EIA REPORT: ECOLOGY

PROPOSED SANNASPOS 75 MW SOLAR ENERGY FACILITY

FREE STATE

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Prepared for:

SolaireDirect Southern Africa (Pty) Ltd

Prepared by:

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Executive Summary

Savannah Environmental (Pty) Ltd has been appointed by SolaireDirect Southern Africa Pty (Ltd) to initiate investigations regarding the potential impacts that may be associated with the creation of a 75 MW Solar Energy Facility near Sannaspos in the Free State.

The proposed 75 MW photovoltaic (PV) solar energy facility will be located on the farms Lejwe 2962 and Besemkop 1808, between the N8 and the Rustfontein dam. The study area is close to the secondary road from the N8 to the Rustfontein dam and the Eskom Sannaspos Substation.

This report discusses the approach and findings of a desktop and field survey carried out on the study area, to assess the likelihood of ecological sensitivities occurring within the project area as well as potential impacts that could arise on and beyond the project area as a result of the proposed development.

The study area is located within the Central Free State Grassland as defined by Mucina and Rutherford (2006). Within the study area is a small man-made dam, and a larger drainage line. On the dam wall, as well as the low rocky ridges and outcrops within the study area, a higher shrub layer characterised by *Searsia erosa* and a generally high species diversity can be found.

A list of plant species that has been recorded to date in the representative grid has been obtained from the POSA SANBI website, whilst a list of terrestrial vertebrate fauna that might occur in the study area has been derived from the SANBI SIBIS and ADU Databases as well as from Apps (2000). These lists have been evaluated against the IUCN Species Status database and relevant legislation to obtain a list of species that are protected and/or in any way threatened, that may occur in the study area and that could be affected by the proposed development.

Four vegetation associations could be identified:

» Association 1: The *Searsia erosa – Eragrostis obtusa* shrublands are restricted to rocky outcrops, ridges and small koppies. The shrubland is relatively open with only patches of higher shrubs and low trees. Several species are restricted to these habitats only, including a multitude of geophytes, phanerophytes (ferns) and several succulents – amongst the latter large specimens of *Euphorbia pulvinata.*

» Association 2: The *Themeda triandra – Chrysocoma ciliata* grasslands are widespread on the gently undulating plains surrounding the outcrops. Within

the study area, species composition and plant density of the grasslands is very variable, influenced to a large degree by soil depth, but also grazing. Occasional bare patches do occur within the grasslands, and soils there are highly erodible, with moderate to severe sheet erosion and occasionally slight terracette erosion visible.

» Association 3: The *Panicum coloratum – Chasmatophyllum musculinum* grasslands occur on plains where soil moisture is less favourable, creating large expanses of variable vegetation, ranging from small clumps of shrubs to bare areas with succulents, interspersed by bands of low and variably dense grasslands. Moderate to severe sheet erosion as well as extensive soil surface capping is prominent. It can be expected that degraded states of Association 2 will become similar to this vegetation.

» Association 4: The *Paspalum – Schoenoplectus* species riparian areas are restricted to the small drainage channel traversing the study area in a north-easterly direction, ending up in the Modder River east of the study area. Most of the vegetation of this vegetation type, as it is adapted to higher moisture levels, was extremely dry and difficult to identify at the time of the survey. It can also be expected that several additional species, also restricted to these higher-moisture habitats, may occur after sufficient rains. The habitat of this association and immediate surrounds must be treated as a No Go area.

Impact statement

» The proposed photovoltaic facility development on the site may have significant impacts on the ecology of the site and lower-lying wetlands, if mitigation measures are not strictly adhered to

» Development will have to be restricted to the grasslands, and it will be important to monitor and mitigate erosion from construction to decommissioning phase. The most important part of mitigation would be the most appropriate site location and to maintain as dense a perennial herbaceous layer below the development as possible.

» Potentially significant negative impacts on the ecological environment would be soil degradation issues (erosion, depletion of nutrients) as a result of construction activity and the operation of the facility; possible introduction of alien invasive plants and a long-term (more than 8 months) low or absent vegetation cover after construction. In addition, a loss of niches and specialised habitats for flora and fauna could occur with the removal or significant degradation of large expanses of vegetation. With the diligent implementation of mitigating measures by the developer, contractors, and operational staff, the severity of these impacts can be minimised.

» Runoff from the proposed development area is channeled via the drainage line into the nearby Modder River and associated downstream water bodies. Due care will thus have to be taken to not only prevent excessive erosion of

riparian areas, but also any kind of pollution within the development that could end up in the downstream wetlands.

» Several protected and red-data species potentially occur on the site, apart from those already recorded. At the time of the field visit, most grasses just started sprouting, a small number of geophytic species could already be observed, but the herbaceous layer was still poorly developed. Most of the species that just started emerging were too small to be identifiable at the time of the survey. It is thus imperative that a detailed site-walk be undertaken during optimal growing conditions (late November to early February) to enable all potentially rare and protected plant species to be recorded and relocated.

» The impact on fauna is expected to be negligent. Currently there was minimal presence of wild animals due to current land use patterns. Animals that may be present are mobile and will move away during construction, possibly resettling after construction. No restricted or specific habitat of vertebrates will be affected by the proposed development; especially if the proposed development remains outside the more sensitive areas.

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General Information

1.1. Applicant

SolaireDirect Southern Africa (Pty) Ltd has appointed Savannah Environmental (Pty) Ltd to manage the EIA process for the proposed development.

Project

Sannaspos Solar Energy Facility Phase 1

Proposed Activity

The facility is proposed to include several arrays of photovoltaic (PV) solar panels and includes the following associated infrastructures:

- Solar panels with a generating capacity of 75 MW
- Cabling between the project components, to be lain underground where practical;
- An overhead power line feeding into the Eskom electricity network at Sannaspos Rural Substation that is located near the site;
- Internal access roads; and
- Workshop area for maintenance and storage

At this stage the layout has not been finalised, but will be decided upon once known sensitivities of the target area have been delineated and described. A preliminary layout was provided for assessment within the EIA process.

1.2. Specialist Investigator

This report has been prepared by:

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A *Curriculum Vitae* and summary of expertise of the compiler is attached as Appendix D of this document

Specialist affiliation

South African Council for Natural Scientific Professions (SACNASP) (PrSciNat; Registration no. 400079/10, Botanical Science, Ecological Science).
South African Association of Botanists (www.sabotany.com)
Desert Net International (www.european-desertnet.eu)

1.3. Declaration of Independence

A signed declaration of independence for Marianne Strohbach is attached in Appendix C.

1.4. 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. The author, however, accepts no liability for any actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, and by the use of the information contained in this document. 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.

Scope and Purpose of Report

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

1.5. Terms of reference

- A description of the environment - habitat, general ecology and vegetation of the area that may be affected by the activity
- A description of the manner in which the environment may be affected by the proposed project
- A description of all environmental issues that were identified, i.e. direct, indirect and cumulative impacts of the identified issues must be evaluated
- An assessment of the significance of direct, indirect and cumulative impacts
- Recommendations regarding practical mitigation measures for potentially significant impacts
- An indication of the extent to which an impact can be addressed by the adoption of mitigation measures
- An environmental impact statement

» This report lists avifauna that have been previously observed in the study area according to nationally available databases, but does not constitute an avifaunal assessment

1.6. Legislation

This study has been conducted in accordance with the following legislation:

1.6.1. Provincial

» The Nature Conservation Ordinance 19 of 1974 and subsequent amendments (**NCO**)

» The Free State Nature Conservation Bill 23 of 2010 (**FSNCB**)

- The following sections of the FSNCB should also be taken into consideration:
- Chapter 10, Section 31:
  - Except on authority of a permit issued by the MEC or under environmental authorisation no person may –
    a) Drain or mechanically disturb any wetland or portion thereof
    b) Utilise a wetland or portion thereof in a manner that would damage the hydrological or ecological function thereof
    c) Engage in activities outside but adjacent to the wetland which would damage the hydrological or ecological functioning of such wetland
  - Chapter 10, Section 32: No person may undertake any activity involving any species of wild animal or plant which causes or has the potential to cause a degradation in the natural state of the indigenous biodiversity of that area

1.6.2. 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 list of ecosystems that are threatened and in need of protection (Government Notice 1002 of 2011)

» 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

1.6.3. International

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

2. Introduction

South Africa is committed to the Convention of Biological Diversity, and has introduced several legislative mechanisms to ensure that the preservation and sustainable use of all biological diversity, including ecosystem, species, and genetic diversity, is guaranteed for the benefit of current and future generations in South Africa and beyond. The impact of past and present conversion of natural habitat types by cultivation, grazing, urban developments, forestation, mining, dams, industries, and alien plant invasions continues to have a substantial impact on South African biodiversity, with significant portions of South Africa's flora and fauna being threatened (Wynberg 2002). Arid, semi-arid and dry sub-humid areas, covering an estimated 91% of South African land area (Hoffman and Ashwell 2001), including the study area, are particularly prone to degradation arising from human activities, leading to the acceleration of soil erosion, deterioration of the biotic, abiotic and economic properties of soil, and the long-term loss of natural vegetation (UNCCD 1995) and associated habitats for fauna. Rapid recovery of degradation is inhibited by the loss of topsoil and natural seed banks, low rainfall regimes and the unpredictability of rainfall events.

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This report lists the findings of a flora and terrestrial vertebrate assessment of the site selected for the proposed Sannaspos Phase 1 Solar Energy Facility, and associated access roads.

3. Study Area

3.1. Locality

The proposed 75 MW photovoltaic (PV) solar energy facility will be located on the farms Lejwe 2962 and Besemkop 1808, between the N8 and the Rustfontein dam. The study area is close to the secondary road from the N8 to the Rustfontein dam and the Eskom Sannaspos Substation.

- The approximate corners of the area investigated, as derived from the Google Earth are:

Western points, from N to S:	S 29° 11' 34.4"; E 26° 34' 17.3"
	S 29° 11' 47.4"; E 26° 34' 19.7"
	S 29° 11' 48.5"; E 26° 34' 50.6"
	S 29° 11' 54.5"; E 26° 34' 51.6"
	S 29° 11' 51.2"; E 26° 35' 08.8"

	S 29° 12′ 14.6″; E 26° 35′ 16.5″
Eastern points, from N to S:	S 29° 10′ 57.9″; E 26° 35′ 43.2″
	S 29° 11′ 41.7″; E 26° 36′ 05.9″
	S 29° 11′ 49.5″; E 26° 35′ 58.1″
	S 29° 11′ 58.2″; E 26° 35′ 45.5″
	S 29° 11′ 58.6″; E 26° 35′ 37.9″
	S 29° 12′ 10.9″; E 26° 35′ 38.8″

3.2. Surrounding environment

3.2.1. Climate and rainfall

The climate for Sannaspos has been derived from climatic data summarised for Thaba Nchu (SA Explorer), located about 18 km east of Sannaspos. The area normally receives about 435 mm of rain per year. From May to September, rainfall is minimal, with most rainfall occurring from November to March, peaking between January and March. Temperatures in summer peak during December and January at a daily average of 28.5°C, with an average of 15.4°C for June. During July, night temperatures are on average 0.1°C, but frosts during winter are common.

Plant species resprouting from storage tubers (geophytes) will take advantage of the first rains, stored reserves and low grass cover after the dry season to grow and flower during early summer (November to January) and then die back, whilst herbs/forbs and grasses first need adequate rainfall before being able to fully grow and flower between January and March. Geophytes, forbs, succulents, and grasses can only be fully identified if they are actively growing AND have either flowers or fruit. By April, most species will have produced seed and most of the herbaceous flora will die back to below-ground storage or seed reserves to survive the cold winters in a dormant state.

3.2.2. Topography and drainage

The site is gently undulating to flat with isolated rocky ridges and low rocky outcrops. Runoff from the plains and southern outcrops is collected in a drainage line that crosses the study area in a northerly direction, then draining north-easterly into the Modder River that runs just east of the study area. Soils are highly dispersive and erosion is one of the immediate consequences of loss of vegetation cover.

3.2.3. Land use

The site itself is primarily used for livestock farming. Within a radius of 10 km of the study site, land uses also include formal settlements, nature reserves, game farming, and crop farming.

3.2.4. Vegetation overview

The study site falls within the Central Free State Grassland as described by Mucina and Rutherford (2006, Figure 1). Towards the west and north west of the study area, but beyond it, are patches of Highveld Alluvial Vegetation and Bloemfontein Dry Grasslands, the latter listed as a vulnerable ecosystem.

The Central Free State Grassland is relatively short grassland. Where in its original form, it is dominated by *Themeda triandra* whilst *Eragrostis curvula* and *E. chloromelas* become more dominant in degraded habitats. Severely degraded clayey bottomlands are often dominated by dwarf karooid shrubs, whilst riverine areas and severely overgrazed/trampled low-lying areas are prone to encroachment by *Acacia karroo* (Mucina and Rutherford 2006).

This vegetation type is not officially listed as a threatened ecosystem, but it is regarded as vulnerable (Mucina and Rutherford 2006) due to large portions of it being transformed either for cultivation or by dams, with only small portions that are protected such as in the nearby Rustfontein Dam Nature Reserve.

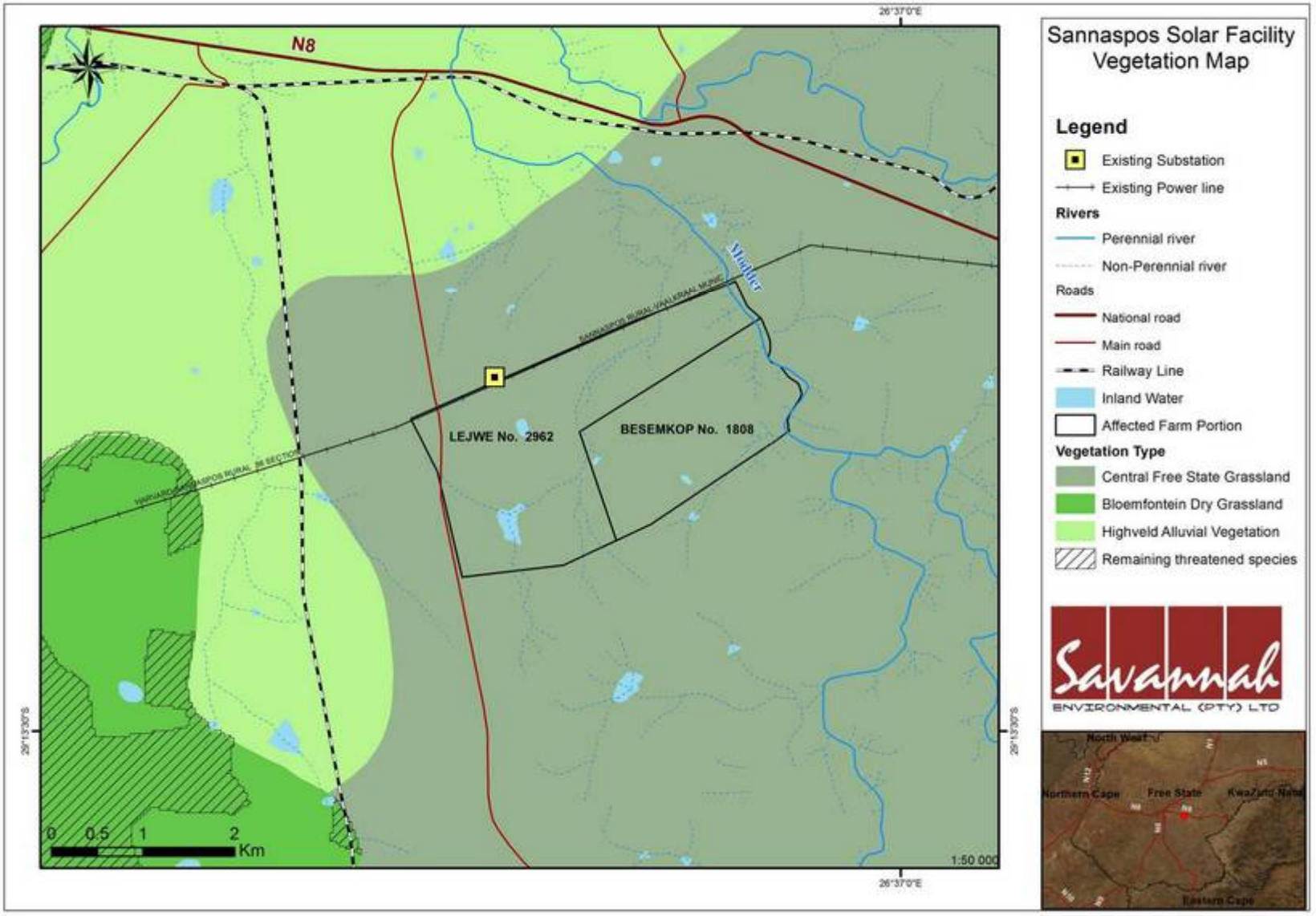

Figure 1: Map of the vegetation types on and around the study area.

4. Methods

4.1. Vegetation Survey

The site was visited on 23 and 24 October 2012 for a vegetation survey. At that time, only a limited amount of rain had fallen. A few bulbous species were in flower, but the herb layer was still very poorly developed (Figure 2). Thus, several species could only be identified up to genus level. Likewise, perennial grasses were difficult to differentiate and identify and cover estimates recorded may thus be inaccurate. It is expected that after sufficient rain several additional geophytic and annual species will emerge.

Figure 2: View of the study area on 23 November 2012.

Prior to the site visit, the vegetation was delineated into homogenous units on currently available Google Earth imagery. At several sites within each homogeneous unit, a survey of total visible floristic composition and the relative cover percentage of each species was recorded, following established vegetation survey techniques (Mueller-Dombois & Ellenberg 1974; Westhoff & Van der Maarel 1978). These vegetation survey methods have been used as the basis of a national vegetation survey of South Africa (Mucina *et al.* 2000) and are considered an efficient method of describing vegetation and capturing species

information. Notes were additionally made of the general habitat and any other features, biotic and abiotic, that might have an influence on the composition of landscape components and functioning of the landscape.

Surveys for Environmental Assessments are usually not exhaustive due to time and budget constraints, hence it can be expected that a number of species that may be present on site are not observed. The total number of plant species that can be expected on site can be estimated with a jack-knife statistical calculation on species-sample data. This is done with the PcOrd Program (McCune and Mefford 2006).

Vegetation analysis was carried out using the standard TurboVeg phytosociological database (Hennekens and Schaminée 2001) and TWINSPAN classification techniques with JUICE (Tichý 2002). The assessment did not cover an extensive area necessary to fully describe plant communities; hence, the vegetation is described in terms of 'vegetation associations'. Extrapolation of vegetation associations from survey sites to entire sample area was done by traversing the larger area without doing additional surveys as such and mapping this on Google Earth satellite data.

A species list from POSA (http://posa.sanbi.org, October 2012, Grid reference: 2926) containing the species that might occur in the area is listed in Annexure A.1. POSA generated species lists also contain Red Data species with updated threatened status according to the book Red List of South African Plants 2009 published by SANBI in *Strelitzia* 25 (Raimondo *et al.* 2009) as recorded up to date for the respective grid reference investigated. These lists were then evaluated in terms of habitat available on the site, and in terms of the present development and presence of man in the area. It must be noted, however, that the POSA lists are not comprehensive as many locations within South Africa are still under-collected and a backlog with entering existing specimens onto the national species database remains a continuous challenge for SANBI.

Alien invasive species, according to the Conservation of Agricultural Resources Act (Act No.43 of 1983) as listed in Henderson (2001), are indicated.

The status of plant species recorded in each vegetation association is indicated by using the following symbols as applicable:

Protected species, indicated according to relevant legislation (see section 1.6):

1: FSNCB Schedule 1 or NCO Schedule 3
2: FSNCB Schedule 2 or NCO Schedule 4

NFA
NEMA:BA
I: CITES Appendix 1
II: CITES Appendix 2

end = endemic to South Africa (or green text)
IP = Invasive Plant (Indigenous)
W = Weed (ruderal species that can be potentially invasive)
A = Alien Invasive Plant
Red data listed species are indicated by their status (and by red text)

Plant species nomenclature follows Germishuizen and Meyer (2003). This reference has also been used to verify protected species in cases where the legislation has not yet been updated to the reflect the current scientific taxonomy.

4.2. Terrestrial Vertebrate Survey

The SANBI SIBIS and ADU database was queried regarding amphibians, reptiles and mammals historically recorded in the study area and surroundings. The likelihood of such species still occurring in the area was verified according to Apps (2000). A full list of species that could occur in the study area according to available literature is listed in Appendix A2. Avifauna that have been recorded in the area according to the above databases have been included in the lists of Appendix 2, but this report does not comprise an avifaunal evaluation. Species that were sighted or of which relatively recent signs were found are listed under results.

Protected species, indicated according to relevant legislation (see section 1.6):
1: FSNCB Schedule 1 or NCO Schedule 1
2: FSNCB Schedule 2 or NCO Schedule 2
NEMA:BA

end = endemic to South Africa (or green text)
Red data listed species are indicated by their status (and by red text)

4.3. Explanations of Red Data classes

Critically Endangered (CR): A species is Critically Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Critically Endangered, indicating that the species is facing an extremely high risk of extinction.

Endangered (EN): A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.

Vulnerable (VU): A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.

Near Threatened (NT): A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable, and is therefore likely to become at risk of extinction in the near future.

Critically Rare: A species is Critically Rare when it is known to occur at a single site, but is not exposed to any direct or plausible potential threat and does not otherwise qualify for a category of threat according to one of the five IUCN criteria.

Rare: A species is Rare when it meets at least one of four South African criteria for rarity, but is not exposed to any direct or plausible potential threat and does not qualify for a category of threat according to one of the five IUCN criteria.

Declining: A species is Declining when it does not meet or nearly meet any of the five IUCN criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened, but there are threatening processes causing a continuing decline of the species.

Least Concern: A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.

Data Deficient - Insufficient Information (DDD): A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that a threatened classification is appropriate.

Data Deficient - Taxonomically Problematic (DDT): A species is DDT when taxonomic problems hinder the distribution range and habitat from being well defined, so that an assessment of risk of extinction is not possible.

Not Evaluated (NE): A species is Not Evaluated when it has not been evaluated against the criteria. The national Red List of South African plants is a comprehensive assessment of all South African indigenous plants, and therefore all species are assessed and given a national Red List status. However, some species included in Plants of southern Africa: an online checklist are species that do not qualify for national listing because they are naturalized exotics, hybrids (natural or cultivated), or synonyms. These species are given the status Not

Evaluated and the reasons why they have not been assessed are included in the assessment justification.

4.4. Sensitivity Analysis and Criteria

Determining ecosystem services and sensitivity of ecosystem components, both biotic and abiotic, is rather complex and no single overarching criterion will apply to all habitats studied. The main aspects of an ecosystem that need to be incorporated in a sensitivity analysis, however, include the following:

- Describing the nature and number of species present, taking into consideration their conservation value as well as the probability of such species to survive or re-establish itself following disturbances of various magnitudes
- Identifying the species or habitat features that are 'key ecosystem providers' and characterising their functional relationships (Kremen 2005)
- Determining the aspects of community structure that influence function, especially aspects influencing stability or rapid decline of communities (Kremen 2005)
- Assessing key environmental factors that influence the provision of services (Kremen 2005)
- Gaining knowledge about the spatio-temporal scales over which these aspects operate (Kremen 2005).

Habitats and their vegetation units, which are regarded the basis of the ecological sensitivities of the study area, were classified as High (No Go Areas), Medium or Low Sensitivity. The following criteria were used in the sensitivity ratings:

4.4.1. Sensitivity criteria relating to Conservation Value

Species diversity

The number and abundance of species strongly influences key ecosystem processes such as pollination, air quality, primary production, nutrient and water cycling and soil formation and retention. All these processes provide ecosystem services such as shelter, potable water, and nutrients to higher trophic levels. The species composition, including dominant, minor and keystone species, is critical in maintaining ecosystem services (Chapin *et al.* 2000).

A higher number of species ensures a stable supply of ecosystem goods and services as spatial and temporal variability increases, which typically occurs over longer time periods. Within a community several species may have similar functions, but react differently to environmental variables, thus can buffer ecosystem function to some degree during short-term environmental fluctuations (Hooper *et al.* 2005, Chapin *et al.* 2000). Further, coexisting plants with very different but complementary resource use strategies will use available resources

more effectively, and a larger species pool is more likely to contain more groups of complementary species. Overall, productivity, nutrient retention, and resistance to invasion tend to increase with increasing species number, especially in environments where overall species cover is relatively low.

Expected species diversity

Species diversity ranges enormously between habitats, thus what may seem low species diversity in one habitat, may in fact be maximal species diversity in another, hence a standardisation of number of species across large areas to rank conservation value of an area will be misleading. Added to this, most standard methods for collecting plant species data miss many species, especially species that are less common, patchily distributed or dormant – either in the form of seeds or underground storage organs – at the time of survey. To compensate for this, species-area curves are drawn from the data to estimate total species richness (Chong and Stohlgren 2007, Garrard *et al.* 2008) with PcOrd (McCune and Mefford 2006). This is considered a useful tool in conservation biology, because information from the curves allows a comparison of different communities without the absolute knowledge of all species present in unsampled areas (Chong and Stohlgren 2007). Should the area surveyed differ considerably from surrounding areas, such surrounding areas should also be surveyed to obtain a more realistic measure of expected species diversity.

Species that are less common or endemic

It is often difficult to identify what exactly limits the distribution of a species. Factors that have been identified as playing a major role, either on their own or together, are habitat limitation and dispersal limitation (Münzbergová 2006), as well as minimum number of individuals required to enable a viable population. Rare taxa often have specialised habitat requirements and are thus restricted to rare environmental conditions, of which rock outcrops and narrow water channels are typical (Keith 1998). A restricted availability of a habitat may also reduce the dispersal capability of a species. Species of conservation concern are protected from provincial to international level, be it due to their restricted numbers, decreasing habitat availability and/or exploitation, and therefore their Red Data and protection status can be used as a surrogate to assess the sensitivity of an area to man-made disturbances.

Within a community, the species composition is often as or more important than the species number in affecting ecosystem processes. Changes in species compositions can occur indirectly by an altered resource supply due to anthropogenic influence e.g. change of moisture flows. Although a reduction in the number of species may initially have small effects, even minor losses may indicate that the capacity of the ecosystem to adjust to a changing environment is being lost (Chapin *et al.* 2000, Hooper *et al.* 2005). Species are allocated an official conservation status to prevent their further decline due to identified

threats (Keith 1998). Protected or red-data species, as well as endemic species, apart from their conservation status, are a first indicator of the health of an ecosystem. They will most probably be the first to show a sudden decline should their environment be changed beyond a specific threshold, e.g. by excessive erosion.

4.4.2. Sensitivity criteria relating to ecosystem function

Soil water availability

The most limiting factor in arid and semi-arid systems is moisture. Soil water availability is limited not only by timing and amount of rainfall events, but also by low infiltration rates of water into the soil. Vegetation itself, however, promotes the rate of infiltration due to increasing soil surface roughness as well as soil surface porosity, providing a further positive feedback between increased infiltration and increased plant growth. Therefore, with increasing plant density, the rate of infiltration into the soil will increase significantly, instead of most water being lost as runoff during infrequent rain showers (Dekker *et al.* 2007). Soil surface roughness can also be provided by various degrees of surface rockiness, living soil crusts and micro topography - including the fertile-island effect created by shrubs (Esler *et al.* 2006), which aid as resource traps for runoff and nutrients. Compacted, denuded soils are often prone to surface capping – even more so if the soils have a fine texture due to higher clay or loam contents. Such capped soils are prone to ever increasing erosion, creating a leaky ecosystem that rapidly loses soil, nutrients and seeds from the ecosystem (Tongway and Hindley 2004).

Niches

Relief, topography, and micro-topography are important features of the habitat, because evapotranspiration and photosynthesis correlate with the resultant solar radiation and temperatures, and the variability of in soil attributes and water flows highly depend on these features (Dirnböck *et al.* 2002). Topography has a major influence on the redistribution of rainfall, affecting moisture limitations for plant present, and the effect of this on vegetation increases significantly with aridity, but is also coupled to the geology of the terrain (Dirnböck *et al.* 2002).

Habitat

Several studies have shown that the vegetation associations contributing the most to regional species diversity cover the smallest areas because these species are concentrated on and some limited to particular habitats (Chong and Stohlgren 2007, Keith 1998). However, these communities or habitats may contain species that are of high importance to the entire ecosystem, and an extinction of such a local plant population, or their reduction to a point where they become functionally extinct, can have dramatic consequences on the regulation and support of ecosystem services. The diversity and size of a landscape unit also

influences ecosystem services – species on the edges of a habitat are more vulnerable to environmental stresses, and the more a habitat is fragmented, the higher this stressful edge effect becomes, in addition to habitat loss. Habitat loss and/or fragmentation can thus have disproportionately large effects on ecosystem services.

Overall, the properties of species, together with the species composition is often more critical in retaining the function of an ecosystem than species numbers or total cover (Chapin *et al.* 2000). Many of these species will, however, only establish if the habitat is suitable (Carrick and Krüger 2007). Added to that, rehabilitation in arid and semi-arid zones has been difficult due to either difficulties in establishment because of low, erratic and unpredictable rainfall or the lack of available seed material (Le Houérou 2000).

4.5. 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 is to be assessed by means of the criteria of extent (scale), duration, magnitude (severity), probability (certainty) and direction (negative, neutral or positive). This methodology is utilized in the EIA phase to assess the significance of impacts associated with the proposed project.

The **nature** of the impact refers to the causes of the effect, what will be affected and how it will be affected.

Extent (E) of impact

Local (site or surroundings)
Regional (provincial)

Rating = 1 (low) to 5 (high).

Duration (D) rating is awarded as follows:
Whether the life-time of the impact will be:

- Very short term – up to 1 year: Rating = 1
- Short term – >1 – 5 years: Rating = 2
- Moderate term - >5 – 15 years: Rating = 3
- Long term – >15 years: Rating = 4

The impact will occur during the operational life of the activity, and recovery may occur with mitigation (restoration and rehabilitation).

- Permanent – Rating = 5

The impact will destroy the ecosystem functioning and mitigation (restoration and rehabilitation) will not contribute in such a way or in such a time span that the impact can be considered transient.

Magnitude (M) (severity):
A rating is awarded to each impact as follows:

- Small impact – the ecosystem pattern, process and functioning are not affected.
  Rating = 0
- Minor impact - a minor impact on the environment and processes will occur.
  Rating = 2
- Low impact - slight impact on ecosystem pattern, process and functioning.
  Rating = 4
- Moderate intensity – valued, important, sensitive or vulnerable systems or communities are negatively affected, but ecosystem pattern, process and functions can continue albeit in a slightly modified way.
  Rating = 6
- High intensity – environment affected to the extent that the ecosystem pattern, process and functions are altered and may even temporarily cease. Valued, important, sensitive or vulnerable systems or communities are substantially affected.
  Rating = 8
- Very high intensity – environment affected to the extent that the ecosystem pattern, process and functions are completely destroyed and may permanently cease.
  Rating = 10

Probability (P) (certainty) describes the probability or likelihood of the impact actually occurring, and is rated as follows:

- Very improbable – where the impact will not occur, either because of design or because of historic experience.
  Rating = 1
- Improbable – where the impact is unlikely to occur (some possibility), either because of design or historic experience.
  Rating = 2
- Probable -there is a distinct probability that the impact will occur (<50% chance of occurring).
  Rating = 3
- Highly probable - most likely that the impact will occur (50 – 90% chance of occurring).
  Rating = 4
- Definite – the impact will occur regardless of any prevention or mitigating measures (>90% chance of occurring).
  Rating = 5

Significance (S) - Rating of low, medium or high. Significance is determined through a synthesis of the characteristics described above where:
S = (E+D+M)*P

The **significance weighting** should influence the development project as follows:

- Low significance (significance weighting: <30 points)
  If the negative impacts have little real effects, it should not have an influence on the decision to proceed with the project. In such circumstances, there is a significant capacity of the environmental resources in the area to respond to change and withstand stress and they will be able to return to their pre-impacted state within the short-term.

- Medium significance (significance weighting: 30 – 60 points)
  If the impact is negative, it implies that the impact is real and sufficiently important to require mitigation and management measures before the proposed project can be approved. In such circumstances, there is a reduction in the capacity of the environmental resources in the area to withstand stress and to return to their pre-impacted state within the medium to long-term.

- High significance (significance weighting: >60 points)
  The environmental resources will be destroyed in the area leading to the collapse of the ecosystem pattern, process and functioning. The impact strongly influences the decision whether or not to proceed with the project. If mitigation cannot be effectively implemented, the proposed activity should be terminated.

5. Results

5.1. Vegetation Survey

Vegetation of the study area is dominated by a dense grass layer interspersed with low woody, sometimes spiny dwarf shrubs. The dominant species are a combination of *Themeda triandra, Digitaria eriantha, Eragrostis* species*, Chrysocoma ciliata, Felicia* species*, and Asparagus* species.

On the rocky ridges, higher shrubs of the genera *Searsia* and *Diospyros* become more prominent, with *Olea europaea subsp africana* a common low tree. On the slightly sloping plains the vegetation structure and density is relatively uniform.

Towards lower lying areas, soil surface capping and sheet erosion becomes prominent. The less favourable moisture regime of these areas results in a variable vegetation cover, with a mosaic of low shrubs, dense patches of grasses and large bare patches. These 'erosion plains' typically have a high number of bulbous and succulent species and are at risk of rapid degradation upon disturbance.

At the time of the vegetation survey, the herbaceous layer was still very poorly developed, and several more species can be expected to emerge after sufficient rainfalls. This is confirmed by preliminary statistical analysis of the survey data:

Number of (indigenous) species observed:	141
Second-order jack-knife estimate:	218

It can thus be expected that approximately 218 species can be present on the study area. However, this is a rough estimate only and has been used as a comparative tool to help assess the conservation value and sensitivities of habitats.

Vegetation associations identified during this study are based on the overall similarity in species composition, vegetation structure and biophysical attributes that are part of an ecosystem, but smaller phytosociological differences within each vegetation unit are present. This is attributable to the relatively variable substrate: generally, soils are fine textured, loamy with a variably clay content, but soil surfaces range from bare (and capped) and eroded with higher clay content to areas with a high amount of surface rockiness and a mosaic of shrubs and grasses.

5.2. Description of vegetation associations and their habitats

Four vegetation associations could be identified (Figure 3):

» Association 1: The *Searsia erosa – Eragrostis obtusa* shrublands are restricted to rocky outcrops, ridges and small koppies. The shrubland is relatively open with only patches of higher shrubs and low trees. Several species are restricted to these habitats only, including a multitude of geophytes, phanerophytes (ferns) and several succulents – amongst the latter large specimens of *Euphorbia pulvinata.*

» Association 2: The *Themeda triandra – Chrysocoma ciliata* grasslands are widespread on the gently undulating plains surrounding the outcrops. Within the study area, species composition and plant density of the grasslands is very variable, influenced to a large degree by soil depth, but also grazing. Occasional bare patches do occur within the grasslands, and soils there are highly erodible, with moderate to severe sheet erosion and occasionally slight terracette erosion visible.

» Association 3: The *Panicum coloratum – Chasmatophyllum musculinum* grasslands occur on plains where soil moisture is less favourable, creating large expanses of variable vegetation, ranging from small clumps of shrubs to bare areas with succulents, interspersed by bands of low and variably dense grasslands. Moderate to severe sheet erosion as well as extensive soil surface capping is prominent. It can be expected that degraded states of Association 2 will become similar to this vegetation.

» Association 4: The *Paspalum – Schoenoplectus* species riparian areas are restricted to the small drainage channel traversing the study area in a north-easterly direction, ending up in the Modder River east of the study area. Most of the vegetation of this vegetation type, as it is adapted to higher moisture levels, was extremely dry and difficult to identify at the time of the survey. It can also be expected that several additional species, also restricted to these higher-moisture habitats, may occur after sufficient rains. The habitat of this association and immediate surrounds must be treated as a No Go area.

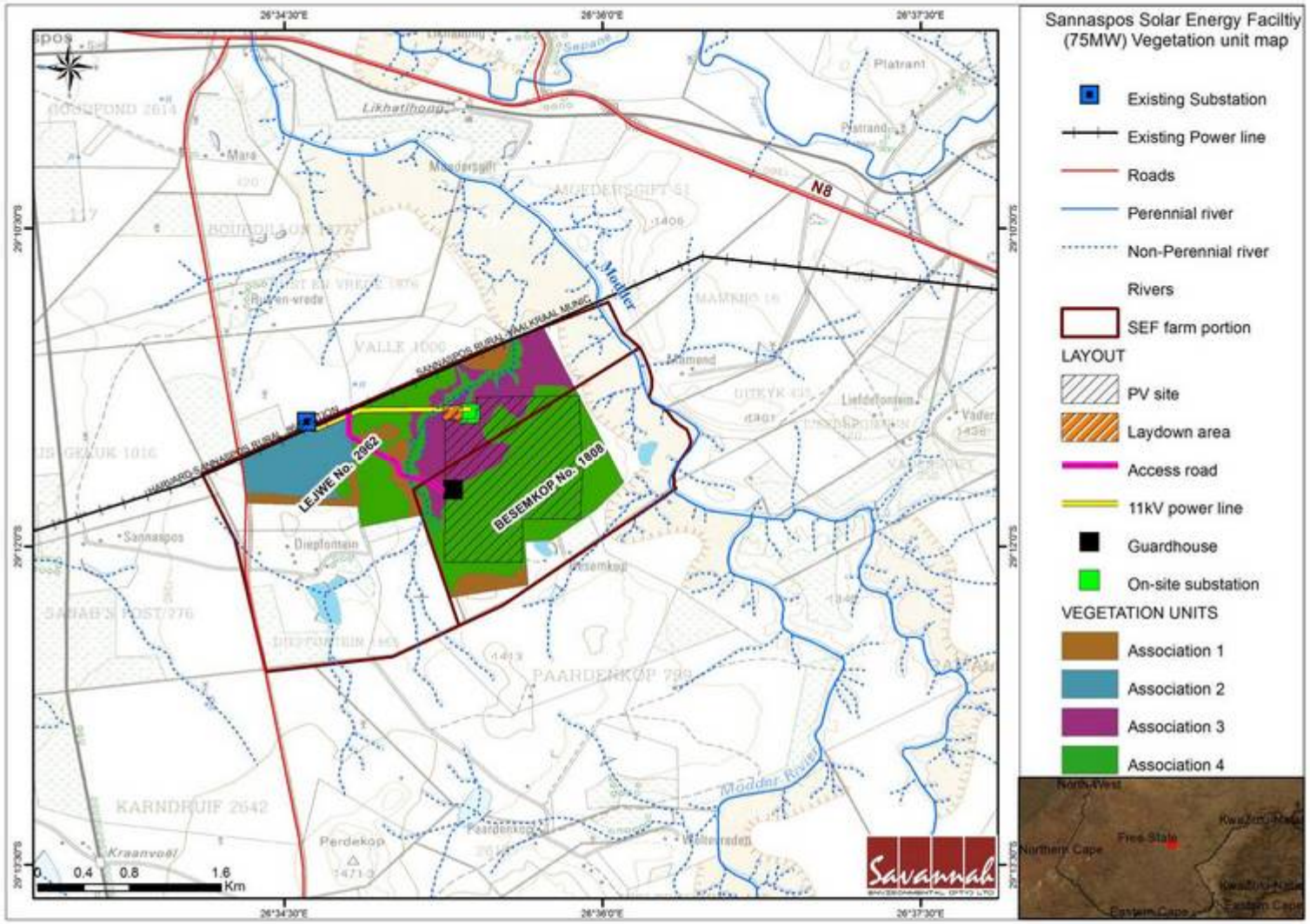

Figure 3: The distribution of the four vegetation associations as surveyed on the study area.

5.2.1. *Searsia erosa – Eragrostis obtusa* shrublands

Habitat and Land use			
Substrate	Boulder rocks, slopes variable, fine textured, clay rich soils	**Disturbance**	Slight grazing
Species Richness	57 species recorded of 218 expected on study area	**Conservation value:**	Medium 40 % of species restricted to these habitats
Ecosystem function	Specialised niches for higher biodiversity; rockiness creates localised improved moisture retention to sustain this biodiversity. High structural diversity creates several microhabitats for fauna and flora.	**Sensitivity:**	High
Need for rehabilitation	Occasional alien invasive, few alien plants	**Agricultural potential**	Limited grazing

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High shrubs and trees	0.8 - 4	0.1 - 15
Low Shrubs	0.2 – 0.7	3 - 20
Grass	0.05 – 1.2	10 - 55
Forbs	0.05 – 0.7	0.1 - 5
Dominant species	*Eragrostis obtusa, Themeda triandra, Eragrostis chloromelas, Tragus koelerioides, Searsia erosa, Eragrostis curvula, Olea europaea s. africana, Heteropogon contortus, Rosenia humilis, Searsia burchellii, Diospyros* species	

This vegetation unit is restricted to rocky outcrops, ridges, and small koppies (Figure 4). The shrubland is relatively open with mosaics of higher shrubs, low trees and grasslands. Several species are restricted to these habitats only, including a multitude of geophytes, phanerophytes (ferns), long-lived (slow-growing) trees and high shrubs and several succulents – amongst the latter large specimens of *Euphorbia pulvinata* (Figure 5).

Rockiness varies from small boulders with a steep slope (over 30°) to large rock fragments that cover 40 to 90 % of the soil surface. Vegetation is wedged in-between cracks and crevices or small areas where pockets of soil have accumulated. Rainfall is channelled into these cracks and crevices, becomes

trapped below rock from where it cannot evaporate, and remains available to plants. Crevices below rocks and large shrubs are also habitat to smaller mammals and reptiles.

Figure 4: High shrubs, trees, and sparse grasses of Association 1 as found on small rocky ridges and outcrops.

Figure 5: Large specimen of *Euphorbia pulvinata* occur on the slopes of small outcrops.

Soils are dispersive and prone to erosion. Erosion is limited where the perennial grass layer is relatively dense on pockets of soil between rocks.

Species composition and typical observed cover percentages:

Species	Status	avg %	max %
Succulents			
Euphorbia pulvinata	**1, II, end**	**0.3**	**1**
Duvalia species	**1**	0.1	
Low shrubs			
Asparagus suaveolens		**0.6**	
Chrysocoma ciliata		**0.1**	2
Felicia fascicularis	**end**	**0.3**	
Felicia filifolia		**0.1**	
Felicia muricata		**1.2**	3
Helichrysum zeyheri	1	**0.2**	0.5
Lantana rugosa		**0.1**	
Lycium cinereum		**1.2**	3
Melolobium microphyllum		**0.1**	
Nenax microphylla		**1.4**	
Selago species		**0.1**	
Trees			
Celtis africana		**0.2**	
Olea europaea s. africana	1	**0.5**	10
High shrubs			
Asparagus laricinus		**0.2**	
Diospyros austro-africana		**1.2**	3
Diospyros lycioides s. lycioides		**0.7**	
Ehretia rigida		**0.1**	
Grewia occidentalis		**0.1**	

Species	Status	avg %	max %
Gymnosporia buxifolia		**0.5**	
Lycium oxycarpum		**0.3**	1
Searsia burchellii		**2.0**	5
Searsia ciliata		**0.8**	
Searsia erosa		**4.4**	8
Searsia pyroides		**0.2**	
Searsia tridactyla	**end**	**0.2**	**0.5**
Herbs and forbs			
Berkheya onopordifolia		**0.1**	
Berkheya pinnatifida	**W**	**0.4**	**1**
Falkia oblonga		**0.1**	
Gazania krebsiana		**0.1**	
Geigeria filifolia		**0.1**	
Gerbera species		**0.1**	
Helichrysum rugulosum	1	**0.2**	
Hibiscus pusillus		**0.1**	
Indigofera species		**0.1**	
Peliostomum leucorrhizum		**0.1**	
Pellaea calomelanos		**0.1**	
Pseudognaphalium luteo-album		**0.1**	
Rhynchosia totta		**0.1**	
Richardia brasiliensis	**W**	**0.1**	
Salvia disermas		**0.1**	
Scabiosa columbaria		**0.3**	
Viscum species		0.1	
Grasses			
Aristida diffusa		**0.2**	

Species	Status	avg %	max %
Cymbopogon pospischilii		**1.7**	5
Eragrostis chloromelas		**8.3**	25
Eragrostis curvula		**3.8**	10
Eragrostis obtusa		**12**	25
Heteropogon contortus		**3.3**	10
Themeda triandra		**11.7**	25
Tragus koelerioides		**6.7**	**15**
Triraphis andropogonoides		**0.7**	2
Geophytes			

Species	Status	avg %	max %
Albuca setosa		**0.1**	
Dipcadi crispum		**0.1**	
Gladiolus permeabilis	1	**0.1**	
Moraea species	2	**0.1**	
Alien Invasive plants			
Eucalyptus species	A	**0.2**	10
Opuntia robusta	A	**0.9**	

General development recommendations:

These areas should be treated as No Go areas. Once the habitats have been physically altered, they cannot be recreated or returned to their former diversity and functionality. During construction, any disturbance to these habitats must also be totally avoided. No PV panels, roads, or underground cabling may be placed on these areas.

5.2.2. *Themeda triandra – Chrysocoma ciliata* grasslands

Habitat and Land use			
Substrate	Undulating to relatively flat plains, fine textured dispersive soils, variable degree of surface stoniness	**Disturbance**	Occasional bare patches prone to erosion and further degradation Heavy grazing, Alien Invasive Plants
Species Richness	89 species recorded of 218 expected	**Conservation value:**	Medium
Ecosystem function	Vegetation as grazing, dense vegetation aids infiltration of water, the latter limiting runoff and associated erosion of plains and lower-lying drainage lines and rivers	**Sensitivity:**	Low Highly erodible if degraded, then difficult to reverse
Need for rehabilitation	Erosion to be monitored and mitigated, Alien Invasive Plants to be cleared	**Agricultural potential**	Grazing

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High shrubs and trees	0.8 - 2	0 - 1
Low Shrubs	0.2 – 0.6	0.1 - 15
Grass	0.05 – 0.8	10 – 80
Forbs	0.02 – 0.5	0.1 - 10
Dominant species:	*Themeda triandra, Cynodon dactylon, Digitaria eriantha, Sporobolus coromandelianus, Eragrostis obtusa, Eragrostis chloromelas, Eragrostis curvula, Chrysocoma ciliata*	

This vegetation unit covers the majority of the study area and beyond – primarily on gently undulating plains (Figure 6). The vegetation structure is relatively uniform – being dense short grassland – but the species composition varies significantly within the vegetation unit. This depends on degradation state, soil surface characteristics, soil depth, and slope. On rockier areas with shallow soils, there is a significantly higher cover of dwarf shrubs. Geophytic species are relatively common on these grasslands – at the time of the study *Tulbaghia*- and *Albuca* species were relatively common and widespread. It is expected that after sufficient rains, several more species that are geophytic will emerge from woody rootstocks.

The main cause of degradation of this vegetation on the study area is continued heavy grazing. Species composition on such overgrazed areas changes to have less grass and more dwarf shrubs, much resembling Association 3, except that succulent and bulbous species naturally present within Association 3 are absent on these degraded plains. The more degraded areas of this vegetation are particularly prone to invasion by alien species, most notably *Prosopis* and *Opuntia* species.

Soils are dispersive and highly erodible; erosion can only be limited with a dense grass cover. As soon as that cover has been significantly reduced, soil surfaces cap, sheet erosion becomes prominent and develops into terracette and later rill erosion (Figure 7). After rainfall events, large amount of debris and associated nutrients are lost from the system, which again causes a lower nutrient status of these soils over the long term. The maintenance of some vegetation between PV panels on these plains will thus be important to prevent excessive degradation, which will be costly and difficult to reverse, of these areas, whilst retaining some of the ecosystem functions, like resource trapping and seed regeneration.

Figure 6: The *Themeda triandra – Chrysocoma ciliata* grasslands of Association 2 in better condition.

Figure 7: Vegetation of Association 2 in a more degraded state with frequent sheet and terracette erosion.

Species composition and typical observed cover percentages:

Species	Status	avg %	max %
Trees			
Acacia karroo		**0.1**	
High shrubs			
Asparagus laricinus		**0.4**	
Lycium oxycarpum		**1**	
Searsia erosa		**0.3**	
Searsia lancea		**0.2**	
Searsia pyroides		**0.3**	
Succulents			
Crassula lanceolata		**0.1**	
Rabiea albinota	**2**	**0.1**	
Stapelia species	**1**	**0.1**	
Low shrubs			
Asparagus suaveolens		**0.5**	
Chrysocoma ciliata		**1.5**	8
Felicia muricata		**0.6**	3
Felicia petiolata		**1**	
Jamesbrittenia aurantiaca		**0.1**	
Lycium cinereum		**1.3**	3
Nenax microphylla		**1.8**	5
Pentzia incana		**0.3**	
Pentzia sphaerocephala		**0.1**	
Rosenia humilis		**3.3**	8
Salsola rabieana		**0.2**	
Selago species		**1.1**	3
Stachys hyssopoides		**0.2**	
Herbs and forbs			
Acalypha segetalis		**0.1**	

Species	Status	avg %	max %
Aptosimum procumbens		**0.1**	
Arctotis arctotoides		**0.1**	
Asclepias meyeriana	**1**	**0.1**	
Berkheya onopordifolia		**0.1**	
Berkheya pinnatifida		**0.2**	
Blepharis integrifolia		**0.1**	
Convolvulus boedeckerianus	**end**	**0.1**	
Cotula anthemoides	**W**	**0.2**	
Cucumis species		**0.1**	
Falkia oblonga		**0.1**	
Galenia pubescens		**0.1**	
Garuleum pinnatifidum	**end**	**0.1**	
Gazania krebsiana		**0.1**	
Geigeria filifolia		**0.2**	
Gnaphalium filagopsis		**0.2**	
Helichrysum dregeanum	**1**	**0.3**	
Helichrysum rugulosum	**1**	**0.2**	
Hermannia coccocarpa		**0.1**	
Hermannia depressa		**0.4**	
Hermannia erodioides		**0.1**	
Hibiscus pusillus		**0.1**	
Hibiscus trionum		**0.1**	
Indigofera species		**0.1**	
Ipomoea pellita		**0.1**	
Kohautia species		**0.1**	
Lactuca inermis	**W**	**0.1**	
Lessertia pauciflora		**0.1**	
Lotononis listii		**0.1**	
Nidorella resedifolia	**W**	**0.1**	
Ophioglossum polyphyllum		**0.1**	
Polygala species		**0.1**	
Pseudognaphalium		**0.2**	

Species	Status	avg %	max %
luteo-album			
Richardia brasiliensis	**W**	**0.1**	
Salvia disermas		**0.1**	
Scabiosa columbaria		**0.8**	3
Schkuhria pinnata	**W**	**0.1**	
Senecio hastatus		**0.1**	
Senecio hieracioides		**0.1**	
Tephrosia species		**0.1**	
Tripteris aghillana		**0.1**	
Vahlia capensis		**0.1**	
Wahlenbergia denticulata		**0.1**	
Grasses			
Aristida diffusa		**0.3**	
Brachiaria eruciformis		**0.6**	
Cymbopogon pospischilii		**2.5**	**5**
Cynodon dactylon		**7.2**	15
Digitaria eriantha		**6.8**	10
Eragrostis chloromelas		**6**	10
Eragrostis curvula		**2**	5
Eragrostis obtusa		**21**	
Setaria sphacelata		**2**	

Species	Status	avg %	max %
Sporobolus coromandelianus		**7**	20
Themeda triandra		**27**	**50**
Tragus koelerioides		**15**	
Geophytes			
Albuca humilis		**0.1**	
Ammocharis coranica	**1**	**0.1**	
Anthericum species		**0.1**	
Dipcadi crispum		**0.1**	
Dipcadi gracillimum		**0.1**	
Eriospermum species		**0.1**	
Hypoxis angustifolia	**2**	**0.1**	
Moraea species	**2**	**0.1**	
Nerine species	**1**	**0.1**	
Oxalis species		**0.1**	
Talinum arnotii		**0.1**	
Tulbaghia acutiloba	**2**	**0.1**	
Alien Plant Species			
Opuntia robusta	**A**	**0.6**	**2**
Prosopis glandulosa	**A**	**1.3**	3

General development recommendations:

It is recommended that the PV array and surrounding infrastructure be restricted as much as practically possible to this vegetation association, and that the development be kept as close as possible to the existing developments. However, as these plains are prone to severe degradation as soon as the vegetation cover becomes significantly reduced – as may happen under the PV panels, mechanisms must be in place to prevent accelerated erosion and further degradation from these plains. Around the edges of all hard-surface infrastructure, including mounted PV panels, a grass layer with a canopy cover of at least 50 – 60% must be maintained to absorb raindrop and runoff impact. Accelerated erosion and degradation of these plains will lead to the gradual degradation of the lower-lying vegetation Associations 3 and 4, as well as lower lying wetlands.

Most of the protected species, can and should be transplanted to suitable habitats nearby and/or used in revegetation efforts after construction and stabilisation of soils. Continued monitoring for and eradication of alien invasive plants will be necessary.

5.2.3. *Panicum coloratum – Chasmatophyllum musculinum* grasslands

Habitat and Land use			
Substrate	Flat to slightly undulating plains, loamy to clay-rich soils, no or slight surface rockiness	**Disturbance**	Slight to severe sheet erosion, occasional terrace erosion, bare patch formation
Species Richness	74 species recorded of 218 expected on study area	**Conservation value:**	Medium Several species restricted to these habitats
Ecosystem function	Niches for succulents and geophytic species that cannot persist in dense grasslands, slowing of runoff and filtering of such before it enters riparian areas and the drainage line	**Sensitivity:**	Medium - High Avoid, especially in areas adjacent to drainage lines
Need for rehabilitation	Erosion control, removal of alien invasive plants	**Agricultural potential**	Grazing

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High shrubs and trees	1 – 4	0 - 2
Low Shrubs	0.1 – 0.5	2 – 20
Grass	0.05 – 0.9	5 – 60
Forbs	0.05 – 0.6	0.5 - 15
Dominant species	*Eragrostis curvula, Themeda triandra, Panicum coloratum, Eragrostis chloromelas, Sporobolus coromandelianus, Eragrostis obtusa, Chasmatophyllum musculinum, Rosenia humilis, Lycium cinereum*	

This vegetation unit forms a transition between higher-lying vegetation and the riparian areas of Association 4, thus often merging or extending in bands into other vegetation rather than being clearly delineated (Figure 8). Surface rockiness varies – either it is absent or varying amounts of pebbles and rock fragments can be observed. The soil is generally loamy, often with high clay content, and after sufficient rainfall will be transformed into areas with deep, impassable mud. The fine texture of the soil, however, also leads to its rapid desiccation after rains have ceased.

The vegetation consists either of sparse to moderately dense grasslands, or a sparse layer of dwarf shrubs with low succulents, often in dense mats, between them. Low shrubs, succulents, and geophytes are better adapted to the less favourable moisture conditions of these low plains, and here face less competition form dense grasses. The diversity of geophytes recorded during the field survey was already relatively high, but even more species are expected to occur here.

Bare patches are common and generally, their upper surface is strongly capped and devoid of organic matter. If the system is functional, these bare bands serve as runoff zones to channel moisture and nutrients to lower-lying, vegetated run0on zones. As long as these bands of alternative vegetation cover are maintained, the system remains functional. Once the vegetated bands of this association become decimated, erosion becomes more severe and in the absence of run-on zones, quickly degrades and loses its functionality. A severe degradation of this association can be expected to lead to the erosion and severe degradation of lower-lying riparian areas, and erosion may cut back into higher-lying grasslands of Association 2.

Figure 8: Vegetation of the *Panicum coloratum – Chasmatophyllum musculinum* grasslands

Species composition and typical observed cover percentages:

Species	*Status*	*avg %*	*max %*
Succulents			
Chasmatophyllum musculinum	**2**	**3.3**	**8**
Chortolirion latifolium	**2**	**0.1**	
Crassula lanceolata		**0.1**	
Rabiea albinota	**2**	**0.1**	
Ruschia hamata	**2**	**0.1**	
High shrubs			
Asparagus laricinus		**1.1**	2
Searsia pyroides		**0.7**	
Low shrubs			
Asparagus suaveolens		**0.2**	
Chrysocoma ciliata		**0.2**	
Felicia muricata		**1.3**	2
Hertia ciliata		**0.1**	
Lycium cinereum		**2.1**	5
Nenax microphylla		**0.3**	
Pentzia incana		**0.1**	
Pentzia sphaerocephala		**0.1**	
Rosenia humilis		**3.2**	12
Salsola rabieana		**0.3**	
Selago species		**1.4**	5
Herbs and forbs			
Aptosimum procumbens		**0.1**	
Asclepias meyeriana	**1**	**0.1**	
Berkheya onopordifolia		**0.1**	
Berkheya pinnatifida		**0.2**	

Species	*Status*	*avg %*	*max %*
Blepharis integrifolia		**0.1**	
Convolvulus boedeckerianus	**end**	**0.1**	
Denekia capensis		**0.1**	
Dimorphotheca caulescens		**0.1**	
Gazania krebsiana		**0.1**	
Geigeria filifolia		**0.1**	
Helichrysum rugulosum	1	**0.2**	
Hermannia coccocarpa		**0.1**	
Hermannia depressa		**0.1**	
Hibiscus pusillus		**0.1**	
Indigofera species		**0.1**	
Ipomoea pellita		**0.2**	
Lotononis listii		**0.1**	
Richardia brasiliensis		**0.1**	
Salvia disermas		**0.1**	
Scabiosa columbaria		**0.1**	
Seddera capensis		**0.2**	
Selago densiflora		**0.1**	
Senecio glaberrimus		**0.1**	
Senecio hastatus		**0.1**	
Senecio hieracioides		**0.1**	
Thesium species		**0.2**	
Tripteris aghillana		**0.2**	
Grasses			
Aristida congesta s. barbicollis		**0.1**	
Cynodon dactylon		**1.2**	2
Digitaria eriantha		**1.7**	3
Eragrostis chloromelas		**11**	20

Species	*Status*	*avg %*	*max %*
Eragrostis curvula		**19**	30
Eragrostis obtusa		**5**	
Heteropogon contortus		**0.1**	
Oropetium capense		**0.1**	
Panicum coloratum		**11**	15
Setaria sphacelata		**1**	
Sporobolus africanus		**0.6**	
Sporobolus coromandelianus		**10**	20
Themeda triandra		**19**	40
Tragus koelerioides		**1**	
Geophytes			
Albuca humilis		**0.1**	
Ammocharis coranica	**1**	**0.1**	
Bulbine narcissifolia		**0.2**	
Dipcadi crispum		**0.1**	

Species	*Status*	*avg %*	*max %*
Dipcadi gracillimum		**0.1**	
Drimia species		**0.1**	
Eriospermum species		**0.1**	
Hypoxis angustifolia	**2**	**0.1**	
Hypoxis hemerocallidea	**2, Declining**	**0.1**	
Ledebouria revoluta		**0.1**	
Moraea pallida	**2**	**0.1**	
Nerine species	**1**	**0.1**	
Raphionacme hirsuta	**1**	**0.1**	
Talinum arnotii		**0.1**	
Tulbaghia acutiloba	**2**	**0.1**	
Alien Invasives			
Cyclospermum leptophyllum	**A**	**0.1**	
Opuntia robusta	**A**	**0.1**	
Prosopis glandulosa	**A**	**1.3**	2

General development recommendations:

It is recommended that development within this vegetation association will be avoided as far as possible, especially in areas within 100 m of drainage lines. These plains are prone to severe degradation as soon as the vegetated run-on zones become significantly reduced and the area of runoff zones. Where development is to take place, mechanisms must be in place to prevent accelerated erosion and further degradation from these plains. Around the edges of all hard-surface infrastructure, including mounted PV panels, a grass layer with a canopy cover of at least 60 – 70% must be maintained to absorb raindrop and runoff impact.

Accelerated erosion and degradation of these plains will lead to the rapid degradation of the lower-lying riparian areas of Association 4 and lower lying wetlands. Such erosion may, however, also lead to degradation of higher lying grasslands. The intactness and functionality of Association 3 is thus important for the overall ecosystem functionality of the plains on the study area.

Most of the protected species, can and should be transplanted to suitable habitats nearby and/or used in revegetation efforts after construction and stabilisation of

soils. Continued monitoring for and eradication of alien invasive plants will be necessary.

5.2.4. *Paspalum – Schoenoplectus* species riparian areas

Habitat and Land use			
Substrate	Sandy loams, occasionally high clay content	**Disturbance**	Alien invasives in close proximity that could pose a threat to this ecosystem
Species Richness	17 species recorded of 218 expected on study area	**Conservation value:**	Medium 47 % of species restricted to specialised habitat
Ecosystem function	Specialised niches for biodiversity dependent on high-moisture environments, dense herb layer slows and filters runoff to retain moisture, sediment and nutrients in this and surrounding ecosystems, generally higher herb productivity provides seasonal grazing, banks often habitat and/or shelter for fauna	**Sensitivity:**	High No-Go Area
Need for rehabilitation	Eradication of alien invasive species in close proximity	**Agricultural potential**	Seasonal grazing, seasonal surface water

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High shrubs and trees		
Low Shrubs	0.2 – 0.5	0 - 5
Grass	0.02 – 1.5	60 - 95
Forbs	0.01 – 0.5	0 - 10
Dominant species	*Paspalum* species, *Eragrostis curvula, Panicum coloratum, Schoenoplectus* species	

This vegetation unit occurs along smaller drainage lines within and beyond the study area. Species composition varies, as does the height of the dominant herbaceous layer (Figure 9). The edges of this association usually merge into surrounding vegetation; hence, a clear delineation of the drainage channels based on vegetation alone is not always possible.

At the time of the survey, the overall vegetation diversity in these drainage lines was very low, but this is expected to change once sufficient moisture is available. Important however, is that the total extent of these habitats is restricted, and a large portion of the species present here can only persist in these habitats.

Figure 9: Different views of the riparian areas of Association 4 in the small drainage line that traverses the study area.

Species composition and typical observed cover percentages:

Species	***Status***	***avg %***	***max %***
Low shrubs			
Lycium cinereum		**2**	
Nenax microphylla		**1**	
Rosenia humilis		**2**	
Herbs and forbs			
Arctotis arctotoides		**2**	
Falkia oblonga		**1**	
Hermannia coccocarpa		**0.1**	
Ranunculus multifidus		**0.1**	
Scabiosa columbaria		**0.2**	

Schoenoplectus species		**3**	
Trifolium africanum		**0.2**	
Wahlenbergia lobulata	end	**0.1**	
Grasses			
Cynodon dactylon		**0.1**	
Echinochloa species		**0.1**	
Eragrostis curvula		**15**	
Panicum coloratum		**10**	
Paspalum species		**60**	
Sporobolus coromandelianus		**0.1**	

General development recommendations:

These areas should be treated as No Go areas. The dense vegetation of the riparian areas fringing the drainage channels is essential in keeping the drainage channel intact and protects it from erosion. The stability of this vegetation can be greatly compromised if runoff from surrounding plains is not slowed down by vegetation; hence, the intactness of the drainage lines is significantly linked to the intactness of the adjacent plains, mostly Association 3. It is thus imperative that the minimum legal buffer of developments of 32 m from drainage lines be extended in the study area. It is recommended that a buffer of at least 100 m be maintained around riparian areas.

This drainage channel is in close proximity to the Modder River and further significant water bodies further downstream. For this reason, any kind of pollution, especially spillage of fuels and chemicals, must be prevented at all cost and immediately removed if it should occur.

These habitats are prone to invasion by ruderal, alien species, necessitating continued monitoring for and prompt eradication of invasive alien plants.

5.3. Amphibians, Reptiles and Terrestrial Mammals

A list of amphibian, reptile, and mammal species that could occur in the study area according to the ADU and SANBI database and Apps (2000) is presented in Appendix A2. Avifauna has been included in the list, but no avifaunal observations were made on site.

Vertebrates and signs of such sighted during the survey on and in the vicinity of the study area were:

Vertebrates sighted during the survey in the vicinity of the study area were the Scrub Hare and the Common Duiker.

5.4. Sensitivity analysis

5.4.1. *Searsia erosa – Eragrostis obtusa* shrublands

Species summary	Indigenous	Aliens Weeds	% restricted to association	Red Data	Protected	Endemic to RSA
Trees	2	1	**2**		1	
High shrubs	12		**8**			1
Succulents	2	1	**2**		2	
Low shrubs	9		**3**			
Forbs	19		**5**		2	
Grasses	9		**1**			
Geophytes	4		**2**		2	
Total	**57**	**2**	**40%**	**0**	**7**	**1**

Conservation status: Medium -high, 40% of species are restricted to these habitats, most of these long-lived species, more species expected to be present

Ecosystem function: Specialised niches for higher biodiversity; rockiness creates localised improved moisture retention to sustain this biodiversity. High structural diversity creates several microhabitats for fauna and flora.

Stability: Medium to high if habitat is kept intact

Reversibility of degradation: habitat will be impossible to recreate after significant modification, rehabilitation of vegetation and ecosystem functionality after disturbance will be very slow and will not reach former functionality or diversity

Rating: High sensitivity

5.4.2. *Themeda triandra – Chrysocoma ciliata* grasslands

Species summary	Indigenous	Aliens Weeds	% restricted to association	Red Data	Protected	Endemic to RSA
Trees	1	1	**1**			
High shrubs	5		**1**			
Succulents	3	1	**1**		2	
Low shrubs	13		**3**			
Forbs	43		**16**		3	2
Grasses	12		**1**			
Geophytes	12		**2**		5	
Total	**89**	**2**	**28 %**	**0**	**10**	**2**

Conservation status: Medium, high diversity, some species restricted to this vegetation type, but most of these are short-lived, more species expected

Ecosystem function: Vegetation as grazing, dense vegetation aids infiltration of water, the latter limiting runoff, and associated erosion of plains and lower-lying drainage lines and rivers

Stability: High if vegetation layer is kept intact, low if soils become bare

Reversibility of degradation: moderate, will require intervention

Rating: Low sensitivity

5.4.3. *Panicum coloratum – Chasmatophyllum musculinum* grasslands

Species summary	Indigenous	Aliens Weeds	% restricted to association	Red Data	Protected	Endemic to RSA
Trees		1				
High shrubs	2					
Succulents	5	1	**3**		4	
Low shrubs	11		**1**			
Forbs	27	1	**6**		2	1
Grasses	14		**4**			
Geophytes	15		**6**	1	7	
Total	**74**	**3**	**27 %**	**1**	**13**	**1**

Conservation status: Medium, high species diversity, several species restricted to these habitats, one red data species, higher species diversity expected

Ecosystem function: Specialised niches that allow establishment of low succulents that stabilise bare soils and trap debris and nutrients from runoff to

retain them in the ecosystem, filtering and slowing of runoff to limit erosion of lower-lying drainage lines

Stability: High but dynamic if vegetation layer is kept intact, low if soils become bare, several areas currently degraded due to overgrazing and past ripping

Reversibility of degradation: possible, will require intensive intervention – especially erosion control and active revegetation, will be slow to reach former functionality

Rating: Medium-high sensitivity

5.4.4. *Paspalum – Schoenoplectus* species riparian areas

Species summary	Indigenous	Aliens Weeds	Total	Red Data	Protected	Endemic to RSA
Trees						
High shrubs						
Succulents						
Low shrubs	3					
Forbs	8		**4**			
Grasses	6		**4**			
Geophytes	0		**0**			
Total	**17**	**0**	**47 %**	**0**	**0**	**0**

Conservation status: Medium, large portion of species restricted to these habitats, species diversity expected to be higher

Ecosystem function: Specialised niches for biodiversity dependent on high-moisture environments, dense herb layer slows and filters runoff to retain moisture, sediment, and nutrients in this and surrounding ecosystems, generally higher herb productivity provides seasonal grazing, banks often habitat and/or shelter for fauna

Stability: High if vegetation layer is kept intact, low to dysfunctional and quickly degrading further if soils become bare or vegetation structure is changed after disturbance

Reversibility of degradation: Moderate to low if habitat is not altered, will require intensive intervention, very unlikely if habitat is significantly altered

Rating: High sensitivity; No Go Areas

According to the above, ecological sensitivities of the study area have been mapped in Figure 10.

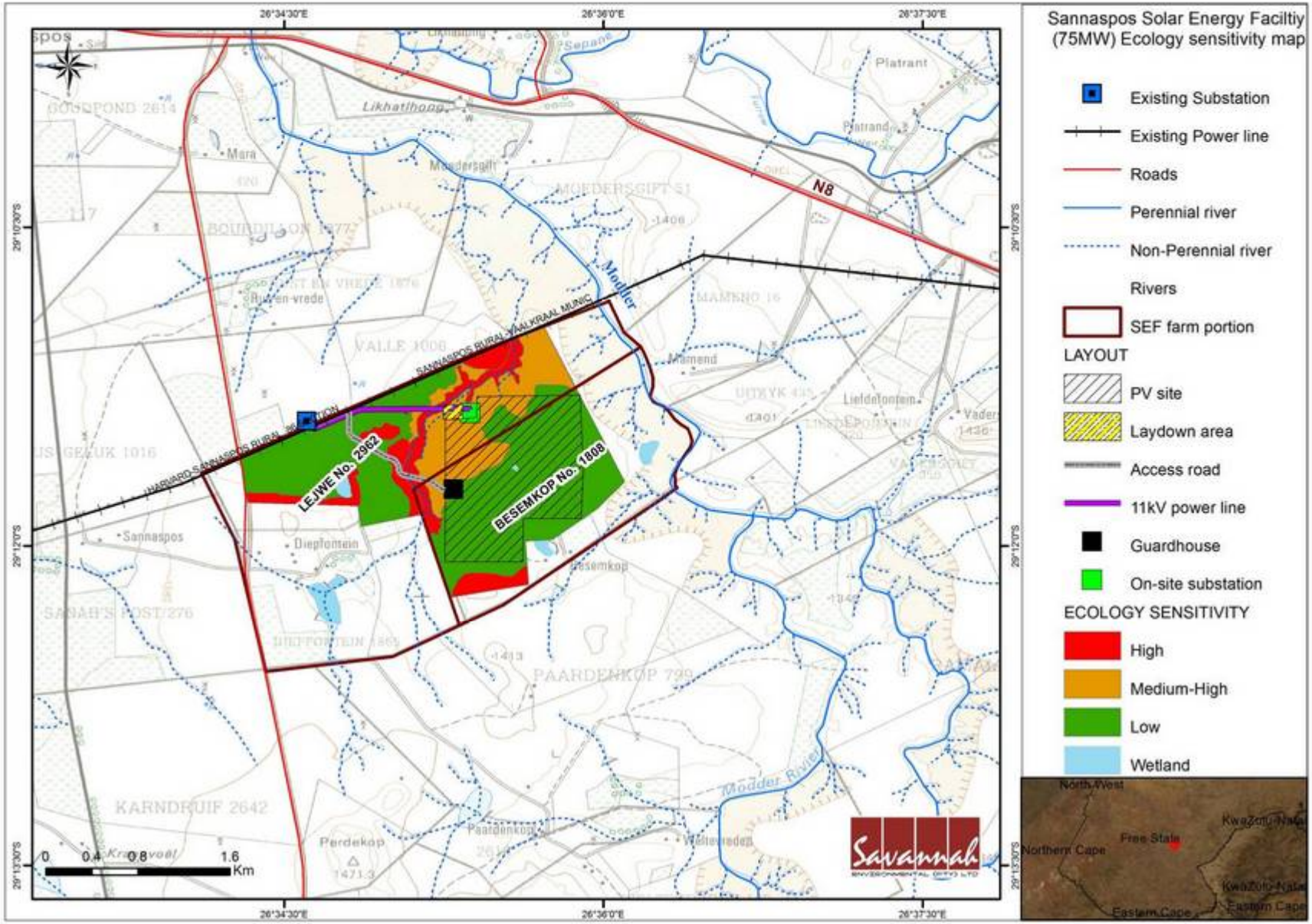

Figure 10: Ecological sensitivity of the study area.

5.5. Plant species of conservation concern

The following red data plant species have been recorded from the area (2926) according to the new red data species list of SANBI

Species	RD Status	Suitable Habitat	Possibility of being present	Threat
Brachystelma duplicatum	Critically Rare	Variable	Slight	Habitat destruction
Boophone disticha	Declining	Variable	Slight	Harvesting
Gunnera perpensa	Declining	Drainage lines, rivers, other wetlands	Slight	Habitat destruction
Hypoxis hemerocallidea	Declining	Rocky footslopes, grasslands	Likely	Harvesting
Pelargonium sidoides	Declining	Variable	Slight	Harvesting

The following plants encountered on the study site are protected (Figure 11):

FSNCB Schedule 1 and NCO Schedule 3: Specially Protected Species

Ammocharis coranica
Asclepias meyeriana
Duvalia species
Euphorbia pulvinata
Gladiolus permeabilis
Gladiolus permeabilis
Helichrysum dregeanum
Helichrysum rugulosum
Helichrysum zeyheri
Nerine species
Olea europaea s. africana
Raphionacme hirsuta
Stapelia species

FSNCB Schedule 2 and NCO Schedule 4: Protected Species

Albuca setosa
Chasmatophyllum musculinum
Chortolirion latifolium
Hypoxis angustifolia
Hypoxis hemerocallidea
Moraea pallida
Moraea species
Rabiea albinota
Ruschia hamata
Tulbaghia acutiloba

Figure 11: Some of the protected species occurring on the study area: *Stapelia* species (top left), *Tulbaghia acutiloba* (top centre), *Chortolirion latifolium* (top right), *Ammocharis coranica* (bottom left), *Chasmatophyllum musculinum* (bottom right).

5.6. Alien invasive species

Few alien invasive species were encountered on the study area, with additional species within surrounding areas and along larger transport routes leading to the study area. Thus, a strong possibility exists that such species may be introduced to the study area during construction. The species of most concern are of the genera *Prosopis, Eucalyptus, and Opuntia* (Figure 12). These invasives alter ecosystem functionality by displacing indigenous vegetation, as can be clearly seen below the *Prosopis* tree in Figure 12.

A detailed alien invasive management and monitoring program will thus have to be implemented throughout the construction and operational phase of the development.

Figure 12: Some of the Alien Invasive Plants on the study area: *Prosopis glandulosa* (top) and *Opuntia robusta* (bottom). Both must be eradicated.

5.7. Assessment of impacts

5.7.1. Assumptions

The following is assumed:

- Existing access roads and tracks will be used and upgraded, whilst new servitudes or power lines will coincide as far as possible with existing infrastructure
- The proposed development will be as close as possible to existing electricity infrastructure, thus minimising the need for additional overhead power lines to connect to the grid
- A thorough ecological investigation be conducted of all footprint areas to detect and relocate all plant species of conservation concern by a suitably qualified botanist prior to a geotechnical survey and construction
- Development of the PV-footprint area will retain a minimum 50 m, preferably 100 m buffer from all drainage lines and/or wetlands within the area assessed
- Prior to development the footprint area will be entirely cleared of all alien invasive plants

5.7.2. Localised vs. cumulative impacts: some explanatory notes

Ecosystems consist of a mosaic of many different patches. The size of natural patches affects the number, type and abundance of species they contain. At the periphery of patches, influences of neighbouring patches become apparent, known as the 'edge effect'. Patch edges may be subjected to increased levels of heat, dust, desiccation, disturbance, invasion of exotic species and other factors. Edges seldom contain species that are rare, habitat specialists or that require larger tracts of undisturbed core habitat. Fragmentation due to development reduces core habitat and greatly extends edge habitat, which causes a shift in the species composition, which in turn puts great pressure on the dynamics and functionality of ecosystems (Perlman & Milder 2005).

The most severe form of ecosystem fragmentation is in the form of 'perforation' – being a multitude of smaller, isolated developments rather that one larger cluster of developments in close proximity. Research has shown that several smaller but isolated developments rapidly increase the amount of edge effect and related disturbances through access routes, greatly reduce core habitat and have a far greater detrimental effect on species diversity than clustered developments (Maestas *et al.* 2003). Species populations that become too fragmented may result in future extinction debts as sizes of fragmented populations are too small to maintain genetic diversity and will eventually die off.

From the above it is clear that cumulative impacts of developments on population viability of species can be reduced significantly if new developments are kept as close as possible to existing developed areas or, where such is not possible,

different sections of a development be kept as close together as possible. Thus new power lines should follow routes of existing servitudes if such exist, renewable energy facilities should be constructed as close as possible to existing infrastructure or substations, and if several developments are planned within close proximity, these developments should be situated as close together as possible, not scattered throughout the landscape.

5.7.3. Impacts of PV array, access roads and associated infrastructure

Activity: Upgrading of Access Road		
Environmental Aspect: Removal of vegetation, compaction of soils, creation of runoff zone		
Environmental impact: Loss of vegetation, increase in runoff and erosion (as the road already exists, no additional impact on terrestrial fauna is expected to arise from the development)		
	Without mitigation	**With mitigation**
Extent (E)	Local (3)	Local (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Low (4)	Small (0)
Probability (P)	Definite (5)	Definite (5)
Significance **(S = E+D+M)*P**	**Medium (55)**	**Low (25)**
Status (positive, neutral or negative)	Negative	Neutral
Reversibility	Not reversible	Partially reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably	
Mitigation: ▪ Make use of existing tracks as far as possible ▪ Ensure an adequate plant search and rescue program prior to commencement of activity, especially geophytes may need to be relocated ▪ 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, together with revegetation of adjacent areas) ▪ 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
Cumulative impacts: ▪ Possible erosion of areas lower than the access road, possible contamination of lower-lying wetlands due to oil or other spillage, ▪ Possible spread and establishment of alien invasive species
Residual impacts: ▪ Altered vegetation composition and structure, ▪ Barren areas, ▪ Potential for erosion

Activity: Fencing area – may also serve as access road to PV panels and fire-break		
Environmental Aspect: Removal of vegetation, compaction of soils, creation of runoff zone		
Environmental impact: Loss of vegetation, loss of micro-habitat, increase in runoff and erosion, window of opportunity for the establishment of alien invasive species, altered topsoil characteristics prone to capping, increased runoff and erosion (as fences already exist, no significant additional impact on terrestrial fauna is expected to arise from the development)		
	Without mitigation	**With mitigation**
Extent (E)	Local (2)	Local (1)
Duration (D)	Long-term (4)	Long term (4)
Magnitude (M)	Moderate (6)	Minor (2)
Probability (P)	Definite (5)	Definite (5)
Significance (S = E+D+M)*P	**Medium (60)**	**Medium (35)**
Status (positive, neutral or negative)	Negative	Neutral
Reversibility	Partially reversible	Partially reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably	
Mitigation: ▪ Minimise area affected, especially during construction ▪ Avoid development and disturbance on low rocky ridges or outcrops as well as plains adjacent to and drainage lines themselves ▪ Use topsoils removed for redistribution outside the LOWEST borders of the development to stop erosion off the cleared areas, possibly to construct contour buffer strips to help limit erosion ▪ Remove and collect all bulbous plants from cleared areas and transplant onto the		

newly redistributed topsoils, together with other species used for revegetation ▪ Prevent leakage of oil or other chemicals ▪ Monitor the establishment of alien invasive species and remove as soon as detected, whenever possible *before* regenerative material can be formed ▪ Should the area along the fence be used for occasional access and fire breaks, regular mowing of the grass layer to reduce fire loads is recommended rather than the removal of vegetation
Cumulative impacts: ▪ Possible erosion of cleared areas and thus also accelerated erosion from surrounding areas ▪ Possible excessive fragmentation and thus reduction of core habitats that may negatively influence species population viability.
Residual impacts: ▪ Altered vegetation composition, ▪ Compacted topsoils, ▪ Possibility for erosion.

Activity: Construction and operation of PV panels		
Environmental Aspect: Removal of or excessive damage to vegetation, compaction of soils, creation of runoff zone, redistribution and concentration of runoff from panel surfaces, artificial shading of vegetation		
Environmental impact: Loss of vegetation, loss of and alteration of microhabitats, altered vegetation cover, altered distribution of rainfall and resultant runoff patterns, increase in runoff and accelerated erosion, loss of faunal habitat and resource availability to terrestrial fauna		
	Without mitigation	**With mitigation**
Extent (E)	Local (5)	Local (2)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Very High (10)	Moderate (6)
Probability (P)	Definite (5)	Definite (5)
Significance (S = E+D+M)*P	**High (95)**	**Medium (60)**
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Difficult to reverse	Partially reversible
Irreplaceable loss of resources?	Highly Probable	Probable
Can impacts be mitigated?	Reasonably	
Mitigation: ▪ Keep areas affected to a minimum		

▪ Utilise area as close as possible to existing infrastructure, keep buffer zone of a minimum of 50m, preferably 100 m around drainage lines ▪ Keep leveling earthworks and soil disturbance to the minimum practically possible, implement a comprehensive topsoil management, soil erosion control and rehabilitation plan once layouts have been finalised ▪ Remove as little indigenous vegetation as practically possible, revegetate areas below/between panels immediately after construction ceases ▪ Relocate all geophytes, use as far as possible in rehabilitation efforts ▪ No development on drainage lines or other wetlands and low rocky ridges and outcrops, limit development on lower-lying plains adjacent to drainage lines ▪ 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 microtopography and revegetation efforts accordingly ▪ Aim to maintain a reasonable cover of indigenous perennial vegetation throughout the operational phase within and on the periphery of the PV array, preferably low dense perennial grasses that can be mowed as need be to reduce fuel loads ▪ Prevent leakage of oil or other chemicals ▪ Monitor the establishment of alien invasive species and remove as soon as detected, whenever possible before regenerative material can be formed
Cumulative impacts: ▪ possible erosion of areas lower than the panels ▪ possible contamination and siltation of the drainage lines and lower-lying wetlands ▪ possible fragmentation of plant populations ▪ possible alteration of occupancy by terrestrial fauna, possible reduction of available habitat to terrestrial fauna ▪ possible spread and establishment of alien invasive species
Residual impacts: ▪ altered topsoil characteristics ▪ altered vegetation composition ▪ altered habitat and resource availability to terrestrial fauna

Activity: Construction of power line to substation		
Environmental Aspect: Removal of vegetation, compaction of soils		
Environmental impact: Loss of vegetation, increase in runoff and erosion, temporary displacement of terrestrial fauna		
	Without mitigation	**With mitigation**
Extent (E)	Local (2)	Local (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Minor (2)	Small (0)
Probability (P)	Definite (5)	Definite (5)
Significance (S = E+D+M)*P	**Medium (40)**	**Low (25)**
Status (positive, neutral	Negative	Neutral

or negative)		
Reversibility	Partially reversible	Partially reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably	
Mitigation: ▪ Place pylons as far as possible on sites where the slope and erosion risk is minimal or negligible ▪ No pylons may be placed within drainage lines or 32 m of such ▪ Riparian areas may not be used as access points to pylon areas ▪ Conduct a search and rescue operation for bulbous plants prior to pylon construction ▪ Prevent spillage of construction material beyond area affected ▪ Monitor the establishment of alien invasive species and remove as soon as detected, whenever possible before regenerative material can be formed		
Cumulative impacts: ▪ Possible erosion of surrounding areas, no major cumulative impact on vegetation expected		
Residual impacts: ▪ Very localised alteration of soil surface characteristics		

Activity: Construction of power line to substation		
Environmental Aspect: Habitat destruction and disturbance during construction of the facilities		
Environmental impact: Avifauna habitat destruction and disturbance		
	Without mitigation	**With mitigation**
Extent (E)	Local (1)	Local (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Minor (2)	Small (2)
Probability (P)	Definite (4)	Definite (4)
Significance (S = E+D+M)*P	**Low (28)**	**Low (28)**
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes – but only partially	

Mitigation: ▪ Before development can continue the regions need to be checked for the presence of bird nesting sites, particularly those of ground nesting species. ▪ Ensure bird-friendly tower designs are implemented to minimise the risk of electrocutions. ▪ Fit overhead power lines with appropriate flappers in areas of sensitivity to increase the visibility thereof to avifauna. ▪ Notes of electrocution and collision events must be sent to a qualified Ornithologist for the recommendation of further mitigation measures if necessary.
Cumulative impacts: ▪ Could be quite substantial if more projects are built in the same area. Collectively these facilities could remove quite a lot of habitat from the area. However on a landscape level this is still not believed to be significant in this area.
Residual impacts: ▪ None

Activity: Construction and operation of substation area		
Environmental Aspect: Removal of vegetation, compaction of soils, creation of runoff zone, possible contamination		
Environmental impact: loss of vegetation, loss of micro-habitats, increased runoff and erosion, possibly altered chemistry of surrounding soils, window of opportunity for the establishment of alien invasive species After decommissioning: altered topsoil characteristics with low moisture infiltration capacity, low niche diversity, and increased runoff and slow plant establishment		
	Without mitigation	**With mitigation**
Extent (E)	Local (3)	Local (2)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Moderate (6)	Low (4)
Probability (P)	Definite (5)	Definite (5)
Significance **(S = E+D+M)*P**	**High (65)**	**Medium (50)**
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Low reversibility	Partially reversible
Irreplaceable loss of resources?	Highly probable	Probable
Can impacts be mitigated?	Reasonably	

Mitigation:

- Keep development as close as possible to existing tracks, infrastructure and other planned developments
- Position in such a way that grid connections from PV arrays and to national grid have minimal crossings over drainage lines, rocky ridges or grassy depressions and can also remain as close as possible to other infrastructure
- Minimise disturbance to footprint area
- Align design to avoid all areas with surface rock and/or high species diversity
- Conduct a thorough search and rescue operation of all footprint areas prior to construction to remove and relocate all species of conservation concern
- 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)
- Remove topsoils and redistribute to mimic the microtopography of the original vegetation to stop erosion
- Remove all succulent and bulbous plants and replant onto redistributed topsoil – prevent increased herbivory of such replanted species by especially duiker and porcupine
- Prevent leakage of oil or other chemicals or pollutants
- Monitor the establishment of alien invasive species and remove as soon as detected, whenever possible *before* regenerative material can be formed
- After decommissioning, remove all foreign material, rip to loosen topsoils, aim to recreate a high surface roughness resembling the initial vegetation, undertake active revegetation

Cumulative impacts:

- possible erosion of areas lower than the access road,
- possible contamination of lower-lying areas,
- possible spread and establishment of alien invasive species to wider areas
- Possible excessive fragmentation and thus reduction of core habitats that may negatively influence species population viability.

Residual impacts:

- altered vegetation composition,
- altered topsoil characteristics,
- very slow recovery of non-herbaceous perennial vegetation

Activity: Construction and operation of workshop area and guard houses
Environmental Aspect: Removal of vegetation, compaction of soils, introduction of pollutants
Environmental impact: Loss of vegetation, increase in runoff and erosion, pollution, loss of faunal habitat and resource availability to terrestrial fauna

	Without mitigation	With mitigation
Extent (E)	Local (4)	Local (2)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Moderate (6)	Minor (2)
Probability (P)	Definite (5)	Definite (5)
Significance (S = E+D+M)*P	**High (70)**	**Medium (40)**
Status (positive, neutral or negative)	Negative	Neutral
Reversibility	Difficult to reverse	Partially reversible
Irreplaceable loss of resources?	Probable	Probable
Can impacts be mitigated?	Reasonably	

Mitigation:

- Avoid placing infrastructure on rocky ridges and outcrops, within 100 m of any drainage line or in the lowest sections of the landscape (apart from drainage lines), restrict to vegetation Association 2 as far as possible
- Limit disturbance to footprint area as far as practically possible – including disturbance to soil
- Implement a comprehensive topsoil management plan as soon as layout plans are finalised and site preparation commences
- Conduct a search and rescue operation for bulbous plants prior to construction
- Prevent spillage of construction material and other pollutants beyond area affected, implement a comprehensive waste management plan for the operation of the facilities
- Rehabilitate and revegetate all areas outside footprint area that have been disturbed immediately after construction
- Monitor adjacent areas for accelerated erosion and mitigate as required
- Monitor the establishment of alien invasive species and remove as soon as detected, whenever possible before regenerative material can be formed

Cumulative impacts:

- possible erosion of adjacent or lower-lying areas
- possible contamination and siltation of drainage lines and lower-lying wetlands
- possible fragmentation of plant populations
- possible alteration of occupancy by terrestrial fauna, reduction of available habitat to terrestrial fauna
- possible spread and establishment of alien invasive species
- Possible erosion of surrounding areas

Residual impacts:

- altered topsoil characteristics
- altered vegetation composition
- altered habitat and resource availability to terrestrial fauna

Implications of the anticipated impacts for the development:

» The proposed photovoltaic facility development on the site may have significant impacts on the ecology of the site and lower-lying wetlands, if mitigation measures are not strictly adhered to

» Potentially significant negative impacts on the ecological environment would be soil degradation issues (erosion, depletion of nutrients) as a result of construction activity and the operation of the facility; possible introduction of alien invasive plants and a long-term (more than 8 months) low or absent vegetation cover after construction. In addition, a loss of niches and specialised habitats for flora and fauna could occur with the removal or significant degradation of large expanses of vegetation. 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 negligent. Currently there was minimal presence of wild animals due to current land use patterns. Animals that may be present are mobile and will move away during construction, possibly resettling after construction. No restricted or specific habitat of vertebrates will be affected by the proposed development; especially if the proposed development remains outside the more sensitive areas.

5.8. Limitations of study

There is a key difference between the approach of the ecological consultant and that of the ecological researcher. In consultancy, judgements have to be made and advice provided that is based on the best available evidence, combined with collective experience and professional opinion. The available evidence may not be especially good, potentially leading to over-simplification of ecological systems and responses, and do contain a considerable deal of uncertainty. This is opposed to ecological research, where evidence needs to be compelling before conclusions are reached and research is published (Hill & Arnold 2012). The best option available to the consulting industry is to push for more research to be conducted to address its questions. However, such research is often of a baseline nature and thus attracts little interest by larger institutions that need to do innovative research to be able to publish and attract the necessary funding. Clients in need of ecological assessments are used to funding such assessments, but are seldom willing to fund further research to monitor the effects of developments. Furthermore, a review to test the accuracy of the predictions of an ecologist following completion of the development is very rarely undertaken, which means the capacity to predict the future is not tested and therefore remains unknown (Hill & Arnold 2012).

Predictions on future changes on ecosystems and populations once a development has happened are seldom straightforward, except in cases of such as the total loss of a habitat to development. However, most development impacts are indirect, subtle, and cumulative or unfold over several years following

construction or commencement of the operation of the development. Whilst a possible mechanism for an impact to occur can usually be identified, the actual likelihood of occurrence and its severity are much harder to describe (Hill & Arnold 2012).

A closely related issue is that of the effectiveness of ecological mitigation which stems from ecological assessments, as well as in response to legal and planning policy requirements for development. Many recommendations may be incorporated into planning conditions or become conditions of protected species licences, but these recommendations are implemented to varying degrees, with most compliance being for the latter category, protected species, because there is a regulatory framework for implementation. What is often missing is the follow-up monitoring and assessment of the mitigation with sufficient scientific rigour or duration to determine whether the mitigation, compensation or enhancement measure has actually worked in the way intended (Hill & Arnold 2012).

6. Discussion and Conclusion

Development will have to be restricted to the grasslands, and it will be important to monitor and mitigate erosion from construction to decommissioning phase. The most important part of mitigation would be the most appropriate site selection and to maintain as dense a perennial herbaceous layer below the development as possible.

Runoff from the proposed development area is channeled via the drainage line into the nearby Modder River and associated downstream water bodies. Due care will thus have to be taken to not only prevent excessive erosion of riparian areas, but also any kind of pollution within the development that could end up in the downstream wetlands.

Several protected and red-data species potentially occur on the site, apart from those already recorded. At the time of the field visit, most grasses just started sprouting, a small number of geophytic species could already be observed, but the herbaceous layer was still poorly developed. Most of the species that just started emerging were too small to be identifiable at the time of the survey. It is thus imperative that a detailed site-walk be undertaken during optimal growing conditions (late November to early February) to enable all potentially rare and protected plant species to be recorded and relocated.

Four vegetation associations could be identified:

» Association 1: The *Searsia erosa – Eragrostis obtusa* shrublands
Sensitivity rating: High

» Association 2: The *Themeda triandra – Chrysocoma ciliata* grasslands
Sensitivity rating: Low

» Association 3: The *Panicum coloratum – Chasmatophyllum musculinum* grasslands
Sensitivity rating: Medium-high

» Association 4: The *Paspalum – Schoenoplectus* species riparian areas
Sensitivity rating: High – No Go Areas

Of the four vegetation associations, Association 2 is the most suitable for the development. Higher-lying portions of Association 3 could be developed, but areas within 100 m of drainage lines must be avoided due to high erosion and associated degradation risks.

Development must be kept off rocky ridges and outcrops (Association 1). However, alien invasive plants on such areas within the development areas must be cleared to avoid their establishment within the development area in coming years.

The riparian areas of vegetation Association 4, as well as lower-lying drainage lines and rivers that were not specifically assessed must be regarded as No Go Areas, and a buffer of the legal 32 m, preferably between 50 and 100 m, maintained between any development and these areas. Access roads to the development must strictly adhere to existing tracks only, the creation of new access roads crossing drainage lines or rivers cannot be ecologically justified.

Several alien invasive plants have been observed on the study site, with more species in close proximity. For all species, there is a very high risk of spread throughout the project area following disturbance. This implies that a detailed Invasive Plant Management Plan will have to be in place prior to commencement of activity and be diligently followed and updated throughout the project cycle up to the decommissioning phase.

Significant impacts on terrestrial vertebrates are not anticipated, if developments are kept within the recommended areas.

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8. Appendix A1: Plant species that have been recorded in the wider area according to the SANBI POSA database

Species	Status
Succulents	
Aloe aristata	1
Aloe grandidentata	1
Anacampseros filamentosa* subsp. *filamentosa	**1**
Anacampseros rufescens	**1**
Brachystelma duplicatum	**Critically Rare, end, 1**
Bulbine abyssinica	
Bulbine frutescens	
Bulbine narcissifolia	
Chasmatophyllum musculinum	2
Chrysanthemoides monilifera subsp. *canescens*	
Cotyledon orbiculata var. *oblonga*	
Cotyledon orbiculata* var. *dactylopsis	
Crassula campestris	
Crassula capitella* subsp. *capitella	
Crassula capitella subsp. *thyrsiflora*	
Crassula lanceolata* subsp. *lanceolata	
Crassula lanceolata subsp. *transvaalensis*	
Crassula nudicaulis* var. *herrei	
Crassula nudicaulis var. *nudicaulis*	
Crassula sarcocaulis subsp. *rupicola*	
Euphorbia caterviflora	**1**
Euphorbia clavarioides	1
Euphorbia clavarioides* var. *truncata	**1**
Euphorbia mauritanica	1
Euphorbia pulvinata	1
Euphorbia rectirama	1
Hereroa glenensis	**2**
Hertia ciliata	

Species	Status
Hertia pallens	
Ipomoea bolusiana	
Ipomoea oblongata	
Ipomoea oenotheroides	
Kalanchoe paniculata	
Mestoklema tuberosum	**2**
Mossia intervallaris	
Pachycarpus rigidus	
Pelargonium aridum	
Pelargonium dolomiticum	
Portulaca oleracea	
Raphionacme hirsuta	1
Sarcostemma viminale	1
Stapelia grandiflora	1
Stoeberia utilis	2
Stomatium mustellinum	**2**
Talinum caffrum	
Trichodiadema pomeridianum	2
Low shrubs	
Abutilon piloso-cinereum	
Acalypha segetalis	
Anthospermum dregei subsp. *dregei*	
Anthospermum rigidum	
Anthospermum rigidum subsp. *pumilum*	
Aptosimum elongatum	
Aptosimum indivisum	
Aptosimum spinescens	
Artemisia afra var. afra	
Asparagus concinnus	
Asparagus cooperi	
Asparagus laricinus	
Asparagus striatus	
Asparagus suaveolens	
Atriplex muelleri	
Atriplex semibaccata	
Barleria rigida	
Chaenostoma halimifolium	

Species	Status
Chrysocoma ciliata	
Cliffortia serpyllifolia	
Clutia pulchella	
Deverra burchellii	
Dichilus gracilis	
Dichilus strictus	
Elephantorrhiza elephantina	
Erica drakensbergensis	1
Erica maesta var. maesta	1
Eriocephalus eximius	
Eriocephalus karooicus	
Eriocephalus tenuifolius	
Erythrina zeyheri	1
Euphorbia epicyparissias	1
Euryops annae	
Euryops empetrifolius	
Euryops subcarnosus subsp. *vulgaris*	
Felicia fascicularis	
Felicia filifolia	
Felicia muricata	
Felicia ovata	
Galenia prostrata	
Galenia pubescens	
Geranium robustum	
Gnidia caffra	
Gnidia capitata	
Gnidia gymnostachya	
Gnidia polycephala	
Gnidia wikstroemiana	
Gomphostigma virgatum	
Hebenstretia dura	
Helichrysum albirosulatum	1
Helichrysum dasycephalum	1
Helichrysum dregeanum	1
Helichrysum pentzioides	1
Helichrysum rosum	1
Helichrysum zeyheri	1
Heliophila suavissima	
Hermannia cuneifolia var. *glabrescens*	
Hermannia geniculata	
Hermannia linearifolia	

Species	Status
Hermannia multiflora	
Hertia kraussii	
Hypertelis salsoloides	
Indigofera cryptantha	
Indigofera filipes	
Indigofera nigromontana	
Jamesbrittenia albiflora	
Jamesbrittenia atropurpurea subsp. *atropurpurea*	
Jamesbrittenia filicaulis	
Jamesbrittenia stricta	
Lantana rugosa	
Lessertia depressa	
Lessertia perennans	
Lotononis divaricata	
Lotononis sericophylla	
Lycium cinereum	
Lycium ferocissimum	
Lycium hirsutum	
Lycium horridum	
Lycium pilifolium	
Lycium schizocalyx	
Melolobium calycinum	
Melolobium candicans	
Melolobium canescens	
Melolobium microphyllum	
Melolobium obcordatum	
Nemesia fruticans	
Nenax microphylla	
Oligomeris dregeana	
Osteospermum spinescens	
Othonna protecta	
Passerina montana	
Pavonia burchellii	
Pegolettia retrofracta	
Pelargonium abrotanifolium	
Pelargonium longicaule	
Peliostomum leucorrhizum	
Pentzia cooperi	
Pentzia globosa	
Pentzia quinquefida	
Pentzia sphaerocephala	
Phymaspermum parvifolium	

Species	Status
Polemannia simplicior	
Polygala ephedroides	
Polygala hottentotta	
Rosenia humilis	
Salsola glabrescens	
Salsola rabieana	
Selago albida	
Selago saxatilis	
Senecio burchellii	
Solanum lichtensteinii	
Solanum supinum	
Solanum tomentosum	
Sphaeralcea bonariensis	
Sutherlandia frutescens	
Sutherlandia microphylla	
Tephrosia capensis var. *capensis*	
Thesium hystrix	
Wahlenbergia albens	
High shrubs and trees	
Acacia karroo	
Acacia tortilis subsp. *heteracantha*	
Anisodontea julii	
Buddleja saligna	
Buddleja salviifolia	
Celtis africana	
Cussonia paniculata subsp. *sinuata*	1
Diospyros austro-africana var. *microphylla*	
Diospyros austro-africana var. *rubriflora*	
Diospyros lycioides subsp. *lycioides*	
Ehretia rigida* subsp. *rigida	
Euclea crispa subsp. *crispa*	
Euclea crispa* subsp. *ovata	
Grewia occidentalis	
Halleria lucida	
Heteromorpha arborescens var. *abyssinica*	
Heteromorpha arborescens	

Species	Status
var. *arborescens*	
Kiggelaria africana	
Leucosidea sericea	
Lycium arenicola	
Melianthus comosus	
Olea europaea subsp. *africana*	1
Osyris lanceolata	
Plumbago auriculata	
Rhamnus prinoides	
Rhigozum obovatum	
Rhoicissus tridentata* subsp. *tridentata	
Rubus ludwigii subsp. *ludwigii*	
Rubus rigidus	
Searsia bolusii	
Searsia burchellii	
Searsia dentata	
Searsia divaricata	
Searsia erosa	
Searsia lancea	
Searsia pyroides	
Searsia tridactyla	
Ziziphus mucronata subsp. *mucronata*	
Herbs and forbs	
Acrotome inflata	
Ajuga ophrydis	
Alectra sessiliflora	
Amaranthus dinteri* subsp. *brevipetiolatus	
Amaranthus dinteri subsp. *dinteri*	
Amaranthus thunbergii	
Ammannia baccifera	
Anchusa capensis	
Anthospermum herbaceum	
Aptosimum procumbens	
Arctotis arctotoides	
Arctotis microcephala	
Arctotis venusta	
Argyrolobium humile	
Argyrolobium molle	

Species	Status
Argyrolobium pauciflorum	
Aristea abyssinica	
Asclepias gibba	1
Asclepias meyeriana	1
Asclepias multicaulis	1
Asparagus asparagoides	
Asplenium adiantum-nigrum	2
Asplenium aethiopicum	2
Asplenium cordatum	2
Asplenium trichomanes subsp. *quadrivalens*	2
Atriplex suberecta	
Barleria macrostegia	
Berkheya discolor	
Berkheya onopordifolia	
Berkheya pinnatifida* subsp. *pinnatifida	
Berkheya pinnatifida subsp. *stobaeoides*	
Blechnum australe	
Blepharis integrifolia	
Bupleurum mundii	
Cerastium capense	
Chaenostoma patrioticum	
Chascanum pinnatifidum	
Cheilanthes eckloniana	
Cheilanthes hirta	
Cheilanthes involuta	
Cheilanthes quadripinnata	
Chenopodium phillipsianum	
Chlorophytum fasciculatum	
Cineraria aspera	
Cineraria erodioides	
Cineraria lyratiformis	
Clematis brachiata	
Cleome gynandra	
Cleome rubella	
Coccinia rehmannii	
Commelina africana var. *barberae*	
Commelina africana var. *krebsiana*	
Commelina africana var. *lancispatha*	

Species	Status
Commelina benghalensis	
Commicarpus pentandrus	
Convolvulus arvensis	
Convolvulus boedeckerianus	
Convolvulus dregeanus	
Convolvulus multifidus	
Convolvulus ocellatus	
Convolvulus sagittatus	
Convolvulus thunbergii	
Conyza podocephala	
Corchorus schimperi	
Cotula australis	
Crabbea acaulis	
Crabbea hirsuta	
Crotalaria distans	
Cucumis myriocarpus subsp. *leptodermis*	
Cucumis myriocarpus subsp. *myriocarpus*	
Cullen tomentosum	
Cynanchum virens	
Cynoglossum austroafricanum	
Cynoglossum hispidum	
Cynoglossum lanceolatum	
Cyphia triphylla	
Denekia capensis	
Dianthus basuticus subsp. *basuticus*	
Dianthus micropetalus	
Diascia capsularis	
Diclis petiolaris	
Dicoma macrocephala	
Dimorphotheca caulescens	
Dimorphotheca zeyheri	
Dolichos angustifolius	
Epilobium capense	
Chamaesyce inaequilatera	
Falkia oblonga	
Fallopia convolvulus	
Felicia petiolata	
Frankenia pulverulenta	
Galenia subcarnosa	
Galium capense subsp. *capense*	

Species	Status
Galium capense subsp. *garipense*	
Galium thunbergianum	
Garuleum pinnatifidum	
Gazania krebsiana subsp. *krebsiana*	
Gazania krebsiana subsp. *serrulata*	
Geigeria filifolia	
Geigeria ornativa	
Gerbera piloselloides	
Gisekia pharnacioides	
Gnaphalium filagopsis	
Gomphocarpus fruticosus	
Gomphocarpus tomentosus	
Haplocarpha scaposa	
Harveya pauciflora	
Harveya pumila	
Hebenstretia dentata	
Helichrysum argyrosphaerum	1
Helichrysum aureum	1
Helichrysum caespititium	1
Helichrysum cerastioides	1
Helichrysum chionosphaerum	1
Helichrysum lineare	1
Helichrysum melanacme	1
Helichrysum nudifolium	1
Helichrysum odoratissimum	1
Helichrysum paronychioides	1
Helichrysum pedunculatum	1
Helichrysum rugulosum	1
Helichrysum rutilans	1
Heliotropium lineare	
Hermannia coccocarpa	
Hermannia comosa	
Hermannia cordata	
Hermannia depressa	
Hermannia erodioides	
Hermannia linnaeoides	
Hermannia oblongifolia	
Hermannia pulverata	
Hibiscus aethiopicus	
Hibiscus pusillus	

Species	Status
Hibiscus trionum	
Hypericum lalandii	
Hypericum wilmsii	
Hypertelis bowkeriana	
Indigastrum argyraeum	
Indigastrum fastigiatum	
Indigofera alternans	
Indigofera evansiana	
Indigofera hedyantha	
Indigofera rhytidocarpa	
Ipomoea obscura	
Jamesbrittenia aurantiaca	
Kedrostis africana	
Kohautia cynanchica	
Lactuca inermis	
Lasiopogon muscoides	
Lasiospermum pedunculare	
Lepidium africanum subsp. *africanum*	
Lepidium africanum subsp. *divaricatum*	
Lepidium schinzii	
Lessertia annularis	
Lessertia pauciflora	
Lessertia stenoloba	
Limeum aethiopicum	
Limeum argute-carinatum	
Limeum sulcatum	
Limeum viscosum	
Linum thunbergii	
Lithospermum cinereum	
Lithospermum hirsutum	
Litogyne gariepina	
Lobelia erinus	
Lobelia thermalis	
Lotononis burchellii	
Lotononis calycina	
Lotononis laxa	
Lotononis listii	
Lotononis pusilla	
Manulea plurirosulata	
Menodora africana	
Merremia verecunda	

Species	Status
Monsonia angustifolia	
Monsonia emarginata	
Nemesia rupicola	
Nidorella anomala	
Nidorella auriculata	
Nidorella resedifolia	
Oncosiphon piluliferum	
Osteospermum muricatum	
Papaver aculeatum	
Pelargonium minimum	
Pellaea calomelanos	
Pharnaceum detonsum	
Phyllanthus maderaspatensis	
Phyllanthus parvulus	
Plantago lanceolata	
Platycarphella parvifolia	
Pleopeltis macrocarpa	
Pollichia campestris	
Polygala gracilenta	
Polygala gymnoclada	
Polygala rehmannii	
Polygonum plebeium	
Polystichum monticola	
Psammotropha mucronata	
Psammotropha myriantha	
Pseudognaphalium oligandrum	
Pseudognaphalium undulatum	
Pteris cretica	
Pulicaria scabra	
Rhynchosia adenodes	
Rhynchosia caribaea	
Rhynchosia confusa	
Rhynchosia hirsuta	
Rhynchosia minima	
Rhynchosia nervosa	
Rhynchosia totta	
Riocreuxia burchellii	
Rubia cordifolia subsp. *conotricha*	
Rumex lanceolatus	
Salvia repens	
Salvia runcinata	
Salvia verbenaca	

Species	Status
Scabiosa columbaria	
Schistostephium crataegifolium	
Sebaea compacta	
Sebaea filiformis	
Sebaea leiostyla	
Sebaea pentandra var. *burchellii*	
Sebaea pentandra var. *pentandra*	
Seddera capensis	
Selaginella dregei	
Selago albomarginata	
Selago densiflora	
Senecio achilleifolius	
Senecio harveianus	
Senecio hastatus	
Senecio hieracioides	
Senecio inaequidens	
Senecio isatideus	
Senecio laevigatus* var. *integrifolius	
Senecio laevigatus* var. *laevigatus	
Sesamum triphyllum	
Sida dregei	
Silene burchellii	
Silene undulata	
Sisymbrium capense	
Solanum retroflexum	
Sonchus dregeanus	
Stachys aethiopica	
Stachys hyssopoides	
Stachys spathulata	
Stenostelma capense	
Stenostelma corniculatum	
Striga bilabiata	
Striga elegans	
Tephrosia capensis	
Tephrosia longipes	
Tephrosia purpurea subsp. *leptostachya*	
Teucrium trifidum	
Thalictrum minus	

Species	Status
Thesium spartioides	
Trifolium africanum	
Trigonella anguina	
Tripteris aghillana	
Troglophyton capillaceum subsp. *capillaceum*	
Troglophyton capillaceum subsp. *diffusum*	
Ursinia nana	
Vahlia capensis	
Viscum rotundifolium	
Wahlenbergia androsacea	
Wahlenbergia denticulata var. *denticulata*	
Wahlenbergia denticulata* var. *transvaalensis	
Wahlenbergia paniculata	
Wahlenbergia undulata	
Zaluzianskya karrooica	
Zaluzianskya peduncularis	
Zaluzianskya schmitziae	
Geophytes	
Eulophia hians var. *nutans*	1
Eulophia ovalis var. *ovalis*	1
Gethyllis transkarooica	1
Gladiolus longicollis subsp. *longicollis*	1
Gladiolus permeabilis subsp. *edulis*	1
Habenaria epipactidea	2
Haemanthus humilis subsp. *humilis*	2
Hesperantha longituba	
Hypoxis acuminata	2
Hypoxis angustifolia var. *angustifolia*	2
Hypoxis angustifolia var. *buchananii*	2
Hypoxis argentea var. *argentea*	2
Hypoxis argentea var. *sericea*	2
Hypoxis filiformis	2
Hypoxis hemerocallidea	**Declining 2**
Hypoxis rigidula var. *rigidula*	2

Species	Status
Ledebouria apertiflora	
Ledebouria luteola	
Massonia jasminiflora	
Moraea pallida	2
Moraea simulans	2
Moraea stricta	2
Nerine laticoma	1
Ophioglossum polyphyllum	
Ornithogalum tenuifolium subsp. *tenuifolium*	
Oxalis depressa	
Oxalis smithiana	
Pelargonium sidoides	**Declining,**
Schizocarphus nervosus	
Strumaria tenella subsp. *orientalis*	2
Trachyandra asperata var. *asperata*	
Trachyandra asperata var. *basutoensis*	
Trachyandra asperata var. *macowanii*	
Trachyandra saltii var. *saltii*	
Tulbaghia acutiloba	2
Tulbaghia leucantha	2
Cyperoids	
Abildgaardia ovata	
Bulbostylis humilis	
Cyperus bellus	
Cyperus capensis	
Cyperus difformis	
Cyperus esculentus	
Cyperus indecorus var. *decurvatus*	
Cyperus obtusiflorus var. *flavissimus*	
Cyperus parvinux	
Cyperus squarrosus	
Cyperus usitatus	
Ficinia gracilis	
Kyllinga alata	
Kyllinga alba	
Schoenoxiphium perdensum	

Species	Status
Schoenoxiphium rufum	
Scirpoides dioecus	
Grasses	
Agrostis lachnantha	
Andropogon appendiculatus	
Andropogon schirensis	
Anthephora pubescens	
Aristida adscensionis	
Aristida bipartita	
Aristida canescens subsp. *canescens*	
Aristida congesta subsp. *barbicollis*	
Aristida congesta subsp. *congesta*	
Aristida diffusa subsp. *burkei*	
Aristida junciformis subsp. *junciformis*	
Aristida meridionalis	
Aristida vestita	
Brachiaria eruciformis	
Brachiaria glomerata	
Brachiaria marlothii	
Brachiaria serrata	
Chloris pycnothrix	
Chloris virgata	
Cymbopogon dieterlenii	
Cynodon bradleyi	
Cynodon dactylon	
Cynodon incompletus	
Cynodon transvaalensis	
Dactyloctenium australe	
Digitaria argyrograpta	
Digitaria eriantha	
Digitaria tricholaenoides	
Ehrharta erecta var. *natalensis*	
Eleusine coracana subsp. *africana*	
Elionurus muticus	
Enneapogon cenchroides	
Enneapogon scoparius	
Eragrostis biflora	

Species	Status
Eragrostis capensis	
Eragrostis chloromelas	
Eragrostis cilianensis	
Eragrostis curvula	
Eragrostis echinochloidea	
Eragrostis gummiflua	
Eragrostis lehmanniana	
Eragrostis micrantha	
Eragrostis nindensis	
Eragrostis obtusa	
Eragrostis pallens	
Eragrostis plana	
Eragrostis planiculmis	
Eragrostis procumbens	
Eragrostis racemosa	
Eragrostis remotiflora	
Eragrostis stapfii	
Eragrostis superba	
Eragrostis trichophora	
Eragrostis truncata	
Eustachys paspaloides	
Festuca scabra	
Fingerhuthia africana	
Fingerhuthia sesleriiformis	
Harpochloa falx	
Helictotrichon turgidulum	
Heteropogon contortus	
Hordeum capense	
Hyparrhenia anamesa	
Hyparrhenia dregeana	
Hyparrhenia hirta	
Koeleria capensis	
Melica decumbens	
Melica racemosa	
Melinis nerviglumis	
Melinis repens subsp. *repens*	
Microchloa caffra	
Microchloa kunthii	
Miscanthus capensis	
Oropetium capense	
Panicum arcurameum	
Panicum coloratum	

Species	Status
Panicum deustum	
Panicum maximum	
Panicum schinzii	
Panicum stapfianum	
Paspalum distichum	
Pennisetum sphacelatum	
Pennisetum unisetum	
Pentaschistis airoides subsp. *airoides*	
Pogonarthria squarrosa	
Schismus barbatus	
Setaria incrassata	
Setaria nigrirostris	
Setaria pumila	
Setaria sphacelata var. *sphacelata*	
Setaria sphacelata var. *torta*	
Setaria verticillata	
Sorghum bicolor subsp. *drummondii*	

Species	Status
Sporobolus acinifolius	
Sporobolus coromandelianus	
Sporobolus discosporus	
Sporobolus fimbriatus	
Sporobolus ioclados	
Sporobolus ludwigii	
Stipagrostis uniplumis var. *uniplumis*	
Stipagrostis zeyheri subsp. *sericans*	
Tetrachne dregei	
Themeda triandra	
Tragus berteronianus	
Tragus koelerioides	
Tragus racemosus	
Trichoneura grandiglumis	
Triraphis andropogonoides	
Triraphis purpurea	
Urochloa panicoides	

Note: use of colours and symbols are explained under section 4.1.

9. Appendix A2: Vertebrate species that have been recorded in the wider area

Lists according to the ADU and SANBI database and Apps (2000)

Common Name	Species Name	Status
Amphibians		
Guttural Toad	*Amietophrynus gutturalis*	
Ranger's Toad or Raucous Toad	*Amietophrynus rangeri*	
Pygmy Toad; African Dwarf Toad	*Poyntonophrynus vertebralis*	
Karoo Toad; Gariep Toad	*Vandijkophrynus gariepensis*	
Bubbling Kassina	*Kassina senegalensis*	
Weale's Frog	*Semnodactylus wealii*	
Natal River Frog	*Phrynobatrachus natalensis*	
African clawed toad, Platanna	*Xenopus laevis*	
Common or Angola River Frog	*Amietia angolensis*	
Cape River Frog	*Amietia fuscigula*	
Boettger's Caco	*Cacosternum boettgeri*	
Giant Bullfrog	*Pyxicephalus adspersus*	
Gray's Stream Frog	*Strongylopus grayii*	
Tremelo Sand Frog	*Tomopterna cryptotis*	
Tandy's Sand Frog	*Tomopterna tandyi*	
Chelonia: Tortoises and terrapins		
Marsh Terrapin	*Pelomedusa subrufa*	1
Greater Padloper	***Homopus femoralis***	**1, end**
Serrated Tent Tortoise	*Psammobates oculifer*	1
Leopard Tortoise	*Stigmochelys pardalis*	1
Squamata: Snakes (Serpentes)		
Black-headed Centipede-eater	*Aparallactus capensis*	1
Bibron's Stiletto Snake	*Atractaspis bibronii*	1
Striped Harlequin Snake	***Homoroselaps dorsalis***	**1, Near Threatened, end**
Bicoloured Quill-snouted Snake	*Xenocalamus bicolor* subsp *bicolor*	1
Brown House Snake	*Boaedon capensis*	1
Red-lipped Snake	*Crotaphopeltis hotamboeia*	1
Rhombic Egg-eater	*Dasypeltis scabra*	1

Common Name	Species Name	Status
South African Slug-eater	***Duberria lutrix* subsp *lutrix***	**1, end**
Aurora House Snake	***Lamprophis aurora***	**1, end**
Spotted House Snake	*Lamprophis guttatus*	1
Brown Water Snake	*Lycodonomorphus rufulus*	1
Cape Wolf Snake	*Lycophidion capense* subsp *capense*	1
Sundevall's Shovel-snout	*Prosymna sundevallii*	1
Cross-marked Grass Snake	*Psammophis crucifer*	1
Karoo Sand Snake	*Psammophis notostictus*	1
Fork-marked Sand Snake	*Psammophis trinasalis*	1
Spotted Grass Snake	*Psammophylax rhombeatus* subsp *rhombeatus*	**1**
Striped Grass Snake	*Psammophylax tritaeniatus*	**1**
Mole Snake	*Pseudaspis cana*	1
Highveld Garter Snake	*Elapsoidea sundevallii* subsp *media*	1
Rinkhals	*Hemachatus haemachatus*	1
Cape Cobra	*Naja nivea*	1
Eastern Thread Snake	*Leptotyphlops scutifrons* subsp *conjunctus*	1
Peters' Thread Snake	*Leptotyphlops scutifrons* subsp *scutifrons*	1
Delalande's Beaked Blind Snake	*Rhinotyphlops lalandei*	1
Puff Adder	*Bitis arietans* subsp *arietans*	1
Squamata: other than snakes		
Gekkonidae (geckos)		
Bibron's Gecko	*Chondrodactylus bibronii*	1
Common Tropical House Gecko	*Hemidactylus mabouia*	1
Common Dwarf Gecko	*Lygodactylus capensis* subsp *capensis*	1
Cape Gecko	*Pachydactylus capensis*	1
Marico Gecko	***Pachydactylus mariquensis***	**1, end**
Scincidae (skinks)		
Thin-tailed Legless Skink	***Acontias gracilicauda***	**1, end**
Wahlberg's Snake-eyed Skink	*Afroablepharus wahlbergii*	1
Cape Skink	*Trachylepis capensis*	1
Speckled Rock Skink	*Trachylepis punctatissima*	1

Common Name	Species Name	Status
Speckled Sand Skink	*Trachylepis punctulata*	1
Variable Skink	*Trachylepis varia*	1
Cordylidae (girdled lizards)		
Karoo Girdled Lizard	*Karusasaurus polyzonus*	1
Common Crag Lizard	***Pseudocordylus melanotus* subsp *melanotus***	**end**
Amphisbaenidae (worm lizards)		
Cape Worm Lizard	*Monopeltis capensis*	1
Gerrhosauridae (plated lizards)		
Yellow-throated Plated Lizard	*Gerrhosaurus flavigularis*	1
Lacertidae (lacertids, wall lizards)		
Holub's Sandveld Lizard	*Nucras holubi*	1
Spotted Sand Lizard	***Pedioplanis lineoocellata***	**1, end**
Chamaeleonidae (chameleons)		
Eastern Cape Dwarf Chameleon	***Bradypodion ventrale***	**1, end**
Common Flap-neck Chameleon	*Chamaeleo dilepis* subsp *dilepis*	1
Agamidae (agamas)		
Distant's Ground Agama	*Agama aculeata* subsp *distanti*	**1, end**
Southern Rock Agama	*Agama atra*	**1**
Varanidae (monitors)		
Rock Monitor	*Varanus albigularis* subsp *albigularis*	1
Water Monitor	*Varanus niloticus*	1
Aves - Birds		
Lesser Swamp-Warbler	*Acrocephalus gracilirostris*	1
Common Sandpiper	*Actitis hypoleucos*	1
Malachite Kingfisher	*Alcedo cristata*	1
Egyptian Goose	*Alopochen aegyptiaca*	2

Common Name	Species Name	Status
Red-headed Finch	*Amadina erythrocephala*	2
Cape Teal	*Anas capensis*	1
Red-billed Teal	*Anas erythrorhyncha*	1
Hottentot Teal	*Anas hottentota*	1
Cape Shoveler	*Anas smithii*	1
African Black Duck	*Anas sparsa*	1
Yellow-billed Duck	*Anas undulata*	2
African Darter	*Anhinga rufa*	1
African Pipit	*Anthus cinnamomeus*	1
African Rock Pipit	*Anthus crenatus*	1
Plain-backed Pipit	*Anthus leucophrys*	1
Long-billed Pipit	*Anthus similis*	1
Buffy Pipit	*Anthus vaalensis*	1
Little Swift	*Apus affinis*	1
Common Swift	*Apus apus*	1
African Black Swift	*Apus barbatus*	1
White-rumped Swift	*Apus caffer*	1
White-rumped Swift	*Apus horus*	1
Tawny Eagle	*Aquila rapax*	1
Verreaux's Eagle	*Aquila verreauxii*	1
Grey Heron	*Ardea cinerea*	1
Goliath Heron	*Ardea goliath*	1
Black-headed Heron	*Ardea melanocephala*	1
Squacco Heron	*Ardeola ralloides*	1
Kori Bustard	***Ardeotis kori***	**1, Vulnerable, NEMA: BA**
Marsh Owl	*Asio capensis*	1
Pririt Batis	*Batis pririt*	1
Hadeda Ibis	*Bostrychia hagedash*	1
Little Rush-Warbler	*Bradypterus baboecala*	1
Spotted Eagle-Owl	*Bubo africanus*	1
Cattle Egret	*Bubulcus ibis*	1
Spotted Thick-knee	*Burhinus capensis*	1
Jackal Buzzard	*Buteo rufofuscus*	1
Steppe Buzzard	*Buteo vulpinus*	1

Common Name	Species Name	Status
Red-capped Lark	*Calandrella cinerea*	1
Sabota Lark	*Calendulauda sabota*	1
Curlew Sandpiper	*Calidris ferruginea*	1
Little Stint	*Calidris minuta*	1
Rufous-cheeked Nightjar	*Caprimulgus rufigena*	1
Burchell's Coucal	*Centropus burchellii*	1
Familiar Chat	*Cercomela familiaris*	1
Sickle-winged Chat	*Cercomela sinuata*	1
Karoo Scrub-Robin	*Cercotrichas coryphoeus*	1
Kalahari Scrub-Robin	*Cercotrichas paena*	1
Cape Long-billed Lark	*Certhilauda curvirostris*	1
Pied Kingfisher	*Ceryle rudis*	1
Common Ringed Plover	*Charadrius hiaticula*	1
Kittlitz's Plover	*Charadrius pecuarius*	1
Three-banded Plover	*Charadrius tricollaris*	1
Spike-heeled Lark	*Chersomanes albofasciata*	1
Whiskered Tern	*Chlidonias hybrida*	1
White-winged Tern	*Chlidonias leucopterus*	1
Diderick Cuckoo	*Chrysococcyx caprius*	1
White Stork	*Ciconia ciconia*	1
Black Stork	*Ciconia nigra*	1
White-bellied Sunbird	*Cinnyris talatala*	1
Black Harrier	*Circus maurus*	1
African Marsh-Harrier	*Circus ranivorus*	1
Desert Cisticola	*Cisticola aridulus*	1
Wing-snapping Cisticola	*Cisticola ayresii*	1
Neddicky	*Cisticola fulvicapilla*	1
Zitting Cisticola	*Cisticola juncidis*	1
Wailing Cisticola	*Cisticola lais*	1
Cloud Cisticola	*Cisticola textrix*	1
Levaillant's Cisticola	*Cisticola tinniens*	1
Great Spotted Cuckoo	*Clamator glandarius*	1
Jacobin Cuckoo	*Clamator jacobinus*	1
African Olive-pigeon	*Columba arquatrix*	1
Speckled Pigeon	*Columba guinea*	2

Common Name	Species Name	Status
Rock Dove	*Columba livia*	1
European Roller	*Coracias garrulus*	1
White-necked Raven	*Corvus albicollis*	1
Cape Robin-Chat	*Cossypha caffra*	1
Common Quail	*Coturnix coturnix*	1
Wattled Starling	*Creatophora cinerea*	1
White-throated Canary	*Crithagra albogularis*	1
Black-throated Canary	*Crithagra atrogularis*	1
Yellow Canary	*Crithagra flaviventris*	1
Red-chested Cuckoo	*Cuculus solitarius*	1
Burchell's Courser	*Cursorius rufus*	1
Temminck's Courser	*Cursorius temminckii*	1
White-faced Duck	*Dendrocygna viduata*	2
Cardinal Woodpecker	*Dendropicos fuscescens*	1
Great Egret	*Egretta alba*	1
Little Egret	*Egretta garzetta*	1
Yellow-billed Egret	*Egretta intermedia*	1
Black-shouldered Kite	*Elanus caeruleus*	1
Cape Bunting	*Emberiza capensis*	1
Golden-breasted Bunting	*Emberiza flaviventris*	1
Lark-like Bunting	*Emberiza impetuani*	1
Cinnamon-breasted Bunting	*Emberiza tahapisi*	1
Yellow-bellied Eremomela	*Eremomela icteropygialis*	1
Chestnut-backed Sparrowlark	*Eremopterix leucotis*	1
Grey-backed Sparrowlark	*Eremopterix verticalis*	1
Common Waxbill	*Estrilda astrild*	1
Yellow-crowned Bishop	*Euplectes afer*	1
Long-tailed Widowbird	*Euplectes progne*	1
Karoo Korhaan	*Eupodotis vigorsii*	1
Lanner Falcon	*Falco biarmicus*	1
Lesser Kestrel	***Falco naumanni***	**1, Vulnerable, NEMA: BA**
Rock Kestrel	*Falco rupicolis*	1
Greater Kestrel	*Falco rupicoloides*	1
Red-Knobbed Coot	*Fulica cristata*	2

Common Name	Species Name	Status
Large-billed Lark	*Galerida magnirostris*	1
African Snipe	*Gallinago nigripennis*	1
Common Moorhen	*Gallinula chloropus*	1
Ground Woodpecker	*Geocolaptes olivaceus*	1
Bald Ibis	***Geronticus calvus***	**1, Vulnerable, NEMA: BA**
Cape Vulture	***Gyps coprotheres***	**1, Endangered, NEMA: BA**
African Fish-Eagle	*Haliaeetus vocifer*	1
Black-winged Stilt	*Himantopus himantopus*	1
White-throated Swallow	*Hirundo albigularis*	1
Greater Striped Swallow	*Hirundo cucullata*	1
Pearl-breasted Swallow	*Hirundo dimidiata*	1
Rock Martin	*Hirundo fuligula*	1
Barn Swallow	*Hirundo rustica*	1
Red-breasted Swallow	*Hirundo semirufa*	1
South African Cliff-Swallow	*Hirundo spilodera*	1
Greater Honeyguide	*Indicator indicator*	1
Lesser Honeyguide	*Indicator minor*	1
Red-throated Wryneck	*Jynx ruficollis*	1
Cape Glossy Starling	*Lamprotornis nitens*	1
Common Fiscal	*Lanius collaris*	1
Red-backed Shrike	*Lanius collurio*	1
Cape Longclaw	*Macronyx capensis*	1
Rufous-eared Warbler	*Malcorus pectoralis*	1
Giant Kingfisher	*Megaceryle maximus*	1
Southern Black Flycatcher	*Melaenornis pammelaina*	1
Southern Pale Chanting Goshawk	*Melierax canorus*	1
European Bee-eater	*Merops apiaster*	1
White-fronted Bee-eater	*Merops bullockoides*	1
Swallow-tailed Bee-eater	*Merops hirundineus*	1
Rufous-naped Lark	*Mirafra africana*	1
Cape Clapper Lark	*Mirafra apiata*	1
Melodious Lark	*Mirafra cheniana*	1
Short-toed Rock-Thrush	*Monticola brevipes*	1
Sentinel Rock-Thrush	*Monticola explorator*	1

Common Name	Species Name	Status
Cape Rock-Thrush	*Monticola rupestris*	1
African Pied Wagtail	*Motacilla aguimp*	1
Cape Wagtail	*Motacilla capensis*	1
Spotted Flycatcher	*Muscicapa striata*	1
Yellowbilled Stork	*Mycteria ibis*	1
Anteating Chat	*Myrmecocichla formicivora*	1
Malachite Sunbird	*Nectarinia famosa*	1
Ludwig's Bustard	***Neotis ludwigii***	**1, Vulnerable, NEMA: BA**
Southern Pochard	*Netta erythrophthalma*	1
Helmeted guineafowl	*Numida meleagris*	2
Black-crowned Night-Heron	*Nycticorax nycticorax*	1
Namaqua Dove	*Oena capensis*	1
Mountain Wheatear	*Oenanthe monticola*	1
Capped Wheatear	*Oenanthe pileata*	1
African Quailfinch	*Ortygospiza atricollis*	1
Osprey	*Pandion haliaetus*	1
Layard's Tit-Babbler	*Parisoma layardi*	1
Chestnut-vented Tit-Babbler	*Parisoma subcaeruleum*	1
Ashy Tit	*Parus cinerascens*	1
Southern Grey-headed Sparrow	*Passer diffusus*	1
Reed Cormorant	*Phalacrocorax africanus*	1
White-breasted Cormorant	*Phalacrocorax lucidus*	1
Greater Flamingo	*Phoenicopterus ruber*	1
Green Wood-Hoopoe	*Phoeniculus purpureus*	1
Willow Warbler	*Phylloscopus trochilus*	1
African Spoonbill	*Platalea alba*	1
Spur-winged Goose	*Plectropterus gambensis*	2
Glossy Ibis	*Plegadis falcinellus*	1
White-browed Sparrow-Weaver	*Plocepasser mahali*	1
Great Crested Grebe	*Podiceps cristatus*	1
Martial Eagle	***Polemaetus bellicosus***	**1, Vulnerable, NEMA: BA**
Black-chested Prinia	*Prinia flavicans*	1
Drakensberg Prinia	*Prinia hypoxantha*	1
Natal Spurfowl	*Pternistis natalensis*	1

Common Name	Species Name	Status
Swainson's Spurfowl	*Pternistis swainsonii*	2
Namaqua Sandgrouse	*Pterocles namaqua*	1
Green-winged Pytilia	*Pytilia melba*	1
Pied Avocet	*Recurvirostra avosetta*	1
Scimitar-bill Hoopoe	*Rhinopomastus cyanomelas*	1
Double-banded Courser	*Rhinoptilus africanus*	1
Three-banded Courser	*Riparia cincta*	1
Brown-throated Martin	*Riparia paludicola*	1
Sand Martin	*Riparia riparia*	1
Secretarybird	*Sagittarius serpentarius*	1
African Stonechat	*Saxicola torquatus*	1
Grey-wing Francolin	*Scleroptila africanus*	2
Red-wing Francolin	*Scleroptila levaillantii*	1
Orange River Francolin	*Scleroptila levaillantoides*	2
Hamerkop	*Scopus umbretta*	1
Cape Canary	*Serinus canicollis*	1
Fiscal Flycatcher	*Sigelus silens*	1
Cape Grassbird	*Sphenoeacus afer*	1
Pink-billed Lark	*Spizocorys conirostris*	1
Scaly-feathered Finch	*Sporopipes squamifrons*	1
Pied Starling	*Spreo bicolor*	1
Fairy Flycatcher	*Stenostira scita*	1
Cape Turtle-Dove	*Streptopelia capicola*	2
Red-eyed Turtle-Dove	*Streptopelia semitorquata*	2
Laughing Dove	*Streptopelia senegalensis*	2
Ostrich	*Struthio camelus*	1
Dickson’s Brown	*Stygionympha irrorata*	1
Long-billed Crombec	*Sylvietta rufescens*	1
Little Grebe	*Tachybaptus ruficollis*	1
Alpine Swift	*Tachymarptis melba*	1
South African Shelduck	*Tadorna cana*	2
Brown-crowned Tchagra	*Tchagra australis*	1
Bokmakierie	*Telophorus zeylonus*	1
Mocking Cliff-Chat	*Thamnolaea cinnamomeiventris*	1
African Sacred Ibis	*Threskiornis aethiopicus*	1

Common Name	Species Name	Status
Crested Barbet	*Trachyphonus vaillantii*	1
Acacia Pied Barbet	*Tricholaema leucomelas*	1
Wood Sandpiper	*Tringa glareola*	1
Common Greenshank	*Tringa nebularia*	1
Marsh Sandpiper	*Tringa stagnatilis*	1
Olive Thrush	*Turdus olivaceus*	1
Barn Owl	*Tyto alba*	1
African Grass-Owl	***Tyto capensis***	**1, Vulnerable, NEMA: BA**
African Hoopoe	*Upupa africana*	1
Blue Waxbill	*Uraeginthus angolensis*	1
Blacksmith Lapwing	*Vanellus armatus*	1
Crowned Lapwing	*Vanellus coronatus*	1
Pin-tailed Whydah	*Vidua macroura*	1
Orange River White-eye	*Zosterops pallidus*	1
Chiroptera - Bats		
Lesueur's Wing-gland Bat	*Cistugo lesueuri*	
Geoffroy's Horseshoe Bat	*Rhinolophus clivosus*	
Insectivora - Insectivores		
South African Hedgehog	*Atelerix frontalis*	1
Reddish-grey Musk Shrew	*Crocidura cyanea*	
Tiny Musk Shrew	*Crocidura fuscomurina*	
Maquassie Musk Shrew	*Crocidura maquassiensis*	
Swamp Musk Shrew	*Crocidura mariquensis*	
Lesser Grey-brown Musk Shrew	*Crocidura silacea*	
Least Dwarf Shrew	*Suncus infinitesimus*	
Lesser Dwarf Shrew	*Suncus varilla*	
Macroscelidae – Elephant Shrews		
Rock Elephant-shrew	*Elephantulus myurus*	
Rodentia - Rodents		
Red Veld Rat	*Aethomys chrysophilus*	

Common Name	Species Name	Status
Tete Veld Rat	*Aethomys ineptus*	
Namaqua Rock Mouse	*Aethomys namaquensis*	
Common Molerat	*Cryptomys hottentotus*	
Grey Climbing Mouse	*Dendromus melanotis*	
Short-tailed Gerbil	*Desmodillus auricularis*	
Woodland Dormouse	*Graphiurus murinus*	
Cape Porcupine	*Hystrix africaeaustralis*	
Large-eared Mouse	*Malacothrix typica*	
Natal Multimammate Mouse	*Mastomys natalensis*	
Pygmy Mouse	*Mus minutoides*	
White-tailed Rat	*Mystromys albicaudatus*	
Vlei Rat	*Otomys irroratus*	
Saunder's Vlei Rat	*Otomys saundersiae*	
Springhare	*Pedetes capensis*	
Striped Mouse	*Rhabdomys pumilio*	
Highveld Gerbil	*Tatera brantsii*	
Bushveld Gerbil	*Tatera leucogaster*	
Cape Ground Squirrel	*Xerus inauris*	
Lagomorpha – Rabbits and Hares		
Desert/Cape Hare	*Lepus capensis*	2
Savannah/Scrub Hare	*Lepus saxatilis*	2
Hyracoidea - Dassies		
Rock Dassie	*Procavia capensis*	
Artiodactyla – even-toed ungulates		
Springbuck	*Antidorcas marsupialis*	2
Black Wildebeest	*Connochaetes gnou*	1
Blesbuck	*Damaliscus pygargus phillipsi*	2
Klipspringer	*Oreotragus oreotragus*	
Steenbuck	*Raphicerus campestris*	2
Common Duiker	*Sylvicapra grimmia*	2
Carnivora - Carnivores		

Common Name	Species Name	Status
African Clawless Otter	*Aonyx capensis*	1
Marsh Mongoose	*Atilax paludinosus*	1
Yellow Mongoose	*Cynictis penicillata*	1
Black-footed Cat	*Felis nigripes*	1
African Wild Cat	*Felis silvestris*	1
Small Grey Mongoose	*Galerella pulverulenta*	1
Slender Mongoose	*Galerella sanguinea*	1
Small-spotted Genet	*Genetta genetta*	1
White-tailed Mongoose	*Ichneumia albicauda*	1
Striped Polecat	*Ictonyx striatus*	1
Spotted-necked Otter	*Lutra maculicollis*	1
Bat-eared Fox	*Otocyon megalotis*	1
Suricate	*Suricata suricatta*	1
Cape Fox	*Vulpes chama*	1
Tubilidentata - Aardvark		
Antbear / Aardvark	*Orycteropus afer*	1

Note: use of colours and symbols are explained under section 4.2.

10. Appendix B: Ecological Environmental Management Plan: Sannaspos Solar Energy Facility

10.1. Design Phase

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

Soils in the study area and beyond are highly erodible, and hence erosion of fields and water courses throughout the Free State is of major concern. Erosion can mostly be prevented by an intact, high-cover grass layer. Currently it is difficult to predict how the local vegetation, adapted to high levels of irradiance, will respond to the shading of the PV arrays. The development will thus have to be designed and positioned in a way that will minimise the risk of accelerated erosion within the development, and avoid degradation of drainage lines within the project area and associated degradation of down-stream wetlands.

Project Component/s	» PV Array » Grid connection and associated servitudes » Access roads » Workshop and guard houses
Potential Impact	» Placement that degrades the environment unnecessarily, particularly with respect to habitat destruction, loss of indigenous flora, drainage lines, and erosion.
Activities/Risk Sources	» Positioning of solar components and internal access routes » Positioning of workshop and guard houses » Alignment of power lines and servitudes » Alignment of access roads to development
Mitigation: Target/Objective	» To position and align the proposed infrastructure to be the most environmentally compatible option » Ecological sensitivities are taken into consideration and avoided as far as possible, thereby mitigating potential impacts

Mitigation: Action/Control	Responsibility	Timeframe
Undertake pre-construction surveys for protected flora » Such surveys need to be undertaken during the optimal growing season (December to February) to ensure that all species of conservation concern can be detected	Specialist	Design review phase
Obtain permits for protected plant removal and relocation prior to commencement of activity in an area	Developer	Pre-construction

Mitigation: Action/Control	Responsibility	Timeframe
Use design-level mitigation measures recommended in respect of habitat and ecosystem intactness and 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 throughout, especially where drainage lines/rivers need to be crossed to gain access to the site » Sites for storing, mixing, and handling introduced materials, including all machinery, must be placed in an ecologically least sensitive area. Such sites must be clearly indicated in site plans and method statements and strictly adhered to. » Volumes of topsoil and subsoil that will have to be removed for the development must be determined in the design phase » Handling of topsoils and subsoils must be outlined and adequate storage areas included in the final layout plan o Topsoils comprise the upper 30 cm of uncultivated soils only, and may not be stored higher than 1 m o Storage of topsoils must be limited to 6 months; alternatively a detailed topsoil storage management plan must be followed o Management and handling of topsoil should be tailored to optimise the viability of the soil seed bank	Developer	Prior to submission 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 project area as part of the final design of the project » Areas where vegetation will be kept intact or a dense grass layer will be re-established immediately after construction as part of the stormwater and erosion management plan must be indicated in the final layout plans	Developer	Design phase

Performance Indicator	» Grid connection and road alignments meet ecological objectives.

	» Solar components and access road alignments meet ecological objectives » Ecosystem fragmentation is kept to a minimum » No accelerated erosion as a result of the development
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 construction.

10.2. Construction and Operational Phase

OBJECTIVE: Environmentally sensitive location of construction equipment camps on site

It is expected that all construction workers will be accommodated within existing accommodation in nearby townships as far as possible. No construction workers will be accommodated on site. Construction equipment may need to be stored at an appropriate location on the site for the duration of the construction period.

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
Activities/Risk Sources	Vegetation clearing and levelling of equipment storage area/s; and Access to and from the equipment storage area/s.
Mitigation: Target/Objective	To minimise impacts on biophysical environment; and To limit equipment storage to within the demarcated site.

Mitigation: Action/Control	Responsibility	Timeframe
The location of the construction equipment camp will take cognisance of any ecologically sensitive areas identified. The location of this construction equipment camp shall be approved by the project ECO.	Contractor	Pre-construction
No temporary site camps will be allowed outside the	Contractor	Contract

Mitigation: Action/Control	Responsibility	Timeframe
footprint of the development area.		duration
As far as possible, minimise vegetation clearing and levelling for equipment storage areas.	Contractor	Erection: Site establishment Maintenance: contract duration
Rehabilitate and revegetate all disturbed areas at the construction equipment camp as soon as construction is complete within an area.	Contractor	Duration of Contract

Performance Indicator	» No visible erosion scars once construction in an area is completed. » No claims regarding damage due to unauthorised removal of vegetation. » All damaged areas successfully rehabilitated one year after completion. » No damage to drainage lines and/or riverine areas. » Appropriate waste management.
Monitoring	» Regular audits of the construction camps and areas of construction on site. » 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.

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

Prior to any earthworks (including road construction or upgrading) 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 (December to February) along the entire footprint area (on foot).

Project Component/s	Project components affecting the objective: » PV Array » Grid connection and associated servitudes » Workshop and guard houses » Access roads
Potential Impact	» Substantially increased loss of species of conservation concern and other natural vegetation at construction phase and waste of on-site plant resources, and lack of locally sourced material for rehabilitation of disturbed areas;

	» Increased cost of having to buy in material for rehabilitation » Increased risk and/or occurrence of accelerated erosion
Activities/Risk Sources	» Construction related loss and damage to remaining natural vegetation via heavy machinery, etc.
Mitigation: Target/Objective	» Rescue, maintenance and subsequent replanting of at least 70% of the natural vegetation in all development footprints within any areas of natural vegetation on site

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Ecological footprint investigation and recording by GPS of localities of red data species and approximate extent of localities of all protected plant species	Ecologist	Prior to construction
» Search and Rescue (S&R) of transplantable succulents, tubers, and bulbs occurring in long term and permanent, hard surface development footprints (i.e. all buildings, new roads and tracks, and panel mount positions) should take place. » All development footprints must be surveyed and pegged out as soon as possible, and then a local horticulturist with Search and Rescue experience should be appointed to undertake the S&R. » All rescued species should be bagged (and cuttings taken where appropriate) and kept in the horticulturist's or a designated on-site nursery, and should be returned to site once all construction is completed and rehabilitation of disturbed areas is required. » Replanting should only occur in spring or early summer (October to November), once the first rains have fallen, in order to facilitate establishment.	ECO and horticultural Contractor	Prior to construction
In line with the erosion management plan, it must be made clear what height of vegetation is permissible under and between the PV array » A minimum percentage cover (base cover) of vegetation set that should be permanently maintained after construction » A detailed rehabilitation and revegetation plan must be implemented during and after construction, aiming to achieve the desired vegetation cover within 12 months after construction of a particular area is completed	Developer horticultural Contractor	Prior to and after construction, throughout operational phase

Performance Indicator	» Horticulturist to submit list of target species to botanist for approval; » Rescue of material; » Replanting in rehabilitation areas to cover 70% of these

	areas within 12 months of rehabilitation works; » Stable vegetation cover throughout the development area as determined desirable to curb erosion prior to construction; » Improvement of vegetation cover where it is currently degraded to a dominance of perennial grasses.
Monitoring	» ECO to monitor Search and Rescue; » Horticulturist to liaise with botanist; » Botanist to review rehabilitation success after 8 months of replanting of rehabilitation areas. » Continued monitoring of vegetation below and around the PV array throughout the operational phase and revegetation when ever needed

OBJECTIVE: To avoid and or minimise the potential negative impact on current and future farming activities during the construction phase.

Construction activities of the proposed facility could lead to the loss of productive farm land.

Project component/s	Project components affecting the objective: » PV Array » Grid connection and associated servitudes » Workshop and guard houses » Access roads
Potential Impact	» The footprint of the developments will result in a loss of land that will impact on farming activities on the site. » Change of species composition to vegetation with lower productivity and agricultural potential » Loss of nutrient-rich topsoil due to accelerated erosion and thus reduction of vegetation growth potential » Displacement of indigenous vegetation by invasive vegetation
Activities/risk sources	» The footprint taken up by the development » Introduction and/or further distribution of invasive plant species » Excessive fragmentation of habitats » Accelerated erosion
Mitigation: Target/Objective	» To minimise the loss of land and desirable indigenous vegetation by the construction of the development and to enable farming activities to continue where possible, specifically grazing.

Mitigation: Action/control	Responsibility	Timeframe
Minimise the footprint of the development where possible, but not at the cost of impacting on sensitive habitats	Contractor	Before and during construction

Mitigation: Action/control	Responsibility	Timeframe
» Footprint for each development component, including temporarily accessed areas should be defined in the layout before construction phase commences.		
Rehabilitate disturbed areas on completion of the construction phase of each development component. Details of the rehabilitation programme should be contained in the EMP.	ECO and Contractors	Ongoing during construction phase

Performance Indicator	» Footprint of development components included in the Construction Phase EMP. » Improvement of vegetation cover from current dominance of invasive shrubs to dominance of perennial grasses and dwarf shrubs » Meeting/s held with farmers during construction phase.
Monitoring	» ECO must monitor indicators listed above to ensure that they have been met for the construction phase.

OBJECTIVE: Minimisation of disturbance to topsoil

In order to minimise impacts on flora, fauna, and ecological processes, the development footprint should be limited to the smallest area possible.

Project Component/s	Project components affecting the objective: » PV Array » Grid connection and associated servitudes » Workshop and guard houses » Access roads
Potential Impact	» Impacts on natural vegetation » Impacts on soil » Loss of topsoil
Activity/Risk Source	» Site preparation and earthworks » Excavation of foundations » Construction of site access road » Construction of workshop and guard houses » Site preparation (e.g. compaction) » Power line construction activities » PV array construction activities » Stockpiling of topsoil, subsoil and spoil material
Mitigation: Target/Objective	» To prevent, contain and/or reduce any form of erosion » 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
The extent of clearing and disturbance to indigenous vegetation must be kept to a minimum to restrict impact on flora and fauna and their habitats.	Contractor	Site establishment & duration of contract
Construction activities must be restricted to demarcated areas so that impact on flora and fauna is restricted.	Contractor	Site establishment & duration of contract
Any fill material required must be sourced from a commercial off-site suitable/permitted source, quarry or borrow pit. Where possible, material from foundation excavations must be used as fill on-site.	Contractor	Duration of contract
Excavated topsoil must be stockpiled in designated areas separate from subsoil and base material and protected from erosion or any form of degradation until rehabilitated. As far as possible, topsoil must not be stored for longer than 6 months. » A detailed topsoil management plan must be implemented, which must make provision for topsoil treatment if topsoil cannot be reapplied within 6 months. » The topsoil management pan must be designed to optimise the viability of soil seed banks and survival of soil organisms	Contractor	Site establishment & duration of contract
Topsoil must not be stripped or stockpiled when it is raining or when the soil is wet as compaction will occur.	Contractor	Site establishment and construction
The maximum topsoil stockpile height must not exceed 1 m in order to preserve micro-organisms and soil seed banks within the topsoil, which can be lost due to compaction and lack of oxygen.	Contractor	Duration of contract

Performance Indicator	» Minimal disturbance outside of designated work areas » Minimise clearing of existing vegetation » Topsoil appropriately stored and re-applied
Monitoring	» Observation of vegetation clearing and soil management activities by ECO throughout construction phase » Supervision of all clearing and earthworks

	» An incident reporting system will be used to record non-conformances to the EMP

OBJECTIVE: Manage and reduce the impact of invasive vegetation

Within the project area invasive species 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.

Species of concern within the project area: *Prosopis* species, *Opuntia* species, *Eucalyptus* species
Species of concern observed along access routes: *Pennisetum* species, *Argemone* species, *Agave* species, *Flaveria* species, *Alternanthera pungens*

Project Component/s	» Transport of construction materials. » PV Array » Grid connection and associated servitudes » Workshop and guard houses » Access roads
Potential Impact	» Impacts on natural vegetation » Impacts on soil » Impact on faunal habitats » Loss of agricultural potential
Activity/Risk Source	» Transport of construction materials » 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
Mitigation: Target/Objective	» 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	Specialist	Pre-construction

Mitigation: Action/Control	Responsibility	Timeframe
» It must provide for a continuous monitoring programme to detect new infestations		
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 » Use the above material with shredded material of indigenous vegetation (latter can contain regenerative material) and use as mulch as part of the erosion control, rehabilitation and revegetation plan » Do not import soil from areas with alien plants	Contractor	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	Construction phase Operational phase
» Immediately control any alien plants that become newly established using registered control measures	Contractor	Construction phase Operational phase

Performance Indicator	» Visible reduction of number and cover of alien invasive plants within the project area. » Improvement of vegetation cover where it is currently degraded to dominance of perennial grasses » 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.

11. Appendix C: Declaration of Independence

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/
NEAS Reference Number:	DEAT/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010

PROJECT TITLE

Sannaspos Solar Energy Facility Phase 1

Specialist:	Marianne Strohbach		
Contact person:	Marianne Strohbach		
Postal address:	PO Box 148, Sunninghill		
Postal code:	2157	Cell:	079 963 4806
Telephone:	*(011) 234-6621*	Fax:	*086 684 0547*
E-mail:	marianne@savannahsa.com		
Professional affiliation(s) (if any)	SACNASP (Reg No 400079/10) Desert Net International South African Association of Botanists		

Project Consultant:	Savannah Environmental (Pty) Ltd		
Contact person:	Jo-Anne Thomas		
Postal address:	PO Box 148, Sunninghill		
Postal code:	2157	Cell:	
Telephone:	*(011) 234-6621*	Fax:	*086 684 0547*
E-mail:	joanne@savannahsa.com		

4.2 The specialist appointed in terms of the Regulations_

I, Marianne Strohbach , declare that --

General declaration:

- I act as the independent specialists in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- **all the particulars furnished by me in this form are true and correct; and**
- **I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.**

Signature of the specialist:

Savannah Environmental (Pty) Ltd

Name of company (if applicable):

29 November 2012

Date:

12. Appendix D: Curriculum vitae of specialist

CURRICULUM VITAE

MARIANNE STROHBACH
SAVANNAH ENVIRONMENTAL (PTY) LTD

Profession : Specialist Scientist
Specialisation: Plant Ecology and Botany, with special reference to vegetation mapping, vegetation state assessment, dynamics of arid and semi-arid vegetation and population dynamics of harvested plants, conservation planning
Work experience: Twenty (20) years active in Plant Ecology

SKILLS BASE AND CORE COMPETENCIES

- Four years Plant Conservation (Namibia)
- 16 years active research in vegetation mapping, vegetation state assessment, vegetation and plant population dynamics, long-term vegetation monitoring
- Advisory to International Standards for plant species that are harvested for commercial purposes
- Research Project Management
- Ecological assessments for developmental purposes (BAR, EIA)
- Working knowledge of environmental planning policies, regulatory frameworks and legislation
- Identification and assessment of potential environmental impacts and benefits
- Development of practical and achievable mitigation measures and management plans and evaluation of risk to project execution
- Experienced in environmental monitoring
- Completed projects in several Provinces of South Africa, as well as Zimbabwe and Namibia

EDUCATION AND PROFESSIONAL STATUS

Degrees:
2003 M.Sc. in Botany, University of Pretoria, Pretoria, RSA
1991 B.Sc. Hons in Botany, Nelson Mandela Metropolitan University, Port Elizabeth, RSA
1990 B.Sc. in Biological Sciences, Nelson Mandela Metropolitan University, Port Elizabeth

Short Courses:
2008 Landscape Functional Analysis for vegetation condition and restoration monitoring
2002 Satellite Image Analysis for Vegetation Mapping, German Aerospace Centre (DLR) Cologne/Würzburg, Germany
Methods and Techniques of Environmental Management, Deutsche Stiftung für Internationale Entwicklung, Berlin, Germany
1993 Conservation Law Enforcement, Ministry of Environment and Tourism, Namibia

Professional Society Affiliations:
South African Association for Botanists
Association of Desert Net International
The South African Council for Natural Scientific Professions: Pr. Sci. Nat. Reg. No. 400079/10 (Botany and Ecology)

Publications:
Articles in peer- reviewed scientific journals
Book-chapters in scientific publications
Popular articles
Scientific conferences
Contributions to TV documentaries
Project-specific reports

EMPLOYMENT
Current: Ecologist, Savannah Environmental (Pty) Ltd
2011: Lecturer, Plant Ecology, University of Pretoria
1997 onwards: working as vegetation ecologist on a freelance basis, involved in part-time positions and contractual research as outlined below
1995 to 1996: Agricultural Researcher at the National Botanical Research Institute, Windhoek, Namibia
1992 to 1995: Vegetation ecologist at the Ministry of Environment and Tourism, Namibia, Directorate of Scientific Services
Past Affiliations and Research

2001 – 2010: contractual work with BIOTA (BIOdiversity Transect analysis in Africa) as affiliate to the National Botanical Research Institute, Namibia.
Deliverables:
Project management, including research proposal, financial management, and project implementation.

Modelling of Savanna Dynamics:
Collating and summarising available phytosociological data for ecological modellers to use in creating a generic savanna model for the Namibian savannas
Defining plant functional types to simplify vegetation data and to use as indicators in monitoring techniques by livestock farmers

Vegetation Patterns and Processes in Namibian Savannas:
Small scale monitoring of vegetation dynamics over a range of soil conditions and seasons
Determine ecological barriers to and best practice for rangeland restoration

Vegetation classification and mapping in Central Namibia:
Collection and analysis of phytosociological baseline data for the central Thornbush Savanna in Namibia, delineation of vegetation types with the aid of satellite imagery

2006: German Scientific Authority to CITES, Plants, Federal Agency for Nature Conservation
International Standard for the Sustainable Wild Collection of Medicinal & Aromatic Plants
Assisting in the compilation of a reference guide for minimum research standards necessary to ensure sustainable use of economically utilised plants (updated in FairWild Standard Version 2, 2010)

2004: contractual work for Desert Research Foundation of Namibia
Vegetation description and mapping of the Namibian Eastern Communal Areas and assess possible development options using indigenous plant resources

1997 to 2010: contractual work with CRIAA-SADC as ecologist.
Deliverables:

The Sustainably Harvested Devil's Claw Project:
Annual surveys of Harpagophytum populations to determine harvesting quotas for rural communities
Determine and monitor impact of harvesting frequency and techniques on survival of Harpagophytum procumbens
Educate harvester communities on issues of resource management
In collaboration with the German Federal Agency for Nature Conservation
This work was extended in 2006 to the Hwange Area, NW Zimbabwe, together with Africa Now

Pilot Devil's Claw cultivation trials:
Increase available resources of Harpagophytum procumbens
Give communities ownership and better access of their resources to improve their income

Namibian National Devil's Claw Situation Analysis:
Design and implement a country-wide survey of Harpagophytum species to assess resource availability compared to annual export figure

1999 to 2001: Assistant curator at the Swakopmund Museum (part-time position)
Help maintain existing collections and exhibits , design and create new exhibits for the museum in collaboration with the Museum Hannover, Germany

Specialist Scientist Vegetation Surveys and related Impact Assessments were done for following clients:
Langer Heinrich Uranium Pty (Ltd): Central Namib Desert, Namibia
University of Namibia, Hentiesbay Research Centre: West Coast, Namibia
Sasol – Limpopo Province
EcoAgent – Northern Cape, Eastern Cape, Limpopo and Mpumalanga
Namwater – Karst aquifers, north-central Namibia
ENVASS (for AfriDevo) – Northern Cape