

ECOLOGICAL FAUNA AND FLORA HABITAT SURVEY

**Proposed Roan PV 2, Portions 4,5,9 & 16 of the farm
Rhenosterhoek 299, Hartbeesfontein, North West Province**



Flowers of the widespread indigenous plant species, *Commelina africana*, at the site.

Photo: Reinier F. Terblanche.

FEBRUARY 2022

Compiled by:

Reinier F Terblanche

(M.Sc Ecology, *Cum Laude*; Pr.Sci.Nat, Reg. No. 400244/05)

ANTHENE ECOLOGICAL CC

TABLE OF CONTENTS

1. INTRODUCTION	6
2. STUDY AREA	7
3. METHODS	11
4. RESULTS	15
5. DISCUSSION	38
6. RISKS, IMPACTS AND MITIGATION	49
7. CONCLUSION	58
8. REFERENCES	62
9. ANNEXURE 1 LIST OF PLANT SPECIES	71

I) SPECIALIST EXPERTISE

SYNOPTIC CV: REINIER. F. TERBLANCHE

Reinier is an ecologist and in particular a habitat specialist with an exceptional combination of botanical and zoological expertise which he keeps fostering, updating and improving. He is busy with a PhD for which he registered at the Department of Conservation Ecology at the University of Stellenbosch in July 2013. The PhD research focuses on the landscape ecology of selected terrestrial and wetland butterflies in South Africa. Reinier's experience includes being a lecturer in ecology and zoology at the North West University, Potchefstroom Campus (1998-2008). Reinier collaborates with a number of institutes, organizations and universities on animal, plant and habitat research.

Qualifications:

Qualification	Main subject matter	University
M.Sc Cum Laude, 1998: Botany: Ecology	Quantitative study of invertebrate assemblages and plant assemblages of rangelands in grasslands.	North-West University, Potchefstroom
B.Sc Honns Cum Laude, 1992 Botany: Taxonomy	Distinctions in all subjects: Plant Anatomy, Taxonomy, Modern Systematics, System Modelling, Plant Ecology, Taxonomy Project, Statistics Attendance Course.	North-West University, Potchefstroom
B.Sc Botany, Zoology	Main subjects: Botany, Zoology.	North-West University, Potchefstroom
Higher Education Diploma, 1990	Numerous subjects aimed at holistic training of teachers.	North-West University, Potchefstroom

In research Reinier specializes in conservation biology, threatened butterfly species, vegetation dynamics and ant assemblages at terrestrial and wetland butterfly habitats as well as enhancing quantitative studies on butterflies of Africa. He has published extensively in the fields of taxonomy, biogeography and ecology in popular journals, peer-reviewed scientific journals and as co-author and co-editor of books (see 10 examples beneath).

Reinier practices as an ecological consultant and has been registered as a Professional Natural Scientist by SACNASP since 2005: Reg. No. 400244/05. His experience in consultation includes: Flora and fauna habitat surveys, Threatened species assessments, Riparian vegetation index surveys, Compilation of Ecological Management Plans, Biodiversity Action Plans and Status quo of biodiversity for Environmental Management Frameworks, Wetland Assessments, Management of Rare Wetland Species.

Recent activities/ awards: Best Poster Award at Oppenheimer De Beers Group Research Conference 2015, Johannesburg. One of the co-authors of Guidelines for Standardised Global Butterfly Monitoring, 2015, Group on Earth Observations Biodiversity Observation Network, Leipzig, Germany (UNEP-WCMC), GEO BON Technical Series 1. Awarded the prestigious Torben Larsen Memorial Tankard in October 2017; one is awarded annually to the person responsible for the most outstanding written account on Afrotropical Lepidoptera. Lectured as Conservationist-in-Residence in the Wildlife Conservation Programme of the African Leadership University, Kigali, Rwanda, 9-23 February 2019. Reinier won a photographic competition which resulted his photograph of the Critically Endangered *Erikssonia edgei* (Waterberg Copper) being on the front cover of the Synthesis Report of the National Biodiversity Assessment (2018) prepared by SANBI.

EXPERIENCE

Lecturer: Zoology 1998-2008	Main subject matter and level	Organization
Lectured subjects	- 3 rd year level Ecology, Plantparasitology - 2 nd year level Ethology - <i>Master's degree</i> Evolutionary Ethology, Systematics in Practice, Morphology and Taxonomy of Insect Pests, Wetlands.	North-West University, Potchefstroom and University of South Africa
Co-promoter	PhD: Edge, D.A. 2005. Ecological factors that influence the survival of the Brenton Blue butterfly	North-West University, Potchefstroom
Study leader/ assistant study leader	Six MSc students, One BSc Honn student: Various quantitative biodiversity studies (terrestrial and aquatic).	North-West University, Potchefstroom
Teacher 1994-1998	Biology and Science, Secondary School	Afrikaans Hoër Seunskool, Pretoria
Owned Anthene Ecological CC 2008 – present	- Flora and Fauna habitat surveys - Highly specialized ecological surveys - Riparian vegetation index surveys - Ecological Management Plans - Biodiversity Action Plans - Biodiversity section of Environmental Management Frameworks - Wetland assessments	Private Closed Corporation that has been subcontracted by many companies
Herbarium assistant 1988-1991	- Part-time assistant at the A.P. Goossens herbarium, Botany Department, North-West University, 1988, 1989, 1990 and 1991 (as a student).	North-West University, Potchefstroom

10 EXAMPLES OF PUBLICATIONS OF WHICH R.F. TERBLANCHE IS AUTHOR/ CO-AUTHOR

(Three books, two chapters in books and five articles are listed here as examples)

- HENNING, G.A., **TERBLANCHE, R.F.** & BALL, J.B. (eds) **2009**. *South African Red Data Book: butterflies. SANBI Biodiversity Series 13*. South African National Biodiversity Institute, Pretoria. 158p. ISBN 978-1-919976-51-8
- MECENERO, S., BALL, J.B., EDGE, D.A., HAMER, M.L., HENNING, G.A., KRÜGER, M, PRINGLE, E.L., **TERBLANCHE, R.F.** & WILLIAMS, M.C. (eds). 2013. *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and atlas*. Safronics (Pty) Ltd., Johannesburg & Animal Demography Unit, Cape Town.
- VAN SWAAY, C., REGAN, E., LING, M., BOZHINOVSKA, E., FERNANDEZ, M., MARINI-FILHO, O.J., HUERTAS, B., PHON, C.-K., KÖRÖSI, A., MEERMAN, J., PE'ER, G., UEHARA-PRADO, M., SÁFIÁN, S., SAM, L., SHUEY, J., TARON, D., **TERBLANCHE, R.F.** & UNDERHILL, L. 2015. Guidelines for Standardised Global Butterfly Monitoring. Group on Earth Observations Biodiversity Observation Network, Leipzig, Germany. GEO BON Technical Series 1.
- TERBLANCHE, R.F.** & HENNING, G.A. **2009**. *A framework for conservation management of South African butterflies in practice*. In: Henning, G.A., Terblanche, R.F. & Ball, J.B. (eds). *South African Red Data Book: Butterflies. SANBI Biodiversity Series 13*. South African National Biodiversity Institute, Pretoria. p. 68 – 71.
- EDGE, D.A., **TERBLANCHE, R.F.**, HENNING, G.A., MECENERO, S. & NAVARRO, R.A. 2013. Butterfly conservation in southern Africa: Analysis of the Red List and threats. In: Mecenero, S., Ball, J.B., Edge, D.A., Hamer, M.L., Henning, G.A., Krüger, M., Pringle, E.L., Terblanche, R.F. & Williams, M.C. (eds). *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and Atlas*. pp. 13-33. Safronics (Pty) Ltd., Johannesburg & Animal Demography Unit, Cape Town.
- TERBLANCHE, R.F.**, SMITH, G.F. & THEUNISSEN, J.D. **1993**. Did Scott typify names in *Haworthia* (Asphodelaceae: Alooideae)? *Taxon* **42**(1): 91–95. (International Journal of Plant Taxonomy).
- TERBLANCHE, R.F.**, MORGENTHAL, T.L. & CILLIERS, S.S. **2003**. The vegetation of three localities of the threatened butterfly species *Chrysoritis aureus* (Lepidoptera: Lycaenidae). *Koedoe* **46**(1): 73-90.
- EDGE, D.A., CILLIERS, S.S. & **TERBLANCHE, R.F.** **2008**. Vegetation associated with the occurrence of the Brenton blue butterfly. *South African Journal of Science* **104**: 505 - 510.
- GARDINER, A.J. & **TERBLANCHE, R.F.** **2010**. Taxonomy, biology, biogeography, evolution and conservation of the genus *Erikssonia* Trimen (Lepidoptera: Lycaenidae) *African Entomology* **18**(1): 171-191.
- TERBLANCHE, R.F.** 2016. *Acraea trimeni* Aurivillius, [1899], *Acraea stenobea* Wallengren, 1860 and *Acraea neobule* Doubleday, [1847] on host-plant *Adenia repanda* (Burch.) Engl. at Tswalu Kalahari Reserve, South Africa. *Metamorphosis* **27**: 92-102.

* A detailed CV with more complete publication list is available.

II) SPECIALIST DECLARATION

I, Reinier F. Terblanche, as the appointed independent specialist, in terms of the 2014 EIA Regulations (as amended), hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 (as amended) and any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Name of Specialist: Reinier F. Terblanche



Signature of the specialist

Date: 11 March 2022

1 INTRODUCTION

An ecological habitat survey is required for proposed development at Portions 4, 5, 9 & 16 of the farm Rhenosterhoek 299, approximately 3 km south of Hartbeesfontein, North West Province South Africa (elsewhere referred to as the site). 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

- 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 at at Portions 4, 5, 9 & 16 of the farm Rhenosterhoek 299, approximately 3 km south of Hartbeesfontein, North West Province South Africa (elsewhere referred to as the site). Grassland at the site is represented by two vegetation types the Vaal-Vet Sandy Grassland (Gh 10) and the Klerksdorp Thornveld (Gh 13).

Gh 10 Vaal-Vet Sandy Grassland

Distribution: In South Africa the Vaal-Vet Sandy Grassland is present in the North-West Province and Free State Province. Vaal-Vet Sandy Grassland ranges from south of Lichtenburg and Ventersdorp to Klerksdorp, Leeudoringstad, Bothaville and to the Brandfort areas north of Bloemfontein. Altitude ranges from 1 220 – 1560 m for the entire vegetation type (Mucina & Rutherford 2006).

Vegetation and landscape features: Plains-dominated landscape with some scattered, slightly undulating plains and hills. Mainly low-tussock grasslands with an abundant karroid element are present. Dominance of *Themeda triandra* is an important feature of this vegetation unit. Locally low cover of *Themeda triandra* and the associated increase in *Elionurus muticus*, *Cymbopogon pospischilii* and *Aristida congesta* is attributed to heavy grazing and/or erratic rainfall. Geology and soils: Aeolian and colluvial sand overlying sandstone, mudstone, and shale of the Karoo Supergroup (mostly the Ecca group) as well as older Ventersdorp Supergroup and basement gneiss in the north (Mucina & Rutherford 2006).

Climate: Warm-temperate, summer-rainfall climate, with overall mean annual precipitation of 530 mm. High summer temperatures. Severe frost (37 days per year on average) occurs in winter (Mucina & Rutherford 2006).

Important taxa of the Vaal-Vet Sandy Grassland listed by Mucina & Rutherford (2006):
Graminoids: *Antheophora pubescens*, *Aristida congesta*, *Chloris virgata*, *Cymbopogon caesius*, *Cynodon dactylon*, *Digitaria argyrograpta*, *Elionurus muticus*, *Eragrostis chloromelas*, *Eragrostis lehmanniana*, *Eragrostis plana*, *Eragrostis trichophora*, *Heteropogon contortus*, *Panicum gilvum*, *Setaria sphacelata*, *Themeda triandra*, *Tragus berteronianus*, *Brachiaria serrata*, *Cymbopogon pospischilii*, *Digitaria eriantha*, *Eragrostis curvula*, *Eragrostis obtusa*, *Eragrostis superba*, *Panicum coloratum*, *Pogonarthria squarrosa*, *Trichoneura grandiglumis*,

Triraphis andropogonoides. Herbs: *Stachys spathulata*, *Barleria macrostegia*, *Berkheya onopordifolia* var. *onopordifolia*, *Chamaesyce inaequilatera*, *Geigeria aspera* var. *aspera*, *Helichrysum caespititium*, *Hermannia depressa*, *Hibiscus pusillus*, *Monsonia burkeana*, *Rhynchosia adenodes*, *Selago densiflora*, *Vernonia oligocephala*. Geophytic Herbs: *Bulbine narcissifolia*, *Ledebouria marginata*. Succulent Herb: *Tripteris aghillana* var. *integrifolia*. Low shrubs: *Felicia muricata*, *Pentzia globosa*, *Anthospermum rigidum* subsp. *pumilum*, *Helichrysum dregeanum*, *Helichrysum paronychioides*, *Ziziphus zeyheriana*.

Klerksdorp Thornveld (Gh 13)

Distribution: In South Africa the Klerksdorp Thornveld is present in the North West Province in two sets of patches, one in the Wolmaransstad, Ottosdal and Hartbeesfontein region, and the other from the Botsalano Game Park north of Mafikeng in the vicinity of Madibogo in the south. Altitude for the entire vegetation type is 1260 – 1580 m (Mucina & Rutherford 2006).

Vegetation and landscape features: Plains or slightly irregular undulating plains with open to dense *Acacia karroo* bush clumps in dry grasslands (Mucina & Rutherford 2006). Geology and soils: Shale, slate and quartzite of the Pretoria Group with interlaid diabase sills and Hekpoort lava supporting relatively shallow and rocky soils (Glenrosa and Mispah forms). Equally represented are eutrophic red plinthic soils (Hutton form) derived mainly from a thick succession of volcanics and sediments of the Ventersdorp Supergroup (Mucina & Rutherford 2006).

Climate: Warm-temperate, summer-rainfall region, with overall mean annual precipitation of 533 mm. Summer temperatures are high. Frequent frosts occur in winter (Mucina & Rutherford 2006).

Important taxa of the Klerksdorp Thornveld listed by Mucina & Rutherford (2006): Small Trees: *Acacia karroo*, *Acacia caffra*, *Celtis africana*, *Searsia lancea*, *Ziziphus mucronata*. Tall Shrubs: *Acacia hebeclada*, *Diospyros lycioides* subsp. *lycioides*, *Ehretia rigida*, *Grewia flava*, *Gymnosporia buxifolia*, *Searsia pyroides*, *Tarchonanthus camphoratus*. Woody Climber: *Asparagus africanus*. Low Shrubs: *Asparagus laricinus*, *Asparagus suaveolens*, *Felicia muricata*, *Anthospermum hispidulum*, *Anthospermum rigidum* subsp. *pumilum*, *Aptosimum elongatum*, *Gnidia capitata*, *Gomphocarpus fruticosus* subsp. *fruticosus*, *Helichrysum dregeanum*, *Leucas capensis*, *Pavonia burchellii*, *Pentzia globosa*, *Solanum supinum* var.

supinum, *Triumfetta sonderi*, *Ziziphus zeyheriana*. Graminoids: *Aristida congesta*, *Cynodon dactylon*, *Eragrostis lehmanniana*, *Eragrostis trichophora*, *Microcloa caffra*, *Panicum coloratum*, *Sporobolus fimbriatus*, *Themeda triandra*, *Andropogon shirensis*, *Anthephora pubescens*, *Aristida junciformis* subsp. *galpinii*, *Aristida stipitata* subsp. *gracilliflora*, *Brachiaria nigropedata*, *Brachiaria serrata*, *Bulbostylis burchellii*, *Cymbopogon pospischilii*, *Digitaria eriantha*, *Diheteropogon amplexans*, *Elionurus muticus*, *Eragrostis curvula*, *Eragrostis obtusa*, *Eragrostis racemosa*, *Eragrostis superba*, *Eustachys paspaloides*, *Heteropogon contortus*, *Setaria sphacelata*, *Sporobolus africanus*, *Tragus berteronianus*, *Trichoneura grandiglumis*, *Triraphis andropogonoides*. Herbs: *Acalypha angustata*, *Acanthospermum australe*, *Berkheya onopordifolia* var. *onopordifolia*, *Berkheya setifera*, *Blepharis integrifolia* var. *clarkei*, *Chamaesyce inaequilatera*, *Chascanum adenostachyum*, *Dicoma macrocephala*, *Helichrysum nudifolium* var. *nudifolium*, *Hermannia lancifolia*, *Hibiscus pusillus*, *Justicia anagalloides*, *Lippia scaberrima*, *Nidorella microcephala*, *Nolletia ciliaris*, *Pollichia campestris*, *Rhynchosia adenodes*, *Salvia radula*, *Selago densiflora*, *Teucrium trifidum*, *Tolpis capensis*. Geophytic Herbs: *Bulbine narcissifolia*, *Ledebouria marginata*, *Ornithogalum tenuifolium* subsp. *tenuifolium*, *Raphionacme hirsuta*. Herbaceous Climber: *Rhynchosia venulosa*.

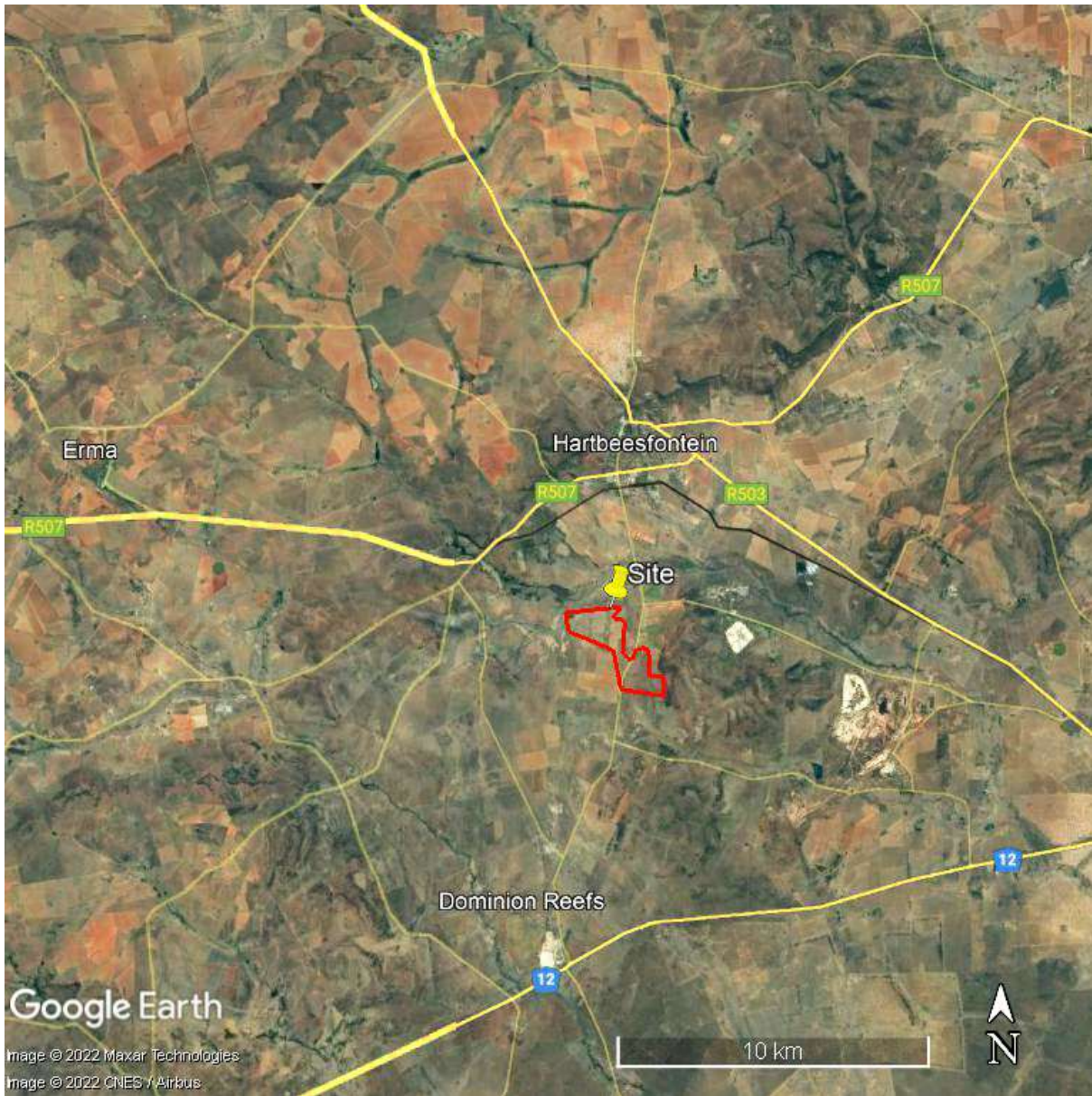


Figure 1 Map with an indication of the location of the site.

Map information were analysed and depicted on Google images with the aid of Google Earth Pro (US Dept. of State Geographer, MapLink/ Tele Atlas, Google, 2021).

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 by R.F. Terblanche during January 2022 and February 2022 were conducted to note key elements of habitats on the site, relevant to the conservation of fauna and flora. The main purpose of the site visits was ultimately to serve as a habitat survey 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 or signs that were observed.

3.1 Habitat characteristics and vegetation

The habitat was investigated by noting habitat structure (rockiness, slope, plant structure/ physiognomy) 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 Boon (2010), 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 (1997). 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).

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 spoor and signs. Trapping was not done since it proved not necessary in the case of this study. Habitat characteristics were also surveyed to note potential occurrences of mammals. 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 then some species need examination of skulls, or even chromosomes (Apps, 2000).

3.3 Birds

Birds were noted as sight records, mainly with the aid of binoculars (10x30). Nearby bird calls of which the observer was sure of the identity were also recorded. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques Ryan (2001) is followed. For information on identification, biogeography and ecology Barnes (2000), Hockey, Dean & Ryan, P.G. (2005), Cillié, Oberprieler & Joubert (2004), Tarboton & Erasmus (1998) and Chittenden, Davies & Weiersbye (2016) were consulted. Ringing of birds fell beyond the scope of this survey and was not deemed necessary. Sites have been walked, covering as many habitats as possible. Signs of the presence of bird species such as spoor and nests have additionally been recorded. Habitat characteristics were surveyed to note potential occurrences of birds.

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. 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*, *Chrysothrix*, *Erikssonina*, *Lepidochrysothrix* and *Orachrysothrix* 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 is on a habitat survey.

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 *Ichneustoma* 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. Surveys were conducted during January 2022 and February 2022 which include an optimal time of the year to find signs of animals such as invertebrates, signs of habitat sensitive plant species and vertebrate animal species high conservation priority. Weather conditions during the surveys were favourable for recording fauna and flora. The focus of the 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

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

HABITAT FEATURE	DESCRIPTION
Topography	The area proposed for the development is on gentle (flat) to moderate slopes.
Rockiness	Rocky ridges are absent at most of the site. Rocky outcrops are present at the western part of the site.
Presence of wetlands	No wetlands appear to be present at the footprint proposed for the development. A narrow non-perennial river, with its active channel and riparian zone, is present at the northwestern part of the site. An in-channel dam (Dam 1), is present at the northeastern part of the site. Another poorly defined active channel and riparian zone is present at the central part of the site. There is a very small dam (Dam 2) at this poorly defined active channel.
Vegetation	<p>Vegetation at the site ranges from modified (cultivated fields) and ecologically degraded to patches of grassland in fair condition. The grass species <i>Digitaria eriantha</i> is conspicuous at the cultivated fields.</p> <p>Terrestrial vegetation at the site comprises grassland with a few trees. Cultivated fields planted for grazing as well as more natural grassland are present at the western and central part of the site. Savanna-like grassland is present at the eastern part of the site.</p> <p>Vegetation reminiscent of savanna at eastern part of the site. The indigenous tree species <i>Vachellia karoo</i>, <i>Vachellia hebeclada</i> and some individuals of <i>Vachellia erioloba</i> are present at the eastern savanna-like grassland at the site. Other indigenous tree species at this eastern part of the site include <i>Grewia flava</i>, <i>Ziziphus mucronata</i> and <i>Searsia lancea</i>. The shrub <i>Asparagus laricinus</i> and the climber <i>Clematis brachiata</i> are also visible in this area. Dwarf shrubs <i>Felicia muricata</i> and <i>Ziziphus zeyheriana</i> are also present. Indigenous grass species include <i>Elionurus muticus</i>, <i>Eragrostis gummiflua</i>, <i>Aristida congesta</i>, <i>Cynodon dactylon</i>, <i>Eragrostis lehmanniana</i>, <i>Sporobolus fimbriatus</i>, <i>Sporobolus africanus</i>, <i>Themeda triandra</i>, <i>Aristida junciformis</i>, <i>Cymbopogon pospischilii</i>, <i>Digitaria eriantha</i>, <i>Heteropogon contortus</i>, <i>Setaria sphacelata</i>, <i>Sporobolus africanus</i> and <i>Eragrostis superba</i>. Indigenous herbaceous plant species include <i>Helichrysum nudifolium</i>, <i>Helichrysum rugulosum</i>, <i>Hilliardiella oligocephala</i>, <i>Lippia scaberrima</i>, <i>Teucrium trifidum</i>, <i>Chamaesyce inaequilatera</i>, <i>Barleria macrostegia</i> and <i>Pavonia burchellii</i>. The geophytes <i>Bulbine narcissifolia</i>, <i>Hypoxis hemerocallidea</i> and <i>Boophone disticha</i> are present.</p> <p>Terrestrial grassland at central and western part of the site. The most conspicuous grass species at the cultivated grassland (for grazing) is <i>Digitaria eriantha</i>. More natural grassland with few trees and shrubs occurs at this central and western part of the site, as well. Trees and shrubs include <i>Vachellia karoo</i>, <i>Searsia pyroides</i>, <i>Asparagus laricinus</i>, <i>Vachellia hebeclada</i> and <i>Seriphium plumosum</i>. Grass species in the more natural but somewhat degraded grassland include <i>Aristida congesta</i>, <i>Pogonarthria squarrosa</i>, <i>Cynodon dactylon</i>, <i>Eragrostis curvula</i>, <i>Eragrostis chloromelas</i>, <i>Eragrostis lehmanniana</i>, <i>Chloris virgata</i>, <i>Cymbopogon caesius</i>, <i>Eragrostis superba</i>, <i>Setaria sphacelata</i>, <i>Themeda triandra</i>, <i>Hyparrhenia hirta</i>, <i>Cymbopogon pospischilii</i>, <i>Digitaria eriantha</i>, <i>Eragrostis gummiflua</i>, <i>Melinis repens</i> and <i>Urochloa mocambicensis</i>. Dwarf shrubs <i>Felicia muricata</i> and <i>Ziziphus zeyheriana</i> are also found at this area. The karoo element <i>Pentzia globosa</i> occurs at hitherto cleared or eroded areas.</p> <p>Vegetation at the riparian zone and along the fringes of the in-channel dam (Dam 1) at the western part of the site include the trees <i>Vachellia karoo</i> and <i>Searsia pyroides</i>. Shrubs such as <i>Asparagus laricinus</i> and the herbaceous shrub <i>Gomphocarpus fruticosus</i> are conspicuous near and at the riparian zone. The indigenous herbaceous plant species <i>Berkheya radula</i> and the alien invasive <i>Cirsium vulgare</i> are found at the outer edges of the riparian zone. Sedge species such as <i>Cyperus longus</i> and <i>Eleocharis limosa</i>, with the grass species <i>Echinochloa holubii</i> and herbaceous <i>Persicaria</i> species are present at the more permanently inundated soils at the riparian zone. The alien invasive grass</p>

	<p>species <i>Paspalum dilatatum</i> as well as the alien invasive herbaceous species <i>Oenothera rosea</i> and <i>Rumex crispus</i> occur at the riparian zone and edges of the in-channel dam as well.</p> <p>The riparian vegetation along the poorly defined active channel at the central part of the site is also poorly defined in many areas. Few trees or shrubs are present at this riparian zone. This area appears to be trampled or eroded. The succulents <i>Chasmatophyllum muscilinum</i> and <i>Ruschia canonotata</i> are present at some of these bare areas with the karoo element <i>Pentzia globosa</i>. The sedge <i>Kyllinga erecta</i> is in particular conspicuous at wet areas along the riparian zone. The graminoids <i>Echinochloa holubii</i>, <i>Eleocharis limosa</i> and <i>Kyllinga erecta</i> are visible at the periphery of this small dam (Dam 2).</p> <p>A number of alien invasive weed species are present at disturbed areas across the site. These alien invasive weeds include <i>Bidens bipinnata</i>, <i>Bidens pilosa</i>, <i>Argemone ochroleuca</i>, <i>Gomphrena celosioides</i>, <i>Schkuhria pinnata</i>, <i>Conyza bonariensis</i>, <i>Datura ferox</i>, <i>Richardia brasiliensis</i>, <i>Acanthospermum australe</i>, <i>Tagetes minuta</i>, <i>Guilleminea densa</i> and <i>Alternanthera pungens</i>.</p>
Signs of disturbances	<p>Large parts of the site consist of cultivated or hitherto cultivated fields. Ecological disturbances such as homesteads, fences, dirt roads and concrete dams, infrastructure typically associated with farming, are present at the site. A tar road runs through the site. Diggings, where water may occasionally gather during some rainfall events, are present at the site. Alien invasive weeds are conspicuous at disturbed areas, in particular at hitherto cleared places.</p>
Connectivity	<p>There is little scope for most of the site to be part of a corridor of particular conservation importance, excluding the watercourses (with their bufferzones) and the area where rocky outcrops are present. The non-perennial rivers at the site, as well as the rocky outcrops at the western part of the site are considered to be biodiversity corridors of particular conservation importance.</p>



Photo 1 Cultivated fields, where a grazing grass species *Digitaria eriantha* is conspicuous at the central-western part of the site.

Photo: R.F. Terblanche.



Photo 2 View from the central-western part of the site.

Photo: R.F. Terblanche



Photo 3 In-channel dam (Dam 1) at the northwestern part of the site. Areas in the background are outside the site.
Photo: R.F. Terblanche.



Photo 4 Small in-channel dam (Dam 2) at the central part of the site.
Photo: R.F. Terblanche



Photo 5 View of the eastern part of the site. The hill in the background is not part of the area considered for the footprint.

Photo: R.F. Terblanche.



Photo 6 View of savannoid vegetation at the eastern part of the site.

Photo: R.F. Terblanche



Photo 7 View at the eastern part of the site.
Photo: R.F. Terblanche.



Photo 8 View towards the southern fence of the eastern part of the site where clumps of alien invasive *Eucalyptus* trees are present.
Photo: R.F. Terblanche



Photo 9 Inflorescence of the grass species *Digitaria eriantha* at the site.
Photo: R.F. Terblanche.



Photo 10 Inflorescence of the grass species *Pogonarthria squarrosa* at the site.
Photo: R.F. Terblanche



Photo 11 The shrub *Seriphium plumosum* (Bankrupt Bush) at the site.
Photo: R.F. Terblanche.



Photo 12 The shrub *Asparagus larycinus*, at the site.
Photo: R.F. Terblanche



Photo 13 Flowers of the widespread indigenous plant species *Helichrysum nudifolium*, at the site.
Photo: R.F. Terblanche.



Photo 14 The widespread plant species *Commelina africana*, at the site.
Photo: R.F. Terblanche



Photo 15 The alien invasive succulent plant species *Opuntia ficus-indica*, at the site.
Photo: R.F. Terblanche.



Photo 16 Alien invasive *Cirsium vulgare*, at the site.
Photo: R.F. Terblanche



Photo 17 The widespread but Declining plant species, *Hypoxis hemerocallidea*, at the site.
Photo: R.F. Terblanche.



Photo 18 The widespread but Declining plant species, *Boophone disticha*, at the site.
Photo: R.F. Terblanche



Photo 19 *Vachellia erioloba* (Camel Thorn tree) at the eastern part of the site.
Photo: R.F. Terblanche.



Photo 20 Foliage and branches of *Vachellia erioloba* (Camel Thorn tree) at the site.
Photo: R.F. Terblanche



Photo 21 Leaves of *Erythrina zeyheri*, among grasses, at the site.
Photo: R.F. Terblanche.



Photo 22 The widespread butterfly species, *Papilio demodocus* (Citrus Swallowtail) feeding on the nectar of flowers of *Lippia scaberrima* at the site.
Photo: 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
<i>Brachystelma canum</i>	Critically Endangered	No
<i>Brachystelma gracillimum</i>	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
<i>Aloe peglerae</i>	Endangered	No
<i>Brachystelma discoideum</i>	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
<i>Brachycorythis conica</i> subsp. <i>transvaalensis</i>	Vulnerable	No
<i>Brachystelma incanum</i>	Vulnerable	No
<i>Ceropegia decidua</i> subsp. <i>pretoriensis</i>	Vulnerable	No
<i>Ceropegia stentiae</i>	Vulnerable	No
<i>Ledebouria atrobrunnea</i>	Vulnerable	No
<i>Marsilea farinosa</i>	Vulnerable	No
<i>Melolobium subspicatum</i>	Vulnerable	No
<i>Prunus africana</i>	Vulnerable	No
<i>Rennera stellata</i>	Vulnerable	No
<i>Searsia maricoan</i>	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:	Resident at the site
	Global status or national status indicated	
<i>Adromischus umbraticola</i> subsp. <i>umbraticola</i>	Near Threatened	No
<i>Ceropegia turricula</i>	Near Threatened	No
<i>Cineraria austrotransvaalensis</i>	Near Threatened	No
<i>Cleome conrathii</i>	Near Threatened	No
<i>Delosperma leendertziae</i>	Near Threatened	No
<i>Drimia sanguinea</i>	Near Threatened	No
<i>Elaeodendron transvaalense</i>	Near Threatened	No
<i>Kniphofia typhoides</i>	Near Threatened	No
<i>Lithops leslei</i> subsp. <i>leslei</i>	Near Threatened	No
<i>Nerine gracilis</i>	Near Threatened	No
<i>Sporobolus oxyphyllus</i>	Near Threatened	No
<i>Stenostelma umbelluliferum</i>	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
<i>Gladiolus filiformis</i>	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:	Resident at the site
	Global status or national status indicated	
<i>Brachystelma dimorphum</i> subsp. <i>gratum</i>	Rare	No
<i>Ceropegia insignis</i>	Rare	No
<i>Frithia pulchra</i>	Rare	No
<i>Gnaphalium nelsonii</i>	Rare	No
<i>Habenaria culveri</i>	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
<i>Boophone disticha</i>	Declining	Yes
<i>Crinum bulbispermum</i>	Declining	No
<i>Crinum macowanii</i>	Declining	No
<i>Drimia altissima</i>	Declining	No
<i>Eucomis autumnalis</i>	Declining	No
<i>Gunnera perpensa</i>	Declining	No
<i>Hypoxis hemerocallidea</i>	Declining	Yes
<i>Ilex mitis</i>	Declining	No
<i>Pelargonium sidoides</i>	Declining	No

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 15(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
<i>Boscia albitrunca</i> (Sheppard's tree)	Protected	No
<i>Combretum imberbe</i> (Leadwood)	Protected	No
<i>Sclerocarya birrea</i> (Marula)	Protected	No
<i>Securidaca longepedunculata</i> (Violet Tree)	Protected	No
<i>Vachellia erioloba</i> (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	Recorded at site during survey	Likely to be found based on habitat assessment
<i>Chrysospalax villosus</i> Rough-haired golden mole	Vulnerable	No	No
<i>Cloeotis percivali</i> Short-eared Trident Bat	Vulnerable/ Near-threatened	No	No
<i>Diceros bicornis</i> Black rhinoceros	Critically Endangered	No	No
<i>Lycaon pictus</i> African wild dog	Endangered	No	No
<i>Loxodonta africana</i> African elephant	Vulnerable	No	No
<i>Mystromys albicaudatus</i> White-tailed mouse	Endangered	No	No
<i>Neamblysomus julianae</i> Juliana's Golden Mole	Critically Endangered	No	No
<i>Panthera leo</i> Lion	Vulnerable	No	No
<i>Rhinolophus blasii</i> Blasi's Horseshoe Bat	Vulnerable	No	No
<i>Smutsia temminckii</i> Ground Pangolin	Vulnerable	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	Recorded at site during survey	Likely to be found based on habitat assessment
<i>Ceratotherium simum</i> White Rhinoceros	Near threatened	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
<i>Myosorex varius</i> Forest shrew	Uncertain	No	No

4.3.2 Birds of particular high conservation priority

Kindly refer to the avifaunal specialist study (Van Rooyen, 2022).

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
<i>Crocodylus niloticus</i> 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 of 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
<i>Homoroselaps dorsalis</i> 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
<i>Pyxicephalus adspersus</i> Giant Bullfrog	Least Concern (IUCN) Remains a species of particular conservation concern.	No	No	No

4.4 ASSESSMENT OF INVERTEBRATE SPECIES OF PARTICULAR CONSERVATION PRIORITY

4.4.1 Butterflies of particular conservation priority

Table 4.16 Threatened butterfly species in North West Province and Gauteng Province (Mecenero *et al.* 2020). Sources of information: Henning, Terblanche & Ball (2009), Mecenero *et al.* (2013), Mecenero *et al.* (2020). 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
<i>Aloeides dentatis dentatis</i> Roodepoort Toothed Russet	Endangered	No	Highly unlikely
<i>Chrysochrysis aureus</i> Golden Opal/ Heidelberg Copper	Endangered	No	Highly unlikely
<i>Lepidochrysops praeterita</i> Highveld Giant Cupid/ Highveld Blue	Endangered	No	Highly unlikely
<i>Orachrysops mijburghii</i> Heilbron Cupid	Endangered	No	Highly unlikely

Table 4.17 Butterfly species of the North West Province and Gauteng Province that are Near Threatened (Mecenero *et al.*, 2020). No = Butterfly species is unlikely to be a resident at the study area;

Yes = Butterfly species is a resident at the study area. Sources of information Henning, Terblanche & Ball (2009), Mecenero *et. al.* (2013), Mecenero *et. al.* (2020).

Species	Threatened Status	Recorded at site during survey	Residential status at the site: Yes confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Metisella meninx</i> Marsh Sylph	Near Threatened	No	Possibly but riparian zone at site not ideal habitat; could use riparian zone as corridor

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
<i>Ichnestoma stobbiai</i>	Uncertain	No	No
<i>Trichocephala brincki</i>	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
<i>Hadogenes gracilis</i>	Uncertain	No	No
<i>Hadogenes gunningi</i>	Uncertain	No	No

5 DISCUSSION

5.1 Habitat and vegetation characteristics

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

5.2 Plants

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.

One plant species, *Vachellia erioloba* (Camel Thorn) that is not threatened but listed as Protected tree species occurs at the site. In terms of a part of section 15(1) of the National Forests 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. *Vachellia erioloba* does not occur in any large numbers at the site. A Camel Thorn Tree Forest or large camel thorn trees (>10 m) such as at Kathu and Witsand in the Northern Cape

Province, are absent at the site. If the development is approved it is likely that some Camel Thorn trees (*Vachellia erioloba*) should be removed, in which case a permit should be applied for.

Two plant species, which are not threatened but listed as Declining occur at the site: *Boophone disticha* and *Hypoxis hemerocallidea* (Star Flower). A search and rescue operation should apply for these plant species. These plant species can be translocated to a suitable area nearby or at the site by a qualified specialist (plant species such as *Boophone disticha* are highly toxic to humans).

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

Kindly refer to the avifaunal specialist study (Van Rooyen, 2022)

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. Main Source used for the conservation status and identification of reptiles are Bates, Branch, Bauer, Burger, Marais, Alexander & de Villiers (2014). Alexander & Marais (2007) as well as Tolley & Burger 2007) give useful indications of distributions, habitats and identification of the reptile species. 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 listed as Threatened species (Vulnerable, Endangered or Critically Endangered) or Near Threatened species according to IUCN Amphibian Specialist Group (2013). Table 4.15 lists *Pyxicephalus adspersus* (Giant Bullfrog) as Least Concern globally.). Suitable habitat for Giant Bullfrog at site appears to be absent.

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 Toothed Russet)**

The proposed global red list status for *Aloeides dentatis dentatis* according to the most recent IUCN criteria and categories is Endangered (Mecenero *et al.*, 2020). *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.

***Chrysochrysis aureus* (Golden Opal/ Heidelberg Copper)**

The proposed global red list status for *Chrysochrysis aureus* according to the most recent IUCN criteria and categories is Endangered (Mecenero *et al.*, 2020) *Chrysochrysis aureus* (Golden

Opal/ Heidelberg Copper) is a resident where the larval host plant, *Clusia 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 *Chrysothrix 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 *Chrysothrix 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.*, 2020). *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 mijburghii* (Mijburgh's Blue)**

The proposed global red status for *Orachrysops mijburghii* according to the most recent IUCN criteria and categories is Endangered (Mecenero *et al.*, 2020). *Orachrysops mijburghii* favours grassland depressions where specific *Indigofera* plant species occur (Terblanche & Edge 2007). The Heilbron population of *Orachrysops mijburghii* 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 mijburghii* on the site and it is unlikely that *Orachrysops mijburghii* 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 Near Threatened

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 Near Threatened (Mecenero *et al.*, 2020). 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). There is not an ideal habitat for the species at the riparian zone at the site. However, it could be that the butterfly species uses the riparian zone as corridor, or even habitat if more suitable from time to time.

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 *Ichneustoma stobbiai* or *Trichocephala brincki* were found during the surveys. There appears to be no suitable habitat for *Ichneustoma 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 Screening tool (DEFF) and groundtruthing

Possible ecological sensitivities at the site were indicated by a report generated from the screening tool of DEFF (most recent generated report done in February 2022). These ecological sensitivities that could possibly/ are present at the site, follows.

Plant species theme sensitivity

Relative plant species theme sensitivity is medium. During the surveys at the site the medium sensitivity of plant species at the site has been confirmed. This medium sensitivity is because of the presence of widespread (not threatened) Declining plant species *Boophone disticha* and *Hypoxis hemerocallidea*. The widespread (not threatened) Protected tree species *Vachellia erioloba* is also present at the eastern part of the site.

Animal species theme sensitivity

Relative animal species theme sensitivity is low. During the surveys this status quo has been confirmed. The watercourses at the site remain an important conservation corridor at the larger area for a number of animal species including waterbirds. The importance of the watercourses at the site as a conservation corridor is accounted for in the aquatic biodiversity theme and also the mitigation measures with regards to proposed developments or avoidance of any developments at parts of the site.

Aquatic biodiversity theme sensitivity

Relative aquatic biodiversity theme sensitivity at the site is very high. This very high sensitivity is owing to the presence of watercourses at the site. Surveys at the site identified these watercourses as non-perennial active channels (streambeds), with riparian zones. There are

also small in-channel dams which contain some wetland vegetation at and near the edges of these artificial waterbodies (dams). Kindly refer to the wetland and riparian assessment which are addressed in a separate report (Terblanche, 2022b) which accompanies this report.

Terrestrial biodiversity theme sensitivity

Relative terrestrial biodiversity at the site is very high. This high sensitivity that is ascribed to most of the site area, is because of the presence of Critical Biodiversity Area 1 as well as Ecological Support Area 1. The main basis of these terrestrial biodiversity sensitivities at the site is the presence of an Endangered ecosystem, the Vaal-Vet Sandy Grassland vegetation type which include the site. During surveys at the site, it was found that the original vegetation type is modified at large parts of the site and that the scope to conserve the small more natural remaining grassland at the site as a conservation area for the vegetation type, is small.

5.6 Ecological Sensitivity at the site

Ecological sensitivity at the site ranges from high and medium to low. Ecological sensitivity at the hitherto cultivated areas is low. Ecological sensitivity at the disturbed grassland at the site is medium. Ecological sensitivity at the non-perennial active channels, in-channel dams and riparian zones, as well as the area with rocky outcrops at the site is high owing to the importance of these watercourses and outcrops as conservation corridors for biodiversity in the larger area (Figure 5).

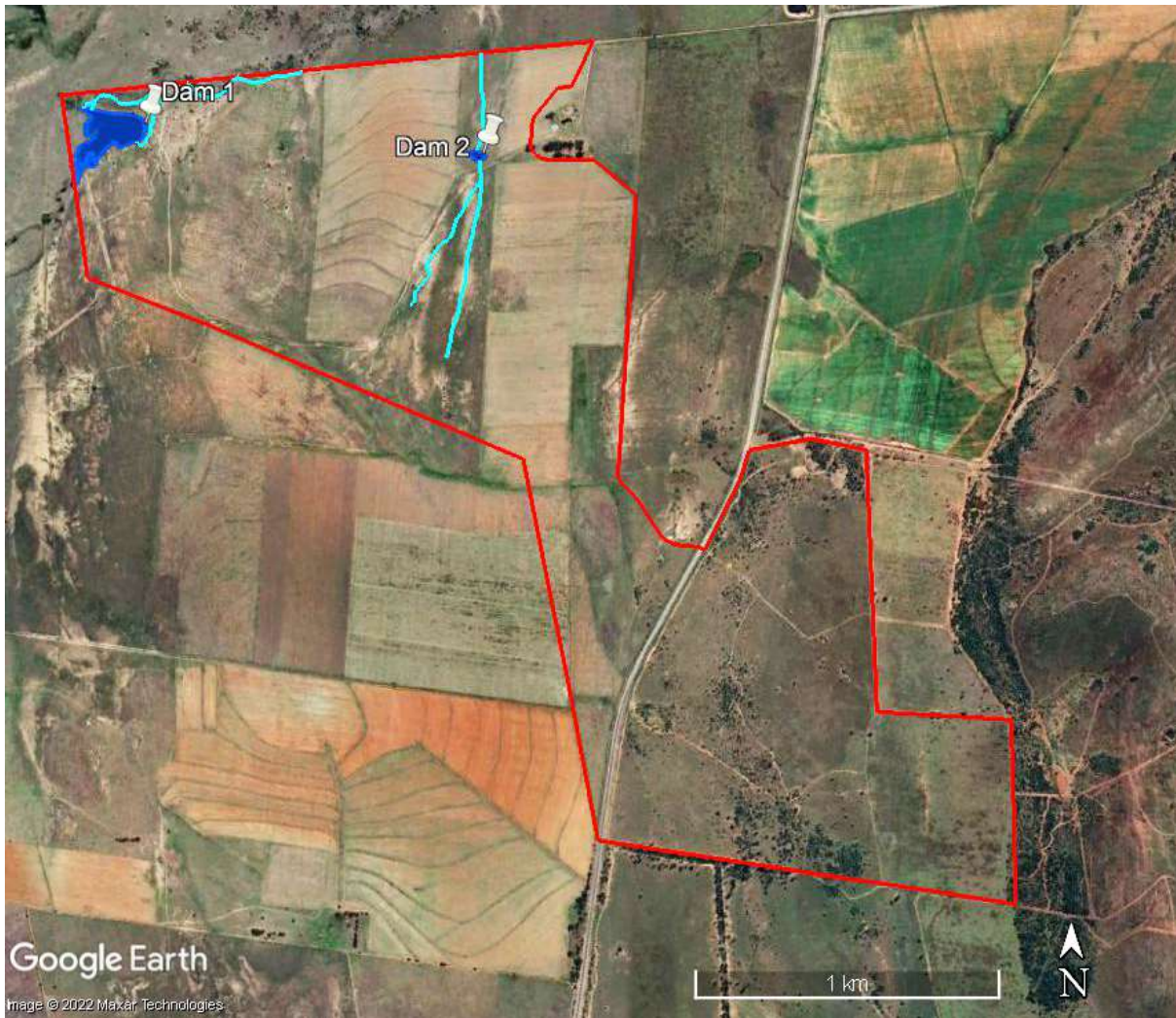


Figure 2 Indication the narrow non-perennial rivers and in-channel dams, at the site.

- | | |
|---|--|
| <ul style="list-style-type: none"> — Light blue outline — Darker blue outline and shading | <ul style="list-style-type: none"> Route of active channel at the site Artificial Waterbody (In-channel Dam) |
|---|--|

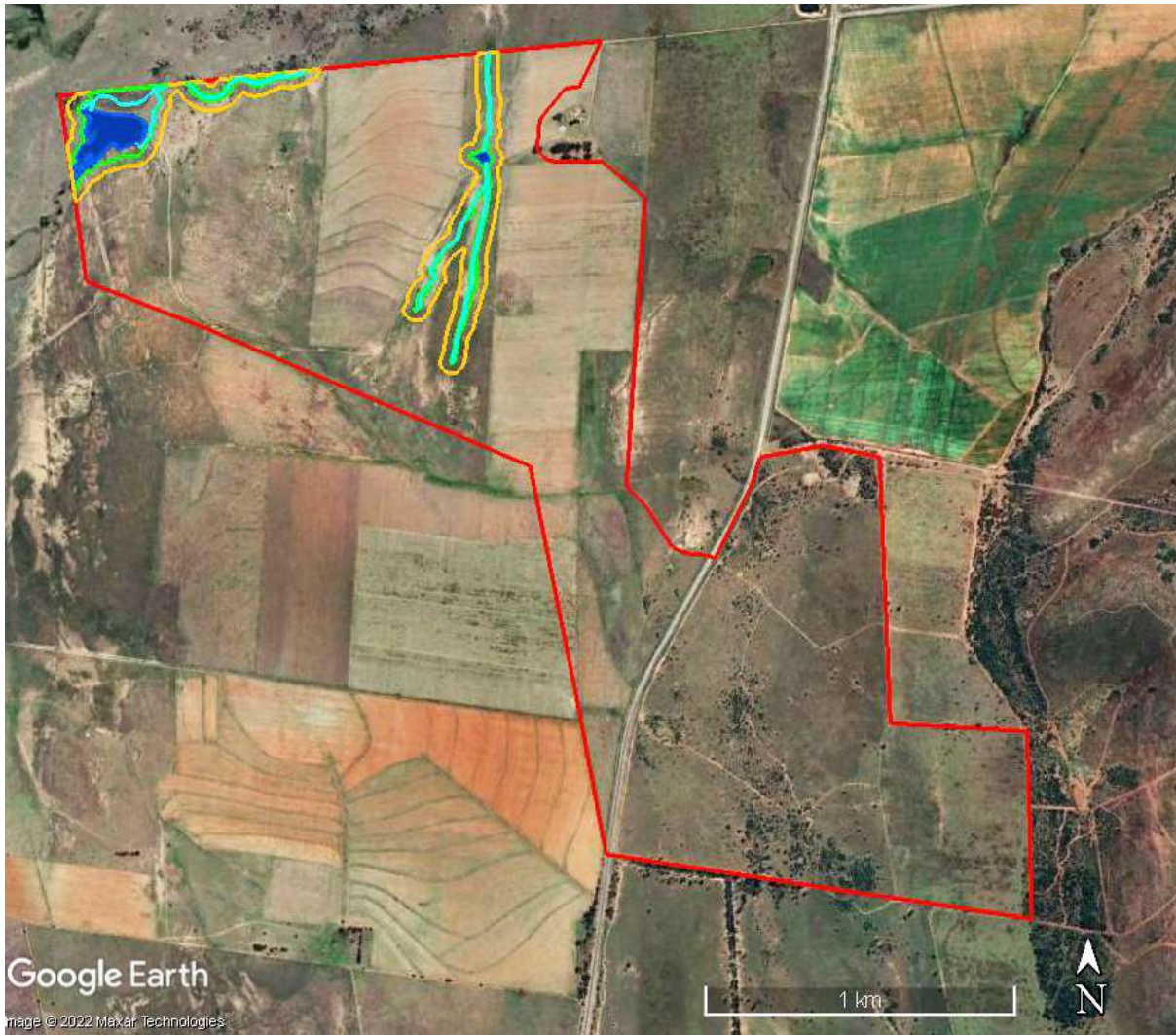






Figure 3 Indication of non-perennial rivers, in-channel dams, with their riparian zones and buffer zones (30 m), at the site.

- | | | |
|---|---------------------------------|---------------------------------------|
|  | Light blue outline | Route of active channel at the site |
|  | Green outline and shading | Outer edge of riparian zone |
|  | Orange outline | Outer edge of buffer zone |
|  | Darker blue outline and shading | Artificial Waterbody (In-channel Dam) |

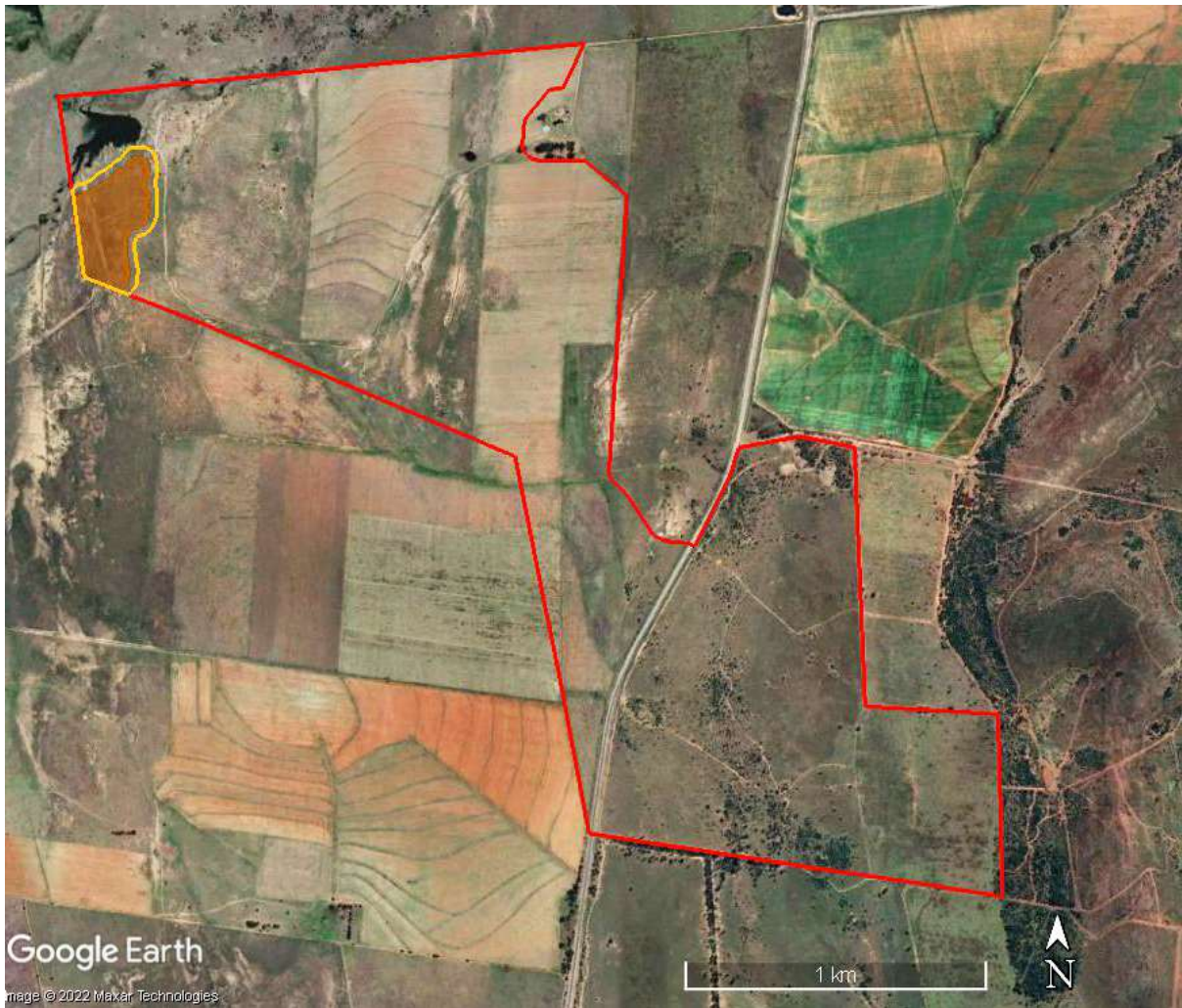



Figure 4 Indication of an area where a number of rocky outcrops are present at the site. A buffer zone (30 m) is also indicated.

-  Brown outline and shading Area where a number of rocky outcrops are present

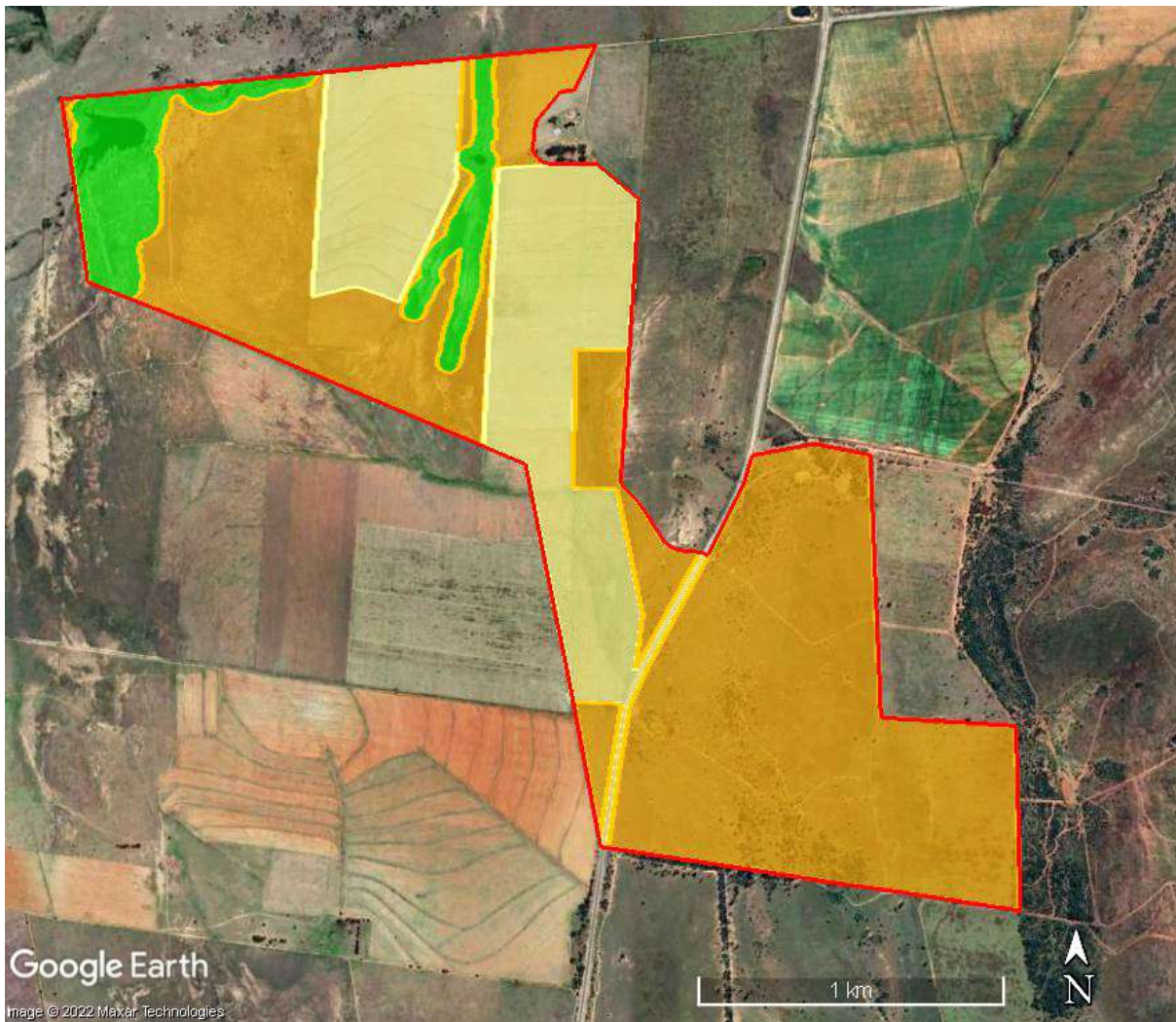


Figure 5 Indications of ecological sensitivity at the site.

- | | | |
|---------------------------------------|----------------------------------|------------------------|
| — | Red outline | Boundaries of the site |
| — | Light yellow outline and shading | Low Sensitivity |
| — | Orange outline and shading | Medium Sensitivity |
| — | Green outline and shading | High Sensitivity |

6 RISKS, IMPACTS AND MITIGATION

Background:

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). Furthermore, corridors and linkages may play a significant role in insect conservation (Pryke & Samways, 2003, Samways, 2005).

Urbanisation is a major additional influence on the loss of natural areas (Rutherford & Westfall 1994). In the South Africa the pressure to develop areas are high since its infrastructure allows for improvement of human well-being. Urban nature conservation issues in South Africa are overshadowed by the goal to improve human well-being, which focuses on aspects such as poverty, equity, redistribution of wealth and wealth creation (Cilliers, Müller & Drewes 2004). Nevertheless, the conservation of habitats is the key to invertebrate conservation, especially for those threatened species that are very habitat specific. This is also true for any detailed planning of corridors and buffer zones for invertebrates. Though proper management plans for habitats are not in place, setting aside special ecosystems is in line with the recent Biodiversity Act (2004) of the Republic of South Africa.

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). 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.

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

In the case of this study:

The site contains hitherto cultivated areas, disturbed grassland patches and riparian vegetation along the watercourses. Ecological sensitivity at the site ranges from high and medium to low. Ecological sensitivity at the hitherto cultivated areas is low. Ecological sensitivity at the disturbed grassland at the site is medium. Ecological sensitivity at the non-perennial active channels, in-channel dams and riparian zone, as well as the area with rocky outcrops at the site is high owing to the importance of these watercourses and outcrops as conservation corridors for biodiversity in the larger area (Figure 5).

No Threatened or Near Threatened plant or animal species appear to be resident at the site.

One plant species, *Vachellia erioloba* (Camel Thorn) that is not threatened but listed as Protected tree species occurs at the site. In terms of a part of section 15(1) of the National Forests 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. *Vachellia erioloba* does not occur in any large numbers at the site. A Camel Thorn Tree Forest or large Camel Thorn trees (>10 m) such as at Kathu and Witsand in the Northern Cape Province, are absent at the site. If the development is approved it is likely that some Camel Thorn trees (*Vachellia erioloba*) should be removed, in which case a permit for removal would be imperative, and should be applied for.

An Endangered ecosystem, the Vaal-Vet Sandy Grassland vegetation type, is mapped for parts of the site. During surveys at the site, it was found that the original vegetation type is modified at large parts of the site and that the scope to conserve the small more natural remaining grassland at the site as a conservation area for the vegetation type, is small.

There is little scope for most of the site to be part of a corridor of particular conservation importance. The non perennial streambeds, in-channel dams, riparian zones and buffer zones, as well as the area with rocky outcrops are corridors of particular conservation concern.

The following potential risks, impacts and mitigation measures apply to the proposed development:

6.1 Identification of potential impacts and risks

The potential impacts identified are:

Construction Phase

- Potential impact 1: Loss of habitat owing to the removal of vegetation at the proposed development.
- Potential impact 2: Loss of sensitive species (Threatened, Near Threatened, Rare, Declining or Protected species) during the construction phase.
- Potential impact 3: Loss of connectivity and conservation corridor networks in the landscape.
- Potential impact 4: Contamination of soil during construction in particular by hydrocarbon spills.
- Potential impact 5: Killing of vertebrate fauna during the construction phase.

Operational Phase

- Potential impact 6: An increased infestation of exotic or alien invasive plant species owing to disturbance.

6.2 Potential impacts and risks during the construction phase

Classes of impacts for this study: Very High, High, Moderate, Low, Very Low

Aspect/Activity	Clearance of vegetation at part of the site for the development
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Clearing of vegetation at the proposed development. This will entail the partial destruction of habitat of medium and low ecological sensitivity.
Status	Negative
Mitigation Required	Non-perennial active channels, in-channel dams and riparian zones with 30 m bufferzones, as well as the area with rocky outcrops with 30 m buffer zones are excluded from the development.
Impact Significance (Pre-Mitigation)	High
Impact Significance (Post-Mitigation)	Moderate
RISK	Following the mitigation measures a moderate risk of impact is expected.

Aspect/Activity	Removal of sensitive species
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Sensitive species: Presence of Threatened or Near Threatened Plants, Mammals, Reptiles, Amphibians and Invertebrates at the site appear to be unlikely. A Protected tree species <i>Vachellia erioloba</i> (Camel Thorn) is present at the site.
Status	Negative.
Mitigation Required	No specific mitigation measures for Threatened or Near Threatened sensitive species at the site apply at the site. <u>Mitigation measures for Protected tree species if development is approved:</u> Marking or avoidance of the <i>Vachellia erioloba</i> (Camel Thorn Tree) at the site.
Impact Significance (Pre-Mitigation)	Moderate
Impact Significance (Post-Mitigation)	Low
RISK	A low risk of threat to any sensitive species at the site is anticipated.

Aspect/Activity	Fragmentation of corridors of particular conservation concern
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Non-perennial rivers, in-channel dams, as well as the area with rocky outcrops at the site are corridors of particular conservation concern.
Status	Negative
Mitigation Required	Non-perennial active channels, in channel-dams, riparian zones with 30 m bufferzones as well as area with rocky outcrops with 30 m buffer zones are excluded from the development.
Impact Significance (Pre-Mitigation)	High
Impact Significance (Post-Mitigation)	Low
RISK	Following mitigation, a low impact risk is expected.

Aspect/Activity	Contamination of soil by leaving rubble/ waste or spilling petroleum fuels or any pollutants on soil which could infiltrate the soil
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Rubble or waste could lead to infiltration of unwanted pollutants into the soil. Spilling of petroleum fuels and unwanted chemicals onto the soils that infiltrate these soils could lead to pollution of soils.
Status	Negative
Mitigation Required	Rubble or waste that could accompany the construction effort, if the development is approved, should be removed during and after construction. Measures should be taken to avoid any spills and

	infiltration of petroleum fuels or any chemical pollutants into the soil during construction phase.
Impact Significance (Pre-Mitigation)	Moderate
Impact Significance (Post-Mitigation)	Low
RISKS	A low risk is expected following mitigation.

Aspect/Activity	Possible disturbance, trapping, hunting and killing of vertebrates during construction phase
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	During the construction phase animal species could be disturbed, trapped, hunted or killed.
Status	Negative
Mitigation Required	If the development is approved, contractors must ensure that no animal species are disturbed, trapped, hunted or killed during the construction phase.
Impact Significance (Pre-Mitigation)	Moderate
Impact Significance (Post-Mitigation)	Low
RISKS	Following mitigation a low risk is anticipated.

6.3 Potential impacts during the operational phase

Aspect/Activity	An increased infestation of exotic or alien invasive plant species owing to clearance or disturbance where the footprint took place.
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Infestation by alien invasive species could replace indigenous vegetation or potential areas where indigenous vegetation could recover. It is in particular declared alien invasive species such as <i>Prosopis glandulosa</i> (Mesquite), <i>Melia azedarach</i> (Syringa) or alien invasive Australian <i>Acacia</i> species (Australian Wattles) that should not be allowed to establish. Once established these combatting these alien invasive plant species may become very expensive in the long term.
Status	Negative
Mitigation Required	Continued monitoring and eradication of alien invasive plant species are imperative. It is in particular declared alien invasive species such as <i>Prosopis glandulosa</i> (Mesquite), <i>Melia azedarach</i> (Syringa) and alien invasive Australian <i>Acacia</i> species (Australian wattles) that should not be allowed to establish.
Impact Significance (Pre-Mitigation)	Moderate
Impact Significance (Post-Mitigation)	Low
RISKS	Following mitigation, a low risk is anticipated.

6.4 Risk and impact assessment summary for the construction phase

Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of Impact	Irreplaceability	Potential Mitigation Measures	Significance of Impact and Risk		Confidence Level
										Without Mitigation/ Management	With Mitigation/ Management (Residual Impact/ Risk)	
Clearing of vegetation	Habitat loss, loss of indigenous species	Negative	Part of site	Long-Term	Substantial	Very likely	Low	Low	Keep disturbance to less sensitive area. Avoid watercourse and buffer zone and avoid rocky outcrops and buffer zones. Non-perennial active channels, riparian zones with 30 m bufferzones as well as area with rocky outcrops and 30 m buffer zones are excluded from the development.	High	Moderate	High
Loss of sensitive species	Loss of sensitive species (Note no Threatened species or Near-threatened species)	Negative	Site	Long-Term	Very low (No species anticipated)	Unlikely	Not applicable	Not applicable	No specific mitigation measures apply to Threatened and Near Threatened sensitive species at the site. Mitigation measures for Protected tree species: Marking of the <i>Vachellia erioloba</i> (Camel Thorn) trees at the site. Avoid of these trees where possible. Apply for permit where avoidance is not practical.	High	Moderate	High

Loss of corridors of particular conservation concern	Fragmentation of landscape and loss of connectivity	Negative (Neutral for threatened species)	Site	Long-Term	Moderate	Unlikely	Moderate	Moderate	Demarcate and avoid watercourses and buffer zones. Non-perennial active channels, riparian zones with 30 m bufferzones are excluded from the development. Area with rocky outcrops and 30 m bufferzones are excluded from the development.	High	Low	High
Contamination of soil by spilling pollutants on soil which could infiltrate the soil	Soil contamination	Negative	Site	Long-Term	Moderate	Unlikely	Moderate	Moderate	Rubble and waste removal. Measures that avoid hydrocarbon (petroleum) spills to get into contact with the soil.	Moderate	Low	High
Disturbance or killing of vertebrates	Disturbance or killing of species	Negative	Site	Long-Term	Moderate	Unlikely	Moderate	Moderate	If the development is approved, contractors must ensure that no animal species are disturbed, trapped, hunted or killed during the construction phase.	Moderate	Low	High

6.5 Risk/ Impact assessment summary for the operational phase

Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of Impact	Irreplaceability	Potential Mitigation Measures	Significance of Impact and Risk		Confidence Level
										Without Mitigation/ Management	With Mitigation/ Management (Residual Impact/ Risk)	
Increased infestation of exotic or alien invasive plant species	Loss of habitat quality	Negative	Site	Long-Term	Substantial	Likely	Moderate	Moderate	Monitoring and eradication of alien invasive plant species	Moderate	Low	High

6.6 Summary of risks and impacts

Ecological sensitivity at the site ranges from high and medium to low. Ecological sensitivity at the hitherto cultivated areas is low. Ecological sensitivity at the disturbed grassland at the site is medium. Ecological sensitivity at the non-perennial active channels, in-channel dams and riparian zone, as well as the area with rocky outcrops at the site is high owing to the importance of these watercourses and outcrops as conservation corridors for biodiversity in the larger area (Figure 5).

One plant species, *Vachellia erioloba* (Camel Thorn) that is not threatened but listed as Protected tree species occurs at the site. In terms of a part of section 15(1) of the National Forests 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. *Vachellia erioloba* does not occur in any large numbers at the site. A Camel Thorn Tree Forest or large camel thorn trees (>10 m) such as at Kathu and Witsand in the Northern Cape Province, are absent at the site. If the development is approved it is likely that some Camel Thorn trees (*Vachellia erioloba*) should be removed, in which case a permit should be applied for.

Two plant species, which are not threatened but listed as Declining occur at the site: *Boophone disticha* and *Hypoxis hemerocallidea* (Star Flower). A search and rescue operation should apply for these plant species. These plant species can be translocated to a suitable area nearby or at the site by a qualified specialist (plant species such as *Boophone disticha* are highly toxic to humans).

The non-perennial rivers and in-channel dams (with active channel, riparian zone and buffer zone) as well as the area with rocky outcrops and their buffer zones are excluded from the development. Risks and possible impacts to the watercourses if the bufferzone is upheld, are not expected to be significant because excessive surface flow and erosion are not anticipated. There is no distinct indication that interflow plays an important role in the maintenance of the watercourse. The geomorphological setting and flow regime will not be impacted. Loss of any wetland animal or plant species are not expected.

Following the mitigations which will be upheld and planned footprint for development all the impact risks listed above are moderate or low.

7 CONCLUSION

- Vegetation at the site ranges from modified (cultivated fields) and ecologically degraded to patches of grassland in fair condition. The grass species *Digitaria eriantha* is conspicuous at the cultivated fields.
- Terrestrial vegetation at the site comprises grassland with a few trees. Cultivated fields planted for grazing as well as more natural grassland are present at the western and central part of the site. Savanna-like grassland is present at the eastern part of the site.
- Vegetation reminiscent of savanna at eastern part of the site. The indigenous tree species *Vachellia karoo*, *Vachellia hebeclada* and some individuals of *Vachellia erioloba* are present at the eastern savanna-like grassland at the site. Other indigenous tree species at this eastern part of the site include *Grewia flava*, *Ziziphus mucronata* and *Searsia lancea*. The shrub *Asparagus larycinus* and the climber *Clematis brachiata* are also visible in this area. Dwarf shrubs *Felicia muricata* and *Ziziphus zeyheriana* are also present. Indigenous grass species include *Elionurus muticus*, *Eragrostis gummiflua*, *Aristida congesta*, *Cynodon dactylon*, *Eragrostis lehmanniana*, *Sporobolus fimbriatus*, *Sporobolus africanus*, *Themeda triandra*, *Aristida junciformis*, *Cymbopogon pospischilii*, *Digitaria eriantha*, *Heteropogon contortus*, *Setaria sphacelata*, *Sporobolus africanus* and *Eragrostis superba*. Indigenous herbaceous plant species include *Helichrysum nudifolium*, *Helichrysum rugulosum*, *Hilliardiella oligocephala*, *Lippia scaberrima*, *Teucrium trifidum*, *Chamaesyce inaequilatera*, *Barleria macrostegia* and *Pavonia burchellii*. The geophytes *Bulbine narcissifolia*, *Hypoxis hemerocallidea* and *Boophone disticha* are present.
- Terrestrial grassland at central and western part of the site. The most conspicuous grass species at the cultivated grassland (for grazing) is *Digitaria eriantha*. More natural grassland with few trees and shrubs occurs at this central and western part of the site, as well. Trees and shrubs include *Vachellia karoo*, *Searsia pyroides*, *Asparagus larycinus*, *Vachellia hebeclada* and *Seriphium plumosum*. Grass species in the more natural but somewhat degraded grassland include *Aristida congesta*, *Pogonarthria squarrosa*, *Cynodon dactylon*, *Eragrostis curvula*, *Eragrostis chloromelas*, *Eragrostis lehmanniana*, *Chloris virgata*, *Cymbopogon caesius*, *Eragrostis superba*, *Setaria sphacelata*, *Themeda triandra*, *Hyparrhenia hirta*, *Cymbopogon pospischilii*, *Digitaria eriantha*, *Eragrostis gummiflua*, *Melinis repens* and *Urochloa*

mocambicensis. Dwarf shrubs *Felicia muricata* and *Ziziphus zeyheriana* are also found at this area. The karoo element *Pentzia globosa* occurs at hitherto cleared or eroded areas.

- Vegetation at the riparian zone and along the fringes of the in-channel dam (Dam 1) at the western part of the site include the trees *Vachellia karroo* and *Searsia pyroides*. Shrubs such as *Asparagus laricinus* and the herbaceous shrub *Gomphocarpus fruticosus* are conspicuous near and at the riparian zone. The indigenous herbaceous plant species *Berkheya radula* and the alien invasive *Cirsium vulgare* are found at the outer edges of the riparian zone. Sedge species such as *Cyperus longus* and *Eleocharis limosa*, with the grass species *Echinochloa holubii* and herbaceous *Persicaria* species are present at the more permanently inundated soils at the riparian zone. The alien invasive grass species *Paspalum dilatatum* as well as the alien invasive herbaceous species *Oenothera rosea* and *Rumex crispus* occur at the riparian zone and edges of the in-channel dam as well.
- The riparian vegetation along the poorly defined active channel at the central part of the site is also poorly defined in many areas. Few trees or shrubs are present at this riparian zone. This area appears to be trampled or eroded. The succulents *Chasmatophyllum muscilinum* and *Ruschia canonotata* are present at some of these bare areas with the karoo element *Pentzia globosa*. The sedge *Kyllinga erecta* is in particular conspicuous at wet areas along the riparian zone. The graminoids *Echinochloa holubii*, *Eleocharis limosa* and *Kyllinga erecta* are visible at the periphery of this small dam (Dam 2).
- A number of alien invasive weed species are present at disturbed areas across the site. These alien invasive weeds include *Bidens bipinnata*, *Bidens pilosa*, *Argemone ochroleuca*, *Gomphrena celosioides*, *Schkuhria pinnata*, *Conyza bonariensis*, *Datura ferox*, *Richardia brasiliensis*, *Acanthospermum australe*, *Tagetes minuta*, *Guilleminea densa* and *Alternanthera pungens*.
- Large parts of the site consist of cultivated or hitherto cultivated fields. Ecological disturbances such as homesteads, fences, dirt roads and concrete dams, infrastructure typically associated with farming, are present at the site. A tar road runs through the site. Diggings, where water may occasionally gather during some rainfall events, are present at the site. Alien invasive weeds are conspicuous at disturbed areas, in particular at hitherto cleared places.
- An area with some low rocky outcrops is present at the western part of the site.
- No wetlands appear to be present at the footprint proposed for the development. A narrow non-perennial river, with its active channel and riparian zone, is present at the northwestern part of the site. An in-channel dam (Dam 1), is present at the northeastern part of the site. Another

poorly defined active channel and riparian zone is present at the central part of the site. There is a very small dam (Dam 2) at this poorly defined active channel (Kindly see the wetland report that accompanies this report).

- Grassland at the site is represented by the Vaal-Vet Sandy Grassland (Gh 10) vegetation type and the Klerksdorp Thornveld (Gh 13) vegetation type. The Vaal-Vet Sandy Grassland vegetation type is listed as a Threatened Ecosystem, Endangered, according to the National List of Threatened Ecosystems (2011). The Klerksdorp Thornveld (Gh 13) vegetation type is not listed as a threatened vegetation type according to the National List of Threatened Ecosystems (2011). Terrestrial vegetation at the site has been modified and transformed at parts, in the past and most of the vegetation appears degraded. The scope overall, for the conservation of the Vaal-Vet Sandy Grassland vegetation type, at the site, is small.
- Site is part of the Middle Vaal Water Management Area (WMA 9). The site is not part of a Freshwater Ecosystem Priority Area (FEPA) or wetland cluster (Nel *et al.*, 2011a, 2011b).
- No Threatened or Near Threatened animal or plant species appear to be resident at the site or use the site as particular habitat.
- One plant species, *Vachellia erioloba* (Camel Thorn) that is not threatened but listed as Protected tree species occurs at the site. *Vachellia erioloba* is not particularly numerous at the site. In terms of a part of section 15(1) of the National Forests 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. *Vachellia erioloba* does not occur in any large numbers at the site. A Camel Thorn Tree Forest or large camel thorn trees (>10 m) such as at Kathu and Witsand in the Northern Cape Province, are absent at the site. If the development is approved it is likely that some Camel Thorn trees (*Vachellia erioloba*) should be removed, in which case a permit should be applied for.
- Two plant species, which are not threatened but listed as Declining occur at the site: *Boophone disticha* and *Hypoxis hemerocallidea* (Star Flower). A search and rescue operation should apply for these plant species. These plant species can be translocated to a suitable area nearby or at the site by a qualified specialist (plant species such as *Boophone disticha* are highly toxic to humans).
- There is little scope for most of the site to be part of a corridor of particular conservation importance. The non perennial streambeds, in-channel dams, riparian zones and buffer zones, as well as the area with rocky outcrops are corridors of particular conservation concern.

- Ecological sensitivity at the site ranges from high and medium to low. Ecological sensitivity at the hitherto cultivated areas is low. Ecological sensitivity at the disturbed grassland at the site is medium. Ecological sensitivity at the non-perennial active channels, in-channel dams and riparian zones, as well as the area with rocky outcrops at the site is high owing to the importance of these watercourses and outcrops as conservation corridors for biodiversity in the larger area (Figure 5).
- Continued monitoring and eradication of alien invasive plant species are imperative. It is in particular declared alien invasive species such as *Prosopis glandulosa* (Mesquite), *Melia azedarach* (Syringa) and alien invasive Australian *Acacia* species (Australian wattles) that should not be allowed to establish.
- Following the mitigations which will be upheld and planned footprint for development all the impact risks listed above are moderate or low.
- From an ecological perspective the proposed development is found to be acceptable, this for the proposed footprint of the photovoltaic power plant, associated infrastructure and also the powerline that would connect the photovoltaic power plant.

8 REFERENCES

Alexander, G. & Marais, J. 2007. A guide to the reptiles of Southern Africa. Struik, Cape Town.

Apps, P. 2012. Smithers' mammals of Southern Africa 4th ed: A field guide, revised and updated by Peter Apps. Struik Nature, Cape Town.

Armstrong, A.J. 1991. On the biology of the marsh owl, and some comparisons with the grass owl. *Honeyguide* 37:148-159.

Barnes, K.N. ed. 2000. The Eskom Red Data Book of birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg.

Bates, M.F., Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, G.J. & De Villiers, M.S. (eds). 2014. Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland. *Suricata* 1. South African National Biodiversity Institute, Pretoria.

Boon, R. 2010. *Pooley's trees of eastern South Africa: a complete guide 2nd ed.* Flora and Fauna Publications Trust, Durban.

Branch, B. 1998. Field guide to snakes and other reptiles of southern Africa. 3rd ed. Struik, Cape Town.

Branch, B. 2008. Tortoises, Terrapins & Turtles of Africa. Struik Nature, Cape Town.

Branch, W.R. & Patterson, R.W. 1975. Notes on the ecology of the Giant Girdled Lizard, *Cordylus giganteus*. *Journal of Herpetology* 9(4): 364-366.

Bronner, G. 2011. *Mammals*. In: Picker, M. & Griffiths, C. 2011. *Alien & Invasive animals: a South African perspective*. Struik Nature, Cape Town, p 22-35.

Bromilow, C. 2010. Problem plants and alien weeds of South Africa. Briza Publications, Pretoria.

Carruthers, V. & Du Preez, 2011. Frogs and frogging in southern Africa 2nd ed. Struik, Cape Town.

Child, M.F., Roxburgh, L., Do Linh San, E., Raimondo, D. & Davies-Mostert, H.T. (eds.). 2017. The 2016 Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Chittenden, H., Davies, G. & Weiersbye, I. 2016. Roberts Bird Guide. 2nd ed. John Voelcker Book Fund, Cape Town.

Cillié, B., Oberprieler, U. & Joubert, C. 2004. Animals of Pilanesberg: an identification guide. Game Parks Publishing, Pretoria.

Cilliers, S.S., Müller, N. & Drewes, E. 2004. Overview on urban nature conservation: situation in the western-grassland biome of South Africa. *Urban forestry and urban greening* 3: 49-62.

Coetzee, N. & Monadjem, A. 2008. *Mystromys albicaudatus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>.

Conradie, W., Du Preez, L.H., Smith, K. & Weldon, C. 2006. Field guide to the frogs and toads of the Vredefort Dome World Heritage Site. School of Environmental Sciences and Development, Potchefstroom.

Court, D. 2010. *Succulent Flora of Southern Africa*. Struik Nature, Cape Town.

Crouch, N.R., Klopper, R.R., Burrows, J.E. & Burrows, S.M. 2011. Ferns of Southern Africa: a comprehensive guide. Struik Nature, Cape Town.

Del Hoyo, J., Elliot, J. & Sargatal, J. 1992. Handbook of the birds of the world, Vol. 1. Lynx Editions, Barcelona.

Deuschländer, M.S. & Bredenkamp, C.J. 1999. Importance of vegetation analysis in the conservation management of the endangered butterfly *Aloeides dentatis* subsp. *dentatis* (Swierstra) (Lepidoptera: Lycaenidae). *Koedoe* 42(2): 1-12.

Dippenaar-Schoeman, A.S. 2002. Baboon and trapdoor spiders in southern Africa: an identification manual. Plant Protection Research Institute Handbook No. 13. Agricultural Research Council, Pretoria.

Dippenaar-Schoeman, A.S. 2014. Field guide to the spiders of South Africa. LAPA, Pretoria.

Dippenaar-Schoeman, A.S. & Jocqué, R. 1997. African spiders: an identification manual. Plant Protection Research Institute Handbook No. 9. Agricultural Research Council, Pretoria.

Drinkwater, T.W., Bate, R. & Du Toit, H.A. 1998. A field guide for identification of maize pests in South Africa. Agricultural Research Council: Grain-crops Institute, Potchefstroom.

Duncan, G. 2016. The Amaryllidaceae of southern Africa. Umdaus Press, Hatfield.

Du Preez, L.H. 1996. Field guide and key to the frogs and toads of the Free State. Department of Zoology and Entomology, University of the Orange Free State, Bloemfontein.

Du Preez, L.H. & Carruthers, V. 2009. A complete guide to the frogs of southern Africa. Struik Nature, Cape Town. CD with calls included.

Edge, D.A., Cilliers, S.S. & Terblanche, R.F. 2008. Vegetation associated with the occurrence of the Brenton blue butterfly. *South African Journal of Science* 104: 505 - 510.

Fish, L., Mashau, A.C., Moeaha, M.J. & Nembudani, M.T. 2015. Identification guide to southern African grasses. An identification manual with keys, descriptions and distributions. *Strelitzia* 36. South African National Biodiversity Institute, Pretoria.

Filmer, M.R. 1991. Southern African spiders: an identification guide. Struik, Cape Town.

Gardiner, A.J. & Terblanche, R.F. 2010. Taxonomy, biology, biogeography, evolution and conservation of the genus *Erikssonia* Trimen (Lepidoptera: Lycaenidae). *African Entomology* 18(1): 171 – 191.

Germishuizen, G. 2003. Illustrated guide to the wildflowers of northern South Africa. Briza, Pretoria.

Germishuizen, G., Meyer, N.L. & Steenkamp (eds) 2006. A checklist of South African plants. Southern African Botanical Diversity Network Report No. 41. SABONET, Pretoria.

Goldblatt, P. 1986. The Moraeas of Southern Africa. *Annals of Kirstenbosch Botanic Gardens*, Volume 14. National Botanic Gardens, Cape Town.

Goldblatt, P. 1989. The genus *Watsonia*. *Annals of Kirstenbosch Botanic Gardens*, Volume 19. National Botanic Gardens, Cape Town.

Goldblatt, P. & Manning, J. 1998. *Gladiolus* in Southern Africa.

Henderson, L. 2001. *Alien weeds and alien invasive plants: a complete guide to the declared weeds and invaders in South Africa*. Plant Protection Research Institute Handbook No. 12. ARC: Plant Protection Research Institute, Pretoria.

Henderson, L. & Cilliers, C.J. 2002. *Invasive aquatic plants: a guide to the identification of the most important and potentially dangerous invasive aquatic and wetland plants in South Africa*. Plant Protection Research Handbook No. 16. Agricultural Research Council, Pretoria.

Henning, S.F. & Henning, G.A. 1989. South African Red Data Book: butterflies. *South African National Scientific Programmes Report* No. 158. CSIR, Pretoria.

Henning, G.A., Terblanche, R.F. & Ball, J.B. (eds) 2009. South African Red Data Book: butterflies. *SANBI Biodiversity Series No 13*. South African National Biodiversity Institute, Pretoria.

Hill, C.J. 1995. Conservation corridors and rainforest insects. (*In* Watt, A.D., Stork, N.E. & Hunter, M.D. (eds.), *Forests and Insects*. Chapman & Hall, London. p. 381-393.)

Hockey, P. 2011. *Birds*. *In*: Picker, M. & Griffiths, C. 2011. *Alien & Invasive animals: a South African perspective*. Struik Nature, Cape Town, p 36-44.

Hockey, P.A.R., Dean, W.J.R. & Ryan, P.G. (eds.). 2005. Roberts Birds of Southern Africa. John Voelcker Bird Book Fund, Cape Town.

Holm, E. & Marais, E. 1992. Fruit chafers of southern Africa. Ekogilde, Hartebeespoort.

IUCN. 2001. *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.

IUCN. 2012. IUCN Red list of Threatened Species. Version 2012.1)

Johnson, S & Bytebier, B. 2015. Orchids of South Africa. Struik Nature, Cape Town.

Kemper, N.P. 2001. RVI: Riparian Vegetation Index, final report, WRC Report No. 850/3/1. Institute for Water Research, Pretoria.

Kok, J.C. 1998. Vrystaatse bome, struik en klimplante Kontak-uitgewers, Pretoria.

Liebenberg, L. 1990. A field guide to the animal tracks of Southern Africa. David Philip Publishers, Cape Town.

Leeming, J. 2003. Scorpions of southern Africa. Struik, Cape Town.

Leroy, A. & Leroy, J. 2003. Spiders of southern Africa. Struik, Cape Town.

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

Manning, J. 2003. Photographic guide to the wild flowers of South Africa. Briza, Pretoria.

Manning, J. 2009. Field guide to the wild flowers of South Africa. Struik, Cape Town.

Marais, J. 2004. A complete guide to the snakes of southern Africa. Struik, Cape Town.

McMurtry, D., Grobler, L., Grobler, J. & Burns, S. 2008. Field guide to the orchids of northern South Africa and Swaziland. Umdaus Press, Hatfield.

Mecenero, S., Ball, J.B., Edge, D.A., Hamer, M.L., Henning, G.A., Krüger, M, Pringle, E.L., Terblanche, R.F. & Williams, M.C. 2013. *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and Atlas*. Saftronics, Johannesburg & Animal Demography Unit, Cape Town.

Minter, L.R., Burger, M., Harrison, J.A., Braack, H.H., Bishop, P.J. & Kloepfer, D. eds. 2004. Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB series 9, Smithsonian Institution, Washington DC.

Mucina, L. & Rutherford, M.C. eds. 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. Pretoria: South African National Biodiversity Institute.

Mucina, L., Rutherford, M.C., and Powrie, L.W. eds. 2005. Vegetation map of South Africa, Lesotho and Swaziland, 1:1 000 000 scale sheet maps. Pretoria: South African National Biodiversity Institute.

New, T.R. 1993. ed. Conservation biology of *Lycaenidae* (butterflies). *Occasional paper of the IUCN Species Survival Commission* No. 8.

Peacock, F. 2006. Pipits of Southern Africa. Published by the author, Pretoria. www.pipits.co.za.

Pfab, M.F. 2002. Priority ranking scheme for Red Data plants in Gauteng, South Africa. *South African Journal of Botany* (68): 299-303.

Pfab, M.F. & Victor, J.E. 2002. Threatened plants of Gauteng, South Africa. *South African Journal of Botany* (68): 370-375.

Picker, M. & Griffiths, C. 2011. Alien & Invasive animals: a South African perspective. Struik Nature, Cape Town.

Picker, M., Griffiths, C. & Weaving, A. 2004. Field guide to insects of South Africa. 2nd ed. Cape Town: Struik.

Pooley, E. 1998. A field guide to wild flowers of KwaZulu-Natal and the eastern region. Natal Flora Publications Trust, Durban.

Pringle, E.L., Henning, G.A. & Ball, J.B. eds. 1994. Pennington's Butterflies of Southern Africa. Struik Winchester, Cape Town.

Pryke, S.R. & Samways, M.J. 2001. Width of grassland linkages for the conservation of butterflies in South African afforested areas. *Biological Conservation* 101: 85-96.

Pullin, A.S. ed. 1995. Ecology and conservation of butterflies. Chapman & Hall, London.

Raimondo, D., von Staden, L., Foden, W., Victor, J.E., Helme, N.A., Turner, R.C., Kamundi, D.A. & Manyama, P.A. (eds.). 2009. Red list of South African plants 2009. *Strelitzia* 25. South African National Biodiversity Institute, Pretoria.

Retief, E. & Herman, P.P.J. 1997. Plants of the northern provinces of South Africa: keys and diagnostic characteristics. *Strelitzia* 6. National Botanical Institute, Pretoria.

Rutherford, M.C. & Westfall, R.H. 1994. Biomes of southern Africa: An objective categorisation, 2nd ed. Memoirs of the Botanical Survey of South Africa, Vol. 63, pp. 1-94. National Botanical Institute, Pretoria.

Ryan, P. 2001. Practical Birding: A guide to birdwatching in southern Africa. Struik, Cape Town.

SANBI. 2017. Technical guidelines for CBA Maps: Guidelines for developing a map of Critical Biodiversity Areas & Ecological Support Areas using systematic biodiversity planning. First Edition (Beta Version), June 2017. Compiled by Driver, A., Holness, S. & Daniels, F. South African National Biodiversity Institute, Pretoria.

Samways, M.J. 2005. Insect diversity conservation. Cambridge University Press, Cambridge.

Skelton, P. 2001. A complete guide to the freshwater fishes of Southern Africa. Struik, Cape Town.

Skelton, P. & Weyl, O. 2011. *Fishes*. In: Picker, M. & Griffiths, C. 2011. *Alien & Invasive animals: a South African perspective*. Struik Nature, Cape Town, p 36-44.

Skinner, J.D. & Chimimba, C.T. 2005. The mammals of the southern African subregion. Cambridge University Press, Cape Town.

Sliwa, A. 2008. *Felis nigripes*. In: IUCN 2012. IUCN Red List of Threatened Species.

Smit, N. 2008. Field guide to the *Acacias* of South Africa. Briza, Pretoria.

Smith, G.F., Crouch, N.R. & Figueiredo, E. 2017. Field guide to succulents in southern Africa. Struik Nature, Cape Town.

Smithers, R.H.N. 1986. South African Red Data Book: Terrestrial mammals. *South African National Scientific Programmes Report No. 125*. CSIR, Pretoria.

South Africa. 2004. National Environmental Management: Biodiversity Act No. 10 of 2004. Government Printer, Pretoria.

Stuart, C. & Stuart, T. 2006. Field guide to the larger mammals of Africa 3rd ed. Struik Nature, Cape Town.

Stuart, C. & Stuart, T. 2013. A field guide to the tracks and signs of Southern, Central and East African wildlife 4th ed. Struik Nature, Cape Town.

Tarboton, W. & Erasmus, R. 1998. Owls and owling in southern Africa. Struik, Cape Town.

Taylor, J.C., Janse Van Vuuren, M.S. & Pieterse, A.J.H. 2007. The application and testing of diatom-based indices in the Vaal and Wilge Rivers, South Africa. *Water SA* 33(1): 51-59.

Terblanche, R.F. & Edge, D.A. 2007. The first record of an *Orachrysops* in Gauteng. *Metamorphosis* 18(4): 131-141.

Terblanche, R.F., Morgenthal, T.L. & Cilliers, S.S. 2003. The vegetation of three localities of the threatened butterfly species *Chrysoritis aureus* (Lepidoptera: Lycaenidae). *Koedoe* 46(1): 73-90.

Terblanche, R.F. & Van Hamburg, H. 2003. The taxonomy, biogeography and conservation of the myrmecophilous *Chrysoritis* butterflies (Lepidoptera: Lycaenidae) in South Africa. *Koedoe* 46(2): 65-81.

Terblanche, R.F. & Van Hamburg, H. 2004. The application of life history information to the conservation management of *Chrysoritis* butterflies (Lepidoptera: Lycaenidae) in South Africa. *Koedoe* 47(1): 55-65.

Terblanche, R.F. *In Prep.* Functional land ethic for butterfly conservation in South Africa. Unpublished PhD *In Prep.* Stellenbosch University, South Africa.

Van den Berg, J. & Drinkwater, T.W. 1998. Field guide to identification of sorghum pests in South Africa. Agricultural Research Council: Grain-crops Institute, Potchefstroom.

Van Ginkel, C.E., Glen, R.P., Gordon-Gray, K.D., Cilliers, C.J., Muasya, M. & van Deventer, P.P. 2011. Easy identification of some South African Wetland Plants. WRC Report No TT 479/10. Water Research Commission, Gezina.

Van Jaarsveld, E.J. 2006. The Southern African *Plectranthus* and the art of turning shade to glade.

Van Oudtshoorn, F. 2012. Guide to grasses of southern Africa, 3rd ed. Briza, Pretoria.

Van Wyk, B. 2000. A photographic guide to wild flowers of South Africa. Struik, Cape Town.

Van Wyk, B. & Malan, S. 1998. Field Guide to the Wild Flowers of the Highveld. Struik, 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, Pretoria.

Van Wyk, B.E. & Smith, G.F. 2014. Guide to the aloes of South Africa, 3rd ed. Briza, Pretoria.

Van Wyk, B.E., van Oudtshoorn, B. & Gericke, N. 2009. Medical plants of South Africa. Briza, Pretoria.

Van Wyk, B. & Van Wyk, P. 2013. Field guide to trees of southern Africa. 2nd ed. Struik Nature, Cape Town.

Walker, C. 1996. Signs of the Wild. 5th ed. Struik, Cape Town.

Watt, A.D., Stork, N.E. & Hunter, M.D. (eds.), Forests and Insects. London: Chapman & Hall. (p. 381-393.)

ANNEXURE 1

List of plant species recorded at the site.

Plant species marked with an asterisk (*) are exotic.

Sources: Bromilow (2010); Crouch, Klopper, Court (2010); Duncan (2016); Fish, Mashau, Moeaha & Nembudani (2015); Germishuizen (2003), Goldblatt (1986); Goldblatt & Manning (1998); Johnson & Bytebier (2015); Manning (2007), Manning (2009), McMurtry, Grobler, Grobler & Burns (2008); Smith, Crouch. & Figueiredo (2017); Van Ginkel *et al.* (2011); Van Jaarsveld (2006); Van Oudtshoorn (2012); Van Wyk (2000); Van Wyk & Gericke (2000); Van Wyk & Malan (1998); Van Wyk & Van Wyk (2013); Van Wyk & Smith (2014); Van Wyk, van Oudtshoorn & Gericke (2009)

TAXON	COMMON NAMES	FAMILY
ANGIOSPERMAE: MONOCOTYLEDONS		
<i>Albuca setosa</i>		HYACINTHACEAE
<i>Aloe grandidentata</i>		ASPHODELACEAE
<i>Ammocharis coranica</i>		AMARYLLIDACEAE
<i>Aristida adscensionis</i>		POACEAE
<i>Aristida junciformis</i>		
<i>Aristida congesta</i>	Tassel Three-awn	POACEAE
<i>Asparagus larycinus</i>	Common Wild Asparagus	ASPARAGACEAE
<i>Boophone disticha</i>		AMARYLLIDACEAE

<i>Bulbine narcissifolia</i>		ASPHODELACEAE
<i>Chloris virgata</i>		POACEAE
<i>Cymbopogon caesius</i>	Broad-leaved Turpentine Grass	POACEAE
<i>Cymbopogon pospischilii</i>	Narrow-leaved Turpentine Grass	POACEAE
<i>Cynodon dactylon</i>	Couch Grass	POACEAE
<i>Cyperus esculentus</i>		CYPERACEAE
<i>Cyperus longus</i>		CYPERACEAE
<i>Digitaria eriantha</i>	Common Finger Grass	POACEAE
<i>Echinochloa holubii</i>		POACEAE
<i>Eleocharis limosa</i>		CYPERACEAE
<i>Elionurus muticus</i>		POACEAE
<i>Eragrostis chloromelas</i>		POACEAE
<i>Eragrostis curvula</i>		POACEAE
<i>Eragrostis gummiflua</i>		POACEAE
<i>Eragrostis lehmanniana</i>		POACEAE
<i>Eragrostis superba</i>	Saw-toothed Love Grass	POACEAE
<i>Heteropogon contortus</i>	Spear Grass	POACEAE
<i>Hyparrhenia hirta</i>		POACEAE
<i>Hypoxis hemerocallidea</i>		HYPOXIDACEAE
<i>Kyllinga erecta</i>		CYPERACEAE
<i>Melinis repens</i>	Natal Red-top	POACEAE
* <i>Paspalum dilatatum</i>	Dallis Grass	POACEAE
<i>Pogonarthria squarrosa</i>	Herringbone Grass	POACEAE
<i>Themeda triandra</i>	Red Grass	POACEAE
<i>Urochloa mocambicensis</i>	Bushveld Signal Grass	POACEAE
ANGIOSPERMS: DICOTYLEDONS		
* <i>Alternanthera pungens</i>	Dubbeltjie	AMARANTHACEAE
<i>Aptosimum decumbens</i>		SCROPHULARIACEAE
* <i>Argemone ochroleuca</i>	White-flowered Mexican poppy	PAPAVARACEAE
<i>Barleria macrostegia</i>		ACANTHACEAE

<i>Berkheya onopordifolia</i>		ASTERACEAE
<i>Berkheya radula</i>		ASTERACEAE
* <i>Bidens bipinnata</i>	Spanish Black Jack	ASTERACEAE
* <i>Bidens pilosa</i>	Black Jack	ASTERACEAE
<i>Chamaecrista mimosoides</i>		FABACEAE
<i>Chasmatophyllum musculinum</i>		AIZOACEAE
* <i>Chenopodium album</i>	White Goosefoot	CHENOPODIACEAE
* <i>Cirsium vulgare</i>		ASTERACEAE
<i>Clematis brachiata</i>	Traveller's Joy	RANUNCULACEAE
<i>Cleome maculata</i>		CAPPARACEAE
<i>Cleome monophylla</i>	Single-leaved Cleome	CAPPARACEAE
<i>Commelina africana</i>		COMMELINACEAE
<i>Convolvulus sagittatus</i>	Wild Bindweed	CONVOLVULACEAE
<i>Conyza podocephala</i>		ASTERACEAE
<i>Chrysocoma ciliata</i>		ASTERACEAE
<i>Cyanotis speciosa</i>		COMMELINACEAE
<i>Cyphia stenopetala</i>		LOBELIACEAE
* <i>Datura ferox</i>	Thorn Apple	SOLANACEAE
* <i>Datura stramonium</i>		SOLANACEAE
<i>Diospyros lycioides</i> subsp. <i>lycioides</i>		EBENACEAE
<i>Ehretia alba</i>	White Puzzlebush	BORAGINACEAE
<i>Erythrina zeyheri</i>		FABACEAE
* <i>Eucalyptus camaldulensis</i>	Red Gum	MYRTACEAE
<i>Falkia oblonga</i>		CONVOLVULACEAE
<i>Felicia muricata</i>		ASTERACEAE
* <i>Flaveria bidentis</i>	Smelter's Bush	ASTERACEAE
<i>Gazania krebsiana</i> subsp. <i>krebsiana</i>		ASTERACEAE
<i>Gomphocarpus fruticosus</i>	Cotton Milkbush	APOCYNACEAE
* <i>Gomphrena celosioides</i>	Bachelor's Button	AMARANTHACEAE

<i>Grewia flava</i>	Velvet Raisin	SPARRMANNIACEAE
* <i>Guilleminea densa</i>	Matweed	AMARANTHACEAE
<i>Helichrysum argyrosphaerum</i>	Wild Everlasting	ASTERACEAE
<i>Helichrysum aureonitens</i>		ASTERACEAE
<i>Helichrysum nudifolium</i>		ASTERACEAE
<i>Helichrysum rugulosum</i>		ASTERACEAE
<i>Hibiscus pusillus</i>		MALVACEAE
<i>Hibiscus trionum</i>	Bladder Hibiscus	MALVACEAE
<i>Hilliardiella oligocephala</i>		ASTERACEAE
<i>Lepidium africanum</i>	Pepperweed	BRASSICACEAE
* <i>Lepidium bonariense</i>	Pepperweed	BRASSICACEAE
<i>Lippia scaberrima</i>		VERBENACEAE
<i>Monsonia angustifolia</i>		GERANIACEAE
<i>Nidorella microcephala</i>		ASTERACEAE
* <i>Oenothera rosea</i>		ONAGRACEAE
<i>Osteospermum muricatum</i>		ASTERACEAE
* <i>Oxalis corniculata</i>	Creeping Sorrel	OXALIDACEAE
<i>Pavonia burchellii</i>		MALVACEAE
<i>Pentarrhinum insipidum</i>		APOCYNACEAE
<i>Pentzia globosa</i>		ASTERACEAE
<i>Persicaria</i> sp.	Knotweed	POLYGONACEAE
<i>Pollichia campestris</i>	Waxberry	ILLECEBRACEAE
* <i>Portulaca oleracea</i>		PORTULACACEAE
<i>Portulaca quadrifida</i>		PORTULACACEAE
* <i>Pseudognaphalium luteo-album</i>		ASTERACEAE
<i>Pterodiscus speciosus</i>		PEDALIACEAE
* <i>Rumex crispus</i>		POLYGONACEAE
<i>Ruschia canonotata</i>		AIZOACEAE
* <i>Schkuhria pinnata</i>	Dwarf Marigold	ASTERACEAE
<i>Searsia lancea</i>	Karee	ANACARDIACEAE

<i>Searsia pyroides</i>		ANACARDIACEAE
<i>Selago densiflora</i>		SCROPHULARIACEAE
* <i>Solanum elaeagnifolium</i>	Silverleaf Bitter Apple	SOLANACEAE
<i>Solanum lichtensteinii</i>		SOLANACEAE
* <i>Sonchus oleraceus</i>		ASTERACEAE
<i>Stachys spathulata</i>		LAMIACEAE
* <i>Tagetes minuta</i>		ASTERACEAE
<i>Teucrium trifidum</i>		LAMIACEAE
<i>Tribulus terrestris</i>	Devil's Thorn	ZYGOPHYLLACEAE
<i>Vachellia erioloba</i>	Camel Thorn	FABACEAE
<i>Vachellia hebeclada</i> subsp. <i>hebeclada</i>	Candlepod Thorn	FABACEAE
<i>Vachellia karroo</i>	Sweet Thorn	FABACEAE
* <i>Verbena aristigera</i>	Fine-leaved Verbena	VERBENACEAE
* <i>Verbena bonariensis</i>	Purple Top	VERBENACEAE
<i>Wahlenbergia undulata</i>		CAMPANULACEAE
* <i>Zinnia peruviana</i>		ASTERACEAE
<i>Ziziphus mucronata</i>	Buffalo-thorn	RHAMNACEAE
<i>Ziziphus zeyheriana</i>	Dwarf Buffalo-thorn	RHAMNACEAE