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Soil, Land Use, Land Capability and Agricultural Potential Assessment for the Proposed Khunab Solar Grid Connection

Submitted by TerraAfrica Consult cc
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DEFINITIONS AND ACRONYMS

Calcareous: Containing calcium carbonate or magnesium carbonate.

Cutan: Cutans occur on the surfaces of peds or individual particles (sand grains, stones). They consist of material which is usually finer than, and that has an organisation different to the material that makes up the surface on which they occur. They originate through deposition, diffusion or stress. Synonymous with clayskin, clay film, argillan.

Erosion: The group of processes whereby soil or rock material is loosened or dissolved and removed from any part of the earth's surface.

Land capability: The ability of land to meet the needs of one or more uses under defined conditions of management.

Land type: (1) A class of land with specified characteristics. (2) In South Africa it has been used as a map unit denoting land, map able at 1:250000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.

Land use: The use to which land is put.

Orthic A horizon: A surface horizon that does not qualify as organic, humic, vertic or melanic topsoil although it may have been darkened by organic matter.

Texture, soil: The relative proportions of the various size separates in the soil as described by the classes of soil texture shown in the soil texture chart (see diagram on next page). The pure sand, sand, loamy sand, sandy loam and sandy clay loam classes are further subdivided (see diagram) according to the relative percentages of the coarse, medium and fine sand sub-separates.

Declaration of the Specialist

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Declaration of Independence

I, Mariné Pienaar, hereby declare that TerraAfrica Consult, an independent consulting firm, has no interest or personal gains in this project whatsoever, except receiving fair payment for rendering an independent professional service.

I further declare that I was responsible for collecting data and compiling this report. All assumptions, assessments and recommendations are made in good faith and are considered to be correct to the best of my knowledge and the information available at this stage.

TerraAfrica Consult cc represented by M Pienaar
September 2019

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1. Introduction

Savannah Environmental (Pty) Ltd appointed Terra Africa Consult to conduct the soil, land use, land capability and agricultural potential study as part of the Basic Assessment (BA) process for the proposed Khunab Solar Grid Connection. The grid connection solution will connect the proposed McTaggarts PV1, McTaggarts PV2, McTaggarts PV3 and Klip Punt PV1 solar PV facilities to the Upington Main Transmission Substation (MTS) and will include the development of a single circuit power line and two collector substations, each including switching station components. Access roads to the grid infrastructure will also be developed. The collector substations will be known as, the Khunab Substation and the Klip Punt Substation. The proposed grid connection is located between Upington and Keimoes in Northern Cape Province (Figure 1), falling within the Upington REDZ. The Khunab Solar Grid Connection traverses through the following properties:

- Portion 12 of the Farm Klip Punt 452;
- Portion 3 of the Farm McTaggarts Camp 453; and
- Olyvenhouts Drift Settlement Agricultural Holdings 1080

A grid connection corridor that is 300m wide and 13km long is being assessed to allow for the optimisation of the grid connection infrastructure to accommodate the identified environmental sensitivities.

2. Objective of the study

The objective of the Soil, Land Use and Land Capability study is to fulfil the requirements of the most recent South African Environmental Legislation with reference to the assessment and management of these natural resource aspects (stipulated in Section 3 below).

The purpose of the study is to determine and describe the baseline soil properties and the land capabilities and land uses associated with the proposed project's direct and indirect areas of influence from on-site investigations and data currently available. It also assists with the identification of gaps in information. Once these conditions have been established, the anticipated impacts of the project on these soil properties can be determined. Mitigation and management measures can be recommended to minimise negative impacts and maximise land rehabilitation success towards successful closure at the end of the project life.

3. Environmental legislation applicable to study

The following South African Environmental Legislation needs to be considered for any new or expanding developments with reference to the management of soil and land use:

- The Conservation of Agricultural Resources (Act 43 of 1983) states that the degradation of the agricultural potential of soil is illegal. This Act requires the protection of land against soil erosion and the prevention of water logging and salinisation of soils by means of suitable soil conservation works to be constructed and maintained. The utilisation of marshes, water sponges and watercourses are also addressed.

- In addition to this, the National Water Act (Act 36 of 1998) deals with the protection of wetlands. This Act defines wetlands as "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil." This Act therefore makes it necessary to also assess soil for its hydropedological properties.
- Section 3 of the National Environmental Management Act, the EIA Regulations, 2014 (as amended) and the Subdivision of Agricultural Land Act is also relevant to the development.

4. Terms of Reference

The following Terms of Reference as stipulated by Savannah Environmental (Pty) Ltd applies to the soil, land use and land capability study:

- Undertake a desktop study and site investigation to establish broad baseline soil conditions, land capability and areas of environmental sensitivity within the proposed grid connection corridor in order to rate their sensitivity to the proposed development;
- Undertake a soil survey of the proposed development area focusing on all landscape features including areas with potentially wetland land capability;
- Describe soils in terms of soil texture, depth, structure, moisture content, organic matter content, slope and land capability of the area;
- Classify and describe soils using the South African Soil Classification: A Natural and Anthropogenic System for South Africa (2018);
- Identify and assess potential soil, land use and land capability impacts resulting from the proposed Khunab Solar Grid Connection;
- Identify and describe potential cumulative soil, land use and land capability impacts resulting from the proposed development in relation to proposed and existing developments in the surrounding area;
- Recommend mitigation, management and monitoring measures to minimise impacts and/or optimise benefits associated with the proposed project.

5. Assumptions

No assumptions were made in the assessment and report.

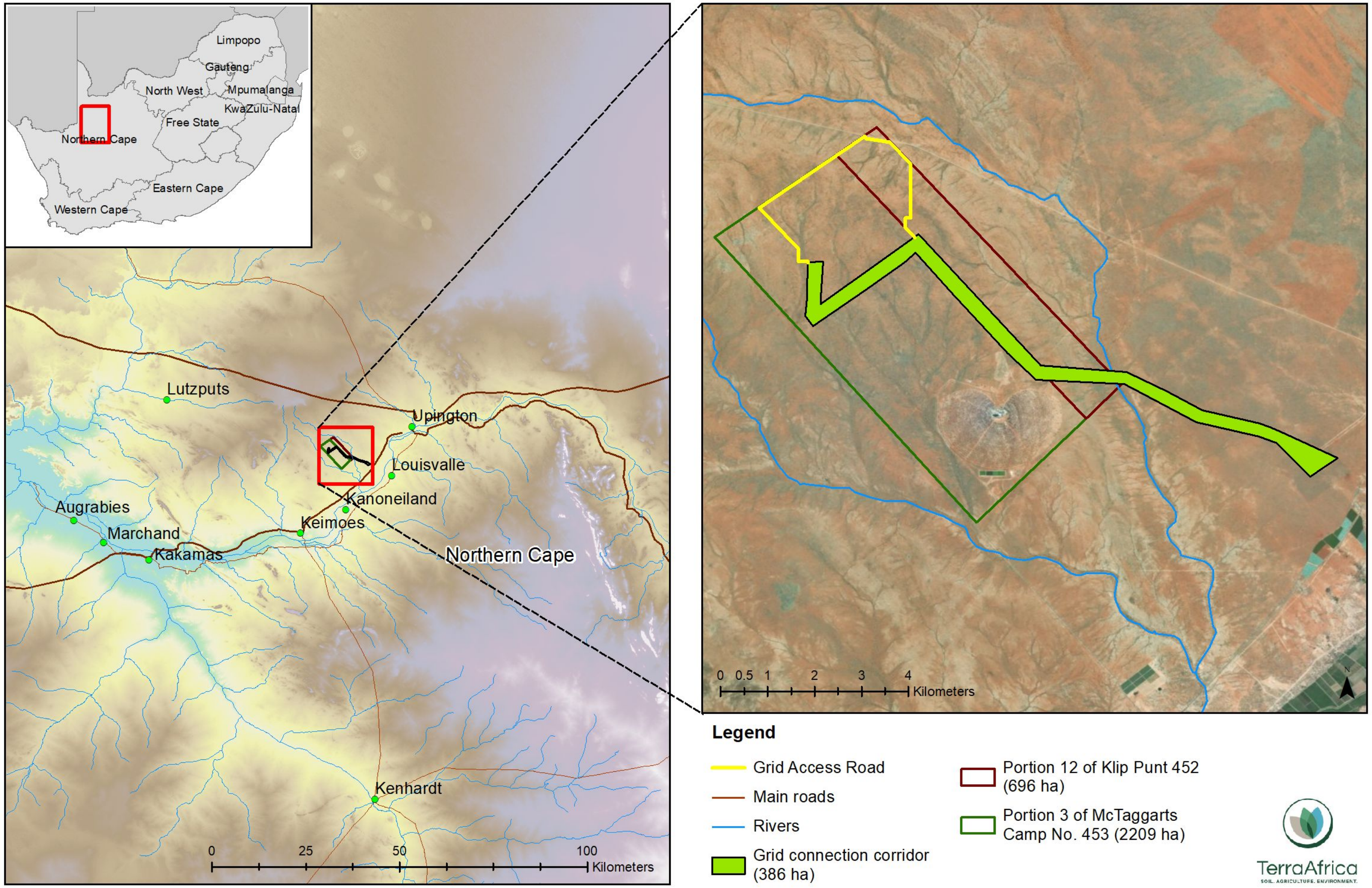

Figure 1: Locality map of the Khunab Solar Grid Connection

6. Uncertainties, limitations and gaps

The following uncertainties, limitations and gaps exists with regards to the study methodology followed and conclusions derived from it:

- Soil profiles were observed using a 1.5m hand-held soil auger. A description of the soil characteristics deeper than 1.5m cannot be given.
- The study does not include a land contamination assessment to determine pre-construction soil pollution levels (should there be any present).

7. Response to concerns raised by I&APs

Thus far, no concerns were raised by I & APs during the Public Participation Process pertaining to the continuation of existing land uses in the surrounding area. Should any comment be received, it will be addressed in this report.

8. Methodology

8.1 Desktop study

The following data was obtained and studied for the desktop study:

- Land type data for the grid connection corridor was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC) (Land Type Survey Staff, 1972 – 2006). The land type data is presented at a scale of 1:250 000 and entails the division of land into land types, typical terrain cross sections for the land type and the presentation of dominant soil types for each of the identified terrain units (in the cross section). The soil data is classified according to the Binomial System (MacVicar et al., 1977). The soil data was interpreted and re-classified according to the Taxonomic System (MacVicar, C.N. et al. 1991).
- The newly released National Land Capability Evaluation Raster Data Layer was obtained from the Department of Agriculture, Forestry and Fisheries (DAFF) to determine the land capability classes of the grid connection corridor according to this system. The new data was developed by DAFF to address the shortcomings of the 2002 national land capability data set. The new data was developed using a spatial evaluation modelling approach (DAFF, 2017).
- The most recent aerial photography of the area available from Google Earth was obtained. The aerial photography analysis was used to determine areas of existing impact, land uses within the grid connection corridor as well as the larger landscape, wetland areas and preferential flow paths.

8.2 Study area survey

A systematic soil survey was undertaken during two days, i.e. on 4 and 5 July 2019. The season in which the site visit took place has no influence on the results of the survey. A total of sixty-one (61) soil profiles were observed (
Figure 2). The soil profiles were examined to a maximum depth of 1.5m using a hand-held auger. Observations were made regarding soil texture, structure, colour and soil depth at each survey point. A cold 10% hydrochloric acid solution was used on site to test for the presence of carbonates in the soil. The soils are described using the S.A. Soil Classification Taxonomic System (Soil Classification Working Group, 1991) published as memoirs on the Agricultural Natural Resources of South Africa No.15. For soil mapping, the soils were grouped into classes with relatively similar soil characteristics.

8.3 Analysis of samples at soil laboratory

Two soil samples (one topsoil [KH1] and one subsoil [KH2]) were collected within the grid connection corridor. The samples were sealed in a soil sampling plastic bag and sent to Eco Analytica Laboratory that is part of North West University for analyses. Samples taken to determine baseline soil fertility were analysed for pH (KCl), plant-available phosphorus (Bray1), exchangeable cations (calcium, magnesium, potassium, sodium), organic carbon (Walkley-Black) and texture classes (relative fractions of sand, silt and clay).

8.4 Land capability classification

Agricultural potential is described through the term land capability. Land capability means “the most intensive long term use of land for purposes of rainfed farming, determined by the interaction of climate, soil and terrain and makes provision for eight land capability classes”. The newly developed land capability classification system that was released by the Department of Agriculture, Forestry and Fisheries (DAFF)[1] was used to combine different soil forms into land capability units. The new system has a few strong departures from the old system developed by Schoeman et al. (2002). The new system has fifteen land capability classes as opposed to the initial eight classes. In the new system, Classes 1 to 7 are considered to be of very low land capability making it only suitable for wilderness and grazing with a variety of management measures. The remaining classes (Class 8 to 15) are considered to have arable land capability with the potential for high yields increasing with the number of the land capability class.

It should be noted that this land capability classification system does not indicate wetland land capability (soils with hydromorphic properties) as a class in the same way the land capability classification system of the South African Chamber of Mines does for mining projects. Should hydromorphic soil forms be present though, it will be addressed and described using wetland delineation guidelines.

[1] The now Department of Agriculture, Rural Development and Land Reform

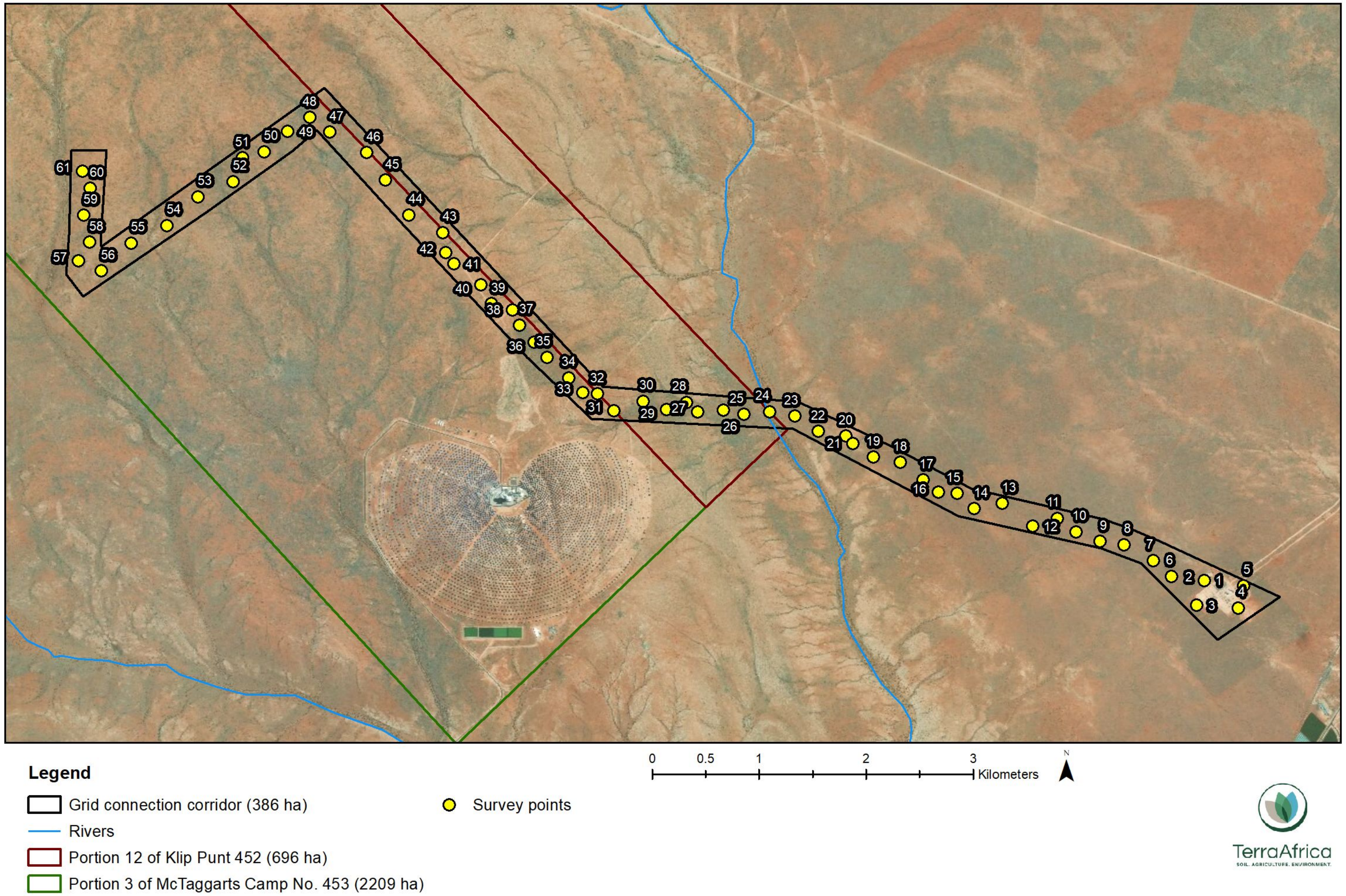

Figure 2 Survey points map of the 300m wide corridor assessed for the Khunab Solar Grid Connection

8.5 Impact assessment methodology

Following the methodology prescribed by Savannah Environmental (Pty) Ltd., the direct, indirect and cumulative impacts associated with the project have been assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3;
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5;

- The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- the **status**, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:

S=(E+D+M)P

S = Significance weighting
E = Extent
D = Duration
M = Magnitude

P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

9. Baseline conditions

9.1 Land types

The proposed Khunab Solar Grid Connection traverses through two land types i.e. Land Type Ae10 and Land Type Ag1 (Figure **5**). The largest section of the grid connection corridor consists of Land Type Ae10 (both the western and the eastern ends) while the middle of the grid connection corridor is underlain by Land Type Ag1. Each of the land types are described below.

Land Type Ag1

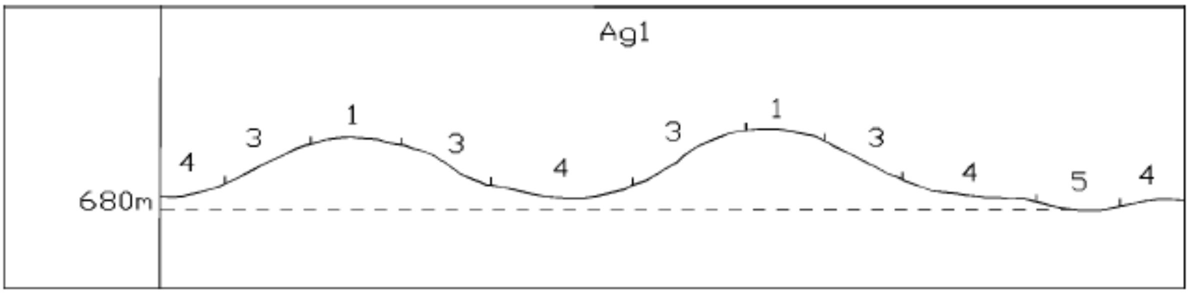

Figure 3: Terrain form sketch of Land Type Ag1

Land Type Ag 1 has four different terrain positions and indicates a slightly undulating landscape. The land type is dominated by very shallow soil profiles and includes soil of the Mispah form as well as forms where shallow red apedal or yellow-brown apedal soil is underlain either by rock or a carbonate horizon. Soil depths in this land type range between 10 and 45 cm with only Terrain Position 4 having a possibility for deep Hutton soil profiles that range between 60 and 150cm in depth. The underlying geology of Land Type Ag1 is described as granite, migmatite and gneiss of the Namaqualand Metamorphic Complex.

Land Type Ae10

According to the land type data sheet, Land Type Ae10 is underlain by migmatite, gneiss and ultra-metamorphic rocks of the Namaqualand Metamorphic Complex. Considering Figure 4, this land type also has four different terrain positions with the flat plains of Position 4 dominating the landscape and Position 5 indicating small depressions where water can accumulate in the landscape after rainfall events. Position 4 consists of an equal mixture of shallow Mispah soil as well as shallow red apedal soil profiles underlain by limestone (either soft or hardpan carbonate horizons). Position 5 is dominated by the Mispah form interspersed with approximately 10% of Hutton soil profiles. Positions 1 and 3 (hilltop and mid-slope respectively) are dominated by rock interspersed with shallow Mispah profiles.

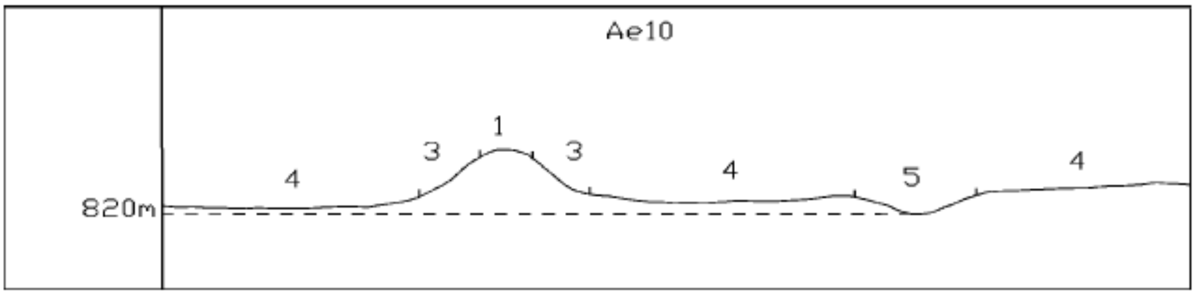

Figure 4: Terrain form sketch of Land Type Ae10

9.2 Soil forms present in the affected area

Six different soil forms are present within the development area. These six soil forms have been grouped into three groups (Figure 6). Differentiation was made between the deeper Hutton profiles in the south-eastern part of the grid connection corridor assessed for the Khunab Solar Grid Connection and the shallow Hutton profiles observed elsewhere. The very shallow to shallow soil of the Mispah, Glenrosa, Brandvlei and Coega forms have been grouped together since they occur in close proximity to each other over large areas and consist of only an orthic A horizon underlain by a depth-limiting C-horizon. The third group consists of shallow Hutton and Plooysburg forms where a red apedal B1-horizon is present.

Below follows a description of each of the soil groups and forms identified:

Hutton 80+

The 71 ha where Hutton 80+ were indicated in Figure **6** consists of red, sandy soil profiles deeper than 80 cm. The Hutton soil form has an orthic A-horizon (ranging between 5cm and 20cm in this area) overlying a red apedal, sandy B1-horizon. The depth-restricting material at 80cm or deeper consists of rocky material and weathering parent material. This area of deeper soil supports denser grass and vegetation growth than was observed in the surrounding areas where the shallow soil profiles supports sparse vegetation dominated by low shrubs. Although Hutton soil profiles deeper than 50 cm are considered suitable for arable agriculture, the areas where the Hutton profiles of 80 cm and deeper are present within the corridor assessed for the Khunab Solar Grid Connection, still have grazing land capability as rainfed agriculture is not viable in the arid climate experienced within the area.

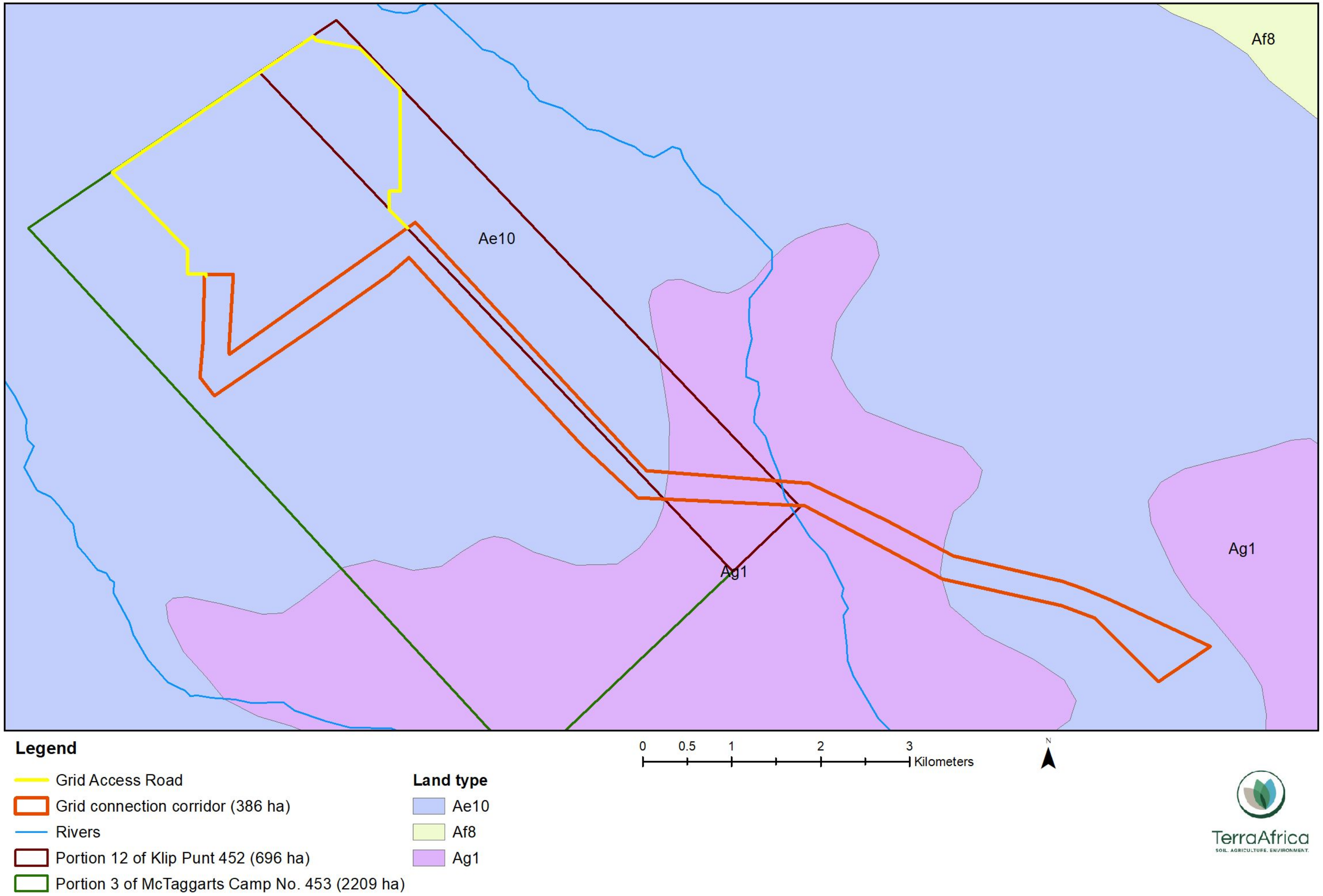

Figure 5: Land type map of the 300m wide corridor assessed for the Khunab Solar Grid Connection

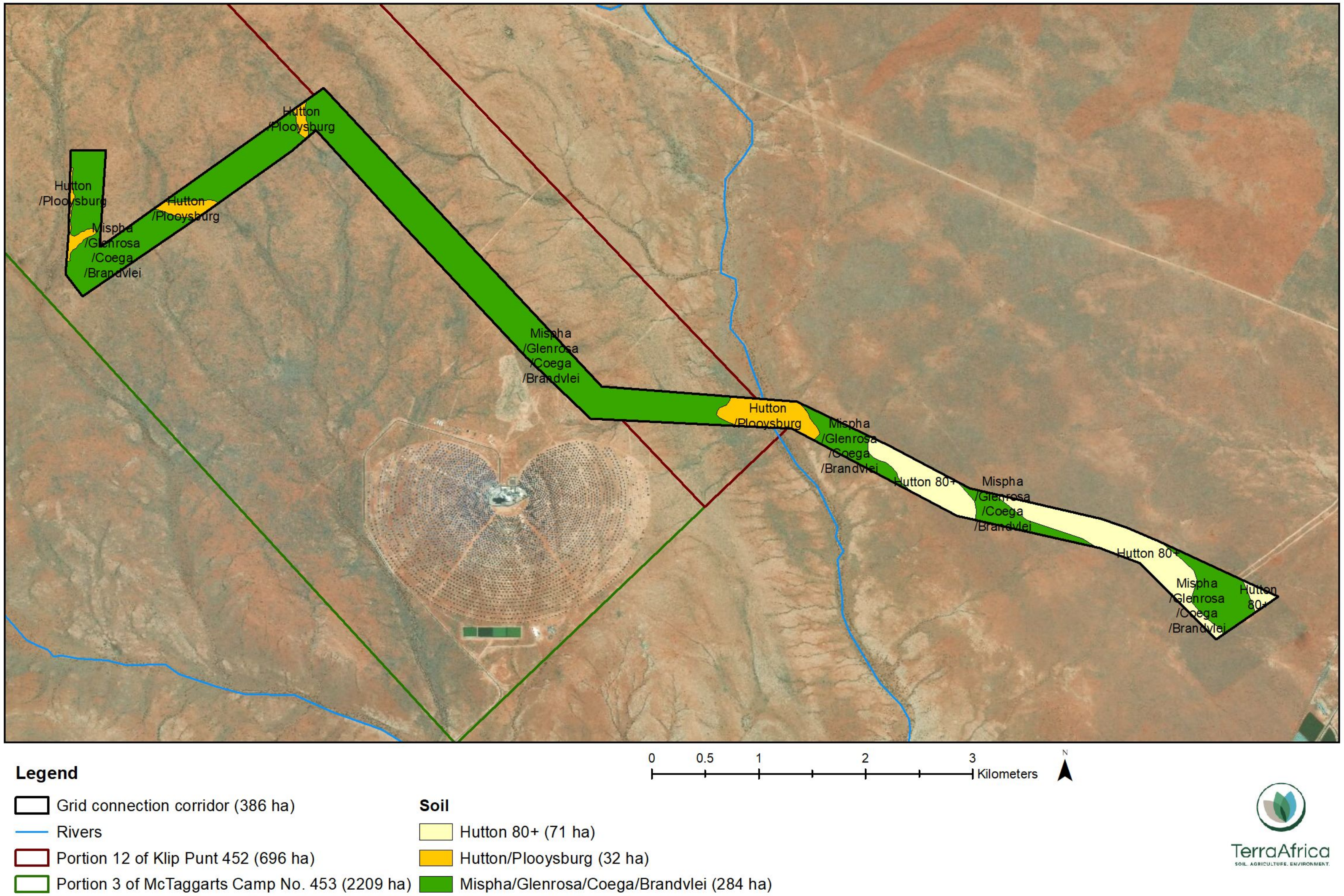

Figure 6: Soil map of the 300m wide corridor assessed for the Khunab Solar Grid Connection

Mispah/Glenrosa/Coega/Brandvlei

This group occupies 284 ha within the corridor assessed for the Khunab Solar Grid Connection. All the soil profiles observed in these areas have very shallow soil depth (300mm or less) and are underlain by a variety of underlying material ranging from rock (Mispah), lithic material (Glenrosa), soft carbonate (Brandvlei) and hardpan carbonate (Coega). These soil forms underlie a homogeneous vegetation type with some variation between the carbonate C-horizons and the rock and weathering rock. However, the dominant soil physical property (shallow soil depth) as well as texture (very sandy soil), is homogeneous for the entire area. The different shallow soil forms occur in an interspersed mixture over this area with changes in underlying material ranging from a few meters to more than 500m apart.

This soil group supports indigenous vegetation that is currently used for small-stock (sheep) grazing. The grazing capacity in these areas is very low as a result of the combination of shallow soil depth and arid climatic conditions. The land capability of this soil group is Class 4 Low - Very low.

Shallow Hutton/Plooysburg

This group of soil forms consist of deeper profiles ranging between 30 cm and 45 cm deep and covers 32 ha of the Khunab Solar Grid Connection. This group of slightly deeper soil profiles is present in the dry streambeds in the landscape as water movement in the landscape has washed the sandy soil particles into these areas.

The Hutton soil form consists of an orthic A horizon on a red apedal B horizon overlying unspecified material. The red apedal soils B1-horizon has more or less uniform "red" soil colours in both the moist and dry states and has a weak structure or is structureless in the moist state (Soil Classification Working Group, 1991). The Plooysburg soil form differs from the Hutton soil form by the horizon underlying the red apedal B1 horizon. In the case of the Plooysburg form, it is underlain by a hardpan carbonate horizon (and not unspecified material).

The shallow Hutton and Plooysburg profiles within the corridor assessed for the Khunab Solar Grid Connection have no suitability for dryland crop production. The area has very limited grazing capacity (Class 04 Low - Very low).

9.3 Soil chemical conditions

The chemical composition of the modal Hutton profile deeper than 80cm are represented by samples KH01 (topsoil) and KH2 (subsoil) (attached as Appendix 1).

The pH(KCl) levels measured are slightly acidic at pH 5,75 and pH 5,74. The major cation levels are normal to slightly high with the calcium levels higher in the subsoil at 1147,1 mg/kg. There are also higher plant-available phosphorus levels in the topsoil (12,3 mg/kg) than for the average undisturbed South Africa veld conditions. The texture is dominated by the sand fraction (97,2 and 97,1% sand in the topsoil and subsoil respectively) and the organic carbon level is very low 0,18% and 0,28%.

9.4 Land capability

Land capability can be defined as "the extent to which land can meet the needs of one or more uses under defined conditions of management" (Schoeman, 2002). The land capability of an area is the combination of the inherent soil properties and the climatic conditions as well as other landscape properties such as slope and drainage patterns that may inhibit agricultural land use or result in the development of specific land functionality such as wetlands. Land capability affects the socio-economic aspects of human settlements and determine the livelihood possibilities of an area. Baseline land capabilities are also used as a benchmark for rehabilitation of land in the case of project decommissioning.

Following the newly launched land capability classification systems as released by DAFF (2017), the Khunab Solar Grid Connection area is considered to have both Low-Very low (Class 4) land capability and low land capability (Class 5). The Class 5 Low land capability is associated with the deeper Hutton soil profiles identified in the south-eastern part of the grid connection corridor. Both these land capability classes indicate that the grid connection corridor is only suitable for animal grazing and no dryland crop production. This is also relevant to the proposed main access roads.

The grazing capacity of a specified area for domestic herbivores is given either in large animal unit per hectare or in hectares per large animal unit. One large animal unit is regarded as a steer of 450kg whose weight increases by 500g per day on veld with a mean energy digestibility of 55%. Large animal units can again be converted to small animal units or small stock units. The conversion factor is 4 small stock units that equates one large stock unit.

The grazing capacity of the veld in the proposed development is 30 to 40 hectares per large animal unit or large stock unit (Morgenthal et al., 2015). When this is converted to small stock units (8 to 10 hectares per small stock unit), it indicates that the corridor assessed for the Khunab Solar Grid Connection can support 39 to 48 head of sheep for grazing purposes. Sheep farming is a viable long-term land use of the site permitting that the current crippling drought conditions ceases and as long as the field quality is maintained by never exceeding the grazing capacity. Post-project land use can aim to re-establish the sheep farming potential of the land.

9.5 Agricultural potential

The entire extent of the corridor assessed for the Khunab Solar Grid Connection has limited to no suitability for rainfed crop production. The data gathered during the site visit correlates well with the metadata released by DAFF in 2017 that indicates that the area has very low to low land capability and is better suited to livestock grazing. While the larger region is known for its high quality horticultural products, these are only produced where irrigation water and infrastructure is present along the Orange River. No irrigation infrastructure or alternative irrigation water supply is present within the grid connection corridor.

9.6 Sensitivity analysis

Considering all the baseline properties as discussed in Sections 9.1 to 9.5, the grid connection corridor, as well as the main access roads, have a low sensitivity to the proposed development (Figure **9**). The shallow soil profiles have grazing capacity albeit very limited and the development of the Khunab Solar Grid Connection will have very little to no negative effect on the agricultural economy of the region.

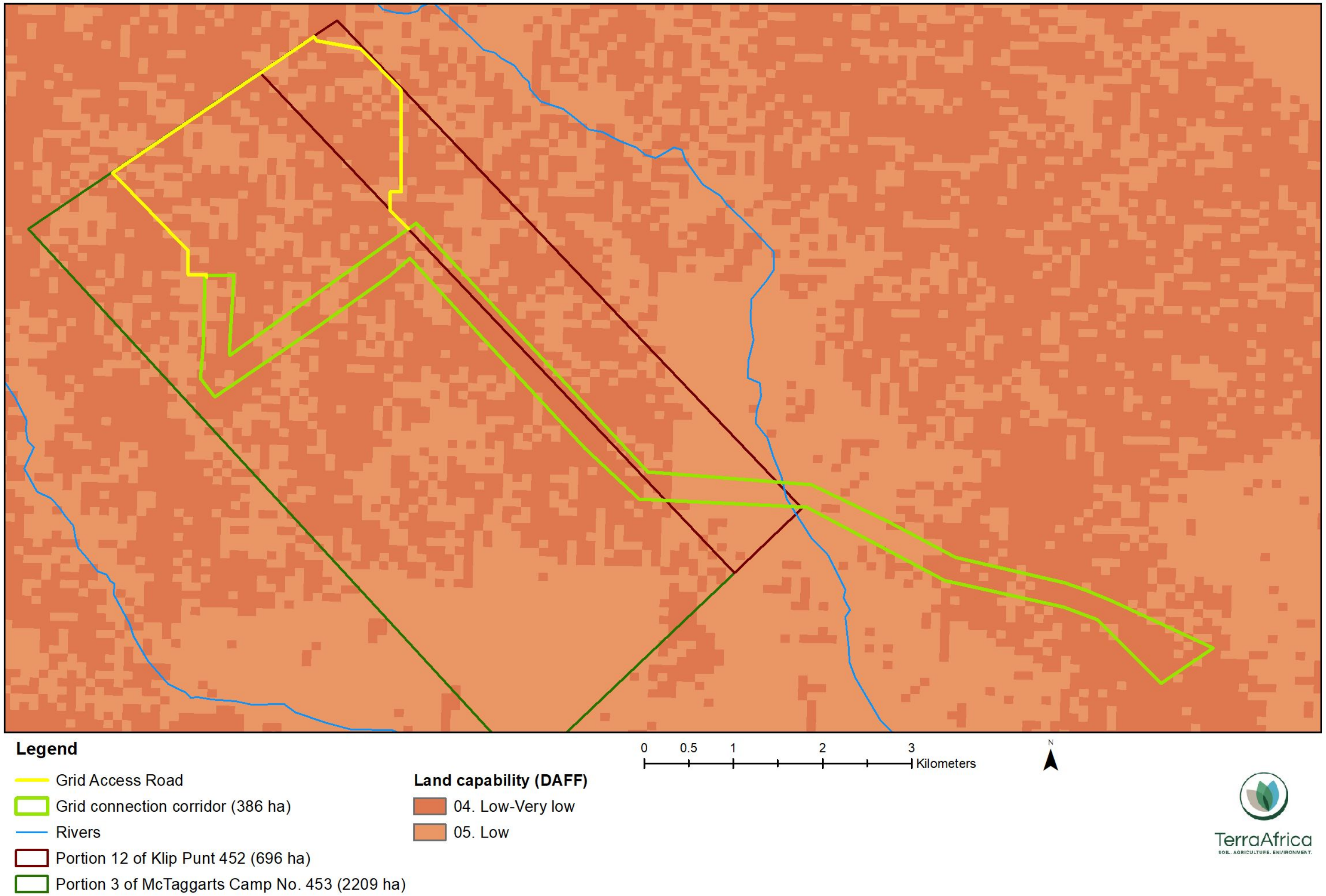

Figure 7: Land capability of the 300m wide corridor assessed for the Khunab Solar Grid Connection (data source: DAFF, 2017)

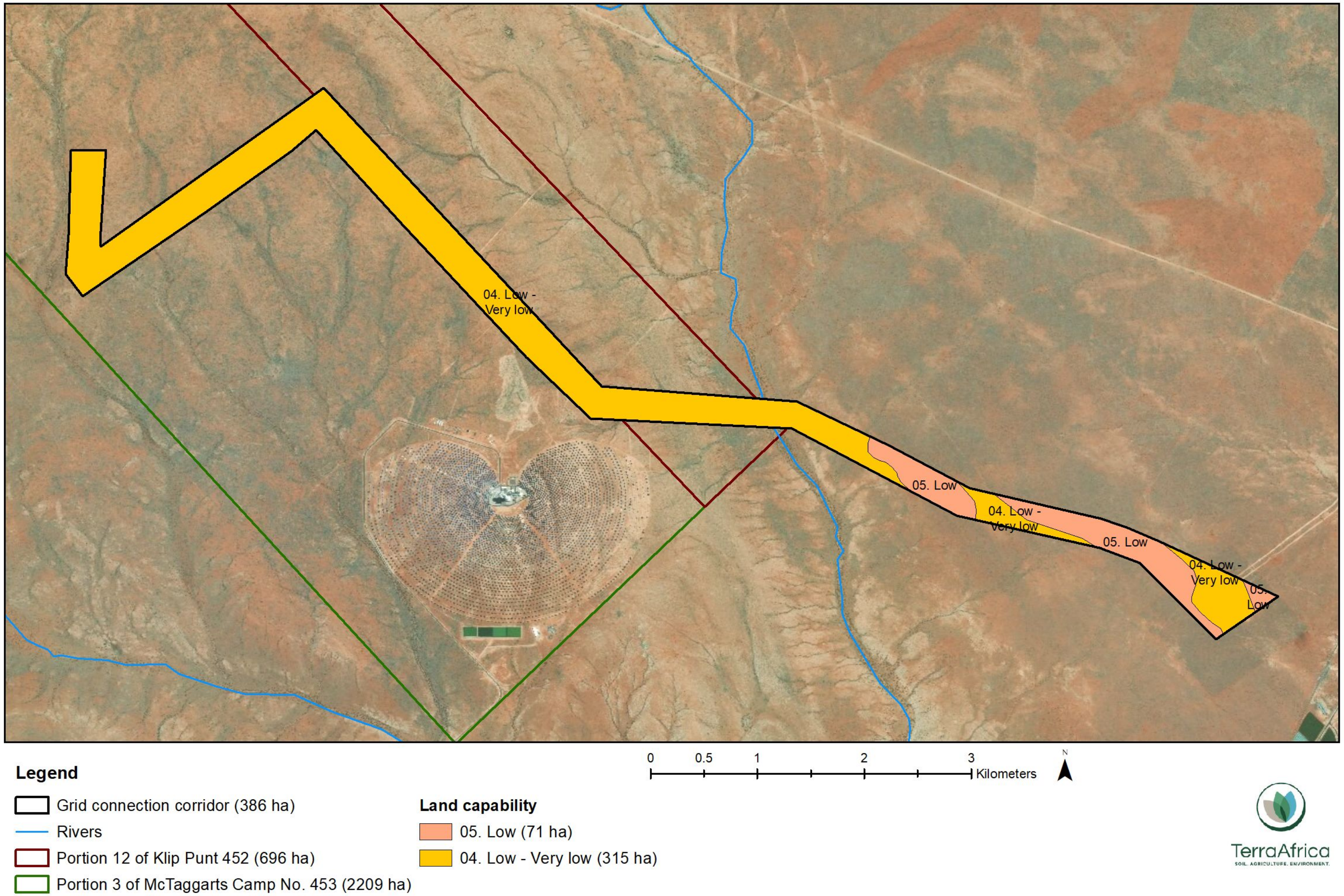

Figure 8: Land capability of the 300m wide corridor assessed for the Khunab Solar Grid Connection

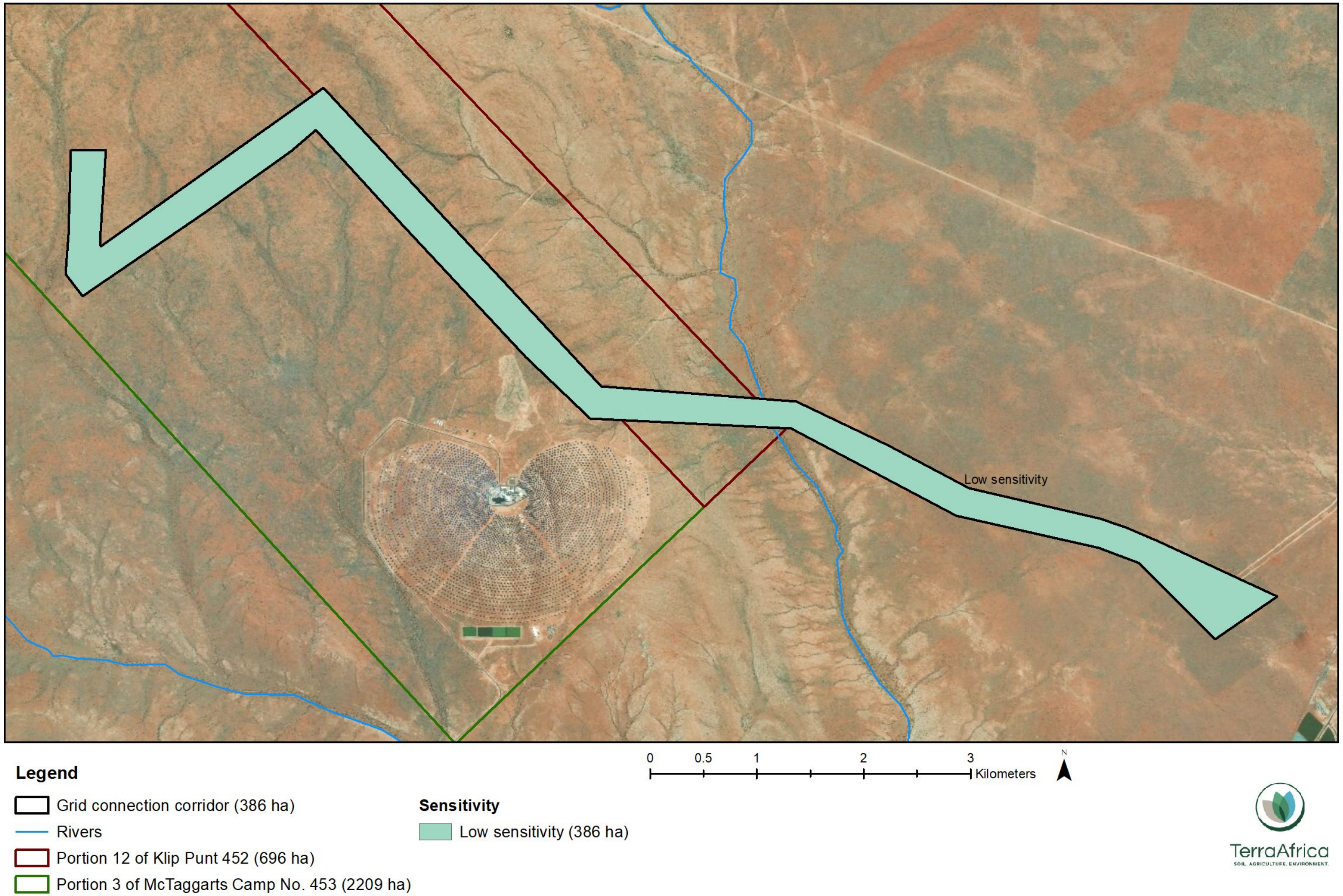

Figure 9: Sensitivity analysis of the 300m wide corridor assessed for the Khunab Solar Grid Connection

10. Impact Assessment

10.1 Project description

A grid connection corridor that is 300m wide (and increases to approximately 700m wide at the Upington Main Transmission Substation) and 13 km long is being assessed to allow for the optimisation of the grid connection and associated infrastructure to accommodate the identified environmental sensitivities. The associated infrastructure include access roads, feeder bays, two collector substations, each including a switching station component, a fibre and optical ground wire (OPGW) layout, insulation and assembly structures. The grid connection infrastructure will be developed within the 300m wide grid connection corridor. The height of the power line pylons will be up to 32m and will be located within a servitude of up to 36m and the two collector substations will evacuate power at 132kV.

10.2 Description of the impacts anticipated for the project phases

The main envisaged activities during construction, which considers the infrastructure listed under section 10.1, include the following:

- Construction of the access roads, which includes the clearing vegetation
- Vegetation removal in areas where the pylons will be constructed
- Delivery of construction materials to site
- Drilling of holes for construction of pylons

The site preparation activities are disruptive to the natural soil horizon distribution and will impact on the current soil hydrological properties and functionality of soil.

The following anticipated impacts have been assessed.

* Soil erosion is anticipated due to slope and vegetation clearance. The impacts of soil erosion are both direct and indirect. The direct impacts are the reduction in soil quality which results from the loss of nutrient-rich upper layers of the soil and the reduced water-holding capacity of severely eroded soils. The off-site indirect impacts of soil erosion include the disruption of riparian ecosystems and sedimentation.

* Soil chemical pollution as a result of storage of hazardous chemicals, concrete mixing, temporary sanitary facilities and potential oil and fuel spillages from vehicles. This impact will be localised within the grid connection corridor boundary.

* In areas of permanent changes such as roads and the erection of infrastructure, the current land capability and land use will be lost permanently. This impact will also be

localised within the grid connection corridor boundary, as well as the main access roads providing access to the grid connection infrastructure.

All infrastructure and activities required for the operation phase will be established during the construction phase. Once the construction phase is completed, a number of impacts remain during the operation phase. During the operation phase the impacts related to loss of land use and land capability will stay the same. Areas under permanent infrastructure are no longer susceptible to erosion, but hard surfaces will increase run-off during rain storms onto bare soil surfaces.

Soil chemical pollution during the operation phase will be minimal. Possible sources are oil that need to be replaced and fuel spillage from maintenance vehicles. This impact will be localised within the grid connection corridor boundary.

Although wind erosion may have an impact before revegetation on adjacent bare areas, the loss of soil as a resource is restricted to the actual footprint of the Khunab Solar Grid Connection. The only impact that may have effects beyond the footprint area is erosion which may cause the sedimentation of the adjacent watercourses.

10.3 Susceptibility to soil erosion due to the construction and operation of Khunab Solar Grid Connection

Table 1 Summary of soil erosion impact assessment

Nature: The construction of the Khunab Solar Grid Connection will require the clearing and levelling of a limited area of land. The following construction activities will result in bare soil surfaces that will be at risk of erosion:

1. vegetation removal during site clearing;
2. creating impenetrable surfaces during the construction phase that will increase run-off onto bare soil surfaces; and
3. leaving soil surfaces uncovered during the rainy season during the construction phase.

During the operation phase the impenetrable surfaces such as paved areas and covered roads stay intact, however, the impact of increased run-off persists on surrounding areas.

	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (30)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation:

- Land clearance must only be undertaken immediately prior to construction activities and only within the development footprint;
- Unnecessary land clearance must be avoided;
- Soil stockpiles must be dampened with dust suppressant or equivalent;
- Soil stockpiles must be located away from any waterway or preferential water flow path in the landscape, to minimise soil erosion from these;

• Geo-textiles must be used to stabilise soil stockpiles and uncovered soil surfaces during the construction phase and to serve as a sediment trap to contain as much soil as possible that might erode away; • The Stormwater Management Plan (SWMP) should provide for a drainage system sufficiently designed to prevent water run-off from the solar panels to cause soil erosion; • Where discharge of rainwater on roads will be channelled directly into the natural environment, the application of diffuse flow measures must be included in the design; and • Revegetate cleared areas as soon as possible after construction activities.
Residual Impacts: The residual impact from the construction and operation of the Khunab Solar Grid Connection infrastructure on the susceptibility to erosion will be negligible.

10.4 Chemical pollution due to the construction and operation of the Khunab Solar Grid Connection

Table 2 Summary of soil chemical pollution impact assessment

Nature: The following construction activities can result in the chemical pollution of the soil: 1. Hydro-carbon spills by machinery and vehicles during earthworks and the mechanical removal of vegetation during site clearing. 2. Spills from vehicles transporting workers, equipment and construction material to and from the construction site. 3. The accidental spills from temporary chemical toilets used by construction workers. 4. The generation of domestic waste by construction and operational workers. 5. Spills from fuel storage tanks during construction. 6. Polluted water from wash bays and workshops during the construction phase. 7. Accidental spills of other hazardous chemicals used and stored on site. 8. Pollution from concrete mixing. The operation of the grid connection infrastructure can result in the chemical pollution of the soil: 1. Spills from vehicles transporting workers and equipment to and from the grid connection corridor. 2. Accidental spills of other hazardous chemicals used and stored on site.		
	Without mitigation	**With mitigation**
Extent	High (3)	Low (1)
Duration	Medium-term (3)	Short-term (2)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (36)**	**Low (14)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	
Mitigation: • High level maintenance must be undertaken on all vehicles and construction/maintenance machinery to prevent hydrocarbon spills; • Impermeable and bunded surfaces must be used for storage tanks and to park vehicles on; • Site surface water and wash water must be contained and treated before reuse or discharge from site; • Spills of fuel and lubricants from vehicles and equipment must be contained using a drip tray with plastic sheeting filled with adsorbent material; • Spill kits should be available on site and should be serviced regularly; • Waste disposal at the construction site and during operation must be avoided by separating, trucking out and recycling of waste;		

• Potentially contaminating fluids and other wastes must be contained in containers stored on hard surface levels in bunded locations; and • Accidental spillage of potentially contaminating liquids and solids must be cleaned up immediately by trained staff with the correct equipment and protocols as outlined in the EMPr.
Residual Impacts: The residual impact from the construction and operation of the proposed grid connection infrastructure will be low to negligible

10.5 Loss of land capability as a result of the Khunab Solar Grid Connection

Table 3 Summary of land capability impact assessment

Nature: The land capability of the development footprint of the grid connection infrastructure where soil layers are changed and construction of infrastructure is done, will be lost. The impact remains present through the operation phase. The following activities can result in the loss of land capability within the grid connection infrastructure development footprint:

1. The removal of vegetation during site clearing;
2. Earthworks which destroy the natural layers of the soil profiles; and
3. The construction of access roads, collector substations and power line infrastructure which will cover soil surfaces.

	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (3)	Permanent (3)
Magnitude	Moderate (6)	Low (4)
Probability	Definite (4)	Probable (4)
Significance	**Medium (40)**	**Medium (32)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation:

- Keep the grid connection infrastructure development footprint as small as possible.

Residual Impacts:

The residual impact from the construction and operation of the Khunab Solar Grid Connection will be of low significance.

11. Assessment of cumulative impacts

11.1 Assessment rationale

"Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities[2]. The role of the cumulative assessment is to test if such impacts are relevant to the proposed project in the proposed location (i.e. whether the addition of the proposed project in the area will increase the impact). This section should address whether the construction of the proposed grid connection infrastructure will result in:

[2] Unless otherwise stated, all definitions are from the 2014 EIA Regulations (GNR 326).

- Unacceptable risk
- Unacceptable loss
- Complete or whole-scale changes to the environment or sense of place
- Unacceptable increase in impact

Table 4 Summary of other renewable projects in the larger area around the Khunab Solar Grid Connection that may result in cumulative impacts

Project Name	DEA Reference Number(s)	Location	Project Status
Sirius Solar PV Project One (1 x 75MW PV)	14/12/16/3/3/2/469	Remaining Extent of the Farm Tungsten Lodge No. 638 – located in the south east of the development area.	Preferred Bidder project under construction
Sirius Solar PV Project Two (1 x 75MW PV)	14/12/16/3/3/2/470	Remaining Extent of the Farm Tungsten Lodge No. 638 – located in the south-east of the development area.	Approved
Sirius Solar PV Project Three (1 x 100MW PV)	TBC	Remaining Extent of the Farm Tungsten Lodge No. 638 – located in the south-east of the development area.	Proposed
Sirius Solar PV Project Four (1 x 100MW PV)	TBC	Remaining Extent of the Farm Tungsten Lodge No. 638 – located in the south-east of the development area.	Proposed
Khi Solar One (1 x 50MW CSP)	12/12/20/1831	Portion 03 of the Farm McTaggarts Camp No. 435 – located immediately south east and within the development area.	Operational
Kai Garib (1 x 125MW CSP)	14/12/16/3/3/2/656	Portion 03 of the Farm McTaggarts Camp No. 435 – located immediately to the south of the development area	Approved
Eskom Kiwno CSP (1 x 100MW CSP)	12/12/20/777	Farm Olyvenhouts Drift No. – located immediately to the east of the development area.	Approved
Dyasons Klip 1 and 2 (2 x 75MW)	14/12/16/3/3/2/538/1 14/12/16/3/3/2/538/2	Remainder of the Farm Dyasonklip No. 454 – immediately west of the development area.	Preferred Bidder projects under construction
Bloemsmond Solar 1 and 2 (2 x 75MW PV)	14/12/16/3/3/2/815 14/12/16/3/3/2/816	Portions 5 and 14 of the Farm Bloems Mond No. 455 – located to the south-west of the development area.	Approved
Bloemsmond 3,4 & 5 (3 x100 MW PV)	TBC	Portions 5 and 14 of the Farm Bloemsmond No. 455 – located to the south-west	Proposed

Upington Solar Park (1 x 1 000MW CSP and PV)	12/12/20/2146	Farm Klip Kraal No. 451 – located to the east of the development area.	Approved
S-Kol PV Plant (1 x 100MW PV)	12/12/20/2230	Farm Geelkop No. 456 – located to the south-west of the development area.	Approved
Rooipunt (1 x 150MW CSP)	14/12/16/3/3/1/427	Farm McTaggarts Camp No. 435 – located directly to the north-west of the development area.	Approved
Solis Power I and II Projects (1 x 150MW CSP, 1 x 125MW CSP)	14/12/20/16/3/3/3/82 14/12/16/3/3/2/621	Portion 443 to 450 of the Farm Van Rooys Vlei – located to the north-west of the development area.	Approved
Upington Airport Solar PV (1 x 8.9MW PV)	12/12/20/2146	Erf 6013 Upington – located to the north-east of the development area.	Operational
Allepad PV (4 x 100MW)	14/12/16/3/3/2/1105 14/12/16/3/3/2/1106 14/12/16/3/3/2/1107 14/12/16/3/3/2/1108	Erf 5315 and Erf 01 Upington - located north-east of the development area.	Approved
Ephraim Sun Solar PV (1 x 75MW PV)	14/12/16/3/3/2/821	Remaining Extent of Portion 62 of the Farm Vaalkoppies No. 40 – located to the south-east of the development area.	Approved
Ofir-Zx PV Plant (1 x 200MW PV)	12/12/20/2229	Remaining extent of the Farm 616 - located to the south-west of the development area.	Approved
Eenduin Solar Park (1x 75MW PV)	14/12/16/3/3/2/631	Portion 2 of the Farm Eenduin No. 465 – located to the south-west of the development area.	Proposed
Bright Source CSP Facility (1 x 125MW CSP)	14/12/16/3/3/2/605	Remaining extent of the Farm No. 426 - located to the north-north-east of the development area.	Approved

11.2 Other projects in the area

The broader study area around the 300m wide corridor assessed for the Khunab Solar Grid Connection has been subject to up to twenty other renewable projects (and its associated grid connection infrastructure) (as listed in Table **4**) in different stages of the authorisation process. In addition to the sites where the projects will be constructed, there will be several linear developments to construct the grid connection infrastructure required to feed the electricity generated by the projects into the existing electricity grid.

Such a large number of projects will change the dominant current land use of the area from livestock farming to electricity generation. This is in line with the planning for this area, which falls within the northern corridor of the Strategic Transmission Corridors, as well as a Renewable Energy Development Zone (REDZ). In addition to this, cumulative impacts will be an increased risk for soil erosion when vegetation is removed and there is possible pollution of soil resources.

Table 5 Assessment of cumulative impact of decrease in areas available for livestock farming

Nature: Decrease in areas with suitable land capability for livestock farming.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Regional (2)
Duration	Permanent (5)	Permanent (5)
Magnitude	Minor (2)	Moderate (3)
Probability	Probable (4)	Probable (4)
Significance	**Medium (32)**	**Medium (40)**
Status (positive/negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	No
Confidence in findings: High.		
Mitigation: The only mitigation measure for this impact is to keep the footprints of all grid connection infrastructure as small as possible and to manage the soil quality by avoiding far-reaching soil degradation such as erosion.		

Table 6 Assessment of cumulative impact of areas susceptible to soil erosion

Nature: Increase in areas susceptible to soil erosion		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Regional (2)

Duration	Medium-term (3)	Permanent (5)
Magnitude	Moderate (6)	Moderate (3)
Probability	Probable (3)	Probable (4)
Significance	**Medium (30)**	**Medium (40)**
Status (positive/negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	No
Confidence in findings: High.		
Mitigation: Each of the projects should adhere to the highest standards for soil erosion prevention and management as defined in Section 10.3 above.		

Table 7 Assessment of cumulative impact of increased risk of soil pollution

Nature: Increase in areas susceptible to soil pollution		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	High (3)	Regional (2)
Duration	Medium-term (3)	Permanent (5)
Magnitude	Moderate (6)	Moderate (3)
Probability	Probable (3)	Probable (4)
Significance	**Medium (36)**	**Medium (40)**
Status (positive/negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	No
Confidence in findings: High.		
Mitigation: Each of the projects should adhere to the highest standards for soil pollution prevention and management as defined in Section 10.4 above.		

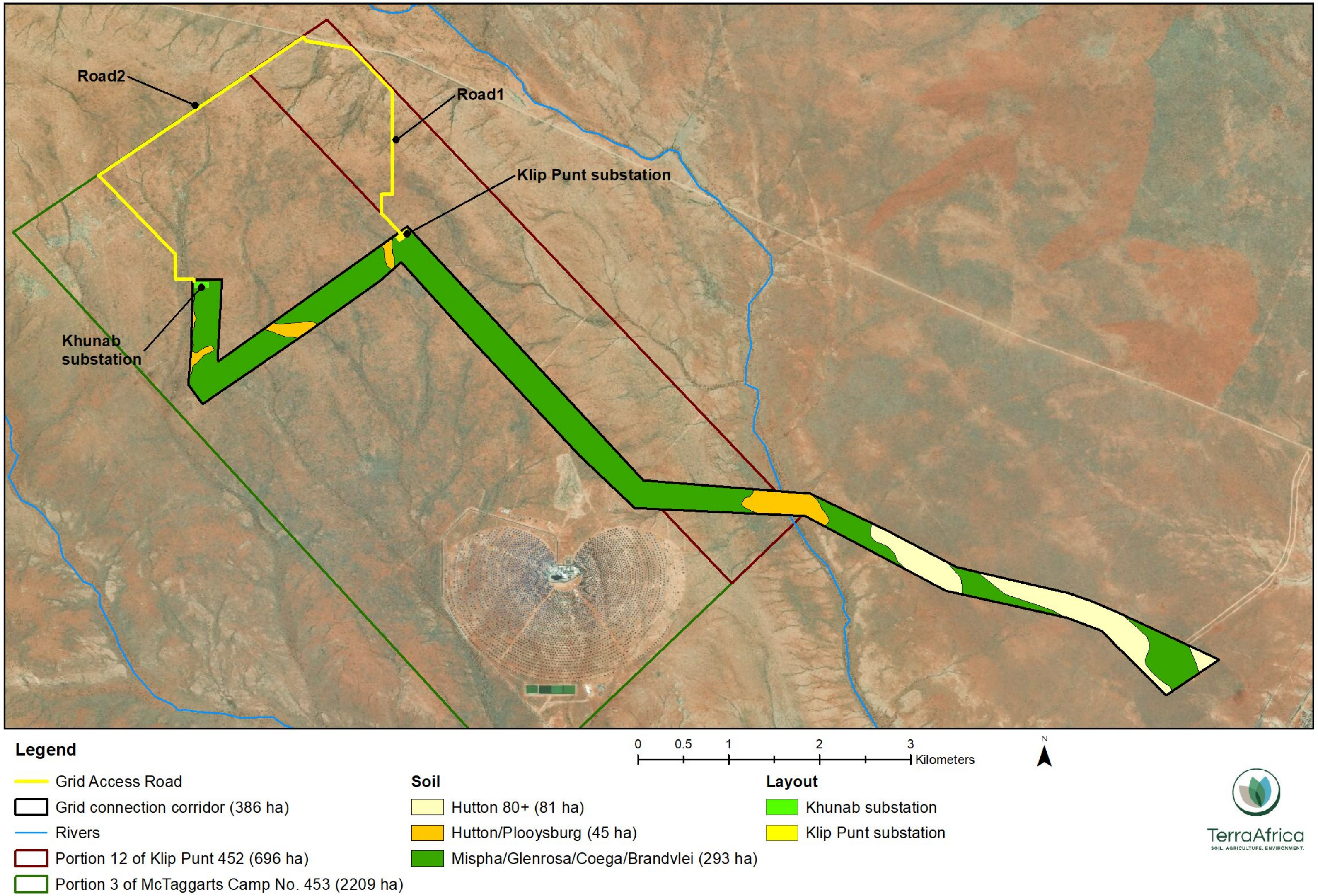

Figure 10: The grid connection corridor assessed for the proposed Khunab Solar Grid Connection, superimposed on soil data

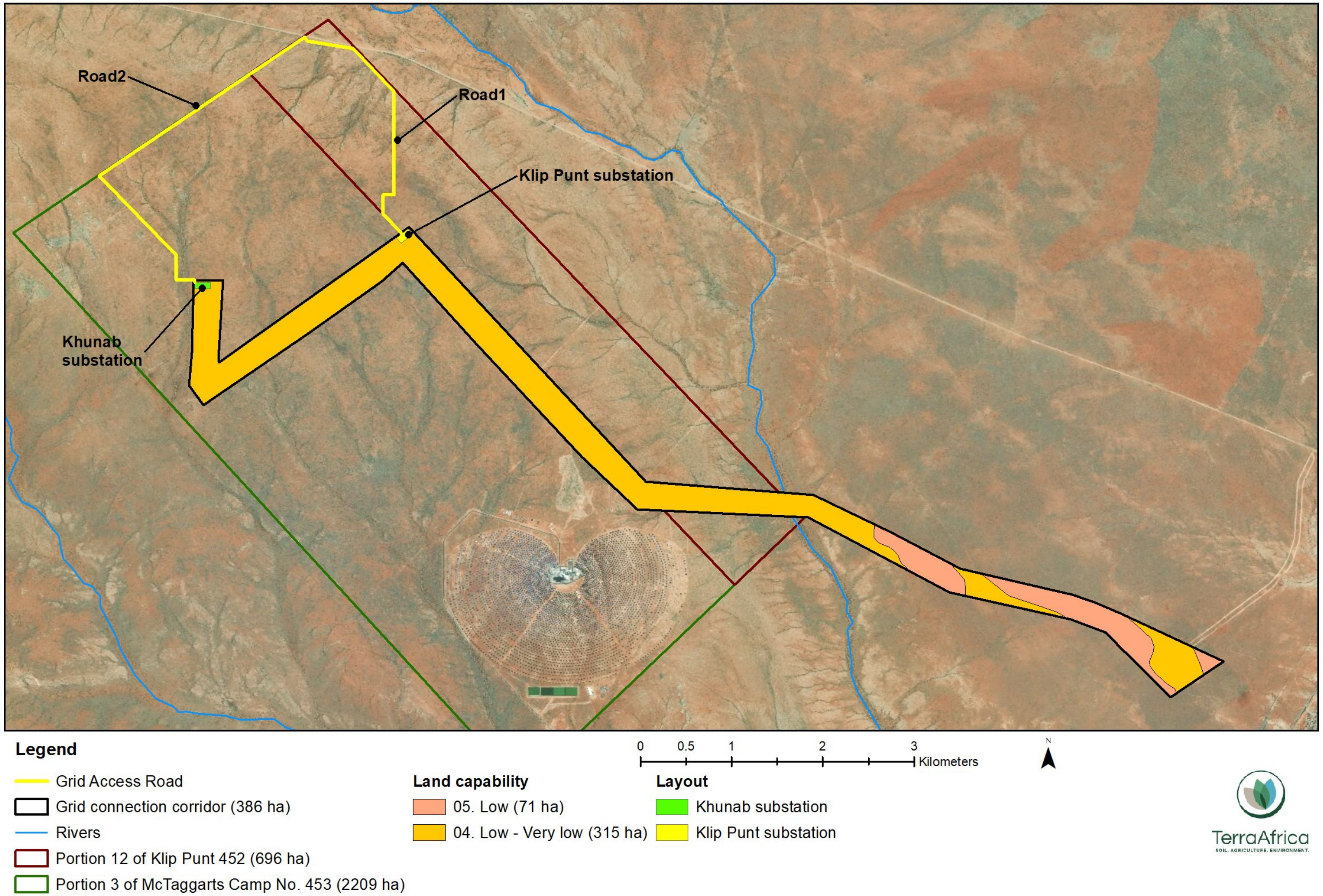

Figure 11: The grid connection corridor assessed for the proposed Khunab Solar Grid Connection, superimposed on land capability data

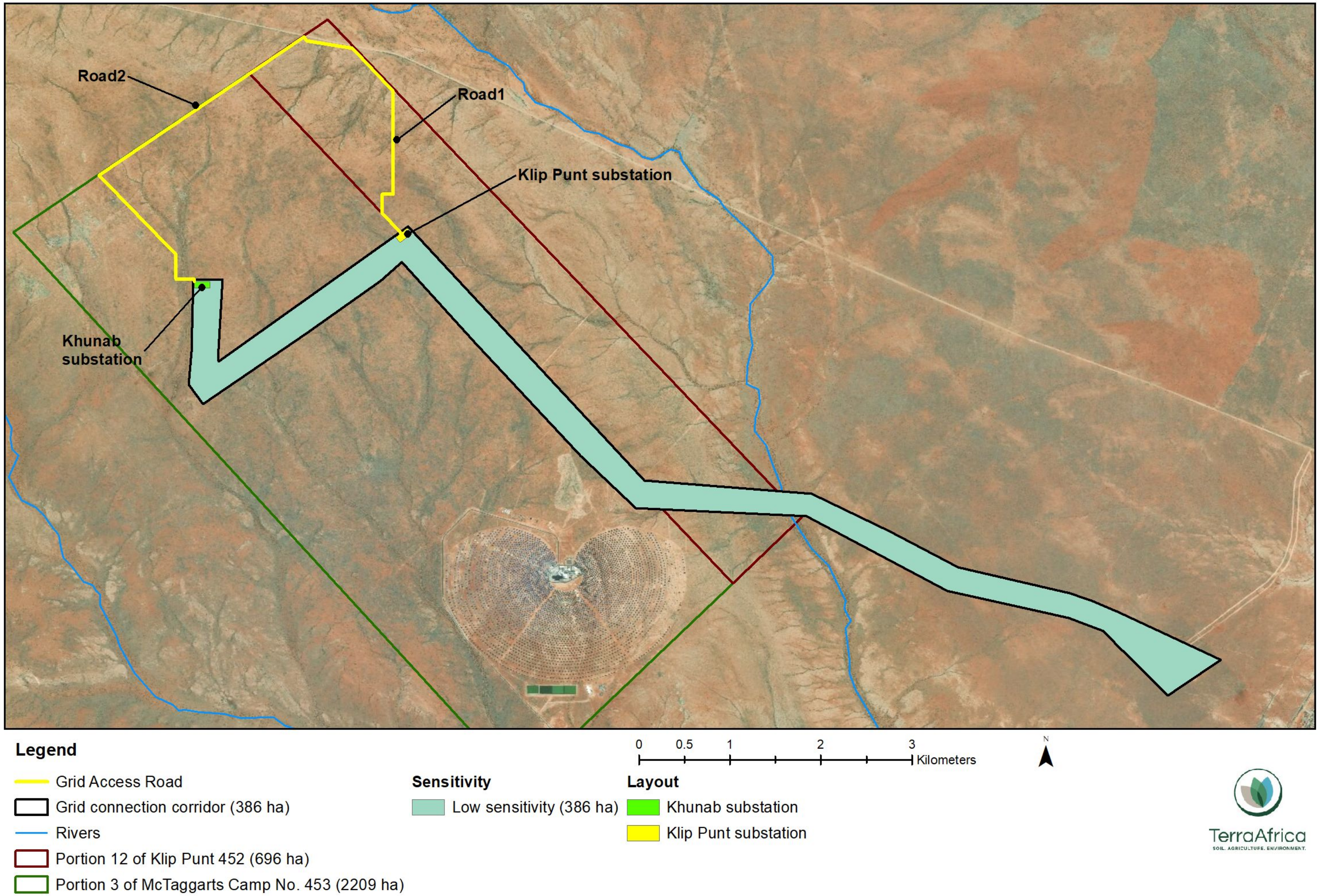

Figure 12: The grid connection corridor assessed for the proposed Khunab Solar Grid Connection, superimposed on baseline sensitivity data

12. Soil, land use and land capability management plan

The management plan for the management of the impacts described in Section 10.

Table 8 Measures to mitigate, manage and monitor soil for susceptibility to erosion

OBJECTIVE: To construct the grid connection infrastructure in a manner that ensures the protection of soils against erosion caused by the removal of vegetation cover and compaction of soil, and to maintain and monitor the terrain of the Khunab Solar Grid Connection.		
Project Component/s	Construction and Operation Phases	
Potential Impact	Susceptibility to erosion.	
Activity / Risk source	• Vegetation removal during site clearing; • Creating impenetrable surfaces; • Leaving soil surfaces uncovered by vegetation.	
Mitigation: **Target / Objective**	Revegetate, maintain and monitor the Khunab Solar Grid Connection development footprint.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
• Soil stockpiles must be dampened with dust suppressant or equivalent to prevent erosion by wind. • Land clearance must only be undertaken immediately prior to construction activities. • Unnecessary land clearance must be avoided. • All graded or disturbed areas which will not be covered by permanent infrastructure such as paving, buildings or roads must be stabilised with erosion control mats (geo-textiles) and revegetated. • Ensure vegetation is re-established on disturbed surfaces as soon as construction has been completed in an area.	» EPC Contractor » EO	Ongoing during construction. Revegetate as soon as possible after construction is completed.
Performance indicator	Prevent, minimise and manage any visible erosion in the development footprint and directly adjacent areas during construction and operation of the Khunab Solar Grid Connection.	
Monitoring	• On-going visual assessment of compliance with erosion prevention by EPC Contractor and EO. • Monitor visual signs of erosion such as the formation of gullies after rainstorms and the presence of dust emissions during wind storms. • Any signs of soil erosion in the development footprint should be documented (including photographic evidence and coordinates of the problem areas) and submitted to the management team of McTaggarts PV1 (Pty) Ltd.	

	• Monitor compliance of construction workers to restrict construction work to the clearly defined limits of the construction site in order to keep footprint as small as possible. • Where vegetation is not re-establishing itself in areas where surface disturbance occurred, soil samples must be collected, analysed for pH levels, electrical conductivity (EC) and major plant nutrient levels (calcium, magnesium, potassium) and sodium. • When vegetation re-establishment still remains unsatisfactory, the bulk density of the soil should be measured with a penetrometer to determine whether compaction is an issue. • The results must be submitted to a professional soil or agricultural scientist for recommendations on the amendment of the issue to ensure that the vegetation cover is established and erosion prevented.

Table 9 Measures to mitigate, manage and monitor soil for susceptibility to soil pollution

OBJECTIVE: To construct and operate the Khunab Solar Grid Connection in a manner that minimise the pollution of soil by hydrocarbon spills from vehicles and machinery, and resultant waste material and pollution that may result from personnel accessing the grid connection infrastructure footprint area during the operation phase, as well as the undertaking of maintenance activities. To store and use fuel, lubricants and other hazardous chemicals safely, and to prevent spills and contamination of the soil resource.		
Project Component/s	Construction and Operation Phases	
Potential Impact	Soil pollution	
Activity / Risk source	• Hydrocarbon spills by vehicles and machinery during levelling, vegetation clearance and transport of workers, materials and equipment; • Accidental spills of hazardous chemicals; • Generation of domestic waste by construction workers;	
Mitigation: **Target / Objective**	Prevent and contain hydrocarbon leaks. Undertake proper waste management. Store hazardous chemicals safely in a bunded area.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
• Losses of fuel and lubricants from the oil sumps and steering racks of vehicles and equipment must be contained using a drip tray with plastic sheeting filled with absorbent material when not parked on hard standing areas. • Waste disposal at the construction site and during operation must be avoided by separating and trucking out of waste. • Accidental spillage of potentially contaminating liquids and solids must be cleaned up immediately in line	» EPC Contractor » EO	On-going visual assessment during the construction and operation phases to detect polluted areas and the application of clean-up and preventative procedures. .

with procedures by trained people with the appropriate equipment.		
Performance indicator	Check vehicles and machinery daily for oil, fuel and hydraulic fluid leaks; Undertake high standard maintenance on vehicles; Proper waste management; Safe storage of hazardous chemicals.	
Monitoring	• On-going visual assessment to detect polluted areas and the application of clean-up and preventative procedures. • Monitor hydrocarbon spills from vehicles and machinery during construction continuously and record volume and nature of spill, location and clean-up actions. • Monitor maintenance of drains and intercept drains weekly. • Analyse soil samples for pollution in areas of known spills or where a breach of containment is evident when it occurs. • Records of accidental spills and clean-up procedures and the results thereof must be audited on an annual basis by the EO during construction and the environmental manager during operation. • Records of all incidents that caused chemical pollution must be kept and a summary of the results must be reported to the McTaggarts PV1 (Pty) Ltd management team annually. • Gaps must be identified and procedures must be amended if necessary by the project management team.	

Table 10 Measures to mitigate, manage and monitor loss of land capability

OBJECTIVE: To keep the Khunab Solar Grid Connection footprint as small as possible and minimise the loss of land capability.		
Project Component/s	Construction and Operation Phases	
Potential Impact	Loss of Land Capability	
Activity / Risk source	• The removal of vegetation during site clearing; • Earthworks which destroy the natural layers of the soil profiles; and • The construction of access roads, collector substations and power line infrastructure which will cover soil surfaces.	
Mitigation: **Target / Objective**	Keep the project footprint as small as possible	
Mitigation: Action/control	**Responsibility**	**Timeframe**
• Keep the project footprint as small as possible.	» EPC Contractor » EO	On-going visual assessment of compliance by EPC Contractor to stay within the design footprint. .
Performance indicator	Stay within the boundary of the Khunab Solar Grid Connection corridor as designed and agreed upon.	
Monitoring	• Monitor compliance of construction workers to restrict construction work to the clearly defined limits of the construction site by EO. • Reporting by EO to the McTaggarts PV1 (Pty) Ltd management team if any impacts outside the grid connection infrastructure development footprint take place. • If any transgressions occur, corrective actions should be taken.	

13. Consideration of alternatives

No alterative grid connection corridors were assessed for the development of the Khunab Solar Grid Connection as there are no other technically feasible alternatives.

14. Reasoned opinion

The proposed Khunab Solar Grid Connection is predominantly located on shallow, rocky soils with very low to low land capability. While irrigation can increase the yield of marginal land, South Africa is a water-stressed country where a large fraction of the available water has already been allocated to food production. Irrigated crop production also requires significant capital investment and running costs that may not be financially viable for the landowner. It is also possible that the affected properties of the grid connection corridor do not have any viable boreholes that can supply irrigation water.

The proposed Khunab Solar Grid Connection will have medium to minor impacts on soil and land capability properties as well as current land uses in the areas where the footprint will result in surface disturbance. Cumulative impacts are related to an increase in the loss of agricultural land used for livestock farming. These impacts can be reduced by keeping the footprints minimised where possible and strictly following soil management measures pertaining to erosion control and management and monitoring of any possible soil pollution sources such as vehicles traversing over the grid connection corridor.

No alternative grid connection corridors were provided for consideration as there are no other technically viable alternatives for the development of the Khunab Solar Grid Connection.

The proposed Khunab Solar Grid Connection falls within a larger area of a number of solar energy projects (including the associated grid connection infrastructure) that are in different stages of development, intermixed with livestock and grape farming and settlements (farm houses, the town of Upington, etc.). The land capability and soil quality of land affected by the surface footprint of the proposed grid connection infrastructure will be slightly compromised. If soil management measures are followed as outlined in this report and the land rehabilitated to the highest standard possible, livestock farming will be possible on the rehabilitated land.

It is therefore the opinion of the author that the activity should be authorised and that the development of the grid connection infrastructure within the assessed grid connection corridor is acceptable from a soils and agricultural perspective. It follows that the recommendations and monitoring requirements as set out in this report should form part of the conditions of the environmental authorisation for the proposed project.

15. Reference list

The Soil Classification Working Group (2018). *Soil Classification – Taxonomic System for South Africa.* Dept. of Agric., Pretoria.

Fey, M. (2010). *Soils of South Africa*. Cambridge. Cape Town.

Morgenthal, T.L., D.J. du Plessis, T.S. Newby and H.J.C. Smith (2005). *Development and Refinement of a Grazing Capacity Map for South Africa.* ARC-ISCW, Pretoria.

Appendix 1 – Laboratory analyses sheet

NOORDWES UNIVERSITEIT
ECO-ANALYTICA

Eco Analytica
Posbus 19140
NOORDBRUG 2522
Tel: 018-285 2732/3/4

TERRA AFRICA (KLIP PUNT GRID)

18/7/2019 **Nutritional status**

Monster no.	Ca	Mg	K	Na	P	pH(KCl)
	(mg/kg)					
KH01	714,2	70,6	132,1	6,6	12,3	5,75
KH02	1147,1	105,8	114,4	9,1	4,7	5,74

Exhangeable cations

Monster no.	Ca	Mg	K	Na	S-waarde	LOI
	(cmol(+)/kg)					%C
KH01	3,56	0,58	0,34	0,03	4,51	0,18
KH02	5,72	0,87	0,29	0,04	6,93	0,28

15/7/2019 **Particle Size Distribution**

Sample no.	**> 2mm (%)**	**Sand**	**Silt**	**Clay**
		(% < 2mm)		
KH01	2,5	97,2	1,2	1,6
KH02	3,4	97,1	1,2	1,6

APPENDIX 2 - CURRICULUM VITAE OF SPECIALIST (Mariné Pienaar)

- **Personal Details**

  Last name: **Pienaar**
  First name: **Mariné**
  Nationality: **South African**
  Employment: **Self-employed (Consultant)**

- **Contact Details**

  Email address: mpienaar@terraafrica.co.za
  Website: **www.terraafrica.co.za**
  Mailing address: **PO Box 433, Ottosdal, 2610**
  Telephone: **+27828283587**
  Address: **57 Kruger Street, Wolmaransstad, 2630, Republic of South Africa**
  Current Job: **Lead Consultant and Owner of TerraAfrica Consult**

- **Concise biography**

Mariné Pienaar is a professionally registered soil- and agricultural scientist (SACNASP) who has consulted extensively for the past eleven years in the fields of soil, land use and agriculture in several African countries. These countries include South Africa, Liberia, Ghana, DRC, Mozambique, Botswana, Angola, Swaziland and Malawi. She has worked with mining houses, environmental consulting companies, Eskom, government departments as well as legal and engineering firms. She conducted more than three hundred specialist studies that included baseline soil assessment and rehabilitation planning for new projects or expansion of existing projects, soil quality monitoring, land rehabilitation assessment and monitoring, natural resource assessment as part of agricultural project planning, evaluation and development of sustainable agriculture practices, land use assessment and livelihood restoration planning as part of resettlement projects and land contamination risk assessments. She holds a BSc. Agriculture degree with specialisation in Plant Production and Soil Science from the University of Pretoria and a MSc in Environmental Science from the University of the Witwatersrand. In addition to this, she has attended a number of courses in Europe, the USA and Israel in addition to those attended in South Africa. Mariné is a contributing author of a report on the balance of natural resources between the mining industry and agriculture in South Africa (published by the Bureau for Food and Agricultural Policy, 2015).

- **Qualifications**

  Academic Qualifications:

  - **MSc Environmental Science**; University of Witwatersrand, South Africa, 2017
  - **BSc (Agric) Plant Production and Soil Science;** University of Pretoria, South Africa, 2004
  - **Senior Certificate / Matric;** Wolmaransstad High School, South Africa, 2000

Courses Completed:

- **World Soils and their Assessment;** ISRIC – World Soil Information, Wageningen, 2015
- **Intensive Agriculture in Arid- and Semi-Arid Environments** – Gilat Research Centre, Israel, 2015
- **Hydrus Modelling of Soil-Water-Leachate Movement;** University of KwaZulu-Natal, South Africa, 2010
- **Global Sustainability Summer School 2012;** Institute for Advanced Sustainability Studies, Potsdam, Germany, 2012
- **Wetland Rehabilitation;** University of Pretoria, South Africa, 2008
- **Enviropreneurship Institute;** Property and Environment Research Centre [PERC], Montana, U.S.A., 2011
- **Youth Encounter on Sustainability;** ACTIS Education [official spin-off of ETH Zürich], Switzerland, 2011
- **Environmental Impact Assessment │Environmental Management Systems – ISO 14001:2004 │Environmental Law;** University of Potchefstroom, South Africa, 2008
- **Carbon Footprint Analyst Level 1;** Global Carbon Exchange Assessed, 2011
- **Negotiation of Financial Transactions;** United Nations Institute for Training and Research, 2011
- **Food Security: Can Trade and Investment Improve it?** United Nations Institute for Training and Research, 2011

- **Language ability**

Perfectly fluent in English and Afrikaans (native speaker of both) and conversant in French.

- **Professional Experience**

Name of firm	Terra Africa Environmental Consultants
Designation	Owner | Principal Consultant
Period of work	December 2008 to Date

- **Prior Tenures**

Integrated Development Expertise (Pty) Ltd; **Junior Land Use Consultant** [July 2006 to October 2008]
Omnia Fertilizer (Pty) Ltd; **Horticulturist and Extension Specialist** [January 2005 to June 2006]

- **Professional Affiliations**

- South African Council for Natural Scientific Professions [SACNASP]
- Soil Science Society of South Africa [SSSA]
- Soil Science Society of America
- South African Soil Surveyors' Organisation [SASSO]
- International Society for Sustainability Professionals [ISSP]

Summary of a selected number of projects completed successfully:

[Comprehensive project dossier available on request]

1. *Sekoko Railway Alignment and Siding Soil, Land Use and Capability Study* in close proximity to the Medupi Power Station in the Lephalale area, Limpopo Province.

2. *Italthai Rail and Port Projects, Mozambique* – The study included a thorough assessment of the current land use practices in the proposed development areas including subsistence crop production and fishing as well as livestock farming and forestry activities. All the land uses were mapped and intrinsically linked to the different soil types and associated land capabilities. This study was used to develop Livelihood Restoration Planning from.

3. *Bomi Hills Railway Alignment Project, Liberia:* soil, land use and agricultural scientist for field survey and reporting of soil potential, current land use activities and existing soil pollution levels, as well as associated infrastructure upgrades of the port, road and railway.

4. *Kingston Vale Waste Facility, Mpumalanga Province, South Africa*: Soil and vegetation monitoring to determine the risk of manganese pollution resulting from activities at the waste facility.

5. *Keaton Mining's Vanggatfontein Colliery, Mpumalanga*: Assessment of soil contamination levels in the mining area, stockpiles as well as surrounding areas as part of a long-term monitoring strategy and rehabilitation plan.

6. *Richards Bay Minerals, KwaZulu-Natal*: Contaminated land assessment of community vegetable gardens outside Richards Bay as a result of spillages from pipelines of Rio Tinto's Richards Bay Minerals Mine.

7. *Buffelsfontein Gold Mine, Northwest Province, South Africa:* Soil and land contamination risk assessment for as part of a mine closure application. Propose soil restoration strategies.

8. Glenover Phosphate Mining Project near Steenbokpan in the Lephalale area – Soil, Land Use and Land Capability Study as part of the environmental authorisation process.

9. *Waterberg Coal 3 and 4 Soil, Land Use and Land Capability Study* on 23 000 ha of land around Steenbokpan in the Lephalale area.

10. *Lesotho Highlands Development Agency, development of Phase II (Polihali Dam and associated infrastructure)*: External review and editing of the initial Soil, Land Use and Land Capability Assessment as requested by ERM Southern Africa.

11. *Tina Falls Hydropower Project, Eastern Cape , South Africa*: Soil, land use and land capability assessment as part of the ESIA for the construction of a hydropower plant at the Tina Falls.
12. *Graveyard relocation as part of Exxaro Coal's Belfast Resettlement Action Plan*: Soil assessment to determine pedohydrological properties of the relocation area in order to minimise soil pollution caused by graveyards.

13. *Rhino Oil Resources: Strategic high-level soil, land use and land capability assessment of five proposed regions to be explored for shale gas resources in the KwaZulu-Natal, Eastern Cape, North-West and Free State provinces of South Africa.*

14. *Eskom Kimberley Strengthening Phase 4 Projec*t, Northern Cape & Free State, South Africa: soil, agricultural potential and land capability assessment.

15. *Mocuba Solar Project, Mozambique* – The study included a land use assessment together with that of the soil and land capabilities of the study area. All current land uses were documented and mapped and the land productivity was determined. This study advocated the resettlement and livelihood restoration planning.

16. *Botswana (Limpopo-Lipadi Game Reserve).* Soil research study on 36 000 ha on the banks of the Limpopo River. This soil study forms part of an environmental management plan for the Limpopo-Lipadi Game Reserve situated here as well as the basis for the Environmental Impact Assessment for the development of lodges and Land Use Management in this area.

17. *TFM Mining Operations [proposed] Integrated Development Zone, Katanga, DRC* [part of mining concession between Tenke and Fungurume]: soil and agricultural impact assessment study.

18. *Closure Strategy Development for Techmina Mining Company – Lucapa, Angola.* Conducted an analysis of the natural resources (soil, water) to determine the existing environmental conditions on an opencast diamond mine in Angola. The mine currently experience severe problems with kimberlite sediment flowing into the river. A plan is currently being developed to change the mining area into a sustainable bamboo farming operation.

19. *Closure of sand mining operations, Zeerust District.* Succesfully conducted the closure application of the Roos Family Sand Mine in the Zeerust District. Land Use Management Plans for rehabilitated soil were developed. The mine has closed now and the financial provision has been paid out to the applicant.

20. *ESIA for [proposed] Musonoi Mine, Kolwezi area, Katanga, DRC:* soil, land use and land capability assessment.

21. *Bauba A Hlabirwa Moeijelik Platinum mine [proposed] project, Mpumalanga, South Africa:* soil, land use and land capability assessment and impact on agricultural potential of soil.

22. *Commissiekraal Coal Mine [proposed] project, KwaZulu*-Natal, South Africa: sustainable soil management plans, assessment of natural resource and agricultural potential and study of the possible impacts of the proposed project on current land use. Soil conservation strategies included in soil management plan.

23. *Cronimet Chrome Mine [proposed] project, Limpopo Province, South Africa:* soil, land use and land capability of project area and assessment of the impacts of the proposed project.
24. *Moonlight Iron Ore Land Use Assessment, South Africa* – Conducted a comprehensive land use assessment that included interviews with land users in the direct and indirect project zones of influence. The study considered all other anticipated social and environmental impacts such as water, air quality and noise and this was incorporated into a sensitivity analysis of all land users to the proposed project.

25. *Project Fairway Land Use Assessment, South Africa* – The study included an analysis of all land users that will directly and indirectly be influenced by the project. It analysed the components of their land uses and how this components will be affected by the proposed project. Part of the study was to develop mitigation measures to reduce the impact on the land users.

26. *Bekkersdal Urban Renewal Project – Farmer Support Programme,* Independent consultation on the farmer support programme that forms part of Bekkersdal Renewal Project. This entailed the production of short and long term business plans based on soil and water research conducted. Part of responsibilities were the evaluation of current irrigation systems and calculation of potential water needs, etc. as well as determining quantities and prices of all project items to facilitate the formalisation of tender documents.

27. *Area-based agricultural business plans for municipalities in Dr. Kenneth Kaunda Municipal District.* Evaluation of the agricultural and environmental status of the total district as well as for each municipality within the district. This included the critical evaluation of current agricultural projects in the area. The writing of sustainable, executable agricultural business plans for different agricultural enterprises to form part of the land reform plans of each Municipality within the district.

28. *Batsamaya Mmogo, Hartswater.* Conducted a soil and water assessment for the farm and compiled management and farming plans for boergoats grazing on *Sericea lespedeza* with pecan nuts and lucerne under irrigation.

29. *Anglo Platinum Twickenham Mine – Irrigated Cotton Project.* Project management of an irrigated cotton production project for Twickenham Platinum Mine. This project will ensure that the community benefit from the excess water that is available from the mine activities.

30. *Grasvally Chrome (Pty) Ltd Sylvania Platinum [proposed] Project, Limpopo Province, South Africa:* Soil, land use and agricultural potential assessment.

31. *Jeanette Gold mine project [reviving of historical mine], Free State, South Africa:* Soil, land use and agricultural potential assessment.

32. *Kangra Coal Project, Mpumalanga, South Africa:* Soil conservation strategies proposed to mitigate the impact of the project on the soil and agricultural potential.

33. *Richards Bay Integrated Development Zone Project, South Africa* [future development includes an additional 1500 ha of land into industrial areas on the fringes of Richards Bay]: natural resource and agricultural potential assessment, including soil, water and vegetation.

34. *Exxaro Belfast Coal Mine [proposed] infrastructure development projects* [linear: road and railway upgrade | site-specific coal loading facilities]: soil, land capability and agricultural potential assessment.

35. *Marikana In-Pit Rehabilitation Project of Aquarius Platinum, South Africa:* soil, land capability and land use assessment.

36. *Eskom Bighorn Substation proposed upgrades, South Africa:* soil, land capability and agricultural potential assessment.

37. *Exxaro Leeuwpan Coal Mining Right Area, South Africa:* consolidation of all existing soil and agricultural potential data. Conducted new surveys and identified and updated gaps in historic data sets.

38. *Banro Namoya Mining Operation, DRC:* soil, land use and agricultural scientist for field survey and reporting of soil potential, current land use activities and existing soil pollution levels, including proposed project extension areas and progressive soil and land use rehabilitation plan.

39. *Kumba Iron Ore's Sishen Mine, Northern Cape, South Africa: soil, land use and agricultural scientist* | *Western Waste Rock Dumps [proposed] Project:* soil, land use and agricultural potential assessment, including recommendations regarding stripping/stockpiling and alternative uses for the large calcrete resources available.

40. *Vetlaagte Solar Development Project, De Aar, South Africa:* soil, land use and agricultural scientist. Soil, land use and agricultural potential assessment for proposed new 1500 ha solar development project, including soil management plan.