

**Vegetation and Red Data plant species assessment on Erf 1202 South Hills, portion  
65 of the farm Klipriviersberg-106 IR and holding 88 Klipriviersberg Estate,  
Johannesburg, Gauteng**

Prepared by

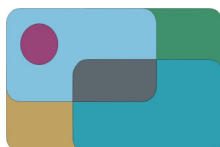
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9 December 2009



**David Hoare Consulting cc**  
**Biodiversity Assessments, Vegetation Description /**  
**Mapping, Species Surveys**

### ***Appointment of specialist***

David Hoare of David Hoare Consulting cc was commissioned by Animalia Zoological and Ecological Consultation cc to conduct a vegetation and Red List plant species assessment of a site on Erf 1202 South Hills, portion 65 of the farm Klipriviersberg-106 IR and holding 88 Klipriviersberg Estate, Johannesburg, Gauteng. The terms of reference were to undertake a specialist study to describe the vegetation and flora on site.

### ***Details of specialist***

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### ***Summary of expertise***

David Hoare:

- Registered professional member of The South African Council for Natural Scientific Professions (Ecological Science), registration number 400221/05.
- Founded David Hoare Consulting cc, an independent consultancy, in 2001.
- Ecological consultant since 1995.
- Conducted, or co-conducted, over 200 specialist ecological surveys as an ecological consultant.
- Published six technical scientific reports, 15 scientific conference presentations, seven book chapters and eight refereed scientific papers.
- Attended 15 national and international congresses & 5 expert workshops, lectured vegetation science at 2 universities and referee for 2 international journals.

### ***Independence:***

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### ***Scope and purpose of report***

The scope and purpose of the report are reflected in the "Terms of reference" section of this report

### ***Indemnity and conditions relating to this report***

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## **INTRODUCTION**

### **Terms of reference**

On 17 November 2009 David Hoare Consulting cc was appointed by Animalia Zoological and Ecological Consultation, to undertake a specialist vegetation and Red Data plant species survey of the site of a proposed development on Erf 1202 South Hills, portion 65 of the farm Klipriviersberg-106 IR and holding 88 Klipriviersberg Estate, Johannesburg, Gauteng. The study was to cover a total area of approximately 200 ha.

The study was to be based on detailed fieldwork and interpretation of aerial photographs as well as a review of literature information pertaining to the vegetation and threatened plant species of the study area. The specific terms of reference were as follows:

- According to the national vegetation map (Mucina *et al.* 2005), the site occurs partially within an Endangered vegetation type classified as Soweto Highveld Grassland. The field survey will collect information that can be used to determine whether the site is typical of this vegetation type and the approximate boundary of the vegetation type on site will be determined on the basis of floristic information.
- A vegetation community description will be provided, including a description of the dominant and characteristic species identified within vegetation units.
- Plant species list: to provide an accurate indication of the floristic diversity.
- Alien species: List of naturalized plant species, indicating which are declared weeds or alien invasive species, according to the Conservation of Agricultural Resources Act (Act No. 43 of 1983) as amended in 2001.
- Threatened plant species: determination of the occurrence, or possible occurrence, of threatened plant species on the basis of the field survey, historical distribution records obtained from GDACE database and available literature.
- Identify sensitive habitats and plant communities on site based on the conservation value of these at national and provincial level.

### **Limitations**

The study constituted a single survey in one season. It is therefore unlikely that all species that occur on site were located. The study was undertaken towards the beginning of the growing season, but the results from the field survey indicate that this was not a limitation for assessing the sensitivity of the site.

## DESCRIPTION OF STUDY AREA

### Study area

#### Location

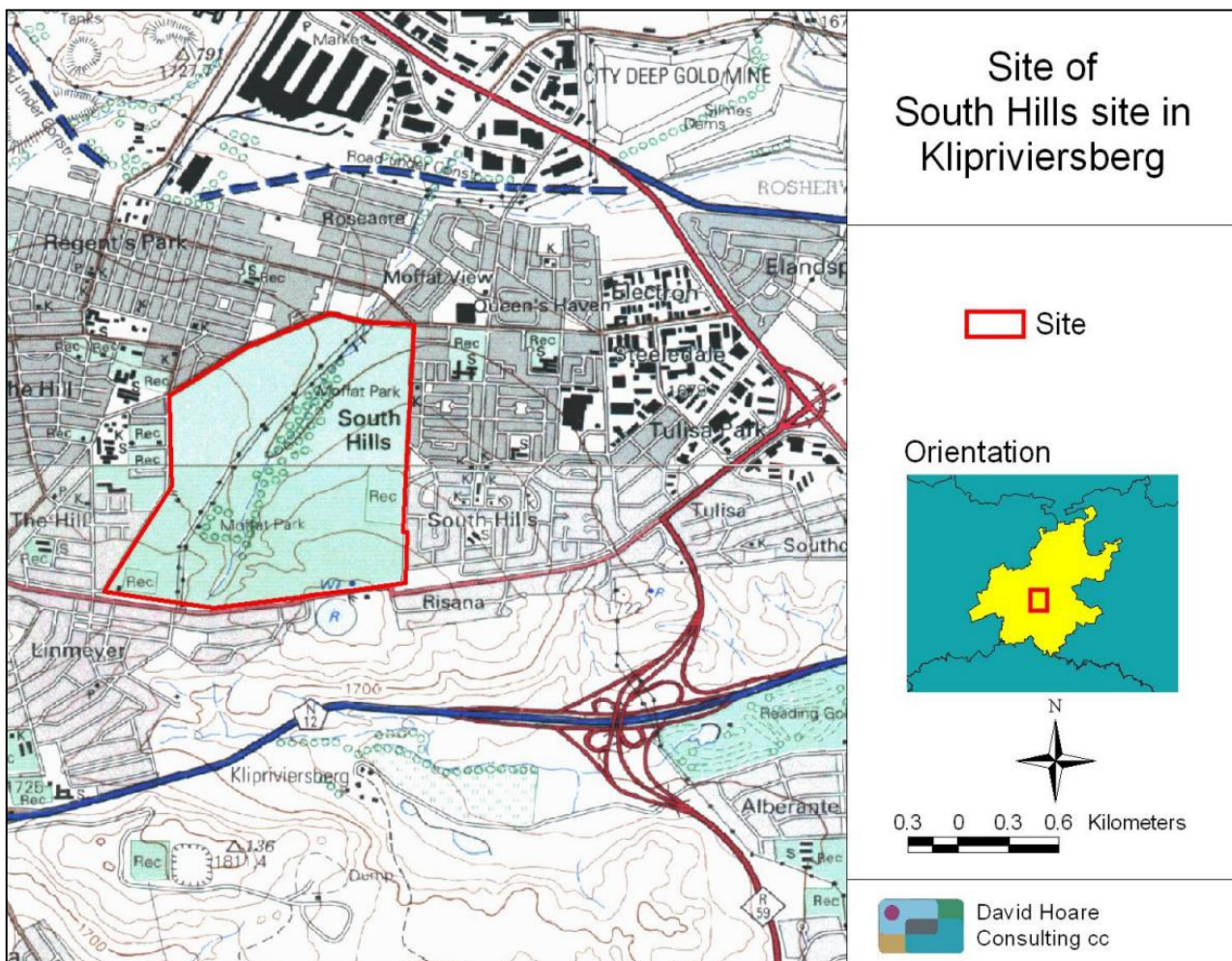
The site of the proposed development is just to the north of the N12 highway, north-east of the intersection with the R59 in the suburb of South Hills in the Johannesburg Municipal area, Gauteng (Figure 1). The site constitutes Erf 1202 South Hills, portion 65 of the farm Klipriviersberg-106 IR and holding 88 Klipriviersberg Estate in the grid squares 2628AA and AC. The boundaries of the site are shown in Figure 2. South Rand Road forms the southern boundary of the site, East Road the western boundary, Nephin Road the eastern boundary and Southern Klipriviersberg Road the northern boundary.

#### Topography

The study area is situated on the northern face of a ridge, which gradually flattens out towards the north of the site. There is a non-perennial stream running through the centre of the site in a south to north direction. This is within a narrow valley towards which the surrounding landscape also slopes. Slope aspect varies from north-east to north-west. The site is at an elevation of approximately 1686–1788 m. The highest point is in the south-east corner of the site next to the water tower and the lowest in the north where the stream exits the site.

#### Geology, soils and rainfall

The geology consists of one main type, Turffontein Subgroup of the Central Rand Formation,



**Figure 1: Location of site.**



consisting primarily of lutaceous arenite and conglomerate. Arenite is a sedimentary rock composed of sand-sized fragments irrespective of composition. Conglomerate composition depends on the make-up of the rock that originally formed it. On site the conglomerate contains large amounts of pebble-sized quartzite. The soils on the site are sandy and generally very shallow.

The land type of the site, which is an area with largely uniform soils, topography and climate, is the Ib land type on the southern portion of the site and the Ba land type on the remainder of the site (MacVicar *et al.* 1974, Land Type Survey Staff, 1987). Unit Ib indicates land types with exposed rock, stones or boulders covering 60 – 80% of the area. Unit Ba indicates land in which red and/or yellow apedal soils that are dystrophic and/or mesotrophic predominate over red and/or yellow apedal soils.

The rainfall in the study area is approximately 700 mm per annum and occurs mainly in the summer (Dent *et al.* 1989) .

### ***Landuse and landcover***

Most of the site is natural, although there are various features in and around the site that have caused local degradation. The most obvious degradation is the dense invasion of alien plants in the central drainage line, visible on the aerial photographs of the site (Figure 2). These aliens are slowly spreading into the surrounding vegetation. There are various buildings visible on site and sports fields that appear as greener areas on the aerial photograph (Figure 2). There may have been additional buildings on site that have been demolished over time, but remaining foundations still occur on site. There are also vehicle tracks and human pathways on site, areas where dumping has occurred and localised impacts on natural vegetation.



**Figure 2: Aerial photo image of site showing current status of the site and surrounding areas.**

The entire site is surrounded by built-up areas. The only remaining natural link from the site is towards the south onto the Klipriviersberg ridge, but this is across a band of built-up area (Figure 2).

### ***General vegetation patterns of the area***

There are three general descriptions of the vegetation of South Africa. These are useful for evaluating the vegetation of a specific site since they provide contextual species compositional information that can be used to evaluate the status of the vegetation on site. Acocks (1953) published the first comprehensive description of the vegetation of South Africa, which was updated in 1988. This was followed by an attempted improvement (Low & Rebelo 1998) which has become widely used due to the inclusion of conservation evaluations for each vegetation type, but is often less rigorous than Acocks's original publication. Recently, a more detailed map of the country was produced (Mucina *et al.*, 2005). A companion guide to this map (Mucina & Rutherford 2006), containing up-to-date species information and a comprehensive conservation assessment of all vegetation types, has recently been published.

According to the 'Vegetation Map of South Africa, Lesotho and Swaziland' (Low & Rebelo 1998), the study area is situated within the Vegetation Type classified as Moist Cool Highveld Grassland, which forms part of the Grassland Biome (Rutherford & Westfall, 1994). Acocks (1953) classified this area as Cymbopogon-Themeda Veld. The most recent vegetation map for South Africa (Mucina *et al.*, 2005), classifies this area as Soweto Highveld Grassland.

As at 1998 Moist Cool Highveld Grassland covered an area of approximately 48 959 km<sup>2</sup> within South Africa, approximately 72% of which had been transformed and 0.3% of which was conserved (Low & Rebelo 1998). The transformation within this Vegetation Type was found to be mainly attributable to cultivation and remaining areas degraded by widespread overgrazing (Low & Rebelo 1998). The most important conservation areas that contain examples of this vegetation type are Bronkhorstspuit Dam, Vaal Dam, Rustfontein Dam, Willem Pretorius and Koppies Dam Nature Reserves.

According to Acocks (1988), there are two variations of Cymbopogon-Themeda Veld, a northern and a southern one. The northern variation occurs on the Highveld and represents the study area. It is a sparse and tufted grassland occurring in areas with an elevation of 300 to 1500 m above sea level, summer rainfall and frosty winters (Acocks 1988). Important species include the grasses *Setaria sphacelata* var. *torta*, *Themeda triandra*, *Heteropogon contortus*, *Eragrostis racemosa*, *Eragrostis chloromelas*, *Elionurus muticus*, *Cymbopogon plurinodis*, *Brachiaria serrata* and *Eragrostis obtusa*, as well as a variety of forbs, including *Vernonia oligocephala*, *Scabiosa columbaria*, *Ziziphus zeyheriana*, *Helichrysum rugulosum*, *Anthospermum pumilum* subsp. *rigidum*, *Felicia filifolia* and many others.

According to the most recent vegetation map of the country (Mucina *et al.*, 2005) the study area falls within Soweto Highveld Grassland. According to this publication, this vegetation type is considered to be Endangered, with none conserved and at least 45% transformed, mostly by urbanization (8%), which is spreading rapidly, and cultivation (36%) (Mucina & Rutherford, 2006). The Draft National List of Threatened Ecosystems (GN1477 of 2009), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004), lists this vegetation type as Vulnerable. Soweto Highveld Grassland occurs on gently to moderately undulating landscapes. there is a continuous grassland cover that is only occasionally interrupted by small wetlands, narrow stream alluvia, pans and ridges or rocky outcrops. Soweto Highveld Grassland occurs on shale, sandstone or mudstone of the Madzarawinge Formation or the intrusive Karoo Suite dolerites. Soils are deep, reddish on flat plains and are typically Ea, Ba and Bb landtypes. The vegetation is described as a short to medium-high, dense, tufted grassland dominated almost entirely by *Themeda triandra* accompanied by other



grasses such as *Elionurus muticus*, *Eragrostis racemosa*, *Heteropogon contortus* and *Tristachya leucothrix*. A more complete list of expected species in undisturbed Soweto Highveld Grassland include the following:

Graminoids (dominant): *Andropogon appendiculatus*, *Brachiaria serrata*, *Cymbopogon pospischilii*, *Cynodon dactylon*, *Elionurus muticus*, *Eragrostis capensis*, *Eragrostis chloromelas*, *Eragrostis curvula*, *Eragrostis plana*, *Eragrostis planiculmis*, *Eragrostis racemosa*, *Heteropogon contortus*, *Hyparrhenia hirta*, *Setaria nigrirostris*, *Setaria sphacelata*, *Themeda triandra*, *Tristachya leucothrix*.

Graminoids (accompanying): *Andropogon schirensis*, *Aristida adscensionis*, *Aristida bipartita*, *Aristida congesta*, *Aristida junciformis*, *Cymbopogon caesius*, *Digitaria diagonalis*, *Diheteropogon amplectens*, *Eragrostis micrantha*, *Eragrostis superba*, *Harpochloa falx*, *Michrochloa caffra*, *Paspalum dilatatum*.

Herbs: *Hermannia depressa* (d), *Acalypha angustata*, *Berkheya setifera*, *Dicoma anomala*, *Euryops gilfillanii*, *Geigeria aspera*, *Graderia subintegra*, *Haplocarpha scaposa*, *Helichrysum miciniifolium*, *Helichrysum nudifolium*, *Helichrysum rugulosum*, *Hibiscus pusillus*, *Justicia anagalloides*, *Lippia scaberrima*, *Rhynchosia effusa*, *Schistostephium crataegifolium*, *Selago densiflora*, *Senecio coronatus*, *Vernonia oligocephala*, *Wahlenbergia undulata*

Geophytes: *Haemanthus humilis*, *Haemanthus montanus*

Herbaceous climbers: *Rhynchosia totta*

Low shrubs: *Anthospermum hispidulum*, *Anthospermum rigidum* subsp. *pumilum*, *Berkheya annectens*, *Felicia muricata*, *Ziziphus zeyheriana*.

Besides the broad descriptions of Acocks (1988) and Low and Rebelo (1998), the vegetation of the Ba and Ib landtypes in this area has been studied in detail by Coetzee *et al.* (1994a, 1994b, 1995) and there have been a number of other local studies (e.g. Grobler 2000 as well as various unpublished studies). There is therefore some published information that can be used to place the current study area in context. However, much of this data has been collected at different intensities and scales over a wide area and doesn't provide site-specific information on the current study area (Mucina *et al.* 2000).

## **METHODOLOGY**

### **Vegetation survey**

Fieldwork for this study was conducted on 24 November and 1 December 2009. Quantitative data was collected in natural vegetation by undertaking vegetation sampling according to the Braun-Blanquet approach (Mueller-Dombois & Ellenberg 1974; Westhoff & van der Maarel 1978). In each sample quadrat the following data was collected:

- species present,
- aerial cover estimate of each species according to the Braun-Blanquet scale,
- vegetation height,
- amount of bare soil and rock cover,
- slope, aspect in degrees, latitude and longitude position (from GPS) in decimal degrees,

Additional checklists of plant species were compiled by traversing the site on foot and recording species as they were encountered. Plant names follow Germishuizen *et al.* (2005). Due to the brief duration of the survey and the lack of seasonal coverage, the species list provided for the area can not be regarded as comprehensive, but is nevertheless likely to include the majority of the dominant and common species present.

Vegetation mapping was done with the use of available aerial photography as well as observations made in the field during the survey. A standard visual mapping approach was followed. During the survey, features of interest were marked with a hand-held GPS receiver. Habitat boundaries were mapped in ArcView GIS software using the aerial photography as a base map. The stratified units were verified in the field and changes then made to the original map, where necessary.

### **Red Data plant species**

A list of Red Data flora species which could potentially occur within the study area was compiled on the basis of existing data from GDACE (refer to Appendix 1). Prior to fieldwork, lists of historical occurrences of Threatened and Orange List plant species were obtained from GDACE within the quarter degree squares in which the site is located. Information about the species on this list were updated from literature sources. The list was evaluated to determine which species were likely to occur in the available habitats in the study area. For all listed plant species that occur in the general geographical area of the site, a rating of the likelihood of it occurring on site is given as follows:

LOW: no suitable habitats occur on site / habitats on site do not match habitat description for species;

MEDIUM: habitats on site match general habitat description for species (e.g. grassland), but detailed microhabitat requirements (e.g. rocky grassland on shallow soils overlying dolomite) are absent on the site or are unknown from the descriptions given in the literature or from the authorities;

HIGH: habitats found on site match very strongly the general and microhabitat description for the species (e.g. rocky grassland on shallow soils overlying dolomite);

DEFINITE: species found on site.

## Sensitivity assessment

The assessment of sensitivity on site follows the guidelines provided by GDACE in the section on Sensitivity Mapping Rules for Biodiversity Assessments in the GDACE document on "Requirements for Biodiversity Assessments, Version 2, November 2009". According to GDARD Urban boundary shapefiles of July 2002, the site is inside the urban edge. As per these guidelines, the sensitive features that may occur on site, based on the desktop assessment, and the mapping rules are given in Table 1 below:

**Table 1: GDACE sensitivity mapping rules for various features.**

<b>Biodiversity element</b>	<b>Sensitivity mapping rule</b>
Wetland	Wetland + 30 m buffer zone (inside urban edge) extending from edge of wetland temporary zone
Rivers (perennial / non-perennial)	The riparian zone must be delineated according to "DWAF, 2003: A Practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones". A 32m buffer zone from the edge of the riparian zone for rivers/streams within the urban edge.
Good condition natural vegetation and primary grassland (even if it is in a poor/degraded condition)	Must be mapped and designated as sensitive. Buffer zones of at least 200m must be provided
Primary vegetation classified as Endangered (SANBI VegMap)	Extent of vegetation type in moderate to good condition + 200 m buffer zone
Red or Orange List plants	Entire area occupied by populations of Red List and Orange List plant species. Buffer zones of 200m for Red List and Orange List plant populations occurring within urban areas.
Primary vegetation suitable as habitat for Red or Orange List plant species	Extent of vegetation type in moderate to good condition
Ridges	All ridges, as delimited by GDACE, must be designated as sensitive. Already transformed areas (i.e. dominated by exotics, denuded of vegetation, landscaped, covered in development structures) can be ascribed a low sensitivity. A 200m buffer zone for Class 1 ridges must be designated as sensitive.

The area in hectares of sensitive features was calculated using a GIS function on the basis of mapped features represented as ArcView shapefiles.

Information from GDACE's C-Plan version 2 as well relevant legislation, policies and Provincial guidelines was used to provide additional information on the conservation value of features within the study area.

## RESULTS

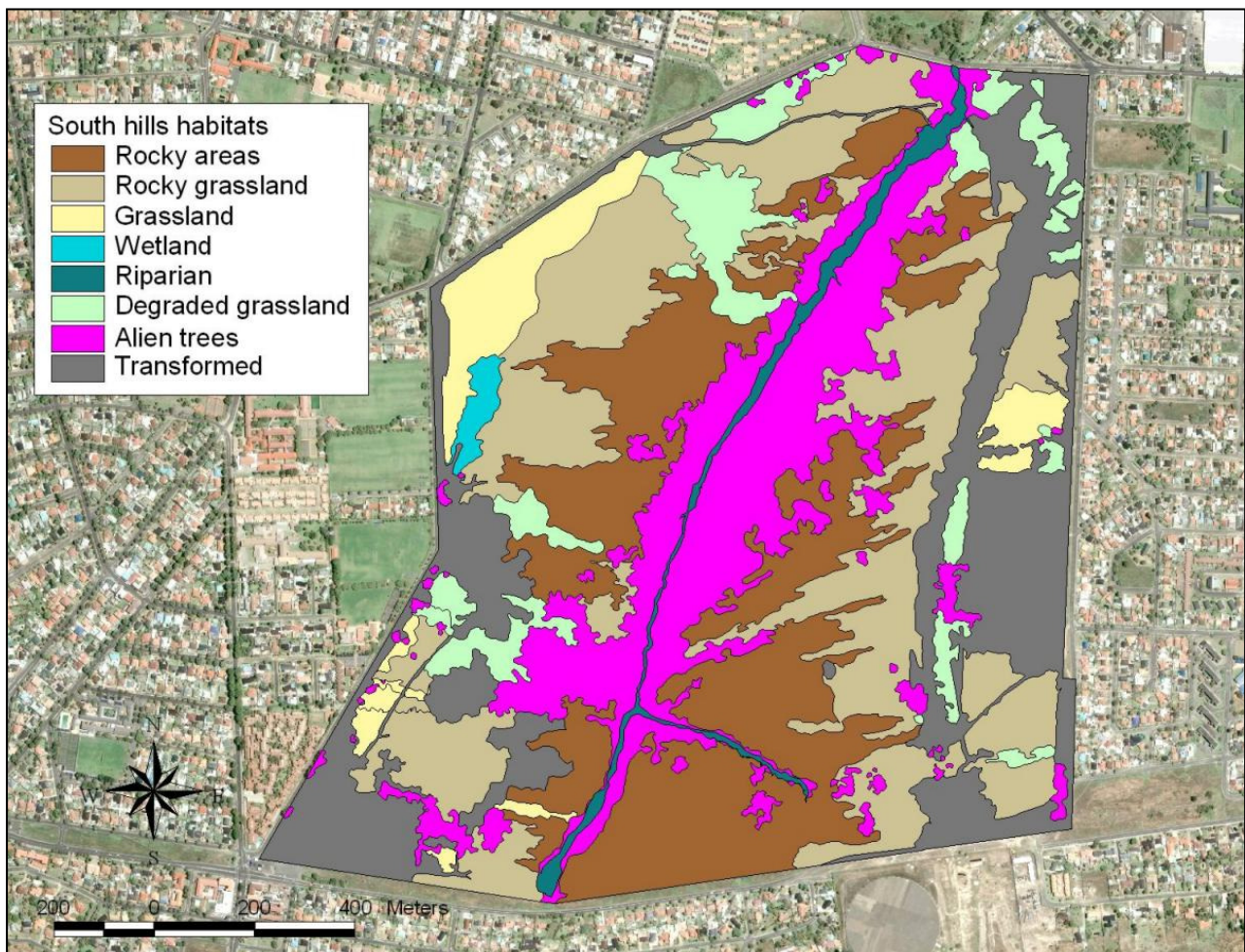
The site is mostly natural vegetation. There are some degraded areas on site and various pathways across the site, but the vegetation is largely intact. The most prominent degradation on site is the dense alien infestation within the central drainage line. The vegetation types / landcover classes on the site are described in more detail below.

### Vegetation and landcover of the study area

Different landcover types are shown in Figure 3. The approximate areas taken up by each of the main landcover types is given in Table 2. It adds up to slightly less than 200 ha, of which 43% of the site consists of degraded or transformed areas or dense stands of alien trees.

**Table 2: Landcover areas on site.**

Landcover	Area (ha)	Proportion of site (%)
Rocky areas	46.25	23.3
Rocky grassland	52.20	26.3
Grassland	9.26	4.7
Wetland	1.19	0.6
Riparian	3.54	1.8
Degraded grassland	11.92	6.0
Alien trees	34.50	17.4
Transformed	39.35	19.9
TOTAL	198.21	100.0



**Figure 3: Landcover and habitat types on site.**



### **Rocky areas**

A characteristic feature of the site are the rocky outcrops, ledges and ridges, especially in the areas close to the central drainage line and in the more steeply sloping parts in the south of the site (Figure 3). The vegetation in these areas consists of grassland in-between the rocks and scattered to clumped low shrubs (Figure 3). Plant species occurring commonly in these areas include the shrubs, *Canthium gilfillanii*, *Englerophytum magalismontanum* and *Rhus magalismontanum*, the grasses *Aristida junciformis*, *Melinis repens*, *Sporobolus iocladius*, *Eragrostis chloromelas*, *Eragrostis racemosa* and *Schizachyrium sanguineum*, and the forbs, *Eriospermum porphyrovalve*, *Selaginella dregei*, *Khadia acutipetala*, *Dipcade ciliare*, *Crassula setulosa*, *Lotononis listii* and *Craterostigma wilmsii*.

There are no sensitive plant species that were recorded within rocky areas, but it was considered likely that eight species of conservation concern could occur here (one Endangered, two Vulnerable, three Near Threatened and two Declining species). The rocky areas are therefore considered to have high ecological sensitivity.

### **Rocky grassland**

Most of the open grassland on site occurs on very shallow soils, often with sheets of rocks protruding at the surface. These occur adjacent to the rocky areas and from the drainage line (Figure 3). The soils are sandy and often contain quartz pebbles. The vegetation is a medium-height open to semi-closed grassland (Figure 4). Plant species occurring commonly in these areas include the grasses *Eragrostis chloromelas*, *Eragrostis curvula*, *Eragrostis racemosa*, *Melinis repens*, *Sporobolus iocladius*, *Michrochloa caffra*, *Aristida junciformis*, *Heteropogon contortus*, *Trachypogon spicatus*, *Cynodon dactylon* and *Hyparrhenia hirta* and the forbs, *Ledebouria revoluta*, *Kohautia amatymbica*, *Pearsonia sessilifolia*, *Eriospermum porphyrovalve*, *Felicia muricata*, *Ursinia nana*, *Helichrysum callicomum*, *Helichrysum caespitium*,



**Figure 3: Rocky areas on site.**



*Helichrysum rugulosum*, *Crassula lanceolata*, *Walafrida densiflora*, *Selaginella dregei*, *Scabiosa columbaria*, *Khadia acutipetala* and *Felicia muricata*. The species richness is moderate for grasslands at 20 species per 100m<sup>2</sup>. Many of the species are indicators of shallow soils or rocky areas and often occur on ridges or rocky outcrops.

There was one plant species of conservation concern (Vulnerable) that was recorded within rocky grasslands and it was considered likely that four additional species of conservation concern could occur here (one Vulnerable, two Near Threatened and one Declining species). The rocky grassland is therefore considered to have high ecological sensitivity.

### **Grassland**

There are small areas of grassland on site that occurs on deeper soils without any surface rock. The largest area of such grassland is in the western side of the site against the road (Figure 3). The vegetation is a tall grassland dominated by the thatching grass, *Hyparrhenia hirta*. Plant species occurring commonly in these areas include the grasses *Eragrostis chloromelas*, *Melinis repens*, *Heteropogon contortus*, *Cynodon dactylon* and *Hyparrhenia hirta* and the forbs, *Ledebouria revoluta*, *Eriospermum porphyrovalve*, *Felicia muricata*, *Polygala hottentotta*, *Helichrysum nudifolium*, *Helichrysum rugulosum*, *Wahlenbergia undulata*, *Walafrida densiflora*, *Conyza podocephala*, *Nidorella anomala*, *Justicia anagalloides* and *Commelina africana*. The species richness is low for grasslands at 14 species per 100m<sup>2</sup>. These grasslands appear to have been disturbed in the past and are located adjacent to a public road. Some of the species are indicators of disturbance.

There were no plant species of conservation concern recorded within grasslands and it was considered unlikely that species of conservation concern could occur here. This grassland is therefore considered to have medium ecological sensitivity. It is, however, representative of



**Figure 4: Rocky grassland on site.**

an Endangered vegetation type, protected under provincial and National legislation and policies.

### **Wetlands and riparian**

There is a drainage line running from south to north through the site. This contains wetland vegetation, but is also severely invaded by alien trees, especially *Acacia mearnsii*. There is also a small wetland area in the western side of the site. This is a seasonal to temporary wetland that contains grassland vegetation. Some common species recorded in this area includes *Verbena bonariensis*, *Hyparrhenia hirta*, *Eragrostis curvula*, *Melinis repens* and *Setaria sphacelata*. The wetland areas are hydrologically important areas protected according to the National Water Act. The wetlands on and adjacent to the site are therefore considered to have high conservation importance and sensitivity.

### **Degraded grassland**

Where there is local disturbance of sufficient proportions, the natural grassland has been altered to a degraded form dominated by weeds and perennial species that are able to tolerate the disturbance. Such grasslands are found in various large patches on site (Figure 3), but also in small patches in localised areas. Some common species recorded in this area includes *Hyparrhenia hirta*, *Eragrostis curvula*, *Cyperus esculentus*, *Walafrida densiflora*, *Heteropogon contortus*, *Cynodon dactylon*, *Eriospermum tenellum*, *Albuca* species, *Felicia muricata* and *Conyza podocephala*.

### **Floristic gradients**

There were two reasons to determine floristic gradients on site: firstly, to evaluate whether grasslands on site are typical of rocky outcrops or of plains grassland (Soweto Highveld Grassland) and secondly, to determine the relative condition of grasslands on site. Multivariate statistical analysis tools were used to classify the site data and to evaluate the relative similarity of sites to one another with respect to floristic composition.

A classification of the site data (Appendix 3) indicated that most of the grasslands on site belong to a single plant community (called "Rocky grassland"). Sites within areas mapped as "Rocky areas" are distinct and areas mapped as "Grassland" are distinct, although they are lumped with "Disturbed grassland". The greatest significance of this finding is that the Rocky grasslands on the flat areas and on the ridge are both considered to be part of a single plant community.

An ordination of the site data places sites in proximity to one another according to their floristic similarity. From this it is possible to interpret gradients of floristic change. An ordination scattergram is given in Appendix 4. The first ordination axis represents the biggest gradient in the floristic data. For the current data set, it represents a disturbance gradient. The second axis is linked to a suite of habitat differences. The significance of this finding is that it indicates that disturbed grassland and natural grassland are distinct from one another in terms of floristic composition and that most of the grasslands on site are in moderately good condition.

### **Flora of the study area**

All plant species found during the survey in remaining natural areas are listed in Appendix 2. Due to the fact that the fieldwork component of this survey lacked seasonal coverage, the species list provided is unlikely to be comprehensive, but nevertheless provide a good

indication of the species diversity and composition of the study area. In the species list (Appendix 2) all exotic species are indicated by an asterisk.

Species richness in the grassland vegetation of the study area is relatively high. A total of 105 species were recorded on the site during the brief survey, 6 of which are exotic and an additional 9 of which are declared weeds or invader plants. The proportion of naturalized exotic and invader species is low (14%) despite the high levels of disturbance of the habitat of some parts of the site.

The declared weeds or alien invader species, according to the Conservation of Agricultural Resources Act (Act No.43 of 1983) are *Pennisetum clandestinum*\* *Agave americana* (proposed declared invaders), *Acacia mearnsii*\*, *Argemone ochroleuca*\*, *Datura ferox*\*, *Opuntia ficus-indica*\* and *Solanum sisymbriifolium*\* (Declared weeds category 1) and *Eucalyptus* species\* and *Melia azeradach*\*.

### Red List Plant Species

There are 21 Red or Orange List plant species that have been recorded from the quarter degree grids in which the study site is situated. These 21 species are listed in Appendix 1 together with their conservation status categories according to the IUCN Version 3.1 criteria (IUCN, 2001) and relevant information, such as habitat and flowering time.

**Table 3: Explanation of IUCN Ver. 3.1 categories (IUCN, 2001), and Orange List categories (Victor & Keith, 2004).**

IUCN category	Definition	Class
EX	Extinct	Extinct
CR	Critically Endangered	Threatened
EN	Endangered	Threatened
VU	Vulnerable	Threatened
NT	Near Threatened	Orange List
LC (Declining)	Least Concern, declining taxa	Orange List
LC (Rare)	Least Concern, rare	Orange List
LC (Critically Rare)	Least Concern, rare: only one subpopulation	Orange List
LC (Rare-Sparse)	Least Concern, rare: widely distributed but rare	Orange List
DDD	Data Deficient: well known but not enough information for assessment	Orange List
DDT	Data Deficient: taxonomic problems	Data Deficient
DDX	Data Deficient: unknown species	Data Deficient
LC	Least Concern	Least Concern

Of these 21 species, nine were considered to have a high chance of occurring in the type of habitats available on site and one species was found on site (see Appendix 1). One of the nine species that could occur on site is classified as Endangered, two as Vulnerable, three as Near Threatened and three as Declining (see Table 3 for explanation of categories). The site is therefore considered to have habitat suitable for a number of species of conservation concern.

According to the GDACE Threatened Species Policy, there are three basic rules of conservation that apply to populations of Red List Plant Species, as follows:

1. All populations of Near Threatened and Threatened plant taxa must be conserved *in situ*, i.e. on site where they currently occur.
2. All populations of Near Threatened and Threatened plant taxa must be protected with a buffer zone in accordance with guidelines as set out in the Policy.

3. An Ecological Management Plan must be compiled in respect of all actions that affect populations of Red List Plant Species, and such Ecological Management Plans must conform to the Guidelines.

For the species found on site (*Khadia beswickii*), these guidelines apply.

### **Sensitivity assessment**

The sensitivity assessment is an attempt to identify those parts of the study area that may have high conservation value or that may be sensitive to disturbance. Areas containing untransformed natural vegetation, high diversity or habitat complexity, Red List organisms or systems vital to sustaining ecological functions are considered sensitive. In contrast, any transformed area that has no importance for the functioning of ecosystems is considered to have low sensitivity. Information from GDACE's C-Plan version 2 in conjunction with observations made in the field was used to locate potentially sensitive features.

According to C-plan version 2 (GDACE 2006) portions of the site are classified as "Irreplaceable" due to the presence of the following:

1. primary vegetation,
2. Red or Orange List confirmed location,
3. Red or Orange List plant historical location,
4. Habitat important for Red or Orange Data plant metapopulation dynamics.

There are additional features that need to be taken into account in order to evaluate sensitivity of the site and its surroundings. These include the following:

1. Wetlands and riparian areas: There is one small wetland in the central western part of the site and a non-perennial stream running from south to north through the centre of the site. The wetlands and riparian areas are classified by GDACE as important ecological process surrogates. The ecological process surrogates are groundwater dynamics, hydrological processes, nutrient cycling and wildlife dispersal. The wetlands are also protected according to the National Water Act.
2. Sensitive vegetation: identification of the vegetation on site as belonging to a highly threatened ecosystem; the terrestrial vegetation on site is Soweto Highveld Grassland, classified as an Endangered ecosystem due to high rates of transformation across its geographic range. Soweto Highveld Grassland has high conservation priority with none conserved and more than 45% transformed. Any natural grassland on site would therefore be considered to have elevated conservation status. Threatened ecosystems are protected according to the National Biodiversity Act.
3. Regional plans: The Johannesburg Metropolitan Open Space System (JMOSS), a component of their Integrated Development Plan (IDP), identifies all sites that constitute priority conservation area within the Metropolitan Municipality area. According to the Johannesburg IDP and JMOSS, the site is classified as a "Protected Area" and should not, therefore, be developed.
4. Centres of Endemism: The study site is not close to any of the Centres of Plant Endemism (van Wyk & Smith 2001).



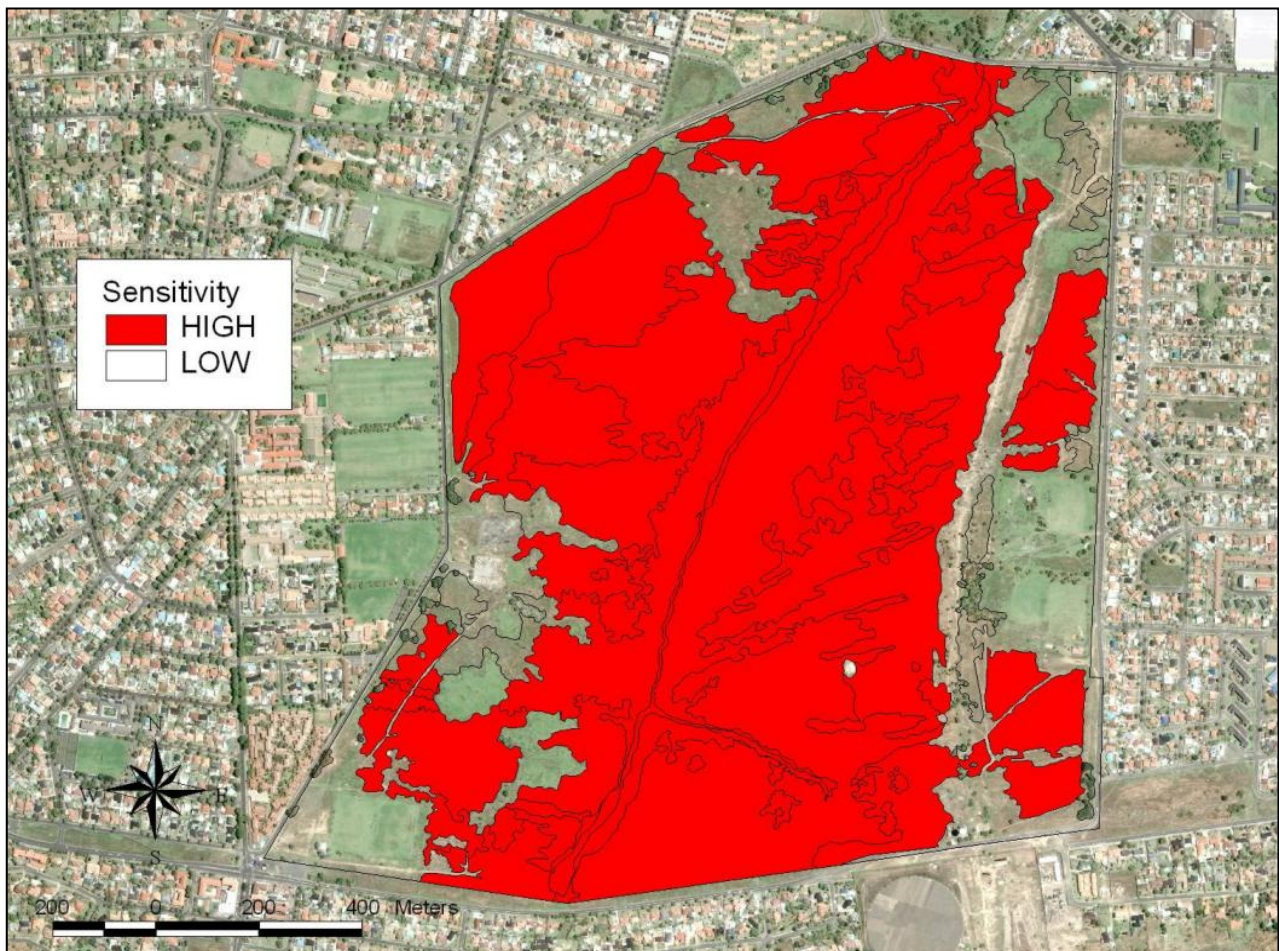
Additional requirements, as per GDACE Departmental policies and other environmental legislation are as follows:

1. The GDACE "Requirements for Biodiversity Assessments" stipulate that all untransformed grasslands have to be classified as having high sensitivity.

The information, as described above, was used to compile the sensitivity map (Figure 6). On the basis of current information and the requirements of all the above guidelines, policies and Acts, **73.4%** (145.5 ha) of the site is classified as having **HIGH** sensitivity. A summary of the factors used to classify the different habitats is given in Table 4.

**Table 4: Factors contributing to sensitivity classification of different habitats on site.**

Vegetation/habitat type	Sensitivity	Reason
Wetlands	High	<ul style="list-style-type: none"> <li>wetlands in main drainage line classified as seasonal wetlands (National Water Act). Any activities within this area are limited by and governed by the National Water Act.</li> <li>Classified as sensitive according to GDACE "Requirements for Biodiversity Assessments: Sensitivity mapping rules."</li> </ul>
Riparian areas	High	<ul style="list-style-type: none"> <li>Classified as riparian areas according to the National Water Act. Any activities within this area are limited by and governed by the National Water Act.</li> <li>Classified as sensitive according to GDACE "Requirements for Biodiversity Assessments: Sensitivity mapping rules."</li> </ul>



**Figure 6: Sensitive vegetation features on site.**



Rocky areas	High	<ul style="list-style-type: none"> <li>Ecologically part of ridge environment</li> <li>According to GDACE "Requirements for Biodiversity Assessments: Sensitivity mapping rules." all good condition natural vegetation must be mapped and designated as sensitive.</li> <li>Habitat suitable for a number of Red or Orange List plant species.</li> </ul>
Rocky grassland	High	<ul style="list-style-type: none"> <li>According to GDACE "Requirements for Biodiversity Assessments: Sensitivity mapping rules." all primary grassland (even if it is in poor/degraded condition) must be mapped and designated as sensitive.</li> <li>Habitat suitable for a number of Red or Orange List plant species, including one species classified as "Vulnerable", which was found on site.</li> <li>Part of a vegetation type (Soweto Highveld Grassland) classified as Endangered (Mucina et al. 2006) or Vulnerable (Draft Ecosystem List, National Environmental Management: Biodiversity Act).</li> </ul>
Grassland	High	<ul style="list-style-type: none"> <li>According to GDACE "Requirements for Biodiversity Assessments: Sensitivity mapping rules." all primary grassland (even if it is in poor/degraded condition) must be mapped and designated as sensitive.</li> <li>Habitat suitable for a number of Red or Orange List plant species.</li> <li>Part of a vegetation type (Soweto Highveld Grassland) classified as Endangered (Mucina et al. 2006) or Vulnerable (Draft Ecosystem List, National Environmental Management: Biodiversity Act).</li> </ul>
Ridge	High	<ul style="list-style-type: none"> <li>According to GDACE "Requirements for Biodiversity Assessments: Sensitivity mapping rules." all ridges, as delimited by GDACE, must be designated as sensitive. Development on ridges is limited according to the GDACE "Ridges Policy".</li> </ul>
Populations of Red List plant species	High	<ul style="list-style-type: none"> <li>According to GDACE "Requirements for Biodiversity Assessments: Sensitivity mapping rules." the entire area occupied by populations of Red List and Orange List plant species must be designated as sensitive. Habitats in which Red or Orange List plant species occur are protected according to GDACE "Threatened species policy" and the National Environmental Management: Biodiversity Act. At least one Vulnerable plant species was found on site and there is a high chance of occurrence of 4 other Red List plant species.</li> </ul>
Protected areas	High	<ul style="list-style-type: none"> <li>According to the City of Johannesburg Metropolitan Open Space System, the site is classified as a "Protected Area".</li> </ul>

Buffer zones for sensitive areas are according to "GDACE Requirements for Biodiversity Assessments Version 2, February 2009". The following features that occur on or adjacent to the site were taken into account in determining buffer zones from the sensitivity map:

1. Wetlands (including pans): Wetlands are considered to be sensitive according to GDACE and according to the National Water Act. The GDACE document is quoted, as follows:
  - "The wetland and a protective buffer zone, beginning from the outer edge of the wetland temporary zone, must be designated as sensitive. Rules for buffer zone widths are as follows:*
    - **30m** for wetlands occurring inside the urban edge"
    - **50m** for wetlands occurring outside the urban edge"
2. Riparian areas: Riparian areas are considered to be sensitive according to GDACE and according to the National Water Act. The GDACE document is quoted, as follows:
  - "Riparian zones and buffer zones must be designated as sensitive". Rules for buffer zone widths are as follows:
    - **32m** for riparian areas occurring inside the urban edge.
    - **100m** for riparian areas occurring outside the urban edge.

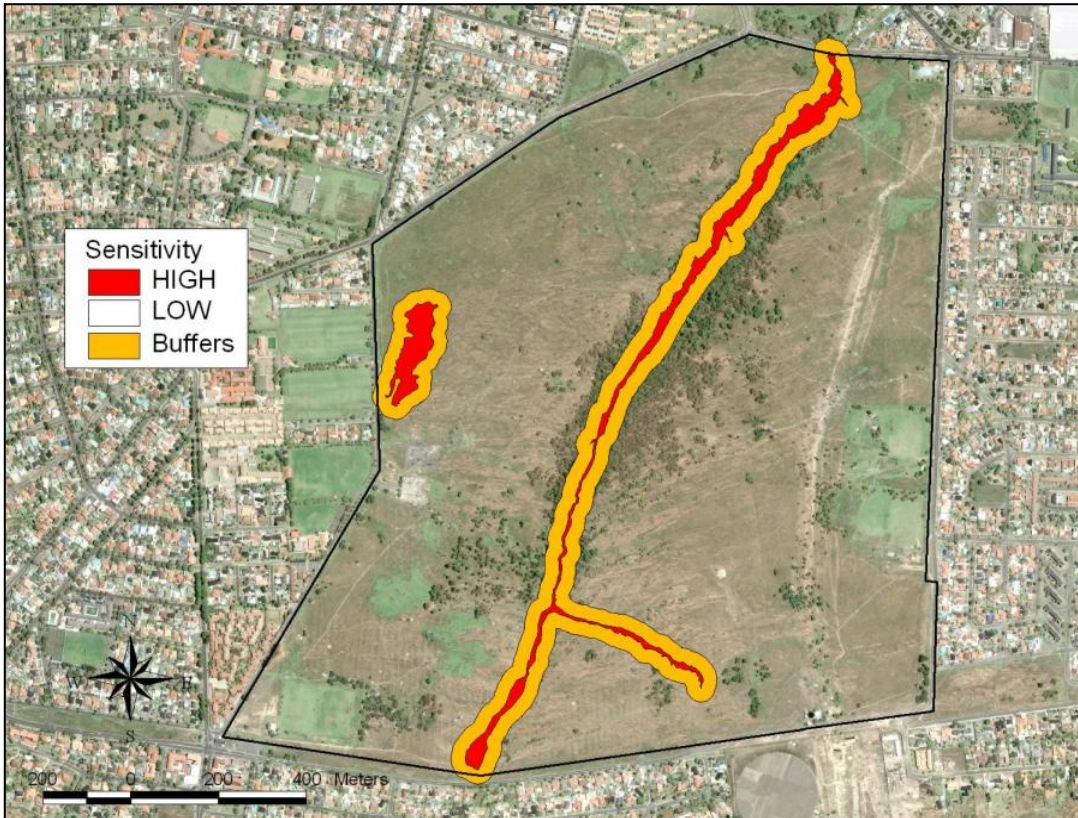
3. Grassland: Grasslands are considered to be sensitive according to GDACE and according to the National Environmental Management: Biodiversity Act. The GDACE document is quoted, as follows: "*all primary grassland (even if it is in poor/degraded condition) must be mapped and designated as sensitive*". Rules for buffer zone widths are as follows:
  - at least **200m**.
4. Ridges: Ridges areas are considered to be sensitive according to GDACE. The GDACE document is quoted, as follows: "*All ridges must be designated as sensitive*" and "*Where the interface between the lower slopes and adjacent land is deemed important for certain species (e.g. important/rare invertebrates), a buffer zone of 200m must be mapped and designated as sensitive.*" Rules for buffer zone widths are as follows:
  - **200m** buffer zone for Class 3 ridges containing habitat suitable for important/rare species must be designated as sensitive.
5. Red List plants: If any Red List plant populations occur on site, these would have to be mapped and buffer zones provided around them. According to GDACE the buffer zones required are "200m for Red List and Orange List plant populations occurring within urban areas". One Red List plant species was found on site during this survey. It is considered likely that other Red List plant populations could occur on site.

The wetland and riparian sensitive areas and required buffers are shown in Figure 7.

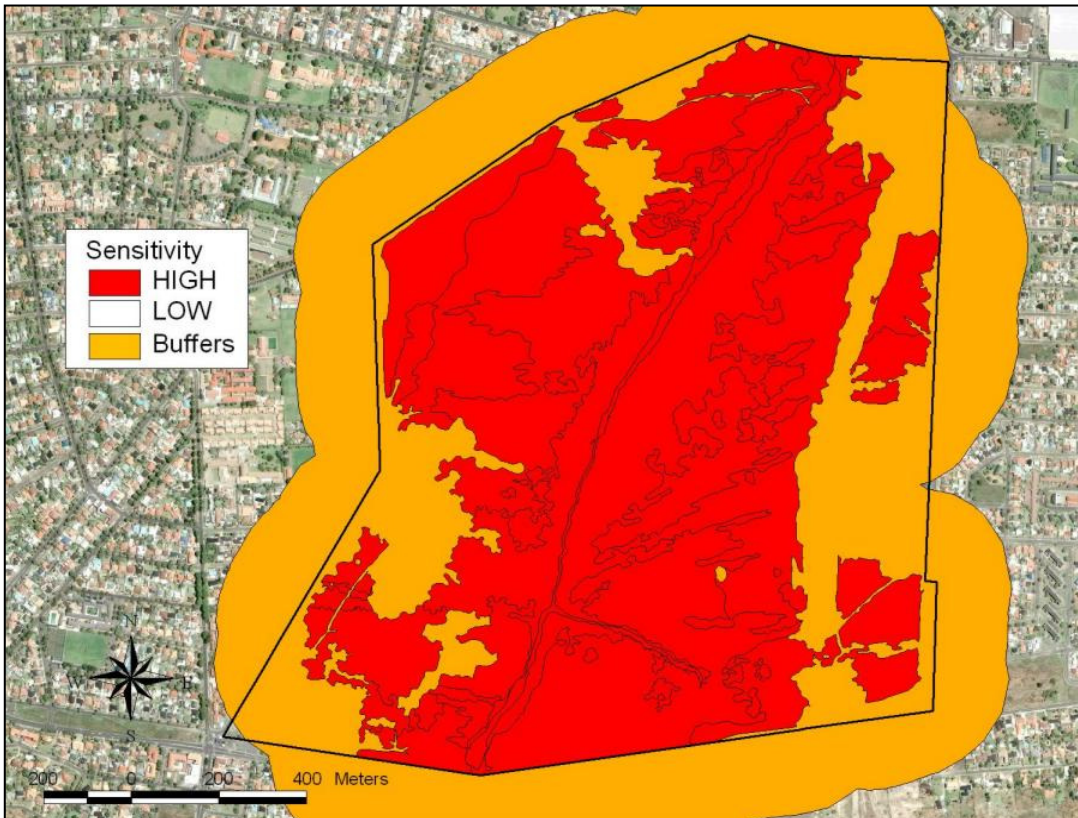
The sensitive habitats and required buffers are shown in Figure 8.

Ridges and required buffers are shown in Figure 9.

The location of Red List plants and required buffers are shown in Figure 10. Note that this is a preliminary map awaiting field confirmation of the extent of the population of the Red List species.

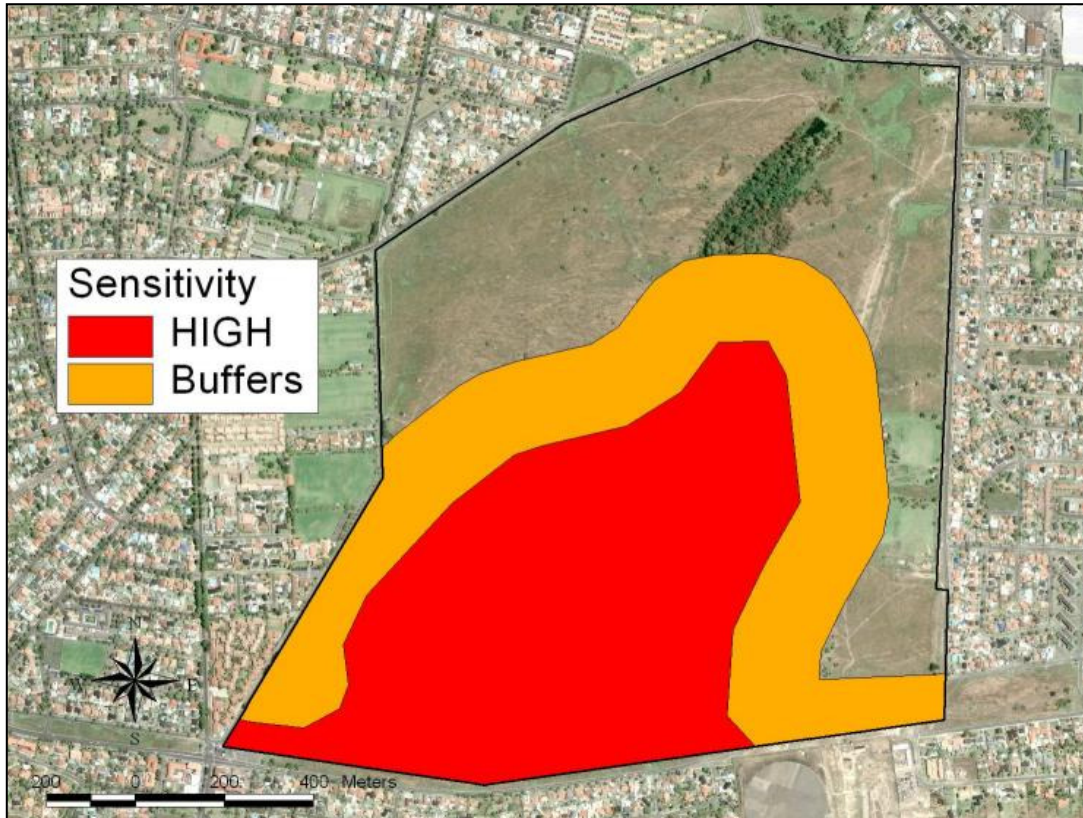


**Figure 7: Sensitive wetland and riparian features on site with required buffers shown.**

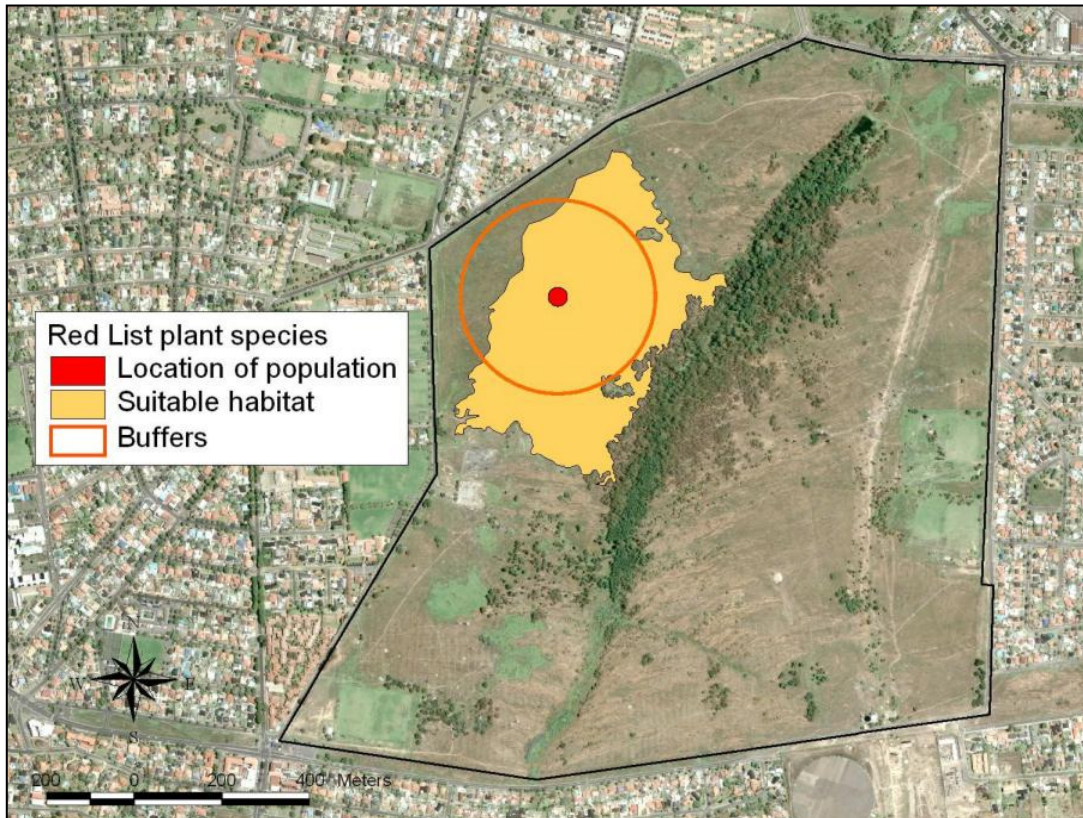


**Figure 8: Sensitive habitat features on site with required buffers shown.**





**Figure 9: Sensitive ridge features on site with required buffers shown.**



**Figure 10: Populations of Red List plant species on site with required buffers and suitable habitat for metapopulation dynamics shown.**

## DISCUSSION AND CONCLUSIONS

Most of the site is in a natural state, although there are various factors that have caused transformation or degradation of parts of the site. Most of the area surrounding the site consists of urban suburbs. There is a list of sensitive features on site, including the following:

1. Ridge
2. Wetlands and riparian areas
3. Red and Orange List plant
4. Threatened ecosystem (Soweto Highveld Grassland)
5. Protected area (JMOSS).

From a vegetation point of view, the site is therefore considered to have high sensitivity. According to GDACE Policy, predetermined buffer zones are required around sensitive features. These required buffer zones are shown in Figures 7-10 and constitute areas that GDACE would require to not be developed. This covers most of the site. Some parts of the site are sensitive for multiple reasons.

The grasslands on the lowlands of the site are floristically indistinguishable from grasslands on the ridge. These are mapped as Rocky grassland in Figure 3. According to the vegetation map of South African vegetation, the grasslands on site belong to a threatened ecosystem, Soweto Highveld Grassland. This vegetation is protected under GDARD policies as well as under the National Environmental Management: Biodiversity Act (Act No. 10, 2004).

In terms of legislation, wetlands and riparian areas are defined in the Water Act as a water resource and any activities that are contemplated that could affect the wetlands or riparian areas requires authorisation (Section 21 of the National Water Act of 1998). In addition they are also regarded as sensitive habitats in the National Environmental Management Act implying that they are afforded a higher level of protection. Once delineated, these wetland and riparian areas must be considered to be sensitive and suitable buffer zones are required around them to protect them from development impacts. In terms of the GDACE requirements, within the urban edge 30m beyond the wetland boundaries must be reserved as a buffer zone (as shown in Figure 7), the wetland areas and associated buffer zones must be designated as sensitive areas and must be excluded from the development.

One Red List plant species was found on site. It is also considered likely that any one or more of another nine Red or Orange List plant species could occur on site. For the species found on site, the GDARD Threatened Species Policy requires three basic rules of conservation to be applied, as follows:

1. All populations of Near Threatened and Threatened plant taxa must be conserved *in situ*, i.e. on site where they currently occur. These plants may not be moved or disturbed by any activities on site.
2. All populations of Near Threatened and Threatened plant taxa must be protected with a buffer zone in accordance with guidelines as set out in the Policy. For the species found on site, this buffer zone is set at 200 m.
3. An Ecological Management Plan must be compiled in respect of all actions that affect populations of Red List Plant Species, which must conform to the Guidelines.

There are an additional nine Red or Orange List plant species that may occur in the types of habitats that are found on site. Although the current survey was undertaken during their flowering season, none of these species were found on site and it may be necessary to undertake a follow-up survey to confirm whether they occur there or not.



From a vegetation and threatened plant species point of view, it is not recommended that development be permitted on this site. This is based on the multiple sensitivities on site, including the presence of sensitive vegetation (grassland), the confirmed presence of Red List plant populations, the possible presence of additional Red or Orange List plant species, the presence of wetlands and riparian areas and the location of a significant portion of the site within a ridge. The site is also protected according to the City of Johannesburg Metropolitan Open Space System (JMOSS) — if the objectives of the City’s Development Framework are to be taken seriously then the JMOSS should not be compromised for development expediency. The site is also one of the last remaining natural open spaces in this area — it should be properly fenced, cleared of aliens, degraded areas rehabilitated, proper access control put in place and treated with the respect of a rare natural asset.

Recommendations are provided below for specific actions that need to be taken to improve the sensitivity assessment of the site or to comply with specific legislation. These are provided in the following section.

## RECOMMENDATIONS

The following is recommended:

- Follow-up surveys may be required to search for nine Red or Orange List plant species that were not in flower at the time of this survey or which were not detected during the current brief survey. This includes *Cineraria austrotransvaalensis* (March to June), *Cineraria longipes* (March to May), *Eulophia coddii* (December) and *Holothrix micrantha* (October).
- According to the Conservation of Agricultural Resources Act (Act No. 43 of 1983), all declared aliens that occur on the property must be effectively controlled. In terms of this Act 198 alien species were listed as declared weeds and invaders and ascribed to one of the following categories:
  - **Category 1:** Prohibited and must be controlled.
  - **Category 2** (commercially used plants): May be grown in demarcated areas provided that there is a permit and that steps are taken to prevent their spread.
  - **Category 3** (ornamentally used plants): May no longer be planted. Existing plants may be retained as long as all reasonable steps are taken to prevent the spreading thereof, except within the flood line of watercourses and wetlands.

The declared aliens that occur on site are listed in Appendix 1.

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**Appendix 1: Red / Orange List plant species recorded within the quarter degree within which the study area is situated, namely 2628AA and 2628AC.**

Taxon	Latest (IUCN version 3.1) Threat Status*	Habitat	Flowering Time	Probability of occurrence <sup>3</sup>	Priority rating
<i>Adromischus umbraticola</i> subsp. <i>umbraticola</i>	NT	Rock crevices on rocky ridges, usually south-facing, or in shallow gravel on top of rocks, but often in shade of other vegetation.	Sep-Jan	<b>HIGH</b>	A2
<i>Argyrolobium campicola</i>	NT	Highveld grassland	Nov-Feb	MEDIUM	A3
<i>Bowiea volubilis</i>	LC (Declining)	Shady places, steep rocky slopes and in open woodland, under large boulders in bush or low forest.	Sep-Apr	<b>HIGH</b>	n/a
<i>Callilepis leptophylla</i>	LC (Declining)	Grassland or open woodland, often on rocky outcrops or rocky hillslopes.	Aug-Jan & May	<b>HIGH</b>	n/a
<i>Cineraria austrotransvaalensis</i>	NT	Amongst rocks on steep slopes of hills and ridges, as well as at the edge of thick bush or under trees; on all aspects and on a range of rock types: quartzite, dolomite and shale; 1400 – 1700 m.	Mar-Jun	<b>HIGH</b>	A3
<i>Cineraria longipes</i>	VU	Koppies to the south of Johannesburg, amongst rocks and along seep lines in association with <i>Pteridium</i> .	Mar-May	<b>HIGH</b> although most drainage lines are heavily infested with alien trees	A1
<i>Delosperma leendertziae</i>	NT	Rocky ridges; on rather steep south facing slopes of quartzite in mountain grassveld.	Oct-Apr	LOW, slopes all north-facing	A2
<i>Delosperma purpureum</i>	EN	South facing slopes, grows in shallow soils among quartzitic rocks of crystalline or conglomerate type, in open or in broken shade, rarely in shade, in grassland with some trees.	Nov-Apr	LOW, slopes all north-facing	A1
<i>Dioscorea sylvatica</i>	VU	Wooded places with fair to reasonably good rainfall, such as the moister bushveld areas, coastal bush and wooded mountain kloofs.	Oct-Jan	MEDIUM	B
<i>Eucomis autumnalis</i> subsp. <i>clavata</i>	LC (Declining)	Open grassland, marshes.	Nov-Apr	LOW	n/a
<i>Eulophia coddii</i>	VU	Steep hillsides on soil derived from sandstone; grassland or mixed bush.	Dec	<b>HIGH</b>	A2
<i>Gunnera perpensa</i>	LC (Declining)	In cold or cool, continually moist localities, mainly along upland streambanks.	Oct-Mar	<b>HIGH</b> although most drainage lines are heavily infested with alien trees	n/a
<i>Habenaria bicolor</i>	NT	Terrestrial in drained grassland, recorded from about 1800m	Jan-Mar	LOW	B
<i>Habenaria mossii</i>	EN	Open grassland on dolomite or in black sandy soil.	Mar-Apr	LOW	A1
<i>Holothrix micrantha</i>	EN	Terrestrial on grassy cliffs, recorded from 1500 to 1800m. SNR.	Oct	<b>HIGH</b>	A1
<i>Holothrix randii</i>	NT	Grassy slopes and rock ledges, usually southern aspects.	Sep-Jan	<b>HIGH</b>	B
<i>Hypoxis hemerocallidea</i>	LC (declining)	Grassland and mixed woodland. Often observed adjacent to marsh wetlands in hillslope seepage areas.	Sep-Mar	MEDIUM	n/a
<i>Khadia beswickii</i>	VU	Open areas on shallow surfaces above rocks in grassland.	Jul-Mar	<b>DEFINITE</b> , found on site	A1

<b>Taxon</b>	<b>Latest (IUCN version 3.1) Threat Status*</b>	<b>Habitat</b>	<b>Flowering Time</b>	<b>Probability of occurrence<sup>3</sup></b>	<b>Priority rating</b>
<i>Lithops lesliei</i> subsp. <i>lesliei</i>	NT	Primary habitat appears to be the arid grasslands in the interior of South Africa where it usually occurs in rocky places, growing under the protection of surrounding forbs and grasses.	Mar-Jun	MEDIUM	B
<i>Stenostelma umbellifera</i>	NT	Deep black turf in open woodland mainly in the vicinity of drainage lines.	Sep-Mar	LOW	A3
<i>Trachyandra erythrorrhiza</i>	NT	Marshy areas, grassland, usually in black turf marshes.	Sep-Nov	LOW	A3

\*\* Status according to GDACE list of Red and Orange list plants.

\*Probability of occurrence, as follows: LOW – no suitable habitats occur on site / habitats on site do not match habitat description for species, MEDIUM – habitats on site match general habitat description for species (e.g. grassland), but microhabitat requirements are absent (e.g. rocky grassland on shallow soils overlying dolomite), HIGH – habitats on site match very strongly the general and microhabitat description for the species, DEFINITE – species found on site.



## Appendix 2: Provisional checklist of plant species found on the site

Acacia karroo	Hyparrhenia hirta
Albuca species	Hypoxis iridifolia
Alloteropsis semialata ssp. eckloniana	Indigofera melanadenia
Aloe greatheadii var. davyana	Indigofera species
Aristida junciformis	Justicia anagalloides
Asclepias species	Khadia acutipetala
Bidens pilosa	Khadia beswickii
Brachiaria serrata	Kohautia amatymbica
Bulbine narcissifolia	Kohautia virgata
Bulbostylis burchellii	Lactuca inermis*
Canthium gilfillanii	Ledebouria ovatifolia
Chenopodium album	Ledebouria revoluta
Commelina africana	Ledebouria species
Conyza canadensis*	Lepidium africanum
Conyza podocephala	Lotononis listii
Crassula lanceolata ssp. transvaalensis	Loudetia simplex
Crassula setulosa	Manulea parviflora
Craterostigma wilmsii	Melinis repens
Cyanotis speciosa	Microchloa caffra
Cynodon dactylon	Monsonia angustifolia
Cyperus esculentus var. esculentus*	Nemesia fruticans
Cyperus rupestris	Nidorella anomala
Dianthus basuticus	Nidorella hottentotica
Dicoma anomala	Oldenlandia herbacea
Digitaria eriantha	Pearsonia sessilifolia
Digitaria monodactyla	Pollichia campestris
Diheteropogon filifolius	Polygala hottentotta
Diospyros lycioides	Psammotropha mucronata
Dipcadi ciliare	Pygmaeothamnus zeyheri
Elephantorrhiza elephantina	Rhus magalismontana
Elionurus muticus	Scabiosa columbaria
Eragrostis chloromelas	Schizachyrium sanguineum
Eragrostis curvula	Selaginella dregei
Eragrostis gummiflua	Senecio inaequidens
Eragrostis racemosa	Setaria sphacelata var. torta
Eriosema species	Solanum species
Eriospermum porphyrovalve	Sporobolus ioclados
Euryops laxus	Stoebe vulgaris
Felicia muricata	Tagetes minuta*
Gazania krebsiana ssp. serrulata	Themeda triandra
Gomphrena celosioides*	Thesium magalismontanum
Harpochloa falx	Trachypogon spicatus
Helichrysum caespititium	Tristachya rehmannii
Helichrysum callicomum	Ursinia nana
Helichrysum nudifolium	Verbena bonariensis*
Helichrysum rugulosum	Vernonia galpinii
Hemizygia pretoriae	Wahlenbergia undulata
Heteropogon contortus	Walafrida densiflora

Declared weeds and invader plants found on site:

Acacia mearnsii*	(Declared weed category 1)
Agave americana s. americana v. am*	(Proposed declared weed)
Argemone ochroleuca ssp. ochroleuca*	(Declared weed category 1)
Datura ferox*	(Declared weed category 1)
Eucalyptus species*	(Declared invader category 2)
Melia azedarach*	(Declared invader category 2)
Opuntia ficus-indica*	(Declared weed category 1)
Pennisetum clandestinum*	(Proposed declared weed)
Solanum sisymbriifolium*	(Declared weed category 1)

### Appendix 3: Classification of floristic sample sites

Site no.	6 923481 57
Brachiaria serrata	- -434-- -2
Cyanotis speciosa	- 222222 -2
Digitaria monodactyla	- 242322 --
Bulbostylis burchellii	- 2333-2 --
Microchloa caffra	- -22322 --
Diheteropogon filifolius	- -34--- --
Gazania krebsiana	- 22---- --
Helichrysum caespititium	- -22-22 --
Hemizygia pretoriae	- -222-2 --
Indigofera meladenia	- -22--- --
Khadia beswickii	- 3----- --
Themeda triandra	- -33--- --
Tristachya rehmannii	- -23--- --
Asclepias species	- 2----2 --
Bulbine narcissifolia	- -2-2-2 --
Dianthus basuticus	- -2---2 --
Digitaria erianthe	- --2-22 --
Eucalyptus species	- ---2-2 --
Helichrysum callicomum	- --2-22 --
Ledebouria ovatifolia	- ---2-2 --
Melia azeradach	- -2---2 --
Nidorella hottentotta	- ---2-2 --
Pearsonia sessiflifolia	- -3-3-4 --
Psammotropha myriantha	- 2----2 --
Pygmaeothamnus zeyheri	- -2-2-2 --
Scabiosa columbaria	- ---2-2 --
Trachypogon spicatus	- -2---3 --
Ursinia nana	- ---222 --
Vernonia galpinii	- -2---2 --
Aristida junciformis	4 555442 --
Sporobolus iocladius	3 432222 --
Eragrostis racemosa	2 354332 --
Selaginella dregei	4 222-22 --
Khadia acutipetala	2 222223 --
Crassula setulosa	2 222-22 --
Lotononis listii	2 -22--- --
Manulea parviflora	2 --2-3- --
Oldenlandia herbacea	2 2----2 --
Schizachyrium sanguineum	2 5--2-2 --
Canthium gilfillanii	3 ----- --
Craterostigma wilmsii	3 ----- --
Rhus magalismsontanum	3 ----- --
Cyperus rupestris	2 222233 -2
Eragrostis chloromelas	2 446556 5-
Melinis repens	3 323444 22
Eriospermum porphyrovalve	2 22222- 22
Kohautia amatymbica	- -22222 2-
Stoebe vulgaris	- 322233 3-
Ledebouria revoluta	- -23233 23
Felicia muricata	- -33222 43

Hyparrhenia hirta	- -32232 55
Heteropogon contortus	- --32-2 54
Eragrostis curvula	- 2--3-4 -6
Acacia mearnsii	- -2-2-2 -2
Nemesia fruticans	- --2-2- -2
Aloe greatheadii	- -----2 -2
Argemone ochroleuca	- -----2 -2
Chenopodium album	- -----2 -2
Albuca species	- -----2- 23
Conyza canadensis	- -----2 22
Conyza podocephala	- ----- 23
Wahlenbergia undulata	- ----- 22
Cynodon dactylon	- -----3 44
Cyperu esculentus	- -----2 24
Helichrysum rugulosum	- -----2 52
Justicia anagalloides	- -----2- 22
Nidorella anomala	- -----2- 22
Walafrida densiflora	- -----2 23

**Appendix 4: Ordination of floristic sample sites.**

