FAUNAL AND FLORAL DIVERSITY AND HABITAT ASSESSMENTS:

FOR THE PROJECT:

Boitshoko Solar Power Plant (Pty.) Ltd. near Kathu

ON:

THE REMAINING EXTENT OF PORTION 1 OF THE FARM LIMEBANK NO. 471, REGISTRATION DIVISION KURUMAN, NORTHERN CAPE PROVINCE.

March 2016

Report prepared by:

ENVIRONMENT RESEARCH CONSULTING

ERC forms part of **Benah Con cc**

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1 SPECIALIST INVESTIGATORS

Primary specialist investigator: Albert R. Götze (*Pr.Sci.Nat.*)

Highest tertiary qualification: M.Sc. *cum laude* (Phytosociology & Restoration Ecology)

Professional affiliation: SACNASP (reg. no. 400011/08)

Background & expertise:

I have been consulting as a professional ecologist, botanist and soil scientist since 2002. I gained valuable experience in the fields of vegetation classification, various restoration disciplines, faunal trapping, soil surveying and wetland surveying during my post graduate studies and later as fieldwork mentor for post graduate ecology students of the Northwest University, Potchefstroom Campus (2008 - 2014), on occasion for game ranch management students of the Tshwane University of Technology. As independent ecological consultant I have experience in various types of scientific floral and faunal studies in the grassland and savannah in Gauteng, North West, Limpopo, Mpumalanga, Free State, Eastern and Northern Cape. I have also on occasion performed vegetation studies in the KwaZulu-Natal savannah and Indian Ocean Coastal Belt, the Eastern Cape thicket, the Western Cape fynbos, Namaqualand, the Karoo and Swaziland. I have 13 years experience in specialist biodiversity, soil and wetland studies and have performed numerous (at least 95) such studies since 2002. I have authored two and co-authored four scientific papers for various local scientific publications since 2004.

Secondary specialist investigator: Leon Kotze

Highest tertiary qualification: BSc (Conservation Ecology)

Professional affiliation: None

Background & expertise:

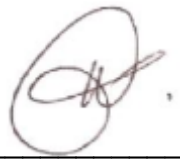
I am currently studying towards a M.Sc. in Small Mammal Ecology at the University of Witwatersrand and have captured, handled and recorded individual information for close to 500 small mammals to date. My highest qualification is a B.Sc. in Conservation Ecology (obtained at Stellenbosch University) in which Biome ecology and Zoology were my major subjects.

2 PROFESSIONAL DECLARATION

The specialist investigators responsible for conducting this particular specialist faunal and floral and habitat assessment declare that:

- We consider ourselves bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP).

- At the time of conducting the study and compiling this report we did not have any interest, hidden or otherwise, in the proposed development that this study has reference to, except for financial compensation for work done in our professional capacity.
- Work performed for this study was done in an objective manner. Even if this study results in views and findings that are not favorable to the client/applicant, we will not be affected in any manner by the outcome of any environmental process of which this report may form a part, other than being members of the general public.
- We declare that there are no circumstances that may compromise our objectivity in performing this specialist investigation. We do not necessarily object to or endorse the proposed development, but aim to present facts, findings and recommendations based on relevant professional experience and scientific data.
- We do not have any influence over decisions made by the governing authorities.
- Should we, at any point, consider ourselves to be in conflict with any of the above declarations, we shall formally submit a Notice of Withdrawal to all relevant parties and formally register as an Interested and Affected Party.
- We undertake to disclose all material information in our possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by a competent authority to such a relevant authority and the applicant.
- We have expertise and experience in conducting specialist reports relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity.
- This document and all information contained herein are and will remain the intellectual property Benah Con cc (Environment Research Consulting) and the specialist investigator(s) responsible for conducting the study. This document, in its entirety or any portion thereof, may not be altered in any manner or form, for any purpose without the specific and written consent of the specialist investigator(s).
- We will comply with the Act, regulations and all other applicable legislation.
- All the particulars furnished in this document are true and correct.
- We realize that a false declaration is an offence in terms of Regulation 71 of NEMA and is punishable in terms of section 24F of the Act.



A.R. Götze (M.Sc.; *Pr.Sci.Nat.*) Leon Kotze (B.Sc.)

3 EXECUTIVE SUMMARY

Based on the findings of this study it is the opinion of the specialist investigators that from a faunal, floral, wetland and general ecological point of view, the proposed development on the preferred area is considered favourably, provided that due care is taken to minimise and properly mitigate all identified impacts.

Introduction & Site Description

This study aims to assess the impact that the development of a Photovoltaic Solar Power Plant, on farmland in the Northern Cape about 6 km east-southeast of Deben and about 13 km northwest of Kathu, will have on the faunal and floral diversity within the site concerned (development footprint of approximately 250ha – with one preferred- and one alternative site), with special reference to Threatened or Protected Species (ToPS). *Environment Research Consulting* (*ERC*) was contracted to conduct a biodiversity (faunal & floral) and general habitat assessment of a portion of the remainder of portion 1 of the farm Limebank 471 near Deben in the Northern Cape Province. This report presents the findings of a once off, summer assessment that was conducted over a three day period from 06 to 08 March 2016.

The site falls within the Eastern Kalahari Bushveld Bioregion of the Savanna Biome, with annual precipitation and temperature averaging 362 mm and 17.8 °C, respectively (Rutherford et al. 2006). Livestock ranching dominates the immediate surrounds and mining activities are a prominent feature in the region (*pers. obs.*). Topography remains homogeneous throughout both sites with no obvious change in slope.

The area is visibly transformed with signs of overgrazing (bush encroachment). Some areas are very densely populated by trees and large shrubs. The area is not particularly sandy with ground cover showing some regeneration after the farm-owner removed his cattle (*pers. comm.* Hendrik van der Merwe). There are three pans in close proximity to the preferred site.

Faunal Assessment

Three small mammal trap lines (live trapping) were placed in the study area on 300 m transects. Non-invasive walk transects were performed daily, documenting all animal sightings (including spoor and / or scat) in writing or by photographs. Drive transects were also conducted, twice per day, along the same 5 km route.

Two Murid species were captured during the study period. Only two of the three were successful, with mean trap success = 3.33%, and the min. / max. = 2 / 4. Eighteen walk transects were performed and at least one hour was spent inspecting the area surrounding each transect. No animals were recorded during this effort. Drive transects, delivered three additional mammal species sightings.

According to literature research, and considering the bioregion, landscape and habitat characteristics, the plausible species richness of the study site is as indicated in Table A according to a ratio of total species vs. total protected and data deficient species.

Table A: Plausible species richness of the study site

Faunal type	Ratio = total species : total protected and data deficient species
Mammals	32 : 4
Reptiles	28 : 0
Amphibians	7 : 1
Butterflies	1

Literature research revealed that no animals were restricted or endemic to the area. Some species listed have a low likelihood of occurring within the site, but are nonetheless listed if their habits, habitat requirements and estimated distribution ranges agree with the study findings. The plausible reptile species richness of the area (Table A) was negatively affected by the wealth of crown cover as well as a lack of rockiness or sandy substrates (within our site). For the most part of the year the likelihood of any amphibians occurring on the site is low but there is no doubt some species would gather at the pans after good rain. No physical record of the listed butterfly occurring in the site exists (Appendix A, Table 12-4), but has been included due to the close proximity of the nearest record (i.e. Hotazel) and its “Data deficient” status. Furthermore, the species is endemic to the region and has habitat preferences corresponding with the environmental characteristics of the site.

Floristic & Habitat Assessment

A plotless sampling method was used to record floristic and general habitat data. Plant species observed in the study area during the time of the study were recorded and included in plant species lists. The floristic composition of each of the identified broad vegetation units and/or application area are described and discussed.

According to Mucina & Rutherford (2006) the study area falls in the Kathu Bushveld vegetation type (SVk12). The habitat characteristics of the study area largely resemble the description given for SVk12. The areas studied (i.e. the preferred and alternative sites) are mostly flat sandy plains with shrubs and few tall trees. Soils are sandy and vary in depth from shallow to moderately deep. Rockiness of the soil surface also varies. A number of non-perennial pans were observed in the area and some drainage lines were also recorded on the alternative site.

151 plant species are recorded on the POSA data base of SANBI for the relevant QDS 2722 DB & DD, the study area is situated in. This list contains species for at least two different vegetation types.

A total of 130 plant species (from 45 plant families and 101 genera) (Table B) were recorded in the study area during the time of the study and indicates moderate species diversity.

Table B: Summary of plant families, genera and species recorded in the study area

	Families	Genera	Species
ANGIOSPERMAE (seed plants): ***Monocotyledonae:***	7	23	39
Dicotyledonae:	38	78	91
Total:	**45**	**101**	**130**

Two broad Vegetation Units (VU's) were recorded and described:

- VU 1: *Acacia mellifera* semi-closed rocky shrubland
- VU 2: Non-perennial pans

10 plant species of specific conservation significance were recorded in the study area during the study period. Two are listed by Raimondo *et al* (2009) in the South African Red Data list as Declining species. Two tree species are included in the protected tree species list published by the National Forests Act (Act no.84 of 1998) (NFA, 1998), and nine of the 10 are listed as protected by the Northern Cape Nature Conservation Act (Act no. 9 of 2009) (NCNCA, 2009). No species listed as Threatened or Protected Species (ToPS) by the National Environmental Management: Biodiversity Act's (Act No. 10 of 2004) list of ToPS as published in Government Gazette no. 36375 of 16 April 2013 (NEMBA ToPS, 2013), were recorded in the study area during this study.

During the study nine exotic plant species were recorded in the study area. Four are classified as alien weed or invader species, according to the Conservation of Agricultural resources Act (Act No. 43 of 1983) (CARA, 1983) in Henderson (2001) and also according to the National Environmental Management: Biodiversity Act's 2014 list of proposed weeds and invaders (NEMBA, 2014) and five are uncategorized and non-invasive herbaceous weeds.

No ecosystems that are threatened and in need of protection according to the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) was recorded in or in the vicinity of the study area.

Delineation of pans

According to Kotze *et al*. (2009) and DWAF (2005) a pan can be one of the hydro-geomorphic forms of a wetland. As a result it was decided to study and

delineate six pans in the vicinity of the preferred development area of the study area. None of these pans actually occur on the preferred site, but were studied none the less because of their proximity to the site and their potential ecological importance in the larger ecological system within which the study area falls. Mention is also made of five other nearby pans, which were not specifically studied or delineated.

From a hydrological point of view none of the pans were inundated during the time of the study and only two of the six investigated pans had visibly moist or wet soils patches at their lowest points. The current dryness of the pans is ascribed to the fact that drought conditions were experienced in the region during the time of the study.

The pans were delineated on a visual level in the field, mostly focusing on the hydrology, terrain unit and the presence of water loving plants indicators. A buffer zone of 32 m from the edge of all pans, as prescribed for wetlands in Government Notice R.544 in Government Gazette 33306 of 18 June 2010, was delineated and mapped for all pan areas.

Impact Assessment

Based on an impact assessment it is evident that there are four expected impacts on the faunal, floral and general habitat ecology within the study area. Table C summarises the findings indicating the significance of the impact before mitigation and management takes place and the likely impact if mitigation and management takes place. From Table C it is evident that prior to management measures being put in place, the impacts are negative-medium or negative-high level impacts. If effective management takes place, all impacts will be reduced to lower level impacts.

Table C: A summary of the results from the impact assessments

Impact	Not mitigated / managed	Mitigated / managed
1. Loss of habitat for faunal and floral species	negative medium impact	negative low impact
2. Loss of indigenous faunal and floral species diversity	negative medium impact	negative low impact
3. Loss of faunal and floral species of conservation significance	negative high impact	negative medium to low impact
4. Degradation and/or destruction of natural pans.	negative medium impact	negative low impact

Due the destructive nature of the proposed development to the floristic diversity occurring in the directly affected area and the direct impact it will also have on the faunal diversity of the area on a local scale, the **no-go alternative** will see the area stay in the current condition. The current impacts exerted on the area from an agricultural point of view (not assessed in

this study) will remain and, depending on the management strategies employed by the land owner and natural climatic conditions, the current natural condition may improve or deteriorate in future.

A number of monitoring requirements are listed.

Concluding remarks

The low faunal and moderately high floristic species richness and density recorded would equate to a low impact to the regional diversity of plants, mammals, reptiles and amphibians. Although the number of protected faunal species possibly occurring on or in close proximity to the site is low, these deserve consideration. It must be stressed that the short study period may affect the generation of a representative sample (see also 'Assumptions and Limitations'). We are nonetheless confident in the sampling methods employed as the methodology was designed with the study limitations in mind.

When considering the different sites (preferred and alternative sites) that were investigated during this study it is concluded that the preferred site may be accepted from a faunal, floral, wetland and general ecological point of view for the proposed development.

4 INTRODUCTION

4.1 Background

Under the National Environmental Management Act (107 of 1998) any development that may cause significant damage to the natural environment is by law required to undergo stringent evaluation with the aim of reducing and mitigating the potential environmental impact (www.eia.org.za). This study aims to assess the impact that the development of a Photovoltaic Solar Power Plant, on farmland in the Northern Cape about 6 km east-southeast of Deben and about 13 km northwest of Kathu (Figure 1), will have on the faunal and floral diversity within the site concerned (development footprint of approximately 250ha) (Figure 2), with special reference to Threatened or Protected Species (ToPS).

Environment Research Consulting (*ERC*) was contracted to conduct a biodiversity (faunal & floral) and general habitat assessment of a portion of the remainder of portion 1 of the farm Limebank 471 near Deben in the Northern Cape Province. This report presents the findings of a once off, summer assessment that was conducted over a three day period from 06 to 08 March 2016.

Figure 1: Google earth image indicating the regional setting of the study area

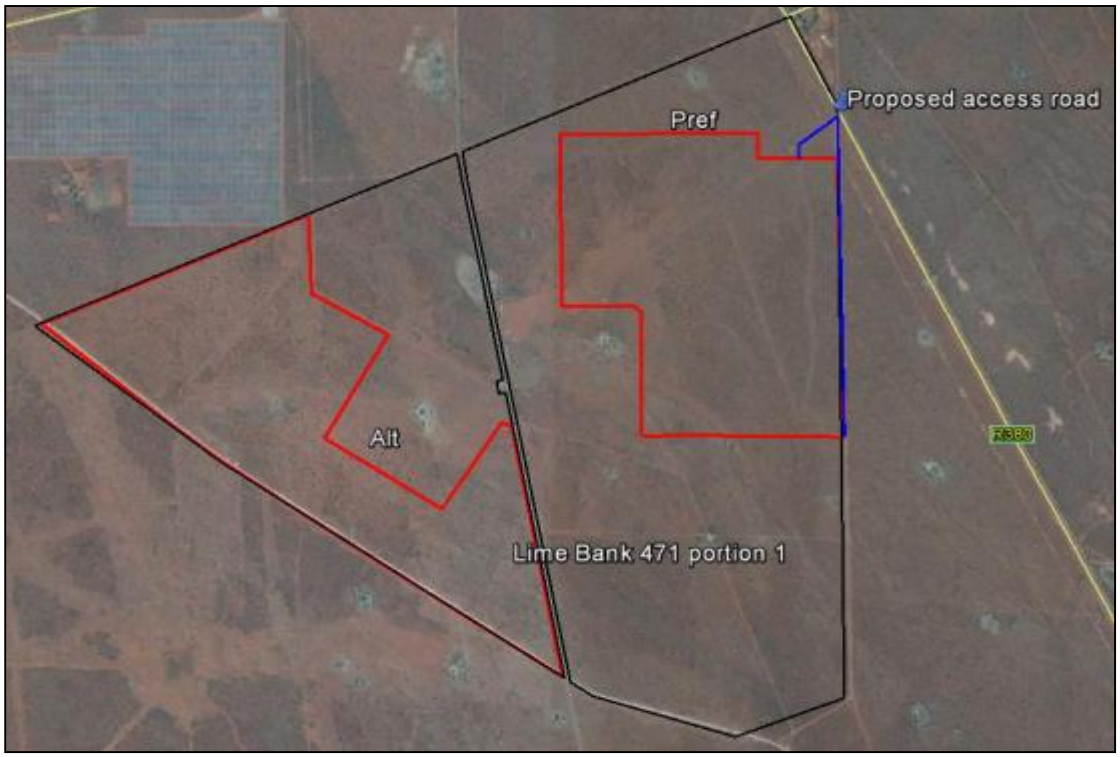


Figure 2: Image indicating the preferred and alternative development sites

4.2 Terms of Reference & General Requirements

The scope of the assessment included the PV Solar Energy Facility and its associated structures and infrastructure (such as the power line and access route). The impacts associated with the power line and access route that run beyond the site are considered to be negligible since the actual footprints of disturbance of the power lines is confined to the pylon bases. Furthermore, the power line and access route are aligned with existing roads as far as possible to avoid any negative environmental impacts.

The following ToR and general requirements were supplied by the client:

Specialists in their field of expertise will consider baseline data and identify and assess impacts according to predefined rating scales – refer to attached method of assessment. Specialists will also suggest optional or essential ways in which to mitigate negative impacts and enhance positive impacts. Further, specialists will, where possible, take into consideration the cumulative effects associated with this and other projects which are either developed or in the process of being developed in the local area.

Specialists' reports must comply with Appendix 6 of GNR982 published under sections 24(5), and 44 of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and whereby the following are to be included:

- The details of:
    - the specialist who prepared the report; and

  - the expertise of that specialist to compile a specialist report including a curriculum vitae;
- A declaration that the specialist is independent in a form as may be specified by the competent authority;
- An indication of the scope of, and the purpose for which, the report was prepared;
- The date and season of the site investigation and the relevance of the season to the outcome of the assessment;
- A description of the methodology adopted in preparing the report or carrying out the specialised process; the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;
- An identification of any areas to be avoided, including buffers;
- A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;
- A description of any assumptions made and any uncertainties or gaps in knowledge;
- A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;
- Any mitigation measures for inclusion in the EMPr;
- Any conditions for inclusion in the environmental authorisation;
- Any monitoring requirements for inclusion in the EMPr or environmental authorisation;
- A reasoned opinion-
  - as to whether the proposed activity or portions thereof should be authorised; and
  - if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;
- A description of any consultation process that was undertaken during the course of preparing the specialist report;
- A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and
- Any other information requested by the competent authority.

In addition to the above, specialists were expected to:

- Review Scoping Reports, with specific reference to the Comments and Response Report to familiarize with all relevant issues or concerns relevant to their field of expertise;
- In addition to the impacts listed in the Scoping Report, identify any issue or aspect that needs to be assessed and provide expert opinion on any issue in their field of expertise that they deem necessary in order to avoid potential detrimental impacts;
- Assess the degree and extent of all identified impacts (including cumulative impacts) that the preferred project activity and its proposed alternatives, including that of the no-go alternative, may have;
- Identify and list all legislation and permit requirements that are relevant to the development proposal in context of the study;
- Reference all sources of information and literature consulted; and
- Include an executive summary to the report.

4.3 Aims of the study

- Provide a detailed fauna and flora habitat survey.
- Provide a detailed habitat survey of possible threatened or localised plant species and vertebrates.
- Take count and map the location (and provide coordinates) of any protected species or sensitive habitats found on site.
- Evaluate the conservation importance and significance of the site with special emphasis on the current status of threatened species.
- Record possible host plants or food plants of fauna such as butterflies.
- Conduct a literature investigation of possible species that may occur on site.
- Identify potential ecological impacts on fauna and flora that could occur as a result of the development.
- An assessment of the potential direct and indirect impacts resulting from the proposed development during the construction, operation and decommission phases.
- Make recommendations to reduce or minimise impacts, should the development be approved.
- Comment on plant species that can be utilized socially (medicine, food or other cultural or social purposes).

4.4 Assumptions and Limitations

- It was assumed that 3 trap days would be near sufficient for capturing a representative sample of small mammal diversity within the study site (the optimal period being 4 days) (Avenant & Cavallini 2007). The study area, however, was too large to sample thoroughly for either mammals or reptiles in the time available. Also, faunal observations during the midday heat were unlikely as temperatures ranged between 30°C and 40°C during the time of the study, causing most animals to reduce activity and seek shelter. Detection was further constrained by the inherently cryptic and/or evasive nature of most wildlife.
- No attempt was made towards sampling Amphibia, due to the small amount of species possibly occurring on the site (Appendix A, Table 12-3) and the complete lack of standing / surface water.
- Regarding the faunal species lists (Appendix A), it is important to note that distribution maps are often constructed with limited ecological knowledge available for the species under question and are thus not consistently reliable in predicting a species' occurrence (Hernandez et al. 2006; Newbold 2010). Furthermore, some uncertainty remains regarding the conservation priority for a great deal of southern African species as not all have been assessed and may classify as "Not listed" or "Data deficient".
- As no other insect conservation assessments are available we were limited to assessing only butterfly occurrence. In addition, Mecenero et al. (2013) found that butterfly research is lacking in the region concerned.
- It is assumed that plant species flowering only during specific times of the year could be confused with a very similar species of the same genus.
- Some plant species that emerge and bloom during another time of the year or under very specific circumstances may have been missed entirely.
- Due to the conditions encountered during the time of this study some species (faunal & floral) could only be identified up to genus level.
- All species included in the plant species list (Appendix B) were actually observed and recorded in the study area during the time of the study.
- No scientific data was collected or analyzed for the calculation of ecological veld condition. Any comments or observations made in this regard are based on observations, the expert knowledge and relevant professional experience of the specialist investigators.
- *ERC* reserves the right to amend this report, recommendations and/or conclusions at any stage should any additional or otherwise significant information come to light.

4.5 General Site Description

The study site (S27° 36' 31.99" E22° 57' 21.08", alt. 1150m) is located 13 km northwest of Kathu. The site falls within the Eastern Kalahari Bushveld Bioregion of the Savanna Biome, with annual precipitation and temperature

averaging 362 mm and 17.8 °C, respectively (Rutherford et al. 2006). Livestock ranching dominates the immediate surrounds and mining activities are a prominent feature in the region (*pers. obs.*). Topography remains homogeneous throughout both sites with no obvious change in slope. The area is visibly transformed with signs of overgrazing (bush encroachment). Some areas are very densely populated by trees and large shrubs. The area is not particularly sandy with ground cover showing some regeneration after the farm-owner removed his cattle (*pers. comm.* Hendrik van der Merwe). There are three pans in close proximity to the preferred site (see Figure 2) though no surface water was visible during our visit. Habitat characteristics are comparable between both the preferred and alternative site.

5 FAUNAL ASSESSMENT

5.1 Methodology

Before our initial visit, satellite images (Google Earth) of the site were studied and the different habitat types identified (uniform features from an aerial perspective). Upon arrival the sites were ground-truthed. The small mammal trap transects were then placed, at least one transect per habitat type, and each trap baited with a mixture of peanut-butter, oats, sunflower oil and marmite (Avenant & Cavallini 2007). Transects consisted of 30 traps, placed 10 m apart and were checked every morning at 08h00, again at 15h00 and were re-baited daily. Species, sex and reproductive status were recorded for each animal captured, although only species data has been reported here.

Non-invasive walk transects were performed daily, documenting all animal sightings (including spoor and / or scat) in writing or by photograph. Non-invasive walk transects were done along the small mammal trap transects (Figure 3). The area ahead of the observer was observed attentively, specifically for animals flushed from shelter, and stretched a minimum of 250 m. After each trap check a minimum of 20 minutes was designated to examining the environment around each transect, during which I would frequently investigate the area surrounding me with binoculars.

Figure 3: A local scale map. The white border represents the proposed development footprint (preferred site). The numbered red lines represent small mammal trap transects.

Drive transects were also conducted, twice per day, along the same 5 km route. Driving 20-40 km/h the driver would report any animal observed ahead of the vehicle and the passenger would record any animal seen in a 15 m zone to his side of the vehicle. The area surrounding the study site was also extensively travelled throughout the study period and sampled in a similar

fashion. This method of sampling served to record the more conspicuous fauna (e.g. tortoises, large mammals and active snakes).

Species lists (Appendix A, Tables 12-1 to 12-4) were constructed using field guides, Red Data Books and Species Atlases (see 'References') complementarily. Only butterflies were considered in constructing an insect species list as they are the subject of the only existing South African insect conservation assessment. As far as information was available, species habitat requirements were also taken into account to substantiate the likelihood of their occurrence. Hence, veld condition (i.e. pristine or disturbed), vegetation structure and other habitat characteristics contributed to determining the likelihood of a species' occurrence.

No formal consultation prosess was conducted as part of this faunal study as it was not deemed necessary at the time of the study.

5.2 Results

The study period lasted 3 days and nights with no less than 8 hours spent on the site per day. Three small mammal traplines were placed in the study area (Figures 4 – 6). Traps were removed following the third evening. In an effort to record landscape elements as well as faunal tracks and signs, extensive notes and photographs were taken throughout this period.

Figure 4: The direct surrounds of trap transect 1.

Figure 5: The direct surrounds of trap transect 2. Significantly more grass cover compared to Figure 4.

Figure 6: The direct surrounds of trap transect 3. The area west of transect 3 has abundant grass cover, in contrast to dominant shrub cover to the east of the line, comparable to transect 1.

5.2.1 Trap transects (Direct sampling)

Two Murid species were captured during the study period (Appendix A, Table 12-1). Only transects 2 and 3 (see Figure 3) were successful, with mean daily trap success (i.e. average amount of occupied traps per day) = 3.33%, and the min. / max. animals captured on a single day = 1 /5.

5.2.2 Walk transects (Indirect sampling)

Eighteen walk transects were performed and at least one hour was spent inspecting the area surrounding each transect. No animals were recorded during this effort.

5.2.3 Drive transects (Indirect sampling)

Drive transects, within the site, averaged in excess of 5 km per day and near similar distances was covered outside the study site daily. Three mammals were recorded during this effort: Southern African Ground Squirrel (*Xerus inauris*), Slender Mongoose (*Galerella sanguinea*) and Greater Kudu (*Tragelaphus strepsiceros*).

5.2.4 Desktop Study

According to literature research, and considering the bioregion, landscape and habitat characteristics, the plausible species richness of the study site is as indicated in Table 5-1 according to the ratio of total species vs. total protected and data deficient species.

Table 5-1: Plausible species richness of the study site

Faunal type	Ratio = total species : total protected and data deficient species
Mammals	32 : 4
Reptiles	28 : 0
Amphibians	7 : 1
Butterflies	1

Literature research revealed that no animals were restricted or endemic to the area. Some species listed have a low likelihood of occurring within the site, but are nonetheless listed if their habits, habitat requirements and estimated distribution ranges agree with the study findings. Reptiles with distribution ranges overlapping with the locality are generally adapted to arid Kalahari - Karoo habitats. The plausible species richness of the area (Table 5-1) was therefore affected by the wealth of crown cover as well as a lack of rockiness or sandy substrates (within our site). For the most part of the year the likelihood of any amphibians occurring on the site is low but there is no doubt some species would gather at the pans (Figure 3) after good rain. No physical record of the listed butterfly occurring in the site exists (Appendix A, Table 12-4), but has been included due to the close proximity of the nearest record (i.e. Hotazel) and its “Data deficient” status. Furthermore, the species is endemic to the region and has habitat preferences corresponding with habitat characteristics of the alternative site.

6 FLORISTIC AND GENERAL HABITAT ASSESSMENT

6.1 Methodology

Prior to visiting the site, a list of species that could potentially occur at the site was downloaded from "Plants of Southern Africa" (POSA) on the South African Biodiversity Institute's (SANBI) website at http://posa.sanbi.org. This list is provided at the quarter degree square (QDS) level of accuracy for the QDS 2722 DB & DD and included in Appendix B. At this broad scale, the list often includes many species that may not be found at the proposed site. However, any species of conservation concern will be indicated in the list and was researched before the site visit in order to know what species of conservation concern should be looked out for.

A visual reconnaissance of the study area was done before surveying commenced. Different homogenous vegetation units were identified and subsequently surveyed on foot and by vehicle in order to determine the floristic composition of each. The following data was recorded:

- All identifiable indigenous plant species (Appendix B) including red data or specially protected and also exotic plant species in each identified vegetation unit.
- General ecological and habitat data that may assist in the description of the floristic component of the study area.

A plotless sampling method was used to record data. Plant species observed in the study area during the time of the study were recorded and included in the plant species lists (Appendix B). The floristic composition of each of the identified broad vegetation units and/or application area are described and discussed. Plant species identification was done following the checklist of Germishuizen & Meyer (2003). Plant material was collected for identification purposes and where necessary the South African National Biodiversity Institute (SANBI) in Pretoria and other specialists were consulted in order to assist in plant species identification. All collected plant material will, if so requested by them, be donated to the South African National Herbarium of SANBI in Pretoria for inclusion into their extensive collection.

No formal consultation prosess was conducted as part of this floristic study as it was not deemed necessary at the time of the study.

6.2 General floristic and habitat information

According to Mucina & Rutherford (2006) the study area falls in the Kathu Bushveld vegetation type (SVk12). The following description of SVk12 has been summarized from Mucina & Rutherford (2006):

> **Kathu Bushveld**
>
> The Kathu Bushveld vegetation type (SVk12) occurs in the Northern Cape Province from the plains surrounding Kathu and Dibeng (Deben) in the south through Hotazel (vicinity of Freylinckspan) to the Botswana border roughly between Van Zylsrus and McCarthysrus in the north. Summer and autumn

rainfall (MAP: 220 – 280 mm) and high summer temperatures reaching an average of 37.0 degrees Celsius on average in December and cold winter nights averaging –2.2 degrees Celsius with frost in July, characterize the climate of the area. Aeolian deep red sandy soils (Hutton and Clovelly forms) and shallower sands and surface calcrete occur with Ah, Ae and Ag being the main land types in the area.

The landscape is mostly flat with some small interspersed pans. The main vegetation features include a medium-tall tree layer with mostly *Boscia albitrunca,* but also *Acacia erioloba* in places, as the prominent trees. The shrub layer is generally most important with, for example, *Acacia mellifera* subsp. *detinens, Diospyros lycioides* and *Lycium hirsutum*. The grass layer is variable in cover. The most important trees and shrubs are *Acacia erioloba, A. mellifera* subsp. *detinens, Boscia albitrunca, Diospyros lycioides* subsp*. lycioides, Grewia flava, G. retinervis, Gymnosporia buxifolia, Lycium hirsutum and Rhigozum brevispinosum.* Dominant and other grasses include *Aristida meridionalis, A. congesta, Brachiaria nigropedata, Centropodia glauca, Eragrostis lehmanniana, E. biflora, E. chloromelas, E. heteromera, E. pallens, Melinis repens, Schmidtia pappophoroides, S. kalahariensis, Stipagrostis ciliata, S. uniplumis* and *Tragus berteronianus.* Significant low shrubs and herbs are *Aptosimum decumbens, Acrotome inflata, Erlangea misera, Gisekia africana, Heliotropium ciliatum, Hermbstaedtia fleckii, H. odorata, Limeum fenestratum, L. viscosum, Lotononis platycarpa, Nolletia arenosa, Senna italica, Sida cordifolia, Tragia dioica* and *Tribulus terrestris.* Biogeographically important species include the Kalahari endemics *Acacia luederitzii* var. *luederitzii* (small tree), *Anthephora argentea, Megaloprotachne albescens, Panicum kalahariense* (grasses) and *Neuradopsis bechuanensis* (herb).

The conservation status of SVk12 is Least Threatened. A conservation target of 16% is envisioned by conservation authorities, but to date no portion of SVk12 is statutorily conserved. More than 1% is totally transformed by mainly mining activities and settlements. This vegetation type resembles the description of Acocks' (1953) *Kalahari Thornveld and Shrub Bushveld* (VT 16) and also the description in Low and Rebelo (1996) of *Kalahari Plains Thorn Bushveld* (LR 30).

The habitat characteristics of the study area largely resemble the description given for SVk12 above. The areas studied (i.e. the preferred and alternative sites – see Figure 2) are mostly flat sandy plain with shrubs and few tall trees. Soils are sandy and vary in depth from shallow to moderately deep. Rockiness of the soil surface also varies. A number of non-perennial pans were observed in the area and some drainage lines were also recorded on the alternative site. The pans are discussed under the description of the vegetation units under Vegetation Unit 2 and again in more detail under the section Delineation of Pans (section 7).

151 plant species are recorded on the POSA data base of SANBI for the relevant QDS 2722 DB & DD and is included in Appendix B, Table 13-6. Keep in mind that this list contains species of at least two different vegetation types.

6.3 Floristic diversity recorded in the study area

A total of 130 plant species (from 45 plant families and 101 genera) (Table 6-1 & Appendix B, Table 13-1) were recorded in the study area during the time of the study and indicates moderate high species diversity. The woody layer (trees & shrubs) is represented by 16 woody species and the herbaceous layer is made up of 30 graminoids* and 83 herbaceous shrubs, dwarf shrubs, geophytes and other herbs. 93% (120 of 129) of the recorded plant species are indigenous to South Africa. From available literature (Pujol 1988; Pooley, 1998; Schmidt *et* al 2002; Shearing & Van Heerden 1994; Van Wyk *et al* 1997; Van Wyk & Gericke 2003) it was established that at least 37 of the recorded plant species in the study area are used for some or other social activities (medicinal, food/nourishment and/or cultural).

Table 6-1: Summary of plant families, genera and species recorded in the study area

	Families	Genera	Species
PTERIDOPHYTA (ferns):	0	0	0
GYMNOSPERMAE (Coniferous plants):	0	0	0
ANGIOSPERMAE (seed plants): ***Monocotyledonae:***	7	23	39
Dicotyledonae:	38	78	91
Total:	**45**	**101**	**130**

During the survey, which was done on foot and by vehicle, only taxa that were identifiable during the time of the study were noted and included in the plant species lists in Appendix B (Tables 13-1 to 13-5). The possibility exists that some plant species that emerge and bloom during another time of the year or under very specific circumstances, or species that are locally rare could have been missed during the survey, but on the other hand, the specialist is convinced that the majority of the species occurring in the study area were identified and recorded. The mentioned species lists contain the plant family name and scientific and common names of all plant species that was observed in the study area during the time of the study. Also included is, where applicable, the status of a species, which provides information on endemism, red data status or exotic status. Information on whether a species is utilized for medicinal, cultural or nutritional uses is also provided in the mentioned species lists.

* graminoids = grass like plants (grasses and sedges)

Appendix B, Table 13-1 presents the diversity of plant families, genera and species recorded in the study area. A check list of plant species recorded during this study is included in Tables 13-2 through 13-5 of Appendix B.

6.4 Description of Broad Vegetation Units in the Study Area

Two broad Vegetation Units (VU's) were recorded and are described in the sections below (Figure 7). The VU's are:

- VU 1: *Acacia mellifera* semi-closed rocky shrubland
- VU 2: Non-perennial pans

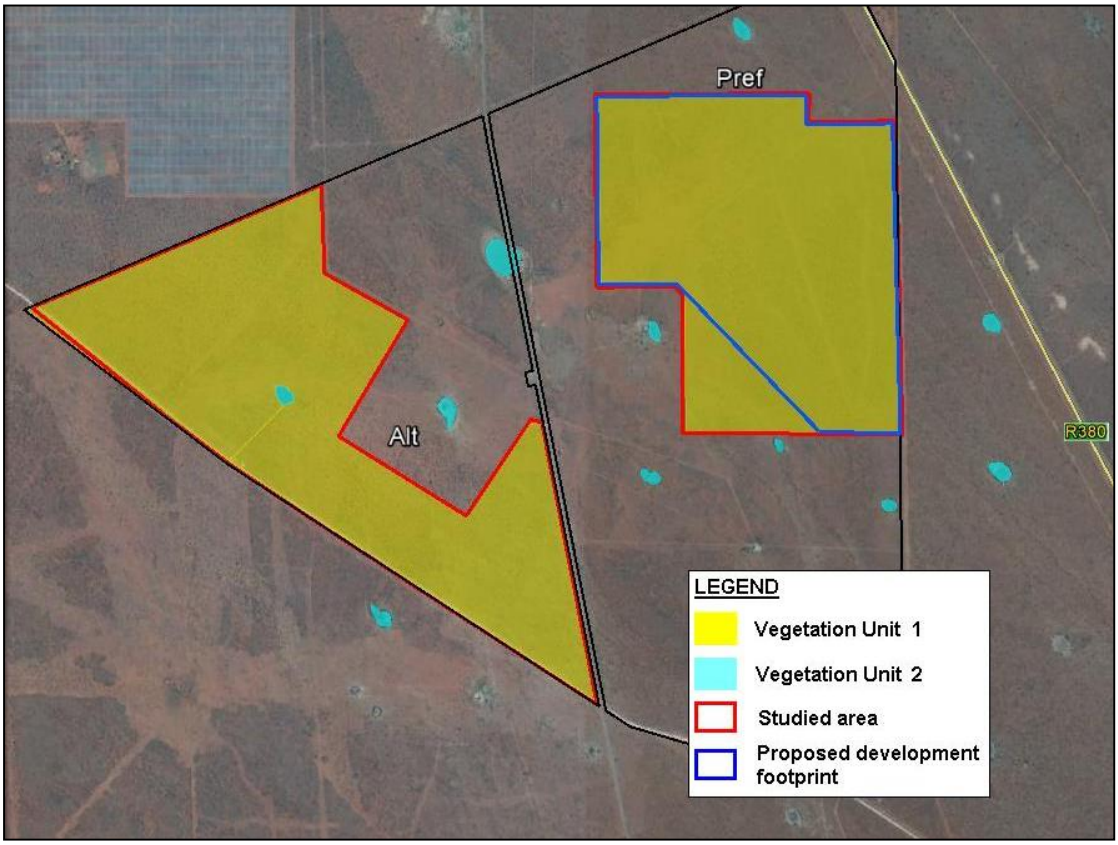


Figure 7: Image depicting the two vegetation units recorded in the study area

6.4.1 VU1: *Acacia mellifera – Tarchonanthus camphoratus* semi-closed woodland

This is the only VU occurring on the preferred development site (Figures 8 & 9) and also covers most of the alternative site. Soils vary between shallow to moderately deep with calcareous outcrops in places. The vegetation is dominated by tall woody shrubs, which also vary in height from one area to the next. On the largest part of the study area the woody vegetation reaches an average height of approximately 1.5 to 2.0 m (Figure 8) and a smaller area is covered by lower shrubs of between 0.5 and 1.5 m (Figure 9). The areas with lower shrubs generally also have a better grass cover and are mostly situated on shallower, rocky soils. From an ecological point of view VU1 is in a moderate to poor veld condition due to overgrazing in the past and high

levels of bush encroachment by *Acacia mellifera* subsp*. detinens* and *Tarchonanthus camphoratus*.

The dominant woody species in VU1 is *Tarchonanthus camphoratus, Acacia mellifera* subsp*. detinens, Grewia flava* and *Lycium* c.f. *grandicalyx.* Prominent, but not dominant trees are *Boscia albitrunca* and *Acacia erioloba.* Dominant graminoids are *Bulbostylis hispidula, Schmidtia pappophoroides, Stipagrostis uniplumis, S. obtusa, Oropetium capense, Eragrostis trichophora, Enneapogon cenchroides, E. desvauxii* and *Tragus berteronianus*. Herbaceous shrubs, dwarf shrubs and forbs include *Aptosimum marlothii, Barleria rigida, Indigofera alternans, Pentzia calcarea, Phyllanthus maderaspatensis, Peliostomum leucorrhizum, Limeum sulcatum, Geigeria ornativa* and *Tribulus terrestris.*

During the time of this study 113 plant species (110 indigenous, 3 exotic) were recorded in VU1. These included 14 woody species (1 exotic), 21 graminoids (none exotic) and 74 herbaceous and dwarf shrubs and other forbs (2 exotic) were recorded. It was established from available literature (Pujol 1988; Pooley 1998; Schmidt *et* al 2002; Shearing &Van Heerden 1994; Van Wyk *et al* 1997; Van Wyk & Gericke 2003), that at least 32 of the plant species recorded in this VU are to some extent utilized for some or other social activity or use (medicinal, nourishment/food, and/or cultural).

Figure 8: VU1 – portion of VU1 with taller woody vegetation (1.5 – 2.0 m) and relatively poor grass cover.

Figure 9: VU1 – portion of VU1 with shorter woody vegetation (0.5 – 1.5 m) and moderately good grass cover.

6.4.2 VU2: Non-perennial pans

This VU, consisting of a number of non-perennial pans (Figures 10 & 11), occur imbedded in VU1 in low lying areas where rainwater accumulates during wet seasons. Some of these pans are associated with drainage lines, but not all of them. No pans were recorded directly on the preferred site and only one on the alternative site (Figure 7). Soils are shallow sandy clays to sandy loam with some rocks (mostly calcrete) on the soil surface. Structurally the vegetation is mostly dominated by grasses and forbs with a cover of trees and tall shrubs surrounding the pans. From an ecological point of view most of the pans are in a moderate to moderately good condition (Figure 10), but some have been severely degraded through decades of anthropogenic interference (Figure 11). The grass cover is fairly good in some of the pans, but generally poor in the directly surrounding areas.

The dominant tree species in VU4 are *Diospyros lycioides, Grewia flava, Ziziphus mucronata, Tarchonanthus camphoratus* and *Acacia mellifera*. The most significant graminoids are *Panicum impeditum, P. lanipes, Eragrostis rotifer, Echinochloa holubii, Enneapogon desvauxii, Cenchrus ciliaris and Cyperus squarrosus*. The herbaceos shrubs and forbs that mostly occur are the indigenous *Vahlia capensis, Lotononis* species*, Mollugo cerviana, Heliotropium* species and the exotic *Gomphrena celosioides* and *Verbesina encelioides*.

During the time of this study 64 plant species (55 indigenous, 9 exotic) were recorded in VU2. These included 10 woody species (2 exotic), 19 graminoids (none exotic) and 33 herbaceous and dwarf shrubs and other forbs (7 exotic)

were recorded. It was established from available literature (Pujol 1988; Pooley 1998; Schmidt *et* al 2002; Shearing &Van Heerden 1994; Van Wyk *et al* 1997; Van Wyk & Gericke 2003), that at least 20 of the plant species recorded in this VU are to some extent utilized for some or other social activity or use (medicinal, nourishment/food, and/or cultural).

Figure 10: VU2 – a pan, which is in a moderately good ecological condition, about 360 m north of the preferred area

Figure 11: VU2 – a small pan, which is in a severely degraded state, just 80 m west of the preferred area

6.5 Red Data, Protected and Endemic Plant Species

10 plant species of specific conservation significance were recorded in the study area during the study period. Two are listed by Raimondo *et al* (2009) in the South African Red Data list as Declining species. Two tree species are included in the protected tree species list published by the National Forests Act (Act no.84 of 1998) (NFA, 1998), and nine of the 10 are listed as protected by the Northern Cape Nature Conservation Act (Act no. 9 of 2009) (NCNCA, 2009). No species listed as Threatened or Protected Species (ToPS) by the National Environmental Management: Biodiversity Act's (Act No. 10 of 2004) list of ToPS as published in Government Gazette no. 36375 of 16 April 2013 (NEMBA ToPS, 2013), were recorded in the study area during this study.

Table 6-2 lists the recorded Red Data listed and protected species relative to the different vegetation units they were recorded in during the time of this study. In Appendix C, Table 14-1 a list appears with the coordinates of recorded protected plant species in the study area. Figure 12 shows the positions of the recorded specimens in relation to the different studied areas. More specimens of these species, which are not listed in Appendix C, do occur in the study area, but due to time constraints these could not be referenced during this study. **It is strongly advised** that once the exact position of development activities and infrastructure has been planned and finalized that a full population study of each affected area be done to determine the population size and extent of these and possibly other protected species within the study area and the relevant appropriate action is then taken.

Table 6-2: List of protected plant species recorded in the study area

Note: abbreviations used in Table 6-2 are as follows:
D – Declining (Raimondo *et al*, 2009); P(SA) – nationally protected tree species (NFA, 1998); P(NC) – provincially protected species (NCNCA, 2009).

SPECIES NAME	FAMILY	GROWTH FORM	SPECIES STATUS	VU	
				1	2
Acacia erioloba	FABACEAE	Tree	D, P(SA)	X	
Ammocharis coranica	AMARYLLIDACEAE	Geophyte	P(NC)	X	X
Asclepias aurea	APOCYNACEAE	Geophytic herb	P(NC)	X	
Boscia albitrunca	CAPPARACEAE	Tree	P(SA), P(NC)	X	
Crinum c.f. *macowanii*	AMARYLLIDACEAE	Geophyte	D, P(NC)	X	
Gomphocarpus fruticosus subsp. *fruticosus*	APOCYNACEAE	Herbaceous shrub	P(NC)	X	X
Gymnosporia buxifolia	CELASTRACEAE	Tree	P(NC)	X	X
Nerine laticoma	AMARYLLIDACEAE	Geophyte	P(NC)	X	
Oxalis species	OXALIDACEAE	Geophyte	P(NC)	X	
Pergularia daemia	APOCYNACEAE	Herb, climber	P(NC)	X	

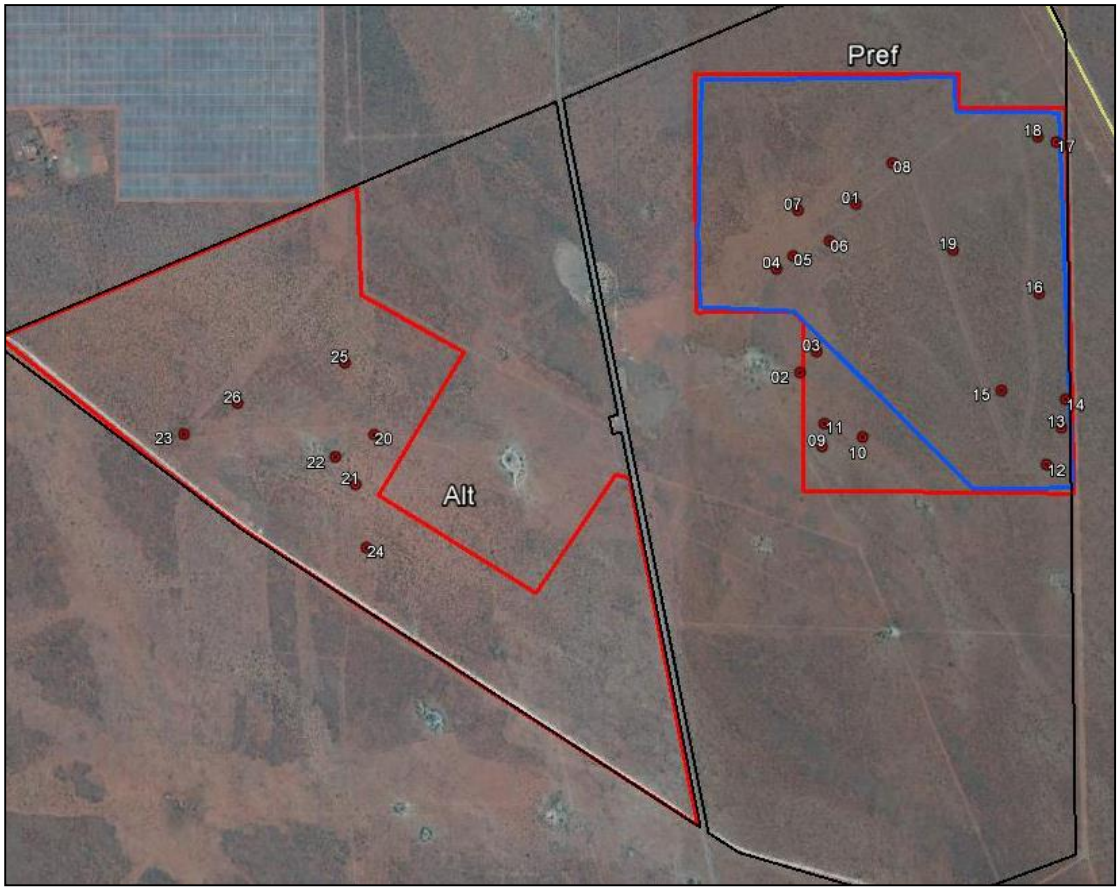


Figure 12: Recorded positions of some red data and/or protected plant species in the study area

Note: The numbered labels on Figure 12 correspond to the serial number (S/N) in the first column of Table 14-1 of Appendix C.

6.6 Exotic Plant Species

During the study nine exotic plant species were recorded in the study area. One of these species is the alien invasive woody species *Prosopis glandulosa* var. *torreyana*, which according to Hoffman *et al* (1999) (in Mucina & Rutherford, 2006), is one of the 12 agriculturally most important invasive alien plants in South Africa. This species together with three others are classified as alien weed or invader species, according to the Conservation of Agricultural resources Act (Act No. 43 of 1983) (CARA, 1983) in Henderson (2001) and also according to the National Environmental Management: Biodiversity Act's 2014 list of proposed weeds and invaders (NEMBA, 2014). Five uncategorized and non-invasive herbaceous weeds were also recorded. Table 6-3 presents a list of all exotic plant species recorded during this study.

Exotic plant species in the species lists (Appendix B: Tables 13-1 to 13-5 and also Table 6-3) are preceded by an asterisk (*) and/or indicated by the letter "E" in the Species Status column in the case of uncategorized exotic species. In the case of declared or proposed weeds or invaders the invasive status of the species, according to CARA (1983) (Table 6-4) and NEMBA (2014) (Table 6-5) are indicated in the Species / Invasive Status column of the species lists in Appendix B and also Table 6-3, as follows:

- C1 – declared weed category 1 (CARA, 1983).
- C2 – declared invader category 2 (CARA, 1983).
- C3 – declared invader category 3 (CARA, 1983).
- CX1, CX2 or CX3 – proposed weed or invader (CARA, 1983).
- N1b – NEMBA (2014) category 1b
- N2 – NEMBA (2014) category 2
- N3 – NEMBA (2014) category 3

Table 6-3: List of exotic (alien) plant species recorded in the study area

SPECIES NAME	FAMILY	INVASIVE STATUS	GROWTH FORM	VU	
				1	2
**Amaranthus viridis*	AMARANTHACEAE	E	Herb		X
**Boerhavia cordobensis*	NYCTAGINACEAE	E	Herb	X	X
**Chenopodium carinatum*	CHENOPODIACEAE	E	Herb	X	X
**Datura ferox*	SOLANACEAE	C1 / N1b	Herb		X
**Gomphrena celosioides*	AMARANTHACEAE	E	Herb		X
**Melia azedarach*	MELIACEAE	C3 / N3	Tree		X
**Prosopis glandulosa* var. *torreyana*	FABACEAE	C2 / N2	Tree	X	X
**Verbesina encelioides* var. *encelioides*	ASTERACEAE	E	Herb		X
**Xanthium strumarium*	ASTERACEAE	C1 / N1b	Herb		X

Table 6-4: Description of the invasive status of exotic plant species according to Henderson (2001)

Invasive status (category)	Description
Declared weed (category 1) **– C1** Proposed weed **– CX1**	• Prohibited on any land or water surface in South Africa. • Must be controlled or eradicated were possible (except in biological control reserves).

Invasive status (category)	Description
Declared invader (category 2) **– C2** Proposed invader **– CX2**	• Allowed only in demarcated areas under controlled conditions. • Import of propagative material and trading allowed only by permit holders. • Outside demarcated areas, it must be controlled, or eradicated where possible (except in biological control reserves). • Prohibited within 30 m of the 1:50 year flood-line of watercourses or wetlands unless authorization is obtained.
Declared invader (category 3) **– C3** Proposed invader **– CX3**	• No further plantings of these species are allowed (except with special permission). • Trade of propagative material is strictly prohibited. • Existing plants may remain but must be prevented from spreading. • Prohibited within 30 m of the 1:50 year flood-line of watercourses or wetlands, or as directed.

Table 6-5: Description of the invasive status of exotic plant species according to NEMBA (2014)

Invasive status (category)	Description
Category 1b **– N1b**	• Invasive species requiring compulsory control as part of an invasive species control program • Remove and destroy • These plants are deemed to have such a high invasive potential that infestations can qualify to be placed under a government sponsored invasive species management program • No permits will be issued
Category 2 **– N2**	• Invasive species regulated by area • A demarcation permit is required to import, possess, grow, breed, move, sell, buy or accept as a gift any plants listed as Category 2 plants • No permits will be issued for these plants to exist in riparian zones
Category 3 **– N3**	• Invasive species regulated by activity • An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed, move, sell, buy or accept as a gift) involving a Category 3 species • No permits will be issued for Cat 3 plants to exist in riparian zones

7 DELINEATION OF PANS

According to Kotze *et al*. (2009) and DWAF (2005) a pan can be one of the hydro-geomorphic forms of a wetland. As a result it was decided to study and delineate six pans (pans 1 to 6) in the vicinity of the preferred development area of the study area (Figure 13). The approximate courses of drainage lines were also investigated (Figure 3). None of the pans or drainage lines indentified and studied, actually occur on the preferred site, but were studied none the less because of their proximity to the site and their potential ecological importance in the larger ecological system within which the study area falls. Mention is also made of five other nearby pans (pans 7 to 11), which were not specifically studied or delineated.

The general floristic and habitat characteristics of the pans are discussed under section 6.4.2 (VU2) of this report. From a hydrological point of view none of the pans were inundated during the time of the study and only two of the six investigated pans had visibly moist or wet soils in small patches. The current dryness of the pans is ascribed to the fact that drought conditions were experienced by the region during the time of the study. Similarly the drainage lines are also non-perennial and dry and no riparian zones occur in the study area. The drainage lines were therefore not studied in further detail.

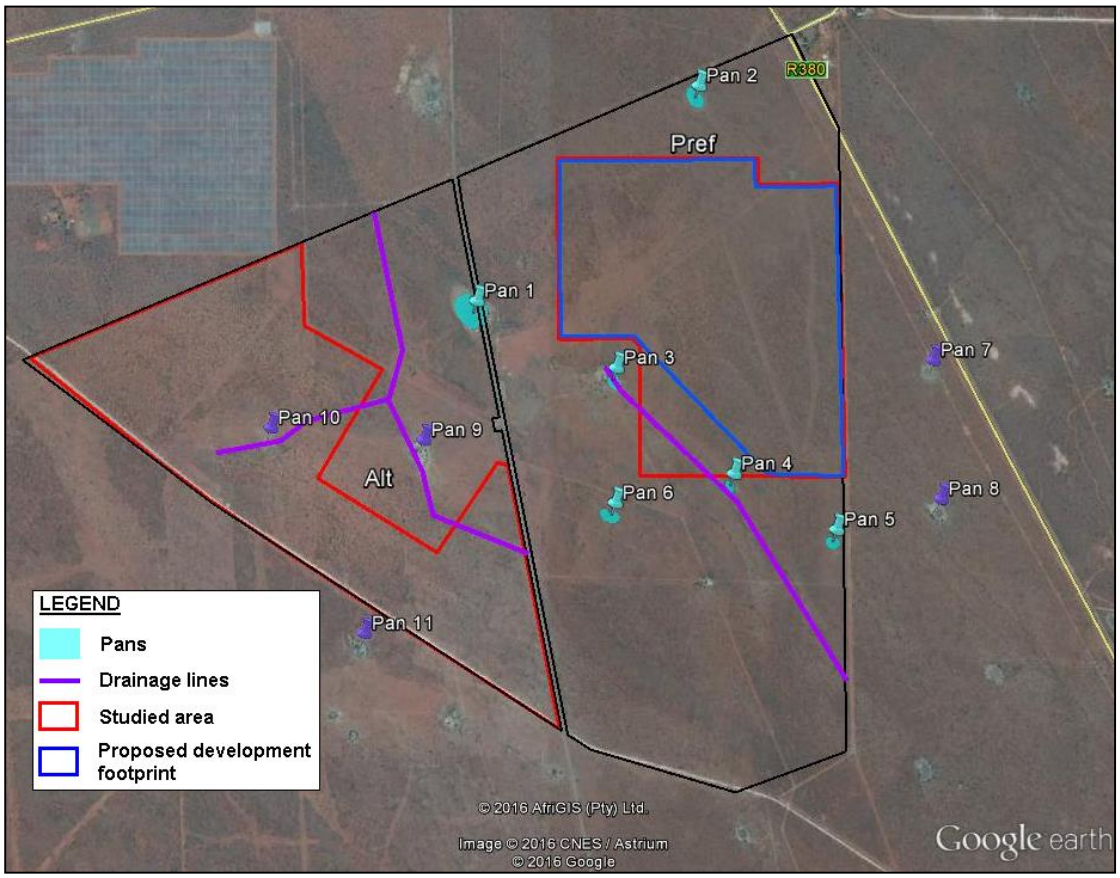


Figure 13: Positions of pans recorded in the vicinity of the study area

7.1 Legislation, definitions and terminology relevant to the description surface water resources

The National Water Act (Act No. 36 of 1998) (NWA, 1998) was drafted in order to ensure the protection and sustainable use of water resources (including wetlands and pans) in South Africa. According to NWA (1998) a water resource is defined as one of, or a combination of, the following

- A watercourse.
- Surface water.
- An estuary.
- An aquifer.

The NWA (1998) defines a wetland as, “land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil”. From this definition is may be argued that a pan, such as those recorded in the study area, fits the description of a wetland and therefore warrants further investigation.

Moreover, wetlands are regarded as an area of land on which the period of saturation of water is sufficient to allow for the development of hydric/hydromorphic soils, which in normal circumstances would support hydrophilic vegetation (i.e. vegetation adapted to grow in differing levels of saturated and anaerobic soil conditions).

According to the Department Water Affairs and Forestry – DWAF (2005), the four main indicators of the presence of a wetland are:

- The presence of water (hydrology).
- The presence of wetland (hydromorphic) soils.
- The presence of water loving plants (hydrophytes).
- The terrain unit, which indicates the position in the landscape where wetlands are most likely to occur.

Although all four indicators are important in the identification and delineation of a wetland the soil form indicator is the most important and the most accurate due to the fact that the morphological indicators in the soil are far more permanent and will hold signs of frequent saturation long after a wetland has been drained or otherwise transformed. The other three indicators are used more in a confirmatory role (DWAF, 2005). Because of this and because it is difficult to define the minimum frequency and duration of saturation that creates a wetland, the finding of the outer edge of the wetland is dependent on four, more specific indicators:

- The Terrain Unit Indicator (as mentioned above).
- The Soil Form Indicator, which identifies soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.

- The Soil Wetness Indicator, which identifies the morphological signatures that develop in the soil profile as a result of prolonged and frequent saturation.
- The Vegetation Indicator, which identifies hydrophilic vegetation that is associated with permanent or frequently saturated soils.

Three zones are distinguished within a wetland i.e. the permanent zone (all year round wetness), the seasonal zone (wet for at least three months of a year), and the temporary zone (wet for less than three months of a year). The object of a wetland delineation procedure, therefore, is to identify the outer edge of the temporary zone. This outer edge marks the boundary between the wetland and the adjacent terrestrial areas (DWAF, 2005).

Wetlands may either be palustrine (marsh-like) or lacustrine (lake-like) in nature. Palustrine and lacustrine wetlands can be divided up into different hydro-geomorphic forms, based on their position within the landscape, hydrological connectivity and water input. Kotze *et al*. (2009) have described a number of different wetland hydro-geomorphic forms:

- Hillslope Seepage feeding a stream.
- Hillslope Seepage not feeding a stream.
- Channelled Valley Bottom.
- Un-channelled Valley Bottom.
- **Pan / Depression.**
- Floodplain.

7.2 General Methodology

The general method described by (DWAF, 2005) for the delineation of wetlands is as follows:

- First the position of the wetland is visually determined (Terrain Unit Indicator).
- Starting at the wettest parts, a transect is then followed width ways across the wetland and using a soil auger the soil profile is examined up to a depth of 50cm for the presence of soil form indicators and / or soil wetness indicators. Vegetation indicators are also recorded.
- Proceeding outwards towards the estimated edge of the wetland, sampling continues at regular intervals to check for wetness and vegetation indicators.
- The outer edge of the wetland is subsequently defined as the point where soil wetness indicators are no longer visible within the top 50cm of the soil profile.
- The outer edge is recorded with a handheld GPS and eventually the GPS waypoints are plotted and joined on a map to visually indicate the extent of the outer edge (temporary zone) of the wetland.
- Several further transects are then also followed at regular intervals and at other strategic points in the wetland paying particular attention to features

that may disrupt the wetland boundary, such as seeps entering the wetland, large floodplains, etc.
- Where access to a wetland or section(s) of a large wetland was restricted the onsite delineation of adjacent areas was extrapolated on a desktop level.

7.3 Delineation results

The pans in the study area were delineated on a visual level in the field mostly focusing on the hydrology, terrain unit and the presence of water loving plants indicators. A buffer zone of 32 m from the edge of all pans, as prescribed for wetlands in Government Notice R.544 in Government Gazette 33306 of 18 June 2010, was delineated and mapped for all investigated pans.

The coordinates and approximate sizes (in ha) of the pans in the vicinity of the study area (preferred and alternative sites) are presented in Table 7-1.

Table 7-1: GPS coordinates and approximate sizes of pans in the vicinity of the study area on Limebank

Pan no.	Coordinates		Approximate size (ha)
	S	E	
Studied & delineated pans			
1	27° 36' 39.3"S	22° 56' 30.5"E	2.8
2	27° 35' 57.2"S	22° 57' 19.5"E	0.9
3	27° 36' 52.4"S	22° 57' 01.3"E	0.6
4	27° 37' 13.1"S	22° 57' 27.2"E	0.3
5	27° 37' 24.0"S	22° 57' 49.8"E	0.5
6	27° 37' 18.8"S	22° 57' 01.0"E	0.7
Other pans			
7	27° 36' 50.9"S	22° 58' 11.1"E	0.6
8	27° 37' 18.0"S	22° 58' 12.8"E	0.5
9	27° 37' 06.5"S	22° 56' 18.8"E	0.8
10	27° 37' 04.1"S	22° 55' 45.0"E	0.4
11	27° 37' 44.3"	22° 56' 05.7"E	0.7

7.3.1 Pan 1

Pan 1 (Figures 14 & 15) is the largest in the area and about 2.8 ha in extent and is situated 390 m west of the preferred area and 540 m northeast of the alternative area (Figure 13). It is moderately degraded and a railway line with its associated service road and other infrastructure has been constructed through the pan in the past.

Figure 14: Photographic image of Pan 1

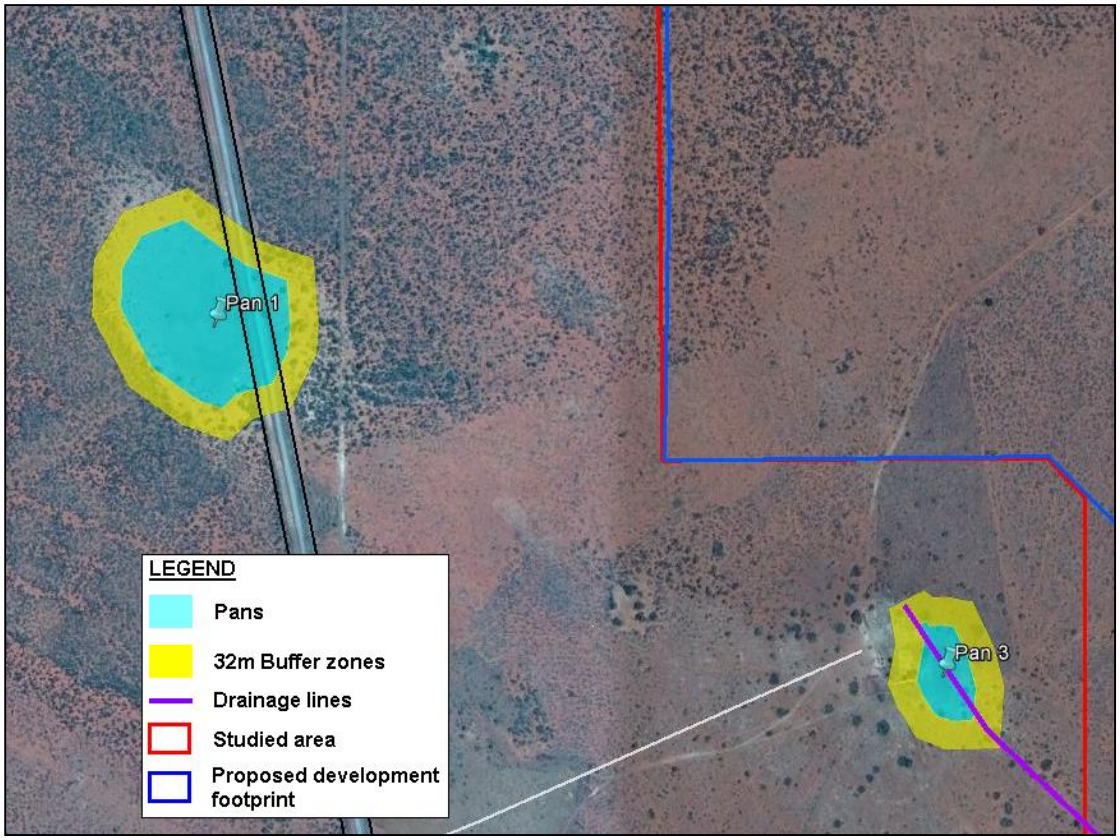


Figure 15: Outer edge of Pans 1 & 3 with a delineated 32 m buffer zone

7.3.2 Pan 2

Pan 2 is about 0.9 ha in size and is situated in the about 360 m directly north of the preferred area (Figure 13) and is in a relatively good ecological state compared to the other pans. This pan was one of only two of the delineated pans with visible signs of wetness on the soil surface at its lowest point during the time of the study (Figures 16 & 17).

Figure 16: Photographic image of Pan 2

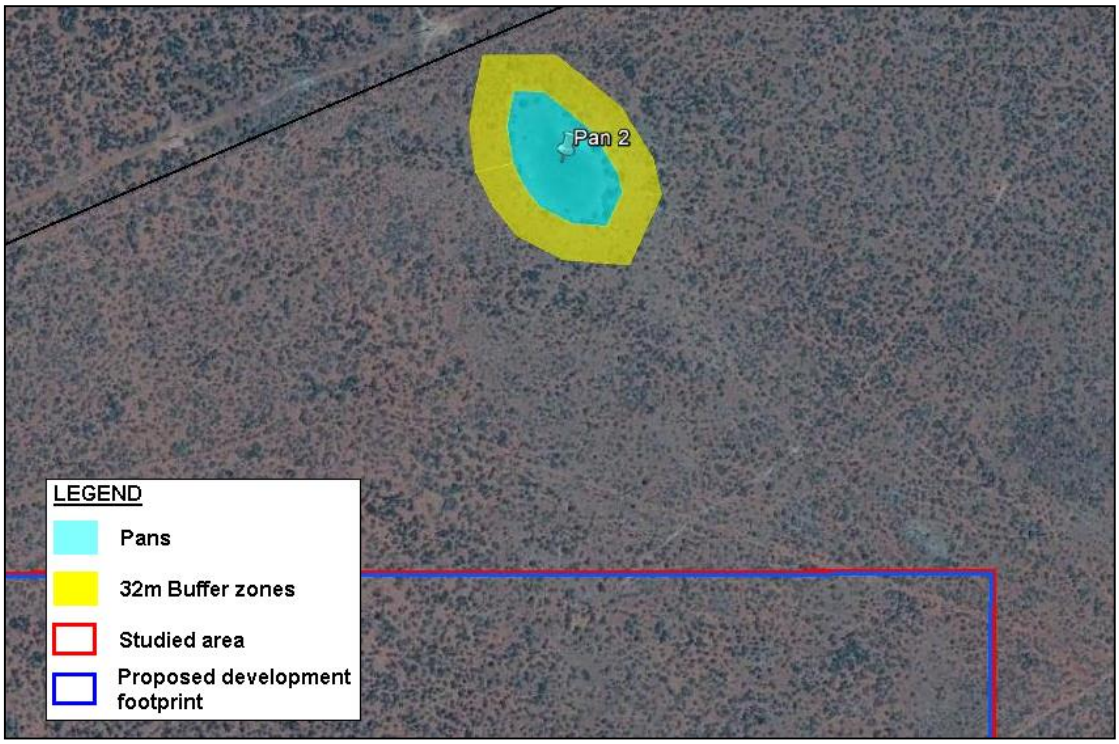


Figure 17: Outer edge of Pan 2 with a delineated 32 m buffer zone

7.3.3 Pan 3

Pan 3 is about 0.6 ha in size and is situated just about 80 m west of the preferred area (Figure 13). It is severely degraded due to the close proximity of a stock pen (kraal) to its west and a drinking trough in the pan and a fence line running through it (Figures 18 & 15).

Figure 18: Photographic image of Pan 3

7.3.4 Pan 4

Pan 4 (Figures 19 & 20) is the smallest of the investigated pans and only approximately 0.3 ha in size. It is also the closest pan to the edge of the preferred site and is only about 30 m directly south thereof (Figure 13), but is about 190 m from the proposed development footprint. It is in a poor, slightly degraded ecological state due to a fence line running through it.

Figure 19: Photographic image of Pan 4

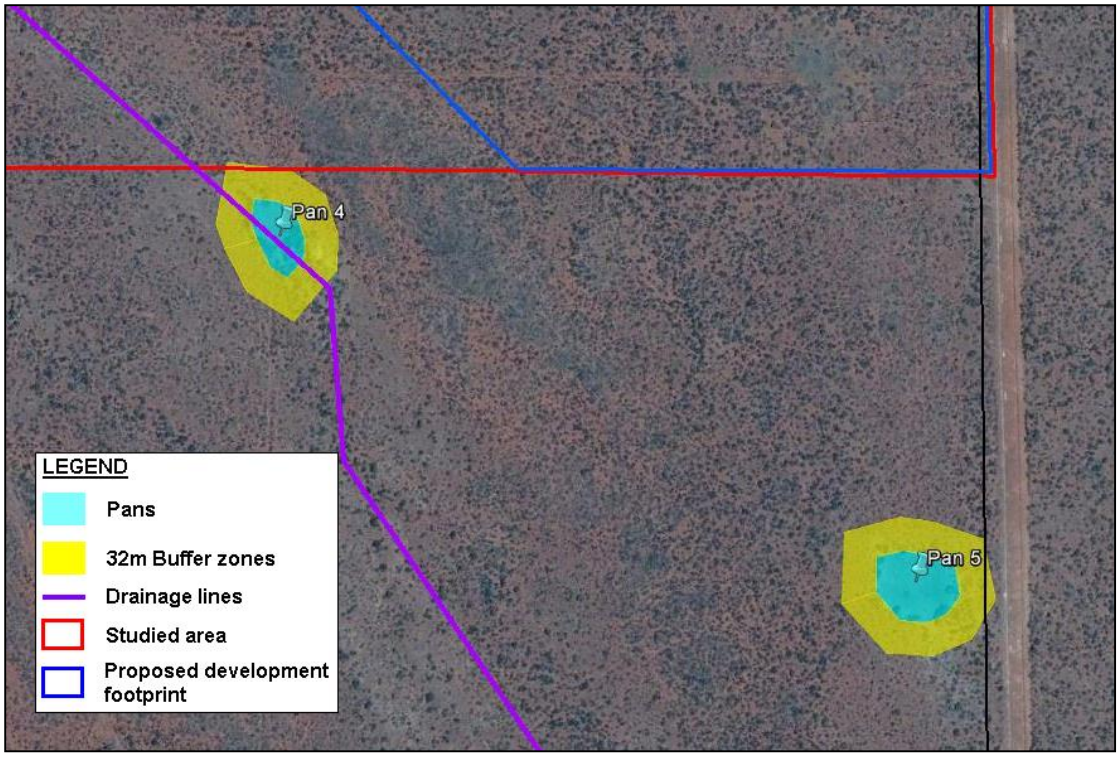


Figure 20: Outer edge of Pans 4 & 5 with a delineated 32 m buffer zone

7.3.5 Pan 5

Pan 5 is about 0.5 ha in size and is situated just about 360 m south-southeast of the preferred area. It is slightly degraded and generally in a moderate to good ecological condition (Figures 21 & 20).

Figure 21: Photographic image of Pan 5

7.3.6 Pan 6

Pan 6 is situated 250 m southwest of the preferred site and is approximately 0.7 ha in size. As Pan 2 it had a visible wet surface patch at its lowest point due to recent rains. It is in a relatively good ecological state (Figures 22 & 23).

Figure 22: Photographic image of Pan 6

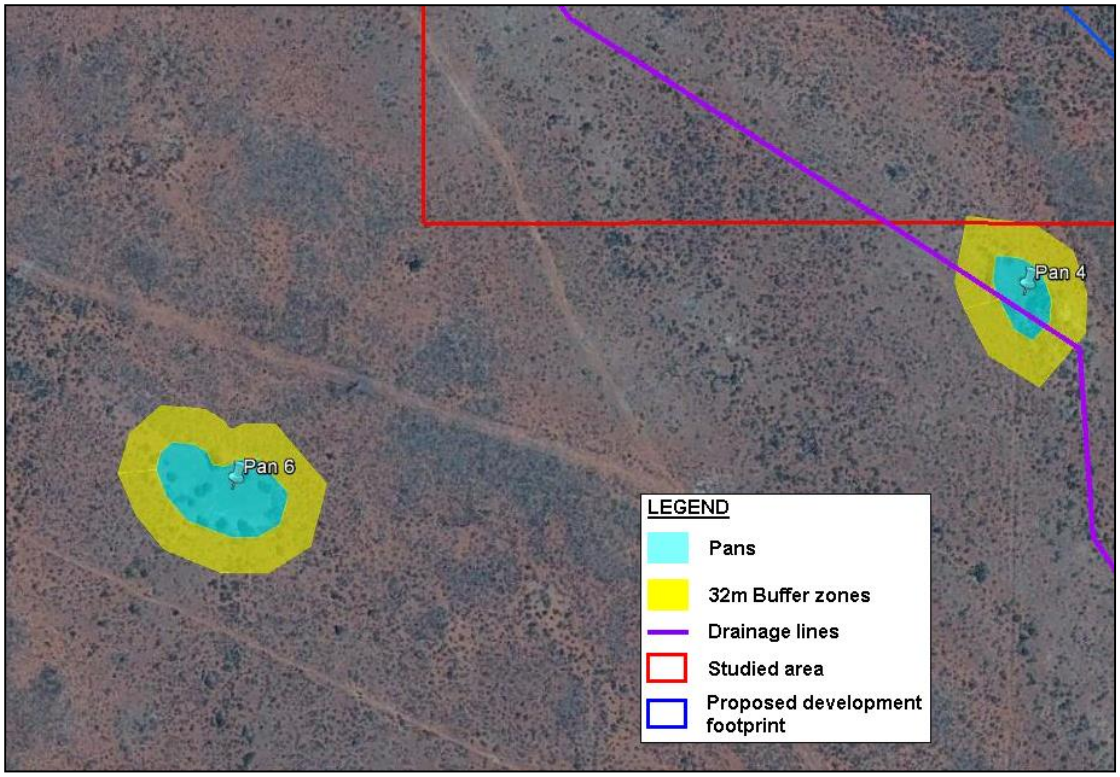


Figure 23: Outer edge of Pan 6 with a delineated 32 m buffer zone

7.3.7 Other pans

A number of other pans also occur in the area (Pans 7 – 11, Figure 13). One of these occurs on the alternative site (Pan 10) and others some distances away from either the preferred or alternative sites. These pans are estimated to be ecologically the same as the six that were studied, both in degree of degradation as well as ecological functioning.

8 THREATENED AND PROTECTED ECOSYSTEMS

No ecosystems that are formerly listed as threatened and in need of protection according to the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) was recorded in or in the vicinity of the study area.

9 IMPACT ASSESSMENT

9.1 Assessment of expected impacts and relevant mitigation

The six tables in the section below (Tables 9-1 to 9-6) serve to summarise the significance of expected and potential impacts on the faunal, floral and habitat features occurring on or directly adjacent to the study area. A summary of expected construction, operational and decommissioning phase impacts are provided. No significant impacts are expected during the pre-construction phase. Tables 9-2 to 9-5 present the descriptions of impacts as well as impact assessments according to the method and rating system described in Table 9-1. In addition, Tables 9-2 to 9-5 also indicates mitigatory and management measures needed to minimise the expected ecological impacts.

Table 9-1: Rating system for the evaluation of impacts related to the proposed development

NATURE		
A brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be experienced.		
1	Site	The impact will only affect the site.
2	Local/district	Will affect the local area or district.
3	Province/region	Will affect the entire province or region.
4	International and National	Will affect the entire country.
PROBABILITY		
This describes the chance of occurrence of an impact.		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
DURATION		
This describes the duration of the impacts. Duration indicates the lifetime of the impact as a result of the proposed activity.		
1	Short term	The impact will either disappear with mitigation or will be mitigated through natural processes in a span shorter than the construction phase (0 – 1 years), or the impact will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 30 years).

4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered indefinite.
INTENSITY/ MAGNITUDE		
Describes the severity of an impact.		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/ component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired. Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
REVERSIBILITY		
This describes the degree to which an impact can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures.
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts. A cumulative impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible cumulative impact	The impact would result in negligible to no cumulative effects.
2	Low cumulative impact	The impact would result in insignificant cumulative effects.
3	Medium cumulative impact	The impact would result in minor cumulative effects.
4	High cumulative impact	The impact would result in significant cumulative effects

SIGNIFICANCE		
Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The calculation of the significance of an impact uses the following formula: (Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity. The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.		
Points	**Impact significance rating**	**Description**
6 to 28	Negative low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative high impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive high impact	The anticipated impact will have significant positive effects.
74 to 96	Negative very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive very high impact	The anticipated impact will have highly significant positive effects.

Table 9-2: Assessment of Impact 1: Loss of habitat for faunal and floral species

Impact	Construction phase	Operational phase	Decommissioning phase
IMPACT 1: Loss of habitat for faunal and floral species.	Site clearing and the removal of vegetation leading to loss of faunal & floral habitat.	Ongoing disturbance of soils with general operational activities leading to altered faunal & floral habitat.	Disturbance of soils as part of demolition activities may alter faunal & floral habitat.
	Site clearing and the disturbance of soils leading to increased erosion.	Increased run off from paved areas and access roads causing erosion in adjacent areas; Insufficient maintenance of run off systems leading to erosion.	Disturbance of soils as part of demolition activities leading to increased erosion; Insufficient aftercare and maintenance leading to erosion.
	Compaction of soils by construction vehicles.	Ongoing ompaction of soils by maintenance vehicles.	Compaction of soils by construction vehicles as part of demolition and rehabilitation activities.
	Movement of construction vehicles impacting on habitat trough pollution by noise, fuel, oils, hydraulic fluids, etc.	Continued movement of vehicles in the area impacting on habitat trough pollution by noise, fuel, oils, hydraulic fluids, etc.	Movement of construction vehicles as part of demolition and rehabilitation activities impacting on habitat trough pollution by noise, fuel, oils, hydraulic fluids, etc.

	Disturbance of the soil will transform the vegetation in the study area and create conditions favorable for the establishment of populations of alien and invader plant species as well as common weeds.	Lack of management of transformed habitat will create favorable conditions for the spread of populations of alien and invader plant species to neighboring natural habitats causing further transformation.	Ineffective rehabilitation of impacted areas and failure to implement a comprehensive alien weed control plan may lead to ongoing loss of habitat.
	With the development of any infrastructure the fragmentation of natural habitats can occur with the negative effect that the flow of ecosystem services (seed dispersal, pollination, exchanging of genes from one area to the next, etc.) may be interrupted having a negative long term effect on isolated fragments.	Solar panels trap solar energy, effectively altering the microclimate and habitat beneath them.	

Impact assessment:

Geographical Extent	Probability	Duration	Intensity / Magnitude	Reversibility	Irreplaceable loss of resources	Cumulative Effect	Significance
2	4	3	3	2	2	3	**48** (negative medium impact)

Mitigation of Impact 1:

Injudicious and unnecessary destruction of natural vegetation, other than the footprint area of the proposed development, must be avoided at all cost.

To prevent the erosion of topsoil, management measures may include berms, soil traps, hessian curtains and stormwater diversion away from areas susceptible to erosion. Water control structures should be constructed and well maintained to minimize erosion and to create a favorable habitat for the establishment of vegetation during the operation of the development and after decommissioning and rehabilitation.

Wherever possible, any soil that can serve as a growth medium for plants must be stripped and stockpiled for future landscaping and/or rehabilitation after or during the construction phase and should be used as soon as possible after “harvesting” to ensure that seed sources does not become worthless due to decomposition of the seed over time. It must be ensured that such topsoil stockpiles are located outside of any drainage lines and areas susceptible to erosion or siltation. Stockpiles should also be placed away from areas known to contain hazardous substances such as fuel.

All soils compacted as a result of construction activities falling inside the development footprint areas should be ripped and profiled after the construction phase. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout all development and decommissioning phases to prevent loss of floral habitat.

Proliferation of alien and invasive species is expected within any disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the development/ decommissioning footprint. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled. A management plan and proper follow-up strategy for the prevention of the establishment and/or further spread of new populations of such species should be developed and enforced.

Vehicles should be well maintained to prevent oil and other chemically based materials to enter the area. Refueling points should be well managed and if any soils are contaminated, it should be stripped and disposed of at a registered hazardous waste dumping site.

After the construction phase and aslo during the decommissioning/rehabilitation phase, reseeding of indigenous grasses should be done in between the developed infrastructure and all affected areas to re-establish microclimates and niche habitats. These re-seeded areas should be well maintained during the operational phase. Upon decommissioning, all fencing should be removed to re-establish landscape connectivity.

Table 9-3: Assessment of Impact 2: Loss of indigenous faunal and floral species diversity

Impact	Construction phase	Operational phase	Decommissioning phase
IMPACT 2: Loss of indigenous faunal and floral species diversity.	Site clearance and removal of vegetation for construction of infrastructure and access roads through natural areas leading to a loss of natural species diversity.	Ongoing edge effects from operating the SPP impacting on natural species diversity.	Disturbance of soils as part of demolition activities and ineffective rehabilitation of impacted areas further impacting on natural species diversity.
	Proliferation of alien species may alter plant community structure. Failure to implement a comprehensive alien weed control plan leading to an increase in alien vegetation encroachment.	An increase in alien species leading to altered plant community structure and composition especially in neighboring habitats.	Ineffective rehabilitation of impacted areas and failure to implement a comprehensive alien weed control plan may lead to ongoing loss of natural species diversity.
		Erosion and sedimentation as a result of operational activities leading to a loss of natural species diversity.	Continued erosion and sedimentation during closure and decommissioning leading to a loss of natural species diversity.

Impact assessment:							
Geographical Extent	Probability	Duration	Intensity / Magnitude	Reversibility	Irreplaceable loss of resources	Cumulative Effect	Significance
2	2	4	2	4	3	3	**36** (negative medium impact)

Mitigation of Impact 2:
An alien vegetation control plan has to be implemented in order to manage alien plant species occurring within the developed and surrounding area. Removal of the alien and weed species encountered on the property must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal of species should take place throughout the construction, operational, closure/decommissioning and rehabilitation/ maintenance phases. Care should be taken with the choice of herbicides to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicides used. Proper training should be given to contractors/applicators to avoid spraying indigenous vegetation. Landscaping with local indigenous species is preferable and could include forage and host plants required by pollinators. After the construction phase and aslo during the decommissioning/rehabilitation phase, reseeding of local indigenous plant species should be done in between the developed infrastructure and all affected areas to re-establish plant species diversity, which in turn will create habitat for the return of faunal species, especially small mammals and invertebrates. These re-seeded areas should be well maintained during the operational phase. To prevent the erosion of topsoil, management measures may include berms, soil traps, hessian curtains and stormwater diversion away from areas susceptible to erosion. Water control structures should be constructed and well maintained to minimize erosion and to create a favorable habitat for the establishment of vegetation during the operation of the development and after decommissioning and rehabilitation.

Table 9-4: Assessment of Impact 3: Loss of faunal and floral species of conservation significance

Impact	Construction phase	Operational phase	Decommissioning phase
IMPACT 3: Loss of faunal and floral species of conservation significance.	Site clearance and removal of vegetation leading to a loss of any recorded and unrecorded species of conservation significance such as ToPS, Red Data Listed species, Protected species (nationally and/or provincially), plant species with medicinal or other cultural value.	An increase in alien plant species leading to loss of species of conservation significance such as ToPS, Red Data Listed species, Protected species (nationally and/or provincially), plant species with medicinal or other cultural value by outcompeting these species.	Ineffective rehabilitation of exposed and impacted areas and failure to implement a comprehensive alien weed control plan leading to ongoing loss of species of conservation significance.
		Erosion and sedimentation as a result of operational activities leading to a loss of species of conservation significance.	Continued erosion and sedimentation during closure and decommissioning leading to a loss of species of conservation significance.

Impact assessment:							
Geographical Extent	Probability	Duration	Intensity / Magnitude	Reversibility	Irreplaceable loss of resources	Cumulative Effect	Significance
2	4	4	3	4	2	3	**57** (negative high impact)

Mitigation of Impact 3:
According to SANBI's Guidelines for Environmental Impact Assessments (http://redlist.sanbi.org/eiaguidelines.php), *in situ* conservation of species of conservation significance is vital and is recommended as the only option for conserving species of conservation concern. *Ex situ* conservation, i.e. the removal of a subpopulation from its natural habitat to an artificial environment, a practice often termed "search and rescue", will result in the erosion of the inherent genetic diversity and characteristics of that species and increase its risk of extinction in the wild. Similarly, translocation of subpopulations is an unacceptable conservation measure. Translocations are expensive and rarely successful. Even if they are successful, translocated individuals may harm other species within the receiving environment, the translocated individuals may transmit pathogens and/or parasites, and translocation may result in rapid changes in the species itself. In spite of the above point, if species of conservation significance, and more specifically plant species, are going to be destroyed due to the construction of the proposed development. It may be recommended that these species, especially geophtyes, be located and "rescued" by transplanting specimens into a nursery or other safe site until they can be used during rehabilitation and/or landscaping. Populations of species of conservation significance (ToPS, Red Data Listed species, Protected species (nationally and/or provincially), plant species with medicinal or other cultural value) occurring outside the areas that will be directly impacted by the proposed development needs to be actively conserved in order to conserve a viable, non-fragmented gene pool of these species in the local area. If possible, developments that jeopardize any large populations of species of conservation significance should be planned in such a way as to avoid the populations and their habitat. Any specimens of protected plant species known to occur in the vicinity of the development footprint and may potentially be impacted by the development activities, are to be fenced off for the duration of the activity. If these species fall within the development footprint special authorisation is to be obtained from relevant conservation authorities for such species to be cut, disturbed, damaged or destroyed. Applications for such activities should be made to the responsible official within the relevant Northern Cape Nature Conservation Agency.

Table 9-5: Assessment of Impact 4: Degradation and/or destruction of natural pans.

Impact	Construction phase	Operational phase	Decommissioning phase
IMPACT 4: Degradation and/or destruction of natural pans.	Sedimentation of pans due to soil erosion as a result of construction activities nearby leading to a loss of natural functioning.	Sedimentation of pans due to soil erosion as a result of operational activities nearby leading to a loss of natural functioning.	Continued sedimentation during closure and decommissioning leading to a loss of natural functioning.
	The surface catchment area (size and quality) of the pans as well as the natural drainage of water to the pans could be negatively affected by construction activities. Water that will naturally flow from the surrounding areas that feed the pans and associated habitats may be cut off due to ditches, water runoff control structures, etc.	Natural drainage of water to the pans could be negatively affected by operational activities. Water that will naturally flow from the surrounding areas that feed the pans and associated habitats may be cut off due to ditches, water runoff control structures, etc.	Natural drainage of water to the pans could be negatively affected by post operational activities. Water that will naturally flow from the surrounding areas that feed the pans and associated habitats may be cut off due to ditches, water runoff control structures, etc.
	Environmentally harmful pollutants (fuel, oil, hydraulic fluids, cement, paint, turpentine, hydrochloric acid, cleaning chemicals, etc.) from the construction phase of the development may end up in the pans.	Environmentally harmful pollutants (fuel, oil, hydraulic fluids, cement, paint, turpentine, hydrochloric acid, cleaning chemicals, etc.) from the operational phase of the development may end up in the pans.	Environmentally harmful pollutants (fuel, oil, hydraulic fluids, cement, paint, turpentine, hydrochloric acid, cleaning chemicals, etc.) from the decommissioning phase of the development may end up in the pans.

	Workers entering and using pan areas for inappropriate activities (dumping materials, depositing human faecal and urine waste etc.) may negatively impact on the surface water resources and the general ecological health of the pans.	Workers entering and using pan areas for inappropriate activities (dumping materials, depositing human faecal and urine waste etc.) may negatively impact on the surface water resources and the general ecological health of the pans.	Workers entering and using pan areas for inappropriate activities (dumping materials, depositing human faecal and urine waste etc.) may negatively impact on the surface water resources and the general ecological health of the pans.
	Proliferation of alien species may alter plant community structure. Failure to implement a comprehensive alien weed control plan leading to an increase in alien vegetation encroachment.	An increase in alien species leading to altered plant community structure and composition especially in neighboring habitats.	Ineffective rehabilitation of impacted areas and failure to implement a comprehensive alien weed control plan may lead to ongoing loss of natural species diversity.

Impact assessment:

Geographical Extent	Probability	Duration	Intensity / Magnitude	Reversibility	Irreplaceable loss of resources	Cumulative Effect	Significance
1	3	3	3	3	3	3	**48** (negative medium impact)

Mitigation of impact 4:
In terms of section 19 of the NWA (1998), owners / managers / people occupying land on which any activity or process undertaken which causes, or is likely to cause pollution or degradation of a water resource must take all reasonable measures to prevent any such disturbance from occurring, continuing or recurring. These measures may include measures to (inter alia): • Cease, modify, or control any act or process causing the pollution/degradation. • Comply with any prescribed waste standard or management practice. • Contain or prevent the movement of pollutants or the source of degradation. • Remedy the effects of the pollution/degradation. • Remedy the effects of any disturbance to the bed and banks of a watercourse/wetland.
Any construction activities in or within a delineated buffer zone of a water resource may only take place after the necessary water use license has been obtained.
Where possibility exists that a pan is close to a construction site, the pan should be fenced off to avoid unnecessary or unauthorized access to these areas.
During excavations, soil stockpiling should be as far as possible away from the pan edge to avoid siltation of pans from soil stock piles.
Construction machinery and vehicles may not be allowed to enter pans. Strictly no re-fuelling of vehicles or machinery should be allowed to take place in any construction area close to a pan.
During and after construction it is important to take runoff control into serious consideration. Areas of exposed soil can easily erode and subsequently end up in the pans. After construction water runoff control is equally important in order to avoid polluted water to end up in the pans. A well designed storm water drainage system must be constructed in order to channel water, which may potentially be polluted, away from pan areas. Natural runoff from the natural terrestrial habitat surrounding the pans should however not be restricted unnecessarily.
The use of potential pollutants (paint, chemicals, etc.) during construction and operational phases must be strictly controlled and a high quality of management and supervision concerning such materials must be enforced, especially close to pan areas.
Sanitary facilities must be made available to construction workers working in or near to prevent urine and faecal waste entering the pans.

Populations of alien and invader plant species within as well as alongside the pan areas should be monitored on a regular basis and actions to eradicate these species at an early stage should be implemented.
According to the NWA (1998) part of the definition of pollution of water resources states that any physical alterations to a water resource, for example the excavation of a wetland / pan or changes to the morphology of such a water resource may be considered to be pollution. Activities which cause an alteration to the biological properties of a pan i.e. the fauna and flora contained within and supported by that water resource are therefore also considered to be a form of pollution.

Based on the above assessment it is evident that there are three expected impacts on the floral ecology within the study area. Table 9-6 summarises the findings indicating the significance of the impact before management takes place (as described in Tables 9-2 to 9-5) and the likely impact if management and mitigation takes place. From Table 9-6 it is evident that prior to management measures being put in place, the impacts are negative-medium or negative-high level impacts. If effective management takes place, all impacts will be reduced to low level impacts.

Table 9-6: A summary of the results from the impact assessments

Impact	Not mitigated / managed	Mitigated / managed
1. Loss of habitat for faunal and floral species	negative medium impact	negative low impact
2. Loss of indigenous faunal and floral species diversity	negative medium impact	negative low impact
3. Loss of faunal and floral species of conservation significance	negative high impact	negative medium to low impact
4. Degradation and/or destruction of natural pans.	negative medium impact	negative low impact

9.2 Assessment of the no-go alternative

Due the destructive nature of the proposed development to the floristic diversity occurring in the directly affected area and the direct impact it will also have on the faunal diversity of the area on a local scale, the no-go alternative will see the area stay in the current condition. The current impacts exerted on the area from an agricultural point of view (not assessed in this study) will remain and, depending on the management strategies employed by the land owner and natural climatic conditions, the current natural condition may improve or deteriorate in future.

9.3 Monitoring requirements

From a floristic point of view the following should be monitored during all phases of the proposed development:

- Floristic diversity of the development area as well as areas directly adjacent.
- Populations of ToPS, Red Data and other protected plant species on neighbouring properties / areas must be assessed and monitored during all project phases.
- The removal of any ToPS, Red Data and other protected plant species must be well monitored and managed. Authorisation, through a provincial and/or national permitting system, is to be obtained from relevant conservation authorities for such species to be cut, disturbed, damaged or destroyed.

From a faunal point of view the following should be monitored:

- Faunal diversity of the areas directly adjacent to the develpoment area.
- During construction any faunal species caught up in the midst of activities, which can be tanslocated to neighbouring open areas, such as tortoises, should be handled by trained professionals and strictly monitored.
- During the operational phase, as the floristic habitat recovers, the return of especially small mammals should be promoted as these species play an important role in the natural health of an ecosystem. This process can also be monitored by annual or bi-annual monitoring.

From a wetland / pans point of view the following should be monitored:

- All delineated pans in or adjacent to the development area should be treated as sensitive and need to be monitored from an ecological and hydrological point of view, throughout all project phases.
- Unnecessary movement of vehicles and persons in these areas should be strictly restricted and monitored.

- All aspects mentioned in the mitigation of impacts should be well monitored.

10 CONCLUDING REMARKS

The low faunal and moderately high floristic species richness and density recorded would equate to a low impact to the regional diversity of plants, mammals, reptiles and amphibians. Although the number of protected faunal species possibly occurring on or in close proximity to the site is low, these deserve consideration. It must be stressed that the short study period may affect the generation of a representative sample (see also 'Assumptions and Limitations'). We are nonetheless confident in the sampling methods employed as the methodology was designed with the study limitations in mind.

The loss of topsoil and fragmentation of natural habitats that is virtually unavoidable with any type of development, has a negative impact on the regional ecosystem as it disrupts the natural flow of ecosystem services and affects all fauna and flora that are dependent on those habitats. Linear ridges, water courses, wetlands, drainage lines, etc. are especially sensitive to and easily fragmented. A high conservation value is attributed to the plant communities and faunal assemblages of these areas as they contribute significantly to the biodiversity of a region. Care should be taken not to unnecessarily clear or destroy natural vegetation and where possible the rehabilitation of transformed areas and restoration of degraded natural veld should take place in order to improve the ecological health of the floristic component on the property. Development should therefore be planned in such a way that totally transformed areas are chosen for major developments and natural veld, even if it is already degraded and/or fragmented, is avoided as far as possible. A legitimate and well-designed rehabilitation plan must be set in place before mining commences and be strictly enforced on an on-going basis throughout the life of the mine and thereafter.

When considering the different sites (preferred and alternative sites) that were investigated during this study it is concluded that the preferred site may be accepted from a faunal, floral, wetland and general ecological point of view for the proposed development.

11 REFERENCES

11.1 Literature referred to in this report

Acocks, J.P.H. 1953. Veld Types of South Africa. *Memoirs of the Botanical Survey of South Africa No. 57*. Department of Agriculture and Water Supply, South Africa.

Avenant, N.L. & Cavallini, P. 2007. Correlating rodent community structure with ecological integrity, Tussen-die-Riviere Nature Reserve, Free State province, South Africa. *Integrative Zoology* 2, pp. 212-219.

Cowling, R.M., Richardson, D.M. & Pierce, S.M. 2004. *Vegetation of Southern Africa*, p. 167. Cambridge University Press, London.

DWAF, 2005. A practical field procedure for identification and delineation of wetlands and riparian areas (1st Edition). Pretoria.

Francis, C.D. & Barber, J.R. 2013. A framework for understanding noise impacts on wildlife: an urgent conservation priority. *Frontiers in Ecology and the Environment* 11, pp. 305-313.

Henderson, L. 2001. Alien weeds and Invasive Plants. Plant Protection Research Institute, Agricultural Research Council. Paarl Printers, Cape Town.

Hernandez, P.A., Graham, C.H., Master, L.L. & Albert, D.L. 2006. The effect of sample size and species characteristics on performance of different species distribution modeling methods. *Ecography* 29, pp. 773-785.

Hoffman, M.T., Todd, S., Ntshona, Z. & Turner, S. 1999. *Land degradation in South Africa*. South African National Botanical Institute, Kirstenbosch.

http://www.eia.org.za/introduction.html (accessed 24/03/2016 at 11:00AM).

http://redlist.sanbi.org/eiaguidelines.php

Kotze, D.C., Marneweck, G.C., Batchelor, A.L., Lindley, D.S. & Collins, N.B. 2009. WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands. WRC Report no. TT339/09. Water Research Commission, Pretoria.

Low, A.B. & Rebelo, A.G. 1996. Vegetation of South Africa, Lesotho and Swaziland.Department of Environmental Affairs and Tourism, Pretoria.

McCrary M.D., McKernan P.A.F. & Wagner W.D. 1982. Wildlife interactions at solar one: final report. Rosemead, California.

Mucina, L. & Rutherford, C. 2006. The vegetation of South Africa, Lesotho and Swaziland. South African National Biodiversity Institute. Tien Wah Press, Singapore.

NCNCA, 2009. Northern Cape Nature Conservation Act no. 9 of 2009. *Provincial Gazette no 1566, 19 December 2011*.

NEMBA, 2004. National Environmental Management: Biodiversity Act (Act no. 10 of 2004). *Government Gazette No. 26436, Vol. 467, of 7 June 2004*, Pretoria.

NEMBA, 2014. National Environmental Management: Biodiversity Act (Act no. 10 of 2004): Alien and Invasive Species Lists. *Government Gazette No. 37886, Vol. 599, of 01 August 2014*, Pretoria.

NEMBA TOPS, 2013. National Environmental Management: Biodiversity Act (Act 10 of 2004): Publication of Lists of Species that are Threatened or Protected, Activities that are Prohibited and Exemption from Restrictions. *Government Gazette No. 36375, of 16 April 2013. Notice no. 389 of 2013*.

Newbold, T. 2010. Applications and limitations of museum data for conservation and ecology, with particular attention to species distribution models. *Progress in Physical Geography* 34.

NFA, 1998. List of protected tree species under the National Forests Act of 1998 (Act no.84 of 1998), Dept. of Water affairs and Forestry. *Government Gazette No. 30253, Vol. 817*, Pretoria.

NWA, 1998. National Water Act. Act No. 36 of 1998, Government Gazette no. 19182 of 26 august 1998.

Pooley, E. 1998. A Field Guide to Wild Flowers of Kwazulu-Natal and the Eastern Region. Natal Flora Publications Trust, Durban.

Pujol, J. 1988. The Herbalist Handbook – African Flora Medicinal Plants.NaturAfrica, Jean Pujol Natural Healers Foundation, Durban.

Raimondo, D., von Staden, L., Foden, W., Victor, J.E., Helme, N.A., Turner, R.C., Kamundi, D.A. and Manyama, P.A. 2009. Red List of South African Plants.Strelitzia 25. South African National Biodiversity Institute, Pretoria.

Rutherford, M.C., Mucina, L. & Powrie, L.W. 2006. Biomes and Bioregions of Southern Africa. *Strelitzia 19: Vegetation of South Africa, Lesotho & Swaziland*, chapter 3. SANBI, Pretoria.

Schmidt, E., Lötter, M. & McCleland, W. 2002. Trees and Shrubs of Mpumalanga and Kruger National Park.Jacana, Johannesburg.

Schradin, C., Krackow, S., Schubert, M., Keller, C., Schradin, B. & Pillay, N. 2007. Regulation of Activity in Desert-Living Striped Mice: The Importance of Basking. *Ethology* 113, pp. 606-614.

Shepard, D.B., Kuhns, A.R., Dreslik, M.J. & Phillips, C.A. 2008. Roads as barriers to animal movement in fragmented landscapes. *Animal Conservation* 11, pp. 288-296.

Shearing, D. & Van Heerden, K. 1994. Karoo.South African Wild Flower Guide 6. Botanical Society of South Africa, Kirstenbosch, Claremont.

Turney, D. & Fthenakis, V. 2011. Environmental impacts from the installation and operation of large-scale solar power plants. *Renewable and Sustainable Energy Reviews* 15, pp. 3261-3270.

Van Wyk, Ben-Erik & Gericke, N. 2003. Peoples Plants, a Guide to Useful Plants of Southern Africa, Briza Publications, Pretoria.

Van Wyk, Ben-Erik, Van Oudtshoorn, B. & Gericke, N. 1997. Medicinal Plants of South Africa, Briza Publications, Pretoria.

11.2 Other Literature and Field Guides Consulted

The following were used for desktop studies and identification of faunal and floral species in the field and not necessarily referred to in the text of this document:

Alexander, G.J. & Marais, J. 2007. *A Guide to Reptiles of Southern Africa*. Struik Nature, Cape Town.

Bates, M.F., Branch, W.R, Bauer, A.M., Burger, M., Marais, J., Alexander, G.J. & De Villiers, M.S. 2014. *Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland*. SANBI, Pretoria.

Bromilow. C. 1995. Problem Plants of South Africa. Briza Publications cc, Arcadia.

Du Preez, L. & Carruthers, V. 2009. *A Complete Guide to Frogs of Southern Africa*. Struik Nature, Cape Town.

Friedmann, Y. & Daly, B, 2004. *Red Data Book of the Mammals of South Africa: A Conservation Assessment*. Endangered Wildlife Trust. South Africa.

Germishuizen, G. & Fabian, A. 1997. Wild Flowers of Northern South Africa. Fernwood Press, Cape Town.

Manning, J. 2003. SASOL *Eerste Veldgids tot Parasitiese en Vleis-etende Plante van Suider Afrika*. Struik Publishers, Cape Town.

Republic of South Africa, 2007. *Government Gazette No. 29657, No. R 151*, Pretoria.

Stuart, C. & Stuart, M. 2015. *Stuart's Field Guide to Mammals of Southern Africa*. Struik Nature, Cape Town.

Van der Walt, R. 2009. Wild Flowers of the Limpopo Valley. Retha Van der Walt, Ludwigslust Game Farms, Musina.

Van Oudtshoorn, F. 1999. Guide to the grasses of Southern Africa. Briza Publications, Pretoria.

Van Rooyen, N., Bezuidenhout, H. & De Kock, E. 2001. Blomplante van die Kalahari-duineveld. Ekotrust cc, Lynwood.

Van Wyk, A.E. & Malan, S.J. 1997. Field Guide to the Wild Flowers of the Highveld (2nd edn.). Struik Publishers, Cape Town.

Van Wyk, A.E. & Smith, G.F. 2001. Regions of floristic endemism in southern Africa. A review with emphasis on succulents. Umdaus Press, Hatfield, Pretoria.

Van Wyk, B. & Smith, G.F. 1996. Guide to Aloes of South Africa. Briza Publications, Pretoria.

Van Wyk, B. & Van Wyk, P. 1997. Field guide to Trees of Southern Africa, Struik Publishers, Cape Town.

12 APPENDIX A: lists of faunal species that may occur in the study area

Table 12-1: Mammal species likely to occur on or in close proximity to the study site. Species observed during the study period are included; along with the conservation status of each species (protected statuses have been highlighted)

Order	Family	Common Name	Species Name	Conservation Status
Eulipotyphla	Erinaceidae	Southern African Hedgehog	*Atelerix frontalis*	Near threatened
Pholidota	Manidae	Ground Pangolin	*Smutsia temminckii*	Vulnerable
Lagomorpha	Leporidae	Cape Hare	*Lepus capensis*	Least concern
		Scrub Hare	*Lepus saxatilis*	Least concern
Rodentia	Sciuridae	Southern African Ground Squirrel	*Xerus inauris*	Least concern
	Myoxidae	Spectacled Dormouse	*Graphiurus ocularis*	Least concern
	Pedetidae	Southern African Springhare	*Pedetes capensis*	Least concern
	Hystricidae	Cape Porcupine	*Hystrix africaeaustralis*	Least concern
	Muridae	Pouched Mouse	*Saccostumus campestris*	Least concern
		Grey Climbing Mouse	*Dendromus melanotis*	Least concern
		Cape Short-tailed Gerbil	*Desmodillus auricularis*	Least concern
		Bushveld Gerbil	*Gerbilliscus leucogaster*	Data deficient
		Highveld Gerbil	*Gerbilliscus brantsii*	Least concern
		Red Veld Rat	*Aethomys chrysophilus*	Least concern
		African Striped Mouse	*Rhabdomys* spp.	Least concern
		Pygmy Mouse	*Mus minutoides*	Least concern
		Black-tailed Tree Rat	*Thallomys nigricauda*	Least concern
		Southern Multimammate Mouse	*Mastomys Coucha*	Least concern

Carnivora	Canidae	Cape Fox	*Vulpes chama*	Least concern
		Black-backed Jackal	*Canis mesomelas*	Least concern
	Mustelidae	Honey Badger	*Mellivora capensis*	Near threatened
		Striped Polecat	*Ictonyx striatus*	Least concern
	Herpestidae	Slender Mongoose	*Galerella sanguinea*	Least concern
		Yellow Mongoose	*Cynictis penicillata*	Least concern
	Viverridae	Small-spotted Genet	*Genetta genetta*	Least concern
	Felidae	African Wild Cat	*Felis silvestris cafra*	Least concern
		Caracal	*Caracal caracal*	Least concern
		Leopard	*Panthera pardus*	Least concern
Tubulidentata	Orycteropodidae	Aardvark	*Orycteropus afer*	Least concern
Cetartiodactyla	Bovidae	Greater Kudu	*Tragelaphus strepsiceros*	Least concern
		Steenbok	*Raphicerus campestris*	Least concern
		Common Duiker	*Sylvicapra grimmia*	Least concern

Table 12-2: Reptile species likely to occur on or in close proximity to the study site. Species observed during the study period are included; along with the conservation status of each species (protected statuses have been highlighted)

Order	Family	Common Name	Species Name	Conservation Status
Testudines	Testudinidae	Leopard Tortoise	*Stigmochelys pardalis*	Least concern
Squamata	Gekkonidae	Bibron's Gecko	*Chondrodactylus bibronii*	Least concern
		Cape Gecko	*Pachydactylus capensis*	Least concern
	Amphisbaenidae	Kalahari Dwarf Worm Lizard	*Zygaspis quadrifrons*	Least concern
	Scincidae	Thin-tailed Legless Skink	*Acontias gracilicauda*	Least concern
		Cape Skink	*Trachylepis capensis*	Least concern
		Kalahari Tree Skink	*Trachylepis spilogaster*	Least concern

		Western Rock Skink	*Trachylepis sulcata sulcata*	Least concern
		Variegated Skink	*Trachylepis variegata*	Least concern
	Varanidae	Southern Rock Monitor	*Varanus albigularis albigularis*	Least concern
	Chamaeleonidae	Common Flap-neck Chameleon	*Chamaeleo dilepis dilepis*	Least concern
	Agamidae	Western Ground Agama	*Agama aculeata aculeata*	Least concern
		Southern Rock Agama	*Agama atra*	Least concern
	Typhlopidae	Delalande's Beaked Blind Snake	*Rhinotyphlops lalandei*	Least concern
	Leptotyphlopidae	Peter's Thread Snake	*Leptotyphlops scutifrons*	Least concern
	Pythonidae	Southern African Python	*Python natalensis*	Least concern
	Viperidae	Puff Adder	*Bitis arietans arietans*	Least concern
	Lamprophiidae	Bibron's Stiletto Snake	*Atractaspis bibronii*	Least concern
		Common House Snake	*Boaedon capensis*	Least concern
		Cape Wolf Snake	*Lycophidion capense capense*	Least concern
		Fork-marked Sand Snake	*Psammophis trinasalis*	Least concern
		Sundevall's Shovel-snout	*Prosymna sundevalli*	Least concern
		Mole Snake	*Pseudaspis cana*	Least concern
	Elapidae	Cape Cobra	*Naja nivea*	Least concern
	Colubridae	Rhombic Egg-eater	*Dasypeltis scabra*	Least concern
	Colubridae	Boomslang	*Dispholidus typus*	Least concern
		Spotted Bush Snake	*Philothamnus semivariegatus*	Least concern
		Eastern Tiger Snake	*Telescopus semiannulatus semiannulatus*	Least concern

Table 12-3: Amphibian species likely to occur on or in close proximity to the study site. Species observed during the study period are included; along with the conservation status of each species (protected statuses have been highlighted)

Order	Family	Common Name	Species Name	Conservation Status
Anura	Brevicipitidae	Bushveld Rain Frog	*Breviceps adspersus*	Least concern
	Bufonidae	Guttural Toad	*Amietophrynus gutturalis*	Least concern
		Western Olive Toad	*Amietophrynus poweri*	Least concern
	Pyxicephalidae	Boettger's Caco	*Cacosternum boettgeri*	Least concern
		Giant Bullfrog	*Pyxicephalus adspersus*	Near threatened
		Tremolo Sand Frog	*Tomopterna cryptotis*	Least concern
		Tandy's Sand Frog	*Tomopterna tandyi*	Least concern

Table 12-4: Protected butterfly species likely to occur on or in close proximity to the site.

Order	Family	Common Name	Species Name	Conservation Status
Lepidoptera	Lycaenidae	Griqua Black Pie	*Tuxentius melaena griqua*	Data deficient

13 APPENDIX B: lists of plant families, genera and species recorded in the study area

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Abbreviations used in Tables 13-2 to 13-5 are declared as follows:

Under the column SPECIES STATUS:

D	Red data – Declining (Raimondo et al, 2009)
P(SA)	Protected nationally (NFA, 1998)
P(NC)	Protected in Northern Cape Province (NCNCA, 2009)
E	Exotic – No formal invasive category – non-invasive weed
C1	Exotic – Declared weed category 1 (CARA, 1983)
C2	Exotic – Declared invader category 2 (CARA, 1983)
C3	Exotic – Declared invader category 3 (CARA, 1983)
N1b	Exotic – Category 1b (NEMBA 2014)
N2	Exotic – Category 2 (NEMBA 2014)
N3	Exotic – Category 3 (NEMBA 2014)

NOTE: All exotic plant taxa are preceded by an asterisk (e.g. **Ricinus communis*) in the species lists of Appendix B (Tables 13-1 to 13-5).

Under the column SOCIAL USE:

F – Food/nourishment

M – Medicinal

C – Cultural

Table 13-1: Plant Families and Genera recorded in the study area

FAMILY	No. of families	No. of genera per family	GENUS	No. of species per genus	No. of species per genus in VU	
					1	2
ANGIOSPERMAE						
MONOCOTYLEDONAE						
AMARYLLIDACEAE	1	3	*Ammocharis*	1	1	1
			Crinum	1	1	
			Nerine	1	1	
ASPARAGACEAE	1	1	*Asparagus*	3	3	
COMMELINACEAE	1	1	*Commelina*	1	1	1
CYPERACEAE	1	2	*Bulbostylis*	2	2	1
			Cyperus	2	2	1
ERIOSPERMACEAE	1	1	*Eriospermum*	1	1	
HYACINTHACEAE	1	1	*Dipcadi*	1	1	
POACEAE	1	14	*Aristida*	2	2	2
			Cenchrus	1	1	1
			Cymbopogon	1	1	1
			Cynodon	1	1	1
			Digitaria	1	1	
			Echinochloa	1		1
			Enneapogon	2	2	2
			Eragrostis	8	6	5
			Melinis	1	1	
			Oropetium	1	1	1
			Panicum	2		2
			Schmidtia	1	1	
			Stipagrostis	2	2	1
			Tragus	2	2	2
Sub-Total:	7	23		39	34	23
DICOTYLEDONAE						
ACANTHACEAE	1	4	*Barleria*	1	1	
			Blepharis	1	1	
			Hypoestes	1	1	
			Monechma	1	1	1
AMARANTHACEAE	1	5	*Kyphocarpa*	1	1	
			Pupalia	1	1	1
			Sericorema	1	1	
			**Amaranthus*	1		1

FAMILY	No. of families	No. of genera per family	GENUS	No. of species per genus	No. of species per genus in VU	
					1	2
			**Gomphrena*	1		1
ANACARDIACEAE	1	1	*Searsia*	1		1
APOCYNACEAE	1	3	*Asclepias*	1	1	
			Gomphocarpus	1	1	1
			Pergularia	1	1	
ASTERACEAE	1	9	*Chrysocoma*	1	1	
			Felicia	1	1	1
			Geigeria	1	1	1
			Helichrysum	1	1	
			Pentzia	1	1	1
			Senecio	1		1
			Tarchonanthus	1	1	1
			**Verbesina*	1		1
			**Xanthium*	1		1
BIGNONIACEAE	1	1	*Rhigozum*	1	1	
BORAGINACEAE	1	2	*Ehretia*	1	1	
			Heliotropium	1	1	1
CAPPARACEAE	1	2	*Boscia*	1	1	
			Cleome	2	2	1
CARYOPHYLLACEAE	1	1	*Herniaria*	1	1	1
CELASTRACEAE	1	1	*Gymnosporia*	1	1	1
CHENOPODIACEAE	1	1	**Chenopodium*	1	1	1
CONVOLVULACEAE	1	2	*Merremia*	1	1	
			Seddera	1	1	
CRASSULACEAE	1	1	*Crassula*	1	1	
CUCURBITACEAE	1	3	*Cucumis*	1	1	1
			Kedrostis	1	1	
			Momordica	1	1	1
EBENACEAE	1	1	*Diospyros*	1	1	1
EUPHORBIACEAE	1	2	*Euphorbia*	1	1	1
			Phyllanthus	2	2	1
FABACEAE	1	9	*Acacia*	3	3	2
			Cullen	1	1	1
			Indigofera	2	2	
			Lessertia	1	1	
			Lotononis	1		1

FAMILY	No. of families	No. of genera per family	GENUS	No. of species per genus	No. of species per genus in VU	
					1	2
			**Prosopis*	1	1	1
			Rhynchosia	1	1	
			Senna	1	1	1
			Tephrosia	1	1	
GISEKIACEAE	1	1	*Gisekia*	1	1	
ILLECEBRACEAE	1	1	*Pollichia*	1	1	
LAMIACEAE	1	2	*Leucas*	1	1	
			Salvia	1		1
MELIACEAE	1	1	**Melia*	1		1
MOLLUGINACEAE	1	2	*Limeum*	1	1	
			Mollugo	1	1	1
NYCTAGINACEAE	1	1	**Boerhavia*	1	1	1
OXALIDACEAE	1	1	*Oxalis*	1	1	
PEDALIACEAE	1	1	*Sesamum*	1	1	1
PHYTOLACCACEAE	1	1	*Lophiocarpus*	1	1	
POLYGALACEAE	1	1	*Polygala*	1	1	
PORTULACACEAE	1	2	*Portulaca*	2	2	1
			Talinum	1	1	
RHAMNACEAE	1	1	*Ziziphus*	1	1	1
RUBIACEAE	1	1	*Kohautia*	1	1	
SCROPHULARIACEAE	1	2	*Aptosimum*	2	2	
			Peliostomum	1	1	
SOLANACEAE	1	3	*Lycium*	2	2	
			Solanum	2	2	
			**Datura*	1		1
STERCULIACEAE	1	2	*Hermannia*	4	4	
			Melhania	1	1	1
TILIACEAE	1	1	*Grewia*	1	1	1
VAHLIACEAE	1	1	*Vahlia*	1		1
VERBENACEAE	1	2	*Chascanum*	1	1	
			Lantana	1	1	
VIOLACEAE	1	1	*Hybanthus*	1	1	
ZYGOPHYLLACEAE	1	2	*Tribulus*	2	2	1
			Zygophyllum	1	1	
Sub-Total:	38	78		91	80	41
Total:	45	101		130	114	64

Table 13-2: Woody Species – ANGIOSPERMAE – Dicotyledonae

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VU	
			AFRIKAANS	ENGLISH			1	2
ANACARDIACEAE	*Searsia pendulina* Jacq.	Tree	Witkaree	White Karee		M/C		X
ASTERACEAE	*Tarchonanthus camphoratus* L.	Tree	Wildekanferbos	Wild camphor bush		M	X	X
BIGNONIACEAE	*Rhigozum trichotomum* Burch.	Tree	Driedoring				X	
BORAGINACEAE	*Ehretia rigida* (Thunb.) Druce subsp. *rigida*	Tree	Deurmekaarbos	Puzzle-bush		F/C	X	
CAPPARACEAE	*Boscia albitrunca* (Burch.) Gilg & Gilg-Ben.	Tree	Witgat	Shepherd's Tree	P(SA), P(NC)	M/F/C	X	
CELASTRACEAE	*Gymnosporia buxifolia* (L.) Szyszyl.	Tree	Gewone Pendoring	Common Spike-thorn	P(NC)	M/C	X	X
EBENACEAE	*Diospyros lycioides* Desf.	Tree	Bloubos	Bluebush		M/F/C	X	X
FABACEAE	*Acacia erioloba* E.Mey.	Tree	Kameeldoring	Camel Thorn	D, P(SA)	M/F/C	X	
FABACEAE	*Acacia hebeclada* DC. subsp. *hebeclada*	Tree	Trassiedoring	Candle Thorn			X	X
FABACEAE	*Acacia mellifera* (Vahl) Benth. subsp. *detinens* (Burch.) Brenan	Tree	Swarthaak	Black Thorn		M/C	X	X
FABACEAE	**Prosopis glandulosa* Torr. var. *torreyana* (Benson) Johnst.	Tree	*Heuningprosopis	*Honey Mesquite	C2 / N2		X	X
MELIACEAE	**Melia azedarach* L.	Tree	*Maksering	*Seringa	C3 / N3	M		X
RHAMNACEAE	*Ziziphus mucronata* Willd. subsp. *mucronata*	Tree	Blinkblaar-wag-'n-bietjie	Buffalo-thorn		M/F/C	X	X
SOLANACEAE	*Lycium cinereum* Thunb.	Shrub	Kleinkriedoring / Slangbessie	Small Honey-thorn		C	X	
SOLANACEAE	*Lycium* c.f. *grandicalyx* Joubert & A.M. Vanter	Shrub / Dwarf shrub					X	
TILIACEAE	*Grewia flava* DC.	Tree	Fluweelrosyntjie	Velvet Raisin		F/C	X	X

Table 13-3: Graminoids – ANGIOSPERMAE – Monocotyledonae

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VU	
			AFRIKAANS	ENGLISH			1	2
CYPERACEAE	*Bulbostylis hispidula* (Vahl) R.W.Haines subsp. *pyriformis* (Lye) R.W.Haines	Herb, cyperoid		Veld Bulrush			X	X
CYPERACEAE	*Bulbostylis humilis* (Kunth) C.B.Clarke	Herb, cyperoid					X	
CYPERACEAE	*Cyperus capensis* (Steud.) Endl.	Herb, cyperoid					X	
CYPERACEAE	*Cyperus squarrosus* L.	Herb, cyperoid					X	X
POACEAE	*Aristida adscensionis* L.	Grass	Eenjarige steekgras	Annual three-awn			X	X
POACEAE	*Aristida congesta* Roem. & Schult. subsp. *congesta*	Grass	Katstertsteekgras	Tassel Three-awn			X	X
POACEAE	*Cenchrus ciliaris* L.	Grass	Bloubuffelgras	Foxtail Buffalo Grass			X	X
POACEAE	*Cymbopogon pospischilii* (K.Schum.) C.E. Hubb.	Grass	Smalblaar-terpentyngras	Narrow-leaved Turpentine Grass			X	X
POACEAE	*Cynodon dactylon* (L.) Pers.	Grass	Kweekgras	Couch Grass			X	X
POACEAE	*Digitaria eriantha* Steud.	Grass	Gewone-vingergras	Common Finger Grass			X	
POACEAE	*Echinochloa holubii* (Stapf) Stapf	Grass	Kalahari Watergras	Kalahari Water Grass				X
POACEAE	*Enneapogon cenchroides* (Roem. & Schult.) C.Eragrostis Hubb.	Grass	Negenaaldgras	Nine-awned Grass			X	X
POACEAE	*Enneapogon desvauxii* P.Beauv.	Grass	Agtdaegras	Eight Day Grass			X	X
POACEAE	*Eragrostis echinochloidea* Stapf	Grass	Bosluisgras	Tick Grass			X	X
POACEAE	*Eragrostis lehmanniana* Nees *var. lehmanniana*	Grass	Knietjiesgras	Lehmann's Love Grass		C	X	X
POACEAE	*Eragrostis nindensis* Ficalho & Hiern	Grass	Hamelgras	Wether Love Grass			X	
POACEAE	*Eragrostis obtusa* Munro ex Ficalho & Hiern	Grass	Douvatgras	Dew Grass				X
POACEAE	*Eragrostis rigidior* Pilg.	Grass	Breë Krulblaar	Broad Curly-leaf			X	

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VU	
			AFRIKAANS	ENGLISH			1	2
POACEAE	*Eragrostis rotifer* Rendle	Grass	Reëngras	Pearly Love Grass				X
POACEAE	*Eragrostis trichophora* Coss. & Durieu	Grass	Harige Pluimgras	Hairy Love Grass			X	X
POACEAE	*Eragrostis truncata* Hack.	Grass					X	
POACEAE	*Melinis repens* (Willd.) Zizka	Grass	Fluweelgras / Natal Rooipluim	Natal Red Top			X	
POACEAE	*Oropetium capense* Stapf	Grass	Haasgras	Dwarf Grass			X	X
POACEAE	*Panicum impeditum* Launert	Grass						X
POACEAE	*Panicum lanipes* Mez	Grass	Wolvoet-panicum					X
POACEAE	*Schmidtia pappophoroides* Steud.	Grass	Sandkweek	Sand Quick			X	
POACEAE	*Stipagrostis obtusa* (Delile) Nees	Grass	Kortbeen Boesmangras	Small Bushman Grass			X	
POACEAE	*Stipagrostis uniplumis* (Licht.) De Winter var. *uniplumis*	Grass	Blinkblaar-boesmangras	Silky Bushman Grass			X	X
POACEAE	*Tragus berteronianus* Schult.	Grass	Kousklits	Carrot-seed Grass			X	X
POACEAE	*Tragus koelerioides* Asch.	Grass					X	X

Table 13-4: Herbaceous Shrubs & Forbs – ANGIOSPERMAE – Monocotyledonae

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VU	
			AFRIKAANS	ENGLISH			1	2
AMARYLLIDACEAE	*Ammocharis coranica* (Ker-Gawl.) Herb.	Geophyte	Seeroogblom / Berglelie	Ground Lily	P(NC)	M	X	X
AMARYLLIDACEAE	*Crinum* c.f. *macowanii* Baker	Geophyte	Rivierlelie	River Lily	D, P(NC)	M	X	
AMARYLLIDACEAE	*Nerine laticoma* (Ker Gawl.) T.Durand & Schinz	Geophyte			P(NC)	M	X	
ASPARAGACEAE	*Asparagus bechuanicus* Baker	Herbaceous shrub					X	
ASPARAGACEAE	*Asparagus cooperi* Baker	Herbaceous shrub	Katbos				X	
ASPARAGACEAE	*Asparagus nelsii* Schinz	Herbaceous shrub	Sandveldkatbos			F	X	
COMMELINACEAE	*Commelina africana* L. var. *lancispatha* C.B.Clarke	Herb	Geeleendagsblom	Yellow Commelina		M	X	X
ERIOSPERMACEAE	*Eriospermum* species	Geophyte					X	
HYACINTHACEAE	*Dipcadi* species	Geophyte					X	

Table 13-5: Herbaceous Shrubs & Forbs – ANGIOSPERMAE – Dicotyledonae

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VU	
			AFRIKAANS	ENGLISH			1	2
ACANTHACEAE	*Barleria rigida* Nees	Dwarf shrub	Skerpioendissel	Scorpion Thistle			X	
ACANTHACEAE	*Blepharis integrifolia* (L.f.) E.Mey. ex Schinz	Herb	Rankklits				X	
ACANTHACEAE	*Hypoestes forskaolii* (Vahl) R.Br.	Herb		White Ribbon Bush			X	
ACANTHACEAE	*Monechma incanum* (Nees) C.B.Clarke	Dwarf shrub	Netvetbossie / Skaapganna				X	X
AMARANTHACEAE	**Amaranthus viridis* L.	Herb	*Skraalmisbredie	*Slender Amaranth	E	F		X
AMARANTHACEAE	**Gomphrena celosioides* Mart.	Herb	*Mierbossie	*Batchelor's Button	E			X
AMARANTHACEAE	*Kyphocarpa angustifolia* (Moq.) Lopr.	Herb					X	
AMARANTHACEAE	*Pupalia lappacea* (L.) A.Juss. var. *lappacea*	Herb, climber	Bosklits	Forest Burr			X	X
AMARANTHACEAE	*Sericorema remotiflora (Hook.f.) Lopr.*	Herb	Kwasbossie				X	
APOCYNACEAE	*Asclepias aurea* (Schltr.) Schltr.	Geophytic herb			P(NC)		X	
APOCYNACEAE	*Gomphocarpus fruticosus* (L.) Aiton f. subsp. *fruticosus*	Herbaceous shrub	Melkbos / Balbossie	Milkweed	P(NC)	M	X	X
APOCYNACEAE	*Pergularia daemia* (Forssk.) Chiov. var. *daemia*	Herb, climber		Trellis Vine	P(NC)	M	X	
ASTERACEAE	*Chrysocoma ciliata* L.	Dwarf shrub	Bitterbos				X	
ASTERACEAE	*Felicia muricata* (Thunb.) Nees subsp. *muricata*	Herb	Bloublommetjie			M/C	X	X
ASTERACEAE	*Geigeria ornativa* O.Hoffm.	Herb	Vermeerbos				X	X
ASTERACEAE	*Helichrysum* species	Dwarf shrub					X	
ASTERACEAE	*Pentzia calcarea* Kies.	Dwarf shrub	Meerkatkaroo				X	X
ASTERACEAE	*Senecio* species	Herb						X
ASTERACEAE	**Verbesina encelioides* (Cav.) Benth. &	Herb	*Wildesonneblom	*Wild Sunflower	E			X

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VU	
			AFRIKAANS	ENGLISH			1	2
	Hook. var. *encelioides*							
ASTERACEAE	**Xanthium strumarium* L.	Herb	*Kankerroos	*Large Cocklebur	C1 / N1b			X
BORAGINACEAE	*Heliotropium* species	Herb					X	X
CAPPARACEAE	*Cleome monophylla* L.	Herb	Rusperbossie	Spindlepod		M/C/F	X	X
CAPPARACEAE	*Cleome rubella* Burch.	Herb	Mooinooientjie	Pretty Lady			X	
CARYOPHYLLACEAE	*Herniaria erckertii* Herm. subsp. e*rckertii*	Herb					X	X
CHENOPODIACEAE	**Chenopodium carinatum* R.Br.	Herb	*Groenhondebossie	*Green Goosefoot	E		X	X
CONVOLVULACEAE	*Merremia verecunda* Rendle (1)	Herb, climber					X	
CONVOLVULACEAE	*Seddera suffruticosa* (Schinz) Hallier f.	Herb					X	
CRASSULACEAE	*Crassula* species	Succulent herb					X	
CUCURBITACEAE	*Cucumis zeyheri* Sond.	Herb, climber	Wildekomkommer	Wild Cucumber		M/F	X	X
CUCURBITACEAE	*Kedrostis foetidissima* (Jacq.) Cogn.	Herb, climber				F	X	
CUCURBITACEAE	*Momordica balsamina* L.	Herb, climber	Laloentjie			M/F	X	X
EUPHORBIACEAE	*Euphorbia inaequilatera* Sond. var. *inaequilatera*	Herb	Rooi-opslag	Smooth Creeping Milkweed			X	X
EUPHORBIACEAE	*Phyllanthus loandensis* Welw. ex Müll.Arg.	Herb					X	
EUPHORBIACEAE	*Phyllanthus maderaspatensis* L.	Herb	Skilpadbossie				X	X
FABACEAE	*Cullen tomentosum* (Thunb.) J.W.Grimes	Herb	Blouklawer / Rivierklawer	Blue Clover			X	X
FABACEAE	*Indigofera alternans* DC. var. *alternans*	Herb	Skaapertjie / Klipertjie				X	
FABACEAE	*Indigofera charlieriana* Schinz var. *charlieriana*	Herb					X	
FABACEAE	*Lessertia prostata* DC.	Herb		Lessertia	SP(NC)		X	
FABACEAE	*Lotononis* species	Herb						X

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VU	
			AFRIKAANS	ENGLISH			1	2
FABACEAE	*Rhynchosia totta* (Thunb.) DC. var. *totta*	Herb, climber				F	X	
FABACEAE	*Senna italica* Mill. subsp. *arachoides* (Burch.) Lock	Herb	Elandsertjie	Eland's Pea		M	X	X
FABACEAE	*Tephrosia purpurea* (L.) Pers.	Herb		Silver Tephrosia			X	
GISEKIACEAE	*Gisekia africana* (Lour.) Kuntze	Herb					X	
ILLECEBRACEAE	*Pollichia campestris* Ait.	Herbaceous shrub	Teesuikerbossie	Waxberry / Barley Sugar Bush		F	X	
LAMIACEAE	*Leucas capensis* (Benth.) Engl.	Herb / shrub					X	
LAMIACEAE	*Salvia runcinata* L.f.	Herb	Wildesalie			M		X
MOLLUGINACEAE	*Limeum sulcatum* (Klotzsch) Hutch var. *sulcatum*	Herb	Klosaarbossie				X	
MOLLUGINACEAE	*Mollugo cerviana* (L.) Ser. ex DC. var. *cerviana*	Herb		Thread-stem Carpetweed			X	X
NYCTAGINACEAE	**Boerhavia cordobensis* Kuntze	Herb			E		X	X
OXALIDACEAE	*Oxalis* species	Geophyte	Suuring	Sorrel	P(NC)	M/F	X	
PEDALIACEAE	*Sesamum triphyllum* Welw. ex Asch. var. *triphyllum*	Herb	Wildesesam	Wild Sesame		F	X	X
PHYTOLACCACEAE	*Lophiocarpus polystachyus* Turcz.	Herb					X	
POLYGALACEAE	*Polygala hottentotta* Presl.	Herb		Small Purple Broom		M/C	X	
PORTULACACEAE	*Portulaca kermesina* N.E.Br.	Succulent					X	
PORTULACACEAE	*Portulaca quadrifida* L.	Succulent	Porslein	Purslane / Pigweed			X	X
PORTULACACEAE	*Talinum caffrum* (Thunb.) Eckl. & Zeyh.	Succulent herb	Ystervarkwortel	Porcupine Root		M/F	X	
RUBIACEAE	*Kohautia caespitosa* Schinizl. Subsp. *brachyloba* (Sond.) D.Mantell	Herb					X	
SCROPHULARIACEAE	*Aptosimum albomarginatum* Marloth & Engl.	Dwarf shrub	Koegab				X	

FAMILY	SPECIES NAME	GROWTH FORM	COMMON NAME		SPECIES STATUS	SOCIAL USE	VU	
			AFRIKAANS	ENGLISH			1	2
SCROPHULARIACEAE	*Aptosimum marlothii* (Engl.) Hiern	Dwarf shrub	Koffiepit				X	
SCROPHULARIACEAE	*Peliostomum leucorrhizum* E.Mey. ex Benth.	Dwarf shrub	Springbokkos / Karooviooltjie	Veld Violet			X	
SOLANACEAE	**Datura ferox* L.	Herb	*Grootstinkblaar	*Large Thorn Apple	C1 / N1b	M		X
SOLANACEAE	*Solanum incanum* L.	Herbaceous shrub	Bitterappel	Bitter Apple		M	X	
SOLANACEAE	*Solanum supinum* Dunal var. *supinum*	Herb					X	
STERCULIACEAE	*Hermannia coccocarpa* (Eckl. & Zeyh.) Kuntze	Herb					X	
STERCULIACEAE	*Hermannia modesta* (Ehrenb.) Mast.	Herb					X	
STERCULIACEAE	*Hermannia tomentosa* (Turcz.) Schinz ex Engl.	Herbaceous shrub					X	
STERCULIACEAE	*Hermannia vestita* Thunb.	Herb	Swaelbossie				X	
STERCULIACEAE	*Melhania rehmannii* Szyszyl.	Herb					X	X
VAHLIACEAE	*Vahlia capensis* (L.f.) Thunb. subsp. *vulgaris* Bridson var. *linearis* E. Mey. ex. Bridson	Herb						X
VERBENACEAE	*Chascanum pinnatifidum* (L.f.) E.Mey.	Herb					X	
VERBENACEAE	*Lantana rugosa* Thunb.	Herb	Voëlbrandewyn	Birds' Brandy		M/F/C	X	
VIOLACEAE	*Hybanthus* c.f. *densifolius* Engl.	Herb		Lady's Slipper			X	
ZYGOPHYLLACEAE	*Tribulus terrestris* L.	Herb	Dubbeltjie	Devil's Thorn			X	X
ZYGOPHYLLACEAE	*Tribulus zeyheri* Sond. subsp. *zeyheri*	Herb	Grootblomdubbeltjie	Devil's Thorn			X	
ZYGOPHYLLACEAE	*Zygophyllum pubescens* Schinz	Succulent dwarf shrub	Spekbos				X	

Table 13-6: Species list downloaded from POSA (http://posa.sanbi.org) on March 31, 2016, 2:34 pm for QDS 2722 DB & DD

Family	Species	Threat status	SA Endemic	Lifecycle	Growth forms
ACANTHACEAE	Barleria macrostegia Nees	LC	No	Perennial	Herb
ACANTHACEAE	Barleria rigida Nees	LC	No	Perennial	Dwarf shrub, shrub
ACANTHACEAE	Justicia puberula Immelman	LC	No	Perennial	Dwarf shrub, herb
ACANTHACEAE	Justicia thymifolia (Nees) C.B.Clarke	LC	No	Perennial	Dwarf shrub, shrub
ACANTHACEAE	Monechma divaricatum (Nees) C.B.Clarke	LC	No	Perennial	Shrub, suffrutex
ACANTHACEAE	Monechma incanum (Nees) C.B.Clarke	LC	No	Perennial	Dwarf shrub, shrub
AMARANTHACEAE	Aerva leucura Moq.	LC	No	Perennial	Herb
ANACARDIACEAE	Searsia tridactyla (Burch.) Moffett	LC	No	Perennial	Shrub, tree
APOCYNACEAE	Fockea angustifolia K.Schum.	LC	No	Perennial	Climber, succulent
APOCYNACEAE	Acokanthera oppositifolia (Lam.) Codd	LC	No	Perennial	Shrub, tree
APOCYNACEAE	Piaranthus decipiens (N.E.Br.) Bruyns	LC	No	Perennial	Succulent
ASPARAGACEAE	Asparagus suaveolens Burch.	LC	No	Perennial	Shrub
ASPHODELACEAE	Aloe hereroensis Engl. var. hereroensis	LC	No	Perennial	Dwarf shrub, succulent
ASPHODELACEAE	Bulbine narcissifolia Salm-Dyck	LC	No	Perennial	Geophyte, herb, succulent
ASTERACEAE	Arctotis leiocarpa Harv.	LC	No	Perennial	Herb
ASTERACEAE	Eriocephalus ericoides (L.f.) Druce subsp. griquensis M.A.N.Müll.	LC	No	Perennial	Shrub
ASTERACEAE	Arctotheca calendula (L.) Levyns	LC	No	Annual	Herb
ASTERACEAE	Chrysocoma ciliata L.	LC	No	Perennial	Shrub
ASTERACEAE	Cineraria lyratiformis Cron	LC	No	Annual (occ. perennial)	Herb
ASTERACEAE	Dicoma anomala Sond. subsp. gerrardii (Harv. ex F.C.Wilson) S.Ortíz & Rodr.Oubiña	LC	No	Perennial	Herb

Family	Species	Threat status	SA Endemic	Lifecycle	Growth forms
ASTERACEAE	Dicoma capensis Less.	LC	No	Perennial	Herb
ASTERACEAE	Dicoma macrocephala DC.	LC	No	Perennial	Herb
ASTERACEAE	Felicia muricata (Thunb.) Nees subsp. muricata	LC	No	Perennial	Shrub
ASTERACEAE	Helichrysum argyrosphaerum DC.	LC	No	Annual	Herb
ASTERACEAE	Helichrysum cerastioides DC. var. cerastioides	LC	No	Perennial	Herb
ASTERACEAE	Helichrysum pumilio (O.Hoffm.) Hilliard & B.L.Burtt subsp. pumilio	LC	No	Perennial	Dwarf shrub, herb
ASTERACEAE	Helichrysum zeyheri Less.	LC	No	Perennial	Dwarf shrub, shrub
ASTERACEAE	Hertia pallens (DC.) Kuntze	LC	No	Perennial	Shrub, succulent
ASTERACEAE	Ifloga glomerata (Harv.) Schltr.	LC	No	Annual	Herb
ASTERACEAE	Lopholaena cneorifolia (DC.) S.Moore	LC	No	Perennial	Shrub, succulent
ASTERACEAE	Metalasia trivialis P.O.Karis	LC	No	Perennial	Shrub
ASTERACEAE	Pentzia incana (Thunb.) Kuntze	LC	No	Perennial	Shrub
ASTERACEAE	Pentzia viridis Kies	LC	No	Perennial	Shrub, suffrutex
ASTERACEAE	Tarchonanthus camphoratus L.	LC	No	Perennial	Shrub, tree
ASTERACEAE	Tarchonanthus obovatus DC.	LC	No	Perennial	Shrub, tree
ASTERACEAE	*Verbesina encelioides (Cav.) Benth. & Hook. var. encelioides	Not Evaluated	No	Annual	Herb
BIGNONIACEAE	Rhigozum brevispinosum Kuntze	LC	No	Perennial	Shrub
BORAGINACEAE	Ehretia rigida (Thunb.) Druce subsp. rigida	LC	No	Perennial	Shrub, tree
CAPPARACEAE	Boscia foetida Schinz subsp. foetida	LC	No	Perennial	Shrub, tree
CELASTRACEAE	Putterlickia pyracantha (L.) Szyszyl.	LC	No	Perennial	Shrub
CHENOPODIACEAE	*Chenopodium carinatum R.Br.	Not Evaluated	No	Annual	Herb

Family	Species	Threat status	SA Endemic	Lifecycle	Growth forms
CHENOPODIACEAE	Chenopodium hederiforme (Murr) Aellen var. undulatum Aellen	LC	No	Annual	Herb
CHENOPODIACEAE	Exomis microphylla (Thunb.) Aellen var. axyrioides (Fenzl) Aellen	LC	No	Perennial	Shrub
COLCHICACEAE	Colchicum melanthoides (Willd.) J.C.Manning & Vinn. subsp. melanthoides	LC	No	Perennial	Geophyte
CONVOLVULACEAE	Evolvulus alsinoides (L.) L.	LC	No	Annual (occ. perennial)	Herb
CONVOLVULACEAE	Ipomoea oenotheroides (L.f.) Raf. ex Hallier f.	LC	No	Perennial	Shrub, succulent
CUCURBITACEAE	Kedrostis crassirostrata Bremek.	LC	No	Perennial	Climber, herb, succulent
CUCURBITACEAE	Momordica balsamina L.	LC	No	Perennial	Climber, herb, succulent
CYPERACEAE	Schoenoplectus muricinux (C.B.Clarke) J.Raynal	LC	No	Perennial	Cyperoid, emergent hydrophyte, helophyte
DIPSACACEAE	Scabiosa buekiana Eckl. & Zeyh.	LC	No	Perennial	Herb
DRACAENACEAE	Sansevieria aethiopica Thunb.	LC	No	Perennial	Geophyte, succulent
EBENACEAE	Euclea undulata Thunb.	LC	No	Perennial	Shrub, tree
EUPHORBIACEAE	Clutia affinis Sond.	LC	No	Perennial	Shrub
EUPHORBIACEAE	Croton gratissimus Burch. var. gratissimus	LC	No	Perennial	Shrub, tree
EUPHORBIACEAE	Euphorbia avasmontana Dinter var. avasmontana	LC	No	Perennial	Shrub, succulent
EUPHORBIACEAE	Euphorbia inaequilatera Sond. var. inaequilatera	LC	No	Annual	Dwarf shrub, herb
EUPHORBIACEAE	Euphorbia juttae Dinter		No	Perennial	Dwarf shrub, succulent
FABACEAE	Acacia haematoxylon Willd.	LC	No	Perennial	Shrub, tree
FABACEAE	Lotononis crumanina Burch. ex Benth.	LC	No	Perennial	Herb
FABACEAE	Acacia erioloba E.Mey.	Declining	No	Perennial	Shrub, tree
FABACEAE	Acacia hebeclada DC. subsp. hebeclada	LC	No	Perennial	Shrub, tree

Family	Species	Threat status	SA Endemic	Lifecycle	Growth forms
FABACEAE	Acacia karroo Hayne	LC	No	Perennial	Shrub, tree
FABACEAE	Calpurnia aurea (Aiton) Benth. subsp. aurea	LC	No	Perennial	Shrub, tree
FABACEAE	Cullen tomentosum (Thunb.) J.W.Grimes	LC	No	Perennial	Herb
FABACEAE	Cyamopsis serrata Schinz	LC	No	Annual	Herb
FABACEAE	Indigofera alternans DC. var. alternans	LC	No	Perennial	Herb
FABACEAE	Indigofera daleoides Benth. ex Harv. var. daleoides	LC	No	Perennial	Herb
FABACEAE	Indigofera rhytidocarpa Benth. ex Harv. subsp. rhytidocarpa	LC	No	Annual	Herb
FABACEAE	Indigofera sessilifolia DC.	LC	No	Perennial	Dwarf shrub, herb
FABACEAE	Lotononis parviflora (P.J.Bergius) D.Dietr.	LC	No	Annual	Herb
FABACEAE	Melolobium calycinum Benth.	LC	No	Perennial	Dwarf shrub, shrub
FABACEAE	Melolobium canescens Benth.	LC	No	Perennial	Dwarf shrub, shrub
FABACEAE	Melolobium humile Eckl. & Zeyh.	LC	No	Perennial	Dwarf shrub
FABACEAE	Ptycholobium biflorum (E.Mey.) Brummitt subsp. biflorum	LC	No	Perennial	Dwarf shrub, herb
FABACEAE	Senna italica Mill. subsp. arachoides (Burch.) Lock	LC	No	Perennial	Herb
FABACEAE	Sutherlandia frutescens (L.) R.Br.	LC	No	Perennial	Dwarf shrub, shrub
FABACEAE	Tephrosia dregeana E.Mey. var. dregeana	LC	No	Annual (occ. perennial)	Dwarf shrub, herb
GISEKIACEAE	Gisekia africana (Lour.) Kuntze var. africana	LC	No	Annual (occ. perennial)	Herb
IRIDACEAE	Moraea pallida (Baker) Goldblatt	LC	No	Perennial	Geophyte, herb
JUNCACEAE	Juncus dregeanus Kunth subsp. dregeanus	LC	No	Perennial	Helophyte, herb
LAMIACEAE	Acrotome inflata Benth.	LC	No	Annual	Herb
LAMIACEAE	Ocimum americanum L. var. americanum	LC	No	Perennial	Herb

Family	Species	Threat status	SA Endemic	Lifecycle	Growth forms
LOBELIACEAE	Lobelia erinus L.	LC	No	Annual (occ. perennial)	Herb
LORANTHACEAE	Tapinanthus oleifolius (J.C.Wendl.) Danser	LC	No	Perennial	Parasite, shrub, succulent
MALVACEAE	Abutilon austro-africanum Hochr.	LC	No	Perennial	Dwarf shrub
MALVACEAE	Grewia flava DC.	LC	No	Perennial	Shrub
MALVACEAE	Hermannia burkei Burtt Davy	LC	No	Perennial	Climber, herb
MALVACEAE	Hermannia comosa Burch. ex DC.	LC	No	Perennial	Herb
MALVACEAE	Hermannia desertorum Eckl. & Zeyh.	LC	No	Perennial	Dwarf shrub
MALVACEAE	Hermannia vestita Thunb.	LC	No	Biennial	Dwarf shrub
MALVACEAE	Melhania rehmannii Szyszyl.	LC	No	Perennial	Dwarf shrub
MALVACEAE	Sida cordifolia L. subsp. cordifolia	LC	No	Annual (occ. perennial)	Dwarf shrub
MALVACEAE	Waltheria indica L.	LC	No	Annual	Herb
MENISPERMACEAE	Cissampelos capensis L.f.	LC	No	Perennial	Climber, herb, shrub
MESEMBRYANTHEMACEAE	Mestoklema arboriforme (Burch.) N.E.Br. ex Glen	LC	No	Perennial	Succulent
MESEMBRYANTHEMACEAE	Trichodiadema pomeridianum L.Bolus	LC	No	Perennial	Succulent
MOLLUGINACEAE	Limeum myosotis H.Walter var. myosotis	LC	No	Annual	Herb
MOLLUGINACEAE	Limeum viscosum (J.Gay) Fenzl subsp. transvaalense Friedrich	LC	No	Annual	Herb
MOLLUGINACEAE	Mollugo cerviana (L.) Ser. ex DC. var. cerviana	LC	No	Annual	Herb
NEURADACEAE	Grielum humifusum Thunb. var. parviflorum Harv.	LC	No	Annual	Herb
ORCHIDACEAE	Disperis macowanii Bolus	LC	No	Perennial	Geophyte, herb
OXALIDACEAE	Oxalis lawsonii F.Bolus	LC	No	Perennial	Geophyte
PEDALIACEAE	Sesamum capense Burm.f.	LC	No	Annual	Herb

Family	Species	Threat status	SA Endemic	Lifecycle	Growth forms
POACEAE	Cenchrus ciliaris L.	LC	No	Perennial	Graminoid
POACEAE	Anthephora pubescens Nees	LC	No	Perennial	Graminoid
POACEAE	Aristida congesta Roem. & Schult. subsp. congesta	LC	No	Perennial	Graminoid
POACEAE	Aristida diffusa Trin. subsp. burkei (Stapf) Melderis	LC	No	Perennial	Graminoid
POACEAE	Aristida engleri Mez var. engleri	LC	No	Perennial	Graminoid
POACEAE	Aristida vestita Thunb.	LC	No	Perennial	Graminoid
POACEAE	Brachiaria nigropedata (Ficalho & Hiern) Stapf	LC	No	Perennial	Graminoid
POACEAE	Chloris virgata Sw.	LC	No	Annual (occ. perennial)	Graminoid
POACEAE	Cynodon incompletus Nees	LC	No	Perennial	Graminoid
POACEAE	Digitaria eriantha Steud.	LC	No	Perennial	Graminoid
POACEAE	Digitaria glauca Stent var. bechuanica Stent	Not Evaluated	No	[No lifecycle defined]	Graminoid
POACEAE	Digitaria seriata Stapf	LC	No	Perennial	Graminoid
POACEAE	Enneapogon scaber Lehm.	LC	No	Perennial	Graminoid
POACEAE	Enneapogon scoparius Stapf	LC	No	Perennial	Graminoid
POACEAE	Eragrostis curvula (Schrad.) Nees	LC	No	Perennial	Graminoid
POACEAE	Eragrostis echinochloidea Stapf	LC	No	Perennial	Graminoid
POACEAE	Eragrostis lehmanniana Nees var. lehmanniana	LC	No	Perennial	Graminoid
POACEAE	Eragrostis nindensis Ficalho & Hiern	LC	No	Perennial	Graminoid
POACEAE	Eragrostis porosa Nees	LC	No	Annual	Graminoid
POACEAE	Eragrostis trichophora Coss. & Durieu	LC	No	Perennial	Graminoid
POACEAE	Eragrostis x pseud-obtusa De Winter	Not Evaluated	No	Perennial	Graminoid
POACEAE	Melinis nerviglumis (Franch.) Zizka	LC	No	Perennial	Graminoid

Family	Species	Threat status	SA Endemic	Lifecycle	Growth forms
POACEAE	Melinis repens (Willd.) Zizka subsp. repens	LC	No	Annual (occ. perennial)	Graminoid
POACEAE	Oropetium capense Stapf	LC	No	Perennial	Graminoid
POACEAE	Panicum gilvum Launert	LC	No	Annual	Graminoid
POACEAE	Pogonarthria squarrosa (Roem. & Schult.) Pilg.	LC	No	Perennial (occ. annual)	Graminoid
POACEAE	Schmidtia kalahariensis Stent	LC	No	Annual	Graminoid
POACEAE	Schmidtia pappophoroides Steud.	LC	No	Perennial	Graminoid
POACEAE	Stipagrostis uniplumis (Licht.) De Winter var. uniplumis	LC	No	Perennial (occ. annual)	Graminoid
POACEAE	Tragus berteronianus Schult.	LC	No	Annual	Graminoid
POACEAE	Tragus koelerioides Asch.	LC	No	Perennial	Graminoid
POACEAE	Urochloa panicoides P.Beauv.		No	Annual	Graminoid
POLYGALACEAE	Muraltia alopecuroides (L.) DC.	LC	No	Perennial	Dwarf shrub, shrub
PORTULACACEAE	Talinum arnotii Hook.f.	LC	No	Annual (occ. perennial)	Dwarf shrub, succulent
PORTULACACEAE	Talinum caffrum (Thunb.) Eckl. & Zeyh.	LC	No	Annual (occ. perennial)	Dwarf shrub, herb, succulent
PORTULACACEAE	Talinum crispatulum Dinter	LC	No	Annual (occ. perennial)	Dwarf shrub, succulent
RHAMNACEAE	Helinus spartioides (Engl.) Schinz ex Engl.	LC	No	Perennial	Dwarf shrub
RICCIACEAE	Riccia okahandjana S.W.Arnell		No	Perennial	Bryophyte
RUBIACEAE	Anthospermum rigidum Eckl. & Zeyh. subsp. rigidum	LC	No	Perennial	Dwarf shrub
SCROPHULARIACEAE	Jamesbrittenia integerrima (Benth.) Hilliard	LC	No	Perennial	Dwarf shrub, herb
SCROPHULARIACEAE	Selago mixta Hilliard	LC	No	Perennial	Herb
SOLANACEAE	Lycium hirsutum Dunal	LC	No	Perennial	Dwarf shrub, shrub

Family	Species	Threat status	SA Endemic	Lifecycle	Growth forms
THYMELAEACEAE	Gnidia kraussiana Meisn. var. kraussiana	LC	No	Perennial	Dwarf shrub, shrub
THYMELAEACEAE	Gnidia polycephala (C.A.Mey.) Gilg	LC	No	Perennial	Dwarf shrub, herb
URTICACEAE	Laportea peduncularis (Wedd.) Chew subsp. peduncularis	LC	No	Annual (occ. perennial)	Herb
VERBENACEAE	Chascanum pinnatifidum (L.f.) E.Mey. var. pinnatifidum	LC	No	Perennial	Herb
VERBENACEAE	Lantana rugosa Thunb.	LC	No	Perennial	Shrub
VISCACEAE	Viscum rotundifolium L.f.	LC	No	Perennial	Parasite, shrub, succulent

14 APPENDIX C: Recorded positions of red data or protected species

Table 14-1: Coordinates of some recorded ToPS, red data and protected plant species

Note: The numbered labels on Figure 12 (p. 29) correspond to the serial number (S/N) in the first column of Table 14-1.

S/N	SPECIES	Coordinates		No of Specimens
		S	E	
Preferred Site				
1	*Ammocharis coranica*	27° 36' 28.1"S	22° 57' 16.3"E	1
2	*Acacia erioloba*	27° 36' 53.1"S	22° 57' 06.9"E	1
3	*Boscia albitrunca*	27° 36' 50.0"S	22° 57' 09.7"E	2
4	*Boscia albitrunca*	27° 36' 37.7"S	22° 57' 03.0"E	1
5	*Acacia erioloba*	27° 36' 35.8"S	22° 57' 05.8"E	1
6	*Acacia erioloba*	27° 36' 33.6"S	22° 57' 11.9"E	4
	Boscia albitrunca			2
7	*Acacia erioloba*	27° 36' 29.0"S	22° 57' 06.6"E	1
8	*Acacia erioloba*	27° 36' 22.0"S	22° 57' 22.4"E	1
9	*Boscia albitrunca*	27° 37' 04.1"S	22° 57' 10.6"E	1
	Nerine laticoma			±10
10	Boscia albitrunca	27° 37' 02.7"S	22° 57' 17.4"E	1
11	*Acacia erioloba*	27° 37' 00.7"S	22° 57' 11.0"E	1
	Nerine laticoma			±20
	Ammocharis coranica			1
12	*Boscia albitrunca*	27° 37' 06.8"S	22° 57' 48.1"E	1
13	*Boscia albitrunca*	27° 37' 01.3"S	22° 57' 50.6"E	1
	Crinum c.f. *macowanii*			8
14	*Boscia albitrunca*	27° 36' 57.1"S	22° 57' 51.3"E	1
15	*Acacia erioloba*	27° 36' 55.8"S	22° 57' 40.6"E	2
16	*Boscia albitrunca*	27° 36' 41.4"S	22° 57' 46.9"E	1
17	*Boscia albitrunca*	27° 36' 18.9"S	22° 57' 49.8"E	1
18	*Acacia erioloba*	27° 36' 18.1"S	22° 57' 46.7"E	1
19	*Boscia albitrunca*	27° 36' 34.9"S	22° 57' 32.5"E	1
Alternative Site				
20	*Acacia erioloba*	27° 37' 02.3"S	22° 55' 55.6"E	1
21	*Acacia erioloba*	27°37'9.70"S	22°55'52.5"E	1
22	*Acacia erioloba*	27°37' 05.6"S	22°55'49.1"E	1
	Boscia albitrunca			1
23	*Acacia erioloba*	27°37' 02.2"S	22°55'23.7"E	7
24	*Acacia erioloba*	27°37'19.1"S	22°55'54.3"E	2

S/N	SPECIES	Coordinates		No of Specimens
		S	E	
	Boscia albitrunca			1
25	*Boscia albitrunca*	27°36'51.6"S	22°55'50.7"E	1
26	*Acacia erioloba*	27° 36' 57.6"S	22°55'32.7"E	2