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TERRASOIL SCIENCE

31 January, 2023

Contact person	Dr. Johan van der Waals
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Bernard de Witt
EnviroAfrica
Somerset West

Dear Mr de Witt,

CONFIRMATION OF STATUS AN APPLICABILITY: VANRHYNSDORP SOLAR ENERGY FACILITY AGRICULTURAL IMPACTS

Reference is made to a report with the title “Basic Assessment Level Report – Soil, Land Use, Land Capability And Agricultural Potential Survey: Proposed Vanrhynsdorp Keren Solar Energy Facility: Vanrhynsdorp, Northern Cape Province”, dated 20 April 2017.

The aforementioned report was generated by myself (Terra Soil Science).

The referenced report’s contents and findings are still applicable and can be applied as is for updated applications on the site that have similar impacts. In this regard a solar facility with the added scope of generating hydrogen will not incur any additional land and agriculture related impacts.

I trust you find the above in order.

Yours sincerely,

DR. J.H. VAN DER WAALS
Terra Soil Science: Director

Appendix D: Specialist Reports

Appendix D1: Updated Soil, Land Use, Land Capabilities and Agricultural Potential Survey (2017)

TERRASOIL SCIENCE

BASIC ASSESSMENT LEVEL REPORT

SOIL, LAND USE, LAND CAPABILITY AND AGRICULTURAL POTENTIAL SURVEY:

PROPOSED VANRHYNSDORP KEREN SOLAR ENERGY FACILITY: VANRHYNSDORP, NORTHERN CAPE PROVINCE

20 April, 2017

Compiled by:
J.H. van der Waals
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Soil Science Society of South Africa (SSSSA)
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South African Soil Surveyors Organisation (SASSO)

Registered with:
The South African Council for Natural Scientific Professions
Registration number: 400106/08

DECLARATION

I, Johan Hilgard van der Waals, declare that –

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- 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 application, including knowledge of 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 have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant 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 application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form 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.

J.H. VAN DER WAALS
TERRA SOIL SCIENCE

Table of Contents

SOIL, LAND USE, LAND CAPABILITY AND AGRICULTURAL POTENTIAL SURVEY – PROPOSED VANRHYNSDORP KEREN SOLAR ENERGY FACILITY: VANRHYNSDORP, NORTHERN CAPE PROVINCE

1. TERMS OF REFERENCE

Terra Soil Science (TSS) was commissioned by EnviroAfrica to undertake a Basic Assessment level soil, land use, land capability, and agricultural potential survey for the proposed Vanrhynsdorp Keren Solar Energy Facility near Vanrhynsdorp in the Northern Cape Province.

2. INTRODUCTION

2.1 Study Aim and Objectives

The study area has been proposed to serve as a locality for the construction of a photovoltaic solar energy facility and associated infrastructure for power generation purposes. This study aims to determine the possible impact that this development could have on the soils, land use, land capability and agricultural potential as well as to identify areas of high sensitivity regarding solar panels and infrastructure.

The study has as objectives the identification and estimation of:

- » Soil form (SA taxonomic system) and soil depth for the area;
- » Soil potential linked to current land use and other possible uses and options;
- » Discussion of the agricultural potential in terms of the soils, water availability, surrounding developments and current status of land; and
- » Discussion of impacts (potential and actual) as a result of the development.

2.2 Agricultural Potential Background

The assessment of agricultural potential rests primarily on the identification of soils that are suited to crop production. In order to qualify as high potential soils they must have the following properties:

- » Deep profile (more than 600 mm) for adequate root development,
- » Deep profile and adequate clay content for the storing of sufficient water so that plants can weather short dry spells,
- » Adequate structure (loose enough and not dense) that allows for good root development,
- » Sufficient clay or organic matter to ensure retention and supply of plant nutrients,
- » Limited quantities of rock in the matrix that would otherwise limit tilling options and water holding capacity,
- » Adequate distribution of soils and size of high potential soil area to constitute a viable economic management unit, and

» Good enough internal and external (out of profile) drainage if irrigation practices are considered. Drainage is imperative for the removal (leaching) of salts that accumulate in profiles during irrigation and fertilization.

In addition to soil characteristics, climatic characteristics need to be assessed to determine the agricultural potential of a site. The rainfall characteristics are of primary importance and in order to provide an adequate baseline for the viable production of crops rainfall quantities and distribution need to be sufficient and optimal. The combination of the above mentioned factors will be used to assess the agricultural potential of the soils on the site.

2.3 Survey Area Boundary

The site lies between 31° 34' 26" and 31° 35' 03" south and 18° 44' 22" and 18° 45' 01" east immediately north of the town of Vanrhynsdorp in the Northern Cape Province (**Figure 1**). The 30 km radius within which the cumulative impacts were assessed is also indicated in **Figure 1**.

2.4 Survey Area Physical Features

The survey area lies on relatively flat terrain between 120 and 140 m above mean sea level with a general north-westerly aspect. The geology of the area is comprised of alluvium, sand and calcrete of Quaternary origin.

3. SOIL, LAND CAPABILITY, LAND USE SURVEY AND AGRICULTURAL POTENTIAL SURVEY

3.1 Method of Survey

The Basic Assessment level soil, land capability, land use and agricultural potential surveys were conducted in three phases.

3.1.1 Phase 1: Land Type Data

Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC). The land type data is presented at a scale of 1:250 000 and entails the division of land into land types, typical terrain cross-sections for the land type and the presentation of dominant soil types for each of the identified terrain units (in the cross section). The soil data is classified according to the Binomial System (MacVicar et al., 1977). The soil data was interpreted and re-classified according to the Taxonomic System (Soil Classification Working Group, 1991).

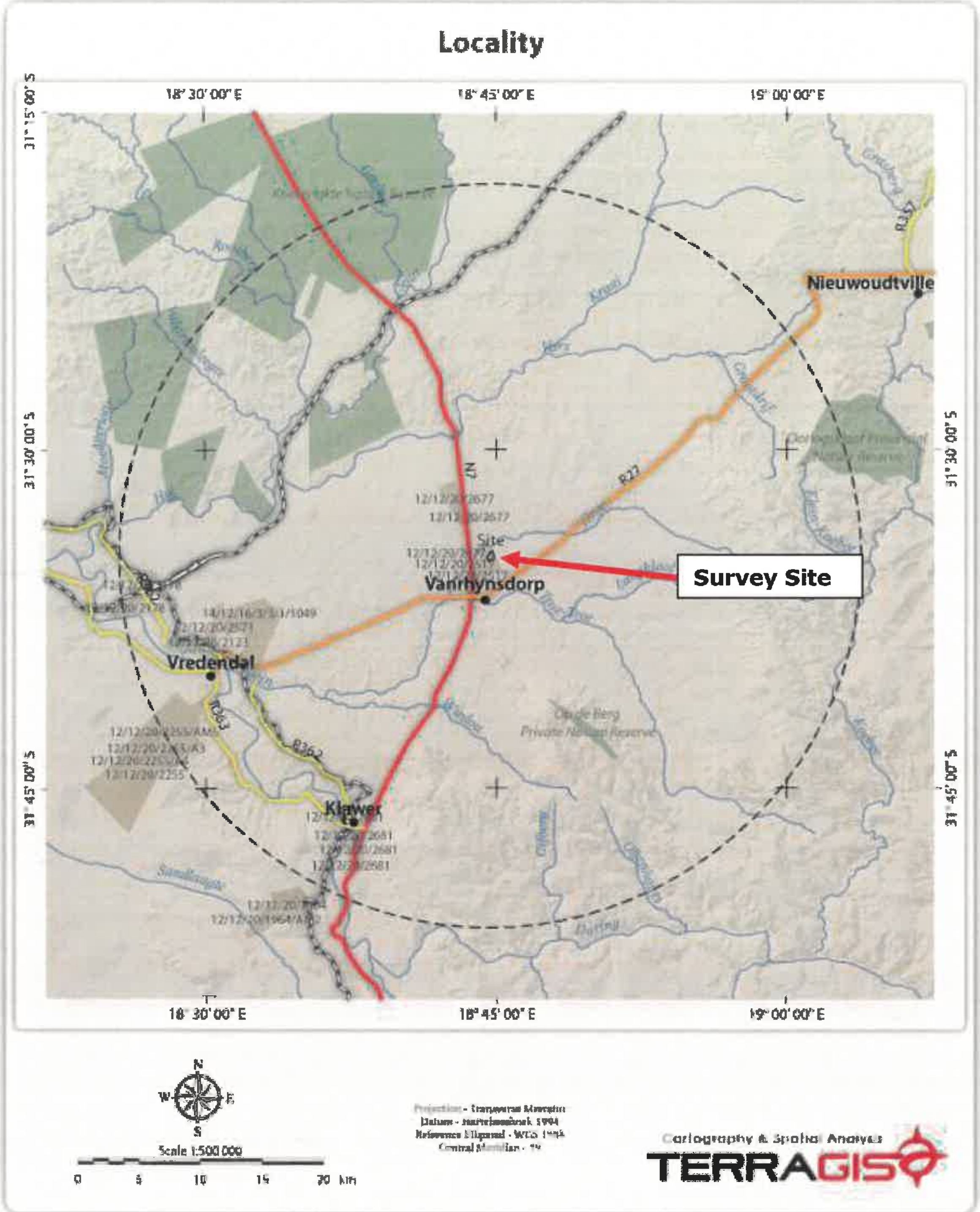

Figure 1 Locality of the survey site

3.1.2 Phase 2: Aerial Photograph Interpretation and Land Use Mapping

The most up to date aerial photographs of the site were obtained from Google Earth. The image was used to interpret aspects such as land use and land cover.

3.1.3 Phase 3: Site Visit and Soil Survey

A site visit was conducted in November, 2011, during which a soil survey was conducted. A follow up site investigation was conducted on the 28th of February 2017. The site was traversed on foot with the aim of ascertaining as much of the soil variability as possible. Soils were described and photographs were taken of pertinent soil, landscape and land use characteristics.

3.1.4 Phase 4: Cumulative Impacts Assessment

The cumulative impacts assessment of the PV facility was assessed through 1) taking into account the other solar facilities that have been applied for and approved in applications under NEMA within a 30 km radius of the site and 2) the making of a comparison of the impacts on the site to coal mining and energy production impacts on the Mpumalanga Highveld on land of high agricultural potential.

3.2 Survey Results

3.2.1 Phase 1: Land Type Data

The site falls into the **Ag202** land type (Land Type Survey Staff, 1972 - 2006). (Refer to **Figure 2** for the land type map of the area). Below follows a brief description of the land type in terms of soils, land capability, land use and agricultural potential.

<u>Land Type Ag202</u>
<u>Soils</u>: Predominantly shallow to moderately deep (mainly red in colour) lime rich soils with extensive dorbank occurrences. The dorbank horizons are often exposed at the surface as is lime mounds associated with "heuweltjies" – a characteristic localised land form associated with the Western Cape and Namaqualand.
<u>Land capability and land use</u>: Exclusively extensive grazing due to climatic and soil constraints.
<u>Agricultural potential</u>: Very low potential due to the low rainfall (less than 100 mm per year – **Figure 3**) and shallow soils.

3.2.2 Phase 2: Aerial Photograph Interpretation and Land Use/Capability Mapping

The interpretation of aerial photographs yielded one dominant land use namely extensive grazing (**Figure 4**). The carrying capacity of the site is very low as rainfall and soils are limiting with regards to biomass production. Additional feeding of sheep and proper grazing management (camps) are imperative for the sustainable production of the sheep.

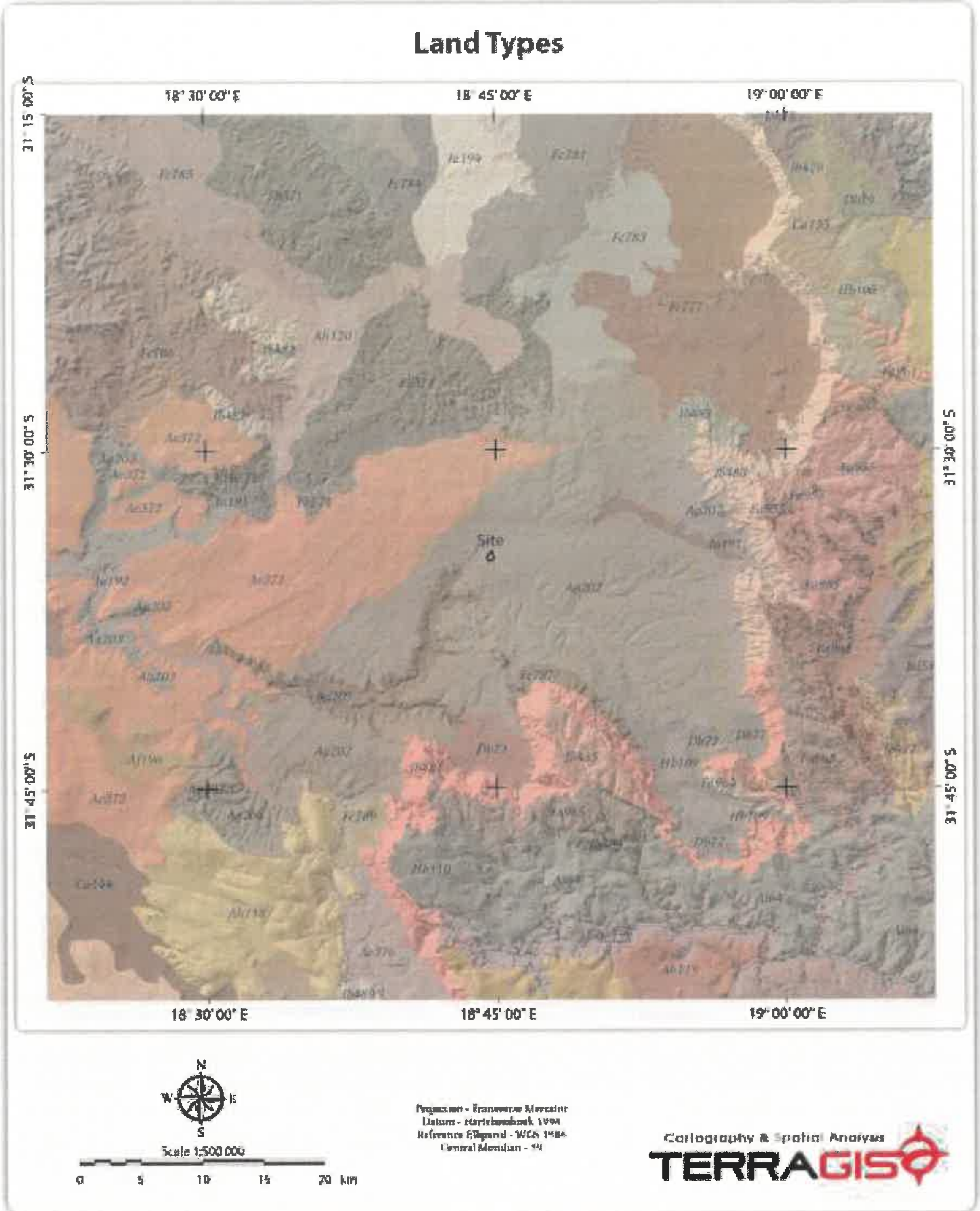

Figure 2 Land type map of the survey area

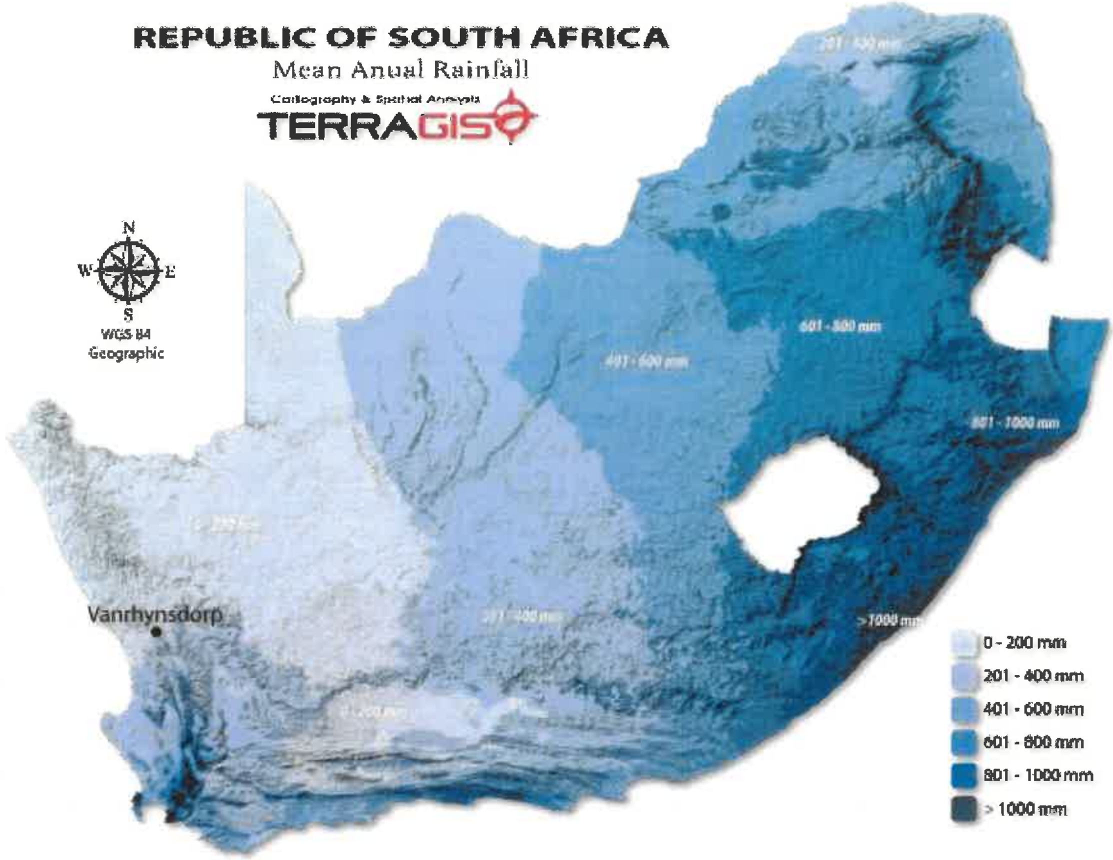

Figure 3 Rainfall map of South Africa indicating the survey site

3.2.3 Phase 3: Site Visit and Soil Survey

The soil survey confirmed the land type data. A soil map of the site was not produced as the soils on the site are very homogenous and distinct soil units could therefore not be delineated meaningfully. The soils on the site consist of red sandy horizons overlying lime rich soft and hardpan carbonate (calcrete) soil horizons as well as dorbank horizons (**Figures 4** to **7**). The depth variability of the lime and dorbank horizons lead to the occurrence of a range of soils that include amongst others Coega (orthic A / hardpan carbonate B), Brandvlei (orthic A / soft carbonate), Augrabies (orthic A / neocarbonate B), Trawal (orthic A / neocarbonate B / dorbank) soils forms. To the north the site is bordered by soils in a drainage depression, used for irrigation purposes, of the Augrabies (orthic A / neocarbonate B) and Dundee (orthic A / lime dominated stratified alluvium) forms.

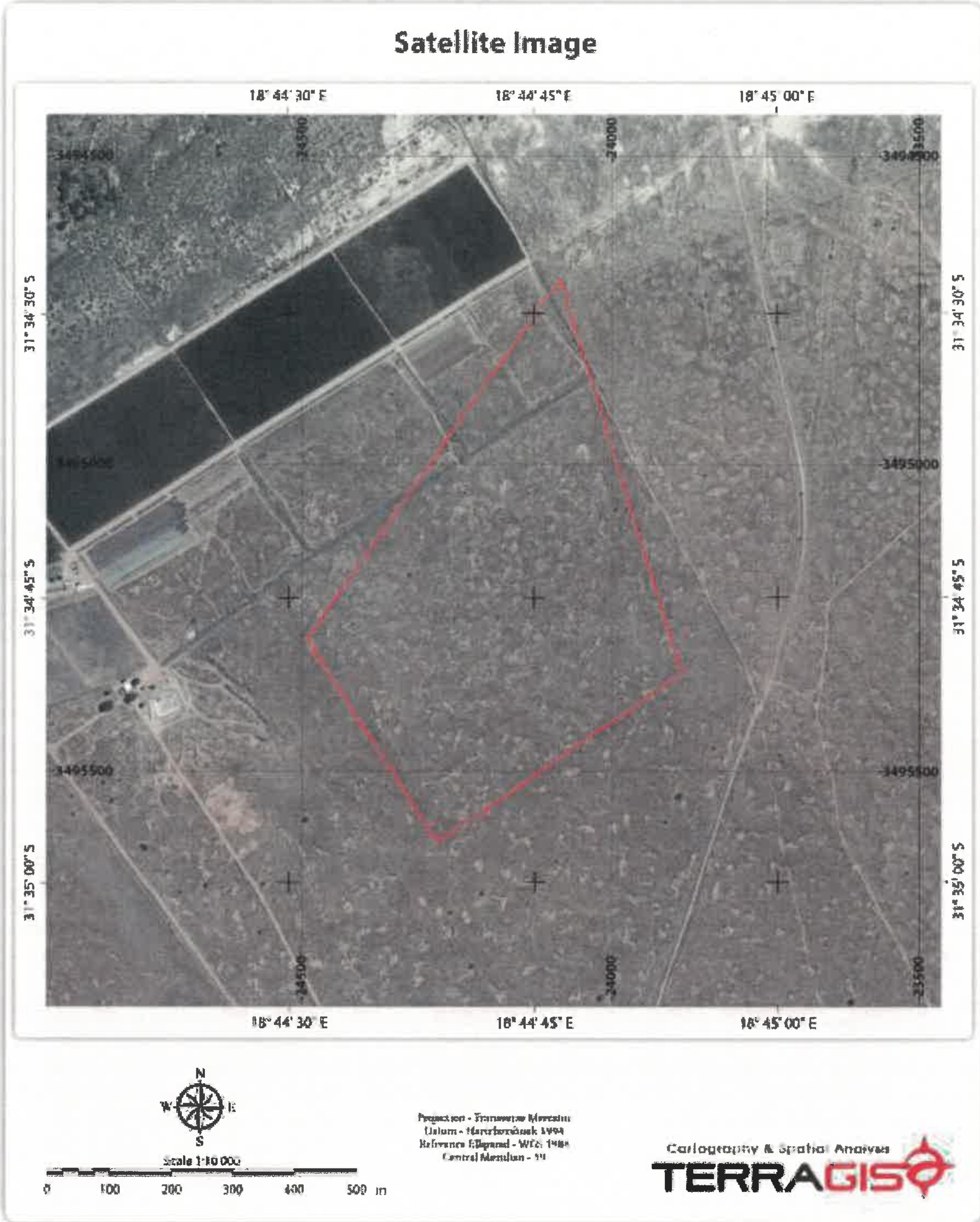

Figure 4 Satellite map of the general and the survey area

Figure 5 Typical land cover with lime nodules at the soil surface

Figure 6 Typical land cover with lime nodules at the soil surface

Figure 7 Typical soil cover with lime nodules and rocks at the soil surface

Figure 8 Exposed dorbank horizon soil material at the soil surface

3.2.4 Phase 4: Cumulative Impacts Assessment

The 30 km radius surrounding the site is indicated in **Figure 1** with the other solar developments indicated in darker shading and with their official names supplied. The contribution of the site under investigation to the total solar surface area impact is provided in **Table 1**. The Vanrhynsdorp site contributes 0.13 % of the total surface area planned for solar projects in a 30 km radius.

Table 1 Area of the Vanrhynsdorp project and cumulative solar project area (ha)

	Site (Vanrhynsdorp)	Projects within 30 km radius (total project area)	Contribution to total (%)
Area (ha)	28.3	22563.1	0.13

4. INTERPRETATION OF SOIL, LAND CAPABILITY AND LAND USE SURVEY RESULTS

The interpretation of the land use and land capability results yielded a number of aspects that are of importance to the project.

4.1 Agricultural Potential

The agricultural potential of the site is determined mainly by the climate in that the rainfall effectively excludes any form of crop production. Additionally, the site specific soils are not suited to crop production under irrigation in their current state and will require significant physical preparation before irrigated land uses are considered. The costs of these physical measures vary between R 150 000 and R 250 000 per hectare depending the extent of blasting required to break large boulders and rock derived from the calcrete and dorbank. The site is therefore only suited to extensive grazing with a very low carrying capacity.

4.2 Overall Soil and Land Impacts

Due to the low agricultural potential of the site as well as the low rainfall the impacts on soils and agriculture is expected to be low – provided that adequate storm water management and erosion prevention measures are implemented. These measures should be included in the layout and engineering designs of the development.

5. ASSESMENT OF IMPACT

5.1 Assessment Criteria

The following assessment criteria (**Table 2**) will be used for the impact assessment.

Table 2 Impact Assessment Criteria

CATEGORY	DESCRIPTION OF DEFINITION
Direct, indirect and cumulative impacts	In relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.
Nature	A description of the cause of the effect, what will be affected and how it will be affected.
Extent (Scale) • 1 • 2 • 3 • 4 • 5	The area over which the impact will be expressed – ranging from local (1) to regional (5).
Duration • 1 • 2 • 3 • 4 • 5	Indicates what the lifetime of the impact will be. • Very short term: 0 – 1 years • Short-term: 2 – 5 years • Medium-term: 5 – 15 years • Long-term: > 15 years • Permanent
Magnitude • 2 • 4 • 6 • 8 • 10	This is quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
Probability • 1 • 2 • 3 • 4 • 5	Describes the likelihood of an impact actually occurring. • Very Improbable • Improbable • Probable • Highly probable • Definite
Significance	The significance of an impact is determined through a synthesis of all of the above aspects. S = (E + D + M)*P S = Significance weighting E = Extent

CATEGORY	DESCRIPTION OF DEFINITION
	D = Duration M = Magnitude
Status • Positive • Negative • Neutral	Described as either positive, negative or neutral
Other	• Degree to which the impact can be reversed • Degree to which the impact may cause irreplaceable loss of resources • Degree to which the impact can be mitigated

5.2 List of Activities for the Site

Table 3 lists the anticipated activities for the site. The last two columns in the table list the anticipated forms of soil degradation and geographical distribution of the impacts.

Table 3 List of activities and their associated forms of soil degradation

Activity	Form of Degradation	Geographical Extent	Comment (Section described)
Construction Phase			
Construction of solar panels and stands	Physical degradation (surface)	Two dimensional	Impact small due to localised nature (Section 5.3.1)
Construction of buildings and other infrastructure	Physical degradation (compound)	Two dimensional	(Section 5.3.2)
Construction of roads	Physical degradation (compound)	Two dimensional	(Section 5.3.3)
Construction and Operational Phase Related Effects			
Vehicle operation on site	Physical and chemical degradation (hydrocarbon spills)	Mainly point and one dimensional	(Section 5.3.4)
Dust generation	Physical degradation	Two dimensional	(Section 5.3.5)

5.3 Assessment of the Impacts of Activities

Many of the impacts are generic and their impacts will remain similar for most areas on the site. The generic activity will therefore be assessed. The impacts associated with the different activities have been assessed below for each activity. These impacts have been summarized in **Table 9**. **Note:** The impacts listed below indicate that no mitigation is possible. It is important to note that any soil impact in the form of drastic physical disturbance (as with construction activities) is a permanent one and no mitigation is possible. The mitigation that can be applied is the restriction of off-site effects due to developments through adequate implementation of environmental management measures (discussed later in the report).

5.3.1 Construction of Solar Panels and Stands

Table 4 presents the impact criteria and a description with respect to soils, land capability and land use for the construction of solar panels and stands.

Table 4 Construction of solar panels and stands

Criteria	Description	
Cumulative Impact	The cumulative impact of this activity will be small as it is constructed on land with low agricultural potential.	
Nature	This activity entails the construction of solar panels and stands with the associated disturbance of soils and existing land use.	
	Without Mitigation	With Mitigation
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed
Duration	5 – Permanent (unless removed)	5 – Permanent (unless removed)
Magnitude	2	2
Probability	4 (highly probable due to inevitable changes in land use)	4 (highly probable due to inevitable changes in land use)
Significance of impact	S = (1 + 5 + 2)*4 = 32 (low)	S = (1 + 5 + 2)*4 = 32 (low)
Status	Negative	Negative
Mitigation	None possible. Limit footprint to the immediate development area	None possible. Limit footprint to the immediate development area

5.3.2 Construction of Buildings and Other Infrastructure

Table 5 presents the impact criteria and a description with respect to soils, land capability and land use for the construction of solar panels and stands.

Table 5 Construction of buildings and other infrastructure

Criteria	Description	
Cumulative Impact	The cumulative impact of this activity will be small as it is constructed on land with low agricultural potential.	
Nature	This activity entails the construction of buildings and other infrastructure with the associated disturbance of soils and existing land use.	
	Without Mitigation	With Mitigation
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed
Duration	5 – Permanent (unless removed)	5 – Permanent (unless removed)
Magnitude	2	2
Probability	4 (highly probable due to inevitable changes in land use)	4 (highly probable due to inevitable changes in land use)
Significance of impact	S = (1 + 5 + 2)*4 = 32	S = (1 + 5 + 2)*4 = 32 (low)
Status	Negative	Negative
Mitigation	None possible. Limit footprint to the immediate development area	None possible. Limit footprint to the immediate development area

5.3.3 Construction of Roads

Table 6 presents the impact criteria and a description with respect to soils, land capability and land use for the construction of roads.

5.3.4 Vehicle Operation on Site

It is assumed that vehicle movement will be restricted to the construction site and established roads. Vehicle impacts in this sense are restricted to spillages of lubricants and petroleum products. **Table 7** presents the impact criteria and a description with respect to soils, land capability and land use for the operation of vehicles on the site.

5.3.5 Dust Generation

Generated dust can impact large areas depending on environmental and climatic conditions. **Table 8** presents the impact criteria and a description with respect to soils, land capability and land use for dust generation on the site.

Table 6 Construction of roads

Criteria	Description	
Cumulative Impact	The cumulative impact of this activity will be small as it is linear and limited in geographical extent.	
Nature	This activity entails the construction of roads with the associated disturbance of soils and existing land use.	
	Without Mitigation	With Mitigation
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed along the road	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed along the road
Duration	5 – Permanent (unless removed)	5 – Permanent (unless removed)
Magnitude	2	2
Probability	4 (highly probable due to inevitable changes in land use)	4 (highly probable due to inevitable changes in land use)
Significance of impact	S = (1 + 5 + 2)*4 = 32 (low)	S = (1 + 5 + 2)*4 = 32 (low)
Status	Negative	Negative
Mitigation	None possible. Limit footprint to the immediate development area and keep to existing roads as far as possible	None possible. Limit footprint to the immediate development area and keep to existing roads as far as possible

Table 7 Assessment of impact of vehicle operation on site

Criteria	Description	
Cumulative Impact	The cumulative impact of this activity will be small if managed.	
Nature	This activity entails the operation of vehicles on site and their associated impacts in terms of spillages of lubricants and petroleum products	
	Without Mitigation	With Mitigation
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed
Duration	2 – Short-term	2 – Short-term
Magnitude	2	2
Probability	4	2 (with prevention and mitigation)
Significance of impact	S = (1 + 2 + 2)*4 = 20	S = (1 + 2 + 2)*2 = 10 (with prevention and mitigation)
Status	Negative	Negative
Mitigation	Maintain vehicles, prevent and address spillages	Maintain vehicles, prevent and address spillages

Table 8 Assessment of impact of dust generation on site

Criteria	Description	
Cumulative Impact	The cumulative impact of this activity will be small if managed but can have widespread impacts if ignored.	
Nature	This activity entails the operation of vehicles on site and their associated dust generation	
	Without Mitigation	With Mitigation
Extent	2 - Local: The impact is diffuse (depending on environmental and climatic conditions) and will probably be limited to within 3 – 5 km of the site	2 - Local: The impact is diffuse (depending on environmental and climatic conditions) and will probably be limited to within 3 – 5 km of the site
Duration	2 – Short-term	2 – Short-term
Magnitude	2	2
Probability	4	2 (with mitigation and adequate management)
Significance of impact	S = (2 + 2 + 2)*4 = 24	S = (2 + 2 + 2)*2 = 12 (with mitigation and adequate management)
Status	Negative	Negative
Mitigation	Limit vehicle movement to absolute minimum, construct proper roads for access	Limit vehicle movement to absolute minimum, construct proper roads for access

5.3.6 Cumulative Impacts Within a 30 km Radius

The cumulative impacts of the development on the site within the context of the planned solar projects within a 30 km radius of the site is a contribution of 0.13%. This contribution is considered to be insignificant and in this regard the impact assessment in section 5.3.1 applies. This is especially relevant in the context of the general low agricultural potential of the site and surrounding area.

5.4 Environmental Management Plan

Tables 10 to **12** provide the critical aspects for inclusion in the EMP.

Table 9 Summary of the impact of the development on agricultural potential and land capability

Nature of Impact	*Loss of agricultural potential and land capability owing to the development*	
	Without mitigation	With mitigation
Extent	Low (1) – Site	Low (1) – Site
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (2)	Low (2)
Probability	Highly probable (4)	Highly probable (4)
Significance*	32 (Low)	32 (Low)
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	No	No
Mitigation: The loss of agricultural land is a long term loss and there are no mitigation measures that can be put in place to combat this loss.		
Cumulative impacts: Soil erosion may arise owing to increased surface water runoff. Adequate management and erosion control measures should be implemented.		
Residual Impacts: The loss of agricultural land is a long term loss. This loss extends to the post-construction phase. The agricultural potential is very low though.		

Table 10 Measures for erosion mitigation and control

Objective: Erosion control and mitigation		
Project components	Soil stabilisation, construction of impoundments and erosion mitigation structures	
Potential Impact	Large scale erosion and sediment generation	
Activity / risk source	Poor planning of rainfall surface runoff and storm water management	
Mitigation: Target / Objective	Prevention of eroded materials and silt rich water running off the site	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Plan and implement adequate erosion control measures	Construction team and engineer	Throughout project
Performance indicator	Assessment of storm water structures and erosion mitigation measures. Measurement of actual erosion and sediment generation.	
Monitoring	Monitor and measure sediment generation and erosion damage	

Table 11 Measures for limiting vehicle operation impacts on site (spillages)

Objective: Erosion control and mitigation		
Project components	Maintenance of vehicles and planning of vehicle service areas	
Potential Impact	Oil, fuel and other hydrocarbon pollution	
Activity / risk source	Poor maintenance of vehicles and poor control over service areas	
Mitigation: Target / Objective	Adequate maintenance and control over service areas	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Service vehicles adequately	Construction team and engineer	Throughout project
Maintenance of service areas, regular cleanup	Construction team and engineer	Throughout project
Performance indicator	Assessment number and extent of spillages on a regular basis.	
Monitoring	Monitor construction and service sites	

Table 12 Measures for limiting dust generation on site

Objective: Dust generation suppression		
Project components	Limit and address dust generation on site linked to construction activities	
Potential Impact	Large scale dust generation on site	
Activity / risk source	Inadequate dust control measures, excessive vehicle movement on unpaved roads	
Mitigation: Target / Objective	Minimise generation of dust	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Implement dust control strategy including dust suppressants and tarring of roads	Construction team and engineer	Throughout project
Limit vehicle movement on unpaved areas to the absolute minimum	Construction team and engineer	Throughout project
Performance indicator	Assessment of dust generated on site	
Monitoring	Monitor construction site and surrounds	

6. CONCLUSIONS AND RECOMMENDATIONS

It is concluded that the proposed development of a photovoltaic facility on the site will not have large impacts due to the low agricultural potential of the site. The low agricultural potential of the site is the result of a dominance shallow lime containing and dorbank dominated soils as well as the very low rainfall of the area.

It is imperative though that adequate storm water management measures be put in place as the soils on the site have no cohesion due to inherent soil properties as well as lack of plant roots. The main impacts that have to be managed on the site are:

1. Erosion must be controlled through adequate mitigation and control structures.
2. Impacts from vehicles, such as spillages of oil and hydrocarbons, should be prevented and mitigated.
3. Dust generation on site should be mitigated and minimised as the dust can negatively affect the quality of pastures as well as sheep production.

The solar panels and storm water infrastructure can be used as an additional water harvesting method to augment water used for irrigation purposes immediately north of the proposed site.

The impacts on the site need to be viewed in relation to the opencast mining of coal in areas of high potential soils – such as the Eastern Highveld. With this comparison in mind the impact of a solar energy facility is negligible compared to the damaging impacts of coal mining – for a similar energy output. Therefore, in perspective, the impacts of the proposed facility can be motivated as necessary in decreasing the impacts in areas where agriculture potential plays a more significant role.

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Appendix D1: Original Soil, Land Use, Land Capabilities and Agricultural Potential Survey (2012)

BASIC ASSESSMENT LEVEL REPORT

SOIL, LAND USE, LAND CAPABILITY AND AGRICULTURAL POTENTIAL SURVEY:

PROPOSED VANRHYNSDORP SOLAR ENERGY FACILITY: VANRHYNSDORP, WESTERN CAPE PROVINCE

April 2nd, 2012

Compiled by:
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Member of:
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Soil Science Society of America (SSSA)

Accredited member of:
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Registered with:
The South African Council for Natural Scientific Professions
Registration number: 400106/08

DECLARATION

I, Johan Hilgard van der Waals, declare that I –

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
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- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant 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 application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form 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.

J.H. VAN DER WAALS
TERRA SOIL SCIENCE

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SOIL, LAND USE, LAND CAPABILITY AND AGRICULTURAL POTENTIAL SURVEY – PROPOSED VANRHYNSDORP SOLAR ENERGY FACILITY: VANRHYNSDORP, WESTERN CAPE PROVINCE

1. TERMS OF REFERENCE

Terra Soil Science (TSS) was commissioned by EnviroAfrica to undertake a Basic Assessment level soil, land use, land capability, and agricultural potential survey for the proposed Vanrhynsdorp Solar Energy Facility near Vanrhynsdorp in the Northern Cape Province.

2. INTRODUCTION

2.1 Study Aim and Objectives

The study area has been proposed to serve as a locality for the construction of a photovoltaic solar energy facility and associated infrastructure for power generation purposes. This study aims to determine the possible impact that this development could have on the soils, land use, land capability and agricultural potential as well as to identify areas of high sensitivity regarding solar panels and infrastructure.

The study has as objectives the identification and estimation of:

» Soil form (SA taxonomic system) and soil depth for the area;
» Soil potential linked to current land use and other possible uses and options;
» Discussion of the agricultural potential in terms of the soils, water availability, surrounding developments and current status of land; and
» Discussion of impacts (potential and actual) as a result of the development.

2.2 Agricultural Potential Background

The assessment of agricultural potential rests primarily on the identification of soils that are suited to crop production. In order to qualify as high potential soils they must have the following properties:

» Deep profile (more than 600 mm) for adequate root development,
» Deep profile and adequate clay content for the storing of sufficient water so that plants can weather short dry spells,
» Adequate structure (loose enough and not dense) that allows for good root development,
» Sufficient clay or organic matter to ensure retention and supply of plant nutrients,
» Limited quantities of rock in the matrix that would otherwise limit tilling options and water holding capacity,
» Adequate distribution of soils and size of high potential soil area to constitute a viable economic management unit, and

» Good enough internal and external (out of profile) drainage if irrigation practices are considered. Drainage is imperative for the removal (leaching) of salts that accumulate in profiles during irrigation and fertilization.

In addition to soil characteristics, climatic characteristics need to be assessed to determine the agricultural potential of a site. The rainfall characteristics are of primary importance and in order to provide an adequate baseline for the viable production of crops rainfall quantities and distribution need to be sufficient and optimal. The combination of the above mentioned factors will be used to assess the agricultural potential of the soils on the site.

2.3 Survey Area Boundary

The site lies between 31° 35' 10" and 31° 35' 31" south and 18° 44' 42" and 18° 45' 13" east immediately northeast of the town of Vanrhynsdorp in the Western Cape Province (**Figure 1**).

2.4 Survey Area Physical Features

The survey area lies on flat terrain at 140 m above mean sea level. The site is also characterised by distinct "heuweltjies" – a relict of long-term ant/termite activity. (Details regarding the Heuweltjies are provided with the soil survey results). The geology of the area consists of red wind-blown sand, alluvium, sandstone and calcrete.

3. SOIL, LAND CAPABILITY, LAND USE SURVEY AND AGRICULTURAL POTENTIAL SURVEY

3.1 Method of Survey

The Basic Assessment level soil, land capability, land use and agricultural potential surveys were conducted in three phases.

3.1.1 Phase 1: Land Type Data

Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC). The land type data is presented at a scale of 1:250 000 and entails the division of land into land types, typical terrain cross sections for the land type and the presentation of dominant soil types for each of the identified terrain units (in the cross section). The soil data is classified according to the Binomial System (MacVicar et al., 1977). The soil data was interpreted and re-classified according to the Taxonomic System (MacVicar, C.N. et al. 1991).

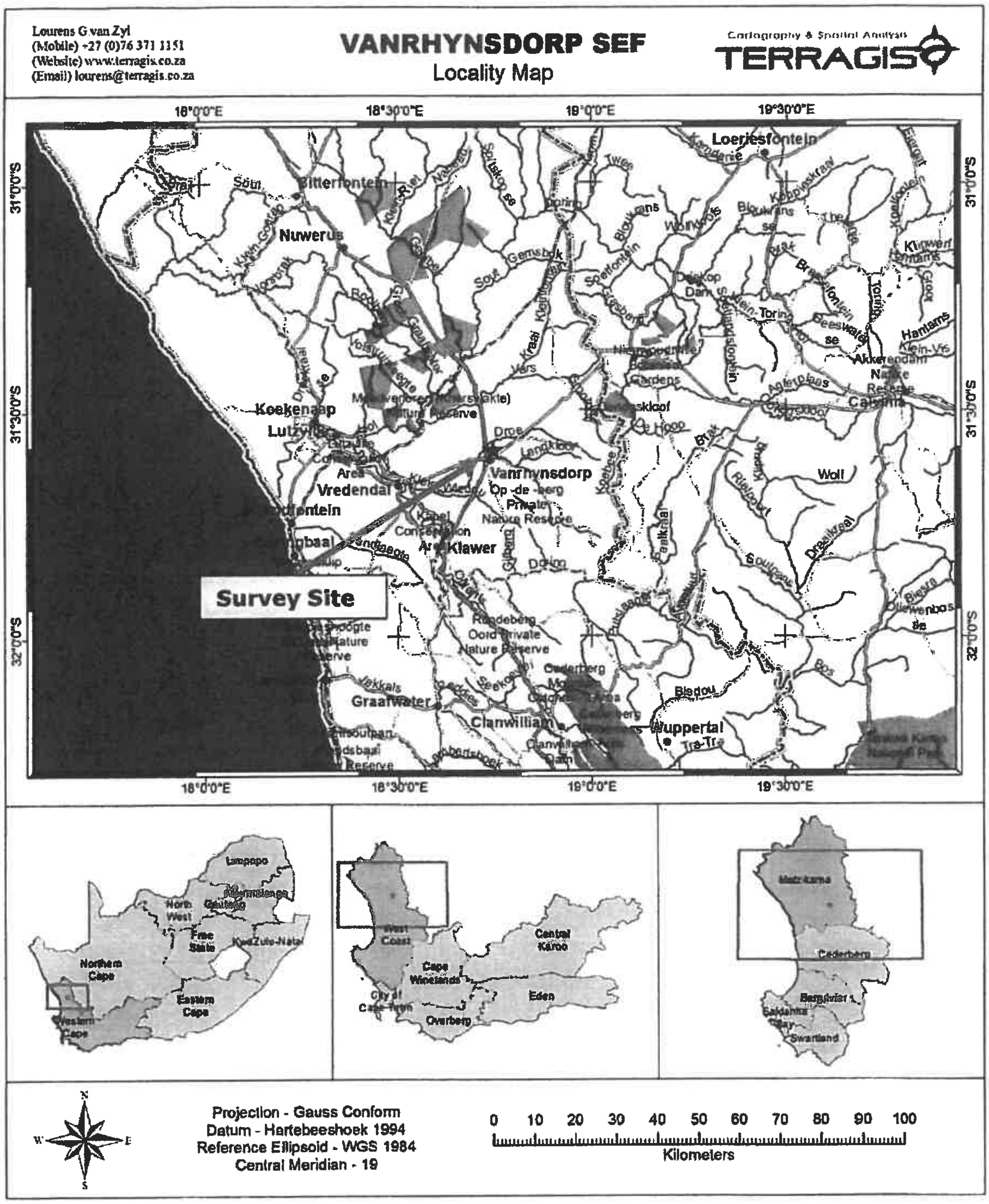

Figure 1 Locality of the survey site

3.1.2 Phase 2: Aerial Photograph Interpretation and Land Use Mapping

The most up to date aerial photographs of the site were obtained from Google Earth. The image was used to interpret aspects such as land use and land cover.

3.1.3 Phase 3: Site Visit and Soil Survey

A site visit was conducted on the 22nd of November, 2011, during which a soil survey was conducted. The site was traversed on foot with the aim of ascertaining as much of the soil variability as possible. Soils were described and photographs were taken of pertinent soil, landscape and land use characteristics.

3.2 Survey Results

3.2.1 Phase 1: Land Type Data

The site falls into the **Ag202** land type (Land Type Survey Staff, 1972 - 2006). (Refer to **Figure 2** for the land type map of the area). Below follows a brief description of the land type in terms of soils, land capability, land use and agricultural potential.

Land Type Ag202

Soils: Shallow apedal (structureless) with regular occurrences of lime in the soil profiles. The soils are of high base status or lime containing hardpan lime at depth. Heuweltjies occur throughout the

Land capability and land use: Mainly extensive grazing due to climatic and soil constraints. Crop production is only possible with very intensive preparation, in the form of ripping and land form shaping, and if water is supplied through irrigation. The preparation and establishment costs are such that it is only considered if a long term plan, with adequate market research and funding, has been drawn up.

Agricultural potential: Very low in the natural state due to soil and climate (rainfall – **Figure 3**) constraints with the potential of improvement in the case of land preparation, provision of water through irrigation and intensive management of water, salts, pests and markets.

3.2.2 Phase 2: Aerial Photograph Interpretation and Land Use/Capability Mapping

The interpretation of satellite image **(Figure 4)** yielded one dominant land use, namely extensive grazing. The presence of grazing cattle or sheep could not be confirmed during the site survey but extensive grazing is known to be practiced widely in the area in the form of sheep production. From the image it is clear that the land has been influenced by human activities to the south. Otherwise it appears that there have been no drastic influences on the land and as such it is considered to be in good physical condition.

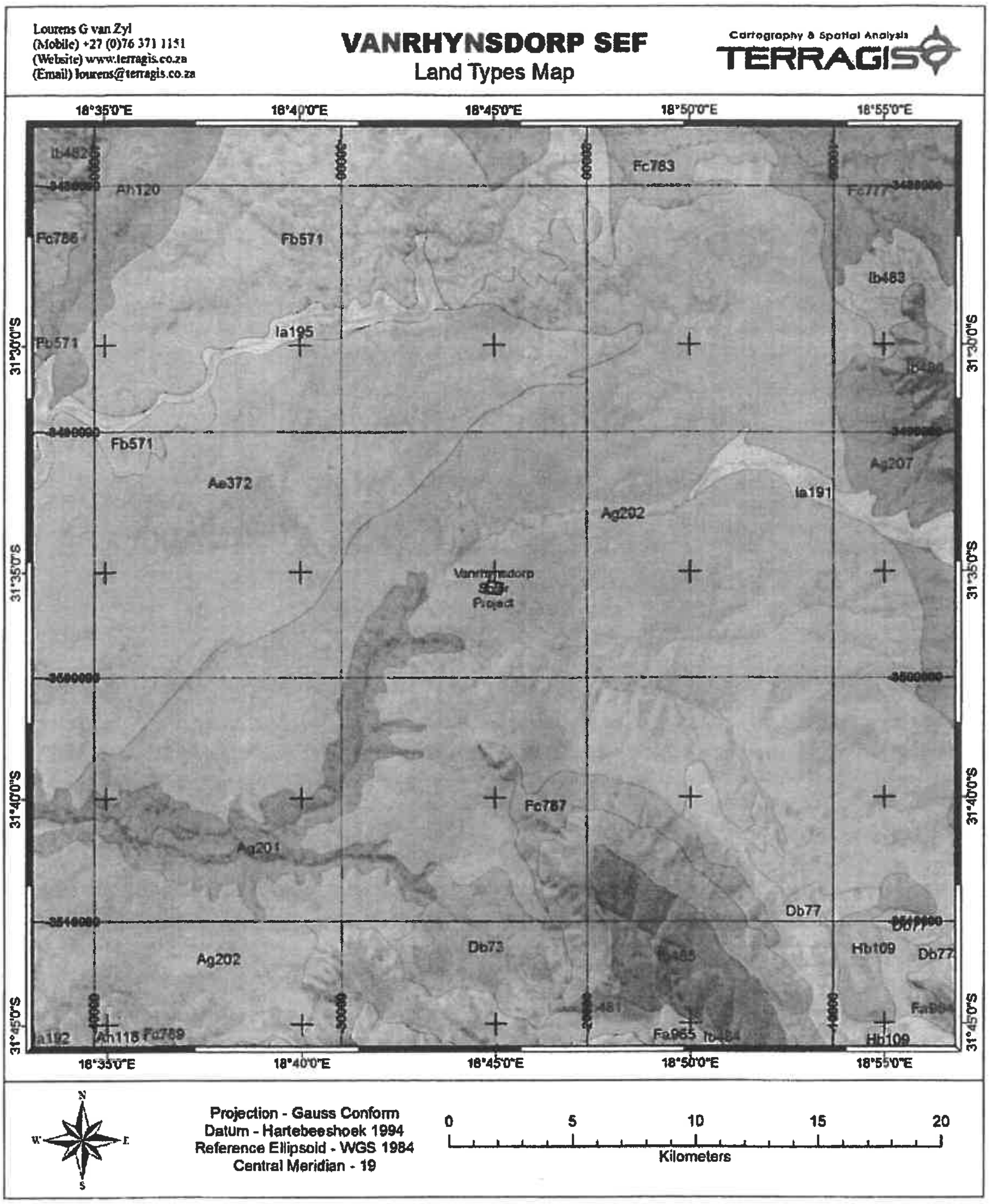

Figure 2 Land type map of the survey area

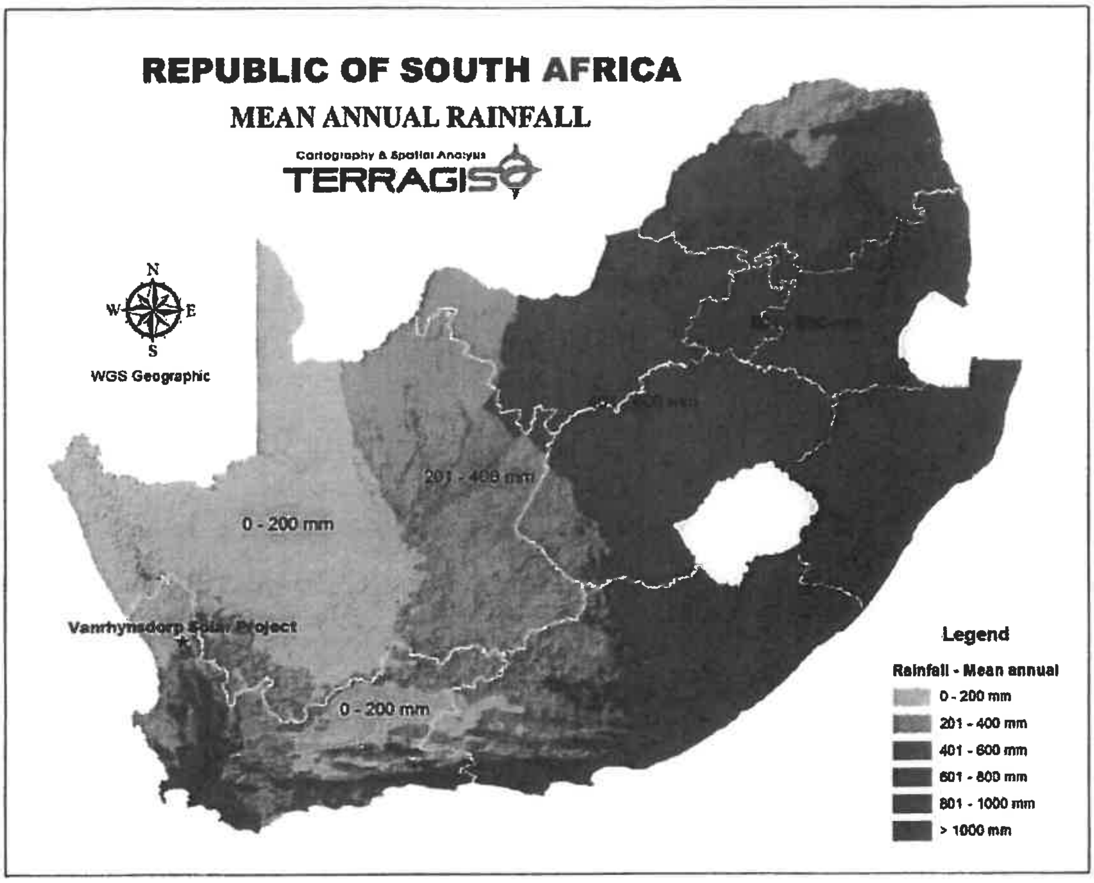

Figure 3 Rainfall map of South Africa indicating the survey site

3.2.3 Phase 3: Site Visit and Soil Survey

The origin of the soils in this area is mainly aeolian and the soils are red due to the relative age of the aeolian deposits. These areas are often associated with "heuweltjies" (**Figures** 5 to 7) that are thought to be the products of long-term vegetation collection by termites (*Microhodotermes*). The specific mechanism of formation is not clear and, although presently associated with the termites, it is also not clear which the formation agent was (Fey, 2010). The heuweltjies are characterised by distinct accumulations of calcium carbonate (lime – **Figures** 8 and 9), silica, sepiolite and manganese oxides (Ellis, 2002; Francis, 2007). All these minerals are indicative of arid soil conditions. Due to the distinct spatial variation in lime distribution on such sites the soils vary significantly and the site is therefore classified rather as one with "heuweltjie" soils. The soils on the heuweltjies are predominantly of the Couga (Orthic A-horizon / Hardpan Carbonate Horizon), Brandvlei (Orthic A-horizon / Soft Carbonate B-horizon) and Prieska (Orthic A-horizon / Neocarbonate B-horizon / Hardpan Carbonate Horizon) forms.

The mechanism of accumulation of materials rich in Ca and other plant nutrients is supported by the observation that pH levels can vary from 8+ on the crest of the heuweltjie to below 5 in the sandy material between the heuweltjies. This pH and nutrent variation causes problems with crop production in such areas and many farmers have invested large amounts of capital to level the terrain and to redistribute the hardpan lime material evenly throughout their fields. In an unprepared state these soils are of low agricultural potential and then only suited to extensive, but managed, grazing.

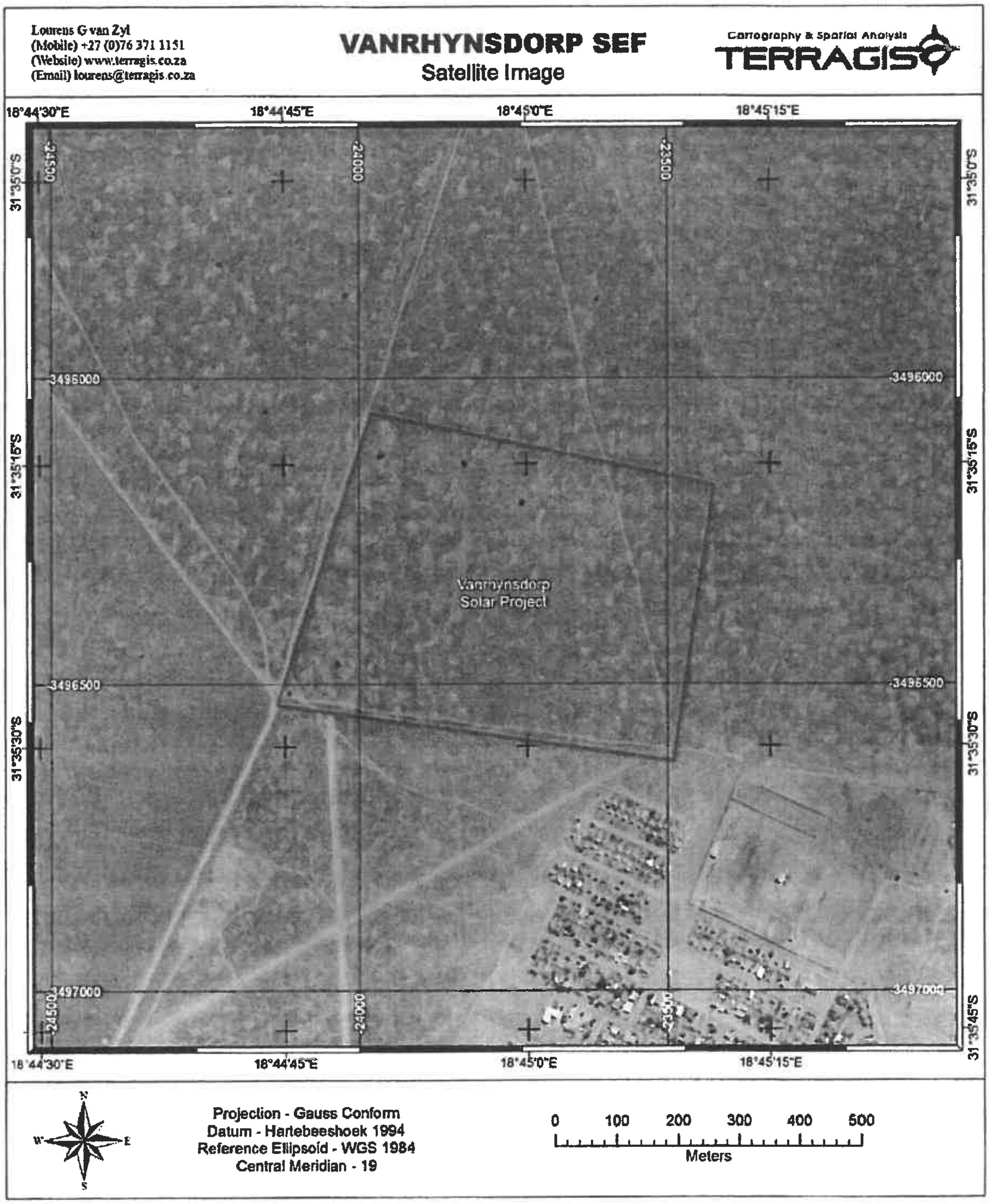

Figure 4 Satellite map of the general and the survey area

Associated with the heuwletjies are dorbank soils. Their formation is similar to those of the heuweltjies with the diffence that the dorbank soils are formed through the mobilisation and redistribution of silica in the soils under arid climate conditions (**Figure 10**). The silica remains in the soil profile due to low rainfall and high evaporative demands and therefore precipitate within the soil matrix to form hardened silica enriched layers. These layers are often laminar or massive and pose significant restrictions to plant root development (as well as auguring!). Without significant mechanical preparation these soils remain of very low agricultural potential. With proper preparation these soils can be used with a large degree of success with irrigation. The dominant soil forms in this section are Garies (Orthic A-horizon / Red Apedal B-horizon / Dorbank), Trawal (Orthic A-horizon / Neocutanic B-horizon / Dorbank)and Knerzvlakte (Orthic A-horizon / Dorbank) forms.

Due to the arid conditions the soils on the site are also prone to crust formation (**Figure 11**). This aspect leads to decreased infiltration and increased surface runoff, in turn leading to increased erosion pressures.

Figure 5 "Heuweltjies" on the site as expressed in small circular structures (red arrows)

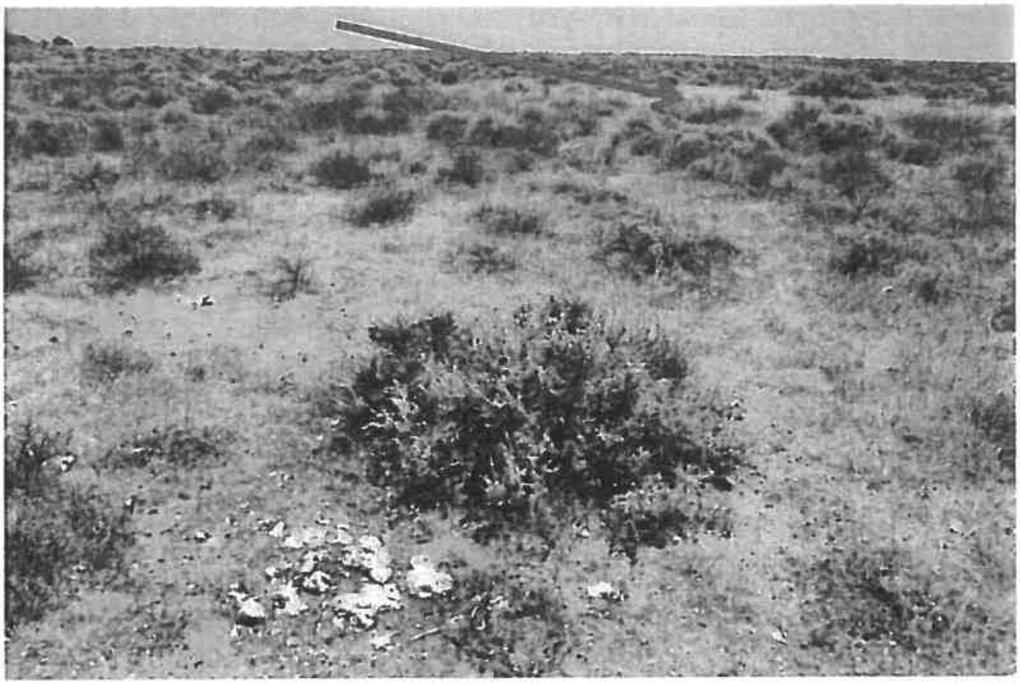

Figure 6 "Heuweltjie" on the site (red arrow)

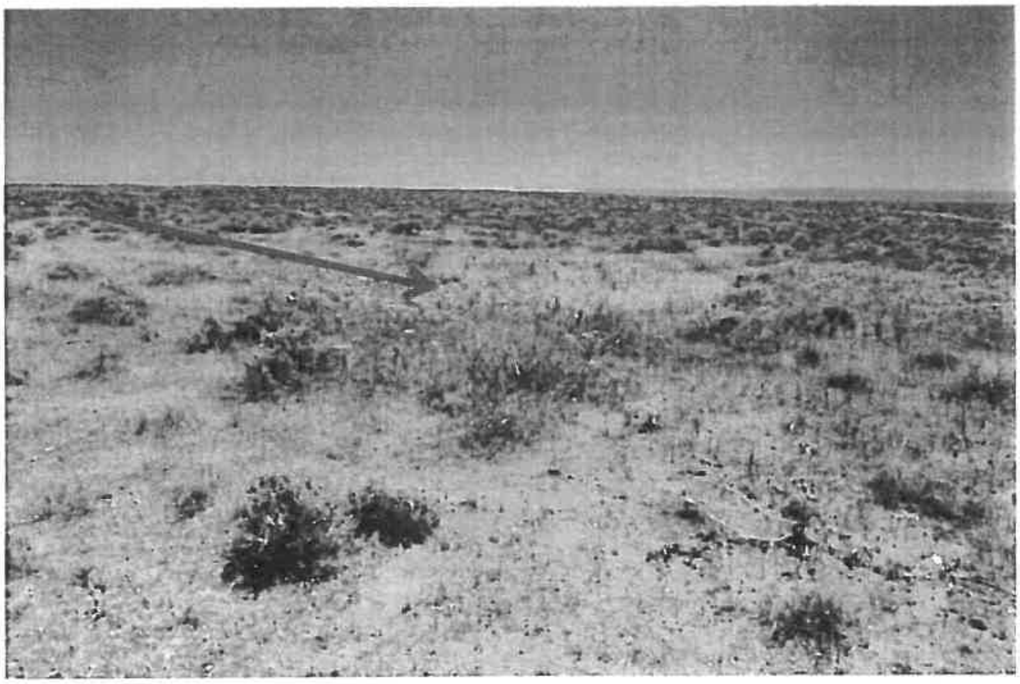

Figure 7 "Heuweltjie" on the site (red arrow)

Figure 8 Lime occurrence on a heuweltjie

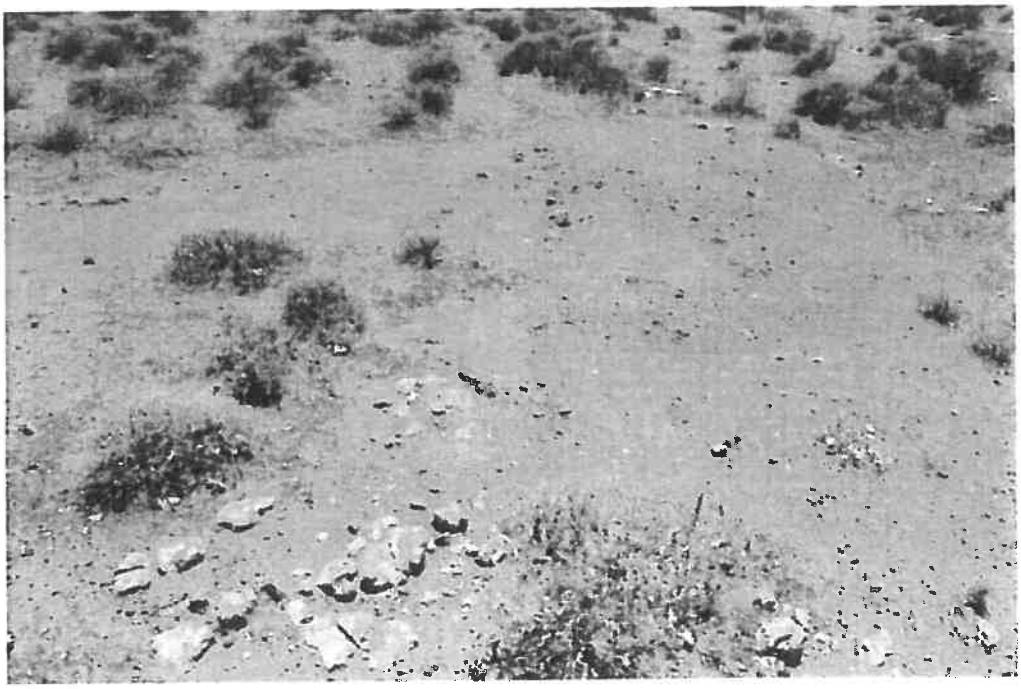

Figure 9 Lime occurrence on a heuweltjie

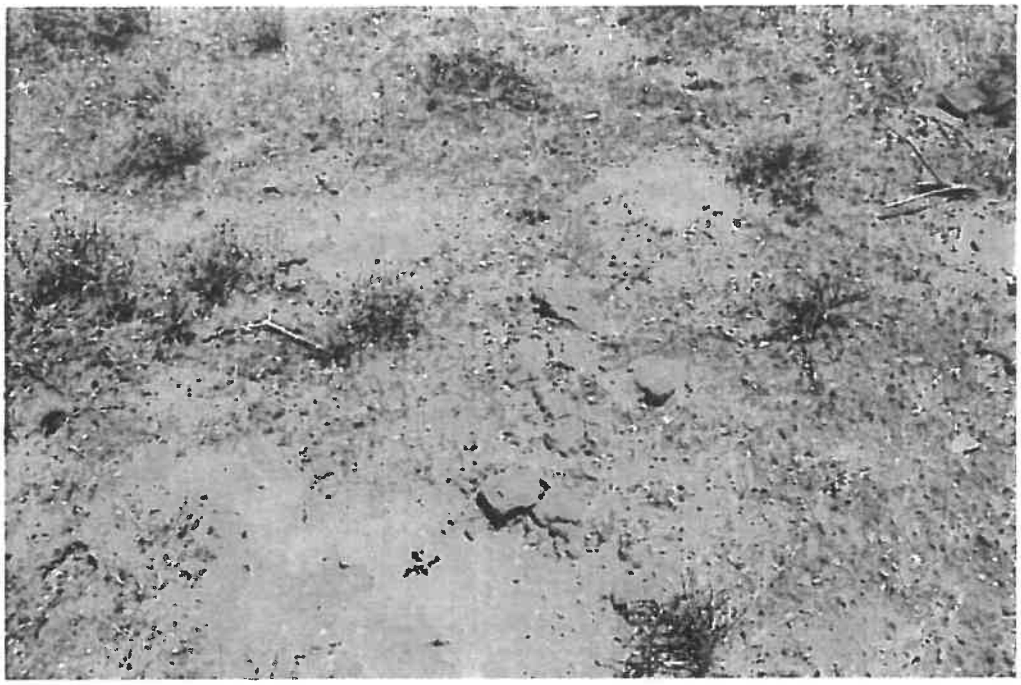

Figure 10 Duric nodules on the soil surface (exposed through historical activities)

Figure 11 Crust formation on the soils on the site

4. INTERPRETATION OF SOIL, LAND CAPABILITY AND LAND USE SURVEY RESULTS

The interpretation of the land use and land capability results yielded a number of aspects that are of importance to the project.

4.1 Agricultural Potential

The agricultural potential of the site is low due to soil and climatic constraints. The presence of the lime and dorbank horizons require significant physical preparation before crop production can be considered. Consequently the site is suited to extensive but managed grazing even though the carrying capacity is low due to the very low rainfall of the area. Irrigation establishment is done in surrounding and lower lying areas but the financial viability of such land uses will depend on a number of factors namely markets for crops, water availability and management. The typical costs for the establishment of irrigation vary between R 150 000 and R 250 000 per hectare depending the intensity of ripping and bulldozing that is required.

4.2 Overall Soil and Land Impacts

Due to the low agricultural potential of the site as well as the low rainfall the impacts on soils and agriculture is expected to be low – provided that adequate storm water management and erosion prevention measures are implemented. These measures should be included in the layout and engineering designs of the development. The erodibility of the soils on the site is associated with the low sparse vegetation cover, sandy topsoils and restricting subsoil layers.

5. ASSESMENT OF IMPACT

5.1 Assessment Criteria

The following assessment criteria (**Table 1**) will be used for the impact assessment.

Table 1 Impact Assessment Criteria

CATEGORY	DESCRIPTION OF DEFINITION
Direct, indirect and cumulative impacts	In relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.
Nature	A description of the cause of the effect, what will be affected and how it will be affected.
Extent (Scale) • 1 • 2	The area over which the impact will be expressed – ranging from local (1) to regional (5).

CATEGORY	DESCRIPTION OF DEFINITION
• 3 • 4 • 5	
Duration • 1 • 2 • 3 • 4 • 5	Indicates what the lifetime of the impact will be. • Very short term: 0 – 1 years • Short-term: 2 – 5 years • Medium-term: 5 – 15 years • Long-term: > 15 years • Permanent
Magnitude • 2 • 4 • 6 • 8 • 10	This is quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
Probability • 1 • 2 • 3 • 4 • 5	Describes the likelihood of an impact actually occurring. • Very Improbable • Improbable • Probable • Highly probable • Definite
Significance	The significance of an impact is determined through a synthesis of all of the above aspects. S = (E + D + M)*P S = Significance weighting E = Extent D = Duration M = Magnitude
Status • Positive • Negative • Neutral	Described as either positive, negative or neutral
Other	• Degree to which the impact can be reversed • Degree to which the impact may cause irreplaceable loss of resources • Degree to which the impact can be mitigated

5.2 List of Activities for the Site

Table 2 lists the anticipated activities for the site. The last two columns in the table list the anticipated forms of soil degradation and geographical distribution of the impacts.

5.3 Assessment of the Impacts of Activities

Many of the impacts are generic and their impacts will remain similar for most areas on the site. The generic activity will therefore be assessed. The impacts associated with the different activities have been assessed below for each activity. These impacts have been summarized in **Table 8**. **Note:** The impacts listed below indicate that no mitigation is possible. It is important to note that any soil impact in the form of drastic physical disturbance (as with construction activities) is a permanent one and no mitigation is possible. The mitigation that can be applied is the restriction of off-site effects due to developments through adequate implementation of environmental management measures (discussed later in the report).

Table 2 List of activities and their associated forms of soil degradation

Activity	Form of Degradation	Geographical Extent	Comment (Section described)
Construction Phase			
Construction of solar panels and stands	Physical degradation (surface)	Two dimensional	Impact small due to localised nature (Section 5.3.1)
Construction of buildings and other infrastructure	Physical degradation (compound)	Two dimensional	(Section 5.3.2)
Construction of roads	Physical degradation (compound)	Two dimensional	(Section 5.3.3)
Construction and Operational Phase Related Effects			
Vehicle operation on site	Physical and chemical degradation (hydrocarbon spills)	Mainly point and one dimensional	(Section 5.3.4)
Dust generation	Physical degradation	Two dimensional	(Section 5.3.5)

5.3 Assessment of the Impacts of Activities

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5.3.1 Construction of Solar Panels and Stands

Table 3 presents the impact criteria and a description with respect to soils, land capability and land use for the construction of solar panels and stands.

Table 3 Construction of solar panels and stands

Criteria	**Description**	
Cumulative Impact	The cumulative impact of this activity will be small as it is constructed on land with low agricultural potential.	
Nature	This activity entails the construction of solar panels and stands with the associated disturbance of soils and existing land use.	
	Without Mitigation	With Mitigation
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed
Duration	5 – Permanent (unless removed)	5 – Permanent (unless removed)
Magnitude	2	2
Probability	4 (highly probable due to inevitable changes in land use)	4 (highly probable due to inevitable changes in land use)
Significance of impact	S = (1 + 5 + 2)*4 = 32 (low)	S = (1 + 5 + 2)*4 = 32 (low)
Status	Negative	Negative
Mitigation	None possible. Limit footprint to the immediate development area	None possible. Limit footprint to the immediate development area

5.3.2 Construction of Buildings and Other Infrastructure

Table 4 presents the impact criteria and a description with respect to soils, land capability and land use for the construction of solar panels and stands.

Table 4 Construction of buildings and other infrastructure

Criteria	Description	
Cumulative Impact	The cumulative impact of this activity will be small as it is constructed on land with low agricultural potential.	
Nature	This activity entails the construction of buildings and other infrastructure with the associated disturbance of soils and existing land use.	
	Without Mitigation	With Mitigation
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed
Duration	5 – Permanent (unless removed)	5 – Permanent (unless removed)
Magnitude	2	2
Probability	4 (highly probable due to inevitable changes in land use)	4 (highly probable due to inevitable changes in land use)
Significance of impact	S = (1 + 5 + 2)*4 = 32	S = (1 + 5 + 2)*4 = 32 (low)
Status	Negative	Negative
Mitigation	None possible. Limit footprint to the immediate development area	None possible. Limit footprint to the immediate development area

5.3.3 Construction of Roads

Table 5 presents the impact criteria and a description with respect to soils, land capability and land use for the construction of roads.

Table 5 Construction of roads

Criteria	Description	
Cumulative Impact	The cumulative impact of this activity will be small as it is linear and limited in geographical extent.	
Nature	This activity entails the construction of roads with the associated disturbance of soils and existing land use.	
	Without Mitigation	With Mitigation
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed along the road	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed along the road
Duration	5 – Permanent (unless removed)	5 – Permanent (unless removed)
Magnitude	2	2
Probability	4 (highly probable due to inevitable changes in land use)	4 (highly probable due to inevitable changes in land use)
Significance of impact	S = (1 + 5 + 2)*4 = 32 (low)	S = (1 + 5 + 2)*4 = 32 (low)
Status	Negative	Negative
Mitigation	None possible. Limit footprint to the	None possible. Limit footprint to the

	immediate development area and keep to existing roads as far as possible	immediate development area and keep to existing roads as far as possible

5.3.4 Vehicle Operation on Site

It is assumed that vehicle movement will be restricted to the construction site and established roads. Vehicle impacts in this sense are restricted to spillages of lubricants and petroleum products. **Table 6** presents the impact criteria and a description with respect to soils, land capability and land use for the operation of vehicles on the site.

Table 6 Assessment of impact of vehicle operation on site

Criteria	**Description**	
Cumulative Impact	The cumulative impact of this activity will be small if managed.	
Nature	This activity entails the operation of vehicles on site and their associated impacts in terms of spillages of lubricants and petroleum products	
	Without Mitigation	With Mitigation
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed
Duration	2 – Short-term	2 – Short-term
Magnitude	2	2
Probability	4	2 (with prevention and mitigation)
Significance of impact	S = (1 + 2 + 2)*4 = 20	S = (1 + 2 + 2)*2 = 10 (with prevention and mitigation)
Status	Negative	Negative
Mitigation	Maintain vehicles, prevent and address spillages	Maintain vehicles, prevent and address spillages

5.3.5 Dust Generation

Generated dust can impact large areas depending on environmental and climatic conditions. **Table 7** presents the impact criteria and a description with respect to soils, land capability and land use for dust generation on the site.

Table 7 Assessment of impact of dust generation on site

Criteria	Description	
Cumulative Impact	The cumulative impact of this activity will be small if managed but can have widespread impacts if ignored.	
Nature	This activity entails the operation of vehicles on site and their associated dust generation	
	Without Mitigation	With Mitigation
Extent	2 - Local: The impact is diffuse (depending on environmental and climatic conditions) and will probably be limited to within 3 – 5 km of the site	2 - Local: The impact is diffuse (depending on environmental and climatic conditions) and will probably be limited to within 3 – 5 km of the site
Duration	2 – Short-term	2 – Short-term
Magnitude	2	2
Probability	4	2 (with mitigation and adequate management)
Significance of impact	S = (2 + 2 + 2)*4 = 24	S = (2 + 2 + 2)*2 = 12 (with mitigation and adequate management)
Status	Negative	Negative
Mitigation	Limit vehicle movement to absolute minimum, construct proper roads for access	Limit vehicle movement to absolute minimum, construct proper roads for access

Table 8 Summary of the impact of the development on agricultural potential and land capability

Nature of Impact	*Loss of agricultural potential and land capability owing to the development*	
	Without mitigation	With mitigation
Extent	Low (1) – Site	Low (1) – Site
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (2)	Low (2)
Probability	Highly probable (4)	Highly probable (4)
Significance*	32 (Low)	32 (Low)
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	No	No
Mitigation: The loss of agricultural land is a long term loss and there are no mitigation measures that can be put in place to combat this loss.		
Cumulative impacts: Soil erosion may arise owing to increased surface water runoff. Adequate management and		

erosion control measures should be implemented.
Residual Impacts:
The loss of agricultural land is a long term loss. This loss extends to the post-construction phase. The agricultural potential is very low though.

5.4 Environmental Management Plan

Tables 9 to **11** provide the critical aspects for inclusion in the EMP.

Table 9 Measures for erosion mitigation and control

Objective: Erosion control and mitigation		
Project components	Soil stabilisation, construction of impoundments and erosion mitigation structures	
Potential impact	Large scale erosion and sediment generation	
Activity / risk source	Poor planning of rainfall surface runoff and storm water management	
Mitigation: Target / Objective	Prevention of eroded materials and silt rich water running off the site	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Plan and implement adequate erosion control measures	Construction team and engineer	Throughout project
Performance indicator	Assessment of storm water structures and erosion mitigation measures. Measurement of actual erosion and sediment generation.	
Monitoring	Monitor and measure sediment generation and erosion damage	

Table 10 Measures for limiting vehicle operation impacts on site (spillages)

Objective: Erosion control and mitigation		
Project components	Maintenance of vehicles and planning of vehicle service areas	
Potential Impact	Oil, fuel and other hydrocarbon pollution	
Activity / risk source	Poor maintenance of vehicles and poor control over service areas	
Mitigation: Target / Objective	Adequate maintenance and control over service areas	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Service vehicles adequately	Construction team and engineer	Throughout project
Maintenance of service areas, regular cleanup	Construction team and engineer	Throughout project
Performance indicator	Assessment number and extent of spillages on a regular basis.	
Monitoring	Monitor construction and service sites	

Table 11 Measures for limiting dust generation on site

Objective: Dust generation suppression		
Project components	Limit and address dust generation on site linked to construction activities	
Potential Impact	Large scale dust generation on site	
Activity / risk source	Inadequate dust control measures, excessive vehicle movement on unpaved roads	
Mitigation: Target / Objective	Minimise generation of dust	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Implement dust control strategy including dust suppressants and tarring of roads	Construction team and engineer	Throughout project
Limit vehicle movement on unpaved areas to the absolute minimum	Construction team and engineer	Throughout project
Performance indicator	Assessment of dust generated on site	
Monitoring	Monitor construction site and surrounds	

6. CONCLUSIONS AND RECOMMENDATIONS

It is concluded that the proposed development of a photovoltaic facility on the site will not have large impacts due to the low agricultural potential of the site. The low agricultural potential of the site is the result of the dominance of shallow soils with root development restrictions as well as the very low rainfall of the area.

It is imperative though that adequate storm water management measures be put in place as the soils on the site have no cohesion due to inherent soil properties as well as lack of plant roots. The main impacts that have to be managed on the site are:

1. Erosion must be controlled through adequate mitigation and control structures.
2. Impacts from vehicles, such as spillages of oil and hydrocarbons, should be prevented and mitigated.
3. Dust generation on site should be mitigated and minimised as the dust can negatively affect the quality of pastures as well as sheep production.

The impacts on the site need to be viewed in relation to the opencast mining of coal in areas of high potential soils – such as the Eastern Highveld. With this comparison in mind the impact of a solar energy facility is negligible compared to the damaging impacts of coal mining – for a similar energy output. Therefore, in perspective, the impacts of the proposed facility can be motivated as necessary in decreasing the impacts in areas where agriculture potential plays a more significant role.

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