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A SPECIALIST REPORT ON THE SOILS, LAND USE, AGRICULTURAL POTENTIAL AND LAND CAPABILITY FOR THE PROPOSED RENEWABLE ENERGY GENERATION PROJECT ON THE FARM RHODES 269, NORTHERN CAPE PROVINCE

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SOILS AND LAND CAPABILITY REPORT

April 2016

Conducted on behalf of:

Miko Energy (Pty) Ltd

Compiled by:

Dr. BJ Henning (PhD plant Ecology; M.Sc Botany - Soil Science related Pr.Sci.Nat)

Reviewed by:

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Ms. E. Grobler	AGES Limpopo

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Declaration

I, Barend Johannes Henning, declare that -

- I act as the independent specialist;
- I will perform the work relating to the project in an objective manner, even if this results in views and findings that are not favourable to the project proponent;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this project, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998; the Act), regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in Regulation 8;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the project proponent and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the project; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority or project proponent;
- All the particulars furnished by me in this document are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.

Signature of specialist

Company: Exigo Sustainability (Pty) Ltd.

Date: April 2016

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1 ASSIGNMENT

Exigo Sustainability was appointed by AGES Limpopo on behalf of Miko Energy to conduct a soil potential and land capability study for the proposed establishment of a solar energy generation facility to be known as Rhodes 2 Solar Park with associated and structures on a footprint area of approximately 250 hectares. The Rhodes 2 solar park will be developed on the farm Rhodes 269 (1810.83 ha), located in the Joe Morolong Local Municipality, John Taolo Gaetsewe District Municipality, Northern Cape Province.

The main purpose of this study was solely to assess the agricultural potential and value of the soil types on the site. This assessment is essential as it will contribute to meeting the requirements of the National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998) in compliance with Regulation 387 of 21 April 2006, promulgated in terms of Section 24 (5) of NEMA.

The assignment is interpreted as follows: Compile a study on the soil potential of the soil forms of the proposed development site according to guidelines and criteria set by the National Department of Agriculture. The study will include a detailed soil assessment and interpretation. In order to compile this, the following had to be done:

1.1 Information Sources

The following information sources were obtained:

- All relevant maps through GIS mapping, and information (previous studies and agricultural databases) on the land use, soils, agricultural potential and land capability of the area concerned;
- Requirements regarding the agricultural potential survey and prime or unique agricultural land as requested by the NDA;
- Obtain relevant information of land type, geology and soil types of the area. This includes information on the soil potential, clay percentage, soil depth and soil forms, as classified by the Environmental Potential Atlas of South Africa (Institute for Soil, Climate and Water, Agricultural Research Institute);
- Obtain information of the prevailing land use and agricultural activities being practiced in the larger area of the neighbouring properties;
- Obtain an aerial photograph of the area to help in the interpretation and identification of major soil types and land uses in the study area.

1.2 Regulations governing this report

1.2.1 National Environmental Management Act Regulation 543 Section 32

This report has been prepared in terms of Regulation 32 of the National Environmental Management Act (No. 107 of 1998) Regulations GN 33306 GNR 543 for environmental impact assessment. Regulation 33 states that a specialist report must contain:

1. An application or the EAP managing an application may appoint a person to carry out a specialist study or specialized process.
2. The person referred to in sub-regulation 1 must comply with the requirements of regulation 17 (General requirements for EAPs or a person compiling a specialist report or undertaking a specialized process).
3. A specialist report or a report on a specialized process prepared in terms of these regulations must contain:
    a. Details of
        i. The person who prepared the report; and Letter of Appointment
        ii. The expertise of that person to carry out the specialist study or specialized process.
    b. A declaration that the person is independent in a form as may be specified by the competent authority;
    c. An indication of the scope of, and purpose for which, the report was prepared;
    d. A description of the methodology adopted in preparing the report or carrying out the specialized process;
    e. A description of any assumptions made and any uncertainties or gaps in knowledge;
    f. A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment;
    g. Recommendations in respect of any mitigation measures that should be considered by the applicant and competent authority;
    h. A description of any consultation process that was undertaken during the course of carrying out the study;
    i. A summary and copies of any comments that were received during any consultation process;
    j. Any other information requested by the competent authority.

1.2.2 Other related legislation

The natural resources of South Africa constitute a national asset, which is essential for the economic welfare of present and future generations. Economic development and national food security depend on the availability of productive and fertile agricultural land, and are threatened by the demand for land for residential and industrial development. Urban and rural planning needs to be integrated rather than sectorial and fragmentary. The use of agricultural land for other purposes should therefore be minimised. Currently the retention of productive agricultural land is administrated through the SUBDIVISION OF AGRICULTURAL LAND ACT, 1970 (ACT NO. 70 OF 1970) which controls the subdivision of agricultural land

and its use for purposes other than agriculture. In the near future the use of these scares resources will be regulated through the SUSTAINABLE UTILISATION of AGRICULTURAL RESOURCES BILL. One of the object of the new Bill is to provide for the use and preservation of agricultural land, especially “prime and unique agricultural land” by means of prescribe criteria in terms of which agricultural land may be used for purposes other than agriculture, in collaboration with principles as laid down in the Development Facilitation Act, 1995 (Act No. 67 of 1995) and also in collaboration with the Land Use Bill, 2001. The prescribe criteria shall relate to the importance of the continued use of those agricultural resources for agricultural purposes in general particularly taking into consideration the use of prime and unique agricultural land or its agricultural importance relative to a particular province or area. Different criteria may be prescribed from time to time and such criteria may differ from province and area.

1.3 Terms of reference

1.3.1 Rationale of solar development

South Africa currently relies principally on fossil fuels (coal and oil) for the generation of electricity. At the present date, Eskom generates approximately 95% of the electricity used in South Africa. On the other hand, South Africa has a largely unexploited potential in renewable energy resources such as solar, wind, biomass and hydro-electricity to produce electricity as opposed to other energy types (fuel or coal). South Africa’s electricity supply still heavily relies upon coal power plants, whereas the current number of renewable energy power plants is limited. In the last few years, the demand for electricity in South Africa has been growing at a rate of approximately 3% per annum. These factors, if coupled with the rapid advancement in community development, have determined the growing consciousness of the significance of environmental impacts, climate change and need for sustainable development. The use of renewable energy technologies is a sustainable way in which to meet future energy requirements. Development of clean, green and renewable energy has been qualified as a priority by the Government of South Africa with a target goal for 2013 of 10,000 GWh, as planned in the Integrated Resource Plan 1 (IRP1). Subsequently the Department of Energy of South Africa (DoE) decided to undertake a detailed process to determine South Africa’s 20-year electricity plan, called Integrated Resources Plan 2010-2030 (IRP 2010).

The IRP1 (2009) and the IRP 2010 (2011) outline the Government’s vision, policy and strategy in matter of the use of energy resources and the current status of energy policies in South Africa. The IRP 2010 highlights the necessity of commissioning 1200 MW with solar PV technology by the end of 2015. In order to achieve this goal, in 2011 the DoE announced a Renewable Energy IPP (Independent Power Producers) Procurement Programme. The IPP Procurement Programme, issued on 3 August 2011, envisages the commissioning of 3725 MW renewable projects (1450 MW with solar PV technology) capable of beginning commercial operation before the end of 2017.

The development of PV power plants will represent a key feature in the fulfilment of a proposed target goal and reduction of CO_2 emissions. The purpose of Rhodes 2 Solar Park is to add new capacity for the generation of renewable electrical energy to the national electricity supply in compliance with the IPP Procurement Programme and in order to meet the "sustainable growth" of the Northern Cape Province. The use of solar radiation for power generation is considered as a non-consumptive use and a renewable natural resource which does not produce greenhouse gas emissions. With specific reference to PV energy and the proposed project, it is important to consider that South Africa has one of the highest levels of solar radiation in the world.

1.3.2 Objectives

The objectives of this report are as follows:

- Conduct a soil survey on the proposed development site and identify the different soil types / forms present on the site;
- From the soil survey results link the optimal land use and other potential uses and options to the agricultural potential of the soils by classifying the soils into different Agricultural Potential classes according to the requirements set by the Department of Agriculture, South Africa. From these results soils maps and an agricultural potential map will be compiled;
- Discussion of the agricultural potential and land capability in terms of the soils, water availability, grazing capacity, surrounding developments and current status of land.
- Identify potential impacts of the development on the soils and provide mitigation measures to manage these impacts.

1.3.3 Limitations and assumptions

- In order to obtain a comprehensive understanding of the dynamics of the soils of the study area, surveys should ideally be replicated over several seasons and over a number of years. Dgue to project time constraints such long-term studies are not feasible;
- The large study area did not allow for a finer level of assessment that can be obtained in smaller study areas. Data collection relied on data from representative, homogenous sections of soils, as well as general observations, aerial photograph analysis, generic data and desktop analysis;

2 INTRODUCTION

Soil physical properties profoundly influence how soils function in an ecosystem and how they can best be managed. Success or failure of agricultural activities often hinges on the physical properties of the soil used (Brady & Weil, 1996). Soil scientists use the colour, texture, and other physical properties of the soil horizons in classifying soil profiles and in making field determinations about soil suitability for agriculture projects. Soil forms generally have limited ranges of physical and hydrological properties. Together with effective depth and clay content, these properties affect the way the soils take up rainwater, store it and make it available to crops.

Although 80% of South Africa's land surface area is used for agriculture and subsistence livelihoods, only about 11% has arable potential. The remaining 69% is used for grazing. Areas of moderate to high arable potential occur mainly in the eastern part of the country, in Mpumalanga and Gauteng. Scattered patches also occur in KwaZulu-Natal, the Eastern Cape, and Limpopo. Low to marginal potential areas occur in the eastern half of the country and in parts of the Western Cape.

The arid nature of the Northern Cape climate results in relatively low carrying capacity for livestock production. However, the province is known for its high-quality meat and meat products. The recent good rains have ensured that an estimated 300 000 herd of cattle, about 4.4 million sheep and 350 000 goats will be marketed in this financial year. Crop estimates also indicate a good year for irrigation farmers with an expected maize crop of 635 000 tons and a predicted wheat crop of 280 000 tons.

The development of Rhodes Solar Park and associated infrastructure may put additional constraints on limited arable land available for agricultural development. To minimize loss of important agricultural land, it is imperative to assess the impact of such projects on critical resources, hence the requirement for the compilation of this report as an inventory.

3 STUDY AREA

3.1 Location and description of activity

The Rhodes 2 Solar Park will be established on the farm Rhodes 269 (1810.8314 ha), located in the Joe Morolong Local Municipality, John Taolo Gaetsewe District Municipality, Northern Cape Province (Figure 1). The proposed project is situated directly north of the town of Hotazel and 62 kilometers to the North of the town of Kathu, with the footprint planned to the east of Eskom's "Hotazel - Heuningvlei" 132 kV power line.

The solar project is called RHODES 2 SOLAR PARK, and it envisages the establishment of a Photovoltaic (PV) Power Plant having a maximum generating capacity up to 120 MW. The PV power plant will have a footprint (fenced area) up to 250 ha, within the total study area 1810 ha in extent.

Thes new access road will start from a local upgraded farm road diverted of the regional road R31, which runs parallel to the eastern boundary of Rhodes.

The chosen site is suitable for the installation of a photovoltaic (PV) power plant. It is appropriate morphologically (flat terrain) and regarding the favourable radiation conditions. The available radiation allows a high rate of electric energy production, as a combination of latitude-longitude and climatic conditions.

The aerial image of the site is indicated in figure 2, while the layout plan of the proposed development is indicated in figure 3.

Rhodes 2 Solar Park Soil Potential Study

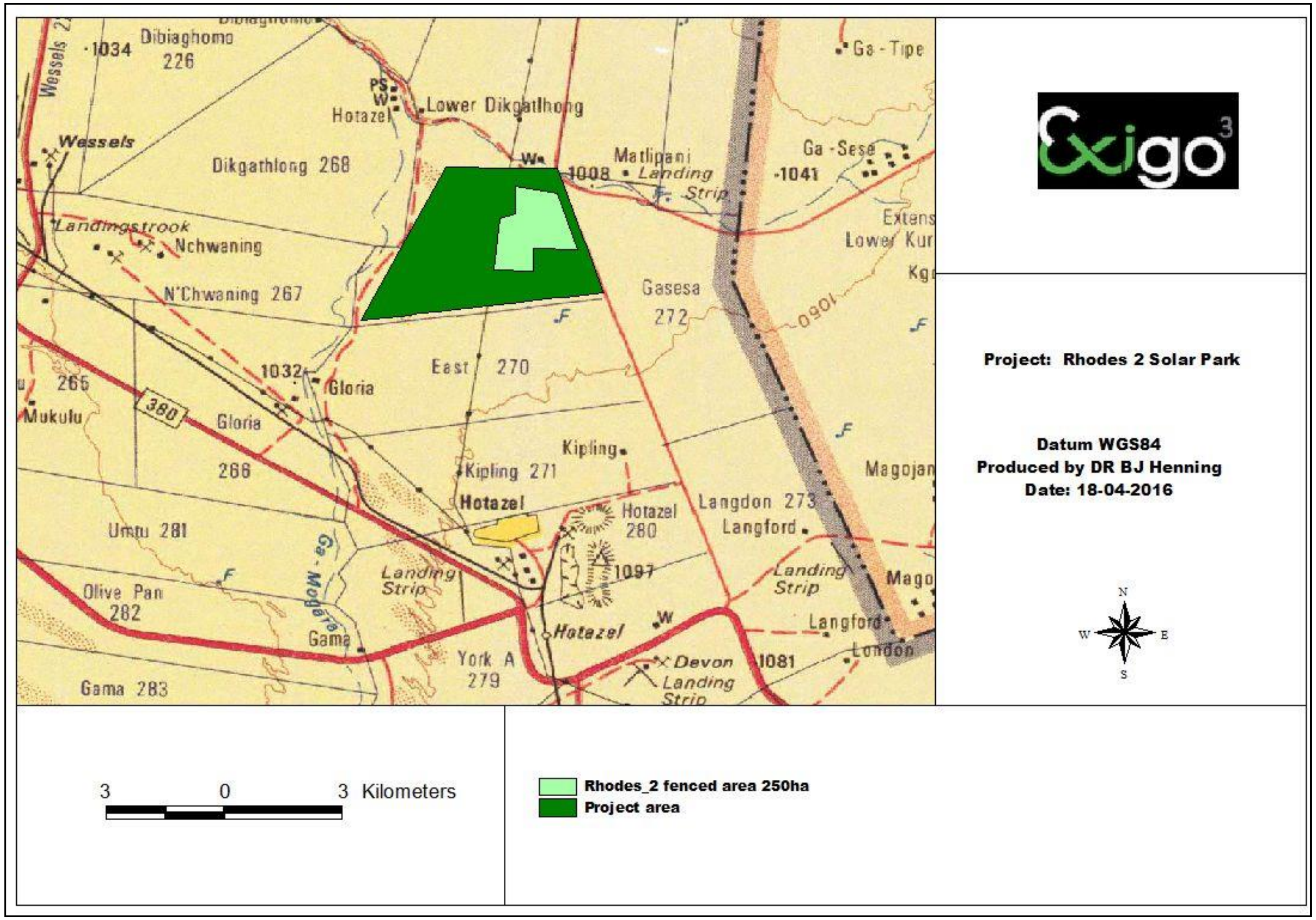

Figure 1. Regional Location Map

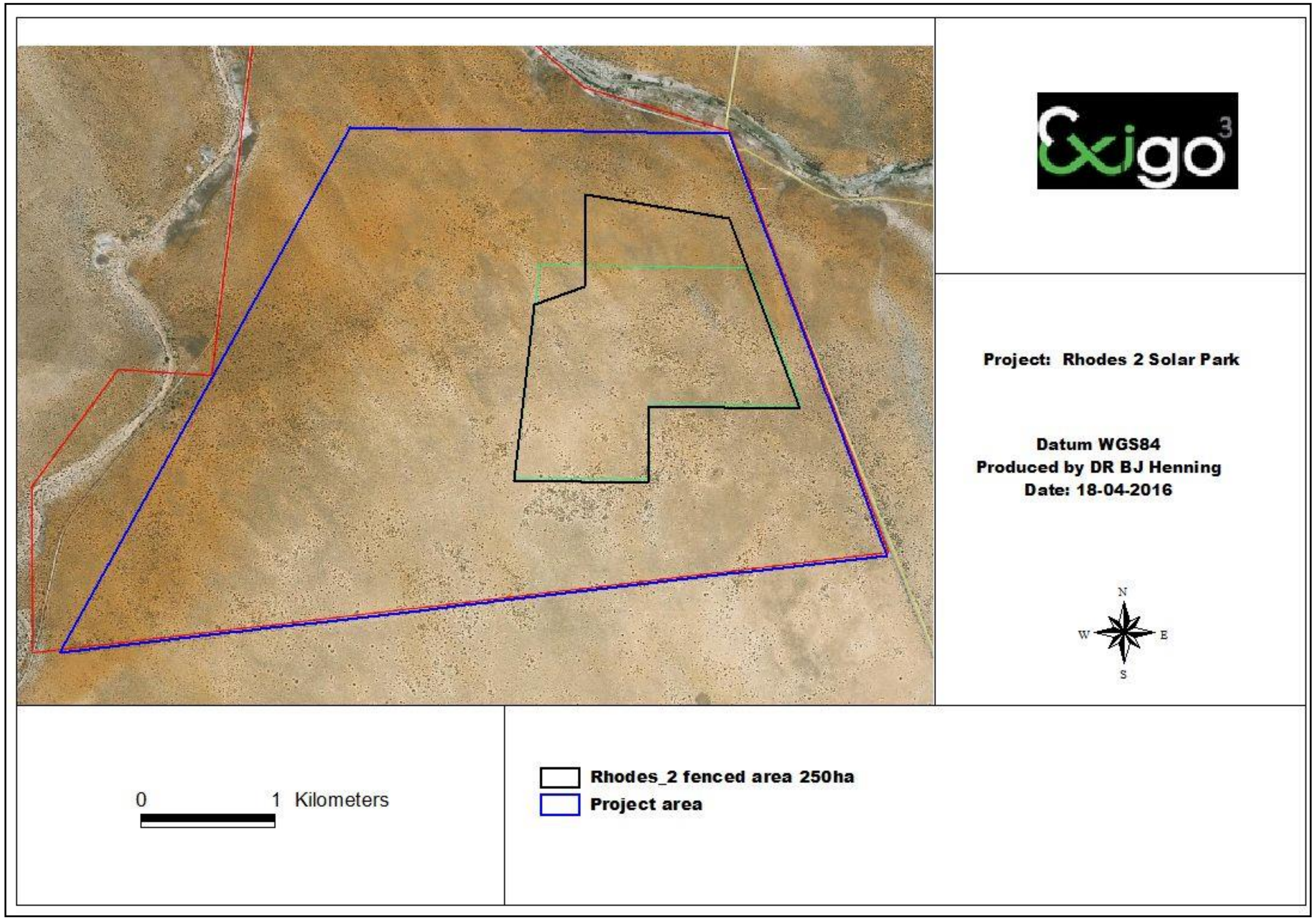

Figure 2. Satelite image showing the project area and proposed access road and focus area (Google Pro, 2010)

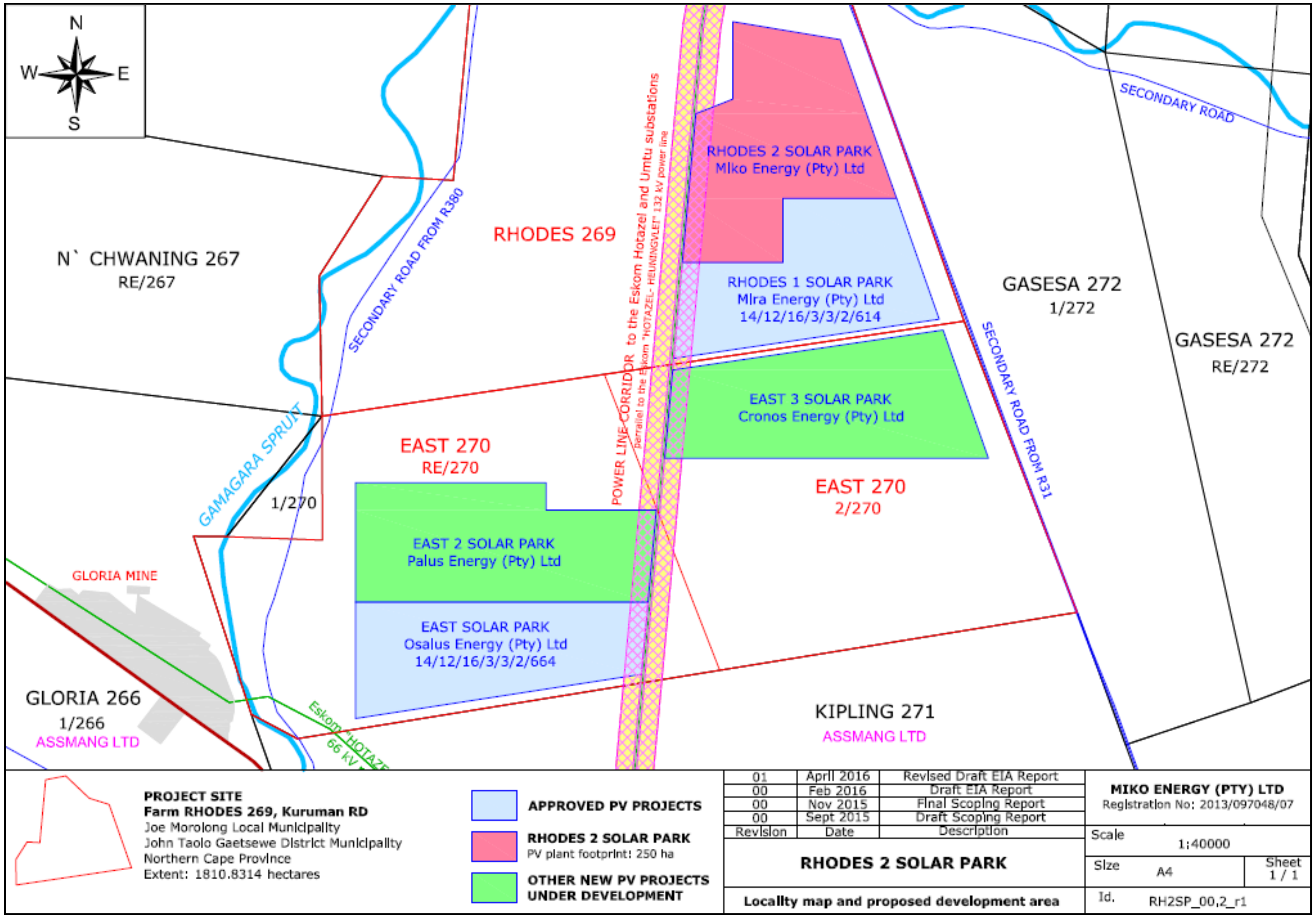

Figure 3. Layout plan for the proposed Rhodes 2 Solar Park in relation to other planned solar park and power lines in the larger area

3.2 CLIMATE

Climate in the broad sense is a major determinant of the geographical distribution of species and vegetation types. However, on a smaller scale, the microclimate, which is greatly influenced by local topography, is also important. Within areas, the local conditions of temperature, light, humidity and moisture vary greatly and it is these factors which play an important role in the production and survival of plants (Tainton, 1981). The climate for the region can be described as warm-temperate. In terrestrial environments, limitations related to water availability are always important to plants and plant communities.

The spatial and temporal distribution of rainfall is very complex and has great effects on the productivity, distribution and life forms of the major terrestrial biomes (Barbour et al. 1987). The study area is situated within the summer and autumn rainfall region with very dry winters and frequent frost that occurs during the colder winter months. The spatial and temporal distribution of rainfall is very complex and has great effects on the productivity, distribution and life forms of the major terrestrial biomes (Barbour et al. 1987). The mean annual precipitation varies between 120 and 260mm. The mean monthly maximum and minimum temperatures for the area are 41.5°C and -4°C, for December and July, respectively.

3.3 VEGETATION TYPES

3.3.1 REGIONAL CONTEXT: THE GRIQUALAND WEST CENTRE OF ENDEMISM

The vegetation of the proposed development site falls within the south-eastern range of the Griqualand West Centre of Endemism (Van Wyk & Smith 2001). A centre of plant endemism is an area with high concentrations of plant species with very restricted distributions. Centres of endemism are important because it is these areas, which if conserved, would safeguard the greatest number of plant species. They are extremely vulnerable; relatively small disturbances in a centre of endemism may easily pose a serious threat to its many range-restricted species (Van Wyk & Smith 2001). The Griqualand West Centre (GWC) is one of the 84 African centres of endemism and one of 14 centres in southern Africa, and these centres are of global conservation significance.

The endemic and near-endemic species make up 2.2% of the total flora, and are mostly from the Asclepiadaceae, Euphorbiaceae and Mesembryanthemaceae families. Some of the endemics are edaphic specialists, adapted to lime-rich substrates.

Endemics and near-endemics include *Searsia tridactyla, Aloinopsis orpenii, Euphorbia planiceps, Euphorbia bergii, Lebeckia macrantha, Lithops aucampiae* subsp. *aucampiae* and *Tarchonanthus obovatus*.

The GWC of endemism is extremely poorly conserved, and is a national conservation priority. Figure 4 shows the extent of the GWC.

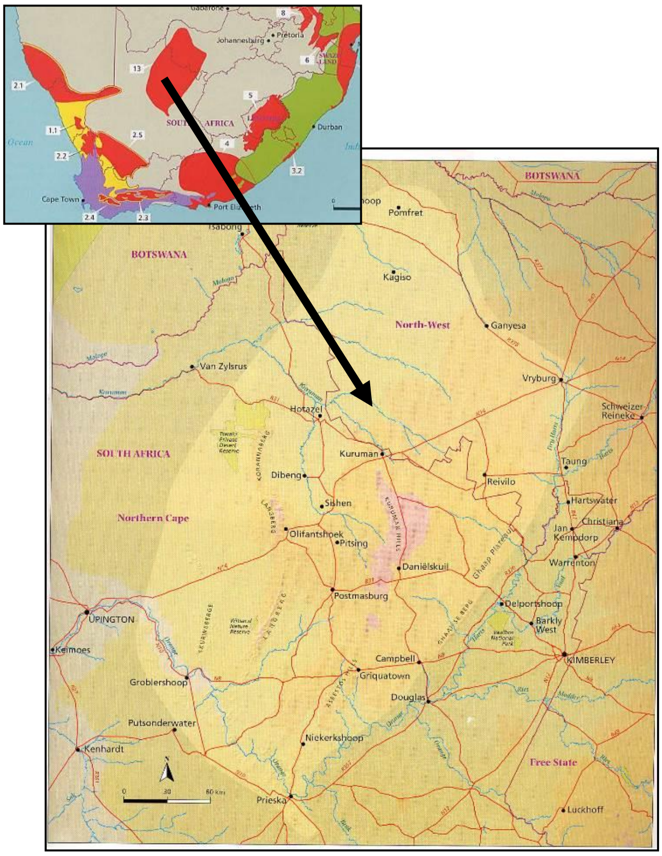

Figure 4. Map showing the extent of the Griqualand West Centre of Endemism (light centre). It is centred on the surface outcrops of the Ghaap Group (limestone and dolomite) and those of the Olifantshoek Supergroup (quartzite). From Van Wyk & Smith (2001)

3.3.2 LOCAL CONTEXT

The development site lies within the Savanna biome which is the largest biome in Southern Africa. It is characterized by a grassy ground layer and a distinct upper layer of woody plants (trees and shrubs). The environmental factors delimiting the biome are complex and include altitude, rainfall, geology and soil types, with rainfall being the major delimiting factor. Fire and grazing also keep the grassy layer dominant. The most recent classification of the area by Mucina & Rutherford (2006) shows that the sites forms part of the Kathu Bushveld and Gordonia Dunveld vegetation types.

The vegetation and landscape characteristics of the Kathu Bushveld include a medium-tall tree layer with dense stands of *Acacia erioloba* in places, but mostly an open woodland with *Boscia albitrunca* as the prominent tree species, while the shrub layer is dominated by *Acacia mellifera, Lycium hirsitum* and *Diospyros lycioides*. This vegetation type in its pristine state is characterized by plains with layer of scattered, low to medium high deciduous microphyllous trees and shrubs with a few broadleaved tree species, and an almost continuous herbaceous layer dominated by grass species. This vegetation type has a Least Threatened conservation status, with 1% transformed and none statutorily conserved.

The landscape features of the Gordonia Duneveld vegetation type are mostly parallel dunes (3-8m in height) with an open shrubland woody structure and ridges of grassland dominated by *Stipagrostis amabilis* on the dune crests and *Acacia haematoxylon* on the dunes slopes. The conservation status of the Gordonia Duneveld is Least Threatened with very little transformation and 14% statutorily conserved in the Kgalagadi Transfrontier Park (Mucina & Rutherford, 2006).

3.4 GEOLOGY AND SOIL TYPES

Geology is directly related to soil types and plant communities that may occur in a specific area (Van Rooyen & Theron, 1996). A Land type unit is a unique combination of soil pattern, terrain and macroclimate, the classification of which is used to determine the potential agricultural value of soils in an area. The land type unit represented within the proposed footprint area include the Ah9 and Af28 land types (Land Type Survey Staff, 1987) (ENPAT, 2000). The land types, geology and associated soil types is presented in Table 1 below as classified by the Environmental Potential Atlas, South Africa (ENPAT, 2000).

Table 1. Land types, geology and dominant soil types of the proposed development site

Land type	Soils	Geology
Ah9	Red-yellow apedal, freely drained soils; red and yellow, high base status, usually < 15% clay	Aeolian sand of Recent age with a few outcrops of Tertiary Kalahari beds (surface limestone, silcrete and sandstone) in the riverbeds.
Af28	Red-yellow apedal, freely drained soils; red, high base status, > 300 mm deep (with dunes)	Red to flesh-coloured wind-blown sand (sand dunes) of Tertiary to Recent age with some outcrops of coarse-grained brown quartzite and subgreywacke and conglomerate (Matsap Formation).

Soils associated with the site are mostly deep, Aeolian sands overlying calcrete

3.5 Topography & Drainage

The assessment of slope class in an area is an important determinant in land evaluation for crop production. Slope impacts the use of mechanical traction and together with soil textural classes, influences the rate of soil erosion. Field topography can also have a direct effect on crop growth and yield by redirecting pools of soil water. Indirectly, slope affects the distribution of certain chemical and physical properties such as organic matter content, base saturation, soil temperature, and particle size distribution (Franzmeier et al., 1969; Stone et al., 1985; Jiang, and Thelen, 2004).

Two land facets are present on the site. Dunes occur as high-gradient hills in the north-western section of the site, while the remainder of the site represents slightly plains. The topography across the site is slightly undulating with the average elevation of 1030 mamsl.

The site is located within two quaternary catchments namely D41K (Eastern section of site) and D41L (western section of site) and is situated in the Lower Vaal Water Management Area. Drainage occurs as sheet-wash towards the major rivers namely the Gamagara River east of the site and the Kuruman River to the north of the site.

3.6 Land use and existing infrastructure

The current land-use of the proposed development site is grazing by livestock and game. Neighbouring farms are being used for livestock grazing and game farming, with mining further away from the site.

The major land use of the study area as classified by the Environmental Potential Atlas of South Africa (2000) is vacant / unspecified land.

3.7 Moisture Availability

The moisture availability of soils is another aspect which recently has become an important factor to consider when cultivating crops under dry-land conditions.

Moisture and water availability will be affected by a temperature increase, regardless of any change in rainfall. Higher temperatures increase the evaporation rate, thus reducing the level of moisture available for plant growth, although other climatic elements are involved. A warming of 1°C, with no change in precipitation, may decrease yields of wheat and maize in the core cropping regions such as the US by about 5%. A very large decrease in moisture availability in the drier regions of the world would be of great concern to the subsistence farmers that farm these lands. Reduced moisture availability would only exacerbate the existing problems of infertile soils, soil erosion and poor crop yields. In the extreme case, a reduction in moisture could lead to desertification. The classes as classified for South Africa are shown in Table 2.

Table 2. Moisture availability classes as derived from seasonal rainfall and evaporation

Moisture availability class	Summer rain season (R/0.25PET)	Winter rain season (R/0.4PET)	Agricultural Potential
1	>34	>34	Conducive to rain-fed arable agriculture
2	27-34	25-34	Conducive to rain-fed arable agriculture
3	**19-26**	**15-24**	**Conducive to rain-fed arable agriculture**
4	12-18	10-14	Marginal for rain-fed arable agriculture
5	6-12	6-9	Conditions too dry for rain-fed arable agriculture
6	<6	<6	Conditions too dry for rain-fed arable agriculture

The soils on the proposed development site are classified as class 5, which suggest that climatic conditions are too dry for rain-fed arable agriculture.

3.8 Soil classification of the site from ARC databases

The Agricultural Research Institute uses specific soil characteristics to indicate the suitability of soils for arable agriculture. These characteristics for the site are as follows:

Structurally favourable soils:

- Soils with a structure that is favourable arable land use scarce or absent;

Soil association:

- Red, yellow and greyish excessively drained sandy soils (Arenosols);

Soil pH:

- 6.5-7.4

Prime agricultural activity for the area:

- Cattle.

Grazing capacity:

- 9-13ha / LSU

Agricultural Potential:

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

Since the classification of the soil characteristics is based on a broad-scale desktop study of the general area, a thorough investigation of the soil types of the proposed development site is necessary for a more accurate classification of the soils. The main aim of the study is to identify the soil types on site and evaluate their specific characteristics to determine the agricultural potential of the soils. The study will thus reduce the scale at which soils for the area was previously mapped. A detailed discussion of the soil characteristics is included in the following section as part of the results.

4 GUIDELINES FOR AGRICULTURAL POTENTIAL

4.1 National assessment criteria

4.1.1 Agricultural Potential of soils in South Africa

The essence of identifying high potential agricultural land in South Africa is to retain prime area for agricultural development and to retain as much productive areas as possible for the future. South Africa is dominated by shallow soils which are predominantly sandy. This poses a severe inherent limitation to crop production. The poor quality of the soil is due to the influence of the parent material in which they were formed. According to Laker (2005), South Africa has only 13 % (approximately 14 million ha) arable land, of which only 3 % is considered to be high potential. Inferring from the international requirement of about 0.4 ha arable land to feed an individual person, South Africa could produce enough food to feed only 35 million people on the available 14 million hectares of arable land. In line with this goal, the Department of Agriculture has developed a set of criteria to define potential and prime areas for agricultural development in South Africa. By definition, based on Part 1 of the Regulation of Conservation of Agricultural Resources Act 43 of 1983, an agricultural land in the Northern Cape Province and specifically in the grid square in which the project site falls is considered high potential if the land:

1. Is under permanent irrigation; or
2. No soil form qualifies for prime or unique agricultural land under rain-fed conditions.

High potential here means prime or unique. Prime refers to the best available land, mainly from the national perspective, suited to and capable of consistently producing acceptable yields of a wide range of crops (food, feed, forage, fibre and oilseeds), with acceptable expenditure of energy and economic resources and minimal damage to the environment. Unique agricultural land means land that is or can be used for producing specific high value crops.

Permanent irrigation means the availability for, and regular artificial application of, water to the soil for the benefit of growing crops. The application may be seasonal.

Figure 7 indicates the classification of the site according to the agricultural potential classes. The site falls within an area with a low potential for crop cultivation.

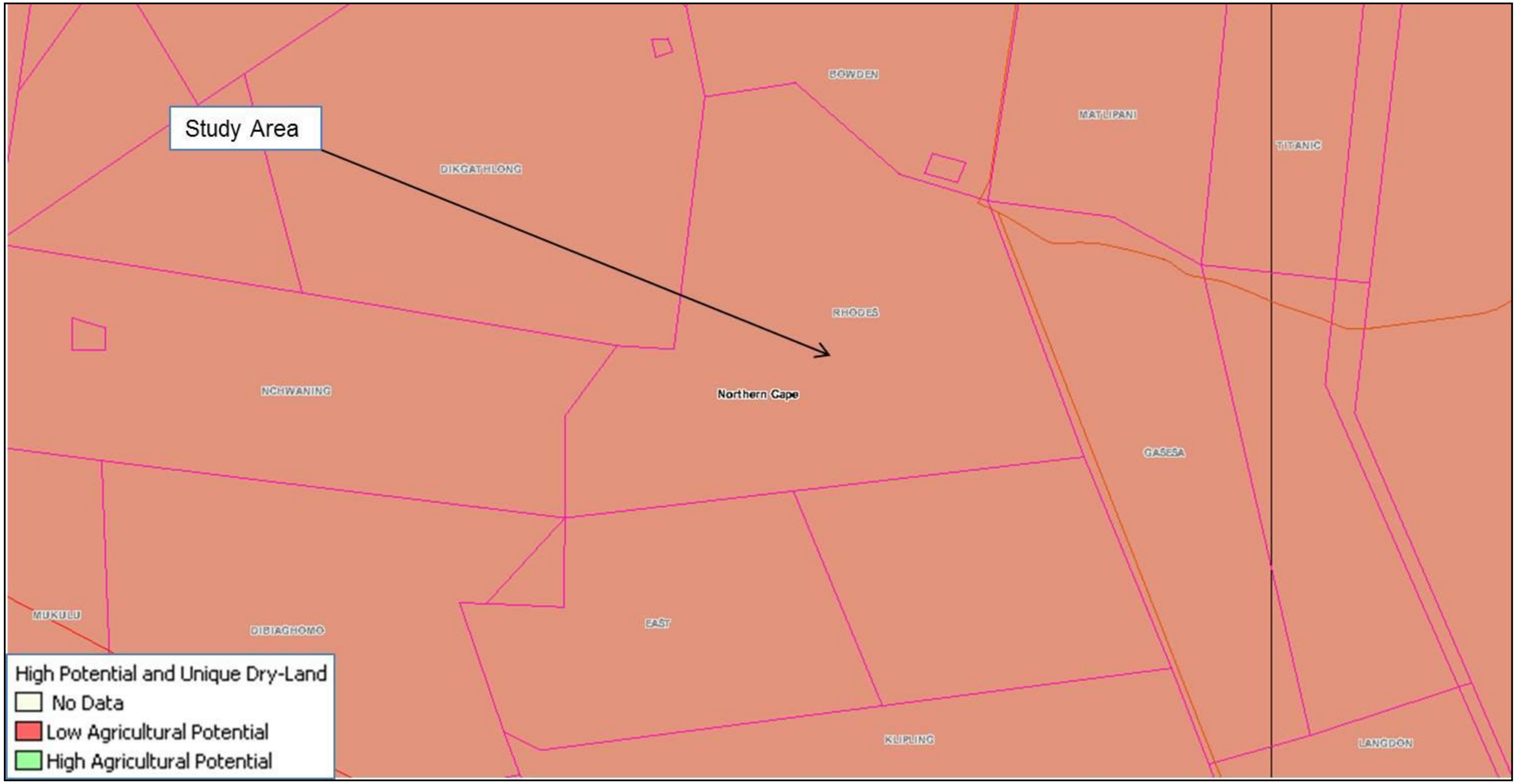

Figure 5. Location of site within the classification of the NDA for high potential or unique agricultural land

Source: [Web] http://www.agis.agric.za/agismap_atlas/AtlasViewer)

4.1.2 Land capability of soils in South Africa

Scotney et al. (1991) within the concept of land capability defines land capability as —the extent to which land can meet the needs of one or more uses under defined conditions of management, without permanent damage. Land capability is an expression of the effect of physical factors (e.g. terrain form and soil type), including climate, on the total suitability and potential for use for crops that require regular tillage, for grazing, for forestry and for wildlife without damage. Land capability involves the consideration of (i) the risks of damage from erosion and other causes, (ii) the difficulties in land use caused by physical factors, including climate and (iii) the production potential‖ (Scotney et al., 1991).

The current land capability data set that is used as the national norm indicates that there are little or no soils in South Africa that are not subject to limitations. Most of the country 's soils have moderate to severe limitations largely due to limited soil depth or moderate erodibility, caused by sandy texture or slopes.

It was determined that nowhere in South Africa do best soil and good climate classes coincide (Schoeman et al, 2002).

The land capability classes used for the South African Agricultural Sector are indicated in Table 3, while Table 4 indicate limitations and land use potential for the Land Capability classes.

Table 3. Land capability classes (Schoeman *et al.* 2002)

Land Capability Class	Increased intensity of use									Land Capability Groups
I	W	F	LG	MG	IG	LC	MC	IC	VIC	Arable land
II	W	F	LG	MG	IG	LC	MC	IC	-	
III	W	F	LG	MG	IG	LC	MC	-	-	
IV	W	F	LG	MG	IG	LC	-	-	-	
V	W	-	LG	MG	-	-	-	-	-	Grazing land
VI	W	F	LG	MG	-	-	-	-	-	
VII	W	F	LG	-	-	-	-	-	-	
VIII	W	-	-	-	-	-	-	-	-	Wildlife

W - Wildlife
LG - Light grazing
IG - Intensive grazing
MC - Moderate cultivation
VIC - Very intensive cultivation
F - Forestry
MG - Moderate grazing
LC - Light cultivation
IC - Intensive cultivation

Table 4. Land capability Classes: Limitations & land use

Land Capability Class	Definition	Conservation Need	Use suitability
I	No or few limitations. Very high arable potential. Very low erosion hazard.	Good agronomic practice.	Annual cropping.
II	Slight limitations. High arable potential. Low erosion hazard.	Adequate run-off control.	Annual cropping with special tillage or ley (25%)
III	Moderate limitations. Some erosion hazards.	Special conservation practice and tillage methods.	Rotation of crops and ley (50 %).
IV	Severe limitations. Low arable potential. High erosion hazard.	Intensive conservation practice.	Long term leys (75 %)
V	Watercourse and land with wetness limitations.	Protection and control of water table.	Improved pastures or Wildlife
VI	Limitations preclude cultivation. Suitable for perennial vegetation.	Protection measures for establishment e.g. Sod-seeding	Veld and/or afforestation
VII	Very severe limitations. Suitable only for natural vegetation.	Adequate management for natural vegetation.	Natural veld grazing and afforestation
VIII	Extremely severe limitations. Not suitable for grazing or afforestation.	Total protection from agriculture.	Wildlife

From the databases of Department of Agriculture, the site has the following land capability (Figure 8):

Non-arable with a low potential for grazing;

These aspects still need to be confirmed at ground level though.

Criteria for determining land capability of a piece of land are based on soil and land characteristics. These criteria related back to hazards or limitations to land use and are as follows:

- Slope %;
- Clay %;
- Effective rooting depth;
- Permeability;
- Signs of wetness;
- Rockiness;
- Soil surface crusting;

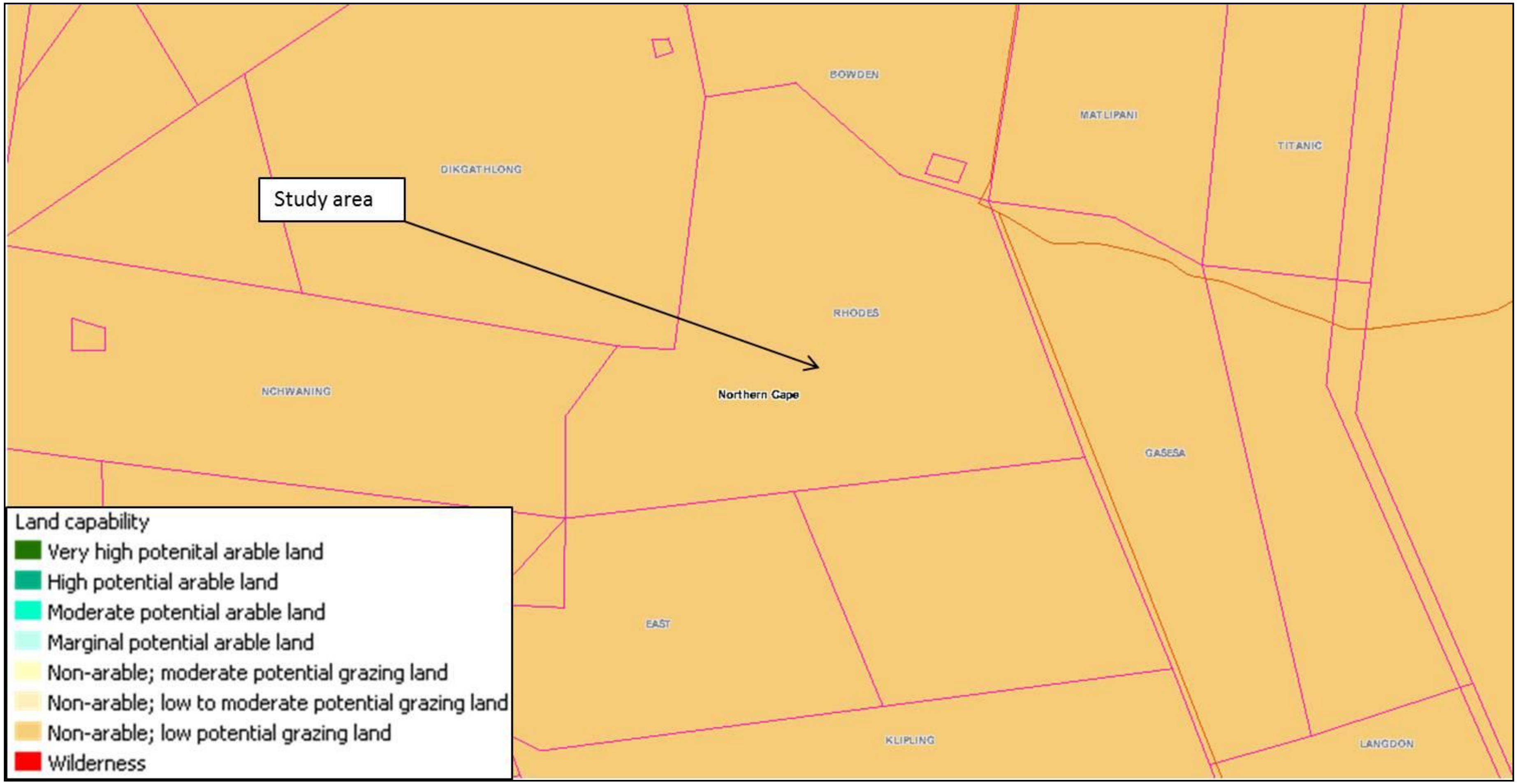

Figure 6. Land capability classes for the site as classified by the ARC: Source: [Web] http://www.agis.agric.za/agismap_atlas/AtlasViewer)

5 METHODS

The assessment of agricultural potential and land capability of the study area was based on a combination of desktop studies to amass general information and then through site visit for status quo assessment, soil sampling and characterization, and also the validation of generated information from the desktop studies:

- Definition of parameters of land as stipulated by the Subdivision of Agricultural Land Act, No. 70 of 1970 and the Amended Regulation of Conservation of Agricultural Resources Act No. 43 of 1983;
- Classification of high potential agricultural land in South Africa compiled by the Agricultural Research Council (Schoeman, 2004) for the National Department of Agriculture;
- Long-term climatic data record of the study area, obtained from Weather SA.
- Geophysical features of the site using Geographical Information System;
- Moisture availability class, determined through seasonal rainfall and fraction of the potential evapotranspiration (ARC, 2002);
- Field visit to the project site for general observation, survey of the farm in terms of vegetation, soils, water resources, terrain type and infrastructural profile;
- Previous and current land use of the farm and that of the neighbourhood;
- Other agro-ecological factors prevailing in the area;
- Agricultural potential of the property;
- Possible crop productivity or value of the farm for grazing purposes.

5.1 Soil surveys

The site surveys were conducted during March 2014 and July 2015. After a thorough investigation of an aerial photograph of the area and visual assessment of the specific sites and areas surrounding the sites, the following was done:

- Field observations were randomly made in the accessible, with specific emphasis on the resource area;
- Since the soils do not qualify as high potential soils according to Department of Agriculture databases, only soil physical characteristics were used to verify the potential of the soils at small-scale and therefore no chemical analyses of the soils was considered necessary.
- Slopes were analysed to determine the viability to cultivate crops in specific areas.
- The following soil physical and chemical characteristics were analysed through physical investigation:
    - Soil Depth (soil auger used);
    - Soil clay content (land type memoirs);
    - Soil texture and general structure.

5.2 Data recorded of surveys included:

- A description of the soil types and profiles identified on the sites;
- Specific soil characteristics on the proposed development sites and areas surrounding the sites;
- Photographs of the soil profiles and associated vegetation were taken and are included as part of the photographic guide.

5.3 Data processing

A broad classification of the soil types on the farm was done. A soil map indicates the dominant soil types identified by using a Geographic Positioning System (GPS) to locate sampled points on the topographical map of the farm. Soils were classified according to the Taxonomic Soil Classification System for South Africa, 1991. The following attributes were recorded and taken into consideration at each of the sites where samples were collected:

- Soil Type;
- Soil Depth;
- Soil clay content;
- Estimated soil texture class and soil structure;
- Slope;
- Moisture availability;
- Agricultural potential.

The agricultural potential of the soils was determined by using the specified guidelines stated above. The actual soil depth, clay content, slope, moisture potential and soil form were evaluated to determine the agricultural potential status. The soil characteristics and norms used to determine the agricultural potential of the soils were obtained from the National Department of Agriculture, which created criteria for high potential agricultural land in South Africa (Schoeman, 2004) as stated in previous discussion in the report.

6 RESULTS

The proposed development site shows some variations in terms of soil characteristics and soil types identified during the survey. The classification of soils on the farm was based on land type description and the Binomial System for South Africa, which classifies soils into forms and families based on the diagnostic horizon of the soil profile. Exposed soil profile characteristics created by road cuttings in the field were also used in describing the local soil form. Soil identification and classification of the dominant soil type were done. The soil type and profile identified on the site will be discussed in detail in the following section.

The soils were classified into broad classes according to the dominant soil form and family as follows:

- Shallow, calcareous soils of the Glenrosa or Mispah soil form;
- Medium depth red Aeolian sands of the Hutton / Clovelly soil forms
- Very deep red apedal Aeolian sandy soils of the Hutton soil form;

The geological formations and vegetation patterns showed a strong correlation to the major soil units mapped in the study area. The location of the soil forms in the landscape is presented in figure 9, while the land capability and agricultural potential maps are indicated in figure 11 and 12 respectively.

6.1 SHALLOW, CALCAREOUS SOILS OF THE GLENROSA / MISPAH SOIL FORM DERIVED FROM DOLOMITIC LIMESTONE

Binominal Classification S.A.: Mispah / Glenrosa / bedrock soil form

Description: The soils are generally shallow and derived from calcrete (limestone) (Photograph 1). All three these soil forms can be categorised in the international classification group of lithic soil forms. In lithic soil forms the solum is dominated by rock or saprolite (weathered rock). These soils have sandy to sandyloam texture, while topsoil structure is apedal and the profiles are very shallow. Exposed calcrete nodules are spread on the soil surface throughout the area (Photograph 1 and 2).

The soil in this area is often weakly structured, sandy and forms a mosaic of shallow Glenrosa soils and very shallow rocky soils (Mispah soil form), with exposed bedrock in some areas. The Mispah and Glenrosa soils found on this section of the site are localised in the northern section of the site and shallow in depth, although it has a medium clay content.

Landscape: Moderately undulating hills;

Depth: 100-250mm;

Texture: Sandy to sandy loam soils

Average Clay Content: 4-8%

Agricultural Potential: Low potential soils, due to the shallow nature of the soils and low soil pH, making these areas are not suitable for crop cultivation under arable conditions. The orthic A-horizon of the lithic soil group is unsuitable for annual cropping or forage plants (poor rooting medium since the low total available moisture causes the soil to be drought prone). These topsoils are not ideal for rehabilitation purposes for they are too shallow and/or too rocky to strip. Topsoil stripping and stockpiling of the „shallow" soils should only be attempted where the surface is not too rocky.

Land capability: The grazing potential of these areas is moderate-low. The most suitable and optimal utilization of the area would be grazing by livestock or game species.

Photograph 1. Landscape associated with shallow calcareous soils in the north-eastern section of the project area

Photograph 2. Exposed limestone nodules on the soil surface

6.2 Medium depth red Aeolian sands of the Hutton / Clovelly soil forms

Binominal Classification S.A.: Hutton / Clovelly soil forms

Description: The red-yellow Hutton soil form occurs throughout most parts of the project area, although in certain locations it has a medium depth compared to the very deep sandy soils on the remainder of the project area. The soil in this area is very sandy and forms a mosaic of Hutton and Clovelly soils. Hutton soils are identified on the basis of the presence of an apedal (structureless) "red" B-horizon. The Hutton and Clovelly soils found on this section of the site are widespread and moderately deep, although it has a low clay content.

Landscape: Undulating plains and dunes (Photograph 3)

Depth: 600-1200mm+

Texture: Fine Sandy soils (Photograph 4)

Average Clay Content: 2-4%

Agricultural Potential: Low potential soils, due to the sandy nature of the soils, the undulating terrain and the climatic conditions, making these areas are not suitable for crop cultivation under arable conditions.

Land capability: The grazing potential of these areas is moderate. The most suitable and optimal utilization of the area would be grazing by livestock or game species.

Photograph 3. Landscape associated with the medium depth Hutton soil forms in the project area

Photograph 4. Sandy nature of the red Aeolian sands associated with the Hutton soil form

6.3 Very deep red apedal Aeolian sandy soils of the Hutton soil form

Binominal Classification S.A.: Hutton / Clovelly soil forms;

Description: Very deep Aeolian sands of the Hutton and Clovelly soil forms. The

Landscape: Slightly undulating plains (Photograph 5)

Depth: >1200mm;

Texture: Fine sandy soils;

Average Clay Content: 2-4%;

Agricultural Potential: Low potential soils, due to the sandy nature of the soils (low water holding capacity), arid climatic conditions and low nutrient values;

Land capability: The soil form is suitable for livestock grazing purposes, although it is limited due to the low nutrient content of the sandy soils and the palatability of the grass layer. The prevailing land capability class in the area is Class VI, which is suitable for moderate grazing at best, with no arable potential (Schoeman et al., 2000). This is due to the combination of unfavourable climate and sandy soils.

Photograph 5. Typical landscape associated with the very deep Aeolian sands

Photograph 6. Typical soil form profile of the Aeolian sands as observed in a burrow

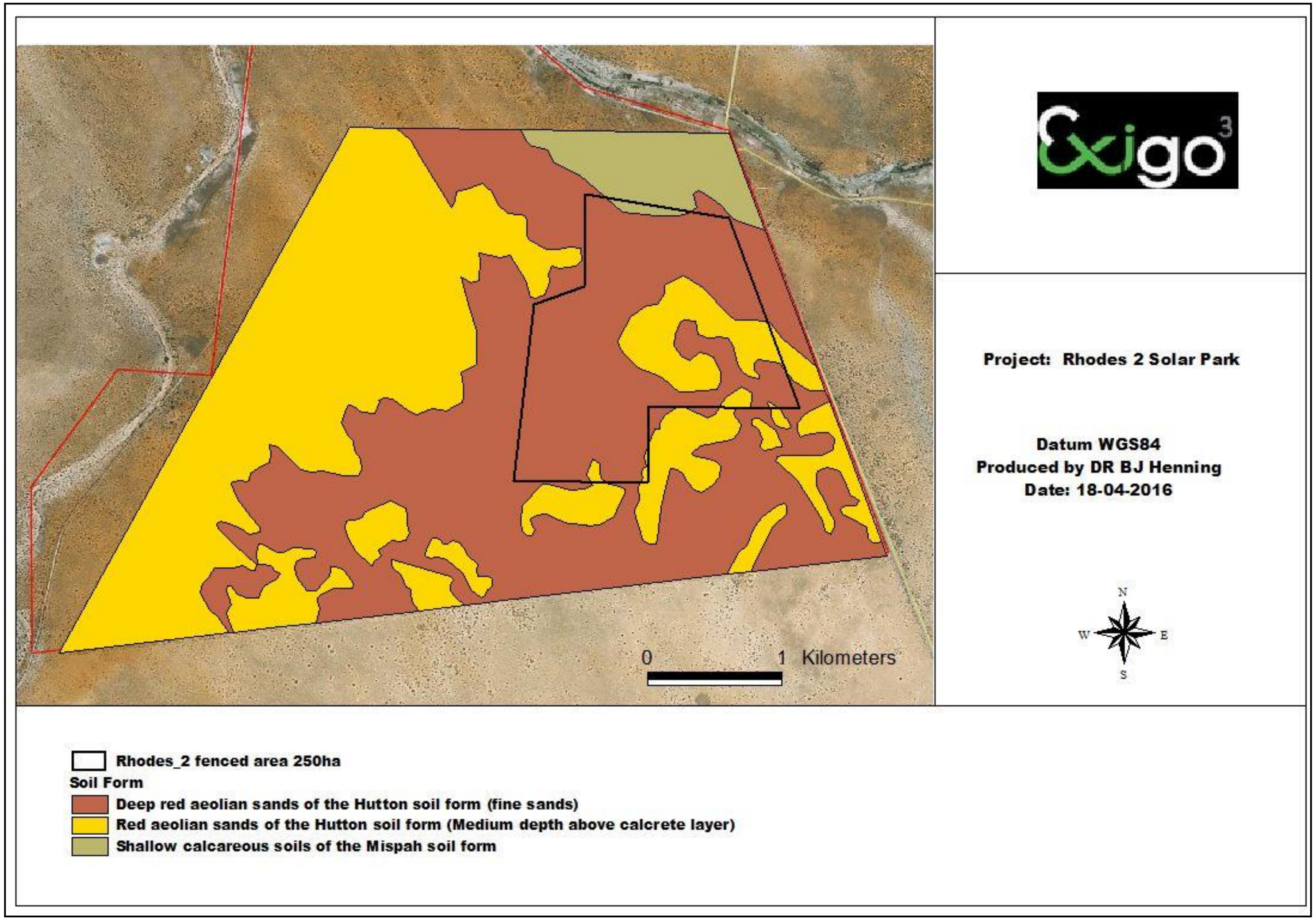

Figure 7. Soil form map of the project area

7 AGRO-ENTERPRISE AND LAND CAPABILITY

Land capability is a system that was developed by the U.S. Department of Agriculture in the 1950s. It separates soils into classes of increasing land use limitations. Criteria used in the original system related only to soil physical properties and not soil fertility. If land capability is to be utilised in the agricultural sector, soil fertility parameters alongside yield data need to be taken into account (Bouma, 2000). Increasingly this has been the case with the development of soil potential mapping.

7.1 Arable land (crop production)

The area is expected to receive an annual total rainfall between 120 and 260mm, mostly between October to April. This amount is very low. The site is considered to be located in an area too dry for rained arable crop production. The high variability in rainfall distribution within the area could further render dryland farming a risky venture, even under irrigated conditions. The climatic conditions, in combination with the sandy nature of the soil are the main factors determining the soils to be unsuitable for arable agriculture.

The project site is thus dry which would contribute to moisture stress condition during crop growth and development. The potential of groundwater is relatively low to sustain a high water demanding irrigated cropping, expected at the project site.

The proposed development site is largely composed of very sandy Aeolian sands (clay content varies between 2 and 8% with depth mostly deeper than 1200mm). The soils are predominantly deep with some areas where the calcrete are exposed closer to the surface. The sandy nature of the soils and climatic conditions of the area renders the area investigated unfavourable for effective crop production. Economically viable crop production is therefore not considered as a viable option on this site.

7.2 Grazing land (Livestock production)

The current vegetation at the proposed site of development consists mainly of microphyllous woodland with a well-developed grass layer. According to databases (ARC), the potential grazing capacity of the area for livestock is estimated to be 9 to 13 ha/LSU (*low to moderate,* Figure 10). When applying the national norms applicable to Act 70 of 70, which indicates the land unit to be able to carry 60 LSU's per farm unit, an economically viable farm for this area will be between 540 and 780 ha. It should be noted that the landowner currently owns the farm Rhodes as an entity (1810.8314ha). The size of the farm therefore constitutes an economically viable piece of land that can support between 139 and 201 LSU's.

The proposed development (footprint: 250 ha) would entail a reduction of its grazing potential for 16 - 23 *potential* LSU's, therefore it will not have a negative impact on the land, being an economically viable unit if one considers that the remainder of the property can still support between 123 and 178 LSU's with the development in place.

Considering that re-growth of grass will take place under the panels as the mounting systems are at least 1m above ground level, the grazing value of the land will still be available to small livestock such as game, goats and sheep. At the end of the lifetime of the solar plant, structures will be removed and natural vegetation will re-establish naturally. The grazing value of the land can therefore be increased by using planted pasture underneath the solar panel mounts.

The *low* agricultural potential of the soils and the *low to moderate* grazing capacity is further confirmed by the Agricultural Maps below (Figures 10, 11, 12):

- Potential Grazing Capacity Map (1993) - indicating that the project site has a potential grazing capacity of 9 -13 ha / LSU's (Figure 8). As indicated in the previous map, this grazing potential is *moderate*, if compared to the maximum value indicated in the legend (less than 4ha / LSU).
- Land Capability Map - site is classified as *Non-arable – low potential grazing land* (Figure 9);
- Agricultural Potential Map - indicating that the project site (Farm Rhodes) is classified as *Low Agricultural Potential (*Figure 10)

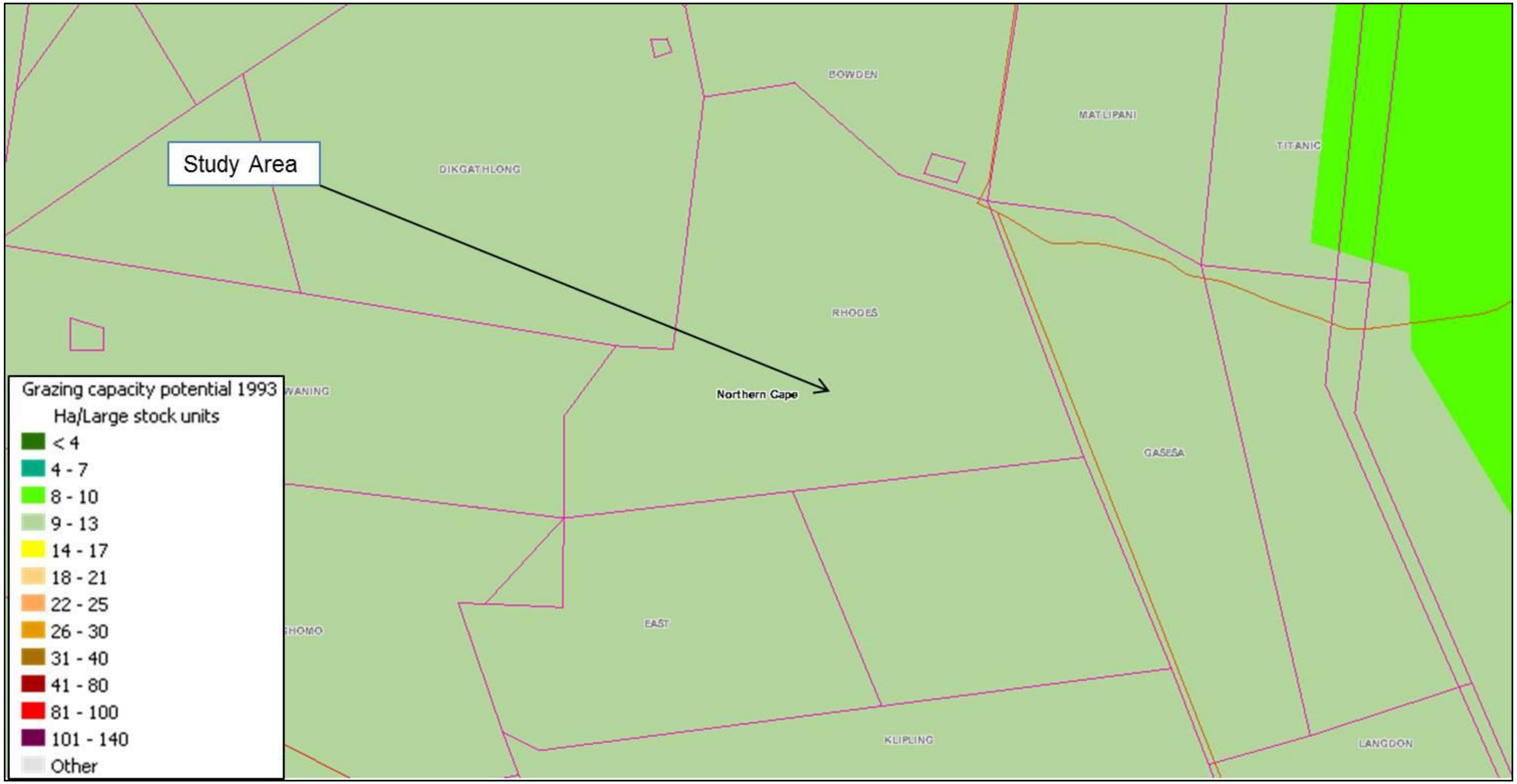

Figure 8. Grazing capacity map of the study area 1993 database

Source: [Web] http://www.agis.agric.za/agismap_atlas/AtlasViewer)

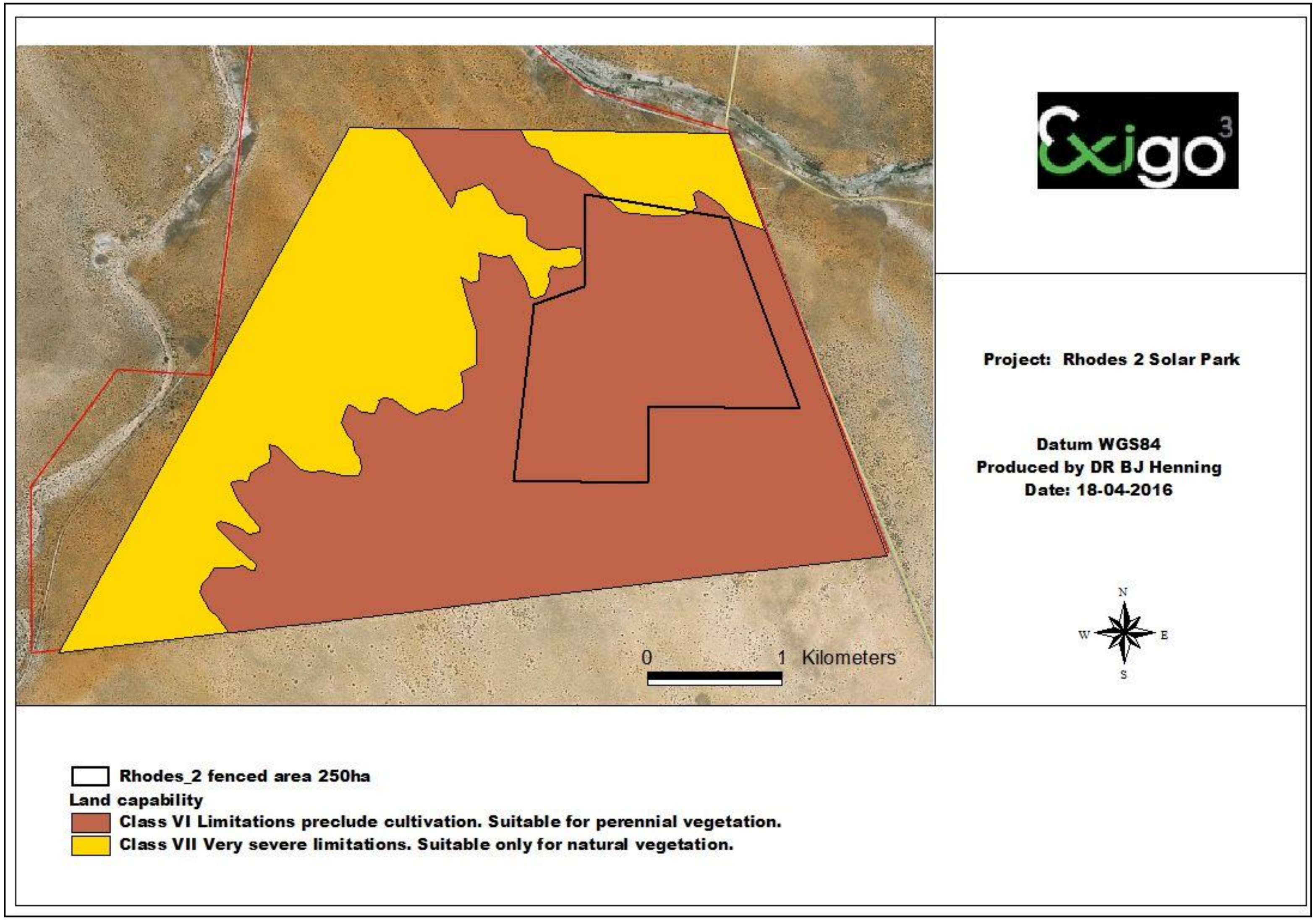

Figure 9. Land capability map for the Solar Parks

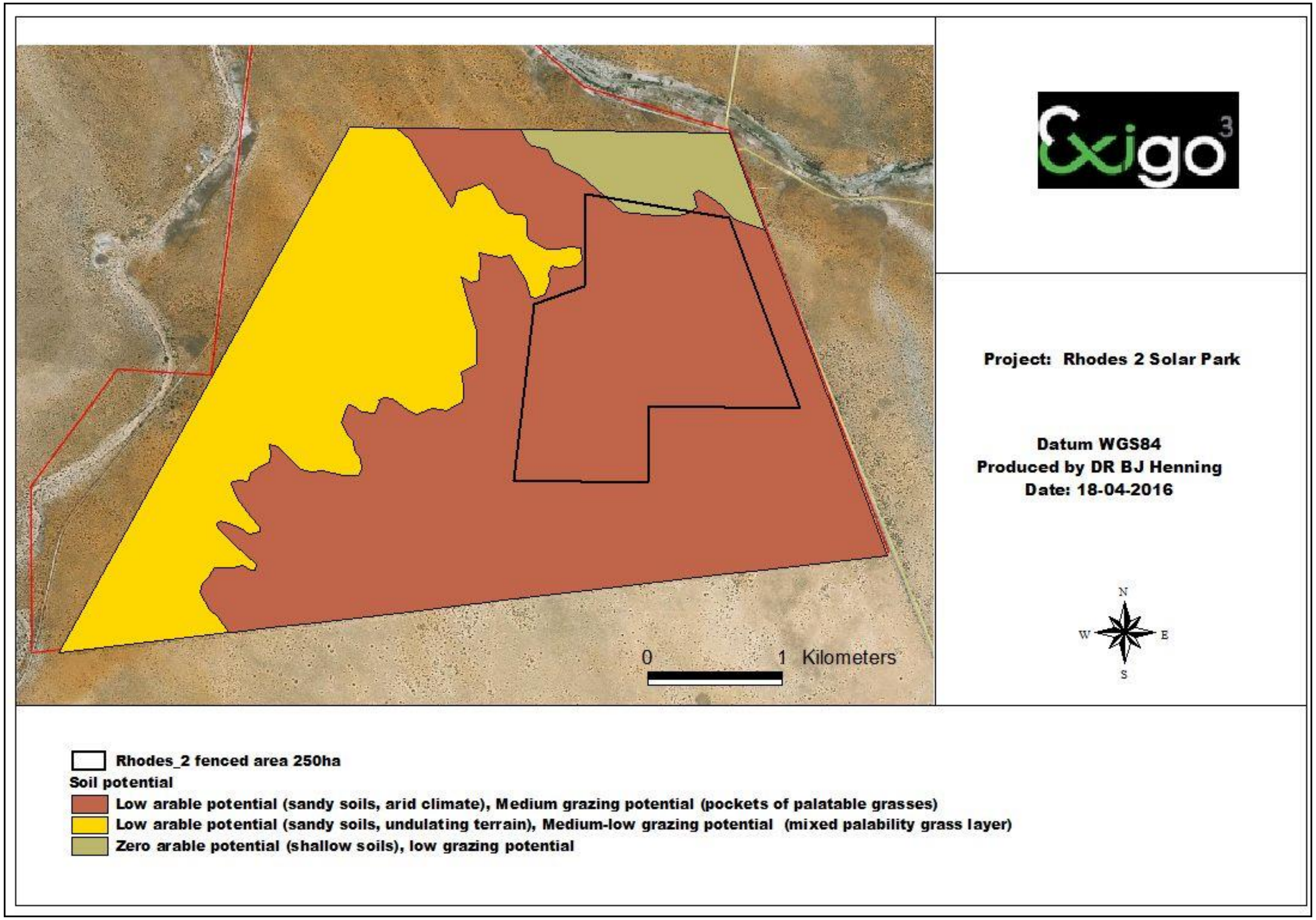

Figure 10. Soil Potential Map for the Solar Parks

8 ANTICIPATED SOIL IMPACTS

Impacts associated with the proposed development on soils and land capability will depend on the specific area where the development will take place. If the activities take place along the slightly undulating terrain plains the impacts will be lower with marginal erosion risks that can be managed through proper mitigation measures. Mitigation of impacts on soils (compaction, erosion) will be easier on flatter areas. The following list of impacts is anticipated with the proposed developments on the soils and land capability in the area during the construction and operational phases:

- Disturbance of soils (Soil compaction, erosion and crusting);
- Sterilisation of soil (soil stripping);
- Soil contamination due to leaching of soluble chemical pollutants;
- Loss of current and potential agricultural land

9 MITIGATION MEASURES

9.1 Soil compaction

- Soil should be handled when dry during removal and placement to reduce compaction risk;
- Vegetation (grass and small shrubs) should not be cleared from the site prior to clearing (except if vegetation requires relocation as determined through an ecology assessment). This material is to be stripped together with topsoil as it will supplement the organic and possibly seed content of the topsoil stockpile depending on the time of soil stripping and
- During construction, sensitive soils with high risk of compaction (e.g. clayey soils) must be avoided in order to reduce potential impacts. Only necessary damage must be caused and unnecessary driving around and/or bulldozing must not take place.

9.2 Soil erosion

- Minimize land disturbance and develop and implement stringent erosion and dust control practices. Control dust on construction sites and access roads using water-sprayers.
- Institute a storm water management plan including strategies such as:
    - Minimising impervious area
    - Increasing infiltration to soil by use of recharge areas
    - Use of natural vegetated swales instead of pipes or
    - Installing detention or retention facilities with graduated outlet control structures.
- Have both temporary (during construction) and permanent erosion control plans.
    - Temporary control plans should include:
        - Short term seeding or mulching of exposed soil areas (slopes)
        - Limit access for heavy machinery to avoid soil compaction.
    - Permanent erosion control plans should focus on the establishment of stable native vegetation communities.

- Other mitigation measures needed to prevent soil erosion include:
  - Ensure the amount of bare soil exposed is minimized by staging earthworks in phases and leaving as much ground cover intact as possible during construction.
  - Protect areas susceptible to erosion and ensure that there is no undue soil erosion from activities within and adjacent to the construction camp and Work Areas.
  - Conservation of topsoil should be prioritized on site and done as follows:
    - Topsoil should be handled twice only - once to strip and stockpile, and secondly to replace, level, shape and scarify.
    - Stockpile topsoil separately from subsoil.
    - Stockpile in an area that is protected from storm water runoff and wind.
    - Topsoil stockpiles should not exceed 2.0 m in height and should be protected by a mulch cover where possible.
    - Maintain topsoil stockpiles in a weed free condition.
    - Topsoil should not be compacted in any way, nor should any object be placed or stockpiled upon it.
    - Stockpile topsoil for the minimum time period possible i.e. strip just before the relevant activity commences and replace as soon as it is completed.

9.3 Soil pollution

- Dry chemicals to be stored on an impervious surface protected from rainfall and storm water run-off;
- Ensure that refuelling stations on site are constructed to prevent spillage of fuel/oil onto soil, and put in place measures to ensure that accidental spillages can be contained and cleaned up promptly.
- Spill kits should be on-hand to deal with spills immediately;
- Spillages or leakages must be treated according to an applicable procedure as determined by a plan of action for the specific type of disturbance;
- All construction vehicles should be inspected for oil and fuel leaks regularly and frequently. Vehicle maintenance will not be done on site except in emergency situations in which case mobile drip trays will be used to capture any spills. Drip trays should be emptied into a holding tank and returned to the supplier.

9.4 Loss of current and potential agricultural land

- Avoidance of the high potential soils under irrigation along proposed access road. The design of the road should subsequently be done in such a way that it will be located outside the crop circle.

10 DISCUSSION

By definition, based on Part 1 of the Regulation of Conservation of Agricultural Resources Act 43 of 1983, the proposed area, earmarked for the development of the Rhodes 2 Solar Park in the Northern Cape Province can be classified as having low potential soils as a result of the following:

It is low potential because:

- The sandy nature of the soil and arid climate (MAP below 500mm) makes the potential to cultivate crops under arable conditions basically impossible, especially considering that the sandy soils have a low water holding capacity unsuitable for arable agriculture. Therefore, the site should be classified as not suitable for arable agriculture due to its physical characteristics.
- The grazing capacity of the land would allow limited grazing of the area. The proposed development site will however not reduce the grazing value of the land considering that the grass and forb layer of the site will still be available underneath the solar panel mounts to small livestock.

11 CONCLUSION

This study addresses the agricultural potential, land capability and general characteristics of the soils on the site for the development on the farm Rhodes 269, Northern Cape Province. The results indicate that the agricultural potential of soils on the proposed development area is mostly low (shallow, calcareous soils or very sandy soils with limited suitability for grazing). The results obtained from the study were done after field observations were done to verify the soil potential classified by the Department of Agriculture on a small scale. The site should subsequently be considered as moderate to low potential grazing land with low to zero potential for arable agriculture considering the climatic conditions, soil physical characteristics and size of land potentially available. Considering that re-growth of grass will take place under the panels as the mounting systems are at least 1m above ground level, the grazing value of the land will not be lost entirely since smaller livestock such as game, goats and sheep will still be able to utilize the grass layer underneath the panels. At the end of the lifetime of the solar plant, structures will be removed and natural vegetation will re-establish naturally.

12 REFERENCES

Acocks, J.P.H. Veld Types of South Africa, Botanical Research Institute, Pretoria.

ARC. Areas in which high potential agricultural land may occur, superimposed on moisture availability zones. 2002. Map Scale: 2 500 000. Project No. 041_2000/bw/Mois.gra.

ENPAT, 2000. Environmental Potential Atlas. Department of Environmental Affairs and Tourism, Pretoria.

Franzmeir, D.P., E.J. Pedersen, T.J. Longwell, J.G. Byrne, and C. Losche. 1969. Properties of some soils in the cuberland plateau as related to slope aspect and position. Soil Sci. Soc. Am. Proc. 33:755-761.

Jiang, P., and K.D. Thelen. 2004. Effect of soil topographic properties on crop yield in north-central corn-soybean cropping system. Agron. J. 96:252-258.

Laker, M.C. 2005. South Africa's soil resources and sustainable development. http://www.environment.gov.za/nssd_2005/Web/NSSD%20Process%20Documents%20and%20Reports/REVIEW_Soil_and_Sustainability_Oct 05.pdf.

Low, A.B. &Rebelo, A.G. (eds). 2006. Vegetation of South Africa, Lesotho and Swaziland, Dept Environmental Affairs & Tourism, Pretoria.

Macvicar, C. N. 1991. Soil Classification: A Taxonomic system for South Africa. Department of Agriculture, Pretoria.

Mucina L., Rutherford M.C. &Powrie L.W. (eds) (2005). Vegetation Map of South Africa, Lesotho and Swaziland, 1:1000000 scale sheet maps.

Peverill, K.I., L.A. Sparrow, and D.J. Reutter. 1999. Soil Analysis, an Interpretation Manual. CSIRO Publication. Collingwood, Victoria. Australia

Schoeman, J.L. National Department of Agriculture. 2004. Criteria for prime or unique agricultural land in South Africa. Report Number GW/A/2002/21.

Soil classification working group. 1991. Soil classification, A Taxonomic System for South Africa. Soil and Irrigation Research Institute, Department of Agricultural Development. Pretoria.

Stone, J.R., J.W. Gilliam, D.K. Cassel, R.B. Daniels, L.A. Nelson, and H.J. Kleiss. 1985. Effect of erosion and landscape position on the productivity of piedmont soils. Soil Sci. Am. J. 49:987-991.

Van Der Merwe, C. R. 1952. Soil Groups and subgroups of South Africa. Science Bulletin 356.