ECOLOGICAL FAUNA AND FLORA HABITAT SURVEY

Portion 3 (Portion of Portion 2) of the Farm Vyflings Pan 598, IN Registration Division, Province of the North-West, measuring 428.2660 (four hundred and twenty eight comma two six six zero) hectares, Title Deed No.: 134/2002

Eragrostis pallens (Broom Love Grass) as well as trailing stems of herbaceous *Hermannia tomentosa* and *Tephrosia lupinifolia,* all sand-loving plant species, at the site. *Eragrostis pallens* is a hard grass and in general unpalatable to grazers.
Photo: November 2015, R.F. Terblanche.

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1 INTRODUCTION

An ecological habitat survey was required for a solar power plant development at Portion 3 (Portion of Portion 2) of the Farm Vyflings Pan 598, IN Registration Division, Province of the North-West, measuring 428.2660 (four hundred and twenty eight comma two six six zero) hectares, Title Deed No.: 134/2002, 27 km west-northwest of Vryburg in the North West Province (elsewhere referred to as the site). The survey focused on the possibility that threatened fauna or flora known to occur in North West Province are likely to occur within the proposed development. Species of known high conservation priority that do not qualify for threatened status also received attention in the survey.

1.1 OBJECTIVES OF THE HABITAT STUDY

The objectives of the habitat study are to provide:

- A detailed fauna and flora habitat survey;
- A detailed habitat survey of possible threatened or localised plant species, vertebrates and invertebrates;
- Recording of possible host plants or foodplants of fauna such as butterflies.
- Evaluate the conservation importance and significance of the site with special emphasis on the current status of threatened species;
- Literature investigation of possible species that may occur on site;
- Identification of potential ecological impacts on fauna and flora that could occur as a result of the development; and
- Make recommendations to reduce or minimise impacts, should the development be approved.

1.2 SCOPE OF STUDY

- Surveys to investigate key elements of habitats on the site, relevant to the conservation of fauna and flora.
- Recording of any sightings and/or evidence of existing fauna and flora.
- The selective and careful collecting of voucher specimens of invertebrates where deemed necessary.
- An evaluation of the conservation importance and significance of the site with special emphasis on the current status of threatened species.
- Recording of possible host plants or foodplants of fauna such as butterflies.
- Literature investigation of possible species that might occur on site.
- Integration of the literature investigation and field observations to identify potential ecological impacts that could occur as a result of the development.
- Integration of literature investigation and field observations to make recommendations to reduce or minimise impacts, should the development be approved.

2 STUDY AREA

The study area is 24 km west-northwest of Vryburg in the North West Province. The site is situated at the Savanna Biome which is represented by the Ghaap Plateau Vaalbosveld vegetation type (Mucina & Rutherford 2006). A brief overview of SVk 7, the Ghaap Plateau Vaalbosveld vegetation type in which the site is located, follows:

Distribution: In South Africa the Ghaap Plateau Vaalbosveld is found in the Northern Cape and North-West Provinces: Flat plateau from around Campbell in the south, east of Danielskuil through Reivilo to around Vryburg in the north. Altitude at the Ghaap Plateau Vaalbosveld is 1100 – 1500 m.

Vegetation and landscape features: Flat plateau with well-developed shrub layer with *Tarchonanthus camphoratus* and *Acacia karroo.* Open tree layer has *Olea europaea* subsp. *africana*, *Acacia tortilis*, *Ziziphus mucronata* and *Searsia [Rhus] lancea*. *Olea europaea* subsp. *africana* is more important in the southern parts of the unit, while *Acacia tortilis, Acacia hebeclada* and *Acacia mellifera* are more important in the north and part of the west of the unit. Much of the south-central part of this unit has remarkably low cover of *Acacia* species for an arid savanna and is dominated by the nonthorny *Tarchonanthus camphoratus*, *Searsia lancea*, and *Olea europaea* subsp. *africana* (Mucina & Rutherford 2006).

Geology and soils: Surface limestone of Tertiary to Recent age, and dolomite and chert of the Campbell Group (Griqualand West Supergroup, Vaalian Erathem) support shallow soils (0.1-0.25 m) of Mispah and Hutton soil forms. Land types mainly Fc with some Ae and Ag (Mucina & Rutherford, 2006).

Climate: Climate is characterized by summer and autumn rainfall and very dry winters. Mean annual precipitation from about 300 mm in the southwest to about 500 mm in the northeast. Frost is frequent to very frequent in winter (Mucina & Rutherford 2006).

Important taxa of the Ghaap Plateau Vaalbosveld listed by Mucina & Rutherford (2006): Tall Tree: *Acacia erioloba.* Small Trees: *Acacia mellifera* subsp. *detinens, Searsia lancea, Acacia karroo, Acacia tortilis* subsp. *heteracantha*, *Boscia albitrunca.* Tall Shrubs: *Olea europaea* subsp. *africana, Rhigozum trichotomum, Tarchonanthus camphoratus, Ziziphus mucronata, Diospyros*

pallens, *Ehretia rigida* subsp. *rigida* (this species complex has been revised and the *Ehretia alba* is the species that occurs at the vegetation type, R.F. Terblanche pers. obs.), *Euclea crispa* subsp. *ovata, Grewia flava, Gymnosporia buxifolia, Lessertia frutescens, Searsia tridactyla.* Low Shrubs: *Acacia hebeclada* subsp. *hebeclada, Aptosimum procumbens, Chrysocoma ciliata, Helichrysum zeyheri, Hermannia comosa, Lantana rugosa, Leucas capensis, Melolobium microphyllum, Peliostomum leucorrhizum, Pentzia globosa, Pentzia viridis, Zygophyllum pubescens.* Succulent Shrubs: *Hertia pallens, Lycium cinereum.* Semi-parasitic Shrub: *Thesium hystrix*. Woody Climber: *Asparagus africanus*. Graminoids: *Anthephora pubescens, Cenchrus ciliaris, Digitaria eriantha* subsp. *eriantha, Enneapogon scoparius, Eragrostis lehmanniana, Schmidtia pappophoroides, Themeda triandra, Aristida adscensionis, Aristida congesta, Aristida diffusa, Cymbopogon pospischilii, Enneapogon cenchroides, Enneapogon desvauxii, Eragrostis echinochloidea, Eragrostis obtusa, Eragrostis rigidior, Eragrostis superba, Fingerhutia africana, Heteropogon contortus, Sporobolus fimbriatus, Stipagrostis uniplumis, Tragus racemosus.* Herbs: *Barleria macrostegia, Geigeria filifolia, Geigeria ornativa, Gisekia africana, Helichrysum cerastoides, Heliotropium ciliatum, Hermbstaedtia odorata, Hibiscus marlothianus, Hibiscus pusillus, Jamesbrittenia aurantiaca, Limeum fenestratum, Lippia scaberrima, Selago densiflora, Vahlia capensis* subsp. *vulgaris.* Succulent herb: *Aloe grandidentata*.

Note: Though many of the above plant species occurs at the site, not all of them necessarily occur at the site.

Ghaap Plateau Vaalbosveld is <u>not</u> listed as threatened according to the National List of Threatened Ecosystems (2011).

3 METHODS

A desktop study comprised not only an initial phase, but also it was used throughout the study to accommodate and integrate all the data that become available during the field observations.

Surveys of a number of study areas in the vicinity of Vryburg, including the site, were conducted from 10 – 16 November 2015, December 2015 and 23 - 31 January 2016 to note key elements of habitats on the site, relevant to the conservation of fauna and flora. Notes and experience from earlier surveys at the larger study area of the Taung-Vryburg area by R.F. Terblanche that had taken place in July 2011, November 2011, January 2012, February 2012, August 2013, December 2013, January 2014 and November 2014 were also taken into account where applicable. The main purpose of the site visits was ultimately to serve as habitat surveys that concentrated on the possible presence or not of threatened species and other species of high conservation priority.

The following sections highlight the materials and methods applicable to different aspects that were observed.

3.1 HABITAT CHARACTERISTICS AND VEGETATION

The habitat was investigated by noting habitat structure (rockiness, slope, plant structure/ physiognymy) as well as floristic composition. Voucher specimens of plant species were only taken where the taxonomy was in doubt and where the plant specimens were of significant relevance for invertebrate conservation. In this case no plant specimens were needed to be collected as voucher specimens or to be send to a herbarium for identification. A wealth of guides and detailed works of plant identifications, ecology and conservation is fortunately available and very useful. Field guides, biogeographic works, species lists, diagnostic outlines, conservation statuses and detail on specific plant groups were sourced from Court (2010), Germishuizen (2003), Germishuizen, Meyer & Steenkamp (2006), Goldblatt (1986), Goldblatt & Manning (1998), Jacobsen (1983), Manning (2003), Manning (2009), McMurtry, Grobler, Grobler & Burns (2008), Pooley (1998), Retief & Herman (1997), Smit (2008), Van Ginkel, Glen, Gordon-Gray, Cilliers, Muasya & Van Deventer (2011), Van Jaarsveld (2006), Van Oudtshoorn (1999), Van Wyk (2000), Van Wyk & Smith (2001), Van Wyk & Smith (2003), Van Wyk & Malan (1998) and Van Wyk & Van Wyk (2013). Lists of species, species names and the conservation status of species were mainly

sourced from Raimondo, von Staden, Victor, Helme, Turner, Kamundi & Manyama (2009) and updated versions of red lists and species from the Threatened Species Programme of SANBI and the Red List of South African Plants (sanbi.org.za).

Indications of abundance and distribution of *Vachellia erioloba* (= *Acacia erioloba*), the Camel Thorn. For areas with where Camel Thorn trees are sparse direct count and positioning of all the individual trees are conducted at the proposed footprint by carefully walking in zigzag fashion through the site. For areas where direct counting become impractical within time and cost limits, counts of individual trees within 50 m x 50 m plots are conducted at zones where higher number of individuals is conspicuous. *Vachellia erioloba* trees sometimes occur in clumps with a number of tree trunks in close proximation which makes the number of individuals difficult to count if the separation of individuals is concerned. As far as possible it was ascertained whether two trunks in close proximation represent different individuals (often the case) or the same individual (when two or more trunks are likely to be part of same tree). Height classes of the trees are taken during the counts.

3.2 MAMMALS

Mammals were noted as sight records by day. For the identification of species and observation of diagnostic characteristics Smithers (1986), Skinner & Chimimba (2005), Cillié, Oberprieler and Joubert (2004) and Apps (2000) are consulted. Sites have been walked, covering as many habitats as possible. Signs of the presence of mammal species, such as calls of animals, animal tracks (spoor), burrows, runways, nests and faeces were recorded. Walker (1996), Stuart & Stuart (2000) and Liebenberg (1990) were consulted for additional information and for the identification of tracks and signs. . Because of the type of threatened mammals that are assessed in the local area such as the blackfooted cat and golden moles or rough-haired golden moles which are not to be trapped in normal way, the poor trapping records of species in question such as the White-tailed Mouse as well as the similarity of terrestrial habitats and lack of unique habitats at the sites, trapping was not done since it was not deemed necessary in the case of this study. The focus has been on signs and surveying habitat characteristics to note potential occurrences of mammals of particular conservation concern. Many mammals can be identified from field sightings but, with a few exceptions bats, rodents and shrews can only be reliably identified in the hand, and even then some species needs examination of skulls, or even chromosomes (Apps, 2000).

3.3 BIRDS

A specific avifaunal study has been conducted for the assessment of birds at the site (see avifaunal study).

3.4 REPTILES

Reptiles were noted as sight records in the field. Binoculars (10x30) can also be used for identifying reptiles of which some are wary. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques, Branch (1998), Marais (2004), Alexander & Marais (2007) and Cillié, Oberprieler and Joubert (2004) were followed. The Atlas and Red List of Reptiles of South Africa, Lesotho and South Africa (Bates, Branch, Bauer, Burger, Marais, Alexander & de Villiers, 2014) has been used as the main source to compile the list for assessment. Sites were walked, covering as many habitats as possible. Smaller reptiles are sometimes collected for identification, but this practice was not necessary in the case of this study. Habitat characteristics are surveyed to note potential occurrences of reptiles.

3.5 AMPHIBIANS

Frogs and toads are noted as sight records in the field or by their calls. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques Carruthers (2001), Du Preez (1996), Conradie, Du Preez, Smith & Weldon (2006) and the recent complete guide by Du Preez & Carruthers (2009) are consulted. CD's with frog calls by Carruthers (2001) and Du Preez & Carruthers (2009) are used to identify species by their calls when applicable. Sites are walked, covering as many habitats as possible. Smaller frogs are often collected by pitfall traps put out for epigeal invertebrates (on the soil), but this practice falls beyond the scope of this survey. Habitat characteristics are also surveyed to note potential occurrences of amphibians.

3.6 BUTTERFLIES

Butterflies were noted as sight records or voucher specimens. Voucher specimens are mostly taken of those species of which the taxa warrant collecting due to taxonomic difficulties or in the cases where species can look similar in the veldt. Many butterflies use only one species or a

limited number of plant species as host plants for their larvae. Myrmecophilous (ant-loving) butterflies such as the *Aloeides*, *Chrysoritis*, *Erikssonia, Lepidochrysops* and *Orachrysops* species (Lepidoptera: Lycaenidae), which live in association with a specific ant species, require a unique ecosystem for their survival (Deutschländer & Bredenkamp, 1999; Terblanche, Morgenthal & Cilliers, 2003; Edge, Cilliers & Terblanche, 2008; Gardiner & Terblanche, 2010). Known food plants of butterflies were therefore also recorded. After the visits to the site and the identification of the butterflies found there, a list was also compiled of butterflies that will most probably be found in the area in all the other seasons because of suitable habitat. The emphasis of this study remains a habitat survey that focuses on the likelihood of occurrence of threatened, near threatened or rare butterfly species.

3.7 FRUIT CHAFER BEETLES

Different habitat types in the areas were explored for any sensitive or special fruit chafer species. Selection of methods to find fruit chafers depends on the different types of habitat present and the species that may be present. Fruit bait traps would probably not be successful for capturing *Ichnestoma* species in a grassland patch (Holm & Marais 1992). Possible chafer beetles of high conservation priority were noted as sight records accompanied by the collecting of voucher specimens with grass nets or containers where deemed necessary.

3.8 ROCK SCORPIONS

Relatively homogenous habitat / vegetation areas were identified and explored to identify any sensitive or special species. Selected stones that were lifted to search for Arachnids were put back very carefully resulting in the least disturbance possible. All the above actions were accompanied by the least disturbance possible.

3.9 LIMITATIONS

For each site visited, it should be emphasized that surveys can by no means result in an exhaustive list of the plants and animals present on the site, because of the time constraint. There are many invertebrate groups with huge taxonomic and biogeographic impediments which further add to limitations of present surveys.

The on site survey was conducted during November 2015, December 2016 and January 2016 which fall within an optimal time of the season to find sensitive plant and animal species of high conservation priority. Weather conditions during the surveys were favourable for recording fauna and flora. Notes and experience from earlier surveys at the Taung-Vryburg area by R.F. Terblanche that had taken place on July 2011, November 2011, January 2012, February 2012, August 2013, December 2013, January 2014 and November 2014 were also taken into account where applicable, these cover a vast range of conditions including optimal conditions for surveys. The focus of the present survey remains a habitat survey that concentrates on the possibility that species of particular conservation priority occur on the site or not. It is unlikely that any more visits would reveal information that would change the outcome of this assessment both in terms of ecosystems of special conservation concern or suitable habitats of species of particular conservation concern. Visits that were conducted therefore appear to be sufficient to address the objectives of this study.

4 RESULTS

4.1 HABITAT AND VEGETATION CHARACTERISTICS

Table 4.1 Outline of main landscape and habitat characteristics of the site.

HABITAT FEATURE	DESCRIPTION
Topography	The site proposed for the developments is on gentle to very gentle slopes (flat plateau, plain).
Rockiness	No rocky ridges are present at the proposed footprint.
Presence of wetlands	No wetlands are found at the proposed footprint.
Vegetation	Vegetation at much of the proposed footprint comprises extensive grassy patches with some trees dotted in the landscape. *Eragrostis pallens* is visibly one of the dominant grass species in extensive sandy soils at the site. A number of indigenous shrubs and trees occur in the landscape often dispersed though clumped in some areas. Indigenous tree species include *Vachellia erioloba* (Camel Thorn), *Vachellia tortilis* subsp. *heteracantha* (Umbrellla Thorn), *Diospyros lycioides* subsp. *lycioides* (Karoo Bluebush), *Tarchonanthus camphoratus* (Camphor Bush), *Grewia flava* (Wild Raisin), *Vachellia karroo* (Sweet Thorn), *Ziziphus mucronata* (Buffalothorn), *Vachellia hebeclada* subsp. *hebeclada* (Candlepod Thorn), *Senegalia mellifera* subsp. *detinens* (Black Thorn) and *Terminalia sericea* (Silver Clusterleaf). Indigenous grass species include *Eragrostis pallens, Eragrostis lehmanniana, Aristida adscensionis* and *Enneapogon cenchroides.* Indigenous herbaceous plant species are often those with trailing stems on the sand such as *Hermannia tomentosa, Tephrosia lupinifolia, Senna italica* subsp. *arachoides* and *Melhania prostrata.*
Signs of disturbances	Fairly natural vegetation with visible high cover of indigenous species but with a number of bare areas is present at the site.
Connectivity of natural vegetation in the site and between the site and surrounding areas	The footprint proposed for the proposed development is not part of a corridor of particular conservation importance.

Photo 1 Extensive grassy patch where *Eragrostis pallens* (Broom Love Grass) is visibly a dominant grass species. Thorn tree in picture is *Vachellia erioloba* (Camel Thorn tree).
Photo: November 2015, R.F. Terblanche.

Photo 2 Caterpillars of *Gonometa postica* (African Wild Silk Moth) at *Acacia erioloba* (Camel Thorn tree) at the proposed footprint.
Photo: November 2015, R. F. Terblanche.

Photo 3 *Eragrostis pallens* (Broom Love Grass) as well as trailing stems of herbaceous *Hermannia tomentosa* and *Tephrosia lupinifolia,* all sand-loving plant species, at the site. *Eragrostis pallens* is a hard grass and in general unpalatable to grazers.

Photo: November 2015, R.F. Terblanche.

Photo 4 *Terminalia sericea* (Silver Clusterleaf) at the proposed footprint.
Photo: November 2015, R.F. Terblanche.

Photo 5 *Tephrosia lupinifolia* at the site.
Photo: November 2015, R.F. Terblanche.

4.2 ASSESSMENT OF PLANT SPECIES OF PARTICULAR CONSERVATION PRIORITY

4.2.1 Plant species of particular conservation concern according to the red list of plants

Table 4.2 Threatened plant species of the North West Province which are listed in the **Critically Endangered** category. The list here follows the most recent updated red list of South African plant species (Raimondo *et al*. 2009). No = Plant species is unlikely to be a resident at the site; Yes = Plant species is a resident at the site.

Species	**Status:** Global status or national status indicated	**Resident at the site**
Brachystelma canum	Critically Endangered	No
Brachystelma gracillimum	Critically Endangered	No

Table 4.3 Threatened plant species of the North West Province which are listed in the **Endangered** category. The list here follows the most recent updated red list of South African plant species (Raimondo *et al*. 2009). No = Plant species is unlikely to be a resident at the site; Yes = Plant species is a resident at the site.

Species	**Status:** Global status or national status indicated	**Resident at the site**
Aloe peglerae	Endangered	No
Brachystelma discoideum	Endangered	No

Table 4.4 Threatened plant species of the North West Province which are listed in the **Vulnerable** category. The list here follows the most recent updated red list of South African plant species (Raimondo *et al*. 2009). No = Plant species is unlikely to be a resident at the site; Yes = Plant species is a resident at the site.

Species	**Status:** Global status or national status indicated	**Resident at the site**
Brachycorythis conica subsp. ***transvaalensis***	Vulnerable	No
Brachystelma incanum	Vulnerable	No
Ceropegia decidua subsp. ***pretoriensis***	Vulnerable	No
Ceropegia stentiae	Vulnerable	No
Ledebouria atrobrunnea	Vulnerable	No
Marsilea farinosa	Vulnerable	No
Melolobium subspicatum	Vulnerable	No
Prunus africana	Vulnerable	No
Rennera stellata	Vulnerable	No
Searsia maricoan	Vulnerable	No

Table 4.5 Near Threatened plant species of the North West Province. The list here follows the most recent updated red list of South African plant species (Raimondo *et al*. 2009). No = Plant species is unlikely to be a resident at the site; Yes = Plant species is a resident at the site.

Species	**Status:** Global status or national status indicated	**Resident at the site**
Adromischus umbraticola subsp**.** ***umbraticola***	Near Threatened	No
Ceropegia turricula	Near Threatened	No
Cineraria austrotransvaalensis	Near Threatened	No
Cleome conrathii	Near Threatened	No
Delosperma leendertziae	Near Threatened	No
Drimia sanguinea	Near Threatened	No
Elaeodendron transvaalense	Near Threatened	No
Kniphofia typhoides	Near Threatened	No
Lithops leslei subsp. ***leslei***	Near Threatened	No
Nerine gracilis	Near Threatened	No
Sporobolus oxyphyllus	Near Threatened	No
Stenostelma umbelluliferum	Near Threatened	No

Table 4.6 Plant species of the North West Province which are not threatened and not near threatened but which are of particular conservation concern and listed in the **Critically Rare** category (Raimondo *et al.* 2009). The list here follows the most recent red list of South African plant species (Raimondo *et al*. 2009). No = Plant species is unlikely to be a resident at the site; Yes = Plant species is a resident at the site.

Species	Conservation status	Resident at the site
Gladiolus filiformis	Critically Rare	No

Table 4.7 Plant species of the North West Province which are not threatened and not near threatened but of which are of particular conservation concern and listed in the **Rare** category (Raimondo *et al*. 2009). The list here follows the most recent red list of South African plant species (Raimondo *et al*. 2009). No = Plant species is unlikely to be a resident at the site; Yes = Plant species is a resident at the site.

Species	Status: Global status or national status indicated	Resident at the site
Brachystelma dimorphum susbp. ***gratum***	Rare	No
Ceropegia insignis	Rare	No
Frithia pulchra	Rare	No
Gnaphalium nelsonii	Rare	No
Habenaria culveri	Rare	No

Table 4.8 Plant species of the North West Province which are not threatened and not near threatened but which are of particular conservation concern and listed in the **Declining** category (Raimondo *et al.* 2009). The list here follows the most recent red list of South African plant species (Raimondo *et al*. 2009). No = Plant species is unlikely to be a resident at the site; Yes = Plant species is a resident at the site.

Species	Status: Global status or national status indicated	Resident at the site
Boophone disticha	Declining	No
Crinum bulbispermum	Declining	No
Crinum macowanii	Declining	No
Drimia altissima	Declining	No
Eucomis autumnalis	Declining	No
Gunnera perpensa	Declining	No
Hypoxis hemerocallidea	Declining	No
Ilex mitis	Declining	No
Pelargonium sidoides	Declining	No
Vachellia erioloba (= *Acacia erioloba*)	**Declining**	**Yes**

4.2.2 Plant species of particular conservation concern: protected species

Table 4.9 Tree species of the North West Province which are listed as **Protected Species** under the National Forests Act No. 84 of 1998, Section 51(1)**.** No = Plant species is not a resident on the site; Yes = Plant species is a resident at the site.

Species	Conservation status	Resident at the site
Boscia albitrunca (Shepherd's Tree)	Protected	No
Sclerocarya birrea (Marula)	Protected	No
Vachellia erioloba **(Camel Thorn Tree)**	**Protected**	**Yes**

4.3 ASSESSMENT OF VERTEBRATE SPECIES OF PARTICULAR HIGH CONSERVATION PRIORITY

4.3.1 Mammals of particular high conservation priority

Table 4.10 Threatened mammal species of the North West Province. Literature sources: Friedman & Daly, (2004), Skinner & Chimimba (2005), Wilson & Reeder (2005). With mammal species which normally needs a large range their residential status does not implicate that they are exclusively dependent on the site or use the site as important shelter or for reproduction. No = Not recorded at site/ Unlikely to be resident at the site. Yes: Recorded at the site/ Likely to be resident at the site.

Species	Threatened Status	Site is part of range	Recorded at site during survey	Likely to be found based on habitat assessment
Chrysospalax villosus Rough-haired golden mole	Vulnerable	No	No	No
Cloeotis percivali Short-eared Trident Bat	Vulnerable/ Near-threatened	No	No	No
Diceros bicornis Black rhinoceros	Critically Endangered	No	No	No
Lycaon pictus African wild dog	Endangered	No	No	No
Loxodonta africana	Vulnerable	No	No	No

African elephant				
Mystromys albicaudatus White-tailed mouse	Endangered	Yes	No	No
Neamblysomus julianae Juliana's Golden Mole	Critically Endangered	No	No	No
Panthera leo Lion	Vulnerable	No	No	No
Rhinolophus blasii Blasi's Horseshoe Bat	Vulnerable	No	No	No

Table 4.11 Near threatened mammal species known to occur in the North West Province. Literature sources: Skinner & Chimimba (2005). No = Not recorded at site/ unlikely to be resident at the site. Yes: Recorded at the site/ Likely to be resident at the site.

Species	Threatened Status	Site is part of range	Recorded at site during survey	Likely to be found based on habitat assessment
Ceratotherium simum White Rhinoceros	Near threatened	No	No	No
Manis temminckii Ground Pangolin	Near threatened	No	No	No

Table 4.12 Data deficient (or uncertain) mammal species of the North West Province. Literature sources: Skinner & Chimimba (2005). No = Not recorded at site/ unlikely to be resident at the site. Yes: Recorded at the site/ Likely to be resident at the site.

Species	Threatened Status	Recorded at site during survey	Likely be a resident at the site
Myosorex varius Forest shrew	Uncertain	No	No

4.3.2 Birds of particular high conservation priority

See separate avifaunal report.

4.3.3 Reptiles of particular high conservation priority

The following tables list possible presence or absence of threatened reptile or near threatened reptile species in the study area. The Atlas and Red List of Reptiles of South Africa, Lesotho and South Africa (Bates, Branch, Bauer, Burger, Marais, Alexander & de Villiers, 2014) has been used as the main source to compile the list for assessment.

Table 4.13 Threatened reptile species in North West Province. Main Source: (Bates, Branch, Bauer, Burger, Marais, Alexander & de Villiers, 2014). No = Reptile species is not a resident on the site; Yes = Reptile species is found to be resident on the site.

Species	Threatened Status	Resident at site	Recorded at site during survey	Likely to be found based on habitat assessment
Crocodylus niloticus Nile Crocodile	Vulnerable	No	No	No

Table 4.14 Near threatened reptile species in North West Province. Main Source: Bates, Branch, Bauer, Burger, Marais, Alexander & de Villiers (2014). Though *Homoroselaps dorsalis* has not yet been recorded from the North West Province, its presence in some areas or the Province is anticipated. No = Reptile species is not a resident on the site; Yes = Reptile species is found to be resident on the site.

Species	Threatened Status	Resident at site	Recorded at site during survey	Likely to be found based on habitat assessment
Homoroselaps dorsalis Striped Harlequin Snake	Near threatened	No	No	No

4.3.4 Amphibian species of particular high conservation priority

Table 4.15 Near threatened amphibian species in North West Province. No = Amphibian species is not a resident on the site; Yes = Amphibian species is found to be resident on the site.

Species	Threatened Status	Resident at site	Recorded at site during survey	Likely to be found based on habitat assessment
Pyxicephalus adspersus Giant Bullfrog	Near threatened (Currently Least Concern)	No	No	No

4.4 ASSESSMENT OF INVERTEBRATE SPECIES OF PARTICULAR HIGH CONSERVATION PRIORITY

4.4.1 Butterflies of particular conservation priority

Table 4.16 Threatened butterfly species in North West Province, northeastern parts of Northern Cape and Gauteng Province. Sources: Henning, Terblanche & Ball (2009), Mecenero *et al*. (2013). Invertebrates such as threatened butterfly species are often very habitat specific and residential status imply a unique ecosystem that is at stake.

Species	Threatened Status	Recorded at site during survey	Residential status at the site: Yes confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
Aloeides dentatis dentatis Roodepoort Copper	**Endangered**	No	**Highly unlikely**
Anthene lindae Kalahari Hairtail	**Vulnerable**	No	**Unlikely**
Chrysoritis aureus Golden Copper	**Endangered**	No	**Highly unlikely**
Lepidochrysops praeterita Highveld Blue	**Endangered**	No	**Highly unlikely**
Orachrysops mijburghi Mijburgh's Blue	**Endangered**	No	**Highly unlikely**

Table 4.17 Butterfly species of the North West Province and Gauteng Province that are not threatened and not near threatened but of which are of particular conservation concern and listed in the **Rare** category (Mecenero *et al.*, 2013). No = Butterfly species is unlikely to be a resident at the study area; Yes = Butterfly species is a resident at the study area.

Species	Threatened Status	Recorded at site during survey	Residential status at the site: Yes confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
Colotis celimene amina Lilac Tip	**Rare (Low density)**	No	**Highly unlikely**
Lepidochrysops procera Savanna Blue	**Rare (Habitat specialist)**	No	**Highly unlikely**
Metisella meninx Marsh Sylph	**Rare (Habitat specialist)**	No	**Highly unlikely**
Platylesches dolomitica Hilltop Hopper	**Rare (low density)**	No	**Highly unlikely**

4.4.2 Beetles of particular conservation priority

Table 4.18 Fruit chafer species (Coleoptera: Scarabaeidae: Cetoninae) in the Gauteng Province and North-West Province which are of known high conservation priority.

Species	Threatened Status	Recorded at site during survey	Likely to be resident based on habitat assessment
Ichnestoma stobbiai	Uncertain	No	**No**
Trichocephala brincki	Uncertain	No	**No**

4.4.3 Scorpion species of particular conservation priority

Table 4.19 Rock scorpion species (Scorpiones: Ischnuridae) species that are of known high conservation priority in the Gauteng Province and North-West Province.

Species	Threatened Status	Recorded at site during survey	Likely to be resident at site based on habitat assessment

Hadogenes gracilis	Uncertain	No	**No**
Hadogenes gunningi	Uncertain	No	**No**

ASSESSMENT OF CAMEL THORN TREES AT THE PROPOSED FOOTPRINT

During the initial surveys it was found that *Vachellia erioloba* (= *Acacia erioloba*), Camel Thorn trees, are present at the site. Additional surveys were conducted to indicate the distribution and abundance of Camel Thorn trees at the site.

A high number of *Vachellia erioloba* is present at the south western areas of the proposed footprint.

Table 4.20 Indication of attributes of population of Camel Thorn tree, *Vachellia erioloba* (= *Acacia erioloba*) at the proposed footprint.

Part of proposed footprint	**Approximate estimation of number of *Vachellia erioloba* taller than 2 m, per hectare at the conspicuour high density zones at proposed footprint.**	**Likelihood of presence of individuals taller than 10 m**	**Notes on individuals less than 2**	**Presence or absence of particular old and remarkable Camel Thorn trees at proposed footprint**	**Presence or absence of Camel Thorn Forest of note**
Southwestern parts of the site	Up to 56/ ha. Numbers at four sample plots of 50 m x 50 m each: 15, 16, 13,12.	Highly unlikely	Many have been found, up to 18 per 50 m x 50 m sample plot. High recruitment in some areas. .	No particularly old or remarkable trees found at proposed footprint.	Absent.

4.6 ASSESSMENT OF ALIEN INVASIVE SPECIES WITH PARTICULAR REFERENCE TO *PROSOPIS GLANDULOSA* (HONEY MESQUITE)

Exotic weeds at the site include *Agremone ochroleuca* (White-flowered Mexican Poppy), *Chenopodium album* (Goosefoot), *Opuntia ficus-indica* (Prickly Pear) and *Schkuhria pinnata* (Dwarf Marigold). Though these exotic weeds easily spring up where disturbances such as overgrazing, scraping of an area and diggings are found, at the present study area no severe infestations such as could often be observed in larger urban areas and surrounds in the North West and Gauteng Provinces, are found.

During the initial surveys it was found that *Prosopis glandulosa* (Honey Mesquite tree) thickets occur in some parts of the Naledi Local Municipality and particular consideration has been given to this highly invasive tree species at and near the proposed footprint. *Prosopis glandulosa* appears to be absent at the site (or if present very few).

Table 4.21 Summary of assessment of the highly alien invasive *Prosopis glandulosa* (Honey Mesquite tree) at the proposed footprint.

Part of the proposed footprint	**Approximate estimation of number of *Prosopis glandulosa* taller than 2 m**	**Notes on *Prosopis glandulosa* individuals of height less than 2 m**	**Presence or absence of severe invasion by *Prosopis glandulosa*.**
Entire area of proposed footprint	Absent (or if present very few)	Absent (or if present very few)	Absent. No trees (or very few if present at all). Therefore no invasion at the proposed footprint.

5 DISCUSSION

5.1 HABITAT AND VEGETATION CHARACTERISTICS

An outline of the habitat and vegetation characteristics is given in Table 4.1.

5.2 PLANT SPECIES

Extinct, threatened, near threatened and other plant species of high conservation priority in North West Province are listed in Tables 4.2 – 4.8. Protected tree species are listed in Table 4.9. The presence or not of all the species listed in the tables were investigated during the survey. None of the threatened and near-threatened plant species are likely to occur on the site. No other plant species of particular conservation concern is likely to be present at the proposed footprint apart from *Vachellia erioloba* that occurs at the site. *Vachellia erioloba* is a Protected Tree species. Protected tree species under the National Forests Act No. 84 of 1998 are listed in Table 4.9. In terms of a part of section 51(1) of Act No. 84 of 1998, no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree, except under a license granted by the Minister. See section 5.5 for a more detailed discussion of the Camel Thorn tree at the proposed footprint.

5.3 VERTEBRATES

5.3.1 Mammals

Table 4.10, Table 4.11 and Table 4.12 list the possible presence or absence of threatened mammal species, near threatened mammal species and mammal species of which the status is uncertain, respectively, at the site. Literature sources that were used are Friedman & Daly (2004), Skinner & Chimimba (2005) and Wilson & Reeder (2005). Since the site falls outside reserves, threatened species such as the black rhinoceros (*Diceros bicornis*) and the African wild dog (*Lycaon pictus*) are obviously not present. No smaller mammals of particular high conservation significance are likely to be found on the site as well.

5.3.2 Birds

See separate avifaunal report for assessment of birds.

5.3.3 Reptiles

Table 4.13 and Table 4.14 list the possible presence or absence of threatened and near threatened reptile species on the site. The Southern African Reptile Conservation Assessment (SARCA) was launched in May 2005 (Branch, Tolley, Cunningham, Bauer, Alexander, Harrison, Turner & Bates, 2006). Its primary aim is to produce a conservation assessment for reptiles of South Africa, Lesotho and Swaziland within a four year period, ending 2009 (Branch *et al*., 2006). Therefore a full up-dated conservation assessment of reptiles, taking into account the recent IUCN (2001) criteria, will only be available in the near future. While the conservation statuses of reptile species are under revision Alexander & Marais (2007) as well as Tolley & Burger 2007) give useful indications of possible red listings in the near future. There appears to be no threat to any reptile species of particular high conservation importance if the site is developed.

5.3.4 Amphibians

No frog species that occur in the North West are threatened as threatened species (vulnerable, endangered or critically endangered) according to Minter, Burger, Harrison, Braack, Bishop and Kloepfer (2004) as well as Du Preez & Carruthers (2009). Table 4.15 lists *Pyxicephalus adspersus* (Giant Bullfrog) as near threatened (Minter *et al*., 2004; Du Preez & Carruthers, 2009). There is no suitable habitat for *Pyxicephalus adspersus* (Giant Bullfrog) at the site. There appears to be no threat to any amphibian species of particular high conservation importance if the site is developed.

5.4 INVERTEBRATES

5.4.1 Butterflies

Studies about the vegetation and habitat of threatened butterfly species in South Africa showed that ecosystems with a unique combination of features are selected by these often localised threatened butterfly species (Deutschländer and Bredenkamp 1999; Edge 2002, 2005; Terblanche, Morgenthal & Cilliers 2003; Lubke, Hoare, Victor & Ketelaar 2003; Edge, Cilliers & Terblanche, 2008). Threatened butterfly species in South Africa can then be regarded as bio-indicators of rare ecosystems.

Four species of butterfly in Gauteng Province and North West Province combined are listed as threatened in the recent butterfly conservation assessment of South Africa (Mecenero *et al*., 2013). The expected presence or not of these threatened butterfly species as well as species of high conservation priority that are not threatened, at the site (Table 4.16 and Table 4.17) follows.

5.4.1.1 Assessment of threatened butterfly species

***Aloeides dentatis dentatis (*Roodepoort Copper)**

The proposed global red list status for *Aloeides dentatis dentatis* according to the most recent IUCN criteria and categories is Endangered (Mecenero *et al.,* 2013). *Aloeides dentatis dentatis* colonies are found where one of its host plants *Hermannia depressa* or *Lotononis eriantha* is present. Larval ant association is with *Lepisiota capensis* (S.F. Henning 1983; S.F. Henning & G.A. Henning 1989). The habitat requirements of *Aloeides dentatis dentatis* are complex and not fully understood yet. See Deutschländer and Bredenkamp (1999) for the description of the vegetation and habitat characteristics of one locality of *Aloeides dentatis* subsp. *dentatis* at Ruimsig, Roodepoort, Gauteng Province. There is not an ideal habitat of *Aloeides dentatis* subsp. *dentatis* on the site and it is unlikely that the butterfly is present at the site.

***Anthene lindae* (Kalahari Hairtail)**

Small but distinct butterfly species discovered by R.F. Terblanche in 1990 at the present Witsand Nature Reserve in the Northern Cape. Recent red listing and exinction risk assessments list *Anthene lindae* as Vulnerable (Henning, Terblanche & Ball, 2009; Mecenero *et al.*, 2013). Because *Acacia erioloba* occurs on the site, the presence or not of *Anthene lindae* (Kalahari

hairtail butterfly, Vulnerable) has bearing. The butterfly is intimately associated with *Acacia erioloba* which may prove to be the larval food plant (Terblanche, 1994). Present observations by V. Jessnitz confirmed egg-laying of females of *Anthene lindae* on *Vachellia erioloba* (unpublished). However, all the localities for this butterfly species have been found on what appears to be a unique catchment area and basins with particular high water tables on the western side of the Langberg mountain chain, Northern Cape Province (Terblanche & Taylor, 2000). According to Henning *et al.* (2009) *Anthene lindae* has up to date only been found at an ecotone between Gordonia Plains Shrubland and Olifantshoek Plains Thornveld (Mucina & Rutherford, 2006). *Anthene lindae* is not found everywhere where *Vachellia erioloba* trees are present. Based on the present knowledge and the surveys at the site, presence of the butterfly at the site is unlikely.

Chrysoritis aureus (Golden Highveld Opal/ Heidelberg Copper)

The proposed global red list status for *Chrysoritis aureus* according to the most recent IUCN criteria and categories is Endangered (Mecenero *et al.,* 2013) *Chrysoritis aureus* (Golden Opal/ Heidelberg Copper) is a resident where the larval host plant, *Clutia pulchella* is present. However, the distribution of the butterfly is much more restricted than that of the larval host plant (S.F. Henning 1983; Terblanche, Morgenthal & Cilliers 2003). One of the reasons for the localised distribution of *Chrysoritis aureus* is that a specific host ant *Crematogaster liengmei* must also be present at the habitat. Fire appears to be an essential factor for the maintenance of suitable habitat (Terblanche, Morgenthal & Cilliers 2003). Research revealed that *Chrysorits aureus* (Golden Opal/ Heidelberg Copper) has very specific habitat requirements, which include rocky ridges with a steep slope and a southern aspect (Terblanche, Morgenthal & Cilliers 2003). Owing to a lack of habitat requirements and ideal habitat the presence of the taxon is highly unlikely.

Lepidochrysops praeterita **(Highveld Blue)**

The proposed global red list status for *Lepidochrysops praeterita* according to the most recent IUCN criteria and categories is Endangered (G.A. Henning, Terblanche & Ball, 2009; Mecenero *et al.,* 2013). *Lepidochrysops praeterita* is a butterfly that occurs where the larval host plant *Ocimum obovatum* (= *Becium obovatum*) is present (Pringle, G.A. Henning & Ball, 1994), but the distribution of the butterfly is much more restricted than the distribution of the host plant. *Lepidochrysops praeterita* is found on selected rocky ridges and rocky hillsides in parts of Gauteng, the extreme northern Free State and the south-eastern Gauteng Province. No ideal

habitat appears to be present for the butterfly on the site. It is unlikely that *Lepidochrysops praeterita* would be present on the site and at the footprint proposed for the development.

***Orachrysops mijburghi* (Mijburgh's Blue)**

The proposed global red status for *Orachrysops mijburghi* according to the most recent IUCN criteria and categories is Endangered (Mecenero *et al.,* 2013). *Orachrysops mijburghi* favours grassland depressions where specific *Indigofera* plant species occur (Terblanche & Edge 2007). The Heilbron population of *Orachrysops mijburghi* in the Free State uses *Indigofera evansiana* as a larval host plant (Edge, 2005) while the Suikerbosrand population in Gauteng uses *Indigofera dimidiata* as a larval host plant (Terblanche & Edge 2007). There is no suitable habitat for *Orachrysops mijburghi* on the site and it is unlikely that *Orachrysops mijburghi* would be present on the site.

Conclusion on threatened butterfly species

There appears to be no threat to any threatened butterfly species if the site is developed.

5.4.1.2 Assessment of butterfly species that are not threatened but also of high conservation priority

Colotis celimene amina (Lilac tip)

Colotis celimene amina is listed as Rare (Low density) by Mecenero *et al.* (2013). In South Africa *Colotis celimene amina* is present from Pietermaritzburg in the south and northwards into parts of Kwa-Zulu Natal, Gauteng, Limpopo, Mpumalanga and the North West Provinces (Mecenero *et al.* In press.). Reasons for its rarity are poorly understood. It is highly unlikely that *Colotis celimene amina* would be present at the site or make use of the site as a particular habitat.

Lepidochrysops procera (Savanna Blue)

Lepidochrysops procera is listed as Rare (Habitat specialist) by Mecenero *et al.* (2013). *Lepidochrysops procera* is endemic to South Africa and found in Gauteng, KwaZulu-Natal, Mpumalanga and North West (Mecenero *et al.,* 2013). Owing to a lack of habitat requirements and ideal habitat the presence of the taxon at the site is highly unlikely.

Metisella meninx (Marsh Sylph)

Henning and Henning (1989) in the first South African Red Data Book of Butterflies, listed *Metisella meninx* as threatened under the former IUCN category Indeterminate. Even earlier in the 20th century Swanepoel (1953) raised concern about vanishing wetlands leading to habitat loss and loss of populations of *Metisella meninx*. According to the second South African Red Data Book of butterflies (Henning, Terblanche & Ball, 2009) the proposed global red list status of *Metisella meninx* has been Vulnerable. During a recent large scale atlassing project the *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and Atlas* (Mecenero *et al.,* 2013) it was found that more *Metisella meninx* populations are present than thought before. Based on this valid new information, the conservation status of *Metisella meninx* is now regarded as Rare (Habitat specialist) (Mecenero *et al.,* 2013). Though *Metisella meninx* is more widespread and less threatened than perceived before, it should be regarded as a localised rare habitat specialist of conservation priority, which is dependent on wetlands with suitable patches of grass at wetlands (Terblanche *In prep*.). Another important factor to keep in mind for the conservation of *Metisella meninx* is that based on very recent discoveries of new taxa in the group the present *Metisella meninx* is species complex consisting of at least three taxa (Terblanche *In prep*., Terblanche & Henning *In prep*.). The ideal habitat of *Metisella meninx* is treeless marshy areas where *Leersia hexandra* (rice grass) is abundant (Terblanche *In prep*.). The larval host plant of *Metisella meninx* is wild rice grass, *Leersia hexandra* (G.A. Henning & Roos, 2001). Owing to a lack of habitat requirements and ideal habitat the presence of the taxon at the site is highly unlikely.

Platylesches dolomitica (Hilltop Hopper)

Platylesches dolomitica is listed as Rare (Low density) by Mecenero *et al.* (2013). Historically the conservation status of *Platylesches dolomitica* was proposed to be Vulnerable (Henning, Terblanche & Ball 2009). However this butterfly which is easily overlooked and has a wider distribution than percieved before. *Platylesches dolomitica* has a patchy distribution and is found on rocky ledges where *Parinari capensis* occurs, between 1300 m and 1800m (Mecenero *et al*. 2013, Dobson Pers comm.). Owing to a lack of habitat requirements and ideal habitat the presence of the taxon at the site is highly unlikely.

5.4.2 Fruit chafer beetles

Table 4.18 lists the fruit chafer beetle species (Coleoptera: Scarabaeidae: Cetoninae) that are of known high conservation priority in the North West Province. No *Ichnestoma stobbiai* or *Trichocephala brincki* were found during the surveys. There appears to be no suitable habitat for *Ichnestoma stobbiai* or *Trichocephala brincki* at the site. There appears to be no threat to any of the fruit chafer beetles of particular high conservation priority if the site were developed.

5.4.3 Scorpions

Table 4.19 lists the rock scorpion species (Scorpiones: Ischnuridae) that are of known high conservation priority in the North West Province. None of these rock scorpions have been found at the site and the habitat does not appear to be optimal.

5.5 CAMEL THORN TREES, *VACHELLIA ERIOLOBA* (= *ACACIA ERIOLOBA*)

Camel Thorn trees (*Vachellia erioloba* = *Acacia erioloba*) are found at the proposed footprint. Recent research reinforces the recognition of two genera *Vachellia* and *Senegalia* for hitherto *Acacia* in South Africa (see Kyalangalilwa *et al*., 2013) hence the name *Vachellia erioloba*. Camel Thorn trees can be described as trees of "great value, beauty and apparent ecological importance" (Anderson & Anderson, 2001).

Table 4.20 gives and indication of attributes of population of Camel Thorn tree, *Vachellia erioloba* (= *Acacia erioloba*) at the proposed footprint. Camel Thorn trees at the site are not particularly large (none taller than 10 m) and are not part of a camel thorn forest of note, even though in the south western parts of the proposed footprint a relatively high density of Camel Thorn trees are present; up to 56 individuals taller than 2 m per hectare area were counted (combined total of four sample plots of 50 m by 50 m). The zone of high density of Camel Thorn trees at the site is at least 25 ha. If conservative estimate of 40 individuals taller than 2 m/ hectare for this zone is made at least a 1000 individuals taller than 2 m are present at the south western parts of the proposed footprint.

It is recommended that a permit at the relevant authorities should be applied for in case of any damage or removal of individual trees and that *Vachellia erioloba* trees (from a nursery or being cultivated) could be planted on site outside the present footprint, especially at the south western parts where conditions appear ideal for Camel Thorn trees to establish. These strategies and actions can only be applied in liason and with the permission of government as outlined above.

5.6 ALIEN INVASIVE SPECIES WITH PARTICULAR REFERENCE TO *PROSOPIS GLANDULOSA (HONEY MESQUITE)*

Exotic weeds at the site are typical for those that are found at disturbed areas at farms in the North West Province. Though these exotic weeds easily spring up where disturbances such as overgrazing, scraping of an area and diggings are found, at the present study area no severe infestations such as could often be observed in larger urban areas and surrounds in the North West and Gauteng Provinces, are found.

No *Prosopis glandulosa* have been observed at the proposed footprint and it is likely that this highly invasive tree is absent (or if present in very low numbers) at the site.

Prosopis should not be allowed to establish at the site from adjacent areas and continuously monitored/ controlled. Many *Prosopis* species have been introduced to South Africa; some taxa and their hybrids have naturalised and become widespread invasive trees. *Prosopis* was introduced to South Africa and has become the second most widespread invasive alien plant taxon in the country (Shackleton et al., 2015c). These invasions have detrimental effects on biodiversity, ecosystem services and human livelihoods Shakleton *et al.*, 2015a). In South Africa it was found that native woody species density, basal area, richness and diversity all decreased significantly as the basal area of *Prosopis* stands increased (Shackleton *et al*., 2015a). The cover of native perennial grasses and herbaceous plants declined from 15–20% where the basal area of *Prosopis* was < 2 m^2/ha to zero where the basal area of *Prosopis* was > 4.5 m^2/ha (Shackleton *et al.,* 2015a). *Prosopis* in South Africa also has higher recruitment (% juvenile plants) than in other areas like Australia. *Prosopis* invasions are having a negative effect on the stability of native tree populations in South Africa, and are linked to increased mortality of native trees. Improved management of *Prosopis* is needed Shackleton *et al.,* 2015c).

Invasive alien trees impact the environment and human livelihoods. Costs associated with *Prosopis* were perceived to exceed benefits, and most stakeholders wanted to see a reduction in the abundance of *Prosopis* stands (Shackleton *et al.*, 2015b). The mean total cost for the management of *Prosopis* was US$ 1914 year^{-1} per farm, where costs ranged from under US$ 10 to over UD$ 500 per ha based on invasion densities and objectives for control (Shackleton *et al*., 2015b).

6 IMPACT ASSESSMENT AND MITIGATION MEASURES

The primary cause of loss of biological diversity is habitat degradation and loss (IUCN, 2004; Primack, 2006). Habitats of threatened plants are in danger most often due to urban developments such as is the case for the Gauteng Province (Pfab & Victor, 2002). Habitat conservation is the key to the conservation of invertebrates such as threatened butterflies (Deutschländer and Bredenkamp 1999; Edge 2002, 2005; Terblanche, Morgenthal & Cilliers 2003; Lubke, Hoare, Victor & Ketelaar 2003; Edge, Cilliers & Terblanche, 2008). Though human impacts in few cases have improved the habitat for mammalian species such as greater cane rats, that prosper in sugar cane and maize fields (Apps 2000), for many mammalian habitat specialist species, human impacts has lead to habitat loss. Some mammal species, especially many of the larger species, could adapt to a wide range of habitat types, but then need a large range. Some animals and plants are rare and occupy only one or a few specialised habitats (Primack 2006). Habitat conservation, either as large available land or as specialised habitats is therefore key to the conservation of many threatened plant species and animal species or any other species of high conservation priority (i.e. rare, near threatened species). In addition corridors and linkages may play a significant role in conservation of fauna.

Corridors are important to link ecosystems of high conservation priority. Such corridors or linkages are there to improve the chances of survival of otherwise isolated populations (Samways, 2005). How wide should corridors be? The answer to this question depends on the conservation goal and the focal species (Samways, 2005). Corridors for mammalian species are especially important for migratory species (Mwalyosi, 1991, Pullin 2002). For an African butterfly assemblage this is about 250m when the corridor is for movement as well as being a habitat source (Pryke and Samways 2003). Hill (1995) found a figure of 200m for dung beetles in tropical Australian forest. In the agricultural context, and at least for some common insects, even small corridors can play a valuable role (Samways, 2005). Much more research remains to be done to find refined answers to the width of grassland corridors in South Africa. The width of corridors will also depend on the type of development, for instance the effects of the shade of multiple story buildings will be quite different from that of small houses. Corridors have a number of advantages related to dispersal and gene flow by avoiding isolation of ecological patches. However, corridors could also have potential drawbacks, for example creating gene flow where none has occurred naturally in the past and also as reservoirs for pathogens or introduced species (Pullin, 2002).

Perhault and Lomolino (2000) studied corridors and mammal community structure in an old-growth forest landscape in the United States of America and their data suggest that each corridor should be valued individually. A lot of research remains to be conducted to have a better idea of the value of corridors, but in general corridors would be of considerable value. It appears that a network of wetland corridors and rocky ridges is highly likely to be of considerable benefit in environmental management and planning. Though proper management plans for habitats are not in place, setting aside special ecosystems is in line with the resent Biodiversity Act (2004) of the Republic of South Africa.

To summarise: In practice, as far as any developments are concerned, the key would be to prioritise and plan according to sensitive species and special ecosystems.

In the case of this study vegetation appear to be disturbed in areas but a high cover of indigenous plant species in a fairly natural area is present. If the development is approved, it is unlikely that there will be a loss of any particular ecosystem or corridor of special conservation concern according to the planned footprint. There appears to be no loss of any particular sensitive species, if the site is developed according to the proposed footprint. Mitigation measures for *Vachellia erioloba* (= *Acacia erioloba*) (Declining, Protected Tree) apply.

The following potential impacts and mitigation measures with a view to the proposed developments apply:

6.1 Anticipated risks or impacts to the loss of habitat

The following impacts on the loss of habitat apply at the site.

Potential impacts on the available habitat will be of local extent, of permanent duration, of medium intensity and high probability. The significance of loss of habitat is expected to be moderate without mitigation and moderate-low with mitigation.

Impact summary matrix:

Phase	Significance of Impact				
	None	Low	Moderate	High	With mitigation
Operational			X		Moderate-low

Mitigation measures:

- Exotic and invasive plant species should not be allowed to establish, if the development is approved, especially an alien invasive tree species such as *Prosopis*.

6.2 Anticipated risks or impacts to the loss of sensitive species

Sensitive species are regarded here as those listed in section 5 and constitutes the flora and fauna that are threatened or of other particular high conservation importance. The presence or not of all the species listed in the tables were investigated during the survey. None of the threatened and near-threatened plant species are likely to occur on the site.

A Protected Tree species, *Vachellia erioloba* (also listed as Declining) is found at the site. Protected Tree species under the National Forests Act No. 84 of 1998 are listed in Table 4.9. In terms of a part of section 51(1) of Act No. 84 of 1998, no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree, except under a license granted by the Minister.

Recommendation for *Vachellia erioloba*:
Acacia erioloba individuals at the site are not particularly large and are not part of a camel thorn forest of note. It is recommended that a permit at the relevant authorities should be applied for in case of any damage or removal of individual trees and that *Vachellia erioloba* (= *Acacia erioloba*) trees (from a nursery) could be planted on site outside the present footprint.

6.3 Anticipated risks or impacts to habitat connectivity and open space

Potential impacts on connectivity will be of local extent, of permanent duration, of medium intensity and high probability. The significance of the impacts on loss of connectivity is expected to be low without mitigation and low with mitigation.

Impact summary matrix: habitat connectivity

Phase	Significance of Impact				
	None	Low	Moderate	High	With mitigation
Construction		X			Low
Operational		X			Low

Mitigation measures:

- If the development is approved, establishment of exotic and invasive plant species should be avoided and where these have been found at the site continuous eradication should take place.
- It is in particular declared alien invasive species such as *Prosopis glandulosa* (Mesquite) that should not be allowed to establish.

6.4 Anticipated risks or impacts associated with construction activities

Overall construction activities associated with the development if approved will be of local extent, of medium duration, of medium intensity and high probability. During the construction phase, the significance of the impacts associated with the construction phase is likely to be moderate without and low with mitigation.

Impact summary matrix:

Phase	Significance of Impact				
	None	Low	Moderate	High	With mitigation
Construction			X		Low
Operational			X		Low

Mitigation measures:

- If the development is approved, contractors must ensure that no animal species are disturbed, trapped, hunted or killed during the construction phase.
- Rubble or waste that could accompany the construction effort, if the development is approved, should be removed during and after construction.
- If the development is approved, measures should be taken to avoid any spills and infiltration of petroleum fuels or any chemical pollutants into the soil during construction phase.

6.5 Cumulative impacts

Cumulative impacts could arise as other similar projects are constructed in the area.

According to the Energy Blog's database only one other solar PV plant has been granted preferred bidders status within close proximity to the proposed Khubu PV plant:

- *Waterloo Solar Park with a capacity of 75MW near Vryburg, North West Province (Approvals, planning and financing phase) – refer to Figure 10.*

According to the Department's database numerous other solar plants have been proposed in relative close proximity to the proposed activity, namely:

- *The proposed Carocraft Solar Park near Vryburg, North West Province (14/12/16/3/3/2/374);*
- *Construction of the 75MW Photovoltaic facility and associated infrastructure in Naledi (14/12/16/3/3/2/390).*
- *The proposed Tiger Kloof Solar Photovoltaic energy facility near Vryburg, North West Province (14/12/16/3/3/2/535).*
- *The proposed Keren Energy Bosh Pan Solar Plant, Northern Cape Province (14/12/16/3/3/1/563);*
- *The proposed renewable energy generation project. Carocraft Solar Park in North West Province (14/12/16/3/3/2/699);*
- *The proposed Renewable Energy Genertion Project rem farm Elda, North West (14/12/16/3/3/2/750);*
- *The proposed Renewable Energy Project on Farm Doornbult 29 and Doornbult 33, North West (14/12/16/3/3/2/751);*

Environamics and other environmental consultants are also in the process of applying for Environmental Authorisation for other PV projects in the area, namely:

- *The proposed Protea Solar Power Plant near Vryburg, North West Province.*

- *The proposed Gamma Solar Power Plant near Vryburg, North West Province.*
- *The proposed Alpha Solar Power Plant near Vryburg, North West Province.*
- *The proposed Meerkat Solar Power Plant near Vryburg, North West Province.*
- *The proposed Sonbesie Solar Power Plant near Vryburg, North West Province.*
- *Three PV Solar Energy facilities on the farm Klondike - AMDA Developments*

The potential for cumulative impacts therefore exists. In the Naledi Local Municipality a number of solar power plants are planned and their cumulative impacts to ecosystem and biodiversity need consideration. Several characteristics and development strategies of utility-scale solar energy systems have low environmental impacts relative to other energy systems, including other renewables (Hernandez *et al.*, 2015) so that their cumulative effects may be relatively lower. Cumulative effects of solar power plants to habitat loss and fragmentation should receive much of the attention. Habitat loss and fragmentation are known to be the main threats to biodiversity (Fahrig, 2003; Wilcove *et al*., 1998; IUCN, 2004; Primack, 2006). Because some fragmentation will take place if the developments are approved the focus of assessing cumulative effects of solar power plants could be on how the different projects allow for enough corridors and linkages in between the locations of solar power plants to enhance connectivity of biodiversity. An outline of possible cumulative impacts follows.

Possible cumulative effects and mitigation/ avoidance thereof:

1) Cumulative impacts on unique or sensitive habitats:

   At the study area cumulative effects on the loss of sensitive habitats are kept to a minimum because such habitats are avoided at large.

2) Cumulative impacts on habitat fragmentation:

   Regionally landscape fragmentation could create barriers to the movement of species and their genes (Saunders *et al.*, 1991). The answer to the width and extent of corridors depends on the conservation goal and the focal species (Samways, 2005). Corridors for mammalian species are especially important for migratory species (Mwalyosi, 1991, Pullin 2002). For an African butterfly assemblage this is about 250m when the corridor is for

movement as well as being a habitat source (Pryke and Samways 2003). Hill (1995) found a figure of 200m for dung beetles in tropical Australian forest. In the agricultural context, and at least for some common insects, even small corridors can play a valuable role (Samways, 2005).

At the study area of which the site is part:

Corridors and linkages of areas with similar habitat are present in the local district where a number of solar power plants are planned. Watercourses and wetlands are avoided by the proposed footprint so that stepping stone corridors (pans) and a network of linked corridors (active channels with riparian zones) remain. No particular habitats of threatened species that are easily isolated (e.g. beetles with flightless females) are known to be impacted locally in the larger study area where a number of solar power plants are planned to be developed.

3) Emissions and pollutants into the air, soil and water:

Overall because of the restricted nature of power plants and few or no emissions and pollutants into air when operational, soil and water cumulative impacts to the environment are limited (if compared for example to emissions from fossil fuel burning). Ultimately power plants could reprieve the pressures to use fossil fuels that are associated with numerous cumulative impacts and habitat losses.

Therefore in the bigger regional context, the vast tracks of relatively similar habitat in the interior are ideal for such power generating facilities. Current developments of solar power plants could therefore not be seen in the same context as many other more developed parts of the world where natural habitats are often severely fragmented. Some fragmentation of habitats will take place and the key issue would be to avoid sensitive habitats and to allow for enough corridors and linkages between habitats such as in the present proposed planned footprints.

The Environmental Impact Assessment (EIA) Report will include a detailed assessment of the potential cumulative impacts associated with the proposed development.

7 CONCLUSION

- Vegetation at much of the proposed footprint comprises extensive grassy patches with some indigenous trees. *Eragrostis pallens* is visibly one of the dominant grass species in extensive sandy soils at the site. Camel Thorn trees are the most conspicuous thorn tree at the proposed footprint. Vegetation at the site is in fairly natural condition for the vegetation type, with some bare areas, but in general a relatively high cover of indigenous plant species versus exotic species.
- The vegetation type to which the site belongs, Ghaap Plateau Vaalbosveld (SVk 7), is not listed as threatened ecosystem according to the National List of Threatened Ecosystems (2011).
- Establisment of exotic weeds should be monitored, during construction, if the development is approved, and exotic weeds at the site should be eradicated. Exotic declared invaders such as the mesquite tree (*Prosopis* species), should not be planted or allowed to establish.
- No wetlands appear to be present at the proposed footprint.
- No loss of particularly sensitive or localised habitat type of particular conservation importance is anticipated if the site is developed.
- No loss of corridors or connectivity of ecosystems is anticipated if proposed footprint is developed.
- Ecological sensitivity at the site is medium: There are no indications of any particular ecosystems of conservation importance, any particular conservation corridors or a significant impact on any plant, mammal, reptile, amphibian or invertebrate species of particular conservation concern if the site is developed.
- A Protected Tree species, *Vachellia erioloba* (= *Acacia erioloba*), the Camel Thorn tree (also listed as a Declining species), is found at the site. Protected Tree species are listed under the National Forests Act No. 84 of 1998. In terms of a part of section 51(1) of Act No. 84 of 1998, no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree, except under a license granted by the Minister.
- At the zone of conspicuous high density of Camel Thorn trees at the south western parts of the proposed footprint 56 individuals were counted at four sample plots of 50 m x 50 m

each. This means that for this high density zone (over 25 ha) of Camel Thorn trees more than a 1000 individuals taller than 2 m would be present.

- No Camel Thorn trees taller than 10 m are present at the proposed footprint and also no remarkable old trees. Camel Thorn tree population at the site would not be regarded as a Camel Thorn tree forest. Reference sites for Camel Thorn forests: Large Camel Thorn forest at Kathu and smaller Camel Thorn forest at Witsand in the Northern Cape visited by R.F. Terblanche during the time span of the surveys.
- Recommendation for Camel Thorn trees at the site, if the development is approved: It is recommended that a permit should be applied for at the relevant authorities in case any removal or damage of Camel Thorn trees. If *Vachellia erioloba* is impacted upon it is also recommended that new (from nursery) Camel Thorn trees could be planted on site outside the present footprint, especially along the south western boundary of the proposed footprint where conditions appear to be ideal for this tree.
- Cumulative effects of solar power plants are considered with special reference to habitat loss and fragmentation. Habitat loss and fragmentation are known to be the main threats to biodiversity (Fahrig, 2003; Wilcove et al., 1998; IUCN, 2004; Primack, 2006). Because some fragmentation will take place if the developments are approved the focus of assessing cumulative effects of solar power plants could be on how the different projects allow for enough corridors and linkages in between the locations of solar power plants to enhance connectivity of biodiversity.
- There is no distinct reason why this relatively small footprint allocated for the development, in the vast countryside of the North West Province is of particular conservation concern for any threatened vertebrate species, including those that roam large areas and which may occasionally or coincidently visit the site.
- It is unlikely that there will be a loss of any known plant, mammal, reptile, amphibian or invertebrate species that are threatened or near threatened, if the site is developed.

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ANNEXURE 1: Plant species list

Plant species recorded or likely to occur at the site.

Plant species are listed alphabetically under life forms that are generally recognizable.
Plant species marked with an asterisk (*) are exotic.
Sources: Germishuizen (2003), Manning (2003), Manning (2009), Van Oudtshoorn (1999), Van Wyk (2000), Van Wyk & Malan (1998), Van Wyk & Van Wyk (2013), Crouch, Klopper, Burrows & Burrows (2011), Goldblatt (1986), Goldblatt & Manning (1998), Jacobsen (1983), McMurtry, Grobler, Grobler & Burns (2008), Smit (2008), Van Ginkel *et al*. (2011), Van Jaarsveld (2006), Van Wyk & Smith (2003).

TAXON	COMMON NAMES	FAMILY
ANGIOSPERMAE: MONOCOTYLEDONS		
Albuca setosa	Fibrous Slime Lily	HYACINTHACEAE
Anthephora pubescens	Wool Grass	POACEAE
Aristida adscensionis	Annual Three-awn	POACEAE
Aristida congesta subsp. ***congesta***	Tassel Three-awn	POACEAE
Aristida meridionalis	Giant Three-awn	POACEAE
Asparagus africanus		ASPARAGACEAE
Bulbine frutescens		ASPHODELACEAE
Bulbine narcissifolia		ASPHODELACEAE
Cenchrus ciliaris	Foxtail Buffalo Grass	POACEAE
Chloris virgata	Feather-top Chloris	POACEAE
Chlorophytum fasciculatum		ANTHERICACEAE
Commelina africana		COMMELINACEAE
Cymbopogon pospischilii	Narrow-leaved Turpentine Grass	POACEAE
Cynodon dactylon	Couch Grass	POACEAE

Digitaria eriantha	Common Finger Grass	POACEAE
Eleusine coracana	Goose Grass	POACEAE
Elionurus muticus	Wire Grass	POACEAE
Enneapogon cenchroides	Nine-awned Grass	POACEAE
Enneapogon scoparius	Bottlebrush Grass	POACEAE
Eragrostis curvula	Weeping Love Grass	POACEAE
Eragrostis lehmanniana	Lehmann's Love Grass	POACEAE
Eragrostis pallens	Broom Love Grass	POACEAE
Eragrostis superba	Saw-toothed Love Grass	POACEAE
Fingerhuthia africana	Thimble Grass	POACEAE
Ledebouria marginata		HYACINTHACEAE
Melinis repens	Natal Red Top	POACEAE
Pogonarthria squarrosa	Herringbone Grass	POACEAE
Schmidtia pappophoroides	Sand Quick	POACEAE
Setaria sphacelata *var.* ***torta***	Creeping Bristle Grass	POACEAE
Stipagrostis uniplumis	Silky Bushman Grass	POACEAE
Themeda triandra	Red Grass	POACEAE
Trachyandra laxa		ASPHODELACEAE
Tragus racemosus		POACEAE
Trichoneura grandiglumis	Small Rolling Grass	POACEAE
ANGIOSPERMS: DICOTYLEDONS		
Acacia **indigenous species: see *Senegalia* and *Vachellia* below**		
Acacia erioloba	Camel Thorn	MIMOSACEAE
Acacia hebeclada subsp. ***hebeclada***	Candlepod Thorn	MIMOSACEAE
Acacia karroo	Sweet Thorn	MIMOSACEAE
Acacia mellifera subsp. ***detinens***	Black Thorn	MIMOSACEAE
Acacia tortilis susbp. ***heteracantha***	Umbrella Thorn	MIMOSACEAE
Acrotome inflata		LAMIACEAE
Aptosimum procumbens	Karoo Violet	SCROPHULARIACEAE
**** Argemone ochroleuca***	White-flowered Mexican poppy	PAPAVERACEAE
Barleria macrostegia		ACANTHACEAE
Ceratotheca triloba	Wild Foxglove	PEDALIACEAE
Chamaecrista species	Cassia	CAESALPINIACEAE
Chamaesyce hirta	Red Milkweed	EUPHORBIACEAE
Chrysocoma ciliata	Bitterbush	ASTERACEAE
Citrullus lanatus	Wild Waterlemon	CUCURBITACEAE

Cleome angustifolia	Yellow Mouse-whiskers	BRASSICACEAE (or Capparaceae)
Convolvulus sagittatus	Wild Bindweed	CONVOLVULACEAE
Cucumus zeyheri		CUCURBITACEAE
Deverra denudata subsp. ***aphylla***	Wild Celery	APIACEAE
Diospyros lycioides subsp. ***lycioides***	Karoo Bluebush	EBENACEAE
Ehretia alba	White Puzzle Bush	BORAGINACEAE
Elephantorrhiza elephantina	Eland's Bean	MIMOSACEAE
Felicia muricata		ASTERACEAE
Gazania krebsiana subsp. ***krebsiana***		ASTERACEAE
Geigeria filifolia		ASTERACEAE
Geigeria ornativa		ASTERACEAE
Gisekia africana		GISEKIACEAE
Gnidia polycephala		THYMELAEACEAE
**** Gomphrena celosioides***	Bachelor's Button	AMARANTHACEAE
Grewia flava	Velvet Raisin	SPARRMANNIACEAE
Helichrysum argyrosphaerum		ASTERACEAE
Helichrysum zeyheri		ASTERACEAE
Heliotropium ciliatum		BORAGINACEAE
Hermbstaedtia odorata	Wild Cockscomb	AMARANTHACEAE
Hermannia tomentosa		MALVACEAE
Indigofera daleoides		FABACEAE
Ipomoea bolusiana		CONVOLVULACEAE
Jamesbrittenia aurantiaca	Cape Saffron	SCROPHULARIACEAE
Limeum fenestratum		
Lycium hirsutum		SOLANACEAE
Lycium horridum		SOLANACEAE
Melhania prostrata		STERCULIACEAE
Melolobium microphyllum		FABACEAE
Monsonia angustifolia	Crane's Bill	GERANIACEAE
**** Opuntia ficus-indica***	Sweet Prickly Pear	CACTACEAE
Pentzia calcarea		ASTERACEAE
Pollichia campestris	Waxberry	ILLECEBRACEAE
Salvia disermas	Large Blue Sage	LAMIACEAE
Scabiosa columbaria	Wild Scabious, Morning Bride	DIPSACACEAE
**** Schkuhria pinnata***	Dwarf Marigold	ASTERACEAE
Searsia lancea	Karee	ANACARDIACEAE

Searsia tridactyla		ANACARDIACEAE
Selago densiflora		SCROPHULARIACEAE
Senecio coronatus	Sybossie	ASTERACEAE
Senecio consanguineus	Starvation Senecio	ASTERACEAE
Senegalia mellifera subsp. ***detinens***	Black Thorn	MIMOSACEAE
Senna italica subsp. ***arachoides***	Wild Senna	CAESALPINIACEAE
Solanum incanum	Bitter Apple	SOLANACEAE
Tarchonanthus camphoratus	Wild Camphor Bush	ASTERACEAE
Tephrosia lupinifolia		FABACEAE
Terminalia sericea	Silver Clusterleaf	COMBRETACEAE
Trichodesma angustifolium	Hairy Blue Bells	BORAGINACEAE
Thesium sp.		SANTALACEAE
Tribulus terrestris	Devil's Thorn	ZYGOPHYLLACEAE
Vachellia erioloba (= *Acacia erioloba*)	Camel Thorn	MIMOSACEAE
Vachellia hebeclada subsp. ***hebeclada***	Candlepod Thorn	MIMOSACEAE
Vachellia karroo	Sweet Thorn	MIMOSACEAE
Vachellia tortilis susbp. ***heteracantha***	Umbrella Thorn	MIMOSACEAE
Vahlia capensis		VAHLIACEAE
Viscum rotundifolium	Round-leaved Mistletoe	VISCACEAE
Ziziphus mucronata	Buffalo-thorn	RHAMNACEAE
Ziziphus zeyheriana	Dwarf Buffalo-thorn	RHAMNACEAE