

ECOLOGICAL ASSESSMENT REPORT

**PROPOSED TUTUKA SOLAR ENERGY
FACILITY NEXT TO THE TUTUKA POWER
STATION**

MPUMALANGA

March 2015

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Executive Summary

Eskom Holdings (SOC) Ltd have appointed Savannah Environmental (Pty) Ltd to manage the EIA process for a photovoltaic Solar Energy Facility next to the Tutuka Power Station, Mpumalanga.

This report discusses the approach and findings of an ecological field study, in addition to a literature survey carried out for the study area to assess the likelihood of ecological sensitivities occurring on the study area. The findings of this report should be used to guide the design of the final layout of the proposed development as well as environmental issues that will have to be adequately addressed and mitigated during the design, construction, operational and decommissioning phase.

The selected study area falls within the original extent of the Soweto Highveld Grassland (Unit Gm8) as defined by Mucina and Rutherford (2006), consisting of gently to moderately undulating landscapes. The short to medium high dense tussock grassland is dominated almost entirely by *Themeda triandra*, with a relatively high diversity of grasses, herbs and geophytes (Mucina and Rutherford 2006). Many of the herbs resprout every year from below-ground storage tubers, usually early in the growing season before the grasses reach their full cover.

None of the grasslands are considered to be in a pristine condition, with only a small section considered to be primary (natural) grassland. Portions of the grassland appear to have been able to regenerate for a longer time and show a considerably higher biodiversity, including a few plants of conservation concern. The remaining extent of primary grassland is classified as Important and Necessary, whilst the better condition rehabilitated and more diverse grassland is classified by the Mpumalanga Biodiversity Conservation Plan (MBCP) as of Least Concern. The remainder of the area has been recognised as rangelands with no Natural Habitat Remaining. It must be noted here that the mapping for the MBCP was done at a high scale, and hence delineations currently available for the different habitats do not entirely match the actual state of the vegetation on the ground, which is especially applicable to the eastern section of Site Alternative 1, where the grasslands have been severely degraded and transformed in the past.

A total of 973 indigenous plant species have been recorded in the Tutuka Area according to the SANBI database. Only 120 indigenous species could be confirmed on site present. A large portion of the study site is disturbed or has been transformed in the past, allowing many alien invasives to become established, with 25 alien invasive species recorded.

At the time of the vegetation survey, the herbaceous layer overall was reasonably well developed, but additional species may occur in the area that were dormant

at the time. Most of the grasslands are still in a state of rehabilitation, thus gradual future changes in species composition can still be expected.

Three vegetation associations could be identified:

- » Association 1: *Andropogon chinensis* - *Aloe ecklonis* Grassland
 - Sensitivity: High
 - MBCP Rating: Important and necessary
- » Association 2: *Pennisetum clandestinum* - *Aristida bipartita* Grassland
 - Sensitivity: Low
 - MBCP Rating: No Natural Habitat Remaining
- » Association 3: *Eragrostis chloromelas* - *Hermannia depressa* Grassland
 - Sensitivity: Low
 - MBCP Rating: Least Concern

In addition, evidence of several wetlands could be identified – where these were clearly visible they have been mapped as wetlands, but are described in more detail in the wetlands delineation report.

It is not expected that the development will compromise the survival of any flora or terrestrial vertebrate species on the study area or beyond, but potentially significant negative impacts on the ecological environment will occur if remaining portions of high diversity natural vegetation will be further disturbed – these sections should be avoided. The most significant impacts are expected to be on ecosystem health and functionality, which should remain relatively intact if all mitigation recommendations are implemented; and the associated integrity of surrounding wetlands.

The largest concerns currently identified are:

- » There are numerous wetland areas on and adjacent to the southern and western portion of the study area
- » The ecological state of the vegetation on especially the site alternative 2 is regarded as Important and Necessary to meet Mpumalanga Biodiversity Targets: this has been confirmed during the field study with a high abundance of some protected plant species
 - It is recommended that site alternative 2 be entirely excluded from the proposed development
- » All indigenous and alien invasives, weeds and potential invasives within the development area will have to be cleared prior to development and controlled after construction until decommissioning
- » Rubble and other pollutants need to be removed from the grasslands
- » An ongoing monitoring program will be necessary to control and/or eradicate newly emerging invasives

- » Newly cleared soils will have to be revegetated and stabilised as soon as construction has been completed
 - Soils are prone to capping and erosion and need to be stabilised by a permanent grass or suitable indigenous vegetation layer.
 - Many of the naturally occurring grass species become moribund and die off if not grazed or burnt regularly. It is thus recommended to implement a regular mowing program (to replace the effect of grazing and burning) to reduce dead biomass accumulation on grass tufts. This will also greatly reduce the risk of fire, which is a natural component of grassland dynamics.

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1. General Information

1.1. Applicant

Eskom Holdings (SOC) Ltd have appointed Savannah Environmental (Pty) Ltd to manage the EIA process for a photovoltaic Solar Energy Facility next to the Tutuka Power Station, Mpumalanga.

Project

Tutuka Solar Energy Facility

Proposed Activity

- » A PV array with a total generating capacity of up to 66 MW
- » Inverter and transformer buildings
- » On-site substation or switching station
- » Underground cabling between project components
- » A direct grid connection from the development to the existing Eskom substation at Tutuka Power Station
- » Upgrading of existing access roads and possibly creating new access roads to the proposed development site
- » Construction of associated infrastructure such as workshops, office, guard houses and fencing
- » As part of the construction process, sections of vegetation on the property will need to be cleared
- » Two alternative sites are currently being investigated for the placement of the PV arrays.

1.2. Declaration of Independence

A signed declaration of independence for the investigating specialist is attached in Appendix A.

1.3. Specialist Investigator

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

Specialist affiliation

South African Council for Natural Scientific Professions (SACNASP) (Pr.Sci.Nat; Registration no. 400079/10, Botanical Science, Ecological Science).

South African Association of Botanists (www.sabotany.com)

Desert Net International (www.european-desertnet.eu)

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 study and impact assessment of the selected study 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. Legislation

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

1.5.1. Provincial

- » The Mpumalanga Nature Conservation Act (Act 10 of 1998) and subsequent amendments
- » Mpumalanga Tourism and Parks Agency Act (Act 5 of 2005)

1.5.2. 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 and regulations

- » National Veld and Forest Fire Act (Act No. 101 of 1998)
- » Conservation of Agricultural Resources Act (CARA) (Act No. 43 of 1983) and amendments

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. 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. Recovery is further hampered by ongoing changes in global climate, leading to a higher incidence of extreme climatic events. There is thus an increasing pressure on reduced emissions of greenhouse gases. In the energy generating sector emissions can be reduced by switching more to renewable energy sources, such as solar- and wind-generated electricity. However, the construction of renewable energy facilities, although regarded a 'green technology', do impose several, potentially negative, impacts on the environment on which they are built.

This report lists the findings of an ecological evaluation of the site selected by Eskom for the development of a photovoltaic energy facility to help evaluate the most likely impacts of such a development on the affected environment.

3. Study Area

3.1. Locality

The proposed photovoltaic (PV) solar energy facility is located on portion 4, 10, 11 and 12 of the farm Pretorius Vley 374 IS, adjacent to the Tutuka Power Station. This is approximately 22 km north-east of Standerton, within the Lekwa Municipality, Mpumalanga. The two alternative sites for the energy facility just south and south-east of the power station currently being investigated are shown in Figure 1. All sites studied and an adjacent buffer of about 100 m is considered as the study area.

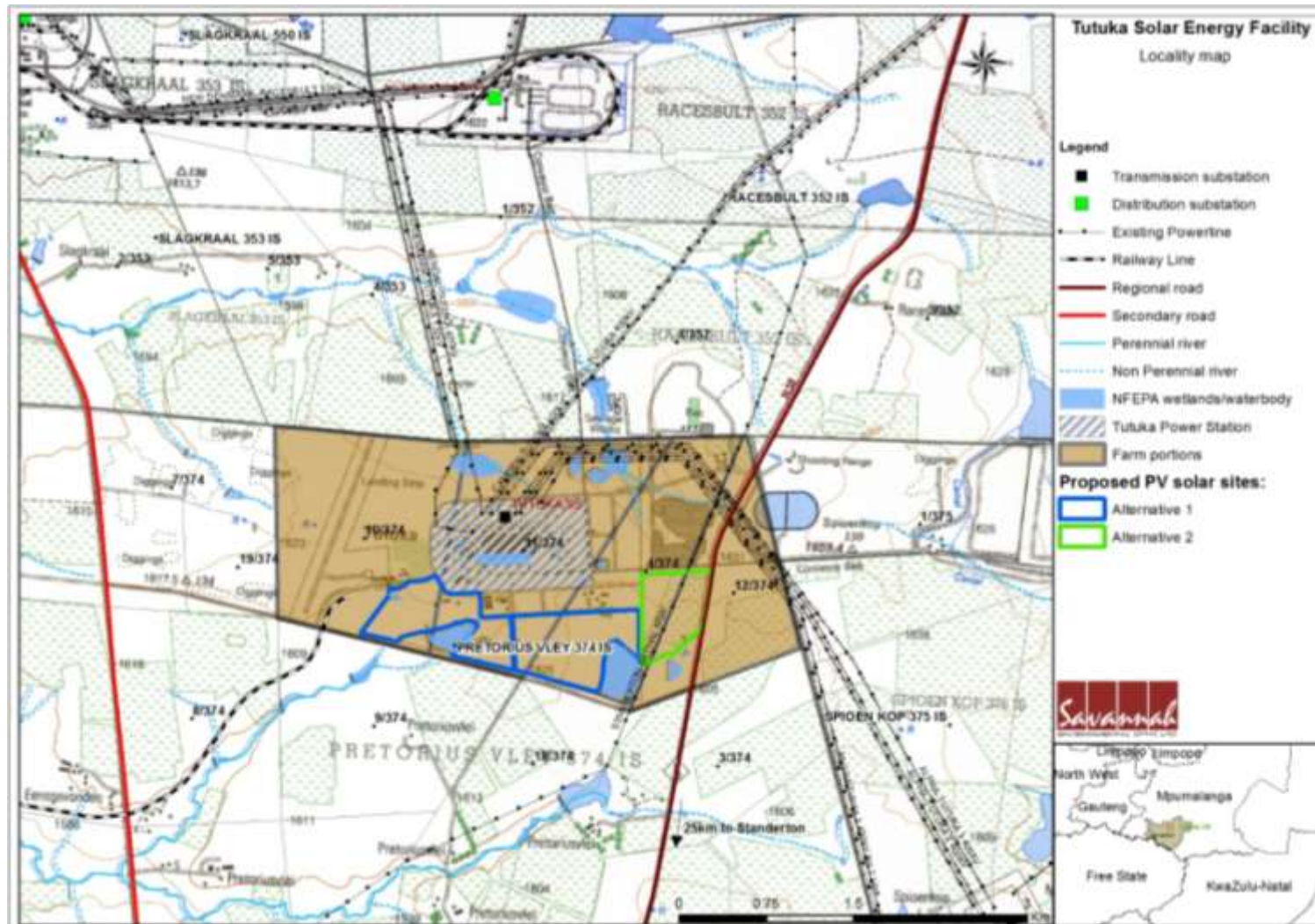


Figure 1: Locality of the Tutuka power station and sites for the proposed solar energy facility

3.2. Surrounding environment

3.2.1. Climate and rainfall

The climate for Tutuka has been derived from climatic data summarised for Standerton (en.climate-data.org, Figure 2), located about 22 km south-west of Tutuka. The area receives about 650 - 750 mm of rain on average per year. From May to September, rainfall is minimal, with most rainfall occurring from late October to March, peaking between November and January. Temperatures in summer peak during December and January at a daily average of 26°C, with an average of 17°C for June. During July, night temperatures are on average -1°C, with frosts during winter common.

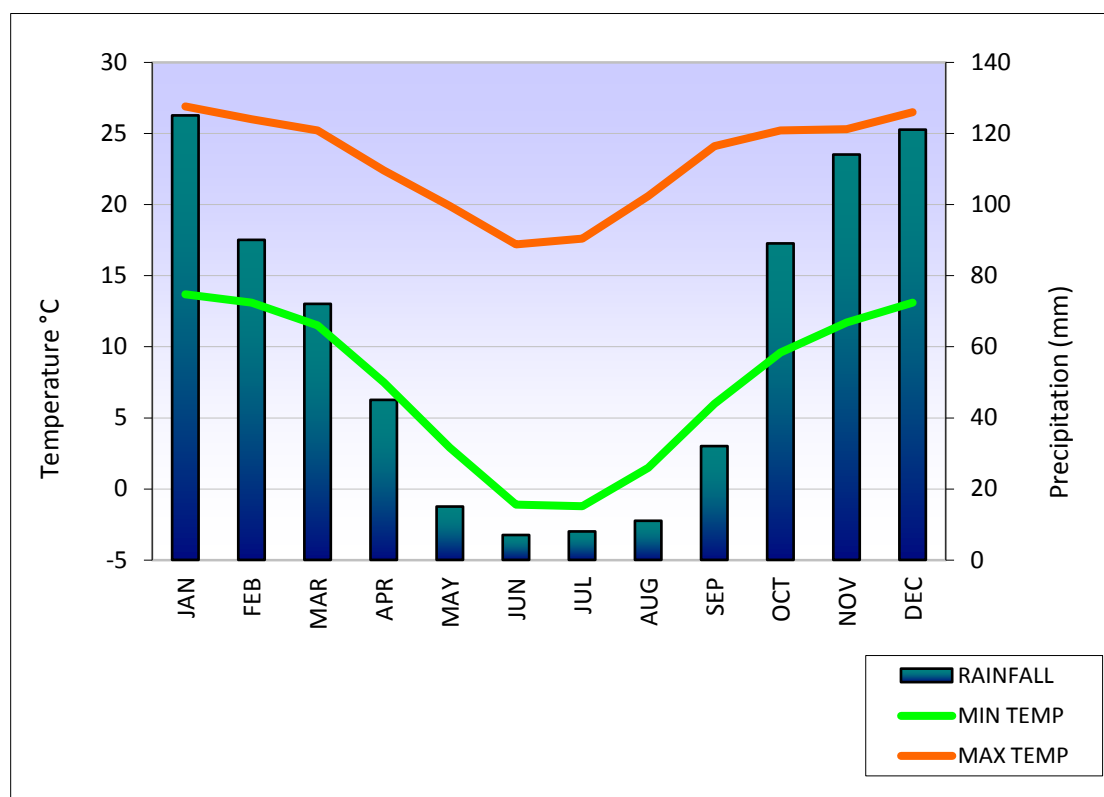


Figure 2: Climate summary for the study area.

3.2.2. Topography, soils and wetlands

From data available on the BGIS website, the following could be determined: The site is expected to be relatively flat to slightly undulating. Within close proximity of the site are several valley floor wetlands (vleis), of which one has been expanded to form a dam for farming purposes.

The soils are expected to be mainly dark cracking clay soils with a high swell-shrink potential, being plastic and sticky when wet. Fertility is high, but due to

occasional seasonal inundations, soils may not always be suitable for crop-based agriculture.

3.2.3. Vegetation overview

The selected property falls within the original extent of the Soweto Highveld Grassland (Unit Gm8) as defined by Mucina and Rutherford (2006).

As explained in the Mpumalanga Biodiversity Conservation Plan Handbook (Ferrar and Lötter 2007): "African grasslands are particularly old, stable and resilient ecosystems. Most plants are perennials and surprisingly long lived, with very few annual species, which are the pioneer plants needed to repair disturbance. This makes our grasslands vulnerable to destruction by cultivation; once ploughed they are invaded by weedy pioneer plants that are mostly alien. Although many grassland plants do produce seed, very little germinates, most being used as vital food for their rich rodent and insect fauna. ... The large number of rare and endangered species in grasslands is a particular problem for environmental impact assessment. They are mostly small, very localised and visible for only a few weeks in the year when they flower. Most surveys will not pick them up and special skills are required to locate and identify them reliably. Highest biodiversity is found in rocky grassland habitats and on sandy soils. Clay soils generally have the lowest biodiversity in grasslands."

Landscapes of the Soweto Highveld Grassland, found within the Highveld Plateau, consist of gently to moderately undulating landscapes. The short to medium high dense tussock grassland is dominated almost entirely by *Themeda triandra*, with other prominent grasses such as *Andropogon appendiculatus*, *Brachiaria serrata*, *Cymbopogon pospischilii*, *Elionurus muticus*, *Eragrostis* species, *Heteropogon contortus* and *Setaria* species. Overall grass diversity is relatively high, as is the diversity of herbs and geophytes (Mucina and Rutherford 2006). Many of the herbs resprout every year from below-ground storage tubers, usually early in the growing season before the grasses reach their full cover. Some of the more common low shrubs scattered in the grassland include *Anthospermum* species, *Felicia muricata* and *Ziziphus zeyheriana*.

Mucina and Rutherford (2006) already classified this grassland as endangered, with only about 0.2% of its original extent protected, and a mere 52% remaining in a natural state. It is listed under the National List of threatened ecosystems as Vulnerable.

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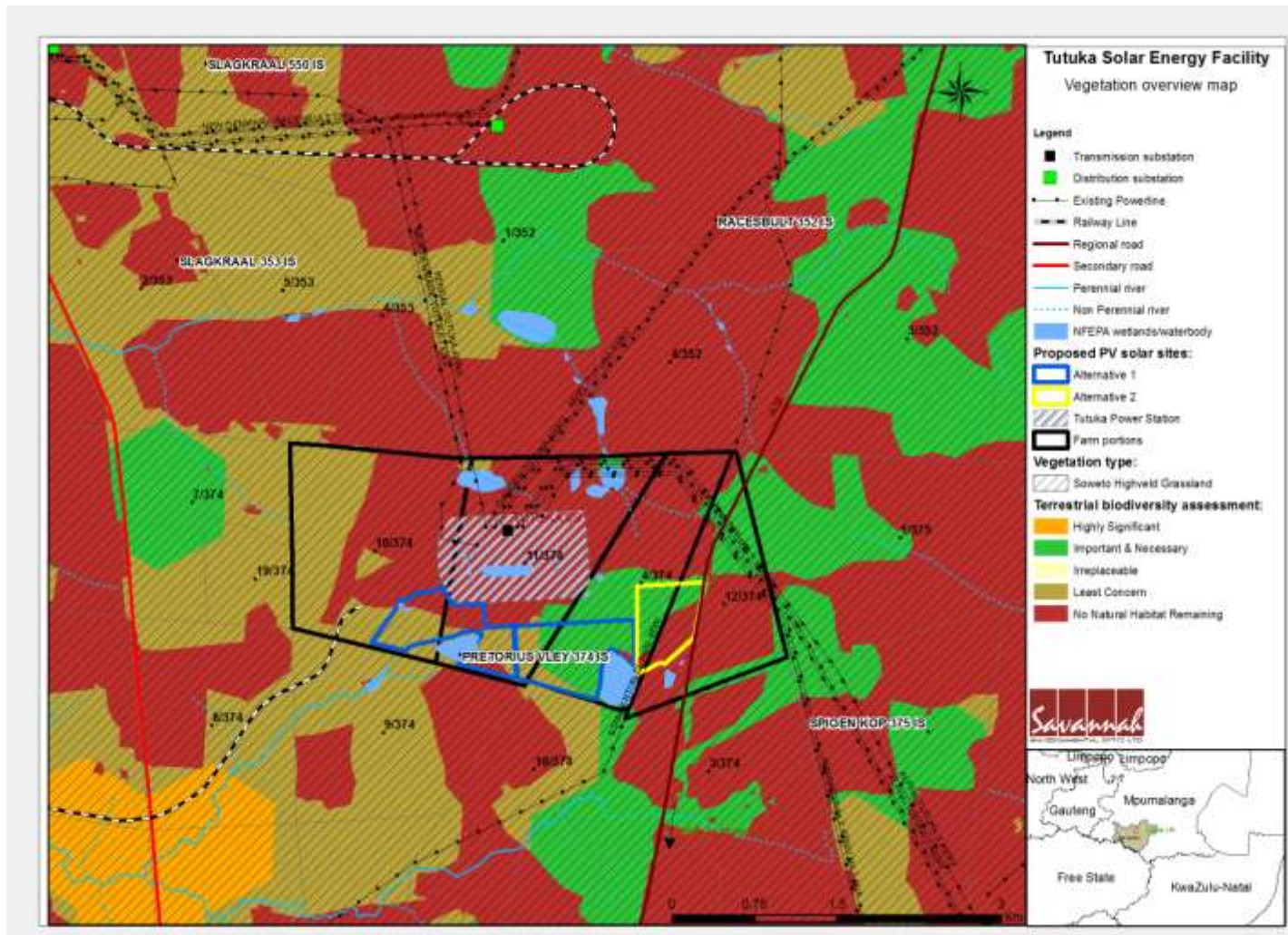


Figure 3: The original extent of the vegetation types on the proposed development site after Mucina and Rutherford (2006), and the relevant Mpumalanga Biodiversity Assessment Categories.

3.3. Mpumalanga Conservation Planning

The systematic conservation planning undertaken for Mpumalanga and culminating in the publishing of the Mpumalanga Biodiversity Conservation Plan Handbook (**MBCP**, Ferrar and Lötter 2007) determined the state of ecosystems, desirable conservation targets and hence rated different vegetation types according to the amount of undisturbed land needed to be kept in that state to meet conservation targets. The resulting irreplaceability values were translated into biodiversity assessment categories. These categories are:

- » Protected areas: already managed for biodiversity protection;
- » Irreplaceable: 100% Irreplaceable - no other options available to meet targets;
- » Highly Significant: 50 - 99% Irreplaceable - very limited options available to meet targets;
- » Important & Necessary: lower irreplaceability value, less than 50% but still required to meet targets;
- » Least Concern: areas of natural habitat that could be used to meet some targets but not needed now, as long as other areas are not lost
- » No natural habitat remaining: virtually all natural habitat has been irreversibly lost as a result of cultivation, timber plantations, mining, urban development

For the above landscape/ecosystem categories, the following land-use guidelines relevant to the proposed development have been developed:

T4. IMPORTANT AND NECESSARY

These areas are significantly important areas of natural vegetation that play an important role in meeting biodiversity targets. Their designation as IMPORTANT AND NECESSARY seeks to minimise conflict with competing land uses and represents the most efficient selection of areas to meet biodiversity targets.

No significant increase in the occurrence of Land-Use Types 5 – 9, should be permitted. Every opportunity to revert to economic options using natural land cover should be taken. Some agricultural land uses may be permitted but with best practice guidelines made conditional and aimed at benefiting the biodiversity assets and reducing the vulnerability of each site.

Requirements for any development set: Undertake specialist studies according to MTPA's 'Requirements for Assessing and Mitigating Environmental Impacts of Development Applications' document.

Land-use and administrative options for positive biodiversity outcomes include:

- » Actively encourage sustainable Land Uses such as Types 1-4
- » Actively discourage Land Uses causing biodiversity loss such as Types 5-9

- » Avoid Land Use Types 10-15
- » Prioritise the monitoring of changes in land use and loss of natural habitat to guide protect ecosystem functioning and connectivity;
- » Conduct focused public awareness and/or extension effort on biodiversity values and uses of these areas, especially to land owners;
- » Develop best practice guidelines for all permitted land uses;
- » Encourage cooperative conservation arrangements, e.g. Protected Environments / conservancies;
- » Develop best-practice guidelines for encouraging free movement of indigenous plants and animals across boundaries and barriers in agricultural landscapes;
- » Regulate for compulsory, full EIA procedures;
- » Compensatory offsets of at least 150% may be considered for land uses 5-15;
- » Prioritise these areas for land-care projects: i.e. MTPA, DALA, WfW, Working on Wetlands and NGOs to redirect their conservation projects, programmes and activities.

T6. LEAST CONCERN

Biodiversity assets in these landscapes contribute to natural ecosystem functioning, ensure the maintenance of viable species populations and provide essential ecological and environmental goods and services across the landscape. Although these areas contribute least to the achievement of biodiversity targets they have significant environmental, aesthetic and social values and should not be viewed as wastelands or carte-blanche development zones.

Development options are widest in these areas. At the broad scale, these areas and those where natural habitat has been lost (see 7, below) serve as preferred sites for all forms of development (Land-Use types 5 – 15). Land-use planners are still required to consider other environmental factors such as socioeconomic efficiency, aesthetics and the sense-of-place in making decisions about development. Prime agricultural land should also be avoided for all non-agricultural land uses.

Land-use and administrative options for positive biodiversity outcomes include:

- » Where this category of land occurs close to areas of high biodiversity value, it may provide useful ecological connectivity or ecosystem services functions, e.g. ecological buffer zones and corridors or water production. In these situations encouragement needs to be given to biodiversity-friendly forms of management and even restoration options where appropriate;
- » Develop incentives to reverse lost biodiversity for selected parcels of land where buffer zones and connectivity are potentially important;
- » Standard application of EIA and other planning procedures required;

- » Along with Category T7. Below, these areas to serve as preferred sites for all forms of urban and industrial development (Land-Use Types 10 – 15).

T7. NO NATURAL HABITAT REMAINING

Areas with no natural habitat remaining are preferred sites for development, even more so than for 6, above. However, in selecting sites for urban and industrial development, planners need to make a special effort to avoid building on areas of high agricultural potential. Prime agricultural land is coming under the same pressures as land with high biodiversity value and needs to be protected for its ability to produce food and fibre sustainably.

Land-use and administrative options for positive biodiversity outcomes include:

- » Where this category of land occurs close to areas of high biodiversity value, and is located to potentially serve useful ecological connectivity functions, such as in ecological corridors, encourage restoration and re-vegetation options;
- » For individual parcels of land identified as having specific biodiversity values, actual or potential, develop incentives to restore lost biodiversity and connectivity;
- » Consider the negative impacts of land uses on these areas which have off-site impacts, e.g. controlling use of pesticides, on neighbouring areas of natural habitat, especially if they are of high biodiversity value;
- » Encourage landowners and developers to use indigenous plants, especially trees, where aesthetic or functional options exist.

Land Use Types defined:

1 – 4 BIODIVERSITY-FRIENDLY LAND USES:

- » Land-Use Type 1. Conservation Management
- » Land-Use Type 2. Extensive Game Farming
- » Land-Use Type 3. Extensive Livestock Production
- » Land-Use Type 4. Rural Recreational Development

5 – 9 HIGH IMPACT RURAL LAND USES

- » Land-Use Type 5. Rural (Communal) Settlement – subsistence agriculture
- » Land-Use Type 6. Dryland Crop Cultivation
- » Land-Use Type 7. Intensive Animal Farming
- » Land-Use Type 8. Irrigated Crop Cultivation
- » Land-Use Type 9. Timber Production

10 – 15 URBAN INDUSTRIAL LAND USES

- » Land-Use Type 10. Urban and Business Development
- » Land-Use Type 11. Major Development Projects
- » Land-Use Type 12. Linear Engineering Structures
- » Land-Use Type 13. Water Projects and Transfers

- » Land-Use Type 14. Underground Mining
- » Land-Use Type 15. Surface Mining, Dumping and Dredging

4. Methods

4.1. Vegetation Survey

The site was visited on 14 January 2015 for a vegetation survey. At the time of the survey, vegetation was actively growing, although some of the annual species were not yet in flower.

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 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.

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 simply described in terms of vegetation associations, which are localised associations within plant communities. Extrapolation of vegetation units 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>, December 2014, Grid reference: 2629) containing the species that might occur in the area was obtained. POSA generated species lists also contain updated Red Data species status according to the Red List of South African Plants 2009 published by SANBI in *Strelitzia* 25 (Raimondo *et al.* 2009, updated 2014).

A list of species of conservation concern that may occur on the site have been extracted from the POSA list, with the status of plant species indicated by using the following symbols:

Plant species nomenclature follows Germishuizen and Meyer (2003), the African Plants Database (GJB), Henderson (2001) and Bromilow (2010).

4.2. Explanations of Red Data classes

(After Raimondo *et al.* 2009):

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.

Implications for development: RED LIST SPECIES: No further loss of natural habitat should be permitted as the species is on the verge of extinction. The Threatened Species Programme must be informed immediately, providing details of the location, size and threats to the subpopulation.

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.

Implications for development: RED LIST SPECIES:

Case A: If the species has a restricted range ($EOO < 2\,000\text{ km}^2$), recommend no further loss of habitat. If range size is larger, the species is possibly long-lived but widespread, and limited habitat loss may be considered under certain circumstances, such as the implementation of an offset whereby another viable, known subpopulation is formally conserved in terms of the National Environmental Management: Protected Areas Act (Act 57 of 2003), and provided that the subpopulation to be destroyed does not occur (i) within a threatened ecosystem or (ii) within an area required for biodiversity conservation in terms of a relevant spatial biodiversity plan or (iii) on a site associated with additional ecological sensitivities.

Case B, C, D: No further loss of habitat should be permitted as the species is likely to go extinct in the near future if current pressures continue. All remaining subpopulations have to be conserved if this species is to survive in the long term.

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.

Implications for development: RED LIST SPECIES:

Case D: This species either constitutes less than 1 000 individuals or is known from a very restricted range. No further loss of habitat should be permitted as the

species' status will immediately become either Critically Endangered or Endangered, should habitat be lost. The Threatened Species Programme must be informed immediately, providing details of the location, size and threats to the subpopulation.

Case B, C: The species is approaching extinction but there are still a number of subpopulations in existence. Recommend no further loss of habitat as this will increase the extinction risk of the species.

Case A: If the species has a restricted range, $EOO < 2\,000\text{ km}^2$, recommend no further loss of habitat. If range size is larger, the species is possibly long-lived but widespread, and limited habitat loss may be considered under certain circumstances, such as the implementation of an offset whereby another viable, known subpopulation is formally conserved in terms of the Protected Areas Act, and provided that the subpopulation to be destroyed does not occur (i) within a threatened ecosystem or (ii) within an area required for biodiversity conservation in terms of a relevant spatial biodiversity plan or (iii) on a site associated with additional ecological sensitivities.

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.

Implications for development: ORANGE LIST SPECIES:

Case D: Currently known from fewer than 10 locations, therefore preferably recommend no loss of habitat. Should loss of this species' habitat be considered, then an offset that includes conserving another viable subpopulation (in terms of the Protected Areas Act) should be implemented, provided that the subpopulation to be destroyed does not occur (i) within a threatened ecosystem or (ii) within an area required for biodiversity conservation in terms of a relevant spatial biodiversity plan or (iii) on a site associated with additional ecological sensitivities. The Threatened Species Programme must be informed immediately, providing details of the location, size and threats to the subpopulation.

Case B, C: The species is approaching thresholds for listing as threatened but there are still a number of subpopulations in existence and therefore there is need to minimise loss of habitat. Conservation of subpopulations is essential if they occur (i) within a threatened ecosystem or (ii) within an area required for biodiversity conservation in terms of a relevant spatial biodiversity plan or (iii) on a site associated with additional ecological sensitivities.

Case A: If the species has a restricted range, $EOO < 2\,000\text{ km}^2$, then recommend no further loss of habitat. If range size is larger, the species is possibly long-lived but widespread, and limited habitat loss may be considered. Conservation of subpopulations is essential if they occur (i) within a threatened ecosystem or (ii) within an area required for biodiversity conservation in terms of a relevant biodiversity conservation plan or (iii) on a site associated with additional ecological sensitivities.

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.

Implications for development: ORANGE LIST SPECIES: This is a highly range-restricted species, known from a single or isolated sites, and therefore no loss of habitat should be permitted as it may lead to extinction of the species. The Threatened Species Programme is not aware of any current threats to this species and should be notified without delay. The Threatened Species Programme must be informed immediately, providing details of the location, size and threats to the subpopulation.

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.

Implications for development: ORANGE LIST SPECIES: The species is likely to have a restricted range, or be highly habitat specific, or have small numbers of individuals, all of which makes it vulnerable to extinction should it lose habitat. Recommend no loss of habitat. The Threatened Species Programme is not aware of any current threats to this species and should be notified without delay. The Threatened Species Programme must be informed immediately, providing details of the location, size and threats to the subpopulation.

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.

Implications for development: ORANGE LIST SPECIES: The species is declining but the population has not yet reached a threshold of concern; limited loss of habitat may be permitted. Should the species is known to be used for traditional medicine and if individuals will not be conserved in situ, plants should be rescued and used as mother stock for medicinal plant cultivation programmes.

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.

Implications for development: ORANGE LIST SPECIES:

Case D: This species is very poorly known, with insufficient information on its habitat, population status or distribution to assess it. However, it is highly likely to be threatened. If a Data Deficient species will be affected by a proposed activity, the subpopulation should be well surveyed and the data sent to the Threatened Species Programme. The species will be reassessed and the new status of the

species, with a recommendation, will be provided within a short timeframe. The Threatened Species Programme must be informed immediately, providing details of the location, size and threats to the subpopulation.

Case T: There is uncertainty regarding the taxonomic status of this species, but it is likely to be threatened. Contact the taxonomist working on this group to resolve its taxonomic status; the species will then be reassessed by the Threatened Species Programme.

Plant species nomenclature follows Germishuizen and Meyer (2003) and the online African Plant Database (CJB 2014), Henderson (2001) and Bromilow (2010).

4.3. Terrestrial Vertebrate Survey

The SANBI SIBIS and ADU database as well as Apps (2000) was queried regarding amphibians, reptiles and mammals historically recorded in the study area and surroundings. A full list of species that could occur in the study area according to these data sources is listed in Appendix C. Species that were sighted or of which relatively recent signs were found are listed under results.

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 criteria 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 amount 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)

This implies that in the sensitivity analysis not only aspects that currently prevail on the area should be taken into consideration, but also if there is a possibility of a full restoration of the original environment and its biota, or at least the

rehabilitation of ecosystem services resembling the original state after an area has been significantly disturbed.

According to the above, sensitivity classes have been summarised as follows:

- » **No-Go Areas:** Areas that have irreplaceable biodiversity or important ecosystem function values, which may be lost permanently if these ecosystems are transformed, with a high potential of also affecting adjacent and/or downstream ecosystems negatively.
- » **High Sensitivity:** Areas that are relatively undisturbed or pristine and
 - either very species-rich relative to immediate surroundings,
 - or have a very unique and restricted indigenous species composition
 - alternatively, constitute specific habitats or high niche diversity for fauna and/or flora species of conservation concern, and where the total extent of such habitats and associated species of conservation concern remaining in southern Africa is limited.
 - Excessive disturbance of such habitats may lead to ecosystem destabilisation and/or species loss.
 - This would also include areas where the abiotic environment is of such nature that the habitat and its niche-diversity are the main reason for a higher species diversity and cannot be reconstructed or rehabilitated once physically altered in any way.
- » **Medium Sensitivity:** Areas where disturbances are at most limited and
 - Areas with a species diversity representative of its natural state, but not exceptionally high or unique compared to its surroundings
 - Areas of which the abiotic or biotic configuration does not constitute a very specific or restricted habitat or very high niche diversity
 - Areas that provide ecosystem services needed for the continued functioning of the ecosystem and the continued use thereof (e.g. grazing or pollinator resources).
 - Although species of conservation concern may occur on the area, these are not restricted to these habitats only.
 - Areas that need to remain intact to ensure the functioning of adjacent ecosystems, or wildlife corridors or portions of land that prevent the excessive fragmentation of natural fauna and flora populations, or areas that will be difficult or impossible to rehabilitate to a functional state after physical alteration
- » **Low Sensitivity:** Areas that have been previously transformed, disturbed or
 - Areas that provide limited ecosystem services, or have a low ecological value.
 - Species diversity may be low or all species present have a much wider distribution beyond this habitat or locality.

- Species of conservation concern may be present on such areas, but these are not restricted to these habitats and can be relocated with ease.
- Further arguments may include landscapes where the abiotic nature is such that it can be rehabilitated relatively easy to allow the re-establishment of the original species composition, and where the development will not lead to any unjustified degradation of landscapes or ecosystem services if adequately mitigated.

4.5. Assessment of Impacts for the EIA

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).

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

- » Site specific: Rating = 1
- » Site and surroundings: Rating = 2
- » Site up to provincial extent: Rating = 3
- » Site up to national extent: Rating = 4
- » Site and beyond national borders: Rating = 5

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

A total of 973 indigenous plant species have been recorded in the Tutuka Area according to the SANBI database. 120 indigenous species could be confirmed on site present. A large portion of the study site is disturbed or has been transformed in the past, allowing many alien invasives to become established, with 25 alien invasive species recorded.

At the time of the vegetation survey, the herbaceous layer overall was reasonably well developed, but additional species may occur in the area that were dormant at the time. Most of the grasslands are still in a state of rehabilitation, thus gradual future changes in species composition can still be expected. The western portion of site alternative 1 has numerous small wetlands, of which the vegetation and delineation will be described in more detail in the wetlands delineation report. Although such wetlands and possible wetlands are mapped, they were not studied in detail during this survey.

None of the grasslands are considered to be in a pristine condition, with only a small section considered to be primary (natural) grassland. Portions of the grassland appear to have been able to regenerate for a longer time and show a considerably higher biodiversity, including a few plants of conservation concern. The remaining extent of primary grassland is classified as Important and Necessary, whilst the better condition rehabilitated and more diverse grassland is classified by the MBCP as of Least Concern. The remainder of the area has been recognised as rangelands with no Natural Habitat Remaining (see section 3.3). It must be noted here that the mapping for the MBCP was done at a high scale, and hence delineations currently available for the different habitats do not entirely match the actual state of the vegetation on the ground, which is especially applicable to the eastern section of Site Alternative 1, where the grasslands have been severely degraded and transformed in the past (see Figures 4 and 5).

Vegetation units 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.

5.2. Description of vegetation units and associated habitats

Three vegetation associations could be identified (Figure 4):

- » Association 1 (red): *Andropogon chinensis* - *Aloe ecklonis* Grassland
 - Sensitivity: High
 - MBCP Rating: Important and necessary

- » Association 2 (orange): *Pennisetum clandestinum* - *Aristida bipartita*
Grassland
 - Sensitivity: Low
 - MBCP Rating: No Natural Habitat Remaining
- » Association 3 (green): *Eragrostis chloromelas* - *Hermannia depressa*
Grassland
 - Sensitivity: Low
 - MBCP Rating: Least Concern

In addition, evidence of several wetlands could be identified – where these were clearly visible they have been mapped as wetlands, but are described in more detail in the wetlands delineation report.

The sensitivity of the above associations is shown in Figure 5, with more detail on the sensitivity rating given within the descriptions below.

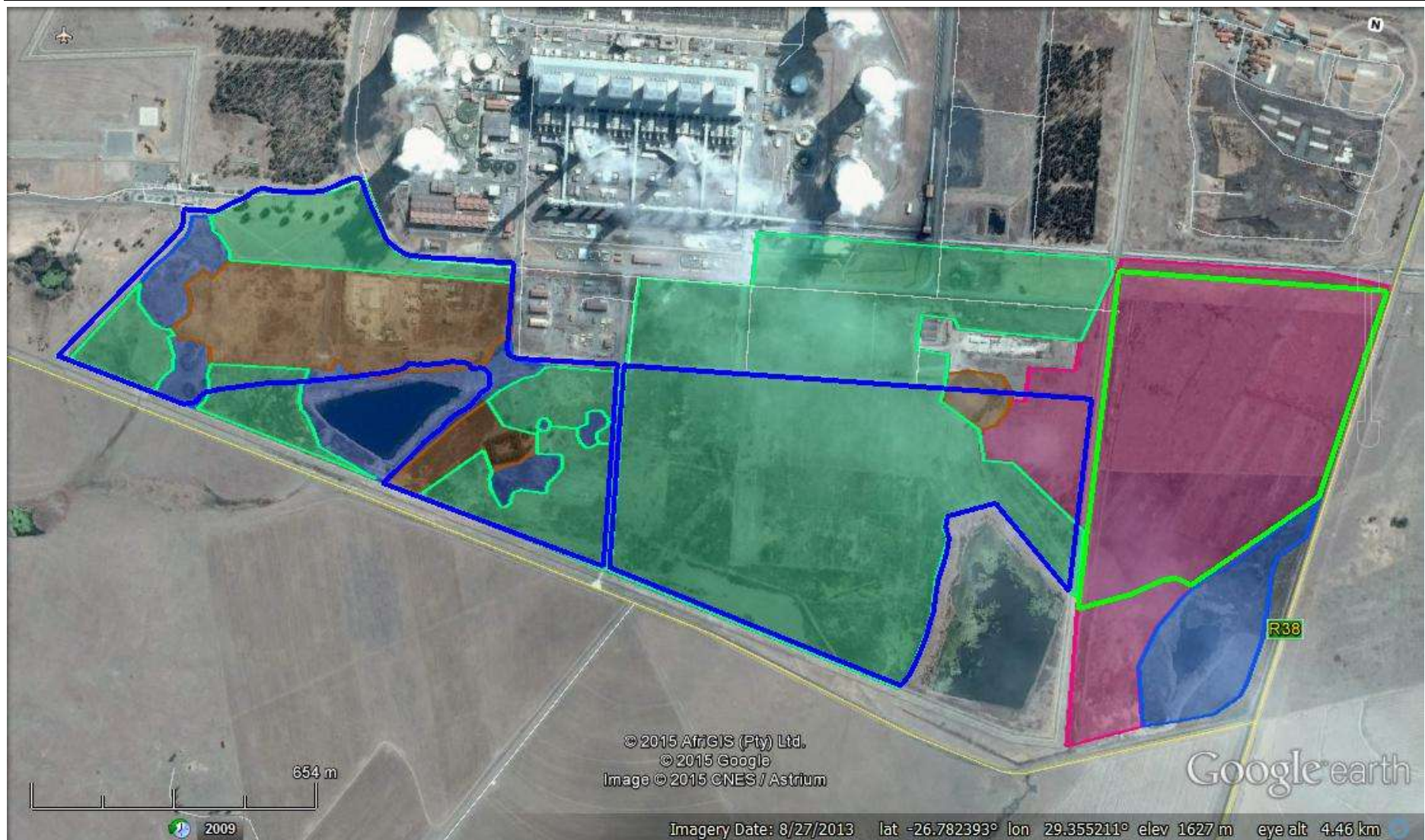


Figure 4: Vegetation associations identified within the study area.

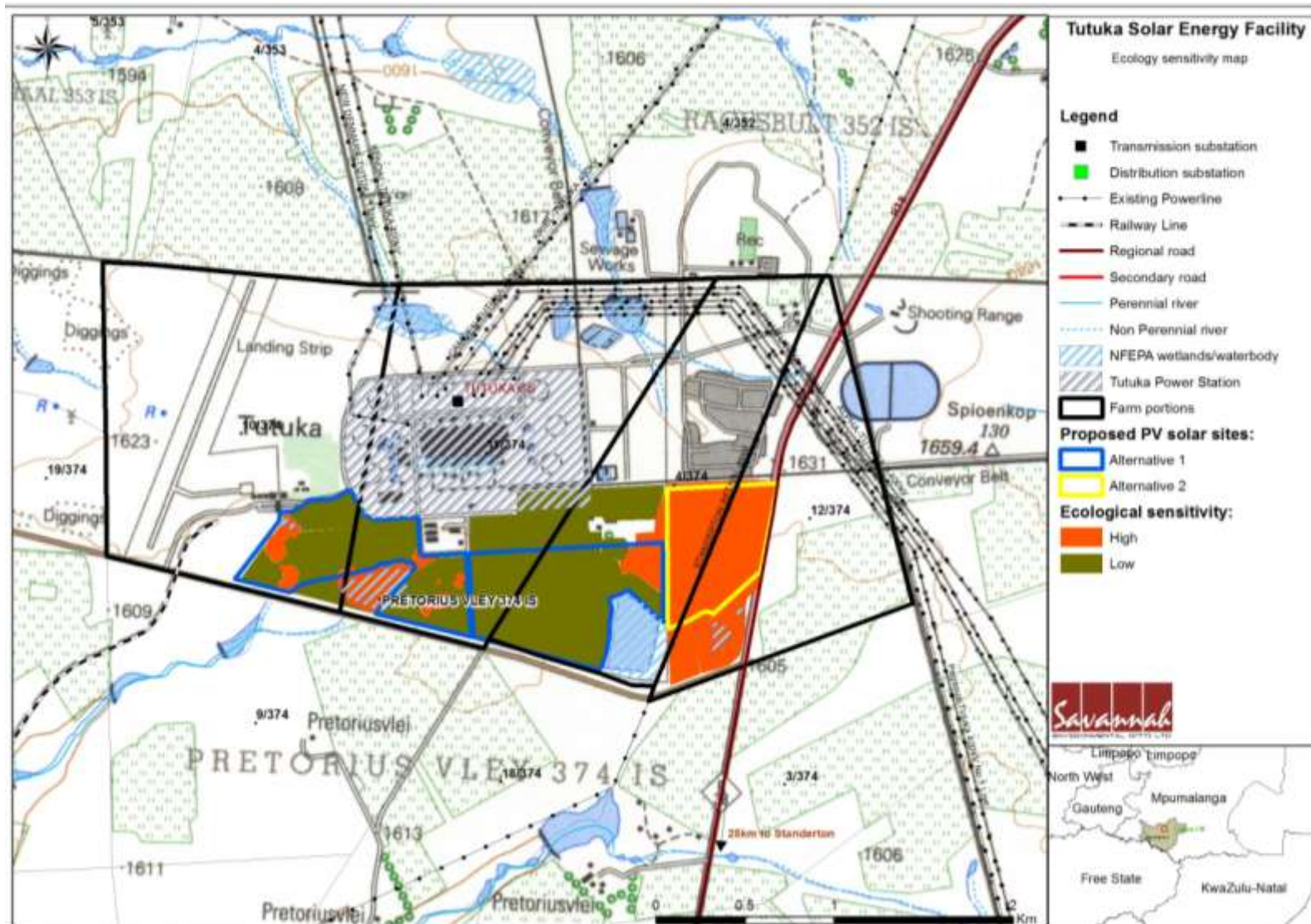


Figure 5: Ecological sensitivity of the study area.

5.2.1. *Andropogon chinensis* - *Aloe ecklonis* Grasslands

Habitat and Land use			
Substrate	Loamy sand, gentle southerly slope, central drainage and small wetlands in-between	Disturbance	Some weed encroachment
Species Richness	70 indigenous species 9 alien invasive species		
Need for rehabilitation	Eradication of alien invasives	Agricultural potential	High grazing potential
Vegetation structure			
Layer	Height (m)	Cover (%)	
Low Shrubs	0.1 – 0.9	5 - 20	
Grass	0.1 – 1.8	60 - 70	
Forbs, including geophytes	0.1 – 0.8	30 - 40	
Dominant species (from highest to lowest cover)	<i>Andropogon chinensis</i> , <i>Aloe ecklonis</i> , <i>Eragrostis curvula</i> , <i>Eragrostis remotiflora</i> , <i>Schkuhria pinnata</i> , <i>Themeda triandra</i> , <i>Cosmos bipinnatus</i> , <i>Conyza podocephala</i> , <i>Brachiaria serrata</i> , <i>Eragrostis capensis</i> , <i>Heteropogon contortus</i> , <i>Selago densiflora</i> , <i>Setaria sphacelata</i>		

Conservation status	Indigenous	Weeds (Indigenous)	Alien	Total	Red Data	Protected
Low shrubs	1	2		3		
Succulents	2			2		1
Forbs	37	1	9	47		1
Grasses	14			14		
Geophytes	12	1		13		5
Total	66	4	9	79	0	7

Portions of this grassland is still in its natural state, portions have been rehabilitated, but can already be considered as in a near-natural state, with a relative abundance of geophytic and non-grass species present (Figure 6). The vegetation consists of a very dense herbaceous layer, with patches of very dense *Aloe ecklonis* stands and also areas with a high abundance of *Eulophia* (orchid) species. The grasslands slope gently southwards, draining into natural and man-made wetlands.



Figure 6: Vegetation on site alternative 2.

Species composition and typical observed cover percentages:

<i>Species</i>	<i>Status</i>	<i>avg %</i>	<i>max %</i>
Succulents			
<i>Aloe ecklonis</i>	11	15	20
<i>Bulbine narcissifolia</i>		0.1	
Low shrubs			
<i>Gomphocarpus fruticosus</i>	W	0.1	
<i>Hermannia erodioides</i>		0.2	
<i>Seriphium plumosum</i>	W	0.1	
Herbs and forbs			
<i>Abildgaardia ovata</i>		0.2	
<i>Anthospermum rigidum</i>		0.5	
<i>Berkheya pinnatifida</i>		0.1	
<i>Berkheya radula</i>		0.1	
<i>Bidens pilosa</i>	AI	2	
<i>Bulbostylis hispidula</i>		0.5	
<i>Cirsium vulgare</i>	AI: 1b	0.1	
<i>Commelina Africana</i>		0.3	
<i>Conyza podocephala</i>	W	5	

<i>Species</i>	<i>Status</i>	<i>avg %</i>	<i>max %</i>
<i>Cosmos bipinnatus</i>	AI	8	
<i>Crepis hypochaeridea</i>	AI	0.5	
<i>Cuscuta campestris</i>	AI: 1b	0.1	
<i>Cyanotis speciosa</i>	11	0.5	
<i>Datura stramonium</i>	AI: 1b	0.1	
<i>Gerbera species</i>		0.1	
<i>Gnidia burchellii</i>		0.1	
<i>Haplocarpha lyrata</i>		0.2	
<i>Haplocarpha scaposa</i>		0.1	
<i>Helichrysum aureonitens</i>		0.2	
<i>Helichrysum coriaceum</i>		0.1	
<i>Helichrysum nudifolium</i>		0.1	
<i>Helichrysum pilosellum</i>		3	
<i>Helichrysum psilolepis</i>		0.1	
<i>Helichrysum rugulosum</i>		2	
<i>Hermannia geniculata</i>		0.3	
<i>Hibiscus microcarpus</i>		0.2	
<i>Hibiscus trionum</i>		0.1	
<i>Indigofera evansiana</i>		0.1	

<i>Species</i>	<i>Status</i>	<i>avg %</i>	<i>max %</i>
<i>Lactuca inermis</i>		0.5	
<i>Oenothera tetraptera</i>	AI	0.5	
<i>Polygala gerrardii</i>		0.1	
<i>Polygala hottentotta</i>		0.1	
<i>Rhynchosia adenodes</i>		0.2	
<i>Scabiosa columbaria</i>		0.1	
<i>Schkuhria pinnata</i>	AI	10	
<i>Seddera capensis</i>		0.1	
<i>Selago densiflora</i>		5	
<i>Senecio consanguineus</i>		1	
<i>Senecio coronatus</i>		0.1	
<i>Senecio erubescens</i>		0.5	
<i>Senecio isatideus</i>		0.5	
<i>Solanum panduriforme</i>		0.3	
<i>Tagetes minuta</i>	AI	0.5	
<i>Tragopogon dubius</i>		0.1	
<i>Vernonia oligocephala</i>		0.5	
<i>Wahlenbergia undulata</i>		0.1	
<i>Wahlenbergia virgate</i>		1	
Grasses			
<i>Andropogon appendiculatus</i>		3	
<i>Andropogon chinensis</i>		30	
<i>Argyrolobium humile</i>		0.1	
<i>Aristida junciformis</i>		1	
<i>Brachiaria serrata</i>		5	
<i>Elionurus muticus</i>		1	
<i>Eragrostis capensis</i>		5	

<i>Species</i>	<i>Status</i>	<i>avg %</i>	<i>max %</i>
<i>Eragrostis curvula</i>		15	
<i>Eragrostis remotiflora</i>		15	
<i>Heteropogon contortus</i>		5	
<i>Setaria incrassata</i>		2	
<i>Setaria sphacelata</i>		5	
<i>Sorghum bicolor s. drummondii</i>		0.5	
<i>Themeda triandra</i>		10	
Geophytes			
<i>Albuca setosa</i>		0.2	
<i>Asclepias eminens</i>		0.1	
<i>Boophane disticha</i>	11	0.2	
<i>Chlorophytum fasciculatum</i>		0.1	
<i>Cyperus esculentus</i>	W	0.1	
<i>Dipcadi viride</i>		0.1	
<i>Eulophia hians</i>	11	0.3	
<i>Eulophia leontoglossa</i>	11	0.1	
<i>Eulophia ovalis</i>	11	0.1	
<i>Gladiolus crassifolius</i>	11	0.1	
<i>Hypoxis angustifolia</i>		0.1	
<i>Hypoxis rigidula</i>		3	
<i>Oxalis obliquifolia</i>		0.1	
Symbols:			
11	= provincially protected, Schedule 11		
AI	= Alien Invasive Plant, indicated by category if listed under NEMA:BA		
W	= Indigenous weed that could potentially become invasive		

Sensitivity Rating:

- Conservation status**
 - » High: several species and large populations of species of conservation concern
 - » MBCP Rating: Important and Necessary
- Ecosystem function**
 - » Grazing
 - » Soil stabilisation
 - » Flood attenuation
 - » Resource for pollinator populations
- Stability**
 - » High if indigenous vegetation is retained
- Reversibility of degradation**
 - » Portions previously transformed/disturbed, improvement to natural grassland progressing well
- Rating**
 - » **High sensitivity**

General development recommendations:

Avoid as far as possible, limit areas affected to the more degraded areas within site alternative 1. Search and Rescue operations prior to commencement of activity will be important. Aim to always maintain a low vegetation layer to cover soils as bare soils will erode and be prone to alien plant invasion.

5.2.2. *Pennisetum clandestinum* - *Aristida bipartita* Grassland

Habitat and Land use			
Substrate	Loamy sand, slightly undulating plains, several wetlands in-between	Disturbance	Extensive amounts of rubble, high amount of ruderal and alien species
Species Richness	36 indigenous species (excluding wetland areas) 15 alien invasive species (excluding wetland areas)		
Need for rehabilitation	Eradication of alien invasives, removal of rubble	Agricultural potential	Low
Vegetation structure			
Layer	Height (m)	Cover (%)	
High Shrubs and trees	2 - 6	0 - 25	
Low Shrubs	0.3 – 0.8	1	
Grass	0.1 - 2	40 - 65	
Forbs, including geophytes	0.05 – 0.6	10 - 20	
Dominant species (from highest to lowest cover)	<i>Eragrostis curvula</i> , <i>Pennisetum clandestinum</i> , <i>Aristida bipartita</i> , <i>Eragrostis lehmanniana</i> , <i>Eragrostis remotiflora</i> , <i>Medicago lupulina</i> , <i>Andropogon appendiculatus</i> , <i>Conyza podocephala</i> , <i>Hyparrhenia hirta</i> (<i>Eucalyptus</i> around old kraals)		

Conservation status	Indigenous	Weeds (Indigenous)	Alien	Total	Red Data	Protected
High shrubs/trees			1	1		
Low shrubs	2	2		4		
Succulents				0		
Forbs	15	2	11	28		
Grasses	13	1	3	17		
Geophytes		1		1		
Total	30	6	15	51	0	0

These grasslands can be considered the most degraded within the study area, with a very high presence of alien invasive species. It consists of a relatively

sparse grass and forb layer (Figure 7), in which short-lived annual species make out some of the dominant species. Old kraal-areas are still surrounded with a row of *Eucalyptus* trees, between which mostly ruderal invasive species are able to persist. Typically for degraded grasslands, the forb diversity is relatively low with an almost complete absence of geophytic species, compared to more productive grasslands.

Sections of this grassland have been completely transformed, and high amounts of rubble are still present.



Figure 7: The degraded Grassland on site alternative 1.

Species composition and typical observed cover percentages:

<i>Species</i>	<i>Status</i>	<i>avg %</i>	<i>max %</i>	<i>Species</i>	<i>Status</i>	<i>avg %</i>	<i>max %</i>
Low shrubs				<i>Bidens pilosa</i>	AI	0.5	
<i>Gomphocarpus fruticosus</i>	W	0.1		<i>Chamaesyce inaequilatera</i>		0.2	
<i>Seriphium plumosum</i>	W	1		<i>Cirsium vulgare</i>	AI: 1b	0.1	
<i>Tephrosia capensis</i>		0.2		<i>Conyza podocephala</i>	W	3	
				<i>Crepis hypochaeridea</i>	AI	1	
Herbs and forbs				<i>Cuscuta campestris</i>	AI: 1b	0.2	
<i>Abildgaardia ovata</i>		0.3		<i>Helichrysum paronychioides</i>		0.3	
<i>Anthospermum rigidum</i>		0.3					

<i>Species</i>	<i>Status</i>	<i>avg %</i>	<i>max %</i>
<i>Helichrysum rugulosum</i>		0.5	
<i>Hermannia geniculate</i>		1	
<i>Hypochaeris radicata</i>	AI	0.1	
<i>Laggera decurrens</i>		0.1	
<i>Lepidium africanum</i>	W	0.1	
<i>Medicago lupulina</i>	AI	5	
<i>Oenothera tetraptera</i>	AI	1	
<i>Plantago lanceolate</i>		0.5	
<i>Polygala gerrardii</i>		0.1	
<i>Polygala hottentotta</i>		0.2	
<i>Schkuhria pinnata</i>	AI	0.3	
<i>Senecio erubescens</i>		1	
<i>Tagetes minuta</i>	AI	0.2	
<i>Tephrosia semiglabra</i>		0.1	
<i>Tragopogon dubius</i>		0.1	
<i>Verbena bonariensis</i>	AI: 1b	2	
<i>Verbena brasiliensis</i>	AI: 1b	0.3	
<i>Vernonia oligocephala</i>		0.5	
<i>Wahlenbergia virgate</i>		0.1	
Grasses			
<i>Agrostis lachnantha</i>		1	
<i>Andropogon appendiculatus</i>		3	

<i>Species</i>	<i>Status</i>	<i>avg %</i>	<i>max %</i>
<i>Andropogon huillensis</i>		2	
<i>Aristida bipartita</i>		8	
<i>Aristida junciformis</i>		1	
<i>Bromus catharticus</i>	AI	0.1	
<i>Cynodon dactylon</i>		0.5	
<i>Eragrostis capensis</i>		2	
<i>Eragrostis curvula</i>		45	
<i>Eragrostis lehmanniana</i>		5	
<i>Eragrostis remotiflora</i>		5	
<i>Hyparrhenia hirta</i>	W	3	
<i>Imperata cylindrica</i>		0.5	
<i>Paspalum dilatatum</i>	AI	0.3	
<i>Pennisetum clandestinum</i>	AI	10	
<i>Setaria nigrirostris</i>		0.5	
<i>Sporobolus africanus</i>		1	
Geophytes			
<i>Cyperus esculentus</i>	W	0.3	
Symbols:			
AI	= Alien Invasive Plant, indicated by category if listed under NEMA:BA		
W	= Indigenous weed that could potentially become invasive		

Sensitivity Rating:

- Conservation status**
 - » Low: no species of conservation concern, high number of alien invasives
 - » Mpumalanga Conservation Plan:
- Ecosystem function**
 - » Grazing
 - » Soil stabilisation
 - » Flood attenuation
- Stability**
 - » High where the lower vegetation layer is dense, medium to low if soils become bare
- Reversibility of degradation**
 - » Possible, will require intervention, clearing of invasives and rubble needed to improve ecosystem functionality
- Rating**
 - » **Low sensitivity**

General development recommendations:

The vegetation itself is suitable for the proposed development, but most of it is positioned in close proximity to wetlands. It would be desirable that the amount of alien invasive species be drastically reduced and rubble removed entirely.

For the development, it is recommended that a low natural grass layer be re-instated to suppress ruderal weed and alien invasive species. Regular mowing of this grass layer will ensure it does not pose a fire risk to the proposed development.

5.2.3. *Eragrostis chloromelas* - *Hermannia depressa* Grassland

Habitat and Land use			
Substrate	Loamy sand, slightly undulating plains	Disturbance	Semi-natural grasslands, extensive previous disturbance (including earthworks) visible.
Species Richness	92 indigenous species 23 alien invasive species		
Need for rehabilitation	Eradication of alien invasives Removal of rubble	Agricultural potential	Mediocre grazing, game (Eland and Hartebeest) roaming this area
Vegetation structure			
Layer	Height (m)	Cover (%)	
High Shrubs and trees	2 - 3	0.5 - 1	
Low Shrubs	0.4 – 1.2	0 - 2	
Grass	0.05 - 20	45 - 70	
Forbs, including geophytes	0.02 – 1.5	20 - 50	
Dominant species (from highest to lowest cover)	<i>Eragrostis chloromelas</i> , <i>Eragrostis curvula</i> , <i>Cosmos bipinnatus</i> , <i>Hyparrhenia hirta</i> , <i>Eragrostis capensis</i> , <i>Eragrostis lehmanniana</i> , <i>Heteropogon contortus</i> , <i>Cynodon dactylon</i> , <i>Themeda triandra</i> , <i>Aristida junciformis</i> , <i>Abildgaardia ovata</i> , <i>Bidens pilosa</i>		

Conservation status	Indigenous	Weeds (Indigenous)	Alien	Total	Red Data	Protected
High shrubs/Trees			1	1		
Low shrubs		3		3		
Succulents	1			1		1
Forbs	43	2	19	64		
Grasses	29	1	3	33		
Geophytes	12	1		13		4

Total	85	7	23	115	0	5
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Most of this grassland has been previously transformed and then rehabilitated. A high amount of ruderal and alien invasive species is still present, but diversity is relatively high, with several species indicative of more stable and natural grassland conditions. These grasslands are utilised by Hartebeest and Eland that are being kept within the Tutuka Power Station enclosure. Small occurrence of species of conservation concern, all geophytes, have been found within this vegetation.



Figure 8: Semi-natural grasslands on site alternative 1.

Species composition and typical observed cover percentages:

<i>Species</i>	<i>Status</i>	<i>avg %</i>	<i>max %</i>	<i>Species</i>	<i>Status</i>	<i>avg %</i>	<i>max %</i>
Succulents				<i>Hermannia geniculata</i>		1	2
<i>Aloe ecklonis</i>	11	0.1		<i>Hermannia oblongifolia</i>		0.5	3
				<i>Hibiscus microcarpus</i>		0.1	
High shrubs				<i>Hibiscus trionum</i>		0.1	
<i>Gleditsia triacanthos</i>	AI: 1b		2	<i>Hypochaeris radicata</i>	AI	0.1	
				<i>Hypodiscus rigidus</i>		0	0.3
Low shrubs				<i>Jamesbrittenia aurantiaca</i>		0.1	0.5
<i>Gomphocarpus fruticosus</i>	W	1	2	<i>Kyllinga pulchella</i>		0.1	0.5
<i>Seriphium plumosum</i>	W	1		<i>Lactuca inermis</i>		0.2	1
<i>Sida chrysantha</i>	W	0.1		<i>Laggera decurrens</i>		0.2	
				<i>Lepidium africanum</i>	W	0.1	
Herbs and forbs				<i>Medicago lupulina</i>	AI	0.3	1
<i>Abildgaardia ovata</i>		2	10	<i>Oenothera rosea</i>	AI	0.3	
<i>Anthospermum rigidum</i>		2	3	<i>Oenothera tetraptera</i>	AI	0.2	2
<i>Berkheya Echinacea</i>		0.2		<i>Paronychia brasiliiana</i>	AI	0.2	
<i>Berkheya pinnatifida</i>		0.2	0.5	<i>Plantago lanceolata</i>		1	2
<i>Bidens bipinnata</i>	AI	0.1		<i>Polygala gerrardii</i>		0.1	
<i>Bidens pilosa</i>	AI	1	10	<i>Polygala hottentotta</i>		0.1	
<i>Bulbostylis hispidula</i>		0.3	1	<i>Pycreus species</i>		0.1	0.5
<i>Chaetacanthus costatus</i>		0.2		<i>Rumex crispus</i>	AI	0.1	
<i>Chamaesyce inaequilatera</i>		0.1	1	<i>Schkuhria pinnata</i>	AI	0.2	1
<i>Cirsium vulgare</i>	AI: 1b	0.1		<i>Seddera capensis</i>		0.1	
<i>Commelina Africana</i>		0.5	1	<i>Selago densiflora</i>		1	3
<i>Conyza podocephala</i>	W	1	2	<i>Senecio consanguineus</i>		0.6	
<i>Cosmos bipinnatus</i>	AI	15	40	<i>Senecio erubescens</i>		0.2	
<i>Crepis hypochaeridea</i>	AI	0.2	0.5	<i>Senecio isatideus</i>		0.1	
<i>Cuscuta campestris</i>	AI: 1b	0.1	0.3	<i>Solanum panduriforme</i>		0.1	1
<i>Cyanotis speciose</i>		0.1		<i>Solanum pseudocapsicum</i>	AI: 1b	0.1	
<i>Foeniculum vulgare</i>	AI	0.1		<i>Sonchus dregeanus</i>		0.1	
<i>Gazania krebsiana</i>		0.1	1	<i>Tagetes minuta</i>	AI	0.2	3
<i>Geigeria aspera</i>		0.3	8	<i>Trifolium africanum</i>		0.1	
<i>Gomphrena celosioides</i>	AI	0.1	0.2	<i>Verbena bonariensis</i>	AI: 1b	0.5	1
<i>Haplocarpha lyrata</i>		0.1	3	<i>Verbena brasiliensis</i>	AI: 1b	0.5	2
<i>Helichrysum aureonitens</i>		0.2		<i>Vernonia oligocephala</i>		0.1	
<i>Helichrysum coriaceum</i>		0.1		<i>Vernonia sutherlandii</i>		0.1	1
<i>Helichrysum nudifolium</i>		0.1		<i>Wahlenbergia undulata</i>		0.2	
<i>Helichrysum rugulosum</i>		1	2	<i>Wahlenbergia virgate</i>		0.1	
<i>Hermannia depressa</i>		0.1	3	<i>Withania somnifera</i>		0.1	

<i>Species</i>	<i>Status</i>	<i>avg %</i>	<i>max %</i>
Grasses			
<i>Agrostis lachnantha</i>		0.6	
<i>Andropogon appendiculatus</i>		1	2
<i>Aristida bipartite</i>		0.1	
<i>Aristida congesta</i>		0.1	
<i>Aristida junciformis</i>		6	8
<i>Aristida recta</i>		0.1	
<i>Brachiaria serrata</i>		2	3
<i>Bromus catharticus</i>	AI	0.2	
<i>Bromus leptoclados</i>		0.1	1
<i>Cymbopogon dieterlenii</i>		0.1	
<i>Cymbopogon validus</i>		0.1	0.5
<i>Cynodon dactylon</i>		3	10
<i>Elionurus muticus</i>		0.2	
<i>Eragrostis bicolor</i>		0.1	
<i>Eragrostis capensis</i>		0.1	10
<i>Eragrostis chloromelas</i>		5	25
<i>Eragrostis curvula</i>		19	35
<i>Eragrostis lehmanniana</i>		8	15
<i>Heteropogon contortus</i>		2	10
<i>Hyparrhenia hirta</i>	W	5	20
<i>Imperata cylindrical</i>		0	0.2
<i>Melinis repens s. repens</i>		0.6	
<i>Microchloa kunthii</i>		0.5	3
<i>Panicum stapfianum</i>		0.7	3
<i>Paspalum dilatatum</i>	AI	0.1	0.5
<i>Pennisetum clandestinum</i>	AI	0	1

<i>Species</i>	<i>Status</i>	<i>avg %</i>	<i>max %</i>
<i>Setaria nigrirostris</i>		0.1	1
<i>Setaria sphacelata</i>		1	
<i>Sporobolus africanus</i>		2	3
<i>Sporobolus fimbriatus</i>		0.1	2
<i>Themeda triandra</i>		7	10
<i>Triraphis andropogonoides</i>		0.1	
<i>Tristachya leucothrix</i>		0.5	1
Geophytes			
<i>Albica setosa</i>		0.1	
<i>Asclepias eminens</i>		0.1	
<i>Boophane disticha</i>	11	0.1	0.3
<i>Chlorophytum fasciculatum</i>		0.2	
<i>Corycium nigrescens</i>	11	0.1	
<i>Cyperus esculentus</i>	W	0.2	1
<i>Dipcadi species</i>		0.1	
<i>Gladiolus crassifolius</i>	11	0.1	
<i>Gladiolus permeabilis</i>	11	0.1	
<i>Hypoxis angustifolia</i>		0.1	
<i>Ledebouria marginata</i>		0.1	
<i>Ledebouria ovatifolia</i>		0.1	
<i>Oxalis smithiana</i>		0.1	
Symbols:			
11 = provincially protected, Schedule 11			
AI = Alien Invasive Plant, indicated by category if listed under NEMA:BA			
W = Indigenous weed that could potentially become invasive			

Sensitivity Rating:

- Conservation status** » Low, previously transformed, only small number of species of conservation concern
- Ecosystem function** » Grazing
 » Soil stabilisation
 » Flood attenuation
 » Resource for pollinator populations
- Stability** » Medium to high if indigenous vegetation can be retained and/or re-established
- Reversibility of degradation** » Previously transformed, improvement to natural grassland possible

Rating » **Low sensitivity**

General development recommendations:

Search and Rescue operations prior to commencement of activity will be important. Listed alien invasive species must be eradicated to prevent further spread of regenerative material into surrounding areas or further downstream. It is recommended that a low natural grass layer be re-instated to suppress ruderal weed and alien invasive species. Regular mowing of this grass layer will ensure it does not pose a fire risk to the proposed development.

5.3. Amphibians, Reptiles and Mammals

A list of protected vertebrate species (amphibians, reptiles, and mammals) that could occur in the study area according to the ADU and SANBI databases, as well as Apps (2000) is presented in Appendix C. A small herd of Hartebeest and Eland have are being kept within the Tutuka Power Station Fenced Portion, and have been found roaming on the study area. No other terrestrial fauna has been observed during the field study.

5.4. Species of conservation concern

The following red data species have been recorded from the area (2827) according to the red data species list of SANBI and the ADU database:

Species	RD Status	Suitable Habitat	Possibility of being present	Threat
<i>Plants</i>				
<i>Aloe cooperi</i> subsp. <i>cooperi</i>	Declining	Grasslands	Slight	Habitat destruction
<i>Aspidoglossum xanthosphaerum</i>	VU	Grasslands	Slight	Medicinal trade
<i>Frithia humilis</i>	EN	Rocky outcrops	Unlikely	Habitat destruction
<i>Khadia carolinensis</i>	VU	Rocky outcrops	Unlikely	Habitat destruction
<i>Miraglossum davyi</i>	VU	High altitude grasslands	Unlikely	Habitat destruction
<i>Pachycarpus suaveolens</i>	VU	High altitude grasslands	Unlikely	Habitat destruction
<i>Acalypha caperonioides</i> var. <i>caperonioides</i>	DDT	Grasslands	Slight	Habitat destruction
<i>Asparagus fractiflexus</i>	EN	High altitude grasslands	Unlikely	Medicinal trade

<i>Cineraria austrotransvaalensis</i>	NT	High altitude grasslands	Unlikely	Habitat destruction
<i>Rapanea melanophloeos</i>	Declining	Riparian areas	Unlikely	Habitat destruction
<i>Alepidea peduncularis</i>	DDT	High altitude grasslands	Unlikely	Habitat destruction
<i>Argyrolobium campicola</i>	NT	High altitude grasslands	Unlikely	Habitat destruction
<i>Gunnera perpensa</i>	Declining	Wetlands	Unlikely	Habitat destruction
<i>Kniphofia typhoides</i>	NT	Wetlands	Unlikely	Habitat destruction
<i>Boophone disticha</i>	Declining	Variable habitats	Observed	Medicinal Trade
<i>Crinum bulbispermum</i>	Declining	Grasslands and wetlands	Slight	Habitat destruction
<i>Drimia elata</i>	DDT	Variable habitats	Slight	Medicinal Trade
<i>Eucomis montana</i>	Declining	High altitude grasslands	Unlikely	Habitat destruction
<i>Gladiolus robertsoniae</i>	NT	Dolerite outcrops	Unlikely	Habitat destruction
<i>Habenaria barbertoni</i>	NT	Rocky hillsides	Not expected	Habitat destruction
<i>Hesperantha rupestris</i>	DDD	Rocky areas or wetlands	Unlikely	Habitat destruction
<i>Hypoxis hemerocallidea</i>	Declining	Variable	Slight	Medicinal Trade
<i>Merwillia plumbea</i>	NT	Rocky hillsides	Not expected	Medicinal Trade
<i>Nerine gracilis</i>	VU	Grassland	Slight	Habitat destruction
<i>Stenostelma umbelluliferum</i>	NT	Riparian areas	Not expected	Habitat destruction
<i>Trachyandra erythrorrhiza</i>	NT	Black turf marshes	Not expected	Habitat destruction
Terrestrial Vertebrates				
Giant Girdled Lizard <i>Smaug (Cordylus) giganteus</i>	VU	Grassland	Slight	Habitat destruction
Giant Bull Frog <i>Pyxicephalus adspersus</i>	NT	Wetlands	Slight	Habitat destruction
Coppery Grass Lizard <i>Chamaesaura aenea</i>	NT	Grasslands	Slight	Habitat destruction

The following plants encountered on the study site are protected:

Mpumalanga Nature Conservation Act (Act 10 of 1998):

Aloe ecklonis

Boophane disticha

Corycium nigrescens

Eulophia hians

Eulophia leontoglossa

Eulophia ovalis

Gladiolus crassifolius

Gladiolus permeabilis



Figure 9: Some of the protected plant species observed
 From left: *Eulophia ovalis*, *Boophane disticha*, *Gladiolus crassifolius* and *Aloe ecklonis*

5.5. Invasive Plants

According to the SANBI-POSA species list, over 80 alien invasive plant species have been recorded up to date within the grid representative of Tutuka. 25 of these species could be confirmed on the study site already (excluding exotic trees planted on the periphery of the study area).

Regulation 598 under the National Environmental Management: Biodiversity Act (No 10 of 2004), which came into effect on 1 August 2014, groups Alien Invasive Species according to following categories:

Category 1a: Listed Invasive Species
 Immediate steps must be taken to combat or eradicate such a species

Category 1b: Listed Invasive Species
 Immediate steps must be taken to control such a species

Category 2: Listed Invasive Species
 Commercial and utility plants, allowed only by permit holders, else must be eradicated or controlled. Must be considered a category 1b species if found within any riparian area

Category 3: Listed Invasive Species
 Commercial and utility plants, allowed only by permit holders, must be considered a category 1b species if found within any riparian area

The following listed alien invasive species have been recorded on the study area:

Category 1b:

Cirsium vulgare

Solanum pseudocapsicum

Cuscuta campestris

Verbena bonariensis

Datura stramonium

Verbena brasiliensis

Gleditsia triacanthos

Category 2:

Eucalyptus species

Additional alien invasive species do occur in the surrounding area along major transport routes, which could be accidentally introduced to the project site during construction. Regular monitoring and early eradication should enable a cost-effective control of invasives.

6. Assessment of impacts

6.1. Assumptions

The following is assumed and/or known:

- » Existing access roads and tracks will be used and upgraded, whilst new access roads, servitudes, or power lines will coincide as far as possible with existing infrastructure. Access roads will be suitably reinforced, but not covered with tar or concrete
- » A thorough ecological investigation of all footprint areas will be conducted to detect and relocate all plant species of conservation concern by a suitably qualified botanist prior to a geotechnical survey and commencement of construction
 - Such investigation must be carried out at a time when the maximum amount of species are actively growing and thus visible
- » Prior to development and after construction, until decommissioning, the footprint area will be routinely cleared of all listed alien invasive plants
- » The construction phase itself will be associated with selective clearing of vegetation and trenching for electrical and other cabling as needed
- » All removal of vegetation for construction purposes will be done mechanically, without the use of herbicides

Fixed and Tracking PV Panels

Impacts on the environment will be influenced by the types of PV panel array to be used. The most important differences that are envisaged to influence the impact on the ecological environment (Tsoutsos *et al.* 2005, Turney and Fthenakis 2011, Strohbach 2012) can be summarised as follows:

<i>Aspect influenced</i>	<i>Fixed panel</i>	<i>Tracking panel</i>
Size of land needed	smaller	larger
Shading and its associated change of vegetation	More continuous and intense shading Less stable and dense vegetation expected, reduced buffering capacity of extreme weather events by vegetation expected	More variable and less intense overall shading More stable and denser vegetation cover expected, smaller reduction of buffering capacity of extreme weather events expected
Effect on runoff and accelerated erosion	Larger continuous panel area, more concentrated runoff, constant runoff edges potentially create more erosion, especially where vegetation is weakened	Smaller continuous panel areas, runoff more dissipated, moderate variation of runoff edges that are expected to create less erosion where vegetation is weakened
Mounting height	PV panels may be as low as 50 cm above ground to allow for higher panels, increasing the limits of permissible vegetation due to maintenance and fire risks	Expected to be more than 1 m off the ground, increasing the possibility of low vegetation establishment and small fauna movement without compromising safety

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

1. Activity: Upgrading and/or creation of site access road and internal maintenance tracks

Note: The study area is surrounded by gravel and tar roads, and on-site access will thus be limited to service and construction tracks

Environmental Aspect: Removal of vegetation, compaction and disturbance of soils, creation of runoff zone, possible destruction of animal burrows, impact on protected species, alteration of soil surface properties, increased coal-dust pollution

Environmental impact: Loss of indigenous (-ve) and alien invasive (+ve) vegetation, increase in runoff and erosion, possible increased distribution of alien invasive species,

possible disturbance and reduction of habitat or injury to/loss of burrowing vertebrates, possible change of natural runoff and drainage patterns, possible loss of protected species, possible permanent loss of revegetation potential of soil surface		
	Without mitigation	With mitigation
Extent (E)	Site specific (1)	Site specific (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Low (4)	Small (0)
Probability (P)	Definite (5)	Probable (3)
Significance (S = E+D+M)*P	Medium (45)	Low (15)
Status (positive, neutral or negative)	Negative	<i>Positive</i> where aliens will be cleared <i>Neutral</i> where roads exist or on transformed areas
Reversibility	Not reversible	Relatively reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably well	
<p>Mitigation:</p> <ul style="list-style-type: none"> » Avoid wetland areas and high diversity grassland sections » After the final layout has been approved, conduct a thorough footprint investigation to detect and map any protected plant species and animal burrows <ul style="list-style-type: none"> ○ Protected plant species: must be relocated ○ Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor » During construction: create designated turning areas and strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas » Keep the clearing of grasslands to a minimum » If filling material is to be used, this should be sourced from areas free of invasive species » Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil » Reinforce portions of existing access routes that are prone to erosion, create structures or low banks to drain the access road rapidly during rainfall events, yet preventing erosion of the track and surrounding areas » Ensure that runoff from compacted or sealed surfaces is slowed down and dispersed 		

<p>sufficiently to prevent accelerated erosion from being initiated (storm water and erosion management plan required)</p> <ul style="list-style-type: none"> » Prevent leakage of oil or other chemicals or any other form of pollution » Monitor the establishment of (alien) invasive species and remove as soon as detected, whenever possible before regenerative material can be formed » After decommissioning, if access road or portion thereof will not be of further use to the landowner, remove all foreign material and rip area to facilitate the establishment of vegetation, followed by a suitable revegetation program
<p>Cumulative impacts:</p> <ul style="list-style-type: none"> » 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 » Increased transformation of rangelands in area
<p>Residual impacts:</p> <ul style="list-style-type: none"> » Altered vegetation composition and structure » Altered topsoil conditions » Potential barren areas » Potential for erosion and invasion by weed or alien species

<p>2. Activity: Fencing area – may also serve as maintenance track to PV panels</p>		
<p>Environmental Aspect: <i>(Note: Fencing already exists around the entire power plant area)</i> Removal of vegetation, compaction of soils, creation of runoff zone, impact on protected species, impact on terrestrial vertebrates</p>		
<p>Environmental impact: Loss of indigenous (-ve) and alien invasive (+ve) vegetation, window of opportunity for the establishment of alien invasive species, altered topsoil characteristics prone to capping, increased runoff and erosion, temporary disturbance of burrowing animals, possible reduction of habitat and forage availability to terrestrial vertebrates by exclusion</p>		
	Without mitigation	With mitigation
Extent (E)	Site specific (1)	Site specific (1)
Duration (D)	Long-term (4)	Long term (4)
Magnitude (M)	Minor (2)	Small (0)
Probability (P)	Probable (3)	Probable (3)
Significance (S = E+D+M)*P	Low (21)	Low (15)
Status (positive, neutral or negative)	Negative	<i>Positive</i> where aliens will be cleared

		<i>Neutral</i> where on transformed or highly degraded areas <i>Minimal new negative impacts expected</i>
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	Not likely	Not likely
Can impacts be mitigated?	Reasonably well	
<p>Mitigation:</p> <ul style="list-style-type: none"> » Avoid wetland areas » After the final layout has been approved, conduct a thorough footprint investigation to detect and map (by GPS) any protected plant species and animal burrows <ul style="list-style-type: none"> ○ Protected plant species: must be relocated ○ Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor » As part of the design phase, it must be made clear what vegetation will be permissible and how this will be kept in a state that is suitable for the development, e.g. regular mowing <ul style="list-style-type: none"> ○ It will be important to maintain a fairly dense, low vegetation layer to protect erodible soils and prevent further wetland degradation » During the design phase, the possible impact of burrowing vertebrates and rodents on the development must be determined, and fencing must be designed to either exclude such fauna if it will be detrimental or enable occasional migration of smaller vertebrates onto and across the site (which could be beneficial to small vertebrate populations) » Minimise area affected, especially during construction » During construction: strictly prohibit any off-road driving or parking of vehicles and machinery outside the footprint areas » Prevent leakage of oil or other chemicals, strictly prohibit littering of any kind » Monitor the establishment of alien and indigenous invasive species and remove as soon as detected, whenever possible <i>before</i> regenerative material can be formed 		
<p>Cumulative impacts:</p> <ul style="list-style-type: none"> » Possible erosion of cleared areas and associated accelerated erosion from surrounding areas » Possible loss of ecosystem functioning due to increase in invasive species » Increased fragmentation of rangelands 		
<p>Residual impacts:</p> <ul style="list-style-type: none"> » Altered vegetation composition (temporary) » Possibility for erosion and invasion by alien invasives 		

3. Activity: Construction and operation of PV panels on transformed/low diversity areas		
<p>Environmental Aspect: Removal of vegetation, compaction of topsoil, creation of new or altered runoff zone, redistribution and concentration of runoff from panel surfaces, artificial shading of vegetation, continued displacement of terrestrial vertebrates, reduced buffering capacities of the landscapes during extreme weather events, reduction of alien invasive species (+ve)</p> <p><i>Note: tracking panels may occupy more land, but will have smaller sealed surfaces leading to smaller concentrated runoff volumes, which will cause less soil erosion. Also, smaller panels spaced wider allow a denser vegetation layer to re-establish to stabilise the soils and suppress weeds and invasives. Fixed panels may create more erosion which should be adequately mitigated.</i></p>		
<p>Environmental impact: Significant decrease of weeds and alien invasive vegetation (+ve, if properly mitigated), loss of indigenous vegetation, site-specific altered distribution of rainfall and resultant runoff patterns, general increase in runoff from PV and/or bare areas and associated accelerated erosion, reduction of habitat for terrestrial fauna, possible increase of detrimental effects during periods of extreme weather events, e.g. increased severe erosion or dust due to lower buffering capacity if vegetation remains sparse</p>		
	Without mitigation	With mitigation
Extent (E)	Site specific (1)	Site specific (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Low (4)	Minor (2)
Probability (P)	Definite (5)	Definite (5)
Significance (S = E+D+M)*P	Medium (55)	Medium (35)
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Partially reversible	Reversible
Irreplaceable loss of resources?	Highly Probable	Slight Probability
Can impacts be mitigated?	Reasonably	
<p>Mitigation:</p> <p>» After the final layout has been approved, conduct a thorough footprint investigation to detect and map any protected plant species and active animal burrows</p>		

- Protected plant species: must be relocated
- Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor
- » Keep areas affected to a minimum, strictly prohibit any disturbance outside the demarcated footprint area
- » As part of the design phase, it must be made clear what vegetation will be permissible and how this will be kept in a state that is suitable for the development, e.g. regular mowing
 - It will be important to maintain a fairly dense, low vegetation layer to protect erodible soils and prevent further wetland degradation
- » Remove all rubble and other foreign materials currently on the site, prevent any further pollution
- » Weeds and alien invasive species must be eradicated or significantly reduced:
 - This is not only to stop the high reproduction and spreading of alien invasives, but also to reduce maintenance costs of the proposed development
 - Continue monitoring and removing all invasive vegetation after construction up to decommissioning
- » After construction, rehabilitate an acceptable vegetation layer according to rehabilitation recommendations of the relevant EMPr
 - Use species that were part of the original indigenous species composition similar to the remaining intact natural vegetation as listed in the specialist report, or sow with *Eragrostis curvula*. It is expected that several indigenous species will naturally re-establish due to existing seed banks.
 - A strong grass layer will suppress the re-emergence of weed species from existing seed banks
- » If filling material is to be used, this should be sourced from areas free of invasive species
- » Topsoil (the upper 25 cm) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil
- » Temporarily stored topsoil must be re-applied within 6 months, topsoils stored for longer need to be managed according to a detailed topsoil management plan and must as minimum be freed of weeds and alien invasive plants
- » Monitor the area below the PV panels regularly after larger rainfall events to determine where erosion may be initiated and then mitigate by modifying the soil micro-topography and revegetation efforts accordingly
- » Prevent leakage of oil or other chemicals, strictly prohibit littering of any kind

Cumulative impacts:

- » If mitigation measures are not strictly followed the following could occur:
 - erosion of areas around the panels and continued erosion of the development area with associated siltation and/or degradation of lower-lying wetlands and adjacent natural endangered vegetation

<ul style="list-style-type: none"> ○ contamination of wetlands ○ spread and establishment of invasive species
<p>Residual impacts:</p> <ul style="list-style-type: none"> » altered topsoil characteristics » altered vegetation composition

<p>4. Activity: Construction and operation of any development component(s) on higher diversity grasslands</p>		
<p>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 and resulting decimation of vegetation, displacement of terrestrial vertebrates, reduced buffering capacities of the landscapes during extreme weather events</p> <p><i>Note: tracking panels may occupy more land, but will have smaller sealed surfaces leading to smaller concentrated runoff volumes, which will cause less soil erosion. Also, smaller panels spaced wider allow a denser vegetation layer to re-establish to stabilise the soils and suppress weeds and invasives. Fixed panels may create more erosion which should be adequately mitigated.</i></p>		
<p>Environmental impact: Loss and further fragmentation of species of conservation concern, altered vegetation cover, window of opportunity for the establishment of alien invasive species, site-specific altered distribution of rainfall and resultant runoff patterns, increase in runoff from PV panels and/or bare areas and accelerated erosion, loss of habitat and resource availability for terrestrial fauna, possible increase of detrimental effects during periods of extreme weather events, e.g. severe erosion or dust due to lower buffering capacity of sparser vegetation</p>		
	Without mitigation	With mitigation
Extent (E)	Site and surroundings (2)	Site specific (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	High (8)	High (8)
Probability (P)	Definite (5)	Definite (5)
Significance (S = E+D+M)*P	High (70)	High (65)
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Partially reversible	Partially reversible
Irreplaceable loss of resources?	Highly Probable	Probable

<p>Can impacts be mitigated?</p>	<p>Reasonably</p>	
<p>Mitigation:</p> <ul style="list-style-type: none"> » After the final layout of permissible development components has been approved, conduct a thorough footprint investigation to detect and map any protected plant species and active animal burrows <ul style="list-style-type: none"> ○ Protected plant species: must be relocated ○ Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor » Keep areas affected to a minimum, strictly prohibit any disturbance outside the demarcated footprint area » Clear as little grassland vegetation as possible, aim to maintain vegetation where it will not interfere with the construction or operation of the development, rehabilitate an acceptable vegetation layer according to rehabilitation recommendations of the relevant EMPr <ul style="list-style-type: none"> ○ use only species that were part of the original indigenous species composition as listed in the specialist report » As part of the design phase, it must be made clear what vegetation will be permissible and how this will be kept in a state that is suitable for the development, e.g. regular mowing <ul style="list-style-type: none"> ○ It will be important to maintain a fairly dense, low vegetation layer to protect erodible soils and prevent further wetland degradation » Remove all rubble and other foreign materials currently on the site, prevent any further pollution » Weeds and alien invasive species must be eradicated or significantly reduced: <ul style="list-style-type: none"> ○ This is not only to stop the high reproduction and spreading of alien invasives, but also to reduce maintenance costs of the proposed development ○ Continue monitoring and removing all invasive vegetation after construction up to decommissioning » After construction, rehabilitate an acceptable vegetation layer according to rehabilitation recommendations of the relevant EMPr <ul style="list-style-type: none"> ○ Use species that were part of the original indigenous species composition similar to the remaining intact natural vegetation as listed in the specialist report, or sow with <i>Eragrostis curvula</i>. It is expected that several indigenous species will naturally re-establish due to existing seed banks. ○ A strong grass layer will suppress the re-emergence of weed species from existing seed banks » If filling material is to be used, this should be sourced from areas free of invasive species » Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil 		

- » Temporarily stored topsoil must be re-applied within 6 months, topsoils stored for longer need to be managed according to a detailed topsoil management plan
- » The rehabilitation plan for all temporarily affected areas and for the development area after decommissioning must aim to re-introduce all non-weed indigenous species listed in the specialist report as a minimum, taking the observed original cover percentages as a guideline of acceptable vegetation cover
- » Prevent leakage of oil or other chemicals, strictly prohibit littering of any kind
- » Remove all alien invasive vegetation prior to construction
- » Monitor the establishment of all invasive species and remove as soon as detected, whenever possible before regenerative material can be formed

Cumulative impacts:

- » If mitigation measures are not strictly e the following could occur:
 - Loss of and further fragmentation of remaining portions of natural grassland and associated ecosystem services such as pollination
 - Alteration of occupancy by terrestrial fauna, possible reduction of available habitat and food availability to terrestrial fauna
 - Spread and establishment of invasive species, and further associated degradation of remaining endangered vegetation

Residual impacts:

- » altered topsoil characteristics
- » altered vegetation composition
- » fragmentation and loss of diversity of endangered vegetation

5. Activity: Construction of a short power line as part of the grid connection (see also impacts and mitigations under activity 4 above)

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

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

	Without mitigation	With mitigation
Extent (E)	Site and surroundings (2)	Site specific (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Minor (2)	Small (0)
Probability (P)	Probable (3)	Probable (3)
Significance (S = E+D+M)*P	Low (24)	Low (15)
Status (positive, neutral	Negative	Slightly negative

or negative)		
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	Not likely	Not likely
Can impacts be mitigated?	Reasonably	
<p>Mitigation:</p> <ul style="list-style-type: none"> » During the design phase, aim to have connection routes coinciding with existing tracks or fence lines to reduce the disturbance to vegetation and avoid creating new tracks and areas of compaction by construction and maintenance machinery <ul style="list-style-type: none"> ○ Avoid crossing wetland areas as far as possible » After the final layout has been approved, conduct a thorough footprint investigation to detect and map any protected plant species and animal burrows <ul style="list-style-type: none"> ○ Protected plant species: must be relocated where affected by pylons, maintenance tracks or construction ○ Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor » During construction: create designated servitude areas and strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas » Limit clearing of indigenous vegetation to pylon positions only » Prevent spillage of construction material, oils or other chemicals, strictly prohibit other pollution » Monitor the establishment of invasive species and remove as soon as detected, whenever possible before regenerative material can be formed 		
<p>Cumulative impacts:</p> <ul style="list-style-type: none"> » Possible erosion of surrounding areas if no mitigation is implemented, no major cumulative impact on flora or fauna expected (excluding avifauna) 		
<p>Residual impacts:</p> <ul style="list-style-type: none"> » Very localised alteration of soil surface characteristics » Very localised alteration of species composition 		

6. Activity: Construction of substation and other electricity-related buildings, workshops, offices, etc. on *transformed areas*

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

Environmental impact: Loss of vegetation and/or species of conservation concern, significant decrease and possible eradication of weeds and alien invasive plants (+ve),

loss of microhabitats, altered and reduced vegetation cover, altered distribution of rainfall and resultant runoff patterns, increase in <i>concentrated</i> runoff from sealed surfaces and possibly higher accelerated erosion, reduction of habitat and resource availability for terrestrial fauna		
	Without mitigation	With mitigation
Extent (E)	Site specific (2)	Site specific (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 or negative)	Negative	Neutral on transformed or degraded grassland areas <i>(Negative on high diversity grassland areas – see under activity 4)</i>
Reversibility	Partially reversible	Reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably	
<p>Mitigation:</p> <ul style="list-style-type: none"> » During the design phase, ensure that none of these development components are situated outside transformed areas, or degraded grassland areas adjacent to existing infrastructure <ul style="list-style-type: none"> ○ Treat higher diversity grasslands and wetlands as No-Go zones for these development components » After the final layout has been approved, conduct a thorough footprint investigation to detect and map any protected plant species and animal burrows <ul style="list-style-type: none"> ○ Protected plant species: must be relocated ○ Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor » Weeds and alien invasive species must be eradicated or significantly reduced: <ul style="list-style-type: none"> ○ Continue monitoring and removing all invasive vegetation after construction up to decommissioning » Limit disturbance to footprint area as far as practically possible » During construction: stay within demarcated footprint areas and strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas 		

- » Prevent spillage of construction material and other pollutants, contain and treat any spillages immediately
- » Topsoil (the upper 25 cm) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil
- » Temporarily stored topsoil must be re-applied within 6 months, topsoils stored for longer need to be managed according to a detailed topsoil management plan
- » If filling material is to be used, this should be sourced from areas free of invasive species
- » Rehabilitate and revegetate all areas outside the footprint area that have been disturbed
- » After decommissioning, remove all foreign material prior to starting the rehabilitation
- » The rehabilitation plan for all temporarily affected areas and for the development area after decommissioning must aim to re-introduce non-weed indigenous species listed for the natural remaining grasslands as described in the specialist, taking the observed original cover percentages of intact grasslands as a guideline of acceptable vegetation cover
- » Monitor the establishment of invasive species and remove as soon as detected, whenever possible before regenerative material can be formed

Cumulative impacts:

- » If mitigation measures are not strictly followed the following could occur:
 - erosion of areas around sealed surfaces and continued erosion or degradation of the development area with associated degradation of lower-lying wetlands
 - contamination of wetlands
 - spread and establishment of invasive species

Residual impacts:

- » altered topsoil characteristics
- » possible removal of existing foreign materials from the environment (which would be desirable and positive)
- » altered vegetation composition (which can be positive if invasives are replaced by indigenous species)

7. Activity: Temporary construction camps and sites where materials, machinery and temporary staff facilities are kept during construction

Environmental Aspect: Removal of vegetation, compaction of soils, creation of runoff zone, displacement of terrestrial vertebrates, possible contamination of topsoil and groundwater by chemicals or oils

Note: within the power plant area are already transformed areas that could possibly be utilised for construction equipment

Environmental impact: Loss of vegetation and/or species of conservation concern,

loss of microhabitats, altered vegetation cover, altered distribution of rainfall and resultant runoff patterns, increase in <i>concentrated</i> runoff from sealed or compacted surfaces and possibly higher accelerated erosion, reduction of habitat and resource availability for terrestrial fauna, possible contaminated topsoil, possible contaminated ground water or wetlands		
	Without mitigation	With mitigation
Extent (E)	Site specific (1)	Site specific (1)
Duration (D)	Moderate-term (3)	Short-term (2)
Magnitude (M)	Low (4)	Small (0)
Probability (P)	Highly Probable (4)	Probable (3)
Significance (S = E+D+M)*P	Medium (32)	Low (9)
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	Not likely	Not likely
Can impacts be mitigated?	Reasonably	
<p>Mitigation:</p> <ul style="list-style-type: none"> » Exclude high diversity grasslands and wetlands from this activity » After the final layout has been approved, conduct a thorough footprint investigation to detect and map any protected plant species and animal burrows <ul style="list-style-type: none"> o Protected plant species: must be relocated o Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor » Stay within demarcated temporary construction areas and strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas » Prevent spillage of construction material and other pollutants, contain and treat any spillages immediately, strictly prohibit any pollution/littering according to the relevant EMPr » No fires may be lit for cooking or any other purposes » Facilities may not be used as staff accommodation » Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil » Temporarily stored topsoil must be re-applied within 6 months, topsoils stored for longer need to be managed according to a detailed topsoil management plan 		

<ul style="list-style-type: none"> » After construction remove all foreign material prior to starting the rehabilitation » The rehabilitation plan for all temporarily affected areas must aim to re-introduce all non-weed indigenous species listed in the specialist report as a minimum, taking the observed original cover percentages of intact grasslands as a guideline of acceptable vegetation cover » Monitor the establishment of invasive species and remove as soon as detected, whenever possible before regenerative material can be formed
<p>Cumulative impacts:</p> <ul style="list-style-type: none"> » If mitigation measures are not strictly followed the following could occur: <ul style="list-style-type: none"> ○ erosion of the development area with associated siltation and/or erosion of lower-lying wetlands ○ contamination of drainage lines, lower-lying rivers, wetlands and ground water ○ spread and establishment of invasive species
<p>Residual impacts:</p> <ul style="list-style-type: none"> » altered topsoil characteristics » altered vegetation composition

<p>8. Activity: Borrow-pits and/or topsoil stockpiles that might be required during construction</p>		
<p>Environmental Aspect: Removal of vegetation, compaction of soils, creation of runoff zone, displacement of terrestrial vertebrates</p>		
<p>Environmental impact: Loss of vegetation and/or species of conservation concern, loss of microhabitats, altered vegetation cover, altered distribution of rainfall and resultant runoff patterns, possibly higher accelerated erosion, possible loss of topsoil resources, reduction of habitat and resource availability for terrestrial fauna</p>		
	Without mitigation	With mitigation
Extent (E)	Local (2)	Local (1)
Duration (D)	Long-term (4)	Short-term (2)
Magnitude (M)	Low (4)	Minor (2)
Probability (P)	Highly Probable (4)	Probable (3)
Significance (S = E+D+M)*P	Medium (40)	Low (15)
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Partially reversible	Reversible

Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably	
<p>Mitigation:</p> <ul style="list-style-type: none"> » Exclude high diversity grasslands and wetlands from this activity » After the final layout has been approved, conduct a thorough footprint investigation to detect and map any protected plant species and animal burrows <ul style="list-style-type: none"> ○ Protected plant species: must be relocated ○ Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor » Stay within demarcated areas and access routes for extraction and/or movement of materials » Strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas » Prevent spillage of pollutants, contain and treat any spillages immediately, strictly prohibit any pollution » Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil, manage stored topsoil according to a dedicated topsoil management plan » Temporarily stored topsoil must be re-applied within 6 months, topsoils stored for longer need to be managed according to a detailed topsoil management plan » Monitor erosion of areas and control where necessary » After construction remove all foreign material prior to starting the rehabilitation » Fill up borrow pits that may be created first with overburden or subsoils, covered with topsoils, following to a detailed rehabilitation plan » The rehabilitation plan for all temporarily affected areas must aim to re-introduce all non-weed indigenous species listed in the specialist report as a minimum, taking the observed original cover percentages as a guideline of acceptable vegetation cover » Monitor the establishment of invasive species and remove as soon as detected, whenever possible before regenerative material can be formed 		
<p>Cumulative impacts:</p> <ul style="list-style-type: none"> » If mitigation measures are not strictly followed the following could occur: <ul style="list-style-type: none"> ○ continued erosion of the altered surfaces with associated siltation and/or erosion of lower-lying wetlands ○ contamination of drainage lines, lower-lying rivers or wetlands ○ spread and establishment of invasive species 		
<p>Residual impacts:</p> <ul style="list-style-type: none"> » altered topsoil characteristics » altered vegetation composition 		

9. Activity: PV array <i>components</i> and their continued maintenance and eventual decommissioning: regular washing and possible breakage of panels		
Environmental Aspect: altered runoff and associated vegetation and erosion patterns, contamination of the environment by possible toxic substances and glass		
Environmental impact: localised increase in runoff and accelerated erosion, possible release of toxic substances and/or heavy metals and associated contamination of soil and groundwater, possible contamination and damage to terrestrial fauna by broken glass		
	Without mitigation	With mitigation
Extent (E)	Site and surroundings (2)	Site specific (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Low (4)	Small (0)
Probability (P)	Definite (5)	Probable (3)
Significance (S = E+D+M)*P	Medium (50)	Low (15)
Status (positive, neutral or negative)	Negative	Neutral
Reversibility	Partially reversible	Reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably	
<p>Mitigation:</p> <ul style="list-style-type: none"> » Where panels need to be washed, no polluting chemicals may be used, and the use of water should be minimal as well » Where water is used for washing, monitor areas around the PV arrays for signs of accelerated erosion and establishment of weeds or alien invasive species and manage according to the erosion- and invasive species management plan » Prior to construction and up to decommissioning, clear instructions must be drafted and at all times available on site on how any breakages of PV panels will be dealt with, including: <ul style="list-style-type: none"> ○ A list of possible toxic substances, heavy metals or other potentially harmful substances that could be released during breakage ○ How to contain and mitigate the release of such substances ○ Correct salvage, disposal and preferably also recycling methods (or 		

possibilities) for any broken materials
<p>Cumulative impacts:</p> <ul style="list-style-type: none"> » Possible pollution of surrounding areas if no mitigation is implemented » Possible increase in and spread of alien invasive species beyond the site if no mitigation is implemented
<p>Residual impacts:</p> <ul style="list-style-type: none"> » None expected if mitigation measures are implemented

Implications of the anticipated impacts for the development:

- » The proposed photovoltaic facility development on the site will not have significant impacts on the above-ground ecology of the site if all mitigation measures are followed, especially if listed alien invasives can be reduced. If such currently present disturbances can be sufficiently mitigated, the impact may be to some extent beneficial for more sensitive surrounding areas. The low ecological sensitivity of the larger portion of the study area is due to the past land-use history, during which these areas were transformed or degraded.
- » Potentially significant negative impacts on the ecological environment will occur if remaining portions of high diversity natural vegetation will be further disturbed – these sections should be avoided.
- » The impact on fauna is expected to be small to negligent. Presence of indigenous terrestrial vertebrates within the study area is low due to current land use. Animals that may be permanently present can be relocated or will move away during construction, and may resettle after construction, depending on safety specifications necessitated by the development. No restricted or specific habitat of vertebrates exists on the study area and will be affected by the proposed development; especially if the proposed development remains outside the recommended buffers around wetland and seepage areas.

7. 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).

8. Discussion and Conclusion

The selected study area falls within the original extent of the Soweto Highveld Grassland (Unit Gm8) as defined by Mucina and Rutherford (2006), consisting of gently to moderately undulating landscapes. The short to medium high dense tussock grassland is dominated almost entirely by *Themeda triandra*, with a relatively high diversity of grasses, herbs and geophytes (Mucina and Rutherford

2006). Many of the herbs resprout every year from below-ground storage tubers, usually early in the growing season before the grasses reach their full cover.

Mucina and Rutherford (2006) already classified this grassland as endangered, with only about 0.2% of its original extent protected, and a mere 52% remaining in a natural state. It is listed under the National List of threatened ecosystems as Vulnerable.

None of the grasslands are considered to be in a pristine condition, with only a small section considered to be primary (natural) grassland. Portions of the grassland appear to have been able to regenerate for a longer time and show a considerably higher biodiversity, including a few plants of conservation concern. The remaining extent of primary grassland is classified as Important and Necessary, whilst the better condition rehabilitated and more diverse grassland is classified by the MBCP as of Least Concern. The remainder of the area has been recognised as rangelands with no Natural Habitat Remaining. It must be noted here that the mapping for the MBCP was done at a high scale, and hence delineations currently available for the different habitats do not entirely match the actual state of the vegetation on the ground, which is especially applicable to the eastern section of Site Alternative 1, where the grasslands have been severely degraded and transformed in the past.

Annual and geophytic species have highly variable emerging patterns, depending on the timing and amount of rainfall received during a season. It is thus quite possible that especially the diversity of geophytic (bulbous) and annual species within the study area will be higher than could be determined during the survey.

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.

It is not expected that the development will compromise the survival of any flora or terrestrial vertebrate species on the study area or beyond, but potentially significant negative impacts on the ecological environment will occur if remaining portions of high diversity natural vegetation will be further disturbed – these sections should be avoided. The most significant impacts are expected to be on ecosystem health and functionality, which should remain relatively intact if all

mitigation recommendations are implemented; and the associated integrity of surrounding wetlands.

The largest concerns currently identified are:

- » There are numerous wetland areas on and adjacent to the southern and western portion of the study area
- » The ecological state of the vegetation on especially the site alternative 2 is regarded as Important and Necessary to meet Mpumalanga Biodiversity Targets: this has been confirmed during the field study with a high abundance of some protected plant species
 - It is recommended that site alternative 2 be entirely excluded from the proposed development
- » All indigenous and alien invasives, weeds and potential invasives within the development area will have to be cleared prior to development and controlled after construction until decommissioning
- » Rubble and other pollutants need to be removed from the grasslands
- » An ongoing monitoring program will be necessary to control and/or eradicate newly emerging invasives
- » Newly cleared soils will have to be revegetated and stabilised as soon as construction has been completed
 - Soils are prone to capping and erosion and need to be stabilised by a permanent grass or suitable indigenous vegetation layer.
 - Many of the naturally occurring grass species become moribund and die off if not grazed or burnt regularly. It is thus recommended to implement a regular mowing program (to replace the effect of grazing and burning) to reduce dead biomass accumulation on grass tufts. This will also greatly reduce the risk of fire, which is a natural component of grassland dynamics.

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Websites:

SANBI: <http://bgis.sanbi.org/website.asp>
<http://posa.sanbi.org/searchspp.php>

ADU data bases: <http://vmus.adu.org.za>

Climate: <http://en.climate-data.org/loaction/26839/>

CJB (Conservatoire et Jardin botaniques de la Ville de Genève): AFRICAN PLANT DATABASE: <http://www.ville-ge.ch/musinfo/bd/cjb/africa/recherche.php>

10. Appendix A: 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:	
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

Tutuka Solar Energy Facility

Specialist:	Marianne Strohbach		
Contact person:	Marianne Strohbach		
Postal address:	PO Box 148, Sunninghill		
Postal code:	2157	Cell:	
Telephone:	(011) 656 3237	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) 656 3237	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):

23 March 2015

Date:

11. Appendix B: Curriculum Vitae of Specialist

<p>CURRICULUM VITAE</p> <p>MARIANNE STROHBACH</p> <p>SAVANNAH ENVIRONMENTAL (PTY) LTD</p>
<p>Profession: Specialist Scientist</p> <p>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</p> <p>Work experience: Twenty (20) years active in Plant Ecology</p>
<p>SKILLS BASE AND CORE COMPETENCIES</p> <ul style="list-style-type: none"> • 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 and research • Working knowledge of GIS applications and analysis of satellite imagery data • Completed projects in several Provinces of South Africa, as well as Zimbabwe and Namibia • Several publications in peer-reviewed journals, book chapters, scientific conference presentations and popular articles
<p>EDUCATION AND PROFESSIONAL STATUS</p> <p>Degrees:</p> <p>2003: M.Sc. in Botany, University of Pretoria, Pretoria, RSA</p> <p>1991: B.Sc. Hons in Botany, Nelson Mandela Metropolitan University, Port Elizabeth, RSA</p> <p>1990: B.Sc. in Biological Sciences, Nelson Mandela Metropolitan University, Port Elizabeth</p> <p>Short Courses:</p> <p>2008: Landscape Functional Analysis for vegetation condition and restoration monitoring</p>

2002: Satellite Image Analysis for Vegetation Mapping, German Aerospace Centre (DLR) in Cologne/Würzburg, Germany

1994: 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:

- 7 Articles in peer-reviewed scientific journals
- 5 Book-chapters in scientific publications
- 10 Popular articles
- 9 presentations at scientific conferences
- 2 contributions to TV documentaries on nature

Ongoing outputs:

- Project-specific specialist reports for Ecological Screening Studies, Basic Assessments, Environmental Scoping and Impact Assessments and Ecological Footprint Investigations
- Compilation of Environmental Management Plans: Invasive Plant management, Plant Search and Rescue, Revegetation, Erosion Control

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

Savannah Environmental – Northern Cape, Eastern Cape, Free State, North-West Province, Western Cape, Limpopo

12. Appendix C: Terrestrial Vertebrate species previously recorded in the area

Species Name	Common Name	Threat Status
Amphibians		
<i>Pyxicephalus adspersus</i>	Giant Bull Frog	p, Near Threatened
Reptiles - Geckos		
<i>Lygodactylus ocellatus</i>	Spotted Dwarf Gecko	p
<i>Pachydactylus affinis</i>	Transvaal Gecko	p
<i>Pachydactylus capensis</i>	Cape Gecko	p
<i>Pachydactylus vansonii</i>	Van Son's Gecko	p
Reptiles - Agamas		
<i>Agama aculeata subsp. distantii</i>	Distant's Ground Agama	p
<i>Agama atra</i>	Southern Rock Agama	p
Reptiles – Lizards and skinks		
<i>Chamaesaura aenea</i>	Coppery Grass Lizard	p, Near Threatened
<i>Cordylus vittifer</i>	Common Girdled Lizard	p
<i>Pseudocordylus melanotus subsp. melanotus</i>	Common Crag Lizard	p
<i>Smaug giganteus</i>	Giant Girdled Lizard	p, Vulnerable
<i>Acontias breviceps</i>	Short-headed Legless Skink	p
<i>Acontias gracilicauda</i>	Thin-tailed Legless Skink	p
<i>Trachylepis capensis</i>	Cape Skink	p
<i>Trachylepis punctatissima</i>	Speckled Rock Skink	p
<i>Trachylepis varia</i>	Variable Skink	p
Chiroptera - Bats		
<i>Rhinolophus clivosus</i>	Geoffrey's Horseshoe Bat	Near Threatened
Insectivora - Insectivores		
<i>Atelerix frontalis</i>	Southern African Hedgehog	p, Near Threatened
Artiodactyla – even-toed ungulates		
<i>Raphicerus campestris</i>	Steenbok	p
Symbols: P = Protected Red data status indicated by category (see 4.2)		

13. Appendix D: Ecological Environmental Management Program

13.1. Design Phase

13.1.1. Optimal design and pre-commencement activities

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

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

The selected study area falls within the original extent of the Soweto Highveld Grassland (Unit Gm8) as defined by Mucina and Rutherford (2006), consisting of gently to moderately undulating landscapes. The short to medium high dense tussock grassland is dominated almost entirely by *Themeda triandra*, with a relatively high diversity of grasses, herbs and geophytes (Mucina and Rutherford 2006).

None of the grasslands are considered to be in a pristine condition, with only a small section considered to be primary (natural) grassland. Portions of the grassland appear to have been able to regenerate for a longer time and show a considerably higher biodiversity, including a few plants of conservation concern. The remaining extent of primary grassland is classified as Important and Necessary, whilst the better condition rehabilitated and more diverse grassland is classified by the MBCP as of Least Concern. The remainder of the area has been recognised as rangelands with no Natural Habitat Remaining.

Annual and geophytic species have highly variable emerging patterns, depending on the timing and amount of rainfall received during a season. It is thus quite possible that especially the diversity of geophytic (bulbous) and annual species within the study area will be higher than could be determined during the survey.

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.

Overall, the species diversity of the study area is low, comprising less than 15% of the floral diversity recorded in the greater area. Nevertheless, a few species (with high abundance) of conservation concern observed as well as wetlands on

the area should be taken into account during the design of the layout and the future environmental management of the proposed development.

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

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

Project Component/s	<ul style="list-style-type: none"> » PV Array » Grid connection and associated servitudes » Access roads » Workshop, substation and other related infrastructure » Temporary construction camps » Protective fencing around development » Potential topsoil stockpiles and/or borrow pits
Potential Impact	<ul style="list-style-type: none"> » Placement that degrades the environment unnecessarily, particularly with respect to habitat destruction, loss of indigenous flora, damage to wetlands, establishment and persistence of alien invasive plants, and erosion.
Activities/Risk Sources	<ul style="list-style-type: none"> » Positioning of solar components and internal access routes » Positioning of workshop, substation and other related infrastructure » Alignment of power lines and servitudes » Alignment of access roads to development » Positioning of temporary sites
Mitigation: Target/Objective	<ul style="list-style-type: none"> » To ensure selection of best environmental option for positioning alignment of proposed infrastructure » Environmental sensitivities are taken into consideration

and avoided as far as possible, thereby mitigating potential impacts

Mitigation: Action/Control	Responsibility	Timeframe
<p>Avoid remaining high diversity grasslands and functional wetland areas as far as possible.</p>	<p>Developer</p>	<p>Design phase</p>
<p>Undertake pre-construction walk-through footprint investigations for protected flora and burrowing terrestrial vertebrates:</p> <p>The final footprint investigation (walkthrough) is aimed to fully inform the developer, responsible conservation authority (that will issue the relevant permits and authorisations), contractors, EO and ECO about:</p> <ul style="list-style-type: none"> » Protected species that will be affected by the development » Location of protected plant species within the footprint area – approximate mapping of areas of occurrence (alternatively, for linear structures, between which structures or other markers) » Identification of the affected species by providing a representative photo record that enables ECOs and contractors to identify such plants » How many specimens per species will be affected – relatively accurate estimate to the nearest 50, more accurate if less than 50 » Which species can be successfully relocated, which and how many will have to be destroyed » Location and nature of any nesting sites or active burrows of vertebrate species (birds, amphibians, reptiles and mammals), mapped by GPS, that will have to be inspected and cleared/relocated prior to construction by the contractor or duly appointed person(s) » Nature of alien invasive species that will have to be cleared by the contractor » Location and nature of any other significant environmental concerns, e.g. extreme gully erosion, that will need to be addressed by the 	<p>Developer, carried out by Specialist</p>	<p>Design review phase</p>

Mitigation: Action/Control	Responsibility	Timeframe
contractor to prevent any unnecessary (further) degradation of the development footprint		
<p>The above pre-construction footprint investigations will be used together with results from the ecological specialist report to draft the following:</p> <ul style="list-style-type: none"> » A comprehensive search and rescue program for plants and possible burrowing animals » A comprehensive alien invasive species eradication and management plan <ul style="list-style-type: none"> o Basic requirements of these are listed under the Construction and operational Phase EMPr 	Developer, drafted by Specialist	Design review phase
Obtain permits for protected plant removal and relocation prior to commencement of any activity related to this development	Developer	Pre-commencement
<p>Use design-level mitigation measures recommended in respect of habitat and ecosystem intactness and prevention of species loss as detailed within the EIA Report</p> <ul style="list-style-type: none"> » This includes positioning components of the development as close as possible together and in close proximity to other existing or planned developments in the area » Strictly adhere to existing tracks/roads where ever possible to gain access to the site » Sites for storing, mixing, and handling topsoil piles (if necessary) or any introduced materials, including all machinery or processing implements, must be placed in an ecologically least sensitive area and at least 500 m from any type of wetland. Such sites must be clearly indicated in site plans and the drafting of relevant detailed method statements and/or management plans requested from the relevant contractor or environmental firm. 	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

Mitigation: Action/Control	Responsibility	Timeframe
<p>Compile a comprehensive storm water management and erosion control plan for the footprint area as part of the final design of the project</p> <ul style="list-style-type: none"> » Basic requirements of these are listed under the Construction and operational Phase EMPr 	<p>Developer and relevant specialist</p>	<p>Design phase</p>
<p>Permissible biodiversity:</p> <ul style="list-style-type: none"> » Depending on the final PV array and mechanism developed and taking all potential impacts, fire risks and maintenance requirements into consideration, it has to be decided upon and made clear: <ul style="list-style-type: none"> ○ Permissible vegetation: maximum height, desirable density and composition ○ Maintenance of this vegetation – mowing, or other means Note: due to the hydrogeology of the area, there should be no application of herbicides 	<p>Developer and relevant specialist</p>	<p>Design phase</p>
<p>After the permissible biodiversity has been determined, compile a comprehensive vegetation rehabilitation management plan.</p> <ul style="list-style-type: none"> » Basic requirements of these are listed under the Construction and operational Phase EMPr 	<p>Developer and relevant specialist</p>	<p>Design phase</p>
<p>Depending on the type of PV panels selected for the development, a plan must be put in place to deal with accidental breakages and potential release of harmful substances. This plan must include as a minimum:</p> <ul style="list-style-type: none"> » How and where broken components and potential harmful substances can be disposed of – it must also be indicated if any material can be recycled, and where materials must then be taken for recycling <ul style="list-style-type: none"> ○ The above will have to be incorporated into the waste management plan 	<p>Developer and relevant waste management specialist</p>	<p>Design phase</p>

<p>Performance Indicator</p>	<ul style="list-style-type: none"> » Grid connection and road alignments meet environmental objectives. » Solar components and all associated temporary and permanent infrastructure and access road alignments meet environmental objectives
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	<ul style="list-style-type: none"> » Ecosystem fragmentation is kept to a minimum » Ecosystem functionality is retained and any degradation prevented
Monitoring	<ul style="list-style-type: none"> » Ensure that the design implemented meets the objectives and mitigation measures in the EIA Report through review of the design by the Project Manager, and the ECO prior to the commencement of activity.

13.2. Construction and Operational Phase

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

The management options below specify the minimum requirements to mitigate the impacts of the proposed development on the biodiversity and overall ecology of the area to be developed. More specific management options will need to be created once the exact layout and type of PV and construction plans are known.

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

The ECO will most likely only be present on site for the duration of construction activities. Where continued monitoring and possible mitigation will be required during the operational phase, an EO or suitable staff must be appointed. It is recommended that the current EMPr be revised after completion of the design,

again after construction and then as necessary, and a new set of EMPs be drafted for the decommissioning phase to continue with mitigations and prevention of all related environmental impacts.

13.2.1. Species search and rescue

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

Prior to commencement of any activity, including earthworks (grading, road construction, etc.), a plant Search and Rescue program should be developed and implemented, preceded by a meticulous investigation of all footprint areas by a suitably qualified botanist, conducted during the optimal growing season (January to April) along the entire footprint area as specified in 13.1.1.

Project Component/s	Project components affecting the objective: <ul style="list-style-type: none"> » PV Array » Grid connection and associated servitudes » Access roads » Workshop, , substation and other related infrastructure » Temporary construction camps » Protective fencing around development <ul style="list-style-type: none"> » Potential topsoil stockpiles and/or borrow pits
Potential Impact	<ul style="list-style-type: none"> » Substantially increased loss of species of conservation concern and other natural vegetation at construction phase, waste of on-site plant resources, lack of locally sourced material for rehabilitation of disturbed areas » Increased cost of rehabilitation
Activities/Risk Sources	<ul style="list-style-type: none"> » Construction related loss and damage to remaining natural and semi-natural vegetation
Mitigation: Target/Objective	<ul style="list-style-type: none"> » Rescue, maintenance and subsequent replanting of at least all bulbous protected plant species within the specific land portion

Mitigation: Action/Control	Responsibility	Timeframe
Ecological footprint investigation and recording by GPS of localities of species of conservation concern as	Ecologist	Prior to commencement

Mitigation: Action/Control	Responsibility	Timeframe
described in 13.1.1 (Design Phase)		of activity
<ul style="list-style-type: none"> » Search and Rescue (S&R) of all protected plants that will be affected by the development, especially species occurring in long term and permanent, hard surface development footprints (i.e. all buildings, new roads and tracks, laydown areas, and panel positions) should take place » All development footprints must be surveyed and pegged out as soon as possible, after which a local horticulturist with Search and Rescue experience should be appointed to undertake the S&R » All rescued species should be either replanted as soon as possible or bagged and kept in the horticulturist’s or a designated on-site nursery, and should be returned to site or land portion once all construction is completed and rehabilitation of disturbed areas is required » Replanting should occur in spring to early summer once sufficient rains have fallen, in order to facilitate establishment 	Horticultural Contractor, monitored and approved by ECO	Prior to construction
In line with specifications regarding permissible biodiversity and the rehabilitation plan (see 13.1.1), a minimum percentage cover of vegetation must be established and permanently maintained post construction	Developer and horticultural contractor	Prior to and after construction, throughout operational phase
<p>All cable trenches, excavations, etc. should be excavated carefully in order to minimise damage to surrounding areas and biodiversity:</p> <ul style="list-style-type: none"> » The trenches must be checked on a daily basis for the presence of trapped animals » Any animals found must be removed in a safe manner, unharmed, and placed in an area where the animal will be comfortable » If the ECO or contractor is unable to assist in the movement of a fauna species, ensure a member of the conservation authorities assists with the translocation » All mammal, large reptiles and avifauna species found injured during construction will be taken to a suitably qualified veterinarian or rehabilitation 	Contractor / ECO	Duration of construction

Mitigation: Action/Control	Responsibility	Timeframe
centre to either be put down in a humane manner or cared for until it can be released again		

Performance Indicator	<ul style="list-style-type: none"> » Rescue of species of conservation concern » No damage or injury to fauna » Re-establishment of rescued species
Monitoring	<ul style="list-style-type: none"> » ECO to monitor Search and Rescue, continue search and rescue operations during the construction process where it becomes necessary after the initial S&R » It may be possible that geophytic species may emerge during construction that were not accounted for in the original S&R plan – once observed the ECO should consult the botanists on the identification and possible S&R for those plant species

13.2.2. Management of temporary construction sites

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

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

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

Project Component/s	Project components affecting the objective: <ul style="list-style-type: none"> » Construction equipment camps » Facilities for storing, mixing and general handling of materials » Temporary staff facilities » Access roads
Potential Impact	<ul style="list-style-type: none"> » Damage to indigenous natural vegetation » Damage to and/or loss of topsoil

	<ul style="list-style-type: none"> » Initiation of accelerated erosion » Compacting of ground » Pollution of the surrounding environment due to inadequate or inappropriate facilities or procedures
Activities/Risk Sources	<ul style="list-style-type: none"> » Vegetation clearing and levelling of temporary construction or storage area/s » Transport to and from the temporary construction or storage area/s » Types of materials or equipment and the manner in which they are stored or handled
Mitigation: Target/Objective	<ul style="list-style-type: none"> » To minimise impacts on the biophysical environment » To prevent any residual or cumulative impacts arising from temporary construction or storage areas

Mitigation: Action/Control	Responsibility	Timeframe
<ul style="list-style-type: none"> » The location of the construction equipment camp and all access routes will take cognisance of any ecologically sensitive areas identified. » The location of this construction equipment camp shall be approved by the project ECO or the specialist doing the pre-commencement footprint investigation 	Contractor/ECO	Pre-construction
<p>As far as possible, minimise natural vegetation clearing for equipment storage areas</p> <ul style="list-style-type: none"> » Aim to locate the temporary construction camps on already degraded and/or heavily disturbed areas 	Contractor, monitored by ECO	During site establishment
<p>Staff shall be supplied with adequate facilities aimed at preventing any kind of pollution</p> <ul style="list-style-type: none"> » Cooking on open fires must be prohibited, if staff need cooking/kitchen facilities on site, such should be provided by the contractor 	Contractor, monitored by ECO	Construction, Operational phase
<p>Identify and demarcate construction areas, servitudes, and access for general construction work and restrict construction activity to these areas.</p> <ul style="list-style-type: none"> » Prevent unnecessary destructive activity within construction areas (prevent over-excavations and double handling) » Create specific turning points and parking 	Contractor, ECO to control	Before and during construction, operational phase

Mitigation: Action/Control	Responsibility	Timeframe
areas for vehicles and heavy machinery as needed » Strictly prohibit any driving outside designated areas and roads		
To limit the possible distribution of undesirable species and possible pollutants onto site: » Regularly check clothing and vehicles for mud and seed and clear in an appropriate manner (see invasive plant management for more details) » Do not wash down any machinery or vehicle within the farm portion, including the footprint area » All materials moved onto the development site must be free of weeds or any other undesirable organisms or pollutants » It is recommended that fuels, lubricants and other chemicals only be stored on site if absolutely necessary, and then in a manner that prevents any accidental spillage	Contractor, ECO to control	Before and during construction, operational phase
Rehabilitate and revegetate all disturbed areas at the construction equipment camp as soon as construction is complete within an area, and mitigate erosion where required as per specific management plans	Contractor, rehabilitation contractor, monitored by ECO	Construction, operational phase

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

13.2.3. Topsoil management

OBJECTIVE: Minimisation of disturbance to and loss of topsoil

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

Removal of topsoil should be done where:

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

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

Project Component/s	Project components affecting the objective: <ul style="list-style-type: none"> » PV Array supports and trenching » Grid connection and associated servitudes » Access roads » Workshop, , substation and other related infrastructure » Potential topsoil stockpiles and/or borrow pits
Potential Impact	<ul style="list-style-type: none"> » Loss of topsoil and natural resources and biological activity within the topsoil » Loss of natural regeneration potential of soils » Loss of agricultural potential of soils.
Activity/Risk Source	<ul style="list-style-type: none"> » Site preparation and earthworks » Excavation of foundations and trenches » Construction of site access road » Power line construction activities » PV array construction activities » Stockpiling of topsoil, subsoil and spoil material.
Mitigation: Target/Objective	<ul style="list-style-type: none"> » To retain full biological activity and functionality of topsoil » To retain desirable natural vegetation, where possible » To minimise footprints of disturbance of

	<p>vegetation/habitats</p> <ul style="list-style-type: none"> » 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
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Mitigation: Action/Control	Responsibility	Timeframe
Areas to be cleared must be clearly marked on-site to eliminate the potential for unnecessary clearing.	Contractor in consultation with Specialist	Pre-construction
Construction activities must be restricted to demarcated areas so that impact on topsoil is restricted.	Contractor, ECO to control	Before and during construction, operational phase
<p>Salvaging topsoil:</p> <ul style="list-style-type: none"> » Topsoil must always be salvaged and stored separately from subsoil and lower-lying parent rock or other spoil material. <ul style="list-style-type: none"> ○ Topsoil stripping removes up to 30 cm or less of the upper soils. ○ In cultivated areas, depth of topsoil may increase and needs to be confirmed with the land owner » Prior to salvaging topsoil, the depth, quality and characteristics of topsoil should be known for every habitat type. <ul style="list-style-type: none"> ○ This will give an indication of total volumes of topsoil that need to be stored to enable the proper planning and placement of topsoil storage. ○ Different types of topsoil – rocky soils and sands must be stored separately » Topsoils should be removed (and stored) under dry conditions to avoid excessive compaction whenever topsoil will have to be stored for longer than one year. 	Contractor, ECO to control	Before and during construction
<p>Storing topsoil:</p> <ul style="list-style-type: none"> » Viability of stored topsoil depends on moisture, temperature, oxygen, nutrients and time stored. » Rapid decomposition of organic material in warm, moist topsoils rapidly decreases microbial activity 	Contractor, ECO to control	Before and during construction

Mitigation: Action/Control	Responsibility	Timeframe
<p>necessary for nutrient cycling, and reduces the amount of beneficial micro-organisms in the soil.</p> <ul style="list-style-type: none"> » Stockpile location if not adjacent to a linear development: <ul style="list-style-type: none"> ○ At least 50 m from any natural wetlands ○ Ideally a disturbed area cleared of weeds and invasives » <i>Topsoil is typically stored in berms with a width of 150 – 200 cm, and a maximum height of 100 cm, preferably lower</i> <ul style="list-style-type: none"> ○ Place berms along contours or perpendicular to the prevailing wind direction ○ Adhere to the following general rule: the larger the pile of topsoil storage needs to be, the shorter should be the time it is stored » Topsoil handling should be reduced to stripping, piling (once), and re-application. Between the piling and reapplication, stored topsoils should not undergo any further handling except control of erosion and (alien) invasive vegetation » Where topsoil can be reapplied within six months to one year after excavation, it will be useful to store the topsoil as close as possible to the area of excavation and re-application, e.g. next to cabling trenches <ul style="list-style-type: none"> ○ In such case, use one side of the linear development for machinery and access only ○ Place topsoil on the other/far side of this development, followed by the subsoil ○ If there will be a need for long-term storage of topsoil in specified stockpiles, this must be indicated in the design phase already and accompanied by a detailed topsoil stockpile management plan » In cases where topsoil has to be stored longer than 6 months or during the rainy season, soils should be kept as dry as possible and protected from erosion and degradation by: <ul style="list-style-type: none"> ○ Preventing puddling on or between heaps of topsoil ○ Or covering topsoil berms ○ Preventing all forms of contamination or pollution 		

Mitigation: Action/Control	Responsibility	Timeframe
<ul style="list-style-type: none"> ○ Preventing any form of compaction ○ Monitoring establishment of all invasive vegetation and removing such if it appears ○ Keeping slopes of topsoil at a maximal 2:1 ratio ○ Monitoring and mitigating erosion where it appears ○ Where topsoil needs to be stored in excess of one year, it is recommended to either cover the topsoil or allow an indigenous grass cover to grow on it – if this does not happen spontaneously, seeding should be considered 		
<p>Reapplying topsoils:</p> <ul style="list-style-type: none"> » Spoil materials and subsoil must be back-filled first, then covered with topsoil » Generally, topsoils should be re-applied to a depth equal to or slightly greater to the topsoil horizon of a pre-selected undisturbed reference site » The minimum depth of topsoil needed for revegetation to be successful is approximately 20 cm » If the amount of topsoil available is limited, a strategy must be worked out to optimise revegetation efforts with the topsoil available » Reapplied topsoils should be landscaped in a way that creates a variable micro topography of small ridges and valleys that run parallel to existing contours of the landscape. The valleys become catch-basins for seeds and act as run-on zones for rainfall, increasing moisture levels where the seeds are likely to be more concentrated. This greatly improves the success rate of revegetation efforts. » To stabilise reapplied topsoils and minimise raindrop impact and erosion: <ul style="list-style-type: none"> ○ Use organic material from cleared vegetation where possible ○ Alternatively, suitable geotextiles or organic erosion mats can be used as necessary » Continued monitoring will be necessary to detect any sign of erosion early enough to allow timeous mitigation 	Contractor, ECO to control	Before and during construction
Re-applied topsoils need to be re-vegetated as soon as possible, following the revegetation and rehabilitation	Contractor, ECO to control	Before and during

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

Performance Indicator	<ul style="list-style-type: none"> » Minimal disturbance outside of designated work areas. » Topsoil appropriately stored, managed, and rehabilitated.
Monitoring	<ul style="list-style-type: none"> » Monitoring of appropriate methods of vegetation clearing and soil management activities by ECO throughout construction phase. » An incident reporting system will be used to record non-conformances to the EMPr. » Regular monitoring of topsoil after construction by developer until such topsoil can be regarded as fully rehabilitated, stable and no longer prone to accelerated erosion

13.2.4. Erosion management

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

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

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

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

Definitions:

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

Project Component/s	Project components affecting the objective: <ul style="list-style-type: none"> » PV Array » Grid connection and associated servitudes » Access roads » Workshop, , substation and other related infrastructure » Potential topsoil stockpiles and/or borrow pits
Potential Impact	<ul style="list-style-type: none"> » Loss of topsoil and natural resources and biological activity within the topsoil » Loss of natural regeneration potential of soils » Loss of agricultural potential of soils.
Activity/Risk Source	<ul style="list-style-type: none"> » Rainfall and wind erosion of disturbed areas » Excavation, stockpiling and compaction of soil » Concentrated discharge of water from construction activity and new infrastructure, including PV panels » Storm water run-off from sealed, altered or bare surfaces » Construction equipment and vehicle movement on site » Cabling and road construction activities » Power line construction activities » River/stream/drainage line road crossings » Roadside drainage ditches » Premature abandonment of follow-up monitoring and adaptive management of rehabilitation
Mitigation: Target/Objective	<ul style="list-style-type: none"> » To minimise erosion of soil from site during construction » To minimise deposition of soil into drainage lines » To minimise damage to vegetation by erosion or deposition » To minimise damage to rock, soil, animals and vegetation by construction activity » No accelerated overland flow related surface erosion as a

	<p>result of a loss of vegetation cover</p> <ul style="list-style-type: none"> » No reduction in the surface area of natural drainage lines and other wetland areas as a result of the establishment of infrastructure » Minimal loss of vegetation cover due to construction related activities » No increase in runoff into drainage lines as a result of construction of project related infrastructure » No increase in runoff into drainage lines as a result of road construction
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Mitigation: Action/Control	Responsibility	Timeframe
Identify and demarcate construction areas for general construction work and restrict construction activity to these areas. Prevent unnecessary destructive activity within construction areas (prevent over-excavations and double handling)	Contractor, ECO to control	Before and during construction
New access roads and other servitudes to be carefully planned and constructed to minimise the impacted area and prevent unnecessary excavation, placement, and compaction of soil. Special attention to be given to roads that may cross drainage lines.	Contractor, ECO to control	Before and during construction
Rehabilitate disturbance areas as soon as construction in an area is completed as per the rehabilitation plan.	Contractor, ECO to control	Immediately after construction, monitored during operational phase
<p>General Erosion control measures:</p> <ul style="list-style-type: none"> » Runoff control and attenuation can be achieved by using any or a combination of sand bags, silt fences, storm water channels and catch-pits, shade nets, geofabrics, seeding or mulching as needed on and around cleared and disturbed areas <ul style="list-style-type: none"> ○ Ensure that all soil surfaces are protected by vegetation or a covering to avoid the surface being eroded by wind or water. » Ensure that heavy machinery does not compact areas that are not meant to be compacted as this will result in sealed hydrophobic, water repellent soils that increase the erosion potential of the area. 	Contractor, ECO to control	Construction, operational phase

Mitigation: Action/Control	Responsibility	Timeframe
<ul style="list-style-type: none"> » Prevent the concentration or flow of surface water or storm water down cut or fill slopes or along pipeline routes or roads and ensure measures to prevent erosion are in place prior to construction. » Storm water and any runoff generated by hard impervious surfaces should be discharged into retention swales or areas with rock rip-rap. These areas should be grassed with indigenous vegetation. These energy dissipation structures should be placed in a manner that flows are managed prior to being discharged. » Minimise and restrict site clearing to areas required for construction purposes only and restrict disturbance to adjacent undisturbed natural vegetation. » Vegetation clearing should occur in parallel with the construction progress to minimise erosion and/or run-off. Large tracts of bare soil will either cause dust pollution or quickly erode and then cause sedimentation in the lower portions of the catchment » If implementing dust control measures, prevent over-wetting, saturation, and run-off that may cause erosion and sedimentation 		
Control depth of excavations and stability of cut faces/sidewalls	Contractor, to be monitored by ECO	Site establishment & duration of contract
Compile a comprehensive storm water management method statement, as part of the final design of the project and implement during construction and operation.	Developer, Contractor, to be monitored by ECO	Site establishment & duration of contract
All vehicles on site must be appropriate to access the site. No off-road driving is permitted unless authorised by the ECO.	Contractor, to be monitored by ECO	Pre-construction, Construction & operation
4x4's or diff lock vehicles must be used in wet slippery conditions to reduce the erosion on the roads and the surrounding area.	Contractor, to be monitored by ECO	Pre-construction, Construction & operation

Performance » Minimal level of soil erosion around site

Indicator	<ul style="list-style-type: none"> » No signs of accelerated soil erosion » Minimal level of soil degradation » Acceptable state of excavations, as determined by EO & ECO » Progressive return of disturbed and rehabilitated areas to the desired end state (Refer also to the Plant Rescue and Rehabilitation Plan)
Monitoring	<ul style="list-style-type: none"> » Fortnightly inspections of the site by ECO » Fortnightly inspections of sediment control devices by ECO » Fortnightly inspections of surroundings, including drainage lines by ECO » Immediate reporting of ineffective sediment control systems » An incident reporting system must record non-conformances according to the EMPr.

13.2.5. Rehabilitation and revegetation

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

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

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

The first vegetation layer must be developed further until a desirable end state, as determined during the design phase and taking the original vegetation description of existing natural vegetation in close proximity of the proposed development site as guideline, is established.

Project Component/s	Project components affecting the objective: <ul style="list-style-type: none"> » PV Array supports and trenching » Grid connection and associated servitudes
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	<ul style="list-style-type: none"> » Access roads » Workshop, , substation and other related infrastructure » Potential topsoil stockpiles and/or borrow pits
Potential Impact	<ul style="list-style-type: none"> » Within the footprint, a change of plant species composition with lower productivity can be expected due to removal, disturbance and continued long-term shading of vegetation » A largely reduced vegetation cover will render the ecosystem more prone to erosion and irreversible degradation » Disturbance of indigenous vegetation creates opportunities for the establishment of invasive vegetation or creation of surfaces that do not support the permanent (re-) establishment of vegetation » Loss of natural regeneration potential of soils
Activity/Risk Source	<ul style="list-style-type: none"> » Site preparation and earthworks » Excavation of foundations and trenches » Construction of site access road » Power line construction activities » PV array construction activities » Stockpiling of topsoil, subsoil and spoil material.
Mitigation: Target/Objective	<ul style="list-style-type: none"> » Recreate a non-invasive, acceptable vegetation cover that will facilitate the establishment of desirable and/or indigenous species » Prevent and accelerated erosion of ecosystem degradation

Mitigation: Action/Control	Responsibility	Timeframe
Rehabilitation of surface		
Prior to the application of topsoil <ul style="list-style-type: none"> » subsoil shall be shaped and trimmed to blend in with the surrounding landscape or used for erosion mitigation measures » ground surface or shaped subsoil shall be ripped or scarified with a mechanical ripper or by hand to a depth of 15 – 20 cm » compacted soil shall be ripped to a depth greater than 25 cm and the trimmed by hand to prevent re-compacting the soil 	Contractor, ECO to control	During and after construction

Mitigation: Action/Control	Responsibility	Timeframe
<ul style="list-style-type: none"> » any foreign objects, concrete remnants, steel remnants or other objects introduced to the site during the construction process shall be cleared before ripping, or shaping and trimming of any landscapes to be rehabilitated takes place » shaping will be to roughly round off cuts and fills and any other earthworks to stable forms, sympathetic to the natural surrounding landscapes 		
<p>Application of topsoil</p> <ul style="list-style-type: none"> » topsoils shall be spread evenly over the ripped or trimmed surface, if possible not deeper than the topsoil originally removed » the final prepared surface shall not be smooth but furrowed to follow the natural contours of the land » the final prepared surface shall be free of any pollution or any kind of contamination » care shall be taken to prevent the compaction of topsoil 	Contractor, ECO to control	During and after construction
<p>Soil stabilisation</p> <ul style="list-style-type: none"> » mulch, if available from shredded vegetation, shall be applied by hand to achieve a layer of uniform thickness » mulch shall be rotovated into the upper 10 cm layer of soil <ul style="list-style-type: none"> ○ this operation shall not be attempted if the wind strength is such as to remove the mulch before it can be incorporated into the topsoil » measures shall be taken to protect all areas susceptible to erosion by installing temporary and permanent drainage work as soon as possible where required <ul style="list-style-type: none"> ○ where natural water flow-paths can be identified, subsurface drains or suitable surface drains and chutes should be installed » additional measures shall be taken to prevent surface water from being concentrated in streams and from scouring slopes, banks or other areas » runnels or erosion channels developing shall be back-filled and restored to a proper condition <ul style="list-style-type: none"> ○ such measures shall be effected immediately before erosion develops at a large scale » where erosion cannot be remedied with available 	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached

Mitigation: Action/Control	Responsibility	Timeframe
mulch or rocks, geojute or other geotextiles shall be used to curtail erosion		
Borrow-pits (if required) <ul style="list-style-type: none"> » shall be shaped to have undulating, low-gradient slopes and surfaces that are rough and irregular, suitable for trapping sediments and facilitation of plant growth » upon completion of rehabilitation these reshaped and revegetated areas shall blend into the natural terrain 	Contractor, ECO to control	After construction
Revegetation		
<ul style="list-style-type: none"> » revegetation of the final prepared area is expected to occur spontaneously to some degree where topsoils could be re-applied within 6 months » revegetation will be done according to an approved planting/landscaping plan according to the desirable end states and permissible vegetation 	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached
Re-seeding <ul style="list-style-type: none"> » revegetation can be increased where necessary by hand- seeding indigenous species <ul style="list-style-type: none"> ○ previously collected and stored seeds shall be sown evenly over the designated areas, and be covered by means of rakes or other hand tools ○ commercially available seed of grass species naturally occurring on site can be used as alternative » re-seeding shall occur at the recommended time to take advantage of the growing season » in the absence of sufficient follow-up rains after seeds started germinating, irrigation of the new vegetation cover until it is established shall become necessary to avoid loss of this vegetative cover and the associated seed bank 	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached
Planting of species <ul style="list-style-type: none"> » the composition of the final acceptable vegetation will be based on the vegetation descriptions of the original ecological investigation, and will include rescued plant 	Contractor, ECO to control	Construction phase Operational phase,

Mitigation: Action/Control	Responsibility	Timeframe
<p>material</p> <ul style="list-style-type: none"> » geophytic plants shall be planted in groups or as features in selected areas » during transplanting care shall be taken to limit or prevent damage to roots » plants should be watered immediately after transplanting to help bind soil particles to the roots (or soil-ball around rooted plants) and so facilitate the new growth and functioning of roots 		<p>followed up until desired end state is reached</p>
<p>Traffic on revegetated areas</p> <ul style="list-style-type: none"> » designated tracks shall be created for pedestrian of vehicle traffic where necessary » Disturbance of vegetation and topsoil must be kept to a practical minimum, no unauthorised off road driving will be allowed » All livestock shall be excluded from newly revegetated areas, until vegetation is well established 	<p>Contractor, ECO to control</p>	<p>Construction phase Operational phase</p>
<p>Establishment</p> <ul style="list-style-type: none"> » The establishment and new growth of revegetated and replanted species shall be closely monitored <ul style="list-style-type: none"> ○ Where necessary, reseeding or replanting will have to be done if no acceptable plant cover has been created 	<p>Contractor, ECO to control</p>	<p>Construction phase Operational phase, followed up until desired end state is reached</p>
Monitoring and follow-up treatments		
<p>Monitor success of rehabilitation and revegetation and take remedial actions as needed according to the respective plan</p> <ul style="list-style-type: none"> » Erosion shall be monitored at all times and measures taken as soon as detected » Where necessary, reseeding or replanting will have to be done if no acceptable plant cover has been created 	<p>ECO during construction, suitable designated person / contractor after that</p>	<p>Construction phase Operational phase</p>
<p>Weeding</p> <ul style="list-style-type: none"> » It can be anticipated that invasive species and weeds will germinate on rehabilitated soils <ul style="list-style-type: none"> ○ These need to be hand-pulled before they are fully established and/or reaching a mature stage where they can regenerate 	<p>Contractor</p>	<p>Construction phase Operational phase</p>

Mitigation: Action/Control	Responsibility	Timeframe
<ul style="list-style-type: none"> ○ Where invasive shrubs re-grow, they will have to be eradicated according to the Working for Water specifications 		

<p>Performance Indicator</p>	<ul style="list-style-type: none"> » No activity in identified no-go areas » Natural configuration of habitats as part of ecosystems or cultivated land is retained or recreated, thus ensuring a diverse but stable hydrology, substrate and general environment for species to be able to become established and persist » The structural integrity and diversity of natural plant communities is recreated or maintained » Indigenous biodiversity continually improves according to the pre-determined desirable end state <ul style="list-style-type: none"> ○ This end state, if healthy, will be dynamic and able to recover by itself after occasional natural disturbances without returning to a degraded state » Ecosystem function of natural landscapes and their associated vegetation is improved or maintained » No signs of accelerated soil erosion
<p>Monitoring</p>	<ul style="list-style-type: none"> » Fortnightly inspections of the site by ECO during construction » An incident reporting system must record non-conformances to the EMPr. » Quarterly inspections and monitoring of the site by the ECO or personnel designated to the rehabilitation process until 80% of the desired plant species have become established <ul style="list-style-type: none"> ○ These inspections should be according to the monitoring protocol set out in the rehabilitation plan » Thereafter annual inspections according to the minimal monitoring protocol

13.2.6. Invasive plant management

OBJECTIVE: Manage and reduce the impact of invasive vegetation

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

Project Component/s	<ul style="list-style-type: none"> » Permanent and temporary infrastructure » Access roads
Potential Impact	<ul style="list-style-type: none"> » Displacement of indigenous vegetation » Degradation of soils » Degradation of faunal habitats » Increase in source of regenerative material of undesirable species that may negatively affect the site and surrounding agricultural lands
Activity/Risk Source	<ul style="list-style-type: none"> » Transport of construction materials to site » Movement of construction machinery and personnel » Site preparation and earthworks causing disturbance to indigenous vegetation » Construction of site access road » Stockpiling of topsoil, subsoil and spoil material » Routine maintenance work – especially vehicle movement
Mitigation: Target/Objective	<ul style="list-style-type: none"> » To significantly reduce the presence of weeds and eradicate alien invasive species » To avoid the introduction of additional alien invasive plants to the project control area » To avoid further distribution and thickening of existing alien plants on the project area » To complement existing alien plant eradication programs in gradually causing a significant reduction of alien plant species throughout the project control area

Mitigation: Action/Control	Responsibility	Timeframe
<ul style="list-style-type: none"> » Compile a detailed invasive plant management and monitoring method statement for the construction phase. » Regularly update the invasive plant management and monitoring programme as needed for the entire construction, operational and decommissioning 	Specialist	Pre-construction

Mitigation: Action/Control	Responsibility	Timeframe
<p>phase</p> <ul style="list-style-type: none"> » This plan must contain WfW-accepted species-specific eradication methods » It must also provide for a continuous monitoring programme to detect new infestations 		
<p>Avoid creating conditions in which invasive plants may become established:</p> <ul style="list-style-type: none"> » Keep disturbance of indigenous vegetation to a minimum » Rehabilitate disturbed areas as quickly as possible » Shred all non-seeding material from cleared invasive shrubs and other vegetation an use as mulch as part of the rehabilitation and revegetation plan » Where possible, destroy seeding material of weeds and invasives by piling burning (in designated areas or suitable containers) » Do not import soil from areas with alien plants 	Contractor, monitored by ECO	Construction phase Operational phase
<ul style="list-style-type: none"> » Eradicate all invasive plants that occur within the development’s temporary and permanent footprint areas » Ensure that material from invasive plants that can regenerate – seeds, suckers, plant parts are adequately destroyed and not further distributed 	Contractor, monitored by ECO	Construction phase Operational phase
<ul style="list-style-type: none"> » Immediately control any alien plants that become newly established using registered control measures 	Contractor, monitored by ECO	Construction phase Operational phase
<p>Risks from alien invasives do not only arise from invasives present within the footprint area, but also from alien invasives along the verges of the major transport routes, especially invasive grasses and smaller weeds. Similarly, invasives can be spread by construction processes to surrounding areas. To avoid the distribution of weeds and invasive plants, establish a routine amongst contractors/all staff to regularly check:</p> <ul style="list-style-type: none"> » that clothing and shoes are free of mud and seeds » that foot wells inside vehicles and mats are cleared of weed seed » radiator and grill, along wheel trims, around wheels, mud flaps, undercarriage of vehicle or other moving machinery for mud and seed 	Contractor, monitored by ECO	Construction phase Operational phase

Mitigation: Action/Control	Responsibility	Timeframe
»		
Performance Indicator	<ul style="list-style-type: none"> » Visible reduction of number and cover of alien invasive plants within the project area. » Improvement of vegetation cover from current dominance of invasive shrubs to dominance of perennial grasses and dwarf shrubs » No establishment of additional alien invasive species. 	
Monitoring	<ul style="list-style-type: none"> » 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. 	