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SPECIALIST REPORT ON THE SOILS, LAND USE, AGRICULTURAL POTENTIAL AND LAND CAPABILITY FOR THE PROPOSED POWERLINE CONNECTION BETWEEN BOLUBEDU SOLAR PARK AND BOLOBEDU SUBSTATION, GREATER LETABA LOCAL MUNICIPALITY, MOPANI DISTRICT, LIMPOPO PROVINCE

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SOILS AND LAND CAPABILITY REPORT

December 2019

Conducted on behalf of:

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: December 2019

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1 ASSIGNMENT

Exigo Sustainability was appointed by AGES Limpopo to conduct a soil potential and land capability study for the proposed development and installation of a connection to a 132kV feeder bay in order to connect the Bolobedu Solar Park and the Bolobedu substation.

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, 1998 (Act No. 107 of 1998) - Regulation No. R982

This report was prepared in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) Gazette No. 38282 Government Notice R. 982, as amended. Appendix 6 – Specialist reports includes a list of requirements to be included in a specialist report:

1. A specialist report or a report prepared in terms of these regulations must contain:

    a. Details of
        i. The specialist who prepared the report; and
        ii. The expertise of that specialist to compile a specialist report, including a curriculum vitae;
    b. A declaration that the specialist 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. The date and season of the site investigation and the relevance of the season to the outcome of the assessment;
    e. A description of the methodology adopted in preparing the report or carrying out the specialized process;
    f. The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;
    g. An identification of any areas to be avoided, including buffers;
    h. A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;
    i. A description of any assumptions made and any uncertainties or gaps in knowledge;
    j. A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment;
    k. any mitigation measures for inclusion in the EMPr;
    l. any conditions for inclusion in the environmental authorisation;
    m. any monitoring requirements for inclusion in the EMPr or environmental authorisation
    n. a reasoned opinion –
        i. As to whether the proposed activity or portions thereof should be authorised and
        ii. If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr and where applicable, the closure plan;
    o. A description of any consultation process that was undertaken during the course of preparing the specialist report;
    p. A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and
    q. 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. Soon the use of these scarce 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 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.

1.3.2 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. However, due to project time constraints such long-term studies are not feasible;
- The large study area did not allow for the finer level of assessment that can be obtained in smaller study areas. Therefore, data collection in this study relied heavily on data from representative, homogenous sections of soils, as well as general observations, aerial photograph analysis, generic data and a desktop analysis;

2 STUDY AREA

2.1 Location and description of activity

The project is located on the farm Bolobedu 1024 LT which has been consolidated. The two farms that have been consolidated include the Remainder of the Farm Kromrivierfontein 360 LT, and the Remainder of the Farm Worcester 200 LT, Greater Letaba local Municipality, Mopani District Municipality, Limpopo Province (Figure 1). The proposed project is situated south of the R81 Mooketsi – Giyani road. The proposed project entails the establishment and installation of a connection of the Bolubedu Solar Park to the Eskom grid. The 75 mW PV Bolobedu PV power plant will be connected to the Eskom grid via a 132 kVa feeder bay. Access to the Bolubedu Solar Park and grid connection site, will be from the tar road between the villages of Lebaka and Ga-Femane to the south of the R81. The aerial image of the site is indicated in figure 2.

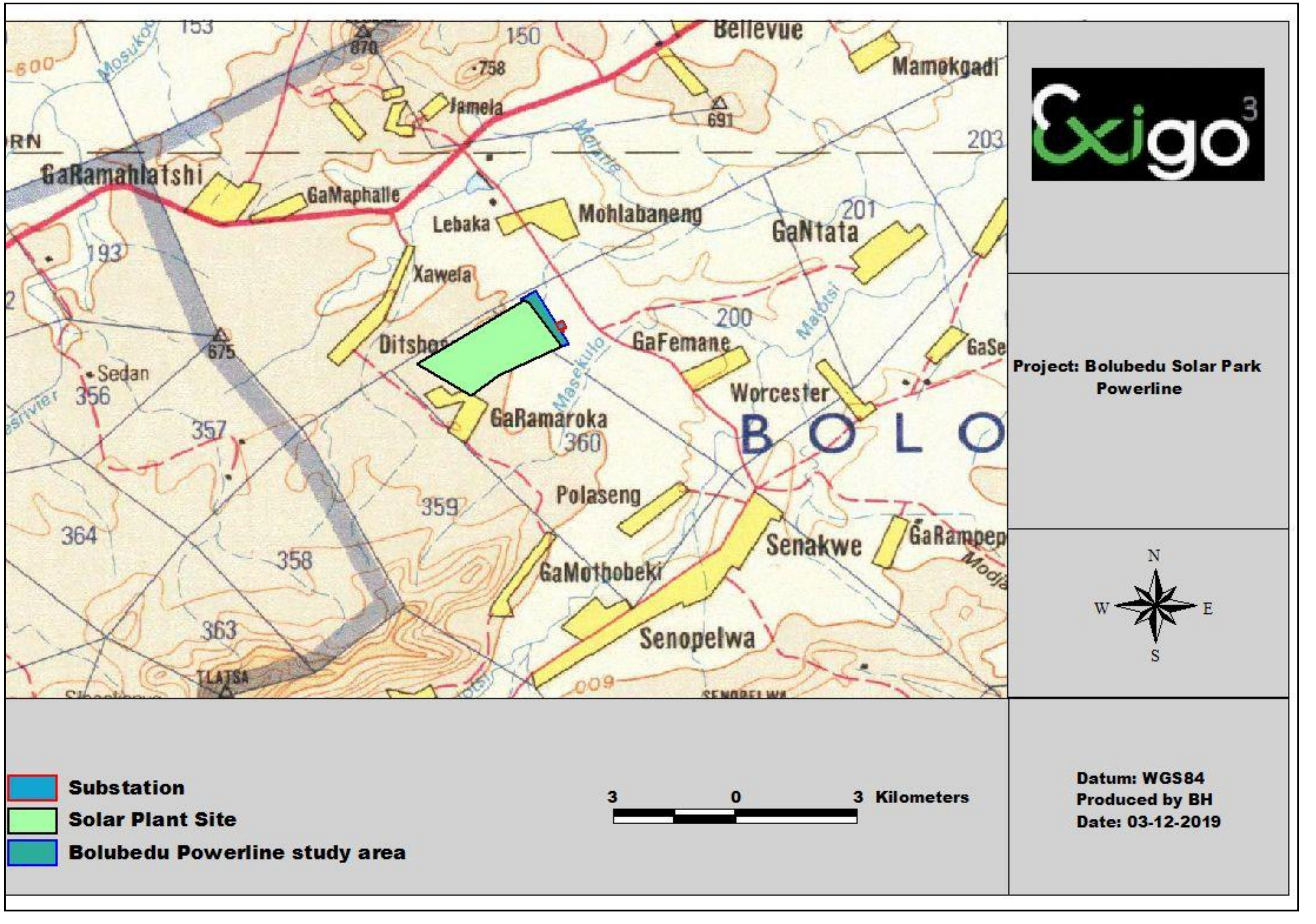

Figure 1. Regional Location Map

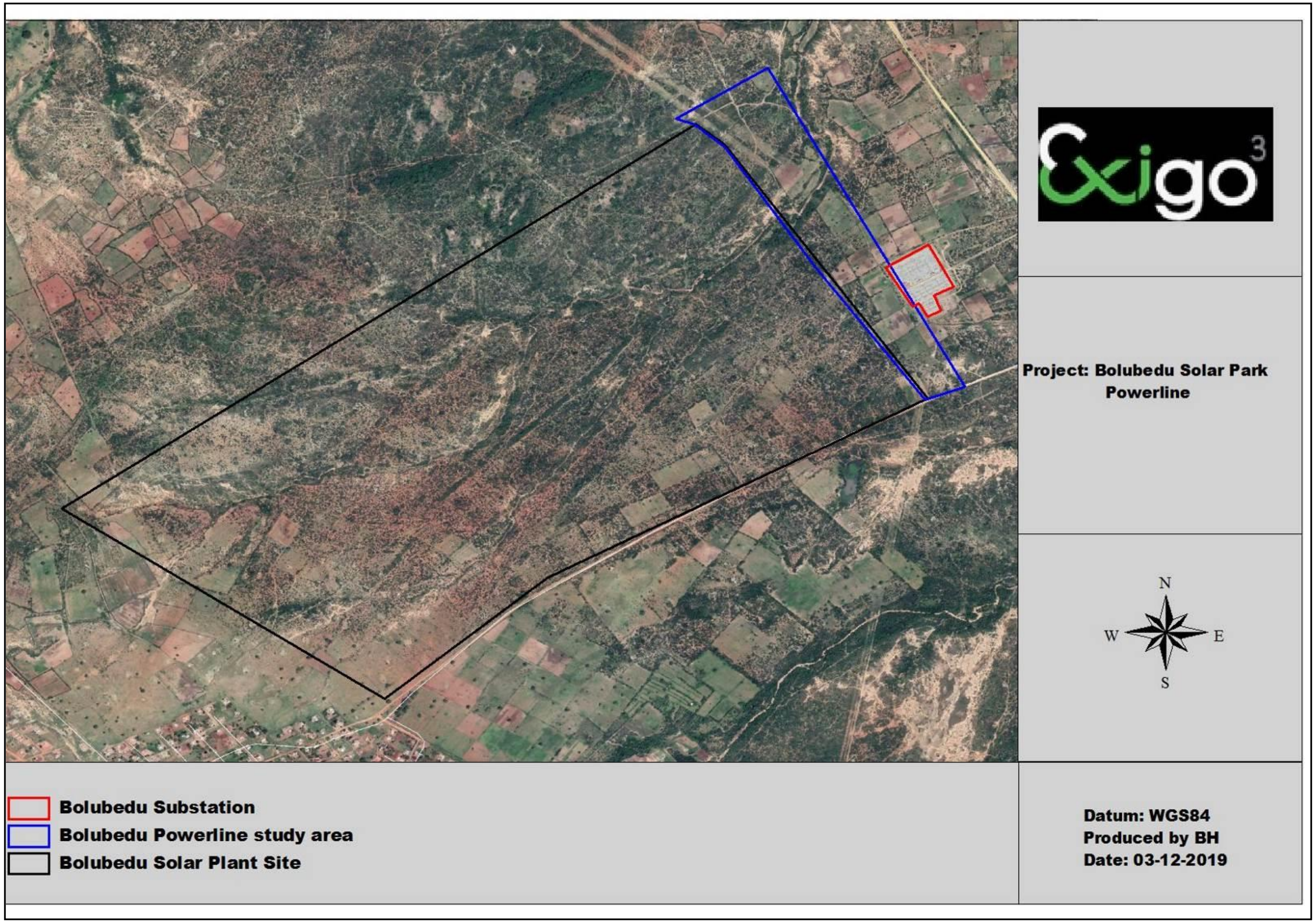

Figure 2. Location Map of the Powerline area in relation to the solar plant and substation

2.2 Climate

Solar radiation, temperature, and precipitation are the main drivers of crop growth; therefore agriculture has always been highly dependent on climate patterns and variations. Since the industrial revolution, humans have been changing the global climate by emitting high amounts of greenhouse gasses into the atmosphere, resulting in higher global temperatures, affecting hydrological regimes and increasing climatic variability. Climate change is projected to have significant impacts on agricultural conditions, food supply, and food security.

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).

Giyani normally receives about 421mm of rain per year, with most rainfall occurring mainly during mid summer. Figure 3 shows the average rainfall values for Giyani per month. It receives the lowest rainfall (0mm) in June and the highest (93mm) in January. The monthly distribution of average daily maximum temperatures (Figure 4) shows that the average midday temperatures for Giyani range from 23.9°C in June to 31°C in January. The region is the coldest during July when the mercury drops to 8°C on average during the night.

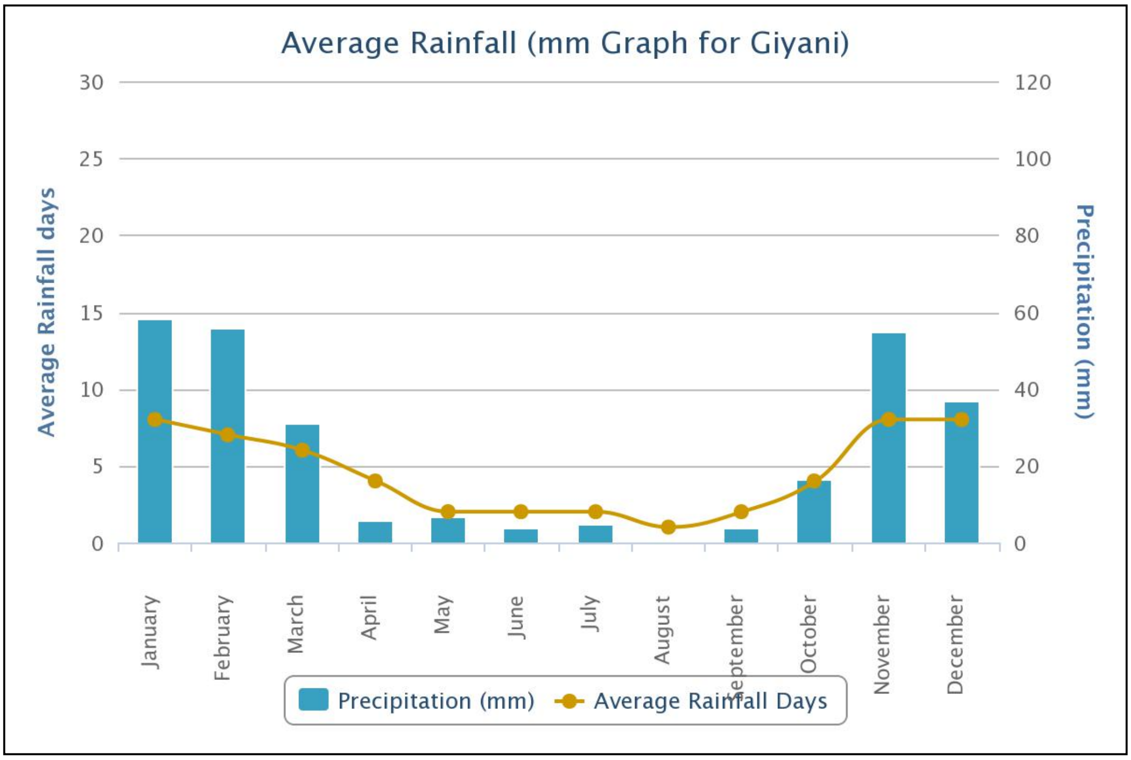

Figure 3. Average monthly rainfall for the Giyani area in the Limpopo Province

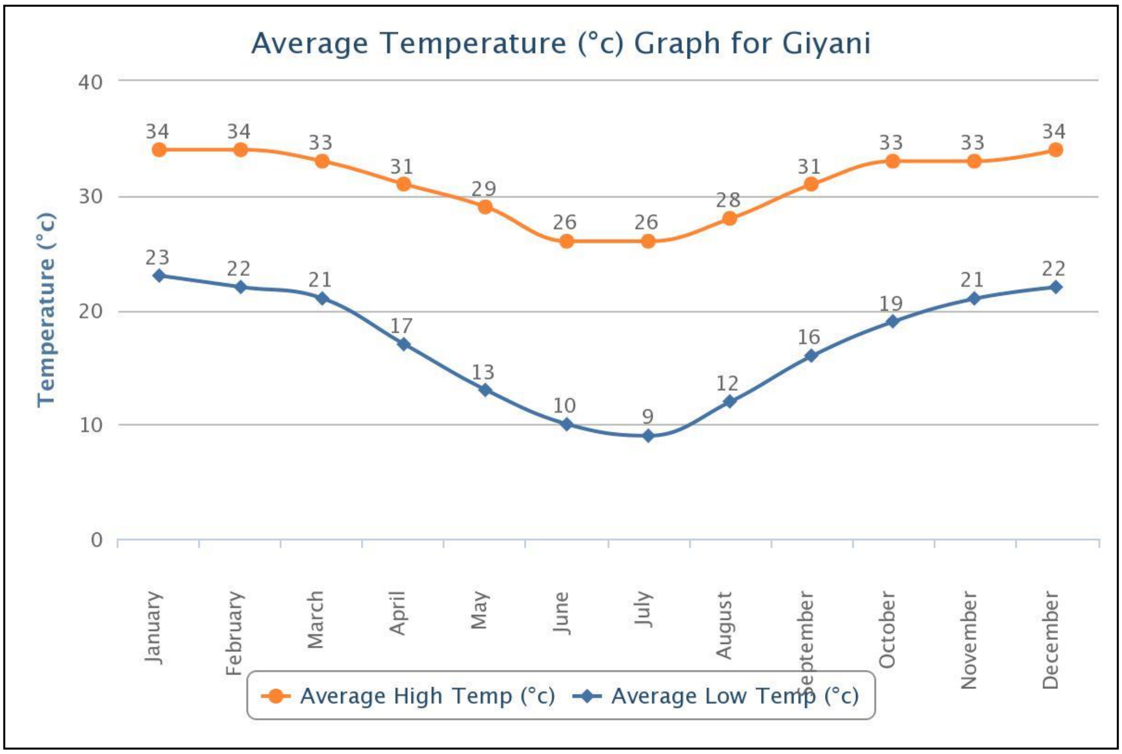

Figure 4. Average monthly temperatures for the Giyani area, Limpopo Province

2.3 VEGETATION TYPES

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 is the Granite Lowveld Bushveld vegetation type, although most of the proposed development sites have been completely modified and represent degraded bushveld or old fields.

The vegetation structure of the Granite Lowveld Vegetation Type is typical tall shrubland with few trees to medium dense low woodland on the deep sandy uplands, while dense thicket to open savanna dominate occurs in the bottomlands. At seeplines where convex topography changes to concave, a dense fringe of Terminalia sericea occurs, with Eragrostis gummiflua in the undergrowth. The conservation status of the vegetation type is vulnerable with some 17% conserved in Kruger National Park, and the same percentage conserved in smaller private reserves. More than 20% of this vegetation type has been transformed, mainly by cultivation and by settlement development.

2.4 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 study area include the Ae326 land type (Land Type Survey Staff, 1987) (ENPAT, 2001). The land type, geology and associated soil type 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

Landtype	Soils	Geology
Ae326	Red-yellow apedal, freely drained soils; red, high base status, > 300 mm deep (no dunes)	Grey biotite gneiss and migmatite of the Goudplaats Gneiss in the north; leucocratic biotite granite of Vaalian age in the south and east; many diabase dykes.

Soils associated with the site are mostly deep red apedal on the plains, while black, alluvial soils are associated with the drainage channels.

2.5 TOPOGRAPHY & DRAINAGE

The project area is characterised by slightly undulating to flat plains with two major drainage channels bisecting the area. The topography across the site is slightly undulating with the average elevation of 580 mamsl.

The site is located within the B81G quaternary catchment and is situated in the Letaba / Levuhu Water Management Area. Drainage occurs as sheet-wash towards the major rivers.

2.6 LAND USE AND EXISTING INFRASTRUCTURE

The current land-use on the project site is cattle grazing and small-scale subsistence farming. Neighbouring farms are being used for crop cultivation, livestock grazing and small-scale subsistence farming.

2.7 MOISTURE AVAILABILITY

Moisture availability of soils is an aspect which recently became an important factor to consider when cultivating crops under dry-land conditions. Moisture and water availability are affected by temperature increases, regardless of a change in rainfall. Higher temperatures increase evaporation rates and reducing the level of moisture available for growth. A warming of 1°C, with no change in rainfall, may decrease yields of wheat and maize. Reduced moisture availability will exacerbate existing problems of infertile soils, soil erosion and poor crop yields. In extreme cases, a reduction in moisture could lead to desertification. Moisture availability classes (classified in SA) 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 2, which suggest that climatic conditions are conducive for rain-fed arable agriculture.

2.8 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 structure favouring arable land use if climate permits

Soil association:

- Red, massive or weakly structured soils with high base status (association of well drained Lixisols, Cambisols, Luvisols)

Soil pH:

- 6.5-7.4

Prime agricultural activity for the area:

- Subsistence

Grazing capacity:

- Transformed Rangeland

Agricultural Potential:

- Soils highly suited to arable agriculture where climate permits

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 specific characteristics to determine agricultural potential of the soils. The study will 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.

3 GUIDELINES FOR AGRICULTURAL POTENTIAL

3.1 National assessment criteria

3.1.1 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 Limpopo Province and specifically in the grid square in which the project site falls is considered high potential if the land:

- Is under permanent irrigation; or
- Can be classified into one of the following soil forms:
  - Avalon
  - Bainsvlei
  - Bloemdal
  - Clovelly
  - Glencoe
  - Hutton
  - Oakleaf
  - Pinedene
  - Shortlands
  - Tukulu;
- The effective soil depth is equal to or greater than 900mm; and
- Topsoil clay content between 10 and 35%.

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.

The site is currently classified as HIGH Potential soils according to databases from the Department of Agriculture. The site is also NOT under any irrigation at present and represents grazing land.

3.1.2 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 5):

- Moderate Potential Arable Land;

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;

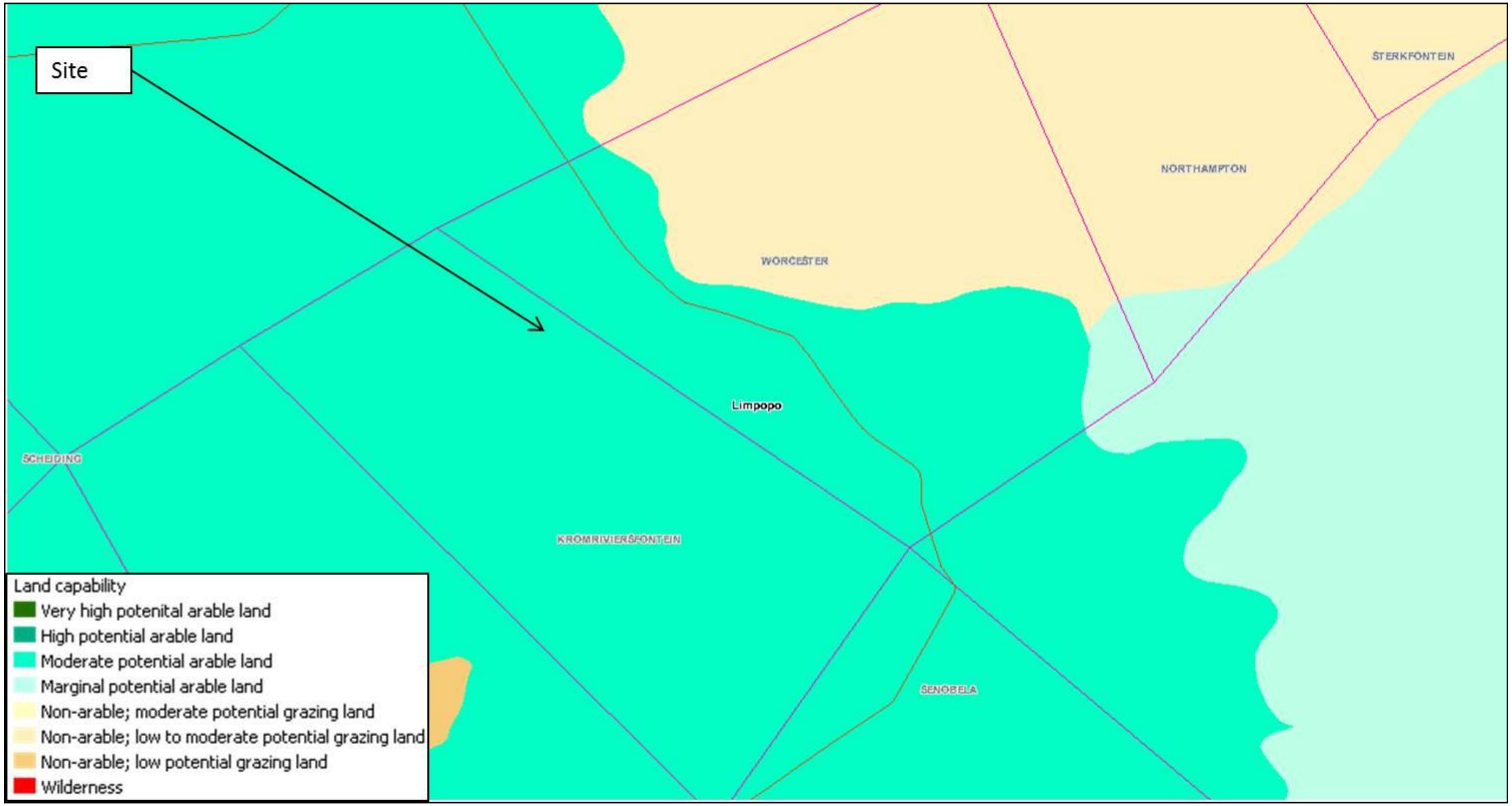

Figure 5. Land capability classes for the site as classified by the ARC: Source: [Web] http://www.agis.agric.za/agismap_atlas/AtlasViewer)

4 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 the validation of generated information from 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.

4.1 Soil surveys

The site surveys were conducted during December 2019. 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;
- 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.

4.2 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 sites;
- Photographs of the soil profiles and associated vegetation were taken and are included as part of the photographic guide.

4.3 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 were 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.

5 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, rocky soils of the Mispah / exposed bedrock form derived from Dolerite;
- Deep red-yellow apedal soils of the Clovelly / Hutton Soil Forms derived from Granite;
- Shallow gravelly soils of the Glenrosa / Clovelly soil form;
- Alluvial soils of the Cartref / Oakleaf 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 6, while the land capability and agricultural potential maps are indicated in figure 8 and 9 respectively.

5.1 Shallow, rocky soils of the Mispah / Glenrosa soil form derived from Dolerite / Gneiss

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

Description: The soils are generally shallow and derived from dolerite. 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 rocks and boulders is spread on the soil surface throughout the area.

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

Landscape: Dykes / outcrop (Photograph 1)

Depth: 200-300mm;

Texture: Sandy to sandy loam soils

Average Clay Content: 10-20%

Agricultural Potential: Low potential soils, due to the shallow nature of the soils and sloping terrain, 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 small livestock or game species.

Photograph 1. Shallow rocky soils associated with dolerite dykes in the project area

5.2 Deep red-yellow apedal soils of the Clovelly / Hutton Soil Forms derived from Granite

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

Description: Hutton soils are identified on the basis of the presence of an apedal (structureless) "red" B-horizon as indicated in the figure below. These soils are the main agricultural soil found in South Africa, due to the deep, well-drained nature of these soils. The Hutton soils found on the site are restricted to the western plains of the site. The Hutton soil form on site is deep, although it has a low clay content. The relatively high magnesium and iron content of the parent rocks from which these soils are derived, impart the strong red colours noted.

Clovelly soils can be identified as an apedal "yellow" B-horizon. These soils along with Hutton soils are the main agricultural soil found within South Africa, due to the deep, well drained nature of these soils. The Clovelly soils are mostly restricted to the eastern plains of the site. The Clovelly soil form on site is deep, although it has very low clay content. Generally, these soils were noted to interface directly on a hard rock or calcrete contact with only a thin saprolitic layer. Compaction and erosion are physical hazards to be aware of, and catered for, when working with these soil types.

Landscape: Slightly undulating landscape;

Depth: >1200mm

Texture: Coarse sand to sandy loam (Photograph 4)

Average Clay Content: 6-15%

Agricultural Potential: Moderate potential soils– soils deep and often very sandy that causes a low water holding capacity, although the clay content of the soils is insufficient.

Under the climatic conditions these soils would not sustain arable crop production. The most viable option for crop production on the soil form is under irrigation considering the variable rainfall and moisture availability due to higher day temperatures. Irrigation is not a common practice in the study area though and for any irrigation to be undertaken in the area, it will require the installation of a number of surface water impoundments as storage during the dry months. The limited water availability, high evaporation rates and high water demands by crops would therefore render crop cultivation not sustainable in the study area. The many old cultivated fields confirm that crop cultivation over the longer term is not a financially viable option under the prevailing climatic conditions.

Land capability: Livestock and / or game grazing are viable due to the slightly higher nutrient and organic content of the topsoil in woodland areas that support a mixture of palatable and unpalatable species.

Photograph 2. Typical small-scale subsistence farming on Hutton soil form in the project area

Photograph 3. Typical landscape associated with the Hutton / Clovelly soils

Photograph 4. Coarse sandy soils of the Clovelly soil form in the project area

5.3 Shallow gravelly soils of the Glenrosa / Clovelly soil form

Binominal Classification S.A.: Clovelly soil form; Glenrosa soil form

Description: The Glenrosa soils found on the site occur in pockets throughout the study area on plateaus and slightly undulating plains. The shallow Clovelly soil forms are especially dominant in the northern section of the study area where the underlying bedrock is gneiss. The Clovelly soil form on site varies from shallow to deeper and has a medium to low clay content. Where it becomes very shallow the soil are classified as Glenrosa soil form.

Landscape: Plains / Plateaus (Photograph 4)

Depth of soil forms: 100-400 (Glenrosa, Clovelly)

Texture: Sandy to sandyloam

Vegetation: Sickle bush – Terminalia woodland

Average Clay Content: 6-10

Agricultural Potential: Medium-Low potential soils. Soils vary from shallow and sandy in some areas (Glenrosa, Clovelly soil form) to deeper with a low clay content (Clovelly soil form). The red-yellow apedal soils has a low clay content in the topsoil with a low water holding capacity. Under the climatic conditions these soils would not sustain arable crop production and as isolated pockets that cannot be considered economically viable units. The areas with deeper soils represent the most viable options for crop production. Considering that the amount of land that is needed to economically sustain arable agriculture, the soil type described above cannot be considered as viable for crop production. The many old cultivated fields confirm that crop cultivation over the longer term is not a financially viable option under the prevailing climatic conditions.

Land capability: Livestock and / or game grazing are viable due to the slightly higher nutrient and organic content of the topsoil in grassland areas that support a mixture of palatable and unpalatable species.

Photograph 5. Gravelly soils of the Glenrosa / Clovelly soil form in the northern section of the project area

5.4 Alluvial soils of the Cartref / Oakleaf soil forms

Binominal Classification S.A.: Oakleaf, Cartref soil forms

Description: These soils occur within the zone of groundwater influence. The soils are alluvial and are deep (>1,2m) with an orthic A and neocutanic B with signs of wetness in the horisons. Brown A horizon and red-brown B horizon. The soils are sensitive to erosion. The subsoil is more sensitive to erosion and should preferably not be exposed.

Landscape: Bottomlands (drainage channel and floodplains; Photograph 6)

Depth: >1200mm

Texture: Sandyclay to Sandyclayloam

Average Clay Content: 10-30%

Agricultural Potential: Zero potential soils, due to the soil wetness these areas are not suitable for crop cultivation under arable conditions.

Land capability: The grazing potential of these low-lying areas is high due to the palatable grasses growing throughout the year on these soils. The only limiting factor may be that livestock movement is limited during the wet season when the clay expands, causing livestock to get stuck in the muddy conditions. Soils are very sensitive and prone to erosion. A specific strategy is needed to prevent damage to these soils considering that overgrazing and trampling has already caused some degradation of the floodplains.

Photograph 6. Landscape associated with alluvial soils in the project area

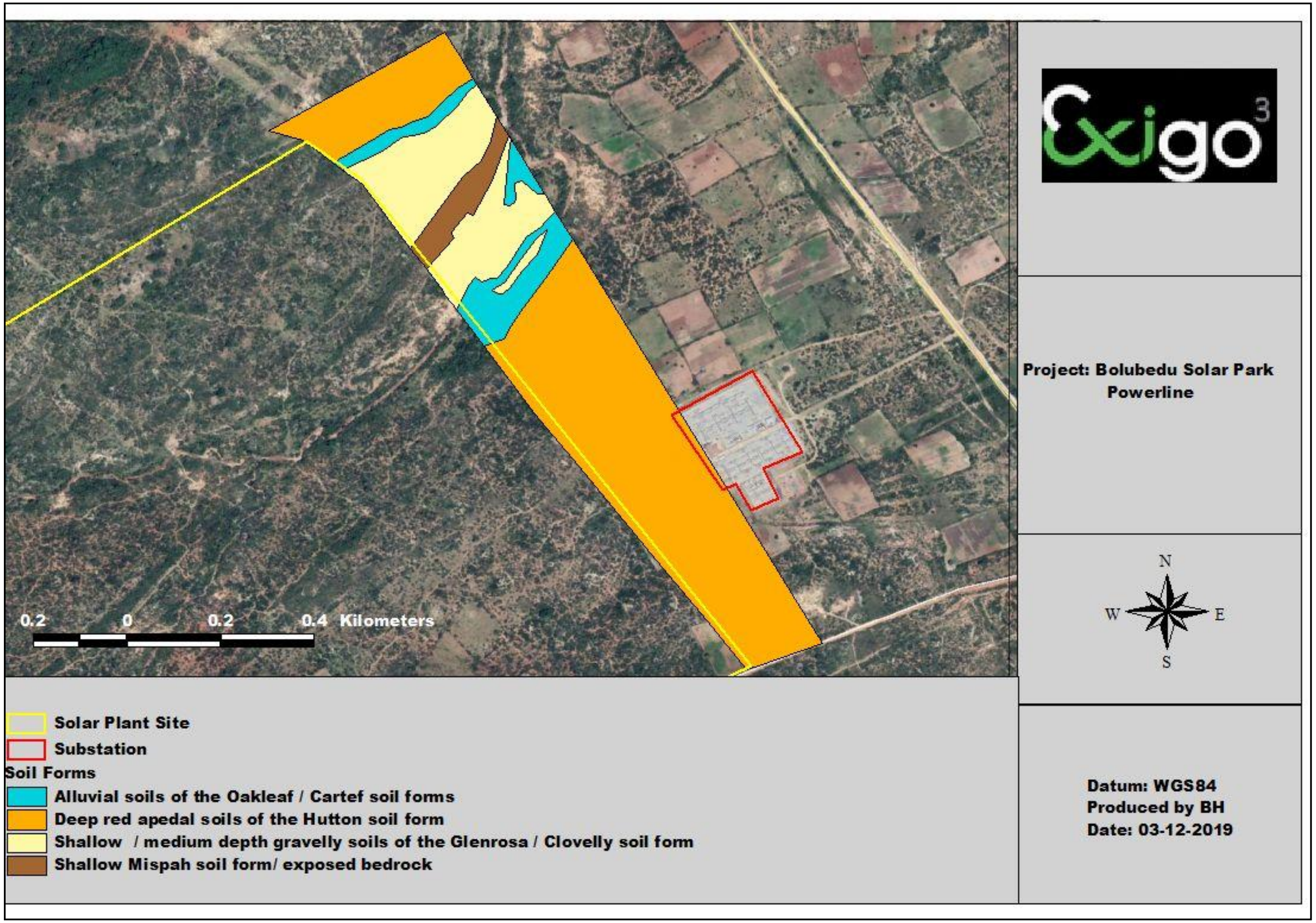

Figure 6. Soil form map of the project area

6 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. The land capability map of the area is indicated in Figure 8.

6.1 Arable land (crop production)

The area is expected to receive an annual total rainfall between 400 and 500, mostly between October to April. This amount is moderate to low. The site is considered to be located in an area conducive for rainfed arable crop production, although this should be considered marginal when taking the annual rainfall into consideration. The high variability in rainfall distribution within the area could however render dryland farming a risky venture, even under irrigated conditions. Higher day temperatures in summer months may hamper soil moisture storage for crop use. At present no irrigation or functional centre pivots occur in the project area. The climatic conditions are the main factor determining the soils to be marginally suitable for arable agriculture.

The dolerite dyke section of the project area is composed largely of shallow, weakly structured soils, with little clay content. The climatic conditions in combination with the shallow nature of the soils render the study area unfavourable for effective crop production.

The drainage channels and floodplains have sandy-clay soils that are seasonally flooded or have a perched water table. These areas are unsuitable for crop cultivation due to the soil wetness factor.

Even though there is evidence throughout the site that small scale subsistence crop cultivation occur, the high ambient temperatures in combination with the high evaporation rates, soils will be under moisture stress conditions for more than 80% of the year. Taking this into consideration with the high variability in rainfall distribution, dry land farming can be considered a risky venture for the project site. The pockets of subsistence farming are also too small to represent an economically viable unit for arable crop cultivation. Many small pockets of previously cultivated lands (abandoned) also exist on site, which further proves that the area cannot sustain arable agriculture, even when it is done on a small-scale subsistence basis by local communities.

Economically viable farming is thus restrictive to irrigated cropping due the high risk that could be associated with dry-land farming. Irrigated farming is not considered an option for the site at present.

6.2 Grazing land (Livestock production)

The current vegetation at the proposed site of development consists mainly of shrubland with a well-developed grass layer. According to databases (ARC) the grazing capacity of the area for livestock is “Unknown” as a result of the overgrazing from livestock often experienced on soils within rural areas. The current state of the site is overgrazed which caused serious erosion along the floodplains as well as serious encroachment of the woody layer on the undulating terrain.

The current vegetation of the project area consists mainly of native woody perennial species and unpalatable grasses on the outcrops, degraded grassland dominated by various low quality grazing grass species associated with old fields, and drainage channels and floodplains with highly palatable grasses. The nature of the vegetation makes the marginal for extensive livestock production. Using planted pasture to supplement livestock production on the old fields is however possible but this could be constrained by high demand for irrigation water and relatively higher day temperatures in summer.

The low agricultural potential of the soils and the low to moderate grazing capacity is further confirmed by the Agricultural Maps below (Figures 7, 8):

- Land Capability Map - site is classified as Marginal Potential Arable Land with a high potential for grazing (Figure 8);
- Potential Grazing Capacity Map (1993) - indicating that the project site has a potential grazing capacity of the site is “Other” and therefore unknown (Figure 7).

Based on the abovementioned factors, it can be concluded that the site has a medium to low potential for grazing due to the dense stands of sickle bush. Werger (1977) showed that when severe and prolonged overgrazing in the semi-arid savanna ecosystem occurs, the grass component is severely restricted in growth, or in moisture usage. Therefore, more moisture remains available in the soil to be used by the woody plants, and the result is bush encroachment, a structural change towards more strongly woody vegetation. Ecological management need therefore be implemented in these areas to address the problem.

The grazing has a low palatability and the soil is in a degraded state at present due to previous overgrazing .

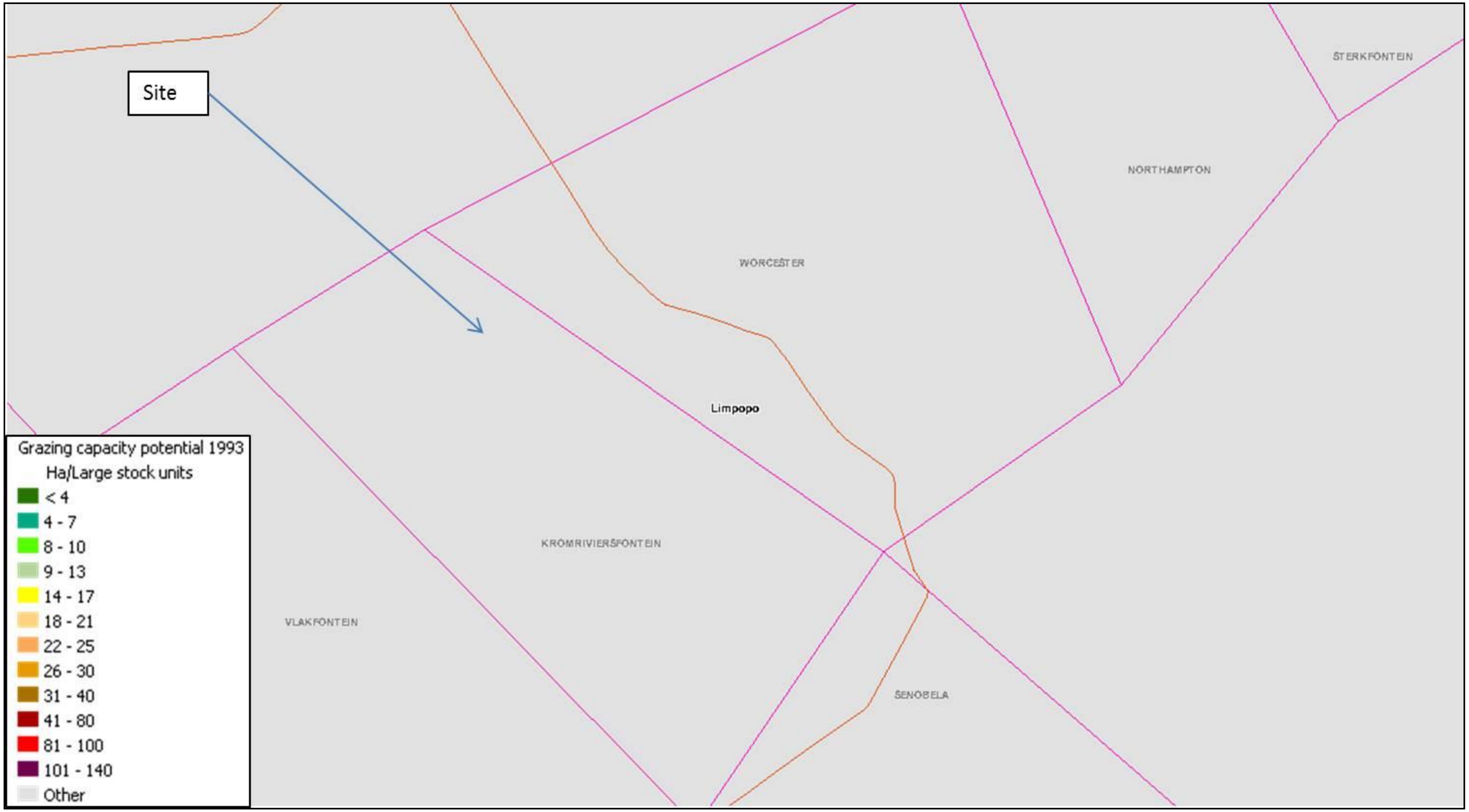

Figure 7. Grazing capacity map of the study area Source: [Web] http://www.agis.agric.za/agismap_atlas/AtlasViewer)

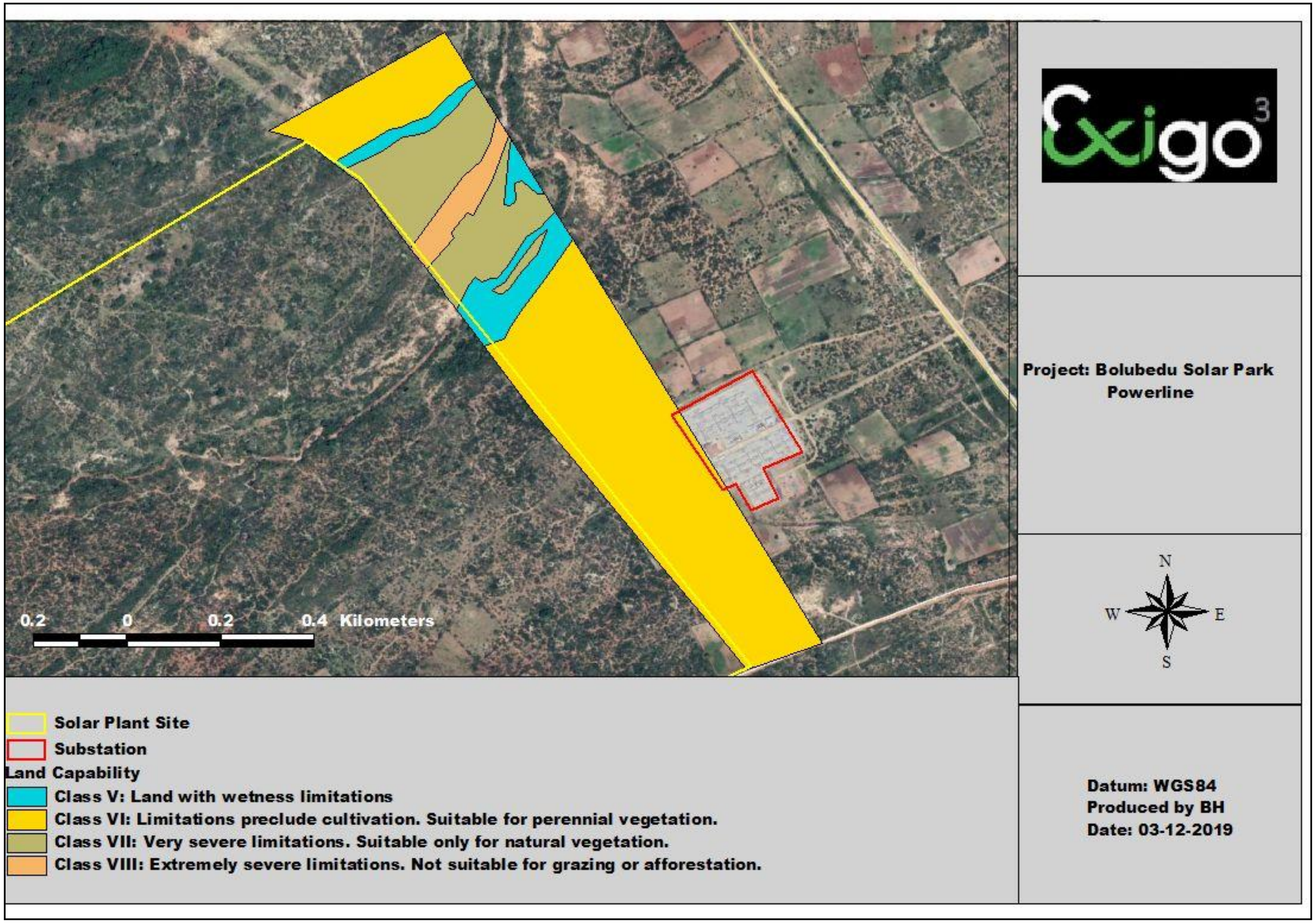

Figure 8. Land capability map for the Bolubedu Powerline

7 ANTICIPATED SOIL IMPACTS

The impacts associated with the proposed powerline and associated infrastructure development on the 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 only marginal erosion risks that can be managed though proper mitigation measures. The mitigation of the overall impacts on soils (compaction, erosion) will be easier on these 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

8 MITIGATION MEASURES

8.1 Soil compaction

- Soil should be handled when dry during removal and placement to reduce the risk of compaction;
- 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 (whether plants are in seed or not); and
- Soil should be sampled and analysed prior to replacement during rehabilitation. If necessary, and under advisement from a suitably qualified restoration ecologist, supplemental fertilisation may be necessary.
- During construction, sensitive soils with high risk of compaction (e.g. clayey soils) must be avoided by construction vehicles and equipment, wherever possible, in order to reduce potential impacts. Only necessary damage must be caused and, for example, unnecessary driving around in the veld or bulldozing natural habitat must not take place.

8.2 Soil erosion

- Minimize the amount of 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 (particularly on slopes)
        - Limitations on access for heavy machinery and the storage of materials 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 all areas susceptible to erosion and ensure that there is no undue soil erosion resultant 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.

8.3 Soil pollution

- Dry chemicals to be stored on an impervious surface protected from rainfall and storm water run-off;
- 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 DISCUSSION & CONCLUSION

This study addresses the agricultural potential, land capability and general characteristics of soils on site for the development of the Bolubedu Powerline, Limpopo Province. 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. 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 Bolubedu Powerline in the Limpopo Province can be classified as having the following soil potential and land capability according to soils identified on site:

Soil Form	Land capability
Clovelly / Hutton	Class VI: Limitations preclude cultivation. Suitable for perennial vegetation.
Shallow Mispah / Bedrock	Class VIII: Extremely severe limitations. Not suitable for grazing or afforestation.
Shallow Clovelly / Glenrosa	Class VII: Very severe limitations. Suitable only for natural vegetation.
Cartref / Oakleaf	Watercourse and land with wetness limitations.

The land capability of the site is mostly restricted to grazing due to the climatic nature of the area, shallow nature of the soils and location of drainage channels in the area. The potential impacts associated with the proposed development are soil disturbance (erosion, compaction), loss of land capability, soil destruction and sterilisation and soil pollution (spillages). The constraints for crop cultivation and areas that can be considered as unsuitable for crop cultivation are as follows:

- Climatic conditions make the potential to cultivate crops under arable conditions low, while the cost implication to apply fertilizers on the soils or to irrigate crops under pivots are considered high. Even though the soils on a large section of the farm are Hutton and / or Clovelly soil forms and deeper than 900 mm with a clay content between 15 and 30%, the soil should be irrigated to sustainably support crop cultivation in the area;
- The annual soil moisture stress percentage, high evaporation rate, coupled with relatively lower rainfall and higher summer day temperatures expected at the site would result in inefficient soil moisture holding capacity and frequent water deficits for crop production;
- A small proportion of the farm has soil forms consisting of Mispah / Glenrosa soil forms which are too shallow; while black clayey soil around the riparian areas are not considered suitable due to the soil being permanently saturated;
- Small pockets of sustainable crop cultivation by the local community do not constitute an economically viable piece of land. Pockets of land currently under cultivation is small and, in many instances, previously cultivated land was abandoned and is utilized for grazing;

- Some section of the site still represents natural woodland and grassland and therefore would be optimally utilized for grazing purposes. The grazing value of the land will not be reduced by the proposed development considering that a large section of the site will remain without any impact, while the grass layer of the impacted area will still be available underneath the solar panel mounts to small livestock and game.

Mitigation measures are provided in the report for the impacts and provided this management measures stipulated in the report are strictly adhered to, the development could be supported.

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