FAUNAL, FLORAL AND WETLAND ECOLOGICAL ASSESSMENT AS PART OF THE ENVIRONMENTAL ASSESSMENT AND AUTHORISATION PROCESS FOR A PROPOSED TOWNSHIP DEVELOPMENT IN DIEPSLOOT, GAUTENG PROVINCE

Prepared for

Nali Sustainable Solutions (Pty) Ltd

November 2015

Section B: Floral Assessment

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Report Reference:	**SAS 215271**
Date:	**November 2015**

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1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a faunal and floral ecological investigation as well as an investigation of the wetland resources associated with a proposed township development in Diepsloot, Gauteng Province, hereafter referred to as “study area”. The study area is situated on the Remaining Extent of Portion 6 and Part of the Remaining Extent of Portion 1 of the Farm Diepsloot 388-JR and is located approximately 0,3km south of the Diepsloot Township, and 1,6km east of Steyn City. The study area is further traversed in the northern section by School Road and is located approximately 0,2km west of the R511 and 2,6 km southeast of the N14 highway.

This report, after consideration and description of the ecological integrity of the study area, must guide the Environmental Assessment Practitioner (EAP), authorities and proponent, by means of recommendations, as to the viability of the proposed development from an ecological perspective.

2 GENERAL SITE SURVEY

A field assessment was undertaken during October 2015, in order to determine the ecological status of the study area. A reconnaissance ‘walkabout’ was initially undertaken to determine the general habitat types found throughout the subject property and, following this, specific study sites were selected that were considered to be representative of the habitats found within the area, with special emphasis being placed on areas that may potentially support floral Species of Conservation Concern (SCC). Sites were investigated on foot in order to identify the occurrence of the dominant plant species and habitat diversities.

3 FLORAL ASSESSMENT METHODOLOGY

3.1 Floral Species of Conservation Concern Assessment

Prior to the field visit, a record of floral SCC and their habitat requirements was acquired from the South African National Biodiversity Institute (SANBI) for the Quarter Degree Square (QDS) 2528CC. Throughout the floral assessment, special attention was paid to the

identification of any of these SCC as well as identification of suitable habitat that could potentially sustain these species.

The Probability of Occurrence (POC) for each floral SCC was determined using the following calculations wherein the habitat requirements and habitat disturbance were considered. The accuracy of the calculation is based on the available knowledge about the species in question, with many of the species lacking in-depth habitat research. Therefore, it is important that the literature available is also considered during the calculation.

Each factor contributes an equal value to the calculation.

Literature availability						
	No literature available					**Literature available**
Site score						
EVC 1 score	0	1	2	3	4	5
Habitat availability						
	No habitat available					**Habitat available**
Site score						
EVC 1 score	0	1	2	3	4	5
Habitat disturbance						
	0	**Very low**	**Low**	**Moderate**	**High**	**Very high**
Site score						
EVC 1 score	5	4	3	2	1	0

[Literature availability + Habitat availability + Habitat disturbance] / 15 x 100 = POC%

3.2 Vegetation Surveys

Vegetation surveys were undertaken by first identifying different habitat units and then analysing the floral species composition. Vegetation analyses were conducted within areas that were perceived to best represent the various floral communities. Species were recorded and a species list was compiled for each habitat unit. These species lists were also compared with the vegetation expected to be found within the relevant vegetation type as described in Section A, which serves to provide an accurate indication of the ecological integrity and conservational value of each habitat unit.

3.3 Vegetation Index Score

The Vegetation Index Score (VIS) was designed to determine the ecological state of each habitat unit defined within an assessment site. This enables an accurate and consistent description of the Present Ecological State (PES) concerning the study area in question. The information gathered during the assessment also contributes towards the sensitivity mapping, leading to a more truthful representation of ecological value and sensitive habitats.

Each defined habitat unit is assessed using separate data sheets (Appendix A) and all the information gathered then contributes to the final VIS score. The VIS is derived using the following formulas:

VIS = [(EVC) + (SI x PVC) + (RIS)]

Where:

1. **EVC** is extent of vegetation cover;
2. **SI** is structural intactness;
3. **PVC** is percentage cover of indigenous species and
4. **RIS** is recruitment of indigenous species.

Each of these contributing factors is individually calculated as discussed below. All scores and tables indicated in blue are used in the final score calculation for each contributing factor.

1. EVC=[(EVC1+EVC2)/2]

EVC 1 - Percentage natural vegetation cover						
Vegetation cover %	**0%**	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Site score						
EVC 1 score	0	1	2	3	4	5
EVC 2 – Total site disturbance						
Disturbance score	**0**	**Very low**	**Low**	**Moderate**	**High**	**Very high**
Site score						
EVC 2 score	5	4	3	2	1	0

2. SI=(SI1+SI2+SI3+SI4)/4)

	Trees (S1)		**Shrubs (S2)**		**Forbs (S3)**		**Grasses (S4)**	
Score	Present state	Perceived reference state	Present state	Perceived reference state	Present state	Perceived reference state	Present state	Perceived reference state
Continuous								
Clumped								
Scattered								
Sparse								

*Present State = currently applicable for each habitat unit

*Perceived Reference State = if in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived reference state (PRS)	**Continuous**	**Clumped**	**Scattered**	**Sparse**
Continuous	3	2	1	0
Clumped	2	3	2	1

Scattered	1	2	3	2
Sparse	0	1	2	3

3. ***PVC=[(EVC)-(exotic x 0.7) + (bare ground x 0.3)]***

Percentage vegetation cover (exotic)						
	0%	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Vegetation cover %						
PVC score	0	1	2	3	4	5
Percentage vegetation cover (bare ground)						
	0%	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Vegetation cover %						
PVC score	0	1	2	3	4	5

4. ***RIS***

Extent of indigenous species recruitment	**0**	**Very low**	**Low**	**Moderate**	**High**	**Very high**
RIS						
RIS Score	0	1	2	3	4	5

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely

3.4 Sensitivity Mapping

All the ecological features of the study area were considered and sensitive areas were delineated with the use of a Global Positioning System (GPS). In addition identified locations of protected species were also marked by means of GPS. A Geographic Information System (GIS) was used to project these features onto aerial photographs and topographic maps. The sensitivity map should guide the design and layout of the proposed development.

4 RESULTS OF FLORAL ASSESSMENT

During the field assessment, a number of habitat units were identified, namely the Impacted Grassland Habitat Unit, the Wetland Habitat Unit and the Rocky Ridge Habitat Unit. These habitat units are described in the sections below.

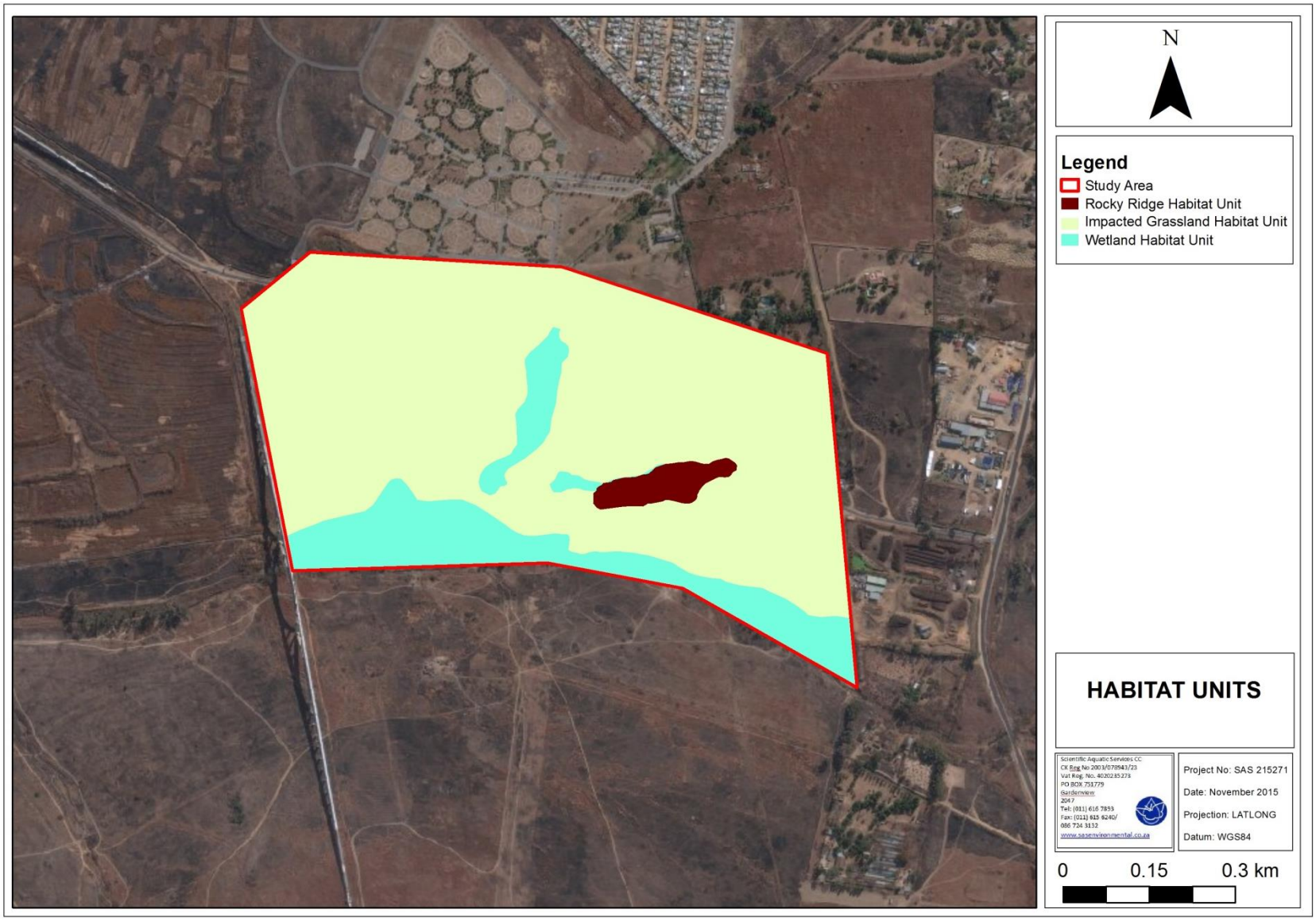

Figure 1: Map of the habitat units identified within the study area.

4.1 Habitat Unit 1: Impacted Grassland Habitat Unit

The Impacted Grassland Habitat Unit comprises the majority of the study area (Figure 2). This habitat unit has been significantly impacted by anthropogenic activities, including historical and current cultivation as well as dumping and the creation of informal access roads. The Impacted Grassland Habitat Unit is dominated by grass species typical of disturbed Egoli Granite Grasslands and includes *Hyparrhenia hirta, Aristida congesta, A. bipartita, Melinis repens, Eragrostis curvula, Setaria sphacelata* and *Cynodon dactylon*. Trees occur scattered throughout the habitat unit, with the woody layer dominated by scattered *Searsia pyroides*. Localised encroachment by indigenous species such as *Asparagus laricinus* and *Seriphium plumosum,* indicating the decreased successional status and degraded condition of the habitat unit, is also present.

The forb layer is relatively diverse and is dominated by *Eriosema burkei* and *Vernonia oligocephala.* Other species present include *Delosperma herbeum, Ledebouria revoluta, Conyza podocephala, Acalypha angustata* and *Cyanotis speciosa.*

Figure 2: The Impacted Grassland Habitat Unit which is representative of the majority of the study area.

Alien vegetation species are abundant in this habitat unit, particularly adjacent to access roads and areas where ongoing dumping of waste material is taking place. Such species include *Argemone ochroleuca, Verbena bonariensis* and *Taraxacum officienale.*

Two floral SCC were encountered within this habitat unit, namely *Boophane disticha* and *Hypoxis hemerocallidea*. *B. disticha* was found to occur in low abundance, however *H. hemerocallidea* was present in very high abundance throughout the habitat unit. Both these floral species are listed by SANBI as being 'Declining', with *B. disticha* listed as such due to habitat loss in the KwaZulu-Natal and Gauteng provinces and because trade volumes suggest unsustainable harvesting, especially because large, reproductive individuals are being removed (Williams *et al*., 2015a). *H. hemerocallidea* is listed as Declining due to extensive commercial exploitation since 1997, which has caused declines in some subpopulations, especially within the Gauteng Province, where it is also threatened by habitat loss and habitat degradation (Williams *et al*., 2015b). It is therefore recommended that any *B. disticha* and *H. hemerocallidea* species located within the development footprint area or species disturbed by the proposed development activities, should be rescued and relocated to suitable, similar habitat, preferably within or in close vicinity to the study area prior to commencement of construction.

The dominant floral species encountered within the Impacted Grassland Habitat Unit are listed in Table 1 below.

Table 1: Dominant species encountered in impacted grassland habitat unit. Alien species are indicated with an asterisk (*) and floral SCC are in bold font.

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Cynodon dactylon	**Argemone ochroleuca*	*Asparagus laricinus*
Eragrostis capensis	**Oenethera rosea*	*Gymnosporia buxifolia*
Eragrostis curvula	**Plantago lanceolata*	*Searsia pyroides*
Eragrostis lehmanniana	**Taraxacum officienale*	
Eragrostis lehmanniana	**Verbena bonariensis*	
Ergrostis racemosa	**Verbena tenuisecta*	
Melinis repens	**Xanthium strumarium*	
Pogonarthria squarrosa	*Acalypha angustata*	
Setaria sphacelata	*Albuca* sp.	
Themeda triandra	*Alectra* sp.	
Heteropogon contortus	*Artemisia afra*	
	Boophane disticha	
	Bulbine abyssinica	
	Chaetacanthus costatus	
	Commelina africana	
	Conyza podocephala	
	Crotalaria eremicola	
	Cyanotis speciosa	
	Delosperma herbeum	
	Drimiopsis burkei	
	Elephantorrhiza elephantina	

Grass/sedge/reed species	Forb species	Tree/Shrub Species
	Eriosema burkei	
	Euphorbia striata	
	Felicia muricata	
	Gazania krebsiana	
	Graderia subintegra	
	Hermannia depressa	
	Helichrysum rugulosum	
	Hypoxis hemerocallidea	
	Hypoxis multiceps	
	Hypoxis rigidula	
	Jamesbrittenia aurantica	
	Kohautia caespitosa	
	Ledebouria ovatifolia	
	Ledebouria revoluta	
	Neorautanenia ficifolius	
	Nesaea schinzii	
	Nidorella anomala	
	Ocimum americanum	
	Paucedanum magalismontanum	
	Pelargonium luridum	
	Rhynchosia minima	
	Scabiosa columbaria	
	Senecio coronatus	
	Seriphium plumosum	
	Silene burchelli	
	Turbina oblongata	
	Vahlia sp.	
	Vernonia oligocephala	
	Vernonia poskeana	
	Vigna vexillata	
	Wahlenbergia caledonica	
	Xysmalobium undulatum	

A decrease in the habitat integrity and ecological function of this habitat unit has occurred as a result of historical and ongoing habitat disturbance. As a result this habitat unit is not regarded as being ecologically sensitive. It has a low value with respect to achieving the national conservation target for Egoli Granite Grasslands and it is unlikely that the impacted anthropogenic grassland will return to the original climax vegetation. Provided that mitigation measures as outlined in this report are adhered to, development within the Impacted Grassland Habitat Unit is not expected to lead to a significant loss of floral habitat within the region.

4.2 Habitat Unit 2: Rocky Ridge Habitat Unit

The Rocky Ridge Habitat Unit is located within the eastern portion of the study area and is of a limited extent with respect to the remainder of the study area (Figure 3). According to Pfab (2001), a ridge is defined by the slope of the site, whereby any topographic feature in the landscape that is characterised by slopes of 5° or more (i.e. $\geq$ 8.8%, $\geq$ 1 in 11 gradient), as

determined by means of a GIS digital elevation model, is defined as a ridge. In addition, due to similar biodiversity, ecological and aesthetic values, the term “ridge” used by Pfab (2002) refers loosely to hills, koppies, mountains, kloofs, gorges, etc.

Although the study area slopes downward from the north of the study area to the south, no typical characteristics of ridges were observed within the study area, apart from the habitat associated with the Rocky Ridge Habitat Unit. This habitat unit provides varied topography, refuge and niche habitat for faunal and floral species, while the remainder of the study area is relatively homogeneous in nature, with the exception of wetland areas.

Figure 3: The Rocky Ridge Habitat Unit within the eastern portion of the study area.

Dominant woody floral species occurring within this habitat unit include *Searsia lancea, S. pyroides, Celtis africana* and *Gymnosporia buxifolia*. Alien woody species encroachment within this habitat unit is however quite severe and alien floral species occurring within the Rocky Ridge habitat unit include *Opuntia ficus-indica, Cereus jamacaru, Melia azedarach* and *Morus alba*.

Indigenous forb species diversity has been impacted by anthropogenic disturbances within the northern portion of the habitat unit, while the lower foothills within the south provide habitat for grassland species such as *Scabiosa columbaria*, *Helichrysum* spp., *Aloe greatheadi* var *davyana*, *Turbina oblongata* as well as the fern species *Pallaea calomelanos* and *Cheilanthus viridus*. The grass layer is dominated by species such as *Themeda triandra, Heteropogon contortus, Cymbopogon plurinodes* and *Panicum maximum*.

The table below lists the dominant floral species found within this habitat unit during the field assessment.

Table 2: Dominant species encountered in the Rocky Ridge Habitat Unit. Alien species are indicated with an asterisk (*).

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Cymbopogon plurinodes	**Bidens pilosa*	**Acacia mearnsii*
Cynodon dactylon	**Oenothera stricta*	**Cereus jamacaru*
Elionurus muticus	**Tagetes minuta*	**Melia azedarach*
Eragrostis capensis	**Verbena bonariensis*	**Morus alba*
Ergrostis racemosa	*Becium obovatum*	**Opuntia ficus-indica*
Haplocloa falx	*Berkeya radula*	*Asparagus laricinus*
Heteropogon contortus	*Cheilanthes viridis*	*Celtis africana*
Hyparrhenia hirta	*Chlorophytum* sp	*Euclea undulata*
Panicum maximum	*Eriosema burkei*	*Searsia lancea*
Setaria sphacelata	*Helichrysum nudifolium*	*Searsia pyroides*
Themeda triandra	*Hermannia depressa*	
Typha capensis	*Hypoxis rigidula*	
	Indigofera hedyantha	
	Kohautia amatymbica	
	Rhynchosia minima	
	Scabiosa columbaria	
	Turbina oblongata	

The Rocky Ridge Habitat Unit has increased ecological functionality and potentially improved levels of habitat integrity for both faunal and floral species. This habitat unit has however been directly impacted by habitat disturbance and alteration, with a resulting high level of alien floral species encroachment. As such, this habitat unit is considered to have moderate ecological sensitivity and should be incorporated into the open space areas of the proposed development as far as possible.

4.3 Habitat Unit 3: Wetland Habitat Unit

Two wetland features have been identified within the study area, comprising of a channelled valley bottom and hillslope seep/ perched wetland (Figure 4), the latter which is closely associated with the rocky ridge and driven by hydrogeological conditions. In addition, an artificial wetland feature was also identified within the central portion of the study area.

Dominant floral species within the channelled valley bottom wetland include the sedges and reeds *Typha capensis, Phragmites australis* and various *Cyperus* spp., while the woody layer is dominated by *Diospyros lycioides* and *Searsia pyroides* as well as alien woody species such as *Melia azedarach, Eucalyptus* sp., *Populus* spp. and *Salix babelonica. The* dominant species associated with the hillslope seep wetland include various *Cyperus* spp, Typha capensis, *Fuirena pubescens* and *Berkeya radula*.

Figure 4: The Wetland Habitat Unit present in the study area.

The dominant floral species encountered within the Wetland Habitat Unit are listed in Table 3 below.

Table 3: Dominant species encountered in the Wetland Habitat Unit. Alien species are indicated with an asterisk (*) and floral SCC are in bold font.

Grass/sedge/reed species	Forb species	Tree/Shrub Species
**Arundo donax*	**Araujia serifera*	**Eucalyptus* sp.
**Pennisetum clandestinum*	**Bromus catharticus*	**Melia azedarach*
Brachiaria serrata	**Chenopodium album*	**Morus alba*
Cynodon dactylon	**Conyza bonariensis*	**Populus simonii*
Cyperus obtusiflorus	**Oenothera rosea*	**Populus x canescens*
Cyperus sexangularis	**Ricinus communis*	**Salix babylonica*
Eragrostis curvula	**Rumex crispus*	*Diospyros lycioides*
Eragrostis gummiflua	**Sonchus oleraceus*	*Searsia pyroides*
Eragrotis plana	**Sonchus wilmsii*	
Fauireia pubescens	**Taraxacum officinale*	
Hyparrhenia hirta	**Verbena bonariensis*	
Imperata cylindrica	*Artemisia afra*	
Melinis repens	*Asclepias fruticosa*	
Miscanthus junceus	*Berkeya radula*	
Phragmites australis	*Eriosema burkei*	
Schoenoplectus corymbosus	*Helichrysum nudifolium*	
Schoenoplectus paludicola	***Hypoxis hemerocallidea***	
Setaria sphacelata	*Persicaria lapathifolia*	

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Sporobolus africanus	*Polygala hottentotta*	
Themeda triandra	*Scabiosa columbaria*	
Typha capensis	*Turbina oblongata*	

The Wetland Habitat Unit provides niche habitat for a high diversity of floral and faunal species and acts as a very important network of migratory corridors for faunal species, particularly the channelled valley bottom wetland bordering the study area in the south. Thus, this habitat unit is considered to be of high ecological sensitivity. As such, any impacts on the wetland features associated with the study area are likely to be significant on a local and potentially regional scale depending on how well impacts are managed and mitigated.

4.4 Vegetation Index Score

The information gathered during the assessment of the study area was used to determine the Vegetation Index Score (VIS) - see Appendix A for calculations. Due to variation between the different habitat units within the site, all habitat units were assessed separately. The tables below list the scoring system as well as the results of each habitat unit.

Table 4: Scoring for the Vegetation Index Score

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely

Table 5: Vegetation Index Score

Habitat Unit	Score	Class	Motivation
Impacted Grassland Habitat Unit	14	**Class D**	High levels of anthropogenic disturbance has taken place and overall loss of vegetation structure has occurred. Some alien invasive vegetation is present
Rocky Ridge Habitat Unit	16	**Class C**	Increased ecological functionality and habitat provision is present. High levels of alien invasive species encroachment have occurred.
Wetland Habitat Unit	16	**Class C**	Increased ecological functionality and habitat provision is present. High levels of alien invasive species encroachment have occurred.

4.5 Floral Species of Conservation Concern Assessment

An assessment considering the presence of any plant species of concern, as well as suitable habitat to support any such species was undertaken. The complete Pretoria Computer Information Systems (PRECIS) Floral Red Data List (RDL) was acquired from SANBI, as well as the GDARD conservation list, for the QDS 2528CC. The following table define the various RDL categories and lists the SCC known to occur within the region.

Table 6: National Red List Categories – Version 2015.1 as supplied by SANBI.

Category	Definition
Extinct (EX)	A species is Extinct when there is no reasonable doubt that the last individual has died.
Extinct in the Wild (EW)	A species is Extinct in the Wild when it is known to survive only in cultivation or as a naturalized population (or populations) well outside the past range.
Regionally Extinct (RE)	A species is Regionally Extinct when it is extinct within the region assessed (in this case South Africa), but wild populations can still be found in areas outside the region.
Critically Endangered, Possibly Extinct (CE PE)	Possibly Extinct is a special tag associated with the category Critically Endangered, indicating species that are highly likely to be extinct, but the exhaustive surveys required for classifying the species as Extinct has not yet been completed. A small chance remains that such species may still be rediscovered.
Critically Endangered (CR)	A species is Critically Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Critically Endangered, indicating that the species is facing an extremely high risk of extinction.
Endangered (EN)	A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.
Vulnerable (VU)	A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.
Near threatened (NT)	A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable, and is therefore likely to become at risk of extinction in the near future.
***Critically Rare**	A species is Critically Rare when it is known to occur at a single site, but is not exposed to any direct or plausible potential threat and does not otherwise qualify for a category of threat according to one of the five IUCN criteria.
***Rare**	A species is Rare when it meets at least one of four South African criteria for rarity, but is not exposed to any direct or plausible potential threat and does not qualify for a category of threat according to one of the five IUCN criteria. The four criteria are as follows: • Restricted range: Extent of Occurrence (EOO) <500 km^2, OR • Habitat specialist: Species is restricted to a specialised microhabitat so that it has a very small Area of Occupancy (AOO), typically smaller than 20 km^2, OR • Low densities of individuals: Species always occurs as single individuals or very small subpopulations (typically fewer than 50 mature individuals) scattered over a wide area, OR • Small global population: Less than 10 000 mature individuals.
***Declining**	A species is Declining when it does not meet or nearly meet any of the five IUCN criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened, but there are threatening processes causing a continuing decline of the species.
Least Concern (LC)	A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.
Data Deficient - Insufficient Information (DDD)	A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that a threatened

Category	Definition
	classification is appropriate.
Data Deficient - Taxonomically Problematic (DDT)	A species is DDT when taxonomic problems hinder the distribution range and habitat from being well defined, so that an assessment of risk of extinction is not possible.

*Categories marked with * are non-IUCN, national Red List categories for species not in danger of extinction, but considered to be of conservation concern. The IUCN equivalent of these categories is Least Concern (LC).

Table 7: PRECIS RDL plant list for the QDS 2528CC (Raimondo *et al*., 2009; SANBI, www.sanbi.org).

Family	Species	Threat status	Habitat
ACANTHACEAE	*Dicliptera magaliesbergensis*	VU	Forest, savanna (Riverine forest and bush).
AMARYLLIDACEAE	*Boophone disticha.*	Declining	Dry grassland and rocky areas.
APOCYNACEAE	*Miraglossum laeve*	Threatened	Hills in Gold Reef Mountain Bushveld and possibly Gauteng Shale Mountain Bushveld
AQUIFOLIACEAE	*Ilex mitis.* var. *mitis*	Declining	Along rivers and streams in forest and thickets, sometimes in the open. Found from sea level to inland mountain slopes
ASTERACEAE	*Callilepis leptophylla*	Declining	Grassland or open woodland, often on rocky outcrops or rocky hill slopes.
CAPPARACEAE	*Cleome conrathii*	NT	Stony quartzite slopes, usually in red sandy soil, grassland or deciduous woodland, all aspects.
FABACEAE	*Melolobium subspicatum*	VU	Grassland.
FABACEAE	*Pearsonia bracteata*	NT	Plants in Gauteng and North West occur in gently sloping Highveld grassland, while those in the Wolkberg were collected from steep wooded slopes and cliffs in river valleys.
GUNNERACEAE	*Gunnera perpensa*	Declining	In cold or cool, continually moist localities, mainly along upland streambanks
HYACINTHACEAE	*Bowiea volubilis* subsp. *volubilis*	VU	Low and medium altitudes, usually along mountain ranges and in thickly vegetated river valleys, often under bush clumps and in boulder screes, sometimes found scrambling at the margins of karroid, In Gauteng, Mpumalanga and North West Province it is often found in open woodland or on steep rocky hills usually in well-shaded situations. Tolerates wet and dry conditions, growing predominantly in summer rainfall areas with an annual rainfall of 200-800 mm
HYACINTHACEAE	*Drimia sanguinea*	NT	Open veld and scrubby woodland in a variety of soil types.
HYPOXIDACEAE	*Hypoxis hemerocallidea*	Declining	Occurs in a wide range of habitats, including sandy hills on the margins of dune forests, open, rocky grassland, dry, stony, grassy slopes, mountain slopes and plateaus. Appears to be drought and fire tolerant
MESEMBRYANTHEMACEAE	*Lithops lesliei.* subsp. *lesliei*	NT	Primarily in arid grasslands, usually in

Family	Species	Threat status	Habitat
			rocky places, growing under the protection of forbs and grasses.
ORCHIDACEAE	*Brachycorythis conica* subsp. *transvaalensis.*	EN	Short, open grassland and wooded grassland, on sandy gravel overlying dolomite, sometimes also on quartzite, 1 000-1 705 m.
ORCHIDACEAE	*Habenaria barbertoni*	NT	Rocky hillsides, in bushveld in association with acacias, 1000-1500 m
ORCHIDACEAE	*Habenaria kraenzliniana*	NT	Stony, grassy hillsides, 1000-1400 m
ORCHIDACEAE	*Habenaria mossii*	EN	Open grassland on dolomite or in black, sandy soil.
ORCHIDACEAE	*Holothrix randii*	NT	Grassy slopes and rock ledges, usually southern aspects
SCROPHULARIACEAE	*Freylinia tropica*	Rare	Riverbanks and stream sides, 1800 m

Table 8: Additional floral SCC for the QDS 2528CC as obtained from GDARD.

Family	Species	Threat status	Habitat
AMARYLLIDACEAE	*Crinum macowanii*	Declining	Mountain grassland and stony slopes in hard dry shale, gravely soil or sandy flats
APOCYNACEAE	*Ceropegia decidua* subsp. *pretoriensis*	VU	Associated with ridges and quartzitic rocky outcrops in pockets of soil among rocks in direct sunshine or shaded areas
CRASSULACEAE	*Adromischus umbraticola* subsp *umbraticola*	NT	South-facing rock crevices on ridges, restricted to Gold Reef Mountain Bushveld in the northern parts of its range, and Andesite Mountain Bushveld in the south
HYACINTHACEAE	*Eucomis autumnalis*	Declining	Damp, open grassland and sheltered places from the coast to 2450 m
PTERIDACEAE	*Cheilanthus deltoidea* subsp. *silicicola*	VU	Southwest-facing soil pockets and rock crevices in chert rock

The POC of each of the species listed above was calculated (table below) with reference to habitat suitability within the study area.

Table 9: POC for floral species of concern.

Species	POC	Motivation
Dicliptera magaliesbergensis	20%	No suitable habitat for this species is available within the study area.
Boophone disticha.	100%	This species was encountered within the Impacted Grassland Habitat Unit
Miraglossum laeve	27%	Limited habitat for this species is available within the study area.
Ilex mitis. var. *mitis*	27%	No suitable habitat for this species is available within the study area. If present, it will occur within the Wetland Habitat Unit associated with the channelled valley bottom wetland feature.
Callilepis leptophylla	47%	Limited suitable habitat for this species is available within the Impacted Grassland Habitat Unit.
Cleome conrathii	13%	No suitable habitat for this species is available within the study area.
Melolobium subspicatum	13%	No suitable habitat for this species is available within the study area.
Pearsonia bracteata	27%	Limited habitat for this species is available within the study area.
Gunnera perpensa	40%	Limited habitat for this species is available within the study area.
Bowiea volubilis subsp.	20%	Limited habitat for this species is available within the study area.

Species	POC	Motivation
volubilis		
Drimia sanguinea	40%	Limited habitat for this species is available within the study area.
Hypoxis hemerocallidea	100%	This species was encountered within the Impacted and Wetland Grassland Habitat Units
Lithops lesliei. subsp. *lesliei*	0%	No suitable habitat for this species is available within the study area.
Brachycorythis conica subsp. *transvaalensis.*	33%	Limited habitat for this species is available within the study area and it was not encountered.
Habenaria barbertoni	33%	Limited habitat for this species is available within the study area and it was not encountered.
Habenaria kraenzliniana	33%	Limited habitat for this species is available within the study area and it was not encountered.
Habenaria mossii	27%	Limited habitat for this species is available within the study area and it was not encountered.
Holothrix randii	27%	Limited habitat for this species is available within the study area and it was not encountered.
Freylinia tropica	33%	No suitable habitat for this species is available within the study area. If present, it will occur within the Wetland Habitat Unit associated with the channelled valley bottom wetland feature.
Crinum macowanii	60%	Suitable habitat for this species is available within the Wetland Habitat Unit, but it has not been encountered.
Ceropegia decidua subsp. *pretoriensis*	6%	No suitable habitat for this species is available within the study area.
Adromischus umbraticola subsp *umbraticola*	33%	Limited habitat for this species is available within the study area. If present it will occur within the Rocky Ridge Habitat Unit.
Eucomis autumnalis	40%	Limited habitat for this species is available within the study area. If present it will occur within the Impacted Grassland Habitat Unit.
Cheilanthus deltoidea subsp. *silicicola*	60%	Limited habitat for this species is available within the study area. If present it will occur within the Rocky Ridge Habitat Unit.

From the above assessment, it is clear that the majority of the floral SCC listed for the QDS 2528CC have a low probability of occurring within the study area and species with an increased POC are more likely to occur within the Wetland and Rocky Ridge Habitat Units.

Two floral SCC, both listed by SANBI as 'Declining' were however encountered within the Impacted Grassland and Wetland Habitat Units, namely *Boophane disticha* and *Hypoxis hemerocallidea*. It is recommended that any *B. disticha* and *H. hemerocallidea* species located within the development footprint area or disturbed by the proposed development activities, should be rescued and relocated to suitable, similar habitat, preferably within or in close vicinity to the study area prior to commencement of construction.

No protected tree species protected under the National Forest Act (Act 84 of 1998), were encountered within the study area and no Threatened or Protected Species (TOPS) species as provided for under the National Environmental Management: Biodiversity Act (NEMBA; Act 10 of 2004) were encountered.

4.6 Alien and Invasive Plant Species

Alien invasive species are plants that are of exotic origin and are invading previously pristine areas or ecological niches (Bromilow, 2001). Not all weeds are exotic in origin but, as these exotic plant species have very limited natural "check" mechanisms within the natural environment, they are often the most opportunistic and aggressively growing species within the ecosystem. Therefore, they are often the most dominant and noticeable within an area. Disturbances of the ground through trampling, excavations or landscaping often leads to the dominance of exotic pioneer species that rapidly dominate the area. Under natural conditions, these pioneer species are overtaken by sub-climax and climax species through natural veld succession. This process however takes many years to occur, with the natural vegetation never reaching the balanced, pristine species composition prior to the disturbance. There are many species of indigenous pioneer plants, but very few indigenous species can out-compete their more aggressively growing exotic counterparts.

Alien vegetation invasion causes degradation of the ecological integrity of an area, causing (Bromilow, 2001):

- A decline in species diversity;
- Local extinction of indigenous species;
- Ecological imbalance;
- Decreased productivity of grazing pastures and
- Increased agricultural input costs.

Table 10: Alien and invasive species within the study area.

Species	English name	Country of Origin	Category*
	Trees/ shrubs		
Acacia mearnsii	Black Wattle	Australia	2
Cereus jamacaru	Queen of the night	South America	1b
Eucalyptus sp.	River Gum	Australia	1b
Melia azedarach	Syringa	India	1b
Morus alba	White mulberry	China	3
Populus x canescens	Grey poplar	Northern hemisphere	2
Salix babylonica	Weeping willow	China	Not Listed
	Forbs and Grass/ Reeds/ Sedges		
Araujia serifera	Moth catcher	South America	1b
Argemone ochroleuca	White-flowered Mexican Poppy	Mexico	1b
Arundo donax	Giant reed	Eurasia	1b
Bidens pilosa	Common blackjack	South America	Not Listed
Bromus catharticus	Prairie grass	South America	Not Listed

Species	English name	Country of Origin	Category*
Chenopodium album	White goosefoot	Europe	Not Listed
Conyza bonariensis	Flax-leaf fleabane	Americas	Not Listed
Oenothera rosea	Rose evening primrose	Central America	Not Listed
Oenothera stricta	Common evening-primrose	Central America	Not Listed
Pennisetum clandestinum	Kikuyu	East Africa	Not Listed
Plantago lanceolata	Buckhorn plantain	Europe	Not Listed
Ricinus communis	Castor-oil plant	Africa	2
Rumex crispus	Curly dock	Europe	Not Listed
Sonchus oleraceus	Sowthistle	Europe	Not Listed
Tagetes minuta	Tall khakiweed	South America	Not Listed
Taraxacum officinale	Common dandlion	Europe and Asia	Not Listed
Verbena bonariensis	Purple top	South America	1b
Verbena tenuisecta	Fine-leaved verbena	South America	Not Listed
Xanthium strumarium	Large cocklebur	South America	1b

Category 1a – Invasive species that require compulsory control.

Category 1b – Invasive species that require control by means of an invasive species management programme.

Category 2 – Commercially used plants that 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 that may no longer be planted. Existing plants may remain, except within the flood line of watercourses and wetlands, as long as all reasonable steps are taken to prevent their spread (Bromilow, 2001).

From the table above it is clear that a high diversity of alien species occurs throughout all habitat units identified within the study area. Alien species located in the study area need to be removed on a regular basis as part of maintenance activities according to the National Environmental Management: Biodiversity Act (Act 10 of 2004): Alien and Invasive Species Regulations, GN R598 of 2014.

4.7 Medicinal Plant Species

Medicinal floral species are not necessarily indigenous species, with many of them regarded as alien invasive weeds.

The table below presents a list of dominant floral species with traditional medicinal value, floral parts traditionally used and their main applications, which were identified during the field assessment.

Table 11: Traditional medicinal floral species identified during the field assessment. Medicinal applications and application methods are also presented (van Wyk, Oudtshoorn, Gericke, 2009).

Species	Name	Plant parts used	Medicinal uses
Aloe greatheadii var *davyana*	Aloe	Stems and leaves	Decoction of powdered stems and leaf bases is taken orally twice a day after delivery to cleanse the system.
Artemisia afra	Wild wormwood	Roots, stems and leaves	One of the oldest and best known medicinal plants, and is still used effectively today in South Africa by people of all cultures. The list of uses covers a wide range of ailments from coughs, colds, fever, loss of appetite, colic, headache, earache, intestinal worms to malaria. The roots, stems and leaves are used in many different ways and taken as enemas, poultices, infusions, body washes, lotions, smoked, snuffed or drunk as a tea.
Elephantorrhiza elephantina	Elandsbean	Underground rhizomes	Traditional remedy for a wide range of ailments, including diarrhoea and dysentery, stomach disorders, haemorrhoids and perforated peptic ulcers, and as emetics. It is popular for the treatment of skin diseases and acne.
Boophane disticha	Bushman poison bulb	Bulb scales	Dry outer scales of the bulb are used as an outer dressing after circumcision and are applied to boils or septic wounds to alleviate pain. Weak decoctions are administered by mouth or as and enema for various complaints such as headaches, abdominal pain, weakness and eye conditions.
Hypoxis hemerocallidea	African potato	Rootstock	Infusions of corm are used as emetics to treat dizziness, bladder disorders and insanity. Decoctions have been given to weak children as a tonic and the juice is reported to be applied to burns.
Pallaea calomelanos	Hard fern	Leaves and rhizomes	Leaves are smoked for head olds, chest olds and asthma.
Ricinus communis	Castor oil plant	Oil extracted from leaves, sometimes also fruits, seeds or leaves	Well known purgative medicine, also used to treat stomach ache. Root and leaf poultices are widely applied to wounds, sores and boils.
Scabiosa columbaria	Wild scabious	Leaves and fleshy roots	Remedy for colic and heartburn, dried roots are made into a wound-healing ointment and powered roots are also used as a pleasant-smelling baby powder.
Typha capensis	Bulrush	Rhizomes	Used for venereal diseases during pregnancy to ensure an easy delivery, and for dysmennorhoea, diarrhoea, dysentery and to enhance male potency and libido.
Taraxacum officienale	Dandelion	Leaves and roots	The dandelion is a commonly used herbal remedy.
Leonotis leonurus	Wild dagga	Mainly the leaves and stems, but also the roots	Widely used as a remedy for snake bite and also to treat other bites and stings. Externally, decoctions have also been applied to treat boils, eczema, skin diseases, itching and muscular cramps. Internally, decoctions are also used for coughs, colds and influenza, and also for bronchitis, high blood pressure and headaches.

Species	Name	Plant parts used	Medicinal uses
Tagetes minuta	Tall khaki bush	Leaves	Highly aromatic leaves have repellent properties of essential oils used by gardeners to keep plants disease free. Oil used in perfumery and as flavouring in foods, beverages and tobacco.
Helichrysum nudifolium	Everlasting	Leaves, twigs and sometimes the roots	Many ailments are treated, including coughs, colds, fever, infections, headache and menstrual pains. It is a popular ingredient in wound dressing.
Pelargonium luridum	Wild Geranium	Rootstock	Infusions of the tubers are used to treat diarrhoea and dysentery.
Asclepias fruticosa	Milkweed	Mainly leaves, sometimes roots.	Snuff is prepared from ground leaves and used for treatment of headaches, tuberculosis and a general emetic to strengthen body.

5 SENSITIVITY MAPPING

The figure below conceptually illustrates the areas considered to be of increased ecological sensitivity in relation to the proposed project. The areas are depicted according to their sensitivity in terms of faunal and floral habitat integrity and their suitability to provide habitat to faunal and floral communities.

The Wetland Habitat Unit provides niche habitat for a high diversity of floral and faunal species and the valley bottom wetland feature in particular acts as a very important network of migratory corridors for faunal species. Thus, this habitat unit is considered to be of high ecological sensitivity and any impacts on the wetland systems associated with the study area are likely to be significant on a local and regional scale. A 30m buffer zone as recommended for by the GDARD Requirements for Biodiversity Assessments (2014) is also indicated in the figure below, as well as a 32m buffer area, as any activities within this buffer will trigger a listed activity in line with the National Environmental Management Act (Act 107 of 1998).

The Rocky Ridge Habitat Unit provides niche habitat for a high diversity of floral and faunal species, but have been impacted and is associated with a high number of alien floral species. This habitat unit is considered to be of moderate ecological sensitivity.

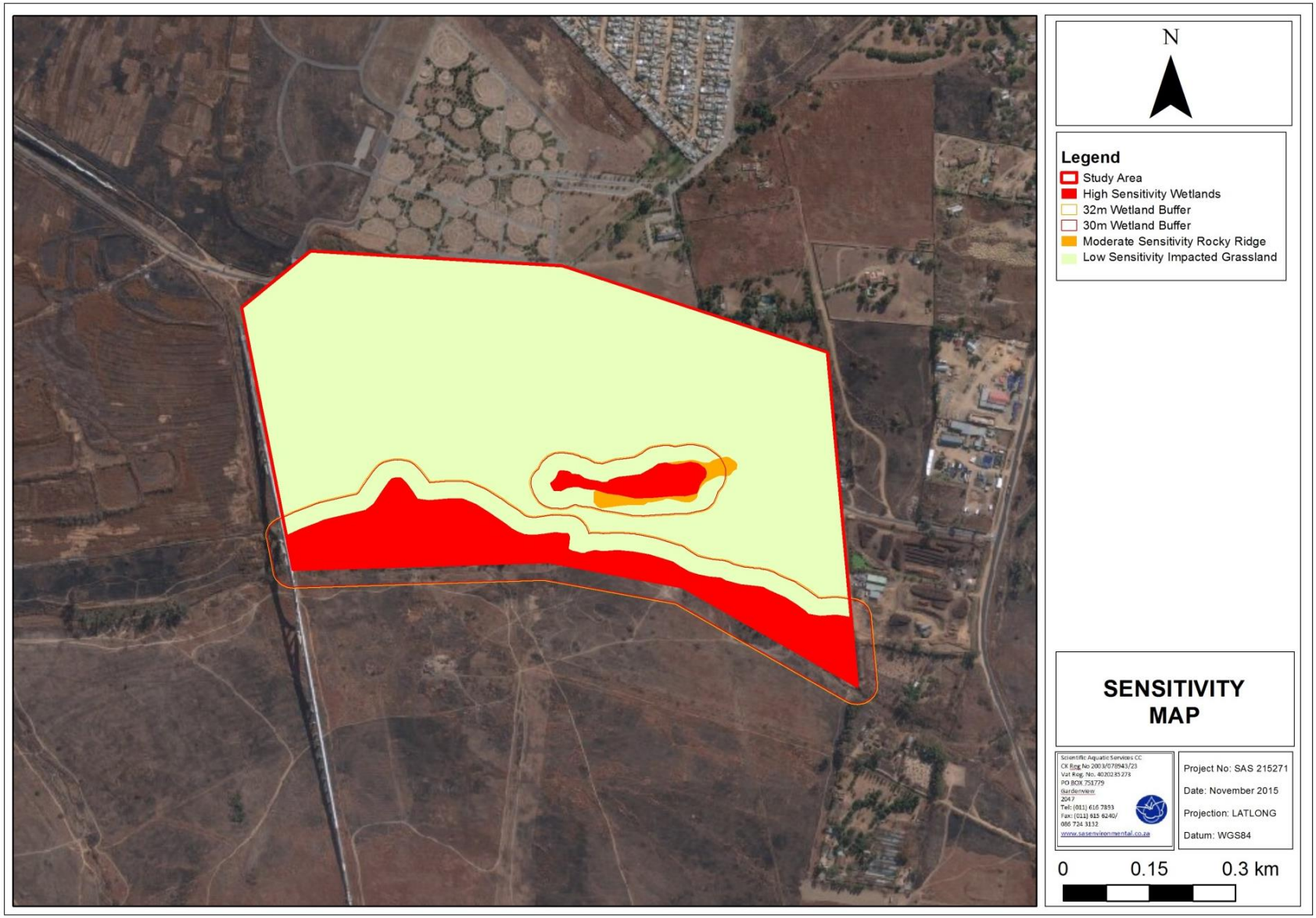

Figure 5: Sensitivity map for the study area

6 IMPACT ASSESSMENT

The tables below serve to summarise the significance of potential impacts on floral species and habitat that may result due to the proposed development activities. A summary of all potential pre-construction, construction and operational phase impacts is provided after the impact discussion. The sections below present the impact assessment according to the method described in Section A. In addition, it also indicates the required mitigatory and management measures needed to minimise potential ecological impacts and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures, assuming that they are fully implemented.

General housekeeping measures include the following:

- No unauthorised or unplanned fires whatsoever should be allowed within the study area;
- Appropriate sanitary facilities must be provided for the duration of the construction phase of the project;
- All soils compacted as a result of construction activities falling outside of the development areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout all development phases to prevent loss of floral habitat.
- To prevent the erosion of top soils, management measures may include berms, soil traps, hessian curtains and storm water diversion away from areas susceptible to erosion, including wetland areas. It must be ensured that topsoil stockpiles are located outside of such area;
- No dumping of waste should take place. If any spills occur, they should be immediately cleaned up;
- In the event of a breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced to prevent the ingress of hydrocarbons into the topsoil;
- It must be ensured that all roads and construction areas are regularly sprayed with water in order to curb dust generation. This is particularly necessary during the dry season when increased levels of dust generation can be expected. These areas should not be over-sprayed causing water run-off and subsequent sediment loss in the vicinity of the study area; and
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage. Regularly inspect all vehicles

for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.

6.1 Impact 1: Impact on Habitat for Floral Species

Activities and aspect registry

Pre-Construction	Construction	Operational
Poor planning of infrastructure placement and design	Site clearing and the removal of vegetation	On-going disturbance of soils due to general operational activities leading to altered floral habitat
Inadequate design of infrastructure	Loss of floral biodiversity through invasion of alien species	Increased introduction and proliferation of alien plant species and further transformation of natural habitat
	Erosion as a result of infrastructure development and storm water runoff	Risk of discharge and contamination from all operational facilities may pollute receiving environment with special mention of the salinisation of soils
	Movement of construction vehicles and access road construction	Seepage affecting soils and the groundwater regime with special mention of the salinisation of soils
	Dumping of material outside designated areas leading to loss of floral habitat	Runoff and seepage from operation facilities may lead to habitat loss with special mention of the salinisation of soils
	Compaction of soils reducing floral re-establishment	On-going disturbance may lead to erosion and sedimentation

Floral habitat provision within the study area has been significantly impacted as a result of historical and on-going anthropogenic activities, including agriculture activities, alien vegetation encroachment, vegetation clearance and ongoing dumping. The proposed development, should mitigation measures be put in place, is therefore unlikely to further significantly affect habitat provision provided that areas of increased ecological sensitivity be avoided. The impact significance after mitigation is considered to be medium-low to low during the operational and construction phases of the development respectively. If recommended mitigation measures as outlined below are implemented during the construction phase, the habitat within the study area is likely to be improved for the lifetime of the development.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	3	3	3	5	6	11	66 (Medium Low)
Operational phase	3	3	3	3	4	6	10	60 (Medium Low)

Essential construction phase mitigation measures:

- The boundaries of the proposed infrastructure footprint areas are to be clearly defined and it should be ensured that all activities remain within the defined footprint areas. The areas surrounding the footprint areas are not to be unnecessary cleared as this may lead to loss of topsoil and unnecessary loss of any available habitat.
- Vehicles should be restricted to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.
- As far as possible, the proposed development infrastructure must be located within designated low sensitivity areas.
- Rehabilitation works must take place as part of the project, with particular focus on wetland rehabilitation and the introduction of indigenous vegetation.
- Only indigenous floral species are to be used in the landscaping of the proposed development.
- All disturbed areas and compacted soils are to be ripped and reprofiled prior to revegetation.
- Edge effects of all construction activities, such as erosion and alien plant species proliferation, which may affect faunal habitat within surrounding areas, need to be strictly managed within the study area.

Recommended construction phase mitigation measures:

- During the construction phases erosion berms should be installed to prevent gully formation and siltation of the wetland resources. The following points should serve to guide the placement of erosion berms:
    - Where the track has a slope of less than 2%, berms every 50m should be installed;
    - Where the track slopes between 2% and 10%, berms every 25m should be installed;
    - Where the track slopes between 10%-15%, berms every 20m should be installed; and
    - Where the track has a slope greater than 15%, berms every 10m should be installed.
- Indigenous floral species may be introduced at strategic locations adjacent to the Wetland Habitat Unit and the canalised drainage line as required, to provide improved habitation conditions for faunal species.
- As part of rehabilitation and landscaping works, it is recommended that indigenous veld grass species, including grassland forbs and bulbs, representative of Egoli Granite Grassland, be introduced where possible.
- Species selected for rehabilitation works may include indigenous species specifically selected to attract invertebrates, birds and small mammal species.

Essential operation phase mitigation measures:

- Ensure that operational related activities are kept strictly within the development footprint.
- Alien and invasive vegetation control should take place throughout the operational phase of the development.

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Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	1	3	2	2	3	4	7	28 (Low)
Operational phase	1	3	2	3	3	4	8	32 (Low)

Probable latent impacts

- Loss of floral habitat may lead to altered floral biodiversity.
- Ineffective rehabilitation may lead to permanent transformation of floral habitat and species composition.

6.2 Impact 2: Impact on Floral Diversity

Activities and aspects registry

Pre-Construction	Construction	Operational
Planning, placement and design of infrastructure leading to overall loss of floral species	Site clearance and removal of vegetation	An increase in alien plant species leading to altered floral community structure and composition
	Construction of infrastructure through natural areas leading to a loss of floral and faunal diversity	Erosion and sedimentation as a result of operational activities leading to a loss of floral species diversity
	Proliferation of alien species may alter floral community structure	Increased pedestrian movement may lead to loss of floral species
	Soil compaction as a result of construction activities may alter floral community structure and composition	On-going edge effects impacting on floral species diversity
	Increased fire frequency and intensity, as well as uncontrolled fires due to increased human activity may impact the floral communities	
	Dust generation from construction vehicles in areas cleared from vegetation impacting on floral species diversity	
	Increased anthropogenic activity and an increase in the collection of medicinal floral species	
	Rehabilitation works conducted during the construction phase may lead to long-term habitat improvement within the study area	

Floral diversity within the study have been impacted as a result of historical and on-going disturbances associated with historic and ongoing anthropogenic activities. The impact significance associated with the loss of species diversity is considered medium to low prior to the implementation of mitigation measures.

With the implementation of mitigation measures within the study area, the impact significance can be decreased to a low significance, should indigenous floral species be re-introduced to the study area and rehabilitation works be successful.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	3	3	3	4	6	10	60 (Medium Low)
Operational phase	3	3	3	3	4	6	10	50 (Medium Low)

Essential construction mitigation measures:

- Keep the proposed development infrastructure within designated low sensitivity areas as far as possible.
- Planning of temporary roads and access routes should take the site sensitivity plan into consideration. If possible, such roads should be constructed a distance from the more sensitive wetland areas and not directly adjacent thereto.
- Prohibit the collection of plant material for firewood or for medicinal purposes.
- Species specific and area specific eradication recommendations:
    - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
    - Footprint areas should be kept as small as possible when removing alien plant species; and
    - No vehicles should be allowed to drive through designated sensitive wetland areas during the eradication of alien and weed species.

Essential operation mitigation measures:

- An alien vegetation control plan has to be implemented in order to manage alien plant species occurring within the study area.
- Removal of the alien and weed species encountered within the mining footprint area must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and NEMBA (Alien and Invasive Species Regulations (2014). Removal of species should take place throughout the operational phase.
- Restrict vehicles to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.
- To prevent the erosion of top soils, management measures may include berms, soil traps, hessian curtains and storm water diversion away from areas susceptible to erosion. It must be ensured that topsoil stockpiles are located outside of any drainage lines and areas susceptible to erosion. Stockpiles should be placed away from areas known to contain hazardous substances such as fuel and if any soils are contaminated, it should be stripped and disposed of at a registered hazardous waste dumping site.

Recommended operational mitigation measures:

- Prohibit the collection of plant material for firewood or for medicinal purposes.

Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	3	2	2	2	5	6	30 (Low)
Operational phase	2	3	2	2	3	4	7	28 (Low)

Probable latent impacts

- Permanent loss of floral diversity within areas where construction has taken place.
- Ineffective rehabilitation may lead to permanent loss of floral biodiversity.

6.3 Impact 3: Impact on Floral SCC

Activities and aspects registry

Pre-Construction	Construction	Operational
Poor planning of infrastructure placement and design	Site clearance and removal of important/ indigenous vegetation within the rocky ridge and wetland habitat	An increase in alien plant species leading to loss of medicinal plant species by outcompeting these species
	Direct loss of floral SCC	Ongoing loss of floral SCC due to no relocation taking place and ineffective rehabilitation
	Construction of infrastructure and access roads through natural areas	Collection of medicinal floral species
	Increased anthropogenic activity and an increase in the collection of plant material for medicinal purposes	Increased anthropogenic activity and an increase in the collection of plant material for medicinal purposes
	Increased fire frequency and intensity, as well as uncontrolled fires due to increased human activity may impact on plant communities	Increased fire frequency and intensity, as well as uncontrolled fires due to increased human activity may impact on plant communities

The SANBI 'Declining' floral SCC species *Boophane disticha* and *Hypoxis hemerocallidea* were encountered within the Impacted Grassland and Wetland Habitat Units and are likely to be affected by the proposed development activities. The impact associated with the loss of these species is considered to be of medium-high significance prior to the implementation of mitigation measures. However, these species are easily relocated and through relocation and rehabilitation activities this impact may be reduced to a medium-low significance level.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	5	3	3	3	4	8	10	80 (Medium High)
Operational phase	3	3	3	3	4	6	10	60 (Medium Low)

Essential construction mitigation measures:

- The footprint of the proposed development activities should be confined to areas which are of low ecological importance.
- Prohibit the collection of plant material for medicinal purposes.
- The existing integrity of flora surrounding the proposed mining site should be upheld and no activities be carried out outside the footprint of the construction areas.
- Edge effect control needs to be implemented to ensure no further degradation outside of the proposed footprint area.
- Floral SCC encountered within the development footprint area should be relocated to suitable similar habitat within or in the vicinity of the study area and all rescue and relocation activities should be overseen by a suitably qualified specialist.

Essential operational phase mitigation measures:

- Ensure that operational related activities are kept strictly within the development footprint.
- Restrict vehicles to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.
- Prohibit the collection of plant material for medicinal purposes.

Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	5	3	3	2	3	8	8	64 Medium Low)
Operational phase	1	3	2	2	4	4	8	32 (Low)

Probable latent impacts

- A decrease in medicinal floral species diversity may lead to a loss of species richness over time within the region.

6.4 Impact Assessment Conclusion

Based on the above assessment it is evident that there are three possible impacts which may affect the floral ecology within the study area. The tables below summarise the findings indicating the significance of the impacts before mitigation takes place as well as the significance of the impacts if appropriate management and mitigation takes place. Table 12 presents the summary for the construction phase of the project and Table 13 present the summary for the operational phase impacts.

Table 12: A summary of the impact significance of the construction phase.

Impact	Unmanaged	Managed
1: Impact on habitat for floral species	Medium-Low	Low
2: Impact on floral diversity	Medium-Low	Low
3: Impact on floral SCC	Medium-High	Medium-Low

Table 13: A summary of the impact significance of the operational phase.

Impact	Unmanaged	Managed
1: Impact on habitat for floral species	Medium-Low	Low
2: Impact on floral diversity	Medium-Low	Low
3: Impact on floral SCC	Medium-Low	Low

7 RECOMMENDATIONS

After the conclusion of this assessment, it is the opinion of the ecologists that the proposed mining activities be considered favourably, provided that the recommendations below are adhered to:

Development footprint

- A sensitivity map has been developed for the study area. It is recommended that this sensitivity map be considered during all development phases to aid in the conservation of floral habitat within the study area.
- No activities are to infringe upon sensitive areas or associated buffer zones.
- Any proposed surface development footprint areas should remain as small as possible.
- All areas of increased ecological sensitivity should be designated as No-Go areas and be off limits to all unauthorised vehicles and personnel. Vehicles should be restricted to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.
- It must be ensured that waste or spillage and effluent do not affect the sensitive habitat boundaries and associated buffer zones.

Alien floral species

- Removal of the alien and weed species encountered on the property must take place in order to comply with existing legislation (Conservation of Agricultural Resources Act, 1983 and NEMBA (Alien and Invasive Species Regulations 2014). Removal of alien and weed species should take place throughout the construction, operational, closure/decommissioning and rehabilitation/ maintenance phases.
- Species specific and area specific eradication recommendations:
  - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used.
  - Footprint areas should be kept as small as possible when removing alien plant species.
  - No vehicles should be allowed to drive through designated sensitive wetland, buffer or intact grassland areas during the eradication of alien and weed species.

Soils

- Any compacted soils outside of the development footprint area must be ripped and reprofiled.

Rehabilitation

- All disturbed areas must be rehabilitated as soon as possible to ensure that floral ecology is re-instated to at least a self-sustaining, secondary state of ecological succession.
- Reseeding with indigenous grasses should be implemented in all affected areas and strategic planting of grassland species should take place to re-establish microclimates and niche habitats.

Fires

- Informal fires should be prohibited during all development phases.

Floral SCC

- Floral SCC, namely *Boophane disticha* and *Hypoxis heemrocallidea* must be rescued and relocated with the process overseen by a botanist.
- Should any other floral SCC be encountered within the proposed development footprint areas, the following should be ensured:
  - If any threatened species, or nationally or provincially protected floral will be disturbed, ensure effective relocation of individuals to suitable similar habitat.
  - All rescue and relocation plans should be overseen by a suitably qualified specialist.

8 REFERENCES

Bromilow, C. 2001. Revised Edition, First Impression. *Problem Plants of South Africa.* Briza Publications, Pretoria, RSA.

Henderson, L. 2001. *Alien Weeds and Invasive plants – A Complete Guide to Declared Weeds and Invaders in South Africa*. Plant Protection Research Institute, Agricultural Research Council Handbook No 12. Pretoria.

Low, A.B. and Rebelo, A.G. (eds). 1998. *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs & Tourism, Pretoria

Pfab, M. 2001. Development Guidelines for Ridges. Departmental Policy Final Draft. Department of Agriculture, Conservation, Environment and Land Affairs. Directorate of Nature Conservation.

Raimondo, D., von Staden, L., Foden, W., Victor, J.E, Helme, NA., Turner, R.C, Kamundi, DA., Manyama, PA. (eds) 2009. *Red List of South African Plants.* Strelitzia 25. South African National Biodiversity Institute, Pretoria. Version 2014.1

SANBI 2015. The South African National Biodiversity Institute is thanked for the use of data from the National Herbarium, Pretoria (PRE) Computerised Information System (PRECIS).

Van Oudtshoorn, F. 1999. *Guide to Grasses of Southern Africa*. 2nd Ed. Briza Publications, Pretoria.

Van Wyk, B. and Malan, S. 1998. *Field Guide to the Wild Flowers of the Highveld*. Struik Publishers, Cape Town.

Van Wyk, B. van Wyk, P. and van Wyk, B. 2000. *Photographic Guide to Trees of Southern Africa*. Briza Publications, Pretoria.

Van Wyk, B., van Oudtshoorn, B. and Gericke, N. 2009. *Medicinal Plants of South Africa*. Briza Publications, Pretoria.

Williams, V.L., Raimondo, D., Brueton, V.J., Crouch, N.R., Cunningham, A.B., Scott-Shaw, C.R., Lötter, M. & Ngwenya, A.M. 2008a. Boophone disticha (L.f.) Herb. National Assessment: Red List of South African Plants version 2015.1. Accessed on 2015/12/07

Williams, V.L., Raimondo, D., Crouch, N.R., Cunningham, A.B., Scott-Shaw, C.R., Lötter, M. & Ngwenya, A.M. 2008b. Hypoxis hemerocallidea Fisch., C.A.Mey. & Avé-Lall. National Assessment: Red List of South African Plants version 2015.1. Accessed on 2015/12/07

APPENDIX A

Vegetation Index Score

Vegetation Index Score – Impacted Grassland Habitat Unit

1. EVC=[[(EVC1+EVC2)/2]

EVC 1 - Percentage natural vegetation cover						
Vegetation cover %	**0%**	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Site score				X		
EVC 1 score	0	1	2	3	4	5
EVC 2 – Total site disturbance						
Disturbance score	**0**	**Very low**	**Low**	**Moderate**	**High**	**Very high**
Site score					X	
EVC 2 score	5	4	3	2	1	0

2. SI=(SI1+SI2+SI3+SI4)/4)

	Trees (S1)		Shrubs (S2)		Forbs (S3)		Grasses (S4)	
Score	Present state	Perceived reference state	Present state	Perceived reference state	Present state	Perceived reference state	Present state	Perceived reference state
Continuous								X
Clumped					X	X		
Scattered	X		X				X	
Sparse		X		X				

Present State (P/S) = Currently applicable for each habitat unit

Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived reference state (PRS)	**Continuous**	**Clumped**	**Scattered**	**Sparse**
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))

Percentage vegetation cover (exotic)						
	0%	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Vegetation cover %			X			
PVC score	0	1	2	3	4	5
Percentage vegetation cover (bare ground)						
	0%	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Vegetation cover %				X		
PVC score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	**0**	**Very low**	**Low**	**Moderate**	**High**	**Very high**
RIS				X		
RIS Score	0	1	2	3	4	5

VIS = [(EVC)+((SIxPVC)+(RIS))] = 14

Vegetation Index Score – Secondary Bushveld Habitat Unit

1. EVC=[[(EVC1+EVC2)/2]

EVC 1 - Percentage natural vegetation cover						
Vegetation cover %	**0%**	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Site score				X		
EVC 1 score	0	1	2	3	4	5
EVC 2 – Total site disturbance						
Disturbance score	**0**	**Very low**	**Low**	**Moderate**	**High**	**Very high**
Site score					X	
EVC 2 score	5	4	3	2	1	0

2. SI=(SI1+SI2+SI3+SI4)/4)

	Trees (S1)		Shrubs (S2)		Forbs (S3)		Grasses (S4)	
Score	Present state	Perceived reference state	Present state	Perceived reference state	Present state	Perceived reference state	Present state	Perceived reference state
Continuous								X
Clumped	X	X	X	X	X		X	
Scattered						X		
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived reference state (PRS)	**Continuous**	**Clumped**	**Scattered**	**Sparse**
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))

Percentage vegetation cover (exotic)						
	0%	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Vegetation cover %				X		
PVC score	0	1	2	3	4	5
Percentage vegetation cover (bare ground)						
	0%	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Vegetation cover %		X				
PVC score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	**0**	**Very low**	**Low**	**Moderate**	**High**	**Very high**
RIS					X	
RIS Score	0	1	2	3	4	5

VIS = [(EVC)+((SIxPVC)+(RIS))] = 16

Vegetation Index Score – Wetland Habitat Unit

1. EVC=[[(EVC1+EVC2)/2]

EVC 1 - Percentage natural vegetation cover						
Vegetation cover %	**0%**	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Site score				X		
EVC 1 score	0	1	2	3	4	5
EVC 2 – Total site disturbance						
Disturbance score	**0**	**Very low**	**Low**	**Moderate**	**High**	**Very high**
Site score					X	
EVC 2 score	5	4	3	2	1	0

2. SI=(SI1+SI2+SI3+SI4)/4)

	Trees (S1)		Shrubs (S2)		Forbs (S3)		Grasses (S4)	
Score	Present state	Perceived reference state	Present state	Perceived reference state	Present state	Perceived reference state	Present state	Perceived reference state
Continuous	X							X
Clumped		X	X	X			X	
Scattered					X	X		
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived reference state (PRS)	**Continuous**	**Clumped**	**Scattered**	**Sparse**
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))

Percentage vegetation cover (exotic)						
	0%	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Vegetation cover %				X		
PVC score	0	1	2	3	4	5
Percentage vegetation cover (bare ground)						
	0%	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Vegetation cover %			X			
PVC score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	**0**	**Very low**	**Low**	**Moderate**	**High**	**Very high**
RIS					X	
RIS Score	0	1	2	3	4	5

VIS = [(EVC)+((SIxPVC)+(RIS))] = 16