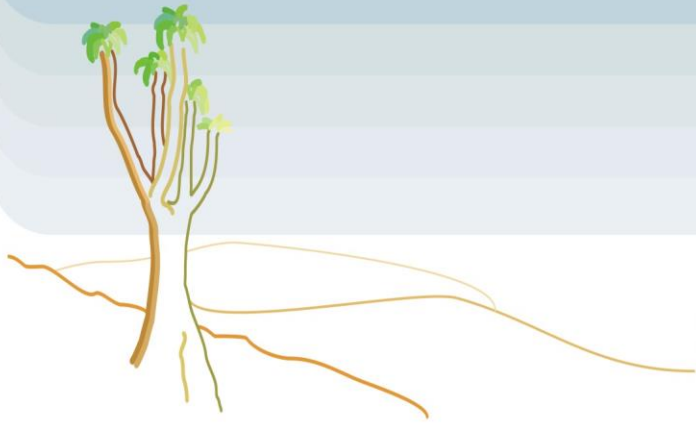


Annexure F

Ecological Assessment



DPR

Ecologists & Environmental Services

Report on the biodiversity and ecological assessment of the proposed residential development on the Farm Kloof 2921, Bloemfontein, Free State Province.

September 2017

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DECLARATION OF INDEPENDENCE

DPR Ecologists and Environmental Services is an independent company and has no financial, personal or other interest in the proposed project, apart from fair remuneration for work performed in the delivery of ecological services. There are no circumstances that compromise the objectivity of the study.

Report Version	Final 1.0		
Title	Report on the biodiversity and ecological assessment of the proposed residential development on the Farm Kloof 2921, Bloemfontein, Free State Province.		
Author	DP van Rensburg (Pr.Sci.Nat)		Sept'17

Executive Summary

The site proposed for the residential development has been rated as being not preferred. However, when taking into consideration that the development will exclude large portions of the site with high species diversity it is considered as acceptable for the development (Map 1).

According to Mucina & Rutherford (2006) the area consists of Bloemfontein Karroid Shrubland (Gh 8) (Map 2). This vegetation type is currently listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009)(National Environmental Management Biodiversity Act, 2004) (Map 2). It is however evident that this vegetation type is increasingly under pressure from urban development and that a large portion has already been transformed (Brown & Du Preez 2014). The site is also listed as an Ecological Support Area 1 under the Free State Province Biodiversity Management Plan (2015) (Map 3). Although this is not a Critical Biodiversity Area it still functions in ecological support of such surrounding areas.

The grassland habitat portion of the site is largely natural with few impacts but do not contain a significantly high diversity of species. It is also not considered to be diagnostic of the Bloemfontein Karroid Shrubland plant community which is considered to be of significant conservation value. As a result this portion of the site is not considered to be of high conservation value and does not warrant exclusion from development. However, it does contain a few protected bulb species which will have to be transplanted to remaining open spaces where they will not be affected by the development (Appendix C).

The portions of the site dominated by exposed dolerite rock is most characteristic of the Bloemfontein Karroid Shrubland and is therefore of significant conservation value. These areas are scattered on the site but with the largest portion occurring on the low hill in the south western corner of the site (Map 1). According to Brown & Du Preez 2014 and Dingaen & Du Preez 2002 the vegetation type must be regarded as endemic to the Free State Province and must be afforded a high conservation status and must be included as a Threatened Ecosystem. Currently this vegetation type is not considered a Threatened Ecosystem (Map 2). Despite this, evidence suggests that this area must be considered to be of high conservation value. However, the development will exclude large portions of this habitat and especially the low hill will be almost entirely excluded from development and will therefore be conserved indefinitely (Map 1). Furthermore, the site is not listed as a Critical Biodiversity Area (CBA 1) according to the Free State Province Biodiversity Management Plan (2015) but only an Ecological Support Area 1 (ESA 1) (Map 3). Exclusion of several portions of the site as indicated by development plans will aid in retaining ecological corridors, decreasing habitat fragmentation and allowing for the exchange of genetic material.

A small drainage line/area occurs along the western portion of the site (Map 1). It does not contain a clear channel but it is evident that it conveys some storm water after heavy rainfall. It is considered of limited conservation value. It lacks a defined channel and as such is not considered a watercourse. As a result it can be incorporated into the development and does not warrant exclusion. However, it still acts in transport of storm water and it is therefore recommended that the development still make provision for storm water management in this area. In addition to the above discussed drainage area another small drainage line occurs along the eastern border of the site (Map 1). It originates outside the south eastern border of the site where it has largely been transformed by a currently operating rock quarry. From here it flows along the border of the site and into the historical borrow pit where the flow is again disrupted. The flow and functioning of this drainage line has therefore been modified to a large

extent. The drainage line is distinct and contains a defined channel. Where it exits the site, a current residential development has also transformed it almost completely. It is therefore not considered to be of high conservation value and its functioning has been altered to a large degree by upstream and downstream residential developments. It does however still function in storm water transport to some extent. As a result it is recommended that it be incorporated into the development but that the development still provide structures for storm water transport much the same as the downstream development.

As previously discussed the site contains a high amount of protected species (Appendix C). This also contributes to the conservation value of the vegetation type. These include the trees, *Olea europaea* subsp. *africana*, *Celtis africana* and *Cussonia paniculata*, which do not transplant easily and will have to be removed where they occur outside private open space. Permits must be obtained to remove any of these tree specimens and can be offset by using saplings in landscaping of the development. The site contains numerous bulb and succulent species which are easily transplanted. Permits must be obtained and these transplanted to areas of private open space where they will remain unaffected. In addition to these protected species, several other species which is considered rare although not protected is also considered of conservation significance (Appendix C). A large percentage of the protected species will remain intact in those portions excluded from development as private open space.

The exotic species occurring on the site, and especially those exotic succulents which have invaded the rocky dolerite habitat must be eradicated prior to construction (Appendix D). It is recommended that the eradication of exotic species be maintained and form part of the management of the residential development throughout the lifetime of the development.

The planning of the residential development has been undertaken in conjunction with the ecological assessment and as a result the most sensitive areas has been excluded from development and will be retained as private open space (Map 1). This layout will result in the lowest impact as long as other mitigation measures such as transplanting of protected species are also adhered to.

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Ecological and biodiversity assessment.

1. INTRODUCTION

1.1 Background

Natural vegetation is an important component of ecosystems. Some of the vegetation units in a region can be more sensitive than others, usually as a result of a variety of environmental factors and species composition. These units are often associated with water bodies, water transferring bodies or moisture sinks. These systems are always connected to each other through a complex pattern. Degradation of a link in this larger system, e.g. tributary, pan, wetland, usually leads to the degradation of the larger system. Therefore, degradation of such a water related system should be prevented.

Though vegetation may seem to be uniform and low in diversity it may still contain species that are rare and endangered. The occurrence of such a species may render the development unviable. Should such a species be encountered the development should be moved to another location or cease altogether.

South Africa has a large amount of endemic species and in terms of biological diversity ranks third in the world. This has the result that many of the species are rare, highly localised and consequently endangered. It is our duty to protect our diverse natural resources.

Development around cities and towns are necessary to accommodate an ever-growing population. Areas along the boundaries of cities and towns are usually in a degraded state due to the impact of the large population these areas house. Though this may be the case in most situations there may still be areas that consist of sensitive habitats such as water courses, wetlands or rare vegetation types that need to be conserved. These areas may also contain endangered fauna and flora.

The proposed residential development will occur on the Farm Kloof 2921 (Map 1). The site is bordered on the east by the R700 tarred road and residential developments to the north (Somerton) and the south (Wild Olive) (Map 2). The extent of the site is approximately 50 hectares in extent.

A site visit was conducted on 9 April 2015 as well as a follow-up survey on 21 September 2017. The entire footprint of the residential development was surveyed over the period of one day. The site survey was conducted during spring and autumn and is considered to give a comprehensive representation of the vegetation on the site.

For the above reasons it is necessary to conduct a biodiversity and ecological assessment of an area proposed for development.

The report together with its recommendations and mitigation measures should be used to minimise the impact of the proposed development.

1.2 The value of biodiversity

The diversity of life forms and their interaction with each other and the environment has made Earth a uniquely habitable place for humans. Biodiversity sustains human livelihoods and life

itself. Although our dependence on biodiversity has become less tangible and apparent, it remains critically important.

The balancing of atmospheric gases through photosynthesis and carbon sequestration is reliant on biodiversity, while an estimated 40% of the global economy is based on biological products and processes.

Biodiversity is the basis of innumerable environmental services that keep us and the natural environment alive. These services range from the provision of clean water and watershed services to the recycling of nutrients and pollution. These ecosystem services include:

- Soil formation and maintenance of soil fertility.
- Primary production through photosynthesis as the supportive foundation for all life.
- Provision of food, fuel and fibre.
- Provision of shelter and building materials.
- Regulation of water flows and the maintenance of water quality.
- Regulation and purification of atmospheric gases.
- Moderation of climate and weather.
- Detoxification and decomposition of wastes.
- Pollination of plants, including many crops.
- Control of pests and diseases.
- Maintenance of genetic resources.

2. SCOPE AND LIMITATIONS

- To evaluate the present state of the vegetation and ecological functioning of the area proposed for the residential development.
- To identify possible negative impacts that could be caused by the proposed construction of a residential development.

2.1 Vegetation

Aspects of the vegetation that will be assessed include:

- The vegetation types of the region with their relevance to the proposed site.
- The overall status of the vegetation on site.
- Species composition with the emphasis on dominant-, rare- and endangered species.

The amount of disturbance present on the site assessed according to:

- The amount of grazing impacts.
- Disturbance caused by human impacts.
- Other disturbances.

2.2 Fauna

Aspects of the fauna that will be assessed include:

- A basic survey of the fauna occurring in the region using visual observations of species as well as evidence of their occurrence in the region (burrows, excavations, animal tracks, etc.).
- The overall condition of the habitat.
- A list of species that may occur in the region (desktop study).

2.3 Limitations

Some bulbous or succulent species may have been overlooked due to a specific flowering time or cryptic nature.

Although a comprehensive survey of the site was done it is still likely that several species were overlooked.

Some animal species may not have been observed as a result of their nocturnal and/or shy habits.

3. METHODOLOGY

3.1 Several literature works were used for additional information.

Vegetation:

Red Data List (Raymondo *et al.* 2009)

Vegetation types (Mucina & Rutherford 2006)

Field guides used for species identification (Bromilow 1995, 2010, Coates-Palgrave 2002, Court 2010, Hartmann 2001, Manning 2009, Moffett 1997, Smith *et al.* 1998, Smith & Crouch 2009, Smith & Van Wyk 2003, Van Oudtshoorn 2004, Van Wyk & Malan 1998, Van Wyk & Van Wyk 1997, Venter & Joubert 1985).

Terrestrial fauna:

Field guides for species identification (Smithers 1986a).

3.2 Survey

The site was assessed by means of transects and sample plots.

Noted species include rare and dominant species.

The broad vegetation types present on the site were determined.

The state of the environment was assessed in terms of condition, grazing impacts, disturbance by humans, erosion and presence of invader and exotic species.

Animal species were also noted as well as the probability of other species occurring on or near the site according to their distribution areas and habitat requirements.

The state of the habitat was also assessed.

3.3 Criteria used to assess sites

Several criteria were used to assess the site and determine the overall status of the environment.

Vegetation characteristics

Characteristics of the vegetation in its current state. The diversity of species, sensitivity of habitats and importance of the ecology as a whole.

Habitat diversity and species richness: normally a function of locality, habitat diversity and climatic conditions.

Scoring: Wide variety of species occupying a variety of niches – 1, Variety of species occupying a single nich – 2, Single species dominance over a large area containing a low diversity of species – 3.

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species on a proposed site plays a large role on the feasibility of a development. Depending on the status and provincial conservation policy, presence of a Red Data species can potentially be a fatal flaw.

Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely – 3.

Ecological function: All plant communities play a role in the ecosystem. The ecological importance of all areas though, can vary significantly e.g. wetlands, drainage lines, ecotones, etc.

Scoring: Ecological function critical for greater system – 1, Ecological function of medium importance – 2, No special ecological function (system will not fail if absent) – 3.

Degree of rarity/conservation value:

Scoring: Very rare and/or in pristine condition – 1, Fair to good condition and/or relatively rare – 2, Not rare, degraded and/or poorly conserved – 3.

Vegetation condition

The sites are compared to a benchmark site in a good to excellent condition. Vegetation management practises (e.g. grazing regime, fire, management, etc.) can have a marked impact on the condition of the vegetation.

Percentage ground cover: Ground cover is under normal and natural conditions a function of climate and biophysical characteristics. Under poor grazing management, ground cover is one of the first signs of vegetation degradation.

Scoring: Good to excellent – 1, Fair – 2, Poor – 3.

Vegetation structure: This is the ratio between tree, shrub, sub-shrubs and grass layers. The ratio could be affected by grazing and browsing by animals.

Scoring: All layers still intact and showing specimens of all age classes – 1, Sub-shrubs and/or grass layers highly grazed while tree layer still fairly intact (bush partly opened up) – 2, Mono-layered structure often dominated by a few unpalatable species (presence of barren patches notable) – 3.

Infestation with exotic weeds and invader plants or encroachers:

Scoring: No or very slight infestation levels by weeds and invaders – 1, Medium infestation by one or more species – 2, Several weed and invader species present and high occurrence of one or more species – 3.

Degree of grazing/browsing impact:

Scoring: No or very slight notable signs of browsing and/or grazing – 1, Some browse lines evident, shrubs shows signs of browsing, grass layer grazed though still intact – 2, Clear browse line on trees, shrubs heavily pruned and grass layer almost absent – 3.

Signs of erosion: The formation of erosion scars can often give an indication of the severity and/or duration of vegetation degradation.

Scoring: No or very little signs of soil erosion – 1, Small erosion gullies present and/or evidence of slight sheet erosion – 2, Gully erosion well developed (medium to large dongas) and/or sheet erosion removed the topsoil over large areas – 3.

Faunal characteristics

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species on a proposed site plays a large role on the feasibility of a development. Depending on the status and provincial conservation policy, presence of a Red Data species or very unique and sensitive habitats can potentially be a fatal flaw.

Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely.

3.4 Biodiversity sensitivity rating (BSR)

The total scores for the criteria above were used to determine the biodiversity sensitivity ranking for the sites. On a scale of 0 – 30, six different classes are described to assess the suitability of the sites to be developed. The different classes are described in the table below:

Table 1: Biodiversity sensitivity ranking

BSR	BSR general floral description	Floral score equating to BSR class
Ideal (5)	Vegetation is totally transformed or in a highly degraded state, generally has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area has lost its inherent ecological function. The area has no conservation value and potential for successful rehabilitation is very low. The site is ideal for the proposed development.	29 – 30
Preferred (4)	Vegetation is in an advanced state of degradation, has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area's ecological function is seriously hampered, has a very low conservation value and the potential for successful rehabilitation is low. The area is preferred for the proposed development.	26 – 28
Acceptable (3)	Vegetation is notably degraded, has a medium level of species diversity although no species of concern are present. Invasive plants are present but are still controllable. The area's ecological function is still intact but may be hampered by the current levels of degradation. Successful rehabilitation of the area is possible. The conservation value is regarded as low. The area is acceptable for the proposed development.	21 – 25
Not preferred (2)	The area is in a good condition although signs of disturbance are present. Species diversity is high and species of concern may be present. The ecological function is intact and very little rehabilitation is needed. The area is of medium conservation importance. The area is not preferred for the proposed development.	11 – 20
Sensitive (1)	The vegetation is in a pristine or near pristine condition. Very little signs of disturbance other than those needed for successful management are present. The species diversity is very high with several species of concern known to be present. Ecological functioning is intact and the conservation importance is high. The area is regarded as sensitive and not suitable for the proposed development.	0 - 10

4. ECOLOGICAL OVERVIEW OF THE SITE

4.1 Overview of ecology and vegetation types (Mucina & Rutherford 2006)

Refer to the list of species encountered on the site in Appendix B.

According to Mucina & Rutherford (2006) the area consists of Bloemfontein Karroid Shrubland (Gh 8) (Map 2). This vegetation type is currently listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009)(National Environmental Management Biodiversity Act, 2004) (Map 2). It is however evident that this vegetation type is increasingly under pressure from urban development and that a large portion has already been transformed (Brown & Du Preez 2014). The site is also listed as an Ecological Support Area 1 under the Free State Province Biodiversity Management Plan (2015) (Map 3). Although this is not a Critical Biodiversity Area it still functions in ecological support of such surrounding areas.

The site consists almost entirely of natural vegetation with little disturbance or modification. Limited disturbance is evident along the eastern border of the site where it is situated adjacent to the R700 tarred road. Here an old borrow pit causes modification and transformation although at a local scale. An electrical distribution station and a few tarred roadways also contribute to local transformation of the vegetation.

The proposed residential development will occur on the Farm Kloof 2921 (Map 1). The site is bordered on the east by the R700 tarred road and residential developments to the north (Somerton) and the south (Wild Olive) (Map 2). The extent of the site is approximately 50 hectares in extent. The dominant vegetation structure on the site consists of a dense grass layer although this structure varies considerably over the site. Where exposed dolerite rock occurs the vegetation structure consists of a shorter, sparser grass layer with prominent succulent, bulb and dwarf shrub component. In lower lying areas, especially in the north-eastern corner, a more prominent thicket/tree layer becomes dominant. The vegetation structure over the site is largely natural and influenced by the soil depth, rock exposure and moisture regime.

The topography of the site consists of a prominent but low hill in the south-western corner while the remainder of the site gradually slopes towards the north from this point. Several ridges and rocky outcrops also occur along this slope and some areas can contain a relatively steep slope. The topography is therefore largely intact with the exception of the small area utilised as a previous borrow pit. Here the excavations have caused local but permanent alteration to the topography. A small very indistinct drainage line occurs along the eastern border of the site and has been affected by the historical borrow pit and adjacent residential developments. The elevation of the site varies from 1430 m in the south west on top of the low hill and decreases to 1392 m in the northern corner.

The geology of the site is dominated by dolerite which outcrops frequently and causes shallow soils over larger portion of the site. The dolerite consists of a thick sill which overly sandstone and mudstone of the Beaufort formation. Soil are mostly of doleritic origin and mostly very shallow and are common on the site. Deeper soils (deeper than 50 mm) is present and occur in some portions of the site. Typical soil forms include Glenrosa and Mispah (Dingaen & Du Preez 2002).

The area has a mean average temperature of 16.2°C, with a maximum of 30.9°C in January and temperatures below zero common in winter (-1.6°C in July). Summer rainfall occurs mostly as thunderstorms with an average annual rainfall of 548 mm (Dingaen & Du Preez 2002).

As mentioned previously the vegetation structure on the site can be divided into three distinct areas according to the different habitats. These are the succulent/bulb/dwarf shrub vegetation associated with the exposed dolerite rock, the denser and taller grass layer associated with areas of deeper soils and the thicket/woodland vegetation associated with areas of higher moisture regime.

The dwarf karroid shrub vegetation layer with high percentage succulent and bulb species covers large portions of the site but much less than the grass layer. This habitat most accurately fits the Bloemfontein Karroid Shrubland (Gh 8) vegetation type. The vegetation consists of a short sparse grass layer, dwarf karroid shrubs, succulents and bulb components. Dominant grass species include *Eragrostis nindensis*, *Aristida congesta*, *A. diffusa*, *Oropetium capense*, *Tragus keolerioides* and *Melinis repens*. Dwarf karroid shrubs consist of *Euryops empetrifolius*, *E. subcarnosus*, *Ruschia intricata*, *Searsia ciliata*, *Eriocephalus spinescens*, *Felicia muricata* and *Pentzia quinquifida*. Despite the generally low canopy of this vegetation layer, taller shrubs are present and sparsely scattered in the vegetation. These include *Diospyros austro-africana*, *Euclea crispa* subsp. *ovata*, *Rhigozum obovatum*, *Olea europaea* subsp. *africana* and *Cussonia paniculata*. They are more common where the slope increases but restricted to areas with a high percentage dolerite and shallow soils. Of these species *O. europaea* subsp. *africana* and *C. paniculata* are both protected species (Appendix C). The most unique and characteristic vegetation of this habitat is the succulent and bulb vegetation. Succulent species include *Euphorbia rhombifolia*, *E. mauritanica*, *Aloe grandidentata*, *Curio radicans*, *Crassula nudicaulis*, *C. capitella*, *Cotyledon orbiculata*, *Stomatium bolusiae*, *Othonna protecta*, *Pachypodium succulentum*, *Pterodiscus speciosus*, *Adromischus trigynus*, *Hereroa glenensis*, *Kalanchoe paniculata*, *Avonia ustulata*, *Ruschia unidens* and *Trichodiadea barbatum*. Of these several are also protected species (Appendix C). It is evident that succulent species make up a significant portion of the biodiversity of this habitat. Bulb species include *Oxalis obliquifolia*, *Albuca setosa*, *Boophone distichia*, *Tulbaghia acutiloba*, *Bonatea antenifera*, *Chlorophytum fasciculatum* and *Ledebouria luteola*. Note again the high diversity of bulb species. Furthermore, of these *B. distichia* and *B. antenifera* are also protected species (Appendix C). In addition to the above growth forms two fern species are also common and characteristic in this habitat. These are *Pellaea calomelanos* and *Cheilanthes eckloniana*. This habitat is largely natural with few impacts. However, some trampling by the natural fauna does cause local disturbance which allows the establishment of exotic succulents in this arid habitat (Appendix D). These include *Oppuntia lindheimeri* and *Echinopsis spachiana*. Other exotic weeds also abundant in this habitat include *Schkuhria pinata*, *Tagetes minuta* and *Bidens bipinnata*.

The grassland habitat within which the above dwarf karroid shrub layer is embedded covers the majority of the site. It is dominated by a relatively dense grass layer and dominant grass species include *Chloris virgata*, *Themeda triandra*, *Digitaria eriantha*, *Eragrostis lehmanniana*, *E. superba*, *E. gummiflua*, *Cymbopogon pospischillii*, *Heteropogon contortus*, *Sporobolus fimbriatus*, *Enneapogon scoparius* and *Eustachys paspaloides*. This species composition is mostly indicative of a relatively healthy climax grass layer in a good condition. Other herbs and similar growth forms scattered in the grass layer include *Ipomoea oblonga* and *Vernonia oligocephala*. The bulb species, *Brunsvigia radulosa*, *Hypoxis hemerocallidae* and *Eucomis autumnalis*, also occurs in the grass layer. All of these are protected species (Appendix C). The

habitat is largely natural with few impacts and exotic weeds including *Bidens bipinnata* and *Tagetes minuta* scattered but not abundant. A patch of the exotic *Agave americana*, a succulent, also occurs and indicates local disturbance (Appendix D).

The woodland vegetation habitat is associated with the lower lying areas and drainage lines on the site. The habitat is found along the lower portions of a small drainage line in the north eastern corner of the site as well as a small drainage area along the western portion of the site. The canopy cover varies from open to closed and can become quite dense in some areas. The tree layer is dominated by several species of varying height and these include *Searsia burchellii*, *S. lancea*, *Diospyros lycioides*, *Vachellia karroo*, *Ziziphus mucronata*, *Buddleja saligna*, *Grewia occidentalis*, *Celtis africana* and *Ehretia rigida*. Of these *C. africana* is considered a protected species (Appendix C). The shrub/climber, *Asparagus larcinus*, is common in the understorey and the herb, *Lantana rugosa*, also occurs below trees. The layer is largely natural and intact with few disturbances except where it is transformed by the historical borrow pit. This is however a small portion.

As mentioned the site slopes from south to north. As a result a small drainage area occurs along the western portion of the site (Map 1). It is approximately 150 meters in length and flows from south west to north east. It does not contain a clear channel but it is evident that it conveys some storm water after heavy rainfall. It drains into a more significant drainage line to the east and outside the borders of the site. It is considered of limited conservation value. It lacks a defined channel and as such is not considered a watercourse. As a result it can be incorporated into the development and does not warrant exclusion. However, it still acts in transport of storm water and it is therefore recommended that the development still make provision for storm water management in this area. In addition to the above discussed drainage area another small drainage line occurs along the eastern border of the site (Map 1). The drainage line flows from the south eastern corner of the site along the border and towards the north eastern corner. It originates outside the south eastern border of the site where it has largely been transformed by a currently operating rock quarry. From here it flows along the border of the site and into the historical borrow pit where the flow is again disrupted. Stands of Bulrush (*Typha capensis*) indicates the presence of standing water for prolonged periods. The flow and functioning of this drainage line has therefore been modified to a large extent. The drainage line is distinct and contains a defined channel. Where it exits the site, a current residential development has also transformed it almost completely. The drainage line into which it flows has also been canalised and transformed. It is therefore not considered to be of high conservation value and its functioning has been altered to a large degree by upstream and downstream residential developments. It does however still function in storm water transport to some extent. As a result it is recommended that it be incorporated into the development but that the development still provide structures for storm water transport much the same as the downstream development.

The grassland habitat portion of the site is largely natural with few impacts but do not contain a significantly high diversity of species. It is also not considered to be diagnostic of the Bloemfontein Karroid Shrubland plant community which is considered to be of significant conservation value. As a result this portion of the site is not considered to be of high conservation value and does not warrant exclusion from development. However, it does contain a few protected bulb species which will have to be transplanted to remaining open spaces where it will not be affected by the development (Appendix C).

The portions of the site dominated by exposed dolerite rock is most characteristic of the Bloemfontein Karroid Shrubland and is therefore of significant conservation value. These areas are scattered on the site but with the largest portion occurring on the low hill in the south western corner of the site. This area also has the highest diversity of species and is considered the most sensitive portion of the site (Map 1). Being high in species diversity with a high proportion of protected species, a habitat specific vegetation type and which is progressively under higher development pressures these areas are considered of high conservation value. According to Brown & Du Preez 2014 and Dingaan & Du Preez 2002 the vegetation type must be regarded as endemic to the Free State Province and must be afforded a high conservation status and must be included as a Threatened Ecosystem. Currently this vegetation type is not considered a Threatened Ecosystem (Map 2). Despite this, evidence suggests that this area must be considered to be of high conservation value. However, the development will exclude large portions of this habitat and especially the low hill will be almost entirely excluded from development and will therefore be conserved indefinitely (Map 1). Furthermore, the site is not listed as a Critical Biodiversity Area (CBA 1) according to the Free State Province Biodiversity Management Plan (2015) but only an Ecological Support Area 1 (ESA 1) (Map 3). A large area to the east of the site is listed as a CBA 1 and the site (ESA) will therefore function in supporting the ecological integrity of this area. Exclusion of several portions of the site as indicated by development plans will aid in retaining ecological corridors, decreasing habitat fragmentation and allowing for the exchange of genetic material (Map 1). An additional recommendation is that the development refrain from introducing any game or domestic animals such as horses to the remaining private open space as these will within a short period trample the vegetation layer and defeat the purpose of the exclusion. These areas of private open space should however be incorporated into the development to increase the aesthetic value of it and walkways should also be considered through these areas for the benefit of the inhabitants.

As previously discussed the site contains a high amount of protected species (Appendix C). This also contributes to the conservation value of the vegetation type. These include the trees, *Olea europaea* subsp. *africana*, *Celtis africana* and *Cussonia paniculata*, which do not transplant easily and will have to be removed where they occur outside private open space. Permits must be obtained to remove any of these tree specimens and can be offset by using saplings in landscaping of the development. The site contains numerous bulb species which are easily transplanted. Permits must be obtained and these transplanted to areas of private open space where they will remain unaffected. These bulb species consist of *Boophone distichia*, *Bonatea antenifera*, *Brunsvigia radulosa*, *Hypoxis hemerocallidae* and *Eucomis autumnalis*. As mentioned a high amount of succulent species occur on the site with many being protected. Permits must be obtained and these transplanted to areas of private open space where they will remain unaffected. Protected succulent species consists of *Euphorbia rhombifolia*, *E. mauritanica*, *Aloe grandidentata*, *Pachypodium succulentum* and *Avonia ustulata*. In addition to these protected species, several other species which is considered rare although not protected is also considered of conservation significance (Appendix C). These include *Cotyledon orbiculata* and *Pterodiscus speciosus*, two widespread but rare species especially in the Free State Province and the Mesembryanthemaceae (Vygie) species with limited distribution including *Stomatium bolusiae*, *Trichodiadema barabtum*, *Hereroa glenensis* and *Ruschia unidens*. A large percentage of the protected species listed above will remain intact in those portions excluded from development as private open space.

The exotic species occurring on the site, and especially those exotic succulents which have invaded the rocky dolerite habitat must be eradicated prior to construction (Appendix D).

Furthermore, and of more importance is that these species should be eradicated from the portions of private open space. The aim of these excluded areas are to preserve a portion of this vegetation type which represents a good example of this sensitive area. In order to maintain this condition, the area should be kept devoid of exotic species. It is therefore recommended that the eradication of exotic species be maintained and form part of the management of the residential development throughout the lifetime of the development.

The planning of the residential development has been undertaken in conjunction with the ecological assessment and as a result the most sensitive areas has been excluded from development and will be retained as private open space (Map 1). This layout will result in the lowest impact as long as other mitigation measures such as transplanting of protected species are also adhered to.

4.2 Overview of terrestrial fauna (actual & possible)

The site contains several mammal species which, although they will present a significant population, will be somewhat altered a result of the proximity of urban areas. Steenbok (*Raphicerus campestris*) were noted on the site. It is a common and widespread species but indicates that larger herbivores are still present on the site. The Leopard Tortoise (*Stigmochelys pardalis*) was also noted on the site. This is a widespread but protected species and as a such does have some conservation value. It is also highly likely that Smith's Red Rock Rabbits (*Pronolagus rupestris*) will occur in the rocky areas of the site. The species is not considered rare or endangered but is nonetheless a protected species and as such have a degree of conservation value. The species inhabits rocky terrain and is confined to these areas. As the species is not rare or endangered it is not of significant conservational concern but does have some conservation value as it is a protected species. The proposed development will transform a portion of the vegetation on the site thus decreasing the available habitat for fauna. The site will therefore not be able to sustain the same population size of mammals as is currently the case. It is therefore likely that the development will have some impact on the mammal population.

It is considered likely that the site will also contain several other mammal species but these were not observed on the site and it is considered unlikely that a rare or endangered species would occur on the site.

In order to ensure no direct impact on the mammals on the site the hunting, capturing or trapping of mammals on the site should be strictly prohibited during construction as well as during inhabitation.

List of some Red Data terrestrial mammals that could occur in the region:

South African Hedgehog	<i>Atelerix frontalis</i>
Aardwolf	<i>Proteles cristatus</i>
African Wild Cat	<i>Felis lybica</i>
Small-Spotted Cat	<i>Felis nigripes</i>
Bat-Eared Fox	<i>Otocyon megalotis</i>
Striped Weasel	<i>Poecilogale albinucha</i>

It is considered unlikely that any of these species would occur on the site due to the proximity of urban developments. The exception being the hedgehog which is often found in peri-urban environments.

5. ANTICIPATED IMPACTS

Anticipated impacts that the development will have is primarily concerned with the loss of habitat and species diversity. The majority of the site consists of grassland with a moderate species diversity where the loss of habitat and diversity will therefore also be moderate. However, portions of the site and especially the low hill in the south western corner contains a significantly high species diversity with a high proportion of protected species (Map 1). The loss of these areas will therefore entail a high impact. The majority of these areas will however be excluded from development which will considerably decrease this impact (Map 1). In addition, this will also aid in retaining ecological corridors and in so doing it will decrease the cumulative impact of habitat fragmentation. The vegetation type is currently under increased pressure for development of urban areas. This increases the impact of habitat fragmentation as developments further isolate pockets of this vegetation type from each other in so preventing or complicating the exchange of genetic material between populations. Furthermore, increased development increases the cumulative impact on the vegetation type as it decreases in percentage land coverage. Therefore the exclusion of large portions of the site will ensure an ecological corridor remains and the exchange of genetic material remains viable. The site also contains a significant faunal population including protected species. The development will primarily entail a loss of habitat for fauna which will decrease the population size. This impact is considered moderate as the site is situated within a peri-urban area which has already impacted on the fauna of the area. The loss of protected plant species should not exceed a moderate impact as large portions of the site will be excluded from development and remaining protected species transplanted to private open space (Appendix C). The drainage area and drainage line in the western portion of the site and along the eastern border respectively has been significantly modified and do not perform a significant ecological function. The transformation of these areas will therefore not entail a high impact. They do however still function as storm water conduits and incorporating them into the development is still considered to have a moderate impact. The development is likely to increase the susceptibility of the surrounding natural areas and excluded, private open space on the site to infestation by exotic species. This impact can be kept low as long as eradication and management of exotics are maintained (Appendix D).

The impact significance has been determined and it is clear that the impacts before mitigation will be significant. However, if adequate mitigation such as excluding large portions of the site and transplanting of protected species is implemented the impacts will be considerably decreased. The impacts before mitigation is anticipated to be moderately-high to high and will be decreased by adequate mitigation to low-moderate to moderate.

Please refer to Appendix E for the impact methodology.

Significance of the impact:

Impact	Severity	Duration	Extent	Consequence	Probability	Frequency	Likelihood	Significance
Before Mitigation								
Loss of vegetation type and clearing of vegetation	4	5	4	4.3	5	5	5	21.5
Loss of protected species	5	5	4	4.6	5	5	5	23
Loss of drainage areas	3	5	2	3.3	4	3	3.5	11.55
Infestation with weeds and invaders	4	4	3	3.6	4	4	4	14.4
Impact on Terrestrial fauna	3	5	2	3.3	4	3	3.5	11.5
After Mitigation								
Loss of vegetation type and clearing of vegetation	3	5	1	3.3	3	5	4	13.2
Loss of protected species	2	5	1	2.6	3	5	4	10.4
Loss of drainage areas	2	5	2	3	4	3	3.5	10.5
Infestation with weeds and invaders	4	2	1	2.3	2	2	2	4.6
Impact on Terrestrial fauna	2	5	1	2.6	4	3	3.5	9.1

6. SITE SPECIFIC RESULTS

Habitat diversity and species richness:

The majority of the site is still in a relatively natural condition with few impacts. The site does not have a high diversity of habitats but the grassland, woodland and exposed dolerite habitats is considered to represent a moderate diversity of habitats. However, the exposed dolerite rock habitat does harbour a high diversity of species.

Presence of rare and endangered species:

The Bloemfontein Karroid Shrub plant community occurring on the exposed dolerite habitat contains a high amount of protected species. A total of fourteen protected species occurs on the site including several other non-protected but nonetheless rare species (Appendix C). These are all considered of significant conservation value. Adequate mitigation including the exclusion of large portions of the site as private open space and transplanting of protected species will significantly decrease the impact on these.

Ecological function:

The ecological function of the majority of the site remains intact and largely natural. However, the drainage lines on the site has been modified and can no longer perform their natural ecological function. Upstream developments has transformed the origin of the larger drainage line and a historical borrow pit has also disrupted its flow. Downstream developments has also canalised these drainage lines and so largely altered their functioning. Furthermore, residential developments to the north and south of the site has largely isolated the site from surrounding natural areas and this impairs its ability to exchange genetic material with surrounding natural areas. However, the proposed development will exclude large portions of the site from development and retain corridors which will retain a genetic population and allow for exchange of genetic material with especially the Critical Biodiversity Area to the east (Map 3).

Degree of rarity/conservation value:

The majority of the site consists of grassland and woodland with a moderate species diversity, no unique features and not considered to be of high conservation value.

However, the site contains several areas which consists of good representative samples of the Bloemfontein Karroid Shrubland vegetation type (Map 2). This vegetation type contains a high species diversity with a significant component of protected and rare species. The species composition is also rather unique as a result of the unique habitat. According to Brown & Du Preez 2014 and Dingaen & Du Preez 2002 the vegetation type must be regarded as endemic to the Free State Province and must be afforded a high conservation status and must be included as a Threatened Ecosystem. Currently this vegetation type is not considered a Threatened Ecosystem (Map 2). Despite this, evidence suggests that this area must be considered to be of high conservation value. However, the development will exclude large portions of this habitat and especially the low hill will be almost entirely excluded from development and will therefore be conserved indefinitely (Map 1). Furthermore, the site is not listed as a Critical Biodiversity Area (CBA 1) according to the Free State Province Biodiversity Management Plan (2015) but only an Ecological Support Area 1 (ESA 1) (Map 3). A large area to the east of the site is listed as a CBA 1 and the site (ESA) will therefore function in supporting the ecological integrity of this area. Exclusion of several portions of the site as indicated by development plans will aid in retaining ecological corridors, decreasing habitat fragmentation and allowing for the exchange of genetic material.

The drainage lines on the site has been modified to a large degree by both surrounding developments as well as on-site modifications. As a result their functioning is also modified to a large degree and consequently their conservation value cannot be considered as high.

As mentioned, the site also contains a high amount of protected species and these are also considered to have a high conservation value (Appendix C).

Percentage ground cover:

The percentage vegetation cover in the grassland portion of the site is relatively high whilst areas of exposed dolerite it is moderate as the geology and habitat prevents a high percentage cover and this is also considered natural to the habitat. Small areas of disturbance such as roadways and the historical borrow pit cause some decrease in vegetation cover but is not considered substantial.

Vegetation structure:

The vegetation structure is varied and include a grass layer, tree/shrub layer and dwarf shrub layer. The exposed dolerite rocky areas contain an additional bulb and succulent layer due to the unique habitat. The vegetation structure is largely natural with limited modification as a result of exotic succulents as well as where the historical borrow pit causes the establishment of trees and other growth forms not natural to this area.

Infestation with exotic weeds and invader plants:

Several exotic species occur on the site, of which the exotic succulents are of concern (Appendix D). They do however not yet dominate and it is therefore still possible to control and eradicate the infestation.

Degree of grazing/browsing impact:

Grazing by domestic stock is absent although the natural mammal population does cause some noticeable browsing and trampling of vegetation. This can however not be considered high.

Signs of erosion:

Erosion is present along roadways and where local disturbance, i.e. historical borrow pit, has caused some disturbance of the soil surface.

Terrestrial animals:

It is evident that the site provides habitat for a variety of species including the protected Smith's Red Rock Rabbits (*Pronolagus rupestris*) and Leopard Tortoise (*Stigmochelys pardalis*). The development will primarily entail a loss of habitat for fauna which will decrease the population size. This impact is considered moderate as the site is situated within a peri-urban area which has already impacted on the fauna of the area.

Table 2: Biodiversity Sensitivity Rating for the proposed residential development (entire site rated with scenario taking into account exclusions given in brackets).

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness		(2)	1
Presence of rare and endangered species		(2)	1
Ecological function		2 (2)	
Uniqueness/conservation value	(3)	2	
Vegetation condition			
Percentage ground cover		2 (2)	
Vegetation structure		2 (2)	
Infestation with exotic weeds and invader plants or encroachers	3	(2)	
Degree of grazing/browsing impact		2 (2)	
Signs of erosion		2 (2)	
Terrestrial animal characteristics			
Presence of rare and endangered species		2 (2)	
Sub total	3 (3)	14 (18)	2
Total		19 (21)	

7. BIODIVERSITY SENSITIVITY RATING (BSR) INTERPRETATION

Table 3: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
residential development	19	Not Preferred	2
Residential development with excluded private open space as per development plans	21	Acceptable	3

8. DISCUSSION AND CONCLUSION

The site proposed for the residential development has been rated as being not preferred. However, when taking into consideration that the development will exclude large portions of the site with high species diversity it is considered as acceptable for the development (Map 1).

The site consists almost entirely of natural vegetation with little disturbance or modification. Limited disturbance is evident along the eastern border of the site where it is situated adjacent to the R700 tarred road. Here an old borrow pit causes modification and transformation although at a local scale. An electrical distribution station and a few tarred roadways also contribute to local transformation of the vegetation.

The dominant vegetation structure on the site consists of a dense grass layer although this structure varies considerably over the site. Where exposed dolerite rock occurs the vegetation structure consists of a shorter, sparser grass layer with prominent succulent, bulb and dwarf shrub component. In lower lying areas, especially in the north-eastern corner, a more prominent thicket/tree layer becomes dominant. The vegetation structure over the site is largely natural and influenced by the soil depth, rock exposure and moisture regime.

According to Mucina & Rutherford (2006) the area consists of Bloemfontein Karroid Shrubland (Gh 8) (Map 2). This vegetation type is currently listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009)(National Environmental Management Biodiversity Act, 2004) (Map 2). It is however evident that this vegetation type is increasingly under pressure from urban development and that a large portion has already been transformed (Brown & Du Preez 2014). The site is also listed as an Ecological Support Area 1 under the Free State Province Biodiversity Management Plan (2015) (Map 3). Although this is not a Critical Biodiversity Area it still functions in ecological support of such surrounding areas.

The grassland habitat portion of the site is largely natural with few impacts but do not contain a significantly high diversity of species. It is also not considered to be diagnostic of the Bloemfontein Karroid Shrubland plant community which is considered to be of significant conservation value. As a result this portion of the site is not considered to be of high conservation value and does not warrant exclusion from development. However, it does contain a few protected bulb species which will have to be transplanted to remaining open spaces where they will not be affected by the development (Appendix C).

The portions of the site dominated by exposed dolerite rock is most characteristic of the Bloemfontein Karroid Shrubland and is therefore of significant conservation value. These areas are scattered on the site but with the largest portion occurring on the low hill in the south western corner of the site (Map 1). According to Brown & Du Preez 2014 and Dingaen & Du Preez 2002 the vegetation type must be regarded as endemic to the Free State Province and must be afforded a high conservation status and must be included as a Threatened Ecosystem. Currently this vegetation type is not considered a Threatened Ecosystem (Map 2). Despite this, evidence suggests that this area must be considered to be of high conservation value. However, the development will exclude large portions of this habitat and especially the low hill will be almost entirely excluded from development and will therefore be conserved indefinitely (Map 1). Furthermore, the site is not listed as a Critical Biodiversity Area (CBA 1) according to the Free State Province Biodiversity Management Plan (2015) but only an Ecological Support Area 1 (ESA 1) (Map 3). Exclusion of several portions of the site as indicated by development

plans will aid in retaining ecological corridors, decreasing habitat fragmentation and allowing for the exchange of genetic material.

A small drainage line/area occurs along the western portion of the site (Map 1). It does not contain a clear channel but it is evident that it conveys some storm water after heavy rainfall. It is considered of limited conservation value. It lacks a defined channel and as such is not considered a watercourse. As a result it can be incorporated into the development and does not warrant exclusion. However, it still acts in transport of storm water and it is therefore recommended that the development still make provision for storm water management in this area. In addition to the above discussed drainage area another small drainage line occurs along the eastern border of the site (Map 1). It originates outside the south eastern border of the site where it has largely been transformed by a currently operating rock quarry. From here it flows along the border of the site and into the historical borrow pit where the flow is again disrupted. The flow and functioning of this drainage line has therefore been modified to a large extent. The drainage line is distinct and contains a defined channel. Where it exits the site, a current residential development has also transformed it almost completely. It is therefore not considered to be of high conservation value and its functioning has been altered to a large degree by upstream and downstream residential developments. It does however still function in storm water transport to some extent. As a result it is recommended that it be incorporated into the development but that the development still provide structures for storm water transport much the same as the downstream development.

As previously discussed the site contains a high amount of protected species (Appendix C). This also contributes to the conservation value of the vegetation type. These include the trees, *Olea europaea* subsp. *africana*, *Celtis africana* and *Cussonia paniculata*, which do not transplant easily and will have to be removed where they occur outside private open space. Permits must be obtained to remove any of these tree specimens and can be offset by using saplings in landscaping of the development. The site contains numerous bulb and succulent species which are easily transplanted. Permits must be obtained and these transplanted to areas of private open space where they will remain unaffected. In addition to these protected species, several other species which is considered rare although not protected is also considered of conservation significance (Appendix C). A large percentage of the protected species will remain intact in those portions excluded from development as private open space.

The exotic species occurring on the site, and especially those exotic succulents which have invaded the rocky dolerite habitat must be eradicated prior to construction (Appendix D). It is recommended that the eradication of exotic species be maintained and form part of the management of the residential development throughout the lifetime of the development.

The planning of the residential development has been undertaken in conjunction with the ecological assessment and as a result the most sensitive areas has been excluded from development and will be retained as private open space (Map 1). This layout will result in the lowest impact as long as other mitigation measures such as transplanting of protected species are also adhered to.

9. RECOMMENDATIONS

- The planning phase of the residential development has been undertaken in conjunction with the ecological assessment and the most sensitive areas has been excluded from development as private open space as per the developmental plans (Map 1). These exclusions should be adhered to and these areas kept free from development.
- Excluded areas should be treated as no-go areas during the construction phase and kept as natural areas (Map 1). This should include the areas not being used as stockpile areas, laydown areas, parking or any other activities associated with construction.
- In addition, it is recommended that the development refrain from introducing any game or domestic animals such as horses to the remaining private open space as these will within a short period trample the vegetation layer and defeat the purpose of the exclusion.
- These areas of private open space should however be incorporated into the development to increase the aesthetic value of it and walkways should also be considered through these areas for the benefit of the inhabitants.
- The site contains a few protected tree species, *Olea europaea* subsp. *africana*, *Celtis africana* and *Cussonia paniculata*, which do not transplant easily and will have to be removed where they occur outside private open space (Appendix C). Permits must be obtained to remove any of these tree specimens and can be offset by using saplings of them in landscaping of the development.
- The site contains numerous bulb and succulent species which are easily transplanted (Appendix C). Permits must be obtained and these transplanted to areas of private open space where they will remain unaffected.
- The process of transplanting protected species should be undertaken and overseen by a suitably qualified person. This should be undertaken during the rainy season when deciduous bulbs will be visible. In addition, during construction these plants will require a temporary storage or nursery area where they can be kept intact until construction is completed and they can be transplanted into landscaping or planted areas. This area should be constructed, overseen and maintained by a suitably qualified person.
- It is recommended that the drainage lines on the site be incorporated in the development but they should still be accommodated in terms of an adequate storm water system to allow for storm water transport in much the same manner is the downstream development.
- The exotic species occurring on the site, and especially exotic succulents must be eradicated prior to construction (Appendix D). It is also recommended that the eradication of exotic species be maintained and form part of the management of the residential development throughout the lifetime of the development.
- The hunting, capturing and trapping of fauna should be prevented by making this a punishable offense during the construction phase and inhabitation of the development.

- After construction has ceased all construction materials should be removed from the area.

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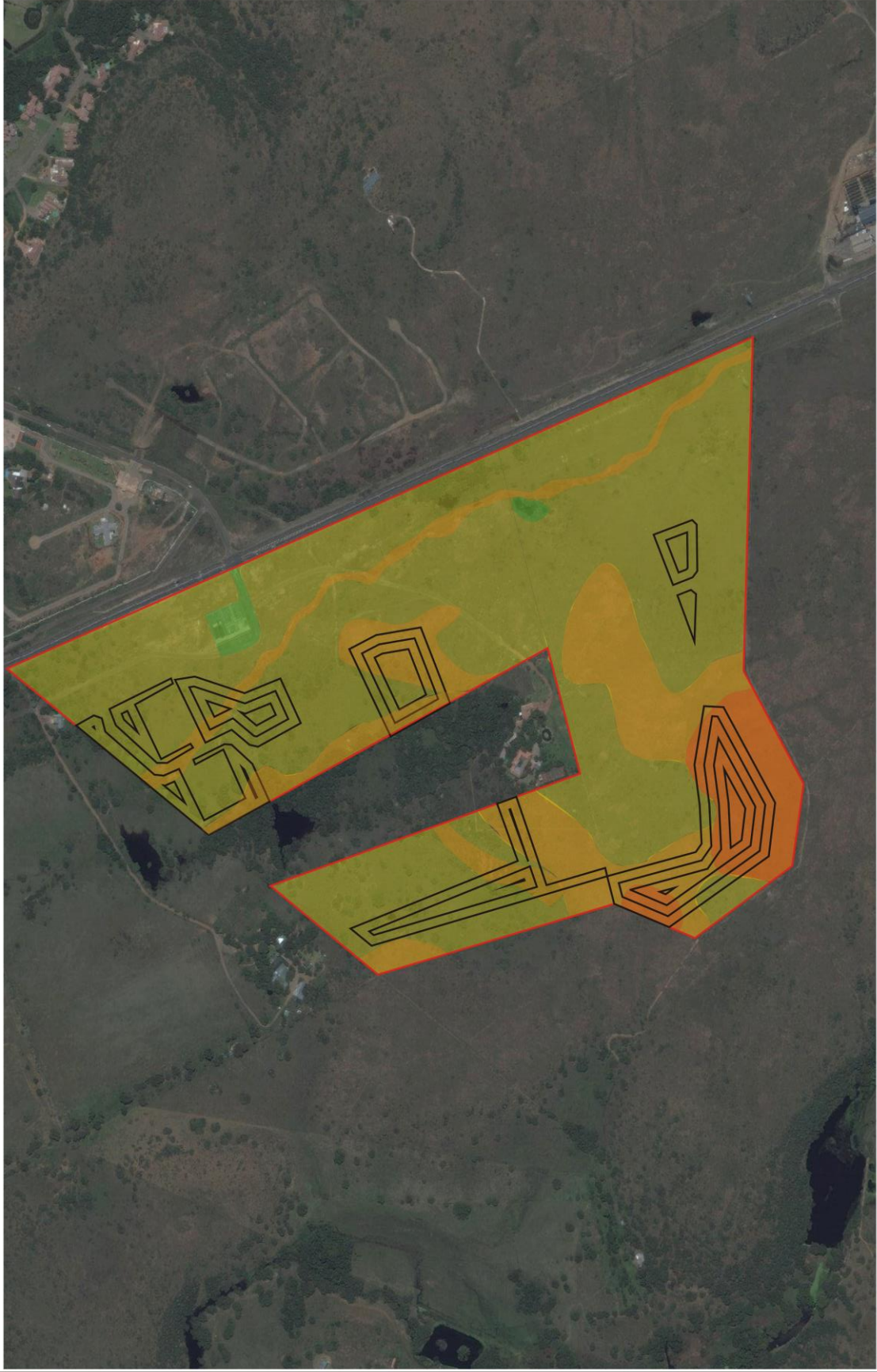
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Annexure A: Maps and Site photos



Sensitivity and layout map for the proposed establishment of a township development on the Remainder of the Farm The Kloof 2921, Bloemfontein, Free State Province.



Map 1: Sensitivity and layout map of the proposed establishment of a township development on the Remainder of the Farm The Kloof 2921, Bloemfontein, Free State Province.
Highly sensitive: Two southern portions consist of high diversity Bloemfontein Karroid Shrubland with exceptional species diversity including protected species. The majority of these areas will be excluded
Sensitive areas: Consists of Bloemfontein Karroid Shrubland with a lower diversity of species but still considered sensitive. Several portions of these areas will also be excluded. These areas include two drainage lines which will be incorporated into the development as storm water systems.
Moderately sensitive: The remainder of the site consists of grassland with a moderate diversity of species. Although not considered as sensitive it retains protected and Red Listed species which will require transplanting.
Low sensitivity: Transformed areas which are not considered significant to conservation



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Legend:

- Site boundary
- Low Sensitivity
- Moderately Sensitive
- Sensitive
- Highly Sensitive
- Exclusion areas

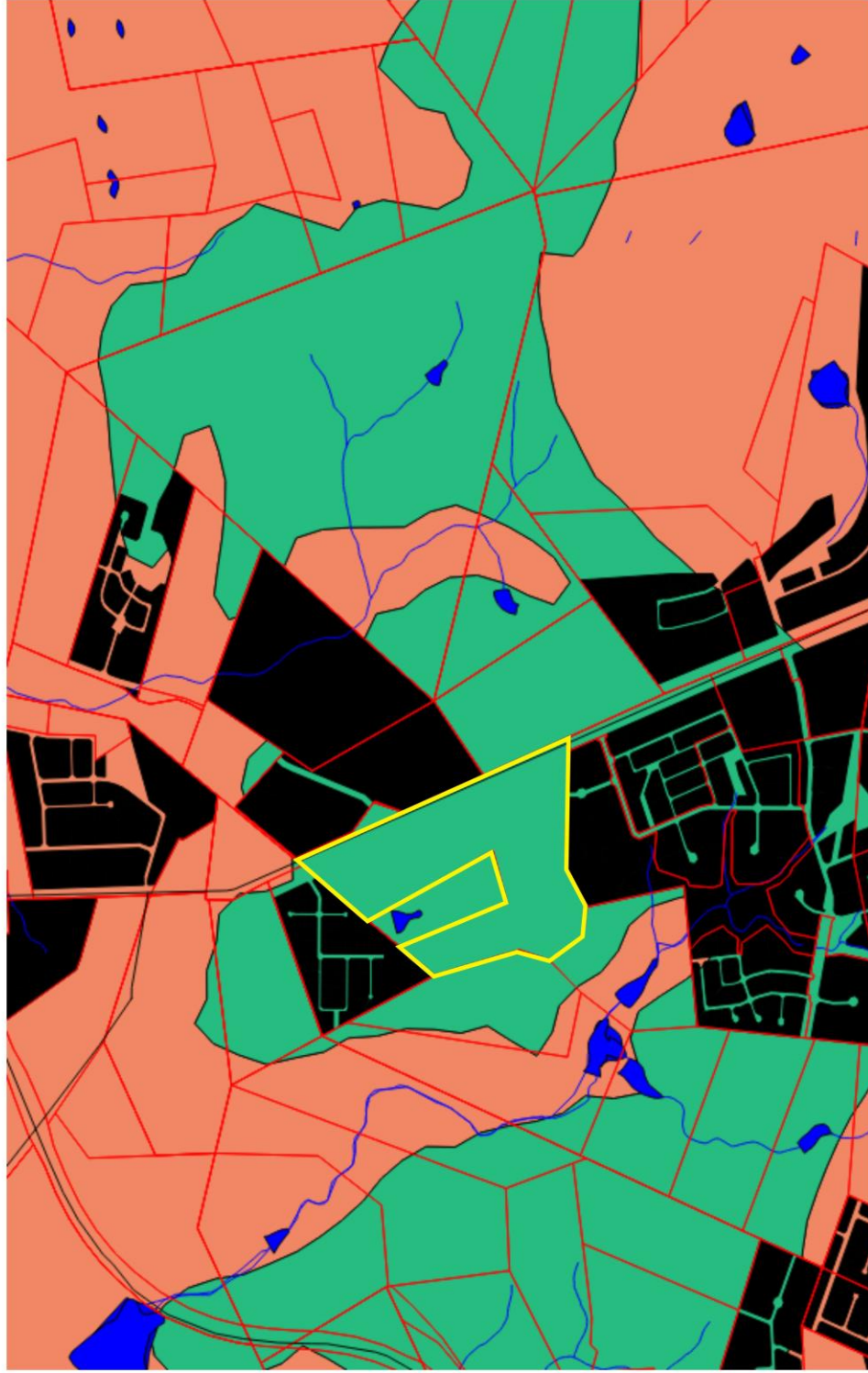
Map Information
Spheroid: WGS 84
Scale: 1:5 000

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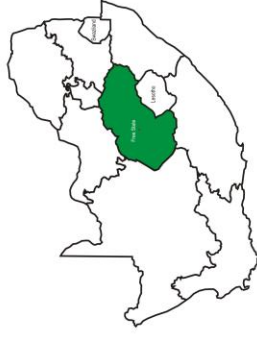




General ecology map for the proposed establishment of a township development on the Remainder of the Farm The Kloof 2921, Bloemfontein, Free State Province.



Map 2: General ecology map of the proposed establishment of a township development on the Remainder of the Farm The Kloof 2921. Note that the site is already surrounded by proposed new developments.



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Legend:

- Road network
- Property boundaries
- Watercourses
- Site boundary
- Wetlands and impoundments
- Bloemfontein Karroid Shrub
- Winburg Grassy Shrubland
- Urban area

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:16 000

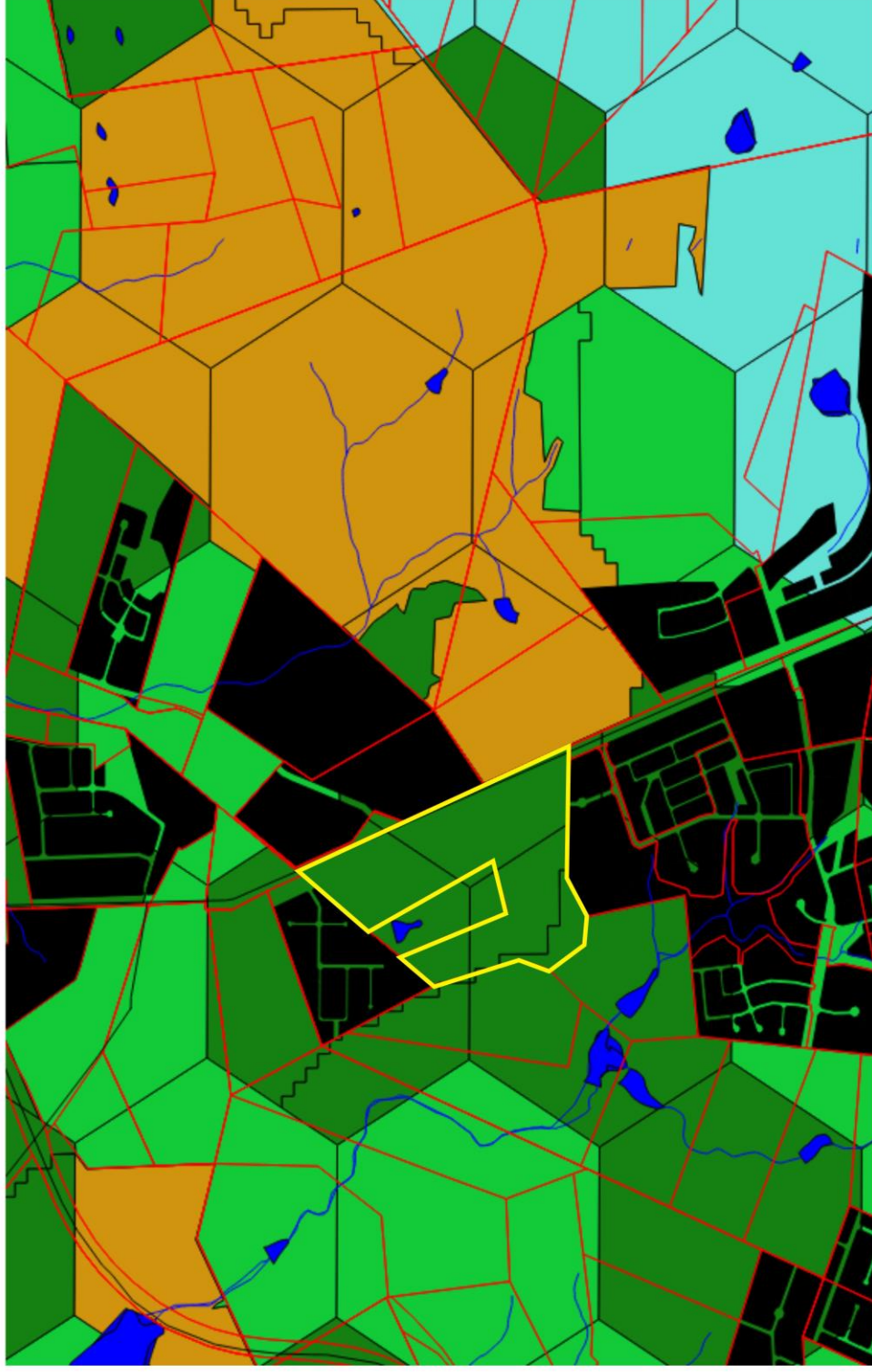
DPR Ecologists

Contact Darius van Rensburg at:

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Free State Biodiversity Plan map for the proposed establishment of a township development on the Remainder of the Farm The Kloof 2921, Bloemfontein, Free State Province.



Prepared for:
 MDA Consultants
 9 Barnes Street
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 9301

Legend:

- Road network
- Property boundaries
- Watercourses
- Site boundary
- Wetlands and impoundments
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- Degraded
- Ecological Support Area 1
- Ecological Support Area 2

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:16 000

DPR Ecologists

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Map 3: Biodiversity plan map of the proposed establishment of a township development on the Remainder of the Farm The Kloof 2921. Note that the site is listed as an Ecological Support Area 1.



Figure 1: Panorama of the grassland portion of the site.



Figure 2: Another panorama of the grassland. Note relatively dense vegetation cover with shrubs and trees largely absent. Clumps of exotic *Agave americana* are indicated.



Figure 3: Panorama of the historical borrow pit on the site. The drainage line is indicated and it is clear that the borrow pit acts as a barrier in its flow path.



Figure 4: View of the low hill in the south western corner of the site. Note exposed dolerite. Specimens of exotic *Opuntia lindheimeri* are indicated.



Figure 5: Close-up panorama of the low hill.



Figure 6: Panorama of the northern portion of the site. Here a woodland component becomes more prominent.



Figure 7: Close-up view of the succulent vegetation characteristic of the Bloemfontein Karroid Shrubland. Note high amount of protected succulent species (red circles).



Figure 8: View of the small drainage line along the eastern border of the site. Note a small and not very distinct channel (red).



Figure 9: View of the drainage line downstream of the site where it has been canalised. It is recommended that the proposed development incorporate it in much the same manner.



Figure 10: Protected Leopard Tortoise (*Stigmochelys pardalis*) occurring on the site. Note eggs raided by carnivore.

Appendix B: Species list

Species indicated with an * are exotic.

Protected species are coloured orange and Red Listed species red.

Species	Growth form
* <i>Agave americana</i>	Succulent
* <i>Bidens bipinnata</i>	Herb
* <i>Echinopsis spachiana</i>	Succulent
* <i>Opuntia lindheimeri</i>	Succulent
* <i>Schkuhria pinata</i>	Herb
* <i>Tagetes minuta</i>	Herb
<i>Adromischus tryginus</i>	Succulent
<i>Albuca setosa</i>	Geophyte
<i>Aloe grandidentata</i>	Succulent
<i>Anacampseros filamentosa</i>	Succulent
<i>Aristida congesta</i>	Grass
<i>Aristida diffusa</i>	Grass
<i>Asparagus larcinus</i>	Shrub/Climber
<i>Avonia ustulata</i>	Succulent
<i>Bonatea antennifera</i>	Geophyte
<i>Boophone distichia</i>	Geophyte
<i>Brunsvigia radulosa</i>	Geophyte
<i>Buddleja saligna</i>	Tree
<i>Bulbina abyssinia</i>	Geophyte
<i>Celtis africana</i>	Tree
<i>Chascanum pinnatifidum</i>	Herb
<i>Cheilanthes eckloniana</i>	Fern
<i>Chloris virgata</i>	Grass
<i>Chlorophytum fasciculatum</i>	Geophyte
<i>Cotyledon orbiculata</i>	Succulent
<i>Crassula capitella</i>	Succulent
<i>Crassula nudicaulis</i>	Succulent
<i>Curio radicans</i>	Succulent
<i>Cussonia paniculata</i>	Tree
<i>Cymbopogon pospischillii</i>	Grass
<i>Digitaria eriantha</i>	Grass
<i>Diospyros austro-africana</i>	Shrub
<i>Diospyros lycioides</i>	Tree
<i>Ehretia rigida</i>	Shrub/Tree
<i>Elephantorrhiza elephantina</i>	Suffrutex
<i>Enneapogon scoparius</i>	Grass
<i>Eragrostis gummiflua</i>	Grass
<i>Eragrostis lehmanniana</i>	Grass
<i>Eragrostis nindensis</i>	Grass
<i>Eragrostis superba</i>	Grass

<i>Eriocephalus spinescens</i>	Dwarf shrub
<i>Euclea crispa</i> subsp. <i>Ovata</i>	Shrub
<i>Eucomis autumnalis</i>	Geophyte
<i>Euphorbia mauritanica</i>	Succulent
<i>Euphorbia rhombifolia</i>	Succulent
<i>Euryops empetrifolius</i>	Dwarf shrub
<i>Euryops subcarneus</i>	Dwarf shrub
<i>Eustachys paspaloides</i>	Grass
<i>Felicia muricata</i>	Dwarf shrub
<i>Geigeria filifolia</i>	Herb
<i>Grewia occidentalis</i>	Shrub
<i>Heliophila suavissima</i>	Herb
<i>Hereroa glenensis</i>	Succulent
<i>Heteropogon contortus</i>	Grass
<i>Hypoxis hemerocallidae</i>	Geophyte
<i>Ipomoea oblongata</i>	Geophyte
<i>Kalanchoe paniculata</i>	Succulent
<i>Lantana rugosa</i>	Dwarf shrub
<i>Ledebouria luteola</i>	Geophyte
<i>Lessertia annularis</i>	Herb
<i>Melinis repens</i>	Grass
<i>Monsonia angustifolia</i>	Herb
<i>Olea europaea</i> subsp. <i>africana</i>	Tree
<i>Ophioglossum polyphyllum</i>	Fern
<i>Oropetium capense</i>	Grass
<i>Othonna protecta</i>	Succulent
<i>Oxalis obliquifolia</i>	Geophyte
<i>Pachypodium succulentum</i>	Succulent
<i>Pellaea calomelanos</i>	Fern
<i>Pentzia quinquefida</i>	Dwarf shrub
<i>Pterodischus speciosus</i>	Geophyte
<i>Pupalia lappacea</i>	Herb
<i>Rhigozum obovatum</i>	Shrub
<i>Ruschia intricata</i>	Succulent
<i>Ruschia unidens</i>	Succulent
<i>Searsia burcehellii</i>	Shrub
<i>Searsia ciliata</i>	Shrub
<i>Searsia lancea</i>	Tree
<i>Setaria pallide-fusca</i>	Grass
<i>Sporobolus fimbriatus</i>	Grass
<i>Stomatium bolusiae</i>	Succulent
<i>Themeda triandra</i>	Grass
<i>Tragus koelerioides</i>	Grass
<i>Trichodiadema barbatum</i>	Succulent
<i>Tulbaghia acutiloba</i>	Geophyte
<i>Typha capensis</i>	Bulrush

<i>Vachellia karroo</i>	Tree
<i>Vernonia oligocephala</i>	Herb
<i>Ziziphus mucronata</i>	Tree

Appendix C: Protected species on the site

Protected species on the site may not be limited to these species but these species have identified on and around the site. Additional sources should be consulted to confirm the presence of protected species.



Adromischus trigynus
Bontplakkie

Not protected in the Free State Province.

National Red List Status: **Least Concern**

Method: **Common on the site. Should be transplanted to private open space where they will not be affected by the development. May also be incorporated in landscaping. Transplants easily.**



Aloe grandidentata
Bont Aalwyn

Protected in the Free State Province

National Red List Status: **Least Concern**

Method: **The species forms dense colonies on the rocky areas of the site. Should be transplanted to private open space where they will not be affected by the development. May also be incorporated in landscaping. Transplants easily.**



Avonia ustulata
Haaskos

Rare species, not protected in the Free State Province

National Red List Status: **Least Concern**

Method: **Common but scattered on the site. Should be transplanted to private open space where they will not be affected by the development. Will not be beneficial in landscaping and should be transplanted to private open space. Transplants easily.**



Bonatea attenifera
Oktoberlelie/Green Wood Orchid

Protected in the Free State Province.

National Red List Status: **Least Concern**

Method: **Rare species, scattered on the site. Should be transplanted to private open space where they will not be affected by the development. Will not be beneficial in landscaping and should be transplanted to private open space. Does not transplant easily and necessary caution should be taken. Will not be visible during winter months.**



Boophane distichia
Poison Bulb/Tumblehead/Gifbol

Protected in the Free State Province

National Red List Status: **Least Concern**

Method: **Scattered on the site. Should be transplanted to private open space where they will not be affected by the development. May also be incorporated in landscaping. Transplants easily.**



Brunsvigia radulosa
Kandelaar Lelie/Candelabra Lily

Protected in the Free State Province

National Red List Status: **Least Concern**

Method: **Scattered specimens occur on the site especially grassland portions. Should be transplanted to private open space where they will not be affected by the development. May also be incorporated in landscaping. Transplants easily. Will not be visible during winter months.**



Celtis africana
White Stinkwood/Witstinkhout

Protected in the Republic of South Africa

National Red List Status: **Least Concern**

Method: **Scattered along the drainage line in the northern corner of the site. Obtain permits to remove specimens which will be affected by construction.**



Cotyledon orbiculata
Pig's Ears/Plakkie

Not protected in the Free State Province.

National Red List Status: **Least Concern**

Method: **Common on the site. Should be transplanted to private open space where they will not be affected by the development. May also be incorporated in landscaping. Transplants easily.**



Crassula nudicaulis

Not protected in the Free State Province.

National Red List Status: **Least Concern**

Method: **Common on the site. Should be transplanted to private open space where they will not be affected by the development. May also be incorporated in landscaping. Transplants easily.**



Cussonia paniculata
Highveld Cabbage Tree/Hoëveld Kiepersol

Protected in the Free State Province

National Red List Status: **Least Concern**

Method: **Common along the steeper slopes of ridges. Significant number of specimens will remain intact in excluded areas. Specimens to be affected by construction must be removed with the possession of a permit to do so.**



Eucomis autumnalis
Pineapple Flower/Wildepynappel

Protected in the Free State Province

National Red List Status: **Least Concern**

Method: **Scattered specimens occur on the site especially grassland portions. Should be transplanted to private open space where they will not be affected by the development. May also be incorporated in landscaping. Transplants easily. Will not be visible during winter months.**



Euphorbia mauritanica
Milk Bush/Geelmelkbos

Protected in the Free State Province.

National Red List Status: **Least Concern**

Method: **Common on the site. Should be transplanted to private open space where they will not be affected by the development. May also be incorporated in landscaping. Transplants easily.**



Euphorbia rhombifolia
Bloumelkbos

Protected in the Free State Province.

National Red List Status: **Least Concern**

Method: **Common on the site. Should be transplanted to private open space where they will not be affected by the development. May also be incorporated in landscaping. Transplants easily.**



Hereroa glenensis
Clock Plant/Slaapvygie

Not protected in the Free State Province.

National Red List Status: **Least Concern**

Method: **Common on the site. Should be transplanted to private open space where they will not be affected by the development. May also be incorporated in landscaping. Transplants easily.**



Hypoxis hemerocallidea
Afrika Aartappel/African Potato/Stargrass

Protected species

National Red List Status: **Least Concern**

Method: **Scattered specimens occur on the site especially grassland portions. Should be transplanted to private open space where they will not be affected by the development. May also be incorporated in landscaping. Transplants easily. Will not be visible during winter months.**



Olea europaea subsp. africana
Wild Olive/Olienhout

Protected in the Free State Province.

National Red List Status: **Least Concern**

Method: **Scattered on the site. Permits must be obtained to remove species that will be affected by construction. Transplanting this species is not feasible. Specimens may also be incorporated into the design.**



Pachypodium succulentum
Bobbejaankambroo/Dikvoet

Protected in the Free State Province

National Red List Status: **Least Concern**

Method: **The species forms dense colonies on the rocky areas of the site. The majority will not be affected by the development. Should be transplanted to private open space where they will not be affected by the development. May also be incorporated in landscaping. Transplants easily. Take care of large tubers which may be damaged during transplanting.**



Ruschia unidens
Red Mountain Mesemb/Rooibergvygie

Not protected in the Free State Province.

National Red List Status: **Least Concern**

Method: **Common on the site. Should be transplanted to private open space where they will not be affected by the development. May also be incorporated in landscaping. Transplants easily.**



Stomatium bolusiae

Rare species, not protected in the Free State Province

National Red List Status: **Least Concern**

Method: **Common but scattered on the site. Should be transplanted to private open space where they will not be affected by the development. Will not be beneficial in landscaping and should be transplanted to private open space. Transplants easily.**

Appendix D: Likely invader weed species

Invader weed species on the site may not be limited to these species but these are considered to be the most likely and significant invaders to occur. Additional sources should be consulted to confirm invader weed species as well as the best method to eradicate them.

According to the Conservation of Agricultural Resources Act, No. 43 of 1983 any Category 1 declared plants must be controlled by the land user on whose land such plants are growing.



Opuntia lindheimeri
Prickly Pear

Type: Weed
Category: 1

Mechanical control is effective for single specimens. All parts of the plant must be removed and burned.

Chemical is most effective control method. Monosodium methanearsonate (MSMA) and glyphosate must be injected into the stem as concentrated solutions.



Echinopsis spachiana
Torch Cactus/Orrelkactus

Type: Weed
Category: 1

Most effective control is by means of herbicide. Effective control has been proven by using Super Lawn Weeder, a broad leaf weed herbicide.



Agave americana* var. *americana
Spreading Century-Plant/Garingboom

Type: Invader

Category: 2

Best method of eradication include removal of small infestations, digging of plants and leaving exposed to desiccate.

Chemical control involve the injection of Tordon/5 parts diesel into the base of the plants.

The area should be monitored on an annual basis as plantlets emerge long after removal of bulk of upper parts.

Appendix E: Impact methodology

The environmental significance assessment methodology is based on the following determination:

Environmental Significance = Overall Consequence x Overall Likelihood

Determination of Consequence

Consequence analysis is a mixture of quantitative and qualitative information and the outcome can be positive or negative. Several factors can be used to determine consequence. For the purpose of determining the environmental significance in terms of consequence, the following factors were chosen: **Severity/Intensity, Duration and Extent/Spatial Scale**. Each factor is assigned a rating of 1 to 5, as described below and in tables 6, 7, 9 and 10.

Determination of Severity

Severity relates to the nature of the event, aspect or impact to the environment and describes how severe the aspects impact on the biophysical and socio-economic environment.

Table 7 will be used to obtain an overall rating for severity, taking into consideration the various criteria.

Table 7: Rating of severity

Type of criteria	Rating				
	1	2	3	4	5
Quantitative	0-20%	21-40%	41-60%	61-80%	81-100%
Qualitative	Insignificant / Non-harmful	Small Potentially harmful	Significant / Harmful	Great / Very harmful	Disastrous Extremely harmful
Social/ Community response	Acceptable / I&AP satisfied	Slightly tolerable / Possible objections	Intolerable/ Sporadic complaints	Unacceptable / Widespread complaints	Totally unacceptable / Possible legal action
Irreversibility	Very low cost to mitigate/ High potential to mitigate impacts to level of insignificance / Easily reversible	Low cost to mitigate	Substantial cost to mitigate / Potential to mitigate impacts / Potential to reverse impact	High cost to mitigate	Prohibitive cost to mitigate / Little or no mechanism to mitigate impact Irreversible
Biophysical (Air quality, water quantity and quality, waste production, fauna and flora)	Insignificant change / deterioration or disturbance	Moderate change / deterioration or disturbance	Significant change / deterioration or disturbance	Very significant change / deterioration or disturbance	Disastrous change / deterioration or disturbance

Determination of Duration

Duration refers to the amount of time that the environment will be affected by the event, risk or impact, if no intervention e.g. remedial action takes place.

Table 8: Rating of Duration

Rating	Description
1: Low	Almost never / almost impossible
2: Low-Medium	Very seldom / highly unlikely
3: Medium	Infrequent / unlikely / seldom
4: Medium-High	Often / regularly / likely / possible
5: High	Daily / highly likely / definitely

Determination of Extent/Spatial Scale

Extent refer to the spatial influence of an impact be local (extending only as far as the activity, or will be limited to the site and its immediate surroundings), regional (will have an impact on the region), national (will have an impact on a national scale) or international (impact across international borders).

Table 9: Rating of Extent / Spatial Scale

Rating	Description
1: Low	Immediate, fully contained area
2: Low-Medium	Surrounding area
3: Medium	Within Business Unit area of responsibility
4: Medium-High	Within Mining Boundary area
5: High	Regional, National, International

Determination of Overall Consequence

Overall consequence is determined by adding the factors determined above and summarised below, and then dividing the sum by 4.

Table 10: Example of calculating Overall Consequence

Consequence	Rating
Severity	Example 4
Duration	Example 2
Extent	Example 4
SUBTOTAL	10
TOTAL CONSEQUENCE:(Subtotal divided by 4)	3.3

Likelihood

The determination of likelihood is a combination of Frequency and Probability. Each factor is assigned a rating of 1 to 5, as described below and in Table 11 and Table 12.

Determination of Frequency

Frequency refers to how often the specific activity, related to the event, aspect or impact, is undertaken.

Table 11: Rating of frequency

Rating	Description
1: Low	Once a year or once/more during operation/LOM
2: Low-Medium	Once/more in 6 Months
3: Medium	Once/more a Month
4: Medium-High	Once/more a Week
5: High	Daily

Determination of Probability

Probability refers to how often the activity/event or aspect has an impact on the environment.

Table 12: Rating of probability

Rating	Description
1: Low	Almost never / almost impossible
2: Low-Medium	Very seldom / highly unlikely
3: Medium	Infrequent / unlikely / seldom
4: Medium-High	Often / regularly / likely / possible
5: High	Daily / highly likely / definitely

Overall Likelihood

Overall likelihood is calculated by adding the factors determined above and summarised below, and then dividing the sum by 2.

Table 13: Example of calculating the overall likelihood

Consequence	Rating
Frequency	Example 4
Probability	Example 2
SUBTOTAL	6
TOTAL LIKELIHOOD (Subtotal divided by 2)	3

Determination of Overall Environmental Significance

The multiplication of overall consequence with overall likelihood will provide the environmental significance, which is a number that will then fall into a range of LOW, LOW-MEDIUM, MEDIUM, MEDIUM, MEDIUM-HIGH or HIGH, as shown in the table below.

Table 14: Determination of overall environmental significance

Significance or Risk	Low	Low-Moderate	Moderate	Moderate-High	High
Overall Consequence X Overall Likelihood	1 - 4.9	5 - 9.9	10 - 14.9	15 - 19.9	20 - 25

Qualitative description or magnitude of Environmental Significance

This description is qualitative and is an indication of the nature or magnitude of the Environmental Significance. It also guides the prioritisations and decision making process associated with this event, aspect or impact.

Table 15: Description of the environmental significance and the related action required.

Significance	Low	Low-Moderate	Moderate	Moderate-High	High
Impact Magnitude	Impact is of very low order and therefore likely to have very little real effect. Acceptable.	Impact is of low order and therefore likely to have little real effect. Acceptable.	Impact is real, and potentially substantial in relation to other impacts. Can pose a risk to the company	Impact is real and substantial in relation to other impacts. Pose a risk to the company. Unacceptable	Impact is of the highest order possible. Unacceptable. Fatal flaw.
Action Required	Maintain current management measures. Where possible improve.	Maintain current management measures. Implement monitoring and evaluate to determine potential increase in risk. Where possible improve	Implement monitoring. Investigate mitigation measures and improve management measures to reduce risk, where possible.	Improve management measures to reduce risk.	Implement significant mitigation measures or implement alternatives.