ECOLOGICAL ASSESSMENT REPORT

PROPOSED LETHABO SOLAR ENERGY FACILITY NEXT TO THE LETHABO POWER STATION

FREE STATE

March 2015

Prepared for:

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Executive Summary

Eskom Holdings (SOC) Ltd have appointed Savannah Environmental (Pty) Ltd to manage the application for a photovoltaic Solar Energy Facility on portion 0 of farm 1814. Two sites are being investigated for the potential placement of the proposed facility, and are together referred to as the study area, which is covered by this ecological scoping report.

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 Central Free State Grassland (Unit Gh 6) as defined by Mucina and Rutherford (2006), consisting of gently to moderately undulating landscapes. Pristine grasslands are dominated by *Themeda triandra,* whilst *Eragrostis curvula* and *E. chloromelas* become more dominant in degraded habitats. Mucina and Rutherford (2006) classified this grassland as vulnerable, with little of its original extent protected, and a mere 52% remaining in a natural state. It is, however, not yet listed under the National List of threatened ecosystems.

115 indigenous plant species could be verified on site, with an additional 22 alien invasive species (excluding planted exotic trees). 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.

Each site alternative had a very different past landuse history, which greatly influenced the current vegetation composition:

Alternative site 1: open cast mining which was rehabilitated, open rangeland, subjected to small portions of past sand mining, occasional excessive grazing, currently covered by semi-natural grasslands.

Alternative site 2: machinery storage, many sealed surfaces and rubble still remaining, currently covered by variable grasslands with a high alien invasive cover. From an ecological perspective, this would be the preferred site for the development.

Three vegetation associations could be identified:

» Association 1: *Digitaria eriantha* Transformed Grassland
    - o Sensitivity: Low
» Association 2: *Paspalum urvillei - Verbena bonariensis* Grassland
    - o Sensitivity: Low
    - o Note: This may be a wetland, which will have to be confirmed by the wetlands delineation
» Association 3: *Cynodon dactylon - Conyza podocephala* Grassland
    - o Medium Sensitivity: high diversity sections

In addition, evidence of 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 or significantly impact any flora or terrestrial vertebrate species on the study area or beyond. 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 issues identified by this study are:

» Wetlands need to be verified by a wetlands study
» All NEMA:BA listed alien invasives within the development footprint area will have to be entirely cleared prior to development, not only to prevent spread of these species but also to ensure efficient maintenance of the proposed development
» 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
    - o Soils are prone to capping and erosion and need to be stabilised by a permanent grass or suitable indigenous vegetation layer.
    - o Locally occurring grass species become moribund and die off if not grazed or burnt regularly. It is thus recommended to allow either seasonal sheep grazing to reduce dead biomass accumulation on grass tufts or implement a regular mowing program (possibly twice a year). 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 undertake the EIA process for a photovoltaic Solar Energy Facility next to the Lethabo Power Station, Free State.

Project
Lethabo Solar Energy Facility

Proposed Activity
» A PV array with a total generating capacity of up to 75 MW
» Inverter and transformer buildings and on-site substation or switching station
» Underground cabling between project components
» A direct grid connection from the development to the existing Eskom substation at Lethabo 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
» After findings of the scoping phase, only 2 alternative sites have been further investigated in detail.

1.2. Declaration of Independence

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

1.3. Specialist Investigator

This report has been prepared by:
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Additional information on faunal sightings was provided by Pieter Muller from Eskom (Lethabo).

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 Nature Conservation Ordinance (NCO) 8 of 1969 and subsequent amendments
  o Note: The Free State Conservation Bill as published in the Provincial Gazette 23 of 2010 has yet to be promulgated

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 list of ecosystems that are threatened and in need of protection (Government Notice 1002 of 2011)
» Threatened or Protected Species Regulations (Government Notice 388 of 2013) under NEMA:BA
» 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 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 Farm 1814 and the remaining portion of farm Bankfontein 9, on which the Lethabo Power Station

has been built. This is approximately 22 km north-east of Standerton, within the Lekwa Municipality, Free State. Of the three alternatives sites investigated during the scoping phase, only alternatives 1 and 2 were further studied for the potential placement of the PV arrays (Figure 1).

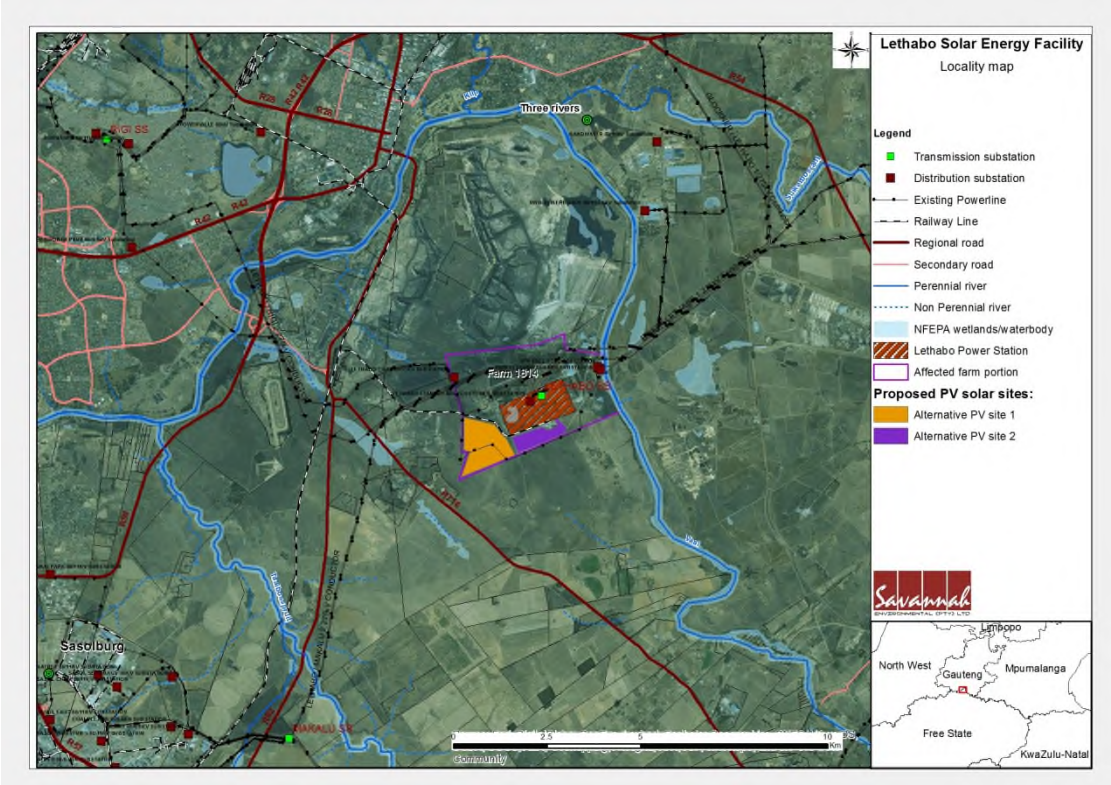

Figure 1: Locality of the Lethabo power station and sites for the proposed solar energy development.

3.2. Surrounding environment

3.2.1. Climate and rainfall

The climate for Lethabo has been derived from climatic data summarised for Standerton (en.climate-data.org, Figure 2), located about 22 km south-west of Lethabo. 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.

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), and the Vaal River.

Soils are imperfectly drained, often shallow and sometimes have a plinthic horizon, which leads to occasional high wetness during the rainfall season (BGIS). Such seasonally wet areas are the preferred habitat of several protected species, amongst which the geophytes *Ammocharis coranica* and *Crinum* species. It is not uncommon that high numbers of these species can occupy a relatively small seasonally wet area.

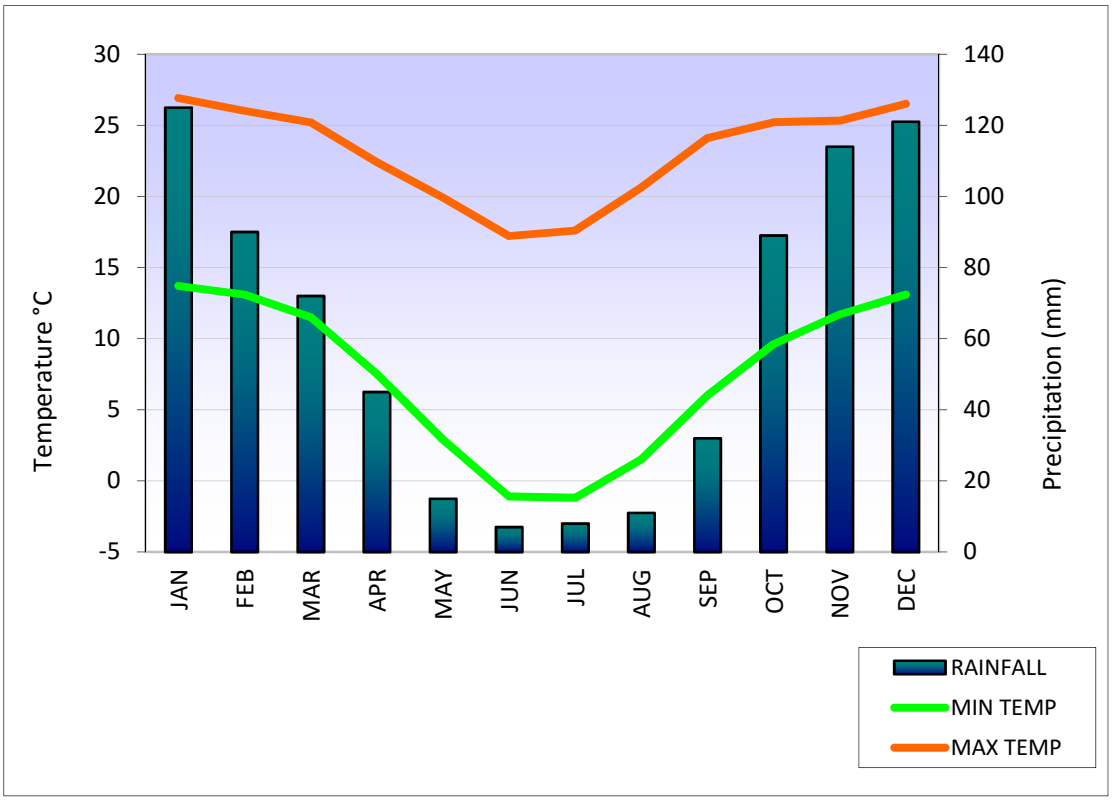

Figure 2: Climate summary for the study area.

3.2.3. Vegetation overview

The selected property falls within the original extent of the Central Free State Grassland (Unit Gh 6, Figure 3) as defined by Mucina and Rutherford (2006).

The Central Free State Grassland (Unit Gh 6) is a relatively short grassland on undulating plains. Where in a pristine condition, it is dominated by *Themeda triandra,* whilst *Eragrostis curvula* and *E. chloromelas* become more dominant in degraded habitats. Severely degraded clayey bottomlands are often dominated by dwarf karroid shrubs, whilst riverine areas and severely overgrazed/trampled low-lying areas are prone to encroachment by *Acacia karroo* (Mucina and Rutherford 2006).

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

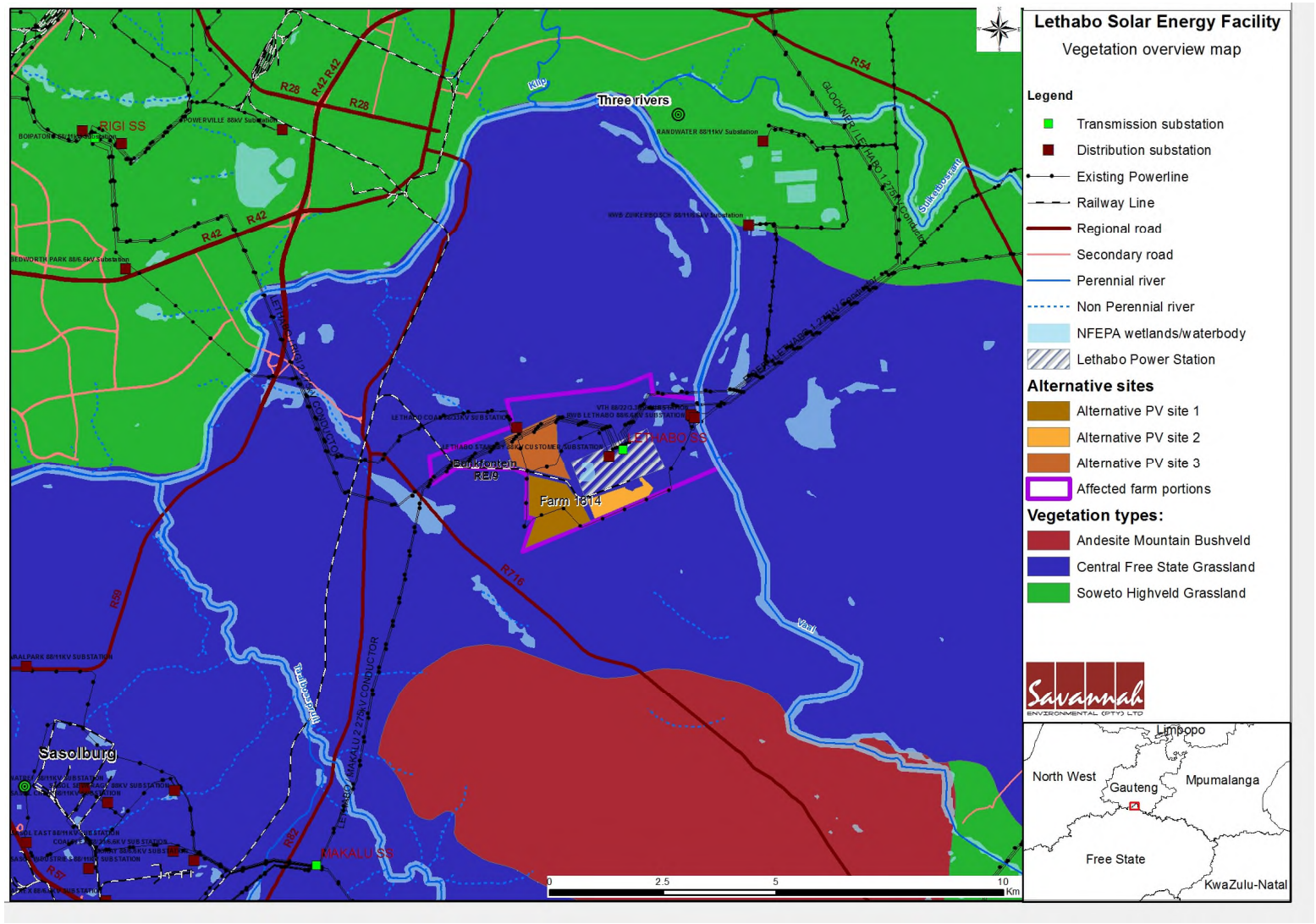

Figure 3: The original extent of the vegetation types on the proposed development site after Mucina and Rutherford (2006).

4. Methods

4.1. Vegetation Survey

The site was visited on 15 January 2015 for a vegetation survey. After initial rainfall from November onwards, the veld was already recovering from the dormant season, but more species are still expected to emerge later in the growing season.

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: 2627) 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).

Plant species nomenclature follows Germishuizen and Meyer (2003) and the online African Plant Database (CJB 2014), 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 km2), 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 km2, 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 km2, 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.

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

Implications for development: GREEN LIST SPECIES: Development is not expected to affect the conservation status of this species. Species removal may still be subject to provincial or national legislation.

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

Implications for development: GREEN LIST SPECIES: Implications for development: GREEN LIST SPECIES: Development is not expected to affect the conservation status of this species. Species removal may still be subject to provincial or national legislation.

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. Species commonly sighted by staff on the study area have been included.

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
    o either very species-rich relative to immediate surroundings,
    o or have a very unique and restricted indigenous species composition
    o 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.
    o Excessive disturbance of such habitats may lead to ecosystem destabilisation and/or species loss.
    o 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
    o Areas with a species diversity representative of its natural state, but not exceptionally high or unique compared to its surroundings
    o Areas of which the abiotic or biotic configuration does not constitute a very specific or restricted habitat or very high niche diversity
    o Areas that provide ecosystem services needed for the continued functioning of the ecosystem and the continued use thereof (e.g. grazing or pollinator resources).
    o Although species of conservation concern may occur on the area, these are not restricted to these habitats only.
    o 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

The selected property falls within the Central Free State Grassland (GH 6) as defined by Mucina and Rutherford (2006). A total of 1432 plant species have been recorded in the Sasolburg/Vereeniging Area according to the SANBI database. This high number is largely attributable to the many diverse habitats within the grid, but will not all be found within any one habitat type. Only 115 indigenous plant species could be verified on site, with an additional 22 alien invasive species (excluding planted exotic trees).

Each site alternative had a very different past landuse history, which greatly influenced the current vegetation composition:

Alternative site 1: open cast mining which was rehabilitated, open rangeland, subjected to small portions of past sand mining, excessive grazing (now resolved), currently covered by semi-natural grasslands

Alternative site 2: machinery storage, many sealed surfaces and rubble still remaining, currently covered by variable grasslands with a high alien invasive content

At the time of the vegetation survey, the herbaceous layer overall was moderately developed due to some initial rains, although some species were still in a juvenile or seedling stage. Several more species, mostly annuals and species resprouting from underground storage organs, can be expected to emerge during more favourable rainfall seasons.

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): *Digitaria eriantha* Transformed Grassland
  - Sensitivity: Low

» Association 2(blue): *Paspalum urvillei - Verbena bonariensis* Grassland
  - Sensitivity: Low

- Note: This may be a wetland, which will have to be confirmed by the wetlands delineation

» Association 3(green): *Cynodon dactylon* - *Conyza podocephala* Grassland
- Sensitivity: Low
- Medium Sensitivity: high diversity sections

In addition, evidence of 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.

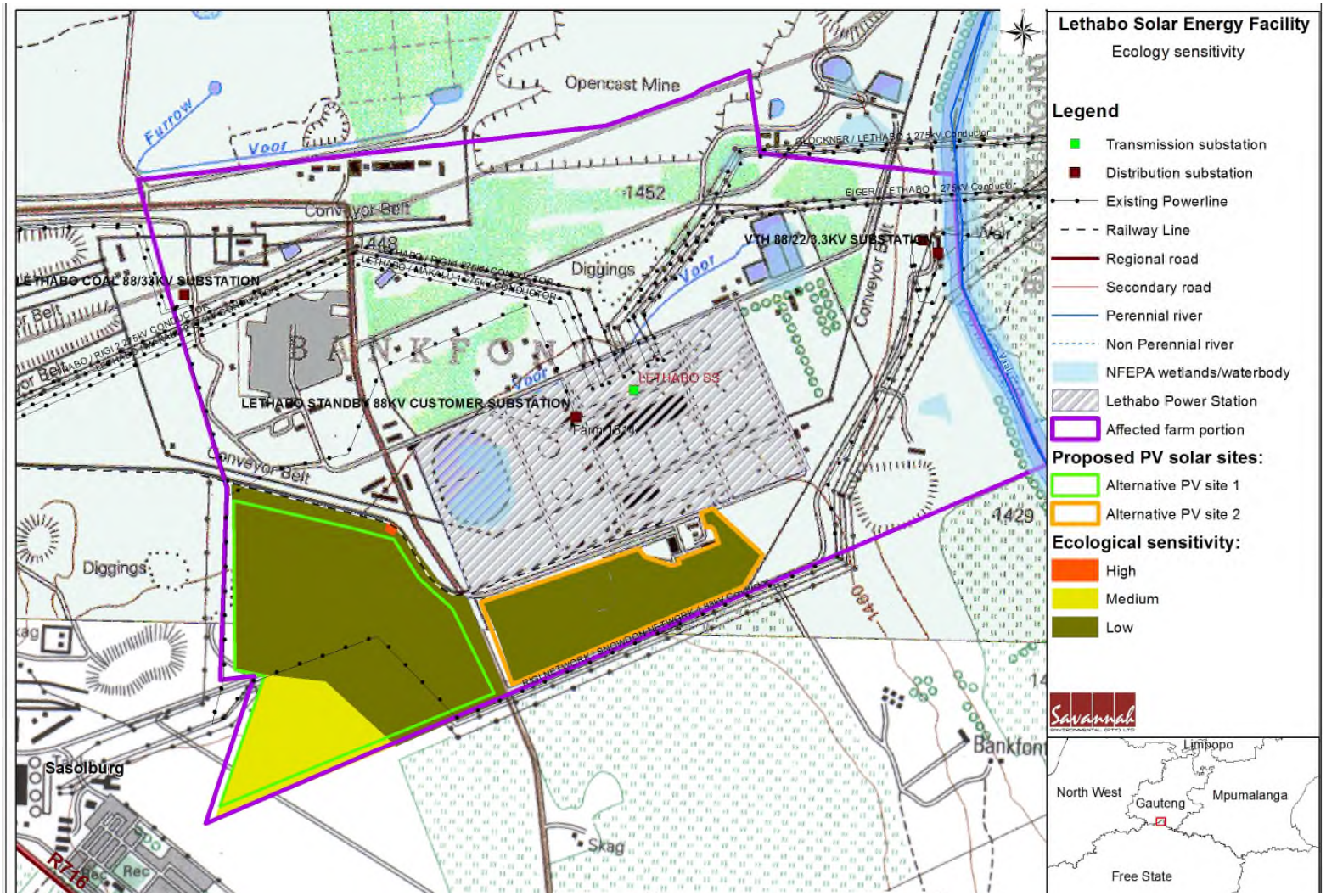

Figure 5: Ecological sensitivity of the study area.

5.2.1. *Digitaria eriantha* Transformed Grassland

Habitat and Land use			
Substrate	Loamy sand	**Disturbance**	Previously transformed, sealed surfaces and rubble remaining, fenced
Species Richness	34 indigenous species 7 alien invasive species		
Need for rehabilitation	Eradication of alien invasives	**Agricultural potential**	Limited grazing

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High shrubs/trees	2 - 3	0.1
Low Shrubs	0.5	1
Grass	0.5 – 1.5	50
Forbs, including geophytes	0.2 – 0.8	40
Dominant species (highest to lowest cover)	*Tagetes minuta, Digitaria eriantha, Eragrostis curvula, Setaria sphacelata, Verbena bonariensis, Conyza podocephala, Cynodon dactylon, Cyperus esculentus*	

Conservation status	**Indigenous**	**Weeds (Indigenous)**	**Alien**	**Total**	**Red Data**	**Protected**
High shrubs/Trees	1	1		**2**		
Low shrubs	3	2		**5**		
Succulents				**0**		
Forbs	11		7	**18**		
Grasses	15			**15**		
Geophytes		1		**1**		
Total	**30**	**4**	**7**	**41**	**0**	**0**

The vegetation consists of a relatively dense herbaceous layer, and covers most of site alternative 2. Past rehabilitation efforts have included overseeding by *Digitaria eriantha* and *Eragrostis curvula*. A large presence of alien invasives, most notable *Tagetes minuta* (Khaki Weed) is still indicative of the disturbed nature of this vegetation (Figure 6), and it is expected that species composition may still change considerably over the next few years if left as is.

Many sections of this vegetation still have remnants of sealed surface that could be incorporated into the proposed development: either as is or the crushed materials used in various applications.

Figure 6: *Digitaria eriantha* Grassland on site alternative 2.

Species composition and typical observed cover percentages:

Species	***Status***	***avg %***	***max %***
High Shrubs and Trees			
Acacia karroo		0.1	
Asparagus laricinus	W	0.1	
Low shrubs			
Chamaecrista mimosoides		0.1	
Felicia muricata		0.1	
Gomphocarpus fruticosus	W	0.1	
Seriphium plumosum	W	1	
Tephrosia capensis		0.2	
Herbs and forbs			
Bidens pilosa	AI	0.1	
Commelina africana		0.1	
Conyza podocephala		2	
Datura stramonium	AI: 1b	0.1	
Foeniculum vulgare	AI	0.1	
Gomphrena celosioides	AI	0.1	

Species	***Status***	***avg %***	***max %***
Helichrysum rugulosum		0.5	
Indigofera filipes		0.3	
Kohautia caespitosa		0.1	
Kyllinga pulchella		0.2	
Monsonia angustifolia		0.1	
Pollichia campestris		0.1	
Richardia brasiliensis	AI	0.1	
Selago densiflora		0.2	
Senecio isatideus		0.2	
Tagetes minuta	AI	30	
Verbena bonariensis	AI: 1b	2	
Xenostegia tridentata		0.1	
Grasses			
Andropogon chinensis		1	
Andropogon huillensis		0.1	
Aristida congesta		0.2	
Aristida transvaalensis		0.2	
Cynodon dactylon		2	

Species	*Status*	*avg %*	*max %*
Digitaria eriantha		20	
Enneapogon cenchroides		0.1	
Eragrostis curvula		10	
Eragrostis gummiflua		0.1	
Eragrostis heteromera		0.5	
Eragrostis lehmanniana		1	
Panicum maximum		0.1	
Pogonarthria squarrosa		0.2	
Setaria sphacelata		5	

Species	*Status*	*avg %*	*max %*
Sporobolus fimbriatus		0.2	
Geophytes			
Cyperus esculentus	W	2	

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, previously transformed
Ecosystem function	»	Grazing and soil stabilisation, especially if further rehabilitated
Stability	»	Medium to high if indigenous vegetation can be retained
Reversibility of degradation	»	Already transformed, improvement to natural grassland should be possible
Rating	»	***Low sensitivity***

General development recommendations:
The site is already completely fenced, hence offers good security for the proposed development. In addition, the high disturbance level makes it ideally suited for the proposed development.

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.

It is desirable that rubble and sealed surfaces be removed.

5.2.2. *Paspalum urvillei - Verbena bonariensis* Grassland

Habitat and Land use			
Substrate	Loamy sand	**Disturbance**	Partial previous transformation
Species Richness	19 indigenous species		

Habitat and Land use			
	7 alien invasive species		
Need for rehabilitation	Eradication of alien invasives	**Agricultural potential**	Limited grazing
Vegetation structure			
Layer	**Height (m)**	**Cover (%)**	
High Shrubs and trees	2 - 4	0.5	
Grass	0.3 – 1.2	70	
Forbs, including geophytes	0.3 – 1.5	30	
Dominant species (highest to lowest cover)	*Paspalum urvillei, Echinochloa species, Verbena bonariensis, Cyperus esculentus, Setaria sphacelata, Ischaemum fasciculatum*		

Conservation status	**Indigenous**	**Weeds (Indigenous)**	**Alien**	**Total**	**Red Data**	**Protected**
High shrubs/Trees	1		1	**2**		
Low shrubs				**0**		
Succulents				**0**		
Forbs	9		5	**14**		
Grasses	7		1	**8**		
Geophytes	1	1		**2**		
Total	**18**	**1**	**7**	**26**	**0**	**0**

A small central section of site alternative 2 clearly has moister soil conditions, which has led to the establishment of some facultative wetland species (Figure 7). This moisture may be due to continued water spillage from adjacent pipelines, or it may be a natural (degraded) wetland, which will have to be determined by the wetlands delineation.

The dense grass layer is heavily invaded by the Category 1b alien invasive *Verbena bonariensis*, which has the capacity to gradually displace more of the natural vegetation.

Figure 7: *Paspalum urvillei - Verbena bonariensis* Grassland on site alternative 2.

Species composition and typical observed cover percentages:

Species	***Status***	***avg %***	***max %***
High shrubs			
Acacia karroo		0.5	
Populus deltoides	AI	0.2	
Herbs and forbs			
Berkheya pinnatifida		0.1	
Cirsium vulgare	AI: 1b	0.5	
Commelina africana		0.1	
Helichrysum rugulosum		0.5	
Kyllinga pulchella		1	
Laggera decurrens		0.1	
Oenothera rosea	AI	0.1	
Rhynchosia totta		0.1	
Rumex crispus	AI	1	
Senecio consanguineus		0.2	
Senecio isatideus		0.5	
Sesamum species		0.1	
Solanum nigrum	AI	0.1	
Verbena bonariensis	AI: 1b	20	

Species	***Status***	***avg %***	***max %***
Grasses			
Cynodon dactylon		1	
Echinochloa species		20	
Eragrostis gummiflua		1	
Imperata cylindrica		0.1	
Ischaemum fasciculatum		2	
Miscanthus junceus		0.2	
Paspalum urvillei	AI	50	
Setaria sphacelata		10	
Geophytes			
Cyperus esculentus	W	10	
Oxalis depressa		0.1	

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
Ecosystem function	» Possible attenuation of high volumes of runoff from extreme rainfall events » Limited grazing » Soil stabilisation
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 needed to improve ecosystem functionality
Rating	» ***Low sensitivity***

General development recommendations:

The wetland status of this vegetation needs to be verified, as well as its current health and ecosystem functionality. Pending this investigation, the sensitivity may be increased to medium or high.

Listed alien invasive species must be eradicated to prevent further spread of regenerative material into surrounding areas. 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. *Cynodon dactylon - Conyza podocephala* Grassland

Habitat and Land use			
Substrate	Loamy sand	**Disturbance**	Past surface mining activities
Species Richness	100 indigenous species 15 alien invasive species		
Need for rehabilitation	Eradication of alien invasives	**Agricultural potential**	Grazing

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High Shrubs and trees	1 - 4	2 - 5
Low Shrubs	0.2 – 0.8	2 - 5
Grass	0.1 – 1.2	20 - 40
Forbs, including geophytes	0.01 – 1	5 - 10
Dominant species (highest to lowest cover)	*Cynodon dactylon, Eragrostis chloromelas, Eragrostis gummiflua, Themeda triandra, Conyza podocephala, Pogonarthria squarrosa, Eragrostis capensis, Seriphium plumosum, Eragrostis lehmanniana, Setaria sphacelata, Andropogon chinensis, Digitaria eriantha*	

Conservation status	Indigenous	Weeds (Indigenous)	Alien	Total	Red Data	Protected
High shrubs/Trees		1	2	**3**		
Low shrubs	6	2		**8**		
Succulents	2			**2**		
Forbs	50	3	13	**66**		
Grasses	28	1		**29**		
Geophytes	6	1		**7**	1	1
Total	**92**	**8**	**15**	**115**	1	**1**

This vegetation covers site alternative 1 and beyond. The area was largely transformed by past mining activities, and then rehabilitated. The resultant grassland has then been subjected to uncontrolled grazing, which has been resolved in the meantime. Diversity of the grassland is already relatively high (Figure 8), but the dominance of *Cynodon dactylon* and abundance of ruderal forbs shows that the vegetation community is still developing and not yet in a stable climax state. Nevertheless, the presence of several geophytes, including the slow-growing *Boophane disticha*, show a positive trajectory of change of these grasslands.

It would appear that the south-western corner of site alternative 1 has been least disturbed, judging from the particularly high species diversity there, including most of the geophytes (Figure 10).

Figure 8: The more disturbed grasslands on site alternative 1.

Figure 9: The well-developed grassland on site alternative 1.

Species composition and typical observed cover percentages:

Species	***Status***	***avg %***	***max %***
Succulents			
Oxygonum dregeanum		0.7	2
Portulaca kermesina		0.1	
High shrubs			
Asparagus laricinus	W	0.1	
Gleditsia triacanthos	AI: 1b	2	5
Populus deltoides	AI	0.1	
Low shrubs			
Acalypha angustata		0.1	
Chamaecrista mimosoides		1	
Dichapetalum cymosum	W	0.1	
Elephantorrhiza elephantina		1	
Felicia muricata		0.2	
Pelargonium pseudofumarioides		0.1	
Seriphium plumosum	W	5	

Species	***Status***	***avg %***	***max %***
Tephrosia capensis		0.3	
Herbs and forbs			
Amaranthus hybridus	AI	0.1	
Barleria lichtensteiniana		0.1	
Bidens bipinnata	AI	0.1	
Chironia purpurascens		0.1	
Cleome rubella		0.2	
Commelina africana		0.3	
Commelina livingstonii		0.1	
Conyza bonariensis	AI	0.7	
Conyza podocephala		6	
Corchorus asplenifolius		0.1	
Crabbea angustifolia		0.1	
Crepis hypochaeridea	AI	0.1	
Cyperus margaritaceus		0.1	
Cyperus semitrifidus		0.2	
Dicoma capensis		0.1	
Dicoma macrocephala		0.1	

Species	Status	avg %	max %
Dicoma schinzii		0.1	
Gazania krebsiana		0.1	
Gisekia africana		0.1	
Gnidia kraussiana		0.1	
Gnidia sericocephala		0.1	
Gomphrena celosioides	AI	0.1	
Guilleminea densa	AI	0.1	
Helichrysum coriaceum		0.1	
Helichrysum paronychioides		0.2	
Helichrysum rugulosum		0.5	
Hermannia depressa		0.3	
Hermannia oblongifolia		0.1	
Hibiscus microcarpus		0.1	
Hypericum lalandii		0.1	
Hypochaeris radicata	AI	0.1	
Indigofera filipes		0.6	
Ipomoea oblongata		0.1	
Kohautia caespitosa		0.1	
Kohautia cynanchica		0.4	
Kyllinga alba		0.1	
Kyllinga pulchella		1	
Laggera decurrens		0.2	
Lepidium africanum	W	0.1	
Mariscus congestus		0.1	
Monsonia angustifolia		0.1	
Nemesia denticulata		0.1	
Nemesia fruticans		0.2	
Nidorella hottentotica	W	0.1	
Oenothera rosea	AI	0.1	
Pollichia campestris		0.6	
Polygala hottentotta		0.1	
Requienia sphaerosperma		0.1	
Rhynchosia totta		0.2	
Rumex crispus	AI	0.1	
Rumex woodii		0.1	
Scabiosa columbaria		0.1	
Schkuhria pinnata	AI	2	
Selago densiflora		1	
Senecio isatideus		0.1	
Solanum panduriforme	W	0.1	
Striga asiatica		0.1	
Tagetes minuta	AI	2	
Tephrosia burchellii		0.1	

Species	Status	avg %	max %
Tephrosia lupinifolia		0.2	
Tribulus zeyheri	AI	0.2	
Ursinia nana		0.1	
Verbena bonariensis	AI: 1b	0.1	
Vernonia oligocephala		0.1	
Vigna oblongifolia		0.8	
Zornia milneana		0.7	
Grasses			
Andropogon chinensis		3	
Andropogon eucomus		0.1	
Aristida congesta		0.7	
Aristida scabrivalvis		1	
Aristida stipitata		0.4	
Brachiaria eruciformis		0.3	
Chloris virgata		0.1	
Cymbopogon plurinodis		0.3	
Cynodon dactylon		20	30
Digitaria eriantha		3	5
Diheteropogon amplectens		0.3	
Eragrostis capensis		5	
Eragrostis chloromelas		12	20
Eragrostis curvula		1	
Eragrostis gummiflua		9	
Eragrostis heteromera		0.1	
Eragrostis lappula		0.2	
Eragrostis lehmanniana		4	
Heteropogon contortus		0.3	
Melinis repens s. repens		0.1	
Pogonarthria squarrosa		5	
Setaria nigrirostris		0.1	
Setaria sphacelata		4	
Sporobolus africanus		0.1	
Sporobolus fimbriatus		0.3	
Themeda triandra		8	
Tragus berteronianus	W	0.1	
Trichoneura grandiglumis		0.8	
Geophytes			
Boophane disticha	**Decl, P**	**0.1**	
Chlorophytum species		0.1	
Cyperus esculentus	W	1	
Dipcadi viride		0.1	

Species	*Status*	*avg %*	*max %*
Ledebouria cooperi		0.1	
Pelargonium luridum		0.1	
Trachyandra laxa		0.1	
Symbols:			

Species	*Status*	*avg %*	*max %*
P = provincially protected AI = Alien Invasive Plant, indicated by category if listed under NEMA:BA W = Indigenous weed that could potentially become invasive **Red data** species are indicated by current status			

Sensitivity Rating:

Conservation status	» Medium-low, high biodiversity, occasional protected species.
Ecosystem function	» Vegetation valuable for grazing » Stabilisation of soils » Maintenance of pollinator populations » Increased infiltration of precipitation
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 needed to improve ecosystem functionality
Rating	» ***Low sensitivity*** » ***Medium Sensitivity: high diversity sections***

General development recommendations:

The site is suitable for development, excluding the high diversity south-western corner and small wetland area on the north-eastern periphery. From an ecological perspective, it is recommended that most of the development be placed on site alternative 2, with only as much of site alternative 1 (eastern section) as needed to obtain enough space for the proposed development.

For the development, protected species should be relocated. 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.

Further, if topsoils need to be removed from areas of this vegetation, it would be desirable to use it for further rehabilitation of site alternative 3, which will not be developed to replace sealed surfaces.

5.3. Amphibians, Reptiles and Mammals

A list of protected vertebrate species (reptiles, birds, 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.

At the time of the survey, small burrows of Yellow Mongoose (*Cynictis penicillata*) could be found on site alternative 1. In addition, following terrestrial vertebrates are commonly observed on the site (Pieter Muller, pers. comm.):

Duiker (*Sylvicapra grimmia*)
Steenbok (*Raphicerus campestris*)
Aardwolf (*Proteles cristata*)
Hares (*Lepus saxatilis* and *L. capensis*)

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
Plants				
Trachyandra erythrorrhiza	NT	Black turf marshes	Not expected	Habitat destruction
Stenostelma umbelluliferum	NT	Riparian areas	Not expected	Habitat destruction
Miraglossum laeve	VU	High altitude grasslands	Unlikely	Habitat destruction
Kniphofia typhoides	NT	Wetlands	Unlikely	Habitat destruction
Khadia beswickii	VU	Rocky outcrops	Unlikely	Illegal trade
Hypoxis hemerocallidea	Declining	Variable	Slight	Medicinal Trade
Habenaria barbertoni	NT	Rocky hillsides	Not expected	Habitat destruction
Gunnera perpensa	Declining	Wetlands	Unlikely	Habitat destruction
Drimia elata	DDT	Variable habitats	Slight	Medicinal Trade
Crinum bulbispermum	Declining	Grasslands and	Slight	Habitat

Species	RD Status	Suitable Habitat	Possibility of being present	Threat
		wetlands		destruction
Cineraria austrotransvaalensis	NT	High altitude grasslands	Unlikely	Habitat destruction
Boophone disticha	**Declining**	**Variable habitats**	**Observed**	**Medicinal Trade**
Acalypha caperonioides var. *caperonioides*	DDT	Grasslands	Slight	Habitat destruction
Adromischus umbraticola subsp. *umbraticola*	NT	Rocky outcrops	Unlikely	Habitat destruction
Alepidea attenuata	NT	Highveld wetlands	Unlikely	Habitat destruction
Brachycorythis conica subsp. *transvaalensis*	EN	Dolomite grasslands	Unlikely	Habitat destruction
Brachystelma incanum	VU	Sandy loam Bushveld	Unlikely	Habitat destruction
Callilepis leptophylla	Declining	Rocky slopes	Unlikely	Medicinal trade
Cineraria longipes	VU	South-facing basalt Koppies	Unlikely	Habitat destruction
Drimia sanguinea	NT	Variable veld	Slight	Medicinal trade
Gnaphalium nelsonii	Rare	Seasonal wetlands	Slight	Habitat destruction
Lepidium mossii	DDD	Grassland	Slight	Habitat destruction
Lessertia mossii	DDT	Variable plains	Unlikely	Habitat destruction
Lithops lesliei subsp. *lesliei*	NT	Rocky outcrops	Unlikely	Illegal trade
Myrothamnus flabellifolius	DDT	Rocky outcrops	Unlikely	Medicinal trade
Pearsonia bracteata	NT	Plateau grassland	Unlikely	Habitat destruction
Stapelia paniculata subsp. *paniculata*	NT	Rocky outcrops	Unlikely	Illegal trade
Terrestrial Vertebrates				
Giant Girdled Lizard ***Smaug (Cordylus) giganteus***	VU	Grassland	Slight	Habitat destruction
Giant Bull Frog ***Pyxicephalus adspersus***	NT	Wetlands	Slight	Habitat destruction
Coppery Grass Lizard ***Chamaesaura aenea***	NT	Grasslands	Slight	Habitat destruction

The following plants encountered on the study site are protected:

The Nature Conservation Ordinance 8 of 1969
Schedule 6: Protected Species

Boophane disticha

5.5. Invasive Plants

According to the SANBI-POSA species list, over 260 alien invasive plant species have been recorded up to date within the grid representative of Lethabo. 22 of these species could be confirmed on the site.

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 (all category 1b) have been recorded on the study area:

Cirsium vulgare
Datura stramonium
Gleditsia triacanthos (Figure 10)
Verbena bonariensis

Figure 10: *Gleditsia triacanthos* on site alternative 1.

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, 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 necessarily covered with tar or concrete

» The proposed development will be closely situated to existing electricity infrastructure, thus minimising the need for extensive overhead power lines to connect to the grid
» 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
    o 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

6.2. 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) can be summarised as follows:

Aspect influenced	*Fixed panel*	*Tracking panel*
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	Smaller continuous panel areas, runoff more dissipated, moderate variation of runoff edges that are expected to create less erosion where

Aspect influenced	*Fixed panel*	*Tracking panel*
	vegetation is weakened	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

6.3. 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	*Positive* where aliens will be cleared *Neutral* 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	

Mitigation:

» 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
  - 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
  - It is recommended that sealed surfaces from site alternatives 2 and 3 be crushed and used as filling material where and if possible
» Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil
» Reinforce portions of existing access routes that are prone to erosion, create structures or low banks to drain the access road rapidly during rainfall events, yet preventing erosion of the track and surrounding areas
» Ensure that runoff from compacted or sealed surfaces is slowed down and dispersed sufficiently to prevent accelerated erosion from being initiated (storm water and erosion management plan required)
» Prevent leakage of oil or other chemicals or any other form of pollution
» Monitor the establishment of (alien) invasive species and remove as soon as detected, whenever possible before regenerative material can be formed
» After decommissioning, if access road or portion thereof will not be of further use to the landowner, remove all foreign material and rip area to facilitate the establishment of vegetation, followed by a suitable revegetation program

Cumulative impacts:

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

Residual impacts:

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

2. Activity: Fencing area – may also serve as maintenance track to PV panels		
Environmental Aspect: Removal of vegetation, compaction of soils, creation of runoff zone, impact on protected species, impact on terrestrial vertebrates ***Note**: Secure fencing already exists around the entire site alternative 2 area, hence this assessment applies to currently unfenced sections of the proposed development only*		
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		
	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	*Positive* where aliens will be cleared *Neutral* where on transformed or highly degraded areas *Minimal new negative impacts expected*
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	Not likely	Not likely
Can impacts be mitigated?	Reasonably well	
Mitigation:		

» Avoid wetland and high biodiversity grassland 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
  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
» 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
  o 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 *before* regenerative material can be formed

Cumulative impacts:
» Possible erosion of cleared areas and associated accelerated erosion from surrounding areas
» Possible loss of ecosystem functioning due to increase in invasive species
» Increased fragmentation of rangelands

Residual impacts:
» Altered vegetation composition (temporary)
» Possibility for erosion and invasion by alien invasives

3. Activity: Construction and operation of PV panels on previously transformed and/or highly degraded areas – site alternative 2 and eastern section of site alternative 1

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)
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.

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

	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?	Probable	Unlikely
Can impacts be mitigated?	Reasonably	

Mitigation:

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

» Keep areas affected to a minimum, strictly prohibit any disturbance outside the demarcated footprint area

» Weeds and alien invasive species must be eradicated or significantly reduced:
  - o 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 EMP
- 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 *Cynodon dactylon* will re-establish by itself.
- A strong grass layer will also 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
- It is recommended that sealed surfaces from site alternatives 2 and 3 be crushed and used as filling material where and if possible

» Topsoil 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
- Excess removed topsoils can be used for the rehabilitation of areas where sealed surfaces have been removed

» 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
- contamination of drainage lines, lower-lying rivers or wetlands
- spread and establishment of invasive species

Residual impacts:

» altered topsoil characteristics

» altered vegetation composition (which will in this case be positive if indigenous grassland vegetation can be re-established)

4. Activity: Construction and operation of any development component(s) on higher diversity grasslands – south western section of site alternative 1

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

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.

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

	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
Can impacts be mitigated?	Reasonably	

Mitigation:

» 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
  - o Protected plant species: must be relocated
  - o Animal burrows: must be monitored by ECO prior to construction for

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

» Keep areas affected to a minimum, strictly prohibit any disturbance outside the demarcated footprint area
» Clear as little 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
    o 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
    o 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:
    o This is not only to stop the high reproduction and spreading of alien invasives, but also to reduce maintenance costs of the proposed development
    o 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
    o 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.
    o 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
    o It is recommended that sealed surfaces from site alternatives 2 and 3 be crushed and used as filling material where and if possible
» Topsoil 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
    o Excess removed topsoils can be used for the rehabilitation of areas where sealed surfaces have been removed
» 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: o Loss of and further fragmentation of remaining portions of natural grassland and associated ecosystem services such as pollination o Alteration of occupancy by terrestrial fauna, possible reduction of available habitat and food availability to terrestrial fauna o 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 or negative)	Negative	Slightly negative
Reversibility	Reversible	Reversible

Irreplaceable loss of resources?	Not likely	Not likely
Can impacts be mitigated?	Reasonably	

Mitigation:

» 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
  - o 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
  - o Protected plant species: must be relocated where affected by pylons, maintenance tracks or construction
  - o Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor

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

» Limit clearing of indigenous vegetation to 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

Cumulative impacts:

» Possible erosion of surrounding areas if no mitigation is implemented, no major cumulative impact on flora or fauna expected (excluding avifauna)

Residual impacts:

» 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 *concentrated* runoff from sealed surfaces and possibly higher accelerated erosion, reduction of habitat and resource availability for terrestrial fauna		
	Without mitigation	**With mitigation**
Extent (E)	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 *(Negative on high diversity grassland areas – see under activity 4)*
Reversibility	Partially reversible	Reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably	

Mitigation:

» During the design phase, ensure that none of these development components are situated outside transformed areas
  - o 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
  - 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

» Weeds and alien invasive species must be eradicated or significantly reduced:
  - o 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 storage of 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 *concentrated* 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	

Mitigation:

» 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
  - 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 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 » 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
Cumulative impacts: » If mitigation measures are not strictly followed the following could occur: o erosion of the development area with associated siltation and/or erosion of lower-lying wetlands o contamination of drainage lines, lower-lying rivers, wetlands and ground water o spread and establishment of invasive species
Residual impacts: » altered topsoil characteristics » altered vegetation composition

8. Activity: Borrow-pits and/or topsoil stockpiles that might be required during construction Note: remaining sealed surfaces on the site alternatives 2 and 3 could be crushed and used as filling material, as this will also greatly benefit the ongoing rehabilitation efforts on that area		
Environmental Aspect: Removal of vegetation, compaction of soils, creation of runoff zone, displacement of terrestrial vertebrates		
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		
	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	

Mitigation:

» 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
  - 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

Cumulative impacts:

» If mitigation measures are not strictly followed the following could occur:
  - continued erosion of the altered surfaces with associated siltation and/or erosion of lower-lying wetlands

o contamination of drainage lines, lower-lying rivers or wetlands o spread and establishment of invasive species
Residual impacts: » altered topsoil characteristics » altered vegetation composition

9. Activity: PV array *components* 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	
Mitigation: » 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: o A list of possible toxic substances, heavy metals or other potentially harmful substances that could be released during breakage o How to contain and mitigate the release of such substances o Correct salvage, disposal and preferably also recycling methods (or possibilities) for any broken materials
Cumulative impacts: » 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
Residual impacts: » 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 high negative impacts on the ecological environment will occur if portions of high diversity grassland vegetation will be further disturbed.

» 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 property falls within the Central Free State Grassland (GH 6) as defined by Mucina and Rutherford (2006). A total of 1432 plant species have been recorded in the Sasolburg/Vereeniging Area according to the SANBI database. Only 115 indigenous plant species could be verified on site, with an additional 22 alien invasive species (excluding planted exotic trees).

Each site alternative had a very different past landuse history, which greatly influenced the current vegetation composition:

Alternative site 1: open cast mining which was rehabilitated, open rangeland, subjected to small portions of past sand mining, occasional excessive grazing, currently covered by semi-natural grasslands. The south-western portion of this site has a high floristic diversity.

Alternative site 2: machinery storage, many sealed surfaces and rubble still remaining, currently covered by variable grasslands with a high alien invasive cover. From an ecological perspective, this would be the preferred site for the development.

Alternative site 1 is suitable for development, excluding the small wetland area on the north-eastern periphery. From an ecological perspective, it is recommended that most of the development be placed on site alternative 2, with only as much of site alternative 1 (eastern section) as needed to obtain enough space for the proposed development.

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 or significantly impact any flora or terrestrial vertebrate species on the study area or beyond. 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 issues identified by this study are:

- » Wetlands need to be verified by a wetlands study
- » All NEMA:BA listed alien invasives within the development footprint area will have to be entirely cleared prior to development, not only to prevent spread of these species but also to ensure efficient maintenance of the proposed development
- » 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
    - o Soils are prone to capping and erosion and need to be stabilised by a permanent grass or suitable indigenous vegetation layer.
    - o Locally occurring grass species become moribund and die off if not grazed or burnt regularly. It is thus recommended to allow either seasonal sheep grazing to reduce dead biomass accumulation on grass tufts or implement a regular mowing program (possibly twice a year). This will also greatly reduce the risk of fire, which is a natural component of grassland dynamics.

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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

Lethabo 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):

24 March 2015

Date:

11. Appendix B: Curriculum Vitae of Specialist

CURRICULUM VITAE

MARIANNE STROHBACH
SAVANNAH ENVIRONMENTAL (PTY) LTD

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

SKILLS BASE AND CORE COMPETENCIES

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

EDUCATION AND PROFESSIONAL STATUS

Degrees:

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

Short Courses:

2008: Landscape Functional Analysis for vegetation condition and restoration monitoring
2002: Satellite Image Analysis for Vegetation Mapping, German Aerospace Centre (DLR) 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 Free State
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: Red data terrestrial vertebrate species previously recorded in the area

Common Name	Species Name	Threat Status
Amphibians		
Pyxicephalus adspersus	Giant Bull Frog	Near Threatened
Reptiles - Serpents		
Homoroselaps dorsalis	Striped Harlequin Snake	Near Threatened
Chiroptera - Bats		
Miniopterus fraterculus	Lesser Long-fingered Bat	Near Threatened
Myotis tricolor	Temminck's Myotis	Near Threatened
Rhinolophus darlingi	Darling's Horseshoe Bat	Near Threatened
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	Near Threatened
Rhinolophus blasii	Blasius's Horseshoe Bat	Vulnerable
Insectivora - Insectivores		
Suncus varilla	Lesser Dwarf Shrew	Data Deficient
Suncus infinitesimus	Least Dwarf Shrew	Data Deficient
Crocidura mariquensis	Swamp Musk Shrew	Data Deficient
Crocidura maquassiensis	Makwassie Musk Shrew	Vulnerable
Atelerix frontalis	Southern African Hedgehog	Near Threatened
Muridae - Gerbils		
Tatera leucogaster	Bushveld Gerbil	Data Deficient
Rodentia - Rodents		
Lemniscomys rosalia	Single-Striped Grass Mouse	Data Deficient
Mystromys albicaudatus	African White-tailed Rat	Endangered

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 property falls within the Central Free State Grassland (GH 6) as defined by Mucina and Rutherford (2006). A total of 1432 plant species have previously been recorded in the Sasolburg/Vereeniging Area. This high number is largely attributable to the many diverse habitats within the grid, but will not all be found within any one habitat type. 115 indigenous plant species could be verified on site, with an additional 22 alien invasive species (excluding planted exotic trees).

Each site alternative had a very different past landuse history, which greatly influenced the current vegetation composition:

Alternative site 1: open cast mining which was rehabilitated, open rangeland, subjected to small portions of past sand mining, occasional excessive grazing, currently covered by semi-natural grasslands.

Alternative site 2: machinery storage, many sealed surfaces and rubble still remaining, currently covered by variable grasslands with a high alien invasive cover. From an ecological perspective, this would be the preferred site for the development.

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.

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	» 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	» 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	» 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	» 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**
Avoid remaining high diversity grasslands and functional wetland areas as far as possible.	Developer	Design phase

Mitigation: Action/Control	Responsibility	Timeframe
Undertake pre-construction walk-through footprint investigations for protected flora and burrowing terrestrial vertebrates: The final footprint investigation (walkthrough) is aimed to fully inform the developer, responsible conservation authority (that will issue the relevant permits and authorisations), contractors, EO and ECO about: » Protected 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 contractor to prevent any unnecessary (further) degradation of the development footprint	Developer, carried out by Specialist	Design review phase
The above pre-construction footprint investigations will be used together with results from the ecological specialist report to draft the following: » A comprehensive search and rescue program for	Developer, drafted by Specialist	Design review phase

Mitigation: Action/Control	Responsibility	Timeframe
plants and possible burrowing animals » A comprehensive alien invasive species eradication and management plan o Basic requirements of these are listed under the Construction and operational Phase EMPr		
Obtain permits for protected plant removal and relocation prior to commencement of any activity related to this development	Developer	Pre-commencement
Use design-level mitigation measures recommended in respect of habitat and ecosystem intactness and prevention of species loss as detailed within the EIA Report » This includes positioning components of the development as close as possible together and in close proximity to other existing or planned developments in the area » Strictly adhere to existing tracks/roads 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
Compile a comprehensive storm water management and erosion control plan for the footprint area as part of the final design of the project » Basic requirements of these are listed under the Construction and operational Phase EMPr	Developer and relevant specialist	Design phase

Mitigation: Action/Control	Responsibility	Timeframe
Permissible biodiversity: » Depending on the final PV array and mechanism developed and taking all potential impacts, fire risks and maintenance requirements into consideration, it has to be decided upon and made clear: o Permissible vegetation: maximum height, desirable density and composition o Maintenance of this vegetation – mowing, or other means Note: due to the hydrogeology of the area, there should be no application of herbicides	Developer and relevant specialist	Design phase
After the permissible biodiversity has been determined, compile a comprehensive vegetation rehabilitation management plan. » Basic requirements of these are listed under the Construction and operational Phase EMPr	Developer and relevant specialist	Design phase

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

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 EMPrs 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	Project components affecting the objective:

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

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Ecological footprint investigation and recording by GPS of localities of species of conservation concern as described in 13.1.1 (Design Phase)	Ecologist	Prior to commencement of activity
» Search and Rescue (S&R) of all protected plants that will be affected by the development, especially species occurring in long term and permanent, hard surface development footprints (i.e. all buildings, new roads and tracks, laydown areas, and panel positions) should take place » 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

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

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

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

Mitigation: Action/Control	Responsibility	Timeframe
» The location of the construction equipment camp and all access routes will take	Contractor/ECO	Pre-construction

Mitigation: Action/Control	Responsibility	Timeframe
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		
As far as possible, minimise natural vegetation clearing for equipment storage areas » Aim to locate the temporary construction camps on already degraded and/or heavily disturbed areas	Contractor, monitored by ECO	During site establishment
Staff shall be supplied with adequate facilities aimed at preventing any kind of pollution » 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
Identify and demarcate construction areas, servitudes, and access for general construction work and restrict construction activity to these areas. » Prevent unnecessary destructive activity within construction areas (prevent over-excavations and double handling) » Create specific turning points and parking areas for vehicles and heavy machinery as needed » Strictly prohibit any driving outside designated areas and roads	Contractor, ECO to control	Before and during construction, operational phase
To limit the possible distribution of undesirable species and possible pollutants onto site: » Regularly check clothing and vehicles for mud and seed and clear in an appropriate manner (see invasive plant management for more details) » Do not wash down any machinery or vehicle within the farm portion, including the footprint area » All materials moved onto the development site must be free of weeds or any other undesirable organisms or pollutants » It is recommended that fuels, lubricants and	Contractor, ECO to control	Before and during construction, operational phase

Mitigation: Action/Control	Responsibility	Timeframe
other chemicals only be stored on site if absolutely necessary, and then in a manner that prevents any accidental spillage		
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 EMPr, 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. In cases where areas from which topsoil is

removed will be transformed, such topsoil can be applied to areas where currently sealed surfaces have been removed to aid the rehabilitation of those sites within the Lethabo Grounds.

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

Mitigation: Action/Control	Responsibility	Timeframe
Areas to be cleared must be clearly marked on-site to eliminate the potential for unnecessary clearing.	Contractor in consultation with Specialist	Pre-construction
Construction activities must be restricted to demarcated areas so that impact on topsoil is restricted.	Contractor, ECO to control	Before and during construction, operational phase
Salvaging topsoil: » Topsoil must always be salvaged and stored separately from subsoil and lower-lying parent rock or other spoil material.	Contractor, ECO to control	Before and during construction

Mitigation: Action/Control	Responsibility	Timeframe
o Topsoil stripping removes up to 30 cm or less of the upper soils. » Prior to salvaging topsoil, the depth, quality and characteristics of topsoil should be known for every habitat type. o This will give an indication of total volumes of topsoil that need to be stored to enable the proper planning and placement of topsoil storage. o Different types of topsoil – rocky soils and sands must be stored separately » Topsoils should be removed (and stored) under dry conditions to avoid excessive compaction whenever topsoil will have to be stored for longer than one year.		
Storing topsoil: » Viability of stored topsoil depends on moisture, temperature, oxygen, nutrients and time stored. » Rapid decomposition of organic material in warm, moist topsoils rapidly decreases microbial activity necessary for nutrient cycling, and reduces the amount of beneficial micro-organisms in the soil. » Stockpile location if not adjacent to a linear development: o At least 50 m from any natural wetlands o Ideally a disturbed area cleared of weeds and invasives » *Topsoil is typically stored in berms with a width of 150 – 200 cm, and a maximum height of 100 cm, preferably lower* o Place berms along contours or perpendicular to the prevailing wind direction o Adhere to the following general rule: the larger the pile of topsoil storage needs to be, the shorter should be the time it is stored » Topsoil handling should be reduced to stripping, piling (once), and re-application. Between the piling and reapplication, stored topsoils should not undergo any further handling except control of erosion and (alien) invasive vegetation » Where topsoil can be reapplied within six months to	Contractor, ECO to control	Before and during construction

Mitigation: Action/Control	Responsibility	Timeframe
one year after excavation, it will be useful to store the topsoil as close as possible to the area of excavation and re-application, e.g. next to cabling trenches o In such case, use one side of the linear development for machinery and access only o Place topsoil on the other/far side of this development, followed by the subsoil o If there will be a need for long-term storage of topsoil in specified stockpiles, this must be indicated in the design phase already and accompanied by a detailed topsoil stockpile management plan » In cases where topsoil has to be stored longer than 6 months or during the rainy season, soils should be kept as dry as possible and protected from erosion and degradation by: o Preventing puddling on or between heaps of topsoil o Or covering topsoil berms o Preventing all forms of contamination or pollution o Preventing any form of compaction o Monitoring establishment of all invasive vegetation and removing such if it appears o Keeping slopes of topsoil at a maximal 2:1 ratio o Monitoring and mitigating erosion where it appears o Where topsoil needs to be stored in excess of one year, it is recommended to either cover the topsoil or allow an indigenous grass cover to grow on it – if this does not happen spontaneously, seeding should be considered		
Reapplying topsoils: » Spoil materials and subsoil must be back-filled first, then covered with topsoil » Generally, topsoils should be re-applied to a depth equal to 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	Contractor, ECO to control	Before and during construction

Mitigation: Action/Control	Responsibility	Timeframe
cm » If the amount of topsoil available is limited, a strategy must be worked to out to optimise revegetation efforts with the topsoil available » Reapplied topsoils should be landscaped in a way that creates a variable 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: o Use organic material from cleared vegetation where possible o Alternatively, suitable geotextiles or organic erosion mats can be used as necessary » Continued monitoring will be necessary to detect any sign of erosion early enough to allow timeous mitigation		
Re-applied topsoils need to be re-vegetated as soon as possible, following the revegetation and rehabilitation plan.	Contractor, ECO to control	Before and during construction, monitored during operational phase

Performance Indicator	» Minimal disturbance outside of designated work areas. » Topsoil appropriately stored, managed, and rehabilitated.
Monitoring	» Monitoring of appropriate methods of vegetation clearing and soil management activities by ECO throughout construction phase. » An incident reporting system will be used to record non-conformances to the 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: » PV Array » Grid connection and associated servitudes » Access roads » Workshop, substation and other related infrastructure » Potential topsoil stockpiles and/or borrow pits
Potential Impact	» Loss of topsoil and natural resources and biological activity within the topsoil » Loss of natural regeneration potential of soils » Loss of agricultural potential of soils.

Activity/Risk Source	» Rainfall and wind erosion of disturbed areas » Excavation, stockpiling and compaction of soil » Concentrated discharge of water from construction activity and new infrastructure, 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 » Roadside drainage ditches » Premature abandonment of follow-up monitoring and adaptive management of rehabilitation
Mitigation: Target/Objective	» To minimise erosion of soil from site during construction » To minimise deposition of soil into drainage lines » To minimise damage to vegetation by erosion or deposition » To minimise damage to rock, soil, animals and vegetation by construction activity » No accelerated overland flow related surface erosion as a result of a loss of vegetation cover » No reduction in the surface area of natural drainage lines and other wetland areas as a result of the establishment of infrastructure » Minimal loss of vegetation cover due to construction related activities » No increase in runoff into drainage lines as a result of construction of project related infrastructure » No increase in runoff into drainage lines as a result of road construction

Mitigation: Action/Control	Responsibility	Timeframe
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,

Mitigation: Action/Control	Responsibility	Timeframe
		monitored during operational phase
General Erosion control measures: » 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 o Ensure that all soil surfaces are protected by vegetation or a covering to avoid the surface being eroded by wind or water. » Ensure that heavy machinery does not compact areas that are not meant to be compacted as this will result in sealed hydrophobic, water repellent soils that increase the erosion potential of the area. » 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	Contractor, ECO to control	Construction, operational phase
Control depth of excavations and stability of cut	Contractor, to	Site

Mitigation: Action/Control	Responsibility	Timeframe
faces/sidewalls	be monitored by ECO	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 Indicator	» Minimal level of soil erosion around site » 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	» Fortnightly inspections of the site by ECO » Fortnightly inspections of sediment control devices by ECO » Fortnightly inspections of surroundings 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: » 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	» 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	» Site preparation and earthworks » Excavation of foundations and trenches » Construction of site access road » Power line construction activities » PV array construction activities » Stockpiling of topsoil, subsoil and spoil material.
Mitigation: Target/Objective	» Recreate a non-invasive, acceptable vegetation cover that will facilitate the establishment of desirable and/or indigenous species » Prevent and accelerated erosion of ecosystem degradation

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Rehabilitation of surface		

Mitigation: Action/Control	Responsibility	Timeframe
Prior to the application of topsoil » subsoil shall be shaped and trimmed to blend in with the surrounding landscape or used for erosion mitigation measures » ground surface or shaped subsoil shall be ripped or scarified with a mechanical ripper or by hand to a depth of 15 – 20 cm » compacted soil shall be ripped to a depth greater than 25 cm and the trimmed by hand to prevent re-compacting the soil » any foreign objects, concrete remnants, steel remnants or other objects introduced to the site during the construction process shall be cleared before ripping, or shaping and trimming of any landscapes to be rehabilitated takes place » shaping will be to roughly round off cuts and fills and any other earthworks to stable forms, sympathetic to the natural surrounding landscapes	Contractor, ECO to control	During and after construction
Application of topsoil » topsoils shall be spread evenly over the ripped or trimmed surface, if possible not deeper than the topsoil originally removed » the final prepared surface shall not be smooth but furrowed to follow the natural contours of the land » the final prepared surface shall be free of any pollution or any kind of contamination » care shall be taken to prevent the compaction of topsoil	Contractor, ECO to control	During and after construction
Soil stabilisation » mulch, if available from shredded vegetation, shall be applied by hand to achieve a layer of uniform thickness » mulch shall be rotovated into the upper 10 cm layer of soil o this operation shall not be attempted if the wind strength is such as to remove the mulch before it can be incorporated into the topsoil » measures shall be taken to protect all areas susceptible to erosion by installing temporary and permanent drainage work as soon as possible where required	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached

Mitigation: Action/Control	Responsibility	Timeframe
o 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 o such measures shall be effected immediately before erosion develops at a large scale » where erosion cannot be remedied with available mulch or rocks, geojute or other geotextiles shall be used to curtail erosion		
Borrow-pits (if required) » shall be shaped to have undulating, low-gradient slopes and surfaces that are rough and irregular, suitable for trapping sediments and facilitation of plant growth » upon completion of rehabilitation these reshaped and revegetated areas shall blend into the natural terrain	Contractor, ECO to control	After construction
Revegetation		
» 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, continued up to desired end state
Re-seeding » revegetation can be increased where necessary by hand- seeding indigenous species o previously collected and stored seeds shall be sown evenly over the designated areas, and be covered by means of rakes or other hand tools o commercially available seed of grass species naturally occurring on site can be used as alternative » re-seeding shall occur at the recommended time to	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached

Mitigation: Action/Control	Responsibility	Timeframe
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		
Planting of species » the composition of the final acceptable vegetation will be based on the vegetation descriptions of the original ecological investigation, and will include rescued plant material » geophytic plants shall be planted in groups or as features in selected areas » during transplanting care shall be taken to limit or prevent damage to roots » plants should be watered immediately after transplanting to help bind soil particles to the roots (or soil-ball around rooted plants) and so facilitate the new growth and functioning of roots	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached
Traffic on revegetated areas » designated tracks shall be created for pedestrian of vehicle traffic where necessary » Disturbance of vegetation and topsoil must be kept to a practical minimum, no unauthorised off road driving will be allowed » All livestock shall be excluded from newly revegetated areas, until vegetation is well established	Contractor, ECO to control	Construction phase Operational phase
Establishment » The establishment and new growth of revegetated and replanted species shall be closely monitored o Where necessary, reseeding or replanting will have to be done if no acceptable plant cover has been created	Contractor, ECO to control	Construction phase Operational phase, continued up to desired end state
Monitoring and follow-up treatments		
Monitor success of rehabilitation and revegetation and take remedial actions as needed according to the respective plan	ECO during construction, suitable	Construction phase Operational

Mitigation: Action/Control	Responsibility	Timeframe
» 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	designated person / contractor after that	phase
Weeding » It can be anticipated that invasive species and weeds will germinate on rehabilitated soils o These need to be hand-pulled before they are fully established and/or reaching a mature stage where they can regenerate o Where invasive shrubs re-grow, they will have to be eradicated according to the Working for Water specifications	Contractor	Construction phase Operational phase

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

Invasive plant management

OBJECTIVE: Manage and reduce the impact of invasive vegetation

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

Project Component/s	» Permanent and temporary infrastructure » Access roads
Potential Impact	» 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	» 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	» To significantly reduce the presence of weeds and eradicate alien invasive species » To avoid the introduction of additional alien invasive plants to the project control area » To avoid further distribution and thickening of existing alien plants on the project area » To complement existing alien plant eradication programs in gradually causing a significant reduction of alien plant species throughout the project control area

Mitigation: Action/Control	Responsibility	Timeframe
» Compile a detailed invasive plant management and	Specialist	Pre-

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

Mitigation: Action/Control	Responsibility	Timeframe
» 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		

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