Boscia
ECOLOGICAL CONSULTING

BOTANICAL ASSESSMENT REPORT

Thunderflex 78 (Pty) Ltd

Engeldewilgeboomfontein Diamond Mine

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Thunderflex 78 (Pty) Ltd

Remainder of the Farm Engeldewilgeboomfontein 22; Remainder, Portion 1, Portion 2, Portion 3 and Portion 4 of the Farm Blaauputs 23; and Remainder and Portion 2 of the Farm Kliphuis 29

Districts of Prieska and Hay

Northern Cape Province

Botanical Assessment Report in application for a flora harvesting permit in respect of a Mining Right Application (Ref: NC 30/5/1/2/2/10084 MR) lodged with the Department of Mineral Resources

December 2015

EXECUTIVE SUMMARY

Thunderflex 78 (Pty) Ltd has applied for a mining right to mine alluvial diamonds on the Remainder of the Farm Engeldewilgeboomfontein 22, Remainder, Portion 1, Portion 2, Portion 3 and Portion 4 of the Farm Blaauputs 23, and the Remainder and Portion 2 of the Farm Kliphuis 29. The properties are located within the Prieska and Hay District Municipalities of the Northern Cape Province. Thunderflex has been conducting prospecting activities on the property since 2013 and found that there are areas that can be viably mined. The proposed mining activities require a licence regarding protected trees from Department of Agriculture, Forestry and Fisheries (DFF) for the removal and/or damage of Nationally protected trees in terms of the National Forests (NFA) Act No 84 of 1998; and a permit regarding protected flora and for the large-scale clearance of indigenous vegetation from the Northern Cape Department of Environment and Nature Conservation (DENC) in terms of the Northern Cape Nature Conservation Act (No. 9 of 2009).

A botanical assessment is required in order to apply for the abovementioned licence and permits and therefore this botanical assessment report was compiled. It describes the vegetation characteristics of Engeldewilgeboomfontein, identifies the listed, protected, invasive and encroaching plant species and their distribution, indicates the source of impacts from the mining operation, and assesses these impacts, as well as the residual impacts after closure.

A desktop study and field investigation was performed to obtain botanical information and identify the vegetation characteristics and sensitivity of the site. Four broad-scale vegetation types occur within the mining area; i.e. Northern Upper Karoo, Lower Gariep Broken Veld, Gordonia Duneveld and Upper Gariep Alluvial vegetation. The latter is regarded as vulnerable, threatened by cultivation; while the remaining units are classified as least threatened. Seven plant communities were identified of which only the open shrubland on calcrete soils and shrubland on surface gravels are included in the core mining area. These areas are considered to be of high floristic sensitivity on account of the richness and frequency of species of conservation concern found here.

Boscia albitrunca shrubs are widespread across the site and it is estimated that ± 8 700 individuals are expected to potentially be affected by the mining activities. A licence application regarding protected trees should be lodged with Department of Agriculture, Forestry and Fisheries prior to any disturbances to these and other protected trees. Similarly, a permit application regarding protected flora and the harvesting of indigenous vegetation need to be lodged with the Northern Cape Department of Environment and Nature Conservation prior to any clearance of vegetation.

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1. INTRODUCTION

1.1. Background information

Thunderflex 78 (Pty) Ltd has applied for a mining right to mine alluvial diamonds on the Remainder of the Farm Engeldewilgeboomfontein 22, Remainder, Portion 1, Portion 2, Portion 3 and Portion 4 of the Farm Blaauputs 23, and the Remainder and Portion 2 of the Farm Kliphuis 29. The proposed mining right area (from here on referred to as Engeldewilgebooomfontein) is located within the Prieska and Hay District Municipalities of the Northern Cape Province. It lies approximately 16 km north of Prieska on a gravel road that turns of from the R386 that connects Prieska and Niekerkshoop (Figure 1). It is situated north and east of the Orange River and collectively cover a total extent of 9 437 ha.

The company has been conducting prospecting activities on the property since 2013 and found that there are areas that can be viably mined. The proposed mining operation requires a licence regarding protected trees from Department of Agriculture, Forestry and Fisheries (DFF) for the removal and/or damage of nationally protected trees in terms of the National Forests (NFA) Act No 84 of 1998; and a permit regarding protected flora and for the large-scale clearance of indigenous vegetation from the Northern Cape Department of Environment and Nature Conservation (DENC) in terms of the Northern Cape Nature Conservation Act (No. 9 of 2009).

A botanical assessment is required in order to apply for the abovementioned licence and permits and therefore Dr Elizabeth (Betsie) Milne has been appointed by Thunderflex to conduct an assessment and provide a botanical assessment report. The botanical assessment report describes the vegetation characteristics of Engeldewilgeboomfontein, identifies the listed, protected, invasive and encroaching plant species and their distribution, indicates the source of impacts from the mining operation, and assesses these impacts, as well as the residual impacts after closure. A variety of avoidance and mitigation measures associated with each identified impact are recommended to reduce the likely impact of the mining operation.

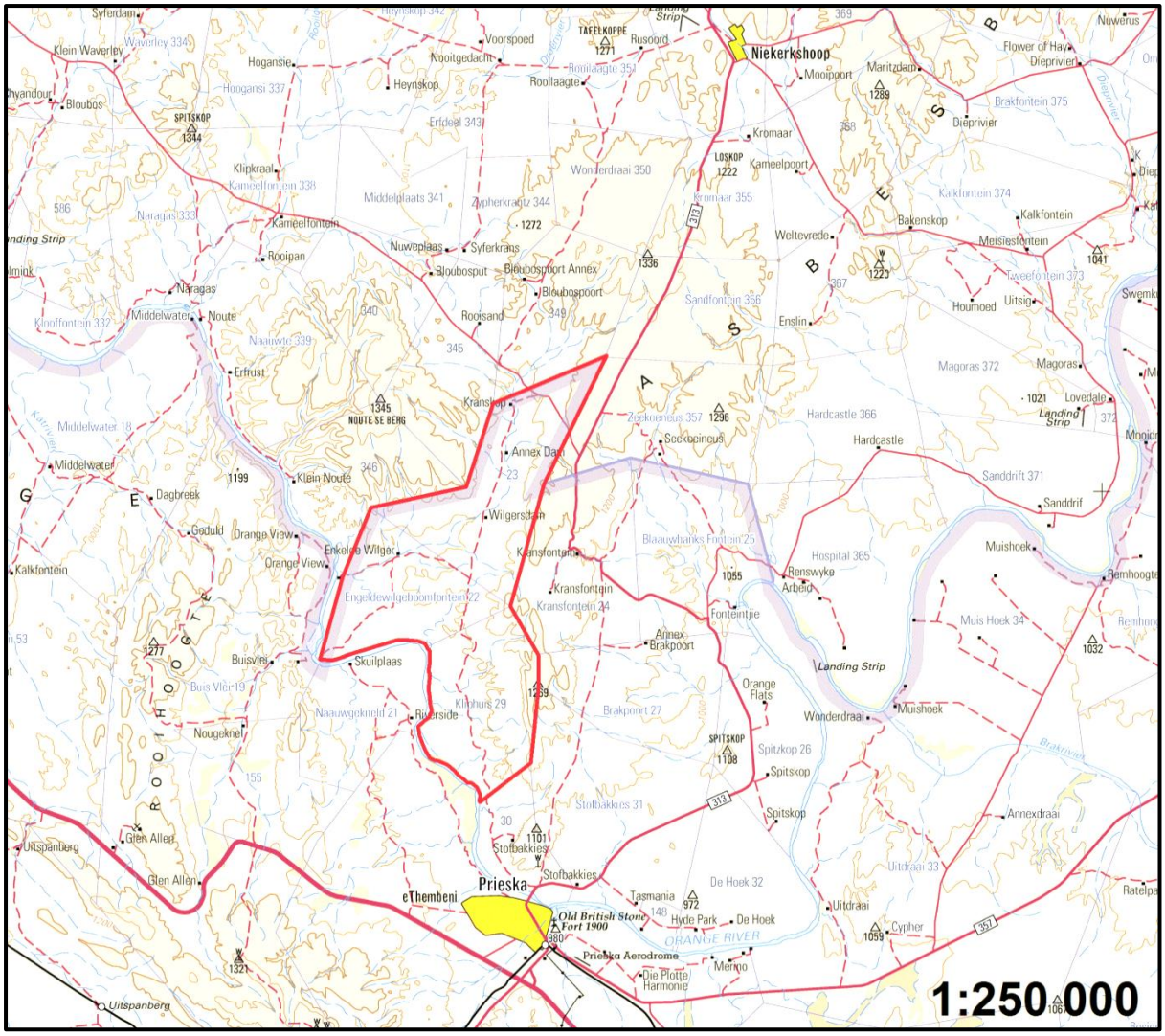


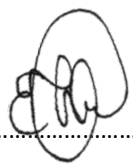
Figure 1. The location of the Engeldewilgeboomfontein Mine in red.

1.2. Scope of study

The specific terms of reference for the study include the following:

- conduct a desktop study and field investigation in order to identify and describe different plant communities and associated species of conservation concern within the environment that may be affected by the proposed activity;
- identify the relative floristic sensitivity of the project area;
- produce an assessment report that:
  - indicates identified plant communities and flora species and their floristic sensitivity,
  - determines the potential impacts of the project on biodiversity,
  - provides mitigation measures and recommendations to limit project impacts.

1.3. Details of the specialist consultant

Company Name	Boscia Ecological Consulting cc	**Registration no:**	2011/048041/23
Address	PostNet Suite #194 Private Bag X2 Diamond 8305		
Contact Person	Dr Elizabeth (Betsie) Milne		
Contact Details	Cell: 082 992 1261	Email: betsiemilne@gmail.com	
Qualifications	PhD Botany (Nelson Mandela Metropolitan University) Masters Environmental Management (University of the Free State) BTech Nature Conservation (Tshwane University of Technology)		
Declaration of independence	I, Elizabeth (Betsie) Milne declare that I: • act as the independent specialist in this application; • regard the information contained in this report as it relates to my specialist input/study to be true and correct; • do not have, and will not have any financial interest in the undertaking of the activity; other than the remuneration of work performed in terms of the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act; • have and will not have any vested interest in the activity proceedings; • have no, and will not engage in conflicting interest in the undertaking of the activities; • undertake to disclose to the component authority any material information that have or may have the potential to influence the decision of the competent authority, or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act; • will provide the competent authority with access to all information at my disposal regarding the study.  ……		

1.4. Description of the proposed activity

The mining operation on Engeldewilgeboomfontein is based on alluvial diamond deposits that are restricted to the lower lying alluvial terraces north, north-east and east of the Orange River (Figure 2). These diamondiferous deposits occur as upper deflation deposits (Rooikoppie-type gravels) and underlying deposits (Primary fluvial-alluvial gravels). The deposits are mined by means of an opencast method using heavy earthmoving machinery and occasional blasting.

Vegetated soil is stripped where required and the underlying gravels are excavated, screened and treated through a combination of Pan Plants and Flow Sort machines. No ore processing reagents are required or used in the treatment of the ore. The rough diamond product is then removed from site for further beneficiation. The estimated production is 938 667 m^3 per year and the estimated lifespan of the mine is 10 years.

Mining activities will primarily make use of existing farm roads and mining infrastructure established during the prospecting operation, but additional haul roads will continuously be created in order to access new mining pits. The associated mine infrastructure includes staff quarters, a temporary office complex, a workshop and storage facility, oil depot, diesel depot, wash bay, french drain, steel water storage dam, central processing plant, a slimes dam and a return water dam. The current footprint of the mine, including infrastructure, mined areas and existing roads are presented in Figure 3.

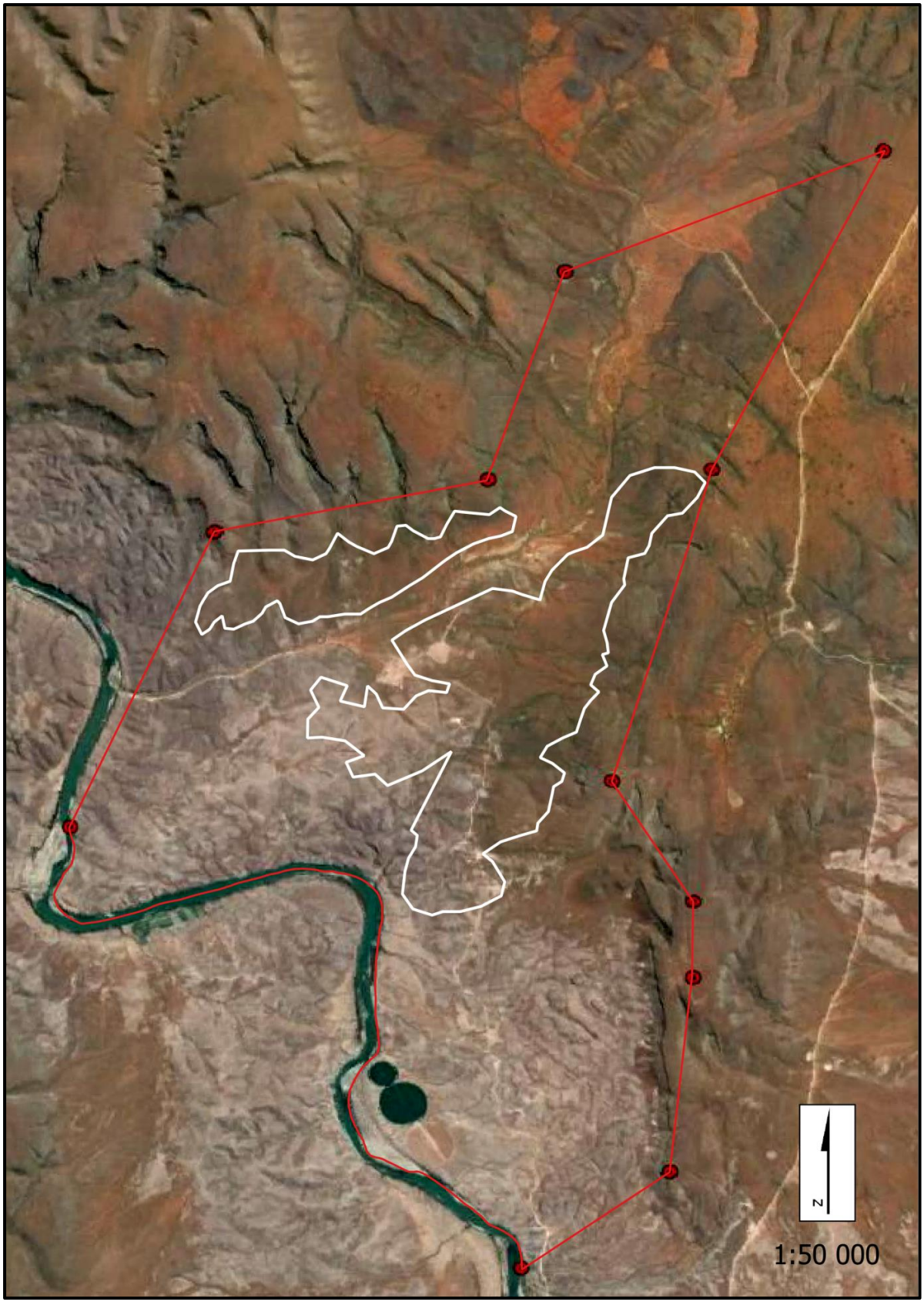


Figure 2. The locality of the core mining area on Engeldewilgeboomfontein is indicated in white. The red line indicates the border of the mining right area.

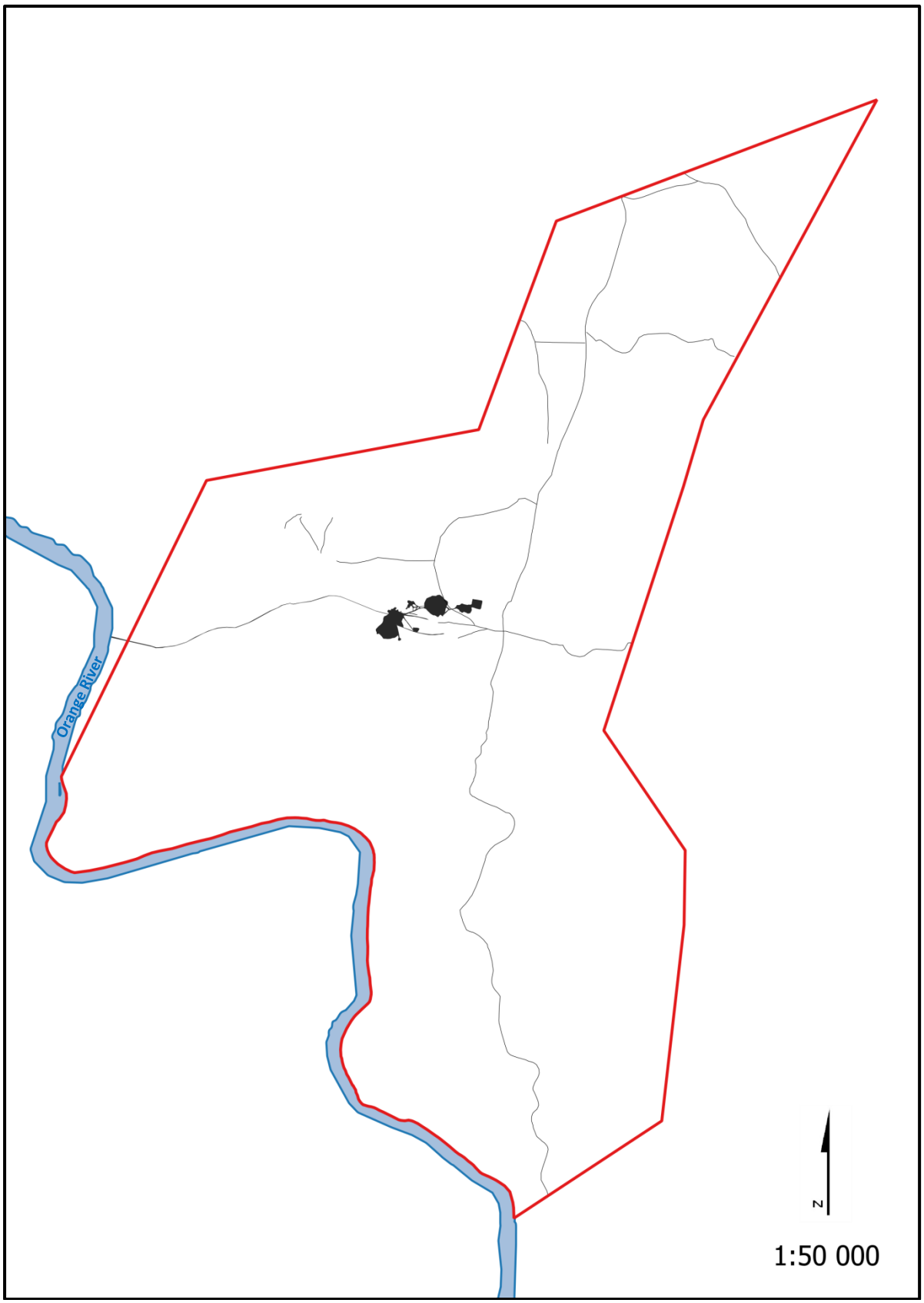


Figure 3. The current footprint of existing roads, mine related activities and infrastructure on Engeldewilgeboomfontein.

2. METHODOLOGY

2.1. Data collection

The study comprised a combination of field and desktop surveys for flora data collection in order to obtain the most comprehensive data set for the assessment.

The fieldwork component was conducted on 10, 11 and 12 November 2015. Satellite images were used to identify homogenous vegetation units within the proposed mining area, excluding the current mining footprint. Representative sampling plots were allocated in these units and sampled with the aid of a GPS in order to characterise the species composition. The following quantitative data was collected:

- Species composition
- Species percentage cover
- Amount of bare soil and rock cover
- Presence of biotic and anthropogenic disturbances

Additional checklists of plant species were compiled during the surveys by traversing a linear route and recording species as they were encountered in each unit. A photographic record of some species encountered is available on http://www.ispotnature.org/projects/encounters-in-the-northern-cape.

For the desktop component, the South African National Vegetation Map (Mucina and Rutherford 2006) was used to obtain data on broad scale vegetation types and their conservation status. The South African National Biodiversity Institute's (SANBI) BGIS database was also consulted to obtain information on biodiversity information for the Siyathemba Local Municipality, in which the study area falls. The Environmental Management Framework for the Municipality (SLM 2014) classifies the study area to be of low to medium sensitivity. No Critical Biodiversity Area mapping or systematic conservation planning has been conducted for the area and therefore no detailed conservation priority area information is available for the study site.

Further searches were undertaken specifically for Red List plant species within the current study area. Historical occurrences of Red List plant species were obtained from the SANBI SIBIS:SABIF database for the quarter degree squares (2922BD, 2922BC and 2922DA) that includes the study area. The IUCN conservation status of plants in the species list was also extracted from the SANBI database and is based on the Threatened Species Programme (SANBI 2014).

2.2. Sensitivity mapping and assessment

A floristic sensitivity map of the site was produced by integrating the information collected on site with the available information available in the literature and various spatial databases. The sensitivity mapping entails delineating different vegetation units identified during vegetation analyses and from satellite images; and assigning likely sensitivity values to the units based on their conservation value, the potential presence of species of conservation concern and their probability of being affected by proposed activities. The sensitivity of the different units identified in the mapping procedure increased with probability and was rated according to the following scale:

Low: Areas of natural or transformed habitat with a low sensitivity where there is likely to be a negligible impact on ecological processes and plant diversity. Most types of activities can proceed within these areas with little floristic impact.

Medium: Areas of natural or previously transformed land where the impacts are likely to be largely local. Activities within these areas can proceed with relatively little floristic impact provided that appropriate mitigation measures are taken.

High: Areas of natural or transformed land where a high impact is anticipated due to the high biodiversity value or sensitivity. Activities within these areas are undesirable and should only proceed with caution as it may not be possible to mitigate all impacts appropriately.

Very High: Critical and unique units that serve as habitat for species of conservation concern, or perform critical ecological roles. These areas are essentially no-go areas for activities and should be avoided as much as possible.

2.3. Sampling limitations

Due to the brief duration of the survey and the lack of seasonal coverage, the species list obtained during the site visit cannot be regarded as comprehensive. Ideally, a site should be visited several times during different seasons to ensure that the full complement of plant species present is captured. However, this is rarely possible due to time and cost constraints. The survey is nevertheless likely to have included the majority of the dominant and common species present.

The site visit for the study took place during early summer, which is generally a favourable time of the year. However, the area is still very dry and therefore most grasses, annuals and other flowering plants were not in the most suitable condition for the survey. The best time to evaluate vegetation in the study area is after at least some summer or late-summer rain when the vegetation has had a chance to respond and is in an actively growing state. The urgency of the survey for this project dictated that it should be done as soon as possible. The results presented here can therefore only reflect the condition of the vegetation. Consequently, the timing of the site visit is considered to be a limiting factor which might compromise the results, as it is likely that there are species of conservation concern that were not visible at the time of sampling.

The geology of the study area is very complex and in reality appears vastly interwoven at a very small scale. Consequently, the vegetation follows the same pattern. Therefore, numerous transitional zones exist across the landscape, which complicates the community classification process, especially considering the time-constraint as mentioned above. In order to simplify the classification, the transitional zones were not included in the community classification process. This is regarded as a limiting factor in the accuracy of the mapping, classification and delineation of plant communities and therefore the fine-scale vegetation map, although more accurate than the current broad-scale vegetation map, can still not be regarded as exact. The transitional areas were however not excluded from the surveys in order to maximise the chances of encountering species of conservation concern.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1. Current and historic land use

Thunderflex conducted prospecting activities on the property since 2013 and evidence of these activities and associated disturbances are clearly visible. There is also evidence of historic small scale asbestos and diamond mining. The majority of the study area is currently utilized for grazing by livestock, while farm land adjacent to the Orange River is being used for irrigated crop production.

3.2. Geology and soils

The bedrock in the region is typically presented as flat-lying Dwyka tillite and siltstone of the Karoo Supergroup. The present surface of the Dwyka comprise a gentle undulating terrain lying at an elevation of between 1 050 m and 1 100 m above mean sea level. The Orange River has carved into the surface to a depth of between 90 m and 150 m. Due to the irregularity of the pre-Dwyka surface, several reaches of the Orange River are superimposed on pre-Dwyka topography highs, which, due to its relative resistance to erosion, give rise to more rugged topography.

At Engeldewilgeboomfontein, weathered material (alluvium) of the Ghaap Group constitutes a large area in the centre of the study area and stretches towards the north and south of the property (Figure 4). Banded Ironstone from the Kuruman Formation of the Asbestos Hills Subgroup (Ghaap Group) line the borders of the property in the north-east and north-west. Dolomite and subordinate limestone of the Campbell Rand Subgroup (Ghaap Group) is largely found in the west and south of the property, while a surface comprising a mixture of diamictite and tillite of the Dwyka Formation is found in the centre and stretches west toward the Orange River. A very small patch of calcrete is found in the far south.

Diamond bearing gravels are encountered in the lower lying areas. Overburden comprises thin layers of Hutton soils and sands, overlaying a diamictite and tillite mixture with the gravel matrix composed of calcrete sands and clays. The diamond bearing gravels are found beneath the diamictite and tillite mixture. Average gravel composition comprises high percentages of Ventersdorp lavas and Banded Iron Formations with constituents of quartz, quartzite, chert, granite and agate to lesser extent. The soils on Engeldewilgeboomfontein are mainly shallow, clayey, well drained soils associated with the Ag141 land type. However, Fb385 and Ag 114 land types (on the hills) and Fc628 (near the Orange River) also occur.

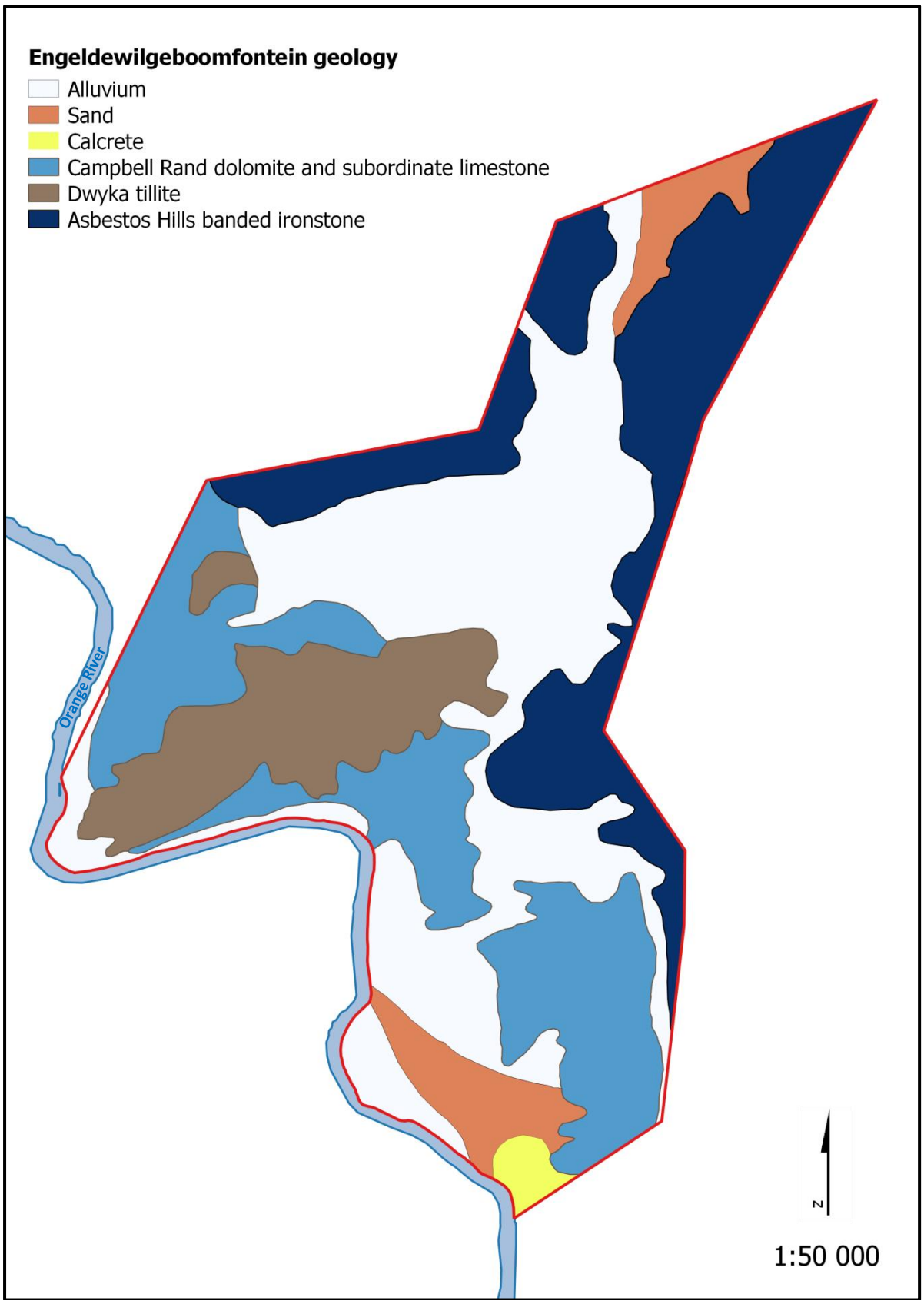


Figure 4. The distribution of geological features in the study area.

3.3. Vegetation

3.3.1. Broad-scale vegetation patterns

The study area falls within the Nama Karoo Biome (Mucina and Rutherford 2006), and according to the vegetation map of Mucina et al. (2005) the majority is represented by Northern Upper Karoo Vegetation, while the riparian vegetation along the Orange River is classified as Upper Gariep Alluvial Vegetation (Figure 5). Lower Gariep Broken Veld is associated with the hills, while a small section in the north comprises Gordonia Duneveld (Figure 5). This vegetation map however does not reflect the true character of the site, because it has not been mapped at a very fine scale.

Northern Upper Karoo is found in the Northern Cape and Free State at altitudes between 1 000 and 1 500 m. It is mostly restricted to the Northern regions of the Upper Karoo plateau from Prieska, Vosburg and Carnarvon in the west to Phillipstown, Petrusville and Petrusburg in the east. The topography is typically flat to gently sloping, but isolated hills of the Upper Karoo Hardeveld (in the south) and Vaalbos Rocky Shrubland (in the northeast) and numerous pans are interspersed in this unit. The vegetation occurs mainly as shrubland dominated by dwarf karoo shrubs, grasses and *Senegalia mellifera*. The geology and soil of this unit varies greatly. Geology include Shales of the Volksrust Formation, Dwyka Group Diamictite, Jurassic Karoo Dolerite sills and sheets, and calcretes of the Kalahari Group.

Soils range from shallow to deep, red-yellow, apedal, freely drained soils to very shallow Glenrosa and Mispah forms. The most dominant landtypes are Ae, Ag and Fc. It is estimated that about 4 % of the unit has been cleared for cultivation or transformed by building of dams; and human settlements are increasing in the north-eastern parts. Erosion is moderate, very low and low, while *Prosopis glandulosa,* considered among the top 12 agriculturally significant invasive alien plants in South Africa, are widely distributed in this unit. The unit is classified as being least threatened and it is not currently conserved within any formal conservation areas. Endemic plant species known from this unit include *Lithops hookeri, Stomatium pluridens, Atriplex spongiosa, Galenia exigua* and *Manulea deserticola*.

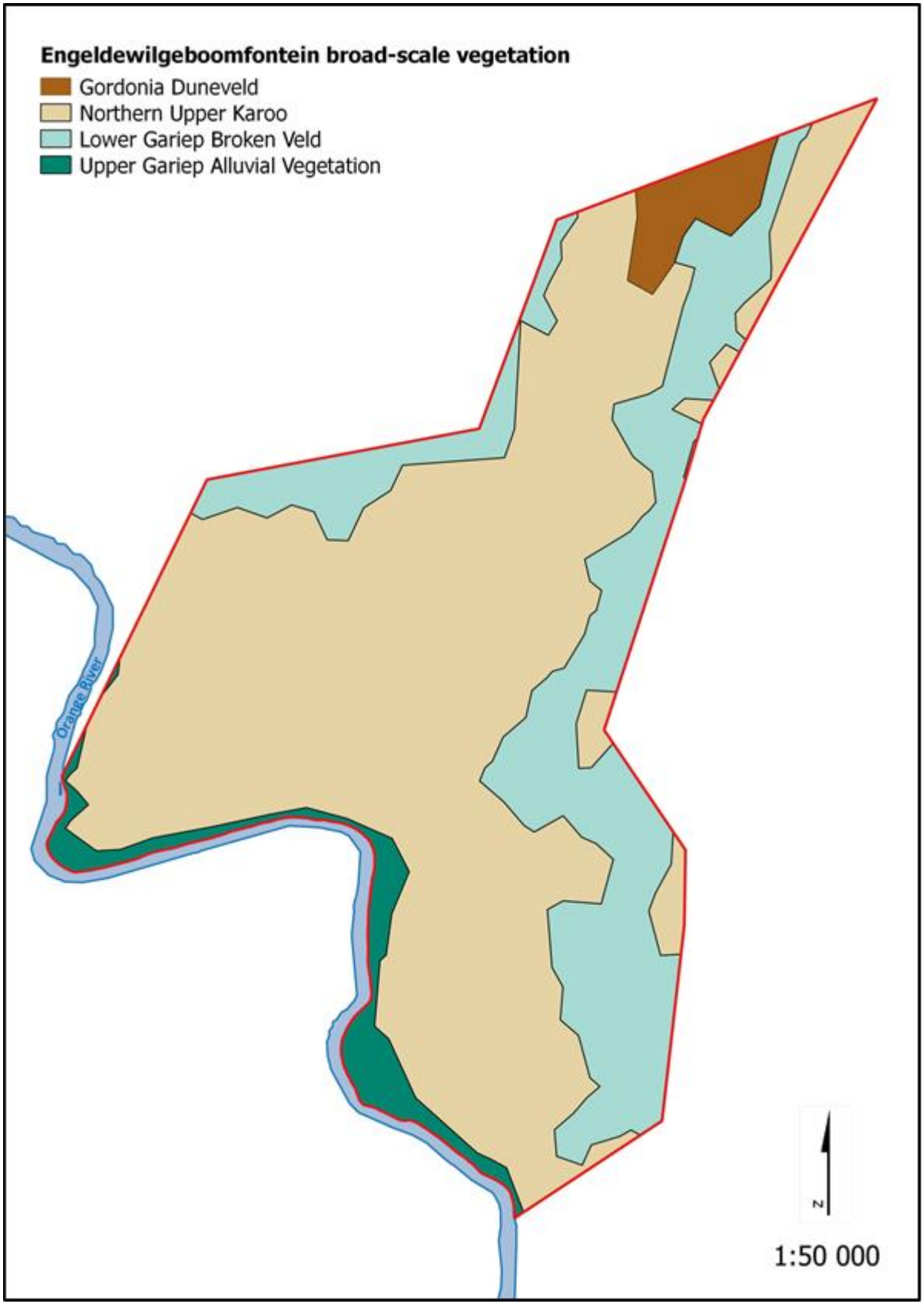


Figure 5. The broad-scale vegetation units (Mucina et al. 2005) present in the study area.

Upper Gariep Alluvial Vegetation is found in the Northern Cape and Free State and includes the broad alluvia of the Orange River, lower Caledon as well as the lower stretches of the Vaal, Riet and Modder Rivers as far as Groblershoop. The topography is typically flat alluvial terraces that host riparian thicket vegetation (dominated by *Vachellia karroo* and *Diospyros lycioides*), flooded grasslands, reed beds and ephemeral herblands found mainly on sand banks within the river and on the river banks. The geology of this unit is presented as recent alluvial deposits underlain by Karoo Supergroup sediments and tillites. The soils are typically of the Ia group land types. This unit is subject to flooding during summer.

It is estimated that more than 20 % of the unit has been transformed for cultivation and the building of dams. Exotic woody species like *Salix babylonica, Eucalyptus camaldulensis, E. Sideroxylon, Prosopis* and *Populus* spp*.,* dominate heavily disturbed alluvial vegetation. The unit is classified as being vulnerable and only 3 % is conserved within formal conservation areas. These include Tussen Die Riviere, Gariep Dam and Oviston Nature Reserves. No endemic plant species are known from this unit.

Lower Gariep Broken Veld is restricted to the Northern Cape Province. It comprises Hardeveld along the Orange River from Onseepkans in the west, to Prieska in the east. The unit varies in altitude from 400 to 1 200 m. The topography includes hills and mountains, slightly irregular plains with sparse vegetation dominated by shrubs and dwarf shrubs. Scattered *Aloidendron dichotomum* individuals grow on the slopes of koppies, while *Senegalia mellifera* is typically found on the sandy soils of foot slopes. The geology of this unit is complicate and includes Banded iron formation and amphibolites of the Asbestos Hills Subgroup, carbonates and cherts of the Campbell Group, Metamorphic rocks in the form of quartzites and gneisses of the Korannaland Subgroup as well as Riemvasmaak gneiss. The Uitdraai Formation and metamorphosed sediments and outcrops of the Namaqualand Metamorphic Complex are also found. The soils are typically shallow and skeletal, with Mispah and Glenrosa soil forms being dominant. The land types include mainly Ib and Ic, but Fb is also found.

The unit is classified as least threatened and only a very small part has been transformed. Erosion risk is regarded as low, very low and moderate. Approximately 4 % is conserved within the Augrabies Falls National Park and *Ruschia pungens* is the only endemic plant species that is known from this unit.

Gordonia Duneveld is also restricted to the Northern Cape Province in areas with dunes. These include the largest part of the Kgalagadi Transfrontier Park and south of the Molopo River border with Botswana (west of Van Zylsrus), interleaving with the Kalahari Karroid Shrubland in the west (south of Rietfontein to the Orange River) and in the south (around Upington and north of Groblershoop). It also occurs as a number of loose dune cordons south of the Orange River near Keimoes and between Upington and Putsonderwater, while outliers are found near Niekerkshoop in the southeast and Floradora in the northeast. Altitude ranges from 800 to 1 200 m. The topography is typically in the form of parallel dunes that stand 3 to 8 m above the plains. The vegetation is presented as open shrubland with ridges of *Stipagrostis amabilis* grassland on the dune crests, *Vachellia haematoxylon* on dune slopes, *Senegalia mellifera* on the lower slopes and *Rhigozum trichotomum* in the interdune straaten. The geology of this unit is presented as aeolian sand underlain by superficial silcretes and calcrete of the Kalahari Group. The parallel sand dunes are fixed and soils are typically of the Af group land type.

The unit is classified as least threatened with very little transformation. Erosion risk is generally low, but increases where dunes have been destabilised through overutilization. Approximately 14 % is conserved within the Kgalagadi Transfrontier Park. No endemic plant species are known from this unit, but Kalahari endemics include *Vachellia haematoxylon, Stipagrostis amabilis, Anthephora argentea, Megaloprotachne albescens, Helichrysum arenicola, Kohautia ramosissima* and *Neuradopsis austro-africana.*

3.3.2. Fine-scale vegetation patterns

Pristine plant communities within the study area are delineated according to plant species correspondences, change in soil structure, topographical changes and disturbance regimes. Areas that have already been cleared for mining or cultivation and farm roads are categorised as mine footprint and transformed habitats, respectively. These were not included in community classifications.

The vegetation on site can be divided into seven distinct units (Figure 6) and are described below. The plant community descriptions include unique characteristics and the dominant species found in each unit. A complete plant species list, including those species likely to occur in the area is presented in Appendix 1.

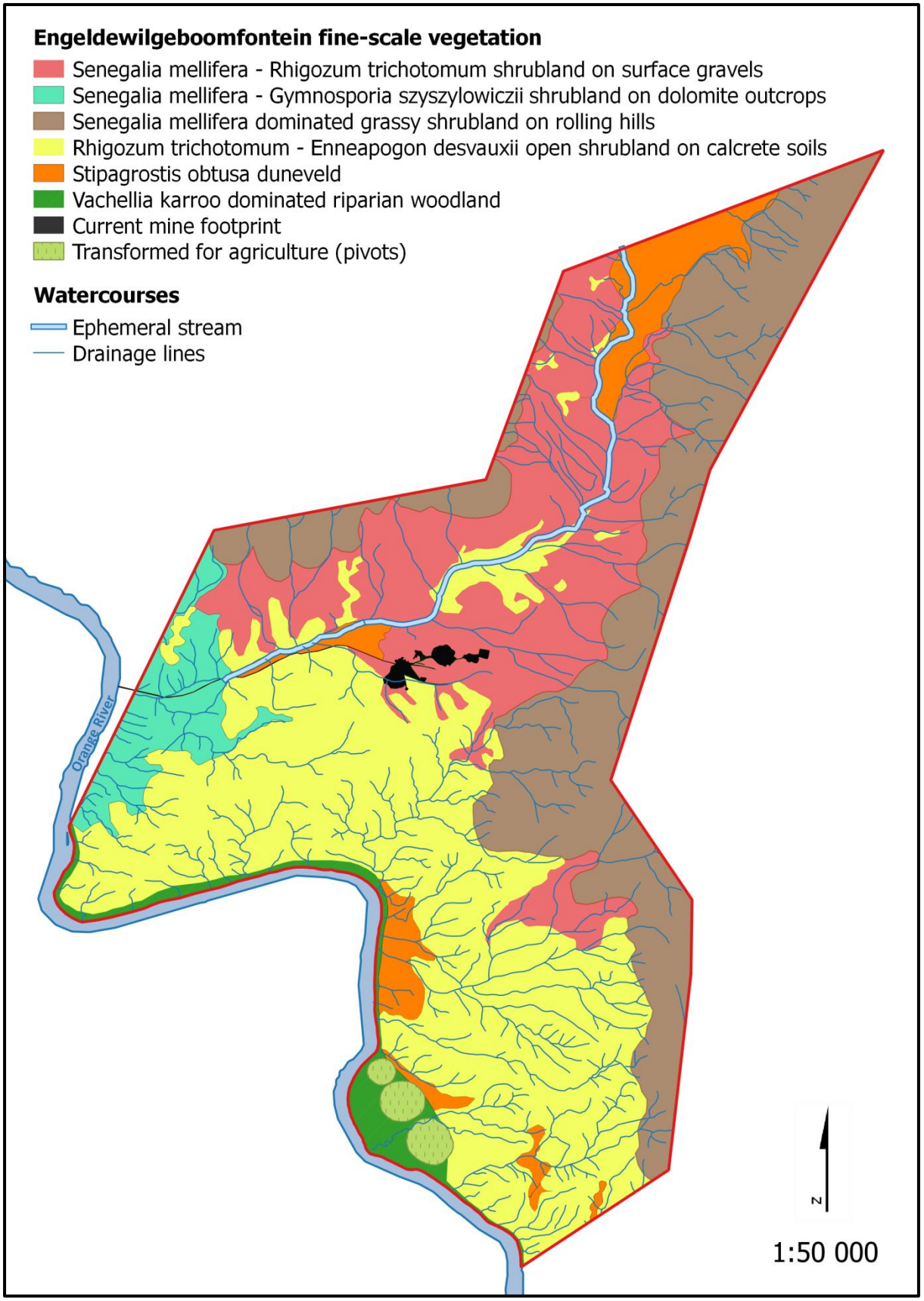


Figure 6. The distribution of fine-scale vegetation units in the study area.

i) *Senegalia mellifera – Rhigozum trichotomum* shrubland on surface gravels

This community occurs on alluvium, found primarily in the north of the study area (Figure 6), but small transitional patches are also scattered across the undulating ridges in the south. Here, shallow rocky soil consisting of iron formation and jaspillite constitutes 40 % of the ground cover (Figure 7). Most of the unit has been overgrazed and little grass cover remains.

Senegalia mellifera and *Rhigozum trichotomum* are the most conspicuous shrubs, while *Ehretia alba, Rhigozum obovatum, Searsia burchellii*, *Gymnosporia szyszylowiczii, Ziziphus mucronata* and *Phaeoptilum spinosum* are also found, but sparsely scattered.

Smaller shrubs that are frequently found include *Aptosimum spinescens, Barleria rigida, Monechma spartioides, Kleinia longiflora, Asparagus burchellii* and *Aizoon burchellii.* Less frequent shrubs include *Pegolettia retrofracta, Zygophyllum rigidum, Sericocoma avolans, Jamesbrittenia* sp., *Thesium lineatum, Aizoon schellenbergii, Aptosimum albomarginatum, A. marlothii, Barleria lichtensteiniana, Chrysocoma ciliata, Melolobium candicans* and *Nolletia chrysocomoides.*

Enneapogon scaber is by far the most dominant grass found across this community, but other grasses include *Aristida congesta* subsp. *barbicollis, Stipagrostis uniplumis* and *Heteropogon contortus.*

Other species found here include *Monechma incanum*, *Asparagus striatus, Pentzia globosa, Blepharis mitrata, Cadaba aphylla, Helichrysum cerastioides, Ocimum americanum* var. *americanum, Limeum aethiopicum* var. *aethiopicum, Tapinanthus oleifolius* and *Eriocephalus* sp.

The protected tree *Boscia albitrunca* occurs widespread and in high densities, i.e. an average of seven individuals per 10 000 m^2 (Figure 8). They are primarily found as young or stunted individuals with average heights ranging between 20 cm and 50 cm, but taller individuals also occur (up to 2.5 m). Canopy widths vary between 80 cm and 3 m. Another protected tree *Vachellia erioloba* is also found in this unit, but occurs at very low densities (< 1 individual per 10 000 m^2) and is sparsely scattered.

The listed *Aloidendron dichotomum* is found in very low densities, while other protected species include *Aloe claviflora, Euphorbia spartaria, Kalanchoe rotundifolia* and *Orbea lutea* subsp. *lutea.* Of these, *A. claviflora* is very common. Please refer to Appendix 2 for a photographic guide to species of conservation concern.

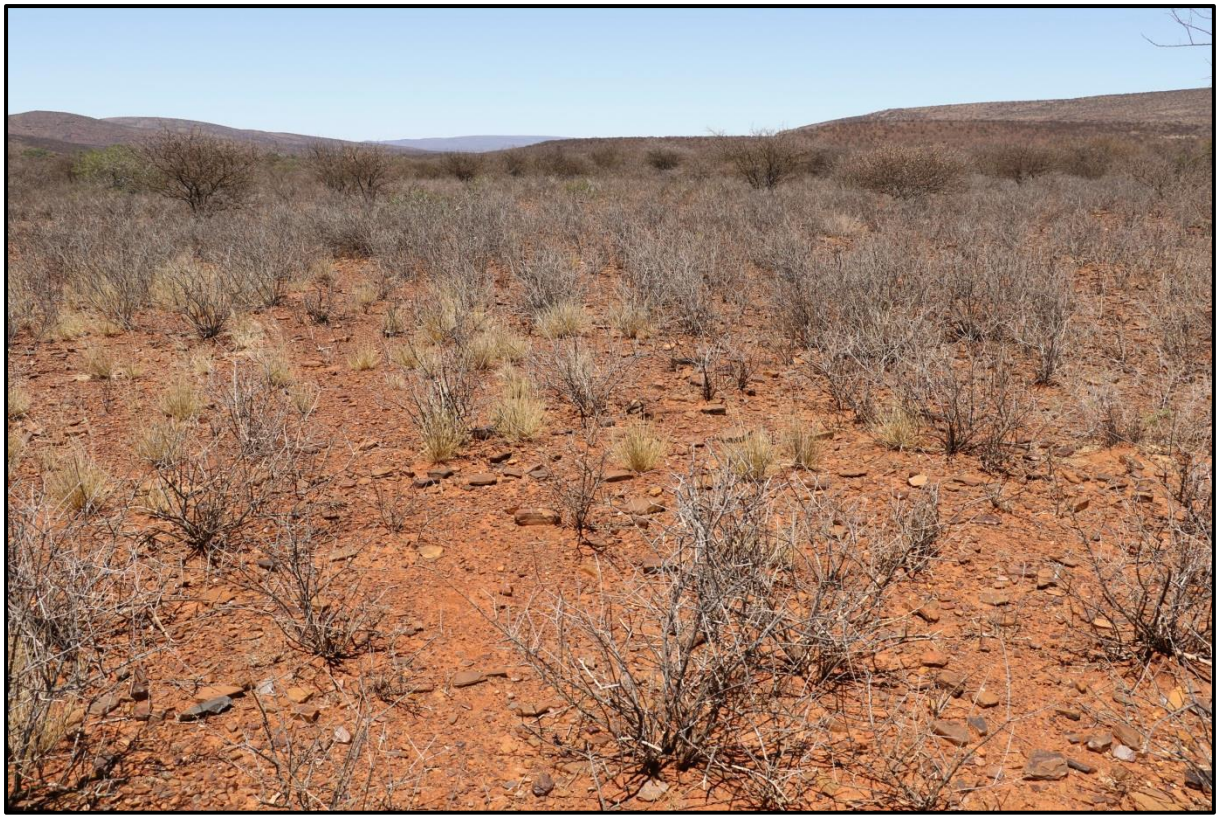


Figure 7. The *Senegalia mellifera – Rhigozum trichotomum* shrubland found on surface gravels are found on shallow rocky soil consisting of iron formation and jaspillite which constitute 40% of the ground cover.

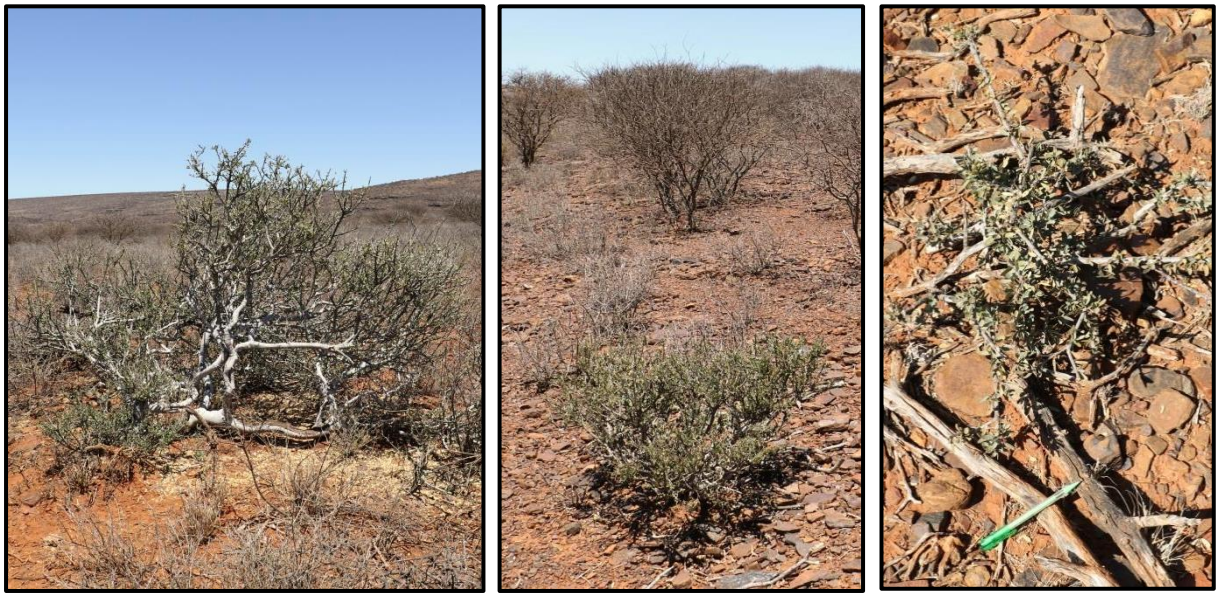


Figure 8. The nationally protected tree *Boscia albitrunca* occurs widespread in the shrubveld on surface gravels as young or stunted individuals.

ii) *Senegalia mellifera – Gymnosporia szyszylowiczii* shrubland on dolomite outcrops

This community occurs on rocky outcrops in the far west of the study area (Figure 6). Here, the vegetation occurs on shallow soils, scattered among dolomites of the Campbell Rand Subgroup (Figure 9). Rocks constitute approximately 60 % of the ground cover.

Figure 9. The vegetation of the shrubland on dolomite outcrops are scattered among the rocks.

Senegalia mellifera and *Gymnosporia szyszylowicziiis* are the most conspicuous large shrubs on these outcrops, while *Euphorbia avasmontana* is a very characteristic sighting in places. *Hermannia cf. desertorum* is the most common dwarf shrub, but others include *Monechma spartioides, Aizoon burchellii, Pentzia incana, Barleria rigida, Zygophyllum rigidum* and *Melolobium candicans.*

The grass layer is well developed with rather high species richness and includes the dominant *Enneapogon scaber*, as well as other grasses such as *Cenchrus ciliaris, Eragrostis annulata, Enneapogon desvauxii, E. scoparius, Heteropogon contortus, Stipagrostis obtusa, S. ciliata* var. *capensis* and *Eragrostis lehmanniana*.

Other species found here include *Kleinia longiflora, Pharnaceum albens* and *Sericocoma avolans.*

The nationally protected tree *Boscia albitrunca* occurs widespread at medium densities; i.e. an average of four individuals per 10 000 m^2. They occur primarily as young or stunted individuals, with an average height of 60 cm and 2 m in width, but taller older trees of up to 2.5 m are also found (Figure 10). The listed *Aloidendron dichotomum* is widespread, but occurs at low densities.

Other species of conservation concern include *Euphorbia avasmontana, Aloe hereroensis* var. *hereroensis, A. claviflora* and *Monsonia salmoniflora*. A photographic guide to these species is attached as Appendix 2.

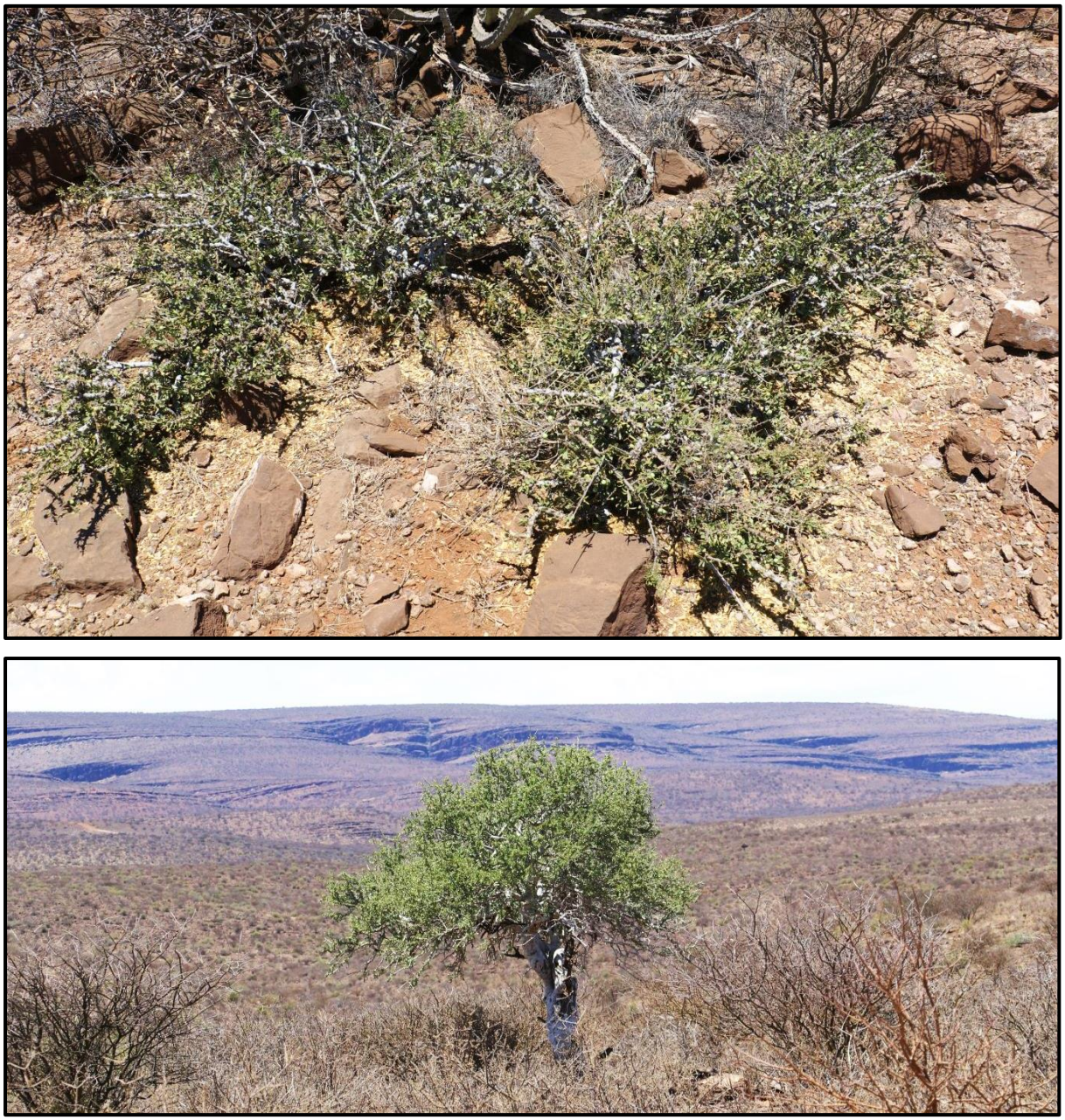


Figure 10. The nationally protected *Boscia albitrunca* occurs widespread on the dolomite outcrops as young or stunted individuals and older trees.

iii) *Senegalia mellifera* dominated grassy shrubland on rolling hills

This plant community is restricted to the slopes and crests of rolling hills that line the study area in the north-west and east (Figure 6). The surface typically represents Hardeveld, with rocks from the Asbestos Hills banded ironstone constituting approximately 40 % of the ground cover (Figure 11).

The shrub *Senegalia mellifera* is the most conspicuous woody species, but *Aloidendron dichotomum* is frequently encountered and a characteristic sighting across the hills. Other more sparsely distributed tall shrubs include *Phaeoptilum spinosum, Rhigozum obovatum, Searsia burchellii* and *Ziziphus mucronata*.

Common lower shrubs include *Rhigozum trichotomum, Asparagus burchellii, Kleinia longiflora, Pegolettia retrofracta, Pteronia glauca, Monechma spartioides, Pentzia incana, P. globosa, Aptosimum spinescens, A. albomarginatum, Aizoon asbestinum, Barleria rigida* and *Eriocephalus* sp.

The grass layer is well developed and contains high species diversity. The species dominance is however patchy and vary across the slopes and crests. Grasses include *Enneapogon scaber, Cenchrus ciliaris, Heteropogon contortus, Eragrostis trichophora, E. lehmanniana, Aristida congesta* subsp*. barbicollis, A. diffusa* subsp*. burkei, Stipagrostis obtusa, S. uniplumis* and *Fingerhuthia africana.*

Other species found here include *Adenia repanda, Barleria lichtensteiniana, Hermannia cf. affinis, H. comosa, Leonotis pentadentata, Melolobium candicans*, *Thesium lineatum, Sericocoma avolans* and *Tapinanthus oleifolius*.

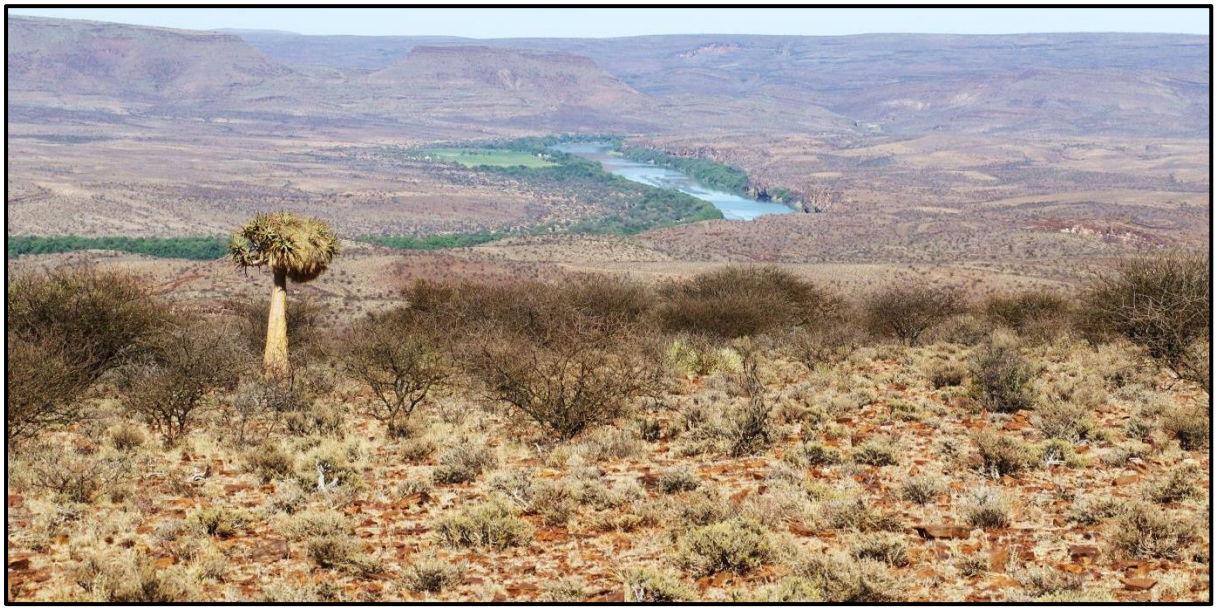


Figure 11. The grassy shrubland of the rolling hills are found on rocks that constitute 40 % of the ground cover.

The nationally protected tree *Boscia albitrunca* occurs widespread in this unit at high densities; i.e. an average of seven individual per 10 000 m^2. Trees vary considerably in size and shape, from small shrubs of ± 80 x 20 cm, to larger trees averaging at 2 m in height and 80 cm to 4 m in width (Figure 12). Much older, tall trees of > 5 m are found on the cliff faces (Figure 12). Most of the larger trees are scattered more sparsely across the unit, while the small individuals occur at higher densities.

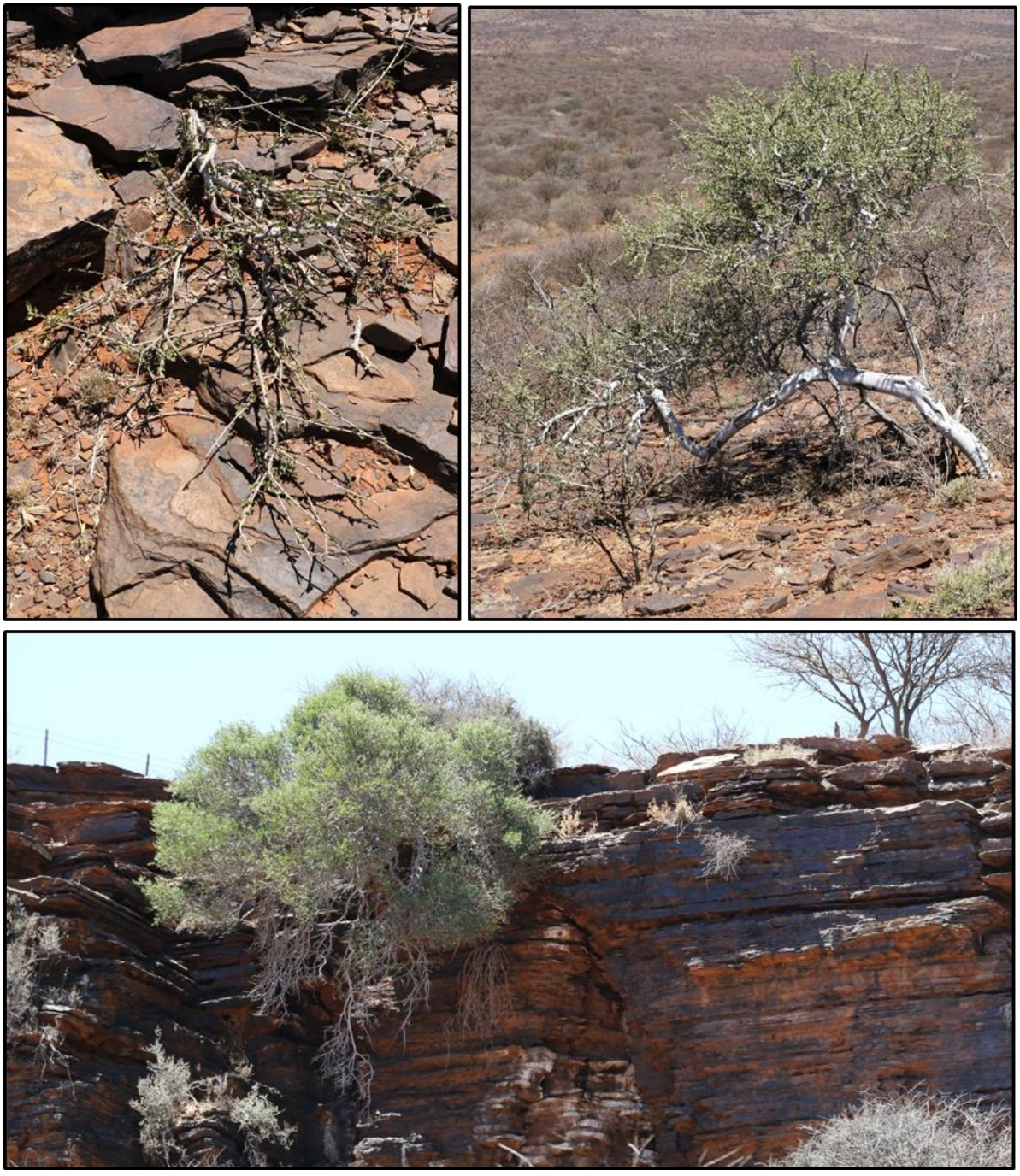


Figure 12. The nationally protected tree *Boscia albitrunca* occurs primarily in the form of small shrubs and larger stunted trees on the slopes and crests of rolling hills, but much taller trees are found on the cliff faces.

The listed *Aloidendron dichotomum* is very abundant on the hills and occurs primarily as trees with an average height of 2 m to 4 m and 50 cm to 3 m in canopy width (Figure 13). Numerous young individuals are also found and some have been pushed over, which indicates the impact of trampling by livestock; presumably cattle, which were seen utilising the veld (Figure 13).

More species of conservation concern found on the rolling hills include *Acanthopsis hoffmanseggiana, Euphorbia avasmontana*, *Monsonia salmoniflora, Pachypodium succulentum, Sarcostemma viminale* subsp. *viminale* and *Mestoklema* sp.

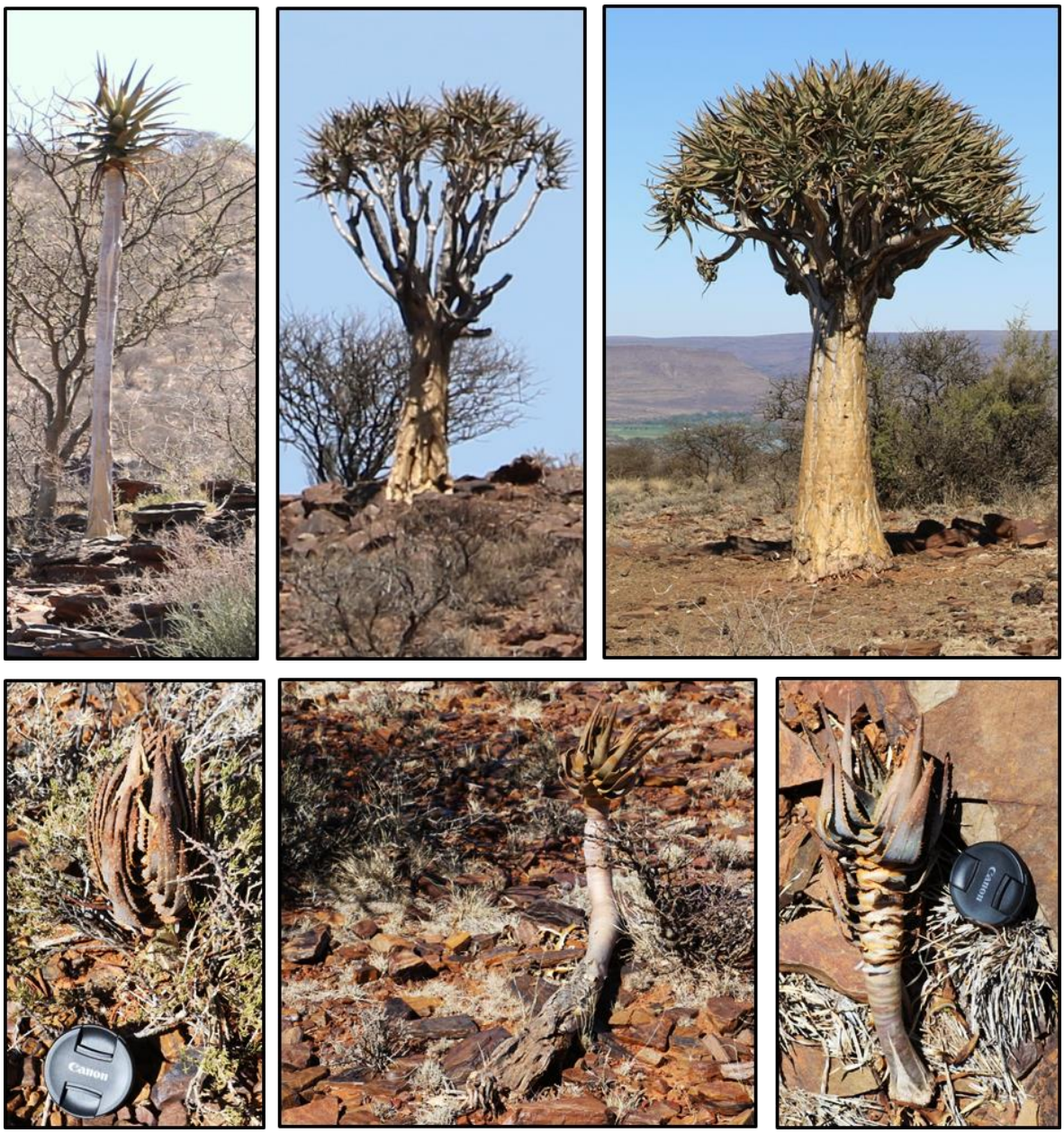


Figure 13. The listed *Aloidendron dichotomum* is very abundant on the hills and is primarily found as tall trees, but very young individuals are also present.

iv) *Rhigozum trichotomum – Enneapogon desvauxii* open shrubland on calcrete soils

This community is found on undulating ridges that vastly occupy the southern half of the study area (Figure 6 and Figure 14). The vegetation grows on gravelly calcrete soils, which constitute approximately 30 % of the ground cover. The unit is frequently intruded by small patches of dolerite outcrops, which lends a mottled appearance to the landscape, but also creates numerous transitional zones between plant communities (Figure 15).

Figure 14. The open shrubland on calcrete soils are restricted to the undulating ridges that vastly occupy the southern half of the study area.

Figure 15. The undulating ridges (light areas) are continuously intruded by dolomite outcrops (dark patches), providing a mottled appearance to the landscape and creates numerous transitional zones.

The community physiognomies vary across the landscape depending on past and current grazing regimes (Figure 16), but species composition is comparable throughout. *Rhigozum trichotomum* is the most dominant shrub, but *Zygophyllum rigidum, Asparagus burchellii, Pentzia incana, Pteronia mucronata, Aptosimum spinescens, A. albomarginatum, Aizoon burchellii* and *Barleria rigida* are also abundant. Larger shrubs like *Senegalia mellifera, Ehretia alba, Phaeoptilum spinosum* and *Searsia burchellii* are sparsely scattered across this unit.

Figure 16. The vegetation community on calcrete soil is found on calcareous gravel, which constitutes 30 % of the ground cover. The physiognomy of the community varies depending on grazing regimes.

The grass layer is well developed, but is not particularly species rich, and with species dominance depending on the grazing regimes. *Enneapogon desvauxii* is the most conspicuous grass, but species like *Stipagrostis obtusa* and *Eragrostis truncata* are also characteristically dominant. Other grasses found here include *Stipagrostis ciliata* var. *capensis* and *S. uniplumis.*

Other species found on the undulating ridges include *Cadaba aphylla, Kleinia longiflora, Thesium lineatum, Lasiosiphon polycephalus, Helichrysum cerastioides, Leonotis pentadentata, Pharnaceum albens, Limeum aethiopicum* var*. aethiopicum* and *Sansevieria aethiopica* and *Salsola* sp.

The nationally protected tree *Boscia albitrunca* is widespread in this unit, but is found at low densities; i.e. an average of two individual per 10 000 m^2. They occur primarily as young or stunted individuals averaging at 20 cm to 80 cm in height and 50 cm to 2 m in width.

Other species of conservation concern found here include *Stapelia* sp*., Larryleachia* sp*., Aloe claviflora, Aloidendron dichotomum, Euphorbia braunsii, Hoodia gordonnii, Monsonia salmoniflora* and *Orbea lutea* subsp. *lutea*. Of these, *A. claviflora* is the most widespread and abundant, while the density of species like *H. gordonnii* and *E. braunsii* is much more pronounced in the small isolated patches in the north of the study area (Figure 6). The remaining species are more sporadically distributed.

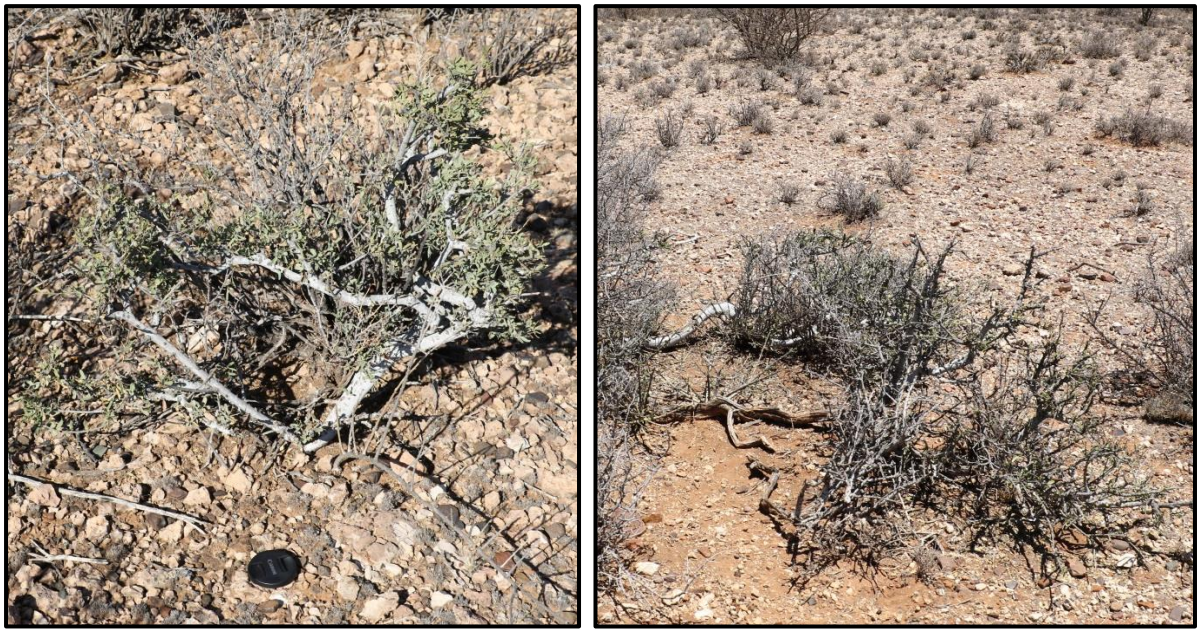


Figure 17. The nationally protected tree *Boscia albitrunca* occurs widespread on the undulating ridges, as young or stunted individuals.

v) *Stipagrostis obtusa* duneveld

This community is restricted to wind-blown sand that typically forms small patches of undulating dunes in the north and south of the study area (Figure 6). Two variants exist; i.e. The *Vachellia erioloba* woodland and the *Senegalia mellifera* grassy shrubland (Figure 18).

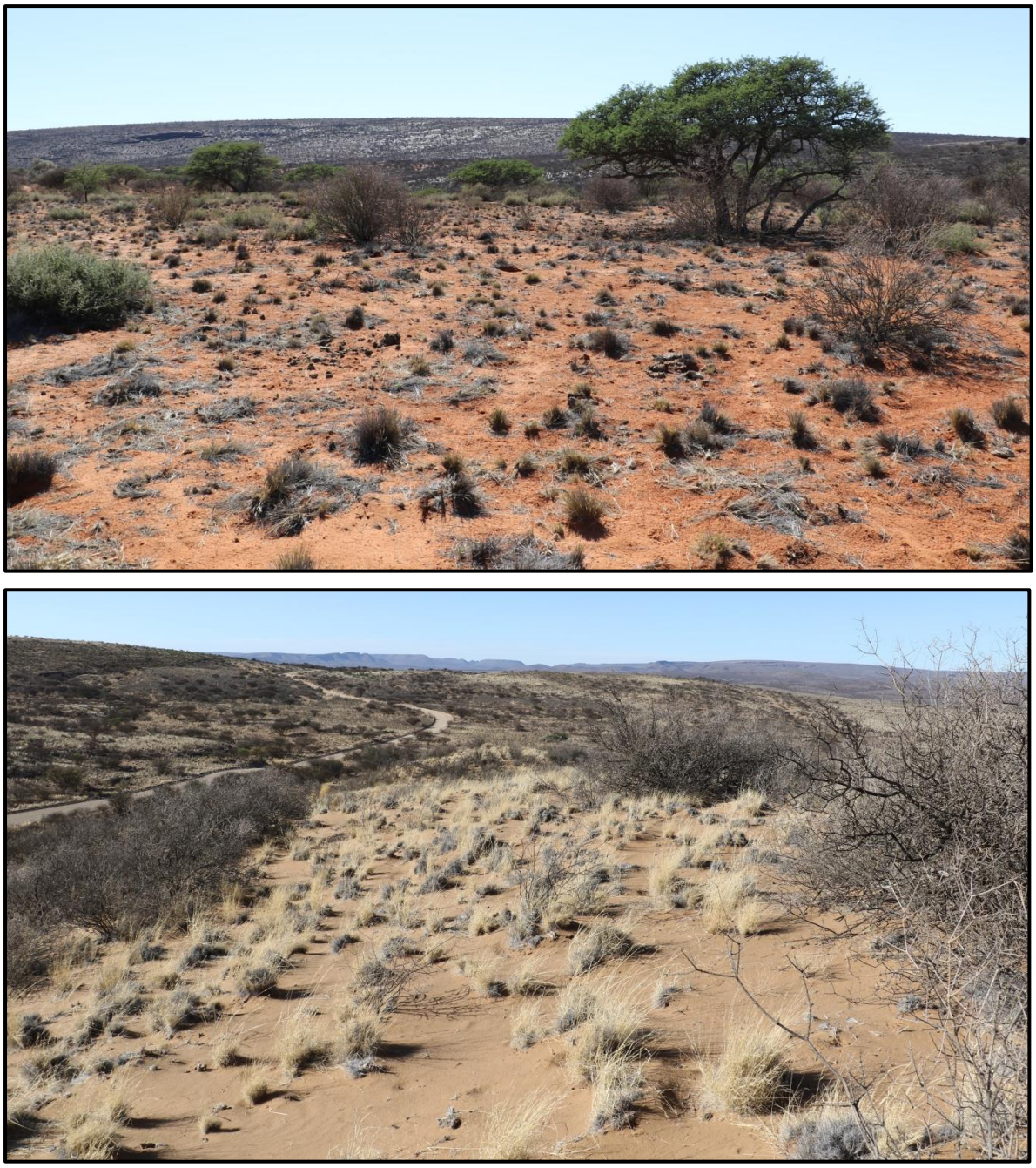


Figure 18. The *Stipagrostis* duneveld occurs as two variants, namely the *Vachellia erioloba* woodland (top) and the *Senegalia mellifera* grassy shrubland (bottom).

- ***Vachellia erioloba* woodland on red sand**

This community is restricted to the duneveld in the north of the study area and is found on red sand, which constitutes 40 % of the ground cover.

The woody stratum is dominated by the nationally protected trees *Vachellia erioloba* and *V. haematoxylon.* These species occur at high and medium densities respectively, i.e. 11 *V. erioloba* and four *V. haematoxylon* individuals per 10 000 m^2. Both trees occur as saplings (20 cm x 20 cm), young trees (1 m x 1.5 m) and tall mature adults of up to 12 m in height and 10 m in canopy width (Figure 19). Another nationally protected tree, *Boscia albitrunca,* is present, but in very low densities (one individual per 10 000m^2) and occurs in the form of young or stunted individuals (20 cm x 40 cm) as well as taller trees of up to 3 m high and 2.5 m in canopy width.

Other common shrubs include *Senegalia mellifera, Rhigozum trichotomum, Asparagus burchellii, Monechma incanum, Lycium hirsutum, Lasiosiphon polycephalus* and *Aptosimum marlothii,* while *Chrysocoma ciliata, Euphorbia mauritanica, Lycium cinereum, Ehretia alba* and *Searsia burchellii* are more sparsely scattered.

The grass layer is well developed and dominated by *Stipagrostis* species. *Stipagrostis obtusa* is most conspicuous, while stands of *S. namaquensis* are characteristic. *Stipagrostis uniplumis* is found in lower densities. Other grasses found here, include *Eragrostis lehmanniana* and *Cenchrus ciliaris*.

Other species found here include *Hermannia comosa, H. tomentosa, Monechma divaricatum, Nolletia chrysocomoides, Chenopodium* sp., *Tapinanthus oleifolius,* and *Viscum rotundifolium.*

Apart from the nationally protected trees, other species of conservation concern found in the woodland on red sand include *Harpagophytum procumbens* subsp. *procumbens* and *Boophone disticha.* Both occur sporadically.

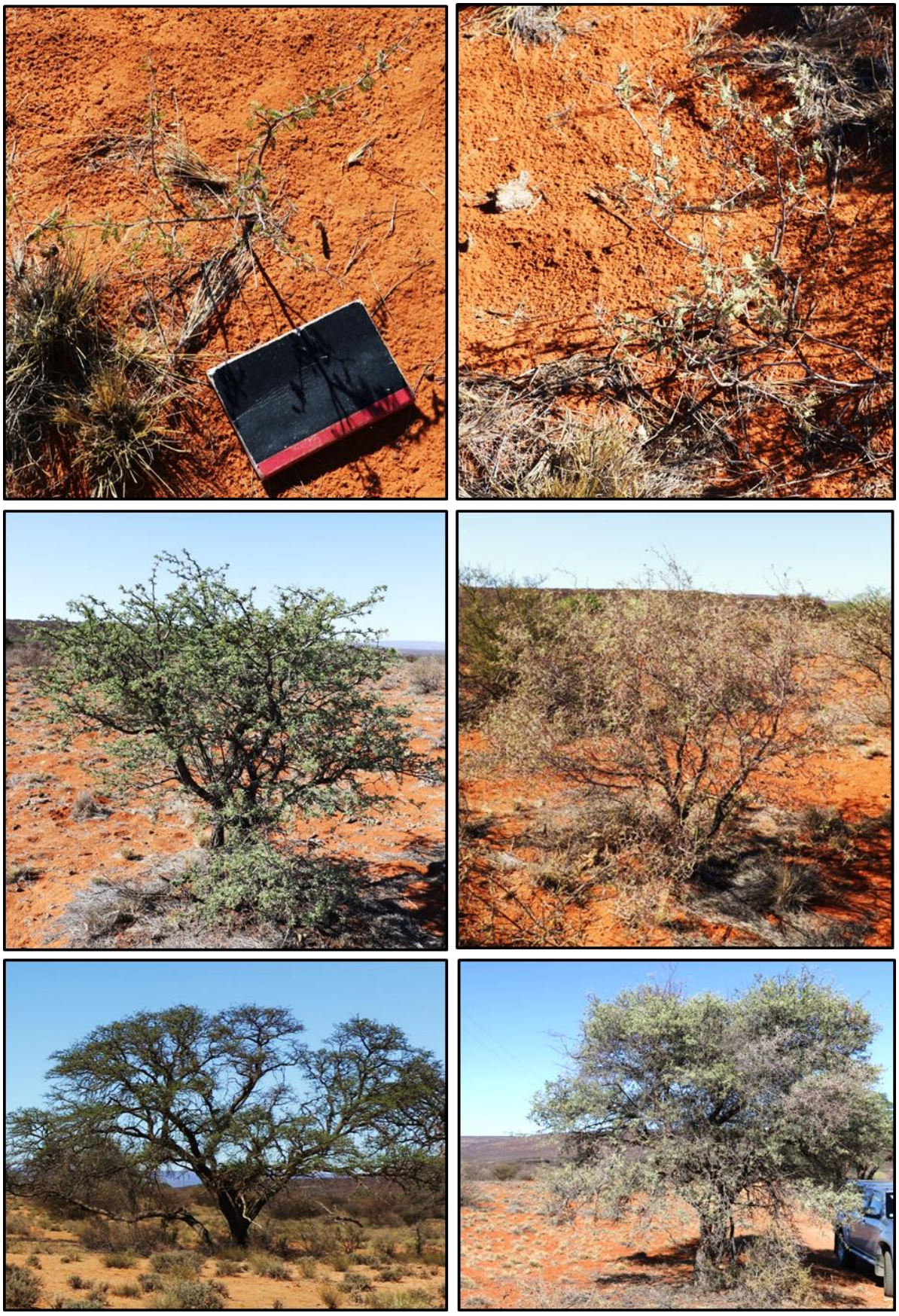


Figure 19. The nationally protected *Vachellia erioloba* (left) and *V. haematoxylon* (right) occur as saplings, young trees and tall mature trees on the duneveld in the north of the study area.

- ***Senegalia mellifera* grassy shrubland on lighter coloured sand**

This variant is found on the duneveld in the south of the study area and is restricted to lighter coloured sand, which constitutes 30 % of the ground cover.

Senegalia mellifera is the most dominant shrub, but *Rhigozum trichotomum* is also common. Other more sparsely scattered shrubs include *Phaeoptilum spinosum, Ziziphus mucronata, Zygophyllum rigidum, Crotolaria cf. spartioides* and *Aptosimum marlothii.*

The well-developed grass layer is dominated by *Stipagrostis obtusa*, while stands of *S. namaquensis* are characteristic. *Stipagrostis ciliata* var. *capensis* and *S. uniplumis* is also common, along with other grasses like *Cenchrus ciliaris* and *Eragrostis lehmanniana.*

Other species found here include *Kleinia longiflora, Nolletia chrysocomoides*, *Polygala seminuda* and *Tapinanthus oleifolius.*

Species of conservation concern include *Boscia albitrunca, Vachellia erioloba* and *Psilocaulon coriarium*. None of these species are common and they are sparsely scattered, but the distribution of *B. albitrunca* is most regular. At densities of less than one individual per 10 000 m^2, they occur primarily as mature trees up to 3 m high, with canopy widths ranging between 3 and 5 m (Figure 20).

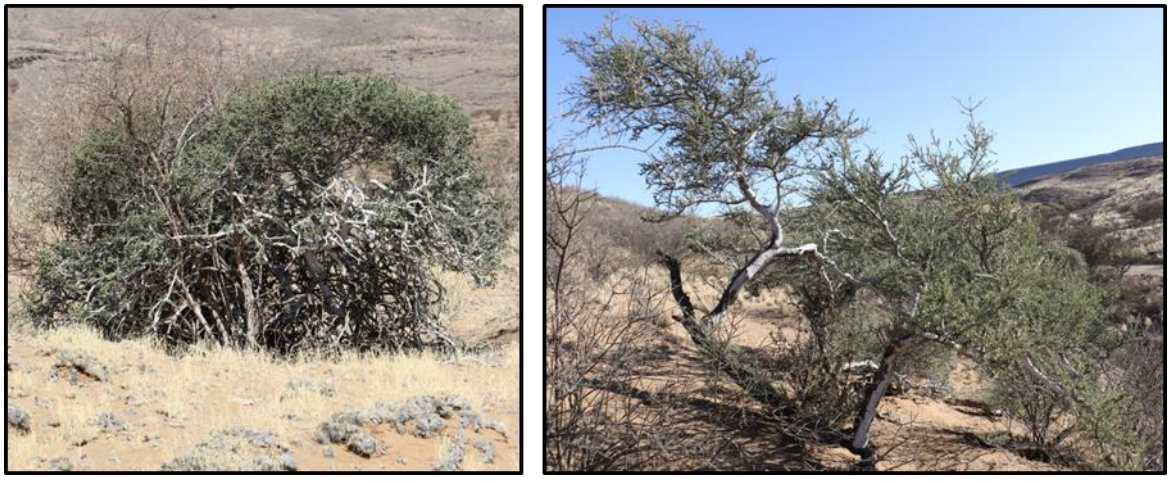


Figure 20. The nationally protected tree *Boscia albitrunca* occurs primarily as mature trees in the grassy shrubland on light coloured sand, but is sparsely distributed.

vi) *Vachellia karroo* dominated riparian woodland

This community is restricted to the banks of the Orange River that line the study area in the south and south-west (Figure 6 and Figure 21). The vegetation forms dense woodland dominated by *Vachellia karoo*, but other dominant species include *Salix mucronata* subsp. *mucronata, Diospyros lycioides, Melianthus comosus* and *Searsia pyroides* var. *pyroides*.

Other species found here include *Asparagus suaveolens, Lycium hirsutum, L. arenicola,* Cyperaceae spp. and numerous climbers.

Figure 21. The dense *Vachellia karoo* woodland lines the banks of the Orange River.

vii) Ephemeral stream and drainage lines

An ephemeral stream is found in the northern half of the study area, where it meanders north to south and south-west towards the Orange River, while a complex network of drainage lines cut across the study area (Figure 6).

Vachellia karroo, Ziziphus mucronata and *Phaeoptilum spinosum* are the most conspicuous species in the ephemeral stream (Figure 22) and are also commonly found in the drainage lines. The latter however, is dominated by *Senegalia mellifera*. Other shrubs found in both watercourses include *Diospyros lycioides* subsp. *lycioides, Ehretia alba*, *Grewia flava*, *Searsia burchellii* and *S. lancea.*

Stipagrostis namaquensis and *Aristida congesta* subsp. *barbicollis* are the dominant grasses, while other species like *Aptosimum marlothii*, *Melolobium candicans*, *Ocimum americanum* var. *americanum* are also found here.

Species of conservation concern include *Psilocaulon coriarium, Boscia albitrunca, Olea europaea* subsp. *africana*, *Vachellia erioloba* and *Gymnosporia szyszylowiczii*. Of these *V. erioloba* grows on the sandy flats associated with the ephemeral stream, while *Boscia albitrunca* and *G. szyszylowiczii* is primarily found in the drainage lines. *Olea europaea* subsp. *africana* is the most widespread and occurs in both these watercourses as large adult trees.

Figure 22. The ephemeral stream of the study area is lined with shrubs and trees like *Vachellia karroo*, *Ziziphus mucronata* and Phaeoptilum spinosum.

3.3.3. Population of sensitive, threatened and protected plant species

Most of the species recorded for the area are classified as least concern; a category which include widespread and abundant taxa. Nine listed species are however known from the study area (Table 1), of which four were encountered during the survey, i.e. *Aloidendron dichotomum* (Vulnerable), *Boophone disticha* (Declining), *Acanthopsis hoffmannseggiana* (Data Deficient - Taxonomically Problematic) and *Hoodia gordonii* (Data Deficient - Insufficient Information).

Of these, *Aloidendron dichotomum* is the most widespread across communities, but is found at very low densities in the area earmarked for mining and the population is well preserved on the rolling hills. On the other hand, *Hoodia gordonii* is very abundant and primarily found in the areas earmarked for mining, i.e. shrubland on surface gravels and open shrubland on calcrete soils. *Boophone disticha* is restricted to the woodland on red sand and *A. hoffmannseggiana* to the rolling hills; communities that are excluded from the mining area.

Species found on the Engeldewilgeboomfontein mining area, that are protected in terms of the National Forests (NFA) Act No 84 of 1998 includes *Vachellia erioloba, V. haematoxylon* and *Boscia albitrunca*. The latter species occurs widespread across the entire study area at low to high densities and it is estimated that more than 1 000 individuals are likely to be affected within the core mining area. *Vachellia erioloba* is also present in the core mining area, but it is estimated that less than 1 000 individuals will be affected. The remaining species are not expected to be affected by the mining activities. In order to damage or remove any protected trees (seedlings to adults) an application must be submitted to the Northern Cape Department of Agriculture, Forestry and Fisheries (DAFF) and a licence obtained from DAFF prior to any removal.

Species known from the region, which are protected in terms of Schedule 1 and Schedule 2 of the Northern Cape Nature Conservation (NCNCA) Act No. 9 of 2009 are listed in Table 1. The only specially protected (Schedule 1) species that was encountered, other than those listed species already mentioned, was *Harpagophytum procumbens* subsp. *procumbens*. It is restricted to the woodland on sand and is not included in the mining area.

Those protected (Schedule 2) species that were encountered in the areas that are most likely to be affected by the mining activities include *Aloe claviflora, Orbea lutea* subsp*. lutea, Stapelia* sp*., Kalanchoe rotundifolia, Euphorbia braunsii, E. spartaria* and *Jamesbrittenia* sp.

A projection for species of conservation concern is presented in Table 2, A photographic guide to those species encountered during the survey is attached as Appendix 2.

Additionally, according to Section 51(2) of NCNCA, a permit is required from the Northern Cape, Department of Environment and Nature Conservation (DENC) for the large-scale clearance of indigenous (Schedule 3) vegetation, before mining commences.

Table 1. Plant species found in the study region that are of conservation concern. Those encountered during the survey is indicated with *.

FAMILY	Scientific name	Status	NFA	NCNCA
ACANTHACEAE	*Acanthopsis hoffmannseggiana**	DDT		
AMARYLLIDACEAE	*Ammocharis coranica*			S2
	*Boophone disticha**	Declining		S2
	Brunsvigia radulosa			S2
	Haemanthus humilis subsp. *humilis*			S2
	Nerine filifolia			S2
	Nerine laticoma			S2
APIACEAE	*Berula thunbergii*			S2
APOCYNACEAE	*Cynanchum orangeanum*			S2
	Duvalia maculate			S2
	Fockea angustifolia			S2
	Gomphocarpus fruticosus subsp. *fruticosus*			S2
	Gomphocarpus tomentosus subsp. *tomentosus*			S2
	*Hoodia gordonii**	DDD		S1
	Hoodia officinalis subsp. *officinalis*	NT		S2
	Larryleachia marlothii			S2
	Larryleachia sp.*			S2
	Microloma armatum var. *armatum*			S2
	Orbea lutea subsp. *lutea**			S2
	*Pachypodium succulentum**			S2
	Pentarrhinum insipidum			S2
	Piaranthus decipiens			S2
	Sarcostemma pearsonii			S2
	Sarcostemma viminale subsp. *viminale**			S2
	Stapelia flavopurpurea			S2
	Stapelia olivacea			S2
	Stapelia sp.*			S2
ASPHODELACEAE	*Aloe claviflora**			S2
	Aloe hereroensis var. *hereroensis**			S2
	*Aloidendron dichotomum**	VU		S1
	Bulbine abyssinica			S2
	Bulbine asphodeloides			S2
	Bulbine lagopus			S2
	Haworthia venosa subsp. *tessellata*			S2
	Trachyandra laxa var. *laxa*			S2
CAPPARACEAE	*Boscia albitrunca**		X	S2
CARYOPHYLLACEAE	*Dianthus thunbergii*			S2
CELASTRACEAE	*Gymnosporia szyszylowiczii**			S2
CRASSULACEAE	*Adromischus trigynus*			S2
	Cotyledon orbiculata var. *oblonga*			S2
	Cotyledon orbiculata var. *orbiculata*			S2
	Crassula atropurpurea var. *atropurpurea*			S2
	Crassula deltoidea			S2
	Crassula dependens			S2

Table 1 (cont.). Plant species found in the study region that are of conservation concern. Those encountered during the survey is indicated with *.

FAMILY	Scientific name	Status	NFA	NCNCA
CRASSULACEAE	*Crassula muscosa* var. *muscosa*			**S2**
	Crassula natans var. *minus*			**S2**
	Kalanchoe brachyloba			**S2**
	Kalanchoe paniculata			
	*Kalanchoe rotundifolia**			**S2**
	Tylecodon rubrovenosus			**S2**
EUPHORBIACEAE	*Euphorbia avasmontana**			**S2**
	*Euphorbia braunsii**			**S2**
	Euphorbia crassipes			**S2**
	Euphorbia gariepina subsp. *gariepina*			**S2**
	Euphorbia inaequilatera var. *inaequilatera*			**S2**
	Euphorbia mauritanica var. *mauritanica**			**S2**
	Euphorbia rhombifolia			**S2**
	*Euphorbia spartaria**			**S2**
	Euphorbia spinea			**S2**
FABACEAE	*Lessertia macrostachya* var. *macrostachya*			**S1**
	Lessertia pauciflora var. *pauciflora*			**S1**
	Sutherlandia frutescens			**S1**
	*Vachellia erioloba**		**X**	
	*Vachellia haematoxylon**		**X**	
GERANIACEAE	*Pelargonium minimum*			**S1**
HYACINTHACEAE	*Lachenalia dasybotrya*			**S2**
	Lachenalia karooica			**S2**
	Ornithogalum flexuosum			**S2**
	Ornithogalum prasinum			**S2**
IRIDACEAE	*Freesia andersoniae*			**S2**
	Gladiolus orchidiflorus			**S2**
	Gladiolus permeabilis subsp. *edulis*			**S2**
	Lapeirousia plicata subsp. *plicata*			**S2**
	Moraea cookie			**S2**
	Moraea polystachya			**S2**
	Moraea simulans			**S2**
	Moraea venenata			**S2**
	Tritonia karooica			**S2**
MELIACEAE	*Nymania capensis*			**S2**
MESEMBRYANTHEMACEAE	*Aptenia geniculiflora*			**S2**
	Aridaria noctiflora subsp. *straminea*			**S2**
	Cheiridopsis denticulate			**S2**
	Dinteranthus pole-evansii	**VU**		**S2**
	Drosanthemum hispidum			**S2**
	Drosanthemum lique			**S2**
	Hereroa wilmaniae	**DDT**		**S2**
	Lampranthus watermeyeri			**S2**

Table 1 (cont.). Plant species found in the study region that are of conservation concern. Those encountered during the survey is indicated with *.

FAMILY	Scientific name	Status	NFA	NCNCA
MESEMBRYANTHEMACEAE	*Lithops hallii*			**S2**
	Lithops hookeri			**S2**
	Mesembryanthemum aitonis			**S2**
	Mesembryanthemum guerichianum			**S2**
	Mestoklema arboriforme			**S2**
	Mestoklema sp.*			**S2**
	Mestoklema tuberosum			**S2**
	Nananthus pole-evansii			**S2**
	Pleiospilos compactus subsp. *canus*			**S2**
	Prenia tetragonum			**S2**
	Psilocaulon articulatum			**S2**
	*Psilocaulon coriarium**			**S2**
	Ruschia canonotata			**S2**
	Ruschia divaricate			**S2**
	Ruschia ferox			**S2**
	Ruschia griquensis			**S2**
	Ruschia intricate			**S2**
	Ruschia pungens	**DDT**		**S2**
	Ruschia ruralis			**S2**
	Sceletium emarcidum			**S2**
	Stomatium bryantii			**S2**
	Titanopsis calcarea			**S2**
	Trichodiadema pomeridianum			**S2**
	Trichodiadema pygmaeum	**VU**		**S2**
	Trichodiadema setuliferum			**S2**
OLEACEAE	*Olea europaea* subsp. *africana**			**S2**
OXALIDACEAE	*Oxalis haedulipes*			**S2**
	Oxalis lawsonii			**S2**
PEDALIACEAE	*Harpagophytum procumbens* subsp. *procumbens**			**S1**
PORTULACACEAE	*Anacampseros filamentosa* subsp. *filamentosa*			**S2**
SCROPHULARIACEAE	*Diascia alonsooides*			**S2**
	Jamesbrittenia argentea			**S2**
	Jamesbrittenia atropurpurea subsp. *atropurpurea*			**S2**
	Jamesbrittenia aurantiaca			**S2**
	Jamesbrittenia canescens var. *canescens*			**S2**
	Jamesbrittenia integerrima			**S2**
	Jamesbrittenia sp. *			**S2**
	Nemesia fruticans			**S2**
	Nemesia hanoverica			**S2**
TECOPHILAEACEAE	Cyanella lutea			**S2**

Table 2. A projection of community sizes and species of conservation concern found in the study area.

Communities	Total size	Predicted extent to be affected by mining	Associated species of conservation concern	Population density (ind/ha)	Estimated population to be affected by mining
Senegalia mellifera – Rhigozum trichotomum shrubland on surface gravels	± 2 063 ha	± 1 000 ha	*Boscia albitrunca*	7	7 000
			Vachellia erioloba	< 1	< 50
			Aloidendron dichotomum	< 1	< 10
			Aloe claviflora	4	± 4 000
			Euphorbia spartaria	< 1	< 50
			Kalanchoe rotundifolia	< 1	< 50
			Orbea lutea subsp. *lutea*	< 1	< 50
Senegalia mellifera – Gymnosporia szyszylowiczii shrubland on dolomite outcrops	± 446 ha	0 ha	*Boscia albitrunca*	4	None predicted
			Aloidendron dichotomum	< 1	None predicted
			Euphorbia avasmontana	6	None predicted
			Aloe hereroensis var. *hereroensis*	< 1	None predicted
			Aloe claviflora	1	None predicted
			Monsonia salmoniflora	< 1	None predicted
Senegalia mellifera dominated grassy shrubland on rolling hills	± 2 361 ha	0 ha	*Boscia albitrunca*	7	None predicted
			Aloidendron dichotomum	2	None predicted
			Acanthopsis hoffmanseggiana	< 1	None predicted
			Euphorbia avasmontana	3	None predicted
			Monsonia salmoniflora	2	None predicted
			Pachypodium succulentum	3	None predicted
			Sarcostemma viminale subsp. *viminale*	< 1	None predicted
			Mestoklema sp.	1	None predicted

Table 2 (cont.). A projection of community sizes and species of conservation concern found in the study area.

Communities	Total size	Predicted extent to be affected by mining	Associated species of conservation concern	Population density (ind/ha)	Estimated predicted population to be affected by mining
Rhigozum trichotomum –Enneapogon desvauxii open shrubland on calcrete soils	± 3 754 ha	± 560 ha	*Boscia albitrunca*	2	± 1 000
			Stapelia sp.	< 1	< 50
			Larryleachia sp.	< 1	< 50
			Aloe claviflora	3	± 1 600
			Aloidendron dichotomum	< 1	< 10
			Euphorbia braunsii	3	± 1 600
			Hoodia gordonnii	5	± 2 800
			Monsonia salmoniflora	< 1	< 50
			Orbea lutea subsp. *lutea*	< 1	< 50
Stipagrostis obtusa duneveld (*Vachellia erioloba* woodland on red sand)	± 382 ha	0 ha	*Vachellia erioloba*	11	None predicted
			Vachellia haematoxylon	4	None predicted
			Boscia albitrunca	1	None predicted
			Harpagophytum procumbens	10	None predicted
			Boophone disticha	< 1	None predicted
Stipagrostis obtusa duneveld (*Senegalia mellifera* grassy shrubland on light coloured sand)	± 189 ha	0 ha	*Boscia albitrunca*	< 1	None predicted
			Psilocaulon coriarium	1	None predicted
Vachellia karroo dominated riparian woodland	± 234 ha	0 ha	None encountered	N/A	N/A
Ephemeral Stream*	± 12 km	0 km		**(ind/km)**	
Drainage lines	± 266 km	± 18 km	*Psilocaulon coriarium**	< 1	None predicted
			Boscia albitrunca	40	± 720
			Olea europaea subsp. *africana*	10	± 180
			*Vachellia erioloba**	5	None predicted
			Gymnosporia szyszylowiczii	6	± 108

3.3.4. Critical biodiversity areas and broad-scale processes

The Northern Upper Karoo, Lower Gariep Broken Veld and Gordonia Duneveld vegetation units found within the study area are classified as least threatened. However, the Upper Gariep Alluvial Vegetation unit is classified as being vulnerable. Nevertheless, no fine-scale conservation planning has been conducted for the area. The area has also not been identified for long-term maintenance of broad-scale ecological processes, and is not known to host exceptional biodiversity. Furthermore, the study area does not fall within a National Protected Areas Expansion Strategy Focus Area. However, these classifications and descriptions are based on available data for the region and it is important to note that the region is greatly understudied and that decision-making should not be based purely on these classifications.

Furthermore, the proposed mining area falls within the Griqualand West Centre of Endemism (Van Wyk and Smith 2001), as does many other mining operations. A centre of plant endemism is an area with high concentrations of plant species with very restricted distributions, known as endemics. They are extremely vulnerable; relatively small disturbances in a centre of endemism may easily pose a serious threat to its many range restricted species. The GWC (Figure 23) is considered a priority in the Northern Cape, because the number of threats to the area is increasing rapidly. This is a cause of concern, because the GWC is still greatly misunderstood and under researched. Important elements might therefore be lost or disturbed due to a lack of knowledge, which could assist in protecting its fundamental processes. The cumulative effect of mining in this region exacerbate the potential risk of losing information on ecosystem function owing to the lack of basic research information within this area.

The mine itself is expected to cause habitat transformation through the excavation of large open pits, and will thereby contribute to cumulative habitat loss and the disruption of the broad-scale landscape connectivity in the region. The study area falls within a zone where one of South Africa's largest economically most important alluvial deposits of diamonds are found. The primary secondary source of alluvial diamond deposits in the Northern Cape extends along the Orange (Figure 24) and Vaal Rivers (Gresse 2003), while the most significant crop irrigation (Figure 24) in the Northern Cape also stretches along these rivers (Durand 2006). According to Mucina et al. (2005), the highest proportion of any type of transformation in the Nama-Karoo Biome is the clearance of the Northern Upper Karoo for cultivation. In addition, it is estimated that more than 20 % of the Upper Gariep Alluvial vegetation unit has been transformed for cultivation. The cumulative impacts in the vicinity of the study area are therefore considered to be very high.

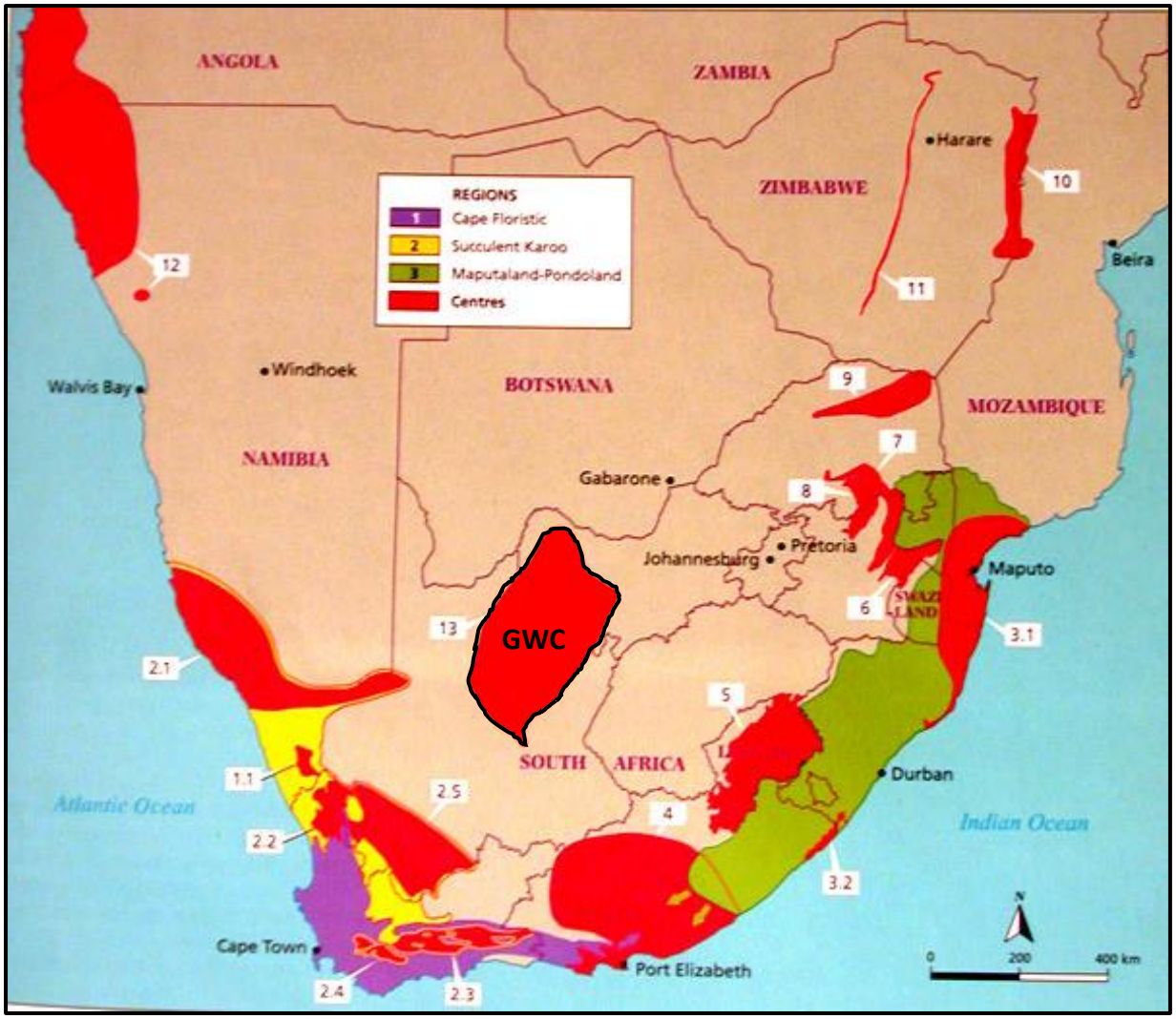


Figure 23. A map indicating the regions of floristic endemism in southern Africa, according to Van Wyk and Smith (2001)

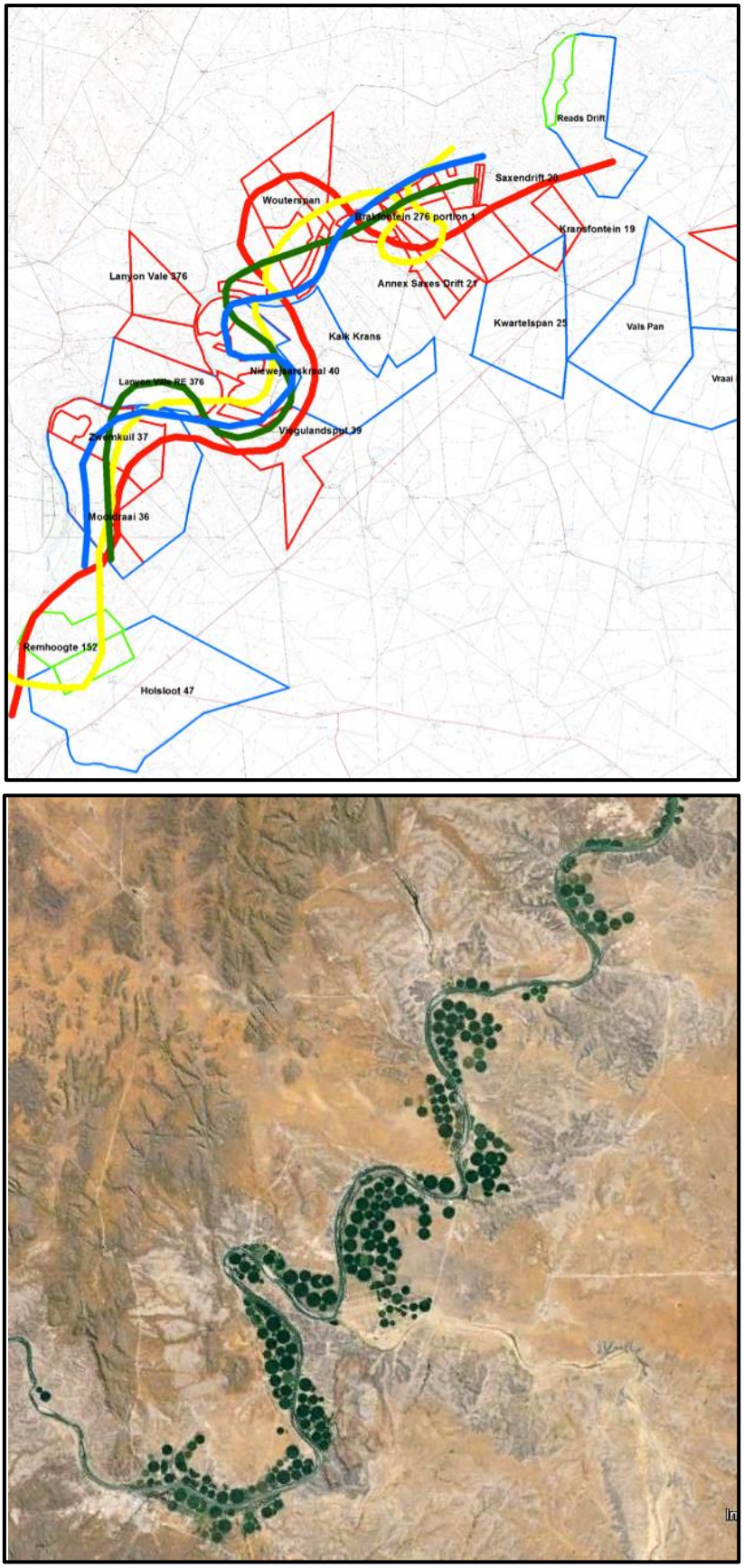


Figure 24. The distribution of mining properties (top) and crop irrigation along the Orange River (bottom) north of Prieska.

3.3.5. Weeds and invader plant species

Weeds and invasive species are controlled in terms of the National Environmental Management: Biodiversity (NEMBA) Act 10 of 2004, the Conservation of Agricultural Resources (CARA) Act 43 of 1993, as well as the NCNCA (Schedule 6). These are species that do not naturally occur in a given area and exhibit tendencies to invade that area, and others; at the cost of locally indigenous species. To govern the control of such species, NEMBA and CARA have divided weeds and invader species into categories (see Table 3). All declared weeds and invasive species recorded in and around the study area are listed in Table 4, along with their categories according to CARA, NEMBA and NCNCA.

Table 3. The categorisation of weeds and invader plant species, according to NEMBA and CARA.

NEMBA		CARA	
1a	Listed invasive species that must be combatted or eradicated.	**1**	Plant species that must be removed and destroyed immediately. These plants serve no economic purpose and possess characteristics that are harmful to humans, animals and the environment.
1b	Listed invasive species that must be controlled.	**2**	Plant species that may be grown under controlled conditions. These plants have certain useful qualities and are allowed in demarcated areas. In other areas they must be eradicated and controlled.
2	Listed invasive species that require a permit to carry out a restricted activity within an area.	**3**	Plant species that may no longer be planted. These are alien plants that have escaped from, or are growing in gardens and are proven to be invaders. No further planting is allowed. Existing plants may remain (except those within the flood line, 30 m from a watercourse, or in a wetland) and must be prevented from spreading.
3	Listed invasive species that are subject to exemptions and prohibitions		

Table 4. A list of declared weeds and invasive species recorded in the study area.

Scientific name	Common name	CARA	NEMBA	NCNCA
Argemone ochroleuca	White-flowered Mexican poppy	1	1b	S6
Austrocylindropuntia cylindrica	Cane cactus	-	1a	-
Echinopsis spachiana	Torch cactus	1	1b	S6
Nicotiana glauca	Wild tobacco	1	1b	S6
Opuntia ficus-indica	Sweet prickly pear	1	1b	S6
Prosopis glandulosa	Honey mesquite	2	3	S6
Prosopis velutina	Velvet mesquite	2	3	S6
Salsola kali	Tumbleweed	-	1b	-
Tephrocactus articulatus	Pine cone cactus	-	1a	-

3.3.6. Indicators of bush encroachment

Bush encroacher species are controlled in terms of Regulation 16 of CARA; where land users of an area in which natural vegetation occurs and that contains communities of encroacher indicator plants are required to follow sound practices to prevent the deterioration of natural resources and to combat bush encroachment where it occurs. Declared indicators of bush encroachment in the Northern Cape, which were recorded in and around the study area, are listed in Table 5.

Table 5. A list of declared indicators of bush encroachment in the Northern Cape recorded in the study area.

Scientific name	Common name
Senegalia mellifera	Black thorn
Vachellia karroo	Sweet thorn
Grewia flava	Wild raisin
Rhigozum trichotomum	Three-thorn rhigozum

3.4. Site sensitivity

The floristic sensitivity map for the Engeldewilgeboomfontein mining operation is illustrated in Figure 25. The grassy shrubland on light coloured sand is considered to be of medium floristic sensitivity due to the low species richness found here, but also because of the sporadic occurrences of species of conservation concern.

The majority of the study area is considered to be of high floristic sensitivity and include the shrublands on dolomite outcrops and surface gravels as well as the open shrubland on calcrete soils. This classification is given on account of the high number and frequency of species of conservation concern found here. The majority of the area also falls within the core mining area that will evidently be mined.

The remaining riparian woodland, ephemeral stream and drainage lines, woodland on red sand and rolling hills are considered to be of very high floristic sensitivity mainly on account of the significance and frequency of species of conservation concern found here, but also due to their general significance. For example, all watercourses in the study area are unique habitats protected in terms of the National Water Act (Act No 36 of 1998). The riparian woodland also falls within a vulnerable broad-scale vegetation unit, threatened by transformation for cultivation, while the rolling hills are highly sensitive due to the drainage systems originating here and associated erosion risks. These units should therefore be demarcated as no-go areas.

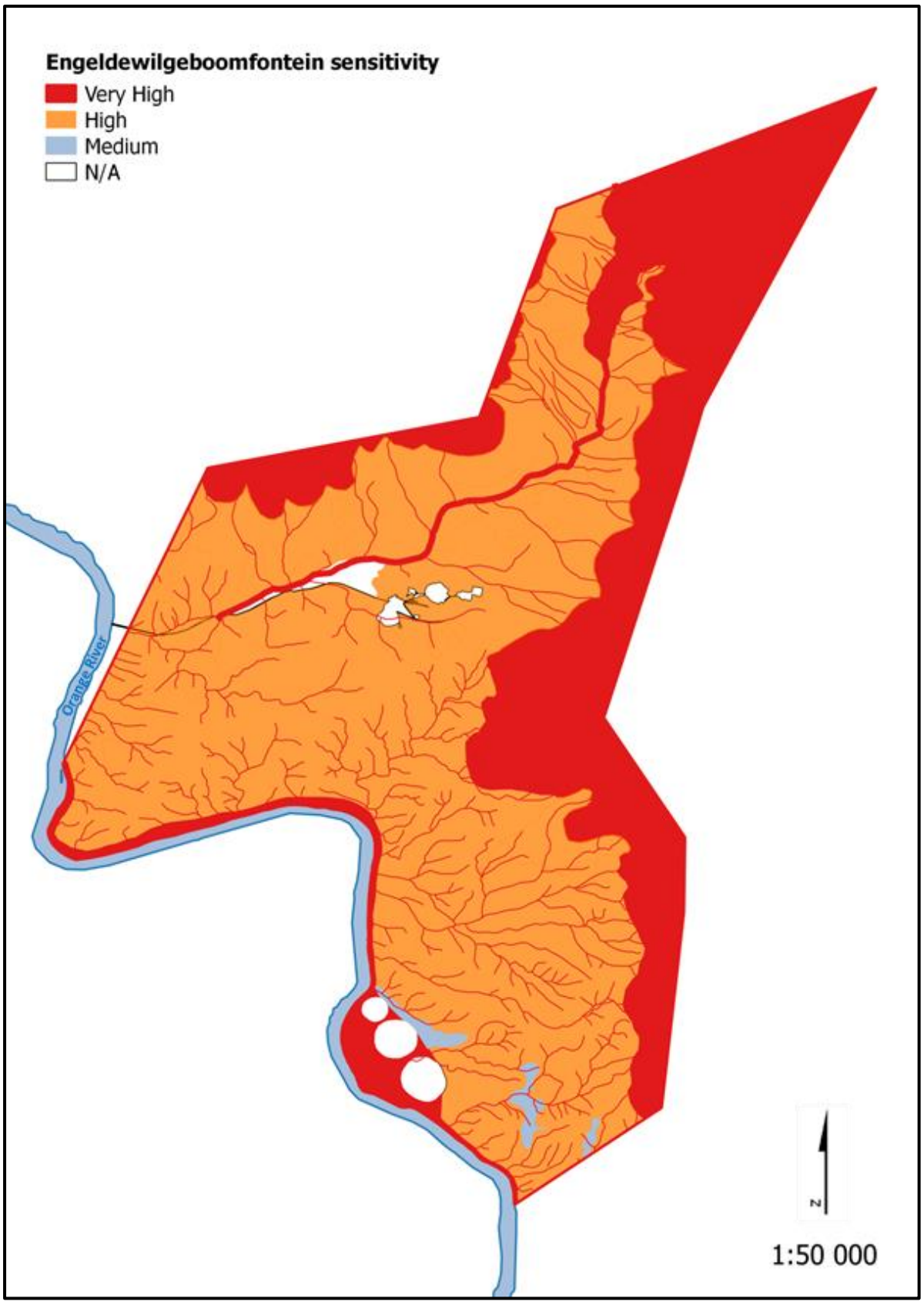


Figure 25. A floristic sensitivity map for the Engeldewilgeboomfontein mining area.

4. IDENTIFICATION AND NATURE OF IMPACTS

In this section, the potential impacts and associated risk factors that may be generated by the Engeldewilgeboomfontein mining operation are identified. In order to ensure that the impacts identified are broadly applicable and inclusive, all the likely or potential impacts that may be associated with the mining activities are listed. Due to the fact that the mine used to operate in the past, only the operational and cumulative impacts are considered in this assessment.

Operational Phase

- Vegetation clearing for mining could impact listed plant species as well as high-biodiversity plant communities. It will also increase erosion risk.
- The mining area will require sound management. If this is not done appropriately, it could impact adjacent intact areas through impacts such as erosion, alien plant invasion and contamination from pollutants, herbicides or pesticides.

Cumulative Impacts

- The loss of unprotected vegetation types on a cumulative basis from the broad area may impact the countries' ability to meet its conservation targets.
- Transformation of intact habitat would contribute to the fragmentation of the landscape and would potentially disrupt the connectivity of the landscape for flora and impair their ability to respond to environmental fluctuations.

4.1. Vegetation and floristics

4.1.1. Loss of natural and unique habitats

The vegetation in the path of mining and within the infrastructure areas will be completely removed. Vegetation clearing during construction and mining activities will lead to the loss of currently intact habitat within the mining area and habitat disturbances. This disturbance destroys primary vegetation and allows secondary pioneers species or invasive plants to enter and re-colonise disturbed area. As primary vegetation is more functional in an ecosystem, this could irreversibly transform the vegetation characteristics in the area. The vegetation within the study area consists of primary vegetation in a moderate to moderately good condition.

4.1.2. Loss of Red data and/or protected floral species

There is a high number of listed and protected species present at the site, such as *Aloidendron dichotomum, Hoodia gordonii, Aloe claviflora, Vachellia erioloba, V. haematoxylon* and *Boscia albitrunca* (also see Table 1). It is highly likely that many would be removed by the mining operation.

4.1.3. Introduction or spread of alien species

The disturbance created during the mining operation is highly likely to encourage the invasion of the disturbed areas by alien species. Although there are not a lot of alien species present within the undisturbed parts of the site, there were some aliens present especially in disturbed areas such as mined areas, along the access roads and areas disturbed by grazing practises. Such species will rapidly increase in abundance and expand into the adjacent areas if given the opportunity. This impact is deemed highly likely to occur.

4.1.4. Encouraging bush encroachment

The disturbance created during the mining operation could potentially encourage bush encroachment. This is especially likely during the clearing of diverse habitats where opportunity is provided for highly competitive encroaching species like *Senegalia mellifera* and *Rhigozum trichotomum* to establish. It is however also possible that the mining operation can control the spread of the latter species, by removing it for mining purposes.

4.2. Topography, soil erosion and associated degradation of ecosystems

The large amount of disturbance created during mining would potentially leave the site vulnerable to soil erosion. This will be most profound on the more sloping areas towards the drainage lines and the ridge slopes. It is likely that these would generate significant amounts of runoff when disturbed. In addition, disturbance leading to the loss of plant cover over large parts of the site will certainly increase the risk of wind and water erosion at the site.

The changed topography in the form of infrastructure, tailings and open pits will generate a high runoff and as a result the amount of runoff the site experience is likely to increase. Soil erosion is therefore considered a likely impact during mining.

4.3. Broad-scale ecological processes

Transformation of intact habitat on a cumulative basis would contribute to the fragmentation of the landscape and would potentially disrupt the connectivity of the landscape for flora and impair their ability to respond to environmental fluctuations. Due to the large amount of mining activities in the area, this is a likely cumulative impact of the mining operation.

5. BOTANICAL IMPACT ASSESSMENT

This section provides a detailed analysis of the impacts associated with the Engeldewilgeboomfontein mining operation. The impacts are assessed in terms of the relevant floristic aspects and each impact is associated with an outline of specific mitigation measures, which with proper implementation, monitoring and auditing, will serve to reduce the significance of the impact.

5.1. Vegetation and floristics

5.1.1. Loss of, and disturbance to indigenous vegetation

Source of the impact

The construction of new roads and other necessary infrastructure; the placement of stockpiles; and the clearing of vegetation for mining, materials storage and topsoil stockpiles; vehicular movement.

Description of the impact

Construction and mining activities on site will reduce the natural habitat for ecological systems to continue their operation. It is not expected that the areas of high floristic significance will rehabilitate following disturbance events. Vehicle traffic generates lots of dust which can reduce the growth success and seed dispersal of many small plant species.

Significance of the impact

INTENSITY	SPATIAL SCOPE	DURATION	PROBABILITY	REVERSIBILITY
High	Local	Long Term	Definite	Low

SIGNIFICANCE OF IMPACT		IMPACT RATING	
Pre-mitigation	**Post mitigation**	**Pre-mitigation**	**Post mitigation**
Medium	Low to medium	Negative	Negative

CONFIDENCE	High

Mitigation and monitoring

- Minimise the footprint of transformation.
- Encourage proper rehabilitation of mined areas.
- Encourage the growth of natural plant species.
- Ensure measures for the adherence to the speed limit.

5.1.2. Loss of flora with conservation concern

Source of the impact

Removal of listed or protected plant species; during the construction of new roads and other necessary infrastructure; the placement of stockpiles; and the clearing of vegetation for mining.

Description of the impact

It is highly possible that mining activities will destroy protected species and other species of conservation concern.

Significance of the impact

INTENSITY	SPATIAL SCOPE	DURATION	PROBABILITY	REVERSIBILITY
High	Local	Long Term	Definite	Low

SIGNIFICANCE OF IMPACT		IMPACT RATING	
Pre-mitigation	**Post mitigation**	**Pre-mitigation**	**Post mitigation**
Medium	Low to medium	Negative	Negative

CONFIDENCE	High

Mitigation and monitoring

- Footprint areas of the mining activities must be scanned for Red Listed and protected plant species prior to mining.
- It is recommended that these plants are identified and marked prior to mining.
- These plants should, where possible, be incorporated into the design layout and left in situ.
- However, if threatened through destruction by mining, these plants should be removed (with the relevant permits from DAFF and DENC) and relocated if possible.
- A management plan should be implemented to ensure proper establishment of ex situ individuals, and should include a monitoring programme for at least two years after re-establishment in order to ensure successful translocation.
- All those working on site must be educated about the conservation importance of the flora occurring on site.

5.1.3. Proliferation of alien vegetation

Source of the impact

Clearing of vegetation; mining activities.

Description of the impact

The extent of alien invasive species in the area shows the high level of past disturbance interference in the natural ecosystem. While general clearing of the area and mining activities destroy natural vegetation, invasive plants can increase due to their opportunistic nature in disturbed areas. If invasive plants establish in disturbed areas, it may cause an impact beyond the boundaries of the mining site. These alien invasive species are thus a threat to surrounding natural vegetation and can result in the decrease of biodiversity and ecological value of the area. Therefore, if alien invasive species are not controlled and managed, their propagation into new areas could have a high impact on the surrounding natural vegetation in the long term. With proper mitigation, the impacts can be substantially reduced.

Significance of the impact

INTENSITY	SPATIAL SCOPE	DURATION	PROBABILITY	REVERSIBILITY
High	Regional	Long Term	High	Medium

SIGNIFICANCE OF IMPACT		IMPACT RATING	
Pre-mitigation	**Post mitigation**	**Pre-mitigation**	**Post mitigation**
Medium	Low	Negative	Positive

CONFIDENCE	High

Mitigation and monitoring

- Minimise the footprint of transformation.
- Encourage proper rehabilitation of mined areas.
- Encourage the growth of natural plant species.
- Mechanical methods of control to be implemented extensively.
- Annual follow-up operations to be implemented.

5.1.4. Encouragement of bush encroachment

Source of the impact

Clearing of vegetation; disturbances through mining activities.

Description of the impact

The extent of bush encroaching species on site shows the high level of past disturbance interference in the natural ecosystem, primarily through grazing practises. While general clearing of the area and mining activities destroy natural vegetation, bush encroaching plants can increase due to their opportunistic nature in disturbed areas. If encroaching plants establish in disturbed areas, it may the lower potential for future land use and decrease biodiversity. With proper mitigation, the impacts can be substantially reduced.

Significance of the impact

INTENSITY	SPATIAL SCOPE	DURATION	PROBABILITY	REVERSIBILITY
Medium	Local	Long Term	Medium	High

SIGNIFICANCE OF IMPACT		IMPACT RATING	
Pre-mitigation	**Post mitigation**	**Pre-mitigation**	**Post mitigation**
Medium	Low	Negative	Positive

CONFIDENCE	High

Mitigation and monitoring

- Minimise the footprint of transformation.
- Encourage proper rehabilitation of mined areas.
- Encourage the growth of a diverse selection of natural plant species.
- Mechanical methods of control to be implemented selectively.
- Annual follow-up monitoring to be implemented.

5.2. Topography, soil erosion and associated degradation of ecosystems

5.2.1. Changes to surface topography

Source of the impact

Development of infrastructure; and residue deposits, excavations and blasting.

Description of the impact

The infrastructure and residue deposits will alter the topography by adding features to the landscape. Topsoil removal, excavations and blasting will unearth the natural topography. The impact will be definite.

Significance of the impact

INTENSITY	SPATIAL SCOPE	DURATION	PROBABILITY	REVERSIBILITY
Medium	Local	Medium Term	High	Low

SIGNIFICANCE OF IMPACT		IMPACT RATING	
Pre-mitigation	**Post mitigation**	**Pre-mitigation**	**Post mitigation**
Medium	Low	Negative	Negative

CONFIDENCE	High

Mitigation and monitoring

- Backfill all excavations continuously.
- Employ effective rehabilitation strategies to restore surface topography of excavations and plant site.
- Stabilise the mine residue deposits.
- All temporary infrastructures should be demolished during closure.

5.2.2. Soil erosion

Source of the impact

Construction of infrastructure; topsoil removal; potential runoff.

Description of the impact

The construction of infrastructure and various facilities in the mining area can result in loss of soil due to erosion. Vegetation will be stripped in preparation for placement of infrastructure and excavations, and therefore the areas will be bare and susceptible to erosion.

The topsoil that is stripped and piled on surrounding areas can be eroded by wind and rain. The soil will be carried away during runoff. The cleared areas will be rehabilitated, but full restoration of soils might only occur over a number of years, subsequent to the re-establishment of vegetation. Therefore the impact will have a moderate severity, throughout the duration of the mine.

Significance of the impact

INTENSITY	SPATIAL SCOPE	DURATION	PROBABILITY	REVERSIBILITY
Medium	Local	Medium Term	High	Low

SIGNIFICANCE OF IMPACT		IMPACT RATING	
Pre-mitigation	**Post mitigation**	**Pre-mitigation**	**Post mitigation**
Medium	Low	Negative	Negative

CONFIDENCE	High

Mitigation and monitoring

- At no point may plant cover be removed within the no-development zones.
- All attempts must be made to avoid exposure of dispersive soils.
- Re-establishment of plant cover on disturbed areas must take place as soon as possible, once activities in the area have ceased.
- Ground exposure should be minimised in terms of the surface area and duration, wherever possible.
- The mining operation must co-ordinate different activities in order to optimise the utilisation of the excavated trenches and thereby prevent repeated and unnecessary excavations.
- Construction that requires the clearing of large areas of vegetation and excavation should ideally occur during the dry season only.

- Construction during the rainy season (November to March) should be closely monitored and controlled.
- The run-off from the exposed ground should be controlled with the careful placement of flow retarding barriers.
- The soil that is excavated during construction should be stock-piled in layers and protected by berms to prevent erosion.
- All stockpiles must be kept as small as possible, with gentle slopes (18 degrees) in order to avoid excessive erosional induced losses.
- Excavated and stockpiled soil material are to be stored and bermed on the higher lying areas of the footprint area and not in any storm water run-off channels or any other areas where it is likely to cause erosion, or where water would naturally accumulate.
- Stockpiles susceptible to wind erosion are to be covered during windy periods.
- Audits must be carried out at regular intervals to identify areas where erosion is occurring.
- Appropriate remedial action, including the rehabilitation of the eroded areas, must occur.
- Rehabilitation of the erosion channels and gullies.
- The mining operation should avoid land with steep slopes.
- Dust suppression must take place, without compromising the sensitive water balance of the area.
- Linear infrastructure such as roads and pipelines will be inspected at least monthly to check that the associated water management infrastructure is effective in controlling erosion.

5.2.3. Loss of soil fertility

Source of the impact

During the removal of topsoil; stockpiling.

Description of the impact

Improper stockpiling and soil compaction can result in soil sterilisation. Leaching can also occur, resulting in the loss of nutrients.

Significance of the impact

INTENSITY	SPATIAL SCOPE	DURATION	PROBABILITY	REVERSIBILITY
Medium	Local	Medium Term	High	Low

SIGNIFICANCE OF IMPACT		IMPACT RATING	
Pre-mitigation	**Post mitigation**	**Pre-mitigation**	**Post mitigation**
Medium	Low	Negative	Negative

CONFIDENCE	High

Mitigation and monitoring

- Topsoil stockpiles must be kept as small as possible in order to prevent compaction and the formation of anaerobic conditions.
- Topsoil must be stockpiled for the shortest possible timeframes in order to ensure that the quality of the topsoil is not impaired.
- Topsoil must not be handled when the moisture content exceeds 12 %.
- Topsoil stockpiles must be kept separate from sub-soils.
- The topsoil should be replaced as soon as possible on to the backfilled areas, thereby allowing for the re-growth of the seed bank contained within the topsoil.

5.2.4. Soil pollution

Source of the impact

Spillage of hazardous material; runoff.

Description of the impact

During the construction and operation of the mine, there is a possibility that equipment might leak oil, thus causing surface spillages. The hydrocarbon soil contamination will render the soil unusable unless they are decontaminated. The storage of fuels on site might have an impact on soil if the tanks that are available on site are not properly monitored and maintained to avoid leakages. Then there is the potential that contaminated soil can be carried through runoff to contaminate water resources and soil stockpiled for rehabilitation. Soil pollution is therefore possible, but through mitigation it can be minimised. The impact will have minimal severity and slight effect on extent.

Significance of the impact

INTENSITY	SPATIAL SCOPE	DURATION	PROBABILITY	REVERSIBILITY
Medium	Local	Medium Term	Medium	Medium

SIGNIFICANCE OF IMPACT		IMPACT RATING	
Pre-mitigation	**Post mitigation**	**Pre-mitigation**	**Post mitigation**
Medium	Low	Negative	Negative

CONFIDENCE	High

Mitigation and monitoring

- Refuelling must take place in well demarcated areas and over suitable drip trays to prevent soil pollution.
- Spill kits to clean up accidental spills from earthmoving machinery must be well-marked and available on site.
- Workers must undergo induction to ensure that they are prepared for rapid clean-up procedures.
- All facilities where dangerous materials are stored must be contained in a bund wall.
- Vehicles and machinery should be regularly serviced and maintained.

5.3. Broad-scale ecological processes

Source of the impact

The construction of new roads and other necessary infrastructure; and the clearing of vegetation for mining.

Description of the impact

Transformation of intact habitat on a cumulative basis would contribute to the fragmentation of the landscape and would potentially disrupt the connectivity of the landscape for flora and impair their ability to respond to environmental fluctuations. Due to the large amount of mining activities in the area, this is a likely cumulative impact of the mining operation.

Significance of the impact

INTENSITY	SPATIAL SCOPE	DURATION	PROBABILITY	REVERSIBILITY
Medium	Regional	Long Term	Medium	Low

SIGNIFICANCE OF IMPACT		IMPACT RATING	
Pre-mitigation	**Post mitigation**	**Pre-mitigation**	**Post mitigation**
Medium	Low	Negative	Negative

CONFIDENCE	Medium - High

Mitigation and monitoring

- Minimise the footprint of transformation.
- Encourage proper rehabilitation of mined areas.
- Encourage the growth of natural plant species.
- The extent of the mining area should be demarcated on site layout plans (preferably on disturbed areas or those identified with low conservation importance).

6. CONCLUSION AND RECOMMENDATIONS

Seven plant communities were identified on site of which the open shrubland on calcrete soils and shrubland on surface gravels are included in the core mining area. These areas are considered to be of high floristic sensitivity on account of the richness and frequency of species of conservation concern. The impacts on vegetation are likely to be relatively high even after mitigation.

Boscia albitrunca shrubs are widespread across the site and it is estimated that ± 8 700 individuals are expected to potentially be affected by the mining activities. These include very small individuals as well as larger trees. A licence application regarding protected trees should be lodged with Department of Agriculture, Forestry and Fisheries prior to any disturbances to these trees.

Similarly, the mining operation will result in the removal of a large number of listed and provincially protected flora and will constitute large-scale clearance of indigenous vegetation. A permit application regarding protected flora as well as the harvesting of indigenous vegetation need to be lodged with the Northern Cape Department of Environment and Nature Conservation prior to any clearance of vegetation.

To conclude, it is clear that the destruction of the natural habitat within the mining area is inevitable. The significance of the impacts will be affected by the success of the mitigation measures implemented and the rehabilitation programme for the mining area.

7. REFERENCES

DURAND, W. 2006. Assessing the impact of climate change on crop water use in South Africa. South Africa: ARC-Grain Crops Institute,

GRESSE, P. G. 2003. The preservation of alluvial diamond deposits in abandoned meanders of the middle-Orange River. *The South African Institute of Mining and Metallurgy*: 535-538.

MUCINA, L. and RUTHERFORD, M. C. 2006. *The Vegetation Map of South Africa, Lesotho and Swaziland.* SANBI*,* Pretoria, South Africa.

MUCINA, L., RUTHERFORD, M. C. and POWRIE, L. W. 2005. *Vegetation Map of South Africa, Lesotho and Swaziland*, 1:1 000 000 (2nd ed.). SANBI, Kirstenbosch, South Africa.

SANBI. 2014. *Red List of South African Plants. Version 2014.1* [Online]. Available: http://redlist.sanbi.org/.

SLM. 2014. Integrated Development Plan (2014-2015): Draft. Siyathemba Local Municipality,

VAN WYK, A. E. and SMITH, G. F. 2001. *Regions of floristic endemism in southern Africa.* Umdaus press*,* Hatfield.

Boscia
ECOLOGICAL CONSULTING

APPENDICES

APPENDIX 1

Plant species list

Family	Scientific name	Status	NFA	NCNCA
ACANTHACEAE	*Acanthopsis disperma*	LC		S3
	Acanthopsis hoffmannseggiana	**DDT**		S3
	Barleria irritans	LC		S3
	Barleria lancifolia subsp. *lancifolia*	LC		S3
	Barleria lichtensteiniana	LC		S3
	Barleria rigida	LC		S3
	Blepharis integrifolia var. *clarkei*	LC		S3
	Blepharis marginata	LC		S3
	Blepharis mitrata	LC		S3
	Justicia petiolaris subsp. *bowiei*	LC		S3
	Justicia thymifolia	LC		S3
	Monechma distichotrichum	LC		S3
	Monechma divaricatum	LC		S3
	Monechma genistifolium subsp. *australe*	LC		S3
	Monechma incanum	LC		S3
	Monechma spartioides	LC		S3
AIZOACEAE	*Aizoon asbestinum*	LC		S3
	Aizoon burchellii	-		S3
	Aizoon schellenbergii	LC		S3
	Galenia africana	LC		S3
	Galenia crystallina var. *crystallina*	LC		S3
	Galenia sarcophylla	LC		S3
	Plinthus cryptocarpus	LC		S3
	Plinthus karooicus	LC		S3
	Tetragonia arbuscula	LC		S3
	Tetragonia calycina	LC		S3
	Tetragonia spicata	LC		S3
	Trianthema parvifolia var. *parvifolia*	LC		S3
AMARANTHACEAE	*Alternanthera pungens*	**Exotic**		
	Amaranthus thunbergii	LC		S3
	Hermbstaedtia fleckii	LC		S3
	Hermbstaedtia odorata var. *odorata*	LC		S3
	Pupalia lappacea var. *lappacea*	LC		S3
	Sericocoma avolans	LC		S3
	Sericocoma pungens	LC		S3
AMARYLLIDACEAE	*Ammocharis coranica*	LC		**S2**
	Boophone disticha	**Declining**		**S2**
	Brunsvigia radulosa	LC		**S2**
	Haemanthus humilis subsp. *humilis*	LC		**S2**
	Nerine filifolia	LC		**S2**
	Nerine laticoma	LC		**S2**
ANACARDIACEAE	*Rhus burchellii*	LC		S3
	Rhus dregeana	LC		S3
	Rhus laevigata var. *laevigata*	LC		S3

Family	Scientific name	Status	NFA	NCNCA
ANACARDIACEAE	*Searsia angustifolia*	LC		S3
	Searsia burchellii	LC		S3
	Searsia lancea	LC		S3
	Searsia pendulina	LC		S3
	Searsia pyroides var. *pyroides*	LC		S3
	Searsia tridactyla	LC		S3
APIACEAE	*Apium graveolens*	**Exotic**		
	Berula thunbergii	LC		**S2**
APOCYNACEAE	*Cynanchum orangeanum*	LC		**S2**
	Duvalia maculata	LC		**S2**
	Fockea angustifolia	LC		**S2**
	Gomphocarpus fruticosus subsp. *fruticosus*	LC		**S2**
	Gomphocarpus tomentosus subsp. *tomentosus*	LC		**S2**
	Hoodia gordonii	**DDD**		**S1**
	Hoodia officinalis subsp. *officinalis*	**NT**		**S2**
	Larryleachia sp.	LC		**S2**
	Microloma armatum var. *armatum*	LC		**S2**
	Orbea lutea subsp. *lutea*	LC		**S2**
	Pachypodium succulentum	LC		**S2**
	Pentarrhinum insipidum	LC		**S2**
	Piaranthus decipiens	LC		**S2**
	Sarcostemma pearsonii	LC		**S2**
	Sarcostemma viminale subsp. *viminale*	LC		**S2**
	Stapelia flavopurpurea	LC		**S2**
	Stapelia olivacea	LC		**S2**
ASPARAGACEAE	*Asparagus africanus*	LC		S3
	Asparagus burchellii	LC		S3
	Asparagus exuvialis	LC		S3
	Asparagus lignosus	LC		S3
	Asparagus mucronatus	LC		S3
	Asparagus retrofractus	LC		S3
	Asparagus striatus	LC		S3
	Asparagus suaveolens	LC		S3
ASPHODELACEAE	*Aloe claviflora*	LC		**S2**
	Aloe hereroensis var. *hereroensis*	LC		**S2**
	Aloidendron dichotomum	**VU**		**S1**
	Bulbine abyssinica	LC		**S2**
	Bulbine asphodeloides	LC		**S2**
	Bulbine lagopus	LC		**S2**
	Haworthia venosa subsp. *tessellata*	LC		**S2**
	Trachyandra laxa var. *laxa*	LC		**S2**
ASPLENIACEAE	*Asplenium cordatum*	LC		S3
ASTERACEAE	*Arctotheca calendula*	LC		S3
	Arctotis arctotoides	LC		S3

Scientific name	Status	NFA	NCNCA
Arctotis leiocarpa	LC		S3
Arctotis microcephala	LC		S3
Aster squamatus	**Exotic**		
Athanasia minuta subsp. *minuta*	LC		S3
Berkheya annectens	LC		S3
Berkheya rigida	LC		S3
Berkheya spinosissima subsp. *namaensis*	-		S3
Chrysocoma ciliata	LC		S3
Chrysocoma obtusata	LC		S3
Cineraria lyratiformis	LC		S3
Conyza bonariensis	**Exotic**		
Conyza podocephala	LC		S3
Cotula anthemoides	LC		S3
Cotula microglossa	LC		S3
Dicoma capensis	LC		S3
Dimorphotheca polyptera	LC		S3
Eriocephalus africanus var. *paniculatus*	LC		S3
Eriocephalus ambiguus	LC		S3
Eriocephalus ericoides subsp. *ericoides*	LC		S3
Eriocephalus eximius	LC		S3
Eriocephalus glandulosus	LC		S3
Eriocephalus merxmuelleri	LC		S3
Eriocephalus microphyllus var. *pubescens*	LC		S3
Eriocephalus pauperrimus	LC		S3
Eriocephalus sp.	-		S3
Euryops multifidus	LC		S3
Euryops subcarnosus subsp. *vulgaris*	LC		S3
Felicia burkei	LC		S3
Felicia fascicularis	LC		S3
Felicia filifolia subsp. *filifolia*	LC		S3
Felicia hirsuta	LC		S3
Felicia hirta	LC		S3
Felicia hyssopifolia subsp. *hyssopifolia*	LC		S3
Felicia muricata subsp. *cinerascens*	LC		S3
Felicia muricata subsp. *muricata*	LC		S3
Foveolina dichotoma	LC		S3
Garuleum schinzii subsp. *schinzii*	LC		S3
Gazania krebsiana subsp. *arctotoides*	LC		S3
Geigeria filifolia	LC		S3
Geigeria ornativa	LC		S3
Geigeria pectidea	LC		S3
Gnaphalium confine	LC		S3
Helichrysum argyrosphaerum	LC		S3
Helichrysum cerastioides var. *cerastioides*	LC		S3

Family	Scientific name	Status	NFA	NCNCA
ASTERACEAE	*Helichrysum gariepinum*	LC		S3
	Helichrysum herniarioides	LC		S3
	Helichrysum lucilioides	LC		S3
	Helichrysum nudifolium var. *nudifolium*	LC		S3
	Helichrysum zeyheri	LC		S3
	Kleinia longiflora	LC		S3
	Laggera decurrens	LC		S3
	Lasiopogon glomerulatus	LC		S3
	Leysera tenella	LC		S3
	Nidorella microcephala	LC		S3
	Nidorella resedifolia subsp. *resedifolia*	LC		S3
	Nolletia chrysocomoides	LC		S3
	Nolletia gariepina	LC		S3
	Oncosiphon piluliferum	LC		S3
	Osteospermum armatum	LC		S3
	Osteospermum microphyllum	LC		S3
	Osteospermum muricatum subsp. *muricatum*	LC		S3
	Osteospermum spinescens	LC		S3
	Othonna auriculifolia	LC		S3
	Othonna graveolens	LC		S3
	Othonna lasiocarpa	LC		S3
	Othonna lobata	LC		S3
	Pegolettia retrofracta	LC		S3
	Pentzia calcarea	LC		S3
	Pentzia globosa	LC		S3
	Pentzia incana	LC		S3
	Pentzia lanata	LC		S3
	Pentzia sphaerocephala	LC		S3
	Pentzia viridis	LC		S3
	Pteronia glauca	LC		S3
	Pteronia mucronata	LC		S3
	Pteronia sordida	LC		S3
	Pteronia unguiculata	LC		S3
	Rosenia humilis	LC		S3
	Senecio burchellii	LC		S3
	Senecio consanguineus	LC		S3
	Senecio harveianus	LC		S3
	Senecio repandus	LC		S3
	Senecio sisymbriifolius	LC		S3
	Sonchus oleraceus	**Exotic**		
	Tagetes minuta	**Exotic**		
	Tarchonanthus camphoratus	LC		S3
	Tripteris aghillana var. *integrifolia*	**Exotic**		
	Tripteris microcarpa subsp. *microcarpa*	**Exotic**		

Family	Scientific name	Status	NFA	NCNCA
ASTERACEAE	*Tripteris sinuata* var. *sinuata*	Exotic		
	Troglophyton capillaceum subsp. *capillaceum*	LC		S3
	Ursinia nana subsp. *nana*	LC		S3
	Verbesina encelioides var. *encelioides*	Exotic		
	Xanthium spinosum	Exotic		
BIGNONIACEAE	*Rhigozum obovatum*	LC		S3
	Rhigozum trichotomum	LC		S3
BORAGINACEAE	*Anchusa riparia*	LC		S3
	Codon royenii	LC		S3
	Ehretia alba	LC		S3
	Ehretia rigida subsp. *rigida*	LC		S3
	Heliotropium ciliatum	LC		S3
	Heliotropium curassavicum	Exotic		
	Heliotropium lineare	LC		S3
	Lappula capensis	LC		S3
	Trichodesma africanum	LC		S3
BRASSICACEAE	*Coronopus integrifolius*	Exotic		
	Heliophila deserticola var. *deserticola*	LC		S3
	Heliophila trifurca	LC		S3
	Lepidium africanum subsp. *africanum*	LC		S3
	Lepidium africanum subsp. *divaricatum*	LC		S3
	Lepidium desertorum	LC		S3
	Lepidium trifurcum	LC		S3
	Sisymbrium burchellii var. *burchellii*	LC		S3
BUDDLEJACEAE	*Buddleja glomerata*	LC		S3
CACTACEAE	*Austrocylindropuntia cylindrica*	Exotic		
	Echinopsis spachiana	Exotic		
	Opuntia ficus-indica	Exotic		
	Tephrocactus articulatus	Exotic		
CAMPANULACEAE	*Wahlenbergia androsacea*	LC		S3
CAPPARACEAE	*Boscia albitrunca*	LC	**X**	**S2**
	Cadaba aphylla	LC		S3
	Cleome angustifolia subsp. *diandra*	LC		S3
	Cleome elegantissima	-		S3
	Cleome oxyphylla var. *oxyphylla*	LC		S3
CARYOPHYLLACEAE	*Dianthus thunbergii*	LC		**S2**
	Pollichia campestris	LC		S3
CELASTRACEAE	*Gymnosporia szyszylowiczii*	-		**S2**
	Maytenus undata	LC		S3
	Putterlickia pyracantha	LC		S3
CHENOPODIACEAE	*Atriplex semibaccata* var. *appendiculata*	LC		S3
	Atriplex suberecta	LC		S3
	Atriplex vestita var. *appendiculata*	LC		S3
	Chenopodium ambrosioides	Exotic		

Family	Scientific name	Status	NFA	NCNCA
CHENOPODIACEAE	*Chenopodium schraderianum*	**Exotic**		
	Chenopodium sp.	-		S3
	Salsola aphylla	LC		S3
	Salsola calluna	LC		S3
	Salsola glabrescens	LC		S3
	Salsola kali	**Exotic**		
	Salsola tuberculata	LC		S3
COLCHICACEAE	*Colchicum asteroides*	LC		S3
	Colchicum melanthoides subsp. *melanthoides*	LC		S3
	Ornithoglossum dinteri	LC		S3
	Ornithoglossum viride	LC		S3
	Ornithoglossum vulgare	LC		S3
CONVOLVULACEAE	*Convolvulus boedeckerianus*	LC		S3
	Convolvulus sagittatus	LC		S3
	Cuscuta hyalina	LC		S3
CRASSULACEAE	*Adromischus trigynus*	LC		**S2**
	Cotyledon orbiculata var. *oblonga*	LC		**S2**
	Cotyledon orbiculata var. *orbiculata*	LC		**S2**
	Crassula atropurpurea var. *atropurpurea*	LC		**S2**
	Crassula deltoidea	LC		**S2**
	Crassula dependens	LC		**S2**
	Crassula muscosa var. *muscosa*	LC		**S2**
	Crassula natans var. *minus*	LC		**S2**
	Kalanchoe brachyloba	LC		**S2**
	Kalanchoe paniculata	LC		**S2**
	Kalanchoe rotundifolia	LC		**S2**
	Tylecodon rubrovenosus	LC		**S2**
CUCURBITACEAE	*Citrullus lanatus*	LC		S3
	Coccinia rehmannii	LC		S3
	Corallocarpus schinzii	LC		S3
	Corallocarpus welwitschii	-		S3
	Cucumis africanus	LC		S3
	Cucumis heptadactylus	LC		S3
	Cucumis myriocarpus subsp. *leptodermis*	LC		S3
	Kedrostis africana	LC		S3
	Trochomeria debilis	LC		S3
CYPERACEAE	*Bulbostylis hispidula*	LC		S3
	Cyperus marginatus	LC		S3
	Isolepis incomtula	LC		S3
	Isolepis setacea	LC		S3
DRACAENACEAE	*Sansevieria aethiopica*	LC		S3
	Sansevieria hyacinthoides	LC		S3
EBENACEAE	*Diospyros lycioides* subsp. *guerkei*	LC		S3
	Diospyros lycioides subsp. *lycioides*	LC		S3

Family	Scientific name	Status	NFA	NCNCA
EBENACEAE	*Euclea undulata*	LC		S3
ELATINACEAE	*Bergia anagalloides*	LC		S3
ERIOSPERMACEAE	*Eriospermum flagelliforme*	LC		S3
	Eriospermum porphyrium	LC		S3
EUPHORBIACEAE	*Croton gratissimus* var. *subgratissimus*	LC		S3
	Euphorbia avasmontana var. *avasmontana*	LC		**S2**
	Euphorbia braunsii	LC		**S2**
	Euphorbia crassipes	LC		**S2**
	Euphorbia gariepina subsp. *gariepina*	LC		**S2**
	Euphorbia inaequilatera var. *inaequilatera*	LC		**S2**
	Euphorbia mauritanica var. *mauritanica*	LC		**S2**
	Euphorbia prostrata	**Exotic**		
	Euphorbia rhombifolia	LC		**S2**
	Euphorbia spartaria	LC		**S2**
	Euphorbia spinea	LC		**S2**
FABACEAE	*Crotolaria cf. spartioides*			
	Cullen biflora	LC		S3
	Cullen tomentosum	LC		S3
	Indigastrum parviflorum subsp. *occidentalis*	-		S3
	Indigofera alternans var. *alternans*	LC		S3
	Indigofera brachystachya	LC		S3
	Indigofera heterotricha	LC		S3
	Indigofera sessilifolia	LC		S3
	Leobordea platycarpa	LC		S3
	Lessertia macrostachya var. *macrostachya*	LC		**S1**
	Lessertia pauciflora var. *pauciflora*	LC		**S1**
	Listia marlothii	LC		S3
	Medicago laciniata var. *laciniata*	**Exotic**		
	Melilotus indicus	**Exotic**		
	Melolobium adenodes	LC		S3
	Melolobium candicans	LC		S3
	Melolobium microphyllum	LC		S3
	Parkinsonia africana	LC		S3
	Prosopis glandulosa var. *glandulosa*	**Exotic**		
	Prosopis velutina	**Exotic**		
	Ptycholobium biflorum subsp. *biflorum*	LC		S3
	Rhynchosia fleckii	LC		S3
	Rhynchosia totta var. *totta*	LC		S3
	Senegalia hereroensis	LC		S3
	Senegalia mellifera subsp. *detinens*	LC		S3
	Senna italica subsp. *arachoides*	LC		S3
	Sutherlandia frutescens	LC		**S1**
	Tephrosia burchellii	LC		S3
	Vachellia erioloba	LC	**X**	S3

Family	Scientific name	Status	NFA	NCNCA
FABACEAE	*Vachellia haematoxylon*	LC	**X**	S3
	Vachellia karroo	LC		S3
GENTIANACEAE	*Sebaea pentandra* var. *pentandra*	LC		S3
GERANIACEAE	*Monsonia burkeana*	LC		S3
	Monsonia crassicaule	LC		S3
	Monsonia glauca	LC		S3
	Monsonia patersonii	LC		S3
	Monsonia salmoniflora	LC		S3
	Pelargonium minimum	LC		**S1**
GISEKIACEAE	*Gisekia africana* var. *africana*	LC		S3
	Gisekia pharnacioides var. *pharnacioides*	LC		S3
HYACINTHACEAE	*Albuca namaquensis*	LC		S3
	Albuca seineri	LC		S3
	Albuca setosa	LC		S3
	Albuca tortuosa	LC		S3
	Albuca unifolia	LC		S3
	Dipcadi bakerianum	LC		S3
	Dipcadi glaucum	LC		S3
	Dipcadi gracillimum	LC		S3
	Dipcadi viride	LC		S3
	Drimia fasciata	LC		S3
	Drimia intricata	LC		S3
	Drimia physodes	LC		S3
	Lachenalia dasybotrya	LC		**S2**
	Lachenalia karooica	LC		**S2**
	Ledebouria apertiflora	LC		S3
	Ledebouria cooperi	LC		S3
	Ledebouria undulata	LC		S3
	Ornithogalum flexuosum	LC		**S2**
	Ornithogalum prasinum	LC		**S2**
IRIDACEAE	*Freesia andersoniae*	LC		**S2**
	Gladiolus orchidiflorus	LC		**S2**
	Gladiolus permeabilis subsp. *edulis*	LC		**S2**
	Lapeirousia plicata subsp. *plicata*	LC		**S2**
	Moraea cookii	LC		**S2**
	Moraea polystachya	LC		**S2**
	Moraea simulans	LC		**S2**
	Moraea venenata	LC		**S2**
	Tritonia karooica	LC		**S2**
LAMIACEAE	*Acrotome inflata*	LC		S3
	Leonotis pentadentata	LC		S3
	Mentha longifolia subsp. *capensis*	LC		S3
	Ocimum americanum var. *americanum*	LC		S3

Family	Scientific name	Status	NFA	NCNCA
LAMIACEAE	*Salvia disermas*	LC		S3
	Salvia namaensis	LC		S3
	Salvia stenophylla	-		S3
	Salvia verbenaca	LC		S3
	Stachys burchelliana	LC		S3
	Stachys cuneata	LC		S3
	Stachys hyssopoides	LC		S3
LOASACEAE	*Kissenia capensis*	LC		S3
LOBELIACEAE	*Lobelia dregeana*	LC		S3
LOPHIOCARPACEAE	*Lophiocarpus polystachyus*	LC		S3
LORANTHACEAE	*Septulina glauca*	LC		S3
	Tapinanthus oleifolius	LC		S3
MALVACEAE	*Abutilon austro-africanum*	LC		S3
	Abutilon dinteri	LC		S3
	Corchorus asplenifolius	LC		S3
	Grewia flava	LC		S3
	Hermannia abrotanoides	LC		S3
	Hermannia bicolor	LC		S3
	Hermannia burkei	LC		S3
	Hermannia cf. affinis	-		S3
	Hermannia comosa	LC		S3
	Hermannia desertorum	LC		S3
	Hermannia erodioides	LC		S3
	Hermannia leucantha	LC		S3
	Hermannia pulchella	LC		S3
	Hermannia pulverata	LC		S3
	Hermannia sp.	-		S3
	Hermannia spinosa	LC		S3
	Hermannia tomentosa	LC		S3
	Hermannia vestita	LC		S3
	Hibiscus aethiopicus var. *aethiopicus*	LC		S3
	Hibiscus elliottiae	LC		S3
	Hibiscus trionum	-		S3
	Malva parviflora var. *parviflora*	**Exotic**		
	Melhania didyma	LC		S3
	Melhania rehmannii	LC		S3
	Pavonia burchellii	LC		S3
	Radyera urens	LC		S3
	Sida dregei	LC		S3
MELIACEAE	*Nymania capensis*	LC		**S2**
MELIANTHACEAE	*Melianthus comosus*	LC		S3
MENISPERMACEAE	*Antizoma miersiana*	LC		S3
	Cissampelos capensis	LC		S3
MESEMBRYANTHEMACEAE	*Aptenia geniculiflora*	LC		**S2**

Family	Scientific name	Status	NFA	NCNCA
MESEMBRYANTHEMACEAE	*Aridaria noctiflora* subsp. *straminea*	LC		**S2**
	Cheiridopsis denticulata	LC		**S2**
	Dinteranthus pole-evansii	**VU**		**S2**
	Drosanthemum hispidum	LC		**S2**
	Drosanthemum lique	LC		**S2**
	Hereroa wilmaniae	**DDT**		**S2**
	Lampranthus watermeyeri	LC		**S2**
	Lithops hallii	LC		**S2**
	Lithops hookeri	LC		**S2**
	Mesembryanthemum aitonis	LC		**S2**
	Mesembryanthemum guerichianum	LC		**S2**
	Mestoklema arboriforme	LC		**S2**
	Mestoklema sp.	-		**S2**
	Mestoklema tuberosum	LC		**S2**
	Nananthus pole-evansii	LC		**S2**
	Pleiospilos compactus subsp. *canus*	LC		**S2**
	Prenia tetragonum	LC		**S2**
	Psilocaulon articulatum	LC		**S2**
	Psilocaulon coriarium	LC		**S2**
	Ruschia canonotata	LC		**S2**
	Ruschia divaricata	LC		**S2**
	Ruschia ferox	LC		**S2**
	Ruschia griquensis	LC		**S2**
	Ruschia intricata	LC		**S2**
	Ruschia pungens	**DDT**		**S2**
	Ruschia ruralis	LC		**S2**
	Sceletium emarcidum	LC		**S2**
	Stomatium bryantii	LC		**S2**
	Titanopsis calcarea	LC		**S2**
	Trichodiadema pomeridianum	LC		**S2**
	Trichodiadema pygmaeum	**VU**		**S2**
	Trichodiadema setuliferum	LC		**S2**
MOLLUGINACEAE	*Corbichonia decumbens*	LC		S3
	Limeum aethiopicum var. *aethiopicum*	LC		S3
	Limeum argute-carinatum	LC		S3
	Limeum fenestratum var. *fenestratum*	LC		S3
	Limeum sulcatum var. *sulcatum*	LC		S3
	Mollugo cerviana var. *cerviana*	LC		S3
	Pharnaceum albens	LC		S3
MORACEAE	*Ficus cordata* subsp. *cordata*	LC		S3
	Ficus ingens	LC		S3
NEURADACEAE	*Grielum sinuatum*	LC		S3
NYCTAGINACEAE	*Boerhavia coccinea* var. *coccinea*	LC		S3
	Phaeoptilum spinosum	LC		S3

Family	Scientific name	Status	NFA	NCNCA
OLEACEAE	*Olea europaea* subsp. *africana*	LC		**S2**
ONAGRACEAE	*Oenothera biennis*	**Exotic**		
OXALIDACEAE	*Oxalis haedulipes*	LC		**S2**
	Oxalis lawsonii	LC		**S2**
PAPAVERACEAE	*Argemone ochroleuca* subsp. *ochroleuca*	**Exotic**		
	Papaver aculeatum	LC		S3
PASSIFLORACEAE	*Adenia repanda*	LC		S3
PEDALIACEAE	*Harpagophytum procumbens* subsp. *procumbens*	LC		**S1**
	Pterodiscus luridus	LC		S3
	Pterodiscus speciosus	LC		S3
	Rogeria longiflora	LC		S3
	Sesamum capense	LC		S3
PHYLLANTHACEAE	*Phyllanthus incurvus*	LC		S3
	Phyllanthus maderaspatensis	LC		S3
	Phyllanthus parvulus var. *garipensis*	LC		S3
PLUMBAGINACEAE	*Dyerophytum africanum*	LC		S3
POACEAE	*Agrostis lachnantha* var. *lachnantha*	LC		S3
	Anthephora pubescens	LC		S3
	Aristida adscensionis	LC		S3
	Aristida congesta subsp. *barbicollis*	LC		S3
	Aristida congesta subsp. *congesta*	LC		S3
	Aristida diffusa subsp. *burkei*	LC		S3
	Aristida engleri var. *engleri*	LC		S3
	Aristida meridionalis	LC		S3
	Aristida stipitata subsp. *spicata*	LC		S3
	Aristida vestita	LC		S3
	Brachiaria marlothii	LC		S3
	Brachiaria nigropedata	LC		S3
	Bromus pectinatus	LC		S3
	Cenchrus ciliaris	LC		S3
	Centropodia glauca	LC		S3
	Chloris virgata	LC		S3
	Cymbopogon pospischilii	**Exotic**		
	Cynodon dactylon	LC		S3
	Cynodon incompletus	LC		S3
	Digitaria eriantha	LC		S3
	Echinochloa colona	LC		S3
	Echinochloa crus-galli	LC		S3
	Echinochloa jubata	LC		S3
	Eleusine coracana subsp. *africana*	LC		S3
	Enneapogon cenchroides	LC		S3
	Enneapogon desvauxii	LC		S3
	Enneapogon scaber	LC		S3
	Enneapogon scoparius	LC		S3

Family	Scientific name	Status	NFA	NCNCA
POACEAE	*Eragrostis annulata*	LC		S3
	Eragrostis barrelieri	**Exotic**		
	Eragrostis bicolor	LC		S3
	Eragrostis biflora	LC		S3
	Eragrostis brizantha	LC		S3
	Eragrostis cilianensis	LC		S3
	Eragrostis curvula	LC		S3
	Eragrostis echinochloidea	LC		S3
	Eragrostis homomalla	LC		S3
	Eragrostis lehmanniana var. chaunantha	LC		S3
	Eragrostis lehmanniana var. lehmanniana	LC		S3
	Eragrostis mexicana subsp. virescens	**Exotic**		
	Eragrostis nindensis	LC		S3
	Eragrostis obtusa	LC		S3
	Eragrostis porosa	LC		S3
	Eragrostis procumbens	LC		S3
	Eragrostis rotifer	LC		S3
	Eragrostis trichophora	LC		S3
	Eragrostis truncata	LC		S3
	Eragrostis x pseud-obtusa	-		S3
	Eriochloa fatmensis	LC		S3
	Eriochrysis pallida	LC		S3
	Eustachys paspaloides	LC		S3
	Fingerhuthia africana	LC		S3
	Hemarthria altissima	LC		S3
	Heteropogon contortus	LC		S3
	Leptochloa fusca	LC		S3
	Lolium temulentum	**Exotic**		
	Melinis repens subsp. *grandiflora*	LC		S3
	Oropetium capense	LC		S3
	Panicum coloratum var. *coloratum*	LC		S3
	Panicum impeditum	LC		S3
	Panicum lanipes	LC		S3
	Panicum maximum	LC		S3
	Panicum schinzii	LC		S3
	Paspalum dilatatum	**Exotic**		
	Polypogon monspeliensis	**Exotic**		
	Polypogon viridis	**Exotic**		
	Schismus barbatus	LC		S3
	Schmidtia kalahariensis	LC		S3
	Schmidtia pappophoroides	LC		S3
	Setaria verticillata	LC		S3
	Sporobolus fimbriatus	LC		S3
	Sporobolus ioclados	LC		S3

Family	Scientific name	Status	NFA	NCNCA
POACEAE	*Sporobolus nebulosus*	LC		S3
	Sporobolus nervosus	LC		S3
	Stipagrostis anomala	LC		S3
	Stipagrostis ciliata var. *capensis*	LC		S3
	Stipagrostis namaquensis	LC		S3
	Stipagrostis obtusa	LC		S3
	Stipagrostis uniplumis var. *neesii*	LC		S3
	Tragus berteronianus	LC		S3
	Tragus koelerioides	LC		S3
	Tragus racemosus	LC		S3
	Triraphis purpurea	LC		S3
POLYGALACEAE	*Polygala asbestina*	LC		S3
	Polygala seminuda	LC		S3
POLYGONACEAE	*Fagopyrum esculentum*	**Exotic**		
	Oxygonum alatum var. *alatum*	LC		S3
	Persicaria lapathifolia	**Exotic**		
	Polygonum arenarium	-		S3
	Polygonum aviculare	LC		S3
	Polygonum plebeium	LC		S3
	Rumex lanceolatus	LC		S3
PORTULACACEAE	*Anacampseros filamentosa* subsp. *filamentosa*	LC		**S2**
	Portulaca oleracea	**Exotic**		
	Portulaca pilosa	LC		S3
	Portulaca quadrifida	LC		S3
	Talinum arnotii	LC		S3
POTAMOGETONACEAE	*Potamogeton crispus*	LC		S3
PTERIDACEAE	*Cheilanthes deltoidea*	LC		S3
PTERIDACEAE	*Cheilanthes hirta*	LC		S3
RESEDACEAE	*Oligomeris dipetala* var. *dipetala*	LC		S3
RHAMNACEAE	*Ziziphus mucronata* subsp. *mucronata*	LC		S3
RUBIACEAE	*Kohautia caespitosa* subsp. *brachyloba*	LC		S3
	Kohautia cynanchica	LC		S3
	Nenax microphylla	LC		S3
SALICACEAE	*Salix mucronata* subsp. *mucronata*	LC		S3
SANTALACEAE	*Thesium hystricoides*	LC		S3
	Thesium hystrix	LC		S3
	Thesium lineatum	LC		S3
SCROPHULARIACEAE	*Aptosimum albomarginatum*	LC		S3
	Aptosimum indivisum	LC		S3
	Aptosimum lineare var. *lineare*	LC		S3
	Aptosimum marlothii	LC		S3
	Aptosimum procumbens	LC		S3
	Aptosimum spinescens	LC		S3
	Chaenostoma halimifolium	LC		S3

Family	Scientific name	Status	NFA	NCNCA
SCROPHULARIACEAE	*Diascia alonsooides*	LC		**S2**
	Diclis petiolaris	LC		S3
	Gomphostigma virgatum	LC		S3
	Jamesbrittenia argentea	LC		**S2**
	Jamesbrittenia atropurpurea subsp. *atropurpurea*	LC		**S2**
	Jamesbrittenia aurantiaca	LC		**S2**
	Jamesbrittenia canescens var. *canescens*	LC		**S2**
	Jamesbrittenia integerrima	LC		**S2**
	Jamesbrittenia sp.	-		**S2**
	Limosella aquatica	**Exotic**		
	Mimulus gracilis	LC		S3
	Nemesia fruticans	LC		**S2**
	Nemesia hanoverica	LC		**S2**
	Peliostomum leucorrhizum	LC		S3
	Peliostomum origanoides	LC		S3
	Selago densiflora	LC		S3
	Selago divaricata	LC		S3
	Selago mixta	LC		S3
	Selago saxatilis	LC		S3
	Veronica anagallis-aquatica	LC		S3
SOLANACEAE	*Lycium arenicola*	LC		S3
	Lycium bosciifolium	LC		S3
	Lycium cinereum	LC		S3
	Lycium hirsutum	LC		S3
	Lycium horridum	LC		S3
	Lycium oxycarpum	LC		S3
	Lycium pilifolium	LC		S3
	Nicotiana glauca	**Exotic**		
	Nicotiana longiflora	**Exotic**		
	Physalis angulata	**Exotic**		
	Solanum burchellii	LC		S3
	Solanum capense	LC		S3
	Solanum lichtensteinii	LC		S3
	Solanum nigrum	**Exotic**		
	Solanum sisymbriifolium	**Exotic**		
	Solanum supinum var. *supinum*	LC		S3
	Solanum tomentosum var. *coccineum*	LC		S3
	Solanum triflorum	**Exotic**		
TAMARICACEAE	*Tamarix usneoides*	LC		S3
TECOPHILAEACEAE	*Cyanella lutea*	LC		**S2**
THYMELAEACEAE	*Lasiosiphon polycephalus*	LC		S3
URTICACEAE	*Forsskaolea candida*	LC		S3
VAHLIACEAE	*Vahlia capensis* subsp. *vulgaris*	LC		S3
VERBENACEAE	*Chascanum garipense*	LC		S3

Family	Scientific name	Status	NFA	NCNCA
VERBENACEAE	*Chascanum pinnatifidum* var. *pinnatifidum*	LC		S3
	Chascanum pumilum	LC		S3
	Lantana rugosa	LC		S3
	Verbena litoralis	**Exotic**		
VISCACEAE	*Viscum rotundifolium*	LC		S3
ZANNICHELLIACEAE	*Zannichellia palustris*	LC		S3
ZYGOPHYLLACEAE	*Tribulus cristatus*	LC		S3
	Tribulus terrestris	LC		S3
	Tribulus zeyheri subsp. *zeyheri*	LC		S3
	Zygophyllum chrysopteron	LC		S3
	Zygophyllum dregeanum	LC		S3
	Zygophyllum incrustatum	LC		S3
	Zygophyllum lichtensteinianum	LC		S3
	Zygophyllum microcarpum	LC		S3
	Zygophyllum retrofractum	LC		S3
	Zygophyllum rigidum	LC		S3

APPENDIX 2

A photographic guide for species of conservation concern encountered during the survey

Acanthopsis hoffmannseggiana

Long, glandular hairs on bracts

Dry seedheads

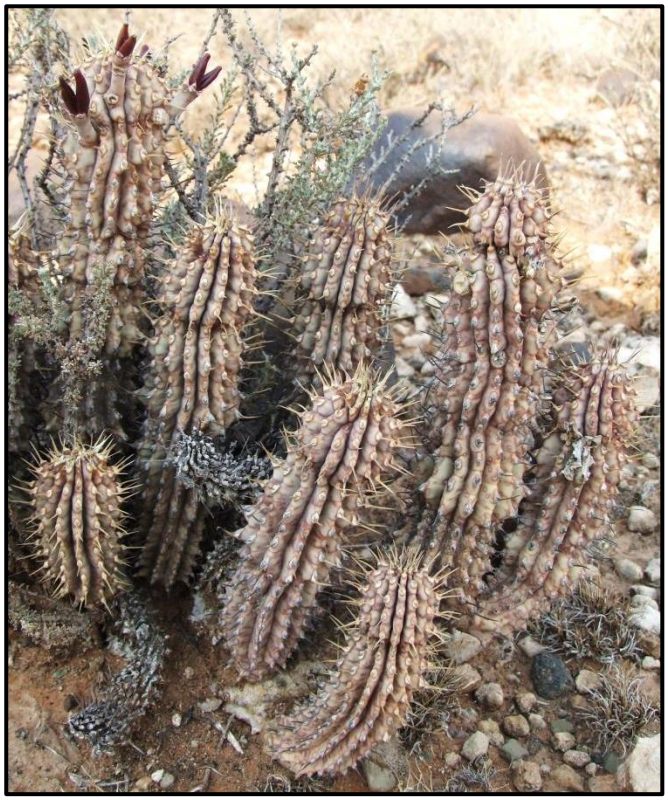
Boophone disticha

Fan-shaped, long and narrow, undulating leaves

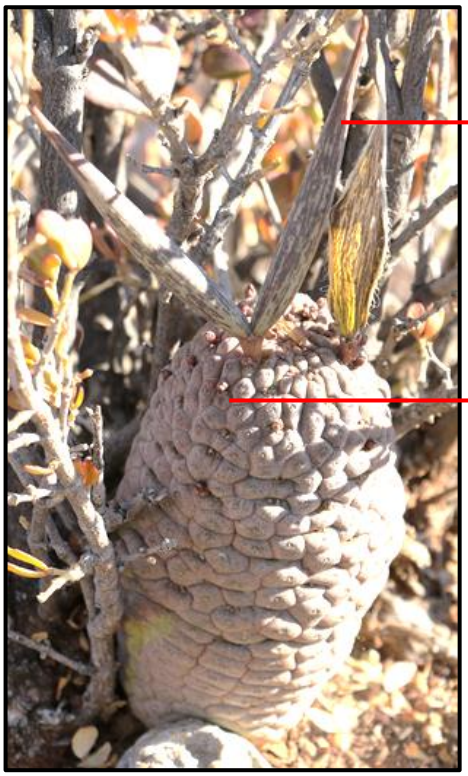
Large bulb half-protruding from the ground

Dry old leaf remnants

Hoodia gordonii



Larryleachia sp.



Seed pods

Small flowers found between blunt mammillae

Orbea lutea subsp. *lutea*

Pachypodium succulentum

Seed pods

Narrow, velvety leaves in tufts

Stipules are modifies spines

Flowers are usually shades of pink (rarely white)

Sarcostemma viminale subsp. *viminale*

Stapelia sp.

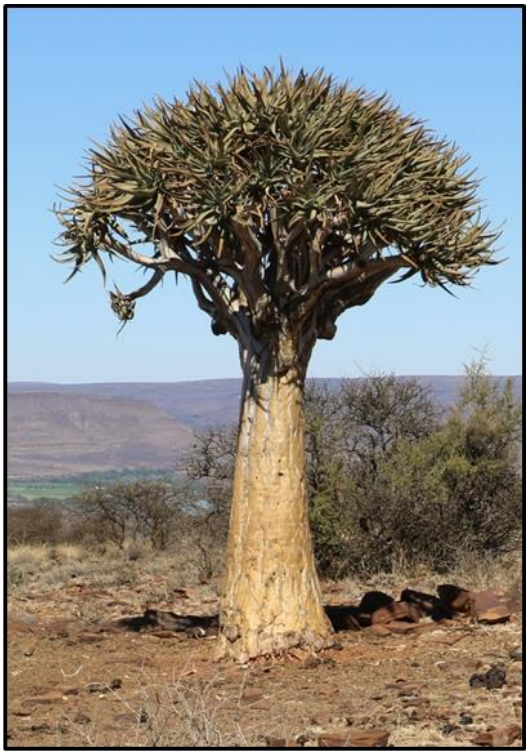
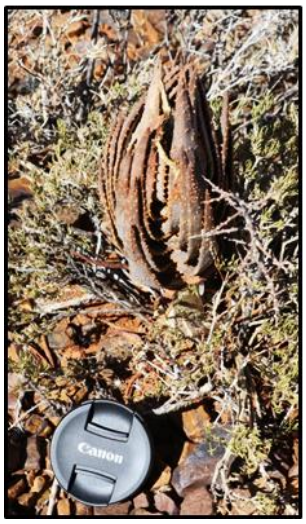
Four-angled succulent stems

Aloe claviflora

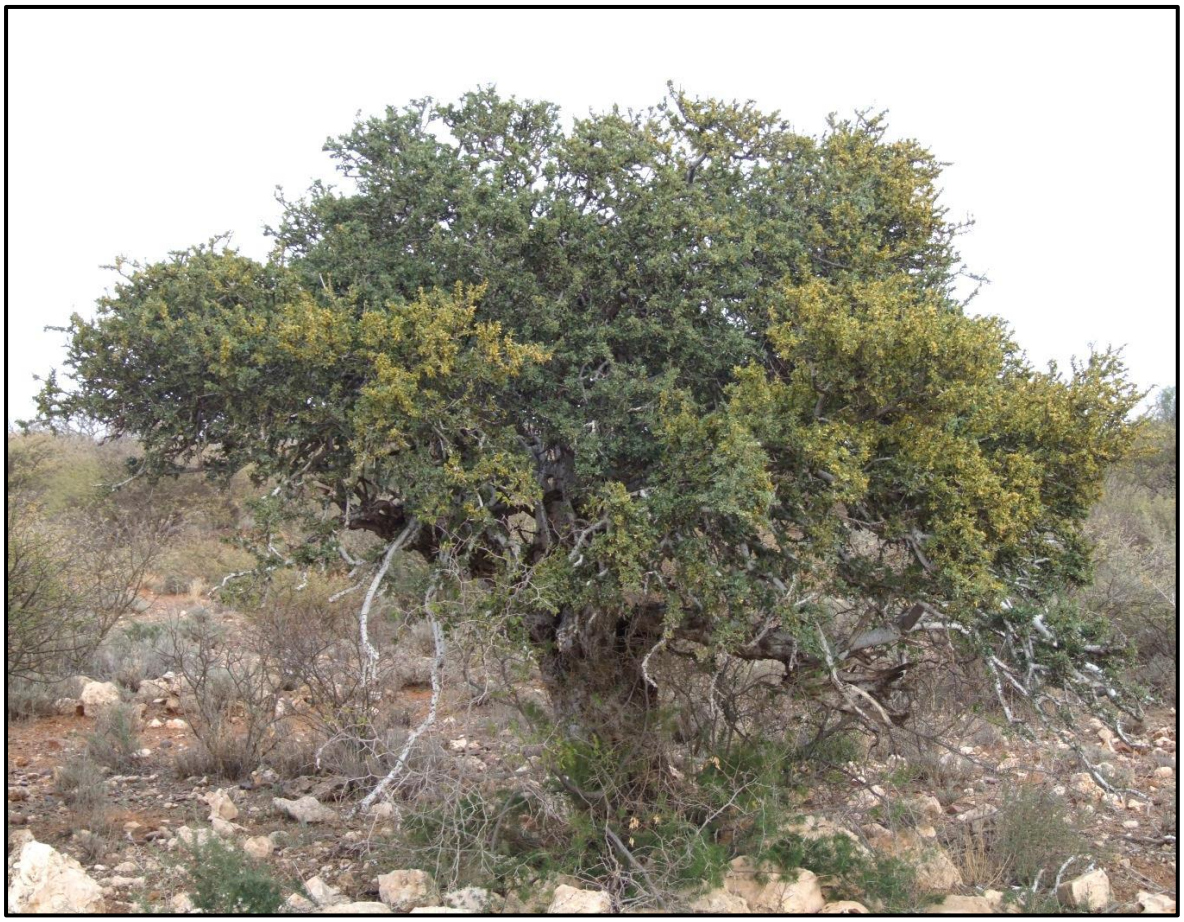
Aloe hereroensis var. *hereroensis*

Aloidendron dichotomum




Boscia albitrunca



Gymnosporia szyszylowiczii

Kalanchoe rotundifolia

Flowers

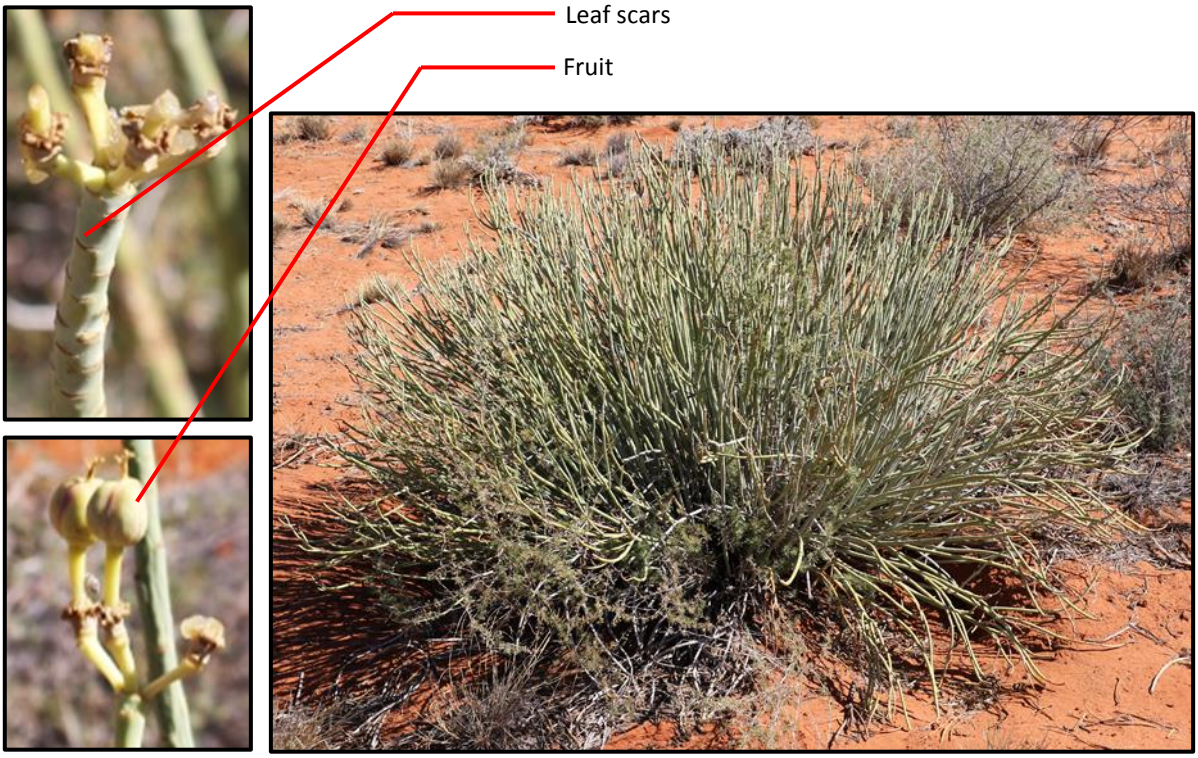
Dry flower heads

Small, round succulent leaves

Euphorbia avasmontana

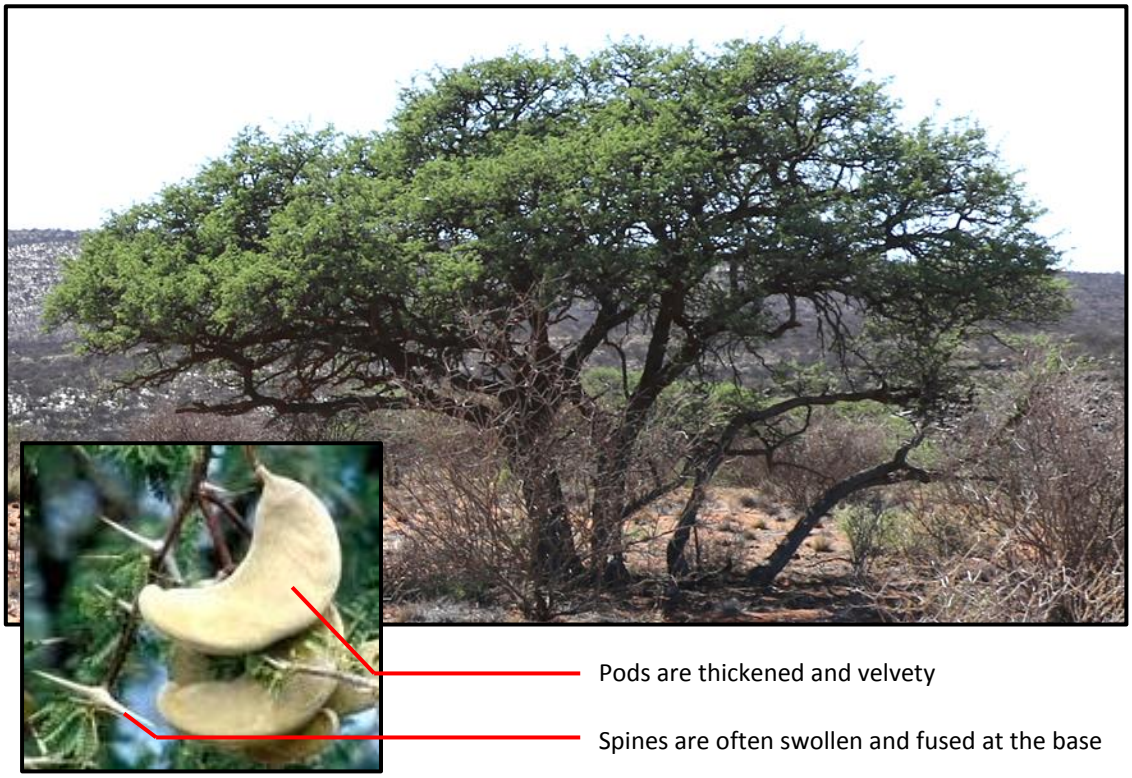
Euphorbia braunsii

Euphorbia mauritanica var. *mauritanica*



Euphorbia spartaria

Vachellia erioloba



Pods are thickened and velvety

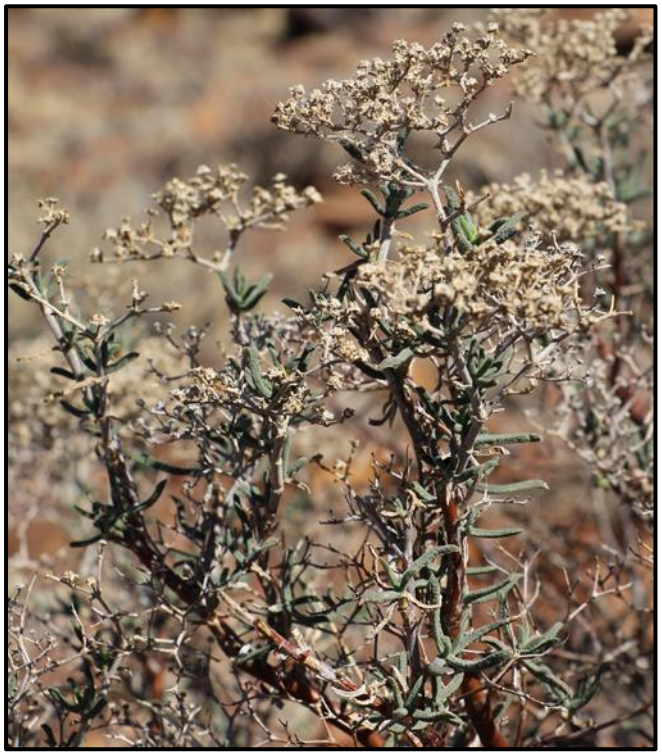
Spines are often swollen and fused at the base

Vachellia haematoxylon

Leaves and young stems are grey-velvety; giving this species their characteristic grey appearance.

Spines are straight and slender

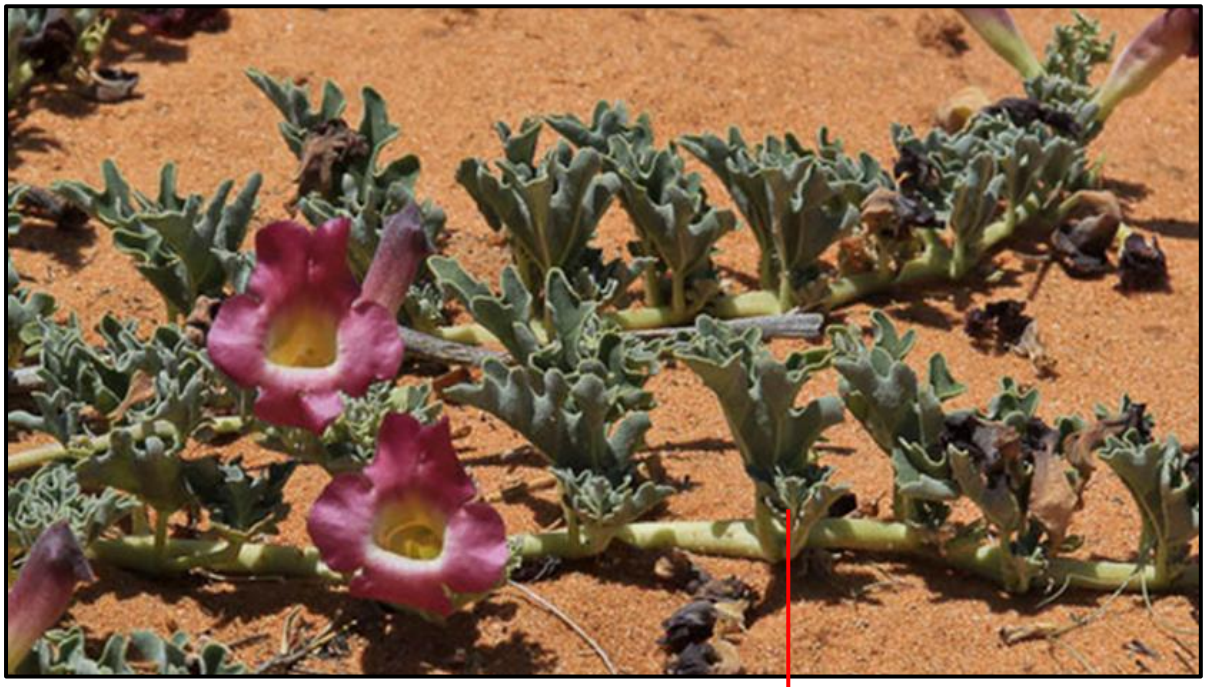
Mestoklema sp.



Psilocaulon coriarium

Olea europaea subsp. *africana*

Harpagophytum procumbens subsp. *procumbens*



A perennial, prostrate creeper with annual stems

Rough, shallowly-lobed leaves

Dry seed head (Devil's claw)