable Energy Facility
ToR	Terms of Reference

ABBREVIATIONS

%	Percent
R	South African Rands
MW	Mega Watts
kV	Kilovolt
cm	Centimetres
m	Metres
km	Kilometres
Kg	Kilograms

DEFINITIONS AND TERMS

Alternative: A possible course of action, in place of another, that would meet the same purpose and need (of the proposal). Alternatives can refer to any of the following but are not limited to: alternative sites for development, alternative projects for a particular site, alternative site layouts, alternative designs, alternative processes and alternative materials.

Blade: The part of the turbine that is moved by the wind, there are three blades on a typical wind turbine.

Environment: The surroundings within which humans exist and that are made up of:

i. the land, water and atmosphere of the earth;
ii. micro-organisms, plant and animal life;
iii. any part or combination of (i) and (ii) and the interrelationships among and between them; and
iv. the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being. This includes the economic, social, cultural, historical and political circumstances, conditions and objects that affect the existence and development of an individual, organism or group.

Environmental Assessment: The generic term for all forms of environmental assessment for projects, plans, programmes or policies. This includes methods/tools such as environmental impact assessment, strategic environmental assessment, sustainability assessment and risk assessment.

Hub: The centre of a wind generator rotor, which holds the blades in place and attaches to the shaft.

Hub Height: The distance from ground level to the centre of the hub.

Impact: The positive or negative effects on human well-being and / or on the environment.

Interested and Affected Parties: Individuals, communities or groups, other than the proponent or the authorities, whose interests may be positively or negatively affected by the proposal or activity and/ or who are concerned with a proposal or activity and its consequences.

Lead Authority: The environmental authority at the national, provincial or local level entrusted in terms of legislation, with the responsibility for granting approval to a proposal or allocating resources and for directing or coordinating the assessment of a proposal that affects a number of authorities.

Mitigate: The implementation of practical measures to reduce adverse impacts or enhance beneficial impacts of an action.

Nacelle: The protective covering over a generator or motor.

Photovoltaic Cell (PV cell): A **PV cell** is a device that converts the energy of sunlight directly into electricity by the photovoltaic effect.

A Photovoltaic Panel (PV panel) is a packaged interconnected assembly of PV cells.

A Photovoltaic Array (PV array) is a linked collection of photovoltaic panels which will make up the solar installation on the proposed project site.

Rotor: Consists of the blade and hub, the mechanical link between the blades and the low-speed shaft.

Rotor Diameter: The diameter of a circle swept by the rotor measured from blade tip to blade tip.

Scoping: The process of determining the spatial and temporal boundaries (i.e. extent) and key issues addressed in an environmental assessment. The main purpose of scoping is to focus the environmental assessment on a manageable number of important questions. Scoping should also ensure that only significant issues ands reasonable alternatives are examined.

Significance: Significance can be differentiated into impact magnitude and impact significance. Impact magnitude is the measurable change (i.e. intensity, duration and likelihood). Impact significance is the value placed on the change by different affected parties (i.e. level of significance and acceptability). It is an anthropocentric concept, which makes use of value judgements and science-based criteria (i.e. biophysical, social and economic).

Stakeholder engagement: The process of engagement between stakeholders (the proponent, authorities and I&APs) during the planning, assessment, implementation and/or management of proposals or activities.

Wind measuring mast: A mast installed prior to wind farm development to monitor wind speed and direction.

1 INTRODUCTION

1.1 OVERVIEW

Mainstream Renewable Power South Africa, hereafter referred to as Mainstream SA, appointed Environmental Resources Management Southern Africa (Pty) Ltd, hereafter referred to as ERM, as independent environmental consultants to undertake the Environmental Impact Assessment (EIA) process for the proposed development of a renewable energy facility (REF) at the Perdekraal Site 2 (a portion of the Mainstream Perdekraal REF), in the Central Karoo (see *Figure 1.1*). The proposed facility will utilise wind turbines and photovoltaic cells to generate electricity that will be fed into the National Power Grid. The Perdekraal REF facility was proposed to have a collective generation capacity of between 310MW – 468MW, however the expected generation was adjusted based on specialist findings as the EIA progressed. The anticipated output of Perdekraal Site 2 is between 140MW and 150MW.

A Final Environmental Impact Report (EIR) for the proposed Mainstream Perdekraal REF was previously compiled and submitted to the Department of Environmental Affairs (DEA) in July 2011 (12/12/20/1783) and the environmental authorisation was obtained on 04 January 2012. In order to comply with the Department of Energy (DoE) Request for Proposal (RFP) for their Renewable Energy Independent Power Producer (IPP) Procurement Programme, Mainstream SA has requested that the existing authorisation be split into Perdekraal Site 1 and Perdekraal Site 2. This EIR therefore covers the REF proposed on Perdekraal Site 2, however reference is still made to the Perdekraal REF site as the whole site was assessed during the EIA process.

This Draft Environmental Impact Report (EIR) has been compiled as part of the EIA process in accordance with regulatory requirements stipulated in the EIA Regulations promulgated in terms of Section 24(5) of the National Environmental Management Act (NEMA) (Act No. 107 of 1998), as amended.

1.2 PURPOSE OF THE REPORT

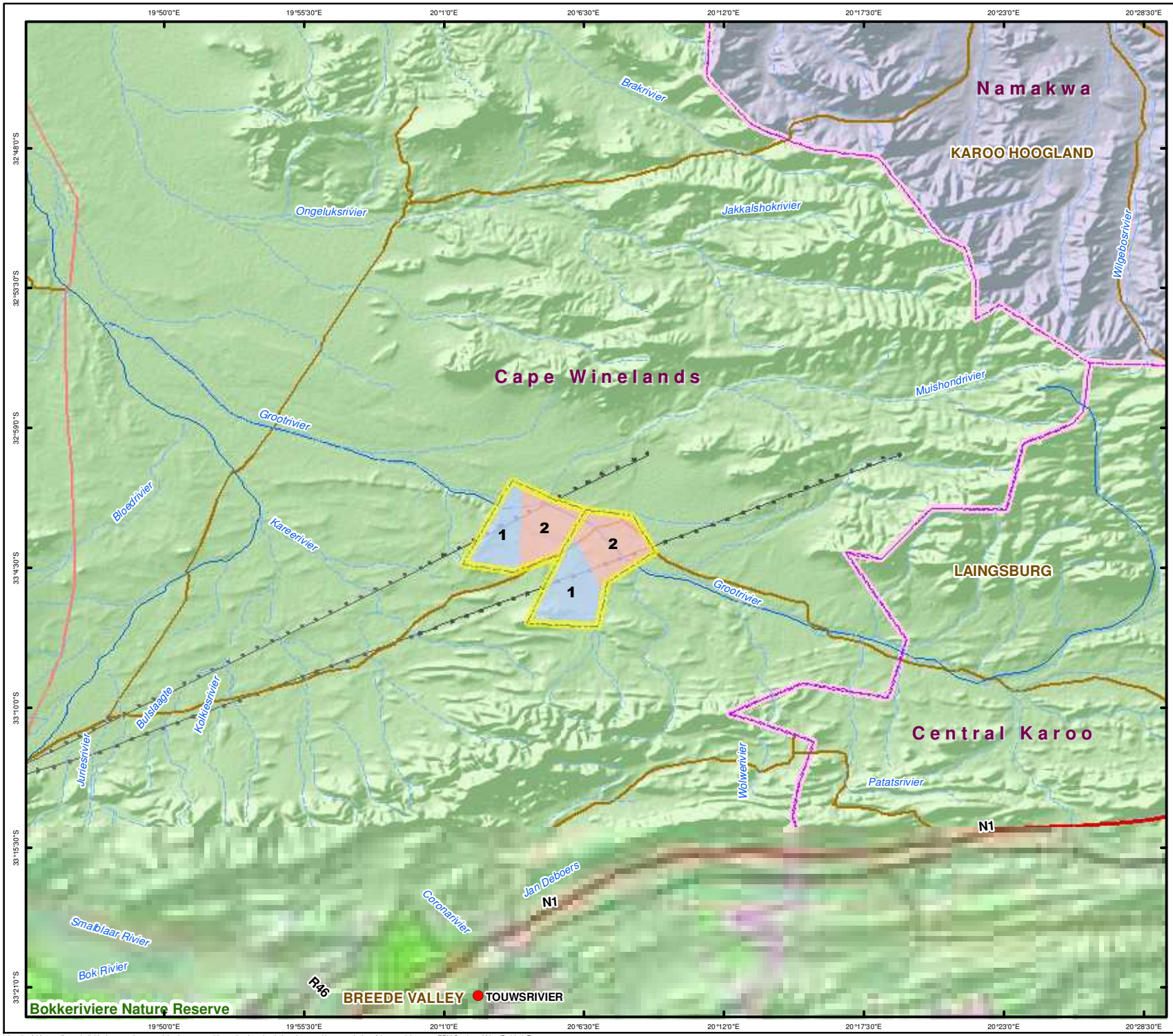
The information contained in the EIR along with comments and inputs received from stakeholders and commenting authorities will assist the competent authority, the National Department of Environmental Affairs (DEA) in deciding whether or not to grant environmental authorisation and inform the conditions associated with authorisation.

Fundamental to an environmental assessment is the identification, prediction and evaluation of the actual and potential environmental consequences of an activity and the options for mitigation of negative impacts and enhancement of positive impacts (DEAT, 2003). It is often possible to introduce measures to avoid, mitigate or compensate for many of the negative environmental

impacts of a particular development provided that these potential impacts are identified early in the planning process.

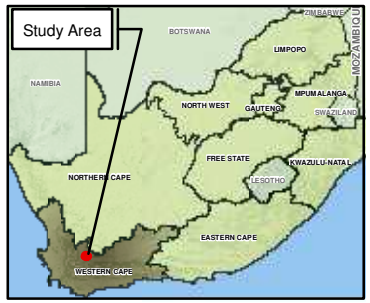
The objectives of this document are to:

- Communicate the results of the EIA process for the proposed development;
- Ensure that the impacts identified during the EIA process are adequately addressed;
- Provide a record of comments and responses received from I&APs during the process; and
- Facilitate informed, transparent and accountable decision-making process by the relevant authorities.



Legend

- Town
- Perennial River
- Non-Perennial River
- National Road
- Main Road
- Secondary Road
- Railway Line
- Transmission Line
- District Municipalities
- Local Municipalities
- Conservation Area
- National Park
- Perdekraal Land Parcels
- Perdekraal 1
- Perdekraal 2



SCALE: 0 2 4 6 8 10 Kilometers

N

TITLE:

Figure 1.1: Location of the Perdekraal REF

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Apr 2012	CHECKED: TS	PROJECT: 0080504
DRAWN: AB	APPROVED: SHC	Scale: 1:380 000

DRAWING: Perdekraal_Locality_REF.mxd | REV: 0

ERM
Block A, Silverwood House
Silverwood Close
Steenberg Office Park, 7945
Cape Town, SOUTH AFRICA
Tel: +27 (0)21 702 9100
Fax +27 (0)21 701 7900

Projection: Geographic, Datum: WGS84
Source: Enpat (2001), Demarcation Board (Dec 2005)
Inset: ESRI Data and Maps

SIZE: A4

T:\Gis Projects\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\30Apr12\Alt2 1\Perdekraal_Locality_REF.mxd

1.3 *PROJECT PROPONENT*

The project proponent is Mainstream Renewable Power South Africa (Mainstream SA). Early in 2009, Mainstream SA was formed by a joint venture agreement between Genesis Eco-Energy, a South African renewable energy development company, and Mainstream Renewable Power (http://www.mainstreamrp.com; www.genesis@eco.com), an international renewable energy development company based in Dublin, Ireland.

Genesis Eco-Energy has a long history in promoting renewable energy in South Africa and Mainstream Renewable Power was established in February 2008 to develop, build and operate renewable energy plants in collaboration with strategic partners across Europe, North America, South America and South Africa.

Mainstream Renewable Power was founded by Dr Eddie O'Connor and Fintan Whelan, the former CEO and Corporate Finance Manager, respectively, of Airtricity, a successful renewable energy company based in Dublin, Ireland.

Mainstream SA combines Genesis Eco-Energy's local knowledge, skills and relationships with Mainstream's global strengths in areas such as finance, engineering and procurement. The experienced staff have a strong track record of funding, developing and delivering large-scale wind projects around the world. Mainstream SA is based in Cape Town and Johannesburg.

The vision for Mainstream SA is to develop, build and operate in excess of 500 MW of wind and solar projects by 2014.

1.4 *DETAILS OF ENVIRONMENTAL PRACTITIONER*

ERM were appointed by Mainstream SA to undertake the EIA for the proposed development. ERM and the specialists appointed by ERM during the course of this EIA have no financial ties to nor are they a subsidiary, legally or financially, of Mainstream SA. Remuneration for the services by the Applicant (Mainstream SA) in relation to this EIA is not linked to approval by any decision-making authority and ERM has no secondary or downstream interest in the development.

The Partner in Charge, Stuart Heather-Clark, is a certified environmental assessment practitioner and the project has been conducted in terms of the code of ethics promulgated by the Certification Board for Environmental Assessment Practitioners of South Africa (EAPSA), which includes a requirement for independence.

ERM is a global environmental consulting organisation employing over 3500 specialists in over 145 offices in more than 41 countries. Founded in 1971, ERM has built an organisation based on the supply of a full range of environmental and social policy, scientific, technical, and regulatory expertise.

Our primary focus is to provide quality work and service to our clients in these areas.

From a regional perspective ERM has been involved in numerous projects in Africa over the past 30 years and in 2003 established a permanent presence in the region to meet the growing needs of our clients. The Southern African ERM offices are based in Cape Town, Johannesburg, Pretoria and Durban. The Southern African Operating Company has a staff complement of over 120 dedicated environmental professionals offering expert skills in EIA, EMP, EMS, risk assessment, EHS management and auditing, corporate social responsibility and socio-economic impact assessment, climate change services, specialist groundwater services as well as contaminated site management.

The responsible personnel at ERM for completing the EIA include Stuart Heather-Clark, Tania Swanepoel and Lindsey Bungartz. Kerryn McKune of ERM provided socio-economic specialist input. Details of the environmental assessment practitioners (EAPs) are provided in *Table 1.1* below.

Table 1.1 Details of Environmental Assessment Practitioners

Name	Stuart Heather-Clark
Responsibility	Partner in Charge
Degree	MPhil Environmental Science and BSc Civil Engineering
Professional registration	Certified EAPSA
Experience in years	15
Experience	15 years experience in EIA in South Africa and various African Countries.

Name	Tania Swanepoel
Responsibility	Project manager
Degree	B.Sc (Hons) (Geology); B.Sc (Hons) (Engineering & Env Geology)
Professional registration	Pr Sci Nat, IAIA
Experience in years	13
Experience	Tania has over thirteen years experience in environmental consulting and engineering geology.

Name	Lindsey Bungartz
Responsibility	Project consultant
Degree	BSocSci Hons (Environmental Management)
Professional registration	IAIA member
Experience in years	3
Experience	Lindsey has over three years experience undertaking basic assessments and EIAs in South Africa

1.5 REPORT STRUCTURE

The structure of this Scoping Report is as follows:

Table 1.2 Report structure

Section	Contents
Section 1 Introduction	Contains a brief description of the proposed activity and an outline of the report structure.
Section 2 Regulatory Framework	Describes the legislative, policy and administrative requirements applicable to the proposed development.
Section 3 Approach and Methodology	Outlines the approach to the EIA study and summarises the process undertaken for the project to date.
Section 4 Project Description	Includes a detailed description of the proposed activities and the alternatives.
Section 5 Environmental Baseline	Describes the receiving biophysical baseline environment.
Section 6 Social Baseline	Describes the receiving socio-economic baseline environment
Section 7 Impacts on Flora and Fauna	Describes and assesses the potential impacts of the proposed development on flora and fauna. Mitigation measures are also recommended.
Section 8 Impacts on Birds	Describes and assesses the potential impacts of the proposed development on birds and describes relevant mitigation measures.
Section 9 Impacts on Bats	Describes and assesses the potential impacts of the proposed development on bats and describes relevant mitigation measures.
Section 10 Impacts on soils, surface and groundwater	Describes and assesses the potential impacts of the proposed development on soils, surface and groundwater. Mitigation measures are also recommended.
Section 11 Noise Impacts	Describes and assesses the potential noise impacts of the proposed development and describes relevant mitigation measures.
Section 12 Visual Impacts	Describes and assesses the potential visual impacts of the proposed development and describes relevant mitigation measures.
Section 13 Impacts on Cultural Heritage	Describes and assesses the potential impacts of the proposed development on cultural heritage aspects and describes relevant mitigation measures.
Section 14 Socio-Economic Impacts	Describes and assesses the potential socio-economic impacts of the proposed development and describes relevant mitigation measures.
Section 15 Other Impacts	Describes and assesses other potential impacts of the proposed development and describes relevant mitigation measures.
Section 16 Cumulative Impacts	Qualitatively assesses potential cumulative impacts.
Section 17 Decommissioning	Describes and discusses the potential impacts of the decommissioning of the development.
Section 18 Conclusions and Recommendations	Summarises the key findings of the EIA and provides recommendations for the mitigation of potential impacts and the management of the proposed project.
Section 19 References	Contains a list of references used in compiling the report and specialist studies.
Section 20 Annexes	

In addition, the report includes the following annexes:

Annex A: Maps and Figures
Annex B: Photographs
Annex C: Public Participation documentation
Annex D: DEA acceptance of Scoping and Relevant Listed Activities
Annex E: Vegetation Specialist Report
Annex F: Ecology Specialist Report
Annex G: Bird Specialist Report
Annex H: Bat Specialist Report
Annex I: Noise Specialist Report
Annex J: Visual Specialist Report
Annex K: Heritage Specialist Report
Annex L: Environmental Management Plan

1.6 OPPORTUNITY TO COMMENT ON THE FINAL ENVIRONMENTAL IMPACT REPORT

Interested and Affected parties (I&APs) and authorities were provided with an opportunity to comment on any aspect of the proposed activity and the Environmental Impact Report (EIR). A hardcopy of the EIR was made available at the Touwsrivier Public Library and can be accessed electronically at www.erm.com/mainstream_sa

A notification letter was sent to all registered and identified I&APs to inform them of the release of the EIR and where the report could be reviewed.

A public meeting was be held at Touwsrivier Primary School Hall on 25 March 2011 to present the findings of the impact assessment phase (including specialist studies) and facilitate the gathering of comments. Newspaper adverts were placed and notifications were sent to I&APs on 11 March 2011, notifying members of the public and I&APs of the public meeting.

Comments on the Final EIR were forwarded to Ms. B. Xalipi of the Department of Environmental Affairs on Tel: 012 310 3105, Fax: 012 320 7539 email: Bxalipi@environment.gov.za or Private Bag X447, Pretoria 0001, or to ERM at the address, tel. /fax numbers or e-mail address shown below.

Att: Lindsey Bungartz
DEA ref: 12/12/20/1787 – Perdekraal Site
ERM Southern Africa (Pty) Ltd
Postnet Suite 90,
Private Bag X12
Tokai, Cape Town,
7966
Tel: (021) 702 9100; Fax: (021) 701 7900
E-mail: mainstream.sa@erm.com

The Scoping Report contained a detailed description of the legislative and policy requirements and guidelines that are relevant to the proposed activity and associated EIA.

The applicable legislation and guidelines include the following:

National:

- National Environmental Management Act (Act No. 107 of 1998), as amended;
- NEMA EIA Regulations, 2006 (Government Notice No R. 385, R. 386 and R. 387);
- National Environmental Management: Biodiversity Act (Act No. 10 of 2004);
- National Heritage Resources Act (Act No. 25 of 1999);
- Electricity Regulation Act (Act No. 4 of 2006);
- Aviation Act (Act No. 74 of 1962);
- Occupational Health and Safety Act (Act No. 85 of 1993);
- Subdivision of Agricultural Land Act (Act No. 70 of 1970); and
- Department of Environmental Affairs and Tourism (DEAT) Integrated Environmental Management Information Series.

Provincial:

- Western Cape Planning and Development Act (Act No. 7 of 1999);
- Department of Environmental Affairs & Development Planning (DEA&DP) NEMA EIA Regulations Guideline and Information Document Series, 2009; and
- Strategic Initiative to Introduce Commercial Land Based Wind Energy Development to the Western Cape, 2006.

International:

- Equator Principles;
- IFC Performance Standards; and
- Clean Development Mechanism (CDM).

The relevant legislation pertaining to the Environmental Authorisation for development is the National Environmental Management Act (NEMA) (No. 107 of 1998) as amended and the Environmental Impact Assessment (EIA) Regulations of 2006 promulgated under NEMA as well as the Amended EIA Regulations of 2010. The relevance of this legislation is summarised below.

2.1 *NATIONAL ENVIRONMENTAL MANAGEMENT ACT*

Section 24 of the National Environmental Management Act (NEMA) (Act No. 107 of 1998, as amended) gives effect to the South African Constitution, which states that all South African citizens have a right to an environment that is not harmful to their health or well being. The Act requires that activities be investigated that may have a potential impact on the environment, socio-economic conditions and cultural heritage. The results of such investigation must be reported to the relevant authority. Procedures for the investigation and communication of the potential impact of activities are contained in Section 24 (7) of the Act.

2.2 *NEMA EIA REGULATIONS*

On 21 April 2006, EIA Regulations (Government Notice No R. 385, R386 and R387) were promulgated in terms of Section 24(5) of NEMA. These regulations came into effect on 3 July 2006. The Minister of Water and Environmental Affairs has in terms of sections 24(2)(a) and (d) of NEMA, listed the activities which may have a detrimental effect on the environment in Government Notice R386 and R387.

The regulations require that written authorisation is obtained from the Minister or his delegated authority, in this case the national Department of Environmental Affairs (DEA), in respect of which the investigation, assessment and communication of potential impacts of these activities must follow the procedure as described in Regulations 27 to 36 of the EIA Regulations. Such authorisation, which may be granted subject to conditions, will only be considered once the regulatory requirements have been met. Government Notice R385 sets out the procedures that need to be complied with.

The activities that would be relevant to the proposed renewable energy facility are listed in the Environmental Impact Assessment (EIA) Regulations. Activities from listings R386 and R387 would be relevant. R386 activities require a simpler Basic Assessment and R387 activities require a more comprehensive Scoping and EIA. Given the applicability of activities from both listings, R387 supersedes R386 and a Scoping and EIA process is being undertaken.

The listed activities from both R386 and R387 are described below.

Government Notice R386:

Activity 1(m) – "The construction of facilities or infrastructure, including associated structures or infrastructure, for any purpose any purpose in the one in ten year flood line of a river or stream, or within 32 metres from the bank of a river or stream where the flood line is unknown, excluding purposes associated with existing residential use, but including - (i) canals; (ii) channels;

(iii) bridges; (iv) dams; and (v) weirs."

Activity 7 – "The aboveground storage of dangerous goods, including petrol diesel, liquid petroleum gas or paraffin, in containers with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres at any one location or site."

Activity 12 - "The transformation or removal of indigenous vegetation of 3 hectares or more or of any size where the transformation or removal would occur within a critically endangered or an endangered ecosystem listed in terms of section 52 of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)."

Activity 14 - "The construction of masts of any material or type and of any height, including those used for telecommunication broadcasting and radio transmission, but excluding a) mast of 15 metres and lower."

Activity 15 - "Road construction if wider than 4m or with reserve wider than 6m unless within ambit of another listed activity or which are access roads of less than 30m long".

Activity 16 (b) – "The transformation of undeveloped, vacant or derelict land to residential, mixed retail, commercial, industrial or institutional use where such development does not constitute infill and where the total area to be transformed is bigger than 1 hectare.

Government Notice R387:

Activity 1(a) – "The construction of facilities or infrastructure, including associated structures or infrastructure, for the generation of electricity where - (i) the electricity output is 20 megawatts or more; or (ii) the elements of the facility cover a combined area in excess of 1 hectare."

Activity 1(I) - "The construction of facilities or infrastructure, including associated structures or infrastructure for the transmission and distribution of above ground electricity with a capacity of 120 kilovolts or more."

Activity 2 - "Any development activity, including associated structures and infrastructure, where the total area of the developed area is, or is intended to be, 20 hectares or more."

2.3 AMENDED EIA REGULATIONS

The NEMA EIA Amendment Regulations of 2010 came into effect on 2 August 2010. These regulations, as with the previous EIA Regulations, have been promulgated in terms of the National Environmental Management Act (Act No. 107 of 1998) (NEMA), as amended. They replace the previous EIA Regulations and comprise three sets of listed activities, Basic Assessment

activities (Listing Notice 1 – R544), activities requiring a Scoping/EIA (Listing Notice 2 – R545) and activities requiring environmental authorization in specific geographical areas (Listing Notice 3 – R546). The procedure to be followed and criteria relating to the submission, processing and consideration and decisions on applications for environmental authorisation are outlined in Government Notice No. R543.

The transitional arrangements applicable to regulations are dealt with in Chapter 9 of R543, in terms of which pending applications (as is the case with this application) must be dispensed with in terms of the previous Regulations as if these new Regulations were not promulgated. However, if the application pending has components which were not listed previously but are listed now, the competent authority may authorise the current listed activity as if it were applied for provided the impacts and the requirements of the new regulations have been considered and assessed. Some listed activities have changed with the introduction of geographical areas and different thresholds however components listed under the new Regulations were previously listed under the old EIA Regulations of 2006. A list of relevant activities from the EIA Regulations of 2006 and the EIA Amendment Regulations of 2010, is included in Annex D.

2.4 OTHER RELEVANT LEGISLATION

2.4.1 Legislation Regulating Heritage Resources

The protection and management of South Africa's heritage resources is controlled by the National Heritage Resources Act (NHRA), 1999 (Act No. 25 of 1999). The objective of the NHRA is to introduce an integrated system for the management of national heritage resources.

Archaeology, Palaeontology and Meteorites

According to Section 35 (Archaeology, Palaeontology and Meteorites) and Section 38 (Heritage Resources Management) of the South African National Heritage Resources Act, palaeontological heritage impact assessments (PIAs) and archaeological impact assessments (AIAs) are required by law in the case of developments in areas underlain by potentially fossiliferous (fossil-bearing) rocks, especially where substantial bedrock excavations are envisaged, and where human settlement is know to have occurred during prehistory and the historic period. Depending on the sensitivity of the fossil and archaeological heritage, and the scale of the development concerned, the palaeontological, and archaeological impact assessment required may take the form of (a) a stand-alone desktop study, or (b) a field scoping plus desktop study leading to a consolidated report. In some cases these studies may recommend further palaeontological and archaeological mitigation, usually at the construction phase. These recommendations would normally be endorsed by the responsible heritage management authority, Heritage Western Cape, to whom

the reports are submitted for review. *Table 2.1* outlines when a permit is required depending on the sensitivity of the heritage resources.

Table 2.1 Permitting requirements for fossil, built environment and Stone Age archaeology

PERMIT APPLICATION SECTION 35 – FOSSILS, BUILT ENVIRONMENT FEATURES, SHIPWRECKS & STONE AGE ARCHAEOLOGY (Ref : NHRA 1999: 58):
(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite; (b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite; (c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite

Burial Grounds and Graves

A Section 36 permit application is made to the South African Heritage Resources Agency (SAHRA) which protects burial grounds and graves that are older than 60 years and must conserve and generally care for burial grounds and graves protected in terms of this section, and it may make such arrangements for their conservation as it sees fit. SAHRA must also identify and record the graves of victims of conflict and any other graves which it deems to be of cultural significance and may erect memorials associated with these graves and must maintain such memorials. A permit is requires under the following conditions:

Table 2.2 Permitting requirements for burial grounds and graves older than 60 years to Heritage Western Cape (HWC) and historic burials to the South African HeritageResources Agency (SAHRA)

PERMIT APPLICATION SECTION 36 – BURIAL GROUNDS & GRAVES (REF: NHRA 1999 : 60)
(a) destroy, damage, alter, exhume or remove from its original position or otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves (b) destroy, damage, alter, exhume, remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; or (c) bring onto or use at a burial ground or grave referred to in paragraph (a) or (b) any excavation equipment, or any equipment which assists in the detection or recovery of metals (d) SAHRA or a provincial heritage resources authority may not issue a permit for thedestruction or damage of any burial ground or grave referred to in subsection (3)(a) unless it is satisfied that the applicant has made satisfactory arrangements for the exhumation and re-interment of the contents of such graves, at the cost of the applicant

Heritage Impact Assessment within the EIA in terms of Section 38

A section 38 application is made to HWC when a Heritage Impact Assessment (HIA) is to be undertaken as a specialist study within the Environmental Impact Assessment (EIA) in terms of Section 38 (8) to undertake a development categorised in below.

Table 2.3 Permitting requirements for demolition of built environment features

PERMIT APPLICATION SECTION 38 (Ref: NHRA 1999 : 62)
(a) the construction of a road, wall, powerline, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length; (b) the construction of a bridge or similar structure exceeding 50 m in length; (c) any development or other activity which will change the character of a site exceeding 5 000 m2 in extent; or (ii) involving three or more existing erven or subdivisions thereof; or (iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or (iv) the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority; (d) the re-zoning of a site exceeding 10 000 m2 in extent; or (e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority

The provisions of this section do not apply to a development if an evaluation of the impact of that development on heritage resources is required in terms of the NEMA and the associated EIA Regulations or the Minerals and Petroleum Resources Development Act, or any other legislation, provided that the consenting authority must ensure that the evaluation fulfils the requirements of the relevant heritage resources authority, and any comments and recommendations of the relevant heritage resources authority with regard to such development have been taken into account prior to the granting of the consent.

2.4.2 Legislation Relating to Fauna and Flora

National Environmental Management: Biodiversity (Act 10 of 2004)

This Act seeks to provide for the management and conservation of biological diversity and its components, the sustainable use of indigenous biological resources, and the fair and equitable sharing of benefits arising from bio-prospecting of indigenous biological resources, amongst others. It further seeks to provide for co-operative governance in biodiversity management and conservation.

Significantly, the Act provides for the protection of ecosystems and species that are threatened or in need of protection and seeks to prevent the introduction and spread of alien or invasive species (see also the Conservation of Agricultural Resources Act, below). As such, it controls and regulates:

- certain threatening activities occurring in identified ecosystems;
- certain activities which may negatively impact on the survival of identified threatened or protected species; and
- certain restricted activities involving alien or listed invasive species.

In accordance with the Biodiversity Act, an important function of the EIA and associated specialist studies is to ensure that sensitive fauna and flora are not

detrimentally affected by the installation and construction activities associated with the proposed development.

The specialist studies conducted as part of the EIA including those for birds, bats and ecology are aimed at assisting the assessment of potential impacts and providing mitigating measures for the negative impacts of the proposed REF.

Conservation of Agricultural Resources Act (Act 43 of 1983)

The Conservation of Agricultural Resources Act, as amended defines different categories of alien plants and those listed under Category 1 are prohibited and must be controlled while those listed under Category 2 must be grown within a demarcated area under permit. This would have relevance if farming activities were to change dramatically with the introduction of the REF or if alien species were used for re-vegetation of areas, neither of which is intended for this project.

2.4.3 Regulations and Guidelines Governing Noise

South African National Standard (SANS)

The noise impact investigation and assessment was conducted in accordance with procedures contained in Section 8 of the South African National Standard (SANS) 10328, *Methods for environmental noise impact assessment* which prescribes how these assessments should be undertaken if required under the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA).

SANS 10328 contains procedures to be followed to estimate the predicted impact that noise emanating from a proposed development will have on potentially affected land based on objective, scientific principles. The purpose of the investigation is to determine and quantify the acoustical impact of a proposed development. The predicted impact is assessed in accordance with SANS 10103, *The measurement and rating of environmental noise with respect to annoyance and to speech communication*, by determining whether the rating level of the predicted noise will exceed the residual (background) noise level on that land and/or the typical rating level of noise pertaining to the particular district and relating this excess to the estimated response by a community to the noise.

World Health Organisation (WHO)

The World Health Organisation (WHO) contains the following summary of thresholds for noise nuisance in terms of outdoor daytime L_{Aeq} in residential districts (WHO 2002):

- At 55-60 dBA noise creates annoyance.
- At 60-65 dBA annoyance increases considerably.

- Above 65 dBA constrained behaviour patterns, symptomatic of serious damage caused by noise, arise.

The WHO recommends a maximum outdoor daytime L_{Aeq} of 55 dBA in residential areas and schools "*in order to prevent significant interference with normal activities of local communities*". It further recommends a maximum night-time L_{Aeq} of 45 dBA outside dwellings (WHO 2002). No distinction is made as to whether the noise originates from road traffic, from industry, or any other noise source.

These recommended maximum levels correspond to the typical daytime rating levels for ambient noise in an urban district referred to in SANS 10103.

Noise Control Regulations (NCR),

The South African legal requirements relating to noise are contained in the National Noise Control Regulations (NCR), GN R154 in Government Gazette No. 13717 dated 10 January 1992. The NCR stipulates that no person may produce or cause a disturbing noise. In essence, the noise emanating from a particular source may not cause an increase of the ambient (prevailing) noise level in an area by more than 6 dB. However, no distinction is made regarding the zoning and use of the affected land and the impact of the prevailing and future noise level.

In terms of Clause 3 (c) of the Noise Control Regulations:

"No person shall make changes to existing facilities or existing use of land or buildings or erect new buildings, if these will house or cause activities that will, after such changes or erection, cause a disturbing noise, unless precautionary measures to prevent the disturbing noise have been taken to the satisfaction of the local authority."

In terms of Clause 4 of the Noise Control Regulations:

"No person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, animal, machine, device or apparatus or any combination thereof."

2.4.4 Legislation and Guidelines Governing Visual

At a national level, the following legislation could apply to visual assessments:

- The National Environmental Management Act (NEMA) and the Regulations in terms of Chapter 5 of NEMA. (Act No.107 of 1998).

- The Protected Areas Act (PAA) (Act 57 of 2003, Section 17), intended to, inter alia, protect natural landscapes.

- The National Heritage Resources Act (NHRA) (Act No. 25 of 1999) and the associated provincial regulations provide legislative protection for listed

or proclaimed sites, such as urban conservation areas, nature reserves and proclaimed scenic routes.

At the provincial level, the following guideline reports could apply:

- Guideline for Involving Visual and Aesthetic Specialists in EIA Processes (B. Oberholzer, 2005). In terms of this report a full 'Level 4' visual assessment is required.

- A Strategic Initiative to Introduce Commercial and Land Based Wind Energy Development to the Western Cape.

The "Strategic Initiative to Introduce Commercial and Land Based Wind Energy Development to the Western Cape" was drafted in 2006 and provides a broad guiding framework for the location of wind energy development in both urban and rural areas, based on the sensitivity and capacity of landscape types and the scale of the project. The Report indicates that, in the rural context, where most commercial wind farms will be located, large scale 'open' landscapes and/or 'disturbed' rural landscapes are preferred for the siting of wind farms. The report further states that

The Report further states that Commercial Wind Energy development should be excluded from:

- Areas of high aesthetic landscape value, particularly national parks and provincial nature reserves and other wilderness areas.
- Areas where technical and safety considerations apply.

Wind energy should be encouraged:

- At strategic locations identified in a Regional Wind Plan (RWP) to be prepared by the relevant planning authority.
- Where they are well located in terms of visual impact, technical and safety criteria and landscape, environmental and planning criteria.
- In large concentrated wind farms rather than small dispersed locations where the distance between large wind farms is at least 30km, and ideally exceeding 50km.
- In appropriate urban and industrial "brownfield" sites.
- Where visual disturbance to the landscape has already occurred (e.g. power transmission lines).
- At the local scale where individual turbines (not exceeding 50m in total height) could provide power to small users.

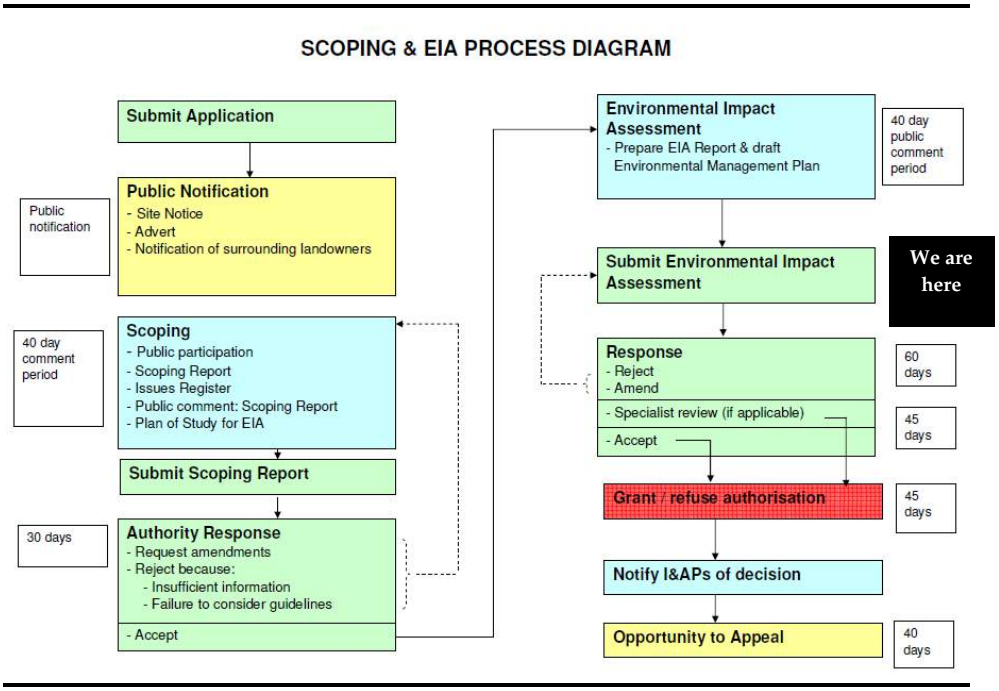
These criteria have not been legislated and serve as guidelines.

3.1 THE EIA PROCESS

EIA is a systematic process that identifies and evaluates the potential impacts a proposed project may have on the biophysical and socioeconomic environment, and develops mitigation measures that will be incorporated in order to avoid, minimise or reduce these impacts. The overall EIA process required for developments in South Africa is shown schematically in *Figure* 3.1. The EIA is not fully a linear process, but one where several stages are carried out in parallel and where the assumptions and conclusions are revisited and modified as the project progresses. The following sections provide additional detail regarding the key stages in the EIA process. These stages are:

- project initiation;
- scoping study phase; and
- integration and assessment phase.

Figure 3.1 EIA Flow Diagram



3.1.1 Project Initiation Phase

The project initiation phase began with a project inception meeting followed by a review of any available project related background information. Key activities during this phase of the project included the following:

- An initial site visit by the applicant and ERM on 01 December 2009;

- Submission of an EIA Application to DEA and receipt of the DEA reference number (12/12/20/1783) for the project in February 2010;

- Authorities meeting with DEA, ERM and Mainstream SA on 12 January 2010 to discuss and agree on the proposed approach to the Scoping/EIA;

- Compilation of a preliminary database of neighbouring landowners, authorities (local and provincial), Non-Governmental Organisations and other key stakeholders into a database of registered I&APs which has been and will be expanded during the ongoing EIA process; and

- Compilation of a Background Information Document (BID) for distribution to I&APs.

3.1.2 Scoping Phase

Environmental scoping has several important functions aimed at facilitating decision-making. These include the following:

- providing a description of the proposed project;
- reviewing existing information and gain an understanding of the baseline environmental conditions;
- identifying any gaps in information and uncertainties;
- investigation and screening of alternatives;
- obtaining input from interested and affected parties about their issues and concerns;
- identifying and assessing potential environmental and social impacts associated with the project; and
- identifying of potential mitigation and management measures.

Accordingly the Scoping Report provided a detailed overview of the project, the associated Public Participation Process, and proposed an EIA methodology. A preliminary identification and evaluation of potential impacts was presented and Plan of Study for the EIA. The draft Scoping Report was released for a 40 day public review period (5 May 2010 to 14 June 2010) prior to submission to the DEA. The Scoping Report was submitted to the DEA on 09 July 2010 and accepted by the DEA on the 23 September 2010 (*Annex D*).

Public Participation

The tasks relating to public participation during the Scoping Phase and included in the Scoping Report are summarised below:

- Expansion of the I&AP database;

- Newspaper advertisements in Die Burger and Cape Times on 18 March 2010 and the Worcester Standard on 11 March 2010 ;

- Distribution of the Background Information Document (BID);
- Erection of on-site notices;
- Throughout the EIA process to date, issues and concerns raised by I&APs and authorities, and communicated to ERM via post, email or fax were recorded and submitted with the Final Scoping Report in *Annex C*;
- The release of the Scoping Report for a 40-day public and authority comment period;
- Placing of a newspaper advert in the Worcester Standard on the 6 May 2010, informing the public of the open day/public meeting to be held in Touwsrivier; and
- An open day/public meeting at the Touwsrivier Primary School on 28 May 2010.

3.1.3 Integration and Assessment

The final phase of the EIA is the Integration and Assessment Phase, which is described in detail in the Plan of Study for EIA included in the Scoping Report. A synthesis of the specialist studies, which addresses the key issues identified during the Scoping Phase, is documented in this Draft EIR. Relevant technical and specialist studies are included as appendices to the Draft EIR.

The Draft EIR will be made available to I&APs for a 30-day comment period, and a notification letter will be sent to all registered and identified I&APs to inform them of the release of the Draft EIR and where the report can be reviewed. State Departments must submit comments within 40 days.

Comments received on the Draft EIR will be assimilated and the EIA project team will provide appropriate responses to all comments. A Comments Report will be appended to the Final EIR, which will be submitted to DEA for decision-making.

All registered I&APs will be notified when an Environmental Authorisation has been issued by DEA. A 40-day appeal period will follow the issuing of the Environmental Authorisation.

Specialist Studies

During the Specialist Study phase, the appointed specialists gathered data relevant to identifying and assessing environmental impacts that might occur as a result of the proposed project. They assisted the project team in assessing potential impacts according to a predefined assessment methodology included in Scoping Report (see also *Section 3.2*). Specialists have also suggested ways in which negative impacts could be mitigated and benefits could be enhanced.

The specialists responsible for the specialist studies were:

- Noise study – Adrian Jongens (Jongens Keet and Associates);
- Archaeological and cultural heritage study – Mary Patrick (Cape Archaeology Survey);
- Visual and landscape study – Bernard Oberholzer and Quinton Lawson;
- Botanical study – David MacDonald (Bergwind Botanical Surveys);
- Fauna study – Simon Todd (University of Cape Town);
- Bird study – Andrew Jenkins (AVISENSE Ornithological Consulting);
- Bats study – David Jacobs (University of Cape Town); and
- Social study – Kerryn McKune (ERM).

The independent specialists responsible for the specialist studies and their qualifications are listed in *Table 3.1.*

Table 3.1 Independent Specialist Studies and Appointed Specialists

Specialist Study	**Specialists and Organisation**	**Qualifications**
Ecological and Biodiversity study	Simon Todd (Simon Todd Consulting)	MSc Conservation Biology, University of Cape Town
Bird study	Andrew Jenkins (AVISENSE Ornithological Consulting)	PhD Zoology, University of Cape Town
Bats study	David Jacobs (University of Cape Town)	PhD in Zoology 18 years bat research
Noise study	Adrian Jongens (Jongens Keet Associates)	M.Sc. Electrical Engineering, University of Cape Town
Visual and Landscape study	Bernard Oberholzer, (Bernard Oberholzer Landscape Architect (Bola)	B.Arch, University of Cape Town and MLA, Univ. of Pennsylvania
	Quinton Lawson (MLB Architects)	PrArch BArch, University of Natal
Archaeological, Heritage and Paleontological study	Lita Webley (ACO Associates *cc*.)	PhD Archaeology, University of Cape Town
	David Halkett (ACO Associates *cc*.)	MA Archaeolgy, University of Cape Town BA Hons Archaeology, University of Cape Town
	John Almond (Natura Viva *cc*)	PhD University of Cantabury
Socio-economic study	Kerryn McKune Desai (ERM Southern Africa)	MA Geography of Third World Development Royal Holloway, University of London BA Hons Environmental & Geographical Science, University of Cape Town

See specialist reports included as *Annex E - K*.

EIR

A synthesis of information, which addresses the key issues and opportunities identified during the EIA process, has been documented in this Draft EIR. Recommendations on the mitigation of adverse impacts and the enhancement of positive impacts associated with the proposed project are included. These mitigation measures / enhancements are translated into specific actions in the draft Environmental Management Programme (EMP) (*Annex L*).

Public Participation

The following tasks relating to public participation have been and will be undertaken as part of the EIA phase:

- The Draft EIR and EMP were released for comment and Registered I&APs were notified of the release of the Draft EIR. Copies of the non-technical summary of the report were distributed with the notification. The full report was made available at key locations and on the project website.

- A public meeting was held on 25 March 2011 at Touwsriver Primary School.

- Comments received on the Draft EIR and EMP have been assimilated and the EIA project team has provided appropriate responses to all comments. A Comments Report has been appended to the Final EIR (refer to *Annex C*), which has been submitted to DEA as part of the decision-making process.

- All registered I&APs will be notified once a decision has been issued by DEA. An appeal period will follow the issuing of the Environmental Authorisation.

Table 3.2 Summary of Public Participation Activities undertaken to date

Activity	Date
Site Notice Placement at Perdekraal	17 March 2010
Distribution of BID to neighbouring landowners and commenting authorities	1 – 6 April 2010
Notification advert placed in the Worcester Standard	11 March 2010
Notification advert placed in the Cape Times	18 March 2010
Notification advert placed in Die Burger	18 March 2010
Distribution of Draft Scoping Report for comment	3 - 6 May 2010
Advertisement of open day meeting in Worcester Standard	6 May 2010
Open day meeting in Touwsrivier	20 May 2010
Notification of submission of Final Scoping Report to DEA	8 – 10 August 2010
Public meeting in Touwsrivier	25 March 2011
Comment on the Draft EIA Report	June – July 2011

Authority Consultation and Involvement

As indicated above, the Scoping Report was submitted and accepted by the DEA. The next key interaction with DEA was the submission of the Draft EIR followed by the Final EIR and EMP for authorisation.

The Western Cape Department of Environmental Affairs and Development Planning (DEA&DP), the provincial commenting authority, will be engaged for their comments on the Draft EIR as will other commenting authorities including but not limited to the Heritage Western Cape, CapeNature and the Department of Agriculture.

Splitting of the Perdekraal Environmental Authorisation

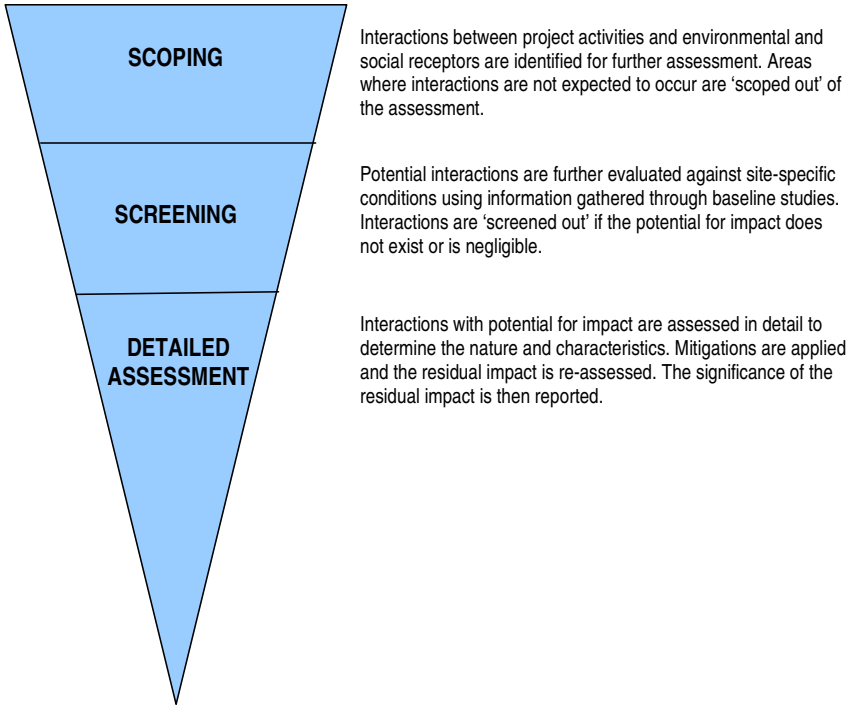
The Perdekraal Site 2 EIR and EMP will be loaded onto the project website and registered I&APs will be notified of the submission of the application and EIA documents to split the authorised Perdekraal REF into Perdekraal Site 1 and Perdekraal Site 2 in preparation for bid submission to DoE.

3.2 IMPACT ASSESSMENT METHODOLOGY

3.2.1 Impact Assessment Process

The following diagram (*Figure 3.2*) describes the impact identification and assessment process through scoping, screening and detailed impact assessment. The methodology for detailed impact assessment is outlined in *Section 3.2.2*, below.

Figure 3.2 Impact Assessment Process



3.2.2 Impact Assessment Methodology

The purpose of impact assessment and mitigation is to identify and evaluate the significance of potential impacts on identified receptors and resources according to defined assessment criteria and to develop and describe measures that will be taken to avoid or minimise any potential adverse effects and enhance potential benefits.

Impact Types and Definitions

An impact is any change to a resource or receptor brought about by the presence of a project component or by the execution of a project related activity. The evaluation of baseline data provides crucial information for the process of evaluating and describing how the project could affect the biophysical and socio-economic environment.

Impacts are described as a number of types as summarised in *Table 3.3*. Impacts are also described as *associated*, those that will occur, and *potential*, those that may occur.

Table 3.3 Impact Nature and Type

Nature or Type	Definition
Positive	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Negative	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
Direct impact	Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors (e.g. between occupation of a site and the pre-existing habitats or between an effluent discharge and receiving water quality).
Indirect impact	Impacts that result from other activities that are encouraged to happen as a consequence of the Project (e.g. in-migration for employment placing a demand on resources).
Cumulative impact	Impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the Project.

Assessing Significance

Impacts are described in terms of '*significance*'. Significance is a function of the **magnitude** of the impact and the **likelihood** of the impact occurring. Impact magnitude (sometimes termed *severity*) is a function of the **extent, duration and intensity** of the impact. The criteria used to determine significance are summarised in *Table 3.4*. Once an assessment is made of the magnitude and likelihood, the impact significance is rated through a matrix process as shown in *Table 3.5*.

Significance of an impact is qualified through a statement of the **degree of confidence**. Confidence in the prediction is a function of uncertainties, for example, where information is insufficient to assess the impact. Degree of confidence is expressed as low, medium or high.

Table 3.4 Significance Criteria

Impact Magnitude	
Extent	**On-site** – impacts that are limited to the boundaries of the REF site. **Local** – impacts that affect an area in a radius of 20km around the development site. **Regional** – impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries, habitat type/ecosystem. **National** – impacts that affect nationally important environmental resources or affect an area that is nationally important/ or have macro-economic consequences.
Duration	**Temporary** – impacts are predicted to be of short duration and intermittent/occasional. **Short-term** – impacts that are predicted to last only for the duration of the construction period. **Long-term** – impacts that will continue for the life of the Project, but ceases when the Project stops operating. **Permanent** – impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime.
Intensity	BIOPHYSICAL ENVIRONMENT: *Intensity can be considered in terms*

	of the sensitivity of the biodiversity receptor (ie. habitats, species or communities). **Negligible** – the impact on the environment is not detectable. **Low** – the impact affects the environment in such a way that natural functions and processes are not affected. **Medium** – where the affected environment is altered but natural functions and processes continue, albeit in a modified way. **High** – where natural functions or processes are altered to the extent that it will temporarily or permanently cease. ***Where appropriate, national and/or international standards are to be used as a measure of the impact.*** *Specialist studies should attempt to quantify the magnitude of impacts and outline the rationale used.* SOCIO-ECONOMIC ENVIRONMENT: *Intensity can be considered in terms of the ability of project affected people/communities to adapt to changes brought about by the Project.* **Negligible** – there is no perceptible change to people's livelihood **Low** - People/communities are able to adapt with relative ease and maintain pre-impact livelihoods. **Medium** - Able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support. **High** - Those affected will not be able to adapt to changes and continue to maintain-pre impact livelihoods.
Impact Likelihood (Probability)	
Negligible	The impact does not occur.
Low	The impact may possibly occur.
Medium	Impact is likely to occur under most conditions.
High	Impact will definitely occur.

Once a rating is determined for magnitude and likelihood, the following matrix can be used to determine the impact significance.

Table 3.5 Significance Rating Matrix

SIGNIFICANCE RATING					
	LIKELIHOOD	**Negligible**	**Low**	**Medium**	**High**
MAGNITUDE	**Negligible**	**Negligible**	**Negligible**	**Low**	**Low**
	Low	**Negligible**	**Negligible**	**Low**	**Low**
	Medium	**Negligible**	**Low**	**Medium**	**Medium**
	High	**Low**	**Medium**	**High**	**High**

Table 3.6 Significance Colour Scale

Negative ratings	**Positive ratings**
Negligible	Negligible
Minor	Minor
Moderate	Moderate
Major	Major

In *Table 3.7*, the various definitions for significance of an impact are given.

Table 3.7 Significance Definitions

Significance definitions	
Negligible significance	An impact of negligible significance (or an insignificant impact) is where a resource or receptor (including people) will not be affected in any way by a particular activity, or the predicted effect is deemed to be 'negligible' or 'imperceptible' or is indistinguishable from natural background variations.
Low significance	An impact of low significance is one where an effect will be experienced, but the impact magnitude is sufficiently small (with and without mitigation) and well within accepted standards, and/or the receptor is of low sensitivity/value.
Medium significance	An impact of medium significance is one within accepted limits and standards. The emphasis for medium impacts is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that 'medium' impacts have to be reduced to 'low' impacts, but that medium impacts are being managed effectively and efficiently.
High significance	An impact of high significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. A goal of the EIA process is to get to a position where the Project does not have any high residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be high residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a development. It is then the function of regulators and stakeholders to weigh such negative factors against the positive factors such as employment, in coming to a decision on the Project.

Once the significance of the impact has been determined, it is important to qualify the **degree of confidence** in the assessment. Confidence in the prediction is associated with any uncertainties, for example, where information is insufficient to assess the impact. Degree of confidence can be expressed as low, medium or high.

3.3 MITIGATION POTENTIAL AND RESIDUAL IMPACTS

It is expected that for the identified significant impacts, the project team will work with the client in identifying suitable and practical mitigation measures that are implementable. Mitigation that can be incorporated into the Project design in order to avoid or reduce the negative impacts or enhance the positive impacts will be developed.

Residual impacts are those impacts which remain once the mitigation measures have been designed and applied. Once the mitigation is applied, each impact is re-evaluated (assuming that the mitigation measure is effectively applied) and any remaining impact is rated once again using the process outlined above. The result is a significance rating for the residual impact.

3.4 SPECIALIST STUDY METHODOLOGY

3.4.1 Flora

The study was done in three phases, namely, scoping, site visit and impact assessment. The site was visited in December 2010. The site was traversed by vehicle and a Garmin ® GPS was used to track the route and record selected waypoints of which there were 22 in the study area. Observations were made at the respective waypoints and recorded with a photographic record of the vegetation and selected plant species. Particular attention was given to the possibility of finding endemic and 'Red Data' species. The impact assessment phase involved the determination of the nature of likely impacts of the development and recommendations on mitigation.

3.4.2 Fauna

The study was done in three phases, namely, scoping, site visit and impact assessment. The site was visited over two days in July. During the course of the site visit, as much of the property as possible was reconnoitered by driving the majority of accessible roads and tracks. The different landscape and vegetation units present were identified and related to satellite imagery of the property for mapping purposes. Photographs of the site were taken and a large number of walk-through surveys were conducted across the property. Special attention was paid to potentially significant or sensitive habitats such as drainage areas, wetlands and rocky ridges. The species present were noted as was the nature and quality of the habitat at each site investigated. In addition, any features that could be observed on the satellite imagery which indicated potentially important or unique ecological zones were identified on the ground and assessed. The impact assessment phase involved the determination of the nature of likely impacts of the development and recommendations on mitigation.

3.4.3 Avifauna

The study was done in three phases, namely, scoping, site visit and impact assessment. A literature review of bird and renewable energy facility interactions and bird species and avian habitats likely to occur in the study area was undertaken during the scoping phase of the assessment. This was followed by a site visit to ground-truth predicted habitats and birds present, mainly by visiting as much of the inclusive area of the proposed development as possible, with an emphasis on sampling the avifauna in all of the primary habitats available. The impact assessment phase involved the determination of the nature of likely impacts of the development and recommendations on mitigation.

3.4.4 Bats

The study was done in three phases, namely, scoping, site visit and impact assessment. A literature review of bat and turbine interactions and bat species and habitats likely to occur in the study area was undertaken during the

scoping phase of the assessment. During the site visit, bat activity was monitored for two nights using the Pettersson D240x ultrasound detector, connected to a wave/MP3 recorder. The impact assessment phase involved the determination of the nature of likely impacts of the development and recommendations on mitigation.

3.4.5 Noise

The environmental noise impact investigation and assessment of the wind farm was conducted in accordance with Section 8 of SANS 10328. This procedure included amongst others, determining the existing residual (ambient) levels of noise within the study area through a site visit. As well as calculating the expected rating level of noise due to the wind turbines on the identified noise sensitive land. The impact assessment phase involved the determination of the nature of likely impacts of the development and recommendations on mitigation

3.4.6 Visual

The Perdekraal land parcels were plotted on maps and distance circles added in order to roughly determine the areas that would be visually affected by the proposed renewable energy facility for use during the field trip. A site visit was undertaken in April 2010. During the site visit numerous critical viewpoints were identified, particularly those relating to intersections of major roads, arterial and scenic routes, as well as settlements, including farmsteads. Panoramic photographs were taken from these viewpoints as a record and to be used to determine the potential visibility of the renewable energy facilities during the VIA stage. A viewshed map was prepared using the site layout and the height of the turbines. This provides a good indication of the areas which will be visually affected by the proposed facility. Photomontages were produced showing turbines superimposed on the panoramic photographs. The above assisted with the determination of the nature of likely impacts of the development and recommendations on mitigation.

3.4.7 Heritage

Paleontology

During the 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. 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 & Pether 2008*).

Heritage

A desktop study was conducted in which the data bases held at Iziko Museum, Heritage Western Cape and the Archaeological Department at University of Cape Town were perused for information relating to archaeological sites in the general area of the site. The archaeological sites were listed on an Excel spread sheet along with the map identification numbers, GPS coordinates and a brief summary of the archaeological details. Sites included both pre-colonial and historical locations. Using this body of information it was possible to make a preliminary statement on the types of site and frequency of occurrence within the Perdekraal area.

An on-site survey of heritage resources has been conducted and heritage indicators (conservation-worthy buildings, archaeological sites and places celebrated as heritage) identified and mapped where appropriate. Definitions of heritage and criteria for assessment of heritage are indicated in the National Heritage Resources Act while the Provincial Guidelines for assessing heritage in the Western Cape applies. Both the NHRA and Provincial Guidelines require that cultural landscapes and areas of particular aesthetic and/or cultural heritage significance are included in the assessment. In the assessment of impacts of wind energy proposals it is, therefore, necessary to assess both physical damage to heritage caused by the establishment of infrastructure, as well as focus on the way that such a facility can change the aesthetic and intangible values of the cultural landscapes in which the physical heritage resources exist.

3.4.8 Socio-economic

The socio-economic specialist study began with the compilation of a baseline description. The baseline description was derived from secondary data (range of sources, including but not limited to, census data, existing reports, and IDP and other strategic planning documents) and primary data collection (using a combination of telephonic and face-to-face interviews). The impact assessment phase incorporated the identification and assessment of socio-economic impacts (direct, indirect and cumulative) that may result from the construction and operation phases of the project. Mitigation measures that address the local context and needs were recommended as the final phase of the study.

3.5 ASSUMPTIONS AND LIMITATIONS

The impact assessment process aims to identify and anticipate possible impacts based on past and present baseline information. As the impact assessment deals with what may occur in the future there is, inevitably, some uncertainty about what will actually happen. Impact predictions have been made based on field surveys and with the data, methods and scientific knowledge available at this time. However, some uncertainties could not be entirely resolved. Where significant uncertainty remains in the impact

assessment, this is acknowledged and the level of uncertainty is provided in the assessment tables.

In line with best practice, this report has adopted a precautionary approach to the identification and assessment of impacts. Where it has not been possible to make direct predictions of the likely level of impact, limits on the maximum likely impact have been reported and the design and implementation of the project (including the use of appropriate mitigation measures) will ensure that these are not exceeded. Where the magnitude of impacts cannot be predicted with certainty, the team of specialists has used professional experience and available scientific research from renewable facilities worldwide to judge whether a significant impact is likely to occur or not. Throughout the assessment this conservative approach has been adopted to the allocation of significance.

3.5.1 Gaps and Uncertainties

Inevitably knowledge gaps remain. For instance, there is an incomplete understanding of cumulative impacts as it is not known how many of the proposed facilities in the vicinity of Perdekraal will be granted authorisation.

Gaps in Project Description

- Access roads: access to the site will be via the existing gravel road however the upgrading required and the transport route from port to site will be investigated through a transport study.
- Turbine locations: the assessment is based on a preferred and final layout based on revision of earlier layouts to accommodate environmental sensitivities. The areas acceptable and not acceptable for development (ie constraints map) and the final layout has been confirmed, however precise turbine locations may be microsited to allow for geotechnical constraints, and possibly the results of bird and bat monitoring, and that this will seek to ensure that all locations remain in areas determined as acceptable as defined by this study and that the specialists will sign off any revised positions.
- Feasibility of borrow pit and on-site batching plant and location with Perdekraal site.
- Selected manufacturer of turbines and proposed output of turbines (between 1.5 MW and 3.5MW).

Gaps in Baseline Information

- Limited fieldwork and understanding of bird and bat abundance and movement patterns across the area.
- Limited understanding of the locations of bat roosting caves and migration routes in South Africa are poorly known and not well documented.

Gaps in Understanding of Impacts

- It should be noted that predictions are based on limited fieldwork and understanding of bird and bat abundance and movement patterns across the area, and therefore in support of the precautionary principal and international best practice, a year of preconstruction monitoring is recommended to confirm predictions and identify additional mitigation measures.
- The evidence of curtailment as an effective mitigation measure.

4 PROJECT DESCRIPTION

4.1 INTRODUCTION

This Chapter provides an overview of the proposed Renewable Energy Facility (REF) at Perdekraal. The need and desirability of the project and the consideration of alternatives is included here as well as a discussion of the main project activities for the construction, operation and decommissioning phases.

4.2 NEED AND DESIRABILITY

The intention of Mainstream SA in establishing renewable energy facilities is to develop wind and solar resources to generate electricity and reduce the dependence on non-renewable fossil fuel resources (see *Box 4.1*). Emergency load shedding in 2007 and 2008 highlighted the challenges facing South Africa in terms of electricity generation, transmission and distribution. The National Energy Response Plan (NERP), drafted at the time, acknowledged the role that independent power producers (IPPs) could play in ensuring sustainable electricity generation.

Box 4.1 Project Motivation

- Reduce South Africa's dependence on fossil fuel resources
- Increase electricity capacity to contribute to the alleviation of SA's energy crisis
- Decentralise energy supply to improve electricity supply stability and reliability
- Meet demand for diversified energy sources
- Ensure the future of sustainable energy use
- Reduce CO_2 emissions and the nation's carbon footprint
- Promote environmental, social and economically sustainable development

In order to incorporate independent energy production facilities within the country, The National Energy Response Plan was initiated that includes an Independent Power Producers (IPP) Bid Programme. The programme seeks to increase the energy generated by independent power producers by 30 percent, in turn creating a stronger foundation for the future incorporation of renewable energy sources (1).

Through the Mainstream SA projects and other renewable energy projects, energy generation will begin to depart from being dominated by coal. The electricity generated by this facility will supply the national grid and positively contribute to the country's goal of emission reduction as outlined in

(1) National Energy Regulator of South Africa **South Africa Renewable Energy Feed-In Tariff** (2009) NERSA Publications.

South Africa's Integrated Plan for Electricity 2010. The drafted legislation notes the following objectives:

- Reduce CO_2 emissions by 34 percent by 2020 and 42 percent by 2025; and
- Apply an increase on the current carbon tax of R100/ton to roughly R750/ton of CO_2 over the next 30 years.

The carbon tax provides industries with incentives to utilise less carbon intensive practices which further increases South Africa's carbon footprint. Under the National Energy Regulator Act, 2004 (Act No 40 of 2004), the Electricity Regulation Act, 2006 (Act No 4 of 2006) includes a tariff that provides the renewable energy sector a competitive gain over current energy production. The motivating principles behind the Renewable Energy Feed-In Tariff (REFIT) include the following:

- Create an enabling environment for renewable electricity power generation in South Africa;
- Establish a guaranteed price for electricity generated from renewables for a fixed period of time that provides a stable income stream and an adequate return on investment;
- Create a dynamic mechanism that reflects market, economic and political developments;
- Provide access to the grid and an obligation to purchase power generated;
- Establish an equal playing field with conventional electricity generation;
- Create a critical mass of renewable energy investment and support the establishment of a self-sustaining market.

The Electricity Regulation Act provides the National Energy Regulator of South Africa (NERSA) authorisation to determine the guidelines of REFIT. The guidelines provide parameters and information on:

- The requirements of the Independent Power Purchaser for the application;
- The issuing of licenses for renewable energy project developments; and
- Tariff structures regarding varying renewable technologies.

The office of Renewable Energy Purchasing Agency (REPA) through the nation's leading public energy provider, Eskom is expected to be the interim single buyer of renewable power until an Independent system and Market Operator is established. If the IPP meets all of the required conditions of licensing, REPA then has an obligation towards the purchase of renewable sources of electricity. However, the IPP can also sell power directly to buyers outside of the REFIT programme, but will still be subject to the same licensing conditions.

Through REFIT there will be a heightened demand throughout the renewable sector (hydro, solar, wind, biomass) due to the set prices for electricity. The price of electricity from wind power under REFIT is listed below in *Table 4.1*.

Table 4.1 Feed-In Tariff for Wind Power

Technology	Unit	REFIT
Wind	R/kWh	1.25
Solar PV (≥ 1 MW)	R/kWh	3.94

The economic rationale backing REFIT is that the establishment of the tariff will cover the cost of electricity generation in addition to producing a small profit to encourage developers to continue investing in the renewable sector (1).

The renewable energy facility would contribute towards the country's Renewable Energy Target of 10,000 GWh of renewable energy by 2013 as well as support the local initiative set in place by the Western Cape Provincial Government. The province plans to have 15 percent of their electricity generated through renewable sources by 2014. The proposed project also provides for a future of increased energy security; by utilising diverse technologies there is a stronger support system for South Africa's rapidly developing infrastructure.

However; the ability to construct the full-scale renewable facility may be constrained by the generation capacity that can be accepted into the National Grid in the vicinity of the site at present. For this reason, the project construction may need to be completed in stages.

The Perdekraal REF has the potential to provide electricity to approximately 681,002 typical South African income households[2](assuming the facility output is 389MW, as initially anticipated). Perdekraal Site 1 and Perdekraal Site 2 could displace approximately 863,171 tonnes of CO_2 annually.

The proposed project has the added advantage of income generation through the sale of the electricity produced, which can supplement the income of marginally productive farms and be used to fund community development projects.

4.3 SITE LOCATION

The proposed Perdekraal site is located in the Karoo and falls within the jurisdiction of the Winelands District Municipality and Breede River Local Municipality (see *Figure 4.1*). The Perdekraal site is located approximately 32 km north of the town of Touwsrivier. The Perdekraal site is made up of two land parcels, as follows:

- Remainder of erf 245 of Perdekraal Farm; and

(1) National Energy Regulator of South Africa **South Africa Renewable Energy Feed-In Tariff** (2009) NERSA Publications.
(2) A typical low income Western Cape household uses approximately 1500kwh per annum. In South African households usage ranges between less than 1000kwh to over 8000kwh per year.

- Portion 1 of Rietpoort Farm 243.

This site has now been divided into two portions, Perdekraal Site 1 and Perdekraal Site 2. Perdekraal Site 2 comprises a portion of both farms mentioned above to ensure that if Perdekraal Site 2 is successfully bid, the development will be split across both land parcels.

19°36'10"E 20°6'20"E 20°36'30"E

32°41'10"S

33°11'10"S

CEDERBERG
WITZENBERG
LAINGSBURG
BREEDE VALLEY
BREEDE RIVER/ WINELANDS
Cape Winelands
Namakwa
KAROO HOOGLAND
Central Karoo
Eden
KANNALAND

Krom
Matjies
Leeu
Doring
Riet
Lang
Kruis
Vis
Tankwa
Grootrivier
Touws
Smalblea
Titus
Hex
Die Brak
Koo
Bree
Hol
Nuy
Prins

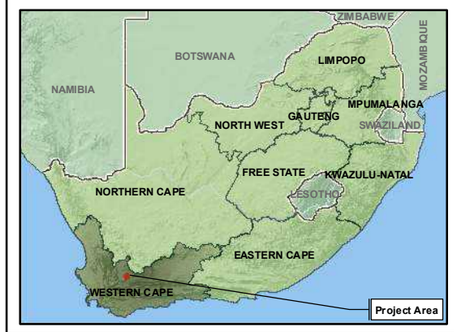
R354
R355
R46
R318
R43
R60
N1

MATJIESFONTEIN
TOUWSRIVIER
MATROOSBERG
DE DOORNS

Bokkeriviere Nature Reserve
Ben Etive Nature Reserve
Anysberg Nature Reserve

Legend

- Towns
- District Municipalities
- Local Municipalities
- Transmission Line
- National Road
- Main Road
- Secondary Road
- Railway Line
- Perennial River
- Non-Perennial River
- Conservation Area
- National Park
- Perdekraal Land Parcels



SCALE:

0 5 10 15 20 25

Kilometers

N

TITLE:

Figure 4.1: Location of Perdekraal in relation to Municipal Areas

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Feb 2011	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 500 000

DRAWING: Perdekraal_Municipal_Areas_Rev1.mxd — REV: 1

ERM
Building 32,
The Woodlands,
Woodlands Drive,
Woodmead, 2148
Johannesburg, South Africa
Tel: +27 (0)11 798 4300
Fax: +27 (0)11 804 2289

Projection: Geographic, Datum: Hartebeesthoek 1994
Source: Enpat (2001), Demarcation Board (Dec 2005)
Inset: ESRI Data and Maps

SIZE: A3

T:\GIS Project\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\Perdekraal_Municipal_Areas_Rev1.mxd

4.4 PROJECT COMPONENTS

The key components of the proposed Perdekraal REF, listed and discussed below, include the following:

- Wind turbine generators;
- Photovoltaic (PV) arrays;
- Internal and external electrical connections;
- Substation and associated transmission line;
- Access roads; and
- Operations and maintenance (O&M) building.

The total Perdekraal REF site area is 6347.37ha (63.47km^2) and it is estimated that approximately 19.01ha (0.19km^2) will be taken up by wind turbine generators, 128.54ha (1.285 km^2) by roads, the PV component of 140ha (1.4km^2) and associated infrastructure would take up roughly 3ha (0.03km^2). This translates into a land take of 290ha (2.90km^2) or approximately 4.5% of the overall site area. Perdekraal Site 2 comprises approximately 3220ha (32.2km^2) and the land take is estimated to be less than 4%.

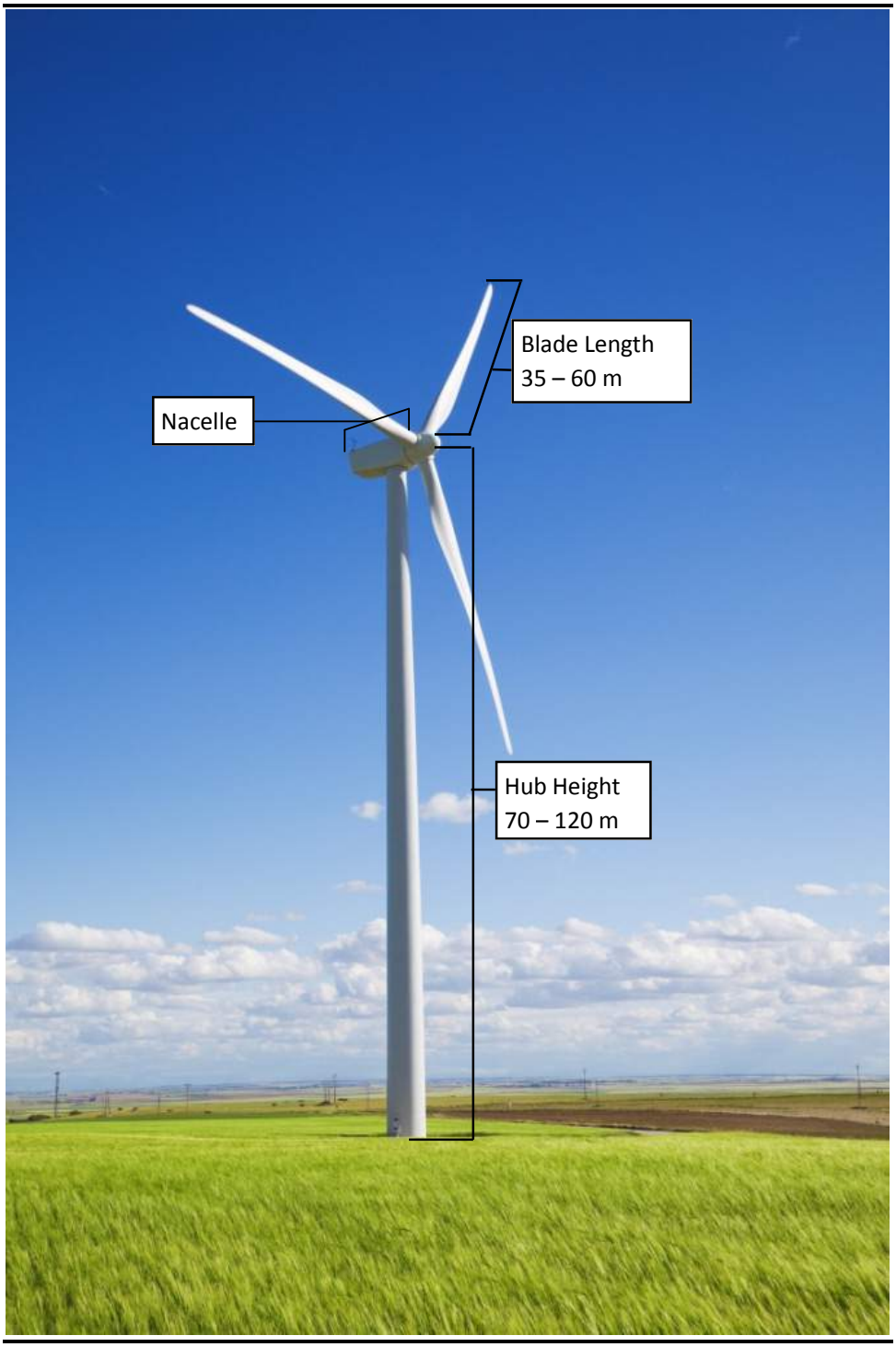
4.4.1 *Wind Turbine Generators*

Modern wind turbine designs incorporate tubular towers, three blades and a nacelle which houses a generator, gearbox and other operating equipment. The turbines will range in hub height from 70m to 120m, with a rotor diameter (measured from blade tip to blade tip) range of between 70m and 120m. It should be noted that the most likely hub height will be 80m and this dimension was used in the visual impact assessment to simulate views of the turbines. An example of a typical wind turbine of the type envisaged for the site is shown in *Figure 4.2* below. It was initially planned for the Perdekraal site to support between 169 to 230 wind turbines with an individual capacity of 1.5 to 3.5MW. However, the turbine numbers have since been reduced based on environmental and social constraints (see *Section 4.6*, below). Perdekraal Site 2 will support between 60 and 65 wind turbines.

The detailed design of the foundation for each turbine will depend on the turbine model procured and the site-specific ground conditions. The turbines are to be supported on reinforced concrete foundations with an approximate area of 325m^2 to a depth of 2.5m. The foundation will include a concrete pedestal at the centre, which projects above ground level and to which the turbine tower is connected.

There will be a gravel surfaced hard standing of approximately 40m x 20m adjacent to each turbine for use by cranes during construction and retained for maintenance use throughout the life span of the project. Each turbine will have an electrical transformer beside it.

Figure 4.2 *A Typical 2.3MW Wind Turbine representative of the type proposed for this project*



4.4.2 *Photovoltaic (PV) Arrays*

The proposed photovoltaic installation portion of the renewable energy facility will occupy an area of up to 1.4km^2 of the site. The number of panels comprising the array will depend on the solar resource at the site, the installed capacity and the choice of panels. The solar field will comprise rows of panels

called strings arranged to capture the most sunlight (see *Figure 4.3*). The panels are typically up to 15m x 4m in area and each panel is mounted on a metal frame. The arrays are either fixed on a tracking system or tilted at an angle equivalent to the site latitude to maximise the exposure to sunlight. The arrays typically reach 5m to 10m above ground level and will allow for grazing of some types of livestock (i.e. sheep). The PV array area will not need to be graded flat. The foundation supporting the panel arrays will comprise concrete or screw pile type foundations.

Figure 4.3 Typical PV Panel Arrays

4.4.3 Electrical Connections

The electrical connections comprise the following:

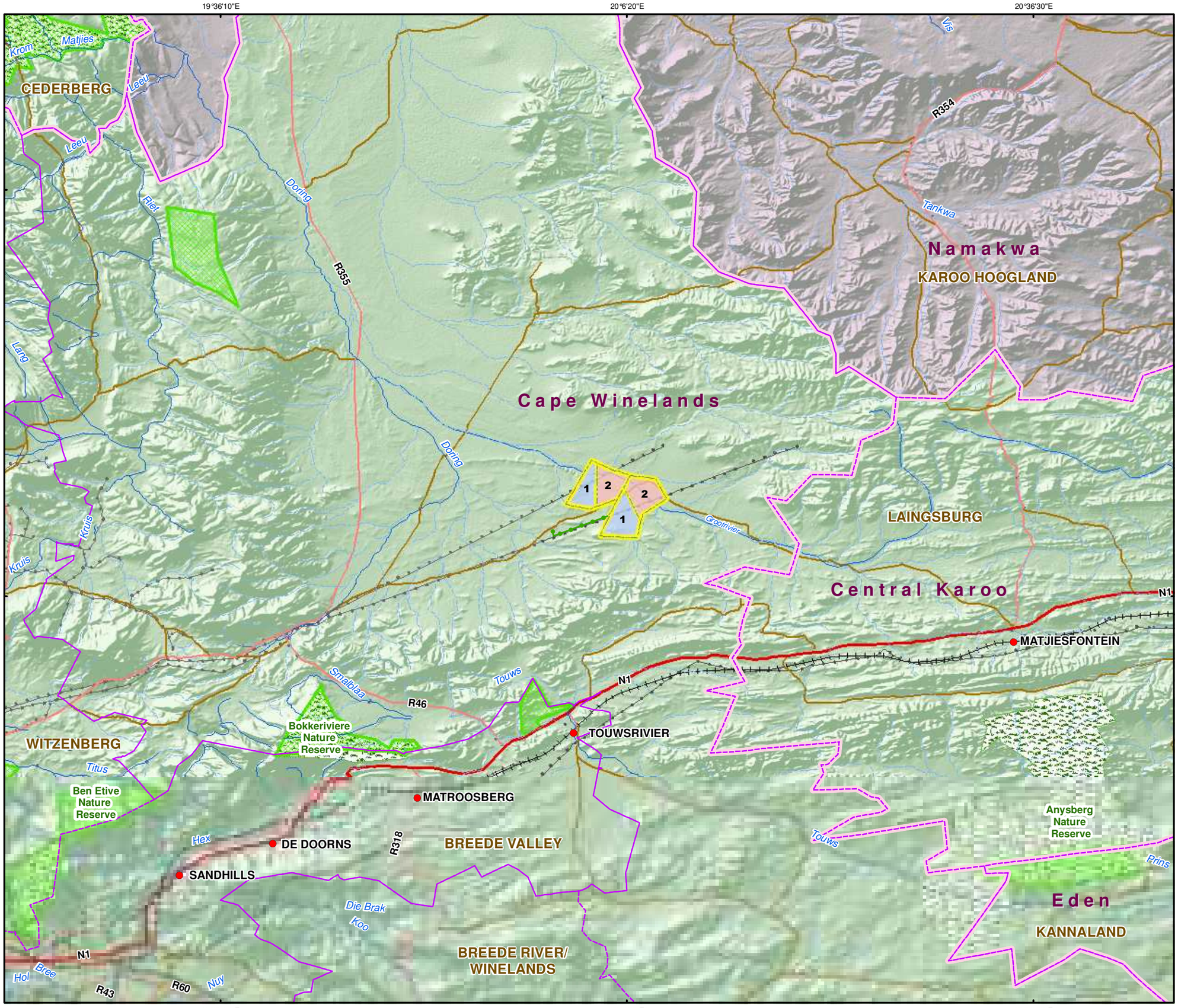
- The Perdekraal Site 2 will be connected to Eskom's national grid at the planned Eskom's Kappa Substation or will connect to the grid on site via a 400kV line that passes through the site. Initial discussions with Eskom indicate that the preferred option will be to connect to via Eskom's Kappa Substation for technical reasons.

- If the site is connected via the planned Eskom Kappa Substation, an overhead line of approximately 7km will be required. The overhead line will run adjacent to the existing 400kV line (see *Figure 4.4*)

- A new substation (with an approximate compound size of 150m x 150m) and a transformer will be constructed in the vicinity of the O&M building compound.

- The connection from the substation to the Eskom grid line is a stretch of overhead line supported on an intermediate pole(s), depending on the location of the substation relative to the 400kV line.

- The wind turbines will be connected to one another and to the substation by means of underground medium voltage cables. These cables will run along the road network required to connect the turbines, the placing of these cables will therefore not increase the footprint of the facility. It is anticipated that the output from the PV panel array will feed into the underground medium voltage connection grid between the wind turbines and the substation.

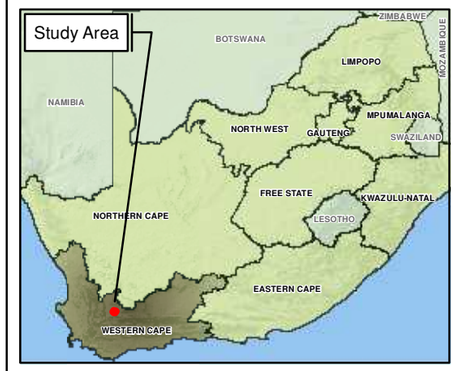


Legend

- Towns
- Perennial River
- Non-Perennial River
- National Road
- Main Road
- Secondary Road
- Railway Line
- Transmission Line
- Transmission Line linking to Kappa SS
- District Municipalities
- Local Municipalities
- Conservation Area
- National Park

Perdekraal Land Parcels

- Perdekraal 1
- Perdekraal 2



SCALE:

0 5 10 15 20 25

Kilometers

N

TITLE:

Figure 4.4: Proposed Grid Connection Options for the Perdekraal REF

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Apr 2012	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 500 000

DRAWING: Perdekraal_Proposed_Grid_Connection_Rev1.mxd

REV: 1

ERM
Block A, Silverwood House
Silverwood Close
Steenberg Office Park, 7945
Cape Town, SOUTH AFRICA
Tel: +27 (0)21 702 9100
Fax +27 (0)21 701 7900

Projection: Geographic, Datum: Hartebeesthoek 1994
Source: Enpat (2001), Demarcation Board (Dec 2005)
Inset: ESRI Data and Maps

SIZE: A3

T:\Gis Projects\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\30Apr12\Alt2 1\Perdekraal_Proposed_Grid_Connection_Rev1.mxd

4.4.4 Access Roads and Site Access

The site can be accessed via a gravel road which connects to the R356 in the west, and the R354 in the east (see *Figure 1.1*). Some existing public roads may need to be upgraded to facilitate turbine transport. Feasible turbine transport routes will be investigated through a site access study which falls outside of the scope of the current Scoping/EIA process. This study will be undertaken approximately 12 months prior to the commencement of the construction phase.

An internal gravel road network will be used by construction vehicles and will be retained throughout the lifetime of the facility for use by maintenance vehicles. Existing roads and tracks will be used, where possible. The roads will be approximately 10m wide including drainage trenches and cabling but may be wider for short sections to enable turning, passing and to accommodate sharp bends.

4.4.5 Additional Infrastructure

Additional temporary infrastructure required during construction will include the following:

- **Lay down areas** will have to be prepared, either beside an access route, for the assembly of the turbine components or as an area adjacent to each turbine. The lay down areas will cover an area of approximately 10,000m^2 – this hard standing area could be temporary or if the landowner prefers, left for long-term use.

- A **temporary site compound** area for contractors of approximately of 5,000m^2 will be constructed which will house the site office, meeting rooms, canteen etc.

- **Borrow pits** (subject to the appropriate permits)may be distributed around the site. The size of these pits will depend on the terrain, suitability of the subsurface soils and the need for granular material for road construction and earthworks. At the end of construction these pits will be reinstated, as far as possible using surplus material excavated from foundations and other onsite excavations. These will be subject to a separate approval process under the Mineral and Petroleum Resources Development Act (Act No. 28 of 2002).

Additional infrastructure associated with the operation of the proposed renewable energy facility will include:

- A single story **Operations and Maintenance building** of 3000m^2 with a warehouse/workspace, office, telecoms, security and ablution facilities will be constructed on the site preferably close to the substation.

- A **substation** with a compound area of 150m by 150m will be constructed in the vicinity of the O&M building.
- At least two permanent **wind measuring mast** of 70m to 100m in height.
- Solar resource measurement equipment.
- Although the bulk of the site is currently fenced, **additional fencing** may be erected as required (i.e. around the operations and maintenance building).
- **Bunding for transformers** and any other oil containing equipment to ensure full containment in the event of any oil leakage.

4.5 PROJECT ACTIVITIES

The project activities can generally be divided into three phases, as follows:

- construction;
- operation (including maintenance and repair); and
- decommissioning.

A description of each phase and the associated activities is provided below.

4.5.1 Construction

An initial site selection process has been conducted based on a number of criteria (see *Section 4.6*) and the preferred facility layout design has been finalised with input from specialists through the EIA process resulting in the preferred **Site Layout Alternative 2**.

The construction and commissioning phase of the project is estimated to take approximately 12-18 months to complete.

Construction activities will include:

- site preparation, including subcontractor mobilisation, erection of fencing or suitable barriers, where required to protect sensitive habitat and archaeological sites, construction of site compound and lay down areas;
- upgrading and construction of internal roads including laying of cables;
- site clearance;
- establishment of borrow pits;
- laying of turbine foundations;
- turbine delivery and installation (see *Figure 4.5*and *Figure 4.6*);
- PV array installation;
- completion of internal electrical connections;
- turbine and PV array function testing to verify proper operation of the facility; and
- commissioning.

Figure 4.5 Turbine installation with adjacent laydown area

Figure 4.6 Typical turbine installation through the use of a crane

4.5.2 *Operation*

Once the renewable energy facility construction is completed and it becomes operational, it is expected that the facility will have a minimum life span of 25 years. Regular maintenance will be required to ensure the turbines and PV arrays are kept in optimal working order. The wind turbines will operate at all times provided wind speeds are suitable with the exception of downtime required for maintenance activities. For the most part, day to day facility operations will be done remotely through the use of computer networks. The renewable energy facility can operate in parallel with daily farming activities due to the relatively small footprint of the turbines (see *Figure 4.7*). The PV portion of the facility cannot operate in conjunction with cultivation activities however, small animals such as sheep may continue to graze around the PV components.

Figure 4.7 An illustration depicting a Renewable Energy Facility operating in parallel to agricultural activities

4.5.3 *Decommissioning*

Once the facility has reached the end of its life cycle, the turbines and PV array may be refurbished or replaced and continue operating as a power generating facility or the facility will be closed and decommissioned. If decommissioned all components, excluding turbine foundations and some roads, of the renewable energy facility will be removed and the site will be rehabilitated. The concrete pedestals of the turbine foundations will be cut down and concrete removed to below finished ground level and covered with topsoil. Some roads will be removed, covered with soil and replanted to allow for a return to agricultural landuse (cultivation and grazing).

4.6 *CONSIDERATION OF ALTERNATIVES*

4.6.1 *Site Alternatives*

Mainstream SA undertook a detailed strategic site selection process for the identification of suitable sites for renewable energy facilities throughout the Western, Eastern and Northern Cape. The selected sites for these renewable energy facilities are considered highly desirable from a technical perspective. The selection of these sites was based on a number of factors, including:

Wind and Solar resource: Analysis of publicly available as well as more specialist analysis of weather data indicated that the sites exhibit a favourable wind and solar resources to make a renewable energy facility financially viable. Wind resource monitoring has begun on the project site through the installation of wind measuring masts. A minimum of one year's recorded

wind data is required before the project developer can finalise the optimum layout for the wind turbines and to demonstrate a bankable project.

Site extent: Sufficient land was secured to allow for a minimum number of wind turbines and space for PV solar to make the project feasible.

Grid access: Access to grid and the distance to a viable connection point were important considerations in terms of prioritising appropriate sites. Grid access is deemed favourable for this site due the existence of an Eskom 132 kV line traverses the project site.

Land suitability and proximity to aerodromes: The land use of each site was an important criterion in terms of limiting the disruption to existing land use practices. In this regard agricultural land was preferred, where the vast majority of farming practices could continue undisrupted once the renewable energy facility was in operation. The proximity to aerodromes and the possible interactions was also a consideration.

Nature reserves: The proximity of the site to statutory reserves, National Parks and Ramsar sites was considered before final selection.

Local economic stimulation: A key consideration in the site selection was the opportunities for advancement of local communities and support to the local economy.

Landowner support: Access to land where land owners are supportive of the development of renewable energy was essential for ensuring access to the required land.

Mainstream SA took cognisance of the comprehensive DEA&DP Strategic Initiative to Introduce Commercial Land Based Wind Energy Development to the Western Cape Reports (2006)[1] and therefore incorporated certain high-level environmental considerations into their screening criteria such as proximity to nature reserves, major scenic routes etc. However, certain criteria such as setbacks from National and Provincial roads, coastal buffers, set backs from airports were considered onerous when compared with international standards. The viability of a proposed wind farm development hinges on the wind resource and the above-mentioned guideline document recognises that this and other concerns were not addressed in the methodology.

The site selection process was performed by overlaying positive and negative criteria using a Graphical Information System (GIS) that resulted in choosing locations through a process of narrowing focus from a regional through to a local level as follows:

[1] Strategic Initiative to Introduce Commercial Land Based Wind Energy Development to the Western Cape, Towards a Regional Methodology for Wind Energy Site Selection Reports 1 – 7.

- Areas of significant environmental value were mapped eg National promulgated nature reserves and coastlines, known biodiversity spots which were buffered out;
- Grid lines were then mapped; and
- The wind resource was mapped using high level metrological data;
- Aviation constraints were mapped.

Out of the analysis above, potential sites were provisionally identified which resulted in approximately 60 potential wind farm locations across the Western, Eastern and Northern Cape.

An iterative process was then implemented as outlined below:

- Landowners at each shortlisted site were then contacted to gauge interest;
- Site visits were conducted for constructability and to verify potential contraints that might impact on size of windfarm;
- Ease of connection to the electricity network was assessed;
- A rationalization process took place and sites that did not have high landowner interest or showed constructability issues were deprioritised; and
- Sites that showed potential for additional benefits such as grid stabilization or economic stimulation were prioritized.

The result of this process was the selection of an initial set of 17 sites by Mainstream and the decision to proceed with eight sites, one of which was Perdekraal.

The eight sites were selected based on the following favourable parameters:

- Good wind speed;
- Proximity to the Eskom grid;
- Low population or forests or tall buildings;
- Willing landowners;
- Ease of access to the site;
- Need for local energy security and or grid stabilization in the region; and
- Opportunity for the local areas to benefit from the socio-economic stimulus of the project.

Specialist studies were commissioned to identify and address environmental and social impacts associated with the proposed development and to inform the site layout design with site-specific buffer zones. The consideration of the above criteria resulted in the selection of the preferred site. No further site alternatives were considered in the EIA process.

4.6.2 Site Layout Alternatives

The turbine layout design may undergo a number of iterations based on technical aspects such as detailed site specific wind data and environmental, social and heritage considerations explored through the EIA process.

From a technical perspective, the turbine layout design depends on:

- the site wind rose (summary wind strength and direction);
- wind turbulence intensity determined from on site measurements; and
- the turbine characteristics (rotor diameter and hub height, rotor speed).

In addition, standard technical and environmental exclusion zones are taken into consideration when designing the turbine layout, namely:

- Slopes of more than 8 degrees;
- Inland water body buffer of 100m;
- House or buildings buffer of 500m;
- Railway buffer of 200m;
- River buffer of 200m;
- Buffer along a road of 200m;
- Boundary buffer around the site of 200m;
- Buffer along grid connection lines of between 200m and 300m depending on the size of the line; and
- Substation buffer of 500m.

The technical and environmental criteria listed above were used to develop an initial 'buildable areas map' which depicts the areas on the site which may be suitable for turbine construction. The Mainstream SA technical team then generated an indicative turbine layout design, Site Layout Alternative 1 (see *Figure 4.8*) for the project using the limited resource data available at the time.

After field surveys by the EIA team particular areas posing additional environmental and social constraints or specific unsuitable turbine locations were identified and fed back to the technical team (refer to *Slopes map*

Figure 4.9). Areas considered unsuitable were excluded based on potential impacts to vegetation, birds, bats, ecology, heritage, noise sensitive receptors and visual considerations. The technical team then generated a revised 'buildable areas map' and from there developed a revised turbine layout design. The Site Layout Alternative 2 took these environmental and social constraints into consideration. This process has encompassed the consideration of layout alternatives in the EIA process and **Site Layout Alternative 2** is the **preferred and final** layout alternative. In order to split the application, Site Layout Alternative 2 has been divided into the Perdekraal Site 2 layout (see *Figure 4.10*) and Perdekraal Site 1 layout.

The aim of considering layout alternatives was to balance the technical and financial objectives of maximising the output of the proposed facility with the other critical environmental and social constraints including visual, noise, vegetation, fauna, heritage, bats and birds. The first step in minimising negative environmental impacts was therefore avoidance through the revision of the infrastructure layout resulting in the preferred Site Layout Alternative 1. The evolution of the changes to the project specifications is indicated in *Table 4.2*, below.

Table 4.2 Layout development

Description	EIA phase	No. of turbines	Output capacity (MW)	Reason
Site Layout Alternative 1	Scoping	169 – 230	310 - 468	Initial buffers and technical constraints
Site Layout Alternative 2	Impact Assessment	100 - 130	230 - 300	Additional buffers and sensitive areas considering inputs from the public and environmental and social constraints.

It should be noted that should the layout undergo adjustments prior to construction, these revisions will be within the areas acceptable for the establishment of turbines and PV, prescribed by this EIR.

4.6.3 Grid Connection Alternatives

The options for connecting the renewable energy facility at Perdekraal Site 2 to the Eskom distribution grid are subject to on-going discussions between Mainstream SA and Eskom. The site connection option considered most viable for the site is to connect to the proposed Eskom Kappa Substation via the establishment of a 7km overhead line in the existing servitude adjacent to the 400kV line running through the site.

4.6.4 Technology Alternatives

There are a number of wind turbine and Photovoltaic (PV) array models from various manufactures with different dimensions and outputs. The preferred infrastructure supplier has not yet been selected. The turbines considered suitable for installation range in output from 1.5 to 3.5 MW with a hub height ranging from 70 to 120m. For the impact assessment, this range was

considered however for the visual assessment, the most likely turbine dimension with a hub height of 80m was used to generate photomontages showing views of turbines superimposed on the landscape.

PV installation infrastructure will either be fixed or will allow for sun tracking. It is not envisaged that the alternative technologies will result in significantly different impacts.

4.6.5 No-Go Alternative

The no-go alternative implies that the proposed project would not be executed. Assuming that the renewable facility would not be developed at the proposed site, there would be no increase in electricity generation from the facility, no CO_2 offsets associated with the proposed development and no economic benefit to the landowners or additional socio-economic benefits associated with the potential income generated through the construction and operation of the facility (see *Section 14*). National and provincial government have set renewable energy targets and made commitments to reducing their reliance on coal, the no-go would not contribute to achieving these goals. There will also be no negative environmental and social impacts associated with a renewable energy facility as discussed in this report.

20°1'30"E 20°3'0"E 20°4'30"E 20°6'0"E 20°7'30"E 20°9'0"E

33°1'30"S 33°3'0"S 33°4'30"S 33°6'0"S 33°7'30"S

Cape Winelands

LOWER ROODEWAL 239

RIET POORT 243

LOWER STINKFONTEIN 215

UPPER STINKFONTEIN

TOOVERBERG 241

Perdekraal

Pramberg

Toorberg

Legend

- Perdekraal Land Parcels
- Contour
- River
- Secondary Roads
- Other Roads
- Track and Hiking Trail
- Tramsmission Line
- Waterbodies
- Proposed O&M Building Location
- Preferred Access Points
- Alternative Access Points
- Connection Point Option 1
- Substation Option 1
- Substation Option 2
- Proposed Transmission Line 1
- Proposed Transmission Line 2
- Proposed Transmission Line 3
- Proposed Transmission Line 4
- PV Area
- Wind Turbine Generator
- Internal Road

SCALE: 0 1 2 Kilometers

N

TITLE:

Figure 4.8: Site Layout Alternative 1 on the Topographical Map

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Apr 2012	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 50 000

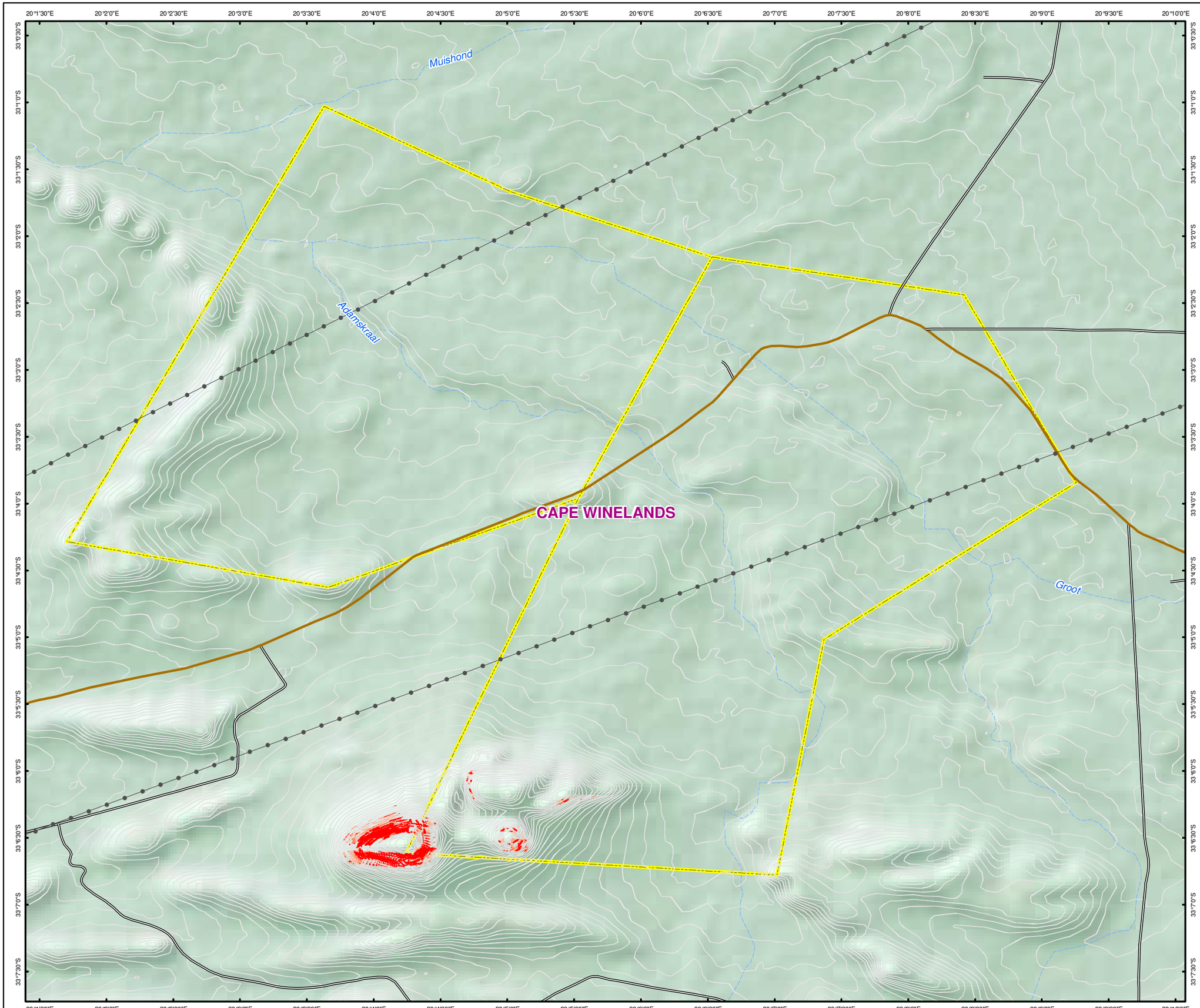
DRAWING: Perdekraal_Topo_Alt1_Rev1.mxd | REV: 1

ERM
Block A, Silverwood House
Silverwood Close
Steenberg Office Park, 7945
Cape Town, SOUTH AFRICA
Tel: +27 (0)21 702 9100
Fax +27 (0)21 701 7900

Projection: Geographic, Datum: WGS84
Source: Chief Directorate: National Geo-Spatial Information
3320AA_2007_ED3_GEO.TIF
Inset: ESRI Data and Maps

SIZE: A3

T:\Gis Projects\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\30Apr12\Alt2 1\Perdekraal_Topo_Alt1_Rev1.mxd

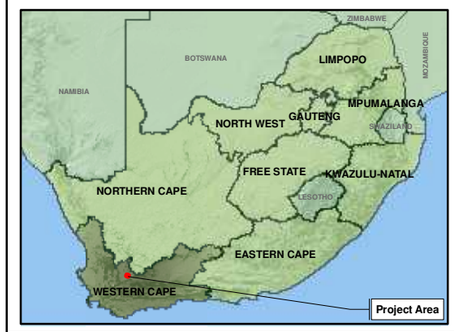


Legend

- Perennial
- Non Perennial
- Railway Line
- Secondary Road
- Other Roads
- Existing Transmission Lines
- Perdekraal Land Parcels
- District Municipalities

Slope (degrees)

- 0 - 8
- 8.1 - 12
- 12.1 - 57



SCALE:

0 500 1,000 1,500 2,000 2,500

Metres

N

TITLE:

Figure 4.9 Slope Map for Perdekraal

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Aug 2011	CHECKED: TS	Project: 0108508
DRAWN: LDT	APPROVED: SHC	SCALE: 1 : 50 000

DRAWING: Fig4.9_Slope Map Perdekraal.mxd

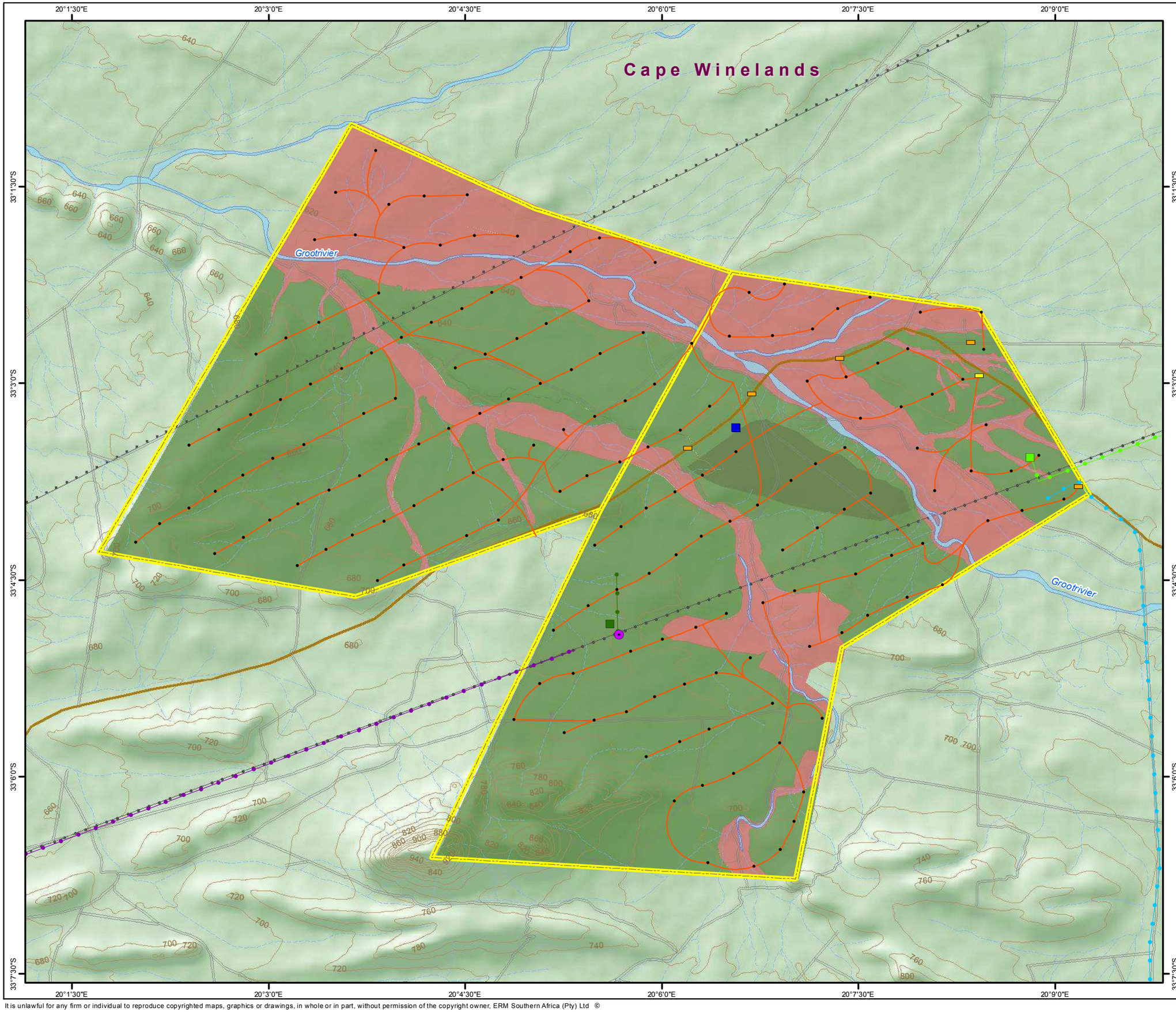
REV: 2

ERM
Hatfield Bridge 3C
213 Richard Street, Hatfield,
Pretoria, South Africa
Tel: +27 12 342 2895
Fax: +27 12 430 4689

Projection: Geographic, Datum: Hartebeesthoek 1994
Source: Surveys and Mapping CapeTown, 3320AA, AB, AC & AD
Inset: ESRI Data and Maps

SIZE: A3

C:\0108508_Mainstream Renewable Power\Mapping\mxd\Fig4.9_Slope Map Perdekraal.mxd



Legend

- Perdekraal Land Parcel
- Contour (20m)
- Non-Perennial River
- River Area
- Secondary Road
- Other Road
- Railway Line
- Transmission Line
- Proposed O&M Building Location
- Preferred Access Points
- Alternative Access Points
- Substation Option 1
- Substation Option 2
- Connection Point Option 1
- Proposed Transmission Line 1
- Proposed Transmission Line 2
- Proposed Transmission Line 3
- Proposed Transmission Line 4
- PV Area
- Wind Turbine Generator
- Internal Road
- Acceptable for establishment of turbines and PV
- Not Acceptable for establishment of turbines and PV

SCALE:

0 500 1,000 1,500 2,000
Metres

N

TITLE:

Figure 7.1: Alternative 1 on the Areas for Establishment of Turbines and PV

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Apr 2012	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 50 000

DRAWING: Perdekraal_Alt1_BIA_Buildable_areas_Rev1.mxd

REV: 1

ERM
Block A, Silverwood House
Silverwood Close
Steenberg Office Park, 7945
Cape Town, SOUTH AFRICA
Tel: +27 (0)21 702 9100
Fax +27 (0)21 701 7900

Projection: Geographic, Datum: Hartebeesthoek 1994
Source:
Inset: ESRI Data and Maps

SIZE: A3

T:\Gis Projects\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\30Apr12\Alt2 1\Perdekraal_Alt1_BIA_Buildable_areas_Rev1.mxd

Cape Winelands

Grootrivier

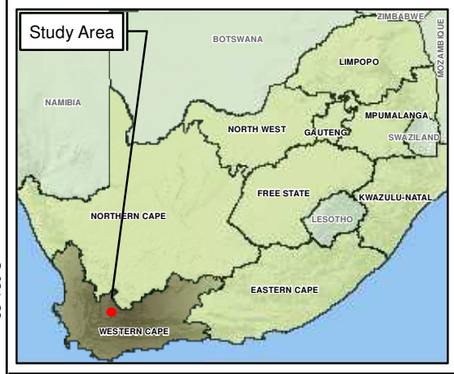
Grootrivier

20°1'30"E 20°3'0"E 20°4'30"E 20°6'0"E 20°7'30"E 20°9'0"E

33°1'30"S 33°3'0"S 33°4'30"S 33°6'0"S 33°7'30"S

Legend

- Perdekraal Land Parcel
- Contour (20m)
- Non-Perennial River
- River Area
- Secondary Road
- Other Road
- Railway Line
- Transmission Line
- Proposed O&M Building Location
- Preferred Access Points
- Alternative Access Points
- Substation Option 1
- PV Area
- Wind Turbine Generator
- Internal Road
- Acceptable for establishment of turbines and PV
- Not Acceptable for establishment of turbines and PV



SCALE:

0 500 1,000 1,500 2,000
Metres

N

TITLE:

Figure 7.2: Alternative 2 (Perdekraal 2) on the Areas for Establishment of Turbines and PV

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Apr 2012	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 50 000

DRAWING: Perdekraal_Alt2_BIA_Buildable_areas_(Perdekraal2)_Rev1.mxd

REV: 1

ERM
Block A, Silverwood House
Silverwood Close
Steenberg Office Park, 7945
Cape Town, SOUTH AFRICA
Tel: +27 (0)21 702 9100
Fax +27 (0)21 701 7900

ERM

Projection: Geographic, Datum: Hartebeesthoek 1994
Source:
Inset: ESRI Data and Maps

SIZE: A3

T:\Gis Projects\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\30Apr12\Alt2 1\Perdekraal_Alt2_BIA_Buildable_areas_(Perdekraal2)_Rev1.mxd

5 BIOPHYSICAL BASELINE DESCRIPTION

This chapter provides a description of the current biophysical conditions against which the potential impacts of the proposed renewable energy facility can be assessed and future changes monitored. The chapter presents an overview of the aspects of the baseline conditions of the site and surrounding area which may be directly or indirectly affected by the proposed development.

5.1 BIOPHYSICAL BASELINE DESCRIPTION

5.1.1 Site Setting

The Perdekraal site is located within the scenic Karoo area, associated with large, open expanses. The site and surrounding area consists of low hills and flat or gently sloping open plains. The Grootrivier runs parallel to the north-eastern boundary of the site with the Bontberg range to the south and the Kleinroggeveld range to the northeast. The site is zoned for agricultural use although farming on site currently is marginal. The landscape is covered with indigenous vegetation, which has been grazed. There are two towns within a 50km radius of the site, namely Touwsrivier and Matjiesfontien. The town of Touwsrivier is located approximately 32km south west of the site, while Matjiesfontein is located approximately 48km south east of the site.

There are a number of private nature reserves and game farms within a 30km radius of the site. Statutory reserves in the area include the Touwsrivier Nature Reserve approximately 30km southwest of the site (see *Figure 4.1*). The Vaalkloof Private Nature Reserve is located 25km southwest of the site, the Inverdoorn Private Game Reserve is located approximately 28km west of the site and the Ibhadi Game Lodge is located approximately 6km south of the site. There are a number of farms in the area where parts of the land have been cultivated and others where natural vegetation is utilised for natural grazing. There are two existing 400kV power lines that transverse through the area in which the site is located and through the site itself.

The proposed site consists of two farms located in a rural area. There is a modest farm house located on each farm, (Reitpoort and Perdekraal), as well as a number of farm buildings. The gravel access road bisects the site and the daily traffic on the road is minimal. The site can be considered remote and during the site visit no man-made noise was audible or measurable on the site.

5.1.2 Geology of the Area

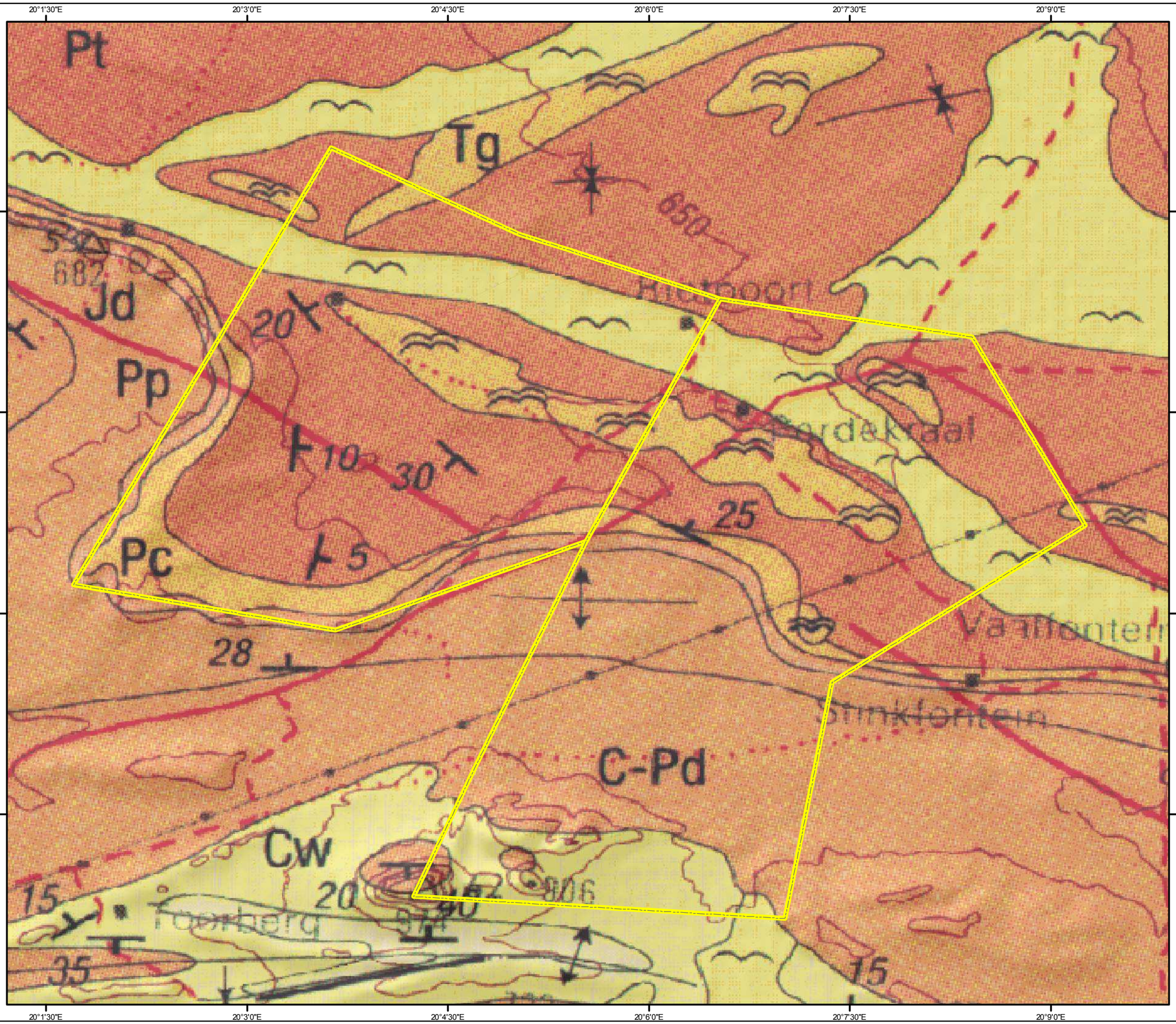
The rugged Bontberg Range and its gentle northern footslopes are formed by rocks of the upper Witteberg Group of Late Devonian to Early Carboniferous age (Cape Supergroup). In the study area only the uppermost unit of the Witteberg Group – the Early Carboniferous Waaiport Formation (Cw) – is

represented in the neighbourhood of Toorberg. Toorberg itself as well neighbouring hills, rocky ridges and much of the southern sector of the study area are underlain by Late Carboniferous to Early Permian glacial sediments of the Dwyka Group (C-Pd), namely the Elandsvlei Formation. The low-lying, low-relief central and northern sectors are underlain by conformably overlying basinal sediments of the Early Permian Ecca Group. Several Ecca formations, predominantly recessive weathering mudrocks, crop out here. In order of decreasing age these are: the Prince Albert Formation (Pp), the Whitehill Formation (Pw), the Collingham Formation (Pc) and the Tierberg Formation (Pt). As is apparent in satellite images, these Palaeozoic sedimentary bedrocks are extensively blanketed by superficial deposits or "drift" comprising colluvium (slope deposits), sheet wash and alluvial (river) sediments and silty, sandy and gravelly / rocky soils of Quaternary to Recent age. Among these drift sediments, most are too thin to be mapped separately. Only substantial units of Late Tertiary High Level Gravels (Tg) and alluvium related to modern drainage systems are therefore shown (see *Figure 5.1*).

The soils along the Grootrivier are alluvial sands which overlie the shale sediments. In the south the soils are composed of quartzitic gravels probably overlying tillites of the Dywka Group but which are not obvious. In places there are outcrops of silcrete where the substrate is not loose but hard and unyielding. The site is not characterised by extensive erosion.

Soils found in the flood plain of the Groot Rivier are characterized by restricted soil depth, excessive drainage, high erodibility and low natural fertility, while soils on the western slopes of the site are characterized by restricted soil depth, excessive or imperfect drainage and high erodibility. On the eastern and south eastern slopes of the site the soils are of restricted depth and associated with rocky outcrops [(1)] .

(1) SANBI BGIS National Land Cover Map 2009

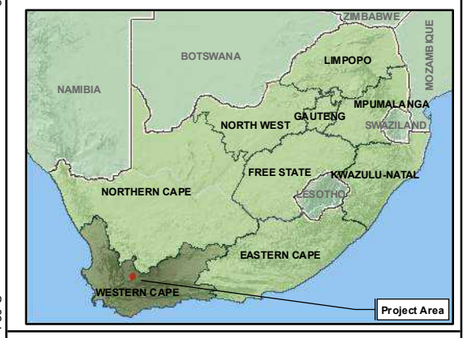


Legend

- Perdekraal Land Parcel
- Road
- Contours
- Transmission Line

Geology

- Alluvium
- Cw Waaipoort
- Pp Prince Albert, C-Pd Dwyka, Jd Dolerite
- Pt Dark-grey shale and siltstone
- Pc Collingham
- Tg High-level terrace gravel, silcrete and ferricrete



SCALE:

0 1 2

Kilometers

N

TITLE:

Figure 5.1: Geology of the Perdekraal Site

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Feb 2011	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 40 000

DRAWING: Perdekraal_Geology_Rev1.mxd | REV: 1

ERM
Building 32,
The Woodlands,
Woodlands Drive,
Woodmead, 2148
Johannesburg, South Africa
Tel: +27 (0)11 798 4300
Fax: +27 (0)11 804 2289

Projection: Geographic, Datum: Hartebeesthoek 1994
Council for Geosciences, Pretoria gcs_3320_c
Inset: ESRI Data and Maps

SIZE: A3

T:\GIS Project\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\Perdekraal_Geology_Rev1.mxd

5.1.3 Hydrology and Hydrogeology

The Grootrivier and associated floodplain is a significant feature of the site. The active channel of the Grootriver is usually only 20 - 30m wide, however, the floodplain is frequently 500 - 700m or more wide. This is typical of ephemeral rivers, which, due to the high variability of flows, usually have compound channels with a low-water configuration to accommodate near-continuous flows and a wider high-water configuration to accommodate rarer high flows. This usually results in a meandering main channel with outer braided channels. Due to the unpredictable nature of flow events in ephemeral rivers, relatively long periods of stability are interrupted by large events which redistribute large amounts of sediment and rearrange the channel and floodplain. Consequently, the current location of the active channel should not be considered stationary, and does not delineate the boundary of the river, which is rather defined by the extent of the floodplain.

The Grootrivier is the dominant landscape feature of the site and runs parallel to the north-eastern boundary of the property. The active channel of the Grootriver is usually only 20-30 m wide, however, the floodplain is frequently 500-700 m or more wide. This is typical of ephemeral rivers, which, due to the high variability of flows, usually have compound channels with a low-water configuration to accommodate near-continuous flows and a wider high-water configuration to accommodate rarer high flows. Typically, as is the case of the Grootrivier, this takes the form of a meandering main channel with outer braided channels. Due to the unpredictable nature of flow events in ephemeral rivers, relatively long periods of stability are interrupted by large events which redistribute large amounts of sediment and rearrange the channel and floodplain. Consequently, the current location of the active channel should not be considered stationary, and does not delineate the boundary of the river, which is rather defined by the extent of the floodplain. Due to the relatively homogenous nature of the surrounding plains, the Grootrivier and other drainage lines at Perdekraal represent an important feature of the landscape as they greatly increase the structural diversity and habitat heterogeneity of the site.

Outside of the drainage lines, the soils are generally very shallow, and gravel or calcrete plains are a common feature of the site. Although the vegetation cover of the site was largely within the range expected under the prevailing rainfall, the vegetation composition is indicative of poor long-term grazing management. The drainage areas were however in an overall better condition and the vegetation of these areas is dominated by various medium to large *Salsola* species and trees such as *Acacia karoo*. There is a large contrast in the sensitivity of the areas within and outside of the drainage areas to disturbance. The drainage areas are highly sensitive due to the fine-textured soils of the floodplains and their dynamic ecological nature. The plains outside of the drainage areas are however, highly homogenous with low species diversity and must in general be considered to be relatively low sensitivity.

The aquifer beneath the site is classified as a fractured aquifer. The groundwater yield potential varies between 2.0 and 5.0 l/s. Electrical conductivity (EC) values seldom exceed 100mS/m and generally range between 200 and 700mS/m.

The Department of Water Affairs and Forestry map (1) classifies the regional aquifer as a major aquifer with moderate vulnerability (2) and high susceptibility (3).

5.1.4 Flora and Fauna

Fauna

The biophysical environment of the Perdekraal site is dominated by open plains and low hills. The Grootrivier and associated floodplain is an important feature of the site. Due to the relatively homogenous nature of the surrounding plains, the Grootrivier and other drainage lines at Perdekraal represent an important feature of the landscape as they greatly increase the structural diversity and habitat heterogeneity of the site. At least 44 mammal species are likely to occur at the Perdekraal site. The most significant of these in terms of conservation status is the Riverine Rabbit *Bunolagus monticularis*, which has been recorded in the immediate vicinity of the Perdekraal site (EWT Riverine Rabbit Project 2010). Based on food plants reported in the literature and the habitat requirements of the species, the flood plain of the Grootrivier is identified as suitable habitat for this species. Given the critical status of this species, a negative impact on the local population of Riverine Rabbit would be of global significance. The flood plain of the Grootrivier supports *Salsola* and *Acacia*, and other dense shrubs which represent likely habitat for Riverine Rabbit (see *Figure 5.2*), suitable habitat areas have been classified as very high sensitivity in the ecological sensitivity map (see *Figure 5.4*). The ecology sensitivity map along with input from the other specialists was used remove turbines and reconfigure the site layout to produce the **preferred Site Layout Alternative 2**.

(1) Department of Water Affairs and Forestry. (1999) Aquifer Classification of South Africa, 1: 3 000 000.
(2) Likelihood of contaminants reaching a receptor
(3) Potential significance of contaminants reaching a receptor

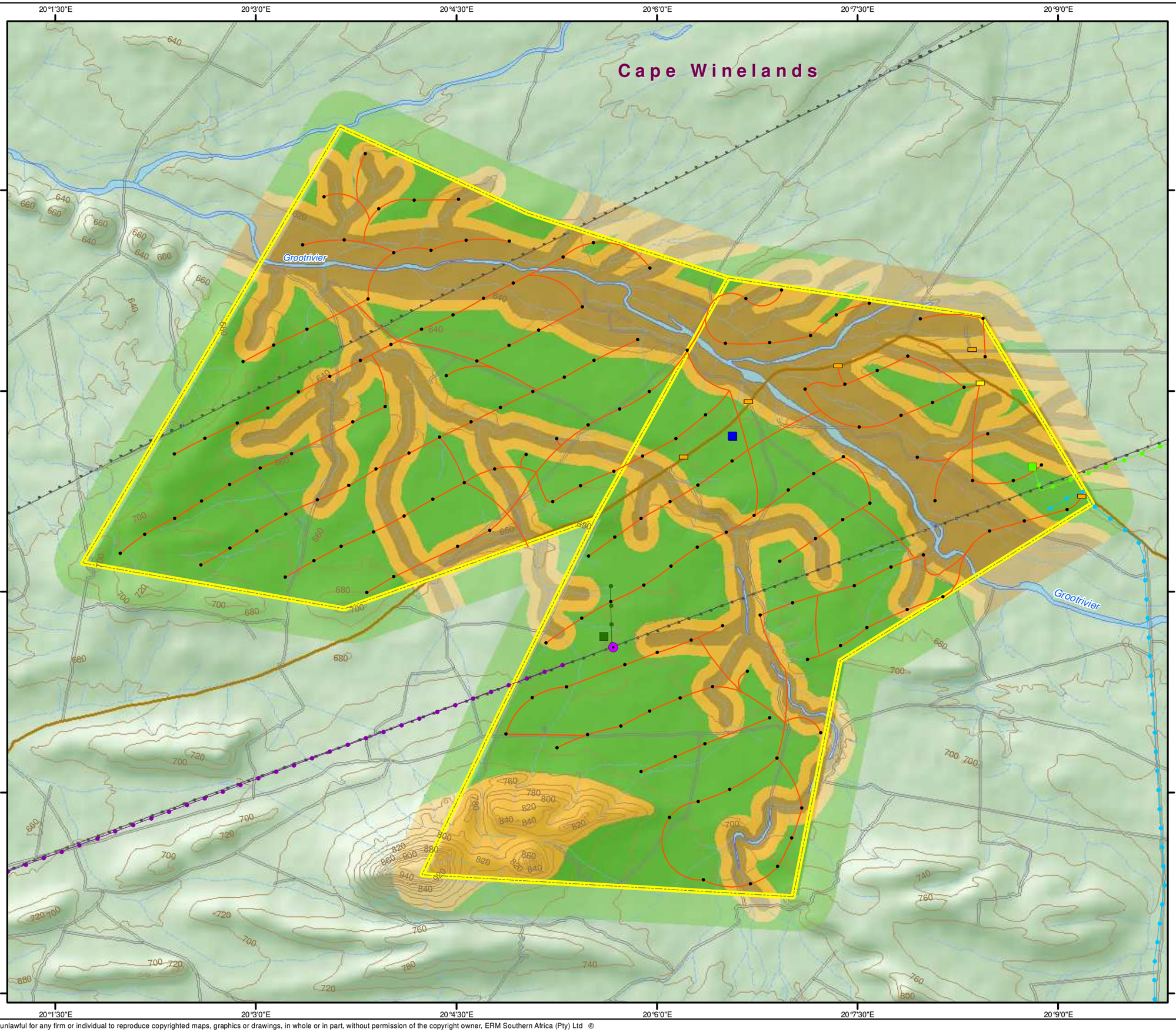
Figure 5.2 ***An example of a the densely vegetated flood plain that can be found on the site***

Due to the semi-arid nature of the region, there are relatively few amphibians which potentially occur at the site. Two regional endemic species, the Karoo Dainty Frog, *Cacosternum karooicum* and Tradouw Toadlet, *Capensibufo tradouwi* are likely to occur. Both are likely to be associated with moist areas along drainage lines. Small semi-permanent pools associated with rocky reaches of the Grootrivier were observed and represent suitable habitat for these and other amphibians (see *Figure 5.3*)

Figure 5.3 ***Seasonal pools in the Grootrivier such as this are important breeding habitat for amphibians***

Forty five reptile species, consisting of 7 tortoises, 16 snakes, 13 lizards, 2 chameleons and 7 geckos potentially occur at the Perdekraal site. More than 25 of these are regional endemics. There were few noteworthy or localized habitats at the Perdekraal site that are likely to be of greater importance in terms of reptile abundance and diversity than other such habitats. For many reptiles, suitable substrate is a primary habitat determinant. Thus at the Perdekraal site it is likely that the composition of the reptile fauna of the sandy and silty substrates associated with the drainage lines is distinct from that of the surrounding stony plains.

The important ecological and biodiversity features (ie the Grootrivier floodplain along the northern portion of the site) of the site were mapped using satellite imagery and the extensive site survey undertaken by the ecology specialist. The Grootrivier is a dominant landscape feature and represents an ecologically sensitive area of the site as shown in *Figure 5.4*, below. The areas outside of the drainage features are homogenous and are considered to be of medium sensitivity.



Legend

- Perdekraal Land Parcel
- Contour (20m)
- Non-Perennial River
- River Area
- Secondary Road
- Other Road
- Railway Line
- Transmission Line
- Proposed O&M Building Location
- Preferred Access Points
- Alternative Access Points
- Substation Option 1
- Substation Option 2
- Connection Point Option 1
- Proposed Transmission Line 1
- Proposed Transmission Line 2
- Proposed Transmission Line 3
- Proposed Transmission Line 4
- Wind Turbine Generator
- Internal Road

Ecological Sensitivity

- Very High
- Very High (Buffer)
- High
- High (Buffer)
- Medium
- Medium (Buffer)

SCALE:

0 500 1,000 1,500 2,000
Metres

N

TITLE:

Figure 4.9: Site Layout Alternative 1 on the Perdekraal Constraints Map

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Apr 2012	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 50 000

DRAWING: Perdekraal_Alt1_Constraints_Map_Rev1.mxd | REV: 1

ERM
Block A, Silverwood House
Silverwood Close
Steenberg Office Park, 7945
Cape Town, SOUTH AFRICA
Tel: +27 (0)21 702 9100
Fax +27 (0)21 701 7900

ERM

Projection: Geographic, Datum: Hartebeesthoek 1994
Source:
Inset: ESRI Data and Maps

SIZE: A3

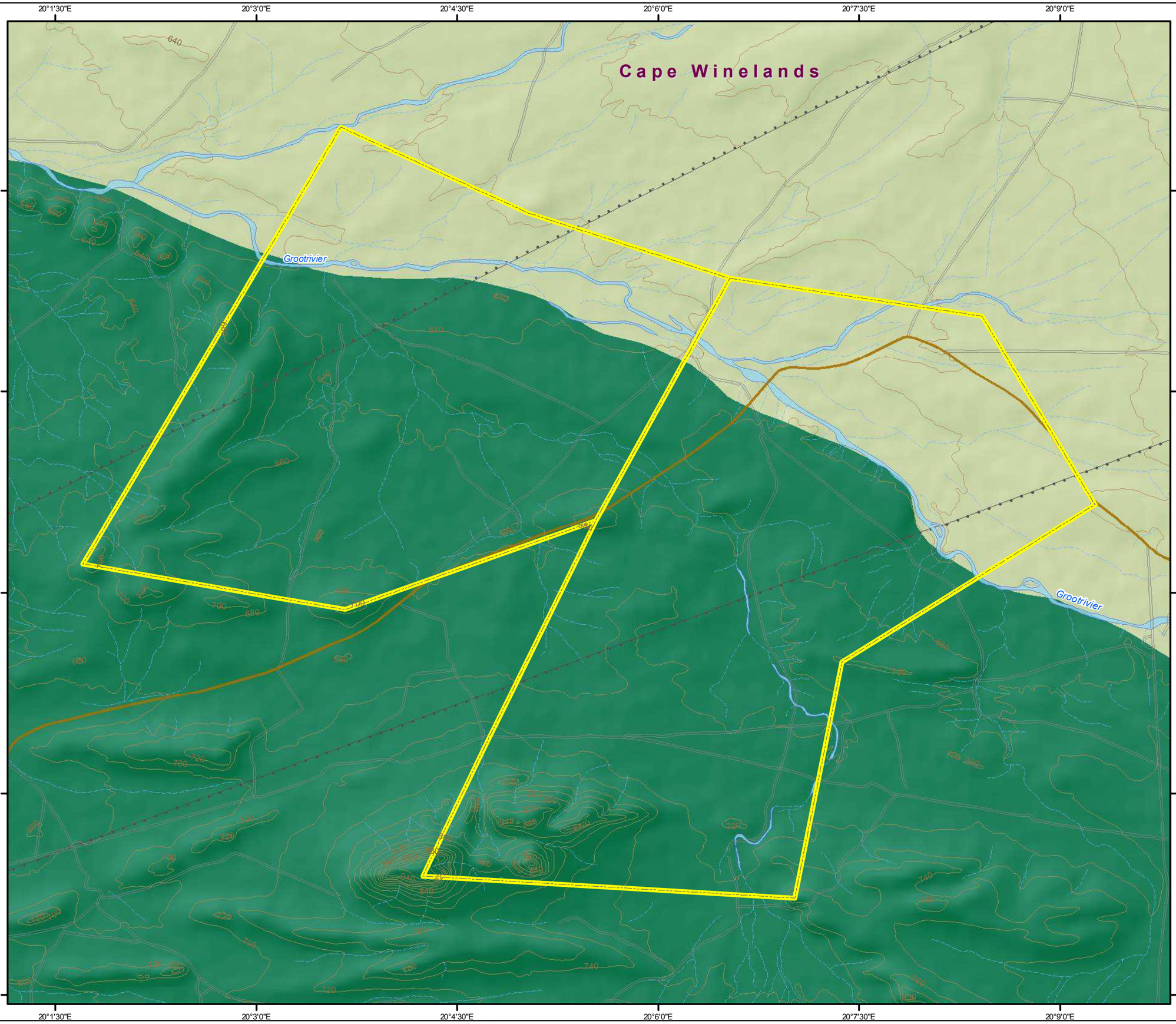
T:\Gis Projects\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\30Apr12\Alt2 1\Perdekraal_Alt1_Constraints_Map_Rev1.mxd

Flora

The site falls within the Succulent Karoo Biome where the soils and climate are the strongest determinants of the distribution of the array of plant species that occur. According to the national classification of the Vegetation of South Africa (Rebelo *et al.* 2006 in Mucina & Rutherford, 2006) the natural vegetation found on the Perdekraal site consists of Tanqua Karoo (SKv 5) southwest of the Grootrivier and Tanqua Wash Riviere (AZi 7) including and to the northeast of the Grootrivier (see *Figure 5.5*).

The farms at the Perdekraal site have been grazed for many years by sheep, resulting in many of the palatable plants being selectively grazed out and what remains are unpalatable plants, some of which are poisonous to stock. The site is dominated by *Pteronia pallens* and *Ruschia spinosa* with few palatable species, such as *Zygophyllum retrofractum* present (see *Figure 5.6*). This is typical of what Acocks (1953) described as being 'terribly trampled out' indicating overuse in excess of a century or longer. The farms comprising the study area are a good example of overgrazing which has been exacerbated by the severe drought of recent years.

The vegetation in the seasonal watercourses is more vigorous than that on the open hills and slopes, and the Grootrivier offers some food value to livestock due to both the perennial availability of shrubs and the occasional flooding which stimulates the growth of the riparian vegetation. The flooding of the river is itself a form of disturbance but is important for recharging the ground table.

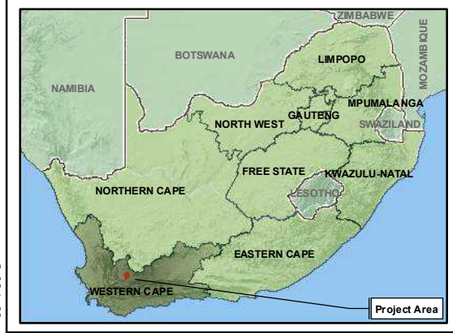


Legend

- Perdekraal Land Parcel
- Transmission Line
- Secondary Road
- Other Road
- Non-Perennial River
- River Area
- Contour (20m)

Vegetation Types

- Tanqua Riviere
- Tanqua Karoo



SCALE:

0 1 2

Kilometers

N

TITLE:

Figure 5.5: Vegetation Types found on the Perdekraal Site

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Feb 2011	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 50 000

DRAWING: Perdekraal_Vegetation_Rev1.mxd | REV: 1

ERM
Building 32,
The Woodlands,
Woodlands Drive,
Woodmead, 2148
Johannesburg, South Africa
Tel: +27 (0)11 798 4300
Fax: +27 (0)11 804 2289

ERM

Projection: Geographic, Datum: Hartebeesthoek 1994
Source: PPF, SANBI (2007)
Inset: ESRI Data and Maps

SIZE: A3

T:\GIS Project\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\Perdekraal_Vegetation_Rev1.mxd

Figure 5.6 ***Typical view of the Perdekraal site showing plains dominated by Ruschia spinosa in the foreground and Acacia karoo trees in the background***

The vegetation in the drainage channels is good condition and the silty bank deposits support vegetation such as grasses and sedges, as well as various medium to large *Salsola* species and trees such as *Acacia karoo*, (see *Figure 5.7*).

Figure 5.7 ***The banks of a tributary to the Grootrivier support grasses and larger shrubs and Acacia karoo***

An attempt was made to determine local-scale (fine-scale) differences in the vegetation at Perdekraal. Four relatively distinct units of vegetation were determined, although between the units there is a high degree of similarity and overlap. The units and their sensitivity are described below.

Community 1: *Ruschia spinescens* – dominated Shrubland

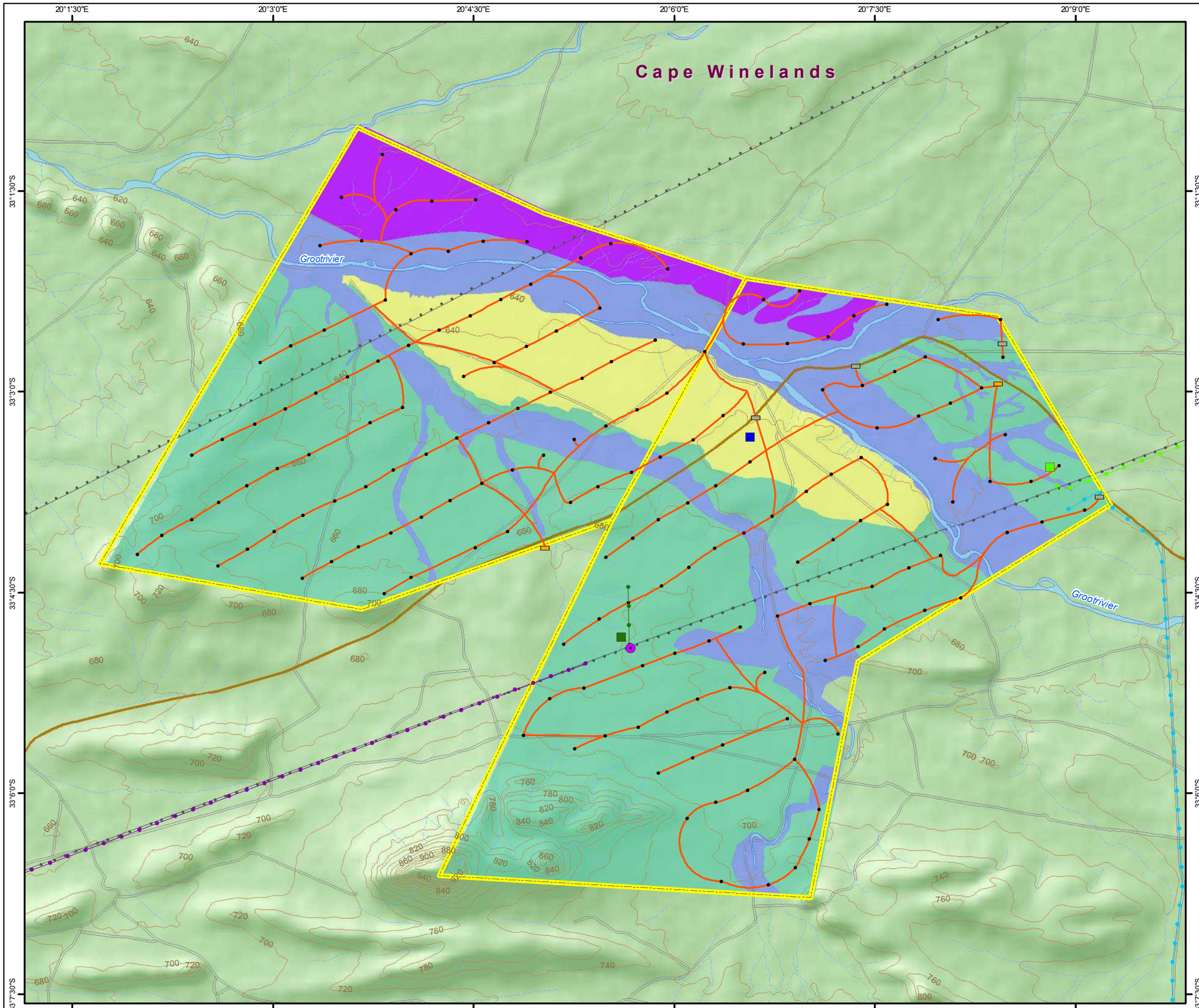
Community 1 is represented by low shrubland vegetation dominated by *Ruschia spinosa* (doringvygie), an unpalatable succulent species that has thorns which discourage grazing. Together with *R. spinosa* is *Psilocaulon* sp. and *Pteronia pallens* which occur occasionally. The substrate is more clay-rich with less gravel than elsewhere and this may account for the difference in vegetation from Community 2. *Aloe variegata* (Kanniedood or Partridge-breast Aloe), a widespread Karoo species was found and also *Aridaria noctiflora*, which is an indicator species for the general vegetation type, was found as was *Tylecodon wallichii* in moderate numbers.

The distribution of Community 1 is in the lower-elevation south and south-west areas of the two farms comprising the Perdekraal site south of the Grootrivier, as well as in the north-east corner of Lower Stinkfontein 245, north of the Grootrivier (see *Figure 5.8*). It is not a sensitive vegetation type and is widespread beyond the boundaries of the study area.

Community 2: *Pteronia pallens* – dominated Shrubland

Pteronia pallens (Scholtzbos) is a shrub species of up to 1 m in height. It is abundant and dominant in the central, elevated part of the study area on substrate that has gravel and cobbles on the surface. From observations at a soil pit it was obvious that this area is underlain by calcrete. Scholtzbos is toxic to livestock and is a good indicator of overgrazing; the abundance of this species attests to the historical heavy grazing although no livestock were noted here at the time of the site visit. This vegetation is referred to as Scholtzbosveld (Vlok & Schutte-Vlok, 2010) and the area at Perdekraal where it occurs fits well with the description by these authors, '(Scholtzbosveld) is a distinctive habitat that is situated on flat-topped hills where the soils are shallow and underlain by calcrete.'; 'Scholtzbos seems to be allelopathic (exuding chemicals that prevent the establishment of other plants close to it). Once Scholtzbos plants establish, they may dominate the local area for centuries. Animals will not eat them and shrubby plants cannot establish near them to replace them.'

Not many species were found in this veld. Apart from the ubiquitous *P. pallens*, the only other species found were *Euphorbia* sp., *Malephora crassa*, *Phyllobolus* sp., *Psilocaulon* spp. (two distinct species), *Ruschia spinosa* and *Zygophyllum retrofractum*. This is in accord with Vlok and Schutte-Vlok (2010) who note the low species richness of Scholtzbosveld. All these factors combine to result in the Scholtzbosveld having low sensitivity.



Legend

- Perdekraal Land Parcel
- Western Cape
- Transmission Line
- Secondary Road
- Other Road
- Non-Perennial River
- River Area
- Contour (20m)
- Proposed Transmission Line 1
- Proposed Transmission Line 2
- Proposed Transmission Line 3
- Proposed Transmission Line 4
- Proposed O&M Building Location
- Preferred Access Points
- Alternative Access Points
- Substation Option 2
- Substation Option 1
- Connection Point Option 1
- Wind Turbine Generator
- Internal Road

Vegetation and Habitats

- Community 1
- Community 2
- Community 3
- Community 4

SCALE: 0 1 2 Kilometers

N

TITLE:

Figure 5.8: The vegetation of Perdekraal incicating four units based on the vegetation and habitats indentified on site

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: March 2011	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 50 000

DRAWING: Perdekraal_BIA_Vegetation_Rev1.mxd | REV: 1

ERM
Building 32,
The Woodlands,
Woodlands Drive,
Woodmead, 2148
Johannesburg, South Africa
Tel: +27 (0)11 798 4300
Fax: +27 (0)11 804 2289

ERM

Projection: Geographic, Datum: Hartebeesthoek 1994
Source: Ecology and Vegetation Impact Assessments (Simon Todd and Dave MacDonald) 2010
Inset: ESRI Data and Maps

SIZE: A3

T:\GIS Project\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\Perdekraal_BIA_Vegetation_Rev1.mxd

Community 3: Ceres Karoo Vygieveld

Mucina et al. (2005) mapped the Tanqua Wash Riviere vegetation as extending well beyond the northern boundary of the study area. This is in fact not so. It is true to say from what was observed on the site that the area north of the Grootrivier does 'wash' after periodic heavy rain. However, the vegetation in this area is very different from the riparian vegetation. It is short vygieveld, no more than 0.3 m tall with *Ruschia spinosa* being dominant. In some places there are clumped vygies (possibly *Antimima* sp.) and areas dominated by low plants of *Malephora crassa*. Apart from *R. spinosa* the only other prominent shrub is *Pteronia pallens* but it is not as abundant as in the area mapped as Community 2.

Although having a prominent shrub stratum, Community 3 has many more vygies (higher diversity) than elsewhere on the site. This vegetation most closely fits with Van der Merwe et al.'s (2008b) plant association No. 9: Mesembryanthemaceae (HRp359) sp. Ceres Karoo Vygieveld. The soil is highly characteristic, derived from shale which has weathered into needle-like fragments lining the 'wash' areas. Consequently the area north of the Grootrivier is mapped entirely as having Community 3 and is rated as Sensitive, see *Figure 5.8*.

Community 4: Riparian vegetation of the Grootrivier and its tributaries

The Grootrivier drains to the Tanquarivier and has riparian vegetation typical of the Tanqua Wash Riviere described by Mucina et al. (2006). Some of the tributaries and watercourses south of the Grootrivier have similar vegetation. *Acacia karoo* is a common tree along the washes and drainage lines with a lower shrub stratum of *Salsola* spp., mainly *Salsola aphylla* and *Lycium* sp. *Melianthus comosus* is also found on the periphery of the main wash.

The soil in the drainage lines (main washes) is silty sand in contrast to the more clay-rich, pebbly or shale soils elsewhere. Apart from the differences in the vegetation, the differences in substrate are strong habitat delimiters.

The Tanqua Wash Riviere vegetation is not threatened but since it is riparian vegetation it has Very High Sensitivity and important conservation status.

Conservation Status

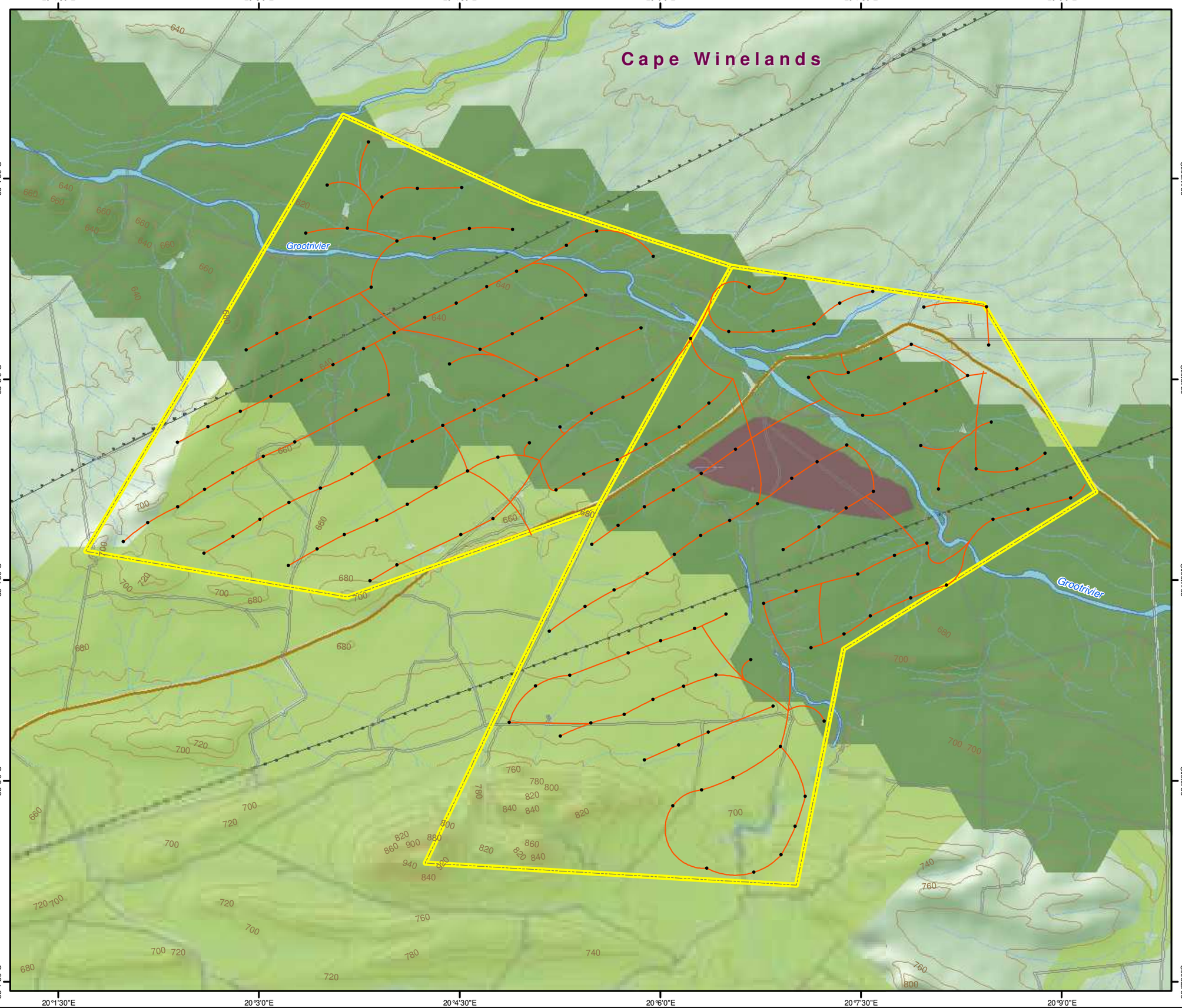
The National Spatial Biodiversity Assessment (NSBA) ((Rouget et al. 2004) rated both the Tanqua Karoo Vegetation and the Tanqua Wash Riviere as Least Threatened. However, riverine systems are considered to be of high conservation value nationally, hence the in the more recent map of the Cape Winelands District Management Area, the Tanqua Wash Riviere is mapped as a Critical Biodiversity Area (CBA) (see *Figure 5.9*). The remainder of the Perdekraal study area is mapped as Ecological Support Area (ESA) which also has a high conservation status Skowno, Holness & Desmet (2009).

Even though a vegetation type may be rated as Least Threatened it is still important to observe caution when developing an area where undisturbed vegetation occurs. Consequently all areas of natural vegetation at the Perdekraal study site (CBA's and Ecological Support Areas) were treated as being important from a conservation viewpoint and the impacts of construction of wind-turbines or photo-voltaic panels were assessed accordingly.

No rare or endemic plant species were found during the survey. However, it is possible that such species may occur. For this reason it is advisable to treat the study area with caution since winter and spring-flowering plant species (particularly geophytes) may be present (particularly after winter rains that would break the drought) that were not found during the survey.

An examination of *Figure 5.9* indicates that the greater proportion of the site falls within a Critical Biodiversity Area (CBA) and the remainder in an Ecological Support Area (ESA). However, the CBA map is based on the national vegetation map (see *Figure 5.5*). The vegetation study has shown that the areas designated as Tanqua Wash Riviere in the national vegetation map (Mucina *et al*. 2005) are not accurate; the CBA map is based on the vegetation map and the 'error' has been perpetuated. Observations in the vegetation study show that the Grootrivier is much narrower on the north side at Perdekraal. Nevertheless the 'vygieveld north of the Grootrivier is also sensitive and justifiably included in the CBA.

The south to south-west limit of the CBA is also liberal and from this study is considered to be further to the north and north-east. This means that more of the proposed turbines would fall within the less sensitive ESA. It is important to note that the CBA's are based on modeled data and suffer from a significant lack of ground-truthing. The veracity of the CBA's must therefore be questioned (and used as a guide) until such time as robust ground-truthed information is available. The botanical survey and assessment of the site was based on a site visit that provides at least reasonable ground truth information as to the nature of the vegetation found on the site. The proposed development was therefore analysed in relation to the vegetation found in the study area with areas viewed as acceptable or unacceptable based on the communities found there and described above.

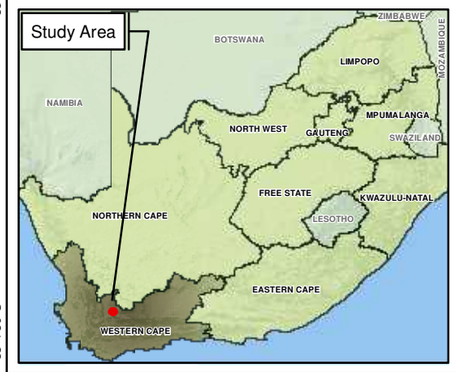


Legend

- Perdekraal Land Parcel
- Western Cape
- Contour (20m)
- Non-Perennial River
- River Area
- Secondary Road
- Other Road
- Railway Line
- Transmission Line
- PV Area
- Wind Turbine Generator
- Internal Road

Critical Biodiversity Area

- Critical Biodiversity Area
- Ecological Support Area



SCALE:

0 500 1,000 1,500 2,000

Metres

N

TITLE:

Figure 5.9: Site Layout Alternative 1 on the Perdekraal Constraints Map

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Apr 2012	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 50 000

DRAWING: Perdekraal_Alt1_CBA_Map_Rev1.mxd

REV: 1

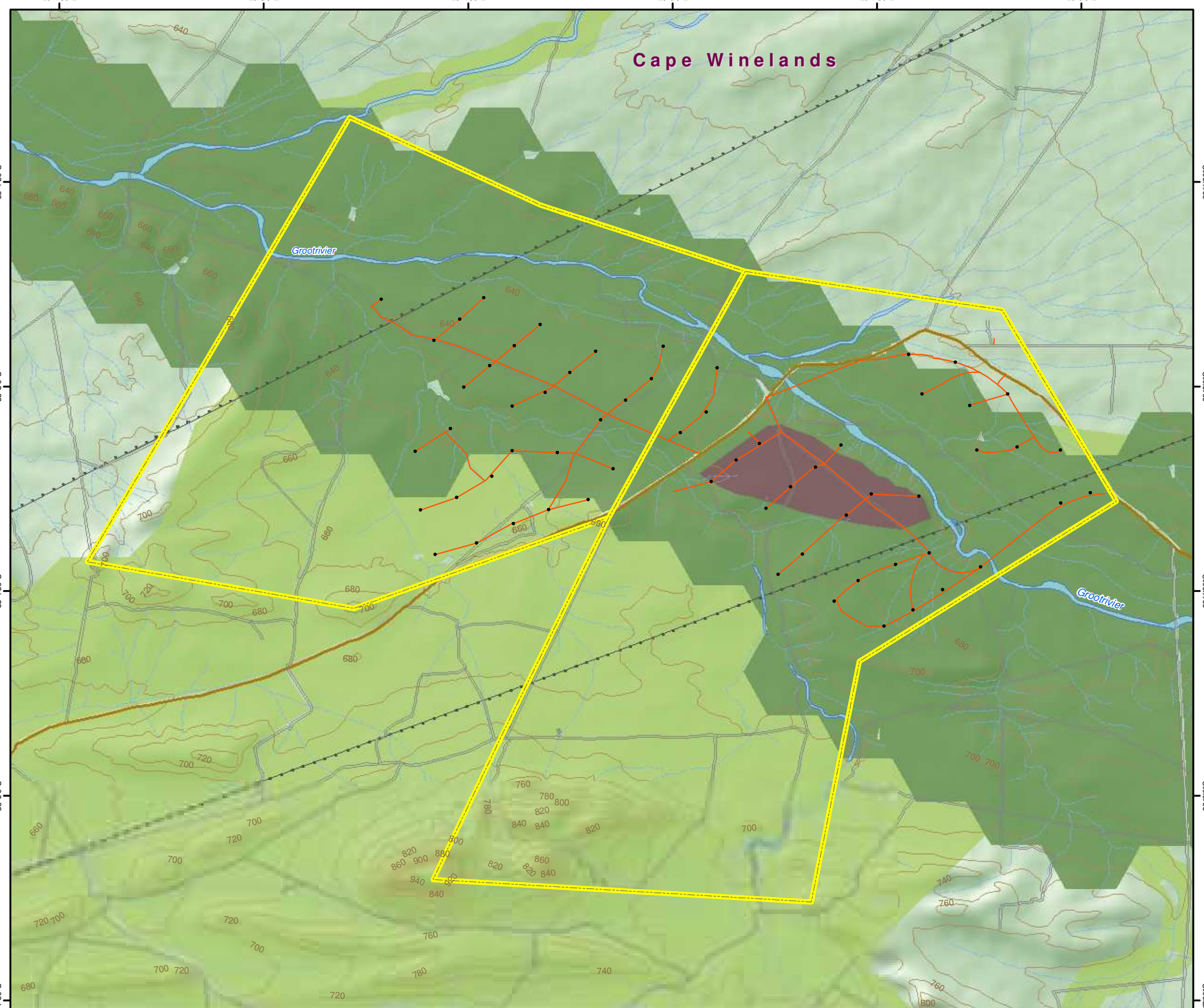
ERM
Block A, Silverwood House
Silverwood Close
Steenberg Office Park, 7945
Cape Town, SOUTH AFRICA
Tel: +27 (0)21 702 9100
Fax +27 (0)21 701 7900

ERM

Projection: Geographic, Datum: Hartebeesthoek 1994
Source:
Inset: ESRI Data and Maps

SIZE: A3

T:\Gis Projects\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\30Apr12\Alt2 1\Perdekraal_Alt1_CBA_Map_Rev1.mxd

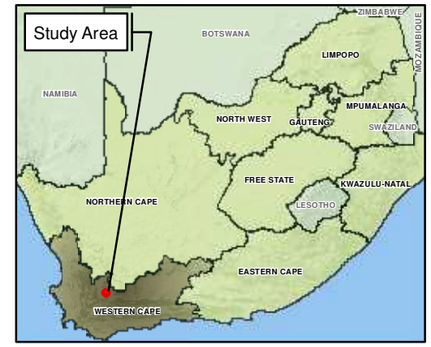


Legend

- Perdekraal Land Parcel
- Western Cape
- Contour (20m)
- Non-Perennial River
- River Area
- Secondary Road
- Other Road
- Railway Line
- Transmission Line
- PV Area
- Wind Turbine Generator
- Internal Road

Critical Biodiversity Area

- Critical Biodiversity Area
- Ecological Support Area



SCALE:

0 500 1,000 1,500 2,000
Metres

N

TITLE:

Figure 5.10: Site Layout Alternative 2 (Perdekraal 2) on the Constraints Map

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Apr 2012	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 50 000

DRAWING: Perdekraal_Alt1(Perdekraal2)_CBA_Map_Rev1.mxd

REV: 1

ERM
Block A, Silverwood House
Silverwood Close
Steenberg Office Park, 7945
Cape Town, SOUTH AFRICA
Tel: +27 (0)21 702 9100
Fax +27 (0)21 701 7900

Projection: Geographic, Datum: Hartebeesthoek 1994
Source:
Inset: ESRI Data and Maps

SIZE: A3

T:\Gis Projects\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\30Apr12\Alt2 1\Perdekraal_Alt1(Perdekraal2)_CBA_Map_Rev1.mxd

5.1.5 Avifauna

Avian Habitats

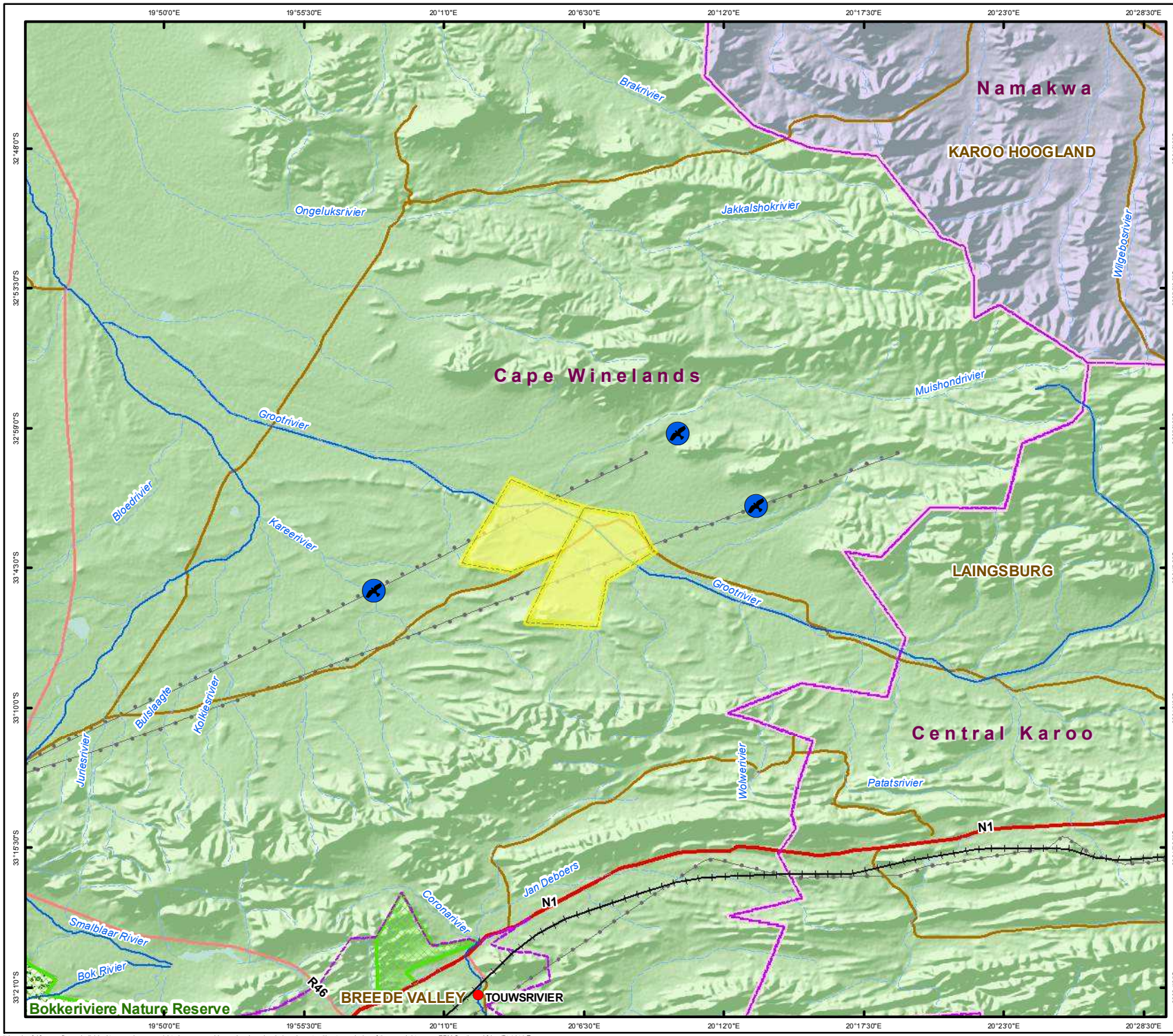
The habitat on site is relatively uniform, dominated by open Tanqua Karoo, with rocky ridges associated with the Toorberg and Pramberg outcrops in the south (*Figure 5.11*), and Acacia woodland along the course of the Groot River (*Figure 5.12*). Artificial impoundments in the area, in particular the large dam on Rietpoort, probably support good numbers of waterbirds in wet years, and the Eskom power pylons are used as roosting, hunting and/or nesting habitat by certain species (e.g. raptors and corvids). The Roosterberge, situated 8-10 km to the north of the REF site, feature some quite high cliff-lines, which probably support a community of cliff-nesting raptor species. The southern edge of the Cedarberg-Koue Bokkeveld Complex – a national Important Bird Area (Barnes 1998) - is located about 30km to the north-west of the study area, while Verkeerdevlei, a locally important habitat for wetland birds, is situated about 30 km to the south-west (Taylor et al. 1999, http://cwac.adu.org.za/).

Figure 5.11 Rocky ridges occur in the southern extremity of the Perdekraal site, around the Toorberg and Pramberg koppies

Figure 5.12 ***Acacia karoo woodland along the bed of the Groot River, with the Bachus-Droërivier 400 kV transmission line in the background***

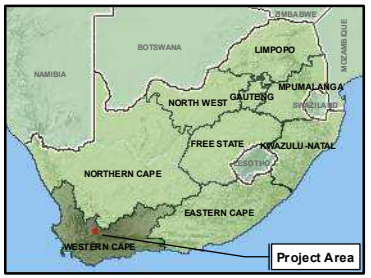
Avian Species Identified

More than 200 bird species could possibly occur on the site (see Appendix 1 of the Bird Specialist Study in *Annex G*), including up to 12 red-listed species, 66 endemics or near-endemics, and three red-listed endemics (Ludwig's Bustard *Neotis ludwigii*, Blue Crane *Anthropoides paradiseus* and Black Harrier *Circus maurus*). Twenty-two species were seen during site visit on 4 - 5 May 2010, during a spell of particularly cold, cloudy and windy weather, which substantially suppressed bird activity. Significant sightings included a single adult Martial Eagle *Polemaetus bellicosus* perched on a low ridge about 2km south-west of Toorberg. Three Martial Eagle nest sites are known in the area, all on the Eskom transmission lines: Droërivier-Muldersvlei tower 667 (32 º 59.240 S, 20 º 10.210 E), about 9 km north-east of the REF area, Droërivier-Muldersvlei 728 (33 º 05.390 S, 19 º 58.250 E), about 5 km south-west of the study site, and Bachus- Droërivier 478 (33 º02.070 S, 20 º13.291 E), about 8 km east of the REF area (*Figure 5.13*).



Legend

- Town
- District Municipalities
- Local Municipalities
- Transmission Line
- National Road
- Main Road
- Secondary Road
- Railway Line
- Perennial River
- Non-Perennial River
- Conservation Area
- National Park
- Perdekraal Land Parcels
- Martial Eagle's Nest



SCALE: 0 2 4 6 8 10 Kilometers

N

TITLE:

Figure 5.13: Martial Eagle Nest Sites within the vicinity of the Perdekraal REF Site

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: March 2011	CHECKED: TS	PROJECT: 0080504
DRAWN: AB	APPROVED: SHC	Scale: 1:380 000

DRAWING: Perdekraal_Bird_Map_Rev1.mxd REV: 1

ERM
Building 32,
The Woodlands,
Woodlands Drive,
Woodmead, 2148
Johannesburg, South Africa
Tel: +27 (0)11 798 4300
Fax: +27 (0)11 804 2289

Projection: Geographic, Datum: Hartebeesthoek 1994
Source: Enpat (2001), Demarcation Board (Dec 2005)
Inset: ESRI Data and Maps

SIZE: A4

T:\GIS Project\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\Perdekraal_Bird_Map_Rev1.mxd

The extensive tracts of open Tanqua Karoo on the site are likely to attract numbers of Ludwig's Bustard as seasonal visitors, and Black Harrier probably uses this habitat too, at least as a late summer/autumn visitor, and both these species could breed in the area after good rains (Allan 1994, Curtis et al. 2004). Limited areas of exposed rock on the Toorberg probably are not sufficient to support cliff-nesting raptors other than perhaps Cape Eagle Owl *Bubo capensis* and Rock Kestrel *Falco rupicolus*. However, Jackal Buzzard *Buteo rufofuscus*, Verreaux's Eagle *Aquila verreauxii*, Booted Eagle *Aquila pennatus*, Lanner Falcon *Falco biarmicus* and Peregrine Falcon *Falco peregrinus* may well to forage within the REF site from nesting areas in the mountains less than 10km to the south and north of the site. Additional important restricted range and/or endemic species which are likely to occur in the area include Karoo Korhaan *Eupodotis vigorsii*, Cinnamon-breasted Warbler *Euryptila subcinnamomea*, Karoo Long-billed Lark *Certhilauda subcoronata*, Karoo Lark *Calendulauda albescens*, Black-eared Sparrowlark *Eremopterix australis*, Layard's Titbabbler *Parisoma layardii*, Namaqua Warbler *Phragmacia substriata* and Black-headed Canary *Serinus alario*.

Thirteen priority species are recognized as key in the assessment of avian impacts of the proposed Perdekraal REF. These are mostly nationally and/or globally threatened species which are known to occur, or could occur in relatively high numbers in the development area and which are likely to be, or could be, negatively affected by the REF project. Six species (Blue Crane, Secretarybird *Sagittarius serpentarius*, Peregrine Falcon *Falco peregrinus*, Black Stork *Ciconia nigra*, Cinnamon-breasted Warbler and Black-eared Sparrowlark were included despite the fact that they were not recorded in either SABAP 1 or SABAP 2 data for the area, because the habitat on the site looks suitable and/or they occur in the nearby Cedarberg-Koue Bokkeveld Complex (Barnes 1998). Cinnamon-breasted Warbler and Black-eared Sparrowlark are range-restricted endemics (Barnes 1998). Verreaux's Eagle is not Red-listed or endemic, but is included because it is an uncommon species and, with Martial Eagle, probably fulfils an important ecological role as an apex predator in the area.

Overall, the most important aspects of the avifauna on the Perdekraal REF site, and those most relevant to this impact assessment, are:

- Seasonal influxes of Ludwig's Bustard. This is a nomadic, nationally 'Vulnerable' and globally 'Endangered', near-endemic species, highly susceptible to collision mortality on power lines (Jenkins *et al.* 2010, Jenkins *et al.* 2010 in prep.), probably susceptible to turbine collision mortality, and possibly susceptible to disturbance and displacement by the wind farm.
- Resident and breeding raptors, in particular Martial Eagle (three pairs just outside the development area), Black Harrier (likely to occur regularly on site, and could breed within it in wet years – Curtis *et al.* 2004). Both are threatened species, the latter is endemic, and both are potentially

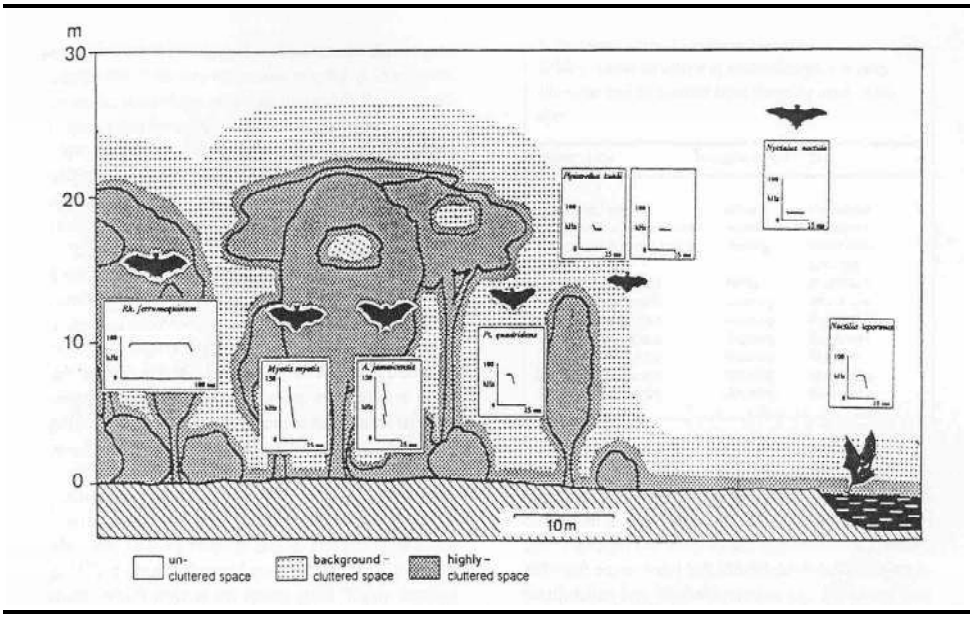
susceptible to collision with and displacement from the area by the turbine arrays.
- Populations of Karoo endemics (e.g. Cinnamon-breasted Warbler, Black-eared Sparrowlark) which lose some habitat, and may be disturbed or displaced.
- Aggregations of wetland species at and around the large dam on the eastern boundary of the study area, which may be at risk of colliding with the turbines.

5.1.6 Bat Habitats

Bat species are protected under the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) which calls for an environmental impact assessment for threatened and protected bat species. Only one species of bat, *Otomops martiensseni*, (Large-eared Free-tailed Bat), is listed as vulnerable in the Act. However, this species does not occur in the area of the proposed REF site. With regards to bats, the *Eurobats Guidance* (Rodrigues et al. 2008) and the *Natural England Interim Guidance* are planning and guideline tools that have been published in the United Kingdom. These were consulted as part of data gathering and used to assist with mitigation recommendations for the proposed development.

Bat habitat is usually characterized by the challenges the habitat presents for flight and echolocation in terms of clutter (objects that have to be detected or avoided). The habitat can thus be divided into several dimensions (highly cluttered space –dense vegetation or close to the substrate), background cluttered space (at the edge of vegetation or approximately 1 metre from the substrate) and open space (high above the substrate and vegetation (see *Figure 5.14*).

Figure 5.14 Bat activity in relation to vegetation characteristics



The Perdekraal Site is dominated by low growing shrubs and/or succulents of the Succulent Karoo Biome and the Fynbos Biome. This type of vegetation decreases the dimensions of the bat habitat, and the habitat is essentially two dimensional i.e. highly cluttered space very close to the ground or open space. The paucity of vegetation at the site also decreases the availability of insect prey and does not provide suitable roosting sites for bats that commonly use tree foliage and tree hollows as roosts. However, the farm houses, outbuildings and introduced vegetation at each site may provide suitable roosting sites and prey items for insectivorous bats.

There are no known bat caves, disused mines, road culverts or bridges on the site to provide suitable roosting sites for bats on the site. This decreases the diversity of the bat fauna likely to occur in the area.

During the survey some bat activity was detected at Perdekraal and was confined between dusk and 22h00 and the species found was Cape Serotine Bat *Neoromicia capensis*. Surveys at this site were done in close proximity to the farm houses. This supports the view, stated above, that suitable roost sites and insect prey are probably restricted to the immediate areas around the farm houses. The bats detected are not tree-roosting and migratory species, species known to be most affected by wind turbines. The species detected here probably uses farm buildings as roosts. The limited bat activity noted during the survey is an observation that is supported by the paucity of vegetation providing habitat for bats and by distribution records (Taylor 2000) which indicate that the biomes under consideration harbour a depauperate bat fauna.

6 SOCIO-ECONOMIC BASELINE DESCRIPTION

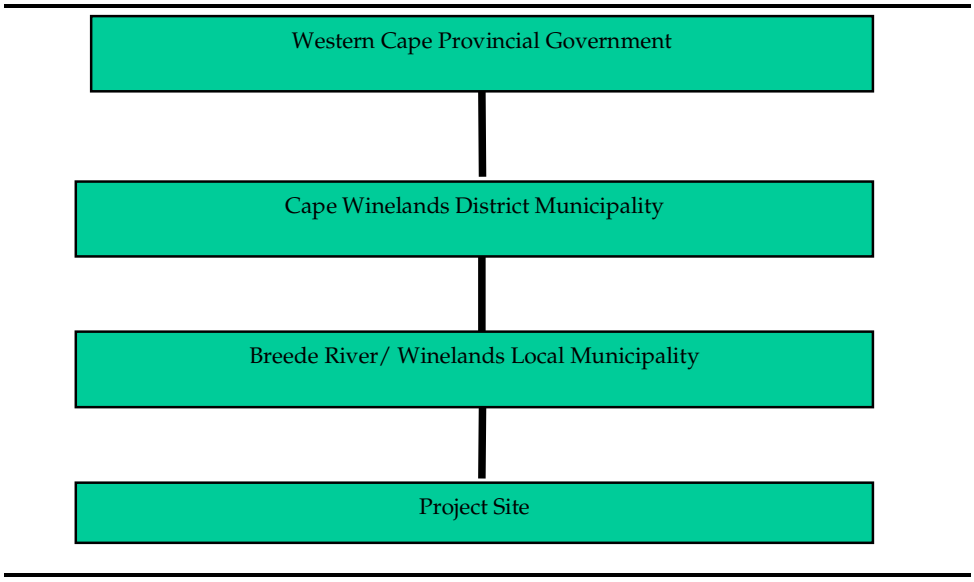
6.1 INTRODUCTION

The proposed project site is located within the Western Cape Province's Cape Winelands District Municipality and the Breede River Local Municipality. The Cape Winelands District Municipality comprises of five local municipalities, namely; Witzenberg, Drakenstein, Stellenbosch, Breede Valley, and Breede River/Winelands. The District covers an area of 22,289 km^2 which equates to 17 percent of the total land area of the Western Cape Province. *Figure 4.1* shows the location of the proposed project site.

6.1.1 *Administrative Structure*

The Provincial government is responsible for providing the strategic vision and framework for the Province. They are responsible for ensuring cooperation and collaboration between municipalities and that each municipality performs their respective functions. In turn, each District Municipality is responsible for the development of Integrated Development Plans and for the overall provision of services and infrastructure within the District. *Figure 6.1* shows the administrative structure for the Western Cape Provincial Government and the location of District and local municipalities.

Figure 6.1 Administrative Structure



6.1.2 Demographic Profile

The population of the Cape Winelands District Municipality was 645,807 in 2005 with an annual growth rate of 0.6 percent (1) since 2001. The projected population growth for the District Municipality was 0.3 percent from 2006 to 2010, resulting in a population projection of 656,902 by 2010. The population density was 32 persons per square kilometres.

The population of the Breede River Local Municipality was recorded at 92,627 in 2006. The projected population for 2010 was 100,151 at an annual growth rate of two percent (2). The Local Municipality covers an area of 3,334 km^2 and a population density of 24.38 persons per square kilometre.

The median age for the population in the Local Municipality was 26 years. Approximately 31.2 percent of the population are under the age of 15 and a further 31.2 percent are between 25 and 44 years (3). The remainder of the population is comprised of; 16.8 percent between 15 to 24 years, 15.1 percent between 45 and 64 years, and 5.7 percent are 65 years of age or older.

The racial composition of the District Municipality is dominated by Coloured people at 65 percent, with Black/Africans at 20 percent, Whites at 14 percent and others forming the last 1.03 percent (4). A similar racial composition was also observed for the Local Municipality with Coloured people forming the majority at 71 percent, Black/Africans at 14.56 percent and Whites at 14.34 percent.

In-migration is high in the District and Local Municipalities as a result of employment opportunities (despite these opportunities being seasonal in nature). In-migration is highest amongst Coloured and White populations. No percentage or numbers were given for the in-migration.

6.1.3 Education

The Cape Winelands District Municipality is the location of significant and specialised educational, training, research, development and financial services within the District. For example, a number of these institutions, e.g. the University of Stellenbosch, Elsenburg and the Agricultural Research Council (ARC) provide globally competitive agricultural courses. However, youth development and education are still a major concern.

In the Local Municipality there are 55 schools (both primary and high) (5). The educator-learner ratio was 1:36. Approximately 38 percent of the total population over the age of 14 years were illiterate (6). This is a very high

(1) Cape Winelands District Municipality IDP, 2007 - 2011
(2) Breede River/ Winelands Local Municipality IDP, 2007 - 2011
(3) Breede River/ Winelands Local Municipality IDP, 2007 - 2011
(4) Winelands District Municipality IDP, 2007 - 2011
(5) Breede River/ Winelands Local Municipality IDP, 2007 - 2011
(6) Breede River/ Winelands Local Municipality IDP, 2007 - 2011

percentage and it has been attributed to teenage pregnancy, child labour and a high school dropout rate. Overall only 22.7 percent of the population had completed high school. *Table 6.1* below shows the educational trends in the Local Municipality.

Table 6.1 Education Levels in Breede River/ Winelands Local Municipality in Percentages

No Schooling	Primary	Some Primary	High School	Some High School	Tertiary
12.1	9.5	28.4	27.3	16.3	6.4

Source: Breede River/Winelands Local Municipality IDP, 2007 - 2011

6.1.4 Health

There are 25 medical facilities in the Local Municipal area (1). The nurse/patient ratio is 1:39; this is lower than the national ratio of 1:34 (2).

The most prevalent illnesses in the area are HIV/Aids and TB. The HIV/Aids prevalence in 2005 was 3.2 percent (3) and it is predicted to increase to four percent by 2010. No reasons were given for the projected increase. The TB prevalence rate was 1,188 for every 100,000 people. There is a link between the TB and HIV/Aids prevalence, as most people who are affected by HIV are likely to capture the TB virus.

6.2 ECONOMIC PROFILE

The average annual growth in the Gross Domestic Product (GDP) for the Cape Winelands was 2.9 percent between 1995 and 2004 and 3.5 percent between 2000 and 2004, contributing 10.45 percent of the Provincial GDP (4). The top growth sectors in the Cape Winelands between 2000 and 2004, based largely on domestic demand, trade and tourism. The sectors that contributed the most were:

- wholesale and retail (including catering and accommodation) (10,12 percent);
- manufacturing (6.83 percent);
- agriculture (15 percent);
- finance and business services (5.58 percent); and
- transport and communication (5.25 percent).

Sectors growing at a slower rate were construction (1.80 percent) and agriculture, forestry and fishing (1.36 percent). Although the district economy is relatively diversified, it must be noted that 30 percent of businesses in the Cape Winelands are wine producers (14 percent), other fruit producers

(1) Breede River/ Winelands Local Municipality IDP, 2007 - 2011
(2) Breede River/ Winelands Local Municipality IDP, 2007 - 2011
(3) Breede River/ Winelands Local Municipality IDP, 2007 - 2011
(4) Cape Winelands District Municipality IDP, 2007 - 2011

(4 percent), or real estate management firms (12 percent) [1]. The district's top 10 products or services generate 38 percent of total business turnover and 27 percent of formal companies. Spatially, there are also concentrations of economic activity. The top five business areas generate 77 percent of the total business turnover within the Cape Winelands District Municipality - Paarl (34 percent), Stellenbosch (20 percent), Worcester (13 percent), Ceres (4 percent) and Wellington (3 percent) respectively [2].

A discussion of the key economic sectors for the Local Municipality during the period of 2001 to 2004 is discussed in greater detail below. The key economic drivers for this period were:

6.2.1 Key Economic Sectors

Agriculture

Approximately15 percent of the Cape Winelands District Municipality's GDP is generated, and more than 38.3 percent of the district's labour force is employed, by the agricultural sector [3]. The main products are deciduous fruits, viticulture and vegetables. 68 percent of South Africa's wine production takes place within the district. 56 percent of all wine grapes are grown in the Breede River Valley, Paarl and Stellenbosch [4]. There is also extensive table grape production in the Hex River Valley. The district boasts the largest pear producing region in the country, and extensive apple and apricot production takes place in Ceres, Robertson and Montagu. Listed below are some of the new industries offering great growth potential within the agricultural sector:

- olives;
- fynbos, buchu and honeybush tea;
- other essential oils;
- fresh and dried flowers;
- cosmetics and medicines;
- aquaculture; and
- poultry.

A number of wine and deciduous fruit farmers have started to diversify their operations by developing products around agri-tourism, such as the conferencing and wedding industries, and combining commodities such as wine, cheese and olives. Refocusing and restructuring the agriculture sector in the area.

The site is evenly divided between "soils not suitable for arable agriculture; suitable for forestry or grazing where climate permits" and "soils of poor suitability for arable agriculture where climate permits" as shown in *Figure 6.2* below.

(1) Cape Winelands District Municipality IDP, 2007 - 2011
(2) Cape Winelands District Municipality IDP, 2007 - 2011
(3) Cape Winelands District Municipality IDP, 2007 - 2011
(4) Cape Winelands District Municipality IDP, 200 7-2011

Manufacturing

The Cape Winelands District Municipality's manufacturing sector is characterized by its backward linkages to the agricultural sector. Food manufacturing enterprises in the Cape Winelands contribute almost a third to the total number of manufacturing enterprises and generate 56.45 percent (1) of total manufacturing sales. The main activities are in the food and beverages sectors e.g. wine, juice, brandy, juice concentrates, dried and tin fruits. The proximity of the firms to raw materials, metro markets and ports boost their comparative advantage. A major opportunity is that currently only 28 percent (2) of agricultural exports from South Africa are processed.

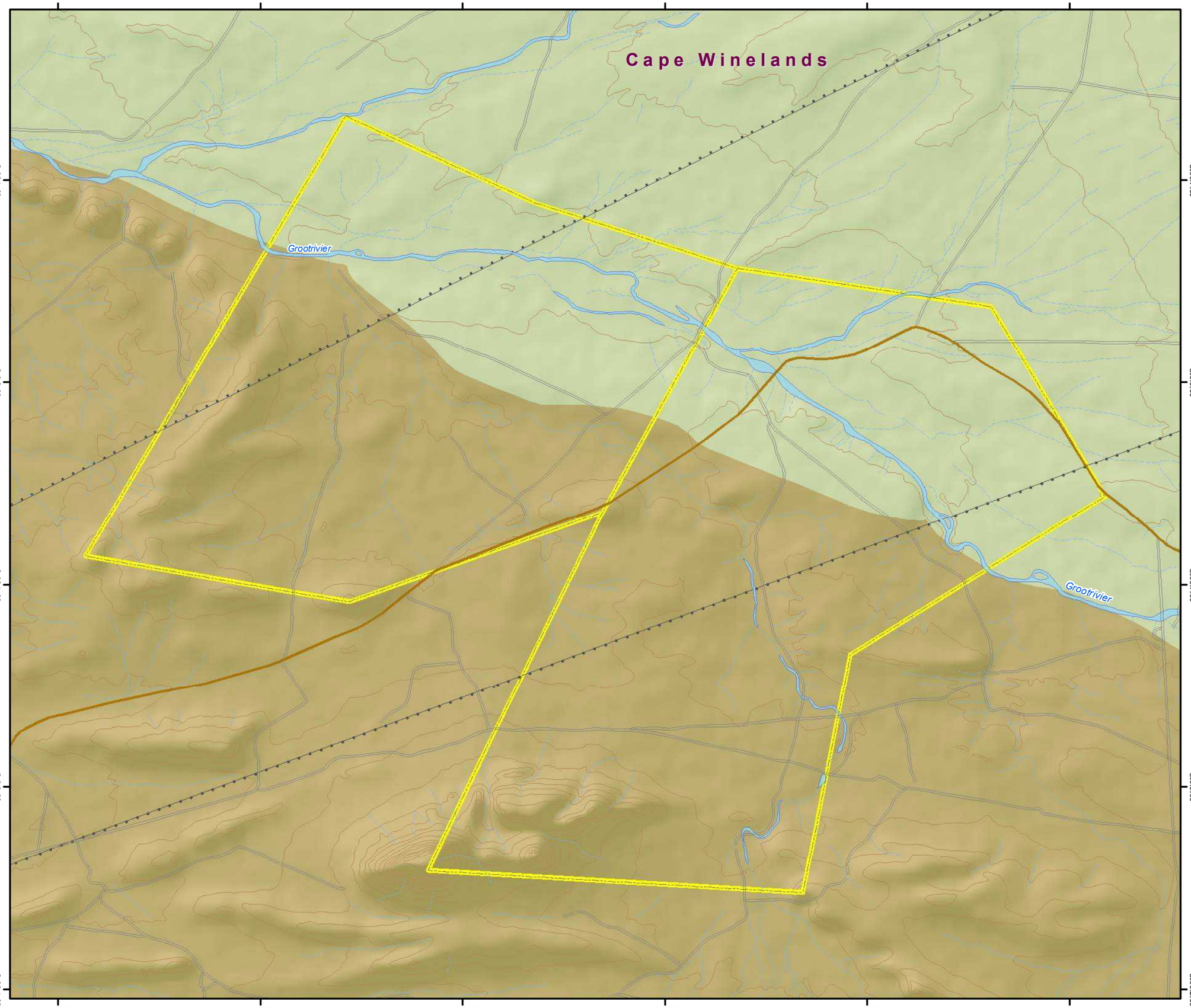
Wholesale and Retail

The wholesale and retail sector is well established in the towns of Worcester, Stellenbosch and Paarl (3). The sector is based primarily on wine, fruit and wheat sales. The attractiveness of the Cape Winelands and its proximity to Cape Town has resulted in a number of national and multi national corporate head offices, such as Medi-Clinic Corporation, Parmalat, Rembrandt, British American Tobacco, Distel and KWV Holdings, choosing to locate here (4). Factors influencing location are favourable social and family aspects, low levels of crime, and proximity to schools, shops, health care and other facilities (5).

Finance/Insurance/Real Estate and Business Services

This sector is still considered a is a growing sector with only 29 percent of firms in the Cape Winelands having been in the business for longer than 15 years. The market for the sector is domestic with 36 percent in the Cape Winelands, 40 percent in the Western Cape and 24 percent national (6). Almost half (48 percent) of firms in the sector are planning to expand and with expansion plans this sector is likely to increase its economic contribution.

(1) Cape Winelands District Municipality IDP, 2007 - 2011
(2) Cape Winelands District Municipality IDP, 2007 -2011
(3) Cape Winelands District Municipality IDP, 2007 -2011
(4) Cape Winelands District Municipality IDP, 2007 -2011
(5) Cape Winelands District Municipality IDP, 2007 - 2011
(6) Cape Winelands District Municipality IDP, 2007 - 2010

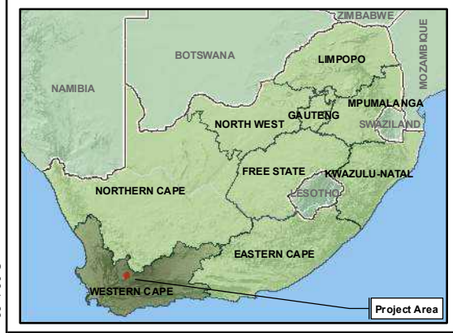


Legend

- Perdekraal Land Parcel
- Transmission Line
- Secondary Road
- Other Road
- Non-Perennial River
- River Area
- Contours (20m)

Soil Potential

- Soils of poor suitability for arable agriculture where climate permits
- Soils not suitable for arable agriculture; suitable for forestry or grazing where climate permits



SCALE:

0 1 2

Kilometers

N

TITLE:

Figure 6.2: Agricultural Potential on the Perdekraal Site

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Feb 2011	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 50 000

DRAWING: Perdekraal_Agricultural_Potential_Rev1.mxd

REV: 1

ERM
Building 32,
The Woodlands,
Woodlands Drive,
Woodmead, 2148
Johannesburg, South Africa
Tel: +27 (0)11 798 4300
Fax: +27 (0)11 804 2289

ERM

Projection: Geographic, Datum: Hartebeesthoek 1994
Source: ENPAT (DEAT, 2008)
Inset: ESRI Data and Maps

SIZE: A3

T:\GIS Project\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\Perdekraal_Agricultural_Potential_Rev1.mxd

6.2.2 Tourism

The Western Cape has the third largest tourism industry in South Africa after Gauteng and KwaZulu/Natal. In 2005, 21,6 percent of all tourists to South Africa, visited the Western Cape Province. This was a decline from the previous years; where 23,5 percent visited the Province in 2003 and 22,9 percent in 2004. The total economic contribution made by tourism was R14,9 billion in 2005 far exceeding 2004 (R8,9 billion). The festive season (December-January) is the most popular time of the year for visitors and in 2005 32,6 percent of all tourists visited the Province. The majority of the tourists are domestic visitors. During the 2005 festive season the domestic tourist accounted for 52.7 percent of the total number of visitors to the Province, 37.8 percent were European, 3,5 percent from North America and 3,2 percent from other African countries. The primary purpose of the tourists differed from leisure (81 percent), visiting friends and relatives (12 percent), business (six percent) and one percent visited the Province for sporting events.

The Cape Winelands District Municipality is considered to have a rich heritage because of the farming activities and wine estates that have been in the area since the 1800. Most of these have been turned into tourist destinations and conference centres. The Karoo is known to have rich paleontological value, and a number of fossils have been found in the Karoo area.

The tourism sector is well established with 50.4 percent of all visitors coming to the Western Cape visit a wine route. The foreign market is significant for the Cape Winelands with the main source countries being the United Kingdom (23 percent), Germany (22 percent), the Netherlands (14 percent) and Europe (other) and the USA both contributing (13 percent) (1). Market demands are for: scenery, peace and quiet, wine, animals, value for money and service. 69 percent of tourists to the Cape Winelands use self drive as a means to travel and 27 percent use guided tours (2). 48 percent of tourists stay for between one and three days. Only 13 percent stay for longer than two weeks.

The visitor profile varies across localities within the district. The three towns of Paarl, Franschhoek and Stellenbosch receive approximately 50 percent of all visitors to the Cape Winelands (3). These visitors are predominantly interested in a one day wine experience.

The remaining 50 percent of visitors are divided between the district's thirteen other towns. The well-known Route 62 draws visitors into Worcester, Robertson, Ashton and Montagu. New routes such as the Freedom Route and Arts and Crafts Route are attracting visitors into longer stays and different

(1) Cape Winelands District Municipality IDP, 2007 - 2011
(2) Cape Winelands District Municipality IDP, 2007 - 2011
(3) Cape Winelands District Municipality IDP, 2007 - 2011

experiences [1]. Annual events such as festivals and concerts attract visitors inland.

6.2.3 Employment, Skills and Income

The average annual growth in the labour force in the Cape Winelands District Municipality was 2.4 percent between 2000 and 2004 [2]. Annual employment grew on average by 1.3 percent and unemployment by 8.2 percent during this same period. The total district unemployment grew by 16 281 people to 49 804 people (or from 13.9 percent to 18.4 percent) between 2000 and 2004.

Large pools of unskilled labourers, mostly female, are dependent on seasonal employment during the pruning and harvesting season in the grape and fruit producing areas of the District Municipality [3]. The impact of seasonal employment is worse in rural communities, as the population is largely dependant on these relatively low and insecure wages.

The employment rate of the Local Municipality was not mentioned in the current Integrated Development Plan; however the unemployment rate in 2001 was 12.2 percent of the population (approximately 3,637 people) [4]. The high unemployment rate for both the District and Local Municipalities can be explained by the high illiteracy of the population and the population's dependency on seasonal employment brought on by the agricultural sector.

In general skills level for both the District and Local Municipalities are very low as most people are employed in the agricultural sector which provides mostly seasonal employment. No percentage or numbers of the population's skills levels were given for the current IDP documents.

In the District Municipality there are a number of relatively low-income families, with 86, 3 percent of all residents earning less than R1600 per month [5]. This means that approximately 550 000 people are living in relative, often seasonal poverty and are in need of survival mechanisms to cope financially.

Within the Local Municipality 10.59 percent of the households do not have any income (approximately 2,240) in 2001 [6]. The average household income during this period was R8,811 [7]. The majority of the population's income was concentrated in people earning between R 4,812 – R 9,600 at (43.7 percent), followed by people whose income ranges from R 9,612 – R 19,200 at (19.1 percent), and with (12.2 percent) earning between R12 and R4,800 [8].

(1) Cape Winelands District Municipality IDP, 2007 - 2011
(2) Cape Winelands District Municipality IDP, 2007 - 2011
(3) Cape Winelands District Municipality IDP, 2007 - 2011
(4) Breede River Local Municipality IDP, 2007 - 2011
(5) Cape Winelands District Municipality IDP, 200 7 - 2011
(6) Breede River/ Winelands Local Municipality IDP, 2007 - 2011
(7) Breede River/ Winelands Local Municipality IDP, 2007 - 2011
(8) Breede River/Winelands Local Municipality IDP, 2007 - 2011

The site remains predominantly natural and isolated, typical of the area, despite some very low key human intervention characterised by powerlines, farm dams with accompanying wind pumps, tracks, fenced stock camps and farm houses.

6.3.1 Archaeology

Pre-colonial Archaeology

Little is known of the archaeology of the study area with few heritage impact assessments listed on the SAHRA database (which includes projects up to 2009). The closest in proximity is the Heritage Impact Assessment Orton (2008) undertook on three farms, namely Platfontein, Kolkiesrivier and Jurgensfontein, for the proposed Eskom Kappa Substation (a proposed grid connection option for the REF). These farms are also situated on the back road between Touwsrivier and Ceres and Platfontein is a few kilometres to the south west of Perdekraal. Orton recorded 9 Middle Stone Age (MSA) surface sites at Platfontein, 22 MSA sites at Jurgensfontein and 48 MSA sites at Kolkiesrivier, and no equivocal Early Stone Age material and only a few traces of Late Stone Age material was observed.

Numerous scatters of stone artefacts were recorded across the study area, although predominantly located on ridges in close proximity to dry river beds. All observations relate to the surface, however, there was no indication of deeply stratified material anywhere on the site. No associated organic remains were noted with any of the stone scatters.

Most of the material observed can probably be ascribed to the Middle Stone Age (MSA), see *Figure 6.3*. A few isolated large implements were recovered which resembled incomplete bifaces (ESA) but the observations remain equivocal (see *Figure 6.4*). There were also some scatters of indurated stone tools which appeared to have recent flake scars and which could be interpreted as Late Stone Age (LSA), although no distinctive LSA implements were recovered or noted. The patination on many of the artefacts is consistent with significant vintage. Flakes, blades, chunks and cores make up the majority of the scatters, and retouch was present on some items. Raw material was almost exclusively hornfels of various colours in the grey to dark black band. There is a characteristic brown to red/orange patina evident on some of the older worked and unworked material. Yellow chert is also used to a lesser degree.

Figure 6.3 Middle Stone Age artefacts recovered from the study area

Figure 6.4 Artefacts which appear to have some Early Stone Age characteristics

Colonial Heritage

The town of Touws River (initially named Montagu Road) originated as a railway town, with the station established in 1877 and the town developing after 1883. It served as a major staging post on the way to the north. However, the area had been settled by trekboers well before this date.

The farm of Lower Stinkfontein 245 (SG 527/1870) was surveyed in 1868. The Groot River is clearly marked on the early map as well as "the main road to

Beaufort (West)". This road probably wound its way down towards Matjiesfontein having come from Ceres and may coincide with the route of an unnamed dirt road running through the site. There are no houses shown on the property at this time. Similarly, Rietpoort (SG529/1870) was also surveyed at this time and the farm granted to a J. Pienaar.

Graves

A single, unfenced, formal graveyard was recovered near the ruins of the Rietpoort farmhouse . This collection of 7 graves, arranged in a row facing east, comprised 5 of packed stone and 2 with cement casings. Two had engraved headstones. One contained a name, the other a more extensive inscription in Dutch. However, the inscription was weathered and no date could be found on it.

Further collections of stone cairns, which are interpreted as graves, were found near ruins of settlements and predominantly situated on the margins of dry river beds. This pattern of burial in the soft river sands has been observed elsewhere.

Figure 6.5 Graves from the Rietpoort family cemetery

6.3.2 Built Environment and Cultural Landscape

Built Environment

There are two extant buildings, one on Rietpoort and one on Perdekraal, both of which are currently occupied (see *Figure 6.6*). The Perdekraal farmhouse has some early 20th century attributes but has been substantially transformed by later additions. The Rietpoort farmhouse, also at least 80 years old, is constructed from stone and mud brick and is in a good condition.

In addition to the above, there are the remains of stone structures on both farms. These include the ruins of a stone house, foundations of rectangular stone structures (possibly workers cottages), stone kraals, a stone oven, a stone windbreak, a possible stone threshing floor and a well.

Figure 6.6 The Perdekraal farmhouse (left) and the Rietpoort farmhouse (right).

Cultural Landscape

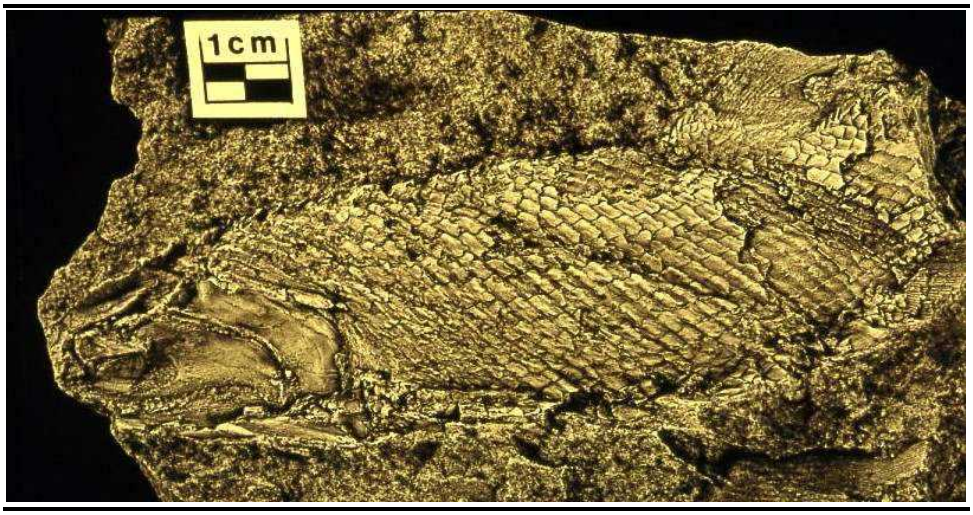
The landscape of the farms Rietpoort and Lower Stinkfontein (Perdekraal) comprises a flat Karoo landscape, with distant views of mountains. There are occasional farmsteads surrounded by a few trees. The landscape is cut up into large camps by means of fences but much remains in fairly "natural" state despite years of grazing. The built environment is marginal and visual impacts are perhaps reduced to a degree by distance from major scenic routes (N1), (R355). There are however no other major industrial interventions at the site itself, although the Kappa Substation is being constructed to the south west. The cultural landscape of the wef site, is therefore considered to be of low significance.

6.3.3 Palaeontology

Fossils of the Witteberg Group

The Waaipoort Formation contains the only substantial biota of Carboniferous age from South Africa. The depositional environment is variously interpreted as an extensive brackish lagoon or a freshwater, perhaps glacially-influenced lake situated at high, subpolar palaeolatitudes (Broquet 1992, Evans 1999, 2005). A moderately diverse, non-marine fish / plant biota of Tournaisian (Early Carboniferous) age is preserved within diagenetic "phosphatic limestone" nodules. The Waaipoort fish fauna includes a range of palaeoniscoids (primitive actinopterygians or ray-finned bony fish), chondrichthyans (ctenacanthiform sharks, possible chimaeroids), two or more acanthodians, and perhaps also rare sarcopterygians (lobe-finned bony fish) (Theron 1962, Marais 1963, Jubb 1965, Loock 1967, Gardiner 1969, 1973, Jubb & Gardiner 1975, Oelofsen 1981, Evans 1997, 1998, 1999, 2005), see *Figure 6.7*.

Figure 6.7 ***Well-preserved palaeoniscoid fish preserved within a phosphatic – carbonate concretion within the Early Carboniferous Waaipoort Formation.***



Fossils of the Dwyka Group

The Dwyka Group in the southern portion of the Main Karoo Basin has a generally poor fossil record (McLachlan & Anderson 1973, Anderson & McLachlan 1976, Visser et al., 1990, Von Brunn & Visser 1999, Visser 2003, Almond & Pether 2008). This is hardly surprising given the glacial climates that prevailed during much of the Late Carboniferous to Permian Periods in southern Africa. However, most Dwyka sediments were deposited during periods of glacial retreat associated with climatic amelioration. Sparse, low diversity fossil biotas within interglacial or postglacial mudrocks mainly consist of arthropod trackways (e.g. Umfolozia - probably made by small crustaceans) associated with dropstone laminites and sporadic vascular plant remains – mainly drifted wood and leaves of the Glossopteris Flora. Palynomorphs are also likely to be present within finer-grained mudrock facies. Glacial diamictites (tillites or "boulder mudstones") are normally unfossiliferous but do occasionally contain fragmentary transported plant material as well as palynomorphs in the fine-grained matrix. Occasional pale grey limestone glacial erratics from tillites along the southern margins of the Great Karoo (Elandsvlei Formation) contain Cambrian eodiscid trilobites as well as archaeocyathid sponges that have been sourced in Antarctica. Such derived fossils provide important data for reconstructing the movement of Gondwana ice sheets.

Fossils of the Prince Albert Formation

The fossil biota of the post-glacial mudrocks of the Prince Albert Formation is usefully summarized by Cole (2005). Typical trace fossil assemblages of the nonmarine Mermia Ichnofacies commonly are dominated by delicate arthropod trackways (especially Umfolozia), scratch burrows or furrows (Isopodichnus), arthropod resting traces (Gluckstadtella) and undulose fish fin trails (Undichna) (e.g. Anderson 1974, 1976, 1981). More complex arthropod traces, some of them possible generated by small eurypterids, are also known

(see *Figure 6.8*). Diagenetic nodules containing the remains of palaeoniscoids (primitive bony fish), sharks, spiral bromalites (coprolites etc) and wood have been found in the Ceres Karoo and rare shark remains (Dwykaselachus) occur near Prince Albert on the southern margin of the Great Karoo (Oelofsen 1986). Microfossil remains in this formation include sponge spicules, foraminiferal and radiolarian protozoans, acritarchs and miospores.

Figure 6.8 ***Bedding plane of Prince Albert Formation mudrocks criss-crossed by walking trails of bottom-dwelling arthropods (possibly small eurypterids)***

Fossils of the Whitehill Formation

In palaeontological terms the Whitehill Formation is one of the richest and most interesting stratigraphic units within the Ecca Group (Almond 2008a, 2010a, 2010b, 2010c and refs. therein). In brief, the main groups of Early Permian fossils found within the Whitehill Formation include:

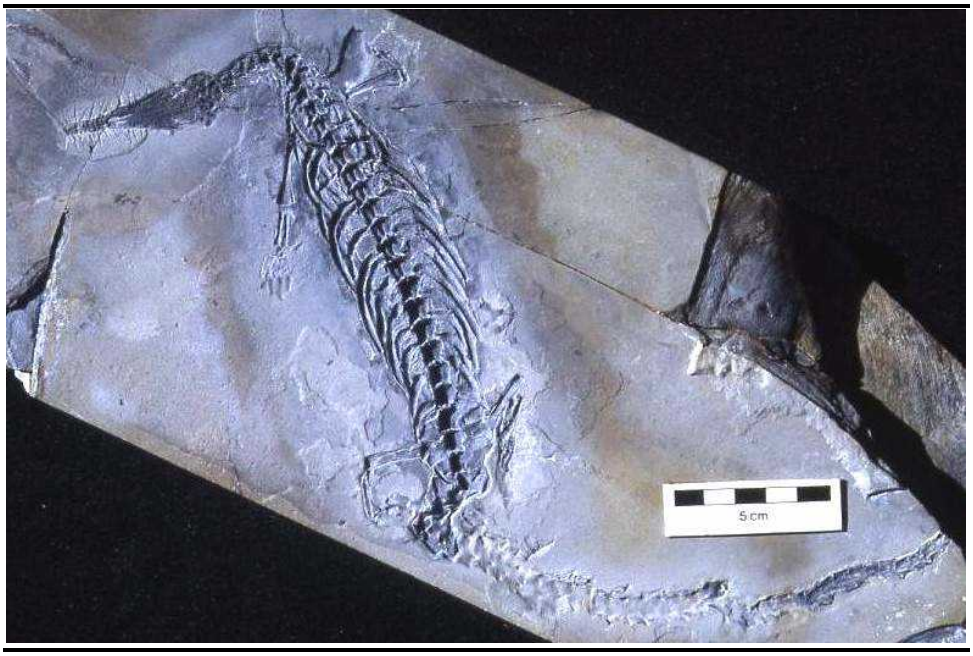
- Small aquatic mesosaurid reptiles (the earliest known sea-going reptiles) (*Figure 6.9*);
- Rare cephalochordates (ancient relatives of the living lancets);
- A variety of palaeoniscoid fish (primitive bony fish);
- Highly abundant small eocarid crustaceans (bottom-living, shrimp-like forms);
- Insects (mainly preserved as isolated wings, but some intact specimens also found);
- A low diversity of trace fossils (e.g. king crab trackways, possible shark coprolites / faeces);
- Palynomorphs (organic-walled spores and pollens);
- Petrified wood (mainly of primitive gymnosperms); and

- Other sparse vascular plant remains (*Glossopteris* leaves, lycopods etc).

The stratigraphic distribution of the most prominent fossil groups – mesosaurid reptiles, palaeoniscoid fishes and notocarid crustaceans – within the Whitehill Formation has been documented by several authors, including Oelofsen (1987), Visser (1992) and Evans (2005). Fossil localities within the Whitehill Formation in the Tanqua Karoo region include Blaauwbosch Kolk (south of the Tanqua River) and Die Bos further to the north (Oelofsen 1981). The former site has yielded pygocephalomorph crustaceans (*Notocaris*), while very well-preserved, almost intact specimens of palaeoniscoid fish have been collected at Die Bos (R.D.F. Oosthuizen collection, Iziko; South African Museum, Cape Town). Mesosaurid reptile fossils from the Tanqua Karoo (locality unspecified) are briefly mentioned by McLachlan and Anderson (1973).

Whitehill Formation rocks are exposed in several shallow and one deep borrow pit close to the Karoopoort – Matjiesfontein dust road which passes through the study area; notocarid crustaceans are recorded from some of these pits (Almond 2010c). The sediments here are for the most part highly weathered, brecciated and ferruginised to a depth of several meters. Extensive near-surface development of secondary gypsum, further disrupting the parent rock, is evident, and indeed gypsum is currently being mined in the Ceres Karoo on the farm Kolkiesrivier 234.

Figure 6.9 ***External mould of an almost complete, fully articulated skeleton of an aquatic mesosaurid reptile from the Whitehill Formation in the Tanqua Karoo region (Collections of Iziko: South African Museum, Cape Town). Mesosaurid reptiles are also known from similar rocks in South America.***



Fossils of the Collingham Formation

The palaeontology of the Collingham Formation has been reviewed by Viljoen (1992, 1994) and Almond (2008a, 2010a, 2010c). Extensive unjointed bedding planes are rarely exposed, seriously compromising the recording of fossils from these beds. Transported, water-logged plant debris and tool marks generated by logs are often associated with thicker turbidite beds, especially within the upper part of the Collingham Formation. Substantial blocks of silicified wood are known from the Laingsburg area. The heterolithic character of this succession favours trace fossil preservation, with very high levels of bioturbation recorded locally. The abundance of fossil burrows indicates that oxygenation of bottom waters and the sea bed had improved substantially since Whitehill times. Abundant, moderately diverse trace fossil assemblages have been recorded from the Collingham Formation in the Tanqua Karoo region, for example along the banks of the Doring River at Leeunershof (Anderson 1974). They include horizontal, 2cm-wide epichnial grooves with obscurely segmented levees ("*Scolicia*", possibly generated by gastropods), narrow, bilobate arthropod furrows ("*Isopodichnus*"), reticulate horizontal burrows (perhaps washed out *Megagrapton*-like systems), densely packed horizontal burrows with a rope-like surface texture covering selected bedding planes (*cf Palaeophycus*), narrow branching burrows, rare arthropod trackways (*Umfolozia*) and fish swimming trails (*Undichna*). The trackway of a giant sweep-feeding eurypterid has been identified from the Collingham Formation near Laingsburg, and fragmentary body fossils of similar animals are known from coeval sediments in South America (Almond 2002). At over two metres long, these bottom-feeding predators are the largest animal so far known from the largely land-locked Ecca Sea.

Fossils of the Tierberg Formation

A wide range of non-marine ichnogenera, including fish swimming tails, arthropod trackways and resting traces and as yet unnamed pellet-filled, strap shaped burrows (so called "*Plagiogmus*" *in lit*.), have been collected from the Tierberg Formation, any of them from the Tanqua Karoo and Roggeveld regions (Wickens 1996, Almond 2008a, b and refs. therein). Leaf compressions of the *Glossopteris* Flora and petrified woods have been collected from these rocks in the Tanqua Karoo region and elsewhere. Rare animal remains include disarticulated microvertebrates from calcareous concretions (Zawada 1992).

Fossil biotas within superficial deposits

The 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, Partridge *et al.* 2006). 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. Late Caenozoic calcretes and silty alluvial deposits locally contain subfossil rhizoliths and invertebrate (probably insect) burrows of various sorts. On the whole fossil preservation is unlikely in coarser, high-energy alluvial sediments such as the Late Tertiary High Level Gravels, and none have been recorded here so far.

6.4 *INFRASTRUCTURE AND SERVICES*

6.4.1 *Housing*

Cape Winelands District municipality has 50.6 percent of the households residing in formal housing, with 45.4 percent resides in workers hostels and one percent resides in informal housing (1). The housing situation of most residents has changed dramatically compare to 2001, whereby 91.6percent of the population had formal housing and no households were recorded as living in workers' hostels (2). The change in the housing status of the communities was not explained, however a growth in the agricultural sector may have played a role and farm owners providing housing for their employees in a form of workers' hostels. In Breede Rive Local Municipality 94.3 percent of households reside in formal housing with 3.4 percent (3) residing in informal housings.

6.4.2 *Water*

In the District Municipality 92.1 percent (4) of the households have access to portable water via a tap inside/ outside their homes or from a communal tap. Approximately 3.9 percent of the population source its water from boreholes. In the Local Municipality 97.4 percent have access to water through an inside/outside tap or communal taps and 2.6 percent (5) having its water from other sources such as boreholes and dams.

6.4.3 *Sanitation*

Approximately 83.1 percent of the households (6) have proper sanitation facilities in the District Municipality comprising of flush toilets linked to sewage system. Another 2.5 percent (7) of the population is still using the bucket system and 4.3 percent having no access to any toilet facilities. In the Local Municipality 91.6 percent of the communities have access to proper sanitation facilities however 5.7 percent (8) has no toilet facilities.

(1) Community Survey, 2007
(2) Community Survey, 2007
(3) Community Survey, 2007
(4) Community Survey, 2007
(5) Community Survey, 2007
(6) Community Survey, 2007
(7) Community Survey, 2007
(8) Community Survey, 2007

6.4.4 *Energy*

An estimated 82.1 percent of the households have access to electricity and use it for lighting purposes, whereas 7.5 percent of households use candles and 6.6 percent uses paraffin within the District Municipality [(1)]. In the Local Municipal area approximately 96.2 percent of the households has access to electricity with another 2.6 percent [(2)] using candles for lighting.

6.4.5 *Policing*

Within the District Municipality the most common crimes committed are drug related and organised crimes. The actual number of police stations available in the District Municipality was not found.

In the Local Municipality there are five police stations and the most common crimes committed are drug related crimes which have seen a significant increase from 360 in 2001/2 to 760 in 2004/5 [(3)]. Rape cases reported also showed an increase during this period from 44 cases to 143 cases [(4)].

6.4.6 *Roads and Transportation*

N1 Highway runs through the District Municipality. Main roads in the area are tarred with the exception of service roads which are gravel. Some of the farm houses maintain their own access roads and keep them as gravel.

6.5 *DESCRIPTION OF AFFECTED PROJECT SITE*

6.5.1 *Site Description*

The Perdekraal site is located approximately 25 km north of the town of Touwsrivier. The site is made up of two land parcels, namely the Perdekraal and Rietpoort farms. The farm covers a land area of approximately 6347ha and Perdekraal Site 2 area covers approximately 3220ha. Both properties are collectively owned and managed by Trusts. These farms were purchased by the South African government on behalf of the beneficiaries and Trustees as part of the land reform programme. Land reform was a mechanism established to redress the past imbalances related to land ownership in South Africa. These groups of people elected to receive farmland as opposed to low-cost housing. The farms were acquired in 2003 and have been occupied since 2004.

The Perdekraal farm is owned and run by five Trustees and 38 beneficiaries. They have recently appointed a new Chairman and they are focussing on rebuilding the farms' livestock and infrastructure. The beneficiaries are all

(1) Community Survey, 2007
(2) Community Survey, 2007
(3) Breede River/ Winelands IDP, 2007-2011
(4) Breede River/ Winelands IDP, 2007 - 2011

family members; as such the farm is run for the collective benefit of the family members. It was clear that the Trustees anticipate that all the beneficiaries remain involved and benefitting from any future activities on the farm

The Rietpoort farm is owned by five Trustees and 18 beneficiaries, they are also family members. Currently only one of the Trustees is actively involved with the farm.

There are four adults and three children currently residing on the Perdekraal farm. They have lived on the since early 2010. The workers are paid R1,500 a month and live on the farm free of charge (including water and firewood, there is no electricity on the site). No one resides on the Rietpoort farm.

6.5.2 Farm Details

Perdekraal farm's main income is generated from rental received from the leased portions of the land. Approximately two of 11 camps are leased out. The stock has gradually been depleted over the years that the Trust has owned the farm. There are approximately 20 sheep on the farm. The Trust is in the process of rebuilding the farm into a fully functional farm. The future plans include growing, harvesting and processing of olives for oil and table and sheep farming. Analysts say that olives will be a sustainable crop in the area.

Rietpoort farm is currently not being farmed, the only economic activity is the collection of firewood for selling to neighbouring farms and residents in the area. There are approximately 30-40 goats grazing on the farm. The current landowner is the only person working on the farm. The farm is not used to its full potential and without any capital the land owner is not able to finance any further activities on the land.

6.5.3 Attitudes Towards Development

Benefits

Perdekraal's Trust say that the income received from leasing some of the land to Mainstream SA will assist in allowing them to develop farming activities on the land. They also plan to establish a Bed and Breakfast as they believe that the wind turbines will attract tourist to the area.

They also plan on setting up a trust fund for selected students in the town of Merweville for education. This will be the Trustees' way of giving back to the community where they originate.

Concerns

The landowners would like to have electricity on the farm when the project has been realised.

The landowners say that the Project implementation is slow. They would like Mainstream SA and the South African Government to move faster so that they can get the opportunity to improve their farms.

7 IMPACTS ON FLORA AND FAUNA

This chapter discusses the impact the proposed Perdekraal Renewable Energy Facility may have on flora and fauna including the destruction, degradation or fragmentation of habitat. The potential impacts are assessed and mitigation measures to reduce the impacts are outlined below.

The constraints map (see *Figure 4.10*) of the site provides a spatial representation of the sensitive habitats located on the site and the areas which are likely to be impacted by the construction and operational of the proposed REF.

These potential impacts are summarised in *Table 7.1.*

Table 7.1 Impact characteristics: Impacts on Flora and Fauna

Summary	Construction	Operation
Project Aspect/ activity	(i) Loss of vegetation associated with site clearance, road construction, laydown and assembly area etc. (ii) Impact on fauna associated with site clearance, road upgrade and establishment of the camp, laydown and assembly areas.	(i) Damage to natural vegetation through movement of vehicles and maintenance activities. (ii) Disturbance fauna associated with the operation of the REF and movement of vehicles.
Impact Type	Direct	Direct
Receptors Affected	(i) Natural vegetation within the site clearance areas. (ii) Fauna on site including amphibians and reptiles.	(i) On-site vegetation (ii) Fauna on the REF site.

7.1 LOSS OF NATURAL VEGETATION

7.1.1 Impact Description and Assessment

Construction Phase Impacts

Vegetation on the REF site would be impacted by the clearing of vegetation for the establishment of wind turbines, PV locations, access roads, a lay-down area, substation site and operation and maintenance building during the construction phase. The area required to establish the wind turbine towers is relatively small (approximately 19 ha) however the area required for the PV

locations and roads linking infrastructure will be greater. It is estimated that approximately 19.01ha (0.19km^2) will be taken up by wind turbine generators, 128.54ha (1.285 km^2) by roads, the PV component of 2140ha (1.4km^2) and associated infrastructure would take up roughly 3ha (0.03km^2). This translates into a land take of 290ha (2.90km^2) or approximately 4.5% of the overall Perdekraal site area with a land take of less than 4% for Perdekraal Site 2.

According to the vegetation Communities as identified in Chapter 5, the vegetation of Community 1 has medium sensitivity, being part of an ESA but also having been overgrazed for a long time. The construction and operation of turbines and PV in this area will therefore have a medium negative impact without mitigation. The effect of turbine construction on Community 2 would be similar to that on Community 1, a medium negative impact without mitigation.

If construction were to take place in areas occupied by Community 3 as proposed in the indicative turbine layouts the fragile and sensitive vygieveld would be highly negatively impacted. Mitigation therefore is to remain out of these areas and treat them as 'no go' zones. This will also ensure that these areas are recognized as part of the CBA at Perdekraal. Riverine and riparian systems in South Africa are important conduits of biodiversity and have important conservation significance. The Tanqua Wash Riviere are no exception and if turbines were to be built in the river channel or even nearby this would negatively impact the riparian ecosystem, with a high negative impact. These areas are also prone to flooding and so from a practical construction and operational standpoint locations in or nearby these areas should be avoided and have been excluded for the placement of turbines and PV.

Unacceptable positions for turbines are all those located in drainage or washes (Community 4) or too close to them. In addition the area occupied by Community 3, vygieveld, is considered to be highly sensitive and a 'no go' area. These areas have been excluded from the placement of turbine and PV infrastructure through the revision of Site Layout Alternative 1 to produce the **preferred Site Layout Alternative 2**.

Box 7.1 Construction Impact: Loss of Natural Vegetation

Nature: Construction activities would result in a **negative direct** impact on the natural vegetation of the REF site.

Impact Magnitude –High-medium

- **Extent:** The extent of the impact is **local** since the potential impacts to plant species would have a local importance of a 20 km radius from the site.
- **Duration:** The duration would be **long-term** as the ecology of the area would be affected at least until the project stops operating.
- **Intensity:** The intensity is **high-medium** due to the high sensitivity of vegetation communities 3 and 4 that would be affected if the preferred layout (Site Layout Alternative 2) is not adopted and if mitigation measures are not adopted.

Likelihood – There is a **high** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) –HIGH-MEDIUM (-VE)

Degree of Confidence: The degree of confidence is **high**.

Operational Phase Impacts

During the operational phase of the REF, the disruptive and destructive activities associated with the construction phase will have ceased. No additional vegetation clearing is anticipated during routine operation and maintenance of the facility. However, vegetation may be impacted should maintenance vehicles leave the roads and disturb vegetation around REF infrastructure.

Box 7.2 Operational Impact: Loss of Natural Vegetation

Nature: Routine operational and maintenance activities may result in a **negative direct** impact on the natural vegetation of the REF site.

Impact Magnitude –Low

- **Extent:** The extent of the impact is **local** since the potential impacts to plant species would have a local importance of a 20 km radius from the site.
- **Duration:** The duration would be **long-term** as the ecology of the area would be affected at least until the project stops operating.
- **Intensity:** The intensity is **low** since undisturbed natural vegetation areas should not be affected.

Likelihood – There is a **medium** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW (-VE)

Degree of Confidence: The degree of confidence is **medium**.

7.1.2 Mitigating vegetation loss

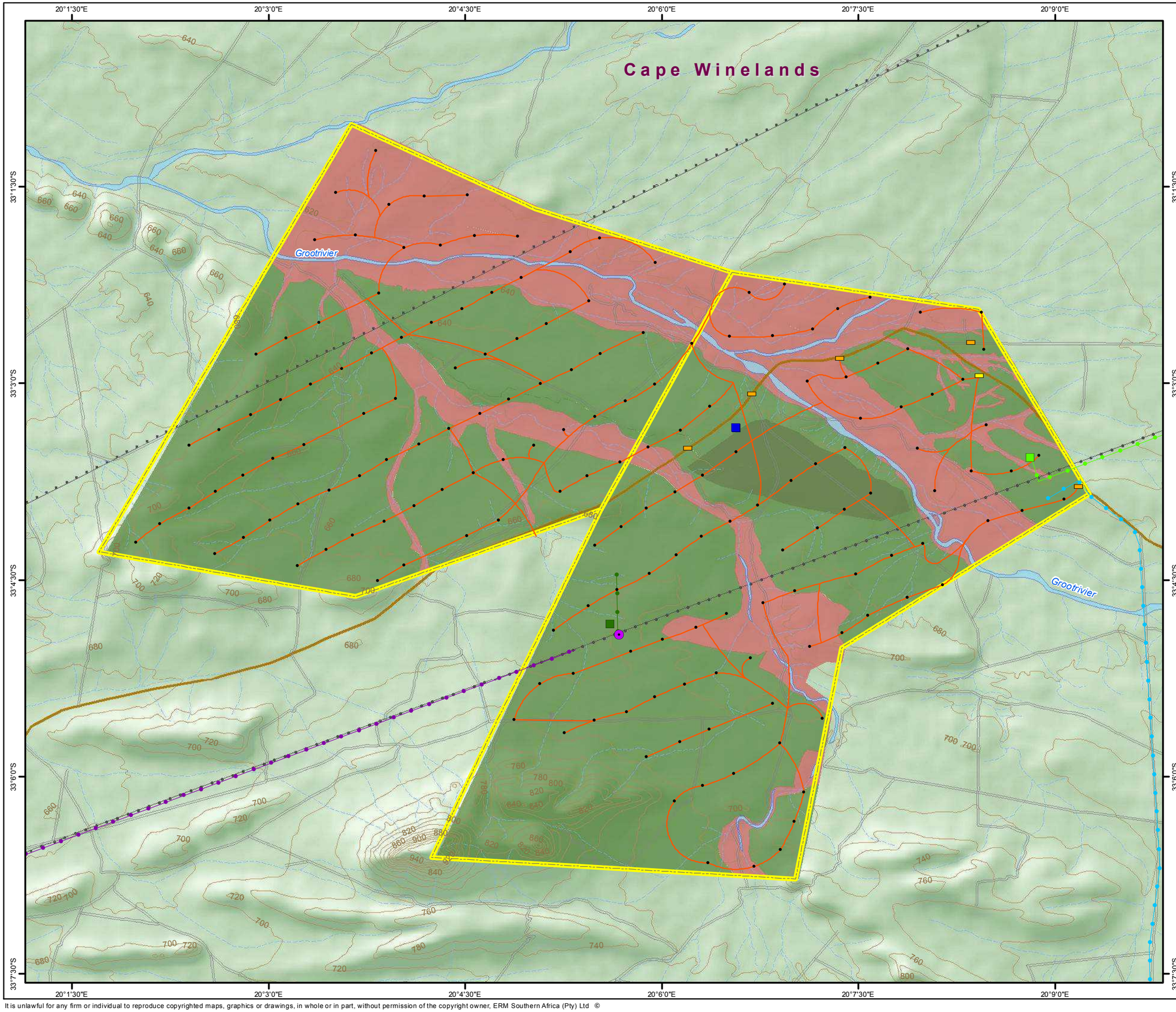
Design Phase

Mitigation to minimise the effects of loss of natural vegetation begins at the design phase by avoiding sensitive areas and limiting the disturbance or destruction of vegetation in those areas. This can be achieved at the site by:

- Removing turbines and PV structures from areas where vegetation Communities 3 or 4 occur (ie remove turbines from areas considered unacceptable and confine locations to acceptable areas as defined by the constraints map);
- Avoiding riparian areas; and
- In cases where planned roads run parallel or nearby existing roads, existing roads should be upgraded rather than constructing new roads. Alternatively, if upgrading is not feasible, then existing roads should be rehabilitated if they are no longer going to be used.

The above-mentioned mitigation measures have been implemented by removing turbines from areas resulting in the **preferred and final Site Layout Alternative 2** which is the preferred alternative incorporating the removal of turbines and PV infrastructure from the unacceptable areas. The iterative process and the evolution of the layout is illustrated below in *Figures 7.1* and *7.2*. *Figure 7.2* shows the Perdekraal Site 2 layout.

A botanist or ecologist should be consulted to ensure protection of sensitive vegetation and to avoid impinging on very or high sensitivity areas during micro-siting prior to construction.



Legend

- Perdekraal Land Parcel
- Contour (20m)
- Non-Perennial River
- River Area
- Secondary Road
- Other Road
- Railway Line
- Transmission Line
- Proposed O&M Building Location
- Preferred Access Points
- Alternative Access Points
- Substation Option 1
- Substation Option 2
- Connection Point Option 1
- Proposed Transmission Line 1
- Proposed Transmission Line 2
- Proposed Transmission Line 3
- Proposed Transmission Line 4
- PV Area
- Wind Turbine Generator
- Internal Road
- Acceptable for establishment of turbines and PV
- Not Acceptable for establishment of turbines and PV

SCALE:

0 500 1,000 1,500 2,000
Metres

N

TITLE:

Figure 7.1: Alternative 1 on the Areas for Establishment of Turbines and PV

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Apr 2012	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 50 000

DRAWING: Perdekraal_Alt1_BIA_Buildable_areas_Rev1.mxd

REV: 1

ERM
Block A, Silverwood House
Silverwood Close
Steenberg Office Park, 7945
Cape Town, SOUTH AFRICA
Tel: +27 (0)21 702 9100
Fax +27 (0)21 701 7900

Projection: Geographic, Datum: Hartebeesthoek 1994
Source:
Inset: ESRI Data and Maps

SIZE: A3

T:\Gis Projects\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\30Apr12\Alt2 1\Perdekraal_Alt1_BIA_Buildable_areas_Rev1.mxd

Cape Winelands

Grootrivier

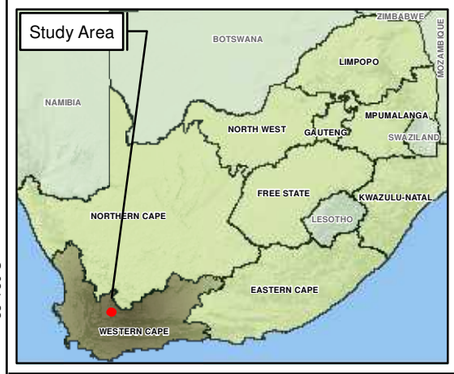
Grootrivier

20°1'30"E 20°3'0"E 20°4'30"E 20°6'0"E 20°7'30"E 20°9'0"E

33°1'30"S 33°3'0"S 33°4'30"S 33°6'0"S 33°7'30"S

Legend

- Perdekraal Land Parcel
- Contour (20m)
- Non-Perennial River
- River Area
- Secondary Road
- Other Road
- Railway Line
- Transmission Line
- Proposed O&M Building Location
- Preferred Access Points
- Alternative Access Points
- Substation Option 1
- PV Area
- Wind Turbine Generator
- Internal Road
- Acceptable for establishment of turbines and PV
- Not Acceptable for establishment of turbines and PV



SCALE:

0 500 1,000 1,500 2,000
Metres

N

TITLE:

Figure 7.2: Alternative 2 (Perdekraal 2) on the Areas for Establishment of Turbines and PV

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Apr 2012	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 50 000

DRAWING: Perdekraal_Alt2_BIA_Buildable_areas_(Perdekraal2)_Rev1.mxd

REV: 1

ERM
Block A, Silverwood House
Silverwood Close
Steenberg Office Park, 7945
Cape Town, SOUTH AFRICA
Tel: +27 (0)21 702 9100
Fax +27 (0)21 701 7900

ERM

Projection: Geographic, Datum: Hartebeesthoek 1994
Source:
Inset: ESRI Data and Maps

SIZE: A3

T:\Gis Projects\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\30Apr12\Alt2 1\Perdekraal_Alt2_BIA_Buildable_areas_(Perdekraal2)_Rev1.mxd

Construction Phase

- Prior to construction, a botanist or ecologist will be consulted to ensure micro-siting of turbines and construction of PV arrays, roads and other infrastructure minimises damage to or loss of sensitive flora;
- Clear demarcation during the construction phase of all sensitive areas which should remain undisturbed and that are not within the direct footprint of the REF to ensure that there is no uncontrolled access by construction vehicles and labourers;
- Educate all contractors as to the importance of the undisturbed conservations areas;
- All vehicles will stick to designated and prepared roads;
- Temporary construction lay-down or assembly areas will be sited on transformed areas;
- Rapid regeneration of plant cover will be encouraged by setting aside topsoil during earthmoving and replacing onto areas where the re-establishment of plant cover is desirable to prevent erosion; and
- Rehabilitation or ecological restoration during and after the construction phase will be undertaken with locally indigenous plants.

Operational Phase

The following mitigation measures will be implemented during the operational phase:

- Laydown or infrastructure assembly areas which will not be required during the operational phase of the facility and the PV area will be re-vegetated with indigenous vegetation to prevent erosion.

- It is understood that lease agreements with landowners are already in place but it is recommended that landowners be encouraged to ensure livestock numbers are kept at or below densities recommended by the Department of Agriculture to prevent over-grazing.

- On-site employees, farm workers and visitors to the site will be informed of the importance of the conservation of vegetation. This will include strict guidelines for remaining on existing roads while on site to avoid unnecessary destruction or damage to undisturbed and rehabilitated vegetation.

7.1.3 Residual Impact

The design phase mitigation measures have been implemented into the **Site Layout Alternative 2** (see *Figure 7.2*) and the implementation of the operational phase mitigation will contribute to reducing the significance of the residual impacts associated with loss of natural vegetation in the construction phase to medium-low (see *Table 7.2*), medium with regards to potential

impacts on vegetation communities 3 and 4 and low in respect of communities 1 and 2. Operational impacts are anticipated to be low.

Table 7.2 ***Pre- and Post-Mitigation Significance: Loss of natural vegetation***

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**HIGH-MEDIUM (-VE)**	**MEDIUM-LOW (-VE)**
Operation	**LOW (-VE)**	**LOW (-VE)**

7.2 IMPACT ON FAUNA

7.2.1 Impact Description and Assessment

Construction Phase Impacts

The potential impacts associated with vegetation loss are closely linked to potential impacts on fauna at the REF site since the determinant of the abundance of most animals is habitat quality. Construction phase activities that will impact animal life include site clearance for establishment of the REF, increased human activity, increase in noise, dust generation, increased potential for soil erosion and increased traffic.

The fauna baseline study indicates that approximately 44 mammal species are likely to occur at the site, the majority of which are widespread species with broad habitat requirements with the exception of the Riverine Rabbit. The Riverine Rabbit is critically endangered and has been recorded in the immediate vicinity of the site according to the Endangered Wildlife Trust (EWT) Riverine Rabbit Project 2010). Based on the food plants reported in the literature and the habitat requirements of the species, it is likely that the riverine rabbit occurs on the Perdekraal site, within the Grootrivier as well as its larger tributaries. There is little doubt that the construction phase of the project will create a disturbance, particularly habitat destruction and noise. The extent to which this will disturb or displace rabbits is not known. However, assuming that suitable habitat has been correctly identified and areas identified as 'unacceptable' are avoided, it is likely that the rabbits will not be overly disturbed as they will be unlikely to flush during the day and will still be able to forage at night when construction ceases.

There are relatively few amphibians which potentially occur at the site with two endemic species, the Dainty Frog (*Cacosternum karooicum*) and Tradouw Toadlet (*Capensibufo tradouwi*). Both species are likely to be associated with the areas long the drainage channels, where there is more moisture available and where small semi-permanent pools form. Provided that development within riverine and floodplain environments does not take place and suitable precautions are taken during the development of the site to limit erosion and sediment transport into the ephemeral streams of the site, then it is unlikely that the development will have a significant impact on this habitat and amphibians in general. The drainage systems on the site may indirectly

affected by potential erosion or increases in silt loads within temporary streams (see *Section 10* for further discussion on erosion).

A large proportion of the reptiles on site are regional endemics and there are localised habitats at occur on the Perdekraal site. The sandy and silty substrate associated with the drainage channels is distinct from the stoney plains of the surrounding area. Should the development avoid the drainage channels, the reptile communities associated with the surrounding plains will be more affected than those of the riparian areas.

The increased volumes of traffic on the site during the construction phase poses a risk to fauna and in particular slow-moving reptiles crossing these roads, in particular, snakes and tortoises are at greatest risk of being hit by vehicles. It is assumed that vehicles on the service roads within the site will be travelling relatively slowly and most mammals should be fleet enough to avoid impacts with vehicles.

Box 7.3 Construction Impact: Impact on Fauna

Nature: Construction activities would result in a **negative direct** impact on fauna present on the REF site.

Impact Magnitude –High -medium

- **Extent:** The extent of the impact is **on-site** since the impacts are limited to the boundaries of the site.
- **Duration:** The duration would be **short-term** for the duration of construction
- **Intensity:** The intensity is **high -medium** since Riverine Rabbit habitat may be impacted with a resultant high impact and a medium impact associated with impacts on amphibians, reptiles if site layout alternative 2 is not adopted.

Likelihood – There is a **medium** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – HIGH-MEDIUM (-VE)

Degree of Confidence: The degree of confidence is **medium**.

Operational Phase Impacts

During the operational phase of the REF, the disruptive and destructive activities associated with the construction phase will have ceased. No additional habitat destruction is anticipated during routine operation and maintenance of the facility. However, fauna may be impacted by soil erosion increasing silt loads within temporary streams, disturbance associated with human activity and maintenance vehicles around REF infrastructure.

The open areas associated with the REF, such as roads and laydown areas may cause significant disturbance for reptiles as crossing these areas will make reptiles more vulnerable to predation. Since the vegetation cover on the site is good, it may suggest that reptiles found on the site will not be well adapted to open areas in terms of their habitat requirements and predator avoidance behaviour. For smaller species, this will likely result in local decline around

roads and lay-down areas. However, for larger species, increased levels of predation may be more serious in terms of their overall on site populations, since they are likely to move over wider areas and encounter roads and lay-down areas on a more frequent basis. The development may also favour a small suite of species as a result of the alteration of habitat, since it will create a relatively large expanse of open ground and loose gravel which may benefit species which forage in such open areas.

Box 7.4 Operational Impact: Impact on Fauna

Nature: Routine operational and maintenance activities may result in a **negative direct** impact on fauna at the REF site.

Impact Magnitude – High -medium

- **Extent:** The extent of the impact is **on-site** since the impacts are limited to the boundaries of the site.
- **Duration:** The duration would be **long-term** as the ecology of the area would be affected at least until the project stops operating.
- **Intensity:** The intensity is **high-medium** since reptiles and mammals may be more susceptible to predation.

Likelihood – There is a **medium** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – HIGH-MEDIUM (-VE)

Degree of Confidence: The degree of confidence is **medium**.

7.2.2 Mitigating impacts on fauna

Design Phase

Mitigation to minimise the impacts on fauna, as with loss of vegetation, begins at the design phase by avoiding sensitive areas and limiting the disturbance or destruction of habitat in those areas. This can be achieved at the site by:

- Avoid areas classified as unacceptable for establishment of turbines including drainage channels and the within the floodplain of the Grootrivier and its tributaries which are possibly suitable habitat for Riverine Rabbit;

- A ground survey for Riverine Rabbit must be undertaken prior to construction. The survey must focus on determining the presence or absence of the species at the site. If the Riverine Rabbit is present then the habitat must be mapped and the population size determined. The findings should be used to further refine the final site layout.

- Although the existing road and some tracks traverse areas mapped as unacceptable, no new access roads will be constructed in these areas; and

- Preferably, access points to the areas on the north-eastern and south-western sides of the Grootrivier should be via the existing public road.

The above-mentioned mitigation measures are incorporated into **Site Layout Alternative 2 which is the preferred alternative**, with the removal of infrastructure in very high sensitivity areas. The iterative process and the evolution of the layout has been illustrated in *Figures 7.1* and *7.2*.

An ecologist should be consulted to inform micro-siting should this change the final Site Layout Alternative 2, to ensure protection of sensitive habitat and to avoid impinging on very high sensitivity areas.

Construction Phase

- Clear demarcation during the construction phase of all undisturbed sensitive areas that are not within the direct footprint of the REF to ensure that there is no uncontrolled access by construction vehicles and labourers;

- Educate contractors as to the importance of the undisturbed conservations areas and importance of avoiding them;

- All vehicles must stick to designated and prepared roads and adhere to the speed limit on site of 40km/hr;

- Mitigating the risk of poaching by fencing in the accommodation compounds of the construction crews, to prevent individuals from wandering in the veld after hours; banning the possession of dogs on site by construction and maintenance staff.

- Where possible, temporary construction lay-down or assembly areas should be sited on transformed areas; and

- Rapid regeneration of plant cover must be encouraged by setting aside topsoil during earthmoving and replacing onto areas where the re-establishment of plant cover is desirable to prevent erosion.

Operational Phase

The following mitigation measures will be implemented during the operational phase:

- Laydown or infrastructure assembly areas which will not be required during the operational phase of the facility and the PV area will be re-vegetated with indigenous vegetation to prevent erosion.

- All vehicles must stick to designated and prepared roads and adhere to the 40 km/hr speed limit on site.

- On-site employees, farm workers and visitors to the site will be educated about the conservation of vegetation. This should include strict guidelines

for remaining on existing roads while on site to avoid unnecessary destruction or damage to undisturbed and rehabilitated vegetation.

7.2.3 Residual Impact

The bulk of the design phase mitigation measures have been implemented into the revised REF layout (refer to *Figure 7.2*), this is the **preferred, final Site Layout Alternative 2**. The implementation of the operational phase mitigation will contribute to reducing the significance of the residual impacts on fauna to low (see *Table 7.3*).

Table 7.3 Pre- and Post-Mitigation Significance: Impacts on Fauna

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**HIGH-MEDIUM (-VE)**	**LOW (-VE)**
Operation	**HIGH-MEDIUM (-VE)**	**LOW (-VE)**

The potential impacts on birds resulting from the establishment of the renewable energy facility include impacts associated with mortality through collision with turbines, habitat loss and disturbance or displacement from foraging or nesting areas. This section examines the potential impacts and mitigation measures to reduce the impacts.

The proposed development is a medium-sized REF situated in an area where there are few major conflicting issues in terms of its avifauna. There are no regionally or nationally critical populations of impact susceptible species within or close to the development area, and the proposed site does not impinge significantly on any major bird fly-ways, unique landscape features, or rare avian habitats. However, the site does occasionally support large numbers of some threatened and/or ecologically significant species, and always supports small numbers of other threatened and/or ecologically significant species, and the proposed REF is likely to have a detrimental effect on these birds, during both the construction and operational phases of the development as summarised in *Table 8.1.*

Table 8.1 Impact characteristics: Impacts on Birds

Summary	Construction	Operation
Project Aspect/ activity	(iii) Disturbance associated with noise and movement. (iv) Loss of vegetation and avian habitat through site clearance, road upgrade and establishment of the camp, laydown and assembly areas.	(iii) Disturbance and/or displacement from foraging or nesting area by movement and/or noise of rotating turbine blades, and by space occupied by solar panels. (iv) Mortality in collisions with turbine blades or by electrocution on new power infrastructure.
Impact Type	Direct	Direct
Receptors Affected	(iii) All birds on site; key species Ludwig's Bustard, Black Harrier, Martial Eagle and Blue Crane, wetland species, Karoo endemics. (iv) Black Harrier, Karoo endemics.	(iii) All birds on site; key species: Ludwig's Bustard, Black Harrier, Martial Eagle and Blue Crane. (iv) All birds on site; key species Ludwig's Bustard, Black Harrier, Martial Eagle, Blue Crane, wetland species.

8.1 COLLISION OF BIRDS WITH WIND TURBINES AND OTHER INFRASTRUCTURE

8.1.1 Impact Description and Assessment

Operational Phase Impact

The wind turbines, once constructed, may impact on bird populations in the area by contributing to bird mortality through birds colliding with turbines or associated structures such as power lines. There are a number of factors which influence the risk of collision and they include the following:

- The abundance of birds in the area and how vulnerable the species are to collision;
- Landscape features can potentially channel birds towards certain areas and influence their flight and foraging behaviour;
- Bird behaviour may be affected by weather conditions, for example, poor weather conditions may affect flight patterns and high densities of prey may make raptors more susceptible to collisions;
- The size, numbers and spacing of turbines may influence collision risk;
- Lattice turbine types allowed for perching thus increasing the likelihood of collisions as birds land at or leave perch or roost sites but this is generally not a problem with modern turbine types and would not be an issue with this project;
- The lighting on turbines may attract birds; and
- The extent to which birds avoid the facility.

Collision prone birds are generally large species with high ratios of body weight to wing surface area like cranes, bustards, vultures, gamebirds, waterfowl and falcons, species which fly at high speeds such as gamebirds, pigeons, sandgrouse, swifts and falcons, species which are distracted in flight like predators or insect eating species, species with aerial displays, species which habitually fly in low light conditions and species with narrow fields of forward binocular vision. These traits confer high levels of *susceptibility*, which may be compounded by high levels of *exposure* to man-made obstacles such as overhead power lines and wind turbine areas (Jenkins *et al.* 2010).

Impacts of the proposed REF are most likely to be manifest in the following ways:

(i) Disturbance and displacement of seasonal influxes of large terrestrial birds (especially Ludwig's Bustard and possibly Blue Crane) from nesting and/or foraging areas by construction and/or operation of the facility, and /or mortality of these species in collisions with the turbine blades or associated new power lines while commuting between resource areas (croplands, nest sites, roost sites/wetlands).

(ii) Disturbance and displacement of resident/breeding raptors (especially Martial Eagle and Black Harrier) from nesting and/or foraging areas by construction and/or operation of the facility, and /or mortality of

these species in collisions with the turbine blades or associated new power lines while slope-soaring or hunting, or by electrocution when perched on power infrastructure.

(iii) Disturbance and displacement of resident/breeding Karoo endemics on the high-lying ridges fringing the study area by construction and/or operation of the facility.

The power line to connect to the proposed Kappa Substation may also pose a collision risk, probably affecting the same suite of collision prone species as the wind turbines (Bevanger 1994, 1995, 1998, Janss 2000b, Anderson 2001, van Rooyen 2004a, Drewitt & Langston 2008, Jenkins *et al.* 2010). Avian electrocutions can occur when a bird perches or attempts to perch on an electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004b, Lehman *et al.* 2007). Electrocution risk is strongly influenced by the voltage and design of the power lines erected (generally occurring on lower voltage infrastructure where air gaps are relatively small), and mainly affects larger, perching species, such as vultures, eagles and storks, easily capable of spanning the spaces between energized components.

Box 8.1 Operational Impact: Collision of birds with wind turbines

Nature: Operational activities would result in a **negative direct** impact on the avifauna of the REF site.

Impact Magnitude – Medium-High

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

Likelihood – There is a **low-medium** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM-HIGH (-VE)

Degree of Confidence: The degree of confidence is **MEDIUM**.

8.1.2 Mitigating for Collision Risks

The only direct way to reduce the risk of birds colliding with turbine blades is to make the blades more conspicuous and hence easier to avoid. Studies have shown that the easiest, cheapest and most visible blade pattern for birds, is a single black blade in an array of white blades (McIsaac 2001, Hodos 2002). Hence blade marking may be an important means to reduce collision rates by making the rotating turbine blades as conspicuous as possible under the least favourable visual conditions, particularly at facilities where raptors are known or likely to be frequent collision casualties. However, given the high visual impact that may be associated with this mitigation measure, it is not recommended.

All other collision mitigation options operate indirectly, by reducing the frequency with which collision prone species are exposed to collision risk. This is achieved mainly by:

- Ensuring that key areas of sensitivity are avoided (See Design Phase mitigation in *Section 8.2.2*);
- Clear demarcation during the construction phase of all undisturbed sensitive areas that are not within the direct footprint of the REF to ensure that there is no uncontrolled access by construction vehicles and labourers;
- Educate all contractors as to the importance of the undisturbed conservations areas;
- Using modern turbine designs, as proposed for this project, which discourage birds from perching on turbine towers or blades;
- Minimizing the length of any new power lines installed, and ensuring that all new lines are marked with bird flight diverters (Jenkins et al. 2010), and that all new power infrastructure is adequately insulated and bird friendly in configuration (Lehman et al. 2007);
- Ensuring that lighting on the turbines is kept to a minimum (but in line with aviation regulations) and intermittent, rather than permanent and white, to reduce confusion effects for nocturnal migrants;
- Carefully monitoring collision incidence and investigate appropriate mitigation measures, when required; and
- Implementing a rigorous pre- and post-construction monitoring programme since effective mitigation can only be achieved through monitoring (see *Section 8.3*).

8.1.3 Residual Impact

The implementation of the above mitigation measures would contribute towards ensuring that the significance remains low negative during the operation phase. The pre- and post-mitigation impacts are compared in *Table 8.2*.

Table 8.2 Pre- and Post- Mitigation Significance of bird collision risk

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**N/A**	**N/A**
Operation	**MEDIUM-HIGH (-VE)**	**LOW (-VE)**

8.2 HABITAT LOSS – DESTRUCTION, DISTURBANCE AND DISPLACEMENT

8.2.1 Impact Description and Assessment

Construction Phase Impacts

The scale of direct habitat loss resulting from the construction of the REF and associated infrastructure depends on the size of the project but, in general, is likely to be small per turbine base. The estimated habitat loss for this project is approximately 4.5% and in the study area, direct habitat loss is not regarded as a major impact on birds, relative to disturbance or displacement. Construction activities, and to a lesser extent ongoing maintenance activities, are likely to cause some disturbance of birds in the general surrounds, and especially to shy and/or ground-nesting species resident in the area.

The potential impact on birds of any solar energy generation facility is the displacement or exclusion of threatened, rare, endemic or range-restricted species from critical areas of habitat. Given the considerable space requirements of commercially viable solar energy facilities, this effect could be significant in some instances and there is the possible cumulative effect of multiple facilities in one area.

The construction of the renewable energy facility could result in impacts related to the disturbance and displacement of species from nesting and/or foraging areas and loss of habitat through clearing to establish the facility. Sources of disturbance and displacement include noise and dust generated by vehicles and machinery during construction and human presence. This disturbance is likely to occur over a 12 to 18 month period although it will be short lived for specific work areas within the site, since the work will be progressive or phased.

There are no regionally or nationally critical populations of impact susceptible species within or close to the development area, and the proposed site does not impinge significantly on any major bird fly-ways, unique landscape features, or rare avian habitats. However, the site does support small numbers of threatened and/or ecologically significant species. Affected species may include resident/breeding raptors (especially Martial Eagle and Black Harrier and) and large terrestrial birds (e.g. Ludwig's Bustard and possibly Blue Crane) being disturbed and displaced from nesting and/or foraging areas. Karoo endemics (e.g. Cinnamon-breasted Warbler, Black-eared Sparrowhawk) may be disturbed and displaced by construction activities.

Box 8.2 ***Construction Impact: Habitat Loss – Destruction, Disturbance and Displacement***

Nature: Construction activities would result in a **negative direct** impact on avifauna of the REF site.

Impact Magnitude – Medium

- **Extent**: The extent of the impact **local** as it will be limited to the site.
- **Duration**: The duration would be **long-term** as the ecology of the area would be altered beyond the completion of the project.
- **Intensity**: Loss of habitat for priority species will be small, so the magnitude of the change will be **high-medium**.

Likelihood – There is a **high** likelihood that moderate areas of habitat will be lost and birds will be disturbed.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM (-VE)

Degree of Confidence: The degree of confidence is **high**.

Operational Phase Impacts

Some studies have shown significant decreases in the numbers of certain birds in areas where wind energy facilities are operational as a direct result of avoidance of the noise or movement of the turbines (e.g. Larsen & Guillemette 2007, Farfán *et al.* 2009, Table 1), while others have shown decreases which may be attributed to a combination of collision casualties and avoidance or exclusion from the impact zone of the facility in question (Stewart *et al.* 2007). Such displacement effects are probably more relevant in situations where wind energy facilities are built in natural habitat (Pearce-Higgins *et al.* 2009, Madders & Whitfield 2006) than in more modified environments such as farmland (Devereaux *et al.* 2008), and are highly species-specific in operation.

Solar installations generally feature large areas of reflective panelling. It is possible that nearby or overflying birds may be disorientated by the reflected light, and consequently be displaced from an area more extensive than just the developed footprint of the facility. Conversely, certain bird species may be attracted to the solar arrays, using the erected structures as prominent perches, sheltered roost sites or even nesting sites, and possibly foraging around the infrastructure in response to changes in the distribution of preferred foods (plants growing under the panelling, other animals attracted to the facility). Such scenarios might be associated with fouling of critical components in the solar array, bringing local bird populations into conflict with the facility operators. Under these circumstances, specialist advice should be sought in devising effective avian deterrents to minimize associated damage.

Box 8.3 ***Operational Impact: Habitat Loss - – Destruction, Disturbance and Displacement***

Nature: Operational activities would result in a **negative direct** impact on the avifauna of the REF site.

Impact Magnitude – **Medium**

- **Extent:** The extent of the impact is **local**, as it may affecting birds outside the development footprint.
- **Duration:** The duration would be **long-term** as the ecology of the area would be affected until the project stops operating (i.e. over 25 years).
- **Intensity:** Some priority species may be displaced for the duration of the project, and there will be some loss of habitat, so the magnitude of the change will be **medium**

Likelihood – There is a **medium** likelihood that some priority species will be disturbed or displaced during operation.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM (-VE)

Degree of Confidence: The degree of confidence is **medium**.

8.2.2 Mitigation of Habitat Loss- Destruction, Disturbance and Displacement

Design Phase

Mitigation against habitat loss begins at the design phase by ensuring that the indicative layout avoids sensitive habitat by creating buffers around specific areas of the site. This can be achieved by:

- Excluding development from:
    - Within 500 m of the centre of the large dam on the farm Rietpoort to reduce disturbance and collision risk for wetland species commuting between this wetland and other resource areas.
    - Along the Grootrivier river bed to reduce collision risk for birds commuting along this central drainage line (because of the difficulty with determining the Grootrivier centreline, the exclusion/ buffer zone that will be maintained has been determined by the botanist and is incorporated into Site Layout Alternative 2).
- Implementing a rigorous pre- and post-construction monitoring programme since effective mitigation can only be achieved through monitoring (see *Section 8.3*).

The exclusion zones are incorporated into Site Layout Alternative 2 although because of the difficulty with determining the Grootrivier centreline, the exclusion/ buffer zone which will be maintained has been determined by the

botanist. The iterative process and the evolution of the layout has been illustrated in *Figures 7.1* and *7.2*.

Construction Phase

- Minimizing the disturbance impacts associated with the construction of the facility, by abbreviating construction time, scheduling activities around avian breeding and movement schedules, lowering levels of associated noise, and reducing the size of the inclusive development footprint.

- Habitat loss and disturbance can be mitigated during the construction phase by on-site demarcation of sensitive areas. These areas should be identified during pre-construction monitoring.

Operational Phase

Maintenance activities should be scheduled to avoid disturbances to sensitive areas (identified through operational monitoring) during breeding season.

8.2.3 Residual Impact

The design phase mitigation measures have been implemented through the revision of the Site Layout Alternative 1 resulting in the **preferred Site Layout Alternative 2**. The implementation of the above construction and operational phase mitigation measures would contribute towards ensuring that the significance remains low negative during both the construction and operation phases. The pre- and post-mitigation impacts are compared in *Table 8.2*.

Table 8.3 Pre- and Post- Mitigation Significance: Habitat loss - Destruction, Disturbance and Displacement

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**MEDIUM (-VE)**	**LOW (-VE)**
Operation	**MEDIUM (-VE)**	**LOW (-VE)**

8.3 MONITORING REQUIREMENTS

Effective mitigation can only be achieved with a commitment to rigorous pre- and post-construction monitoring (see monitoring protocol in the EMP in *Annex L*). At this early stage of wind power development in South Africa, in the interest of research and conservation, it would therefore be valuable to implement a monitoring programme in order to start building a knowledge base of actual impacts at local wind facilities.

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

- Determine the densities of birds resident within the impact area of the REF before construction of the facility, and afterwards, once the facility, or phases of the facility, become operational.

- Document patterns of bird activity and movements in the vicinity of the proposed REF before construction, and afterwards, once the facility is operational.

- Monitor patterns of bird activity and movement in relation to weather conditions, time of day and season for at least a full calendar year after the REF is commissioned.

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

Bird density and activity monitoring should focus on rare and/or endemic, potentially disturbance or collision prone species, which occur with some regularity in the area. Ultimately, the study should provide much needed quantitative information on the effects of the REF on the distribution and abundance of birds, and the actual risk it poses to the local avifauna, and serve to inform and improve mitigation measures to reduce this risk.

It will also establish a precedent and a template for research and monitoring of avian impacts at possible, future REF sites in the region. This monitoring programme outline is informed by monitoring studies established in other countries (e.g. Erickson *et al.* 1999,Scottish National Heritage 2005), but is based substantially on those developed for both the Darling and the Klipheuwel wind power demonstration facilities in South Africa (Jenkins 2003, Küyler 2004). The bulk of the work involved should be done by an expert ornithologist or under the supervision of such.

This section addresses the impacts the proposed renewable energy facility may have on bats (see *Annex H*). The impacts associated with habitat loss, collisions with turbines and barotrauma and are summarised in *Table 9.1*, below.

The paucity of vegetation at the site decreases the availability of insect prey and does not provide suitable roosting sites for bats that commonly use tree foliage and tree hollows as roosts. The farm houses and outbuildings were identified during the field visit as places which would provide suitable roosting sites and food sources for insectivorous bats.

One bat species was detected through the measurement of echolocation calls using a bat detector, the Cape Serotine Bat (*Neoromicia capensis*). The Cape Serotine Bat has a conservation status of *least concern* according to the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN, 2010). Resident bats species may be affected by the proposed development however also of concern are migratory species although these were not identified at the site. There are at least two migratory bat species in South Africa, Cape Hairy Bat *Myotis tricolour* and Natal Long-fingered Bat *Miniopterus natalensis*. These bats generally undertake short (about 240km) migratory flights (from bushveld caves to Highveld caves). There is evidence that while most bats in the colony may migrate, a small group may remain and hibernate in the maternity cave (Dwyer 1965; van der Merwe 1975). This fragmentation may mean that flights to different sets of winter hibernacula might not be clumped in space and time as is often the case North America and Canada. This could result in the impact of wind turbines on migrating bats being much less in South Africa than what has occurred in North America. However, there is a pressing need for research into bat migration in South Africa.

Table 9.1 Impact characteristics: Impacts on Bats

Summary	Construction	Operation
Project Aspect/ activity	(i) Disturbance associated with noise and movement. (ii) Loss of forging habitat.	(i) Disturbance and/or displacement from foraging or roosting areas by movement and/or noise of rotating turbine blades, and by space occupied by solar panels. (ii) Mortality in collisions with turbine blades and/or power lines, or by electrocution on new power infrastructure. (iii) Mortality from barotrauma.
Impact Type	Direct	Direct
Receptors Affected	(i) Bats on site, key species being Cape Serotine Bat.	(i) Bats on site, key species being Cape Serotine Bat.

9.1 HABITAT LOSS – DESTRUCTION, DISTURBANCE AND DISPLACEMENT DUE TO WIND TURBINES

9.1.1 Impact Description and Assessment

Construction Phase Impacts

Although the final footprint of most wind energy facilities is likely to be relatively small, the construction phase of the development inevitably incurs some temporary damage or permanent destruction of habitat. The removal of natural vegetation during the construction phase may alter the foraging habitat of some bat species.

Construction phase impacts could also result in disturbance or displacement of species and loss of foraging habitat associated with clearing of vegetation as well as noise and dust generated from construction activities. The construction phase is short-lived for specific areas as construction progresses across the site and should be completed in approximately 12 months.

Box 9.1 Construction Impact: Habitat Loss – Destruction, Disturbance and Displacement

Nature: Construction activities would result in a **negative direct** impact on bat habitat.

Impact Magnitude – Medium

- **Extent**: The extent of the impact is **local** is it will be limited to the site.
- **Duration**: The duration would be **short-term** for the duration of construction (approximately 12 - 18 months).
- **Intensity:** Owing to the scarcity of roosts, any factor that causes bats to desert their roosts is likely to be of **medium** intensity.

Likelihood – There is a **medium** likelihood that small areas of habitat will be lost.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM

Degree of Confidence: The degree of confidence is **medium**.

Operational Phase Impacts

The operation of the REF may result in the disturbance to and/or displacement of bats from foraging or roosting areas due to blade movement, noise of rotating turbine blades, and by the space occupied by solar panels.

Box 9.2 Operational Impact: Habitat Loss – Destruction, Disturbance and Displacement

Nature: Operational activities would result in a **negative direct** impact on bat habitat.

Impact Magnitude – Low

- **Extent**: The extent of the impact is **local** is it will be limited to the site.
- **Duration**: The duration would be **long-term** as the ecology of the area would be affected until the project stops operating (i.e. over 25 years).
- **Intensity:** Owing to the scarcity of roosts, any factor that causes bats to desert their roosts is likely to be of **medium** intensity.

Likelihood – There is a **low** likelihood that small areas of habitat will be lost.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW

Degree of Confidence: The degree of confidence is **medium**.

9.1.2 Mitigation of Habitat Loss- Destruction, Disturbance and Displacement

Design Phase

The objective of mitigation is to minimize the impacts on bats and their habitat and to maximize rehabilitation of disturbed areas. Specific measures include:

- Wind turbines should be erected to allow for a 500m buffer zone from known bat roosting areas i.e. farm buildings; and

- Topographical features that migratory bats might use e.g. mountain ridges which provide landmarks as well as potential transient roosts, should be avoided.

The above-mentioned mitigation measures are incorporated into Site Layout Alternative 2 which is the preferred alternative and the evolution of the layout has been illustrated in *Figures 7.1* and *7.2*.

Construction and Operational Phase

Construction and operational phase impacts can be mitigated by maintaining a 500m buffer zone around potential roosts such as houses and outbuildings.

9.1.3 Residual Impacts

The design phase mitigation measures of allowing a 500m buffer have been implemented through the revision of the Site Layout Alternative 1 resulting in the preferred Site Layout Alternative 2 (see *Figures 7.1* and *7.2*). The implementation of the above construction and operational phase mitigation measures would contribute towards ensuring that the significance decreases during both the construction and operation phases. The pre- and post-mitigation impacts are compared in *Table 9.2*.

Table 9.2 Pre- and Post- Mitigation Significance: Habitat loss - Destruction, Disturbance and Displacement

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**MEDIUM (-VE)**	**LOW (-VE)**
Operation	**LOW (-VE)**	**LOW (-VE)**

9.2 COLLISIONS WITH TURBINES

9.2.1 Impact Description and Assessment

Operational Phase Impact

The wind turbines, once operational, may impact on bat populations in the area by contributing to bat mortality through direct collisions with the turbine blades. Studies have shown that wind turbines can cause bat fatalities as a result of direct collision with rotating blades or as a result of barotrauma (internal haemorrhaging resulting from the rapid decompression of the air space to the rear of rotating turbine blades). In North America, it is mostly tree-roosting migratory bats that are killed with fatality numbers influenced by the height of towers (taller towers resulting in more fatalities), the level of bat activity at the site and the proximity of turbines to active bat hibernacula. Bats most susceptible to fatalities through collision with wind turbines are likely to be migratory species such as Cape Hairy Bat *Myotis tricolour* and Natal Long-fingered Bat *Miniopterus natalensis*. These were not detected on

site however, it is recognised that longer term monitoring may be required to rule out movement of these species in the vicinity of the site.

There is a relationship between bat activity and the height of wind turbine towers and associated collision risk. Shorter towers (50m) cause less fatalities than higher towers (65m) in areas of high bat activity but in areas of low bat activity, even high towers may cause few fatalities (Baeerwald et al. 2008). The tower heights for the proposed project range from 70m to 120m.

There is some evidence that resident species may be prone to collisions with turbines during periods of greater bat activity such as during mating.

Box 9.3 ***Operational Impact: Collisions of bats with wind turbines***

Nature: Operational activities would result in a **negative direct** impact on the bats of the REF site.

Impact Magnitude – Medium

- **Extent:** The extent of the impact is **local**, affecting bats outside the development footprint.
- **Duration:** The duration would be **long-term** as the ecology of the area would be affected at least until the project stops operating.
- **Intensity:** Numbers of bats may be killed in collision/electrocution incidents with a resulting intensity of **medium**.

Likelihood – There is a **medium** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM (-VE)

Degree of Confidence: The degree of confidence is **low** since there is a need for research about migratory patterns and mating behaviour of bats in South Africa.

9.2.2 Mitigation for Collision Risks

Collision mitigation measures are aimed at reducing the risks of bats colliding with turbines by erecting wind turbines in places of little or no bat activity such as the Perdekraal site. Additional mitigation measures include:

- Siting turbines away from farm houses and mountain ridges (see Design Phase mitigation in *Section 9.1.2*); and
- Implementing pre- and post-construction monitoring (see *Section 9.4*) to inform micro-siting of turbines away from sensitive areas and provide data of actual impacts once the facility is operational.

9.2.3 Residual Impacts

The implementation of the above mitigation measures would result in a low impact significance during the operational phase. The pre- and post-mitigation impacts are compared in *Table 9.3*.

Table 9.3 Pre- and Post- Mitigation Significance: Collision Risk

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**N/A**	**N/A**
Operation	**MEDIUM (-VE)**	**LOW (-VE)**

9.3 BAROTRAUMA

9.3.1 Impact Description and Assessment

Operational Phase Impact

Barotrauma refers to tissue damage of the lungs and is caused by dramatic changes is pressure. When air moves over a turning turbine blade, an area of low pressure is created and bats flying or foraging in the vicinity of this sudden change in pressure can suffer barotrauma resulting in mortality (Baerwald et al, 2009). As with the collision risks discussed above, barotrauma may impact migratory bats, moving through the area or resident bats foraging in the vicinity of wind turbine towers.

Box 9.4 Operational Impact: Barotrauma

Nature: Operational activities would result in a **negative direct** impact on the bats of the REF site.

Impact Magnitude – Medium

- **Extent:** The extent of the impact is **local**, affecting bats inside as well as outside the development footprint.
- **Duration:** The duration would be **long-term** as the ecology of the area would be affected at least until the project stops operating.
- **Intensity:** Barotrauma may result in fatalities in numbers of bats with a resulting intensity of **medium**.

Likelihood – There is a **medium** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM (-VE)

Degree of Confidence: The degree of confidence is **low** since little is know about migratory patterns and mating behaviour of bats in South Africa.

9.3.2 Mitigation for Barotrauma

Collision mitigation measures are aimed at reducing the risks of bats colliding with turbines by erecting wind turbines in places of little or not bat activity such as the Perdekraal site. Additional mitigation measures include:

- Siting turbines away from farm houses and mountain ridges (see Design Phase Mitigation in *Section 9.1.2*);
- Implementing pre- and post-construction monitoring to inform micro-siting of turbines; and

- Developer to ensure a monitoring programme is established once the facility becomes operational for a period for at least one year.

9.3.3 Residual Impacts

The implementation of the above mitigation measures would result in a low impact significance during the operational phase. The pre- and post-mitigation impacts are compared in *Table 9.3*.

Table 9.4 Pre- and Post- Mitigation Significance: Barotrauma

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**N/A**	**N/A**
Operation	**MEDIUM (-VE)**	**LOW (-VE)**

9.4 MONITORING REQUIREMENTS

Effective mitigation can only be achieved with a commitment to rigorous pre- and post-construction monitoring. At this early stage of wind power development in South Africa, in the interest of research and conservation, it would therefore be valuable to implement a monitoring programme in order to start building a knowledge base of actual impacts at local wind facilities.

The monitoring programme would aim to:

- Better understand migratory patterns and mating behaviours of bats in the vicinity of the proposed REF;
- Document bat activity at the site before construction and during operation of the facility;
- Monitor seasonal and diurnal activity rhythms; and
- Record fatalities at randomly selected towers during the operational phase.

The programme would provide quantitative information on the effects of the REF on bats and inform decision-making around reducing potential risks during the construction and operational phases.

- Acoustic monitoring should be conducted at the site once wind measuring masts have been installed across seasons to straddle the times that bats migrate (April/May and August/September) and during mid-summer to inform micro-siting of turbines.
- Monitoring should be done over extended periods within each season e.g. several weeks at 3-4 days per week.
- Bat activity should be assessed with detectors placed at ground level as well as 30 m above ground. The pre-construction wind-measuring masts should be used for this purpose.
- Using systems e.g. the ANABAT SD2 (Titley Electronics PO Box 19 Ballina NSW 2478,Australia info@titley.com.au,

http://www.titley.com.au/batdetection.htm) that enables the remote downloading of echolocation data would allow the collection of data over extended periods.
- Research on seasonal and diurnal activity rhythms is needed for all bat fauna in South Africa.

The operational REF will be regularly monitored for bat activity and bat mortality as follows:

- Acoustic monitoring will be carried out at one or two randomly chosen towers at each site during the periods of migration and mid-summer.

- The acoustic monitoring will be accompanied by monitoring for bat fatalities (carcass searches) at one or two randomly chosen towers at each facility by walking two concentric spiral transects 7m apart with the larger spiral starting at 50m from the tower.

The above-mentioned operational monitoring will be conducted for an initial period of 12 to 24 months after which a decision will be made in conjunction with the bat specialist regarding whether it is necessary to extend this monitoring period.

This chapter discusses the impact the proposed Perdekraal Renewable Energy Facility may have on soils, surface and groundwater including soil erosion and compaction and decrease in water quality through increased sediment loads or spillage of cement, oils, lubricants or fuel. The potential impacts are assessed and mitigation measures to reduce the impacts are outlined below.

The Grootrivier is the dominant landscape feature of the site and runs parallel to the north-eastern boundary of the property. The active channel of the Grootriver is usually only 20-30 m wide, however, the floodplain is frequently 500-700 m or more wide. This is typical of ephemeral rivers, which, due to the high variability of flows, usually have compound channels with a low-water configuration to accommodate near-continuous flows and a wider high-water configuration to accommodate rarer high flows. Typically, as is the case of the Grootrivier, this takes the form of a meandering main channel with outer braided channels. Due to the unpredictable nature of flow events in ephemeral rivers, relatively long periods of stability are interrupted by large events which redistribute large amounts of sediment and rearrange the channel and floodplain. Consequently, the current location of the active channel should not be considered stationary, and does not delineate the boundary of the river, which is rather defined by the extent of the floodplain. Due to the relatively homogenous nature of the surrounding plains, the Grootrivier and other drainage lines at Perdekraal represent an important feature of the landscape as they greatly increase the structural diversity and habitat heterogeneity of the site.

Outside of the drainage lines, the soils are generally very shallow, and gravel or calcrete plains are a common feature of the site. Although the vegetation cover of the site was largely within the range expected under the prevailing rainfall, the vegetation composition is indicative of poor long-term grazing management. The drainage areas were however in an overall better condition and the vegetation of these areas is dominated by various medium to large *Salsola* species and trees such as *Acacia karoo*. There is a large contrast in the sensitivity of the areas within and outside of the drainage areas to disturbance. The drainage areas are highly sensitive due to the fine-textured soils of the floodplains and their dynamic ecological nature. The plains outside of the drainage areas are however, highly homogenous with low species diversity and must in general be considered to be relatively low sensitivity.

Soils found in the flood plain of the Groot Rivier are characterized by restricted soil depth, excessive drainage, high erodibility and low natural fertility, while soils on the western slopes of the site are characterized by restricted soil depth, excessive or imperfect drainage and high erodibility. On

the eastern and south eastern slopes of the site the soils are of restricted depth and associated with rocky outcrops (1).

The aquifer beneath the site is classified as a fractured aquifer and is classified as a major aquifer with moderate vulnerability (2) and high susceptibility (3).

The construction and operation of the REF may impact the soils, surface water and groundwater in the area and these potential impacts are summarised in *Table 10.1.*

Table 10.1 Impact characteristics: Impacts on soils, surface water and groundwater

Summary	Construction	Operation
Project Aspect/ activity	(v) Soil compaction, removal of topsoil and erosion associated with site clearance and preparation, road construction, laydown and assembly area etc. (vi) Impact on surface water and groundwater resulting from fuel, oils or cement spills and increase in sediment load in drainage channels and surface water bodies as a result of erosion.	(v) Soil erosion around cleared areas and roads. (vi) Impact on surface water and groundwater resulting from fuel and oil spills and increase in sediment load in drainage channels and surface water bodies as a result of erosion.
Impact Type	Direct	Direct
Receptors Affected	(v) Soils on site underlying construction areas, turbine and PV sites, roads etc. (vi) Surface and groundwater quality at or near the site (ie Groot River and the seasonal pools which are important breeding habitat for amphibians at the Perdekraal site).	(v) Soils in the vicinity of cleared areas or roads (vi) Surface and groundwater quality at or near the REF site site (ie Groot River and the seasonal pools which are important breeding habitat for amphibians at the Perdekraal site).

(1) SANBI BGIS National Land Cover Map 2009
(2) Likelihood of contaminants reaching a receptor
(3) Potential significance of contaminants reaching a receptor

10.1 LOSS OF TOPSOIL, SOIL COMPACTION AND EROSION

10.1.1 Impact Description and Assessment

Construction Phase Impacts

Preparation of the site for the establishment of wind turbines, PV locations, underground cables, access roads, a lay-down area, substation site and operation and maintenance building during the construction phase will result in vegetation clearance, removal of topsoil and subsoil to varying depths and soil compaction. The deepest excavations will be for turbine foundation which will extend up to 2.5 m depth. The area required to establish the wind turbine towers is relatively small (approximately 19 ha) however the area required for the PV locations and roads linking infrastructure will be greater. If it is assumed that the wind turbines and their associated infrastructure will take up 73.35 ha of the area of the site this translates into 2% which includes the laydown area which may remain after construction depending on whether or not the landowner wishes to use the laydown area during operation. The addition of the PV area increases the area to be disturbed to 290 ha which is roughly 4.5% of the site. However, although the area directly affected may be small, the effects of potential soil erosion and increased sediment load in surface runoff may extend to other areas onsite if appropriate controls are not in place. The intensity of potential erosion is also influenced by precipitation which is generally low in this arid region with an annual rainfall of between 150 – 450 mm.

Compaction of soils results in lower permeability resulting in decrease infiltration and increased runoff. Without appropriate measures, runoff from compacted and hardstanding areas may increase erosion and increase the sediment load entering drainage channels. Removal of the topsoil horizon changes the soil profile which may inhibit rehabilitation which may, in turn, increase the erosion potential of the soil.

Box 10.1 Construction Impact: Loss of topsoil, soil compaction and soil erosion

Nature: The loss of topsoil, changes in the soil profile through compaction and potential soil erosion will have a **negative direct** impact on the soils of the REF site.

Impact Magnitude –Medium

- **Extent:** The extent of the impact is **local** since the impacts are predominantly limited to the boundaries of the site but may extend beyond the site.
- **Duration:** The duration would be **long-term** since although removal of topsoil and compaction will occur largely during the construction phase, the effect may continue through the project lifecycle.
- **Intensity:** The intensity is **medium** since although topsoil removal and soil compaction may be limited to specific areas of the site, potential erosion may affect a larger area.

Likelihood – There is a **medium** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM (-VE)

Degree of Confidence: The degree of confidence is **medium**.

Operational Phase Impacts

Soil erosion caused by stormwater or surface water runoff may occur during the operational phase as a result of additional impervious surfaces onsite resulting in increased runoff. And, although the disturbance associated with the construction phase is over, unless rehabilitation is undertaken loss of topsoil may continue during the operational phase of the project. No additional topsoil clearing is anticipated during routine operation and maintenance of the facility. Soil compaction may occur during the operational phase if heavy vehicles leave the roads and hardstanding areas.

Box 10.2 Operational Impact: Loss of topsoil, soil compaction and soil erosion

---

Nature: Routine operational and maintenance activities may result in a **negative direct** impact on the soils of the REF site.

Impact Magnitude –Low

- **Extent:** The extent of the impact is **local,** the impacts are predominantly limited to the site boundaries but may extend to the immediate vicinity of the site.
- **Duration:** The duration would be **long-term** as the soils may be affected at least until the project stops.
- **Intensity:** The intensity is **low** since the impact will be limited to areas that are already disturbed or to areas in close proximity.

Likelihood – There is a **medium** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW (-VE)

Degree of Confidence: The degree of confidence is **medium**.

10.1.2 Mitigating Loss of Topsoil, Soil Compaction and Erosion

Construction Phase

- Restrict removal of vegetation and soil cover to those areas necessary for the development;
- Implement soil conservation measures such as stockpiling top soil for remediation of disturbed areas;
- Proper drainage controls such as culverts, cut-off trenches will be used to ensure proper management of surface water runoff to prevent erosion;
- Stockpiles should be vegetated or appropriated covered to reduce soil loss as a result of wind or water to prevent erosion;
- Disturbed areas will be rehabilitated as soon as possible to prevent erosion;
- Work areas will be clearly defined and demarcated, where necessary, to avoid unnecessary disturbance or areas outside the development footprint; and
- Construction vehicles will remain on designated and prepared roads.

Operational Phase

The following mitigation measures will be implemented during the operational phase:

- Laydown or infrastructure assembly areas which will not be required during the operational phase of the facility and the PV area will be re-vegetated with indigenous vegetation to prevent erosion.

- Bi-annual monitoring of erosion in the vicinity of the turbines, roads, PV arrays and other hard-standing surfaces will be conducted before and after the rainy season to ensure erosion sites can be identified early and remedied.

10.1.3 Residual Impact

The implementation of construction and operational phase mitigation will contribute to reducing the significance of the residual impacts associated with loss of topsoil, soil compaction and erosion to low (see *Table 10.2*).

Table 10.2 Pre- and Post-Mitigation Significance: Loss of topsoil, soil compaction and erosion

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**MEDIUM (-VE)**	**LOW (-VE)**
Operation	**LOW (-VE)**	**LOW (-VE)**

10.2 IMPACT ON SURFACE AND GROUNDWATER

10.2.1 Impact Description and Assessment

Construction Phase Impacts

Areas cleared in preparation for the establishment of the REF are prone to erosion by wind or rain and may increase the intensity and volume of surfacewater runoff as a result of a decrease in water infiltration. This may impact the drainage channels of the Groot River in the eastern and western portion of the site by exacerbating erosion features and increasing the sediment load of the water entering these channels when they are flowing.

Soil and groundwater may be impacted as a result of infiltration of contaminants associated with spills or leaks of fuels, oils and lubricants from construction vehicles or storage tanks. These impacts are dependent on the size of the spill and the speed with which it is addressed and cleaned up as well as the vulnerability and susceptibility of the aquifer (moderate vulnerability (1) and high susceptibility (1)). The likelihood a spill is also associated with the volume of product that may be stored onsite and it is

(1) Likelihood of contaminants reaching a receptor

anticipated that up to 50 cubic metres of above ground fuel storage in bunded tanks will be required onsite during the construction phase with varying amounts of hydraulic oils, transformer oil and used oils (less than 10 cubic metres).

Box 10.3 Construction Impact: Impact on Surface and Groundwater

Nature: Surface and groundwater impacts resulting from increased sediment load or through leaks or spills would result in a **negative direct** impact.

Impact Magnitude –Low

- **Extent:** The extent of the impact is **local** since the impacts are limited predominantly to the boundaries of the site or in the vicinity of the site.
- **Duration:** The duration would be **short or long-term** depending on the size or nature of the spill.
- **Intensity:** The intensity is **low** since runoff is expected to be low and the quantity of dangerous goods stored onsite is relatively small.

Likelihood – There is a **medium** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW (-VE)

Degree of Confidence: The degree of confidence is **medium**.

Operational Phase Impacts

Soil erosion caused by stormwater or surface water runoff may occur during the operational phase and result in an increase in the sediment load of onsite drainage channels.

Surface water and groundwater impacts associated with leaks and spills are reduced during the operation phase since onsite storage volumes will be decreased to under 10 cubic metres of predominantly hydraulic oil.

(1) Potential significance of contaminants reaching a receptor

Box 10.4 Operational Impact: Impact on Impact on Surface and Groundwater

Nature: Spills and leaks during routine operational and maintenance activities may result in a **negative direct** impact on surface and groundwater.

Impact Magnitude –Low

- **Extent:** The extent of the impact is **on-site** since the impacts are likely to be limited to the boundaries of the site.
- **Duration:** The duration would be **short to long-term** depending on the size of the spill.
- **Intensity:** The intensity is **low** since the size of a spill is likely to be small given the limited volume of product to be stored onsite.

Likelihood – There is a **medium** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW (-VE)

Degree of Confidence: The degree of confidence is **medium**.

10.2.2 Mitigating impacts on surface and groundwater

Construction Phase

- Soil stockpiles will be protected from wind or water erosion through placement, vegetation or appropriate covering;
- Proper drainage controls such as culverts, cut-off trenches will be used to ensure proper management of surface water runoff to prevent erosion;
- Cleared or disturbed areas will be rehabilitated as soon as possible to prevent erosion;
- Fuel, oil and used oil storage areas will have appropriate secondary containment (ie bunds);
- Spill containment and clean up kits will be available onsite and clean-up from any spill will be appropriately contained and disposed of; and
- Construction vehicles and equipment will be serviced regularly and provided with drip trays, if required.

Operational Phase

The following mitigation measures will be implemented during the operational phase:

- Fuel, oil and used oil storage areas will have appropriate secondary containment (ie bunds); and
- Areas disturbed during construction will be re-vegetated with indigenous vegetation to prevent erosion.

10.2.3 Residual Impact

The implementation of the operational phase mitigation will contribute to reducing the significance of the residual impacts on surface and groundwater to low (see *Table 10.3*).

Table 10.3 Pre- and Post-Mitigation Significance: Impacts on surface and groundwater

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**LOW (-VE)**	**LOW (-VE)**
Operation	**LOW (-VE)**	**LOW (-VE)**

The potential noise impacts associated with the proposed REF include noise resulting from construction related activities and noise generated by wind turbine operation. These potential impacts are considered in this section.

Perdekraal is located in a rural setting, far removed from towns and main roads with the nearest town being Touwsrivier, 32km south west of the site (as the crow flies). There is a secondary gravel road that bisects the site and there are several small cottages scattered on the site. The residual noise level of 33 dBA was measured adjacent to the gravel road during clear skies and wind-still conditions.

The residents on site were identified as sensitive receptors, no other noise sensitive receptors were identified in the immediate vicinity of the site.

The noise impacts associated with the construction and operational phases of the proposed REF are summarized in *Table 11.1*.

Table 11.1 Impact characteristics: Noise Impact

Summary	Construction	Operation
Project Aspect/Activity	Noise resulting from construction vehicles, generators and activities such as piling, concrete mixing and steel works.	Noise generated by the wind turbines at the site.
Impact Type	Direct	Direct
Resources / Receptors Affected	On-site residents, no other sensitive receptors were identified in the immediate vicinity of the site	On-site residents, no other sensitive receptors were identified in the immediate vicinity of the site. The impact assessment takes into account the noise impact on the boundary of the site.

11.1 CONSTRUCTION NOISE

11.1.1 Impact Description and Assessment

During construction the main sources of noise will be heavy earthmoving vehicles, delivery vehicles and construction equipment for concrete mixing, sheet piling and steel works. Noise emitted during construction activities will increase the ambient noise levels at the site since current noise levels are low. Noise during construction will be short-lived for specific work areas since the construction work will be progressive. Noisy operations such as piling (if required) will be limited to day light hours. There are four adults and three children currently residing on the Perdekraal farm. They have lived on the farm since early 2010. No one resides on the Rietpoort Farm.

Box 11.1 Construction Impact: Noise generated by construction activities

Nature: Construction activities would result in a **negative direct** noise impact.

Impact Magnitude – Medium

- **Extent**: The extent of the impact is **local** as it will be confined to the vicinity of the site.
- **Duration**: The duration would be **short-term** as the impacts are predicted to last only for the duration of the construction of the facility.
- **Intensity**: The intensity of the impact is expected to be **medium** since ambient noise levels are low.

Likelihood – There is a **high** likelihood that of noise during the construction phase.

IMPACT SIGNIFICANCE (PRE-MITIGATION) –MEDIUM

Degree of Confidence: The degree of confidence is **medium**.

11.1.2 Mitigation measures

The following mitigation measures will be implemented to reduce noise impacts during the construction phase.

- Mechanical equipment with lower sound power levels will be selected to ensure that permissible occupation noise-rating limit of 85 dBA is not exceeded. Construction workers and personnel will wear hearing protection when required.
- Vehicles and machines will be properly serviced and well maintained.
- Mainstream SA will require drivers to adhere to the speed limit of 40km/hr on gravel roads.
- A grievance procedure will be established whereby noise complaints by neighbours are recorded and responded to.

11.1.3 Residual Impacts

Implementing the above mitigation measures will reduce the magnitude of this impact and consequently lower the significance to low-medium.

Table 11.2 Pre- and Post- Mitigation Significance: Construction noise

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**MEDIUM (-VE)**	**LOW - MEDIUM (-VE)**
Operation	**N/A**	**N/A**

11.2 WIND TURBINE NOISE DURING OPERATION

11.2.1 Impact Description and Assessment

The two main sources of wind turbine noise are mechanical noise generated by machinery such as generators and gearboxes in the nacelle and aerodynamic noise emanating from movement of air around the turbine blades and tower. The aerodynamic noise may include continuous broadband noise, noise with a noticeable tone, as well as impulsive noise. Human hearing is particularly sensitive to tonal and impulsive sounds. Although these were emitted by some of the first wind turbines thereby eliciting community complaints, extensive improvements in design have resulted in the virtual elimination of both tonality and impulsivity in the latest generation of wind turbines.

In rural settings, like the Perdekraal site, there are few sources of noise to mask the noise emanating from the operation of the wind turbines. At high wind speeds this is not necessarily a problem but at lower wind speeds, background noise may not be sufficient to mask noise emanating from turbines. The impact assessment has therefore been based on a wind operating speed of 6 m/s since the masking effect of wind noise would be the lowest and the potential noise impact the highest at this speed. In trying to interpret the potential noise impact associated with the establishment of a wind farm, it may be useful to compare this to other environmental noise sources (see *Table 11.3*).

Table 11.3 Indicative noise levels from various sources[1]

Source/Activity	Indicative noise level dB(A)
Threshold of pain	140
Jet aircraft at 250m	105
Pneumatic drill at 7m	95
Truck at ± 48 km/hr at 100m	65
Busy general office	60
Car at ± 65 km/hr at 100m	55
Wind farm at 350m	35 – 45
Quiet bedroom	35
Rural night-time background	20 – 40
Threshold of hearing	0

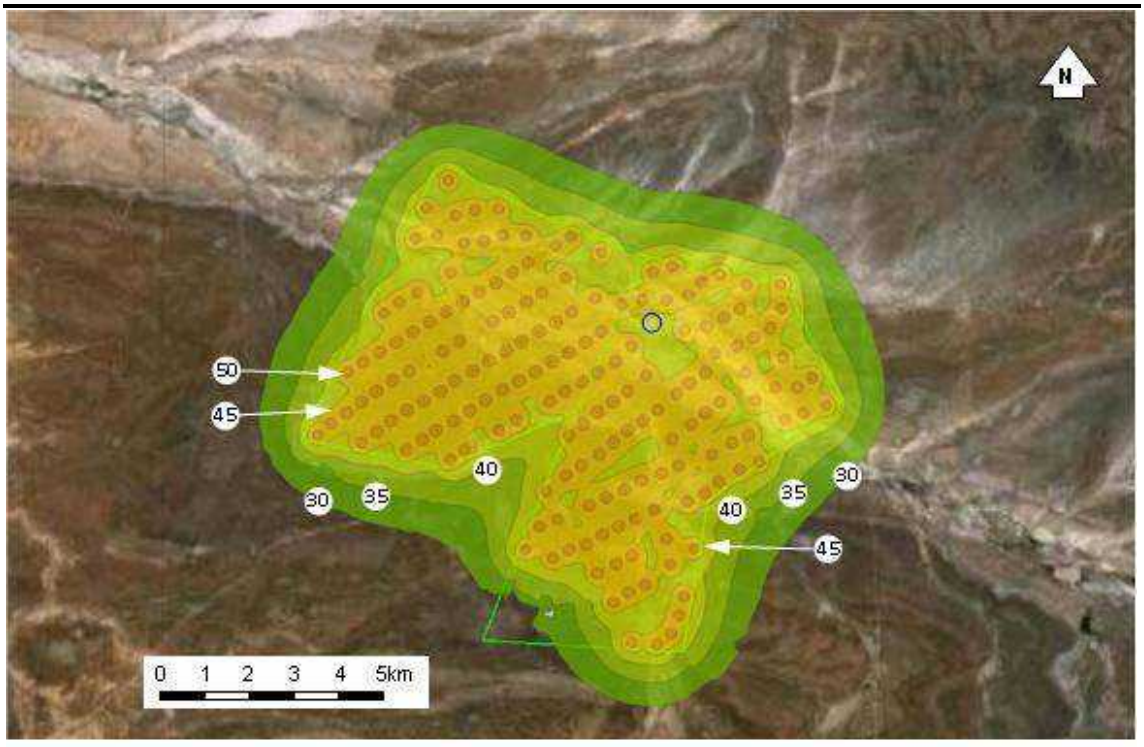
The noise emitted by a wind turbine extends over most of the audio frequency range. The level of noise varies over the operating wind speeds ranging from the cut-in wind speed of approximately 3 m/s (10.8 km/hr) to a maximum wind generating speed of approximately 12 m/s (43 km/hr). The noise emission level is lowest at the cut-in speed but it is not linearly related to wind speed with the maximum emission level generally occurring around 8 m/s; thus not at the maximum wind speed. It is noteworthy that, for most modern

[1] These indicative noise levels were taken from the Scottish Government Planning Advice Note 45 on Renewable Energy Technologies, 2002

wind turbines, the maximum change in overall noise emission level (L_{Aeq}) rarely exceeds 3 dB over the entire operating wind speed range. This difference is considered insignificant in terms of human response to sound/noise. Most humans would barely notice a difference in "loudness" for a 3 dB change in noise level.

The noise impact modelling was conducted on Site Layout Alternative 1, without turbines removed to accommodate other environmental constraints, thus representing a worst case scenario. The anticipated noise contours are shown in *Figure 11.1*, the site boundaries are shown in green, the proposed wind turbine locations are displayed in red and farm residences are circled in blue.

Figure 11.1 ***Perdekraal proposed wind farm with site boundaries demarcated by green lines; wind turbine locations indicated in red; farm residences demarcated by black circles; and calculated LAeq contours due to noise from wind turbine***



The land adjacent to the proposed wind farm site boundary is zoned for agricultural use (rural). In terms of SANS 10103 (Table 11.4), a "rural" district would apply with typical outdoor day time noise level or $L_{Req,d}$ of 45 dBA and a night time level ($L_{Req,n}$) of 35 dBA. The intensity of the noise impact on the boundary of the site is assessed using the lower of the two, i.e. the night-time $L_{Req,n}$ of 35 dBA. In accordance with SANS 10328, the predicted impact that noise emanating from a proposed development would have on surrounding land is assessed by determining whether the daytime rating level, $L_{Req,d}$, and/or the night-time rating level, $L_{Req,n}$, of the predicted ambient noise would exceed the typical rating level of noise on that land as indicated in *Table*

11.4 (which is a reproduction of Table 2 of SANS 10103). If the rating level of the ambient noise under investigation exceeds the typical rating level, it is probable that the noise is annoying or otherwise intrusive to a community exposed to the noise i.e. sensitive site. This excess is then related to the probable response of a community to the noise as indicated in *Table 11.5* (Table 5 of SANS 10103). In estimating the response of a community (such as residents) in a particular district to a particular noise under investigation SANS 10103 incorporates the diversity of response of individuals of a particular community to the same noise level. The estimated response to an excess of $L_{Req,T}$ of noise under investigation over the residual or typical $L_{Req,T}$ is thus not in discrete 5 dB changes, but in overlapping ranges of excess.

Table 11.4 Typical rating levels for noise in districts (Source:SANS 10103 (2008), Table 2)

1	2	3	4	5	6	7
Type of district	**Equivalent continuous rating level ($L_{Req.T}$) for noise,** dBA					
	Outdoors			**Indoors, with open windows**		
	Day-night $L_{R,dn}$[a]	**Day-time $L_{Req,d}$[b]**	**Night-time $L_{Req,n}$[b]**	**Day-night $L_{R,dn}$[a]**	**Day-time $L_{Req,d}$[b]**	**Night-time $L_{Req,n}$[b]**
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts with one or more of the following: workshops; business premises; and main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

Table 11.5 Categories of community/group response (Source: SANS 10103 (2008), Table 5)

1	2	3
Excess ($\Delta L_{Req,T}$)[a] dBA	**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

The intensity of a predicted noise impact was determined in relation to the categories of community response and is qualified as none, low, medium or high as outlined in *Table 11.6*.

Table 11.6 Noise intensity qualifiers

Rating	Intensity qualifier
None	Predicted $L_{Req,T}$ does not exceed the typical $L_{Req,T}$
Low	Predicted $L_{Req,T}$ exceeds the typical $L_{Req,T}$ by between 0 & 5 dB
Medium	Predicted $L_{Req,T}$ exceeds the typical $L_{Req,T}$ by between 5 & 10 dB
High	Predicted $L_{Req,T}$ exceeds the typical $L_{Req,T}$ by more than 10 dB

Noise on the boundary

Much of the land beyond the site boundaries would be exposed to L_{Aeq} less than 35 dBA. No noise impact would occur on that land.

The boundary buffer zone included in Site Layout Alternative 1 is 200m from the boundary, with no turbines erected within this area. The noise intensity in this area is high with the $L_{Aeq,T}$ exceeding 45 dBA on land within approximately 200 m from the boundary.

Large areas of the land particularly to the south east would be exposed to $L_{Aeq,T}$ between 40 dBA and 45 dBA with an associated medium intensity of noise impact within approximately 300 m of the boundary for Site Layout Alternative 1. Between approximately 300 m and 1 000 m from the boundary the land would exposed to $L_{Aeq,T}$ between 40 dBA and 35 dBA with an associated low intensity of noise impact. Beyond 1 000 m there would be no noise impact.

In terms of the Noise Control Regulations, in areas where the noise level due to the wind turbines exceeds the residual level of 33 dBA by 7 dB (ie 40dB) or more this would be construed to be a disturbing noise.

Box 11.2 Operational Impact: Noise on the boundary

Nature: The operation of the REF will result in a **negative direct** noise impact.

Impact Magnitude – Low-medium

- **Extent**: The extent of the impact is **on-site** since the impacts are limited to the boundary of the site with the exception of a small portion of along the southeastern boundary of the site.
- **Duration**: The duration would be **long-term** as the impacts are predicted to last for at least 25 years until the operation ceases.
- **Intensity**: The intensity of the impact is expected to be **low-medium** since the intensity at the boundary would generally be low with a medium intensity predicted a section along the southeastern boundary.

Likelihood – There is a **high** likelihood that the wind turbines will generate noise during the operational phase.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW-MEDIUM

Degree of Confidence: The degree of confidence is **high**.

Noise impact within the site boundary on sensitive receptors

One occupied dwelling was identified on the Perdekraal farm as shown in *Figure 11.1. Table 11.7* summarises the calculated L_{Aeq} due to wind turbine noise at the dwelling, the excess over the night-time $L_{Req,n}$ of 35 dBA typical of a rural district and the predicted intensity of noise impact in terms of SANS 10328 for Site Alternative 1.

Table 11.7 Summary of predicted noise impact on dwellings within the Perdekraal wind energy farm site boundaries in terms of SANS 10328

Dwellings	Turbines L_{Aeq},dBA	Excess, dB	Noise impact
Perdekraal	44	9	Medium

In terms of SANS 10328 the excess over the typical night-time rating level of 35 dBA would result in a **Medium** intensity of noise impact at the dwellings. While in terms of the NCR the noise level due to the wind turbines would exceed the residual level of 33 dBA by 7 dB or more and would thus be construed to be a disturbing noise.

The operational noise impact is summarised below in *Box 11.3*.

Box 11.3 Operational Impact: Noise at sensitive receptors

Nature: The operation of the REF will result in a **negative direct** noise impact.

Impact Magnitude –Medium

- **Extent**: The extent of the impact is **on-site** since the impacts are limited to the boundary of the site with the exception of a small portion of along the southeastern boundary of the site.
- **Duration**: The duration would be **long-term** as the impacts are predicted to last for at least 25 years until the operation ceases.
- **Intensity**: The intensity of the impact is expected to be **medium** since the increase in dB is likely to exceed 9dB.

Likelihood – There is a **high** likelihood that the wind turbines will generate noise during the operational phase.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM

Degree of Confidence: The degree of confidence is **high**.

11.2.2 Mitigating noise impacts

The mitigation implemented to reduce the noise impacts associated with the operation of the REF include:

- Remove the four turbines on the south east corner of the site;
- Increase the buffer around the dwelling to 700m; and
- Remove the turbines just to the north of the dwelling.

These measures were implemented through the development of Site Layout Alternative 2, the closest turbine to the dwelling is over 700m away and turbines have been removed from the southeastern corner of the site. This will result in a low to no impact along the boundary and at the dwelling and compliance with the Noise Control Regulations.

11.2.3 Residual Impacts

Implementation of the required mitigation measures should reduce operation phase impacts to low (*Table 11.8*). The noise modelling will be re-run should the project layout change resulting in turbines being shifted closer to the site boundaries or to the dwelling.

Table 11.8 Pre- and Post- Mitigation Significance: Operation noise

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**N/A**	**N/A**
Operation (boundary impacts)	**LOW-MEDIUM (-VE)**	**LOW (-VE)**
Operation (sensitive sites)	**MEDIUM (-VE)**	**LOW (-VE)**

The Perdekraal site is located within the scenic mountain wilderness area of the Ceres-Karoo. The site is surrounded by mountainous terrain with steep slopes and relatively flat mountain tops and flat valley floors. There is one town within a 30km radius of the site, namely Touwsrivier and Matjiesfontien is located roughly 45km away. There are two existing power lines traversing through the area. The N1 National Road is located south of the site, while district roads bisect the site. The area has a sense of remoteness and farmsteads tend to be far apart.

The visual impact will be largely limited to the operation phase, although aspects of the REF will become visible during the construction phase and large machinery will be visible on site as soon as site preparation begins.

The visual impacts will be perceived by two types of receptors during the operational phase, namely:

- receptors located at a fix point, i.e. dwelling on the site and surrounding areas; and
- receptors who will temporarily come into contact with the REF, such as passing motorists and tourists in the area.

The potential visual impacts are summarised in *Table 12.1*

Table 12.1 Impact characteristics: Visual Impacts

Summary	Construction	Operation
Project Aspect/ activity	N/A	Operation of the REF
Impact Type	N/A	Direct negative
Stakeholders/ Receptors Affected	N/A	Affected landowners, neighbouring land owners, road users, visitors to the area.

12.1 VISUAL ASSESSMENT CRITERIA

The potential visual impacts of the REF are used to determine using a series of quantitative and qualitative criteria. These are rated to determine both the expected level and significance of the visual impacts (Oberholzer et al, 2010). *Table 12.2* below describes the visual assessment criteria in relation to the proposed Perdekraal REF.

Table 12.2 Criteria used to Assess Visual Impacts

Criteria	Description	Comment
View Points	View points are selected based on prominent viewing positions in the area, where uninterrupted views of the proposed site could be obtained.	The proposed REF facilities would be potentially visible from several district roads and a number of farmsteads, including a game farm lodge.
Visibility	Determined by the distance between the REF and the viewer. The degrees of visibility of the key components of the REF in relation to distance are given in *Table 12.3* and *Table 12.4.*	Given the size of the turbines, visibility tends to be significant up to 5km from the REF, *Figure 12.1*shows the distance radii around the site.
Visual Exposure	Determined by the geographical features of the area surrounding the site. Certain areas may fall within view shadows, where geographical features intervene with the line of sight from the REF to the receptor.	The viewshed boundary tends to follow ridgelines and high points in the landscape. Some areas within the view catchment area fall within a view shadow, and would therefore not be affected by the proposed energy facilities (see *Figure 12.2*). The zone of visual influence of the REF tends to fade out beyond 5 km from the site.
Visual Sensitivity	Determined by the presence of topographical features, steepslopes, rivers, protected areas, scenic routes or airfields.	The Groot River is a landscape feature in the area and is considered to have visual sensitivity.
Landscape Integrity	Determined by the lack of other visual intrusions.	Two existing Eskom power lines exist in the area; therefore the area is not visually pristine. The area is otherwise a combination of rural agriculture and Karoo wilderness.
Visual Absorption Capacity	This is the potential for the landscape to screen or absorb the REF.	Given the scale of the proposed facilities and the open nature of the landscape, there is little opportunity for screening.

Table 12.3 Visibility of the wind turbines

Degree of Visibility	Comments	Distance
Highly Visible	Clearly noticeable within the observers' viewframe	0 – 2.5 km
Moderately Visible	Recognisable feature within observer's viewframe	2.5 – 5 km
Marginally Visible	Not particularly noticeable within observer's viewframe	5 – 10 km
Hardly Visible	Practically not visible unless pointed out to the observer	10 – 15 km +

Table 12.4 Visibility of the PV arrays

Degree of Visibility	Comments	Distance
Highly Visible	Clearly noticeable within the observers' viewframe	0 – 1 km
Moderately Visible	Recognisable feature within observer's viewframe	1 – 2.5 km
Marginally Visible	Not particularly noticeable within observer's viewframe	2.5 – 4 km
Hardly Visible	Practically not visible unless pointed out to the observer	4 km +

Figure 12.1 View Points and distance radii

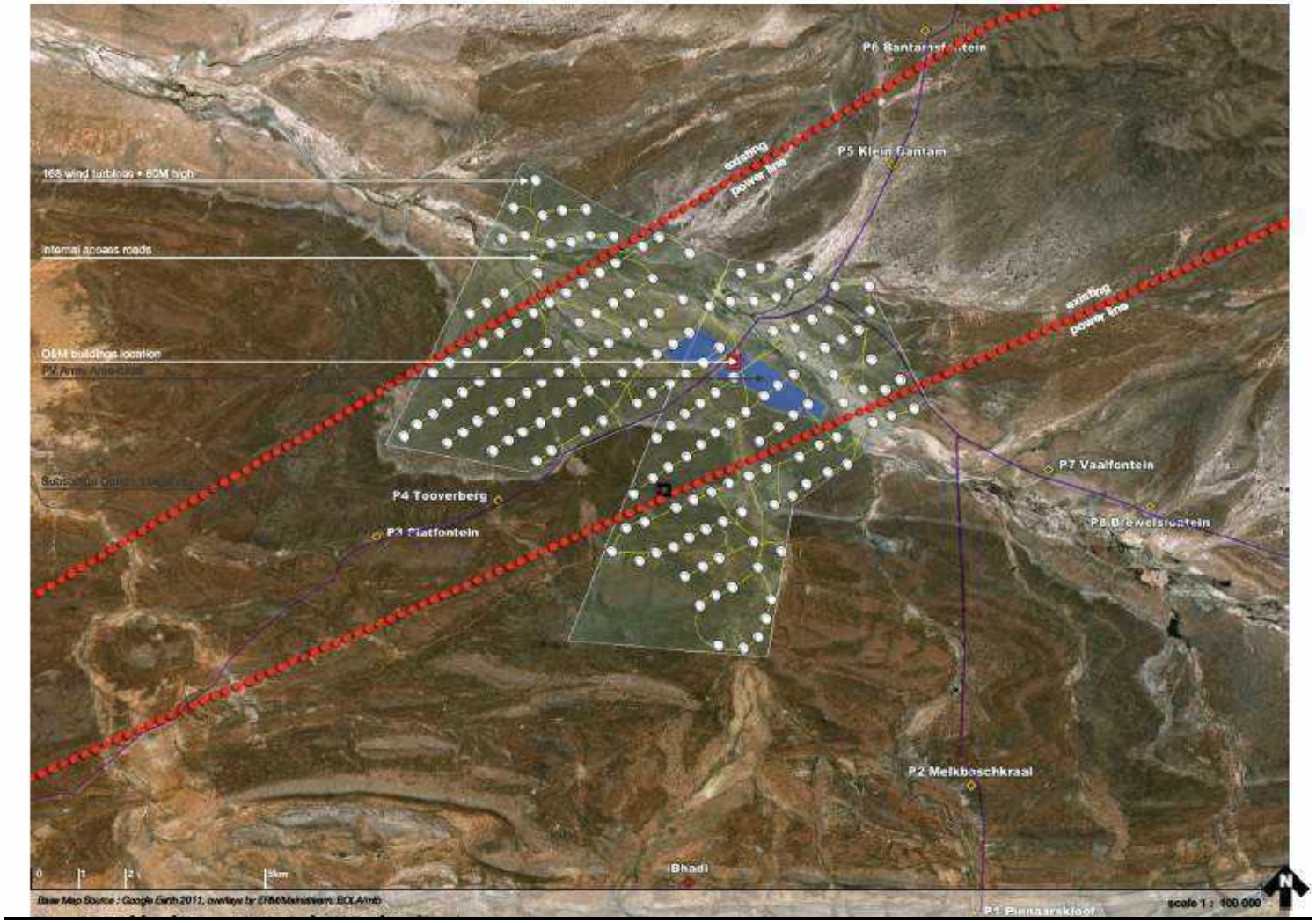
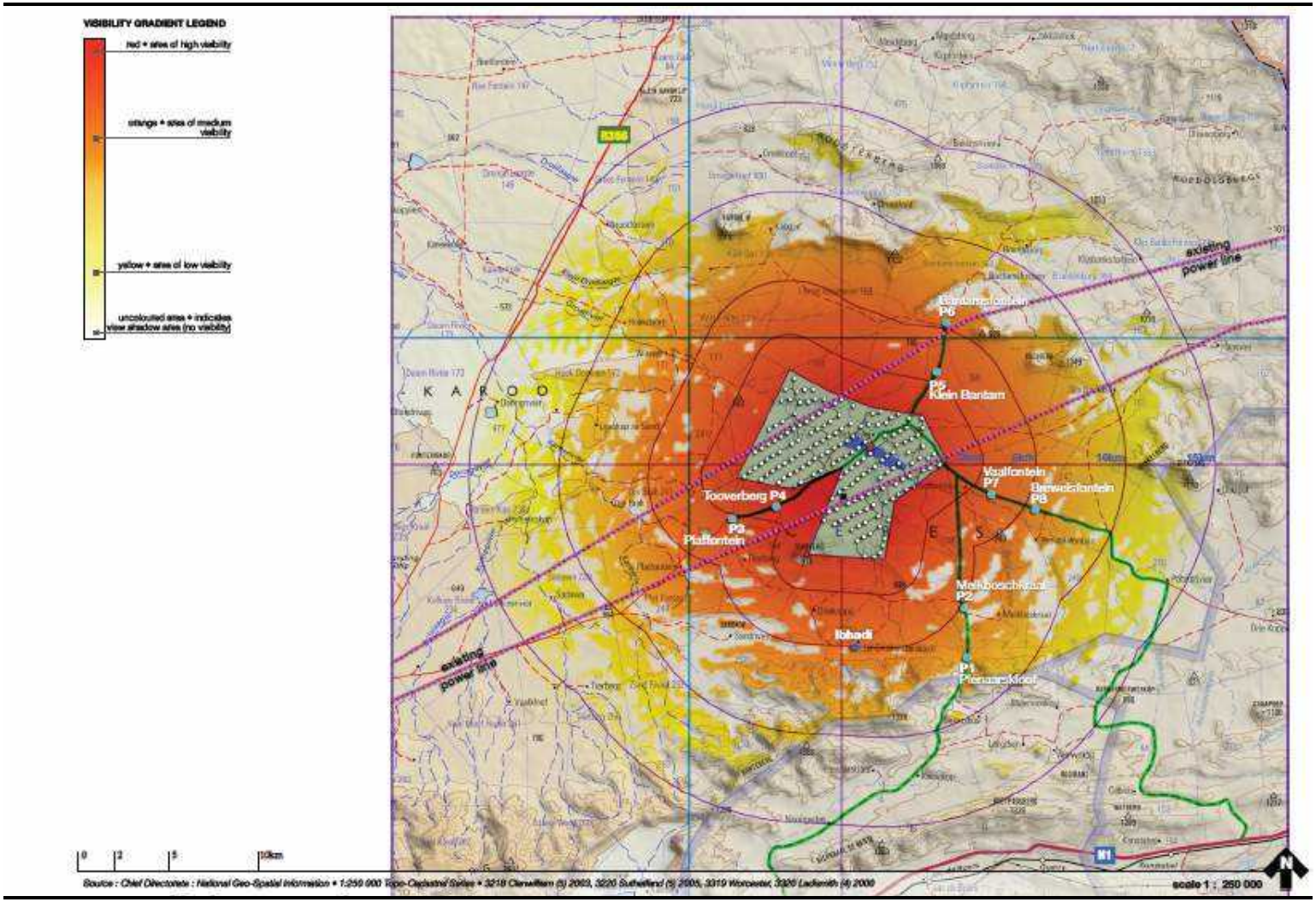


Figure 12.2 Viewshed for the proposed Perdekraal REF



12.2 VISUAL IMPACT ON FIXED POINTS

12.2.1 Impact Description and Assessment

The Perdekraal site is located in a rural area called the Ceres-karoo, with a sense of remoteness and spaciousness. The proposed REF will introduced approximately 62 wind turbines and an area of PV arrays into the area, as well as associated infrastructure such as a substation and Operation and Maintenance (O&M) buildings. It is anticipated that the wind turbines will have the greatest visual significance in the landscape, due to their large scale (80 m hub height). The PV arrays and other infrastructure will be less visible from surrounding areas.

The construction of the REF at Perdekraal may alter the visual character of the landscape, as these features are in contrast to the rural surrounding landscape. There are, however, existing visual intrusions on site, such as power lines, therefore the landscape should not be seen as pristine.

It is important to note that whether the visual impact is seen as positive or negative is highly subjective, and people's attitude towards and perception of the visual impacts associated with the REF may differ vastly.

iBhadi private game lodge is located approximately 5km to the south of the proposed site. The proposed REF will be visible with a medium intensity from iBhadi game lodge.

The dwellings on the Perdekraal site include the Perdekraal farm house and labourers cottages. The REF will be highly visible from these dwellings given the scale of the turbines and relative flatness of the site, (see *Figure 12.2*). It is not likely that the turbines will be absorbed into the surrounding landscape. In order to get an indication of the visibility of the REF from the surrounding landscape, viewpoints were selected along the district roads and the iBhadi game lodge. The potential visibility from these view points is given in *Table* 12.5 below (the View Points can be seen in *Figure 12.1*). From the viewshed analysis or zone of visual influence[1] it can be determine that the REF will not be visible from the N1 national road, Touwsrivier or Matjiesfontein, (refer to *Table 12.3* and *Table 12.4* for the definitions used to describe the visibility of the REF).

Table 12.5 Potential Visibility from Surrounding Dwellings

View Pt	Location	Distance	Comments
P1	Southern district road at Pienaarskloof	7.6 km	Marginally visible in the distance looking north.
P2	Southern district road near Melkboschkraal gate	5.7 km	Marginally visible in the distance, partly screened by foreground ridge.

(1) The area where the project will be visible.

View Pt	Location	Distance	Comments
P3	Western district road at Platfontein	2.45 km	Clearly noticeable in the middle distance, partly screened by ridge.
P4	Western district road at Tooverberg	1.25 km	Clearly noticeable in the foreground to middle distance.
P5	Northern district road opposite Klein Bantam	2.7 km	Recognisable feature in the middle distance over a wide area.
P6	Northern district road at Bantamsfontein gate	5.5 km	Marginally visible in the distance over a wide area.
P7	Eastern district road near Vaalfontein	3.35 km	Recognisable feature in the middle distance over a wide area.
P8	Eastern district road near Brewelsfontein	5.6 km	Marginally visible in the distance over a wide area.
	iBhadi game lodge	5km	Recognisable feature in the middle distance, only partly screened by topography.

Box 12.1 Operational Impact: Fixed receptors

Nature: Operational activities would result in a **negative direct** impact on the visual landscape in the area surrounding the site.

Impact Magnitude –High

- **Extent:** The extent of the impact is **local**, as the facility will be hardly visible beyond 15km from the site.
- **Duration:** The duration would be **long-term** since it will persist for as long at the facility remains operational.
- **Intensity:** The intensity will be **high,** as the REF will be highly visible from the dwellings on site but it will not be visible from surrounding dwellings.

Likelihood – There is a **high** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – HIGH (-VE)

Degree of Confidence: The degree of confidence is **HIGH**.

12.2.2 Mitigating Visual Impacts at Fixed Points

Design Phase

- A visual buffer zone of 500 m for the wind turbines along the main drainage courses (Groot River and Adamskraal River), these being the main landscape features;
- A visual buffer of 500 m for the wind turbines from the local district roads;
- A 250 m setback or the wind turbines from farm boundaries should be observed;
- The PV arrays, substation and O&M buildings to ideally be set back 250 m from local district roads;
- Cables to be located underground as far as possible;

- The substation and O&M buildings to be grouped together as far as possible to minimise the scatter of buildings across the site;
- The design of the buildings to be compatible in scale and form with buildings of the surrounding rural area, and with the regional architecture;
- All yards and storage areas to be enclosed by masonry walls;
- The internal access roads should not be located in drainage courses. The roads should generally follow the grain of the land, and their alignments fine-tuned to fit the topography; and
- Signage related to the enterprise to be discrete and confined to the entrance gates. No other corporate or advertising signage, particularly billboards, to be permitted.

Operational Phase

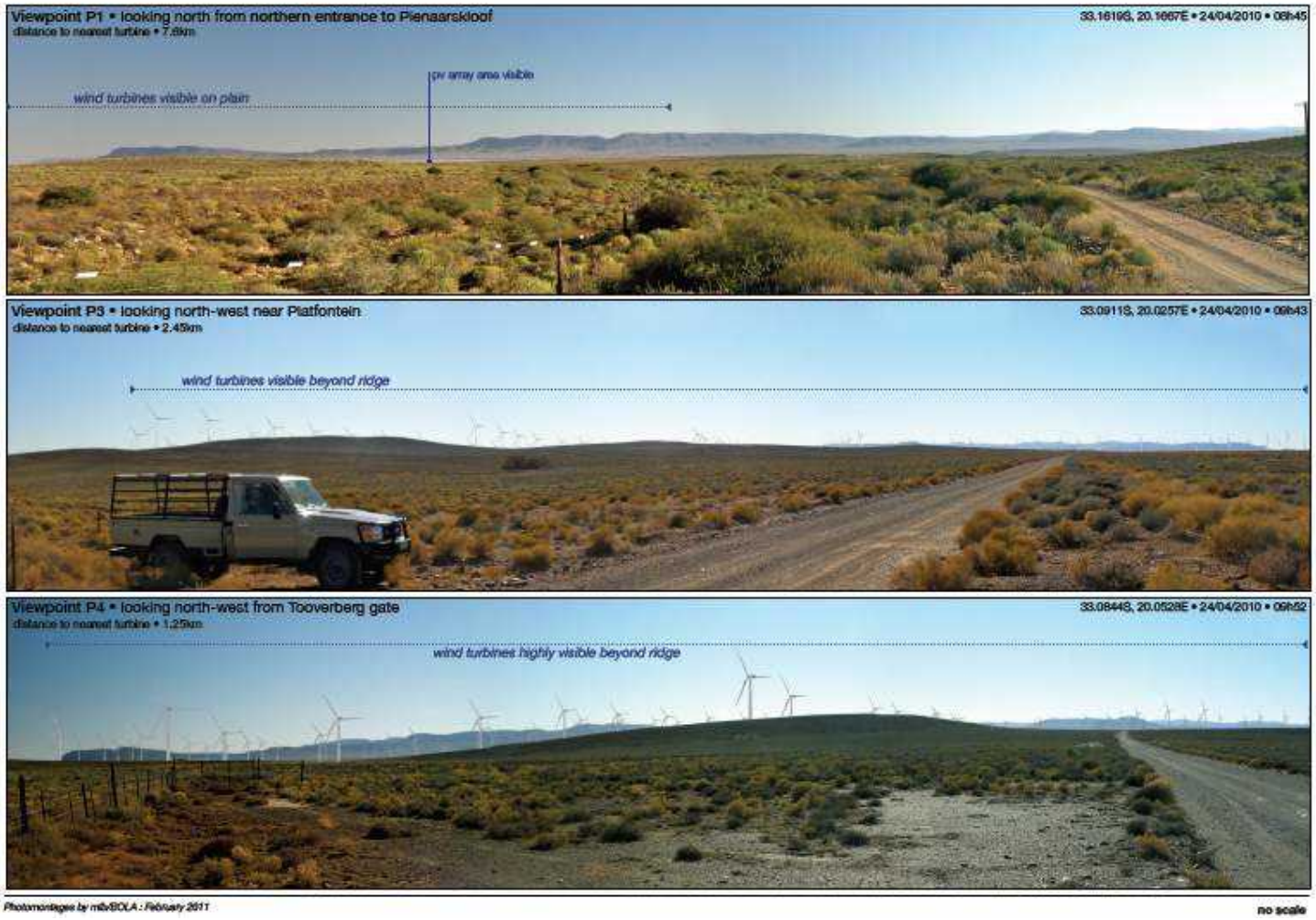
- The footprint of the operations and maintenance facilities, as well as parking and vehicular circulation, should be clearly defined, and not be allowed to spill over into other areas of the site; and
- The operations and maintenance areas should be screened by buildings, walls, hedges and/or tree planting, and should be kept in a tidy state to minimise further visual impact.

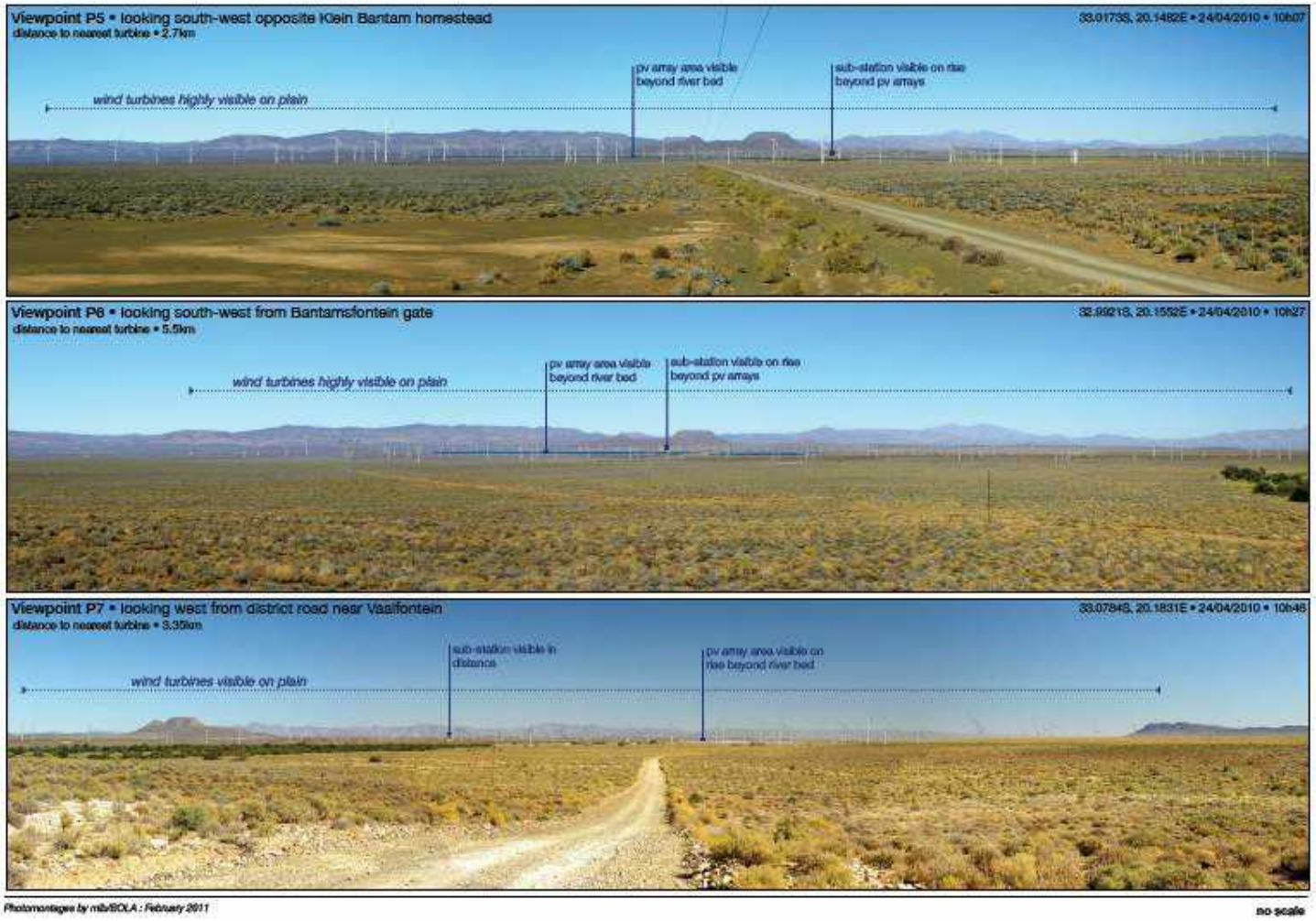
12.2.3 Residual Impact

The design phase mitigation measures mentioned above have been implemented through the revision of the Site Layout Alternative 1 resulting in the **preferred Site Layout Alternative 2**. However, the significance of the residual impacts associated with visual impacts will be not be reduced (see *Table 12.6*)

Table 12.6 Pre- and Post-Mitigation Significance: Visual Impact on fixed points

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Operation	**HIGH (-VE)**	**HIGH (-VE)**


Viewpoint P1 • looking north from northern entrance to Pienaarskloof
distance to nearest turbine • 7.6km
33.1619S, 20.1667E • 24/04/2010 • 08h45
pv array area visible
wind turbines visible on plain
Viewpoint P3 • looking north-west near Platfontein
distance to nearest turbine • 2.45km
33.0911S, 20.0257E • 24/04/2010 • 09h43
wind turbines visible beyond ridge
Viewpoint P4 • looking north-west from Tooverberg gate
distance to nearest turbine • 1.25km
33.0844S, 20.0528E • 24/04/2010 • 09h52
wind turbines highly visible beyond ridge
Photomontages by mbSOLA : February 2011
no scale


Viewpoint P5 • looking south-west opposite Klein Bantam homestead
distance to nearest turbine • 2.7km
33.01735, 20.1482E • 24/04/2010 • 10h07
wind turbines highly visible on plain
pv array area visible beyond river bed
sub-station visible on rise beyond pv arrays
Viewpoint P6 • looking south-west from Bantamsfontein gate
distance to nearest turbine • 5.5km
32.99218, 20.1552E • 24/04/2010 • 10h27
wind turbines highly visible on plain
pv array area visible beyond river bed
sub-station visible on rise beyond pv arrays
Viewpoint P7 • looking west from district road near Vaalfontein
distance to nearest turbine • 3.35km
33.07845, 20.1831E • 24/04/2010 • 10h46
wind turbines visible on plain
sub-station visible in distance
pv array area visible on rise beyond river bed
Photomontages by nb/SOLA : February 2011
no scale

12.3 VISUAL IMPACT ON TEMPORARY RECEPTORS

There are a number of roads in the area surrounding the site, with a district road bisecting the site. The N1 national road runs in a east-west direction south of the site, however, as Figure 12.2 indicates it is unlikely that the site will be visible from the N1. On the southern district road from Pienaarskloof, the site may become visible approximately 7.6km from the site, while on the south-eastern road the site may become visible from Patatsrivier approximately 13 km from the site. On the western district road the site may become visible from approximately 15km from the site and on the northern district road the site may become marginally visible from Brandeberg.

Table 12.7 Potential Visibility from Surrounding Roads

View Pt	Location	Distance	Comments
P1	Southern district road at Pienaarskloof	7.6 km	Marginally visible in the distance looking north.
P2	Southern district road near Melkboschkraal gate	5.7 km	Marginally visible in the distance, partly screened by foreground ridge.
P3	Western district road at Platfontein	2.45 km	Clearly noticeable in the middle distance, partly screened by ridge.
P4	Western district road at Tooverberg	1.25 km	Clearly noticeable in the foreground to middle distance.
P5	Northern district road opposite Klein Bantam	2.7 km	Recognisable feature in the middle distance over a wide area.
P6	Northern district road at Bantamsfontein gate	5.5 km	Marginally visible in the distance over a wide area.
P7	Eastern district road near Vaalfontein	3.35 km	Recognisable feature in the middle distance over a wide area.
P8	Eastern district road near Brewelsfontein	5.6 km	Marginally visible in the distance over a wide area.

Box 12.2 Operational Impact: Temporary receptors

Nature: Operational activities would result in a **negative direct** impact on the visual landscape in the area surrounding the site.

Impact Magnitude – High

- **Extent:** The extent of the impact is **local**, as facility will be hardly visible beyond 15km from the site.
- **Duration:** The duration would be **short-term** as the REF will be visible to the receptor temporarily.
- **Intensity:** The intensity will be **high,** as motorist will be passing the REF and it will be highly visible.

Likelihood – There is a **high** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – HIGH (-VE)

Degree of Confidence: The degree of confidence is **HIGH**.

12.3.1 *Mitigating Visual Impacts on Temporary Receptors*

Design

- The REF and related infrastructure must not be located on landscape features such as rock outcrops, streams and wetlands.

- The design of the buildings must be compatible in scale and form with the regional architecture of the area. Buildings must be clustered together as far as possible and yards enclosed by low walls.

Operational

- Signage related to the REF must be discrete and confined to entrance gates.

12.3.2 *Residual Impact*

The design phase mitigation measures have been implemented through the revision of the Site Layout Alternative 1 resulting in the preferred Site Layout Alternative 2. However, the significance of the residual impacts associated with visual impacts will be not be reduced (see *Table 12.8*)

Table 12.8 Pre- and Post-Mitigation Significance: Visual Impact on Temporary Receptors

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Operation	**HIGH (-VE)**	**HIGH (-VE)**

This chapter discusses the potential impacts on heritage resources resulting from the establishment of the REF at the Perdekraal site including physical effects on sites and features of cultural heritage interest and broader landscape and visual effects on the site setting. The potential impacts are assessed and mitigation measures to reduce the impacts are outlined below. It should be noted that although a Heritage Impact Assessment (HIA) was undertaken as part of this EIA processs, it is intended that palaeontology and additional archaeological fieldwork will undertaken prior to the construction of the REF which will be used to 'micro-site' turbines to mitigate impact on archaeology, palaeontology and cultural heritage resources.

Aspects of the Perdekraal site may be of heritage interest including archaeological sites of interest, palaeontological resources, buildings older than 60 years and visual cultural landscape aspects associated with sense of place. Rocks found underlying the site which may contain fossils of high palaeontological sensitivity include shales of the Whitehill Formation (Ecca Group) and Waaipoort Formation (Witteberg Group). The rocks of the Collingham and Prince Albert Formation (Ecca Group) are considered to contain fossils of moderate palaeontological significance. Scatters of stone age implements were discovered on the site, mainly in close proximity to dry river beds. These are considered to be of minor significance however little is known about the distribution of artefacts in the interior of South Africa and opportunities to record their presence and location prior to and during construction, should be maximised. The buildings on the farm are considered to have low heritage significance and are occupied and will remain intact during both the construction and operational phases of the development. Further, a number of collapsing stone structures, including buildings, kraals, a well, oven and threshing floor were recorded by the heritage specialists and considered to be of low heritage significance. An unfenced graveyard is located on the Rietpoort farm and a number of stone cairns were identified which could represent graves. There is a high probability that additional unmarked graves will be uncovered during the construction phase. The facility will not be visible from the N1 however the construction and operation of the Perdekraal REF will impact on the cultural landscape/sense of place. The above-mentioned palaeontological, archaeological and heritage resource impacts are assessed below.

The proposed REF is likely to have a negative effect on archaeology, palaeontology and cultural heritage resources during the construction and operational phases of the development as summarised in *Table 13.1*. These potential impacts include direct and indirect effects. The direct effects would be physical effects on sites and features of heritage interest within the site and would be associated with the construction phase. Indirect effects incorporate visual effects on the settings of sites in the broader landscape and would continue during the operational phase of the facility. Indirect effects will be

removed after decommissioning of the facility but direct effects are not reversible, only avoidable.

Table 13.1 Impact characteristics: Impacts on Archaeology, Palaeontology and Cultural Heritage

Summary	Construction	Operation
Project Aspect/ activity	(i) Disturbance of or damage to archaeological, cultural heritage sites or palaeontology resources associated with site preparation and construction activities.	(vii) Visual or sense of place impact on cultural heritage features.
Impact Type	Direct	Indirect
Receptors Affected	(i) Archaeological and cultural heritage interests (buildings, ruins, graveyards etc.) within site clearance areas. (ii) On-site fossils which may be found in the Collingham, Whitehill and Prince Albert Formation of the Ecca Group and the Waaipoort Formation of the Witteberg Group.	(vii) Homesteads and other historic structures or features and the heritage value associated with the scenic value and farming history of the Perdekraal site.

13.1 DISTURBANCE OR DAMAGE TO ARCHAEOLOGY, PALAEONTOLOGY AND CULTURAL HERITAGE RESOURCES

13.1.1 Impact Description and Assessment

Construction Phase Impact

The excavation of turbine foundations, road construction, PV installation, installation of cables and digging of building foundations have the potential to destroy or damage archaeological and palaeontological resources.

Archaeological sites of interest include scatters of stone artefacts which were recorded predominantly on ridges and in close proximity to dry river beds. A single, unfenced, formal graveyard was recovered near the ruins of the Rietpoort farmhouse and collections of stone cairns, which are interpreted as graves, were found near ruins of settlements and predominantly situated on the margins of dry river beds. Although the formal graveyard will not be encroached upon by the development, without mitigation measures,

unmarked graves may be may be damaged through the establishment of the REF unless appropriate mitigation measures are employed
Built environment structures located on the Perdekraal site include the two farm houses which are considered to have low heritage significance. These buildings will not be destroyed or damaged through the establishment of the REF at Perdekraal. Other structures observed on the site include ruins of a stone house, foundations of rectangular stone structures (possibly workers cottages), stone kraals, a stone oven, a stone windbreak, a possible stone threshing floor and a well and they too have low heritage significance and do not require mitigation. Provincial Heritage Sites were not identified on the development site or in the immediate vicinity.

Rocks of the Whitehill and Waaipoort Formations may contain a number of fossils assemblages and are considered to have a high palaeontology sensitivity.

Box 13.1 Construction Impact: Destruction or Disturbance of Archaeology, Palaeontology and Cultural Heritage

Nature: Construction activities would result in a **negative direct** impact on cultural heritage interests on the REF site.

Impact Magnitude – High-medium

- **Extent**: The extent of the impact is limited to the **site**.
- **Duration**: The duration would be **permanent** as these resources are non-renewable and once destroyed, they can not be replaced.
- **Intensity**: Loss of heritage resources will be permanent, so the magnitude of the change will be **high-medium**.

Likelihood – There is a **medium** likelihood that localised heritage resources will be lost.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – HIGH- MEDIUM (-VE)

Degree of Confidence: The degree of confidence is **medium**.

13.1.2 Mitigating for Damage or Destruction of Archaeology, Palaeontology and Cultural Heritage

The objective of mitigation is to minimise impacts on archaeology, palaeontology and cultural heritage and ensure opportunities to identify and add to new scientific information are maximised.

Design Phase

The mitigation of impacts on heritage interests can be achieved at the design phase by avoiding sensitive areas:

- Avoid disturbance or damage to buildings and structures older than 60 years by maintaining 500m buffers around the on-site dwellings;
- Avoid inland water bodies (100m buffer) and rivers (200m buffer);
- Maintain a 200m buffer zone around cemeteries or graves onsite; and

- Remove turbines from the 'koppie' in the south eastern portion of the site comprising Waaipoort Formation and ensuring palaeontological input prior to or during construction of turbines along the thin band of Whitehill Formation running through the central portion of the Perdekraal farm (Rem of Lower Stinkfontein 245).

The above-mentioned mitigation measures have been incorporated into the development of the constraints map which formed the basis for the compilation of the **Site Layout Alternative 2, the preferred site layout**.

Construction Phase

- Prior to or during foundation excavations which may be located on the Whitehill Formation, positions and/or excavations must be inspected by a palaeontologist;
- Buffer zones around built structures should be maintained during the construction phase to prevent damage to structures of heritage interest;
- Mitigation of the pre-colonial, colonial archaeology and avoidance of marked graves which may not have been identified during the site survey should involve micro-siting prior to construction; and
- Should any human burials, archaeological or palaeontological materials (fossils, bones, artefacts etc.) be uncovered or exposed during earthworks or excavations, they must immediately be reported to the HWC and/or South African Heritage Resources Agency (SAHRA). After assessment and if appropriate a permit must be obtained from the SAHRA or HWC to remove such remains.

13.1.3 Residual Impact

The design phase mitigation measures have been implemented into the revised REF layout, **Site Layout Alternative 2** (see *Figure 7.2*).and the implementation of operational and construction phase mitigation will contribute to reducing the significance of the residual impacts associated with damage or destruction to Archaeology, Palaeontology and Cultural Heritage to medium-low (see *Table 13.2*).

Table 13.2 Pre- and Post-Mitigation Significance: Damage or destruction to Archaeology, Palaeontology and Cultural Heritage

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**HIGH- MEDIUM (-VE)**	**MEDIUM-LOW (-VE)**
Operation	**N/A**	**N/A**

13.2 VISUAL OR SENSE OF PLACE HERITAGE IMPACT

13.2.1 Impact Description and Assessment

Operational Phase Impacts

The size and height of turbines are such that they have the potential to cause indirect visual effects over a wider area, thereby impacting on the setting of sites of cultural heritage interest within and in the vicinity of the REF. The flat Karoo landscape in the vicinity of the site is cut up into large camps by means of fences but much remains in fairly "natural" state despite years of grazing. The built environment is marginal and visual impacts are perhaps reduced to a degree by distance from major scenic routes (N1), (R355). There are however few other major industrial interventions at the site itself, although the Kappa Substation is being constructed to the south west and two overhead transmission lines traverse the site. The turbines will be highly visible from the local road running through the site and from the onsite dwellings however these are deemed to have low heritage significance. The cultural landscape of the wef site, is therefore considered to be of low significance, the visual aspects of the proposed development are also considered in more detail in *Chapter 12*.

Box 13.2 Operational Impact: Visual or Sense of Place Heritage Impact

Nature: Operational of the REF would result in a **negative direct** visual impact on cultural heritage sites of interest.

Impact Magnitude – Medium

- **Extent**: The extent of the impact is **local**, since the visual influence would extend beyond the site.
- **Duration**: The duration would be **long-term** as the visual character of the site would be altered at least until the project stopped operating.
- **Intensity**: The high visibility of the turbines and the presence of heritage sites would result in a **medium** intensity since the turbines will not be visible from any national or regional roads and the viewshed of the site is confined by surrounding ridges.

Likelihood – There is a **medium** likelihood that small areas of habitat will be lost.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM (-VE)

Degree of Confidence: The degree of confidence is **medium**.

13.2.2 Mitigation of Visual or Sense of Place Heritage Impact

Design Phase

Mitigation of the visual or sense of place cultural heritage impact must be implemented at the design phase as little can be done to affect mitigation once turbines have been constructed and the REF is operational. Mitigation can be achieved by ensuring the turbine layout avoids sensitive areas of cultural heritage interest. This can be achieved by:

- Maintaining a 500m buffer around the onsite dwellings;
- Maintaining a 200m buffer along the local road; and
- Avoid inland water bodies (100m buffer) and rivers (200m buffer).

13.2.3 Residual Impact

The design phase mitigation measures have been implemented through the revision of the Site Layout Alternative 1 resulting in the **preferred Site Layout Alternative 2** (see *Figure 7.2*). These mitigation measures would result in a medium-low impact significance (see *Table 13.3*).

Table 13.3 Pre- and Post- Mitigation Significance: Cultural Heritage Visual or Sense of Place

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**N/A**	**N/A**
Operation	**MEDIUM (-VE)**	**MEDIUM-LOW (-VE)**

14 SOCIO-ECONOMIC IMPACTS

14.1 BENEFITS FOR THE LOCAL ECONOMY

14.1.1 Impact Description and Assessment

The development of the renewable energy facility will result in significant spending in South Africa having a positive impact on the national, regional and local economy to varying degrees. Direct impacts such as employment and procurement associated with the project will have the most significant impact when compared to indirect and induced impacts. However, overtime as the renewable sector develops additional benefits to the national economy may accrue as the supply chain to the renewable energy sector develops. The direct impacts will be most significant during the construction phase of the project, and are likely to have the largest influence on the local economy.

Table 14.1 Impact Characteristics: Benefits for the Local Economy

Summary	Construction	Operation
Project Aspect/ activity	Employment and Procurement of Local contractors. Lease Agreements with directly affected farmers.	Employment and Procurement of Local contractors. Lease Agreements with directly affected farmers. Development of the supply chain for the wind energy sector.
Impact Type	Direct, positive impact.	Direct, indirect and induced positive impact.
Stakeholders/ Receptors Affected	Local community, Local Municipality, and Directly Affected Landowners.	Local community, Local Municipality, suppliers throughout South Africa and Directly Affected Landowners.

Construction Phase Impacts

The capital investment required for the renewable energy facilities is high at approximately R2.3 billion which will be spent over a 12 to 18 month period. During the construction phase the civil and other construction, specialised industrial machinery and building construction sectors would benefit the most. Local procurement will primarily benefit the civils and construction industry, hospitality and service industries, such as accommodation, catering, cleaning, transport, vehicle servicing and security services.

The highly specialised nature of the machinery required for the Project will, however, require that the majority of the technical components associated with the wind turbines be imported from specialist suppliers. The renewable energy sector is still relatively small in South Africa and as such it is unlikely that appropriate supplies and service providers are currently available in the country; this may, however, change over time. It is currently estimated that 70 percent of the project spend will be on turbines which will be imported,

20 percent will be on the balance of plant (buildings, substations etc) and 10 percent on development. While the value of imports is high, it is likely the majority of the balance of plant will be sourced from South Africa, resulting in a significant spend in the economy.

It is estimated that between 100 and 200 direct temporary site construction jobs will be created for the duration of the construction and commissioning phases which is estimated to be between 12 and 18 months. Of these jobs, five percent will require highly skilled personnel, 27 percent semi-skilled and 68 percent unskilled workers.

There are high levels of unemployment in the project area and while the most common skills are related to the farming sector, there are some people involved in construction work with Eskom and road construction. It is intended that Mainstream and its contractors will source up to 80 percent of the unskilled workers from the surrounding municipal area with the remainder being sourced regionally. This will translate to between 55 and 109 job opportunities in the local municipal area. In the local municipal context, this translates into a significant benefit to the local unemployed population, even though these opportunities will only be for the short term i.e. for the duration of the construction phase.

While the intention is to source unskilled jobs locally, there may be some unintended impacts on local farmers, should the relatively skilled farm labourers be recruited for the construction phase of the project. This may result in strained relationships between the developer and local farmers. This could also have an unintended impact on the livelihoods of the skilled farm labourers who may loose their permanent job, and associated security, for a short term job.

It is unlikely that there are many people with the required skills available to fill highly-skilled and semi-skilled opportunities at the local municipal level. There may be more suitably highly and semi-skilled people available at the provincial and national levels.

Initial recruitment and training for local personnel will take place prior to and during the construction phase, in conjunction with Mainstream's contractors. Tasks on site will require skills in a number of areas, including working at height, electrical safety, specific maintenance and troubleshooting, isolation for maintenance, etc. The construction work will create an opportunity for 'on-the-job' training thus increasing general skills levels. The opportunities for skills development and training would extend through from skilled to unskilled personnel.

Box 14.1 Construction Impact: Benefits for the Local Economy

Nature: The benefit to the local economy will be **direct** via employment and procurement of services and **indirect** via the spend in the local economy due to increase in wages etc.

Impact Magnitude – Medium

- **Extent:** Employment and procurement of service will be created for South African's at a **local, provincial and national** level depending on skills and capacity availability.
- **Duration:** Employment generated during the construction phase will take place over a 12 to 24 month period and will therefore be **short-term**.
- **Intensity:** The intensity will be **medium** as there will be between 100 and 200 jobs created with approximately 30% of the total investment being spent on goods and services in South Africa during the construction phase.

Likelihood – There is a **high** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-ENHANCEMENT) – MEDIUM POSITIVE

Degree of Confidence: The degree of confidence is **medium** given that actual figures are not yet available due to the early stage of this project.

Operational Phase Impacts

Direct benefits

Similar to the construction phase, the majority of goods and services will be highly specialised and technical in nature with up to 70 percent of the operational expenditure being initially imported. Locally procured services will include maintenance work for balance of plant facilities, 24 hour security and cleaning contracts resulting in an ongoing investment injection. Over time, as businesses develop locally to meet the needs of the renewables sector, levels of procurement may increase.

Turbine operation is largely automated with routine scheduled services taking place on average twice per annum. There will be a dedicated operations team comprising 10 to 15 full time personnel operating the facility in daytime hours. It is estimated that 60 percent of the operations team will be local, including the site manager and supervisors. The types of jobs that will be generated during the operations phase are likely to include:

- one Site Manager (Degree Qualification);
- two Site Supervisors (1 Mechanical supervisor, 1 Electrical Supervisor);
- one to two Graduates for training purposes; and
- the remainder will be Wind Turbine Technicians (6 to 10 personnel).

In addition, there will be a number of contract jobs including skilled balance of plant maintenance personnel for electrical balance of plant works and crane operators/crew. There are likely to be additional jobs including a number of personnel to cover 24 hour site security, as well as some cleaning contracts. These personnel will be sourced locally at the municipal level where possible. If the appropriate skills are not available at the municipal level these services will be sources regionally.

General training will be provided in management systems, wind turbine performance review. Much of the knowledge regarding wind turbine operations and maintenance will be acquired 'on-the-job'. It is envisaged that Mainstream SA operations personnel will be increasingly trained up and qualified to high levels over a 5-6 year timeframe, consistent with demonstrated capability and ambition.

The farmer will receive payments from Mainstream SA for the use of the land for the life of the Project and the value of the directly affected farms are likely to increase as a result of the added income stream. The renewable energy facility will occupy approximately three percent of the farm area, allowing the existing farm activities to continue. This will enable the landowner to supplement his existing income as opposed to replacing it; this is possible given that the majority of the farm is being used for grazing activities.

Indirect and induced benefits

Apart from the direct benefits resulting from the operational spend and direct jobs created, the spending of those employed directly would result in a positive indirect impact on the local and regional economy.

The supplemental income that the landowners will receive for the renewable energy facilities will enable them to sustain the farms through difficult years, making their farms, and therefore their livelihood, more sustainable. The farmers plan to expand their farming activities, set up a trust fund for selected students in the town of Merweville and establish a Bed and Breakfast facility on the farm (they believe that the turbines will attract visitors to the area) with the increased revenue from Mainstream SA.

The potential for the proposed Project and other future projects to result in greater impacts on local economies and the South African economy as a whole is primarily dependent on economies of scale. Initially import content will be high. However, if the sector grows in size it should provide opportunities for growth of the local supply chain and the additional benefit that would flow from this. The introduction of a large-scale renewable energy programme could provide local economic opportunities for component manufacture, and with an appropriate industrial policy it would be possible to leverage South Africa's relatively cheap steel resources. The distance from other international manufacturers will also confer a competitive advantage, especially for less-specialised large-scale components such as steel towers.

Box 14.2 Operational Impact: Benefits for the Local Economy

Nature: The benefit to the local economy will be **direct** via employment and procurement of services and **indirect** and induced benefits via the spend in the local economy due to increase in wages; local supply chain etc.

Impact Magnitude – Medium

- **Extent:** Employment and procurement of service will be created for South African's at a **local, provincial and national** level depending on skills and capacity availability.
- **Duration:** Employment and procurement of services will be generated during the operational phase over a period of 25 years and will therefore be **long-term**.
- **Intensity:** The intensity will be **low-medium** in the short term as the majority of services will be imported. As the sector matures, the intensity is likely to increase with additional benefits to the economy through the increased employment of local suppliers, increase job opportunities on the farms and increase in the local turbine manufacturing sector.

Likelihood – There is a **high** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-ENHANCEMENT) – MEDIUM POSITIVE

Degree of Confidence: The degree of confidence is **medium** given that actual figures are not yet available due to the early stage of this project.

14.1.2 Mitigation and Enhancement

The objective of enhancement is to optimise opportunities for employment and procurement of local labour and services, wherever possible, or alternatively that procurement at a regional or national level should take place.

Community Development:

- Mainstream SA should continue, as is their stated intention, to explore ways to enhance local community benefits with a focus on broad-based BEE through mechanisms such as community shareholding schemes and trusts. At this preliminary stage, and in accordance with the relevant BEE legislation and guidelines, up to four percent of after tax profit could be used for community development over and above that associated with expenditure injections into the area. As such;
    - Mainstream SA to establish a Community Development Trust for the advancement of local development needs.
    - Mainstream SA will contribute up to four percent of after tax profit to the Trust.
    - Projects will be identified in collaboration with the local Municipality and community representatives to ensure alignment with the key needs identified through the Integrated Development Planning process.
    - All projects will be aligned with Mainstream SA's policies.

Employment and procurement

It is important to recognise that the nature of the project dictates that large proportions of specialist skills and materials will have to come from outside of South Africa as well as the local municipal area with a high portion of international imports. However, the objective of enhancement is to optimise opportunities for employment/procurement of local people/suppliers or alternatively that employment and procurement opportunities are enhanced on a regional or national basis, where possible.

The following measures will be implemented to ensure that employment of local people is maximised and procurement of local, regional and national services is maximised:

- Mainstream SA will establish a recruitment and procurement policy which sets reasonable targets for the employment of South African and local residents /suppliers (originating from the local municipality) and promote the employment of women as a means of ensuring that gender equality is attained. Criteria will be set for prioritising, where possible, local (local municipal) residents/suppliers over regional or national people/suppliers. All contractors will be required to recruit and procure in terms of Mainstream SA's recruitment and procurement policy.

- Mainstream SA will work closely with relevant local authorities, community representatives and organisations to ensure that the use of local labour and procurement is maximised. This may include:
    - sourcing and using available databases on skills/employment-seekers that local authorities may have.
    - advertising job opportunities and criteria for skills and experience needed through local and national media.
    - conducting an assessment of capacity within the Local Municipality and South Africa to supply goods and services over the operational lifetime of the project.

- No employment will take place at the entrance to the site. Only formal channels for employment will be used.

- Mainstream SA to work closely with the wind turbine suppliers to provide the requisite training to the workers. The training provided will focus of development of local skills.

- Ensure that the appointed project contractors and suppliers have access to Health, Safety, Environmental and Quality training as required by the Project. This will help to ensure that they have future opportunities to provide goods and services to the sector.

14.1.3 Residual Impact

The implementation of the above measures would ensure that the construction impacts remain of medium significance and ensure that the significance of the operation impact remains a medium positive. The pre- and post- enhancement impacts are compared in *Table* 14.2.

Table 14.2 Pre- and Post- Enhancement Significance: Local Procurement

Phase	Significance (Pre-enhancement)	Residual Impact Significance
Construction	**MEDIUM positive**	**MEDIUM positive**
Operation	**MEDIUM positive**	**MEDIUM positive**

14.2 INCREASED SOCIAL ILLS LINKED TO INFLUX OF WORKERS AND JOB-SEEKERS

14.2.1 Impact Description and Assessment

Table 14.3 Impact Characteristics: Increased Social Ills

Summary	Construction	Operation
Project Aspect/ activity	Construction staff on site and potential influx of job-seekers.	Operation staff on site.
Impact Type	Direct and indirect, negative impact	Direct, negative impact
Stakeholders/ Receptors Affected	Local residents of the area, most specifically landowners of directly affected farms and neighbouring farms.	Local residents of the area, most specifically landowners of directly affected farms and neighbouring farms.

Construction Phase Impacts

The introduction of construction activity in remote, rural environments can sometimes bring about social change. This change is typically due to an influx of workers and job-seekers into the area. As a worst-case scenario, these changes have been known to increase levels of crime, drug and alcohol abuse, increased incidence of sex workers, and domestic violence.

The Project area is located outside town in a rural setting. The population density of the immediate area is low and the majority of land is farmland. The only people living on the proposed project site and on the neighbouring farms are the landowners and their farm workers. An influx of 'outsiders' could pose a risk to existing family structures and social networks.

Mainstream SA has estimated that there will be between 100 and 200 people employed during the construction phase, which they have estimated will take between 12 to 18 months. Due to the early phase of this project, specific arrangements have not yet been made regarding worker accommodation and terms of employment. Given that the proposed Project is located along a secondary road, approximately 72 km from the nearest access to the N1

highway, it is likely that the workers (from outside the area) will be accommodated in the town of Touwsrivier [(1)]. This will increase the levels of interaction with the local communities. The majority of workers are likely to be male and living away from their families.

The most likely social ills that may occur as a result of the increased number of workers and job-seekers are described below.

- **Theft of livestock** is already problematic on farms located close to towns, roads and in areas where construction work is taking place. It is likely that stock theft will continue and possibly increase during the construction phase.

- **Petty crimes** (e.g. theft of tools, household items and farm materials) on the project affected farm and neighbouring farms could occur.

An increase in disposable income within the project area (among workers) could result in an increase in alcohol and drug abuse, increased incidences of prostitution and casual sexual relations. These sexual relations could result in increased incidents of HIV/AIDS (which the District Municipality is expecting to increase to 4 percent by 2010) and increased numbers of teenage and unwanted pregnancies.

Given the relatively small numbers of workers and job-seekers, it is likely that this impact will be relatively limited. In addition, the skilled workers more likely to be housed in formal accommodation facilities and are unlikely to exacerbate this impact and the low skilled workers are likely to be local residents and as such already part of the community social structures and family networks.

Box 14.3 Construction Impact: Increased Social Ills

Nature: The social ills likely to accompany the Project would be regarded as an **indirect, negative** impact.

Impact Magnitude – Low
- **Extent:** It is anticipated that the potential social ills will have impacts at the **local** scale.
- **Duration:** The social ills likely to accompany the Project are expected to be **short-term**.
- **Intensity:** The intensity will be **low** as people should be able to adapt with relative ease.

Likelihood – There is a **medium** likelihood that this impact will occur during the construction phase.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW NEGATIVE

Degree of Confidence: The degree of confidence is **medium** given that the extent of the influx of job-seekers is unknown.

(1) The lack of and isolation of the Project site makes it difficult to determine where the workers will be accommodated.

Operation Phase Impacts

During the operational phase, there are going to be a limited number of workers (10-14) and/or contractors' onsite. As such, it is unlikely that there will be any social ills linked to the project activities.

Box 14.4 Operational Impact: Increased Social Ills

Nature: The social ills likely to accompany the Project would be regarded as an **indirect, negative** impact.

Impact Magnitude –Negligible

- **Extent:** It is anticipated that the potential social ills will have impacts at the **local** scale.
- **Duration:** The social ills likely to accompany the Project are expected to be **temporary**.
- **Intensity:** The intensity will be **negligible** as people should be able to adapt with relative ease.

Likelihood – There is a **Medium** likelihood that this impact will occur during the construction phase.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – NEGLIGIBLE

Degree of Confidence: The degree of confidence is **medium** given that the extent of the influx of job-seekers is unknown.

14.2.2 Mitigation

The objectives of mitigation are:

- to limit, where possible, social ills brought about by the construction and operation of the renewable energy facility; and
- to ensure that Contractors manage their workers in such a way that the impacts on local communities are limited.

Specific measures include:

- Mainstream SA and its appointed contractors to develop an induction programmes, including a Code of Conduct, for all workers (Mainstream SA and contractors including their workers) directly related to the project. A copy of the Code of Conduct to be presented to all workers and signed by each person.

- The Code of Conduct must address the following aspects:
  - respect for local residents;
  - respect for farm infrastructure and agricultural activities;
  - no hunting or unauthorised taking of products or livestock;
  - zero tolerance of illegal activities by construction personnel including: unlicensed prostitution; illegal sale or purchase of alcohol; sale, purchase or consumption of drugs; illegal gambling or fighting;
  - compliance with the Traffic Management Plan and all road regulations; and

- description of disciplinary measures for infringement of the Code and company rules.

- If workers are found to be in contravention of the Code of Conduct, which they signed at the commencement of their contract, they will face disciplinary procedures that could result in dismissal. Stock theft should be noted as a dismissible offence.

- Mainstream SA will implement a grievance procedure that is easily accessible to local communities, through which complaints related to contractor or employee behaviour can be lodged and responded to. Mainstream SA will respond to all such complaints. Key steps of the grievance mechanism include:
  - Circulation of contact details of 'grievance officer' or other key Mainstream SA contact.
  - Awareness raising among local communities (including all directly affected and neighbouring farmers) regarding the grievance procedure and how it works.
  - Establishment of a grievance register to be updated by Mainstream SA, including all responses and response times.

- Mainstream SA and its contractors will develop and implement an HIV/AIDS policy and information document for all workers directly related to the project. The information document will address factual health issues as well as behaviour change issues around the transmission and infection of HIV/AIDS. Mainstream SA will make condoms available to employees and all contractor workers.

- The construction workers (from outside the area) should be allowed to return home over the weekends or on a regular basis to visit their families; the contractor should make the necessary arrangement to facilitate these visits.

14.2.3 Residual Impact

The implementation of the above mitigation measures ensure that the construction impacts remain of low significance, and the operation impact of negligible significance. The pre- and post-mitigation impacts are compared in *Table 14.4*.

Table 14.4 Pre- and Post- Mitigation Significance: Increased Social Ills

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**LOW**	**LOW**
Operation	**NEGLIGIBLE**	**NEGLIGIBLE**

14.3 DISRUPTION TO AGRICULTURAL ACTIVITIES

14.3.1 Impact Description and Assessment

Table 14.5 Impact Characteristics: Disruption to Agricultural Activities

Summary	Construction	Operation
Project Aspect/ activity	Construction activities. Access through farm gates. Employment of local workers.	Operation activities. Access through farm gates.
Impact Type	Direct, negative impact.	Direct, negative impact.
Stakeholders/ Receptors Affected	Directly affected farmers, and neighbouring farmers.	Directly affected farmers, and neighbouring farmers.

Construction Phase Impacts

During the construction phase, there will be minimal disruptions to agricultural activities as there are limited farming activities taking place on the proposed site. On the Perdekraal farm, there are eleven camps and two of the camps are currently being utilised. The trustees would like to re-establish the farm into a fully functional farm, however they lack financial resources and this has been a slow process. As a result there are low numbers of sheep on the farm (approximately 20 in 2010). If the numbers of live stock on the farm increases, the farmers will practice rotational farming as the vegetation requires time to regenerate. Although the number of livestock found on the farm is minimal, during construction the farmers will need to keep their livestock in alternate camps to the construction area in order to ensure that the stock are not harmed or lost as a result of the intensive construction methods. Rietpoort farm is also not functioning as a fully operational farm at present. The primary source of income on the farm is through the collection and selling of firewood.

As mentioned above, the farms are divided into camps and in order to access the full Project site it will be necessary for the construction team to travel between camps; requiring them to open and close gates as they move. They may, at times, also be required to travel across/alongside neighbouring farms to reach the selected sites. It is critical that the gates are always closed once the team has passed in order to secure the stock.

The high numbers of light and heavy vehicles that will be passing through the farm camps are likely to cause damage to the gates and fencing. Any damage to this infrastructure could also lead to stock losses.

There is a concern amongst some of the farmers (directly affected and neighbouring) that their farm workers will leave their jobs in order to pursue the available construction jobs. Despite the short-term nature of the construction phase, people still fear that they will loose trained workers.

Box 14.5 Construction Impact: Disruption to Agricultural Activities

Nature: The disruption to agricultural activities would be regarded as a **direct, negative** impact.

Impact Magnitude – Low

- **Extent:** It is anticipated that the disruption to agricultural activities will be experienced at the **local** level.
- **Duration:** The disruptions will be experienced during the construction phase and as such will be **short-term**.
- **Intensity:** The intensity will be **low** as the farmers will be able to adapt with relative ease to the disruption, given the low numbers of stock on the farms.

Likelihood – There is a **high** likelihood that this impact will occur during the construction phase.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW NEGATIVE

Degree of Confidence: The degree of confidence is **high.**

Operation Phase Impacts

The disruption of farm activities during the operational phase is going to be significantly less. There will be substantially fewer vehicles on site and the stock will not be limited to the camps that are unaffected by the Project. During operation, the stock will be able to graze in all the camps as the Project activities will not affect their ability to graze.

Box 14.6 Operational Impact: Disruption to Agricultural Activities

Nature: The disruption to agricultural activities would be regarded as a **direct, negative** impact.

Impact Magnitude – Low

- **Extent:** It is anticipated that the disruption to agricultural activities will be experienced at the **local** level.
- **Duration:** The disruptions will be experienced throughout the operation phase and as such will be **short-term**.
- **Intensity:** The intensity will be **low** as the farmers will be able to adapt with relative ease during the operational phase.

Likelihood – There is a **medium** likelihood that this impact will occur during the operational phase.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW NEGATIVE

Degree of Confidence: The degree of confidence is **high.**

14.3.2 Mitigation

The objective of mitigation is to minimise the disruption to agricultural activities as related to the construction and operational phase activities.

Specific measures include:

- All workers will agree to the Code of Conduct and be aware that contravention of the Code could lead to dismissal (as outlined in *Section 14.2*).

- All directly affected and neighbouring farmers will be able to lodge grievances with Mainstream SA using the Grievance Procedure as outlined in *Section 14.2*.

14.3.3 Residual Impact

The implementation of the above mitigation measures would reduce the construction impacts from medium to low significance and the operation impacts from low to negligible. The pre- and post-mitigation impacts are compared in *Table 14.6*.

Table 14.6 Pre- and Post- Mitigation Significance: Disruption to Agricultural Activities

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**LOW**	**LOW**
Operation	**LOW**	**NEGLIGIBLE**

14.4 LOSS OF AGRICULTURAL LAND

14.4.1 Impact Description and Assessment

Table 14.7 Impact Characteristics: Loss of Agricultural Land

Summary	Construction and Operation
Project Aspect/ activity	Land take for the construction and operation of facility.
Impact Type	Direct, negative impact.
Stakeholders/ Receptors Affected	Directly affected land owners, Local, Provincial and National Government.

Construction and Operation Phase Impacts

Currently, there are three relevant pieces of legislation that apply to the change of land use; they are the Land Use and Planning Ordinance (Ordinance 15 of 1985) (LUPO), the Western Cape Planning and Development Act No 7 of 1999 and the Subdivision of Agricultural Land Act No 70 of 1970. DEA&DP is currently discussing the need to update LUPO in the face of numerous renewable energy facilities being proposed for development in the Western Cape Province [(1)]. The Department is reviewing the suitability of the current 'land departure' application for changes in land use from agriculture to an increasingly greater number of renewable energy facilities. There is a possibility that a new section will be added to the ordinance that will address land rezoning and land departures to accommodate wind facilities. To date, no amendments have been made to LUPO.

(1) Personal comms with Doretha Kotze, WCDM, June 2010.

The key issues that affect decision-making regarding any proposed changes to land use are outlined below (1).

- Soil quality: The authorities are unlikely to allow any kind of development in an area that has good soil quality or high potential soil. Most of the soil in the Western Cape Province is considered to be of low quality with a few strips of high value soils, this makes it highly unlikely that a development will be stopped.

- Compatibility of farming and renewable energy facility: The authorities would want to determine if the agricultural land will be maintained alongside the renewable energy facilities. If the project is going to impact negatively on the sustainability of the farm the authorities are unlikely to give a permit for the change in land use.

The construction and operation of the proposed renewable energy facility will require that approximately three percent of the identified land parcel/s will be taken for the construction and operation of the renewable energy facility. The land owner has considered this land loss and believes that this will not require a down-scaling of agricultural activities. On the contrary, the land owner plans to expand the agricultural activities using the income generated from Mainstream in order to improve farming technologies, upgrade farm infrastructure, increase the area being cultivated, hire new workers and improve worker living conditions.

Box 14.7 Construction and Operation Impact: Loss of Agricultural Land

Nature: The impact on agricultural land is going to be experienced as a **direct, negative** impact.

Impact Magnitude – Low
- **Extent:** The impact on agricultural land resulting from the construction and operation activities will occur at the **local/regional** level.
- **Duration:** This impact will occur for the duration of the construction and operation phases and will therefore be **long-term**.
- **Intensity:** The intensity will be **low** as limited agricultural land will be lost.

Likelihood – There is a **high** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW NEGATIVE

Degree of Confidence: The degree of confidence is **high**.

14.4.2 Mitigation

The objective of mitigation is to minimise the loss of agricultural land resulting from project related activities during construction and operational phases.

(1) Personal comms with Andre Roe, Provincial Department of Agriculture: Western Cape, June 2010.

Specific measures include:

- Mainstream to remove turbines from the area ear-marked for agriculture by the farmer in the eastern portion of the property, as per the preferred Site Layout Alternative 2.

- Mainstream to minimise the damage caused by construction activities to the farmland by ensuring strict compliance with construction plans and worker 'Code of Conduct'.

- Any damage to vegetation will be rehabilitated in accordance with mitigation proposed for the rehabilitation of natural vegetation in *Section 7*.

14.4.3 Residual Impact

The implementation of the above mitigation measures would ensure that the construction and operations impacts remain of low significance. The pre- and post-mitigation impacts are compared in *Table 14.8.*

Table 14.8 Pre- and Post- Mitigation Significance: Loss of Agricultural Land

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction and Operation	**LOW**	**LOW**

14.5 TOURISM ACTIVITIES

14.5.1 Impact Description and Assessment

Table 14.9 Impact Characteristics: Tourism Activities

Summary	Construction	Operation
Project Aspect/ activity	N/A	Operation of the renewable energy facility.
Impact Type	N/A	Direct, positive impact.
Stakeholders/ Receptors Affected	N/A	Tourists to the area, directly affected landowner, neighbouring landowners (including 'lifestyle farmers'), private nature reserves, road users, and interested people.

General Discussion

There have been relatively few wind energy facilities in developing countries and certainly no studies reviewing the impacts of wind energy facilities on the local communities, economy or tourism in developing countries. As such, we rely heavily on learning's from research that has been undertaken in developed countries. There are numerous wind energy facilities in developed countries that have used the technology for a relatively long period of time and have been able to reflect upon some of the impacts caused by these

facilities. In South Africa, there are currently two wind farms, one is located in Darling, which was commissioned by the government in 2002 and the other is a demonstration facility in Klipheuwel near Durbanville in the Western Cape Province. The Darling Wind Farm is a small facility consisting of only four turbines. There has not been much information shared with the public in terms of the wind farm's impacts on the surrounding communities, economy or tourism. This assessment is, therefore, based primarily on studies undertaken in developed countries as well as input from interviewees.

Throughout the public consultation process, stakeholders raised concerns about the potential impacts of the renewable energy facility on current and future tourism in the area surrounding the Project site.

The indirect effects of wind farms on tourism have been the subject of substantial debate, but no evidence has been presented to support the view that wind farms have a negative effect on tourism. Results from numerous surveys demonstrate that the effect of wind farms on tourism is negligible at worst, with many respondents taking a positive view to wind farms, and saying it would not affect their likelihood of returning to an area [(1)] . A study by Glasgow Caledonian University, looking into the impacts of wind farms on Scottish tourism, found that 75 percent of tourists surveyed felt that wind farms had a positive or neutral impact on the landscape [(2)] .

The evidence supporting the impacts of wind farms on tourism is, however, contradictory. There are studies (based in Scotland) that provide conflicting findings about actual and perceived impacts. *Box 14.8* presents some contradictory findings related to the Scottish experience.

Box 14.8 Scottish Findings Regarding the Impacts of Wind Facilities

- VisitScotland commissioned independent research on the potential impacts of the development of wind farms on tourism in Scotland. This study concluded that 29 percent of respondents felt that wind farms and turbines had detracted from their experience (3) and 31 percent of respondents considered that the scenery and landscape would be spoiled by wind farm developments.

- In contrast a poll carried out by MORI Scotland found that 91 percent of respondents said that the presence of wind farms in the area made no difference to whether they would return (4). In a similar survey carried out for the Scottish Executive of people living close to wind farms, MORI Scotland found that most people felt that wind farms had had neither a positive or negative impact on their area. Of the remainder, 20 percent said it had had a broadly positive impact and 7 percent thought that there was a negative impact (5). In Cornwall, wind farms have provided a unique visitor attraction and in addition they act as an invaluable educational facility for renewable energy.

(1) BWEA (2006) The Impact of Wind Farms on the Tourist Industry in the UK.
(2) Glasgow Caledonian University (2007). The Economic Impacts of Wind Farms on Scottish Tourism. Report commissioned by the Scottish Government.
(3) NFO System Three, Investigation into the Potential Impact of Wind Farms on Tourism in Scotland - Final Report.
(4) MORI (2002) Tourist Attitudes Towards Wind Farms. Research Study Conducted for Scottish Renewables Forum & the British Wind Energy Association.
(5) MORI (2003) Public Attitudes to Wind Farms, Scottish Executive Energy Policy Unit.

According to other studies undertaken in the United Kingdom, Scotland and Australia by the respective Wind Energy Agencies [(1)], tourism has not been negatively affected by the establishment of wind energy facilities. Surprisingly, in contrast, wind energy facilities have been credited with increasing tourism activities and in turn also positively impacting on the local economy [(2)].

Experience in Scotland has shown that people are fascinated by wind turbines and often travel via the wind energy facilities *en route* to their final destinations. As a result, the construction of new wind energy facilities often includes the construction of a lay-by area so that passing traffic can park safely in order to view the turbines. Many recent planning applications have been modified by the developers to incorporate a viewing platform and visitor centre or information boards in order to maximise on the tourism potential of the project [(3)].

Some relevant positive experiences associated with selected wind energy facilities are provided in *Box 14.9*.

Box 14.9 Relevant Experiences of Selected Wind Energy Facilities

- **Altahullion Wind Facility** (Dungiven, Ireland) - local community groups requested tourist facilities at the site because of the influx of people visiting the facility. Developers persuaded the department of environmental service to provide tourist signage to guide visitors from the main road to the site. The site has a car park and specially designated turbine which people can walk to.

- **Beinn an Tuirc Wind Facility** (Argyll, Scotland) - this wind energy facility has established an open day where visitors can come visit the site. The site is so popular that the local government has been investigating the possibility of introducing a new bus route to take visitors to visit the facility.

- **Albany Wind Facility** (Albany, Western Australia) – this facility is considered by many to be a wonderful tourism attraction, so much so that it has been featured on television's Great Outdoors Show. Planning is underway for a Wind Discovery Centre at the Albany Wind Farm, with the aim of building a world class centre to attract additional tourists to the Albany region. According to the city's economic development statistics, traffic counters suggest about 100,000 people visited the wind facility last year (2005). Unbelievably the site is located near the ocean and the communities and fishermen have not complained about it as a deterrent.

Wind farms bordering national parks have been found to have a positive economic outcome for the parks and surrounding communities [(4)]. Visitors to the park usually visit the park and then take a detour to see the wind farm, and vice versa. There has been an increase in revenue generated at neighbouring national parks as tourists who were initially visiting the wind facility elected to visit the national park as well.

(1) BWEA (2006) Imapct of Wind Farms on Tourist Industry in the UK and AusWEA (2003) Wind Farms and Tourism
(2) http://www.offorsharp.com/downloads/baldhillseconomic.pdf
(3) Tim and Carmel Brady (2003) Wind Farms and Tourism, AusWEA,
(4) BWEA, (2006) Impact of Wind Farms on the Tourist Industry in the UK

Construction Phase Impacts

The construction of the renewable energy facility will result in noise, visual, traffic and a changed the sense of place. These factors are unlikely to have a significant impact on tourism in the area due to the limited duration of the construction activities.

Operation Phase Impacts

Operation of the renewable energy facility is not predicted to have a generally negative impact on tourism-related activities in the area. Given that Renewable Energy Facilities are so new in South Africa, it is anticipated that people will travel to the site in order to view a development that has not yet been seen in our country (with the exception of the Darling Wind Farm that does not compare to the proposed Project in terms of scale and technology). It is most likely that the proposed Project will have a positive impact in terms of attracting interest from passing travellers and interested people. Given the lack of information, it is not known how long this will remain an attraction.

Many of the local farmers and other residents anticipate that the renewable energy facility will create opportunities for the development of tourist accommodation as well as related activities, such as mountain biking routes, 4x4 trails, walks and viewing areas. There is likely to be significant interest in the REF from South Africans.

The site is located in a relatively isolated area of the Karoo, with nearest town being Touwsriver 32 km south west of the site. There are no existing tourism facilities on the proposed site, however there are two private game reserves within a 30 km radius of the site, namely Inverdoorn Game Reserve (25km to the south west) and Ibhadi Game Reserve (9km to the south). It can be seen from the visual assessment that the site would be unlikely to be visible from the Inverdoorn Game Reserve while the Ibhadi Game Reserve falls within the medium visibility area. Changes to land use might have the potential to alter the tourist experience in the area. The responses of individuals will be subjective and dependent on their attitudes and perceptions as well as the purpose and pattern of their visit/interaction with the proposed Project.

Box 14.10 Operational Impact - POSITIVE: Tourism Activities

Nature: The impact on tourism activities is most likely going to be a **direct, positive** impact for most receptors. It will, however be experienced as a **direct, negative** impact by 'lifestyle farmers' who use their farms for tourism and some tourists that will not value the change to the area (impact assessment presented in *Box 14.11*).

Impact Magnitude – Low

- **Extent:** The impacts on tourism linked to the operational activities will occur at the **local** level.
- **Duration:** This impact will occur throughout the operational phase, and will therefore be **long-term**.
- **Intensity:** The intensity will be **low** as those who are directly affected will experience positive impacts that they will adapt to a benefit from directly.

Likelihood – There is a **medium** likelihood that this impact will occur during the operational phase. The likelihood rating is influenced by the positive international experience.

IMPACT SIGNIFICANCE (PRE-ENHANCEMENT) – LOW POSITIVE

Degree of Confidence: The degree of confidence is **medium** given that there are no recorded experiences relating to similar developments in South Africa or other developing countries

Box 14.11 Operational Impact - NEGATIVE: Tourism Activities

Nature: The impact on tourism activities could be experienced as a **direct, negative** impact by 'lifestyle farmers' who will not value the change to the area. It is, however, most likely going to be a **direct, positive** impact for most receptors (impact assessment presented in *Box 14.10*).

Impact Magnitude – Medium

- **Extent:** The impacts on tourism linked to the operational activities will occur at the **local** level.
- **Duration:** This impact will occur throughout the operational phase, and will therefore be **long-term**.
- **Intensity:** The intensity will be **low** as those who are directly affected will be able to adapt with some difficulty. No significant tourist sites currently exist in the immediate area, however there are private game reserves within a 30km radius of the site, one within 9km of the site.

Likelihood – There is a **medium** likelihood that this impact will occur during the operational phase. This rating is largely based on perceptions/ feedback of some directly affected and interested stakeholders.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW NEGATIVE

Degree of Confidence: The degree of confidence is **medium** given that there are no recorded experiences relating to similar developments in South Africa or other developing countries.

14.5.2 Mitigation

The objective of mitigation is to enhance the positive impacts and minimise the negative impacts of the renewable energy facility on tourism activities in the area.

Specific measures include:

- Apply all mitigation measures to reduce the noise and visual impacts as presented in *Sections 11*and *12*).

- Mainstream SA will work with the Local Municipality and local tourism organisations to raise awareness about the renewable energy facility.

- Mainstream SA will establish an information kiosk/notice board at the nearest town (Touwsrivier) educating the public about the need and benefits of project. This is aimed at instilling the concept of sustainability and creating awareness by engaging the community and local schools. Information brochures and posters will be made available at the kiosk to provide more information about the facility. These should be presented in the appropriate languages to maximise the benefits.

14.5.3 Residual Impact

The implementation of the above mitigation measures should enhance the positive operational impacts from low to medium (positive) significance and the negative operation impacts from low to negligible (negative) significance. The pre- and post-mitigation impacts are compared in *Table 14.10*.

Table 14.10 Pre- and Post- Mitigation Significance: Tourism Activities

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Operation POSITIVE	**LOW Positive**	**LOW Positive**
Operation NEGATIVE	**LOW Negative**	**NEGLIGIBLE Negative**

14.6 PROPERTY PRICES AND DESIRABILITY OF PROPERTY

14.6.1 Impact Description and Assessment

Table 14.11 Impact Characteristics: Property Prices and Desirability of Property

Summary	Construction	Operation
Project Aspect/ activity	Existence and Operation of the renewable energy facility.	
Impact Type	Direct, negative impact (for neighbouring land owners). Direct, positive impact (for directly affected land owners).	
Stakeholders/ Receptors Affected	Neighbouring property owners.	

Construction and Operation Phase Impacts

There are relatively few wind energy facilities in developing countries and certainly no studies reviewing the impacts of wind energy facilities on property prices in developing countries. As such, we rely heavily on learning's from research that has been undertaken in developed countries.

According to personal communication with a property evaluator from the Land Bank [(1)], it is believed that the market value of the directly affected farms will increase because of the increased revenue generated from the wind turbines. Depending on the amount of land used for the development, the production value (burden that the property can carry) of the farms is likely to remain the same for the directly affected farms and the neighbouring farms. Farm values are primarily calculated according to the production value and farm infrastructure. The directly affected landowner will be receiving a steady income from leasing a portion of the farm.

There is often an assumption that the presence of renewable energy facilities (particularly wind facilities) in an area has a negative impact on nearby property prices. There is, however, little strong evidence to support this assumption. Given that there are no large-scale fully operational wind facilities in South Africa, we have to rely on international research that has been undertaken in terms of the value of property prices in relation to wind energy facilities. *Box 14.12* presents some of these findings.

Box 14.12 International Research: Relationship between Wind Energy Facilities and Property Prices

In Scotland, research from the Edinburgh Solicitors' Property Centre (ESPC) [(2)] considered property sales near Crystal Rig in the Scottish Borders and found no evidence of a negative effect on the price of property in nearby areas. The ESPC study found that prices in the village of Dunbar had risen from below to above the regional average during the previous four years, during which time the wind farm was built, and that since the wind farm began operating, property price inflation in Dunbar had continued to exceed that achieved across East Lothian.

Reports from the Royal Institute of Chartered Surveyors (RICS) in 2003 [(3)] and December 2007 [(4)] suggest that wind farm development may impact negatively on property prices to some extent. Any impact is most likely to be active during the planning application stage in the development and appears to decline over time. The results were based upon a relatively low number of surveyors who have worked on property near wind farm developments.

A significant number (40 percent) of surveyors reported 'no impact from wind farm developments on residential property values' (RICS, 2003 & 2008).

There is still uncertainty and significant variability regarding house price data with low numbers of housing and few associated sales within the region of proposed developments to form succinct conclusions.

There is no evidence to suggest that wind turbines have a long-term significant effect on the local property market.

A study was undertaken by Poletti and Associates for Invenergy Wind LLC in the states of Wisconsin and Illinois, USA. The aim of the study was to

(1) Personal Comms, Mr Riaan Veragie, Beaufort West Land Bank, July 2010.
(2) Edinburgh Solicitors Property Centre (ESPC) (2007), Impact of Wind Farms on Residential Property Prices – Crystal Rig Case Study, February 2007.
(3) The Royal Institute of Chartered Surveyors (RICS) (2003), Impact of wind farms on the value of residential property and agricultural land, http://www.rics.org/NR/rdonlyres/66225A93-840F-49F2-8820-0EBCCC29E8A4/0/Windfarmsfinalreport.pdf
(4) RICS (2008), Modelling the Impact of Windfarms on House Prices in the UK, accessed at http://www.rics.org/NR/rdonlyres/B3E3D771-F5E9-4298-AD19-5B507695EF43/0/DentandSims.pdf

compare sales of homes and farming properties within an area close to wind energy facilities to other properties (with similar characteristics) in an area far from wind energy facilities [1]. The study looked at property sales from 1998 through to 2006. The results of the studies were:

- Area 1 which was located in Wisconsin had two operational wind energy facilities active since 1998. The results indicated that there were no measurable differences in home values in close proximity to the facility to those located further away from the wind energy facility [2]. These results were based on the analysis of 87 residential and farmland sales for the areas.

- Area 2, located in the state of Illinois had one wind farm which had been operating since 2003. The analysis of 69 residential and farmland property sales revealed that there were no measurable difference in the home values between the area close to a wind energy facility and the area further away from a wind energy facility [3].

A follow up investigation in 2007 of the same two study areas was conducted. The investigation revealed that the property prices continued to increase and the local government had approved the construction of new houses in the area close to the wind farm. These new houses were selling very well and fast.

It is very difficult to apply the findings of these studies to the South African context. The lessons learnt internationally can provide us with some understanding of what might happen but the reality is that we cannot be certain. The assessment of this impact is conservative given the high level of uncertainty.

(1) A Real Estate Study of the Proposed White Oak Wind Energy Centre, McLean and Woodford Counties, Illinois, January 2007. http://amherstislandwindinfo.com/propertyvaluestudy.pdf
(2) A Real Estate Study of the Proposed White Oak Wind Energy Centre; McLean and Woodford Counties, Illinois, January 2007. http://amherstislandwindinfo.com/propertyvaluestudy.pdf
(3) A Real Estate Study of the Proposed White Oak Wind Energy Centre; McLean and Woodford Counties, Illinois, January 2007. http://amherstislandwindinfo.com/propertyvaluestudy.pdf

Box 14.13 Construction and Operational Impact: Property Prices and Desirability of Property

Nature: The impact on property prices is going to be experienced as a **direct, negative** impact on indirectly affected properties initially. It is not certain how this will change over time. *

Impact Magnitude – Low

- **Extent**: The impact on property prices resulting from the operation of the wind energy facility will occur at the **local** level.
- **Duration**: This impact will occur for the duration of the operation phase and will therefore be **long-term**.
- **Intensity**: The intensity will be **low** as research shows that there is unlikely to be a decrease in property prices. For some of the For some of the private nature reserve within 9km whose land value is dependant on the peaceful nature of the area, the intensity may be **medium**. It is, however, difficult to know for certain.

Likelihood – There is a **medium** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW NEGATIVE

Degree of Confidence: The degree of confidence is **low** given the high levels of uncertainty and lack of South Africa specific information.

** The directly affected farms are likely to experience a direct, positive impact - this has not be assessed given that their contracts with Mainstream SA and the associated benefits are private. All pros and cons of the proposed development would have been considered in a private capacity.*

14.6.2 Mitigation

The objective of mitigation is to minimise the negative impacts on property prices.

Specific measures include:

- Mainstream to adhere to the design mitigation measures captured in Site Layout Alternative 2.
- Apply all mitigation measures to reduce the noise and visual impacts as presented in *Sections 11* and *12*.

14.6.3 Residual Impact

The implementation of the above mitigation measures would reduce the construction/operation phase impacts from medium to low negative significance. The pre- and post-mitigation impacts are compared in *Table 14.12.*

Table 14.12 Pre- and Post- Mitigation Significance: Property Prices and Desirability of Property

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction and Operation	**LOW**	**LOW**

15.1 AIR QUALITY

15.1.1 Impact Description and Assessment

This section considers the impacts to air quality during the construction and operation of the Perdekraal Renewable Energy Facility (REF). The two primary areas of interest are:

- dust generated during clearing of vegetation and earthmoving activities and by vehicles on site travelling along unpaved roads;
- emissions from the exhaust of vehicles during construction; and
- the positive impact associated with CO_2 displacement.

Table 15.1 Impact Characteristics: Air Quality

Summary	Construction	Operation
Project Aspect/ activity	Vehicle movement on gravel roads. Soil disturbance and excavating. Emissions from construction vehicles and equipment.	Vehicle movement on gravel roads. CO_2 displacement associated with provision of electricity for a renewable energy source such as wind or solar
Impact Type	Direct negative	Direct negative / Direct positive
Stakeholders/ Receptors Affected	Affected landowners. Road users. Construction personnel.	Affected landowners. South Africa's carbon footprint

Construction Phase Impacts

The presence of dust can be a nuisance to site users and nearby receptors. Dust is expected to be generated during the construction phase of the project by trucks driving on gravel roads and through construction activities that may disturb the soil. The Perdekraal site is accessed via an existing road that is approximately 30km long, so it is likely that dust generation will result from vehicles travelling along this access road as well as the internal road networks with gravel surface covering. The levels of dust are expected to be highly variable and dependent on the time of year, the intensity of the activity and the prevailing winds at the time of construction.

Dust from the construction site can impact on neighbouring properties and vegetation by blanketing plant surfaces. In extreme cases, dust can cause respiratory problems for site users through inhalation, although this is not likely to occur at this site since construction activities will be progressive.

Dust becomes airborne due to the action of winds on material stockpiles and other dusty surfaces, or when thrown up by mechanical action, for example the movement of tyres on a dusty road or activities such as excavating. The quantity of dust released during construction depends on a number of factors, including:

- the type of construction activities occurring (e.g. crushing and grinding);
- volume of material being moved;
- the area of exposed materials;
- the moisture and silt content of the materials;
- distances travelled on unpaved surfaces; and
- the mitigation measures employed.

Dust emissions are exacerbated by dry weather and high wind speeds. The impact of dust also depends on the wind direction and the relative locations of dust sources and receptors. There is potential for dust emissions during construction to impact on residential receptors or sensitive habitats, if these are within 200m of an activity causing dust production.

Potential Receptors on and around the site include:

- the Perdekraal farm house;
- labourers cottages;
- neighbouring properties; and
- the road users.

Construction vehicles and other construction equipment will generate exhaust emissions during construction, although it is not anticipated that large volumes of exhaust emissions will be generated.

Minimal dust generation is expected to occur during the operational phase of the project by maintenance vehicles along the gravel access roads, which will be infrequent. Therefore, impact of dust generated during the operation phase is not considered any further.

Dust will be generated on the public road during the delivery of the turbines, associated infrastructure and concrete. This will be limited to phases of the project when the deliveries are being made. Although there are neighbouring properties adjacent to the site, there are no neighbouring residential receptors within 200m from the site boundary. It is not likely that the Perdekraal farm house will be significantly impacted as no construction will take place within a 700m radius of the house. The prevailing wind in the area is from the north west, which will carry dust towards the public gravel road during construction on the northern half of the site, however this is only likely to occur when construction is taking place in close proximity to the road. During construction on the southern half of the site, dust would be carried away from the public road.

Box 15.1 Construction Impact: Perdekraal REF – Dust

Nature: Construction activities that generate dust would result in a **negative direct** impact on receptors in the area.

Impact Magnitude – Low

- **Extent**: The extent of the impact is **local,** limited to within 200m of construction activities.
- **Duration**: The duration would be **short-term** for the duration of construction.
- **Intensity:** The site is sparsely populated and on site activities will continue largely undisturbed. The dust is, therefore, unlikely to impact any sensitive receptors and the intensity can be considered **low.**

Likelihood – There is a **high** likelihood of dust generation.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW

Degree of Confidence: The degree of confidence is **high**.

Box 15.2 Construction Impact: Perdekraal REF – Emissions

Nature: Construction activities that generate emissions would result in a **negative direct** impact on people in the area.

Impact Magnitude – Low

- **Extent**: The extent of the impact is **local** limited to within 5 km of **site**.
- **Duration**: The duration would be **short-term** for the duration of construction.
- **Intensity:** The site is sparsely populated, emissions are likely to be low and there are no sensitive receptors close to the boundary, therefore the intensity can be considered **low.**

Likelihood – There is a **high** likelihood of emissions generation.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW

Degree of Confidence: The degree of confidence is **high**.

Operational Phase Impacts

The presence of dust can be a nuisance to site users and nearby receptors. Dust is expected to be generated during the operational phase of the project by trucks and maintenance vehicles driving on gravel roads. The Perdekraal site is accessed via an existing road that is approximately 30km long, so it is likely that dust generation will result from vehicles travelling along this access road as well as the internal road networks with gravel surface covering. The levels of dust are expected to be highly variable and dependent on the time of year, the intensity of the maintenance work required and the prevailing winds at the time.

The electricity generated by this facility will supply the national grid and positively contribute to the country's goal of emission reduction as outlined in South Africa's Integrated Plan for Electricity 2010. The facility at Perdekraal has the potential to provide electricity to approximately 681,002 typical South

African income households[1](assuming the facility output is 389MW). This size project could displace approximately 863,171 tonnes of CO_2 annually. Thereby contributing to a reduction in South Africa's carbon footprint.

Box 15.3 Operation Impact: Perdekraal REF – Dust

Nature: Operation and maintenance activities that generate dust would result in a **negative direct** impact on receptors in the area.

Impact Magnitude – Low

- **Extent**: The extent of the impact is **local,** limited to within 200m of the facility.
- **Duration**: The duration would be **short-term** for the duration of any maintenance activity.
- **Intensity:** The site is sparsely populated and on site activities will continue largely undisturbed. The dust is, therefore, unlikely to impact any sensitive receptors and the intensity can be considered **low.**

Likelihood – There is a **high** likelihood of dust generation given that the internal roads will be gravel roads.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW

Degree of Confidence: The degree of confidence is **high**.

Box 15.4 Operational Impact: Perdekraal REF – CO_2 Emissions

Nature: Operation of the renewable energy facility will result in a **positive direct** impact by reducing the CO_2 emissions by displacing approximately 863,171 tonnes of CO_2 annually.

Impact Magnitude – Low

- **Extent**: The extent of the impact is **regional** contributing to a reduction in the carbon footprint of South Africa.
- **Duration**: The duration would be **long-term** for the duration of the operation of the facility.
- **Intensity:** The reduction is relatively small given the countries reliance on coal powered electricity generation, therefore the intensity can be considered **low.**

Likelihood – There is a **high** likelihood of CO_2 emissions displacement during the operational phase of the facility.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW

Degree of Confidence: The degree of confidence is **high**.

15.1.2 Mitigation Measures

Due to the amount of truck traffic that is anticipated during construction and the potentially strong winds that move through the area, mitigation measures are required. Given that the site is located in a water-scarce area, wetting of surfaces to minimise dust is not recommended.

(2) A typical low income Western Cape household uses approximately 1500kwh per annum. In South African households usage ranges between less than 1000kwh to over 8000kwh per year.

Construction phase

- Vehicles travelling on gravel roads will not exceed a speed of 40 km/h.
- Stockpiles of dusty materials will be enclosed or covered by suitable shade cloth or netting to prevent escape of dust during loading and transfer from site.
- Vehicles are to be kept in good working order and serviced regularly to minimise emissions.
- All directly affected and neighbouring farmers and local residents will be able to lodge grievances with Mainstream SA using the Grievance Procedure (included in the EMP) regarding dust emissions that could be linked to the Project.

Operation phase

- Vehicles travelling on gravel roads should not exceed a speed of 40 km/h.
- Regular maintenance will ensure that the facility functions optimally and generates electricity to feed into the grid thereby displacing CO_2 and contributing to a reduction in South Africa's carbon footprint.

15.1.3 Residual Impacts

If mitigation measures are implemented, the overall significance will remain low.

Table 15.2 Pre- and Post- Mitigation Significance: Perdekraal REF – Dust and Emissions

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**LOW (-VE)**	**LOW (-VE)**
Operation NEGATIVE	**LOW (-VE)**	**LOW (-VE)**
Operation POSITIVE	**LOW (+VE)**	**LOW (+VE)**

15.2 TRAFFIC IMPACT

15.2.1 Impact Description and Assessment

This section considers the impacts to traffic and road users during the construction and operation of the Perdekraal REF.

Table 15.3 Impact Characteristics: Traffic

Summary	Construction	Operation

Summary	Construction	Operation
Project Aspect/ activity	Delivery of turbine components and construction equipment. Delivery of concrete. Construction personnel commuting to and from site.	Operational personnel commuting to and from site. Delivery of replacement turbine components.
Impact Type	Direct negative	Direct negative
Stakeholders/ Receptors Affected	Road users. Affect land owner.	Road users. Affect land owner.

Construction Phase Impacts

During the construction phase of the REF, there will be an increase in vehicle movement to and from the site. This has the potential to impact on traffic along the final transport route and on the site. The site is accessed via the N1 and wind turbine components and other equipment will be brought in by road freight, from the Port of Cape Town or the Port of Saldanha. A transport study will be undertaken approximately one year prior to the commencement of construction, in order to determine the most appropriate route to transport the equipment from port to site.

The trucks delivering turbine components will be considered abnormal loads in terms of the Road Traffic Act (Act No 29 of 1989) and a permit will have to acquired from the Provincial Authority. Approximately 7 truck loads will be required per turbine:

- 1 for the nacelle;
- 3 for the turbine tower;
- 1 for the spinner, hub; and
- 2 for the blades.

Therefore, between 1183 and 2940 vehicles will be required to deliver the wind turbine components for the 169 to 230 wind turbines proposed for the site. This provides a worst-case scenario since with the adoption of Site Layout Alternative 2, the preferred and final layout, these numbers will be less. Other heavy vehicle deliveries will be made to transport transformers, cables, solar panels and construction material for the operation and maintenance building, and substation.

It is anticipated that there will not be a concrete batching plant on site, therefore, concrete trucks will make multiple, frequent deliveries to the site when the wind turbine foundations are being laid. Each foundation will take between 80 and 90 loads of concrete (assuming each load is approximately 6m^3). This will result in 8 deliveries per hour for a day for each turbine foundation.

Mainstream SA will assess the feasibility of using onsite borrow pits to obtain stone for the internal roads. This will reduce the amount of vehicle deliveries to site during road construction. However, the final road capping will be

obtained from a commercial quarry to ensure the material meets quality requirements for the road surface layer and transported to site.

The increase in traffic could create noise, dust and safety impacts for other road users and people living or working within close proximity to the roads selected transport route. In addition, the increased volume of traffic along the final transport route will increase the wear and tear on these roads and possibly lead to deterioration in road conditions.

The construction phase of the project will take approximately 12 to 18 months and during this time the impact on traffic levels will be intermittent and temporary in nature.

Box 15.5 Construction Impact: Perdekraal REF – Traffic

Nature: Construction activities that increase traffic would result in a **negative direct** impact on people who use the roads along the final transport route.

Impact Magnitude – Medium

- **Extent**: The extent of the impact is **regional** as the potential impact will extend along the selected transport route.
- **Duration**: The duration would be **short-term** for the duration of construction.
- **Intensity:** The intensity is likely to be **medium** given that the increase in traffic will temporary, but may create a nuisance and impact on the safety of other road users.

Likelihood – There is a **high** likelihood of increased traffic.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM

Degree of Confidence: The degree of confidence is **medium**.

Operation Phase Impacts

A limited number of people will be employed permanently at the site during the operation phase of the REF, these employees will have to commute to and from site on a daily basis. The REF will need to be accessed several times a month for general maintenance by one to two vehicles. Infrequent deliveries of replacement parts may be made during the lifespan of the REF. Traffic impacts associated with the operation of the facility will be largely limited to the site.

Box 15.6 Operation Impact: Perdekraal REF – Traffic

Nature: Operation activities that increase traffic would result in a **negative direct** impact on people who use the site.

Impact Magnitude – Low

- **Extent**: The extent of the impact is **local** as impact would be restricted to the site.
- **Duration**: The duration would be **long-term** for the operation of the REF.
- **Intensity:** The intensity is likely to be **low** given that the increase in traffic minimal.

Likelihood – There is a **high** likelihood of increased traffic.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW

Degree of Confidence: The degree of confidence is **high.**

15.2.2 Mitigation Measures

Design

- A transport study will be undertaken approximately one year prior to the commencement of construction to determine the most appropriate route from port to site. All necessary transportation permits will be applied for at this stage.

- Mainstream SA will develop a Traffic Management Plan including strict controls over driver training, vehicle maintenance, speed restrictions, appropriate road safety signage, and vehicle loading and maintenance measures.

Construction

- During construction, arrangements and routes for abnormal loads must be agreed in advanced with the relevant authorities and the appropriate permit must be obtained for the use of public roads.

- A grievance procedure will be established whereby any complaints by neighbours are recorded and responded to.

Operation

- During operation, if abnormal loads are required for maintenance, the appropriate arrangements will be made to obtain the necessary transportation permits and the route agreed with the relevant authorities to minimise the impact of other road users.

15.2.3 Residual Impacts

If mitigation measures are implemented, the overall significance will be reduced to Low.

Table 15.4 Pre- and Post- Mitigation Significance: Perdekraal REF - Traffic

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**MEDIUM (-VE)**	**LOW (-VE)**
Operation	**LOW (-VE)**	**NEGLIGIBLE**

15.3 WASTE AND EFFLUENT

Waste and effluent will be generated during the construction and operational phases of the REF.

15.3.1 Impact Description and Assessment

Table 15.5 Impact Characteristics: Waste and Effluent

Summary	Construction	Operation
Project Aspect/ activity	Construction activities including excavation, unpacking of turbine equipment, general eating facilities on site, general office facilities.	Maintenance activities and general office facilities.
Impact Type	Direct negative	Direct negative
Stakeholders/ Receptors Affected	Affect land owner. Surrounding habitat	Affect land owner. Surrounding habitat

Construction Phase Impacts

The construction of the REF will produce a variety of waste products. The initial solid waste generated on site will be the cleared vegetation and soil overburden. Construction rubble will be produced throughout the construction phase from activities such as the construction of roads, the construction of buildings and concrete pouring. Packaging material will be accumulated from unpacking of turbine equipment and off cuts will be produced through various construction activities. General waste will be produced by site personnel including wrapping from food, bottles and cans. Effluent will be produced from toilet facilities (temporary chemical toilets).

It is anticipated that waste and effluent will be temporarily stored on site before it is removed by an appropriate contractor. There is potential for waste and effluent stored on site to leach into the soil and/ or groundwater, causing harm to the natural environment and potentially contaminating the soil and/ or groundwater. There is a risk that silt and wash water could enter water courses on site. This is discussed further in *Section 10*.

Box 15.7 Construction Impact: Perdekraal REF – Waste and Effluent

Nature: Construction activities that produce waste would result in a **negative direct** impact on the site.

Impact Magnitude – Low

- **Extent**: The extent of the impact is **local** as impact would be restricted to the site.
- **Duration**: The duration would be **short-term** as impacts could persist after the construction of the REF.
- **Intensity:** The intensity is likely to be **low** as the construction phase is temporary and the site is sparsely populated.

Likelihood – There is a **low** likelihood that waste and effluent generated on site will impact on the soil and/ or groundwater and other site users.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW

Degree of Confidence: The degree of confidence is **high.**

Operation Phase Impacts

General waste, such as office waste, and effluent from onsite toilet facilities will be produced during the operation phase of the REF by onsite personnel. However, this will be limited as there is only likely to be 10 or 14 permanent personnel on site and a small team of personnel expected during maintenance activities.

Maintenance activities may result in the collection of used oil and hydraulic fluid, it is anticipated that this will be temporarily stored on site before being removed by an appropriate contractor. Waste produced during the operation phase will be minimal.

Box 15.8 Operation Impact: Perdekraal REF –Waste and Effluent

Nature: Operation activities that produce waste would result in a **negative direct** impact on the site.

Impact Magnitude – Low

- **Extent**: The extent of the impact is **local** as impact would be restricted to the site.
- **Duration**: The duration would be **long-term** during the operation of the REF.
- **Intensity:** The intensity is likely to be **low** as all oils and hydraulic fluids will be carefully managed and the onsite activities will be limited.

Likelihood – There is a **low** likelihood that oils and hydraulic fluid will be spilt or large quantities of general waste generated on site.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW

Degree of Confidence: The degree of confidence is **high.**

15.3.2 Mitigation Measures

The potential impacts associated with the generation of waste and effluent can be minimised through careful mitigation measure.

Design

- A suitable area for waste skips must be selected, away from water courses, and included in the site layout plan.

Construction

- All waste must be separated into skips for recycling, reuse and disposal.
- Vegetative material will be kept on site and mulched after construction to be spread over the disturbed areas to enhance rehabilitation of the natural vegetation.
- Effluent from temporary staff facilities will be collected in storage tanks, which will be emptied by a sanitary contractor.
- Effluent from concrete washings etc will be contained within a bunded area.
- All solid and liquid waste materials, including any contaminated soils, will be stored in a bunded area and disposed of by a licensed contractor.
- Effluent and stormwater run-off will be discharged away from water courses (drainage channels, streams or dams).
- Steel off-cuts will be re-used or recycled, as far as possible.
- Materials that can not be re-used or recycled will be placed in a skip and removed from site to a licensed municipal disposal site.

Operation

- Used oil stored on site must be stored in an impervious container, within a bunded area.
- General waste must be removed from site by a licensed contractor.

15.3.3 Residual Impacts

If mitigation measures given above and listed in the EMP are implemented, the overall significance will be remain low during the construction phase and negligible during the operation phase of the Perdekraal REF.

Table 15.6 Pre- and Post- Mitigation Significance: Perdekraal REF – Waste and Effluent

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**LOW (-VE)**	**LOW (-VE)**
Operation	**LOW (-VE)**	**NEGLIGIBLE**

15.4 HEALTH AND SAFETY LINKED TO CONSTRUCTION AND OPERATION ACTIVITIES

15.4.1 Impact Description and Assessment

Table 15.7 Impact Characteristics: Health and Safety

Summary	Construction	Operation
Project Aspect/ activity	Construction activities.	Operational activities
Impact Type	Direct, negative impact	Direct, negative impact
Stakeholders/ Receptors Affected	Construction personnel.	Landowner, other sites users, onsite personnel.

Construction Phase Impacts

Construction activities will involve working with heavy machinery and large turbine components. During the construction phase there will be open excavation pits on site, heavy vehicles will be moving on site and large, heavy components will need to be moved across the site, and lifted by crane (refer to *Section 4*, for a description of construction activities). These construction activities are potentially dangerous if not managed appropriately.

There is also potential for construction activities to cause driver distraction amongst road users. The large scale of the construction equipment used to install the wind turbines, together with unfamiliar site of such construction may attract driver curiosity and attention.

Box 15.9 Construction Impact: Health and Safety

Nature: The impact on health and safety will be a **direct, negative** impact.

Impact Magnitude – Low

- **Extent:** The health and safety risks linked to the construction activities will occur at the **local** level.
- **Duration:** This impact will be for the construction phase, and will therefore be for the **short-term**.
- **Intensity:** The intensity will be **low** as those who are directly affected will (in most cases) be able to adapt.

Likelihood – There is a **low** likelihood that this impact will occur during the construction phase as potential accidents can be mitigated through a health and safety plan.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW

Degree of Confidence: The degree of confidence is **Medium**

Operation Phase Impacts

It is recognised that the wind turbines may cause driver distraction among road users where the REF is close to the road. This is particularly the case given that there are few commercial wind farms operating in South Africa at present, and the REF will be a novelty to many road users. The Perdekraal site is bisected by a secondary gravel road and the turbines will be visible to raod users from approximately 15km away from the site as you approach from both directions. This means that drivers will be able to see the facility from a distance and it will gradually become clearer and more visible. Driver distraction is more severe if the driver cannot see the facility upon approach and as they come around a visual barrier, (such as a corner or rise) the REF suddenly becomes visible, this is not the case with this site.

During the operation phase there is a danger of turbine failure, which may occur for a number of reasons. One of the most common causes of turbine failure is gear box failure, which can lead to a fire given the flammable nature of the composites used to make the turbines. Structural failure may result in the turbine collapsing or a blade becoming detached and flying off the structure, this is known as "blade throw." If a turbine were to collapse onto a structure or road it could cause damage to property or harm to persons in the immediate vicinity. Modern wind turbines are fitted with electronic monitoring systems within the transmission system to reduce the risks of mechanical failure.

Box 15.10 Operational Impact: Health and Safety

Nature: The impact on health and safety will be a **direct, negative** impact.

Impact Magnitude – Low

- **Extent:** The health and safety risks linked to the operational activities will occur **on-site**.
- **Duration:** This impact will occur throughout the operational phase, and will therefore be for the **long-term**.
- **Intensity:** The intensity will be **low** as damage or injury from turbine failure can be mitigated.

Likelihood – There is **low** likelihood that this impact will occur during the operational phase given that turbine construction will meet manufacturer's specifications.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW

Degree of Confidence: The degree of confidence is **high**.

15.4.2 Mitigation

The objective of mitigation is to manage construction and operation so that impacts on health and safety risks to local residents, contractors, employees and animals are reduced.

Design

- Turbines must be spaced at least a turbine and a half's distance from another so that if one turbine collapses, it does not make contact with the nearest turbine.

- Standard buffer zones around roads, houses, and any other structures must be observed, (refer to *Section 4.6*).

Construction

- A health and safety plan must be developed prior to the commencement of construction to identify and avoid work related accidents. This plan must be adhered to by the appointed construction contractors and meet Occupational Health and Safety Act (OHSAct), Act 85 of 1993, requirements.

- The healthy and safety plan referred to in the above section must be adhered by the appointed construction contractors.

- Potentially hazardous areas must be clearly demarcated (i.e. unattended foundation excavations).

- Appropriate PPE must be worn by all construction personnel.

Operation

- Regular maintenance of turbines and all other infrastructure must be undertaken to ensure optimal functioning and reducing the chance of gearbox failure.

- Regular inspections of the turbine foundations, towers, blades, spinners and nacelle must be undertaken in order to check for early signs structural fatigue.

15.4.3 Residual Impact

The implementation of the above mitigation measures would reduce the construction and operation impacts from low to negligible. The pre- and post-mitigation impacts are compared in *Table 15.8*.

Table 15.8 Pre- and Post- Mitigation Significance: Health and Safety

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**LOW (-VE)**	**NEGLIGIBLE**
Operation	**LOW (-VE)**	**NEGLIGIBLE**

15.5 SHADOW FLICKER

15.5.1 Impact Description and Assessment

Shadow flicker is not a concern during the construction phase and only has the potential to occur during operation of the REF.

Table 15.9 Impact Characteristics: Shadow Flicker

Summary	Construction	Operation
Project Aspect/ activity	N/A	Operation of wind turbines.
Impact Type	N/A	Direct negative
Stakeholders/ Receptors Affected	N/A	Affected landowner and others people living on site.

Operation Phase Impacts

Shadow flicker is a flickering or strobing effect that moving shadows of rotating blades can cause when perceived by humans. This effect can be a nuisance, particularly when the receptor is in a building, as the effect is amplified. Flickering and strobing can potentially trigger an epileptic fit in cases of photosensitive epileptic. A survey carried out by Epilepsy Action (1) in the UK, concluded that wind turbines may create circumstances where photosensitive seizures can be triggered, however it does appear that this risk is minimal. Furthermore they state that "*newer wind turbines are usually built to operate at a frequency of 1 Hz or less. These flicker rates are unlikely to trigger a seizure.*" (2)

The following physical circumstances need to apply simultaneously before shadow flicker can occur:

- the receptor must be within 10 turbine diameters of the turbine;
- the sun must be shining;
- the wind turbine must be operating (wind speeds must therefore be at least about 2.5m s^{-1});
- the moving shadow cast by rotating blades must be seen from within a building, particularly when viewed through a narrow window;
- the orientation of the turbine and its angle of elevation to the observer must coincide with the angle and the position of the sun in relation to the building so that the shadow falls onto the receptor; and

(1) Epilepsy Action online, available at http://www.epilepsy.org.uk/campaigns/survey/windturbines
(2) Epilepsy Action online, available at http://www.epilepsy.org.uk/info/photosensitive/triggers

- since the origin of the effect is the sun, receptors that may be affected must lie to the south of the point where the sun rises and sets.

Where these circumstances pertain the exact position of shadows can be calculated very accurately for each sensitive location for the key times of day and year to determine the potential for shadow flicker.

The turbine diameter for the proposed REF will be between 70m and 120m. A receptor would therefore need to lie within 700m to 1200m to experience shadow flicker.

Buildings on the Perdekraal site include:

- the two farm houses; and
- out buildings within 50m of the Perdekraal farm house.

The farm houses and out-buildings are located approximately 780m north east of the nearest proposed turbine, and approximately 1000m south east of the next closest turbine. The remainder of the turbines located around the farm house are located over 1200km away from the house. At present there are no dwellings or other structures on adjacent properties that lie within 1200m of any turbines, therefore, it is not anticipated that shadow flicker will impact any neighbouring dwellings.

Shadow flicker is generally not considered a hazard for motorists driving past a wind farm, the variation in light intensity would be similar to driving past a row of trees or structures and this is the same distraction that motorists would need to deal with under normal circumstances. It is likely that shadows will be cast on the gravel secondary road that biscets the site, however, the conclusion drawn by a shadow flicker study undertaken for the proposed Mainstream SA wind farm development near Jeffery's Bay[1] was that these shadows were unlikely to impact on road users significantly.

[1] Analysis of Shadow Flicker on Properties in theVicinity of Jeffrey's Bay Wind Farm, South Africa prepared by Peter Barry of Malachy Walsh and Partners Engineering and Environmental Consultants and included in the EIA for the proposed project.

Box 15.11 Operational Impact: Shadow Flicker

Nature: The impact of shadow flicker will be a **direct, negative** impact.

Impact Magnitude – Low

- **Extent:** The shadow flicker will occur at the **local** level, restricted to the site and its immediate surroundings.
- **Duration:** This impact will be **long-term** throughout the operational phase of the REF.
- **Intensity:** The intensity will be **low** as there is one turbine that may cause flicker at the dwelling, and no dwelling on the adjacent farms will be affected.

Likelihood – There is a **medium** likelihood that this impact will occur during the operational phase.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW

Degree of Confidence: The degree of confidence is **low**

15.5.2 Mitigation

There is one turbine located close enough to a dwelling to potentially cause shadow flicker. Mitigation may include planting indigenous trees to provide screening from the shadow cast by the turbine.

Table 15.10 Pre- and Post- Mitigation Significance: Shadow Flicker

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**N/A**	**N/A**
Operation	**LOW (-VE)**	**NEGLIGIBLE**

15.6 ELECTROMAGNETIC INTERFERENCE

15.6.1 Impact Description and Assessment

Electromagnetic is not a concern during the construction phase and can only occur during the operation of the REF.

Table 15.11 Impact Characteristics: Electromagnetic Interference

Summary	Construction	Operation
Project Aspect/ activity	N/A	Operation of the wind turbines.
Impact Type	N/A	Direct negative
Stakeholders/ Receptors Affected	N/A	Users of communication systems.

Operation Phase Impacts

Operating wind turbines can cause electromagnetic interference (EMI). This can potentially affect communication systems including TV, radio and mobile phone transmitters, microwave links, radar and aircraft navigation beacons.

For broadcast systems, such as television, a wind farm located between a television transmitter and a receiver aerial may cause loss of picture detail, loss of colour or buzz on sound. Viewers situated to the side of a wind farm may experience a delayed image or 'ghost' on the picture, liable to flicker as the blades rotate. In some cases, a wind farm can also affect the re-broadcast link (RBL) feeding the transmitter.

Broadcast radio transmissions are received at radio receivers after radio signals have travelled through free space and often through structures. Because of this method of transmission and reception, it can be concluded that the proposed wind farm would have no detrimental effects on national or local radio in the vicinity of the proposed development.

There is the potential for rotating turbine blades to generate unwanted returns on air traffic control and defence radar displays. This may affect wind turbine developments as much as 75km away from a radar site.

There are no aerodromes located within close proximity of the Perdekraal site and no radio towers or masts were noted in within close proximity of the site.

ERM has consulted with interested and affected parties in order to identify the potential impacts associated with electromagnetic interference at and around the Perdekraal site. Comments received to date have been captured in *Table* 15.12, below and in the comments and responses report in *Annex C*.

Table 15.12 Comments received

Organisation	Comment
Air Traffic and Navigation Services Company Limited (ATNS)	From the perspective of Air Traffic Management (ATM), Communications, Navigation and Surveillance (CNS) the erection of Wind Monitoring Masts and the establishment of Wind Farms at the Perdekraal Site conforming to the specifications provided, will not have a negative impact on ATNS operations.
ICASA	ICASA stated that they are acting as a regulator and will not get involved in telecoms disturbances – This will be between the wind farm developer and the affected operator.
CAA	Awaiting feedback.

Based on comment received so far, the potential impact of electromagnetic interference from the wind turbines has been assessed below.

Box 15.12 Operational Impact: Electromagnetic Intereference

Nature: The impact of electromagnetic interference will be a **direct, negative** impact.

Impact Magnitude – Low

- **Extent:** The impact will occur at the **local** level, restrict to the site and its immediate surroundings.
- **Duration:** This impact will be **long-term** throughout the operational phase of the REF.
- **Intensity:** The intensity will be **low**.

Likelihood – There is a **medium** likelihood that this impact will occur during the operational phase.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW

Degree of Confidence: The degree of confidence is **medium**.

15.6.2 Mitigation

Appropriate mitigation measures might include the replacement of receiving aerial installations, replacement by satellite dishes or the provision of a private transmitter.

If problems do arise once the REF is operational suitable mitigation measures will be put into place, and residual impacts are not anticipated to be significant.

Table 15.13 Pre- and Post- Mitigation Significance: Electromagnetic Intereference

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	**N/A**	**N/A**
Operation	**LOW (-VE)**	**NEGLIGIBLE**

16 CUMULATIVE IMPACTS

16.1 INTRODUCTION

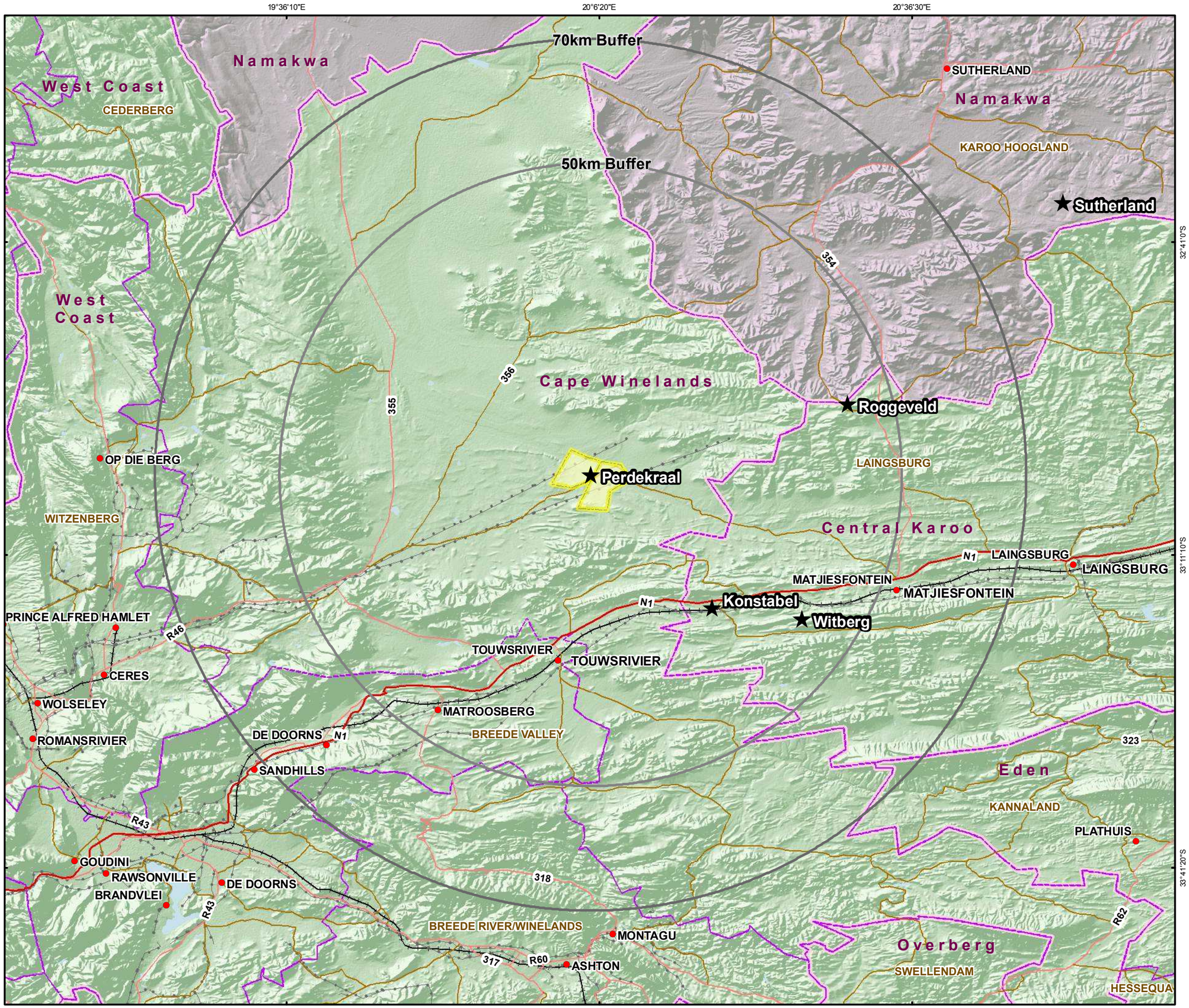
There has been a substantial increase in renewable energy developments (and wind farms in particular) recently as legislation in South Africa is evolving to facilitate the introduction of Independent Power Producers (IPPs) and renewable energy into the electricity generation mix. The focus of the renewable energy developments have largely been in the Northern, Western and Easter Cape. It has been suggested that there is presently over 6 000 MW of proposed wind energy developments in South Africa[1].

The preceding impact assessment chapters have assessed the impacts associated with the REF at Perdekraal largely in isolation. It is important to, and there is a legislated requirement to, assess cumulative impacts associated with a proposed development. The scale at which the cumulative impacts are assessed is important. For example the significance of the cumulative impact on the regional or national economy will be influence by wind farm developments throughout South Africa, while the significance of the cumulative impact on visual amenity may only be influence by wind farm developments that are in closer proximity to each other say 30km to 60km apart. At this stage it is not feasible to look at the wind farm developments at a national scale and for practical purposes a sub-regional scale has been selected. The proposed known REFs or wind farm developments in the vicinity of the proposed Perdekraal REF and their status within the development cycle at the time of this assessment are included in *Table 16.1.* The location of each of the wind farms is shown in *Figure 16.1*.

Table 16.1 Planned wind farms in the vicinity of Perdekraal

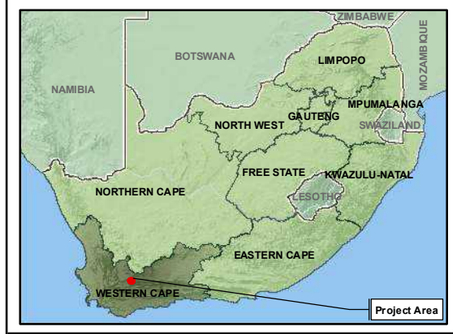
Wind Farm (Developer)	Status of EIA	No. of turbines	Distance (km)
Witberg Wind Farm (G7 Renewable Energies)	EIR Phase	Up to 60	Approx. 38km south east of Perdekraal
Konstabel Wind Farm (Mainstream SA)	EIR Phase	169 to 223	Approx. 30km south east of Perdekraal
Roggeveld Wind Farm (G7 Renewable Energies)	EIR Phase	Up to 250	Approx. 30km north west of Perdekraal
Sutherland (Mainstream SA)	EIR Phase	293 to 386	Approx 70km north east of Perdekraal
Suurplaat Wind Farm (Windlab and Moyeng)	Authorised	Approximately 400	Approx 100km north east of Perdekraal

(1) [1] http://www.engineeringnews.co.za/article/6-000-mw-of-wind-power-ready-to-be-commissioned-sawea-2010-07-23



Legend

- Towns
- Renewable Energy Facilities
- Northern Cape
- Western Cape
- District Municipalities
- Local Municipalities
- Transmission Line
- National Road
- Main Road
- Secondary Road
- Railway
- Perdekraal Land Parcel



SCALE: 0 10 20 30 Kilometers

N

TITLE:

Figure 16.1: Planned Renewable Energy Facilities in the vicinity of Perdekraal REF

CLIENT:

MAINSTREAM, SOUTH AFRICA

DATE: Feb 2011	CHECKED: TS	Project: 0108508
DRAWN: AB	APPROVED: SHC	SCALE: 1 : 650 000

DRAWING: Perdekraal_Planned_REF_Rev1.mxd | REV: 1

ERM
Building 32,
The Woodlands,
Woodlands Drive,
Woodmead, 2148
Johannesburg, South Africa
Tel: +27 (0)11 798 4300
Fax: +27 (0)11 804 2289

Projection: Geographic, Datum: Hartebeesthoek 1994
Source: Enpat (2001), Demarcation Board (Dec 2005)
Inset: ESRI Data and Maps

SIZE: A3

T:\GIS Project\0108508_Mainstream Renewable Power\Mapping\mxd\Perdekraal\Perdekraal_Planned_REF_Rev1.mxd

It is evident from *Table 16.1* and *Figure 16.1* that there are several other proposed wind farm developments in the area, at least 30km away from the Perdekraal wind farm. Perdekraal is located in a valley and is therefore geographically isolated from the proposed developments by the surrounding mountainous terrain. There is uncertainty as to whether all the above mentioned developments will implemented and it is, therefore difficult to quantitatively assess the potential cumulative impacts. It is however important to explore the potential cumulative impacts qualitatively as this will lead to a better understanding of these impacts and the possible mitigation that may be required. As these cumulative impacts are explored in more detail the trade-offs between promoting renewable energy (and the associated benefits in terms of reduction in CO_2 emissions) versus the local and regional environmental and social impacts and benefits (i.e. impacts on bird and bat populations, landscape, tourism, flora, employment etc) will become evident. It is only when these trade-offs are fully understood, that the true benefits of renewable energy can be assessed.

In the sections below we explore the potential cumulative impacts of several wind farms within a 70km radius of the Perdekraal REF. The discussion and associated conclusions must be understood in the context of the uncertainty associated with the proposed developments and the qualitative nature of the assessment.

16.2 CUMULATIVE IMPACT ON FAUNA (EXCLUDING AVIFAUNA AND BATS) AND FLORA

The renewable energy facilities listed in *Table 16.1* are located in the areas with Succulent Karoo Biome and the Fynbos Biome are intermixed. Whilst the majority of the renewable energy sites are likely to be established on existing farms where some disturbance has already occurred, there may be numerous different plant communities present, each associated with different combinations of soil depth and texture, aspect and slope, creating a wide range of potential habitats for resident biota. The sensitivity and conservation worthiness of these areas may differ.

The total land take of each facility is likely to range between 2% to 10% of the total area allocated for the facility, depending on the mix of wind and solar technologies. The majority of these facilities are likely to be placed on existing farm lands where either crop farming or grazing takes place. Apart from this, it is feasible to mitigate potential site specific negative impacts on fauna and flora by avoiding sensitive patches of vegetation/habitat within specific site boundaries. While the cumulative impact is uncertain, and assuming site specific mitigation can avoid sensitive habitats, it is unlikely that the negative cumulative impact on fauna (excluding bats and birds) and flora resulting from the development of several renewable energy facilities in proximity to the Perdekraal REF will be significant.

Farmers may become less reliant on income from stock and/or crop farming as result of increased incomes accruing to them from leasing their land to

renewable energy developers. This may result in a decrease in numbers of animals per hectare which could result in an improvement in the flora and surrounding habitat. However, should farming intensity increase (additional stock or increase in crops lands/orchards) because of the increase income, this could have a significant negative cumulative impact as additional land take may impact sensitive habitats.

16.3 CUMULATIVE SOCIO-ECONOMIC IMPACTS

Benefits to the local, regional and national economy through employment and procurement of services could be substantial should all the renewable energy facilities proceed. This benefit will increase significantly should critical mass be reached that allows local companies to develop the necessary skills to support construction and maintenance activities and that allows for components of the renewable energy facilities to be manufactured in South Africa.

The cumulative impact in terms of loss of agricultural land is unlikely to be significant due to the limited land take and in most cases agricultural activities would be allowed to proceed. Property prices in these areas are likely to increase as a result of the added value that energy generation offers. However, once the renewable energy sector is saturated, property prices that are dependant on the sense of place value rather than on the agricultural potential may be threatened due to the changes in landscape and sense of place.

16.4 CUMULATIVE VISUAL IMPACTS

Many of the sites and surrounds have a wilderness or rural farmland character, typical of the Karoo landscapes. Most of the sites are remote and sparsely populated, which adds to their attraction as getaway destinations. The sheer scale of many of the projects ranging from 100 to few hundred turbines each, along with possible solar energy installations and associated infrastructure could result in a loss of scenic views and inspiring open space related to these landscapes. The alteration of the landscape from wilderness or rural farmland character to a more industrial type character will have an impact on the sense of place which in turn could have an impact on tourisms and associated activities. A single renewable energy facility located in an area of wilderness or rural farmland character is likely to attract interest, resulting in some positive benefits. However, it is unlikely that several such facilities in relatively close proximity are like have the same outcome.

The degree of cumulative impact is a product of the number of and distance between individual wind farms, the inter-relationship between their Zones of Visual Influence (ZVI), the overall character of the landscape and its sensitivity to wind farms, and the siting and design of the wind farms

themselves[1]. Cumulative impacts need to be considered from both a visual amenity and landscape character perspective, while the impact on these may also have a bearing on the enjoyment of the natural heritage.

The cumulative impacts on visual amenity of all the renewable energy facilities, should they all be constructed, will be largely influenced by three factors[2]:

Combine effects: these occur where a static observer is able to see two or more developments from one view point within the observer's arc of vision at the same time;

Successive effects: these occur where two or more wind farms may be seen from a static view point but the observer has to turn to see them;

Sequential effects: these occur when the observer has to move to another view point, for example when travelling along a road or footpath, to see the different developments. Sequential effects may range from *frequent* (the features appear regularly and with short time lapses between, depending on speed and distance) to *occasional* (long time lapses between appearance due to the lower speed of travel and/or the longer distances between the view points.

In the context of the recommendations of the Provincial Government of the Western Cape's guideline document for wind energy developments[3] it is encouraged that large concentrated wind farms should be developed rather than small dispersed locations where the distance between large wind farms is at least 30km, and ideally exceeding 50km. In this regard, the Konstabel REF is located approximately 30km south east of the Perdekraal REF, however, the two sites are separated by a visual divide in the form of the Bontberg and Voetpadsberg Mountain Ranges. The Roggeveld REF is also approximately 30km north west of the Perdekraal REF and the two facilities are separated by the lower Roggeveld mountains.

The Perdekraal REF is located in an isolated area of the Karoo, accessed via a gravel secondary road and while there are proposed wind farms within 30km of the site, they are not in the same viewshed. It is not likely that some one travelling by road would pass the Perdekraal REF, Konstabel REF and Roggeveld Wind Farm in same journey. The cumulative visual impact and impact on landscape character resulting from the other known wind farms in the area may be less significant due to the larger distances between the facilities.

[1] Scottish Natural Heritage Guidance Cumulative Effects of Windfarms Version 2 revised 13.04.05

[3] Strategic Initiative to Introduce Commercial Land Based Wind Energy Development to the Western Cape Provincial Government of the Western Cape and CNdV Africa, 2006.

16.5 CUMULATIVE IMPACT ON BIRDS

The cumulative impact on birds as a result of the development of several wind farm facilities in close proximity could be significant. International experience shows that there is a growing concern about the cumulative impacts that wind farms can have on birds. As with the site specific impacts, cumulative impacts on bird populations could include habitat destruction due to physical footprint of wind farms, disturbance and/or displacement by construction and maintenance activities and possibly by the operation of the facilities, and mortality caused by collision with the wind turbine blades, collision with the power line network associated with the REF, and electrocution on the required power line and substation infrastructure.

While site specific mitigation can be implemented, cumulative impacts are likely to become significant when a number of wind farm developments are located in key habitat types or affect specific bird species considered as high conservation importance or species considered being vulnerable to wind farms by virtue of their behaviour or ecology[1]. Locally, only seven operational individual wind turbines exist in SA, too few to provide any meaningful data on the actual interactions of birds with wind farms[2]. This means that new proposed projects are assessed in the absence of any real local data or experience. There is a potential for cumulative impacts to be significant and more research is required to understand the uncertainties.

Discussions have been initiated between concerned NGO's (Endangered Wild Life Trust and Bird Life South Africa) and wind energy developers concerning cumulative impacts on birds. Numerous international research papers and discussion documents on the subject have been written and provide an essential platform on which to build a better understanding. As more data becomes available on the interaction with birds and wind farms in South Africa, methodologies for the assessment of cumulative will need to be developed and adapted to take cognisance of local conditions. At this stage mitigation of cumulative impacts has been limited to recommending long term monitoring before construction and during the operational phase of the wind farms.

16.6 CONCLUSION

Cumulative impacts and benefits on various environmental and social receptors will occur to varying degrees with the development of several renewable energy facilities in South Africa. The degree of significance of these

(1) [1] Scottish Natural Heritage Guidance Cumulative Effects of Windfarms Version 2 revised 13.04.05

(2) [2] https://www.ewt.org.za/WHATWEDO/OurProgrammes/WildlifeEnergyProgramme/OurProjects/WindEnergyandBirdsinSA.aspx

cumulative impacts is difficult to predict without detailed studies based on more comprehensive data/information on each of the receptors and the site specific developments.

The alignment of renewable energy developments with South Africa's National Energy Response Plan and the global drive to move away from the use of non-renewable energy resources and to reduce greenhouse gas emissions is undoubtedly positive. The economic benefits of renewable energy developments at a local, regional and national level have the potential to be significant. However, there is a lack of understanding of the cumulative impacts on other environmental and social receptors such as birds and bats, visual amenity and landscape character of the affected areas.

There is a need for strategic planning and cooperation to better understand the cumulative impacts that may result from promoting renewable energy. In this regard the Western Cape Department Environmental Affairs and Development Planning (DEA&DP) has recently initiated a Regional Strategic Environmental Assessment of Sites Suitable for Wind Farms. Furthermore, the Endangered Wildlife Trust and Bird Life South Africa have facilitated working groups to engage the wind energy sector on these issues. In order to better understand cumulative impacts, it is helpful to understand location of the various proposed and approved wind farm developments at any one time. In this regard the South African Wind Energy Association is collating spatial information on the approved and proposed wind farm developments of its members.

The impact assessment focussed on impacts associated with the construction and operational phase of the Perdekraal REF. A detailed decommissioning and rehabilitation plan should be developed prior to decommissioning the facility and associated infrastructure. This plan should include, but not be limited to, management of socio-economic aspects such as employment creation, removal, re-use and recycling of materials and vegetative rehabilitation to prevent erosion. The decommissioning activities will be similar to construction activities and therefore recommendations outlined to manage construction phase impacts should be adhered to during decommissioning. Management actions should focus on the rehabilitation of disturbed areas and the removal of infrastructure.

18 CONCLUSIONS AND RECOMMENDATIONS

18.1 OVERVIEW

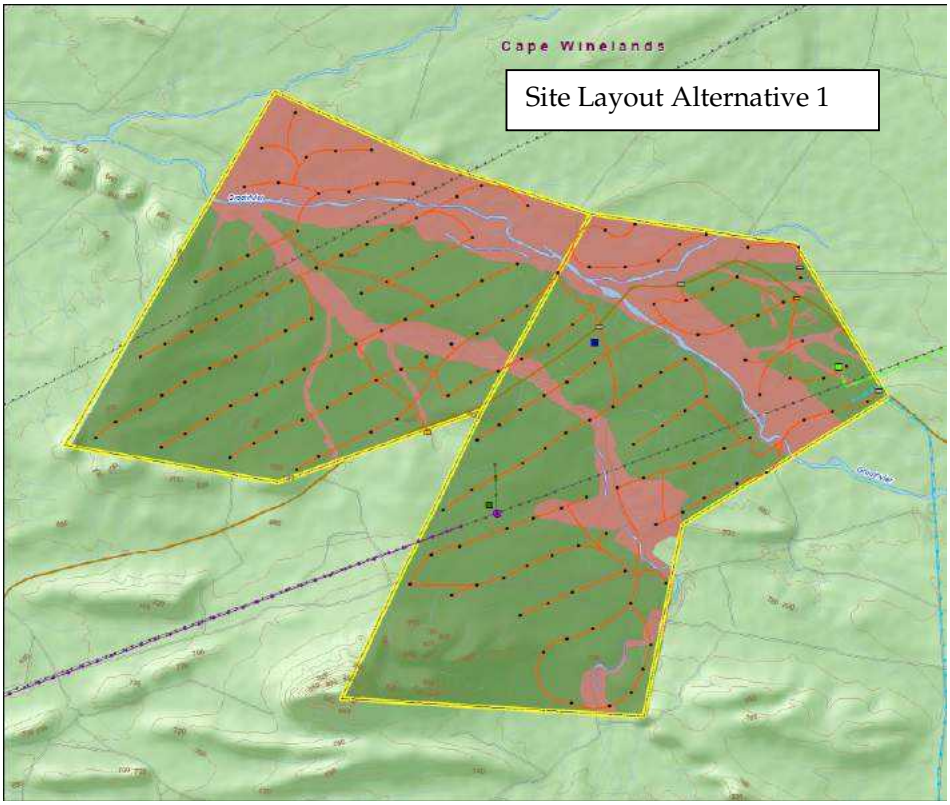
The aim of the EIA for the proposed Perdekraal REF is to provide information to facility decision-making that will contribute to environmentally sound and sustainable development.

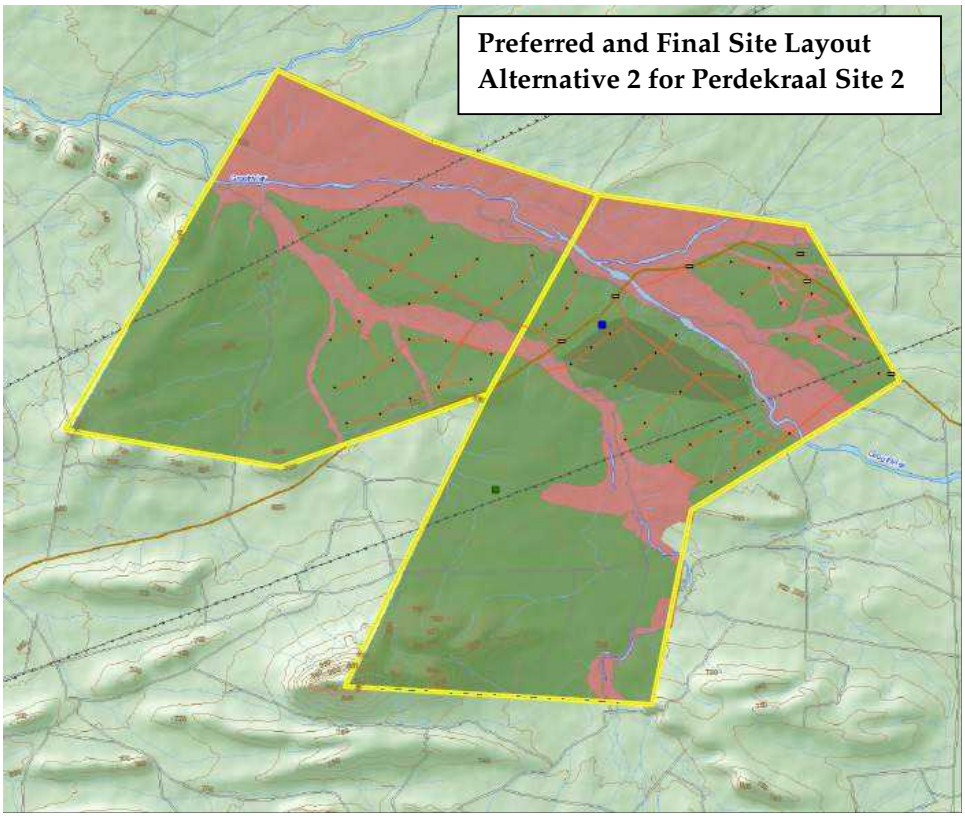
The EIA has identified and assessed a number of issues relating to Mainstream SA's proposed REF at Perdekraal. This chapter provides an overview of the EIA findings and makes recommendations regarding key mitigation measures for the **preferred Site Layout Alternative 2**.

The Site Layout Alternative 2 for Perdekraal Site 2 is based on the sensitivity of the site as established in this EIA and available wind data. *Figure 18.1* shows the site layout from Alternative 1 to Alternative 2 and illustrates how the site layout has been changed based on specialist feedback and input received during public participation activities.

Any further minor changes to the design and layout will be accommodated within the allowable zones prescribed by this EIR.

Figure 18.1 Changes made to the site layout from Alternative 1 to Alternative 2





18.1.1 Comparative assessment of Alternative 1 and 2

Below is a comparative assessment table for the layouts identified as feasible alternatives, followed by a short discussion.

Table 18.1 Comparative assessment of layout alternative 1 and 2

Aspect	Site Layout Alternative 1	Site Layout Alternative 2 for Perdekraal Site 2
Number of turbines	169 turbines	62 turbines
Electricity generation capacity	388MW output for a 2.3 MW turbine	142MW output
Flora and Fauna	Turbines are located on Sensitivity Ceres Karoo Vygieveld and riparian vegetation (the PV area is not affected) along drainage channels. This affects flora and faunal habitats.	Turbines and roads north of the Grootrivier have been removed (21 turbines removed in total) from areas characterised by Ceres Karoo Vygieveld. In addition, a further 105 turbines have been removed from sensitive drainage areas at the site in total.
Birds	Turbines located in close proximity to the dam on Rietpoort and also encroaching on the Grootrivier river bed may impact wetland birds commuting between wetland areas or along the Grootrivier.	Development has been excluded from the area around the dam and along the Grootrivier in the development of Site Layout Alternative 2.
Bats	A buffer zone around farm buildings has been maintained and will assist in avoiding impacts on bats.	A buffer zone around farm buildings and along the Grootrivier has been maintained and will assist in avoiding impacts on bats.
Soils, Surface and Groundwater	Layout alternative 1 requires additional access across the Grootrivier in the northwestern section of the site.	Layout alternative 2 does not require any additional access routes across the Grootrivier.
Noise Impact	Noise impacts on sections of the boundary and in the vicinity of the farm residences were identified with Site Layout Alternative 1.	Mitigation measures such as removing four turbines from the southeastern corner of the site, ensuring a 700m buffer around the residence and removing turbines north of the residence have been implemented in the development of Site Layout Alternative 2.
Cultural Heritage	Buffers around buildings, rivers and have, to some extent, been incorporated into Site Layout Alternative 1. Turbines are located on the palaeontologically sensitive Waaipoort Formation in the southeastern corner of the site.	Buffer around houses and onsite buildings, rivers and dams have increased. Turbines and infrastructure has been removed from the southeastern corner (5 turbines removed).

In the above table, each of the attributes for the site alternatives has been given a "green" or "red" colour. Green indicates that the attribute is favourable in relation to that particular alternative in relation to the other and red indicates that it is not favourable.

The table clearly shows that avoidance of areas based on specialist input has resulted in more favourable attributes relating to Site Layout Alternative 2 when compared to Site Alternative 1. Although **Site Layout Alternative 2** has resulted in a decreased electricity generation capacity for the project, the positive trade-off is the reduction in the environmental impacts in the table

above, through avoidance as the first step in mitigating potential impacts and this is therefore the **preferred layout alternative**.

The potential impacts associated with the development are summarised below and should be considered both in the context of the project rationale and the discussion of cumulative impacts in the previous chapter.

18.2 SUMMARY OF IMPACTS IDENTIFIED AND ASSESSED

18.2.1 Bio-physical and Socio-economic Construction Phase Impacts

During construction, the loss of vegetation and disturbance or damage to cultural heritage resources necessitates a medium-low and medium residual significance impact. The construction phase will involve site clearance for the establishment of laydown, storage areas, roads, buildings, turbines, PV arrays etc. This will involve disturbance of vegetation and excavation of foundations for turbines and roads which may disturb archaeological remains or palaeontological fossil assemblages. It is estimated that approximately 290ha or 4.5% of the total Perdekraal site will be taken up by the various components of the wind farm including hardstanding areas required during construction. The bulk of the disturbance will be on land that has been used for grazing and riparian areas and drainage channels will be avoided. However, it may be necessary for some roads to cross drainage channels and other sensitive areas, this vegetation clearance results in habitat destruction and therefore affects biodiversity. The residual impacts of "low" associated with fauna and flora is based on Mainstream SA's commitment to the implementation of mitigation measures and rehabilitation outlined in the EMP.

Rocks of the Witpoort Formation may have a high local palaeontological sensitivity and rocks of the Waaipoort Formation may contain fossil assemblages and the residual significance associated with excavations during the construction phase is medium negative.

The benefits to the local economy associated with the construction phase of the project warrants a low positive significance rating associated with the benefits from employment as well as local procurement. The civil and other construction, specialised industrial machinery and building construction sectors will benefit predominantly but also hospitality and service industries, such as accommodation, catering, cleaning, transport, vehicle servicing and security services.

A summary of the bio-physical and socio-economic impacts associated with the construction phase of the REF including their pre-mitigation and residual impacts, are given in *Table 18.2*, below.

Table 18.2 Summary of pre-mitigation and residual impacts of the bio-physical and socio-economic environment during construction

	Section	Impact	Pre-mitigation Significance	Residual Impact Significance
Flora and Fauna	7.1	Loss of natural vegetation	**HIGH-MEDIUM (-VE)**	**MEDIUM-LOW (-VE)**
	7.2	Impact on fauna	**HIGH-MEDIUM (-VE)**	**LOW (-VE)**
Birds	8.2	Habitat loss – Destruction, disturbance and displacement	**MEDIUM (-VE)**	**LOW (-VE)**
Bats	9.1	Habitat loss	**MEDIUM (-VE)**	**LOW (-VE)**
Soils, Surface and Groundwater	10.1	Loss of topsoil, compaction and erosion	**MEDIUM (-VE)**	**LOW (-VE)**
	10.2	Impact on surface and groundwater	**LOW (-VE)**	**LOW (-VE)**
Noise Impact	11.1	Construction noise	**MEDIUM (-VE)**	**LOW - MEDIUM (-VE)**
Cultural Heritage	13.1	Disturbance or damage to cultural heritage resources	**HIGH-MEDIUM (-VE)**	**MEDIUM-LOW (-VE)**
Socio-economic	14.1	Benefits to the local economy	**MEDIUM (+VE)**	**MEDIUM (+VE)**
	14.2	Increased social ills	**LOW (-VE)**	**LOW (-VE)**
	14.3	Disruption to agricultural activities	**LOW (-VE)**	**LOW (-VE)**
	14.4	Loss of agricultural land	**LOW (-VE)**	**LOW (-VE)**
	14.6	Property prices and desirability of property	**LOW (-VE)**	**LOW (-VE)**
Other Impacts	15.1	Dust and emissions	**LOW (-VE)**	**LOW (-VE)**
	15.2	Traffic	**MEDIUM (-VE)**	**LOW (-VE)**
	15.3	Waste and effluent	**LOW (-VE)**	**LOW (-VE)**
	15.4	Health and safety	**LOW (-VE)**	**NEGLIGIBLE**

18.2.2 Construction Phase Mitigation/Enhancement

Construction phase mitigation or enhancement measures are summarised below and have been incorporated into the EMP in *Annex L*.

The facility design will be finalised prior to construction based on the data gathered from the wind measuring masts and solar resource measuring stations, as well as the environmental and social considerations described in this EIR. The design phase mitigation measures which have been incorporated into the preferred layout design Site Layout Alternative 2 have been incorporated into the residual impact significance and will not be repeated in this section.

Loss of vegetation

- A botanist or ecologist will be consulted to inform the final design phase and ensure protection of sensitive vegetation and to avoid impinging on very high sensitivity areas;
- During construction in areas classified as high sensitivity areas, a botanist or ecologist will be consulted to ensure micro-siting of turbines minimises damage to or loss of sensitive flora;

- Clear demarcation during the construction phase of all undisturbed sensitive areas that are not within the direct footprint of the REF to ensure that there is no uncontrolled access by construction vehicles and labourers;
- Educate all contractors as to the importance of the undisturbed sensitive areas and importance of avoiding them;
- All vehicles will remain on designated and prepared roads;
- Temporary construction lay-down or assembly areas will be sited on transformed areas;
- Rapid regeneration of plant cover will be encouraged by setting aside topsoil during earthmoving and replacing onto areas where the re-establishment of plant cover is desirable to prevent erosion; and
- Rehabilitation or ecological restoration during and after the construction phase will be undertaken with indigenous plants with input from a botanist with experience in restoration of arid Karoo areas.

Fauna

- During construction in areas classified as high sensitivity areas, an ecologist should be consulted to ensure micro-siting of turbines minimises damage to or loss of sensitive habitat;
- Clear demarcation during the construction phase of all undisturbed sensitive areas that are not within the direct footprint of the REF to ensure that there is no uncontrolled access by construction vehicles and labourers;
- Educate all contractors as to the importance of the undisturbed sensitive areas and importance of avoiding them;
- All vehicles will remain on designated and prepared roads;
- Temporary construction lay-down or assembly areas should be sited on transformed areas; and
- Rapid regeneration of plant cover must be encouraged by setting aside topsoil during earthmoving and replacing onto areas where the re-establishment of plant cover is desirable to prevent erosion.

Birds

Habitat loss and disturbance can be mitigated during the construction phase by on-site demarcation of 'no-go' areas. These areas should be identified during pre-construction monitoring.

Bats

Construction phase impacts can be mitigated by maintaining a 500m buffer zone around potential roosts such as houses and outbuildings.

Loss of topsoil, compaction and erosion

- Restrict removal of vegetation and soil cover to those areas necessary for the development;
- Implement soil conservation measures such as stockpiling top soil for remediation of disturbed areas;

- Proper drainage controls such as culverts, cut-off trenches will be used to ensure proper management of surface water runoff to prevent erosion;
- Stockpiles should be vegetated or appropriated covered to reduce soil loss as a result of wind or water to prevent erosion;
- Disturbed areas will be rehabilitated as soon as possible to prevent erosion;
- Work areas will be clearly defined and demarcated, where necessary, to avoid unnecessary disturbance or areas outside the development footprint; and
- All vehicles will remain on designated and prepared roads.

Surface and groundwater

Mitigation measures listed above to minimise loss of topsoil, compaction and erosion will be applied and in addition:

- Fuel, oil, used oil and other hazardous material storage areas will have appropriate secondary containment (i.e. bunds);
- Spill containment and clean up kits will be available onsite and clean-up from any spill will be appropriately contained and disposed of; and
- Construction vehicles and equipment will be serviced regularly and provided with drip trays, if required.

Noise

- Mechanical equipment with lower sound power levels will be selected to ensure that permissible occupation noise-rating limit of 85 dBA is not exceeded. Construction workers and personnel will wear hearing protection when required.
- Vehicles and machines will be properly serviced and well maintained;
- Mainstream SA will require drivers to adhere to speed limits; and
- A grievance procedure will be established whereby noise complaints by neighbours are recorded and responded to.

Cultural Heritage Resources

- Prior to or during foundation excavations which may be located on the Whitehill Formation, positions and/or excavations must be inspected by a palaeontologist;
- Buffer zones around built structures should be maintained during the construction phase to prevent damage to structures of heritage interest;
- Mitigation of the pre-colonial, colonial archaeology and avoidance of marked graves which may not have been identified during the site survey should involve micro-siting prior to construction; and
- Should any human burials, archaeological or palaeontological materials (fossils, bones, artefacts etc.) be uncovered or exposed during earthworks or excavations, they must immediately be reported to the HWC and/or South African Heritage Resources Agency (SAHRA). After assessment and if appropriate a permit must be obtained from the SAHRA or HWC to remove such remains.

Socio-economic

Community Development:

- Mainstream SA should continue, as is their stated intention, to explore ways to enhance local community benefits with a focus on broad-based BEE through mechanisms such as community shareholding schemes and trusts. At this preliminary stage, and in accordance with the relevant BEE legislation and guidelines, up to four percent of after tax profit could be used for community development over and above that associated with expenditure injections into the area. As such:
    - Mainstream SA to establish a Community Development Trust for the advancement of local development needs.
    - Mainstream SA will contribute up to four percent of after tax profit to the trust.
    - Projects will be identified in collaboration with the local Municipality and community representatives to ensure alignment with the key needs identified through the Integrated Development Planning process.
    - All projects will be aligned with Mainstream SA's policies.

Employment and procurement:

- Mainstream SA will establish a recruitment and procurement policy which sets reasonable targets for the employment of South African and local residents /suppliers (originating from the local municipality) and promote the employment women as a means of ensuring that gender equality is attained. Criteria will be set for prioritising, where possible, local (local municipal) residents/suppliers over regional or national people/suppliers. All contractors will be required to recruit and procure in terms of Mainstream SA's recruitment and procurement policy.

- Mainstream SA will work closely with relevant local authorities, community representatives and organisations to ensure that the use of local labour and procurement is maximised.

- Mainstream SA to work closely with the wind turbine suppliers to provide the requisite training to the workers. The training provided will focus of development of local skills.

- Ensure that the appointed project contractors and suppliers have access to Health, Safety, Environmental and Quality training as required by the Project. This will help to ensure that they have future opportunities to provide goods and services to the sector.

- Mainstream SA and its appointed contractors to develop an induction programmes, including a Code of Conduct, for all workers (Mainstream SA and contractors including their workers) directly related to the project.

A copy of the Code of Conduct to be presented to all workers and signed by each person.

- Mainstream SA will implement a grievance procedure that is easily accessible to local communities, through which complaints related to contractor or employee behaviour can be lodged and responded to.

- Mainstream SA and its contractors will develop and implement an HIV/AIDS policy and information document for all workers directly related to the project.

- The construction workers (from outside the area) should be allowed to return home over the weekends or on a regular basis to visit their families; the contractor should make the necessary arrangement to facilitate these visits.

Dust and Emissions

- Vehicles travelling on gravel roads will not exceed a speed of 40 km/h;
- Stockpiles of dusty materials will be enclosed or covered by suitable shade cloth or netting to prevent escape of dust during loading and transfer from site;
- Vehicles are to be kept in good working order and serviced regularly to minimise emissions; and
- A grievance procedure will be established whereby complaints regarding excessive dust by neighbours are recorded and responded to.

Traffic

- A transport study will be undertaken approximately one year prior to the commencement of construction to determine the most appropriate route from port to site. All necessary transportation permits will be applied for at this stage.
- Mainstream SA will develop a Traffic Management Plan;
- During construction, arrangements and routes for abnormal loads must be agreed in advanced with the relevant authorities and the appropriate permit must be obtained for the use of public roads; and
- A grievance procedure will be established whereby any complaints by neighbours are recorded and responded to.

Waste and Effluent

- All waste must be separated into skips for recycling, reuse and disposal;
- Vegetative material will be kept on site and mulched after construction to be spread over the disturbed areas to enhance rehabilitation of the natural vegetation;
- Effluent from temporary staff facilities will be collected in storage tanks, which will be emptied by a sanitary contractor;

- Effluent from concrete washings etc will be contained within a bunded area;
- All solid and liquid waste materials, including any contaminated soils, will be stored in a bunded area and disposed of by a licensed contractor;
- Effluent and stormwater run-off will be discharged away from water courses (drainage channels, streams or dams);
- Steel off-cuts will be re-used or recycled, as far as possible; and
- Materials that can not be re-used or recycled will be placed in a skip and removed from site to a licensed municipal disposal site.

Health and Safety

- Standard safety buffer zones of at least a turbine and a half's distance from another turbine will be maintained;
- A health and safety plan must be developed prior to the commencement of construction to identify and avoid work related accidents. This plan must be adhered to by the appointed construction contractors and meet Occupational Health and Safety Act (OHSAct), Act 85 of 1993, requirements;
- Potentially hazardous areas must be clearly demarcated (i.e. unattended foundation excavations); and
- Appropriate PPE must be worn by all construction personnel.

18.2.3 Bio-physical and Socio-economic Operational Phase Impacts

Although impacts on birds and bats have not received a medium residual impact, it is important to note that pre- and post-construction monitoring is required to mitigate impacts on birds and bats. Monitoring will assist in refining the final design phase, mitigation measures and will contribute to improving knowledge of the movement of birds and bats in the area and assess actual impacts associated with the proposed development. Monitoring will begin before commencement of construction and continue into the operational phase of the facility.

The shear scale of the wind turbines and their contrast to the rural surrounding landscape has resulted in a high visual and medium-low cultural heritage impact.

Medium positive significance ratings have been assigned to benefits to the local economy associated with the operational phase of the REF. Local economy benefits are associated with direct employment opportunities (i.e. 10 to 14 full time personnel) and indirect employment and revenue generated through procurement of goods and services in the operational phase. The landowner has plans to increase production on the farm by investing the capital received from the developer into improving farm technology and substantially increasing the area of the export fruit crops (from 10 hectares to 100 hectares). These planned expansions and intensification of farming methods will create employment opportunities on the farm (approximately

100 to 250 seasonal jobs and 20 permanent jobs) and increase spending on goods and services.

The impacts associated with the REF at Perdekraal mentioned above, as well as those with low or negligible significance are summarised in *Table 18.3*, below.

Table 18.3 Summary of residual bio-physical and social residual impacts during the operational phase of the project

	Section	Impact	Pre-mitigation Significance	Residual Impact Significance
Flora and Fauna	7.1	Loss of natural vegetation	**LOW (-VE)**	**LOW (-VE)**
	7.2	Impact on fauna	**LOW (-VE)**	**LOW (-VE)**
Birds	8.1	Collisions of birds with turbines	**MEDIUM-HIGH (-VE)**	**LOW (-VE)**
	8.2	Habitat loss – Destruction, disturbance and displacement	**MEDIUM (-VE)**	**LOW (-VE)**
Bats	9.1	Habitat loss – Destruction, disturbance and displacement	**LOW (-VE)**	**LOW (-VE)**
	9.2	Collision with turbines	**MEDIUM (-VE)**	**LOW (-VE)**
	9.3	Barotrauma	**MEDIUM (-VE)**	**LOW (-VE)**
Soils, surface and groundwater	10.1	Loss of topsoil, compaction and erosion	**LOW (-VE)**	**LOW (-VE)**
	10.2	Impact on surface and groundwater	**LOW (-VE)**	**LOW (-VE)**
Noise Impact	11.2	Wind turbine noise during operation (at boundary and at sensitive receptors)	**LOW (-VE)**	**LOW (-VE)**
Visual Impact	12.1	Visual impact on fixed positions and temporary receptors	**HIGH (-VE)**	**HIGH (-VE)**
Cultural Heritage	13.2	Cultural heritage visual or sense of place	**MEDIUM (-VE)**	**MEDIUM -LOW (-VE)**
Socio-economic	14.1	Benefits to the local economy	**MEDIUM (+VE)**	**MEDIUM (+VE)**
	14.3	Disruption to agricultural activities	**LOW (-VE)**	**NEGLIGIBLE**
	14.4	Loss of agricultural land	**LOW (-VE)**	**LOW (-VE)**
	14.5	Tourism activities	**LOW (+VE)**	**LOW (+VE)**
			LOW (-VE)	**NEGLIGIBLE**
	14.6	Property prices and desirability of property	**LOW (-VE)**	**LOW (-VE)**
Other Impact	15.1	Dust and emissions	**LOW (-VE)**	**LOW (-VE)**
	15.2	Traffic	**LOW (-VE)**	**NEGLIGIBLE**
	15.3	Waste and effluent	**LOW (-VE)**	**NEGLIGIBLE**
	15.4	Health and safety	**LOW (-VE)**	**NEGLIGIBLE**
	15.5	Shadow flicker	**LOW (-VE)**	**NEGLIGIBLE**
	15.6	Electromagnetic interference	**LOW (-VE)**	**NEGLIGIBLE**

18.2.4 Operational Phase Mitigation/Enhancement

Loss of vegetation and fauna

- Laydown or infrastructure assembly areas which will not be required during the operational phase of the facility and the PV area will be re-vegetated with indigenous vegetation to prevent erosion;
- On-site employees, farm workers and visitors to the site will be informed of the importance of the conservation of vegetation. This will include strict guidelines for remaining on existing roads while on site to avoid unnecessary destruction or damage to undisturbed and rehabilitated vegetation;
- A fire management policy and guidelines will be developed to ensure that the operation of the REF is compatible with the long-term fire ecology of the site; and
- Where possible enhance flora on the site through rehabilitation or ecological restoration using indigenous plants with input from a botanist with experience in restoration of arid Karoo areas.

Birds

- Using modern turbine designs which discourage birds from perching on turbine towers or blades;
- Ensuring that lighting on the turbines is kept to a minimum (but in line with aviation regulations);
- Implement pre- and post construction monitoring and operational monitoring as detailed in the EMP;
- Carefully monitoring collision incidence and investigating appropriate mitigation measures, when required; and
- Scheduling maintenance activities to avoid disturbances to sensitive areas (identified through operational monitoring) during breeding season.

Bats

- Operational phase impacts can be mitigated by maintaining a 500m buffer zone around potential roosts such as houses and outbuildings; and
- Carefully monitoring collision incidence for up to two years to determine actual impacts and investigate appropriate mitigation measures, when required.

Loss of topsoil, compaction and erosion

- Laydown or infrastructure assembly areas which will not be required during the operational phase of the facility and the PV area will be re-vegetated with indigenous vegetation to prevent erosion.

Surface and groundwater

- Fuel, oil and used oil storage areas will have appropriate secondary containment (ie bunds); and

- Areas disturbed during construction will be re-vegetated with indigenous vegetation to prevent erosion.

Noise

The noise levels generated by the facility during operation must comply with the Noise Control Regulations.

Visual

- Signage related to the REF must be discrete and confined to entrance gates; and
- Design buffers incorporated into Site Layout Alternative 2 and exclusion zones such as ridges and rock outcrops will be maintained.

Socio-economic

Operational phase socio-economic mitigations will be the same as those listed above for the construction phase, see above with some additional enhancement measures outlined below.

- Mainstream SA will work with the Local Municipality and local tourism organisations to raise awareness about the renewable energy facility.

- Mainstream SA will establish a information kiosk/notice board on the site boundary or entrance to facilitate educating the public about the need and benefits of project. This is aimed at instilling the concept of sustainability and creating awareness by engaging the community and local schools. Information brochures and posters will be made available at the kiosk that provide more information about the facility. These should be presented in the appropriate languages to maximise the benefits.

Dust and Emissions

- Vehicles travelling on gravel roads should not exceed a speed of 40 km/h.

Traffic

- During operation, if abnormal loads are required for maintenance, the appropriate arrangements will be made to obtain the necessary transportation permits and the route agreed with the relevant authorities to minimise the impact of other road users.

Waste and Effluent

- Used oil stored on site must be stored in an impervious container, within a bunded area; and
- General waste must be removed from site by a licensed contractor.

Health and Safety

- Regular maintenance of turbines and all other infrastructure must be undertaken to ensure optimal functioning and reducing the chance of gearbox failure; and
- Regular inspections of the turbine foundations, towers, blades, spinners and nacelle must be undertaken in order to check for early signs structural failure.

Shadow Flicker

A shadow flicker study will be undertaken if the cottages on the south eastern portion of the site are likely to be occupied during operation of the REF and if the final layout results in turbines being located within a distance of 10 blade diameters of occupied dwellings.

Electromagnetic Interference

Appropriate mitigation measures might include the replacement of receiving aerial installations, replacement by satellite dishes or the provision of a private transmitter.

18.3 RECOMMENDATIONS

The implementation of the mitigation measures outlined above and included in the Environmental Management Plan, including additional pre-construction monitoring will provide a basis for ensuring that the potential positive and negative impacts associated with the establishment of the Perdekraal REF are enhanced and mitigated. Uncertainties around cumulative impacts associated with similar developments in the vicinity of Perdekraal and the growth of the renewable energy sector requires strategic planning and cooperation on a provincial and national level with input from developers, organisations such as the Endangered Wildlife Trust, Bird Life South Africa and other stakeholders.

Based on the findings of this assessment, there is no reason why the proposed Perdekraal Site 1 renewable energy facility should not be authorised contingent that the mitigations and monitoring for potential environmental and social impacts are implemented.

A.J. Mitchell Jones, 2004. English Nature, Bat Mitigation Guildlines.

Acha, A. 1997. Negative impact of wind generators on the Eurasian Griffon *Gyps fulvus* in Tarifa, Spain. *Vulture News* 38:10-18

Anderson, M.D. 2001. The effectiveness of two different marking devices to reduce large terrestrial bird collisions with overhead electricity cables in the eastern Karoo, South Africa. Draft report to Eskom Resources and Strategy Division. Johannesburg. South Africa.

Arnett, E.B., Brown, K., Erickson, W.P., Fiedler, J., Henry, T.H., Johnson, G.D., Kerns, J., Kolford, R.R., Nicholson, C.P., O'Connell, t., Piorkowski, M., Tankersly, J.R., 2008. Patterns of fatality of bats at wind energy facilities in North America. *Journal of Wildlife Management* 72:61–78.

Avian Powerline Interation Committee (APLIC). 1994. Mitigating bird collisions with power lines: the state of the art in 1994. Edison Electric Institute. Washington DC.

Baerwald, E.F., Barclay, R.M.R., 2009. Geographic variation in activity and fatality of migratory bats at wind energy facilities. *Journal of Mammalogy*, 90(6), 1341–1349.

Baerwald, E.F., D'Amours, G.H., Klug, B.J., Barclay, R.M.R. 2008. Barotrauma is a significant cause of bat fatalities at wind turbines. *Current Biology* 18(16), R695-R696.

Baerwald, E.F., Edworthy, J., Holder, M., Barclay, R.M R., 2009. A large-scale mitigation experiment to reduce bat fatalities at wind energy facilities. *Journal of Wildlife Management* 73(7), 1077–1081.

Barclay, R. M. R., Baerwald, E. F., Gruver, J.C., 2007. Variation in bat and bird fatalities at wind energy facilities: assessing the effects of rotor size and tower height. *Canadian Journal of Zoology* 85:381–387.

Barrios, L. & Rodríguez, A. 2004. Behavioural and environmental correlates of soaring-bird mortality at on-shore wind turbines. *Journal of Applied Ecology* 41: 72-81.

Barnes, K.N. (ed.) 1998. The Important Bird Areas of southern Africa. BirdLife South Africa, Johannesburg.

Barnes, K.N. (ed.) 2000. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg.

Bevanger, K. 1994. Bird interactions with utility structures: collision and electrocution, causes and mitigating measures. *Ibis* 136: 412-425.

Bevanger, K. 1995. Estimates and population consequences of Tetraonid mortality caused by collisions with high tension power lines in Norway. *Journal of Applied Ecology* 32: 745-753.

Bevanger, K. 1998. Biological and conservation aspects of bird mortality caused by electric power lines. *Biological Conservation* 86: 67-76.

BirdLife International (2009) (i) *Important Bird Area factsheet: Anysberg, South Africa*. Downloaded from the Data Zone at http://www.birdlife.org on 7/1/2010.

Branch W.R. 1998. *Field guide to snakes and other reptiles of southern Africa*. Struik, Cape Town.

Bright, J., Langston, R., Bullman, R. Evans, R., Gardner, S., & Pearce-Higgins, J. 2008. Map of bird sensitivities to wind farms in Scotland: A tool to aid planning and conservation. *Biological Conservation* 141: 2342-2356.

Brownlie, S. 2005. Guideline for involving biodiversity specialists in EIA processes: Edition 1. *CSIR Report No. ENV-S-C 2005-053 C*. Provincial Government of the Western Cape: Department of Environmental Affairs and Development Planning.

Breede River/ Winelands Local Municipality: *Integrated Development Plan*, 2007-2011

Cape Birding Route website
http://www.capebirdingroute.org/West_Coast.htm accessed January 2010.

Cape Nature, Anysberg Reserve:
http://www.capenature.org.za/reserves.htm

Cape Town Tourism:
http://www. www.capetowntourism.co.za

Cape Winelands Biosphere
http://www. capewinelandsbiosphere.co.za

Cape Winelands District Municipality: *Integrated Development Plan*, 2007 - 2011

Cape Winelands District Municipality IDP Review, 2005/6
http://www.capewinelands.gov.za/

Central Karoo District Municipality: *Integrated Development Plan*, 2006 -2011

Central Karoo District Municipality*: Central Karoo Nodal Economic Development Profile*, No Date

CNdeV Africa: A Strategic Initiative to Introduce Commercial and Land Based Wind Energy Development to the Western Cape (2006) as quoted in *Draft Proposed Renewable Energy Facilities in the Westerns and Northern Cape by Mainstream SA* Visual Baseline Report, prepared by B Oberholzer and Q Lawson , July 2010 page 15.

Crockford, N.J. 1992. A review of the possible impacts of wind farms on birds and other wildlife. Joint Nature Conservation Committee. JNCC Report number 27. Peterborough, United Kingdom.

Cryan, P.M., 2008. Mating behavior as a possible cause of bat fatalities at wind turbines. *Journal of Wildlife Management* 72:845–849.

Curry, R.C., & Kerlinger, P. 2000. Avian mitigation plan: Kenetech model wind turbines, Altamont Pass WRA, California. In: Proceedings of the National Avian-Wind Power Planning Meeting III, San Diego California, May 1998.

Curtis, O., Simmons, R.E. & Jenkins, A.R. 2004. Black Harrier *Circus maurus* of the Fynbos biome, South Africa: a threatened specialist or an adaptable survivor? *Bird Conservation International* 14: 233-245.

De Lucas, M., Janss, G.F.E., Whitfield, D.P. & Ferrer, M. 2008. Collision fatality of raptors in wind farms does not depend on raptor abundance. *Journal of Applied Ecology* 45: 1695-1703.

De Villiers, C.C. Driver, A. Clark, B. Euston-Brown, D.I.W. Day, E.G. Job, N. Helme, N.A. Holmes, P. M. Brownlie, S. and Rebelo, A. G. 2005. *Fynbos Forum Ecosystem Guidelines for Environmental Assessment in the Western Cape*. Fynbos Forum, Cape Town 94pp.

Devereaux, C/L., Denny, M.J.H. & Whittingham, M.J. 2008. Minimal effects of wind turbines on the distribution of wintering farmland birds. *Journal of Applied Ecology* 45: 1689-1694.

Drewitt, A.L. & Langston, R.H.W. 2006. Assessing the impacts of wind farms on birds. *Ibis* 148: 29-42.

Drewitt, A.L. & Langston, R.H.W. 2008. Collision effects of wind-power generators and other obstacles on birds. *Annals of the New York Academy of Science* 1134: 233-266.

Dürr, T., Bach, L., 2004. Bat deaths and wind turbines—a review of current knowledge, and of the information available in the database for Germany. *Bremer Beiträge für Naturkunde und Naturschutz* 7:253–264.

Dwyer, P.D., 1965. The population pattern of Miniopterus schreibersii (Chiroptera) in north-eastern New South Wales. *Australian Journal of Zoology* 14, 1073-1137.

Erickson, W.P., Johnson, G.D., Strickland, M.D., Young, D.P., Sernka, K.J., Good, R.E. 2001. Avian collisions with wind turbines: a summary of existing studies and comparison to other sources of avian collision mortality in the United States. National Wind Co-ordinating Committee Resource Document.

Erickson, W.P., Johnson, G.D., Strickland, M.D., Kronner, K. & Becker, P.S. 1999. Baseline avian use and behaviour at the CARES Wind Plant Site, Klickitat County, Washington. Unpublished report to the National Renewable Energy Laboratory. NREL, Colorado.

Everaert, J. 2003. Wind turbines and birds in Flanders: Preliminary study results and recommendations. *Natuur. Oriolus* 69: 145-155.

Farfán, M.A., Vargas, J.M. & Duarte, J. 2009. What is the impact of wind farms on birds. A case study in southern Spain. *Biodiversity Conservation* 18: 3743-3758.

Figure: Image showing the proposal in relation to heritage resources on the Perdekraal site: Source Patrick &, Beuster Clarke and Associates. NID Renewable Energy Facilities Perdekraal 2010

Friedmann Y. & Daly B. (eds) 2004. *Red Data Book of the mammals of South Africa: a conservation assessment*. CBSG Southern Africa, Conservation Breeding Specialist Group (SSC/IUCN), Endangered Wildlife Trust, South Africa.

Gill, J.P., Townsley, M. & Mudge, G.P. 1996. Review of the impact of wind farms and other aerial structures upon birds. *Scottish Natural Heritage Review* 21.

Gunerhan, H., Hepbasli, A. & Giresunli, U. 2009. Environmental impacts from the solar energy systems. *Energy Sources, Part A: Recovery, Ulilization and Environmental Effects* 31: 131-138.

H Fransen The Old Buildings of the Cape , Jonathan Ball Publishers Cape Town 2004 pp 544-547

Hanowski, J.M., & Hawrot, R.Y. 2000. Avian issues in development of wind energy in western Minnesota. In Proceedings of the National Avian-Wind Power Planning Meeting III, San Diego California, May 1998.

Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V & Brown, C.J. (eds). 1997. The atlas of southern African birds. Vol. 1&2. BirdLife South Africa, Johannesburg.

Hockey, P.A.R., Dean, W.R.J., Ryan, P.G. (Eds) 2005. Roberts – Birds of Southern Africa, VIIth ed. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

Hodos, W. 2002. Minimization of motion smear: Reducing avian collisions with turbines. Unpublished subcontractor report to the National Renewable Energy Laboratory. NREL/SR 500-33249.

Horn, J.W., Arnett, E. B., Kunz. T.H., 2008. Behavioral responses of bats to operating wind turbines. *Journal of Wildlife Management* 72:123–132.

iKapa Enviroplan (2007) *Cape West Coast Biosphere Reserve Spatial Development Plan Status Quo Report (Draft)*, Cape West Coast Biosphere.

Howell, J.A. 1995. Avian mortality at rotor sweep areas equivalents Altamont Pass and Montezuma Hills, California. Prepared for Kenetech Wind Power, San Francisco, California.

IUCN 2010. IUCN Red List of Threatened Species Version 2010.2, www.iucnredlist.org accessed in July 2010.

Jacobs, D.S., Barclay, R.M.R., 2009. Niche differentiation in two sympatric sibling bat species, *Scotophilus dinganii* and *Scotophilus mhlanganii*. *Journal of Mammalogy* 90(4), 879–887.

Janss, G. 2000a. Bird behaviour in and near a wind farm at Tarifa, Spain: Management considerations. In: Proceedings of National Avian-Wind Power Planning Meeting III, San Diego California, May 1998.

Janss, G.F.E. 2000b. Avian mortality from power lines: a morphologic approach of a species-specific mortality. *Biological Conservation* 95: 353-359.

Jaroslow, B. 1979. A review of factors involved in bird-tower kills, and mitigation procedures. In: G.A. Swanson (Tech co-ord). The Mitigation symposium. A national workshop on mitigation losses of Fish and Wildlife Habitats. US Forest Service General Technical Report. RM-65.

Jenkins, A.R. 1994. The influence of habitat on the distribution and abundance of Peregrine and Lanner Falcons in South Africa. Ostrich 65: 281-290.

Jenkins, A.R. 2001. The potential impact of a demonstration wind farm facility on the birds of the Darling / Yzerfontein area, Western Cape Province, South Africa. Unpublished report to the Environmental Evaluation Unit, University of Cape Town, Cape Town.

Jenkins, A.R. 2003. Populations and movements of priority bird species in the vicinity of the proposed Darling Demonstration Wind Farm facility. Unpublished report to the Environmental Evaluation Unit, University of Cape Town, Cape Town.

Jenkins, A.R. 2008a. Eskom generation wind energy facility – Western Cape: Avifaunal impact assessment. Report to Savannah Environmental Pty (Ltd).

Jenkins, A.R. 2008b. Environmental impacts on birds of Eskom's proposed 66 kV overhead power line between the Skoongesig substation and St Helena Bay, with comments on the preferred line route. Report to EnviroAfrica.

Jenkins, A.R. 2008c. A proposed new list of the threatened raptors of southern Africa. Gabar 19 (1): 27-40.

Jenkins, A.R. 2009. Hopefield wind energy facility: avifaunal impact assessment. Report to Savannah Environmental Pty (Ltd).

Jenkins, A.R., de Goede, J.H. & van Rooyen, C. 2007. Improving the products of the Eskom Electric Eagle Project. Unpublished report to Eskom.

Jenkins, A., Gibbons, B. & Visagie, R. 2009. Long-term fixed site monitoring of wildlife interactions with power lines across a range of biomes: establishment and maintenance of a long-term bird;power line interaction monitoring site in the De Aar (Hydra) area of the eastern Karoo, Northern Cape. Unpublished report to Eskom.

Jenkins, A.R., Smallie, J.J. & Diamond, M. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. *Bird Conservation International*. Published online 19 March 2010.

Kemper, C.A. 1964. A tower for TV: 30 000 dead birds. *Audubon Magazine* 66: 86-90.

Kerlinger, P. & Dowdell, J. 2003. Breeding bird survey for the Flat Rock wind power project, Lewis County, New York. Prepared for Atlantic Renewable Energy Corporation.

King, D.I. & Byers, B.E. 2002. An evaluation of powerline rights-of-way as habitat for early-successional shrubland birds. *Wildlife Society Bulletin* 30: 868-874.

Kingsley, A. & Whittam, B. 2005. Wind turbines and birds – A background review for environmental assessment. Unpublished report for Environment Canada/Canada Wildlife Service.

Krijgsveld, K.L., Akershoek, K., Schenk, F., Dijk, F. & Dirksen, S. 2009. Collision risk of birds with modern large wind turbines. *Ardea* 97: 357-366.

Küyler, E.J. 2004. The impact of the Eskom Wind Energy Demonstration Facility on local avifauna – Results from the monitoring programme for the time period June 2003 to Jan 2004. Unpublished report to Eskom Peaking Generation.

Kuvlevsky, W.P. Jnr, Brennan, L.A., Morrison, M.L., Boydston, K.K., Ballard, B.M. & Bryant, F.C. 2007. Wind energy development and wildlife conservation: challenges and opportunities. *Journal of Wildlife Management* 71: 2487-2498.

Larsen, J.K. & Guillemette, M. 2007. Effects of wind turbines on flight behaviour of wintering common eiders: implications for habitat use and collision risk. *Journal of Applied Ecology* 44: 516-522.

Lehman, R.N., Kennedy, P.L. & Savidge, J.A. 2007. The state of the art in raptor electrocution research: a global review. *Biological Conservation* 136: 159-174.

Madders, M. & Whitfield, D.P. 2006. Upland raptors and the assessment of wind farms impacts. *Ibis* 148: 43-56.

Masden, E.A., Fox, A.D., Furness, R.W., Bullman, R. & Haydon, D.T. 2009. Cumulative impact assessments and bird/wind farm interactions: Developing a conceptual framework. *Environmental Impact Assessment Review* 30: 1-7.

Malan, G. 2009. Raptor survey and monitoring – a field guide for African birds of prey. Briza, Pretoria.

McIsaac, H.P. 2001. Raptor acuity and wind turbine blade conspicuity. Pp. 59-87. National Avian-Wind Power Planning Meeting IV, Proceedings. Prepared by Resolve, Inc., Washington DC.

Mitchell-Jones, T and Carlin, C. 2009. Bats and onshore wind turbines, Interim guidance, Natural England Technical Information Note TIN051, 9pp accessed from www.naturalengland.org.uk in April 2010.

Mucina. L. & Rutherford, M.C. (Eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

Mucina, L., Rutherford, M.C., & Powrie, L.W. (Eds.). 2005. Vegetation map of South Africa, Lesotho, and Swaziland 1:1 000 000 scale sheet maps. South African National Biodiversity Institute, Pretoria. ISBN 1-919976-22-1.

National Wind Co-ordinating Committee. 2004. Wind turbine interactions with birds and bats: A summary of research results and remaining questions. Fact Sheet, Second Edition.

Newton, I. & Little, B. 2009. Assessment of wind-farm and other bird casualties from carcasses found on a Northumbrian beach over an 11-year period. *Bird Study* 56: 158-167.

New York State, Wind Energy Toolkit. Prepared by: AWS Truewind, LLC

Noguera, J.C., Pérez, I. & Mínguez, E. 2010. Impacts of terrestrial wind farms on diurnal raptors: developing a spatial vulnerability index and potential vulnerability maps. *Ardeola* 57: 41-53.

Noss R.F. 1990. Indicators for Monitoring Biodiversity: A Hierarchical Approach. *Conservation Biology*, Vol. 4, No. 4 (Dec., 1990), pp. 355-364

Oberholzer, B. 2005. Guidelines for Involving Visual and Aesthetic Specialists in EIA Process. Edition 1. CSIR Report NO.ENV-S-C 2005 053 F Provincial Government of the Western Cape, Department of Environmental Affairs and Development Planning, Cape Town

Passmore, N.I. & Carruthers, V.C. 1995. *South African Frogs: A complete guide*. Witwatersrand University Press, Johannesburg. 322 pp.

Pennycuick, C.J. 1989. Bird flight performance: a practical calculation manual. Oxford University Press, Oxford.

Pierce-Higgins, J.W., Stephen, L., Langston, R.H.W., Bainbridge, I.P. & Bullman, R. 2009. The distribution of breeding birds around upland wind farms. *Journal of Applied Ecology*, Published Online, September 24, 2009.

Provincial Government of the Western Cape and CNdV Africa, 2006. Stategic Initiative to Introduce Commercial Land Based Wind Energy Development to the Western Cape. Issued by Provincial Government of the Western Cape

Rabe, M.J., Siders M.S., Miller, C.R., Snow, T.K., 1998. Long foraging distance for a spotted bat (*Euderma maculatum*) in northern Arizona. *The Southwestern Naturalist* 3(2):266-286

Rebelo, A.G., Boucher, C., Helme, N., Mucina, L. & Rutherford, M.C. 2006. Fynbos Biome. In: Mucina, L. & Rutherford, M.C. 2006. (eds.)The Vegetation of South Africa. Lesotho & Swaziland. *Strelitzia 19*. South African National Biodiversity Institute, Pretoria. pp. 53 – 219.

Renewable Energy Technologies
http://www.scotland.gov.uk/publications/2002/02/pan45/pan-45

Richardson, W.J. 2000. Bird migration and wind turbines: Migration timing, flight behaviour and collision risk. In Proceedings of the National Avian-wind Power Planning Meeting III, San Diego, California, May 1998.

Rodrigues, L.L, Bach, M.J., Dubourg-Savage, Goodwin, J. and Harbusch, C. 2008. Guidelines for consideration of bats in wind farm projects. EUROBATS Publication Series No. 3(English version). UNEP/EUROBATS Secretariat, Bonn, Germany, 51pp.

Rossing, T.D., 1990. The Science of Sound. 2nd Edition. Addison-Wesley

Rouget, M., Reyers, B., Jonas, Z., Desmet, P., Driver, A., Maze, K., Egoh, B. & Cowling, R.M. 2004. *South African National Spatial Biodiversity Assessment 2004*: Technical Report. Volume 1: Terrestrial Component. Pretoria: South African National Biodiversity Institute.

Rouget, M., Reyers, B., Jonas, Z., Desmet, P., Driver, A., Maze, K., Egoh, B. & Cowling, R.M. 2004. *South African National Spatial Biodiversity Assessment 2004: Technical Report. Volume 1: Terrestrial Component.* Pretoria: South African National Biodiversity Institute.

SANS 10328:2008, Methods for Environmental Noise Impact Assessments.

SANS 10103:2008, The Measurement and rating of environmental noise with respect to annoyance and to speech communication.

Section 34 NHRA 1999.

Scottish National Heritage. 2005. Survey methods for use in assessing the impacts of onshore windfarms on bird communities. Unpublished Report.

Schnitzler, H-U., Kalko, E.K.V., 1998. How echolocating bats search and find food. In: Kunz TH, Racey PA, eds. Bat Biology and Conservation. Washington DC: Smithsonian Institution Press. pp 183–196.

Shaw, J., Jenkins, A.R. & Ryan, P.G. 2010a. Modelling power line collision risk in the Blue Crane *Anthropoides paradiseus* in South Africa. *Ibis* 152: 590-599.

Shaw, J., Jenkins, A.R., Ryan, P.G. & Smallie, J. 2010b. A preliminary survey of avian mortality on power lines in the Overberg, South Africa. *Ostrich* 81: 109-113.

Skinner J.D. & Chimimba C.T. (eds) 2005. *The Mammals of the Southern African Subregion.* Van der Horst D. (Ed.). Third Edition. Cambridge University Press, Cambridge.

Smallwood, K.S. & Thelander, C. 2008. Bird mortality in the Altamont Pass Wind Resource Area, California. *Journal of Wildlife Management* 72: 215-223.

Smallwood, K.S., Rugge, L. & Morrison, M.L. 2009. Influence of behavior on bird mortality in wind energy developments. *Journal of Wildlife Management* 73: 1082-1098.

Sovacool, B.K. 2009. Contextualizing avian mortality: a preliminary appraisal of bird and bat fatalities from wind, fossil-fuel, and nuclear electricity. *Energy Policy* 37: 2241-2248.

Statistics South Africa; *Community Survey*, 2007

Statistics South Africa; Census 2001; Digital Census Atlas: Dominant* Population Group , 2001
http://www.statssa.gov.za/census2001/digiAtlas/index.html.

Stewart, G.B., Pullin, A.S. & Coles, C.F. 2007. Poor evidence-base for assessment of windfarm impacts on birds. *Environmental Conservation* 34: 1-11.

Tapia, L., Dominguez, J. & Rodriguez, L. 2009. Using probability of occurrence to assess potential interaction between wind farms and a residual population of golden eagle *Aquila chrysaetos* in NW Spain. *Biodiversity & Conservation* 18: 2033-2041.

Taylor, P.J., 2000. Bats of southern Africa. University of Natal Press, Pietermaritzburg.

Tsoutsos, T., Frantzeskaki, N., Gekas, V. 2005. Environmental impacts from solar energy technologies. *Energy Policy* 33: 289-296.

UNESCO (2005) Operational Guidelines for the Implementation of the World Heritage Convention UNESCO World Heritage Centre. Paris. Page 83.

Van der Merwe, M., 1973. Aspects of hibernation and winter activity of the Natal clinging bat, Miniopterus schreibersi natalensis (A. Smith 1834), on the Transvaal Highveld. *South African Journal of Science* 69, 116-118.

Van der Merwe, M., 1975. Preliminary study on the annual movements of the Natal clinging bat. *South African Journal of Science* 71, 237-241.

Van Rooyen, C. 2001. Bird Impact Assessment Study – Eskom Wind Energy Demonstration Facility, Western Cape South Africa. Prepared for Eskom Enterprises, TSI Division.

Van Rooyen, C.S. 2004a. The Management of Wildlife Interactions with overhead lines. In The fundamentals and practice of Overhead Line Maintenance (132kV and above), pp217-245. Eskom Technology, Services International, Johannesburg.

Van Rooyen, C.S. 2004b. Investigations into vulture electrocutions on the Edwardsdam-Mareetsane 88kV feeder, Unpublished report, Endangered Wildlife Trust, Johannesburg.

Walker, D., McGrady, M., McCluskie, A., Madders, M. & McLeod, D.R.A. 2005. Resident Golden Eagle ranging behavior before and after construction of a windfarm in Argyll. *Scottish Birds* 25: 24-40.

Weir, R. D. 1976. Annotated bibliography of bird kills at manmade obstacles: a review of the state of the art and solutions. Canadian Wildlife Services, Ontario Region, Ottawa.

Winkelman, J.E. 1995. Bird/wind turbine investigations in Europe. In Proceedings of the National Avian- wind Power Planning Meeting 1994.

Young, D.J., Harrison, J.A., Navarro, R.A., Anderson, M.D. & Colahan, B.D. (eds). 2003. Big birds on farms: Mazda CAR report 1993-2001. Avian Demography Unit, Cape Town.

World Health Organisation. 2002. Protection of the Human Environment; Guidelines for community noise. Chapter 4, Guideline Values

Annex A: Maps and Figures
Annex B: Photographs
Annex C: Public Participation documentation
Annex D: DEA acceptance of Scoping
Annex E: Vegetation Specialist Report
Annex F: Ecology Specialist Report
Annex G: Bird Specialist Report
Annex H: Bat Specialist Report
Annex I: Noise Specialist Report
Annex J: Visual Specialist Report
Annex K: Heritage Specialist Report