WOODHOUSE SOLAR 1 PV FACILITY

VRYBURG

NORTH WEST PROVINCE

ECOLOGICAL IMPACT ASSESSMENT REPORT

APRIL 2016

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DECLARATION OF CONSULTANT'S INDEPENDENCE

I, Gerhard Botha, as the appointed specialist hereby declare that I:

- » act/ed as the independent specialist in this application;
- » regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
- » do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- » have and will not have no vested interest in the proposed activity proceeding;
- » have disclosed, to the applicant, EAP and competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- » am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2014 (specifically in terms of regulation 13 of GN No. R. 543) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;
- » have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- » am aware that a false declaration is an offence in terms of regulation 48 of GN No. R. 982.

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April 2016

WOODHOUSE SOLAR 1 PV FACILITY, NEAR VRYBURG, NORTH WEST PROVINCE
ECOLOGICAL IMPACT ASSESSMENT REPORT

1 INTRODUCTION

1.1 Applicant

The project is to be developed as a stand-alone project by Genesis Eco-energy Developments. Genesis Woodhouse Solar 1 (Pty) Ltd (the Special Purpose Vehicle (SPV)) has been established as the applicant for the project.

1.2 Project

The project will be known as the Woodhouse Solar 1 PV Facility

1.3 Proposed Activity

The proposed facility is envisaged to have a generating capacity of up to 100 MW and would include the following infrastructure:

» Arrays of PV panels with a capacity of up to 100MW
» Mounting structures to support the PV panels.
» On-site inverters to step up the power and a substation to facilitate the connection between the solar energy facility and the Eskom electricity grid.
» A new 132kV power line between the on-site substation and the Eskom grid connection point. Four alternatives will be considered for the grid connection:
    - Alternative 1: a direct connection to the authorised Eskom Bophirima Substation to be constructed within the northern portion of the affected property;
    - Alternative 2: a direct connection to the existing Woodhouse 88/22kV Substation located north of the boundary of the affected property;
    - Alternative 3: a turn-in turn-out connection to the existing Delareyville Munic / Vryburg 1 88kV Feeder located along the northern boundary of the affected property; and
    - Alternative 4: a turn-in turn-out connection to the authorised 132kV Eskom Bophirima–Mookodi power line to be constructed by Eskom.

» Cabling between the project components, to be laid underground where practical.
» Offices and workshop areas for maintenance and storage.
» Temporary laydown areas.
» Internal access roads and fencing around the development area.

1.4 Location

The proposed facility will be located in the northern section of the Remaining Extent of Farm Woodhouse 729, Vryburg, North West Province.

1.5 Terms of reference

To conduct an ecological study for an ecological impact assessment of the target area where the establishment of the Solar Energy Facility and associated infrastructure is proposed to be located and provide a professional opinion on ecological issues pertaining to the target area to aid in future decisions regarding the proposed project.

1.6 Conditions of this report

Findings, recommendations and conclusions provided in this report are based on the authors' best scientific and professional knowledge and information available at the time of compilation. No form of this report may be amended or extended without the prior written consent of the author. Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or make reference to this report. Whenever such recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety.

1.7 Relevant legislation

The following legislation was taken into account whilst compiling this report:

Provincial

» The Transvaal Nature Conservation Ordinance (No. 12 of 1983) in its entirety, with special reference to:
  - Schedule 2: Protected Game
  - Schedule 3: Specially Protected Game
  - Schedule 4: Protected Wild Animals
  - Schedule 5: Wild Animals
  - Schedule 7: Invertebrates
  - Schedule 11: Protected Plants
  - Schedule 12: Specially Protected Plants

» The Bophuthatswana Nature Conservation Act (Act 3 of 1973) in its entirety, with special reference to:
  - Schedule 1: Protected Game
  - Schedule 1A: Specially Protected Game

- Schedule 2: Ordinary Game
- Schedule 3: Wild Animals In Respect Of Which The Provision Of Section 3 (a) (ii) Apply
- Schedule 4: Wild Animals To Which The Provisions Of Section 4 (1) (b) Do Not Apply
- Schedule 7: Protected Plants
- Schedule 7: Specially Protected Plants

The above mentioned Nature Conservation Ordinances accompanied by all amendments is regarded by the North West Department of Rural, Environment, Agricultural Development (READ) as the legal binding, provincial documents, providing regulations, guidelines and procedures with the aim of protecting game and fish, the conservation of flora and fauna and the destruction of problematic (vermin and invasive) species.

National

» National Environmental Management Act / NEMA (Act No 107 of 1998), and all amendments and supplementary listings and/or regulations
» Environment Conservation Act (ECA) (No 73 of 1989) and amendments
» National Environmental Management Act: Biodiversity Act / NEMA:BA (Act No. 10 of 2004) and amendments
» National Forest Act 1998 / NFA (No 84 of 1998)
» National Veld and Forest Fire Act (Act No. 101 of 1998)
» Conservation of Agricultural Resources Act / CARA (Act No. 43 of 1983) and amendments

International

» Convention on International Trade in Endangered Species of Fauna and Flora (CITES)
» Convention on Biological Diversity, 1995

2 METHODOLOGY

2.1 Data scouring and review

Data sources from the literature as well as the Ecological Scoping Report were consulted and used where necessary in the study and include the following:

Vegetation:

» Vegetation types and their conservation status were extracted from the South African National Vegetation Map (Mucina and Rutherford 2006) as well as the National List of Threatened Ecosystems (2011), where relevant.
» Critical Biodiversity Areas for the site and surroundings were extracted (CBA Map for North West Province obtained from http://bgis.sanbi.org/fsp/project.asp).
» Information on plant and animal species recorded for the Quarter Degree Squares (QDS) 2624DD and 2724BB was extracted from the SABIF/SIBIS database hosted by SANBI. This is a considerably larger area than the study area, but this is necessary to ensure a conservative approach as well as counter the fact that the site itself has probably not been well sampled in the past.
» The IUCN conservation status (Table 2) of the species in the list was also extracted from the database and is based on the Threatened Species Programme, Red List of South African Plants (2013).
» Freshwater and wetland information was extracted from the National Freshwater Ecosystem Priority Areas assessment, NFEPA (Nel et al. 2011). This includes rivers, wetlands and catchments defined under the study.

Fauna

» Lists of mammals, reptiles and amphibians which are likely to occur in the study area were derived based on distribution records from the literature and various spatial databases (SANBI's SIBIS and BGIS databases).
» Literature consulted includes Branch (1988) and Alexander and Marais (2007) for reptiles, Du Preez and Carruthers (2009) for amphibians, Friedmann and Daly (2004) and Skinner and Chimimba (2005) for mammals.
» Apart from the literature sources, additional information on reptiles were extracted from the SARCA web portal, hosted by the ADU, http://vmus.adu.org.za
» The faunal species lists provided are based on species which are known to occur in the broader geographical area, as well as a preliminary assessment of the availability and quality of suitable habitat at the site.
» The conservation status of each species is also listed, based on the IUCN Red List Categories and Criteria 2014 (See Figure 3) and where species have not been assessed under these criteria, the CITES status is reported where possible. These lists are adequate for mammals and amphibians, the majority of which have been assessed, however the majority of reptiles have not been assessed and therefore, it is not adequate to assess the potential impact of the development on reptiles, based on those with a listed conservation status alone. In order to address this shortcoming, the distribution of reptiles was also taken into account such that any narrow endemics or species with highly specialized habitat requirements occurring at the site were noted.

2.2 Field Sampling & Assessment Methodology

A site visit was conducted on 05 November 2015 and on the 16th and 17th of April 2016 to survey the site in multiple seasons (owing to the widespread drought conditions experienced across the country).

The proposed development footprint as well as the immediate surrounding farm property was inspected on foot. Randomly selected 10m x 10m sampling plots were selected within and along the proposed footprint area and the total visible floristic composition was noted. All sensitive features present within the development footprint were mapped and any species of conservation concern which might be affected by the development were recorded.

All terrestrial vertebrate fauna directly or indirectly observed at the site were noted and certain habitats such as rocky outcrops etc. were specifically searched for reptiles and amphibians. Furthermore, the likely occurrence, based on the availability of suitable habitat, of species of conservation concern known to or potentially occurring in the area was assessed.

2.3 Criteria used to assess the site

The broad-scale ecological sensitivity map of the site was produced by integrating information acquired during the desktop survey including available ecological and biodiversity information in the literature and various spatial databases (SIBIS, BGIS) as well as the North West Provinces' Critical Biodiversity Areas (CBA) (status and conditions determined during scoping phase site visit of CBAs). The ecological sensitivity of the different units identified in the mapping procedure was rated according to the following scale:

Table 1: Explanation of sensitivity rating

Sensitivity	Factors contributing to sensitivity	Examples of qualifying features
VERY HIGH	Indigenous natural areas that are highly positive for any of the following: ▪ Presence of threatened species (Critically Endangered, Endangered, Vulnerable) and/or habitat critical for the survival of populations of threatened species. ▪ High conservation status (low proportion remaining intact, highly fragmented, habitat for species that are at risk). ▪ Protected habitats (areas protected according to national/provincial legislation, e.g. National Forests Act,	▪ CBA 1 areas ▪ Remaining areas of vegetation type listed in Draft Ecosystem List of NEM:BA as Critically Endangered, Endangered or Vulnerable. ▪ Protected forest patches. ▪ Confirmed presence of populations of threatened species.

Sensitivity	Factors contributing to sensitivity	Examples of qualifying features
	Draft Ecosystem List of NEM:BA, Integrated Coastal Zone Management Act, Mountain Catchment Areas, Lake Areas Development Act) May also be positive for the following: ▪ High intrinsic biodiversity value (high species richness and/or turnover, unique ecosystems) ▪ High value ecological goods and services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value) ▪ Low ability to respond to disturbance (low resilience, dominant species very old).	
HIGH	Indigenous natural areas that are positive for any of the following: ▪ High intrinsic biodiversity value (moderate/high species richness and/or turnover). ▪ Presence of habitat highly suitable for threatened species (Critically Endangered, Endangered Vulnerable species). ▪ Moderate ability to respond to disturbance (moderate resilience, dominant species of intermediate age). ▪ Moderate conservation status (moderate proportion remaining intact, moderately fragmented, habitat for species that are at risk). ▪ Moderate to high value ecological goods & services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value). May also be positive for the following: ▪ Protected habitats (areas protected according to national/provincial legislation, e.g. National Forests Act,	▪ CBA 2 "critical biodiversity areas". ▪ Habitat where a threatened species could potentially occur (habitat is suitable, but no confirmed records). ▪ Confirmed habitat for species of lower threat status (near threatened, rare). ▪ Habitat containing individuals of extreme age. ▪ Habitat with low ability to recover from disturbance. ▪ Habitat with exceptionally high diversity (richness or turnover). ▪ Habitat with unique species composition and narrow distribution. ▪ Ecosystem providing high value

Sensitivity	Factors contributing to sensitivity	Examples of qualifying features
	Draft Coastal Zone Management Act, Mountain Catchment Areas Act, Lake Areas Development Act)	ecosystem goods and services.
MEDIUM-HIGH	Indigenous natural areas that are positive for one or two of the factors listed above, but not a combination of factors.	▪ CBA 2 "corridor areas". ▪ Habitat with high diversity (richness or turnover). ▪ Habitat where a species of lower threat status (e.g. near threatened, rare) could occur (habitat is suitable but no confirmed records).
MEDIUM-LOW	Degraded or disturbed indigenous natural vegetation	
LOW	No natural habitat remaining	

Any natural vegetation within which there are features of conservation concern will be classified into one of the high sensitivity classes (MEDIUM-HIGH, HIGH or VERY HIGH). The difference between these three high classes is based on a combination of factors and can be summarized as follows:

» Areas classified into the VERY HIGH class are vital for the survival of species or ecosystems. They are either known sites for threatened species or are ecosystems that have been identified as being remaining areas of vegetation of critical conservation importance. Proven/ grounthrthed CBA1 areas would qualify for inclusion into this class.
» Areas classified into the HIGH class are of high biodiversity value, but do not necessarily contain features that would put them into the VERY HIGH class. For example, a site that is known to contain a population of a threatened species would be in the VERY HIGH sensitivity class, but a site where a threatened species could potentially occur (habitat is suitable), but it is not known whether it does occur, is classified into the HIGH sensitivity class. The class also includes any areas that are not specifically identified as having high conservation status but, have high local species richness, unique species composition, low resilience or provide very important inclusion into this class, if there were no other factors that would put them into the highest class.
» Areas classified into the MEDIUM-HIGH sensitivity class are natural vegetation in which there are one or two features that make them of biodiversity value, but not to the extent that they would be classified into one of the other two

higher categories. Proven/groundtruthedCBA2 "corridor areas" would qualify for inclusion into this class.

2.4 Assessment of impacts

The Environmental Impact Assessment methodology assists in the evaluation of the overall effect of a proposed activity on the environment. This includes an assessment of the significant direct, indirect, and cumulative impacts. The significance of environmental impacts are to be assessed by means of the criteria of extent (scale), duration, magnitude (severity), probability (certainty) and direction (negative, neutral or positive).

» The **nature**, which includes a description of what causes the effect, what will be affected and how it will be affected.
» The **extent**, wherein it is 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 was assigned as appropriate (with 1 being low and 5 being high).
» The **duration**, wherein it was 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 describes the likelihood of the impact actually occurring. Probability was 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**, was determined through a synthesis of the characteristics described above and can be assessed as **LOW**, **MEDIUM** or **HIGH**; and
» the **status**, which was described as either positive, negative or neutral.
» the degree of 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 was calculated by combining the criteria in the following formula:

S=(E+D+M)P where;

» 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 the 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).

3 STUDY AREA

3.1 Locality

The proposed facility will be located in the northern section of the Remaining Extent of Farm Woodhouse 729, situated approximately 10 km south east of Vryburg. The identified site falls under the jurisdiction of the Naledi Local Municipality and within the greater Dr Ruth Segomotsi Mompati District Municipality in the North West Province.

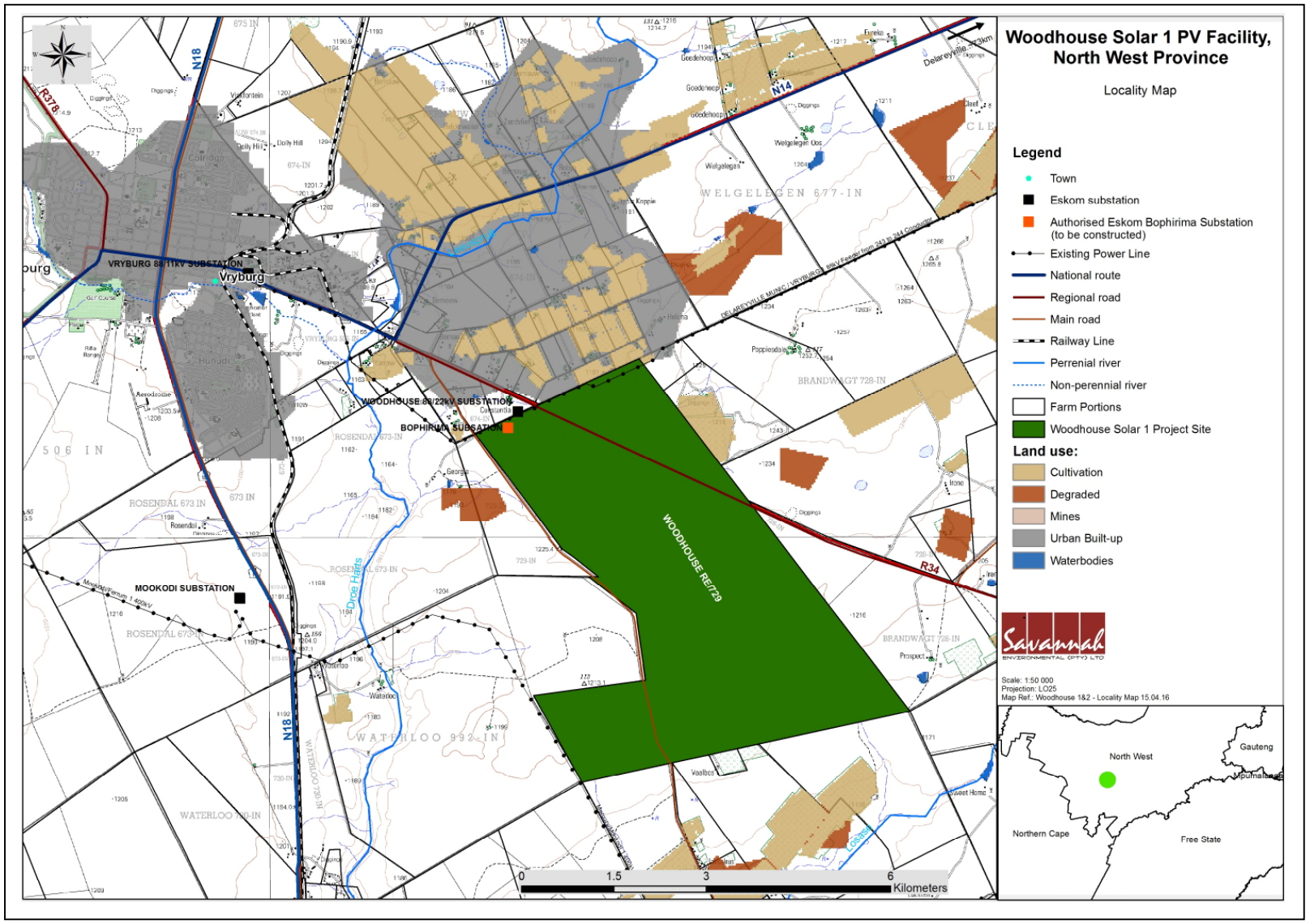

Figure 1: Locality map for the proposed Woodhouse Solar 1 PV Facility development (Map provided by Savannah Environmental).

3.2 Climate and rainfall

The climate associated with the study area has been derived from recorded and extrapolated climatic data (http://en.climate-data.org/location/10658/) for Vryburg. Rainfall occurs mainly in summer and autumn with very dry winters. Mean annual rainfall is about 477mm with January being the wettest month, averaging about 89mm, and July being the driest, with an average of only 4mm. The average annual temperature in Vryburg is 17.9°C with January being the warmest (Ave. 24.8°C) and July being the coldest (Ave 9.3°C). Frost is frequent to very frequent in winter (mean frost days: 40).

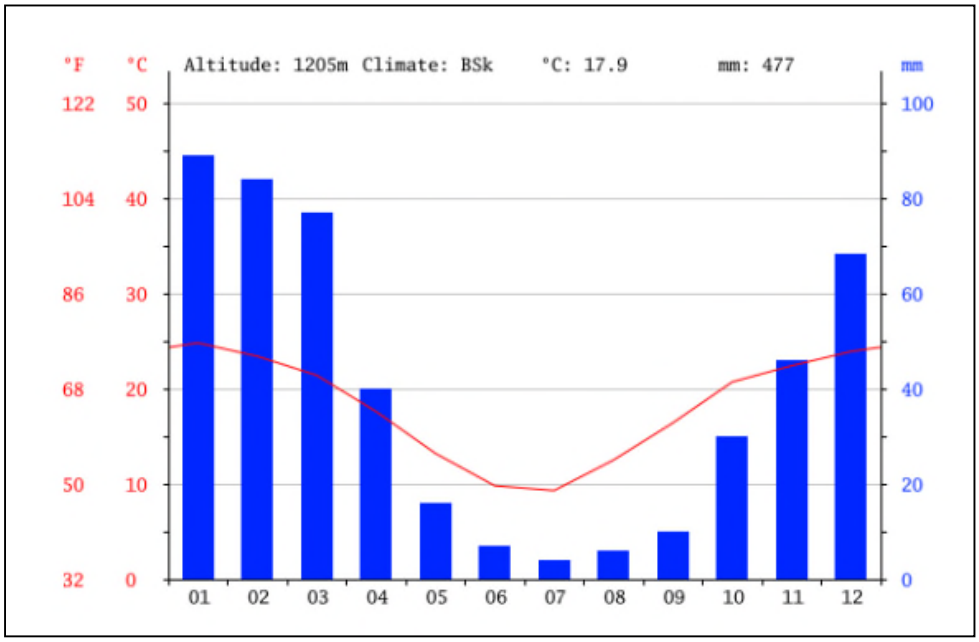

Figure 2: Climate graph of Vryburg (http://en.climate-data.org/location/10658/).

month	1	2	3	4	5	6	7	8	9	10	11	12
mm	89	84	77	40	16	7	4	6	10	30	46	68
°C	24.8	23.4	21.4	17.6	13.2	9.8	9.3	12.5	16.4	20.7	22.4	23.9
°C (min)	17.2	16.3	14.3	9.8	4.4	0.4	-0.3	2.6	7.0	12.0	14.3	16.1
°C (max)	32.4	30.5	28.5	25.5	22.1	19.3	19.0	22.5	25.9	29.5	30.5	31.8
°F	76.6	74.1	70.5	63.7	55.8	49.6	48.7	54.5	61.5	69.3	72.3	75.0
°F (min)	63.0	61.3	57.7	49.6	39.9	32.7	31.5	36.7	44.6	53.6	57.7	61.0
°F (max)	90.3	86.9	83.3	77.9	71.8	66.7	66.2	72.5	78.6	85.1	86.9	89.2

Figure 3: Climate table of Vryburg (http://en.climate-data.org/location/10658/).

3.3 Physiography and soils

Landscape Features

According to Mucina and Rutherford (2006) the region can be described as a flat plateau and is consistent with the landtype classification (AGIS 2007) which classifies the landscape as Class A2 with an average slope of between 0% and 2%.

At a finer scale using a Google elevation profile for the study area and immediate surroundings the area can be described as a plateau.

The farm property is situated at elevations of between 1 197m and 1230m above sea level with an average slope of less than 1.5% and maximum south and north slopes of 5.8% -3.4%. The largest portion of the farm property is situated on a relatively flat plateau with gradual slopes towards lower lying areas to the north (area earmarked for the development of the relevant project), south and the north-west (refer to Figure 4). The north and south facing slopes are relatively gradual (Ave northern slope: 2.1% and Ave southern slope: 3.4%), although the north facing slope contain areas (just below plateau edge) which are more steep (Max slope: 5.8 %). As mentioned the area earmarked as the development footprint area is located in a lower lying flat plain characterized by very low gradients.

A ridge (including the crest and upper slope) is located within the project site and is situated to the west of the R34. This feature is outside of the development footprint proposed for the Woodhouse Solar 1 PV Facility and traverses the project site in an east-west fashion. This ecological feature is avoided by the development area.

Geology

The study area is underlain by siliciclastic (quartzite) rocks of the Vryburg Formation (Transvaal Supergroup) as well as the Dwyka Group (Karoo Supergroup). Dwyka tillites may be found scattered within these areas (refer to Figures 5 and 6).

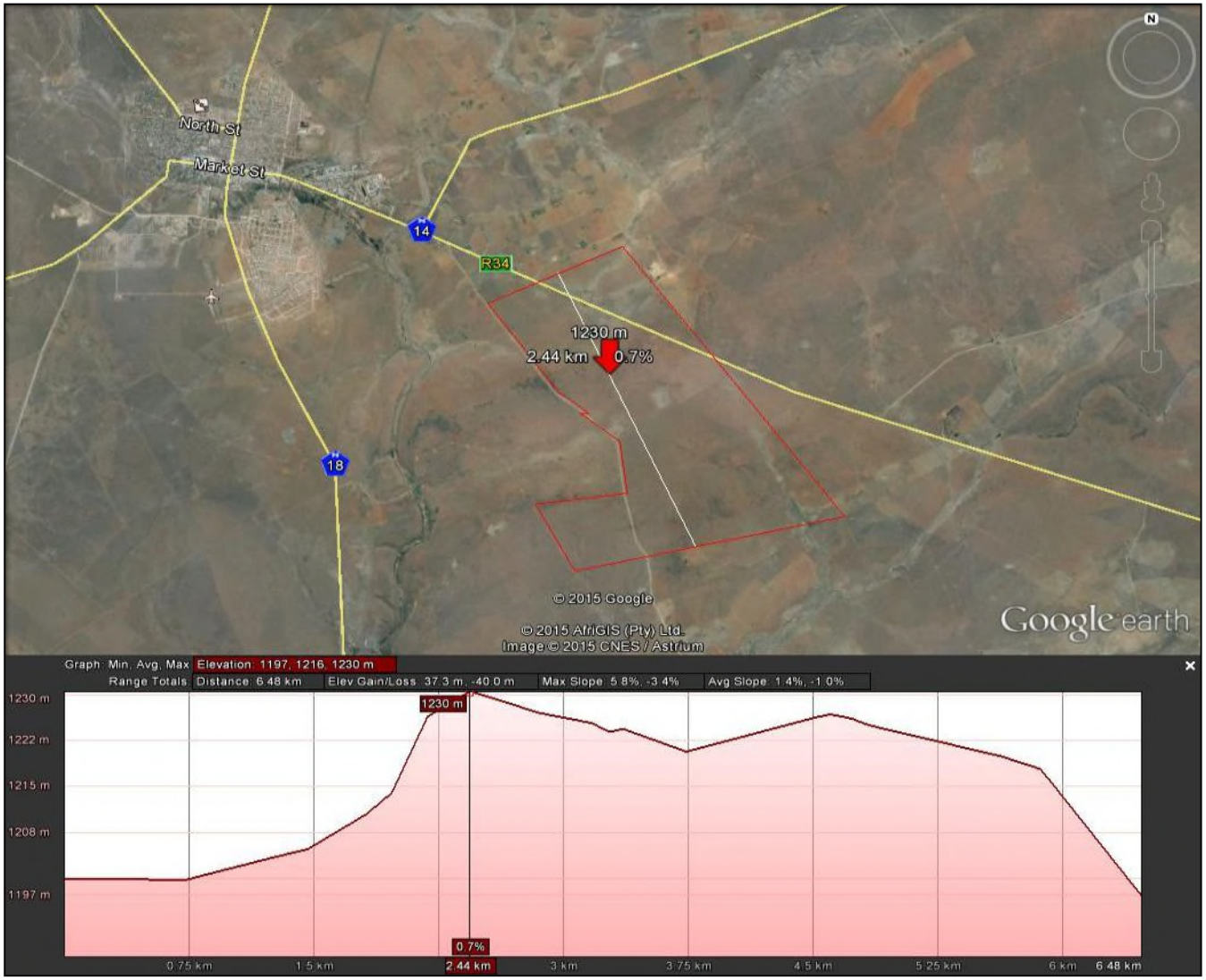

Figure 4: North to South elevation profile (Google) of the study area.

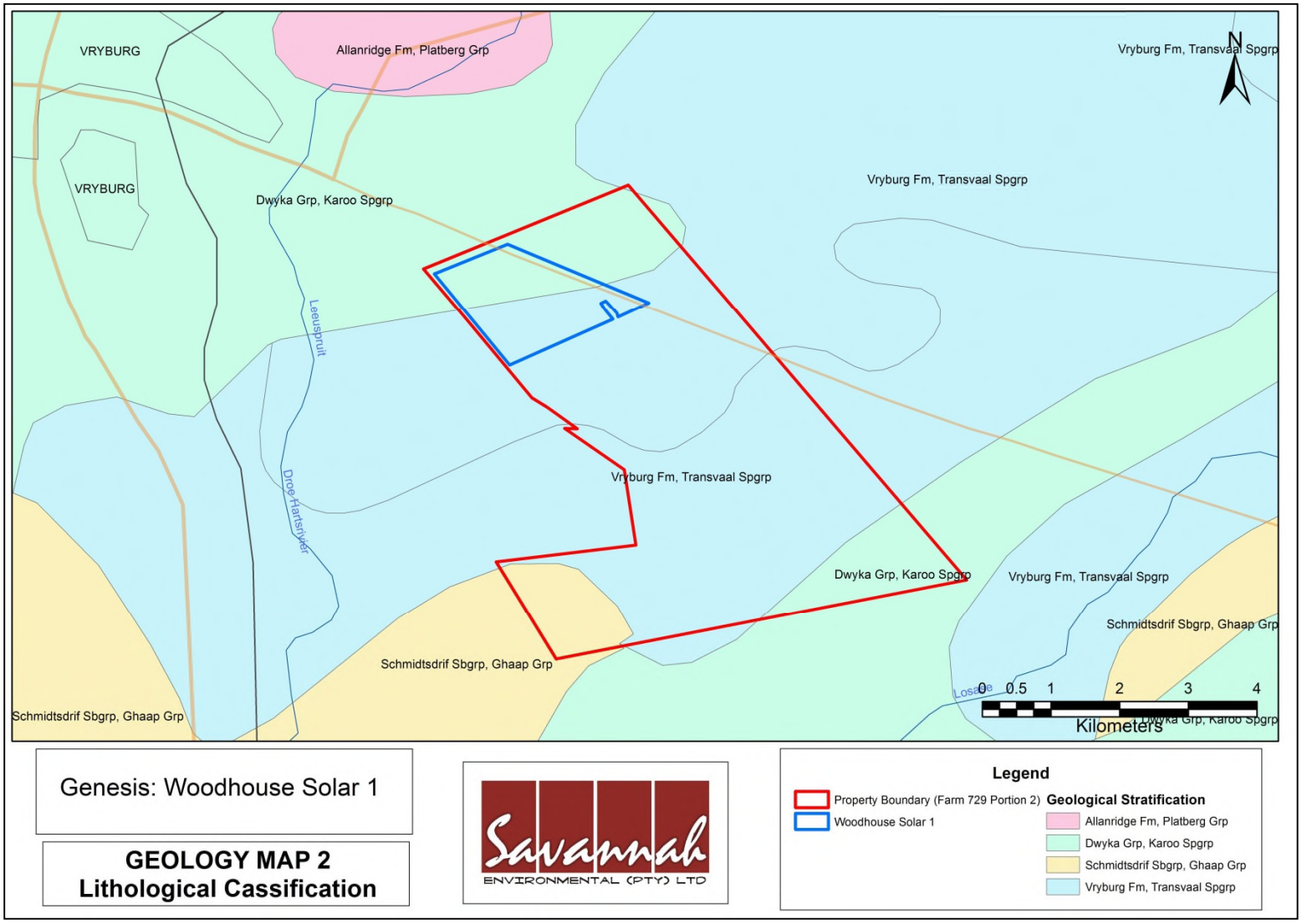

Figure 5: The geological stratification of the farm portion as well as surrounding environment (Map provided by Savannah Environmental).

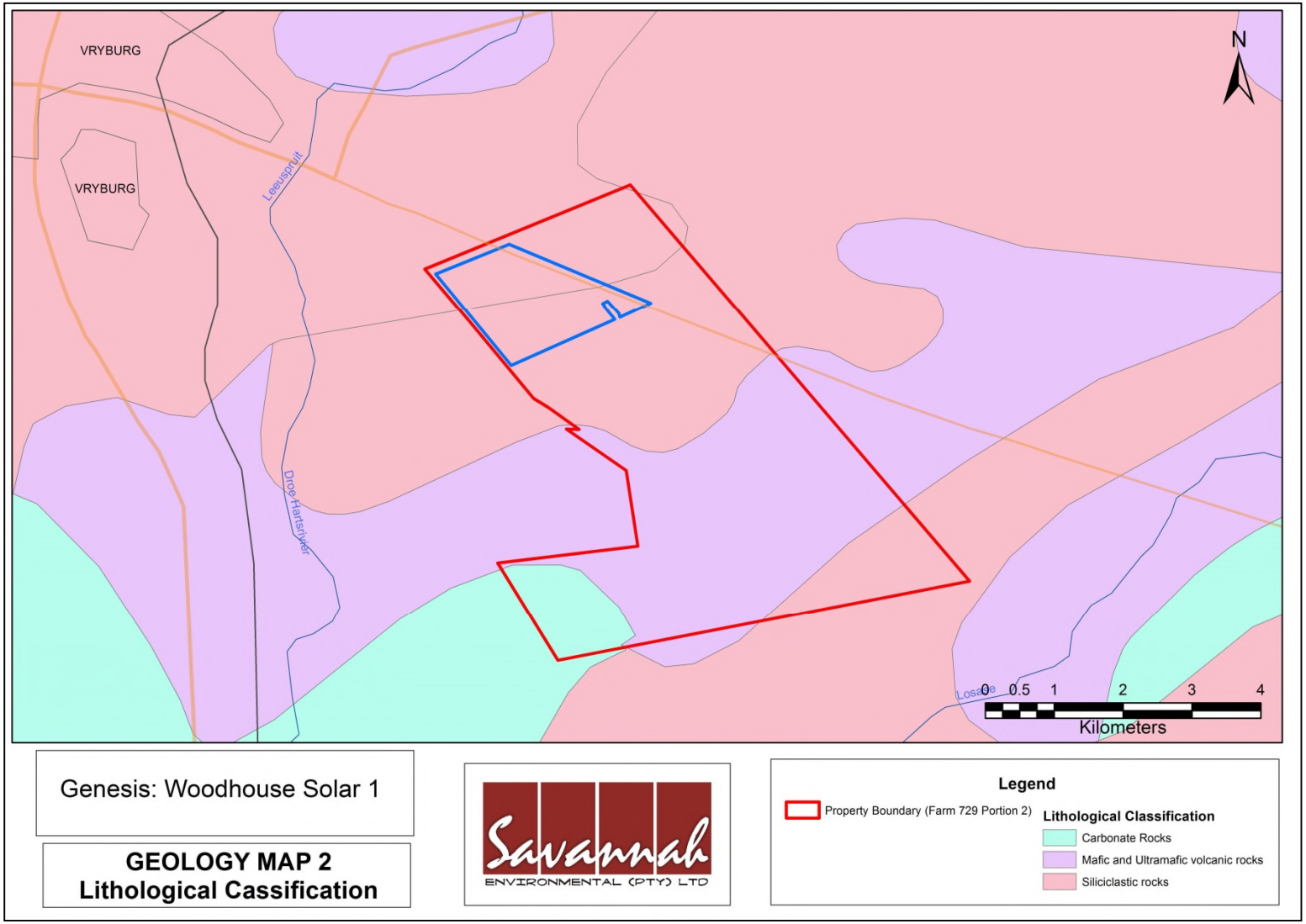

Figure 6: The lithological classification of the rock underlying the study area as well as the surrounding environment (Map provided by Savannah Environmental).

Soil and Landtypes

Detailed soil information is not available for broad areas of the country. As such a surrogate landtype data was used to provide a general description of soil in the study area (landtypes are areas with largely uniform soils, typography and climate). There are two landtypes present in the study area, i.e. the Ae36 and Ag10 landtypes (Land Type Survey Staff, 1987). The largest portion of the development footprint area can be characterised by landtype Ag10, whilst the south and eastern section is characterised by landtype Ae36 (refer to Figure 7).

- The Ae group of landtypes refer to red-yellow apedal, freely drained soils. These soils are moderately deep (ave. 500mm – 1200mm) red, freely drained and apedal (structureless). These soils generally occur in areas associated with low to moderate rainfall (300mm – 700mm per annum) in the interior of South Africa and have a high fertility status. A wide range of texture occurs (usually sandy loam to sandy clay loam). Common soil forms are Mispah and Hutton and to a lesser extent, Clovely, Stertkspruit and Rensburg.
- The Ag group of landtypes refer to red-yellow apedal, freely drained soils. These soils are shallow (less than 300mm), red, freely-drained, apedal soils that occur in arid to semi-arid areas associated with low rainfall (less than 500mm per annum), as well as areas underlain by hard to weathered rock. A wide range of textures may occur (usually loamy sand to sandy loam). Stones or rocks are often present on the soil surface. Common soil forms are Mispah, Hutton and rock whilst soil forms such as Glenrosa and Shortlands are sparsely present.

Hydrology

The study area is situated in the catchment areas of the Losase River and the Droë Harts River. A number of non-perennial (most likely) or perennial drainage lines traverse the farm property most of which flow in a north to south and north-east to south-east direction. According to NFEPA wetland classification, two wetland depressions and two small wetland flats, as well as two channelled valley bottom wetlands can be found within the farm property, none of which is located in close proximity to the development footprint area for Woodhouse Solar 1 PV Facility. Prior a desktop delineation and a site visit, four depression wetlands, one valley bottom wetland which has been transformed by the presence of a small dam, one flat/depression wetland which also seems to have been dammed and two other artificially constructed dams, were identified within the farm property. Most of these wetland bodies area located well beyond the boundary of the proposed Woodhouse 1 Solar PV development. The only wetland body located in close proximity to the site as an artificial dam located in the north-east of the footprint area. As mentioned, non-perennial (most likely) or perennial

drainage lines traverse the farm property. Most of these drainage systems are ephemeral tributaries which link up with larger ephemeral streams to eventually terminate into either the Losase River or the Droë Harts River. Two small ephemeral tributary is present to the south west and south east of the development footprint area and flows in a south-western direction to terminate in the Droë Harts River.

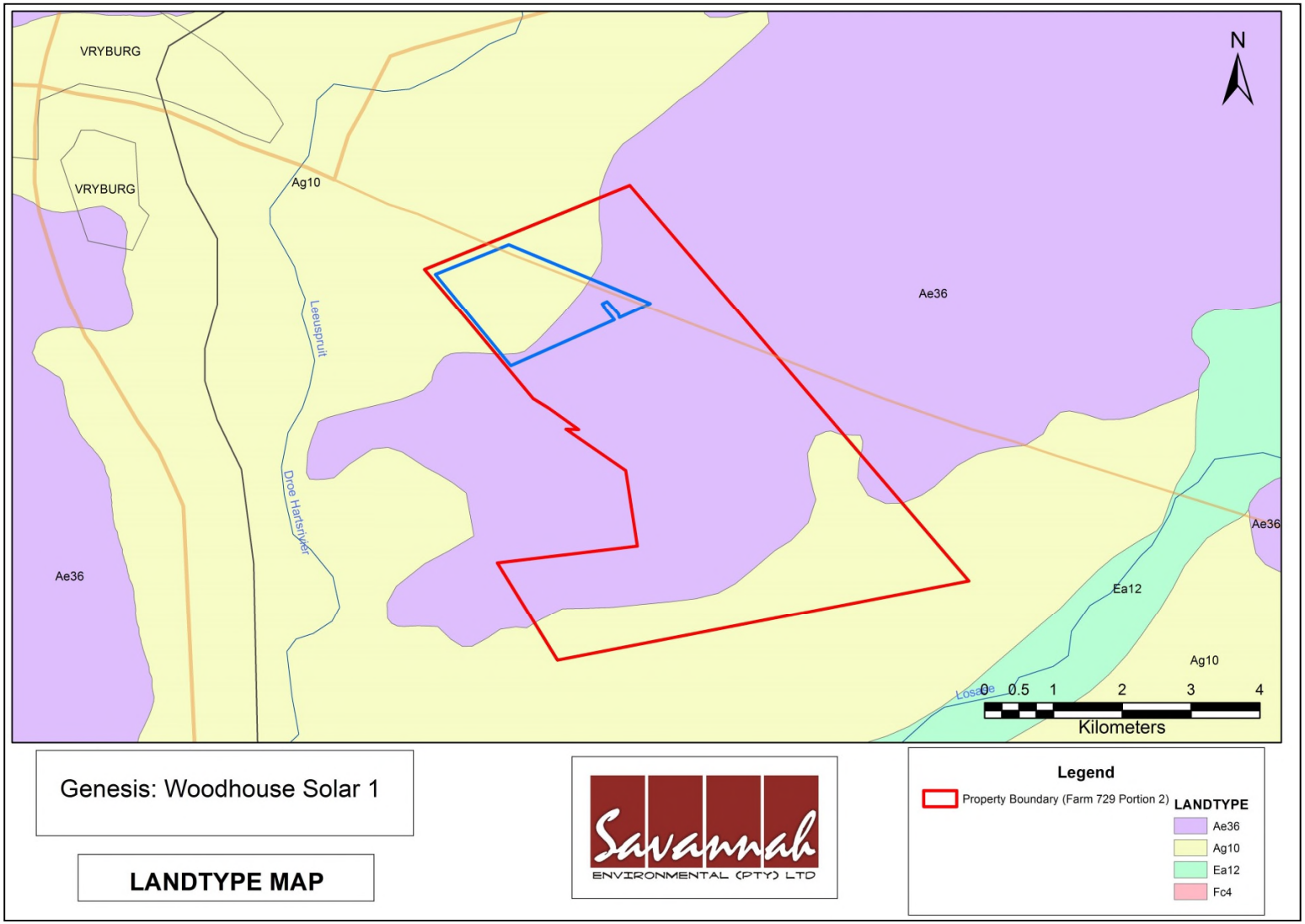

Figure 7: Landtypes found within the study area as well as the surrounding environment (Map provided by Savannah Environmental).

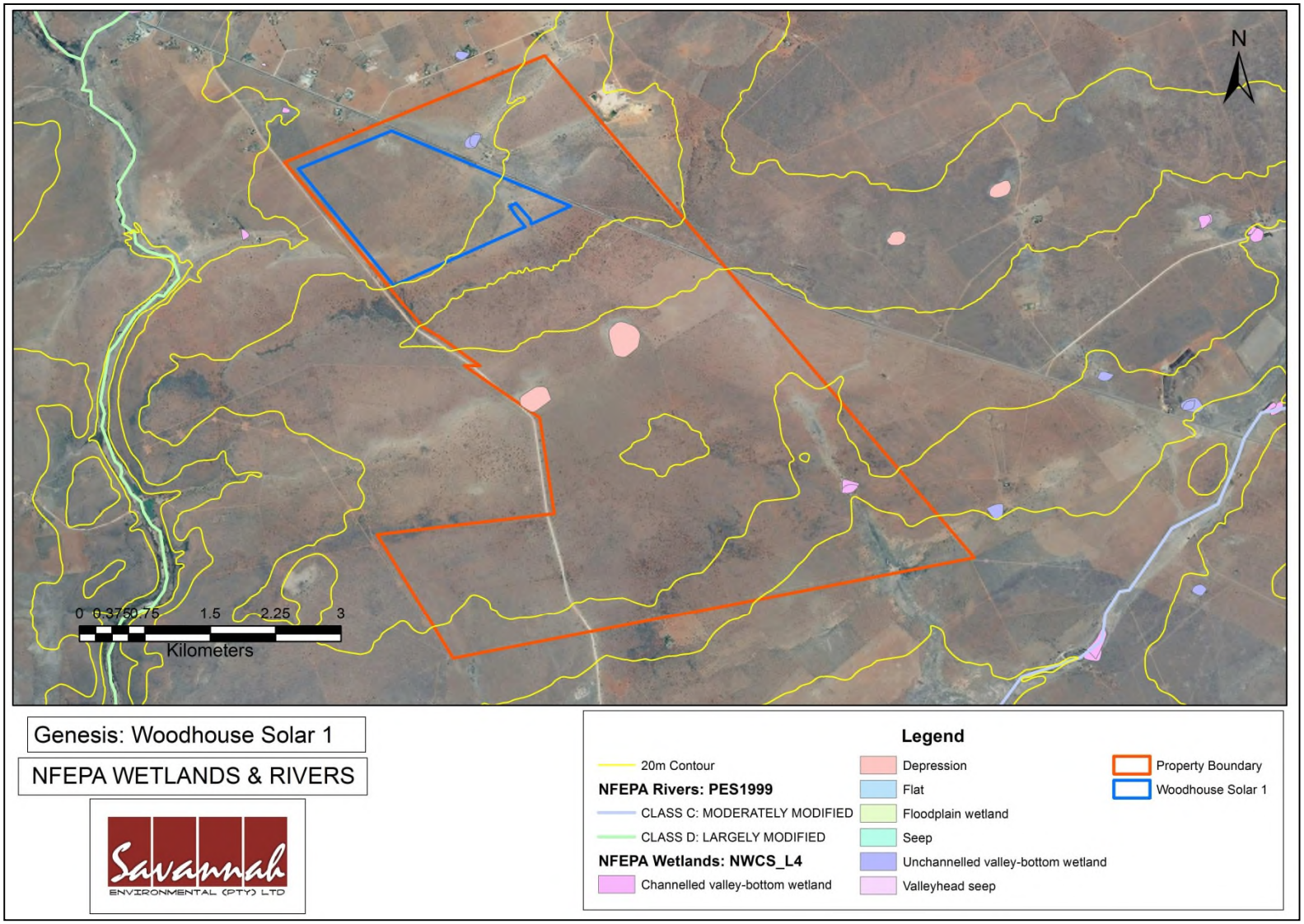

Figure 8: NFEPA wetland and streams (Map provided by Savannah Environmental).

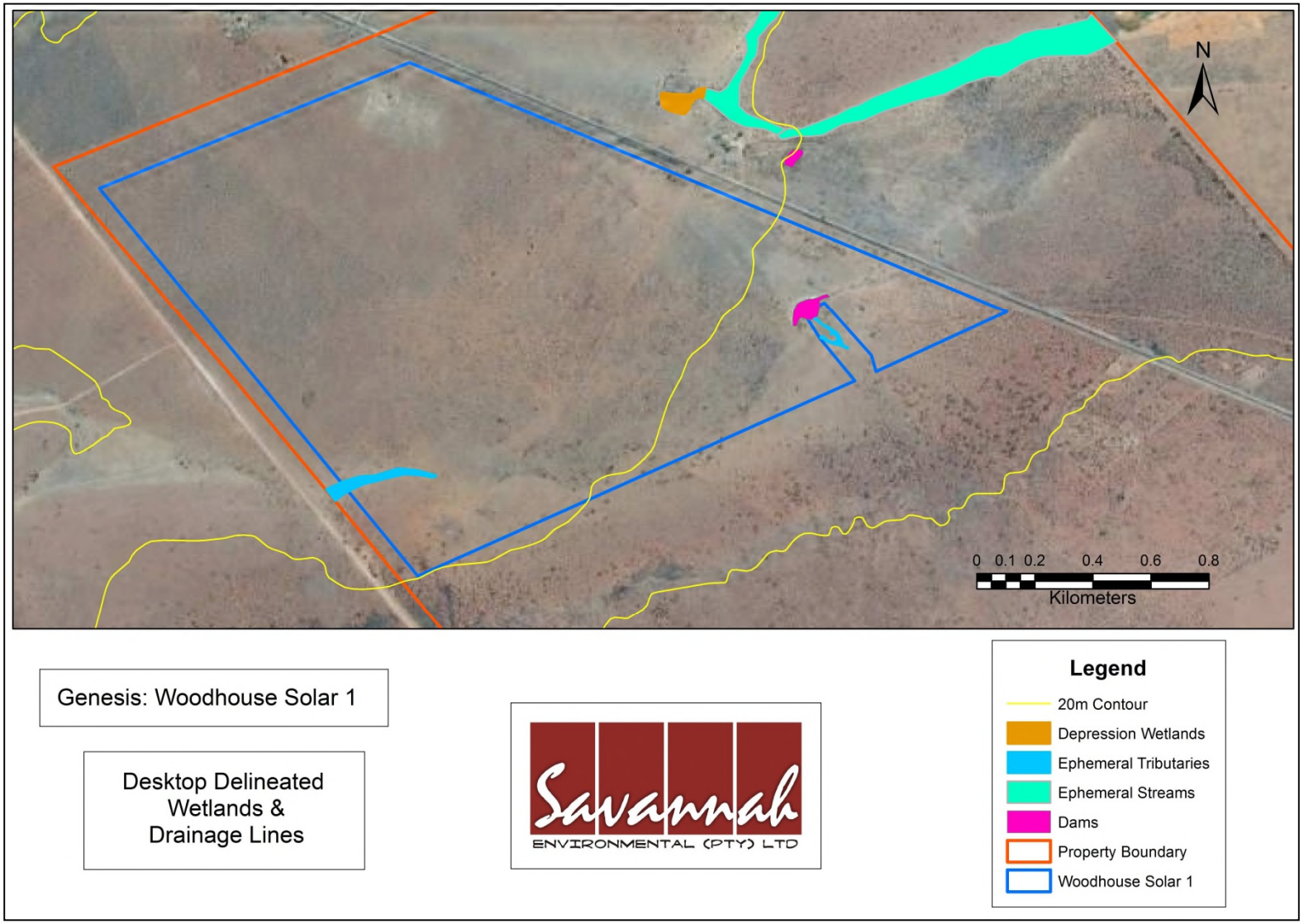

Figure 9: Desktop delineated wetlands and drainage lines (no buffers) (Map provided by Savannah Environmental).

Geohydrology

Regarding the geohydrology of the area a study was conducted by Tessema and Nzotta (2014) wherein they evaluated the groundwater resource potential in the Naledi Local Municipality. From the study the following conclusions were made:

Based on similarity in hydrological properties, the area can be broadly subdivided into three potential aquifer types.

» *Basement Aquifers*: Consisting of Kraaipan, Ventersdorp volcanics and Archaean intrusive rocks. These aquifer types extend over a very large area, but are concealed by a veneer of Tertialry-to-Quaternary terrestrial sedimentary rocks.
» *Inter-granular aquifers*: Comprise of alluvial gravel and clastic sedimentary rocks of the Ventersdorp and Kalahari Group. The alluvial gravel aquifers often occur along major rivers that are located southeast of Stella and south of Vryburg towns.
» *Karst aquifers*: These aquifers are associated with the Malmani Subgroup of the Transvaal basin and consist out of limestone, dolomite and calcareous sedimentary rocks that largely cover the area south of Vryburg town.

The study found that the southern part of the Naledi Local Municipality is characterized by *good groundwater potential*. The most significant zone covers approximately 14% of the municipality and is located within carbonate rocks to the south of the municipality and includes a very small section of the study site. These areas also play an important role as recharge zones. The relatively tritium enrichment of groundwater suggest that the groundwater recharge zone take place through the process of infiltration of rain and surface water. In addition, dissolution of carbonate rocks in these areas, by water that percolates through pre-existing fractures leading to enlarged fracture apertures, may consequently result in the development of large cavities.

The zone of *good groundwater potential* within the Ventersdorp Supergroup coincides with maximum concentration of fractures joints and fissures. Rocks of the Ventersdorp and Transvaal Supergroups in the western edge of the Kaapvaal craton are block faulted during 'cratonic updoming' at approximately 2.1 billion years ago. As a result of this process most of the rocks were deformed and fractured. Surface water or mildly acidic rain water percolates along these features (i.e. fractures and faults) and dissolve the underlying carbonate rocks. This suggests that pre-existing structures within carbonate rocks played a significant role in the development of high yielding wellfields within the region. In addition, younger and coarse sedimentary rocks of the Karoo Supergroup and

Kalahari sand were deposited atop the Transvaal carbonate rocks which enhanced the seepage of rainwater.

Moderate-to-good groundwater potential zones locally follow the main rivers within the Ventersdorp and Kalahari Group suggestive of proximity to river channels as one of important indicators of groundwater potential.

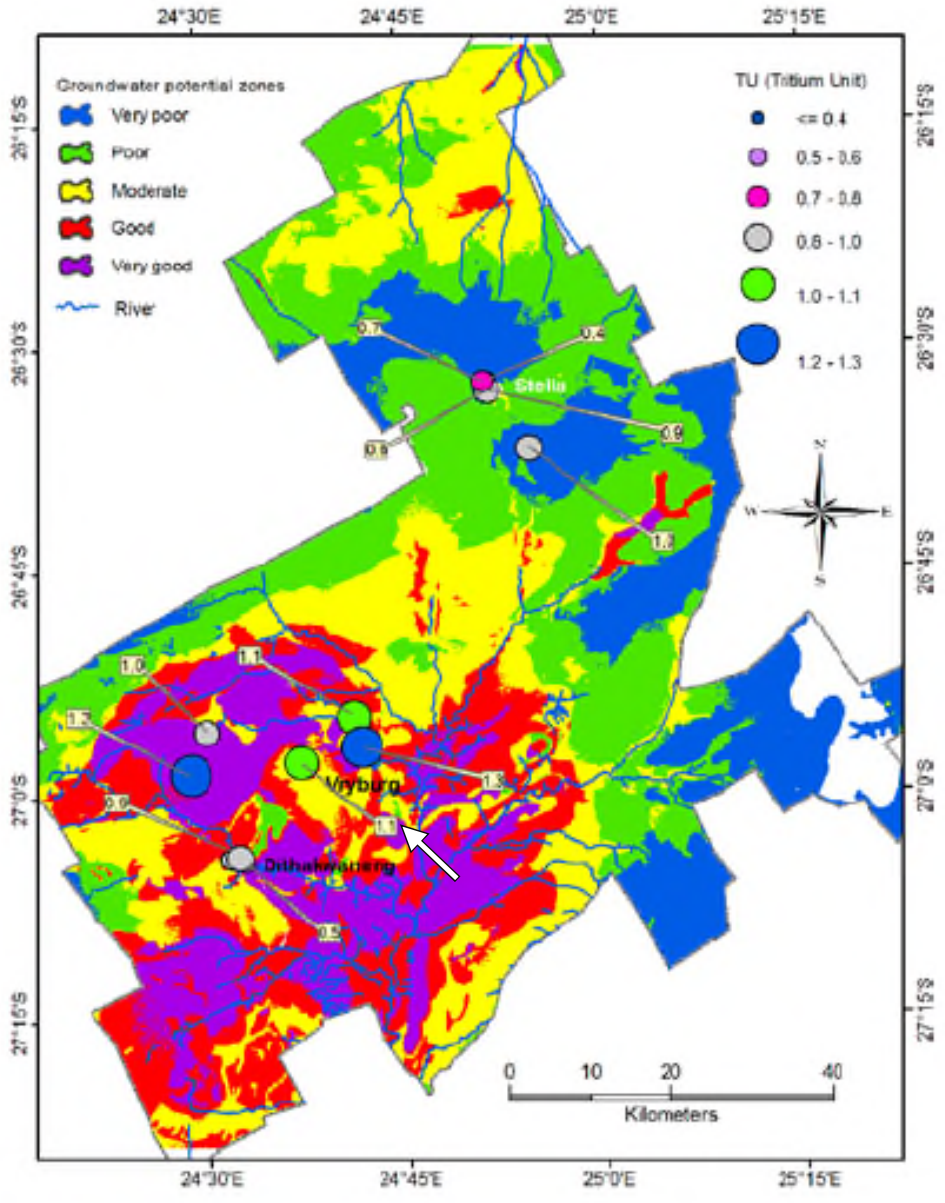

Figure 10: Groundwater potential map of the Naledi Local Municipality, North West Province (approximate position of proposed site indicated with a white arrow). The superimposed graduated solid circles show tritium composition in groundwater (Tessema & Nzotta, 2014)

3.4 Existing Land Use

The study site is most likely being used for livestock farming, with a possible presence of game. The farm portion is traversed by the R34 enabling relatively easy access.

At the time of the survey some bush clearance was underway within the north eastern section of the proposed development footprint area. Moderate levels of historical overgrazing has gradually lead to an increase in woody components (visible, especially to the west) and the current clearance of some of these tree and shrub species are most likely done in an attempt to improve grazing.

Within the north-eastern corner an old gravel pit is present.

3.5 Strategic Environmental Assessment for wind and solar PV energy in South Africa – Renewable Energy Development Zones (REDZs)

A Strategic Environmental Assessment (SEAs) has been undertaken by the Department of Environmental Affairs (DEA) in order to contribute to the implementation of the National Development Plan and National Infrastructure Plan, as well as to provide adaptive processes that streamline the regulatory environmental requirements for Strategic Integrated Projects (SIPs) whilst safeguarding the environment. The wind and solar photovoltaic (PV) SEA was accordingly commissioned by the DEA with the objective of facilitating the implementation of sustainable green energy initiatives.

The SEA identifies areas where large scale wind and solar PV energy facilities can be developed in terms of SIP 8 and in a manner that will significantly limit negative impacts on the environment, whilst yielding the highest possible socio-economic benefits to the country. These areas are referred to as Renewable Energy Development Zones (REDZs).

The SEA undertaken in this regard led to the identification of eight proposed REDZs with a combined size of approximately 80 000 km^2 and comprising about 17 000 farm portions.

The solar PV assessment domain was informed by the location of the majority of existing solar PV project applications at the commencement of the SEA and includes the five provinces of the Northern Cape, Western Cape, Eastern Cape, Free State and North West.

The property earmarked for the proposed PV facility (Remaining Extent of Farm Woodhouse 729, Vryburg, North West Province) is located within such a REDZ area (Figure 11).

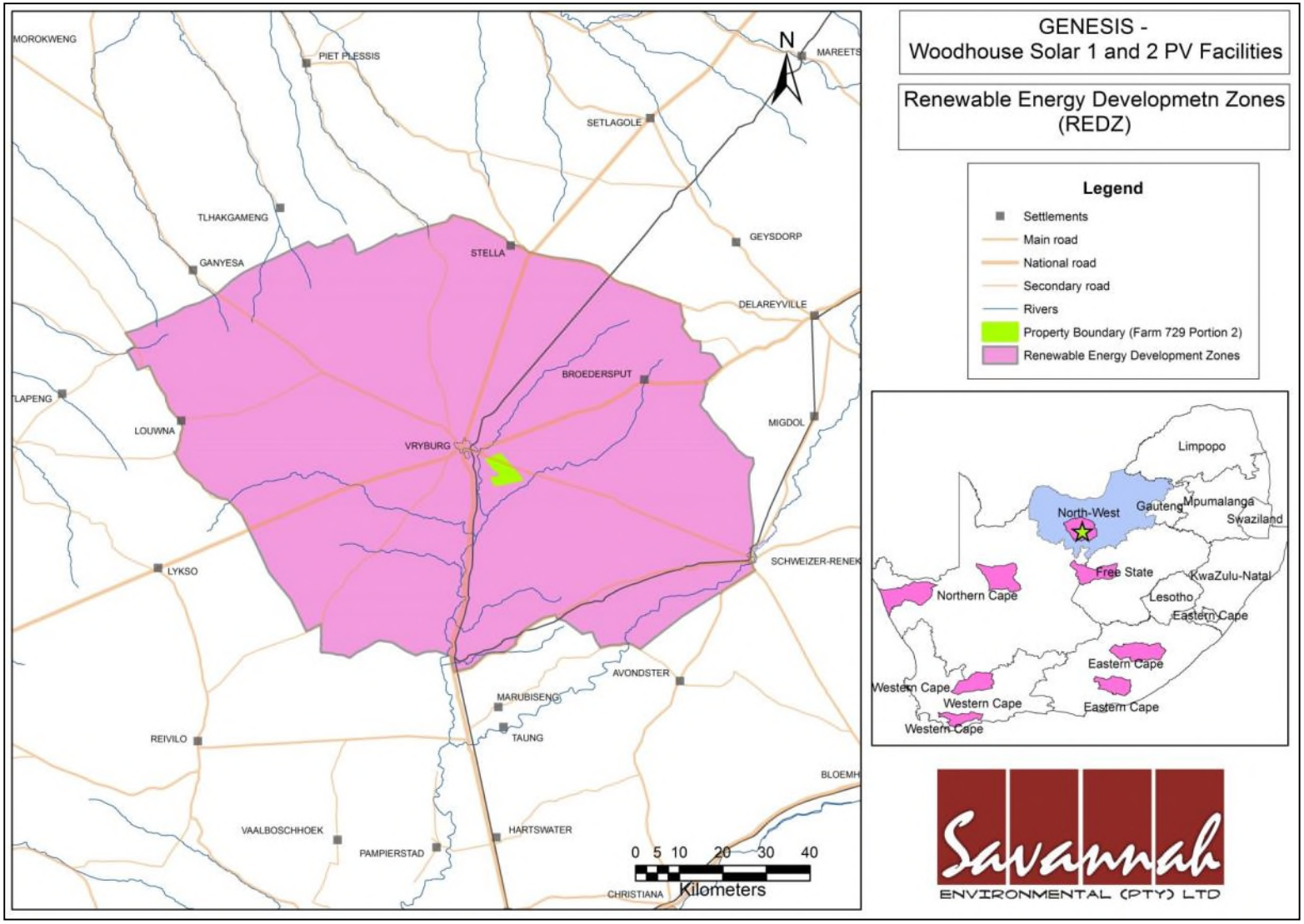

Figure 11: The property earmarked for the proposed PV facility (Remaining Extent of Farm Woodhouse 729, Vryburg, North West Province) is located within a REDZ (Renewable Energy Development Zones) area (Map provided by Savannah Environmental).

3.6 Contamination risk

Although the overall slope is relatively low, a small ephemeral tributary traverse a small portion to the south west of the study area. As mentioned this tributary terminates into a larger ephemeral stream outside of the study area and eventually flows into the Droë Harts River and thus the potential exists (although expected to be low) for contaminants such as chemicals or oils from the solar facility (during construction and operation) to be washed downstream. However, due to the relative flatness of the area, accidental spills can most likely be contained within the spill area, where it can be adequately treated.

Groundwater forms an important water resource within this region and the infiltration rate of surface and rain water is relatively high. Thus there exist a potential of contaminants such as chemicals and oils from the solar facilities (during construction and operation) polluting aquifers and should be addressed during the planning phase.

4 RESULTS

4.1 Vegetation overview

Broad vegetation types

The study area is situated in the Savanna biome and Eastern Kalahari Bushveld Bioregion. The vegetation in and surrounding the study area is Ghaap Plateau Vaalbosveld (SVk 7).

The distribution of the vegetation type is spread across the Northern Cape and North West Province, from about Campbell in the south east of Danielskuil through Reivilo to around Vryburg in the north. This vegetation type has been described by Mucina and Rutherford (2006) as a flat plateau with well-developed shrub layer with *Tarchonanthus camphoratus* and *Acacia karroo*. Open tree layer has *Olea europaea* subsp. *africana*, *A. tortilis*, *Ziziphus mucronata* and *Searsia lanceae*. *Olea* is more important in the southern parts of the unit, while *A. tortilis*, *A. hebeclada* and *A. mellifera* are more important in the north and part of the west of the unit. Much of the south-central part of this unit has remarkably low cover of Acacia species for an arid savanna and is dominated by the non-thorny *T. camphoratus, R. lanceae* and *O. europaea* subsp. *africana.*

A species list from POSA (http://posa.sanbi.org, Grid reference 2624 and 2724) containing the species that have been recorded to date in the Vryburg area was obtained. POSA generated species lists also contain updated Red Data species

status according to the Red List of South African Plants published by SANBI in Strelitzia 25 (Raimondo *et al*. 2009, updated 2013). Only protected and red data species that may potentially occur in the study area have been listed under results. The actual field survey will confirm which of the species already recorded will actually occur in the study area, and may reveal the presence of additional species that may not have been recorded in official databases to date.

A total of 369 indigenous species have been recorded in the Vryburg region according to the SANBI database. It is highly unlikely that all of these species will occur within the project area. Alien invasive species (33) have also been recorded within the relevant quarter degree grids.

Conservation status of broad vegetation types

The vegetation types of South Africa have been categorized according to their conservation status which is, in turn, assessed according to the degree of transformation and rates of conservation. The status of a habitat or vegetation type is based on how much of its original area still remains intact relative to various thresholds. On a national scale these thresholds are as depicted in the table below, as determined by best available scientific approaches (Driver *et al*. 2005). The level at which an ecosystem becomes Critically Endangered differs from one ecosystem to another and varies from 16% to 36% (Driver *et al*. 2005).

Table 2: Determining ecosystem status (from Driver et al. 2005). *BT = biodiversity target (the minimum conservation requirement.

Habitat remaining (%)		
80–100	least threatened	LT
60–80	vulnerable	VU
*BT–60	endangered	EN
0–*BT	critically endangered	CR

The National List of Ecosystems that are Threatened and in need of protection (GN1002 of 2011), published under the National Environment Management: Biodiversity Act (Act No. 10 of 2004), lists national vegetation types that are afforded protection on the basis of rates of transformation. The threshold for listing in this legislation is higher than in the scientific literature, which means there are fewer ecosystems listed in the National Ecosystem List versus in the scientific literature.

Table 3: Conservation status of the vegetation type occurring in and around the study area.

Vegetation Type	Target (%)	Conserved (%)	Transformed (%)	Conservation Status	
				Driver *et al*., 2005; Mucina & Rutherford, 2006	National Ecosystem List (NEM:BA)
Ghaap Plateau Vaalbosveld	16%	0	1%	Least Threatened	Not Listed

According to Mucina and Rutherford (2006) none of the vegetation type is protected within formal conservation areas, but only 1% of this unit has been transformed. The conservation status of this unit is classified as Least Threatened and is not listed under the National List of Ecosystems that are Threatened and in need of protection (GN1002 of 2011), published under the National Environment Management: Biodiversity Act (Act No. 10 of 2004).

Red List and protected plant species of the study area

As previously mentioned, a species list was obtained from POSA for the relevant degree grids. The species on this list were evaluated to determine the likelihood of any of them occurring in the study area. Of the species that are considered to occur within the geographical area under consideration, there were 19 species which are regarded conservation worthy. Three species recorded in the degree grids are listed on the Red List plant species. According to the South African Red List Categories, one is listed as Rare (*Gnaphalium nesonii*), one Vulnerable (*Rennera stellata*) and one Near Threatened (*Lithops lesliei*). *Boscia albitrunca* is the only tree species protected according to the National Forest Act (NFA) that may potentially occur within the study area. The remaining 15 species are protected within the Transvaal Nature Conservation Ordinance (TNCO) and Bophuthatswana Nature Conservation Act (BNCA).

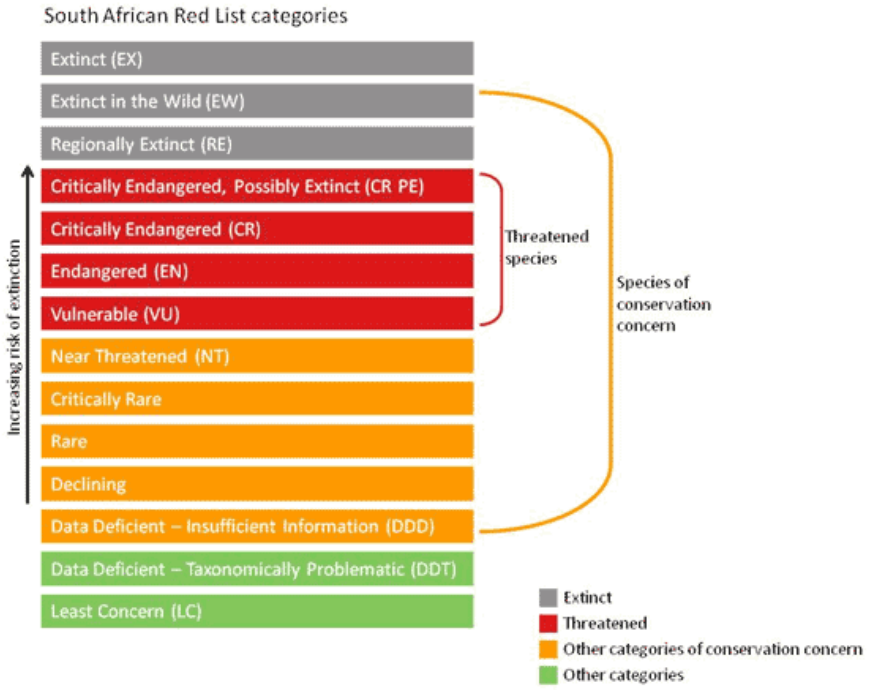

Figure 12: Schematic representation of the South African Red List categories. Taken from http://redlist.sanbi.org/redcat.php

Table 4: Species listed as conservation worthy within the South African Red List, National Forest Act (NFA), Transvaal Nature conservation Ordination (TNCO) and Bophuthatswana Nature Conservation Act (BNCA).

Species	Status
Gnaphalium nesonii	Rare
Rennera stellata	Vulnerable
Lithops lesliei	Near Threatened
Boscia albitrunca	NFA
Ammocharis coranica	TNCO & BNCA
Brunsvigia radulosa	TNCO & BNCA
Crinum crassicaule	TNCO & BNCA
Nerine frithii	TNCO & BNCA
Nerine hesseoides	TNCO & BNCA
Nerine laticoma	TNCO & BNCA
Brachystelma dimorphum subsp. dimorphum	TNCO & BNCA
Brachystelma foetidum	TNCO & BNCA
Ceropegia crassifolia var. crassifolia	TNCO & BNCA
Hoodia pilifera subsp. annulata	TNCO & BNCA
Stapelia grandiflora var. grandiflora	TNCO & BNCA
Aloe grandidentata	TNCO & BNCA
Aloe zebrina	TNCO & BNCA

Species	Status
Chortolirion angolense	TNCO & BNCA
Babiana bainesii	TNCO & BNCA

4.2 Fine-Scale Vegetation Description

The development footprint area is situated within a very uniform habitat with little variation in terms of geology, pedology, slope etc. Subsequently the vegetation also depicts this flat monotonous habitat consisting out of a single vegetation unit consistent with the vegetation classification provided by Mucina & Rutherford (2006) (Ghaap Plateau Vaalbosveld). Soil tends to be a relative deep and sandy and contain some loose stones and rocks. The vegetation unit covering the development footprint area can be classified as: *Enneapogon cencroides – Grewia flava* open bushveld.

Enneapogon cencroides – Grewia flava open bushveld:

This unit stretches well beyond the footprint area and forms the dominant unit within the farm portion as well as beyond the affected farm boundary. This unit is extensively used for grazing and subsequently has been steadily transformed over a very long period of time due to long term grazing (evidence of intense grazing pressure and overgrazing). Although in a semi-natural state this unit still, provide valuable ecological functions. One of the effects of historical grazing pressure within this unit is the increase in the woody component (bush encroachment), especially *Tragonanthus camphoratus* and *Grewia flava*. Even with this increase in woody species this area comprises out of a high diversity of grass species (over 35 species). At the time of the survey, some bush clearance was underway within the north-eastern portion of the footprint area. Apart from this "opened up" area the rest of the unit can be described as a relative open bushveld consisting out of mainly medium to small sized broad leaved trees and shrubs. The grass layer as mentioned is relative well developed and dense consisting mainly out of subclimax increaser 2 species which is indicative of overgrazed veld. The small ephemeral tributary is diffuse with no clear channels distinguishing the tributary from the surrounding environment. Themeda triandra is relative prominent within this tributary whereas T. triandra is almost absent from the surrounding environment.

Species characterising this unit include:

» Medium sized trees: *Acacia mellifera, Acacia robusta* subsp. *robusta*,
» Small trees / Shrubs: *Tragonanthus camphoratus, Grewia flava*
» Dwarf Shrubs: *Lycium cinereum, Asparagus nelsii, Lippia javanica*
» Herbs: *Monsonia burkeana, Senna italic, Convolvulus sagittatus, Aptosimum elongatum, Heliotropium ciliatum, Waltheria indica, Hermbstaedtia odorata, Cleome monophylla, Barleria macrostegia, Commelina africana*
» Climbers: *Pergularia daemia* var. *daemia, Coccinia rehmannii*

» Geophytes: *Moraea stricta, Bulbine narcissifolia, Ammocharis coranica*
» Succulent herbs: *Protulaca oleraceae, Aloe grandidentata*
» Grasses: *Cymbopogon pospischilii, Tragus berteronianus, Anthephora pubescens, Pennisetum spp., Centropodia glauca, Aristida adscensionis, Enneapogon cenchroides, Schmidtia pappophoroides, Eragrostis trichophora, Eragrostis rigidior, Eragrostis curvula, Digitaria eriantha, Urochloa mosambicensis, Eragrostis lehmannaina*

Red List and protected plant species confirmed during the survey

A total of four conservation-worthy species were noted within the development footprint area namely:

» *Aloe grandidentata* (TNCO & BNCA)
» *Ammocharis coranica* (TNCO & BNCA)
» *Acacaia erioloba* (NFA)
» *Boophone disticha* (Declining)

Of the four conservation worthy species, *Aloe grandidentata* (succulent) and *Ammocharis coranica* (geophyte) were quite prominent within this unite and was regularly encountered. *Acacia erioloba* (tree) as well as *Boophone disticha* (geophyte) were sparsely distributed (in low numbers) through this unit. The aloe species as well as the geophytic species can be easily removed and transplanted. As the *A. erioloba* trees are so low in numbers and sparsely distributed the developer should attempt to conserve these species were possible.

Alien Invasive Plants (AIPs) confirmed during the survey

Although a few AIPs and weeds were noted during the survey these species were sparcely distributed throughout the unit and never formed dominant stands. These species were mostly present were the soil have been disturbed (trampling by livestock) or along farm roads or were other forms of disturbances have occurred.

Alien Invasive Plants confirmed, includes:

» *Prosopis glandulosa* (Category 1b – only one species noted at the small gravel dam located to the south-east of the site),
» *Flaveria bidentis* (Category 1b),
» *Xanthium strumarium* (Category 1b),
» *Datura stramonium* (Category 1b),

Other weeds and exotics confirmed during the survey:

» *Chloris virgata, Tragus berteronianus, Tribulus terrestris, Conyza bonariensis, Schkuhria pinnata* and *Alternanthera pungens*

Figure 13: Bush clearance done within the north-eastern section of the development footprint area.

Figure 14: Typical feature of this unit is the numerous small trees and large shrubs such as *Trachonanthus camphoratus* (foreground) and *Grewia flava* (background) dotted within a moderate to well-developed grass layer consisting out of a relive high diversity of species.

Figure 15: Tall form of *Acacia mellifera* (tree to the right). Note the trampling around the tree (bare areas).

Figure 16: Old gravel pit located within the north-eastern corner of the study area.

Figure 17: Medium sized *Acacia erioloba*

4.3 Critical Biodiversity Areas and broad scale ecological processes

Definitions and descriptions of Critical Biodiversity Areas of the North West Province

Critical Biodiversity Areas (CBAs) are terrestrial and aquatic features in the landscape that are critical for retaining biodiversity and supporting continued ecosystem functioning and services. These form the key output of a systematic conservation assessment and are the biodiversity sectors inputs into multi-sectoral planning and decision making tools. The use of CBAs within the North West Province follows the definition laid out in the guideline for publishing bioregional plans (Anon, 2008).

The identification and mapping of CBAs form part of the biodiversity assessment of the North West Province which will be used to inform the development of the Provincial Biodiversity Sector plans, bioregional plans, and also be used to inform Spatial Development Frameworks (SDFs), Environmental Management Frameworks (EMFs), Strategic Environmental Assessments (SEAs) and in the Environmental Impact Assessment (EIA) process in the province.

Simply put the purpose of the CBA is to indicate spatially the location of critical or important areas for biodiversity in the landscape. The CBA, through the underlying land management objectives that define the CBA, prescribes the desired ecological state in which the province would like to keep this biodiversity. Therefore, the desired ecological state or land management objective determines which land-use activities are compatible with each CBA category based on the perceived impact of each activity on biodiversity pattern and process.

According to the guidelines for bioregional plans, three basic CBA categories can be identified based on three high-level and management objectives (Table 5).

Table 5: Definitions and framework for linking CBAs to land-use planning and decision-making guidelines based on a set of high-level land biodiversity management objectives (Adapted from the guidelines for bioregional plans (Anon 2008).

CBA category	**Land Management Objective**
Critical Biodiversity Areas (CBAs) Definition: CBAs are areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. In other words, if these areas are not maintained in a natural or near-natural state then biodiversity conservation targets cannon be met. Maintaining an area in a natural state can include a variety of biodiversity-compatible land uses and resource uses.	
Protected Areas (PA) & CBA 1	***Natural landscapes:*** » Ecosystems and species fully intact and undisturbed. » These are areas with high irreplaceability or low flexibility in terms of meeting biodiversity pattern targets. If the biodiversity features targeted in these areas are lost then targets will not be met. » These are landscapes that are at or past their limits of acceptable change.
CBA 2	***Near-natural landscapes:*** » Ecosystems and species largely intact and undisturbed. » Areas with intermediate irreplaceability or some flexibility in terms of area required to meet biodiversity targets. There are options for loss of some components of biodiversity in these landscapes without compromising the ability to achieve targets. » These are landscapes that are approaching but have not passed their limits of acceptable change.
Ecological Support Areas (ESAs) Definition: ESAs are areas that are not essential for meeting biodiversity representation targets/thresholds but which nevertheless play an important role in supporting the ecological functioning of critical biodiversity areas and / or in delivering ecosystem services that support socio-economic development, such as water provision, food mitigation or carbon sequestration. The degree of restriction on land use and resource use in these areas may be lower than that recommended for critical biodiversity areas.	
ESA	***Functional landscapes:*** » Ecosystem moderately to significantly disturbed but still able to maintain basic functionality. » Individual species or other biodiversity indicators may be severely disturbed or reduced. » These are areas with low irreplaceability with respect to biodiversity pattern targets only.
ONA (Other Natural	Production landscapes: Manage land to optimize sustainable utilization of natural resources.

Areas) and Transformed	

The high-level land management objectives (natural, near-natural and functional) can be further unpacked using the three ecosystem integrity indicators namely; ecosystem composition, structure and function. Composition relates to biodiversity pattern, whereas structure and function relate to ecological process and services (Table 6).

Table 6: A summary of the CBA map categories used in relation to the biodiversity-related land management objectives and potential landscape-level biodiversity indicators.

Land Management Objective:	**Land Management Objective Biodiversity Indicators**			
	Component of biodiversity:	Biodiversity Pattern	Ecological Processes and Services	
	Indicator category	Composition	Structure	Functioning
	Specific Indicators	» Habitat types, » Species; » Populations; » Met-populations; » Alien plants	» Transformation; » Fragmentation	» Fire; » Grazing regimes; » Biogeochemical processes; » Hydrological functioning; » Soil formation and erosion; » Biotic processes.
	CBA Category	*Limit of Acceptable Change (LAC): Permitted amount or degree of change in biodiversity indicator.*		
Natural	PA / CA	None	None	None
	CBA 1	None	None	None
Near-Natural	CBA 2	Some	Some	None
Functional	ESA 1	Significant	Some	None
	ESA 2	Significant	Some	Some
	ONA	Significant	Significant	Some
	Transformed	Significant	Significant	Significant

Desktop description of Critical Biodiversity Areas within the study area.

The entire farm property consists of extensive areas of Aquatic as well as Terrestrial Critical Biodiversity Areas. Regarding the development footprint area for Woodhouse 1 Solar PV Facility the entire area is included in some sort of CBA.

Regarding the Terrestrial Critical Biodiversity Areas, more than three quarters of the study site is covered by some sort of CBA. The largest portion of the CBA consists of Important Ecological Corridors (T2 CBA). The only T1 CBA found

within the study area is located in a small section of the north-western corner of the study area and is due to the area's ecological function as a critical linkage and corridor zone.

As for the Aquatic Critical Biodiversity Areas, these CBAs cover the entire study area. The entire footprint area falls within the A2 CBA due to its location within a sub-Quaternary catchment (Droë Harts) as identified by the CSIR national assessment.

Description of status and condition of Critical Biodiversity Areas within the study area following the site survey

A site visit of the CBA areas falling within the proposed farm portions was conducted on the 5th of November 2015. The purpose of the site visit was to determine the status, condition and capabilities of these areas to fulfil their respective ecological functions and to determine whether the proposed development will have a potential detrimental impact on these areas and their functions. The ecological sensitivity and potential classification as no-go areas will be discussed within Section 4.4

The following observations regarding the CBAs within the study area were made during the site visit. The CBAs as listed in the North West Biodiversity Sector Plan (2015) are based on information mapped at a desk-top level, and based on an extrapolation of data collected for similar areas (similar abiotic and biotic environment) in the Dr Ruth Segomotsi Mompati District. Through the undertaking of field surveys in two seasons (November 2015 and April 2016 – owing to the widespread drought conditions experienced across the country) the following field observations were made regarding the listed CBAs within the project site which provides a more accurate description of the actual state or condition the demarcated CBA areas located within the project site. The ecological field data collected for the purposes of the ecological study suggested that it can be considered reasonable that the areas shown as terrestrial CBA corridors which traverse the site have a low contribution to the functioning of the corridor. The study concluded that due to the level of anthropogenic disturbance in the corridors, these would not be required to be excluded from the developable area. There are areas, however, which are listed as pans or wetland areas, or Aquatic CBA 1 areas that should be buffered and be excluded from the developable area (i.e. avoidance of identified ecologically sensitive areas).

Terrestrial 1 CBA (Critical linkage and core corridor zone)

This Semi-natural Kalahari Bushveld can be described as a low lying plains shrub veld, with a dense, short woody layer dominated by *Trachonanthus camphoratus*

and *Grewia flava.* The majority of the north-western section of the farm portion is moderately overgrazed. A few trampled cattle paths and bare patches of exposed soil are present as a result of the combination of grazing and the drought conditions experienced within the area. The dominance of *Eragrostis rigidior* in the area is an indication of past disturbance and overgrazing. Other disturbances within the area include the existing overhead power lines, service and farm gravel roads, boarder fences and the Woodhouse Substation.

The edge of this T1 CBA link area overlaps with the development area, with the bulk of the CBA link being to the north western corner and the south eastern corner of the site, well outside of the development area. The function of this area as a CBA is to provide a linkage and form a core corridor area between the upper dry Kalahari Bushveld and the lower lying Droë Hartsrivier Valley. When taking into account the small size of the T1 CBA located within the proposed footprint area, the fractured nature of this area and the number of barriers isolating this section from the rest of the T1 CBA, including numerous fences, the provincial gravel road (to Amalia) and the numerous smaller farm tracks and service roads traversing the area, the capabilities of this small portion of T1 CBA to contribute as an important linkage and corridor is considered to be extremely limited. Furthermore the loss of this small section of semi-natural T1 CBA as a result of development is expected to have an insignificant effect on the limit of acceptable change within this T1 CBA unit, as well as a on the potential loss of irreplaceable biodiversity patterns. Therefore, the contribution of this area to ecological processes in this demarcated link/corridor is currently low.

Figure 18: Photo's illustration the landscape falling within the T1 CBA (Linkage & Corridor Zone).

Terrestrial 2 CBA (Corridor Zones) as well as Aquatic 2 CBA (SQ4 or important Sub-Quaternary Catchment Areas):

The majority of the T2 CBA areas within the farm portion are associated with corridor zones linking the lower lying valleys (Droë Harts- and Losase Rivers) with the higher lying dry Kalahari bushveld. These areas also fall within A2 CBAs (SQ4) Most of the T2/A2 CBA within the farm portion falls within a landscape similar to that described for the T1 CBA, namely a semi-natural dry Kalahari Bushveld, moderately disturbed, mainly due to overgrazing. Furthermore, the landscape is highly fractured by access roads, fencing and the larger provincial gravel road as well as the R34 Road. Having said this, the area still provides habitat for numerous smaller mammals as well as reptile species. According to the description of a T2 Corridor Zone within the North West Province Biodiversity Conservation Assessment Technical Report, these corridor/sub-Quaternary catchment networks should focus on all biodiversity patterns and ecological processes. Taking this into account together with the field observations and the nature of the proposed development, the most significant impacts are expected to be during the construction phase. However with careful planning and the necessary mitigation measures in place, the affected footprint area can be restored and rehabilitated to an extent where ecological function and biodiversity is restored and maintained albeit in a slightly altered state. Thus although the area was confirmed as T2/A2 CBAs it can be concluded that the proposed development will not result in a severe alteration of the functionality of the area.

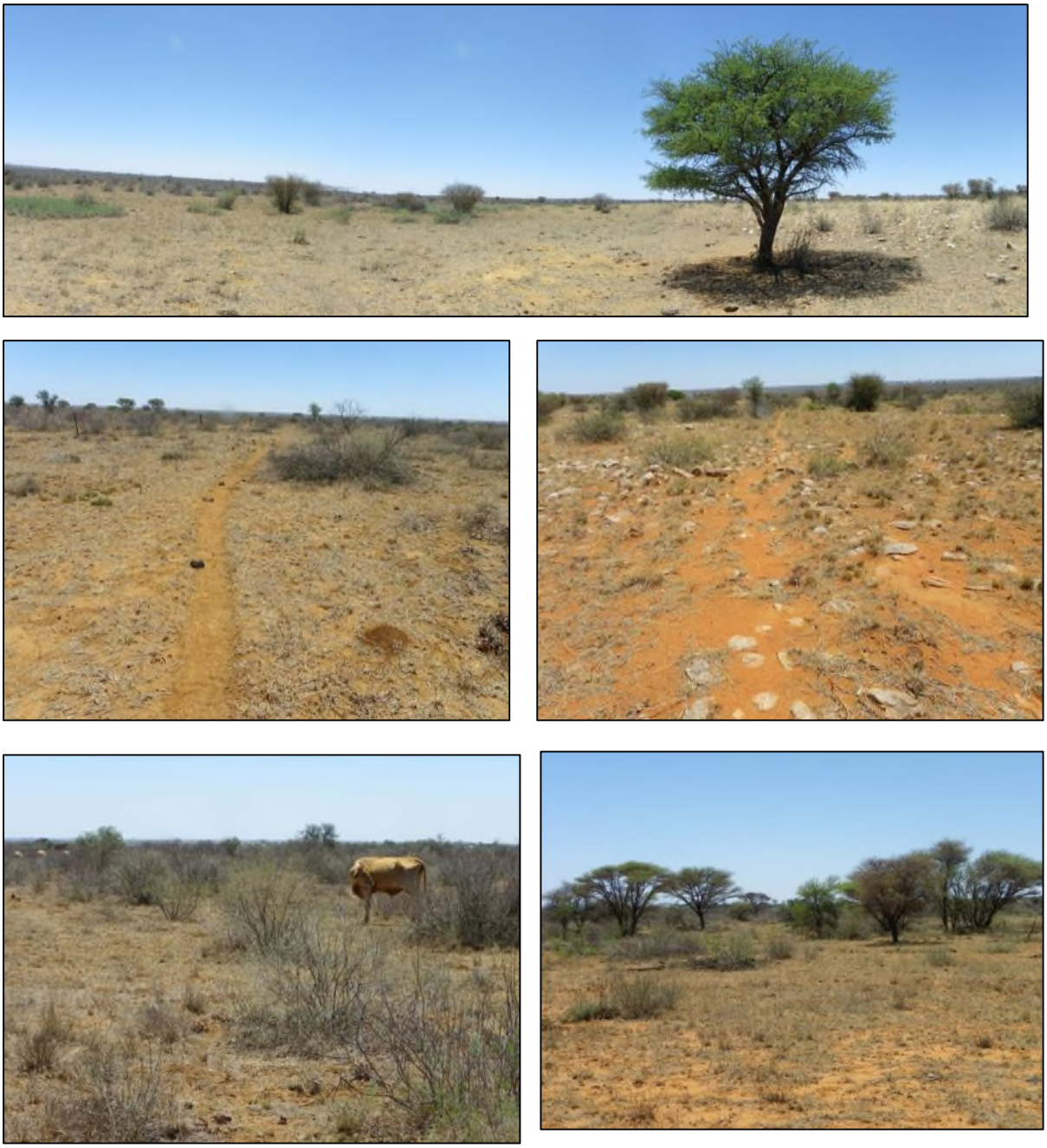

Figure 19: Vegetation and landscape characterizing the T2 CBA (Corridor) and A2 CBA (SQ4). Again as in the case of the T1 CBA (Linkage and Critical Corridor Zone) the area is moderately disturbed due to overgrazing.

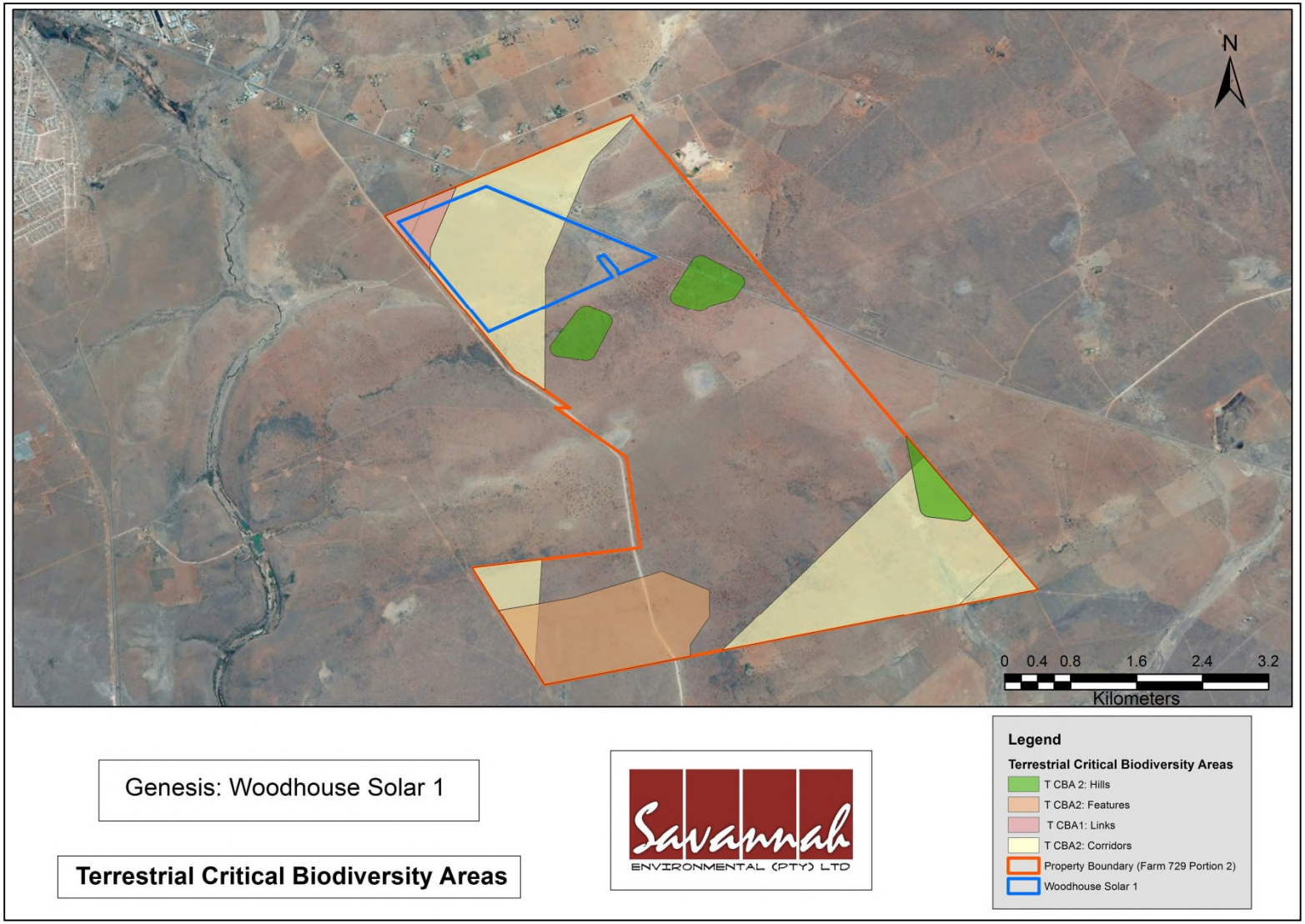

Figure 20: Terrestrial Critical Biodiversity Areas map of the proposed study area and surrounding environment.

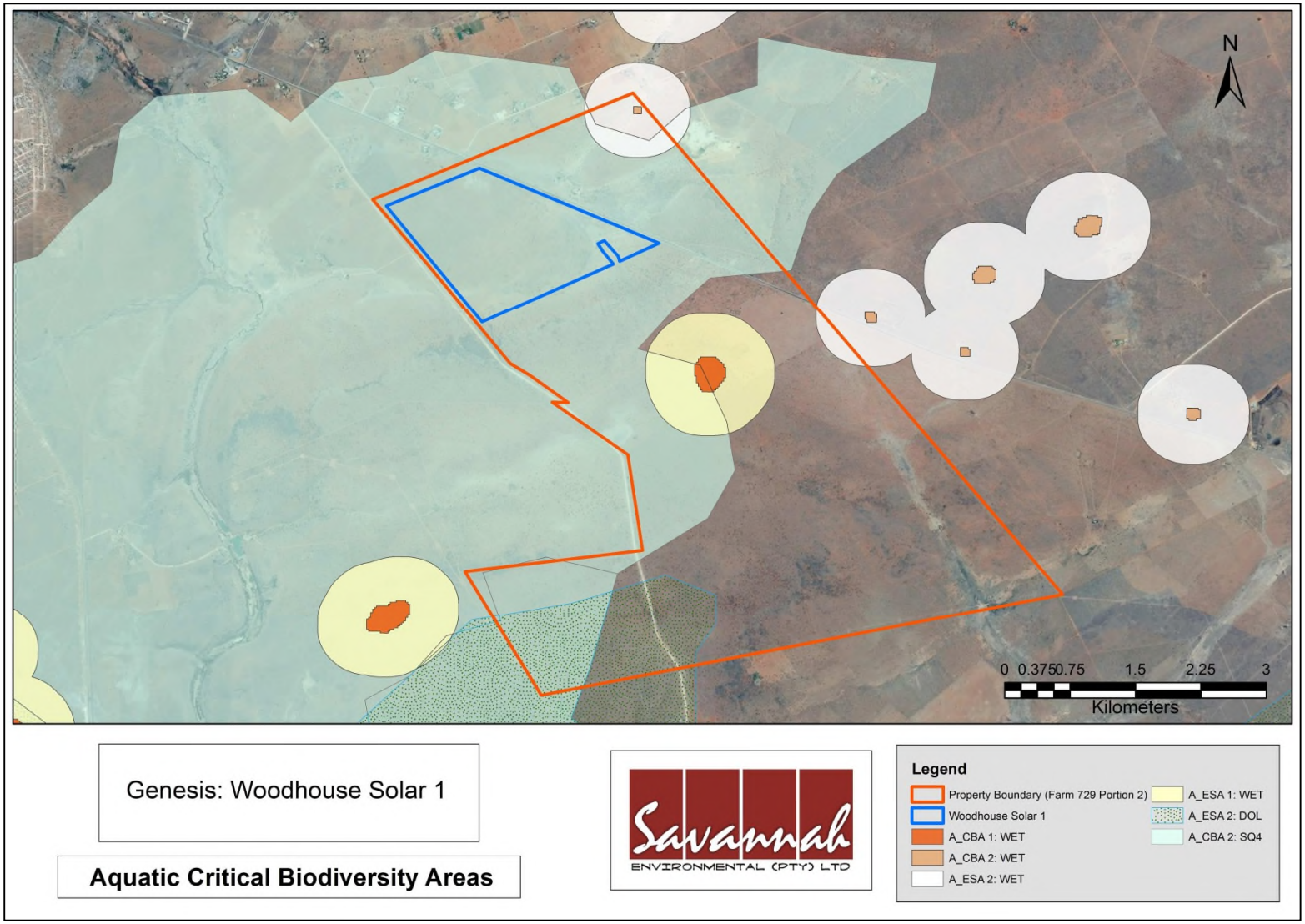

Figure 21: Aquatic Critical Biodiversity Areas map of the study area.

4.4 Fauna Survey

Mammals

Although the potential diversity of mammals within the study area is high with as many as 55 terrestrial mammals and 9 bat species present, there are several factors which will reduce the actual number of species present. This includes the proximity to Vryburg and vehicle movements along the roads in the area.

Listed mammals which may occur in the area include the White-tailed Mouse *Mystromys albicaudatus* (Endangered), Brown Hyaena *Hyaena brunnea* (Near Threatened), Black-footed Cat *Felis nigripes* (Vulnerable), Honey badger *Mellivora capensis* (IUCN LC, SA RDB EN), South African hedgehog *Atelerix frontalis* (SA RDB NT) and Ground Pangolin *Smutsia temminckii* (VU).

During the site visit the following faunal species were confirmed on site:

» Small colony of rodent burrows (most likely Pouched Mouse – *Saccostomus campestris* and/or Bushveld Gerbil – *Gerbilliscus leucogaster* and/or Four-striped Grass Mouse – *Rhabdomys pumilio*)
» Single rodent burrows (most likely Pygmy Hairy-footed Gerbil – *Gerbillurus paeba*)
» Common Mole-rat (*Cryptomys hottentotus*)
» Cape Porcupine (*Hystrix afrecaeaustralis*)
» Slender Mongoose (*Galerella sanguinea*)
» Yellow Mongoose (*Cynictis penicillata*)
» Relative large burrows (likely to have been made and utilized by Aardwolf – *Proteles cristatus* and/or Aardvark – *Orycteropus afer*)
» Greater Kudu (*Tragelaphus strepsiceros*)
» Steenbok (*Raphicerus campestris*)
» Common Duiker (*Sylvicapra grimmia*)

None of these species noted are listed and or protected species. Furthermore most of these species are highly mobile and will move away from the construction area and may move back during operational phase of the project.

Reptiles and Amphibians

Of the 27 reptilian species that have been recorded with the 2624 and 2724 degree grids, eight species have been recorded within the quarter degree grids (2624DD, 2724BB). None of these species are listed as Red Data species.

15 Amphibian species have been recorded within the degree grids and of these 15 species eight species were recorded for the quarter degree grids (QDG) within

which the study area is located. One near threatened species (*Pyxicephalus adspersus*, Giant Bull Frog) has been recorded for the quarter degree grid square (QDGS). Although this species was not recorded for the QDGS, it is still likely for this species to occur within the study area as potential suitable habitat (pans and drainage lines) is available.

4.5 Ecological Sensitivity Analysis

The following sensitivity map has been compiled using existing information such as Critical Biodiversity Areas, NFEPA Wetlands and Desktop Delineated Wetlands in combination with the data sampled during the site visit.

Terrestrial 1 CBA (Critical linkage and core corridor zone)
Due to the size of the CBA falling within the farm portion, the semi-natural as well as fractured and isolated state of the current area, the area should rather be incorporated within the T2 CBA (Corridor Zones) located within the study area and can be regarded as a Medium-Low Sensitive Areas.

Terrestrial 2 CBA (Corridor Zones) as well as Aquatic 2 CBA (SQ4 or important Sub-Quaternary Catchment Areas):
These areas have been confirmed as T2/A2 CBA areas. However due to the nature of the impact and the potential for rehabilitation, these areas can be regarded as Medium-Low Sensitive Areas.

Ephemeral Tributary and associated Buffer Area:
Due to the connectivity of this ephemeral tributary to larger ephemeral streams, downstream wetlands and the Droë Harts River this area along with its recommended buffer is regarded as a High Sensitive Area and subsequently it is recommended that this area should be excluded from the footprint area. The only activities allowed is road crossing (with the necessary mitigation measures in place), and power line crossings where necessary. A buffer of 35m is deemed sufficient due to the nature of the development and the fact that most of this tributaries catchment area is located outside of the proposed development footprint area.

Artificial Wetland (Dam) and drainage line:
It is recommended that the artificial wetland along with its drainage system (as well as their 35m buffers) is regarded as a High Sensitive Areas and subsequently it is recommended that this area should be excluded from the footprint area.

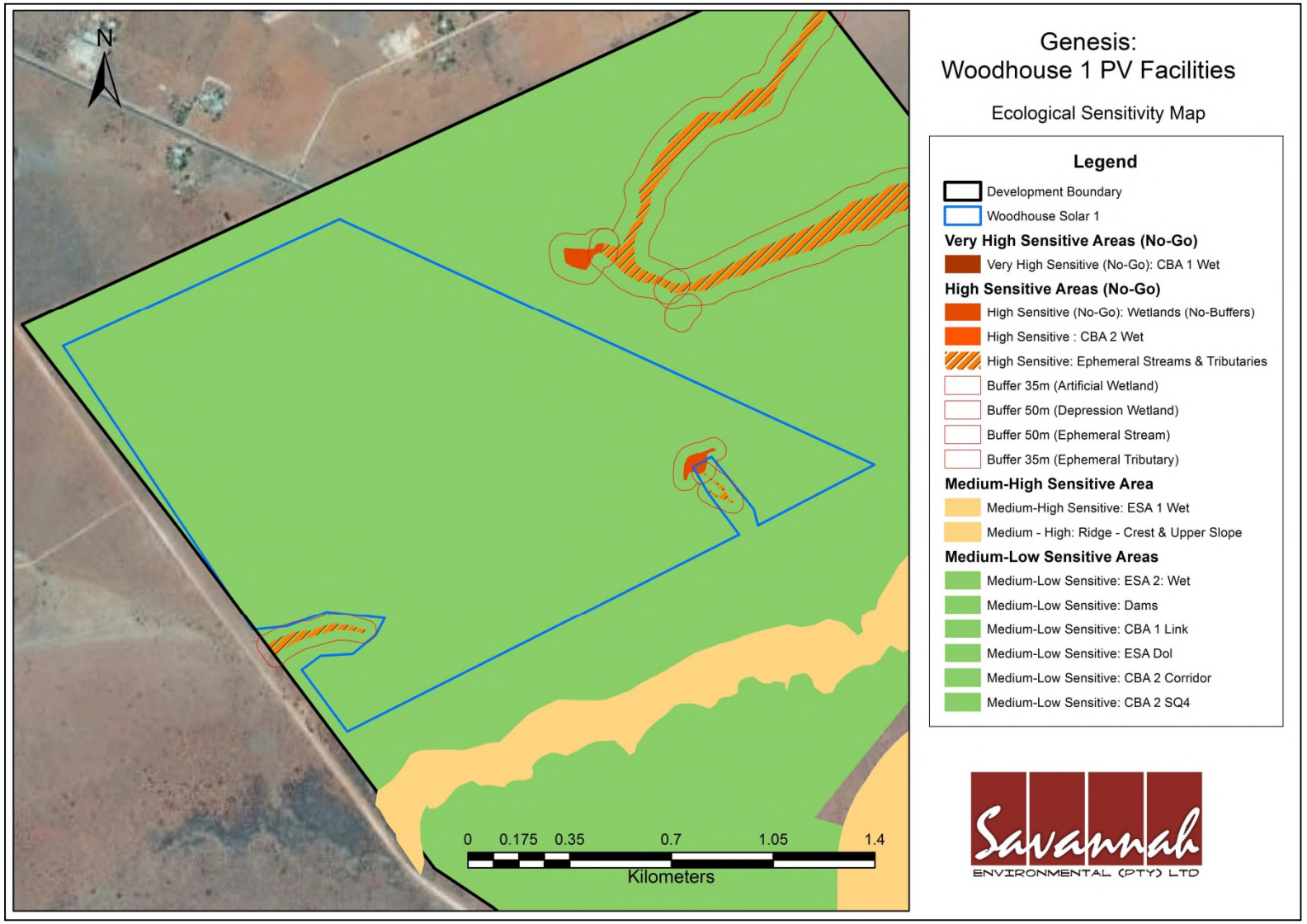

Figure 22: Sensitivity Map compiled for the study area.

5 IDENTIFICATION & NATURE OF IMPACTS

5.1 Overview of the most significant effects of the proposed development

» *Impacts on vegetation and protected plant species*

As mentioned above the most likely and significant impact will be on the vegetation. The proposed development may lead to direct loss of vegetation. Consequences of the impact occurring may include:

- general loss of habitat for sensitive species;
- loss in variation within habitat due to loss of portions of it;
- general reduction in biodiversity;
- increased fragmentation (depending on location of impact);
- disturbance to processes maintaining biodiversity and ecosystem goods and services; and
- loss of ecosystem goods and services

Several protected and red data species occur (confirmed within POSA generated species list – refer to Table 4) within the Quarter Degree Grid Squares (2624DD and 2724BB) encompassing the study site. Of these listed species only *Ammocharis coranica* and *Aloe grandidentata* were confirmed during the survey of the footprint area. Protected species not contained within this list that have been identified during the survey include *Acacia erioloba* (NFA – National Forest Act) and *Boophone disticha* (Declining). Such species are especially vulnerable to infrastructure development due to the fact that they cannot move out of the path of the construction activities, but are also affected by overall loss of habitat. Threatened species (red data species) include those listed as critically endangered, endangered or vulnerable. For any other species a loss of individuals or localised populations is unlikely to lead to a change in the conservation status of the species. However, in the case of threatened plant species, loss of a population or individuals could lead to a direct change in the conservation status of the species, possible extinction. This may arise if the proposed infrastructure is located where it will impact on such an individual or populations. Consequences may include:

- fragmentation of populations of affected species;
- reduction in area of occupancy of affected species; and
- loss of genetic variation within affected species

These may all lead to a negative change in conservation status of the affected species, which implies a reduction in the chances of the species' overall survival.

The impacts can be largely mitigated through avoidance of potential sensitive areas and listed species, by allowing a minimum clearance of vegetation (restricted to the absolute necessary areas) or translocation of specimens, where feasible (and permitted) to do so.

» *Direct Faunal impacts*

Faunal species will primarily be affected by the overall loss of habitat. Increased levels of noise, pollution, disturbance and human presence will be detrimental to fauna. Sensitive and shy fauna would move away from the area during the construction phase as a result of the noise and human activities present, while some slow-moving species and species confined and dependent on specified habitats would not be able to avoid the construction activities and might be killed. Some mammals and reptiles would be vulnerable to illegal collection or poaching during the construction phase as a result of the large number of construction personnel that are likely to be present. This impact is highly likely to occur during the construction-phase and would also potential occur with resident fauna within the facility after construction.

Threatened species (red data species) include those listed as critically endangered, endangered or vulnerable. For any other species a loss of individuals or localised populations is unlikely to lead to a change in the conservation status of the species. However, in the case of threatened animal species, loss of a population or individuals could lead to a direct change in the conservation status of the species, possible extinction. This may arise if the proposed infrastructure is located where it will impact on such individual or populations. Consequences may include:

- fragmentation of populations of affected species;
- reduction in area of occupancy of affected species; and
- loss of genetic variation of affected species

These may all lead to a negative change in conservation status of the affected species, which implies a reduction in the chances of the species' overall survival.

Disturbance of faunal species can be maintained to a minimum and low significance by implementing effective mitigation measures.

» *Impacts on ephemeral tributaries and other water bodies*

Construction may lead to some direct or indirect loss of or damage drainage lines and ephemeral tributaries. This will lead to localised loss of these habitat and may lead to downstream impacts that affect a greater extent of wetlands or impact on wetland function and biodiversity (downstream). Where these habitats are already stressed due to degradation and transformation, the loss may lead to increased vulnerability (susceptibility to future damage) of the habitat. Physical alteration to these ephemeral tributaries can have an impact on the functioning of those wetlands. Consequences may include:

- increased loss of soil;
- loss of or disturbance to indigenous wetland vegetation;
- loss of sensitive wetland habitats;
- loss or disturbance to individuals of rare, endangered, endemic and/or protected species that occur in wetlands;
- fragmentation of sensitive habitats;
- impairment of wetland function;
- change in channel morphology in downstream wetlands, potentially leading to further loss of wetland vegetation; and
- reduction in water quality in wetlands downstream.

By implementing mitigation measures, including the exclusion of these drainage lines and ephemeral tributaries, along with determined buffer areas (minimum of 35m), from the proposed development footprint area, these habitat types can retain their character and functionality. Where watercourses cannot be avoided (e.g. access road crossings and power line crossings), carefully considered mitigation measures, such as culvert design, size and placement as well as measures to control water flow (especially flash floods) and erosion (e.g. gabion structures, bank revegetation and rehabilitation etc.), should be in place. Furthermore the necessary licensing and/or application should be obtained from the relevant authorities.

» *Soil erosion and associated degradation of ecosystems*

Soil erosion is a frequent risk associated with PV facilities on account of the vegetation clearing and disturbance associated with the construction phase of the development and may continue occurring throughout the operational phase. The footprint area earmarked for the development of the Woodhouse Solar 1 PV Facility is located on a flat, outstretched low-lying plain and subsequently erosion within this section is likely to be low. Service roads and

panels will generate an increase in runoff during intense rainfall events and may potentially exaggerate the effects of erosion. These eroded materials may enter the nearby streams and rivers and may potentially impact these systems through siltation and change in chemistry and turbidity of the water.

With effective mitigation measures in place including regular monitoring the occurrence, spread and potential cumulative effects of erosion may be limited to an absolute minimum.

» *Alien Plant Invasions*

Major factors contributing to invasion by alien invader plants includes habitat disturbance and associated destruction of indigenous vegetation. Consequences of this may include:

- further loss and displacement of indigenous vegetation;
- change in vegetation structure leading to change in various habitat characteristics;
- change in plant species composition;
- change in soil chemistry properties;
- loss of sensitive habitats;
- loss or disturbance to individuals of rare, endangered, endemic and/or protected species;
- fragmentation of sensitive habitats;
- change in flammability of vegetation, depending on alien species;
- hydrological impacts due to increased transpiration and runoff; and
- impairment of wetland function.

Alien Invasive Plants confirmed, includes:

» *Prosopis glandulosa* (Category 1b – only one species noted at the small gravel dam located to the south-east of the site),
» *Flaveria bidentis* (Category 1b),
» *Xanthium strumarium* (Category 1b),
» *Datura stramonium* (Category 1b),

Other weeds and exotics confirmed during the survey:

» *Chloris virgata, Tragus berteronianus, Tribulus terrestris, Conyza bonariensis, Schkuhria pinnata* and *Alternanthera pungens*

Although the potential severity of this impact may be high, it can be easily mitigated through regular alien control.

» *Impacts on Critical Biodiversity Areas and Broad-Scale Ecological Processes*

The footprint area is located within Critical Biodiversity Areas (links and corridors) (refer to Figure 20 and Figure 21). Development would potentially impact the ecological functioning of the CBAs and thus the impacts on these CBAs (terrestrial CBA links and corridors and aquatic CBA areas)..

The ecological field data collected for the purposes of the ecological study suggested that it can be considered reasonable that the areas shown as terrestrial CBA corridors which traverse the site have a low contribution to the functioning of the corridor. Due to historical anthropogenic activities which have taken place within the development area (including overgrazing over a long period of time; roads; power lines), the areas shown as being CBAs are considered as being of a medium-low sensitivity[1] .

These medium-low areas are also associated with open bushveld and are located across the majority of the development footprint. The ecological study concluded that due to the level of anthropogenic disturbance in the corridors, these would not be required to be excluded from the developable area. Impact on these Critical Biodiversity Areas can be maintained to an absolute minimum or even avoided by restricting the development to disturbed and transformed areas within the CBAs. By furthermore implementing effective mitigation measures the functionality off these areas and connectivity between these areas may be maintained .

The areas, however, which are listed as pans or wetland areas under the Aquatic CBA 1 areas should be buffered and be excluded from the developable area (i.e. avoidance of identified ecologically sensitive areas). The high ecological sensitivity areas located within the development area include ephemeral tributaries located within the west and east of the development area and an artificial dam and the associated wetland located in the west.

» Reduced ability to meet conservation obligations and targets:

The loss of unprotected vegetation types on a cumulative basis from the broad area may impact the countries' ability to meet its conservation targets. The receiving vegetation types in the study area are classified as Least Threatened and they are extensive vegetation types that are still more than 99% intact. The development of the site would result in the loss of 287ha (and possibly up 600ha with the consideration of two adjacent facilities) of intact, albeit degraded, habitat which on its own is not considered highly significant. Where other developments

[1] This assessment correlates with the findings of the aquatic and terrestrial biodiversity assessment undertaken for the CSIR SEA for the Renewable Energy Development Zones (Part 3, Section 4).

may be constructed within the same area, the possibility for cumulative impact on the affected vegetation types or on more localised plant communities is a potential concern.

5.2 Potential cumulative impacts due to nearby developments

» The affected farm property is situated less than 4 km south-east of the outskirts of the town of Vryburg and adjacent, to the north-east section, to a small holding development. Most of the land within these small holdings have been either transformed or are under cultivation. The bulk of the surrounding land is however in a natural or semi-natural state used primarily as grazing for cattle.

» Further solar developments in the immediate surroundings (10km radius) include (refer to :
    - Proposed 60MW Carocraft PV Solar Park and associated infrastructure (a.k.a the Carocraft Solar Park) on the Remaining Extent and Portion 1 of Farm Weltevrede 681.
    - Construction of the 75MW Photovoltaic facility and associated infrastructure in Naledi (a.ka. the Sediba Solar Energy Facility) on the Remaining Extent of the Farm Rosendal 673
    - Proposed Tiger Kloof Solar Photovoltaic energy facility near Vryburg, North West Province (a.ka. the Tiger Kloof Solar Energy Facility) on Portion 3 (RE) and Portion 4 of the Farm Waterloo 730.
    - Proposed construction of the 75MW Photovoltaic Solar Plant and associated infrastructure on a Portion of the Farm Waterloo 992 in the Naledi Local Municipality of the North West Province (a.k.a the Waterloo Solar Park) on the Remaining Extent of the Farm Waterloo 992
    - Proposed Woodhouse Solar 2 PV Facility, North West Province on the Remaining Extent of the farm Woodhouse 729.

    Conclusion on cumulative impacts due to surrounding developments:
    - It is highly unlikely that a cumulative effect of loss of high biodiversity areas could arise from the Woodhouse Solar 1 development, if the development is restricted to current identified footprint area. Also furthermore it is unlikely that the development in the current position will result the reduced ability of the vegetation unit to meet its conservation targets.
    - Due to the size of the development and the position of the development within a semi-natural environment, already transformed due to some bush clearance to the east, slight bush encroachment to

the west and the highly fractured nature that characterize this area, the earmarked development footprint area contribute little towards the functionality of the CBA areas in which it is located. Thus the development will have an insignificant effect on the limit of acceptable change within the CBA's.

- It is recommended that efforts on invasive species management, erosion control and rehabilitation co-ordinated to avoid negative effects of one development on the environmental state on and around the other.

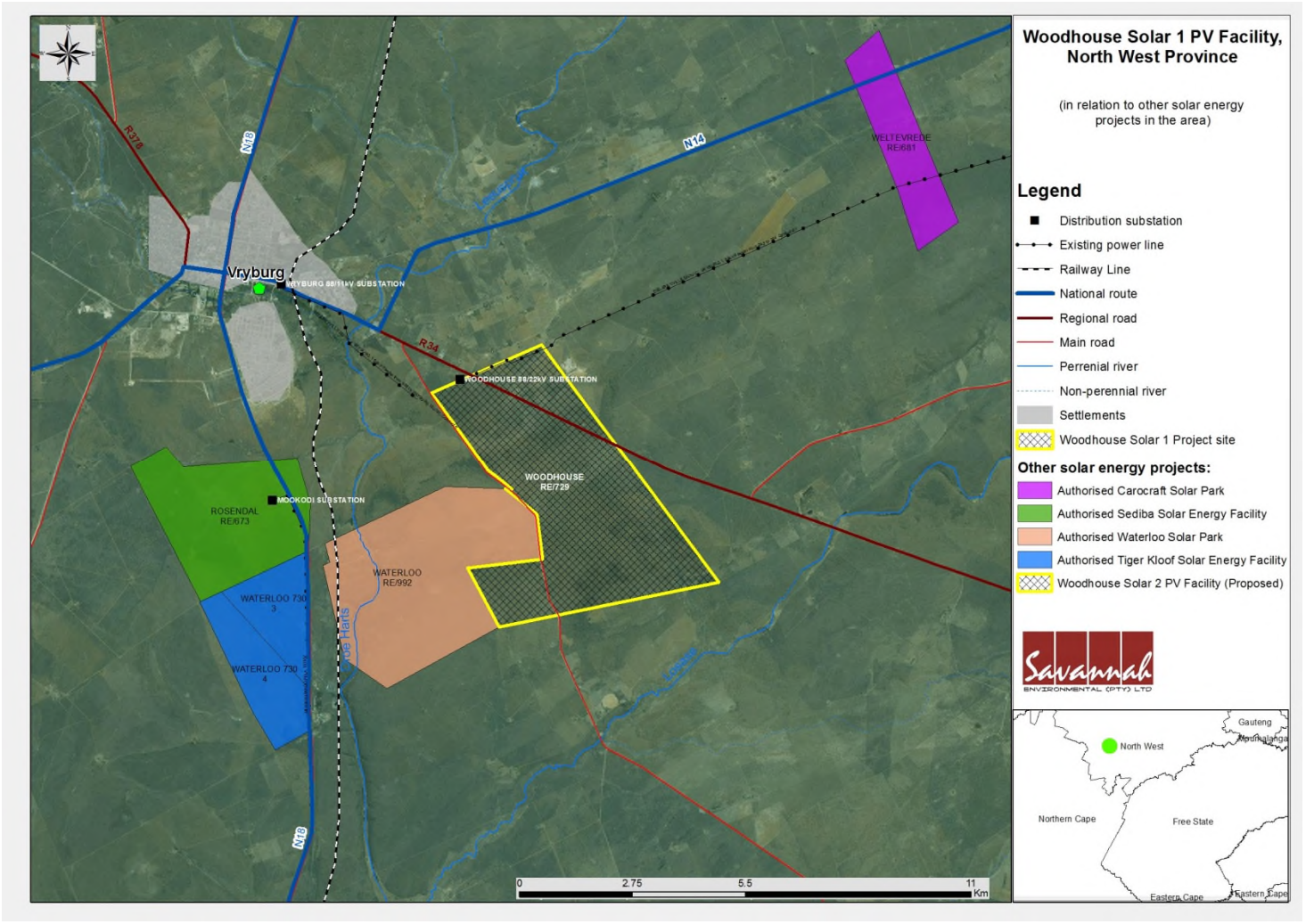

Figure 23: Cumulative Impacts – Other Solar PV Projects occurign within a 10km radius of the Woodhouse Solar 1 PV Facility Project.

5.3 Impact Risk Factors for Different Phases of the Project

Potential ecological impacts resulting from the development would stem from a variety of different activities and risk factors associated with the construction and operational phases of the project including the following:

Construction Phase

- Vegetation clearing for PV panels, troughs, lay down areas, roads, buildings etc. could impact listed plant species as well as high-biodiversity plant communities. Vegetation clearing will also lead to habitat loss for fauna and potentially the loss of sensitive faunal species, habitats and ecosystems.
- Erosion risk may result due to the loss of plant cover and soil disturbance created during the construction phase. This may impact the surrounding ephemeral tributaries and the larger downstream ephemeral streams and subsequently the larger downstream riparian and wetland habitats if a lot of silt enters the drainage systems (although unlikely to be at this extent). Although the effects would probably only become apparent during the operational phase, the impact stems from the construction phase and suitable mitigation measures will also need to be applied at this stage.
- Presence and operation of construction machinery on site. This will create a physical impact as well as generate noise, pollution and other forms of disturbance at the site.
- Increased human presence can lead to poaching, illegal plant harvesting and other forms of disturbance such as fire.
- Loss of connectivity & habitat fragmentation may result due to the presence of the generation infrastructure, roads, site fencing and other support infrastructure of the development.

Operational Phase

- The daily maintenance and operation activities of the facilities would generate some noise and disturbance which may deter some fauna from the area, amounting to a loss of connectivity & habitat fragmentation.
- Maintenance activities such as vegetation clearing will impact the biodiversity of the site if not conducted in a sensitive manner.

5.4 Assessment of Impacts

Impacts of PV array, access roads and associated infrastructure

1. Activity: Upgrading and/or creation of site access road and internal maintenance tracks		
Environmental Aspect: Removal of vegetation, compaction and disturbance of soils, creation of runoff zone, increased erosion risk, destruction of animal burrows, possible traversing of drainage areas (ephemeral tributaries), impact on protected species, alteration of soil surface properties		
Environmental impact: Loss of vegetation, increase in runoff and erosion, possible distribution of alien invasive species, possible disturbance and reduction of habitat or injury to burrowing vertebrates, possible change of natural runoff and drainage patterns, possible loss of protected species, possible permanent loss of revegetation potential of soil surface Note: relatively large access roads already exist on the land portion		
	Without mitigation	**With mitigation**
Extent (E)	Local (1)	Local (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Low (3)	Minor (1)
Probability (P)	Highly Probable (4)	Highly Probable (4)
Significance (S = E+D+M)*P	**Medium (32)**	**Low (24)**
Status (positive, neutral or negative)	Negative	*Neutral* where on transformed areas or on existing access roads *Negative* on undisturbed areas *Minimal new negative impacts expected*
Reversibility	Not reversible	Relatively reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably well	
Mitigation: » After the final layout has been approved, conduct a thorough footprint investigation to detect and map (by GPS) any protected plant species and animal burrows o Protected plant species: must be relocated o Animal burrows: must be monitored by ECO prior to construction for		

activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor

» During construction: create designated turning areas and strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas
» Keep the clearing of natural and semi-natural grasslands to a minimum
» If filling material is to be used, this should be sourced from areas free of invasive species
» Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil
» Reinforce portions of existing access routes that are prone to erosion, create structures or low banks to drain the access road rapidly during rainfall events, yet preventing erosion of the track and surrounding areas
» Ensure that runoff from compacted or sealed surfaces is slowed down and dispersed sufficiently to prevent accelerated erosion from being initiated (storm water and erosion management plan required)
» Access roads (where unavoidable) may cross drainage lines or ephemeral tributaries as well as the 35m buffer zones (with necessary mitigation measures in place).
» Ensure adequate drainage where access roads cross drainage lines or ephemeral tributaries.
» Prevent leakage of oil or other chemicals or any other form of pollution
» Monitor the establishment of (alien) invasive species and remove as soon as detected, whenever possible before regenerative material can be formed
» After decommissioning, if access road or portion thereof will not be of further use to the landowner, remove all foreign material and rip area to facilitate the establishment of vegetation, followed by a suitable revegetation program

Cumulative impacts:

» Possible erosion of areas lower than the access road, possible contamination of lower-lying drainage lines, ephemeral tributaries and wetlands due to oil or other spillage
» Possible spread and establishment of alien invasive species

Residual impacts:

» Altered vegetation composition and structure
» Altered topsoil conditions
» Potential barren areas
» Potential for erosion and invasion by weed or alien species

2. Activity: Fencing area – may also serve as maintenance track to PV panels and as fire-break

Environmental Aspect: ***(Note:*** *Fencing already exists around the entire northern, eastern and western boundaries, but will most likely be upgraded and reinforced.)* Removal of vegetation, compaction of soils, creation of runoff zone, impact on protected species, impact on terrestrial vertebrates

Environmental impact: Loss of vegetation and specifically protected or red data species, window of opportunity for the establishment of alien invasive species, altered topsoil characteristics prone to capping, increased runoff and erosion, temporary disturbance of

burrowing animals, possible reduction of habitat and forage availability to terrestrial vertebrates and livestock		
	Without mitigation	**With mitigation**
Extent (E)	Local (1)	Local (1)
Duration (D)	Long-term (4)	Long term (4)
Magnitude (M)	Low (3)	Small (0)
Probability (P)	Highly Probable (4)	Probable (3)
Significance (S = E+D+M)*P	**Medium (32)**	**Low (15)**
Status (positive, neutral or negative)	Negative	*Neutral* where on transformed areas Slightly *Negative* on natural areas *Minimal new negative impacts expected*
Reversibility	Partially reversible	Reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably well	

Mitigation:

» After the final layout has been approved, conduct a thorough footprint investigation to detect and map (by GPS) any protected plant species and animal burrows
  - Protected plant species: must be relocated
  - Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor

» During the design phase, the possible impact of burrowing vertebrates and rodents on the development must be determined, and fencing must be designed to either exclude such fauna if it will be detrimental or enable occasional migration of smaller vertebrates onto and across the site (which could be beneficial to small vertebrate populations)

» Minimise area affected, especially during construction

» During construction: strictly prohibit any off-road driving or parking of vehicles and machinery outside the footprint areas

» Prevent leakage of oil or other chemicals, strictly prohibit littering of any kind

» Monitor the establishment of alien and indigenous invasive species and remove as soon as detected, whenever possible *before* regenerative material can be formed

» If the area will be used as fire-break as well, maintain a suitably low grass layer by regular mowing or appropriate species selection, but do not leave soil bare. Alternatively, ensure that the soil has a covering that prevents erosion

Cumulative impacts:

» Possible erosion of cleared areas and associated accelerated erosion from surrounding areas » Possible loss of ecosystem functioning due to increase in invasive species
Residual impacts: » Altered vegetation composition » Compacted topsoils » Possibility for erosion and invasion by alien invasives

3. Activity: Construction and operation of the facility on semi-natural vegetation and disturbed areas		
Environmental Aspect: Removal of or excessive damage to vegetation, compaction of topsoil, creation of runoff zone, redistribution and concentration of runoff from panel surfaces, artificial shading of vegetation, displacement of terrestrial vertebrates, reduced buffering capacities of the landscapes during extreme weather events		
Environmental impact: Loss of vegetation and/or species of conservation concern, loss of and alteration of microhabitats, altered vegetation cover, site-specific altered distribution of rainfall and resultant runoff patterns, general increase in runoff from PV and/or bare areas and associated accelerated erosion, reduction of habitat and resource availability for terrestrial fauna, possible increase of detrimental effects during periods of extreme weather events, e.g. increased flooding, severe erosion or dust due to lower buffering capacity of sparser vegetation		
	Without mitigation	**With mitigation**
Extent (E)	Local (1)	Local (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	High (6)	Moderate (5)
Probability (P)	Definite (5)	Definite (5)
Significance (S = E+D+M)*P	**Medium (55)**	**Medium (50)**
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Partially reversible	Partially reversible
Irreplaceable loss of resources?	Highly Probable	Slight Probability
Can impacts be mitigated?	Reasonably	
Mitigation: » After the final layout has been approved, conduct a thorough footprint investigation to detect and map (by GPS) any protected plant species and active animal burrows o Protected plant species: must be relocated o Animal burrows: must be monitored by ECO prior to construction for		

activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor

» Keep areas affected to a minimum, strictly prohibit any disturbance outside the demarcated footprint area
» Clear as little indigenous vegetation as possible, aim to maintain vegetation where it will not interfere with the construction or operation of the development, rehabilitate an acceptable vegetation layer according to rehabilitation recommendations of the relevant EMP
    o Use species that were part of the original indigenous species composition similar to the remaining natural vegetation as listed in the specialist report, or sow with *Digitaria eriantha* and *Themeda triandra*.
    o Shading from fixed panels may prevent or slow the re-establishment of desirable grass species, thus re-establishment must be monitored and species composition adapted if the above species fail to establish sufficiently.
    o A strong herb layer will also suppress the re-emergence of weed species from existing seed banks
» Aim to maintain a buffer zone of a minimum of 35 m around drainage lines / ephemeral tributaries
» Remove all invasive vegetation before and after construction and continuously up to decommissioning
» If filling material is to be used, this should be sourced from areas free of invasive species
» Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil
» Temporarily stored topsoil must be re-applied within 6 months, topsoils stored for longer need to be managed according to a detailed topsoil management plan
» Monitor the area below the PV panels regularly after larger rainfall events to determine where erosion may be initiated and then mitigate by modifying the soil micro-topography and revegetation or soil erosion control efforts accordingly
» Prevent leakage of oil or other chemicals, strictly prohibit littering of any kind
» Monitor the establishment of all invasive species and remove as soon as detected, whenever possible before regenerative material can be formed

Cumulative impacts:

» If mitigation measures are not strictly followed the following could occur:
    o erosion of areas around the panels and continued erosion of the development area with associated siltation and/or erosion of lower-lying wetlands
    o contamination of drainage lines, lower-lying rivers or wetlands
    o alteration of occupancy by terrestrial fauna beyond the project area, possible reduction of available habitat and food availability to terrestrial fauna
    o spread and establishment of invasive species

Residual impacts:

» altered topsoil characteristics
» altered vegetation composition

4. Activity: Construction of a short power line as part of the grid connection
Note: This is applicable for all grid connection alternatives.

Environmental Aspect: Limited removal of vegetation, compaction of soils, temporary or permanent damage to animal burrows

Environmental impact: Loss of vegetation, increase in runoff and erosion, disturbance of burrowing animals

	Without mitigation	**With mitigation**
Extent (E)	Local (1)	Local (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Minor (2)	Small (0)
Probability (P)	Highly Probable (4)	Highly Probable (4)
Significance (S = E+D+M)*P	**Low (28)**	**Low (20)**
Status (positive, neutral or negative)	Negative	Neutral to slightly negative
Reversibility	Partially reversible	Reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably	

Mitigation:

» After the final layout has been approved, conduct a thorough footprint investigation to detect and map (by GPS) any protected plant species and animal burrows
  - o Protected plant species: must be relocated where affected by towers, maintenance tracks or construction
  - o Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor

» During construction: create designated servitude areas and strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas

» Limit clearing of indigenous vegetation to tower positions only

» Prevent spillage of construction material, oils or other chemicals, strictly prohibit other pollution

» Monitor the establishment of invasive species and remove as soon as detected, whenever possible before regenerative material can be formed

» Avoid any placement of towers within drainage lines, ephemeral tributaries or depressions as well as within their designated buffer areas (all alternatives currently avoid these features).

»

Cumulative impacts:

» Possible erosion of surrounding areas if no mitigation is implemented, no significant

cumulative impact on flora or fauna expected (excluding avifauna) due to existing degradation.

Residual impacts:

» Very localised alteration of soil surface characteristics

5. Activity: Construction of substation and facility buildings, workshops, offices, guardhouses, as well as temporary laydown and storage areas

Environmental Aspect: Removal of vegetation, compaction and alteration of topsoils, creation of runoff zone, redistribution and concentration of runoff from sealed surfaces, displacement of terrestrial vertebrates

Environmental impact: Loss of vegetation and/or species of conservation concern, loss of microhabitats, altered and reduced vegetation cover, altered distribution of rainfall and resultant runoff patterns, increase in *concentrated* runoff from sealed surfaces and possibly higher accelerated erosion, reduction of habitat and resource availability for terrestrial fauna

	Without mitigation	**With mitigation**
Extent (E)	Local (1)	Local (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Moderate (5)	Minor (2)
Probability (P)	Highly Probable (4)	Highly Probable (4)
Significance (S = E+D+M)*P	**Medium (40)**	**Low (28)**
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Partially reversible	Reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably	

Mitigation:

» Exclude high sensitivity zones from this footprint
» After the final layout has been approved, conduct a thorough footprint investigation to detect and map (by GPS) any protected plant species and animal burrows
  o Protected plant species: must be relocated
  o Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor
» Aim to maintain a buffer zone of a minimum of 35 m around drainage lines / ephemeral tributaries
» Limit disturbance to footprint area as far as practically possible

» Place infrastructure as far as possible on sites that have been transformed already » During construction: stay within demarcated footprint areas and strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas » Prevent spillage of construction material and other pollutants, contain and treat any spillages immediately » Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil » Temporarily stored topsoil must be re-applied within 6 months, topsoils stored for longer need to be managed according to a detailed topsoil management plan » Rehabilitate and revegetate all areas outside footprint area that have been disturbed » After decommissioning remove all foreign material prior to starting the rehabilitation » The rehabilitation plan for all temporarily affected areas and for the development area after decommissioning must aim to re-introduce all non-weed indigenous species listed in the specialist report as a minimum, taking the observed original cover percentages as a guideline of acceptable vegetation cover » Monitor the establishment of invasive species and remove as soon as detected, whenever possible before regenerative material can be formed
Cumulative impacts: » If mitigation measures are not strictly followed the following may, although regarded as unlikely, occur: o erosion of areas around sealed surfaces and continued erosion of the development area with associated siltation and/or erosion of lower-lying ephemeral streams and downstream wetlands o contamination of drainage lines, lower-lying rivers or wetlands o spread and establishment of invasive species » alteration of occupancy by terrestrial fauna, small reduction of available habitat and food availability to terrestrial fauna
Residual impacts: » altered topsoil characteristics » altered vegetation composition

5. Activity: General construction activities related to the construction phase		
Environmental Aspect: Alien plants are likely to invade the site as a result of the large amounts of disturbance created during construction		
Environmental impact: Loss of natural vegetation, altered vegetation cover,		
	Without mitigation	**With mitigation**
Extent (E)	Local (1)	Local (1)
Duration (D)	Long-term (4)	Medium-term (3)

Magnitude (M)	Medium (5)	Low (3)
Probability (P)	Probable (4)	Improbable (3)
Significance (S = E+D+M)*P	**Medium (40)**	**Low (21)**
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: » Due to the disturbance at the site as well as the increased runoff generated at the site, alien plant species are likely to be a long-term problem at the site and a long-term control plan will need to be implemented. » Rehabilitation of cleared areas with indigenous species after construction to reduce alien invasion potential. » Regular monitoring for alien plants within the development footprint. » Regular alien clearing should be conducted using the best-practice methods for the species concerned. The use of herbicides should be avoided as far as possible and should only be used for woody species which resprout following manual control.		
Cumulative impacts: » Alien invasion would contribute to cumulative habitat degradation in the area, but if alien species are controlled then, then cumulative impact from alien species would not be significant.		
Residual impacts: » If alien species at the site are controlled, then there will be very little residual impact.		

5.5 ASSESSMENT OF CUMULATIVE IMPACTS

11. Nature: *Reduced Ability to meet conservation targets* *The cumulative loss of habitat resulting from the current and as well as the other developments in the area are not likely to impact the country's ability to meet conservation targets and objectives as the affected vegetation types are widespread and have been little impacted by transformation to date.*
Environmental Aspect: Reduced ability to meet conservation targets
Environmental impact: The loss of unprotected vegetation types on a cumulative basis from the broad area may impact the countries' ability to meet its

conservation targets. The area is not included within a National Protected Areas Expansion Strategy focus area, and falls outside any threatened and or endangered ecosystem type / vegetation type. Although the vegetation type in the study area are classified as Least Threatened, it is poorly protected and certain habitats or communities may be disproportionately affected.

	Overall impact of the proposed project considered in isolation	**Cumulative Impact of the project and other projects in the area**
Extent (E)	Local (1)	Local (3)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Small (0)	Low (4)
Probability (P)	Very Improbable (1)	Improbable (2)
Significance (S = E+D+M)*P	**Low (5)**	**Low (22)**
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Partially reversible	Low Reversibility
Irreplaceable loss of resources?	Not Likely	Imrobable
Confidence in finding	High	

Mitigation:

» Preconstruction walk-through of the facility to ensure that sensitive habitats are avoided.
» Minimise the development footprint as far as possible.

12. Nature: *Impact on Critical Biodiversity Areas*

Environmental Aspect: Impact on Critical Biodiversity Areas

Environmental impact: Transformation within CBAs would potentially disrupt the functioning of the CBA or result in biodiversity loss. In addition, the presence of the facility and associated infrastructure could potentially contribute to the disruption of broad-scale ecological processes such as dispersal, migration or the ability of fauna to respond to fluctuations in climate or other conditions. There are a number of other renewable energy facilities in the broad area the cumulative impact of these on habitat loss and the broad scale disruption of landscape connectivity is a potential concern.

	Overall impact of the proposed project considered in isolation	**Cumulative Impact of the project and other projects in the area**

Extent (E)	Local (1)	Regional (3)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Small (0)	Moderate (6)
Probability (P)	Very Improbable (1)	Probable (3)
Significance (S = E+D+M)*P	**Low (5)**	**Medium (39)**
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Partially reversible	Reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably	

Mitigation:

» An open space management plan for the development should be developed.
» Preconstruction walk-through of the facility, especially the roads and turbine locations to ensure that sensitive habitats are avoided and that species of conservation concern can be translocated.
» Minimise the development footprint as far as possible.
» Stringent construction-phase monitoring of activities at the site to ensure that mitigation measures are adhered to and that the overall ecological impact of the development is maintained at a low level.
» The use of structures which may inhibit movement of fauna, such as mesh and electric fencing should be avoided.

Implications of the anticipated impacts for the development:

» The proposed photovoltaic facility development on the site will not have significant impacts on the above-ground ecology of the site, if all mitigation measures are followed. The low ecological sensitivity of the larger portion of the study area is due to bush. Moderate historical overgrazing which has led to an increase in the woody component (*Trachonanthus camphoratus* and *Grewia flava*). Furthermore, the proposed footprint area is located in an extremely fractured portion of landscape as a result of the R34 and Provincial gravel road, and the amount of farm fences, fencing off numerous small grazing camps
» All ephemeral tributaries and drainage lines must be excluded from the development footprint area and an appropriate buffer of 35m should be placed around these areas. The assessed development footprint (i.e. preliminary layout) must be adjusted in order to remain outside of these buffer areas.

- While solar PV facilities may be able to retain a proportion of the preconstruction biodiversity, the resulting habitat is fairly isolated from the surrounding landscape and will be largely anthropogenic in nature. Care must be taken to prevent the encroachment and spread of alien species.
- Potentially significant negative impacts on the ecological environment could be soil degradation issues because of construction activity; possible introduction of alien invasive plants, a long-term (more than 8 months) low or absent vegetation cover after construction and impacts on protected plant species.
- With the diligent implementation of mitigating measures by the developer, contractors, and operational staff, the severity of these impacts can be minimised.
- The impact on fauna is expected to be small to negligent. Presence of indigenous terrestrial vertebrates within the study area is relative low. Animals that may be permanently present can be relocated or will move away during construction, and may resettle after construction, depending on safety specifications necessitated by the development. No restricted or specific habitat of vertebrates exists on the study area and will be affected by the proposed development; especially if the proposed development remains outside the recommended buffers around the ephemeral tributaries and drainage lines.
- Potential for soil erosion within the development area is considered low as a result of the nature of the soils. Due diligence would however need to be taken in order to prevent water and wind erosion in exposed areas. Excavated topsoil will require appropriate management to ensure no loss of this resource. Mitigation procedures as well as hands on maintenance will ensure that medium to long term impacts can be avoided.

6 DISCUSSION AND CONCLUSION

An ecological site sensitivity map had been compiled prior a site visit (refer to Figure 22).

There are no highly sensitive features impacted by the development footprint, however, the facility layout infringes on buffers associated with sensitive features in the development area. Any impact to these areas of high sensitivity can be mitigated through the micro-siting of the facility layout in these areas. The abundance of species of concern within the development area is low and while there are some protected species present, such as Acacaia erioloba, there are no species of high conservation concern present and no significant impacts on the local populations of the protected species present can be expected. The CBA corridor areas within the development area are, as a result of historical and current anthropogenic activities and disturbance, no longer considered to be significant for ecological functioning. The site is considered appropriate for the development of a PV facility, which does not warrant whole-scale clearing of the development footprint and still allows for the functioning of areas as movement corridors. Therefore, the development of the facility within the transformed CBAs which overlap with the project development footprint is considered acceptable in terms of the loss of the area to development. Overall and with the suggested mitigation measures implemented, the ecological impacts of the development are likely to be of moderate to low significance and no impacts of high significance are likely. As a result, there are no ecological fatal flaws or impacts that cannot be mitigated that should prevent the development from being approved.

The most significant potential impacts expected are:

» Reduction of a stable vegetation cover and associated below-ground biomass that currently increases soil surface porosity, water infiltration rates and thus improves the soil moisture availability. Without this vegetation, the soil will be prone to extensive surface capping, leading to accelerated erosion and further loss of organic material and soil seed reserves from the local environment.
» A loss of portions of potential sensitive habitats, should the ecological state and conservation value of the vegetation, as well as the presence of protected plant species be found to be significant during the EIA field study. Such study will also reveal possible changes in the species composition and thus erosion protection by vegetation (and erosion risks) that will occur as the result of long-term shading by the planned PV arrays.
» Disturbed vegetation in the study area carries a high risk of invasion by alien invasive plants, which may or may not be present in the study area or nearby. The control and continuous monitoring and eradication of alien invasive plants

will form and integral part of the environmental management of the facility from construction up to decommissioning.

» Possible impacts on the wetlands and drainage lines that may be present on the site, as well as larger drainage lines and the Droë Harts and Losase Rivers beyond the study area due to altered surface hydrology of the surrounding plains. This may influence species depending on these parts of the ecosystem, as well as downstream wetland ecosystems.

» Aquifers play an important role as a water resource throughout the region. The study area falls within an area with a high amount of groundwater resources. Due to the high infiltration rates of the soils, chemicals and other pollutants pose a threat to these resources if not mitigated effectively. Furthermore an increase in infiltration may potentially lead to dissolution of carbonate rocks in these areas, by water that percolates through pre-existing fractures leading to enlarged fracture apertures which may consequently result in the development of large cavities.

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8 APPENDICES:

Appendix 1. Listed Plant Species

List of plant species of conservation concern which are known to occur in the vicinity of study area. The list is derived from the POSA website (*NE – Note Evaluated).

Colours Relate as follow:
Threatened Status: Critically (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Critically Rare, Rare, Declining and Data Deficient (DDD), Not Evaluated (NE)

- Protected according to National Forest Act 1998 / NFA (No 84 of 1998).
- Protected according to The Transvaal Nature Conservation Ordinance (No. 12 of 1983), and
- Protected according to The Bophuthatswana Nature Conservation Act (Act 3 of 1973).
- Invasive Alien Plant

Family	Species	Threat status
ACANTHACEAE	Barleria irritans	LC
ACANTHACEAE	Barleria macrostegia	LC
ACANTHACEAE	Barleria rigida	LC
ACANTHACEAE	Blepharis integrifolia var. integrifolia	LC
ACANTHACEAE	Crabbea angustifolia	LC
ACANTHACEAE	Dyschoriste pseuderecta	LC
ACANTHACEAE	Dyschoriste transvaalensis	LC
ACANTHACEAE	Monechma divaricatum	LC
ACANTHACEAE	Ruellia patula	LC
ACANTHACEAE	Ruelliopsis setosa	LC
AIZOACEAE	Galenia affinis	LC
AIZOACEAE	Galenia portulacacea	LC
AIZOACEAE	Galenia pubescens	LC
AIZOACEAE	Galenia secunda	LC
AIZOACEAE	Plinthus sericeus	LC
AIZOACEAE	Tetragonia spicata	LC
AIZOACEAE	Trianthema salsoloides var. transvaalensis	LC

Family	Species	Threat status
AIZOACEAE	Zaleya pentandra	LC
ALLIACEAE	Tulbaghia leucantha	LC
AMARANTHACEAE	Achyranthes aspera var. aspera	NE
AMARANTHACEAE	Aerva leucura	LC
AMARANTHACEAE	Alternanthera nodiflora	NE
AMARANTHACEAE	Alternanthera pungens	NE
AMARANTHACEAE	Amaranthus thunbergii	LC
AMARANTHACEAE	Cyathula lanceolata	LC
AMARANTHACEAE	Gomphrena celosioides	NE
AMARANTHACEAE	Hermbstaedtia fleckii	LC
AMARANTHACEAE	Hermbstaedtia odorata var. albi-rosea	LC
AMARANTHACEAE	Hermbstaedtia odorata var. aurantiaca	LC
AMARANTHACEAE	Hermbstaedtia odorata var. odorata	LC
AMARANTHACEAE	Kyphocarpa angustifolia	LC
AMARANTHACEAE	Pupalia lappacea var. lappacea	LC
AMARANTHACEAE	Sericocoma avolans	LC
AMARANTHACEAE	Sericorema sericea	LC
AMARYLLIDACEAE	**Ammocharis coranica**	LC
AMARYLLIDACEAE	**Brunsvigia radulosa**	LC
AMARYLLIDACEAE	**Crinum crassicaule**	LC
AMARYLLIDACEAE	**Nerine frithii**	LC
AMARYLLIDACEAE	**Nerine hesseoides**	LC
AMARYLLIDACEAE	**Nerine laticoma**	LC
ANACARDIACEAE	Ozoroa paniculosa var. paniculosa	LC
ANACARDIACEAE	Searsia burchellii	LC
ANACARDIACEAE	Searsia lancea	LC
ANACARDIACEAE	Searsia leptodictya	NE
ANACARDIACEAE	Searsia magalismontana subsp. magalismontana	LC
ANACARDIACEAE	Searsia pyroides var. pyroides	LC
ANACARDIACEAE	Searsia tenuinervis	LC
ANACARDIACEAE	Searsia tridactyla	LC
ANTHERICACEAE	Chlorophytum angulicaule	LC
ANTHERICACEAE	Chlorophytum fasciculatum	LC
ANTHERICACEAE	Chlorophytum krauseanum	LC
ANTHERICACEAE	Chlorophytum recurvifolium	LC
APIACEAE	Apium graveolens	NE
APIACEAE	Berula thunbergii	LC
APIACEAE	Centella asiatica	LC
APIACEAE	Cyclospermum leptophyllum	NE
APIACEAE	Deverra burchellii	LC
APOCYNACEAE	Asclepias eminens	LC
APOCYNACEAE	**Brachystelma dimorphum subsp. dimorphum**	LC
APOCYNACEAE	**Brachystelma foetidum**	LC

Family	Species	Threat status
APOCYNACEAE	**Ceropegia crassifolia var. crassifolia**	LC
APOCYNACEAE	Fockea angustifolia	LC
APOCYNACEAE	Gomphocarpus fruticosus subsp. fruticosus	LC
APOCYNACEAE	Gomphocarpus tomentosus Burch. subsp. tomentosus	LC
APOCYNACEAE	Gomphocarpus tomentosus subsp. tomentosus	LC
APOCYNACEAE	**Hoodia pilifera subsp. annulata**	LC
APOCYNACEAE	Pentarrhinum insipidum	LC
APOCYNACEAE	Pentarrhinum insipidum E.Mey.	LC
APOCYNACEAE	Pergularia daemia subsp. daemia	LC
APOCYNACEAE	Raphionacme hirsuta	LC
APOCYNACEAE	Raphionacme velutina	LC
APOCYNACEAE	**Stapelia grandiflora var. grandiflora**	LC
APOCYNACEAE	Stenostelma capense	LC
APOCYNACEAE	Xysmalobium gomphocarpoides var. gomphocarpoides	LC
APONOGETONACEAE	Aponogeton rehmannii	LC
ASPARAGACEAE	Asparagus bechuanicus	LC
ASPARAGACEAE	Asparagus cooperi	LC
ASPARAGACEAE	Asparagus laricinus	LC
ASPARAGACEAE	Asparagus nodulosus	LC
ASPARAGACEAE	Asparagus retrofractus	LC
ASPARAGACEAE	Asparagus setaceus	LC
ASPARAGACEAE	Asparagus suaveolens	LC
ASPHODELACEAE	**Aloe grandidentata**	LC
ASPHODELACEAE	**Aloe zebrina**	LC
ASPHODELACEAE	Bulbine abyssinica	LC
ASPHODELACEAE	Bulbine narcissifolia	LC
ASPHODELACEAE	**Chortolirion angolense**	LC
ASPHODELACEAE	Haworthia venosa subsp. tessellata	LC
ASPHODELACEAE	Trachyandra burkei	LC
ASPHODELACEAE	Trachyandra laxa var. rigida	LC
ASPHODELACEAE	Trachyandra saltii var. oatesii	LC
ASPHODELACEAE	Trachyandra saltii var. saltii	LC
ASPLENIACEAE	Asplenium phillipsianum	LC
ASTERACEAE	Acanthospermum glabratum	NE
ASTERACEAE	Amphiglossa triflora	LC
ASTERACEAE	Arctotheca calendula	LC
ASTERACEAE	Arctotis arctotoides	LC
ASTERACEAE	Arctotis microcephala	LC
ASTERACEAE	Arctotis venusta	LC
ASTERACEAE	Artemisia afra var. afra	LC
ASTERACEAE	Aster squamatus	NE
ASTERACEAE	Berkheya carlinopsis subsp. magalismontana	LC

Family	Species	Threat status
ASTERACEAE	Berkheya discolor	LC
ASTERACEAE	Berkheya onopordifolia var. onopordifolia	LC
ASTERACEAE	Berkheya pinnatifida subsp. pinnatifida	LC
ASTERACEAE	Berkheya radula	LC
ASTERACEAE	Bidens bipinnata	NE
ASTERACEAE	Bidens pilosa	NE
ASTERACEAE	Blumea dregeanoides	LC
ASTERACEAE	Chrysocoma ciliata	LC
ASTERACEAE	Chrysocoma obtusata	LC
ASTERACEAE	Cichorium intybus subsp. intybus	NE
ASTERACEAE	Cineraria vallis-pacis	LC
ASTERACEAE	Cirsium vulgare	NE
ASTERACEAE	Conyza bonariensis	NE
ASTERACEAE	Cotula anthemoides	LC
ASTERACEAE	Cotula burchellii	NE
ASTERACEAE	Denekia capensis	LC
ASTERACEAE	Dicoma anomala subsp. anomala	LC
ASTERACEAE	Dicoma anomala subsp. gerrardii	LC
ASTERACEAE	Dicoma capensis	LC
ASTERACEAE	Dicoma macrocephala	LC
ASTERACEAE	Dicoma schinzii	LC
ASTERACEAE	Dimorphotheca cuneata	LC
ASTERACEAE	Dimorphotheca zeyheri	LC
ASTERACEAE	Erlangea misera	LC
ASTERACEAE	Felicia clavipilosa subsp. clavipilosa	LC
ASTERACEAE	Felicia filifolia subsp. filifolia	LC
ASTERACEAE	Felicia hirsuta	LC
ASTERACEAE	Felicia muricata subsp. cinerascens	LC
ASTERACEAE	Felicia muricata subsp. muricata	LC
ASTERACEAE	Flaveria bidentis	NE
ASTERACEAE	Galinsoga parviflora	NE
ASTERACEAE	Gazania krebsiana subsp. serrulata	LC
ASTERACEAE	Geigeria aspera var. aspera	LC
ASTERACEAE	Geigeria brevifolia	LC
ASTERACEAE	Geigeria burkei subsp. burkei var. burkei	LC
ASTERACEAE	Geigeria burkei subsp. burkei var. zeyheri	LC
ASTERACEAE	Geigeria burkei subsp. diffusa	LC
ASTERACEAE	Geigeria burkei subsp. fruticulosa	LC
ASTERACEAE	Geigeria filifolia	LC
ASTERACEAE	Geigeria obtusifolia	LC
ASTERACEAE	Geigeria ornativa subsp. ornativa	LC
ASTERACEAE	Gnaphalium filagopsis	LC
ASTERACEAE	Gnaphalium nelsonii	Rare
ASTERACEAE	Helianthus debilis subsp. cucumerifolius	NE

Family	Species	Threat status
ASTERACEAE	Helichrysum argyrosphaerum	LC
ASTERACEAE	Helichrysum caespititium	LC
ASTERACEAE	Helichrysum cerastioides var. cerastioides	LC
ASTERACEAE	Helichrysum dregeanum	LC
ASTERACEAE	Helichrysum lineare	LC
ASTERACEAE	Helichrysum nudifolium var. nudifolium	LC
ASTERACEAE	Helichrysum obtusum	LC
ASTERACEAE	Helichrysum paronychioides	LC
ASTERACEAE	Helichrysum tomentosulum subsp. aromaticum	LC
ASTERACEAE	Helichrysum zeyheri	LC
ASTERACEAE	Hertia pallens	LC
ASTERACEAE	Hirpicium bechuanense	LC
ASTERACEAE	Ifloga glomerata	LC
ASTERACEAE	Lactuca inermis	LC
ASTERACEAE	Laggera decurrens	LC
ASTERACEAE	Lasiopogon muscoides	LC
ASTERACEAE	Launaea rarifolia var. rarifolia	LC
ASTERACEAE	Litogyne gariepina	LC
ASTERACEAE	Mikaniopsis cissampelina	LC
ASTERACEAE	Nidorella hottentotica	LC
ASTERACEAE	Nidorella resedifolia subsp. resedifolia	LC
ASTERACEAE	Nolletia ciliaris	LC
ASTERACEAE	Osteospermum muricatum ex subsp. muricatum	LC
ASTERACEAE	Pegolettia retrofracta	LC
ASTERACEAE	Pentzia calcarea	LC
ASTERACEAE	Pentzia calcarea Kies	LC
ASTERACEAE	Pentzia globosa	LC
ASTERACEAE	Pentzia incana	LC
ASTERACEAE	Pentzia lanata	LC
ASTERACEAE	Pentzia quinquefida	LC
ASTERACEAE	Pseudognaphalium luteo-album	
ASTERACEAE	Pseudognaphalium oligandrum	LC
ASTERACEAE	Rennera stellata	VU
ASTERACEAE	Schkuhria pinnata	NE
ASTERACEAE	Senecio arenarius	LC
ASTERACEAE	Senecio burchellii	LC
ASTERACEAE	Senecio inaequidens	LC
ASTERACEAE	Senecio reptans	LC
ASTERACEAE	Sonchus oleraceus	NE
ASTERACEAE	Tagetes minuta	NE
ASTERACEAE	Tarchonanthus camphoratus	LC
ASTERACEAE	Tarchonanthus obovatus	LC
ASTERACEAE	Tripteris aghillana var. aghillana	LC
ASTERACEAE	Ursinia nana subsp. leptophylla	LC

Family	Species	Threat status
ASTERACEAE	Verbesina encelioides var. encelioides	NE
ASTERACEAE	Vernonia galpinii	LC
ASTERACEAE	Xanthium spinosum	NE
ASTERACEAE	Zinnia peruviana	NE
BIGNONIACEAE	Rhigozum brevispinosum	LC
BORAGINACEAE	Anchusa riparia	LC
BORAGINACEAE	Cynoglossum lanceolatum	LC
BORAGINACEAE	Ehretia alba	LC
BORAGINACEAE	Heliotropium ciliatum	LC
BORAGINACEAE	Heliotropium nelsonii	LC
BORAGINACEAE	Heliotropium ovalifolium	LC
BORAGINACEAE	Heliotropium strigosum	LC
BORAGINACEAE	Heliotropium zeylanicum	LC
BORAGINACEAE	Lithospermum cinereum	LC
BORAGINACEAE	Lithospermum scabrum	LC
BORAGINACEAE	Trichodesma angustifolium subsp. angustifolium	LC
BRASSICACEAE	Capsella bursa-pastoris	NE
BRASSICACEAE	Coronopus integrifolius	NE
BRASSICACEAE	Erucastrum strigosum	LC
BRASSICACEAE	Rorippa fluviatilis var. caledonica	LC
BRASSICACEAE	Sisymbrium capense	LC
BRASSICACEAE	Sisymbrium turczaninowii	LC
BUDDLEJACEAE	Buddleja saligna	LC
BUDDLEJACEAE	Gomphostigma virgatum	LC
BUDDLEJACEAE	Nuxia gracilis	LC
BURSERACEAE	Commiphora glandulosa	LC
BURSERACEAE	Commiphora pyracanthoides	LC
BURSERACEAE	Commiphora pyracanthoides Engl.	LC
CAMPANULACEAE	Wahlenbergia androsacea	LC
CAMPANULACEAE	Wahlenbergia denticulata var. denticulata	LC
CAMPANULACEAE	Wahlenbergia denticulata var. transvaalensis	LC
CAMPANULACEAE	Wahlenbergia paniculata	LC
CAMPANULACEAE	Wahlenbergia undulata	LC
CAPPARACEAE	**Boscia albitrunca**	LC
CAPPARACEAE	Boscia foetida subsp. minima	LC
CAPPARACEAE	Cadaba aphylla	LC
CAPPARACEAE	Cleome angustifolia subsp. diandra	LC
CAPPARACEAE	Cleome angustifolia subsp. petersiana	LC
CAPPARACEAE	Cleome gynandra	LC
CAPPARACEAE	Cleome maculata	LC
CAPPARACEAE	Cleome monophylla	LC
CAPPARACEAE	Cleome rubella	LC
CARYOPHYLLACEAE	Dianthus micropetalus	LC
CARYOPHYLLACEAE	Pollichia campestris	LC

Family	Species	Threat status
CARYOPHYLLACEAE	Pollichia campestris Aiton	LC
CARYOPHYLLACEAE	Silene undulata	LC
CELASTRACEAE	Gymnosporia buxifolia	LC
CELASTRACEAE	Maytenus acuminata var. acuminata	LC
CELTIDACEAE	Celtis africana	LC
CHENOPODIACEAE	Atriplex semibaccata var. appendiculata	LC
CHENOPODIACEAE	Chenopodium ambrosioides	NE
CHENOPODIACEAE	Chenopodium carinatum	NE
CHENOPODIACEAE	Chenopodium phillipsianum	NE
CHENOPODIACEAE	Salsola atrata	LC
CHENOPODIACEAE	Salsola glabrescens	LC
COLCHICACEAE	Colchicum melanthoides subsp. melanthoides	LC
COLCHICACEAE	Ornithoglossum dinteri	LC
COLCHICACEAE	Ornithoglossum vulgare	LC
COMBRETACEAE	Terminalia sericea	LC
COMMELINACEAE	Commelina africana var. africana	LC
COMMELINACEAE	Commelina africana var. barberae	LC
COMMELINACEAE	Commelina africana var. krebsiana	LC
COMMELINACEAE	Commelina africana var. lancispatha	LC
COMMELINACEAE	Commelina benghalensis	LC
COMMELINACEAE	Commelina livingstonii	LC
COMMELINACEAE	Cyanotis speciosa	LC
CONVOLVULACEAE	Convolvulus multifidus	LC
CONVOLVULACEAE	Convolvulus ocellatus var. ocellatus	LC
CONVOLVULACEAE	Convolvulus sagittatus	LC
CONVOLVULACEAE	Evolvulus alsinoides	LC
CONVOLVULACEAE	Falkia oblonga	LC
CONVOLVULACEAE	Ipomoea bolusiana	LC
CONVOLVULACEAE	Ipomoea obscura var. obscura	LC
CONVOLVULACEAE	Ipomoea oenotheroides	LC
CONVOLVULACEAE	Ipomoea sinensis subsp. blepharosepala	LC
CONVOLVULACEAE	Merremia verecunda	LC
CONVOLVULACEAE	Seddera capensis	LC
CONVOLVULACEAE	Seddera suffruticosa	LC
CONVOLVULACEAE	Xenostegia tridentata subsp. angustifolia	LC
CRASSULACEAE	Crassula lanceolata subsp. transvaalensis	LC
CRASSULACEAE	Kalanchoe paniculata	LC
CUCURBITACEAE	Acanthosicyos naudinianus	LC
CUCURBITACEAE	Coccinia sessilifolia	LC
CUCURBITACEAE	Cucumis africanus	LC
CUCURBITACEAE	Cucumis myriocarpus subsp. myriocarpus	LC
CUCURBITACEAE	Cucumis zeyheri	LC
CUCURBITACEAE	Kedrostis crassirostrata	LC
CUCURBITACEAE	Momordica balsamina	LC

Family	Species	Threat status
CYPERACEAE	Bulbostylis burchellii	LC
CYPERACEAE	Bulbostylis hispidula subsp. pyriformis	LC
CYPERACEAE	Bulbostylis pusilla	LC
CYPERACEAE	Cyperus atriceps	LC
CYPERACEAE	Cyperus austro-africanus	LC
CYPERACEAE	Cyperus bellus	LC
CYPERACEAE	Cyperus decurvatus	LC
CYPERACEAE	Cyperus difformis	LC
CYPERACEAE	Cyperus esculentus var. esculentus	LC
CYPERACEAE	Cyperus fastigiatus	LC
CYPERACEAE	Cyperus indecorus var. namaquensis	LC
CYPERACEAE	Cyperus longus var. tenuiflorus	LC
CYPERACEAE	Cyperus margaritaceus var. margaritaceus	LC
CYPERACEAE	Cyperus marginatus	LC
CYPERACEAE	Cyperus marlothii	LC
CYPERACEAE	Cyperus obtusiflorus var. obtusiflorus	LC
CYPERACEAE	Cyperus palmatus	LC
CYPERACEAE	Cyperus rubicundus	LC
CYPERACEAE	Cyperus sexangularis	LC
CYPERACEAE	Cyperus sphaerospermus	LC
CYPERACEAE	Cyperus squarrosus	LC
CYPERACEAE	Cyperus usitatus	LC
CYPERACEAE	Kyllinga alba	LC
CYPERACEAE	Kyllinga erecta var. erecta	LC
EUPHORBIACEAE	Acalypha segetalis	LC
EUPHORBIACEAE	Acalypha segetalis Müll.Arg.	LC
EUPHORBIACEAE	Euphorbia inaequilatera var. inaequilatera	LC
FABACEAE	Acacia robusta subsp. robusta	LC
FABACEAE	Gleditsia triacanthos	NE
FABACEAE	Indigastrum costatum subsp. macrum	LC
FABACEAE	Indigofera cryptantha var. cryptantha	LC
FABACEAE	Indigofera heterotricha	LC
FABACEAE	Indigofera sessilifolia	LC
FABACEAE	Otoptera burchellii	LC
FABACEAE	Rhynchosia totta var. totta	LC
FABACEAE	Zornia milneana	LC
HYACINTHACEAE	Dipcadi viride	LC
IRIDACEAE	**Babiana bainesii**	LC
IRIDACEAE	Moraea polystachya	LC
LAMIACEAE	Salvia disermas	LC
LAMIACEAE	Teucrium trifidum	LC
MALVACEAE	Hermannia quartiniana	LC
MALVACEAE	Hibiscus pusillus	LC
MALVACEAE	Hibiscus trionum	

Family	Species	Threat status
MALVACEAE	Melhania prostrata	LC
MALVACEAE	Sida chrysantha	LC
MESEMBRYANTHEMACEAE	Lithops lesliei subsp. lesliei	NT
MOLLUGINACEAE	Hypertelis salsoloides var. salsoloides	LC
MOLLUGINACEAE	Limeum viscosum subsp. transvaalense	LC
MOLLUGINACEAE	Limeum viscosum subsp. viscosum var. viscosum	LC
NYCTAGINACEAE	Commicarpus pentandrus	LC
PASSIFLORACEAE	Adenia repanda	LC
PHYLLANTHACEAE	Phyllanthus incurvus	LC
PLUMBAGINACEAE	Plumbago zeylanica	NE
POACEAE	Andropogon schirensis	LC
POACEAE	Anthephora pubescens	LC
POACEAE	Aristida bipartita	LC
POACEAE	Aristida canescens subsp. canescens	LC
POACEAE	Aristida congesta subsp. barbicollis	LC
POACEAE	Aristida congesta subsp. congesta	LC
POACEAE	Aristida meridionalis	LC
POACEAE	Aristida spectabilis	LC
POACEAE	Aristida stipitata subsp. graciliflora	LC
POACEAE	Aristida stipitata subsp. spicata	LC
POACEAE	Aristida vestita	LC
POACEAE	Brachiaria brizantha	LC
POACEAE	Brachiaria deflexa	LC
POACEAE	Brachiaria nigropedata	LC
POACEAE	Cymbopogon pospischilii	NE
POACEAE	Diandrochloa pusilla	LC
POACEAE	Digitaria brazzae	LC
POACEAE	Digitaria eriantha	LC
POACEAE	Digitaria sanguinalis	NE
POACEAE	Diheteropogon amplectens var. amplectens	LC
POACEAE	Elionurus muticus	LC
POACEAE	Enneapogon scoparius	LC
POACEAE	Eragrostis barrelieri	NE
POACEAE	Eragrostis bicolor	LC
POACEAE	Eragrostis chloromelas	LC
POACEAE	Eragrostis curvula	LC
POACEAE	Eragrostis echinochloidea	LC
POACEAE	Eragrostis gummiflua	LC
POACEAE	Eragrostis homomalla	LC
POACEAE	Eragrostis lehmanniana var. lehmanniana	LC
POACEAE	Eragrostis nindensis	LC
POACEAE	Eragrostis pallens	LC

Family	Species	Threat status
POACEAE	Eragrostis rigidior	LC
POACEAE	Eragrostis superba	LC
POACEAE	Eragrostis viscosa	LC
POACEAE	Eragrostis x pseud-obtusa	NE
POACEAE	Fingerhuthia africana	LC
POACEAE	Heteropogon contortus	LC
POACEAE	Hyparrhenia hirta	LC
POACEAE	Leptochloa fusca	LC
POACEAE	Melinis repens subsp. repens	LC
POACEAE	Panicum coloratum var. coloratum	LC
POACEAE	Panicum kalaharense	LC
POACEAE	Panicum maximum	LC
POACEAE	Panicum stapfianum	LC
POACEAE	Pogonarthria squarrosa	LC
POACEAE	Schizachyrium sanguineum	LC
POACEAE	Schmidtia pappophoroides	LC
POACEAE	Sporobolus fimbriatus	LC
POACEAE	Stipagrostis uniplumis var. neesii	LC
POACEAE	Themeda triandra	LC
POACEAE	Tricholaena monachne	LC
POACEAE	Trichoneura grandiglumis	LC
POACEAE	Triraphis andropogonoides	LC
POACEAE	Urochloa panicoides	
POLYGONACEAE	Oxygonum alatum var. alatum	LC
POTTIACEAE	Pseudocrossidium porphyreoneurum	
PTERIDACEAE	Actiniopteris radiata	LC
RICCIACEAE	Riccia albolimbata	
RUBIACEAE	Anthospermum rigidum subsp. rigidum	LC
RUBIACEAE	Kohautia cynanchica	LC
SCROPHULARIACEAE	Aptosimum albomarginatum	LC
SCROPHULARIACEAE	Aptosimum elongatum	LC
SCROPHULARIACEAE	Peliostomum leucorrhizum	LC
SCROPHULARIACEAE	Selago mixta	LC
SCROPHULARIACEAE	Selago mixta Hilliard	LC
SINOPTERIDACEAE	Cheilanthes dolomiticola	LC
SINOPTERIDACEAE	Cheilanthes hirta var. brevipilosa	
SINOPTERIDACEAE	Pellaea calomelanos var. calomelanos	LC
SOLANACEAE	Solanum catombelense	LC
VERBENACEAE	Lantana mearnsii var. latibracteolata	LC
VERBENACEAE	Lantana rugosa	LC
VERBENACEAE	Lippia scaberrima	LC
VERBENACEAE	Verbena officinalis	NE

Appendix 2. List of Mammals

List of Mammals which may potentially occur within the surrounding area. Taxonomy notes are derived from Skinner & Chimimba (2005), while conservation status is according to the IUCN 2010.

Scientific Name	Common Name	Status	Likelihood
Afrosoricida (Golden Moles):			
Chlorotalpa sclateri	Sclater's Golden Mole	LC	
Chrysochloris asiatica	Cape Golden Mole	LC	
Macroscledidea (Elephant Shrews):			
Elephantulus myurus	Eastern Rock Elephant Shrew	LC	Low
Tubulentata:			
Orycteropus afer	Aardvark	LC	High
Hyracoidea (Hyraxes)			
Procavia capensis	Rock Hyrax	LC	Low
Lagomorpha (Hares and Rabbits):			
Pronolagus rupestris	Smith's Red Rock Rabbit	LC	Low
Lepus capensis	Cape Hare	LC	High
Lepus saxatilis	Scrub Hare	LC	High
Rodentia (Rodents):			
Cryptomys hottentotus	African Mole Rat	LC	High
Hystrix africaeaustralis	Cape Porcupine	LC	High
Pedetes capensis	Springhare	LC	High
Xerus inauris	South African Ground Squirrel	LC	High
Rhabdomys pumilio	Four-striped Grass Mouse	LC	High
Mus minutoides	Pygmy Mouse	LC	High
Mastomys coucha	Southern Multimammate Mouse	LC	High
Aethomys ineptus	Tete Veld Rat	LC	High
Aethomys namaquensis	Namaqua Rock Mouse	LC	High
Otomys irraratus	Vlei Rat	LC	Low
Desmodillus auricularis	Cape Short-tailed Gerbil	LC	High

Gerbilliscus leucogaster	Bushveld Gerbil	LC	High
Gerbilliscus brantsii	Highveld Gerbil	LC	High
Mystromys albicaudatus	White-tailed Mouse	EN	High
Saccostamus campestris	Pouched Mouse	LC	High
Malocothrix typica	Gerbil Mouse	LC	Moderate
Dendromus melanotis	Grey Climbing Mouse	LC	High
Steatomys krebsii	Krebs's Fat Mouse	LC	Low
Primates			
Papio ursinus	Chacma Baboon	LC	Low
Eulipotyphla (Shrews):			
Crocidura cyanea	Reddish-Grey Musk Shrew	LC	Moderate
Suncus varilla	Lesser Dwarf Shrew	LC	Moderate
Crocidura fuscomurina	Tiny Musk Shrew	LC	Low
Crocidura hirta	Lesser Red Musk Shrew	LC	High
Erinaceomorpha (Hedgehog)			
Atelerix frontalis	South African Hedgehog	LC	High
Philodota (Pangolins)			
Smutsia temminckii	Ground Pangolin	VU	High
Carnivora:			
Proteles cristatus	Aardwolf	LC	High
Hyaena brunnea	Brown Haena	NT	Moderate
Caracal caracal	Caracal	LC	High
Felis silvestris	African Wild Cat	LC	High
Felis nigripes	Black-footed cat	VU	High
Genetta genetta	Small-spotted genet	LC	High
Panthera pardus	Leopard	SARDB NT	Low
Suricata suricatta	Meerkat	LC	High
Cynictis penicillata	Yellow Mongoose	LC	High
Galerella sanguinea	Slender Mongoose	LC	High
Ichneumia albicauda	White-tailed Mongoose	LC	Moderate
Vulpes chama	Cape Fox	LC	High
Canis mesomelas	Black-backed Jackal	LC	High

Otocyon megalotis	Bat-eared Fox	LC	High
Aonyx capensis	African Clawless Otter	LC	Low
Poecilogale albinucha	African Striped Weasel	LC	Low
Ictonyx striatus	Striped Polecat	LC	High
Rumanantia (Antelope):			
Tragelaphus strepsiceros	Greater Kudu	LC	High
Tragelaphus oryx	Eland	LC	Low
Elea capreolus	Grey Rhebok	LC	Low
Sylvicapra grimmia	Common Duiker	LC	High
Antidorcas marsupialis	Springbok	LC	Low
Raphicerus campestris	Steenbok	LC	High
Chiroptera (Bats)			
Neoromicia capensis	Cape Serotine Bat	LC	High
Tadarida aegyptiaca	Egyptian Free-tailed Bat	LC	High
Nycteris thebaica	Egyptian Slit-faced Bat	LC	High
Miniopterus natalensis	Natal long-fingered Bat	NT	Moderate
Eptesicus hottentotus	Long-tailed serotine Bat	LC	Low
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	LC	High
Rhinolophus denti	Dent's Horseshoe Bat	LC	Moderate
Rhinolophus darling	Darling's Horseshoe Bat	LC	High
Eidolon helvum	Straw-coloured fruit bat	LC	Moderate

Appendix 3. List of Reptiles.

List of reptiles which are known from the broad area (2624 and 2724 Degree Grids) according to the SARCA database. All species that have been noted within the Quarter Degree Grids of the study site (2624DD, 2724BB) are indicated in **green**. All species listed as red data species, highlighted in red.

Family	Species	Common Name	Threat Status
Agamidae	***Agama atra***	Southern Rock Agama	LC
Amphisbaenidae	*Monopeltis capensis*	Cape Worm Lizard	LC
Amphisbaenidae	*Zygaspis quadrifrons*	Kalahari Dwarf Worm Lizard	LC
Atractaspididae	*Aparallactus capensis*	Black-headed Centipede-eater	LC
Atractaspididae	*Atractaspis bibronii*	Bibron's Stiletto Snake	LC
Chamaeleonidae	*Chamaeleo dilepis dilepis*	Common Flap-neck Chameleon	LC
Colubridae	***Boaedon capensis***	Brown House Snake	LC
Colubridae	*Dispholidus typus typus*	Boomslang	LC
Colubridae	*Philothamnus semivariegatus*	Spotted Bush Snake	LC
Colubridae	*Psammophis brevirostris*	Short-snouted Grass Snake	LC
Colubridae	*Psammophis trinasalis*	Fork-marked Sand Snake	LC
Colubridae	*Psammophylax tritaeniatus*	Striped Grass Snake	LC
Cordylidae	***Karusasaurus polyzonus***	Karoo Girdled Lizard	LC
Elapidae	*Naja nivea*	Cape Cobra	LC
Gekkonidae	***Lygodactylus capensis capensis***	Common Dwarf Gecko	LC
Gerrhosauridae	***Gerrhosaurus flavigularis***	Yellow-throated Plated Lizard	LC
Lacertidae	*Nucras intertexta*	Spotted Sandveld Lizard	LC
Leptotyphlopidae	*Leptotyphlops scutifrons scutifrons*	Peters' Thread Snake	Not listed
Scincidae	*Acontias gracilicauda*	Thin-tailed Legless Skink	LC
Scincidae	*Acontias occidentalis*	Western Legless Skink	LC
Scincidae	*Afroablepharus wahlbergii*	Wahlberg's Snake-eyed Skink	LC
Scincidae	***Trachylepis capensis***	Cape Skink	LC
Scincidae	***Trachylepis punctatissima***	Speckled Rock Skink	LC
Scincidae	***Trachylepis varia***	Variable Skink	LC
Varanidae	*Varanus albigularis albigularis*	Rock Monitor	LC
Varanidae	*Varanus niloticus*	Water Monitor	LC
Viperidae	*Bitis arietans arietans*	Puff Adder	LC

Appendix 4. List of Amphibians.

List of amphibians which are known from the broad area (2624 and 2724 Degree Grids) according to the SARCA database. All species that have been noted within the Quarter Degree Grids of the study site (2624DD, 2724BB) are indicated in **green**. All species listed as red data species, highlighted in red.

Family	Species	Common Name	Threat Status
Brevicepitidae	***Breviceps adspersus***	Bushveld Rain Frog	LC
Bufonidae	*Amietophrynus garmani*	Olive Toad	LC
Bufonidae	*Amietophrynus gutturalis*	Guttural Toad	LC
Bufonidae	***Amietophrynus poweri***	Power's Toad	LC
Bufonidae	*Amietophrynus rangeri*	Raucous Toad	LC
Bufonidae	***Schismaderma carens***	Red Toad	LC
Bufonidae	*Vandijkophrynus gariepensis gariepensis*	Karoo Toad	Not listed
Hyperoliidae	***Kassina senegalensis***	Bubbling Kassina	LC
Microhylidae	*Phrynomantis bifasciatus*	Banded Rubber Frog	LC
Pipidae	***Xenopus laevis***	Common Platanna	LC
Pyxicephalidae	*Amietia fuscigula*	Cape River Frog	LC
Pyxicephalidae	***Amietia quecketti***	Queckett's River Frog	LC
Pyxicephalidae	***Cacosternum boettgeri***	Common Caco	LC
Pyxicephalidae	*Pyxicephalus adspersus*	Giant Bull Frog	NT
Pyxicephalidae	***Tomopterna cryptotis***	Tremelo Sand Frog	LC

Appendix 5. Ecological Environmental Management Plan

Design Phase

Optimal design and pre-commencement activities

OBJECTIVE 1: Ensure the selection of the best environmental option for the alignment of the power lines, development areas and access roads

OBJECTIVE 2: Ensure all environmental sensitivities and possible impacts are fully accounted for and methods in place for mitigation prior to commencement of activity

The study area is situated within the original extent of the Least Threatened Ghaap Plateau Vaalbosveld. The vegetation within the development footprint area can be regarded as near-natural with moderate transformation, mainly due to bush clearing towards the east, slight bush encroachment to the west due to moderate levels of historical overgrazing and the presence of an old quarry to the north-east. The site is furthermore highly fractured, mainly due to the R34 and the Provincial gravel road (to Amalia). The study area is still none the less in a good to moderate ecological state. Several protected plant species occur within the study area, some with red data status, and many of the bulbous protected species can be relocated with relative ease.

Opportunities to mitigate the negative impacts of large-scale PV developments largely arise during the planning and design stages. The correct choice of footprint location and layout is paramount, thus ecosystem components such as biodiversity and ecosystem function should be given full consideration during the design phase, as determined by the Environmental Impact Assessments. The exact design of PV arrays (panel size, height, spacing, and nature of panels – tracking or fixed) can be equally important. The timing of pre-commencement, construction, maintenance and decommissioning activities also provides opportunities to reduce negative impacts on biodiversity.

Once the layout has been designed, a detailed investigation of the footprint area, during the optimal growing season and as described below must be conducted before the layout is finalised and activity commences.

Project Component/s	» PV Array » Grid connection and associated servitudes » Access roads » Workshop, guardhouses, substation and other related infrastructure

	» Temporary construction camps » Protective fencing around development » Potential topsoil stockpiles and/or borrow pits
Potential Impact	» Placement that degrades the environment unnecessarily, particularly with respect to habitat destruction, loss of indigenous flora, damage to drainage lines, establishment and persistence of alien invasive plants, and erosion.
Activities/Risk Sources	» Positioning of solar components and internal access routes » Positioning of workshop, guardhouses, substation and other related infrastructure » Alignment of power lines and servitudes » Alignment of access roads to development » Positioning of temporary sites
Mitigation: Target/Objective	» To ensure selection of best environmental option for positioning alignment of proposed infrastructure » Environmental sensitivities are taken into consideration and avoided as far as possible, thereby mitigating potential impacts

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Undertake pre-construction walk-through footprint investigations for protected flora and burrowing terrestrial vertebrates: The final footprint investigation (walkthrough) is aimed to fully inform the developer, responsible conservation authority (that will issue the relevant permits and authorisations), contractors, EO and ECO about: » Protected and red data species that will be affected by the development o indicating the red-data and protection status of each species observed (what red-data classification, which legislation) » Location of protected plant species within the footprint area – either individually mapped or approximate areas of occurrence (alternatively, for linear structures, between which structures or other markers) » Identification of the affected species by providing a representative photo record that enables ECOs and contractors to identify such plants » How many specimens per species will be affected – relatively accurate estimate to the nearest 50, more	Developer, carried out by Specialist	Design review phase

Mitigation: Action/Control	Responsibility	Timeframe
accurate if less than 50 » Which species can be successfully relocated, which and how many will have to be destroyed » Location and nature of any nesting sites or active burrows of vertebrate species (birds, amphibians, reptiles and mammals), mapped by GPS, that will have to be inspected and cleared/relocated prior to construction by the contractor or duly appointed person(s) » Location and nature of any alien invasive species that will have to be cleared by the contractor » Location and nature of any other significant environmental concerns, e.g. gully erosion, that will need to be addressed by the contractor to prevent any unnecessary (further) degradation of the development footprint » Note: should more than 1000 specimens of any critically endangered or endangered species be affected, as risk assessment report for that species must be prepared according to Section 15 of the NEMA:BA Draft Threatened or Protected Species Regulations, Gazetted General Notice 388 of 2013.		
The above pre-construction footprint investigations will be used together with results from the ecological specialist report to draft the following: » A comprehensive search and rescue program for plants and possible burrowing animals » A comprehensive alien invasive species eradication and management plan o Basic requirements of these EMPs are listed under the Construction and operational Phase EMP	Developer, carried out by Specialist	Design review phase
Obtain permits for protected plant removal and relocation prior to commencement of any activity related to this development » As a minimum, permits will be required to remove all or some of the following species: o *Ammocharis coranica* o *Boophone disticha* o *Acacia erioloba* o *Aloe grandidentata*	Developer, or contractor responsible for vegetation clearing	Pre-commencement
Use design-level mitigation measures recommended in respect of habitat and ecosystem intactness and	Developer	Prior to submission

Mitigation: Action/Control	Responsibility	Timeframe
prevention of species loss as detailed within the EIA Report » This includes positioning components of the development as close as possible together and in close proximity to other existing or planned developments in the area » Strictly adhere to existing tracks/roads where ever possible to gain access to the site » Sites for storing, mixing, and handling topsoil piles (if necessary) or any introduced materials, including all machinery or processing implements, must be placed in an ecologically least sensitive area and at least 500 m from any type of wetland. Such sites must be clearly indicated in site plans and the drafting of relevant detailed method statements and/or management plans requested from the relevant contractor or environmental firm.		of final construction layout plan
Access roads and machinery turning points must be planned to minimise the impacted area, avoid the initiation of accelerated soil erosion and prevent unnecessary compaction and disturbance of topsoils, prevent obstruction or alteration of natural water flow	Developer	Design phase
Compile a comprehensive storm water management and erosion control plan for the footprint area as part of the final design of the project » Basic requirements of these EMPs are listed under the Construction and Operational Phase EMP	Developer and relevant specialist	Design phase
Permissible biodiversity: » Depending on the final PV array and mechanism developed and taking all potential impacts, fire risks and maintenance requirements into consideration, it has to be decided upon and made clear: o Permissible vegetation: maximum height, desirable density and composition o Maintenance of this vegetation – mowing, small livestock grazing, etc. o Permissible terrestrial fauna that could be allowed to migrate/return to the area below/between the PV arrays – including species that must be excluded due to potential damage to the development	Developer, in consultation with relevant specialist	Design phase
After the permissible biodiversity has been determined, compile a comprehensive vegetation rehabilitation	Developer and relevant	Design phase

Mitigation: Action/Control	Responsibility	Timeframe
management plan. » Basic requirements of these EMPs are listed under the Construction and operational Phase EMP	specialist	
Depending on the type of PV panels selected for the development, a response and management plan must be drafted and available to deal with accidental breakages and potential release of harmful substances. This plan must include as a minimum: » How and where broken components and potential harmful substances can be disposed of – it must also be indicated if any material can be recycled, and where materials must then be taken for recycling o The above will have to be incorporated into the waste management plan	Developer and relevant waste management specialist	Design phase

Performance Indicator	» Grid connection and road alignments meet environmental objectives. » Solar components and all associated temporary and permanent infrastructure and access road alignments meet environmental objectives » Ecosystem fragmentation is kept to a minimum » Ecosystem functionality is retained and any degradation prevented
Monitoring	» Ensure that the design implemented meets the objectives and mitigation measures in the EIA Report through review of the design by the Project Manager, and the ECO prior to the commencement of activity.

Construction and Operational Phase

The expected lifetime of the development ranges between 25 to 30 years after construction. After that, the development will either be decommissioned or, more likely, upgraded with newer available technology to remain functional and economical. These timeframes are sufficient to cause an irreversible negative shift in natural biodiversity composition and associated loss of ecosystem functionality if impacts are not maximally mitigated and any degradation of the environment prevented from the start and continuously monitored and mitigated until decommissioning.

The management options below specify the minimum requirements to mitigate the impacts of the proposed development on the biodiversity and overall ecology

of the area to be developed. More specific management options will need to be created once the exact layout and type of PV and construction plans are known.

For the optimal implementation and updating of the management plans, it is recommended that the ecological specialist who is familiar with the site or at least did the pre-commencement footprint investigation, visit the site soon after construction has started or immediately after all site preparation earthworks have been completed, and at least once when rehabilitation work is under way. This would be not only to support the ECO, but to ensure that minimum requirements of the mitigation plans are sufficient to retain sufficient functionality of the ecosystem to prevent any undue further degradation of the development site and beyond.

The ECO will most likely only be present on site for the duration of construction activities. Where continued monitoring and possible mitigation will be required during the operational phase, an EO, or suitable staff must be appointed. It is recommended that the current EMP be revised after completion of the design, again after construction and then as necessary, and a new set of EMPs be drafted for the decommissioning phase to continue with mitigations and prevention of all related environmental impacts.

Species search and rescue

OBJECTIVE: Minimise loss of indigenous biodiversity, including plants of conservation concern

Prior to commencement of any activity, including earthworks (grading, road construction, etc) within areas of natural vegetation a plant Search and Rescue program should be developed and implemented, preceded by a meticulous investigation of all footprint areas by a suitably qualified botanist, conducted during the optimal growing season (January to April) along the entire footprint area as specified in 12.1.1.

Project Component/s	Project components affecting the objective: » PV Array » Grid connection and associated servitudes » Access roads » Workshop, guardhouses, substation and other related infrastructure » Temporary construction camps » Protective fencing around development » Potential topsoil stockpiles and/or borrow pits
Potential Impact	» Substantially increased loss of species of conservation concern

	and other natural vegetation at construction phase, waste of on-site plant resources, lack of locally sourced material for rehabilitation of disturbed areas; » Increased cost of rehabilitation
Activities/Risk Sources	» Construction related loss and damage to remaining natural and semi-natural vegetation
Mitigation: Target/Objective	» Rescue, maintenance and subsequent replanting of at least all bulbous protected plant species within the specific land portion

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Ecological footprint investigation and recording by GPS of localities of all red data species and indication of presence of other species of conservation concern (Design Phase)	Ecologist	Prior to commencement of activity
» Search and Rescue (S&R) of all protected plants that will be affected by the development, especially species occurring in long term and permanent, hard surface development footprints (i.e. all buildings, new roads and tracks, laydown areas, and panel positions) should take place. o The necessary permits must be in place » Plants that can be considered for rescue and included in subsequent rehabilitation programs are all tubers, bulbs, and indigenous succulents » All development footprints must be surveyed and pegged out as soon as possible, after which a local horticulturist with Search and Rescue experience should be appointed to undertake the S&R. » All rescued species should be bagged (or cuttings taken where appropriate) and kept in the horticulturist's or a designated on-site nursery, and should be returned to site or land portion once all construction is completed and rehabilitation of disturbed areas is required. » Replanting should occur in spring to early summer once sufficient rains have fallen, in order to facilitate establishment. » List of protected species so far recorded on site: o *Ammocharis coranica* o *Boophone disticha* o *Acacia erioloba* o *Aloe grandidentata*	Horticultural Contractor, monitored and approved by ECO	Prior to construction
In line with specifications regarding permissible biodiversity and the rehabilitation plan, a minimum percentage cover of vegetation must be established	Developer and horticultural contractor	After construction, throughout

Mitigation: Action/Control	Responsibility	Timeframe
and permanently maintained post construction		operational phase
All cable trenches, excavations, etc, through sensitive areas should be excavated carefully in order to minimise damage to surrounding areas and biodiversity. » The trenches must be checked on a daily basis for the presence of trapped animals. » Any animals found must be removed in a safe manner, unharmed, and placed in an area where the animal will be comfortable. » If the ECO or contractor is unable to assist in the movement of a fauna species, ensure a member of the conservation authorities assists with the translocation. » All mammal, large reptiles and avifauna species found injured during construction will be taken to a suitably qualified veterinarian or rehabilitation centre to either be put down in a humane manner or cared for until it can be released again	Contractor / ECO	Duration of construction

Performance Indicator	» Rescue of species of conservation concern » No damage or injury to fauna » Re-establishment of rescued species
Monitoring	» ECO to monitor Search and Rescue, continue search and rescue operations during the construction process where it becomes necessary after the initial S&R » It may be possible that geophytic species may emerge during construction that were not accounted for in the original S&R plan – once observed the ECO should consult the botanists on the identification and possible S&R for those plant species

Management of temporary construction sites

OBJECTIVE1: Environmentally sensitive location of construction equipment camps and all other temporary structures on site to limit impacts

OBJECTIVE2: Environmentally sensitive movement of equipment, machinery, vehicles and materials to, on and from site to limit impacts

It is expected that all construction staff will reside within existing accommodation in nearby townships. No staff should be accommodated on site. Construction equipment and machinery may need to be stored at an appropriate location on the site for the duration of the construction period, and temporary staff facilities will have to be made available.

Project Component/s	Project components affecting the objective: » Construction equipment camps » Facilities for storing, mixing and general handling of materials » Access roads
Potential Impact	» Damage to indigenous natural vegetation; » Damage to and/or loss of topsoil; » Initiation of accelerated erosion; » Compacting of ground; and » Pollution of the surrounding environment due to inadequate or inappropriate facilities or procedures
Activities/Risk Sources	» Vegetation clearing and levelling of temporary construction or storage area/s; » Transport to and from the temporary construction or storage area/s. » Types of materials or equipment and the manner in which they are stored or handled
Mitigation: Target/Objective	» To minimise impacts on the biophysical environment » To prevent any residual or cumulative impacts arising from temporary construction or storage areas

Mitigation: Action/Control	Responsibility	Timeframe
» The location of the construction equipment camp and all access routes will take cognisance of any ecologically sensitive areas identified. » The location of this construction equipment camp shall be approved by the project ECO or the specialist doing the pre-commencement footprint investigation	Contractor/ECO	Pre-construction
No temporary site camps will be allowed outside the footprint of the development area. » To minimise the footprint, temporary storage of equipment and materials on site should be kept at a minimum	Contractor, monitored by ECO	Construction
As far as possible, minimise natural and semi-natural vegetation clearing for equipment storage areas. » Aim to locate the temporary construction camps on already degraded and/or heavily disturbed areas	Contractor, monitored by ECO	During site establishment
Staff shall be supplied with adequate facilities aimed at preventing any kind of pollution	Contractor, monitored by	Construction, Operational

Mitigation: Action/Control	Responsibility	Timeframe
» Cooking on open fires must be prohibited, if staff need cooking/kitchen facilities on site, such should be provided by the contractor	ECO	phase
Identify and demarcate construction areas, servitudes, and access for general construction work and restrict construction activity to these areas. » Prevent unnecessary destructive activity within construction areas (prevent over-excavations and double handling) » Create specific turning points and parking areas for vehicles and heavy machinery as needed » Strictly prohibit any driving outside designated areas and roads	Contractor, ECO to control	Before and during construction, operational phase
To limit the possible distribution of undesirable species and possible pollutants onto site: » Regularly check clothing and vehicles for mud and seed and clear in an appropriate manner (see invasive plant management for more details) » Do not wash down any machinery or vehicle within the farm portion, including the footprint area » All materials moved onto the development site must be free of weeds or any other undesirable organisms or pollutants » It is recommended that fuels, lubricants and other chemicals only be stored on site if absolutely necessary, and then in a manner that prevents any accidental spillage	Contractor, ECO to control	Before and during construction, operational phase
Rehabilitate and revegetate all disturbed areas at the construction equipment camp as soon as construction is complete within an area and mitigate erosion where required as per specific management plans	Contractor, rehabilitation contractor, monitored by ECO	Construction, operational phase

Performance Indicator	» No visible erosion scars or any pollution once construction in an area is completed » All damaged areas successfully rehabilitated one year after completion » No damage to drainage lines or other types of wetland areas » Appropriate waste management
Monitoring	» Regular monitoring and audits of the construction camps and temporary structures on site by the ECO » A photographic record must be established before, during and after mitigation » An incident reporting system should be used to record non-conformances to the EMP, followed by the necessary action from the

	developer to ensure full compliance

Retaining agricultural potential of the site
OBJECTIVE: To avoid and/or minimise the potential negative impact on current and future farming activities during the construction and operational phase.

Construction and operational activities of the proposed facility could lead to the loss of productive farm land. This could be either due to extensive loss of topsoil, soil seed banks, natural vegetation, erosion, or pollution. It is recommended that once it has been determined what the staffing requirements will be during construction and operation of the proposed facility, an open space management plan be drafted in addition to all other management plans related to ecosystem integrity to ensure the safeguarding of the lands productivity and the functionality of the ecosystem on and beyond the development site.

Project component/s	Project components affecting the objective: » PV Array » Grid connection and associated servitudes » Access roads » Workshop, guardhouses, substation and other related infrastructure » Temporary construction camps » Protective fencing around development » Potential topsoil stockpiles and/or borrow pits
Potential Impact	» The footprint of the developments will result in a loss of land that will impact on current farming activities on the site » Within the footprint, a change of plant species composition with lower productivity and agricultural potential can be expected due to removal, disturbance and continued long-term shading of vegetation » A largely reduced vegetation cover will render the ecosystem more prone to erosion and irreversible degradation » Disturbance of indigenous vegetation creates opportunities for the establishment of invasive vegetation or creation of surfaces that do not support the permanent (re-) establishment of vegetation » Accidental release of harmful substances could potentially cause extensive pollution of downstream wetland and water resources beyond the farm portion if not contained immediately

Activities/risk sources	» The footprint taken up by the development » Clearing of vegetation and landscaping on footprint area » Introduction and/or further distribution of invasive plant species » Excessive fragmentation of habitats » Accelerated erosion with extensive loss of topsoils and associated natural seedbanks and nutrients
Mitigation: Target/Objective	» To minimise the loss of land and desirable indigenous vegetation by the construction of the development and to enable selected farming activities (e.g. grazing by small livestock) to continue where possible

Mitigation: Action/control	Responsibility	Timeframe
Minimise the footprint of the development where possible, at the same time avoid impacting on sensitive habitats » The footprint for *all* development components should be defined before the construction phase commences » The specific EMPs shall provide for the mitigations of the impacts of the different types of development components, e.g. if topsoil will have to be stored, a topsoil management plan will have to be drafted o Note: topsoil shall at all times be treated as a valuable agricultural resource	Contractor and relevant specialists, to be monitored by ECO	Before and during construction, operational phase
Rehabilitate disturbed areas on completion of the construction phase. Details of the rehabilitation programme should be contained in the relevant EMP. » Rehabilitation targets must be set according to the original vegetation as described in the ecological specialist report	Contractor, rehabilitation specialist, to be monitored and approved by ECO	Ongoing during construction phase
Monitor erosion and manage all occurrences according to the erosion management plan	Contractor, to be monitored and approved by ECO and EO	Ongoing, from construction to decommissioning
Eradicate all weeds and alien invasive plants as far as practically possible » Continually monitor the re-emergence of these species and manage according to the invasive species management plan	Contractor, to be monitored and approved by ECO and EO	Ongoing, from construction to decommissioning

Performance Indicator	» Footprint of development components included in the Construction Phase EMP » All relevant and specific EMPs also agreed upon by the land owner

	and then diligently implemented by the contractor and developer » Stable vegetation cover throughout the development area as determined desirable to curb erosion and maintain ecosystem functionality
Monitoring	» Regular monitoring and audits of construction activities and the footprint area by the ECO to prevent any degradation of the ecosystem » A photographic record must be established before, during and after mitigation » An incident reporting system should be used to record non-conformances to the EMP, followed by the necessary action from the developer to ensure full compliance

Topsoil management

OBJECTIVE: Minimisation of disturbance to and loss of topsoil

Topsoil conservation is an integral part of rehabilitation efforts and helps to maintain the productive capability and ecological functionality of rangelands.

Removal of topsoil should be done where:

- Areas will be excavated
- Areas will be severely compacted
- Areas will be buried with excavated material
- Areas will be permanently covered with altered surfaces

Topsoil must at all times be treated as a valuable natural resource, and may thus not be discarded or degraded.

Definitions:

Accelerated soil erosion: Soil erosion induced by human activities and ultimately leading to irreversible degradation of the ecosystem and loss of ecosystem functionality

Project Component/s	Project components affecting the objective: » PV Array supports and trenching » Grid connection and associated servitudes » Access roads » Workshop, guardhouses, substation and other related infrastructure » Potential topsoil stockpiles and/or borrow pits

Potential Impact	» Loss of topsoil and natural resources and biological activity within the topsoil » Loss of natural regeneration potential of soils » Loss of agricultural potential of soils.
Activity/Risk Source	» Site preparation and earthworks » Excavation of foundations and trenches » Construction of site access road » Power line construction activities » PV array construction activities » Stockpiling of topsoil, subsoil and spoil material.
Mitigation: Target/Objective	» To retain full biological activity and functionality of topsoil » To retain desirable natural vegetation, where possible » To minimise footprints of disturbance of vegetation/habitats » Remove and store all topsoil on areas that are to be excavated; and use this topsoil in subsequent rehabilitation of disturbed areas » Minimise spoil material

Mitigation: Action/Control	Responsibility	Timeframe
Areas to be cleared must be clearly marked on-site to eliminate the potential for unnecessary clearing.	Contractor in consultation with Specialist	Pre-construction
Construction activities must be restricted to demarcated areas so that impact on topsoil is restricted.	Contractor, ECO to control	Before and during construction, operational phase
Salvaging topsoil: » Topsoil must always be salvaged and stored separately from subsoil and lower-lying parent rock or other spoil material. o Topsoil stripping removes up to 30 cm or less of the upper soils. o In cultivated areas, depth of topsoil may increase and needs to be confirmed with the land owner » Prior to salvaging topsoil the depth, quality and characteristics of topsoil should be known for every management area. o This will give an indication of total volumes of topsoil that need to be stored to enable the proper planning and placement of topsoil storage. o Different types of topsoil – rocky soils and sands must be stored separately » Topsoils should be removed (and stored) under dry	Contractor, ECO to control	Before and during construction

Mitigation: Action/Control	Responsibility	Timeframe
conditions to avoid excessive compaction whenever topsoil will have to be stored for longer than one year.		
Storing topsoil: » Viability of stored topsoil depends on moisture, temperature, oxygen, nutrients and time stored. » Rapid decomposition of organic material in warm, moist topsoils rapidly decreases microbial activity necessary for nutrient cycling, and reduces the amount of beneficial micro-organisms in the soil. » Stockpile location if not adjacent to a linear development: o At least 50 m from any drainage line or ephemeral tributary o Ideally a disturbed but weed-free area » *Topsoil is typically stored in berms with a width of 150 – 200 cm, and a maximum height of 100 cm, preferably lower* o Place berms along contours or perpendicular to the prevailing wind direction o Adhere to the following general rule: the larger the pile of topsoil storage needs to be, the shorter should be the time it is stored » Topsoil handling should be reduced to stripping, piling (once), and re-application. Between the piling and reapplication, stored topsoils should not undergo any further handling except control of erosion and (alien) invasive vegetation » Where topsoil can be reapplied within six months to one year after excavation, it will be useful to store the topsoil as close as possible to the area of excavation and re-application, e.g. next to cabling trenches o In such case, use one side of the linear development for machinery and access only o Place topsoil on the other/far side of this development, followed by the subsoil (also on geotextile) o If there will be a need for long-term storage of topsoil in specified stockpiles, this must be indicated in the design phase already and accompanied by a detailed topsoil stockpile management plan » In cases where topsoil has to be stored longer than 6 months or during the rainy season, soils should be kept as dry as possible and protected from erosion and degradation by:	Contractor, ECO to control	Before and during construction

Mitigation: Action/Control	Responsibility	Timeframe
o Preventing puddling on or between heaps of topsoil o Or covering topsoil berms o Preventing all forms of contamination or pollution o Preventing any form of compaction o Monitoring establishment of all invasive vegetation and removing such if it appears o Keeping slopes of topsoil at a maximal 2:1 ratio o Monitoring and mitigating erosion where it appears o Where topsoil needs to be stored in excess of one year, it is recommended to either cover the topsoil or allow an indigenous grass cover to grow on it – if this does not happen spontaneously, seeding should be considered		
Reapplying topsoils: » Spoil materials and subsoil must be back-filled first, then covered with topsoil » Generally, topsoils should be re-applied to a depth equal to slightly greater to the topsoil horizon of a pre-selected undisturbed reference site » The minimum depth of topsoil needed for revegetation to be successful is approximately 20 cm » If the amount of topsoil available is limited, a strategy must be worked to out to optimise revegetation efforts with the topsoil available » Reapplied topsoils should be landscaped in a way that creates a variable microtopography of small ridges and valleys that run parallel to existing contours of the landscape. The valleys become catch-basins for seeds and act as run-on zones for rainfall, increasing moisture levels where the seeds are likely to be more concentrated. This greatly improves the success rate of revegetation efforts. » To stabilise reapplied topsoils and minimise raindrop impact and erosion: o Use organic material from cleared vegetation where possible o Alternatively, suitable geotextiles or organic erosion mats can be used as necessary » Continued monitoring will be necessary to detect any sign of erosion early enough to allow timeous mitigation	Contractor, ECO to control	Before and during construction
Re-applied topsoils need to be re-vegetated as soon as possible, following a revegetation and rehabilitation plan.	Contractor, ECO to control	Before and during

Mitigation: Action/Control	Responsibility	Timeframe
		construction, monitored during operational phase

Performance Indicator	» Minimal disturbance outside of designated work areas. » Topsoil appropriately stored, managed, and rehabilitated.
Monitoring	» Monitoring of appropriate methods of vegetation clearing and soil management activities by ECO throughout construction phase. » An incident reporting system will be used to record non-conformances to the EMP. » Regular monitoring of topsoil after construction by developer until such topsoil can be regarded as fully rehabilitated, stable and no longer prone to accelerated erosion

Erosion management

OBJECTIVE: Prevention and early mitigation of all erosion and loss of topsoil and ecosystem integrity

Compacted and/or denuded and disturbed soils are usually prone to surface capping – even more so if the soils are dispersive or have a fine texture due to higher clay or loam contents. Such capped soils are prone to ever increasing erosion, creating a dysfunctional landscape and ecosystem that rapidly loses soil, nutrients and seeds from the ecosystem.

Naturally occurring vegetation that historically covered the entire proposed development area not only protects the soil surface from direct raindrop impact, but high portion of biomass in the upper 20 – 50 cm of the soil significantly increases rapid infiltration of rainwater, whilst also binding soil particles and thus preventing erosion. A highly disturbed or reduced vegetation layer will thus naturally be accompanied by higher runoff levels and accelerated erosion, especially during extreme weather events.

The measures below indicate the minimum mitigation that will be required for erosion and stormwater control. A more specific erosion management plan will be possible after the final layouts and choice of PV array components are known.

Definitions:

Accelerated soil erosion: Soil erosion induced by human activities and ultimately leading to irreversible degradation of the ecosystem and loss of ecosystem functionality

Project Component/s	Project components affecting the objective: » PV Array » Grid connection and associated servitudes » Access roads » Workshop, guardhouses, substation and other related infrastructure » Potential topsoil stockpiles and/or borrow pits
Potential Impact	» Loss of topsoil and natural resources and biological activity within the topsoil » Loss of natural regeneration potential of soils » Loss of agricultural potential of soils.
Activity/Risk Source	» Rainfall and wind erosion of disturbed areas » Excavation, stockpiling and compaction of soil » Concentrated discharge of water from construction activity and new infrastructure » Storm water run-off from sealed, altered or bare surfaces » Construction equipment and vehicle movement on site » Cabling and road construction activities » Power line construction activities » River/stream/drainage line road crossings » Roadside drainage ditches » Premature abandonment of follow-up monitoring and adaptive management of rehabilitation
Mitigation: Target/Objective	» To minimise erosion of soil from site during construction » To minimise deposition of soil into drainage lines » To minimise damage to vegetation by erosion or deposition » To minimise damage to soil, animals and vegetation by construction activity » No accelerated overland flow related surface erosion as a result of a loss of vegetation cover » No reduction in the surface area of natural drainage lines and other wetland areas as a result of the establishment of infrastructure » Minimal loss of vegetation cover due to construction related activities » No increase in runoff into drainage lines as a result of construction of project related infrastructure » No increase in runoff into drainage lines as a result of road construction

Mitigation: Action/Control	**Responsibility**	**Timeframe**

Mitigation: Action/Control	Responsibility	Timeframe
Identify and demarcate construction areas for general construction work and restrict construction activity to these areas. Prevent unnecessary destructive activity within construction areas (prevent over-excavations and double handling)	Contractor, ECO to control	Before and during construction
New access roads and other servitudes to be carefully planned and constructed to minimise the impacted area and prevent unnecessary excavation, placement, and compaction of soil. Special attention to be given to roads that cross drainage lines.	Contractor, ECO to control	Before and during construction
Rehabilitate disturbance areas as soon as construction in an area is completed as per the rehabilitation plan.	Contractor, ECO to control	Immediately after construction, monitored during operational phase
General Erosion control measures: » Runoff control and attenuation can be achieved by using any or a combination of sand bags, logs, silt fences, storm water channels and catch-pits, shade nets, geofabrics, seeding or mulching as needed on and around cleared and disturbed areas o Ensure that all soil surfaces are protected by vegetation or a covering to avoid the surface being eroded by wind or water. » Ensure that heavy machinery does not compact areas that are not meant to be compacted as this will result in compacted hydrophobic, water repellent soils which increase the erosion potential of the area. » Prevent the concentration or flow of surface water or storm water along pipeline routes or roads and ensure measures to prevent erosion are in place prior to construction. » Storm water and any runoff generated by hard impervious surfaces should be discharged into retention swales or areas with rock rip-rap. These areas should be grassed with indigenous vegetation. These energy dissipation structures should be placed in a manner that flows are managed prior to being discharged back into the natural water courses, thus not only preventing erosion, but also supporting the maintenance of natural base flows within these systems, i.e.	Contractor, ECO to control	Construction, operational phase

Mitigation: Action/Control	Responsibility	Timeframe
hydrological regime (water quantity and quality) is maintained. » Mitigate against siltation and sedimentation of wetlands using the above mentioned structures and ensure that no structures cause erosion. » Minimise and restrict site clearing to areas required for construction purposes only and restrict disturbance to adjacent undisturbed natural vegetation. » Vegetation clearing should occur in parallel with the construction progress to minimise erosion and/or run-off. Large tracts of bare soil will either cause dust pollution or quickly erode and then cause sedimentation in the lower portions of the catchment » If implementing dust control measures, prevent over-wetting, saturation, and run-off that may cause erosion and sedimentation » Water course / river crossings should not trap any run-off, thereby creating inundated areas, but allow for free flowing water		
Control depth of excavations and stability of cut faces/sidewalls	Contractor, to be monitored by ECO	Site establishment & duration of contract
Compile a comprehensive storm water management method statement, as part of the final design of the project and implement during construction and operation.	Developer, Contractor, to be monitored by ECO	Site establishment & duration of contract
Where access roads cross natural drainage lines or ephemeral tributaries, culverts (or other appropriate measures) must be designed to allow free flow. Regular maintenance must be carried out.	Contractor, ECO to control	Construction phase Operational phase, monitored throughout
All vehicles on site must be appropriate to access the site. No off-road driving is permitted unless authorised by the ECO.	Contractor, to be monitored by ECO	Pre-construction, Construction & operation
4x4's or diff lock vehicles must be used in wet slippery conditions to reduce the erosion on the roads and the surrounding area.	Contractor, to be monitored by ECO	Pre-construction, Construction & operation

Performance Indicator	» Minimal level of soil erosion around site » Minimal level of increased siltation in drainage lines or pans » Minimal level of soil degradation » Acceptable state of excavations, as determined by EO & ECO » Progressive return of disturbed and rehabilitated areas to the desired end state (Refer also to the Plant Rescue and Rehabilitation Plan)
Monitoring	» Fortnightly inspections of the site by ECO » Fortnightly inspections of sediment control devices by ECO » Fortnightly inspections of surroundings, including drainage lines by ECO » Immediate reporting of ineffective sediment control systems » An incident reporting system must record non-conformances according to the EMP.

Rehabilitation and revegetation

OBJECTIVE: Minimisation of disturbance to and loss of topsoil and ecosystem functionality

Immediately after clearing of vegetation (where clearance do occur), the soil surface must be inspected for signs of erosion and stabilised as soon as possible. After completion of construction, such erosion stabilisation should preferably be with a cover of vegetation. A dense initial grass or other perennial cover will be desirable.

The aim of the first vegetation cover is to form a protective, relatively dense indigenous layer to slow runoff, increase moisture infiltration into the soil, and gradually change the soil nutrient status in order for it to be more favourable for other desirable indigenous vegetation to become established.

The first vegetation layer must be developed further until a desirable end state, as determined during the design phase and taking the original vegetation description as guideline, is established.

Project Component/s	Project components affecting the objective: » PV Array supports and trenching » Grid connection and associated servitudes » Access roads » Workshop, guardhouses, substation and other related infrastructure » Potential topsoil stockpiles and/or borrow pits

Potential Impact	» Within the footprint, a change of plant species composition with lower productivity and agricultural potential can be expected due to removal, disturbance and continued long-term shading of vegetation » A largely reduced vegetation cover will render the ecosystem more prone to erosion and irreversible degradation » Disturbance of indigenous vegetation creates opportunities for the establishment of invasive vegetation or creation of surfaces that do not support the permanent (re-) establishment of vegetation » Loss of natural regeneration potential of soils » Loss of agricultural potential of soils.
Activity/Risk Source	» Site preparation and earthworks » Excavation of foundations and trenches » Construction of site access road » Power line construction activities » PV array construction activities » Stockpiling of topsoil, subsoil and spoil material.
Mitigation: Target/Objective	» Recreate a non-invasive, acceptable vegetation cover that will facilitate the establishment of desirable and/or indigenous species » Prevent and accelerated erosion of ecosystem degradation

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Rehabilitation of surface		
Prior to the application of topsoil » subsoil shall be shaped and trimmed to blend in with the surrounding landscape or used for erosion mitigation measures » ground surface or shaped subsoil shall be ripped or scarified with a mechanical ripper or by hand to a depth of 15 – 20 cm » compacted soil shall be ripped to a depth greater than 25 cm and the trimmed by hand to prevent re-compacting the soil » any foreign objects, concrete remnants, steel remnants or other objects introduced to the site during the construction process shall be cleared before ripping, or shaping and trimming of any landscapes to be rehabilitated takes place » shaping will be to roughly round off cuts and fills and any other earthworks to stable forms, sympathetic to the natural surrounding landscapes	Contractor, ECO to control	During and after construction

Mitigation: Action/Control	Responsibility	Timeframe
Application of topsoil » topsoils shall be spread evenly over the ripped or trimmed surface, if possible not deeper than the topsoil originally removed » the final prepared surface shall not be smooth but furrowed to follow the natural contours of the land » the final prepared surface shall be free of any pollution or any kind of contamination » care shall be taken to prevent the compaction of topsoil	Contractor, ECO to control	During and after construction
Soil stabilisation » mulch, if available from shredded vegetation, shall be applied by hand to achieve a layer of uniform thickness » mulch shall be rotovated into the upper 10 cm layer of soil o this operation shall not be attempted if the wind strength is such as to remove the mulch before it can be incorporated into the topsoil » measures shall be taken to protect all areas susceptible to erosion by installing temporary and permanent drainage work as soon as possible o where natural water flow-paths can be identified, subsurface drains or suitable surface drains and chutes need to be installed » additional measures shall be taken to prevent surface water from being concentrated in streams and from scouring slopes, banks or other areas » runnels or erosion channels developing shall be back-filled and restored to a proper condition o such measures shall be effected immediately before erosion develops at a large scale » where erosion cannot be remedied with available mulch or rocks, geojute or other geotextiles shall be used to curtail erosion	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached
Borrow-pits (if required) » shall be shaped to have undulating, low-gradient slopes and surfaces that are rough and irregular, suitable for trapping sediments and facilitation of plant growth » upon completion of rehabilitation these reshaped and revegetated areas shall blend into the natural terrain	Contractor, ECO to control	After construction
Revegetation		

Mitigation: Action/Control	Responsibility	Timeframe
» revegetation of the final prepared area is expected to occur spontaneously to some degree where topsoils could be re-applied within 6 months » revegetation will be done according to an approved planting/landscaping plan according to the desirable end states and permissible vegetation	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached
Re-seeding » revegetation can be increased where necessary by hand- seeding indigenous species o previously collected and stored seeds shall be sown evenly over the designated areas, and be covered by means of rakes or other hand tools o commercially available seed of grass species naturally occurring on site can be used as alternative » re-seeding shall occur at the recommended time to take advantage of the growing season » in the absence of sufficient follow-up rains after seeds started germinating, irrigation of the new vegetation cover until it is established shall become necessary to avoid loss of this vegetative cover and the associated seedbank	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached
Planting of species » the composition of the final acceptable vegetation will be based on the vegetation descriptions of the original ecological EIA investigation, and will include rescued plant material » geophytic plants shall be planted in groups or as features in selected areas » during transplanting care shall be taken to limit or prevent damage to roots » plants should be watered immediately after transplanting to help bind soil particles to the roots (or soil-ball around rooted plants) and so facilitate the new growth and functioning of roots	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached
Traffic on revegetated areas » designated tracks shall be created for pedestrian of vehicle traffic where necessary » Disturbance of vegetation and topsoil must be kept to a practical minimum, no unauthorised off road driving will be allowed	Contractor, ECO to control	Construction phase Operational phase

Mitigation: Action/Control	Responsibility	Timeframe
» All livestock shall be excluded from newly revegetated areas, until vegetation is well established		
Establishment » The establishment and new growth of revegetated and replanted species shall be closely monitored o Where necessary, reseeding or replanting will have to be done if no acceptable plant cover has been created	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached
Monitoring and follow-up treatments		
Monitor success of rehabilitation and revegetation and take remedial actions as needed according to the respective plan » Erosion shall be monitored at all times and measures taken as soon as detected » Where necessary, reseeding or replanting will have to be done if no acceptable plant cover has been created	ECO during construction, suitable designated person / contractor after that	Construction phase Operational phase
Weeding » It can be anticipated that invasive species and weeds will germinate on rehabilitated soils o These need to be hand-pulled before they are fully established and/or reaching a mature stage where they can regenerate o Where invasive shrubs re-grow, they will have to be eradicated according to the Working for Water specifications	Contractor	Construction phase Operational phase

Performance Indicator	» No activity in identified no-go areas » Natural configuration of habitats as part of ecosystems or cultivated land is retained or recreated, thus ensuring a diverse but stable hydrology, substrate and general environment for species to be able to become established and persist » The structural integrity and diversity of natural plant communities is recreated or maintained » Indigenous biodiversity continually improves according to the pre-determined desirable end state o This end state, if healthy, will be dynamic and able to recover by itself after occasional natural disturbances without returning to a degraded state » Ecosystem function of natural landscapes and their associated vegetation is improved or maintained

Monitoring	» Fortnightly inspections of the site by ECO during construction » An incident reporting system must record non-conformances to the EMP. » Quarterly inspections and monitoring of the site by the ECO or personnel designated to the rehabilitation process until 80% of the desired plant species have become established o These inspections should be according to the monitoring protocol set out in the rehabilitation plan » Thereafter annual inspections according to the minimal monitoring protocol

Invasive plant management

OBJECTIVE: Manage and reduce the impact of invasive vegetation

Within the project area invasive species – indigenous and alien - occur, which all have a potential of reproducing to such an extent that the ecosystem within and beyond the project area could be impaired. Additional alien species grow along major transport routes to the area and thus could be potentially spread there as well.

Alien invasive plant species confirmed on site that need to be eradicated as much as possible:

Alien Invasive Plants confirmed, includes:

» Prosopis glandulosa (Category 1b – only one species noted at the small gravel dam located to the south-east of the site),
» Flaveria bidentis (Category 1b),
» Xanthium strumarium (Category 1b),
» Datura stramonium (Category 1b),

Other weeds and exotics confirmed during the survey:

» Chloris virgata, Tragus berteronianus, Tribulus terrestris, Conyza bonariensis, Schkuhria pinnata and Alternanthera pungens

Project Component/s	» Permanent and temporary infrastructure » Access roads
Potential Impact	» Impacts on natural vegetation » Impacts on soil » Impact on faunal habitats » Degradation and loss of agricultural potential
Activity/Risk	» Transport of construction materials to site

Source	» Movement of construction machinery and personnel » Site preparation and earthworks causing disturbance to indigenous vegetation » Construction of site access road » Stockpiling of topsoil, subsoil and spoil material » Routine maintenance work – especially vehicle movement
Mitigation: Target/Objective	» To significantly reduce the presence of weeds and eradicate alien invasive species » To avoid the introduction of additional alien invasive plants to the project control area » To avoid further distribution and thickening of existing alien plants on the project area » To complement existing alien plant eradication programs in gradually causing a significant reduction of alien plant species throughout the project control area

Mitigation: Action/Control	Responsibility	Timeframe
Compile a detailed invasive plant management and monitoring programme as guideline for the entire construction, operational and decommissioning phase » This plan must contain WfW-accepted species-specific eradication methods » It must also provide for a continuous monitoring programme to detect new infestations	Specialist	Pre-construction
Avoid creating conditions in which invasive plants may become established: » Keep disturbance of indigenous vegetation to a minimum » Rehabilitate disturbed areas as quickly as possible » Shred all non-seeding material from cleared invasive shrubs and other vegetation an use as mulch as part of the rehabilitation and revegetation plan » Where possible, destroy seeding material of weeds and invasives by piling burning (in designated areas or suitable containers) » Do not import soil from areas with alien plants	Contractor, monitored by ECO	Construction phase Operational phase
» Eradicate all invasive plants that occur within the development's temporary and permanent footprint areas » Ensure that material from invasive plants that can regenerate – seeds, suckers, plant parts are adequately destroyed and not further distributed	Contractor, monitored by ECO	Construction phase Operational phase
» Immediately control any alien plants that become newly established using registered control measures	Contractor, monitored by ECO	Construction phase Operational phase

Mitigation: Action/Control	Responsibility	Timeframe
Risks from alien invasives do not only arise from invasives present within the footprint area, but also from alien invasives along the verges of the major transport routes, especially invasive grasses and smaller weeds. Similarly, invasives can be spread by construction processes to surrounding areas. To avoid the distribution of weeds and invasive plants, establish a routine amongst contractors/all staff to regularly check: » that clothing and shoes are free of mud and seeds » that foot wells inside vehicles and mats are cleared of weed seed » radiator and grill, along wheel trims, around wheels, mud flaps, undercarriage of vehicle or other moving machinery for mud and seed »	Contractor, monitored by ECO	Construction phase Operational phase

Performance Indicator	» Visible reduction of number and cover of alien invasive plants within the project area. » Improvement of vegetation cover from current dominance of invasive shrubs to dominance of perennial grasses and dwarf shrubs » No establishment of additional alien invasive species.
Monitoring	» Ongoing monitoring of area by ECO during construction. » Ongoing monitoring of area by EO during operation » Audit every two to three years by a suitably qualified botanist to assess the status of infestation and success of eradication measures » If new infestations are noted these must be recorded. A comprehensive eradication programme with the assistance of the WfW (Working for Water) Programme is advisable.