REPORT NO 47579-R01

LAND CAPABILITY AND WETLAND ASSESSMENT FOR ENAMANDLA PV SITE 4 SOLAR FACILITY

BIOTHERM SOUTH AFRICA (PTY) LTD

CONFIDENTIAL

SEPTEMBER 2016

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Project no: 47579
Date: September 2016

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1 INTRODUCTION

WSP Environmental (Pty) Ltd (WSP) was appointed to undertake a Social and Environmental Impact Assessment (SEIA) by BioTherm Energy (Pty) Ltd (BioTherm) for the proposed development of two renewable energy complexes in the Northern Cape, in order to apply for Environmental Authorisation (EA).

The SEIA is divided into two phases, the Scoping Phase, and the Environmental Impact Assessment (EIA) Phase. This report will form part of the Scoping Phase, acting in the capacity of a Land Capability and Wetland Assessment specialist study for the proposed BioTherm Solar Power development.

1.1 SCOPE AND LIMITATIONS

AIMS AND OBJECTIVES

The purpose of this report was to provide an initial scoping of the anticipated impacts relating to the land capability and possible wetland in the proposed solar power development Enamandla PV Site 4. The finding of this report will be used to identify key sensitive areas within the footprint of the development, and the associated infrastructure which will be addressed in more detail in the EIA phase. This study entailed a desktop review of the area, which was followed up by a site visit to verify the information collected in the desktop phase, and to collect additional relevant information.

The key objectives of this report are to:

- Contextualise the natural environment landscape of the proposed development;
- Identify the land capability and presence of wetland(s) within and around the development footprint, based upon visual inspection;
- Provide an initial screening of the anticipated impacts on the land capability and wetlands;
- Provide an outline of the methodology that will be followed in the EIA phase; and
- Outline the anticipated impacts on the land capability and wetlands, highlighting any significant potential risks, with the potential to apply effective mitigation measures.

SOURCES OF INFORMATION

The study made use of the following sources of information:

- Google Earth Pro;
- Agricultural Geo-Referenced Information System (AGIS);
- U.S. Geological Survey (USGS);
- Soil Maps of Africa: European Digital Archive of Soil Maps (EuDASM);
- Mapping and detailed project information provided by BioTherm, and existing reports which were available at the onset of the project;
- Hydrological information provided by The Water Resources 2012 Study (WR2012);
- The Land Capability Classification system described in the South African Chamber of Mines Guidelines;
- Wet-EcoServices Tool, and
- DWAF's Updated Manual for the Identification and Delineation of Wetlands.

SITE DESCRIPTION

The proposed Solar BioTherm development, is located on the remaining extent farm portion Hartebeestvlei RE86 in the Northern Cape Province (**Figure 1**). The Enamandla PV Site 4 occupies an area of 3.75 km^2, in the northern portion of the farm property, which has a total area of 132 km^2 (**Figure 2**). The closest town is a small mining village, Aggeneys, which is 15km north of the sites. The main town of Upington is situated approximately 250km north east of the site. The Orange River is located 55km north of the site, approximately 192km from the Orange River Estuary entering the Atlantic Ocean.

The site is located within the Namakwa District Municipality (DM) and the Khai-Ma Local Municipality (LM). The cities and towns located within the Khai-Ma LM are Aggeneys, Pofadder and Pella. The main economic sectors are agriculture, tourism, community, social and personal services (The Local Government Handbook, accessed 2016). The village of Aggeneys was established to accommodate the employees of the Black Mountain Mine. Most municipal services within the town are provided and funded by the Black Mountain Mining Company. The main road of the N14 runs from Upington to Springbok and serves as the primary access route to Aggeneys and neighbouring towns (**Figure 1**). The Farm Hartebeestvlei RE86 was assessed in the event of any fatal flaws which may result in the inability to utilise an area within a potential identified site.

While the scope of this report is primarily focused towards potential activities and impacts within the Enamandla PV Site 4, there are also proposed infrastructure options associated with the development (i.e. sub-stations and power transmission lines), which is described below and depicted in **Figure 3**. Option 1 is 28.8 km in length, and supplied by Kokerboom Reservoir located at Aggeneys settlement, north of the site;

- Option 1 transmission line is 14.94 km in length and connects to sub-station options 2, 1 and then Eskom sub-station;
- Option 2 transmission line is 23.09 km in length and connects to sub-station options 3, 2 and then Eskom sub-station;
- Option 3 transmission line is 27.84 km in length and connects to sub-station option 3 and then Eskom sub-station;
- Option 4 transmission line is 9.73 km in length and connects to sub-station options 4, 2 and then 1; and
- Option 5 transmission line is 17.61 km in length and connects to sub-station options 2, 1 and then Eskom sub-station.

Currently electricity is supplied to the Black Mountain Mine by the Electricity Supply Commission network at the Hydra sub-station at De Aar, via two 66kV overhead powerlines (RHDHV, 2013). The power requirement of the Gamsberg Project will be provided via the Aggeneys substation, located approximately 15 km from the mine site, through a new 28 km-long power line.

There are additional potential solar/wind power developments planned in the area around the proposed BioTherm solar sites (**Figure 4**). These will be factored into the study as part of the cumulative impact assessment. These renewable energy developer entities include:

- Sato Energy Holdings – Photovoltaics (1 site);
- Solar Capital (Pty) Ltd – Concentrate Solar Power (1 site);
- Mainstream Renewable Power SA – Solar (2 sites); and
- JUWI Renewable Energies (Pty) Ltd – Wind Turbines (2 sites).

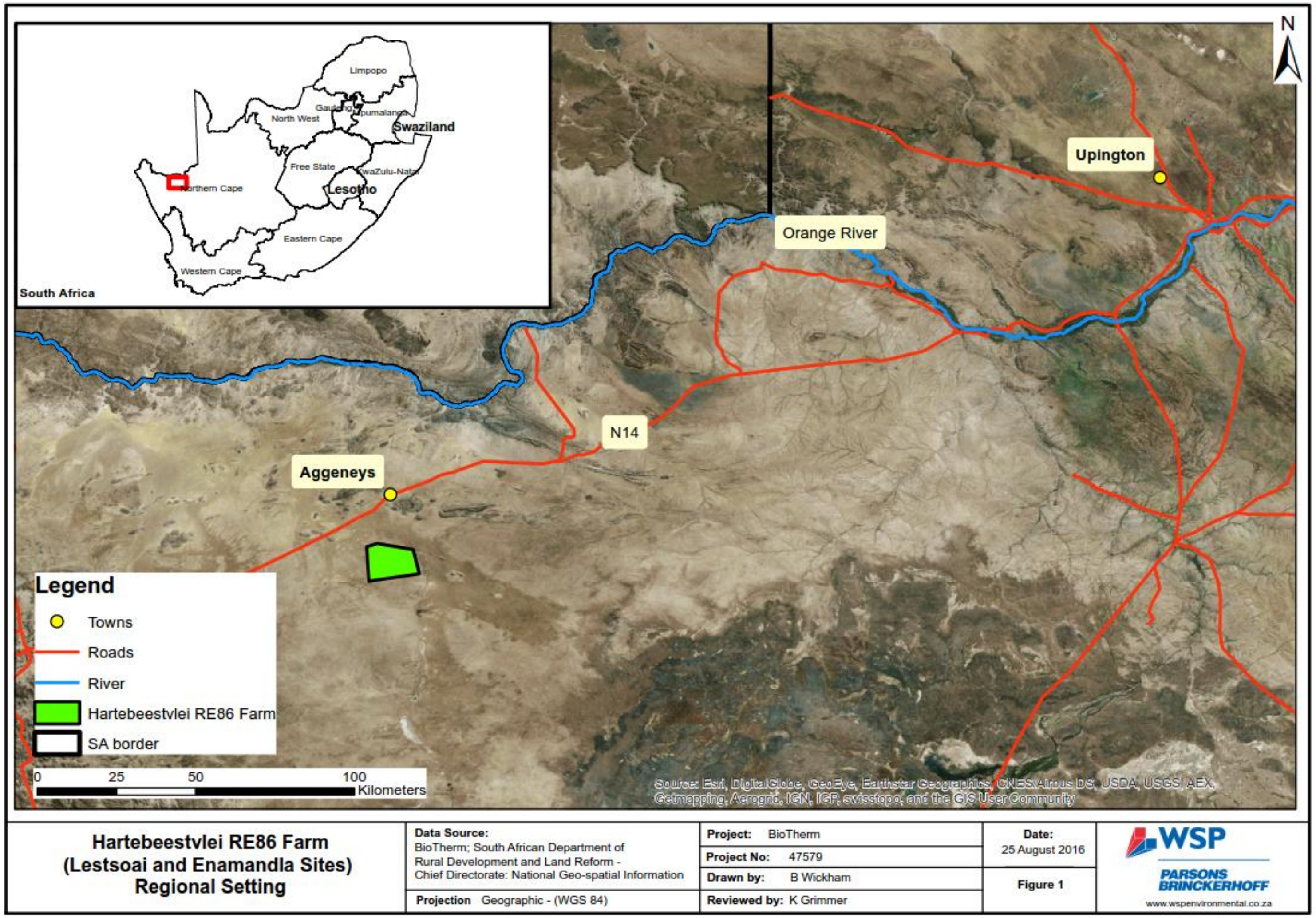

Figure 1 Hartebeesvlei RE86 Farm (Letsoai and Enamandla Sites) Regional Setting

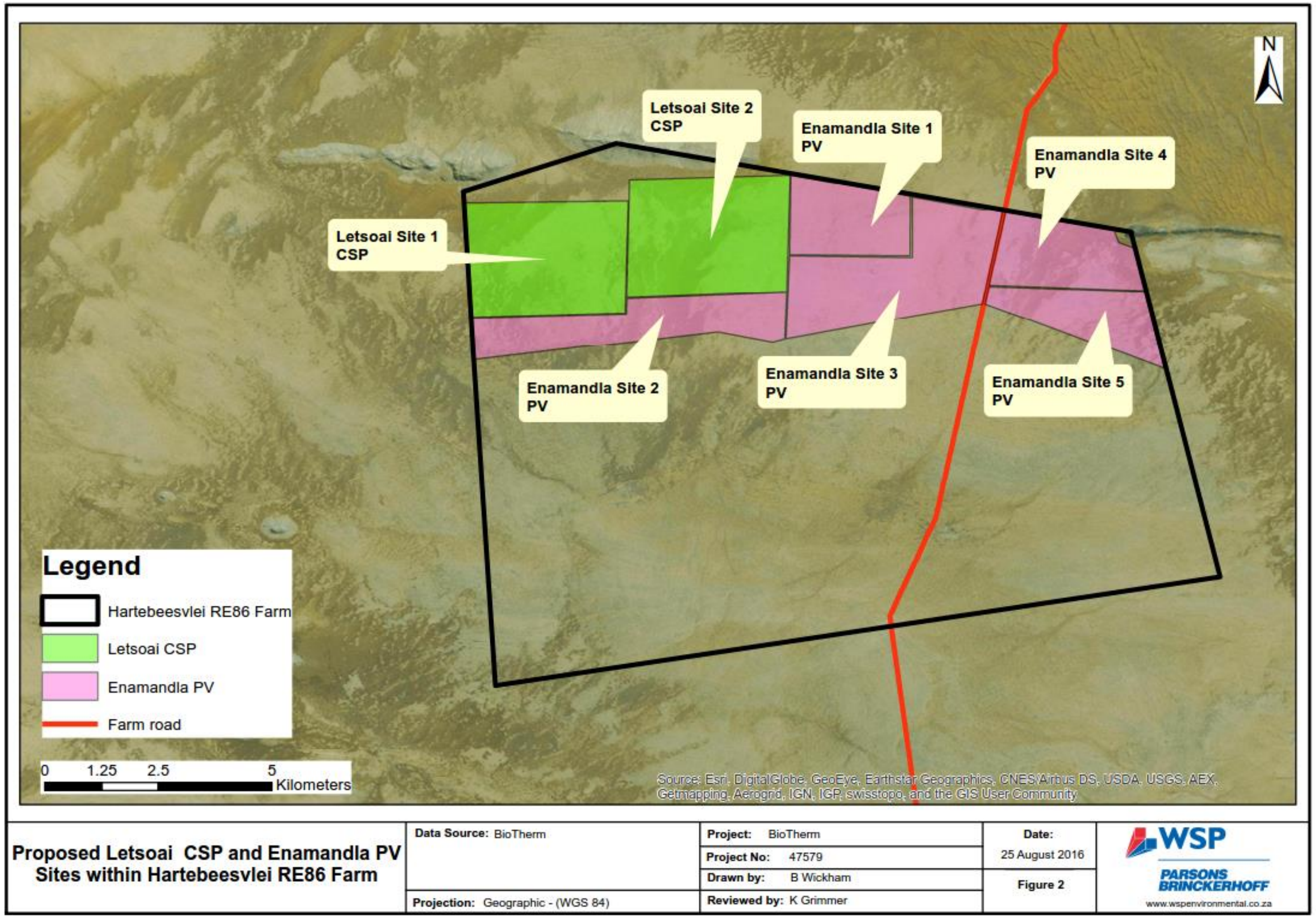

Figure 2 Proposed Letsoai CSP and Enamandla PV Sites within Hartebeestvlei RE86 Farm

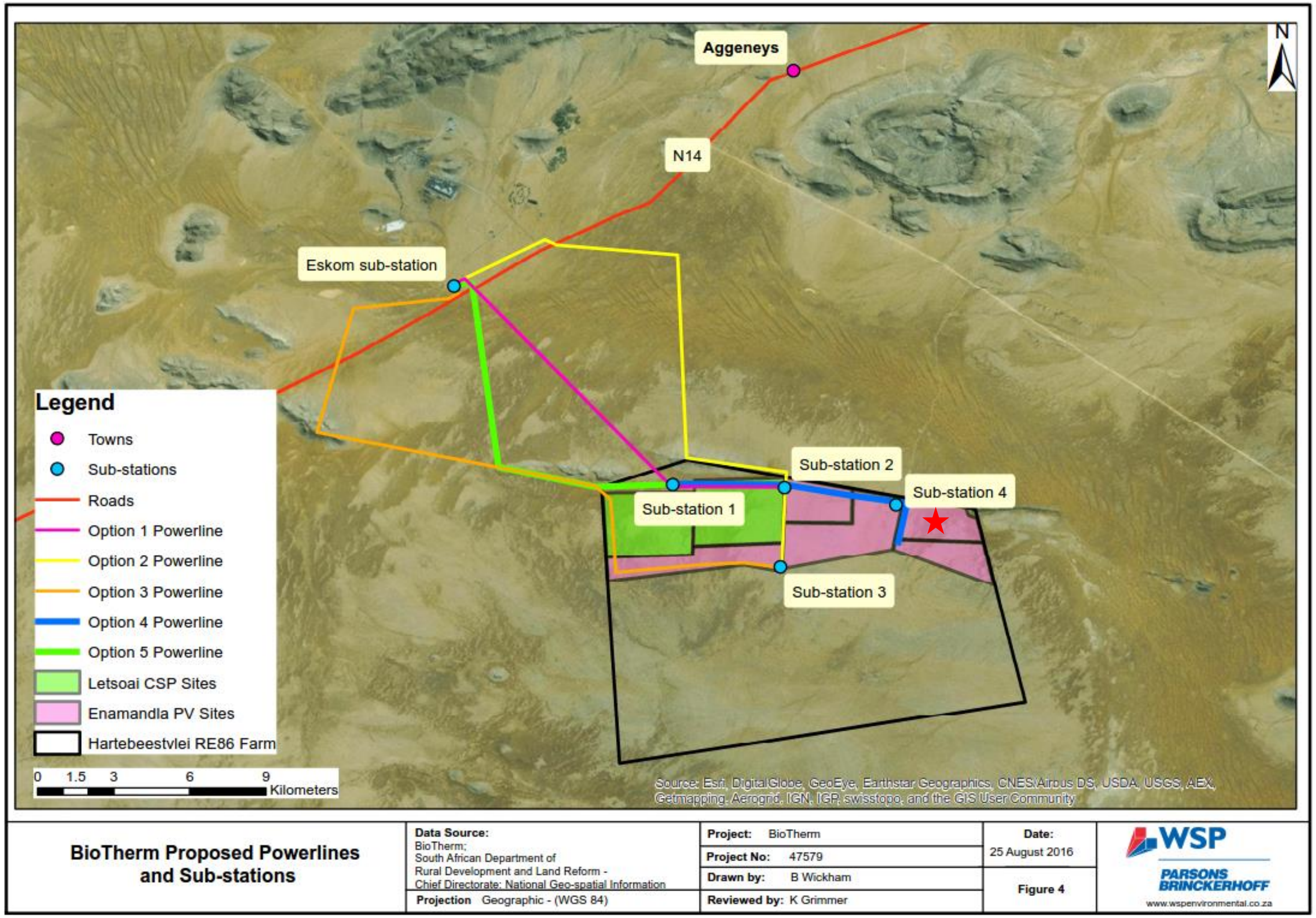

Figure 3 BioTherm Proposed Powerlines and Sub-Stations (Red star denotes location of Enamandla PV Site 4)

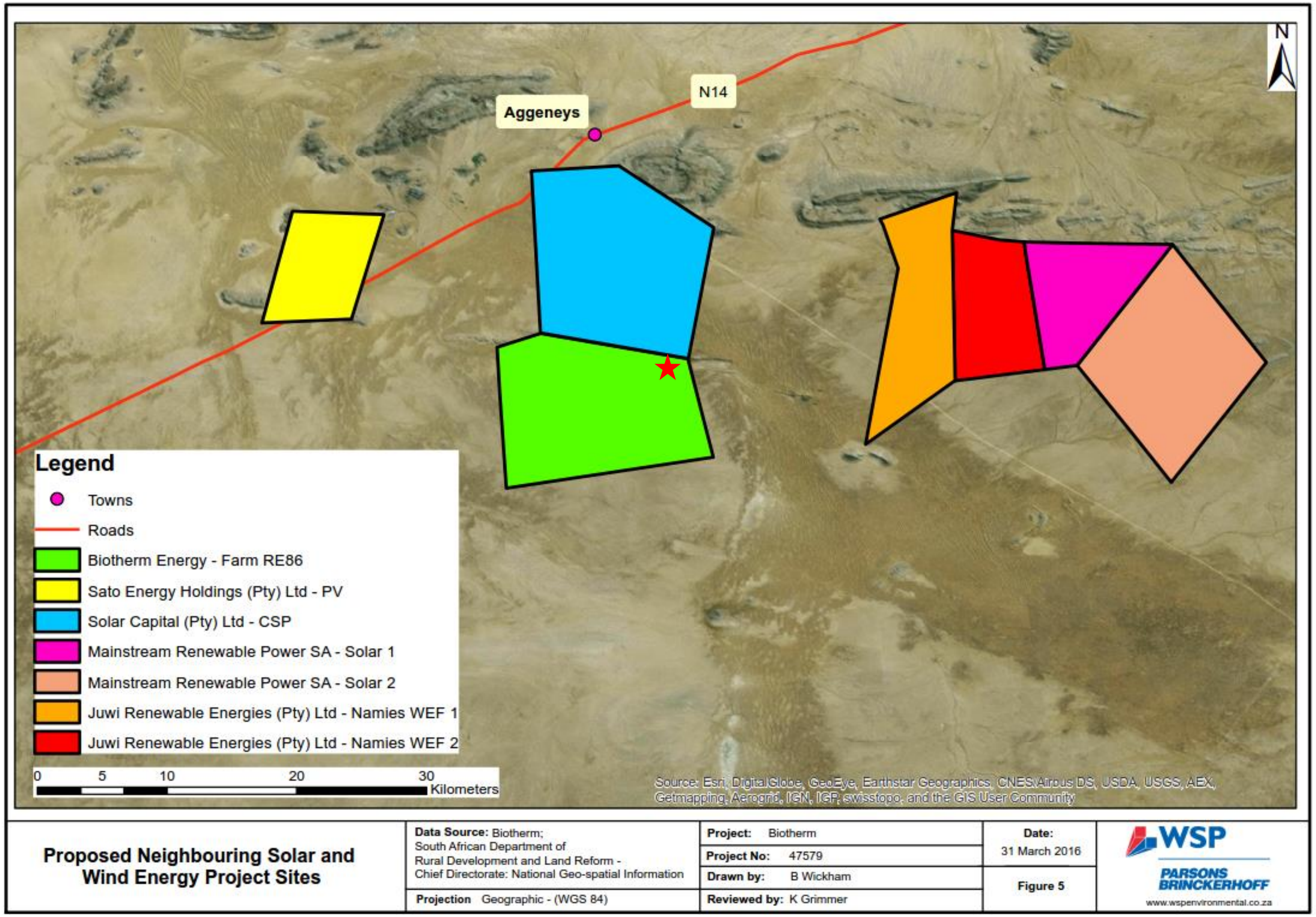

Figure 4 Proposed Neighbouring Solar and Wind Energy Project Sites (Red star denotes location of Enamandla PV Site 4)

PROPOSED TECHNOLOGY

The Enamandla PV Site 4 will house a Concentrating Solar Power (CSP) facility producing 150 MW of power. The energy produced form this facility will be fed directly into the National Grid.

Photovoltaic (PV):

Photovoltaic (PV) solar power converts light directly into electricity. This technology uses photovoltaic cells which convert light into electric current through the 'photovoltaic effect'. The PV system produces direct current power which fluctuates with the sunlight's intensity. Multiple photovoltaic cells are connected to form a module, and in turn the modules are wired together to form an array. The arrays are connected to a transformer, which is able to convert the power to the desired required voltage, or into alternating current (with desired frequency/phase), in order to accommodate the associated powerline.

ASSUMPTIONS AND LIMITATIONS

The various sources of published data have been assumed to be accurate. The field assessment was limited to a 5 km buffer around the property of Hartebeestvlei RE86 Farm. Wetlands identified for delineation were based on a desktop review and confirmed by a site visit. The boundaries for wetlands comprise of gradually changing gradients of wetland indicators, and if a wetland was identified, it should be delineated with some tolerance.

2 APPROACH AND METHODOLOGY

The nature of this scoping report is to provide the initial impacts that are anticipated to impact the land capability and wetlands within a 500 m buffer of the proposed development footprint, and the associated infrastructure. In this scoping phase, the land capability and wetlands were identified solely upon the information collected during the desktop study, and upon visual inspection during the site visit. The actual classification of the land capability and wetland assessment will be carried out in more detail, during the EIA phase of the assessment.

2.1 DESKTOP REVIEW

The desktop review made use of several sources of available information at the onset of the project (as listed under **Section 1.1** of this report - Sources of Information). From these, preliminary maps of the area were created in order to identify areas of focus for the subsequent site investigation. This included the delineation of the following:

- The Letsoai and Enamandla proposed solar sites;
- Natural vegetation and land Use (including neighbouring activities such mining);
- Topographical features;
- Soils (land type) and general geology;
- Watercourses, wetlands and riparian zones;
- Existing infrastructure (roads, houses, powerlines etc.), and
- Neighbouring proposed solar and wind energy developments.

2.2 SITE INVESTIGATION

The site investigation comprised of a three-day site visit from the 9 – 11 February 2016. This entailed a thorough inspection throughout the area, including a 500m buffer around the BioTherm sites, as well as the Hartebeestvlei RE86 Farm property.

The following tasks were undertaken as part of the site investigation:

- Verification of desktop review information: (see listed bullet points above, in the desktop review);
- Description of the soil profile characteristics;
  - Soil depth and profile description (i.e. subjective moisture estimation, effective rooting depth, presence of mottling, gleying, pedocretes and soil structure);
  - Classification of soil form and family based on the Taxonomic Soil Classification System for South Africa (Macvicar, 1991);
  - Permeability based on in-situ estimation and texture properties;
- Description of underlying lithology; and
- Collection of representative soil samples, sent in for laboratory analyses for pH, electrical conductivity, exchangeable sodium and soil texture.

A handheld Global Positioning System (GPS) and camera were used in conjunction with the maps created in the desktop review, to conduct the ground truthing exercise. The GPS was used to delineate areas as well as verify and mark all relevant points of interest with exact co-ordinates, which were subsequently used to create more detailed maps. Representative soil samples were collected using a hand-operated auger, where the holes were drilled until the parent material/refusal was reached.

A more detailed description of the steps followed for defining the Land Capability and Wetland Assessment, will be described in the EIA phase report.

2.3 IMPACT SCREENING TOOL

The scoping phase includes an impact screening process developed by the environmental assessment practitioner (WSP) to assess the significance of identified impacts. The screening tool will allow any impacts of very low significance to be excluded from the detailed study in the EIA phase. The screening tool is based on two criteria, namely probability and severity, as described in **Table 1**, **Table 2** and **Table 3**.

Table 1 Screening Assessment Matrix

		Severity / Beneficial Scale			
Probability Scale		1	2	3	4
	1	Very Low	Very Low	Low	Medium
	2	Very Low	Low	Medium	Medium
	3	Low	Medium	Medium	High
	4	Medium	Medium	High	High

Table 2 Probability Scale

4	Definite
	Where the impact will occur regardless of any prevention measures
3	Highly Probable
	Where it is most likely that the impact will occur
2	Probable
	Where there is a good possibility that the impact will occur
1	Improbable
	Where the possibility of the impact occurring is very low

Table 3 Severity / Beneficial Scale

4	Very severe	Very beneficial
	An irreversible and permanent change to the affected system(s) or party (ies) which cannot be mitigated.	A permanent and very substantial benefit to the affected system(s) or party(ies), with no real alternative to achieving this benefit.
3	Severe	Beneficial

	A long term impacts on the affected system(s) or party(ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming or some combination of these.	A long term impact and substantial benefit to the affected system(s) or party(ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these.
2	Moderately severe	Moderately beneficial
	A medium to long term impacts on the affected system(s) or party (ies) that could be mitigated.	A medium to long term impact of real benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way.
1	Negligible	Negligible
	A short to medium term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary.	A short to medium term impact and negligible benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are easier, cheaper and quicker, or some combination of these.

3 REGIONAL OVERVIEW

3.1 HYDROLOGY

The Water Resources 2012 (WR2012) Study (WRC/DWA, 2012) was used to obtain the climatic and hydrological data for the area. This study modelled South Africa (including Lesotho and Swaziland) on a quaternary basis.

South Africa is divided into 19 Water Management Areas (WMAs); the proposed BioTherm solar power sites are situated in the Lower Orange WMA. This WMA makes up the downstream portion of the Orange River Basin, which starts in the Lesotho Highlands headwaters of the Senqu River. The Upper Orange WMA, as well as the Upper, Middle and Lower Vaal WMA's all contribute to the Orange River Basin as a whole. As one moves westward along the Orange River, from the headwaters in Lesotho to the Atlantic Ocean, the drier the climate becomes (lower precipitation and higher evaporation).

Within the Lower Orange WMA, the proposed site lies within tertiary D82, and overlays parts of the D82B and D82C quaternary catchments (**Figure 5**). The D82 tertiary hydrological characteristics are shown in **Table 4**, including catchment area, Mean Annual Precipitation (MAP), Mean Annual Evaporation (MAE) and Mean Annual Runoff (MAR). The MAE largely exceeds the MAP, resulting in very low runoff of the tertiary, reinforcing the arid conditions of the region.

Table 4 Tertiary D82: Quaternary Information (site within D82B and D82C)

QUATERNARY	CATCHMENT AREA (KM^2)		MAP (MM)	MAE (MM)	MAR (MILLION M^3/A)
	GROSS	NET			
D82A	1 917	1 917	77	2 650	0.28
D82B	4 877	0	80	2 650	0.00
D82C	3 996	0	83	2 650	0.00
D82D	2 967	1 075	111	2 650	0.60
D82E	944	944	100	2 549	0.75
D82F	1 039	1 039	106	2 401	1.00
D82G	594	594	79	2 401	0.19
D82H	822	822	60	2 401	0.09
D82J	1 385	1 385	29	2 401	0.01
D82K	917	917	31	2 201	0.01
D82L	754	619	42	2 401	0.02
TOTAL	**20 212**	**18 185**	**76**	**2 561**	**2.13**

Source: WRC/DWA, 2012

Quaternary catchments D82B and D82C, where the proposed site is located, are 100% endoreic (**Figure 5**) (WRC/DWA, 2012). An endoreic area does not contribute to runoff, and thus rainfall on this area is lost through either evaporation or percolation to the underlying groundwater environment, and as such does not contribute to surface water runoff. This accounts for the gross and net catchment areas reflected in **Table 4** (i.e. the net area is the gross area less the endoreic area).

For a complete assessment of the water component of the Study, the reader is referred to the *Water Assessment of Solar Power Generation in the Northern Cape Province* Report (WSP, 2016).

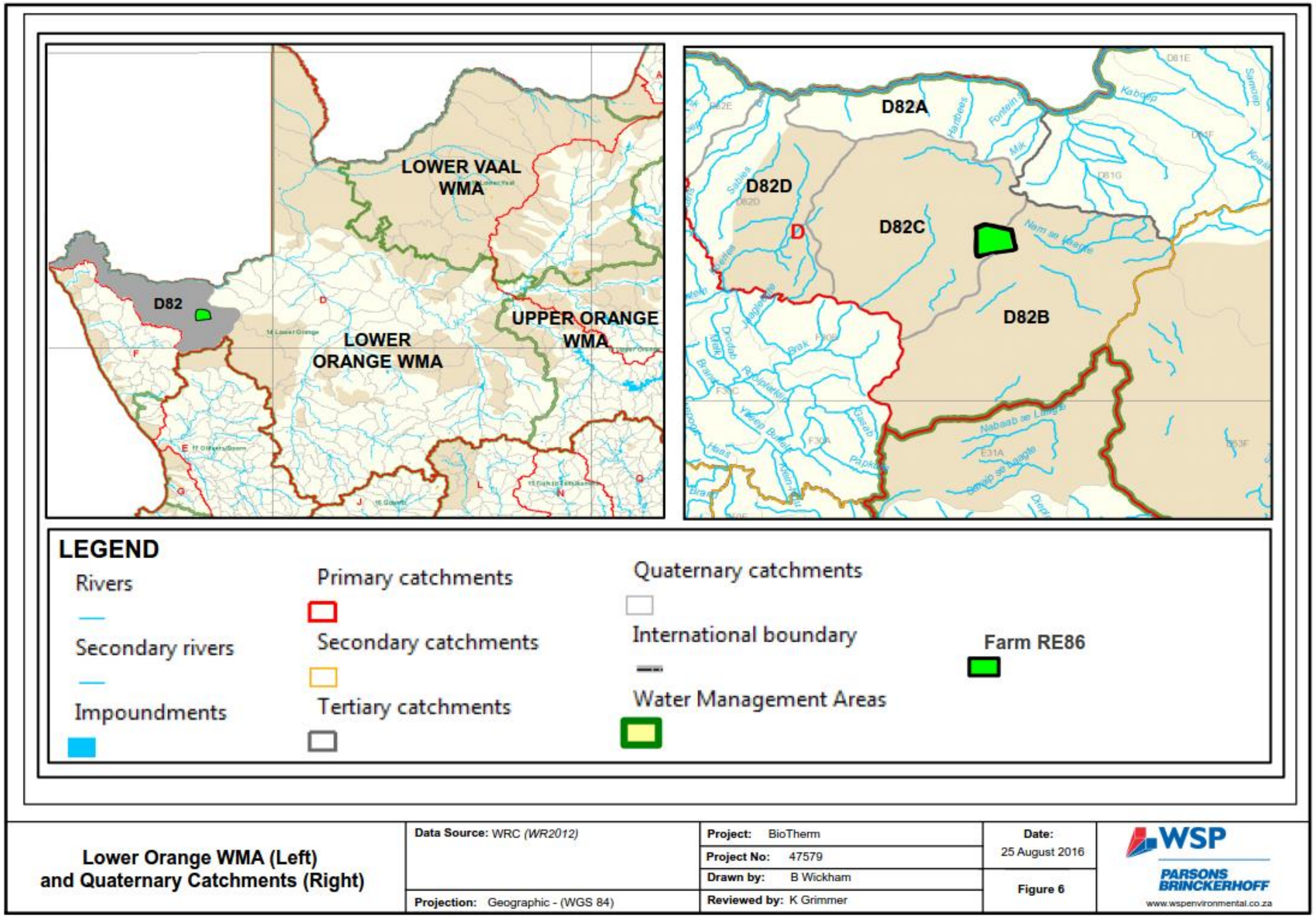

Figure 5 Lower Orange WMA (left) and Quaternary Catchments (right)

3.2 VEGETATION AND LAND USE

NATURAL VEGETATION

According to Mucina and Rutherford (2006) the natural vegetation on the Hartebeestvlei RE86 farm property is mostly Bushmanland Arid Grassland, with minor portions of Bushmanland Inselberg Shrubland situated on the small hills along the northern edge of the property boundary (**Figure 6**).

NATIONAL LAND COVER AND LAND USE

The Department of Agriculture, Forestry and Fisheries (DAFF) define the land use within the Hartebeestvlei RE86 farm property, as predominantly Shrubland and Low Fynbos, with smaller pockets of unimproved (natural) Grassland, and minor areas of Woodlands (DAFF, 2012) (**Figure 7**). As shown in **Figure 7**, there are two wetlands located approximately 3 km south of the proposed Letsoai and Enamandla sites, near the western and lower-middle boundary of the farm property. However, upon the site visit, the wetland near the lower-middle boundary of the farm property was identified as an old broken earth-wall dam, and is thus not a wetland. The second wetland near the east of the farm boundary could not be located and thus it could not be verified or delineated. This may be due to the climate of the area (i.e. low precipitation and high evaporation), combined with a sandy soil (i.e. high transmissivity), and the site visit being conducted within the (particularly) dry season. Areas which may have initially been identified as possible wetlands, may have rather been caused by a single rainfall event, and therefore it was very difficult to identify wetlands which may otherwise exist under the appropriate climate conditions (i.e. the wet season). As such there were no wetlands identified or verified within the BioTherm site.

During the site walkover, the majority of the vegetation was shrub-like arid grassland, which is primarily used for sheep grazing. Cattle grazing activities were also present in the area. In addition, there are herds of antelope (Springbok) grazing on the land within Hartebeestvlei RE86 farm property. The boreholes, driven by windmills, provide water to small reservoirs and water tanks throughout the farm for the sheep. **Plate 1 – Plate 5** shows photos taken during the site walkover including the vegetation cover, sheep and cattle pens, a windmill-driven borehole supplying water to a reservoir and the broken earth-wall dam.

Beyond the Hartebeestvlei RE86 Farm property there is extensive mining and associated infrastructure. Electricity is supplied to the Black Mountain Mine by the Electricity Supply Commission network at the Hydra sub-station at De Aar, via two overhead powerlines (RHDHV, 2013). The water supply to Aggeneys and the mine is currently supplied from the Orange River via the Pelladrift pump station and a 50km pipeline (DWS, 2016).

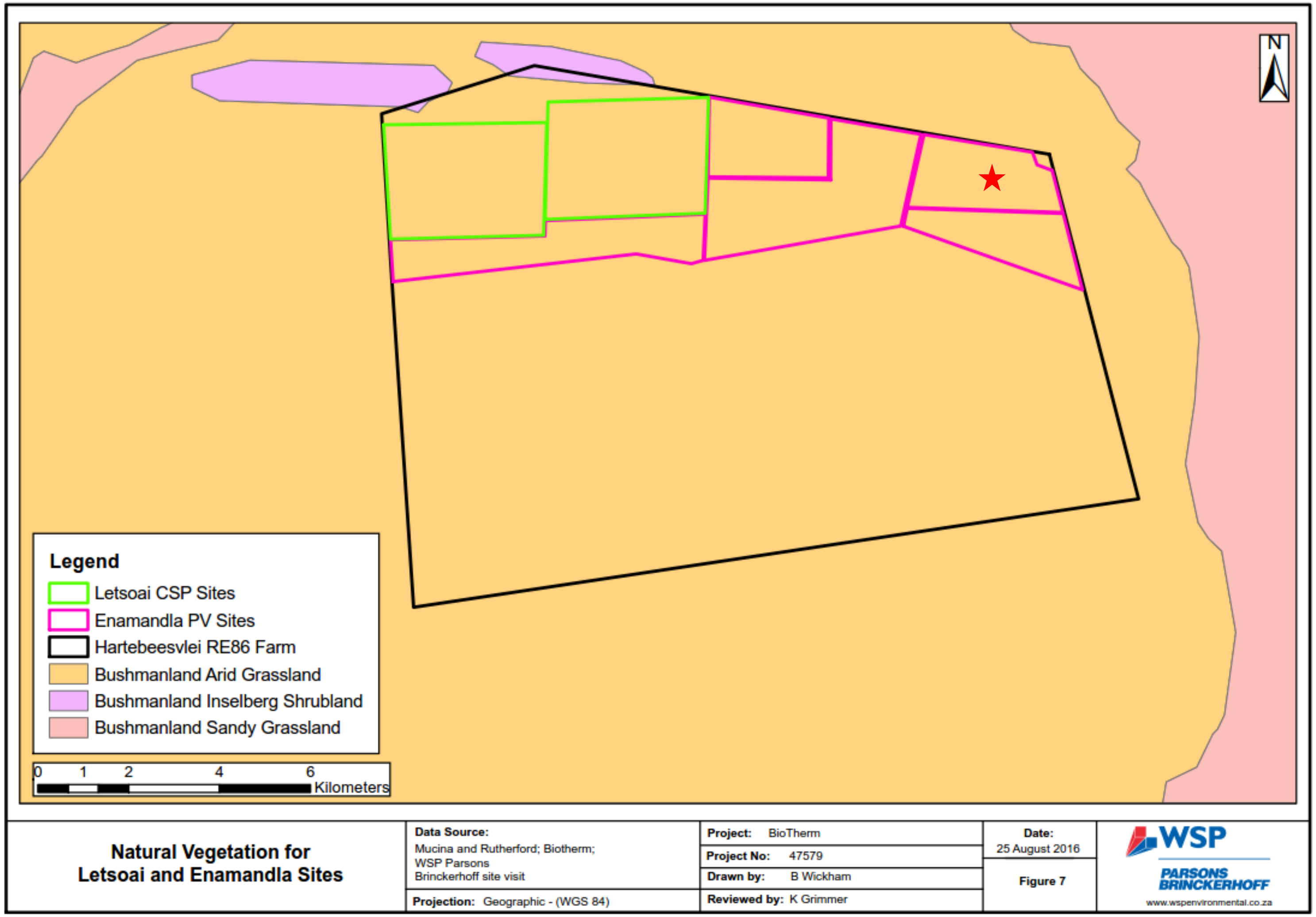

Figure 6 Natural Vegetation for Letsoai CSP and Enamandla PV Sites (Red star denotes location of Enamandla PV Site 4)

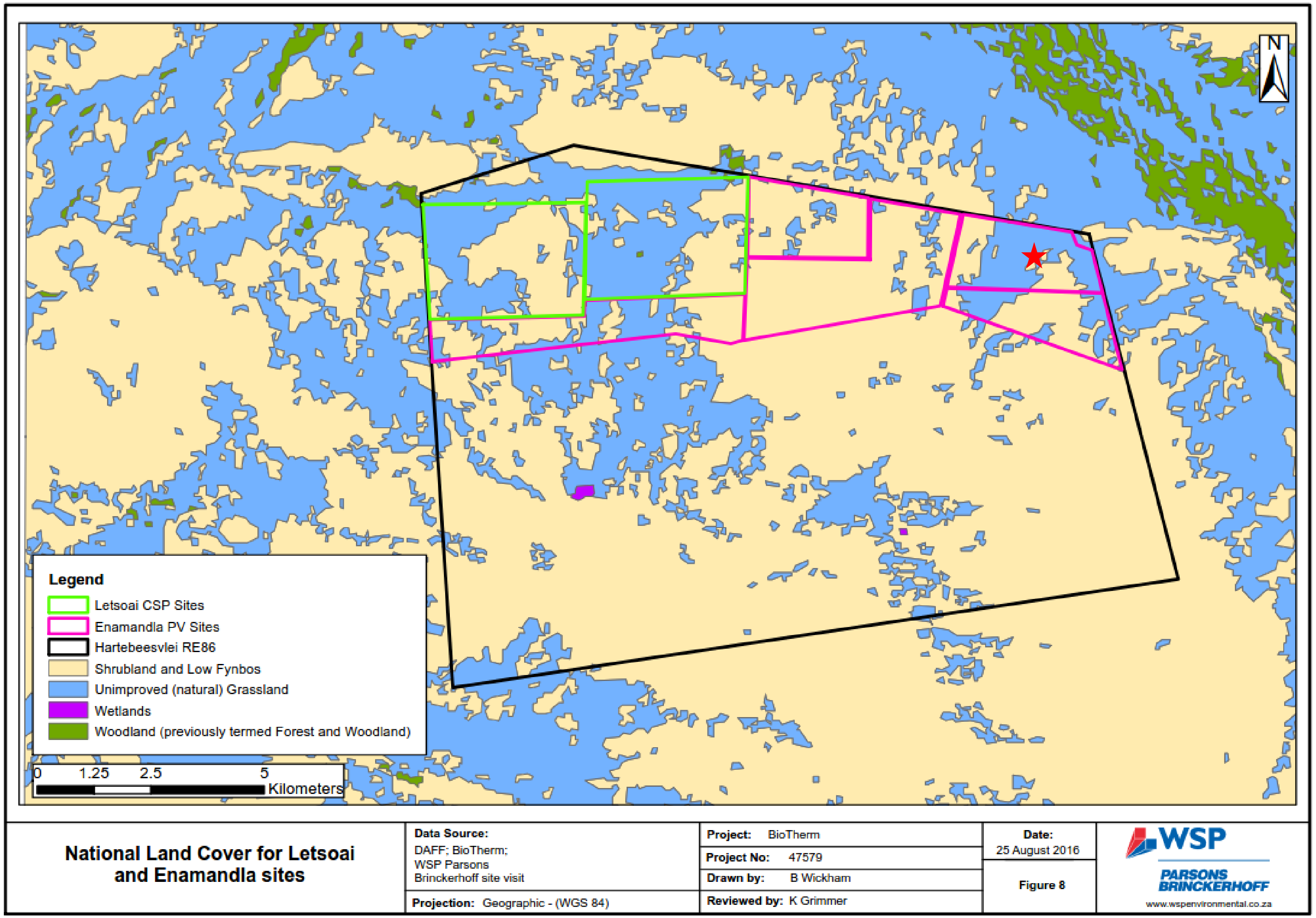

Figure 7 National Land Cover for Letsoai CSP and Enamandla PV Sites (Red star denotes location of Enamandla PV Site 4)

3.3 SOIL AND GEOLOGY

SOIL

Based on the land type maps of South Africa (AGIS, 2007) the soils in the area of the Hartebeestvlei RE86 farm are identified mostly as "Red-yellow apedal, freely drained soils, red, high base status, < 300 mm deep" with minor "Miscellaneous land classes, very rocky with little or no soils" on the inselbergs (small hills) located on the northern boundary of the farm property (**Figure 8**). Upon the site visit, the farm property was sampled at nine locations, numbered SS1 – SS9, to describe the soil characteristics of the area (**Figure 9**). The location of the soil sampling points was determined by the soil land type map as well as on-site observation for changes in the topography and land feature (e.g. wetlands) which might induce a change in the soil type. At each location, the soil depth and diagnostics horizons were identified, and a sample was collected for chemical and physical analyses in a soil laboratory. For practical reasons, soil samples that were collected in a similar setting and had the same soil family, were mixed, to provide representative samples for the area (i.e. SS1 + SS2 + SS3; SS4 + SS5 + SS6; SS7 + SS8 + SS9). The representative soil samples were sent for analyse to the SGS Soil Laboratory situated in Somerset West in the Western Cape, to determine the pH, electrical conductivity, exchangeable sodium and texture.

All the soil samples were identified as Namib soil form (**Plate 6**). The characteristics of the soil samples and profiles are described in **Table 5**. The erodibility of the soil is carried out by two modes of transport *viz.* wind and water. Based upon the DAFF GIS data (AGIS, 2007) the soil within the farm property has a high susceptibility to wind erosion, and a low to moderate water erosion hazard. This is evident, given the following characteristics of the area:

- Fine sand texture;
- Single grained structure;
- Clay content ranging between 2 and 5%;
- Dominant flat topography with large open spaces of shrub-like vegetation cover; and
- Infrequent occurrence of sheet flow (with no evidence of gully erosion).

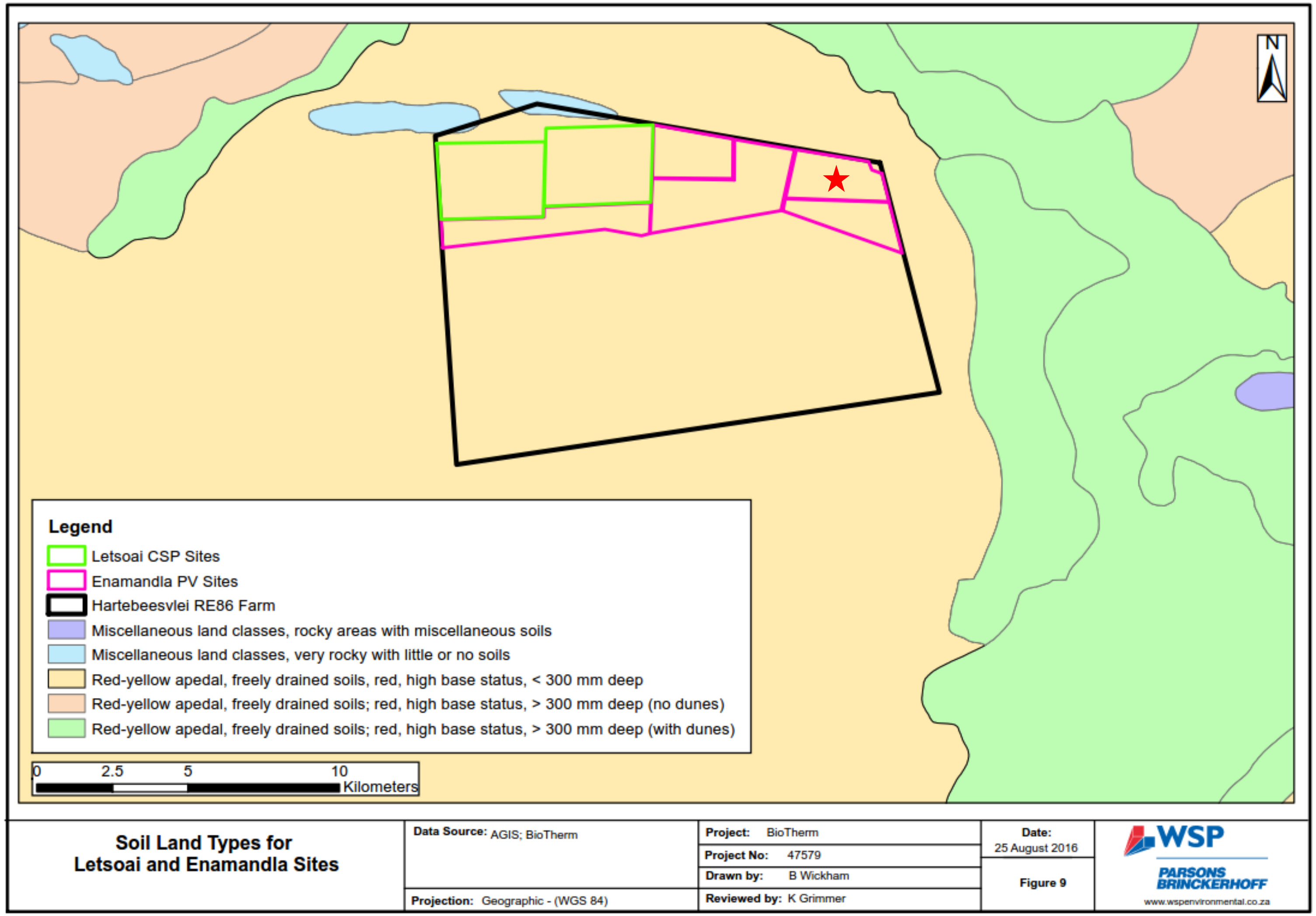

Figure 8 Soil land Types for Letsoai CSP and Enamandla PV Sites (Red star denotes location of Enamandla PV Site 4)

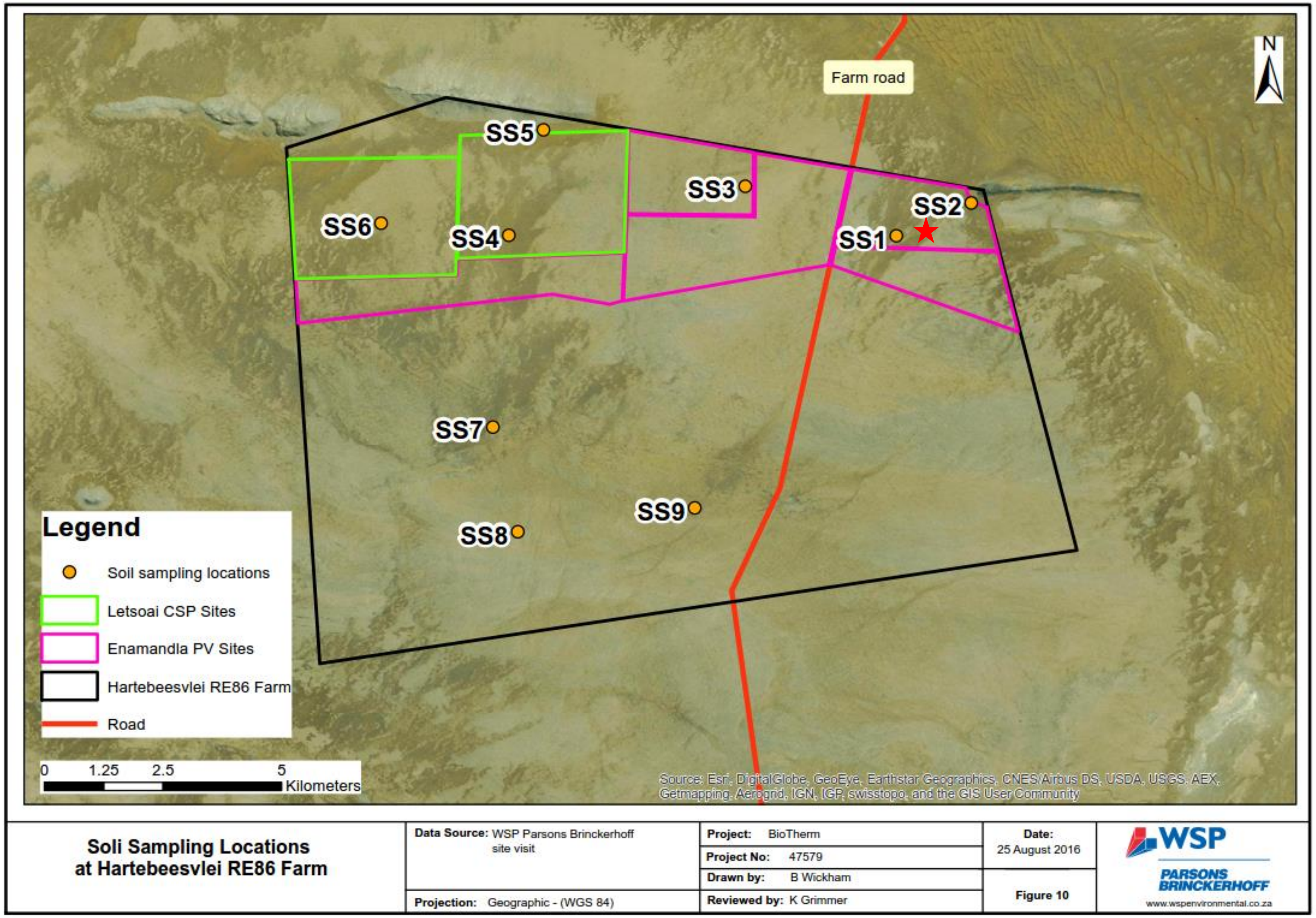

Figure 9 Soil Sampling Locations within Hartebeesvlei RE86 Farm (Red star denotes the location of Enamandla PV Site 4)

Table 5 Summary of Soil Sample Characteristics

Characteristic	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9
Soil Form	Namib	Namib	Namib	Namib	Namib	Namib	Namib	Namib	Namib
Profile Depth	0.16	0.95	0.23	1.58	1.13	0.33	0.31	0.34	0.22
Dry Colour*, mottling and gleying	Pale orange	Pale orange	Orange	Orange	Orange	Pale orange	Orange	Orange	Orange
	Hue 5 YR	Hue 5 YR	Hue 2.5 YR	Hue 2.5 YR	Hue 2.5 YR	Hue 5 YR	Hue 5 YR	Hue 7.5 YR	Hue 7.5 YR
	Value 8	Value 8	Value 8	Value 8	Value 8	Value 8	Value 7	Value 7	Value 7
	Chroma 4	Chroma 4	Chroma 8	Chroma 8	Chroma 8	Chroma 4	Chroma 8	Chroma 6	Chroma 6
Subjective moisture	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Effective rooting depth (m) Grasses	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Effective rooting depth (m) Shrubs	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Soil structure	Single grained	Single grained	Single grained	Single grained	Single grained	Single grained	Single grained	Single grained	Single grained
Presence of rocks, pedocretes, calcareousness	No	No	No	No	No	No	No	No	No
pH	6.7	6.7	6.7	7.1	7.1	7.1	7.4	7.4	7.4
Electrical conductivity (mS/m)	18.4	18.4	18.4	20.1	20.1	20.1	19.9	19.9	19.9
Exchangeable sodium (%)	1.4	1.4	1.4	2.2	2.2	2.2	1.1	1.1	1.1
Sand (S) Silt (Si) & Clay (C) (%)	96, 2, 2	96, 2, 2	96, 2, 2	96, 2, 2	96, 2, 2	96, 2, 2	96, 2, 2	96, 2, 2	96, 2, 2
Texture**	Fine Sand	Fine Sand	Fine Sand	Fine Sand	Fine Sand	Fine Sand	Fine Sand	Fine Sand	Fine Sand
Estimate permeability (m/d)***	1.6 – 6.0	1.6 – 6.0	1.6 – 6.0	1.6 – 6.0	1.6 – 6.0	1.6 – 6.0	1.6 – 6.0	1.6 – 6.0	1.6 – 6.0
Erodibility K factor #	52	52	52	52	52	52	52	52	52

Sources: ** Colour based on the revised Standard Soil Colour Chart (Fujihara Industry Co.,2001) ;*

*** Texture based upon the United States Department of Agriculture (USDA) Soil texture triangle and grain size*

**** Estimate Permeability based upon soil structure and texture (van der Molen, Beltran, & Ochs, 2007)*

 # Estimated from the soil erodibility nomograph of Wischmeier, Johnson and Cross (1971)

GEOLOGY

The topography of Hartebeestvlei RE86 Farm is predominantly flat, with an average slope of 3.1% declining from the south west towards the north east (**Figure 10**). The elevation of the property ranges between 835 – 1009 masl (meters above sea level), and has two inselbergs on the northern boundary, which is typical of the area.

The general geology description of the area is based on the 1:1 000 000 geological map for Northern Cape Province, published by the Trigonometrical Survey Office in 1970 (Schifano *et. al*., 1970). The farm property is located on the Namaqualand and Natal belt of metamorphism and granitization where the rock type comprises of Migmatite, gneiss and ultrametamorphic rocks (**Figure 11**). Upon the site walkover, gneiss rock types were present below the soil profile (**Plate 7**).

The ranges of hills, mountains and inselbergs in the area display some of the most diverse and complex geology in Southern Africa including some of the richest known concentrations of copper, lead and zinc (Mining Technology, accessed 2016). The Aggeneys deposits are in the Precambrian metavolcanic metasedimentary Bushmanland Group which forms part of the Namaqualand Metamorphic Complex. The Bushmanland Group is located within the Namaqualand-Natal Mobile Belt, with and area of approximately 18 000 km^2 (RHDHV, 2013).

Due to the high minerals in the area, mining activities have been active for many years, and projected to continue for decades to come (Black Mountain Mine and Gamsberg Mine). The Black Mountain Mine is an underground base-metal operation mining zinc, lead, copper and silver, and is located 14 km north of Hartebeestvlei RE86 Farm.

The large flat plains dominated by the fine red sand sediment, is underlain by granitic gneisses, while the protruding inselbergs and ranges of hills are characterised by metavolcanic-metasedimentary units of the Bushmanland Group (Bailie et. al., 2007). The orebody at the proposed Gamsberg mine nearby is hosted by iron sulphide-rich pelitic rocks and iron formation, and the economic mineralisation comprises sphalerite (zinc) and minor galena (lead). As of November 2014, the Gamsberg mine was estimated to contain mineral resources of 194 Mt.

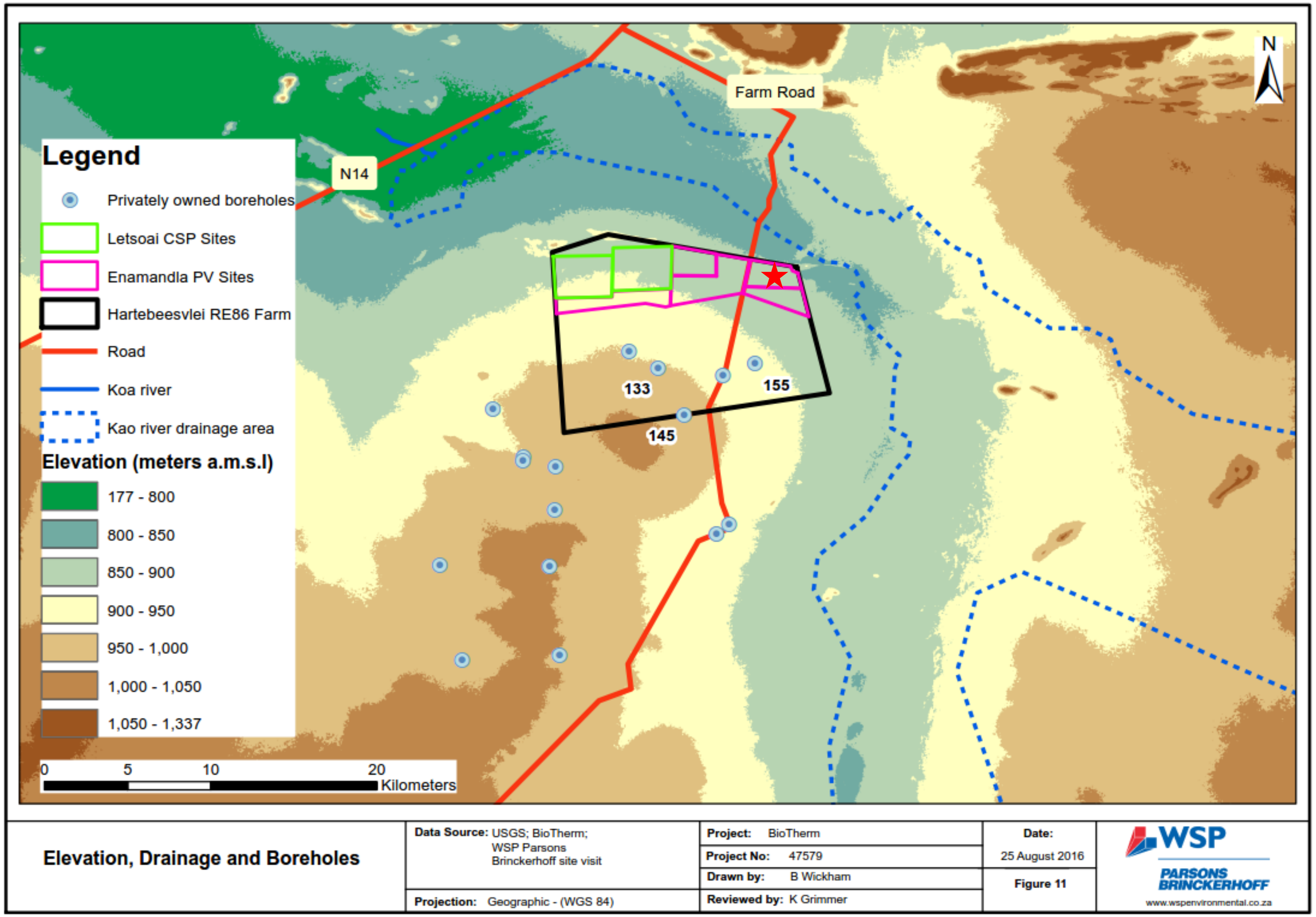

Figure 10 Elevation, Drainage and Boreholes (Red star denotes location of Enamandla PV Site 4)

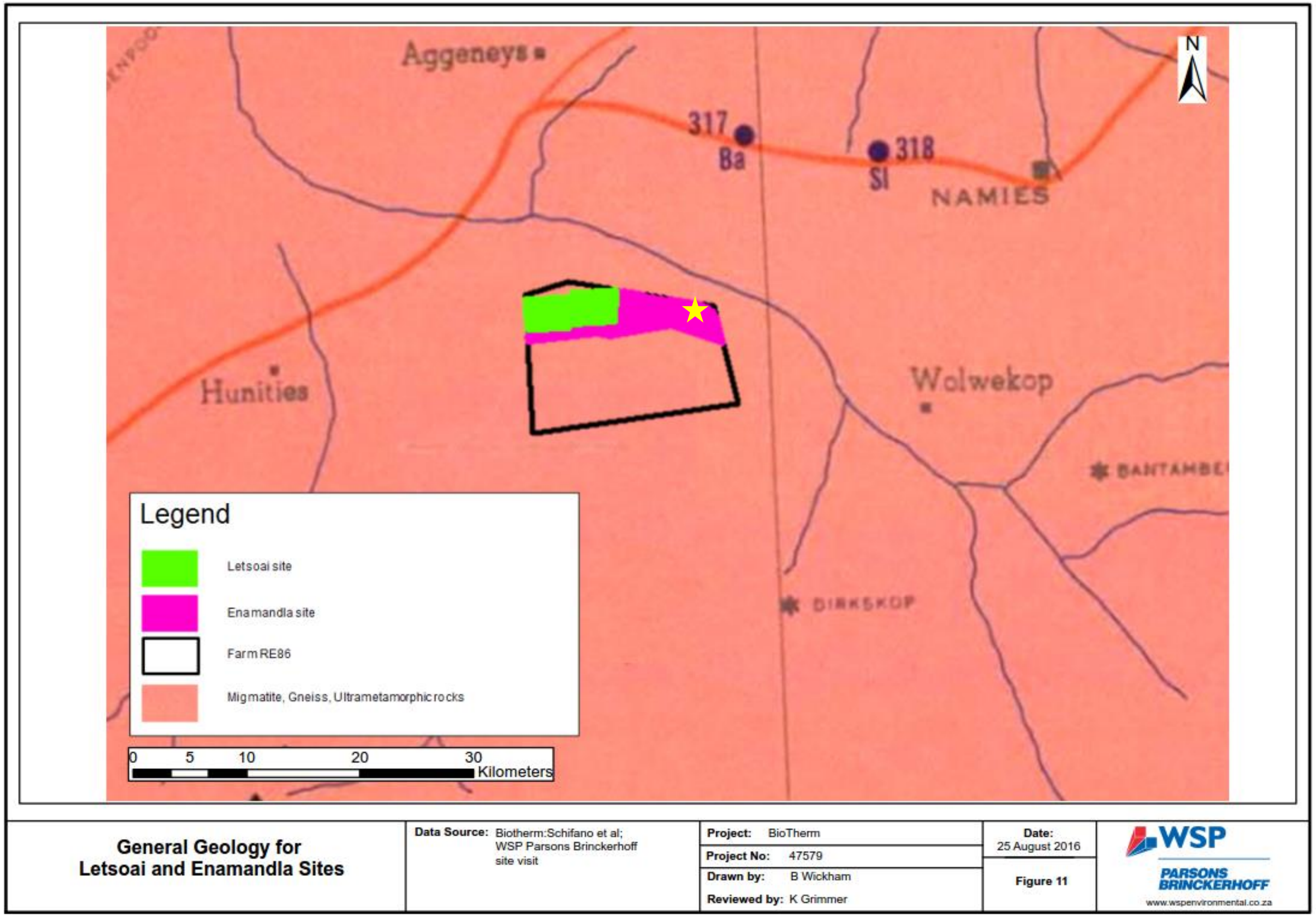

Figure 11 General Geology for Letsoai and Enamandla Sites (Yellow star denotes location of Enamandla PV Site 4)

GROUNDWATER

The groundwater of the area was assessed through a site walkover conducted by WSP and VSA Leboa Consulting (Pty) Ltd. Several boreholes over the area were identified with three representative boreholes chosen to be analysed for both yield and chemical constituents. It was found that the groundwater yield may be able to supplement the demand of the proposed solar power site. However, whether or not it is a cost effective measure is still to be determined, especially due to the water quality of the groundwater compared to the water quality required by the client (i.e. cost of the necessary treatment).

The underlying natural geology is considered to be representative of a poor aquifer, a low-yielding system of poor water quality with a least vulnerability to contamination and the low susceptible to anthropogenic activities.

A water yield assessment was carried out by VSA Leboa Consulting on the three selected boreholes and this data was used to determine the constant yield, sustainable yield and water quality.

It was found that the regional depth to groundwater is 30–50m bgl. However, from the water level measured from the boreholes, the water level is between 27.74 m and 79.59m bgl. Due to deep underground mining, it can be expected that the groundwater level will be induced to drop. Average borehole yields are less than 0.5l/s, mean annual recharge is between 1-5mm per annum with the mean annual precipitation of between 20-150mm per annum. Groundwater quality is dominated by sodium, potassium, chloride and sulphate ions, with dissolved solids typically ranging from 1000–1500mg/l.

Based on the pumping test conducted on BH133 and BH155, the hydraulic parameters are summarised in **Table 6**:

Table 6 Hydraulic Parameters for Boreholes

BH ID.	BH Depth (m)	Static Water Level (m)	Drawdown available (m)	Drawdown achieved (m)	Drawdown achieved (%)	Recovery		Constant Q (l/s)
						%	Hrs	
BH133	77.28	41.24	36.04	12.09	33.55	97.78	8	1.56
BH155	59.55	27.74	31.81	22.26	69.98	91.25	10	1.29

No test was conducted for the third borehole as it failed during the step test. Each borehole comprise of three steps of one hour each

Refer to the Water Assessment of Solar Power Generation in the Northern Cape Province Report (WSP, 2016) for further detail.

4 IMPACTS AND ISSUES IDENTIFICATION

The nature of the local and regional landscape is a sparsely populated with little infrastructure. For the larger part, the natural landscape is generally homogeneous (i.e. mostly flat, arid grasslands, with Red-yellow apedal “Namib” soils). The land use is dominated by sheep grazing and there were no wetlands identified within 500m of the proposed Enamandla PV Site 4 footprint. The anticipated impacts for the land capability at the scoping phase level, is outlined the section below. No impacts on wetlands were considered, given that given that no wetlands were identified within 500m of the proposed development footprint.

4.1 BROADBASED IMPACTS

The anticipated impact on the land capability for the Enamandla PV Site 4, during the construction, operational and decommissioning phases, is as follows.

CONSTRUCTION PHASE

- Reduction in land available for grazing animals, due to the occupation of the project and its associated infrastructure within the footprint of the development;
- Potential increase in soil erosion, due to vegetation clearance, soil disturbance and increased vehicle traffic within the footprint of the development;
- Potential land contamination from spillage of hazardous substances (i.e. concrete, oils, fuels, grease and sewage waste); and
- Loss of aesthetical value due to the disturbance of the natural landscape.

OPERATIONAL PHASE

- Reduction in land available for grazing animals within the footprint of the development; and
- Potential land contamination from spillage of hazardous substances (i.e. oils, fuels, grease and sewage waste); and
- Loss of aesthetical value due to the disturbance of the natural landscape.

DECOMMISSIONING PHASE

- Potential increase in soil erosion, due to the removal of infrastructure resulting in a disturbed exposed soil surface, and the increased vehicle traffic within the footprint of the development.

ALTERNATIVES ASSESSMENTS

The anticipated impacts of the power transmission infrastructure (i.e. power-lines and sub-stations) for the Enamandla PV Site 4 are considered to be the same as those listed above, during the construction, operational and decommissioning phases.

CUMULATIVE IMPACTS

The cumulative impacts are related to the proposed solar and wind energy generation projects within a 100 km radius of the proposed BioTherm development. A 100 km radius is considered acceptable area given the sparsely populated area and homogenous nature of the area (i.e. natural landscape and land use).

There are four renewable energy developers proposing a combined total of six solar and wind sites located around the proposed BioTherm development (**Figure 4**). The **Table 7** provides a simplified comparison between the proposed neighbouring solar and wind energy development options.

Table 7 Simplified Comparison Between the Proposed Neighbouring Solar and Wind Energy Development Options

Energy Entity	Renewable Energy Technology	Footprint (km^2)	No. of Road Crossings	No. of Wetlands/Water Courses	Parent Farm Properties	Towns Intersected
Sato Energy Holdings (Pty) Ltd	Photovoltaics	51.67	1 National Highway (N14)	1 x ephemeral watercourse	Zuurwater62	-
Solar Capital (Pty) Ltd	Concentrated Solar Power	141.54	1 District Road	1 x ephemeral watercourse	Bloemhoek 61	-
Mainstream Renewable Energies	Solar Power	57.82	-	1 x ephemeral watercourse	Namies Suid 212	-

Energy Entity	Renewable Energy Technology	Footprint (km²)	No. of Road Crossings	No. of Wetlands/Water Courses	Parent Farm Properties	Towns Intersected
(Pty) Ltd Site 1						
Mainstream Renewable Energies (Pty) Ltd Site 2	Solar Power	116.27	-	1 x ephemeral watercourse	Poortje 209	-
Juwi Renewable Energies (Pty) Ltd WEF 1	Wind Turbines	72.65	2 District Roads	1 x ephemeral watercourse	Vogelstruis Hoek 88	-
Juwi Renewable Energies (Pty) Ltd WEF 2	Wind Turbines	57.11	2 District Roads	1 x ephemeral watercourse	Namies Suid 212	-

The anticipated impacts for the above mentioned neighbouring solar and wind energy options is considered to the same as the BioTherm listed impacts, with the exception of the proposed developments intersecting a dry watercourse. As in the case of this report, each of the neighbouring sites should be investigated individually, including the process of an initial scoping phase followed by a more in-depth EIA phase. Attention should be given to the affected ephemeral watercourses by these proposed developments.

SCREENING ASSESMENT

The screening phase of the Land Capability is required for EIA phase. To this end, the Screening tool (as described in **Section 2.3**) has been used to undertake a preliminary assessment of the identified potential land capability impacts for the Enamandla PV Site 4.

The rating and overall preliminary assessment of significance for the broad impacts is provided in **Table 8**.

Table 8 Screening Assessment of Broad Land Capability Impacts

Phase	Anticipated Impact	Nature	Probability	Severity/ Benefit	Significance
Construction	Reduction in grazing land	Negative	4	3	High
	Potential Increase in soil erosion	Negative	1	1	Very low
	Potential land contamination from spillage of hazardous substances	Negative	1	1	Very low
	Loss of aesthetical value	Negative	2	2	Low
Operational	Reduction in grazing land	Negative	4	3	High
	Potential land contamination from spillage of hazardous substances	Negative	1	1	Very low
	Loss of aesthetical value	Negative	2	2	Low

Phase	Anticipated Impact	Nature	Probability	Severity/ Benefit	Significance
Decommissioning	Potential Increase in soil erosion	Negative	1	1	Very low
Cumulative Impacts	Reduction in grazing land	Negative	4	3	High
	Potential Increase in soil erosion	Negative	1	1	Very low
	Loss of aesthetical value	Negative	2	2	Low

5 TERMS OF REFERENCE FOR THE IMPACT ASSESSMENT PHASE

There is only one significant land capability impact identified during the scoping phase *viz.* the loss of grazing land available within the Enamandla PV Site 4. However, this is unavoidable given that the proposed BioTherm development will physically occupy the land currently used for grazing.

There is sufficient information present in this report to proceed with an in-depth EIA study of the proposed BioTherm developments. The hacking method will be followed for the assessment of the impact significance during the EIA phase. This methodology is outlined below.

5.1 SPECIALIST REPORTS

The EIA phase will draw upon the relevant specialist reports (Water Availability Assessment, Land Capability and Wetland Assessment, Socio-Economic Assessment, Heritage Assessment, Visual Assessment, Avifauna Assessment, Traffic Assessment and Palaeontological Assessment). It is anticipated that these reports will provide a thorough understanding of the broader impacts associated with the proposed BioTherm development.

5.2 LAND CAPABILITY

The land capability of the Enamandla PV Site 4 will comprise a combination of non-arable, low potential grazing land and wilderness areas; hence, the scope of work will entail a desktop study with subsequent targeted ground-truthing to confirm specific findings.

The desktop study will make use of available Land Type mapping for the area, as well as any existing reports that will be made available to WSP at the outset of the EIA phase. Soil-specific observations, general observations of the land topography, terrain, along with vegetation type and health will be recorded within the study areas and representative soil sampling and will be conducted within the development areas by a suitably competent soil scientist.

In addition to soil-specific observations and sampling, general observations of the land topography, terrain, along with vegetation type and health will be recorded within the study areas. Furthermore, the land-use both within and surrounding the proposed development footprint will be ground-truthed.

Based on the observations, representative soil samples will be retrieved from each of the soil-forms encountered within the defined development areas. Based on the physical and chemical data for the soils, and in conjunction with climatic, topographical, vegetation and land-use information, the Chamber of Mines guidelines (2007) will be utilised to define the land capability. Whilst it is recognised that the Chamber of Mines methodology specifically relates to mine impacts, the underlying methodology is considered broadly applicable to the objectives of this assessment. On this basis the assessment will class the study areas as wetland, arable land, grazing land, or wilderness. This information will feed into the wetland delineation assessment.

5.3 WETLAND ASSESSMENT

Given that there are no wetlands identified within a 500m buffer around the Enamandla PV Site 4 during the scoping phase, there will be no wetland assessment conducted for this site in the EIA phase.

5.4 REPORTING

A draft Land Capability and Wetland Assessment report will be compiled during the EIA phase, defining in more detail the land capability and wetland assessment within the proposed development area. Furthermore, the associated potential impacts and mitigation measures will be described in-depth. Following comments from the relevant stakeholders, the final report will be updated and submitted with the final EIA report.

6 CONCLUSIONS AND RECOMMENDATIONS

The nature of the local and regional landscape in which the proposed BioTherm developments are located is a sparsely populated and arid environment. The area is predominantly flat with arid grassland and shrub-like vegetation which supports the current land use of grazing animals (predominantly sheep), and is characterised by intermittent inselbergs dotting the landscape. There are a few watercourses located throughout the region which are ephemeral in nature, given the dominant sandy soils and mostly endoreic areas (i.e. does not produce run-off). Thus the area of the proposed BioTherm development, is largely regarded as homogenous, and the potential impacts on the land capability and wetlands between the individual sites are regarded to be similar.

The screening assessment for the Enamandla PV Site 4 has not identified any fatal flaws in terms of the land capability and wetlands for the proposed BioTherm site. The only significant impact is the loss of grazing land, which is unavoidable. The anticipated impacts listed in **Table 8** should be considered and carried through to the EIA phase. Lastly, the anticipated impacts from proposed neighbouring solar/wind developments, are expected to be similar to the BioTherm sites, and will have a cumulative effect on the area.

7 PLATES

Plate 1 – Vegetation

Plate 2 – Sheep pen

Plate 3 – Cattle pen

Plate 4 – Windmill-driven boreholes and reservoir

Plate 5 – Broken earth-wall dam

Plate 6 – Red apedal Namib soil form

Plate 7 - Gneiss rock type below soil profile

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9 APPENDICES

Appendix A - SGS Soil results