FAUNAL, FLORAL, WETLAND AND AQUATIC ASSESSMENT AS PART OF THE ENVIRONMENTAL ASSESSMENT AND AUTHORISATION PROCESS FOR THE PROPOSED RIETVLEI COLLIERY OUTSIDE MIDDELBURG, MPUMALANGA PROVINCE

Prepared for

WSP Group

April 2014

SECTION B – Floral Assessment

Prepared by:	**Scientific Aquatic Services**
Report author	**N. Cloete**
Report reviewers	**S. van Staden (Pri. Sci. Nat)**
Report Reference:	**SAS 213295**
Date:	**April 2014**

Scientific Aquatic Services CC
CK Reg No 2003/078943/23
Vat Reg. No. 4020235273
91 Geldenhuis Road
Malvern East Ext 1
2007
Tel: 011 616 7893
Fax: 086 724 3132
E-mail: admin@sasenvironmental.co.za

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

EIA	Environmental Impact Assessment
EAP	Environmental Assessment Practitioner
EVC	Extent of vegetation cover
HU	Habitat Unit
IUCN	International Union for Conservation of Nature
NEMA	National Environmental Management Act
PES	Present Ecological State
POC	Probability of Occurrence
PRECIS	Pretoria Computer Information Systems
PVC	Percentage cover of indigenous species
QDS	Quarter Degree Square
RDL	Red Data Listed
RIS	Recruitment of indigenous species
SANBI	South African National Biodiversity Institute
SAS	Scientific Aquatic Services
SI	Structural intactness
VIS	Vegetation Index Score

1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a faunal, floral, wetland and aquatic assessment as part of the Environmental Assessment (EIA) and authorisation process for the proposed Rietvlei Colliery, hereafter referred to as the "subject property". The subject property is situated south-east of the R555, outside Middelburg, Mpumalanga Province (25°40'18.59"S 29°39'16.47"E). The total area of the subject property extends over approximately 747.16ha.

The subject property is surrounded by properties on which agricultural activities dominate and the subject property itself is currently used for forestry purposes as well as areas used for crop cultivation. The ecological assessment was done with special focus on areas earmarked for mining as well as areas considered of higher ecological importance and sensitivity. The surrounding area was however considered as part of the desktop assessment.

The purpose of the report is to present the floral inventories of species encountered on site, to determine and describe the habitat, communities and ecological state of the subject property. Furthermore, a Red Data Listed (RDL) floral species survey was conducted and sensitive landscape areas were identified. Through this, it will allow informed decision making by the authorities, proponent and Environmental Assessment Practitioner (EAP) consultants.

1.2 Assumptions and limitations

The following assumptions and limitations are applicable to this section of the report:

- The ecological assessment is confined to the subject property and does not include the neighbouring and adjacent properties; these were however considered as part of the desktop assessment; and
- With ecology being dynamic and complex, some aspects (some of which may be important) may have been overlooked. It is, however, expected that most floral communities have been accurately assessed and considered as per the season of the assessment.

2 GENERAL SITE SURVEY

Field assessments were undertaken during April and October 2011 and January 2014, in order to determine the ecological status of the subject property. 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 RDL species. Sites were investigated on foot in order identify the occurrence of the dominant plant species and habitat diversities.

3 FLORAL METHOD OF ASSESSMENT

3.1 Vegetation Index Score (VIS)

The 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 subject property 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 B) 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
EVC2 - Total site disturbance score:						
Disturbance score	**0**	**Very Low**	**Low**	**Moderately**	**High**	**Very High**
Site score						
EVC 2 score	5	4	3	2	1	0

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

	Trees (SI1)		**Shrubs (SI2)**		**Forbs (SI3)**		**Grasses (SI4)**	
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 (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):						
Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
PVC Score	0	1	2	3	4	5
Percentage vegetation cover (bare ground):						
Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
PVC Score	0	1	2	3	4	5

4. ***RIS***

Extent of indigenous species recruitment	**0**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**

RIS	0	1	2	3	4	5

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

Table 1: The VIS score sheet for each assessment class.

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

3.2 Red Data Species Assessment

Prior to the field visit, a record of RDL floral species and their habitat requirements was acquired from the South African National Biodiversity Institute (SANBI) for the Quarter Degree Square (QDS) 2529DA. Throughout the floral assessment, special attention was paid to the identification of any of these RDL species as well as identification of suitable habitat that could potentially sustain these species.

The Probability of Occurrence (POC) for each floral species of concern (within the QDS 2529DA) 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						
Score	0	1	2	3	4	5

Habitat availability

	No Habitat available					Habitat available
Site score						
Score	0	1	2	3	4	5

Habitat disturbance

	0	Very Low	Low	Moderately	High	Very High
Site score						
Score	5	4	3	2	1	0

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

4 RESULTS OF FLORAL INVESTIGATION

The subject property is located within a district utilised for cultivation of maize with gravel roads and farm infrastructure encountered throughout. Large sections of the subject property are currently used for forestry purposes and areas of edible crop lands are also located within the subject property. Therefore the majority of the subject property is considered transformed. However, some natural grassland and wetland features, were found within the subject property that can be considered less transformed.

As a result the subject property can be divided into three dominant habitat units namely transformed grassland habitat; transformed habitat (consisting of plantation areas, bare soil / gravel roads, and agricultural lands) and wetland habitat, discussed in detail below. Each of these habitat units identified was individually assessed to determine the PES of the subject property as a whole.

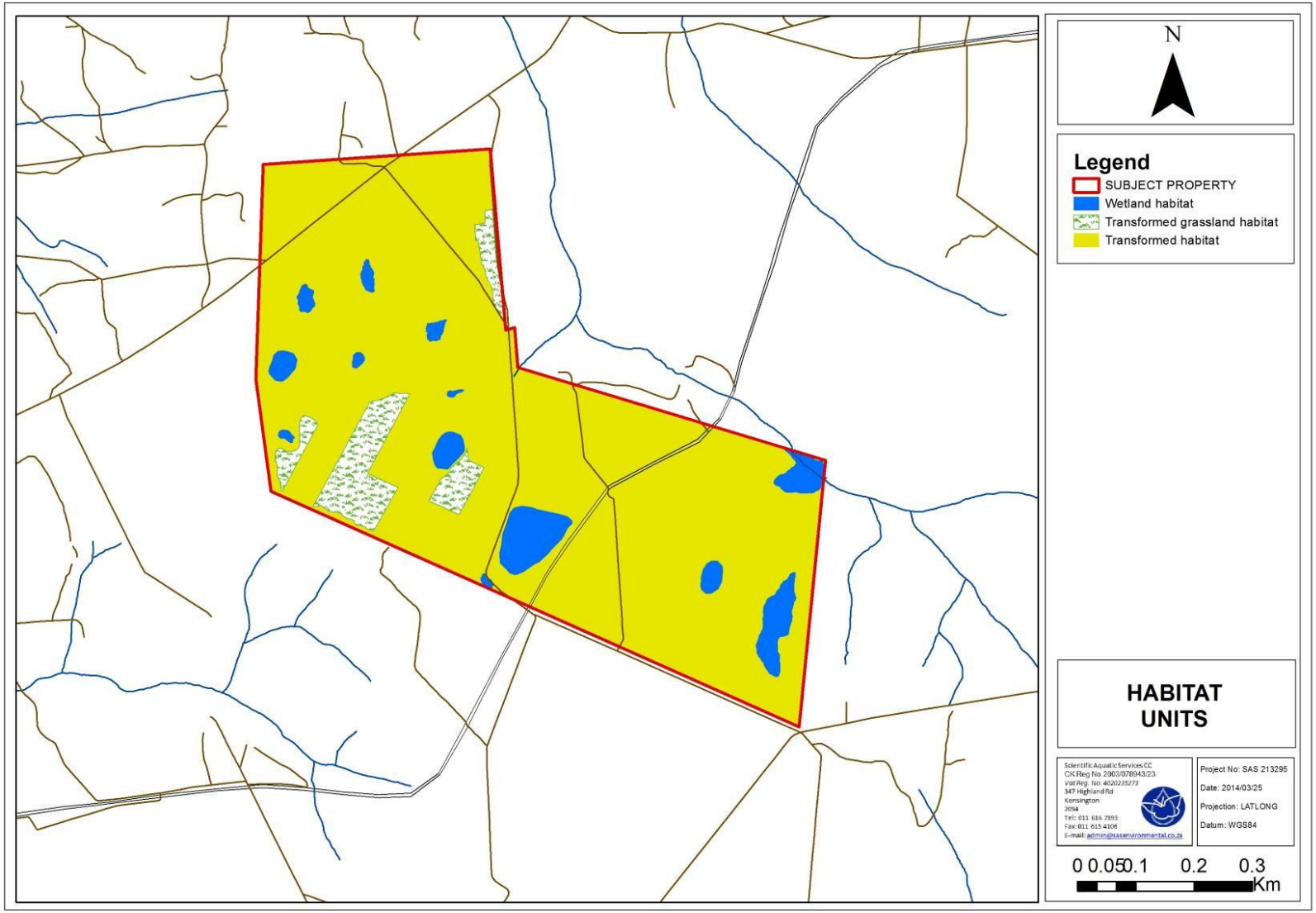


Figure 1: Habitat units identified within the subject property.

4.1 Habitat unit 1: Transformed Grassland habitat

This habitat unit is located between the plantations on the subject property. Very few natural grassland areas remain on the subject property due to the surrounding agricultural and plantation activities that are dominant within the subject property. Floral species found within this habitat unit included *Eucalyptus species*, *Themeda triandra,* various *Eragrostis sp.* species*, Aristida junciforme; Hyparrhenia hirta, Helichrysum setosum, Helichrysum kraussii and Hypoxis rigidula.*

The transformed grassland habitat unit is considered to be of low ecological importance due to historic and on-going activities and disturbance such as agricultural and plantation activities. The transformed grassland unit is affected by alien vegetation encroachment such as *Eucalyptus* sp. and *Tagetes minuta* growing between these transformed grassland sections.

Due to the high level of vegetation transformation mining activities within this habitat unit will have no significant impact on the local ecological conservation of floral species. Table 2 lists the floral species identified during the assessment.

Figure 2: The transformed grassland areas among the plantations.

Table 2: Floral species identified during the assessment of the subject property.

Trees	Grass	Shrub/forb
Acacia mearnsii	*Andropogon eucomus*	*Albuca setosa*
Acacia podalyriifolia	*Aristida congesta*	*Berkheya radula*
Eucalyptus camaldulensis	*Aristida junciforme*	*Calliepis leptophylla*
Eucalyptus cinerea	*Cynodon dactylon*	*Cephalaria zeyheri*
Eucalyptus grandis	*Cyperus esculentis*	*Euphorbia striata*
	Cyperus longus	*Denekia capensisi*
	Cyperus marginatus	*Felicia muricata*
	Cyperus rupestris	*Gazania krebsiana*
	Digitaria eriantha	*Helichrysum krassii*
	Eragrostis curvula	*Helichrysum setosum*

Trees	Grass	Shrub/forb
	Eragrostis chloromelas	*Helichrysum pilosellum*
	Eragrostis plana	*Hypoxis radula*
	Eragrostis rigida	*Ledebouria ovatifolia*
	Heteropogon contortus	*Lopholaena coriifolia*
	Hemarthria altissima	*Mariscus congesta*
	Hyparrhenia hirta	*Monopsis decipiens*
	Imperata cylindrica	*Nemesia fruticans*
	Melinis repens	*Pelargonium pseudofumariodes*
	Pogonathria squarrosa	*Rhynchosia totta*
	Sporobolus centrifugus	*Senecio affinis*
	Themeda triandra	*Senecio inaequidens*
	Typha capensis	*Senecio gregatus*
		Seriphium plumosum
		Tagetes minuta
		Taraxacum officinale
		Verbena bonariensis
		Wahlenbergia eucomus

4.2 Habitat Unit 2: Transformed habitat

Areas which are not characterised as wetlands or transformed grassland areas have been transformed by either crop cultivation or used for forestry purposes. This has led to the alteration of the floral community structure to the extent that it is completely irreversible in some areas.

Ecological functioning was found to be very low in most areas. Alien species consisted of mainly weeds or invaders such as *Eucalyptus sp*. *Datura stramonium, Cirsium vulgare, Bidens pilosa, B. formosa* and *Tagetes minuta.* As the floral community structure and habitat characteristics have been altered, the likelihood of RDL floral species occurring here is very low. Thus this habitat unit is not regarded as sensitive and does not provide an ecologically important function. Any mining activity within this habitat unit is not regarded a threat to the overall floral biodiversity within the region.

Figure 3: Transformed areas associated with agricultural related farming activities

Figure 4: *Eucalyptus sp.* plantations dominated most areas of the subject property (left). *Pinus patula* were also located within the transformed habitat unit and alongside wetland features (right).

4.3 Habitat Unit: Wetland habitat

Several wetland and pan features were identified within the subject property. The pan features were characterised as endorheic depression systems and the wetland features as a flat seepage according to the National Freshwater Ecosystem Priority Areas (NFEPA) water management database.

Further to this the wetland features within the subject property was divided into two broad categories namely wetland features with permanent zones of saturation and wetland features with no permanent zones of saturation (Table 3 and Figure 5). For detail on the function attributes of the wetland and pan features, refer to section D (Wetland Assessment) of the reports.

Table 3: The two broad wetland feature types identified within the subject property.

Wetland features with permanent zones of saturation (Permanent wetland)	Wetland features with no permanent zones of saturation (Seasonal Wetland)
Pan 1	Pan 4
Pan 2	Pan 5
Pan 3	Wetland 1
Pan 6	Wetland 2
Selons River	Wetland 3
	Wetland 4
	Wetland 5
	Wetland 6
	Wetland 7

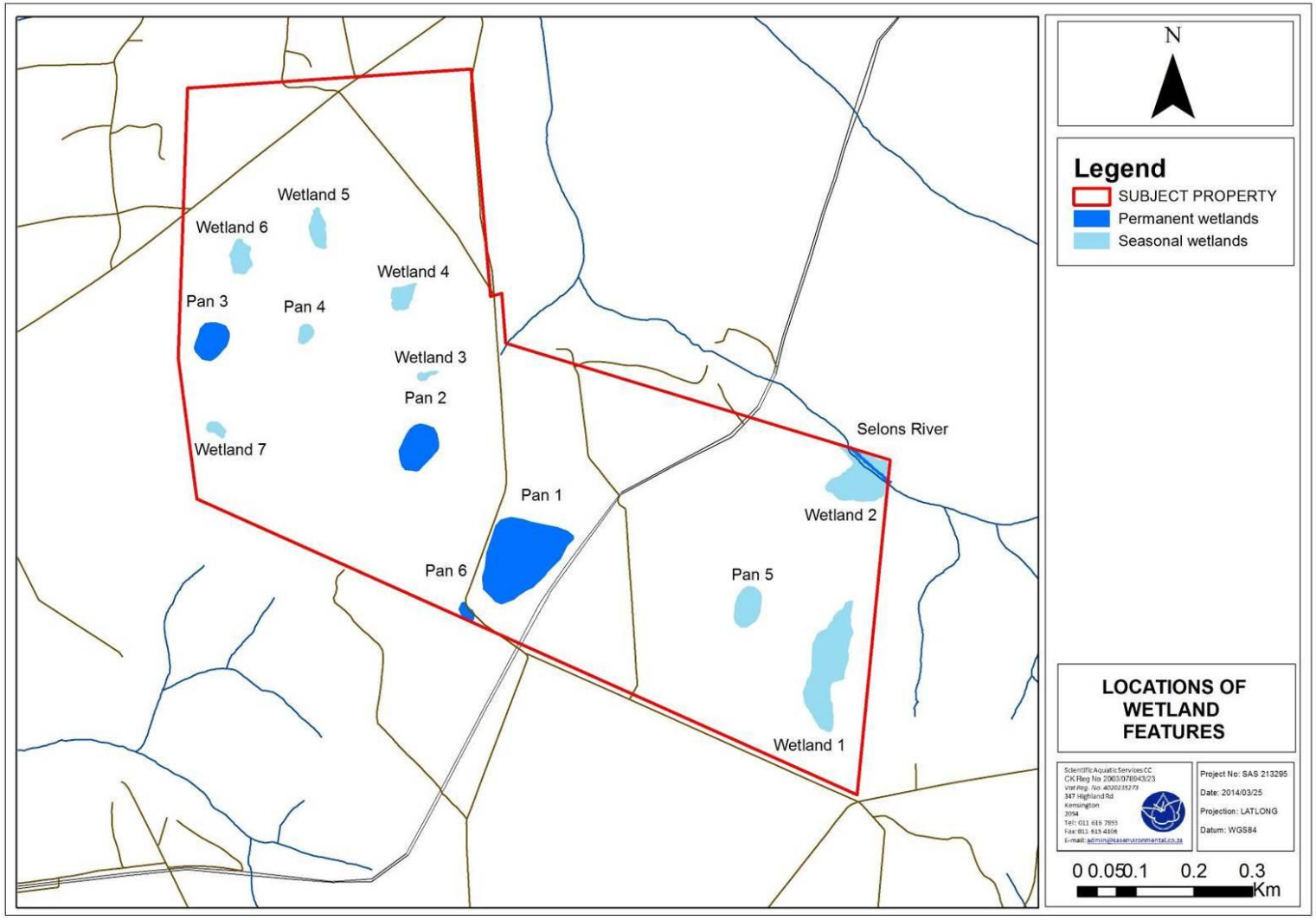


Figure 5: Location of the permanent and non-permanent wetland features within the subject property.

Upon the assessment of the subject property, the various wetland vegetation components were assessed. Dominant species were characterised as either wetland or terrestrial species. The wetland species were then further categorised as temporary, seasonal and permanent zone species. This characterisation is presented in the tables below, including the terrestrial species identified on the subject property.

Table 4: Dominant floral species identified during the wetland delineation of the wetland features with permanent zones (Pan 1-3, 6 and the Selons River) within the subject property.

Terrestrial species	Temporary species	Seasonal species	Permanent species
Acacia mearnsii	*Brachiaria serrata*	*Andropogon eucomus*	*Cyperus esculentis*
Eragrostis chloromelas	*Cyperus esculentis*	*Brachiaria serrata*	*Cyperus rotundus*
Eragrostis rigida	*Cyperus longus*	*Eragrostis heteromera*	*Imperata cylindrica*
Eragrostis gummiflua	*Cyperus marginatus*	*Eragrostis gummiflua*	*Kylinga alba*
Eucalyptus grandis	*Cyperus rupestris*	*Helichrysum pilosellum*	*Mariscus congesta*
Denekia capensis	*Eragrostis curvula*	*Homeria pallida*	*Miscanthus junceus*
Gazania krebsiana	*Eragrostis rigida*	*Hypoxis rigida*	*Phragmites australis*
Hyparrhenia hirta	*Kylinga alba*	*Monopsis decipiens*	*Typha capensis*
Ipoemoea purpurea	*Mariscus congesta*	*Kylinga alba*	*Verbena bonariensis*
Lopholaena coriifolia	*Senecio gregatus*	*Pelargonium luridum*	
Seriphium plumosum	*Taraxicum officinalis*	*Paspalum dilatatum*	
Taraxicum officinalis	*Verbena bonariensis*	*Senecio inaequidens*	
		Sporobulus pyramidalis	
		Wahlenbergia caledonica	

Pan features 1 to 3 and 6 have mostly natural vegetation occurring, with very little alien encroachment except close to the main road and cultivated lands. These pan features could provide very good habitat for avifaunal species.

The Selons River was located on the north-eastern corner of the subject property. This river system is classified as a FEPA river, providing suitable habitat for avifaunal and aquatic species. However, some transformation has occurred within the river system due to grazing of livestock and vegetation clearance resulting in erosion of the river banks. Refer to the sensitivity mapping in Section D (Wetland Assessment Report).

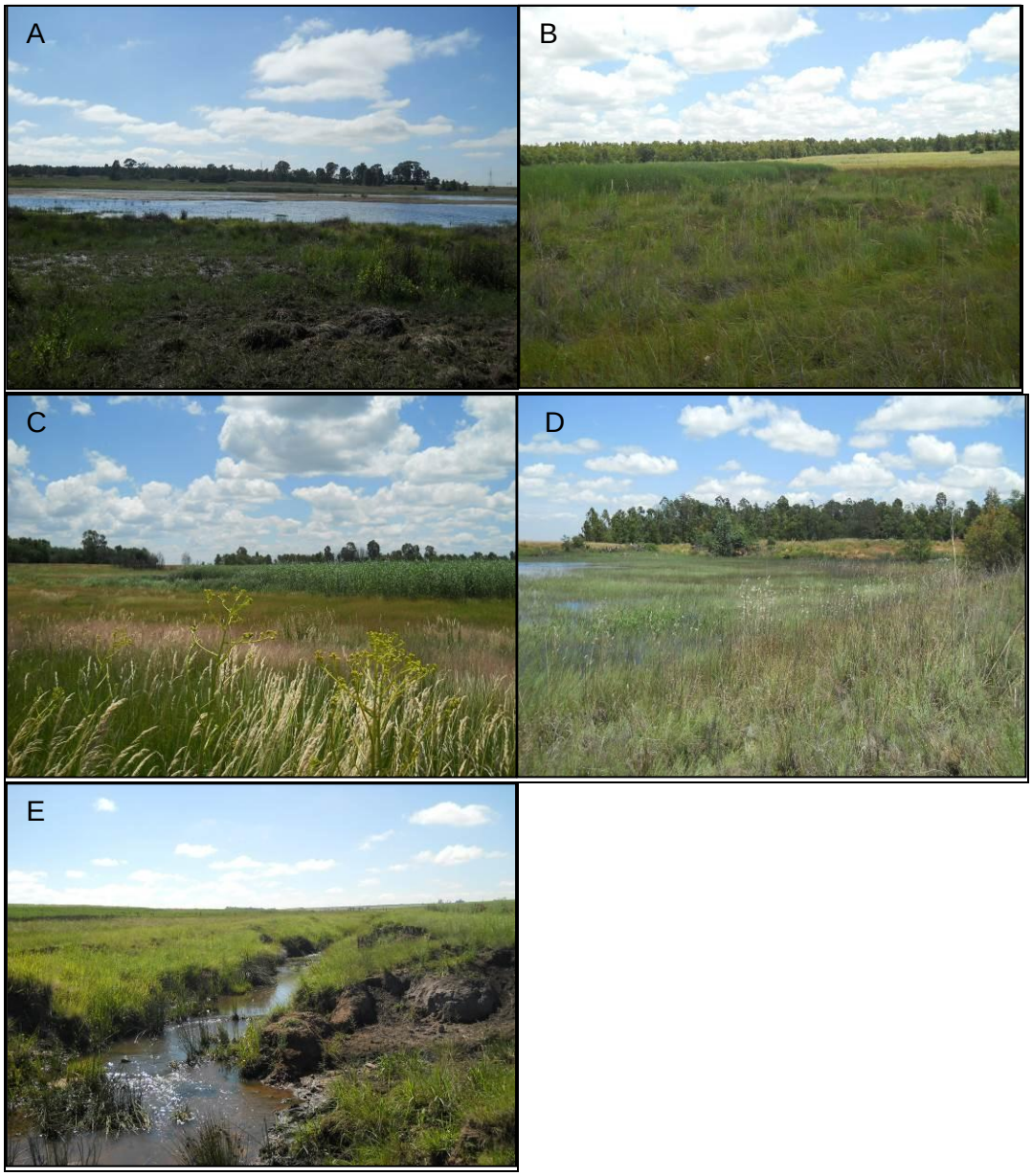


Figure 6: The wetland features with permanent zones identified within the subject property: a) Pan 1, b) Pan 2, c) Pan 3 d) Pan 6 and e) Selons River.

Table 5: Main floral species identified during the wetland delineation of the wetland features with no permanent zones (Pan 4-5, Wetland 1-7) within the subject property.

Terrestrial species	Temporary species	Seasonal species
**Acacia mearnsii*	*Cyperus esculentis*	*Andropogon eucomus*
Eragrostis chloromelas	*Cyperus longus*	*Cyperus marginatus*
Eragrostis rigida	*Cyperus marginatus*	*Cyperus rupestris*
Eragrostis curvula	*Cyperus rupestris*	*Eragrostis heteromera*
Eragrostis gummiflua	*Eragrostis rigida*	*Helichrysum pilosellum*
**Eucalyptus grandis*	*Imperata cylindrica*	*Homeria pallida*

Terrestrial species	Temporary species	Seasonal species
Denekia capensis	*Kylinga alba*	*Hypoxis rigida*
Gazania krebsiana	*Mariscus congesta*	*Monopsis decipiens*
Hyparrhenia hirta	*Senecio gregatus*	*Paspalum dilatatum*
**Ipomoea purpurea*	**Verbena bonariensis*	*Pelargonium luridum*
Lopholaena coriifolia		*Senecio inaequidens*
**Seriphium plumosum*		*Sporobulus pyramidalis*
Themeda triandra		*Wahlenbergia caledonica*

Exotic and invader vegetation species were mainly encountered within the wetland features with no permanent zones of saturation (seasonal wetland features). Although some alien encroachment occurred due to the adjacent plantation and agricultural activities, pockets of well vegetated habitat still occur within these features and will provide foraging and breeding habitat for flora and fauna species.

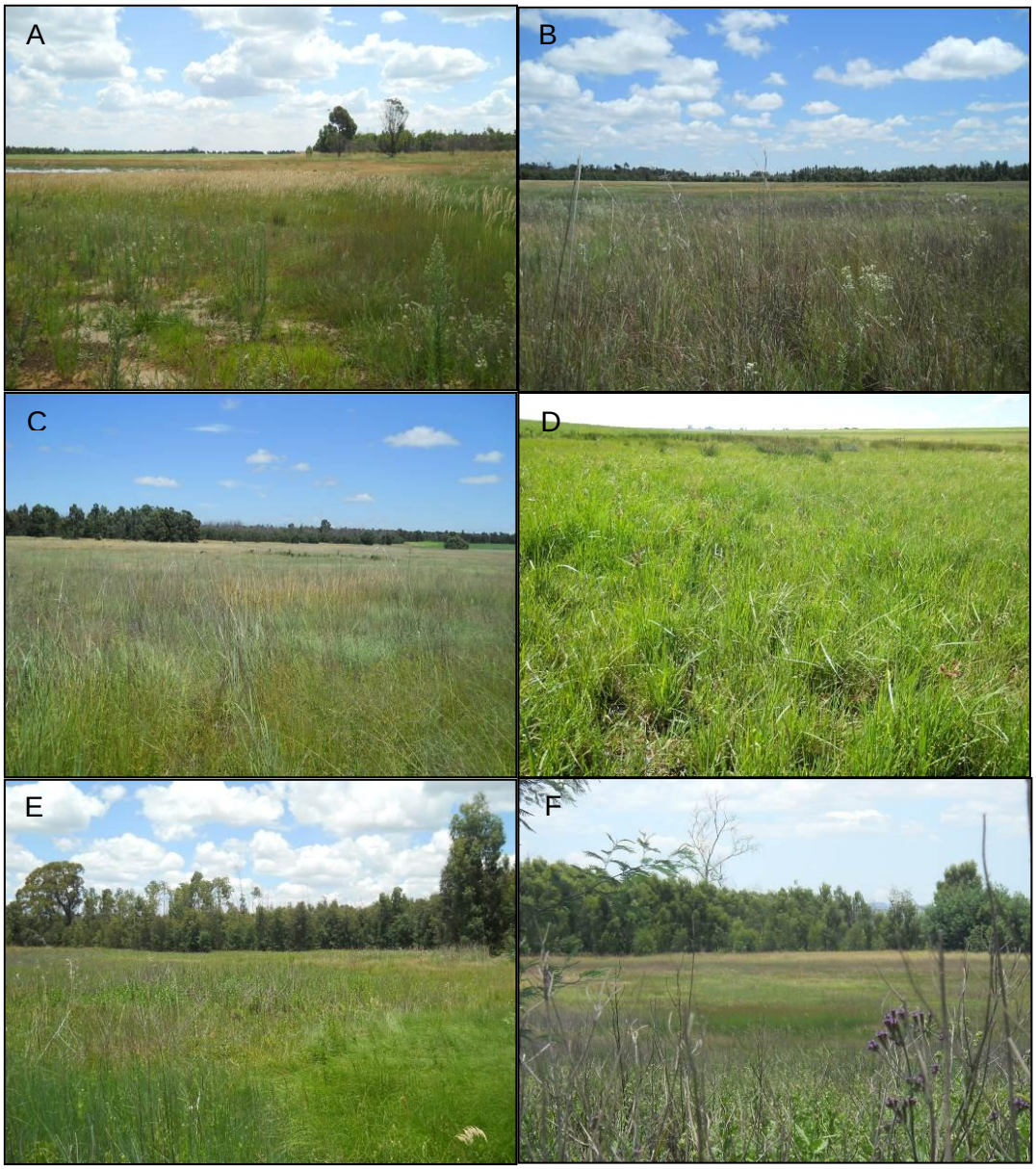


Figure 7: The seasonal wetland features identified within the subject property: a) Pan 4, b) Pan 5, c) Wetland 1, d) Wetland 2, e) Wetland 3 and f) Wetland 4.

Figure 8: The seasonal wetland features identified within the subject property: g) Wetland 5, h) Wetland 6 and i) Wetland 7.

4.4 Floral Community Assessment

Grass communities can provide information regarding the ecological status of specific areas within a subject property. If the species composition is quantitatively determined and characteristics of all components of the grass communities are taken into consideration, it is possible to determine the PES of the portion of land represented by the assessment point. Any given grass species is specifically adapted to specific growth conditions. This sensitivity to specific conditions make grasses good indicators of veld conditions.

The sections below summarise the dominant grass species identified within the transects with their associated habitats and optimal growth conditions with reference to the table and figure below. It should be noted that transect locations were chosen within all areas moderately representative of vegetation in a good condition, therefore areas with complete vegetation transformation such as the transformed habitat unit which have been disturbed due to alien and invader vegetation, were not assessed using this method. These transformed areas were however assessed using the VIS (see section below).

Table 6: Grouping of gasses (Van Oudtshoorn, 2006).

Pioneer	Hardened, annual plants that can grow in very unfavourable conditions. In time improves growth conditions for perennial grasses.
Subclimax	Weak perennials denser than pioneer grasses. Protects soils leading to more moisture, which leads to a denser stand, which deposits more organic material on the surface. As growth conditions improve climax grasses are replaced by subclimax grasses.
Climax	Strong perennial plants adapted to optimal growth conditions.
Decreaser	Grasses abundant in good veld.
Increaser I	Grasses abundant in underutilized veld.
Increaser II	Grasses abundant in overgrazed veld.
Increaser III	Grasses commonly found in overgrazed veld.

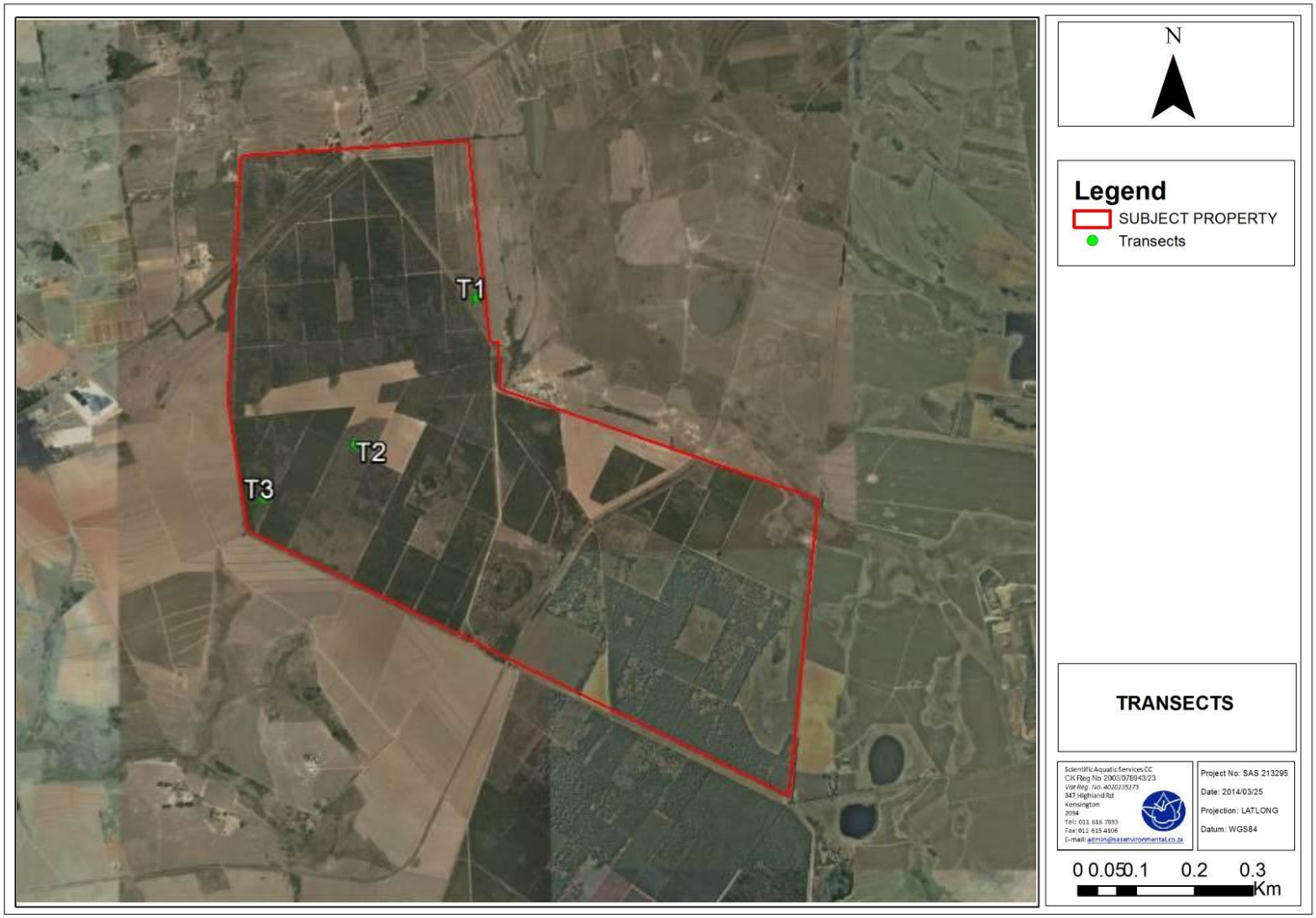
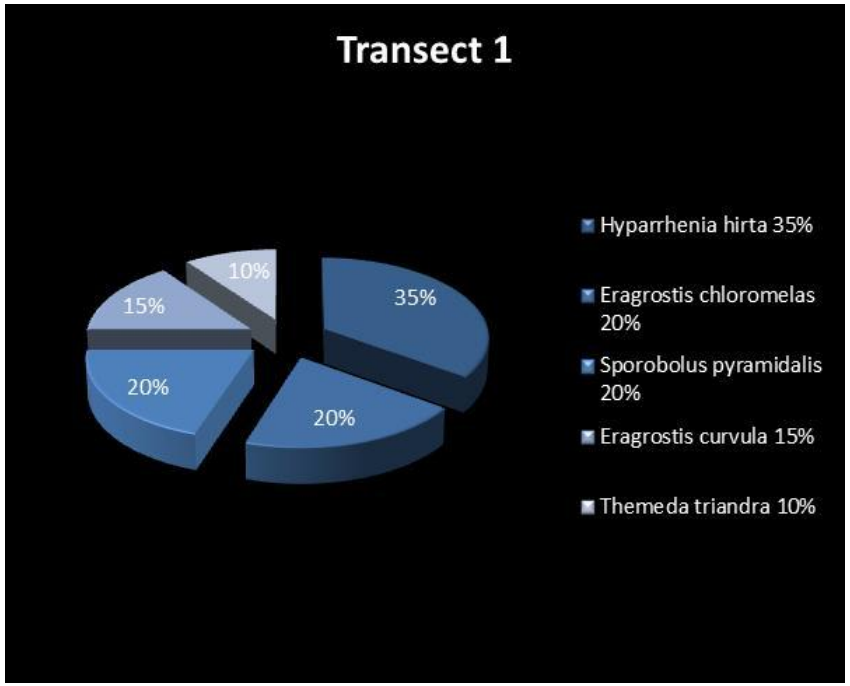


Figure 9: Digital satellite image depicting location of the transects.

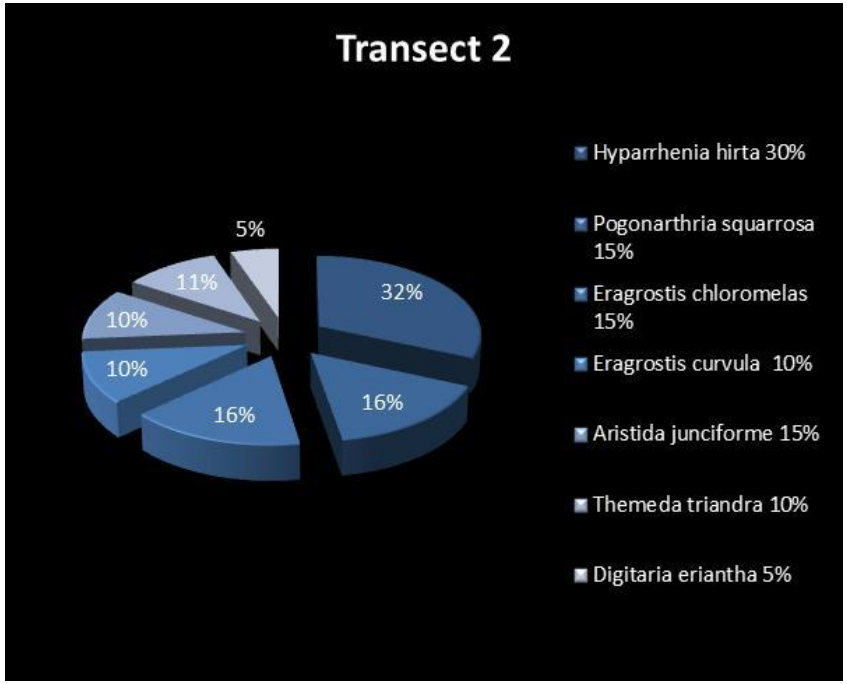


Transect 1 – Close to seasonal wetland feature 2

- *Hyparrhenia hirta* (Common thatching grass) [Increaser I, Climax grass]. Grows well in drained soil, especially gravelly soil, in open grassland, as well as in bushveld. It is often found in disturbed places such as old cultivated lands and road reserves. It is also sometimes found along riversides on heavier soil.
- *Themeda triandra* (Red grass) [Decreaser, climax grass]. Red grass is abundant in undisturbed open grassland and bushveld in parts with an average to high rainfall.
- *Eragrostis curvula* (Weeping love grass) [Increaser II, subclimax, climax grass]. Usually grows in disturbed places such as old cultivated land and along roadsides, mostly in well-drained fertile soil. It is associated with regions with a high rainfall with overgrazed and trampled veld.
- *Eragrostis chloromelas* (Narrow curly leaf) [Increases II, subclimax and climax grass]. Curly leaf grows on stony slopes in sandy and loam soil. It is more common in open grassland than in the bushveld.
- *Sporobolus pyramidalis* (Cats tail dropseed) [Increaser II, subclimax grass]. Catstail dropseed grows in disturbed places such as trampled veld and old cultivated lands in areas with high rainfall or in damp places. It is often found near kraals or other places where animals pass by. It grows in all soil types, especially in fertile soils.

Conclusion: Majority of identified species are floral species with high affinity for moist soils and transformed grassland with special mention of *Sporobolus pyramidalis* and *Hyparrhenia hirta* dominating the area

Figure 10: Transect 1



Transect 2 – Transformed grassland habitat

- *Hyparrhenia hirta* (Common thatching grass) [Increaser I, Climax grass]. Grows well in drained soil, especially gravelly soil, in open grassland, as well as in bushveld. It is often found in disturbed places such as old cultivated lands and road reserves. It is also sometimes found along riversides on heavier soil.
- *Eragrostis curvula* (Weeping love grass) [Increaser II, subclimax, climax grass]. Usually grows in disturbed places such as old cultivated land and along roadsides, mostly in well-drained fertile soil. It is associated with regions with a high rainfall with overgrazed and trampled veld.
- *Eragrostis chloromelas* (Narrow curly leaf) [Increases II, subclimax and climax grass]. Curly leaf grows on stony slopes in sandy and loam soil. It is more common in open grassland than in the bushveld.
- *Themeda triandra* (Red grass) [Decreaser, climax grass]. Red grass is abundant in undisturbed open grassland and bushveld in parts with an average to high rainfall. It grows in any type of soil, but mostly in clay soil.
- *Digitaria eriantha* (Common finger grass) [Decreaser, climax grass]. Common finger grass grows in sandy and gravel soil in parts that are more arid and in damp soils such as vleis in areas with high rainfall. It utilises a wide range of other habitat types. It mainly grows in undisturbed veld.
- *Pogonarthria squarrosa* (Herringbone grass) [Increaser II, subclimax grass]. Herringbone grass grows in disturbed places such as roadsides but is also sparsely distributed in undisturbed veld
- *Aristida junciforme* (Gongoni Tree-awn) [Climax grass, Increaser II]. It grows in most types of soil, but mostly in poor, gravelly soil on slopes and in clay soil in vleis and other wet places.

Conclusion: Majority of identified species are grass species with high affinity for moist soils and transformed grassland with special mention of *Eragrostis chloromelas, Eragrostis curvula* and H*yparrhenia hirta* dominating the area. Other species occurring in undisturbed areas includes *Themeda triandra* and *Digitaria eriantha*.

Figure 11: Transect 2.

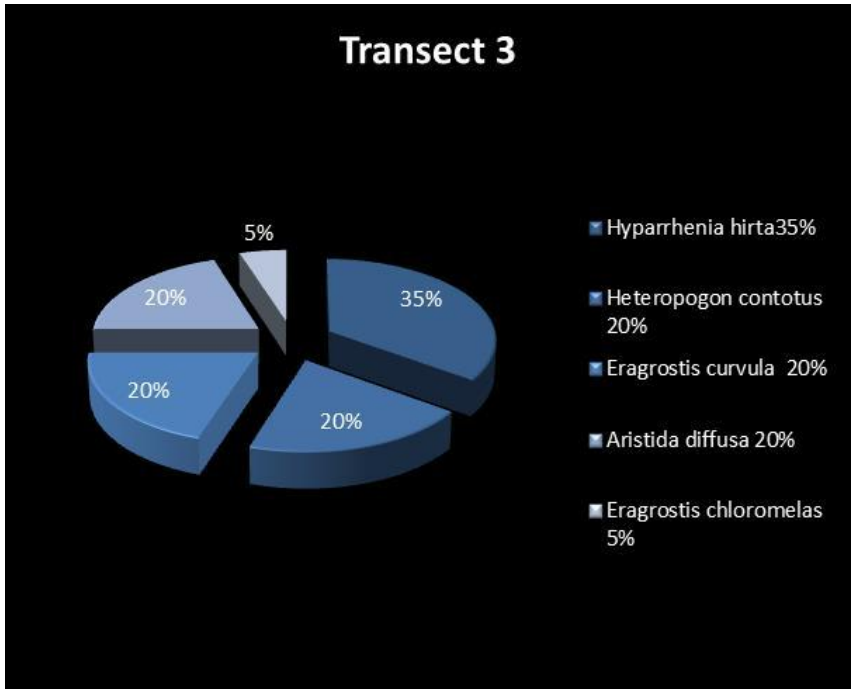


Figure 12: Transect 3.

Transect 3 – South eastern portion of subject property (Pan 1)

- *Hyparrhenia hirta* (Common thatching grass) [Increaser I, Climax grass]. Grows well in drained soil, especially gravelly soil, in open grassland, as well as in bushveld. It is often found in disturbed places such as old cultivated lands and road reserves. It is also sometimes found along riversides on heavier soil.
- *Eragrostis curvula* (Weeping love grass) [Increaser II, subclimax, climax grass]. Usually grows in disturbed places such as old cultivated land and along roadsides, mostly in well-drained fertile soil. It is associated with regions with a high rainfall with overgrazed and trampled veld.
- *Eragrostis chloromelas* (Narrow curly leaf) [Increases II, subclimax and climax grass]. Curly leaf grows on stony slopes in sandy and loam soil. It is more common in open grassland than in the bushveld.
- *Aristida diffusa* (Iron grass) [Increaser III, subclimax and climax grass]. Common finger grass grows in sandy and gravel soil in more arid Iron grass grows in a variety of soil types but mostly on slopes in gravelly soils. It is particularly associated with shallow soils in overgrazed veld.
- *Heteropogon contortus* (Spear grass) [Increases, subclimax grass]. Spear grass grows especially in gravelly and other well-drained soil. It often grows on slopes and in disturbed places such as road reserves where it can form dense stands.

Conclusion: Majority of identified species are grass species, which are indicative of transformed grassland with special mention of H*yparrhenia hirta*, which dominates the area.

The grass species diversity within the transformed grassland habitat unit, assessed, was relatively low due to the degree of vegetation transformation in some habitat units. *Eragrostis* species dominated the grassland area. The vegetation community within the transformed areas were dominated by grass species associated with disturbance. The dominant species associated with disturbance within the areas where the transects were undertaken included *Eragrostis curvula, Hyparrhenia hirta,* and *Eragrostis chloromelas*. The grass community is in a sub-climax condition, no primary grasslands occur on the subject property and the proposed mining activitty does not pose a threat to grassland conservation.

4.5 RDL Floral Assessments

An assessment considering the presence of any floral species of concern, as well as suitable habitat to support any such species, was undertaken. The complete PRECIS (Pretoria Computer Information Systems) floral list for the grid references (2529DA) was enquired from SANBI - see tables below.

Table 7: IUCN RDL Categories – Version 3.1 as supplied by SANBI

Category	Definition
EX	Extinct
EW	Extinct in the wild
CR	Critically endangered
EN	Endangered
VU	Vulnerable
NT	Near threatened
LC	Least concern
DD	Data deficient
NE	Not evaluated

The threatened status of all species listed within the QDS 2529DA was categorised as either least concern or not evaluated. No RDL floral species were listed within the QDS. In addition no RDL floral species were recorded within the subject property during the site assessment.

4.6 VIS

The information gathered during the assessment of the subject property was used to determine the VIS - see Appendix B for calculations. The tables below list the scoring system as well as the results.

Table 8: Scoring for the VIS.

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 9: VIS calculated for each habitat unit.

Habitat unit	Score	Class	Motivation
Transformed habitat	5	**Class E – extensive loss of natural habitat**	This habitat unit is associated primarily with the plantations, alien proliferation as well as agricultural activities. The ecological functionality and habitat integrity of the transformed habitat Unit is regarded as being extremely limited.
Transformed grassland habitat	6	**Class D – largely modified**	This habitat unit has undergone vegetation transformation due to the surrounding alien encroachment and tree plantations
Wetland habitat	16	**Class C – moderately modified**	This habitat unit has undergone some transformation due to the surrounding tree plantations but still provides suitable habitat for numerous wetland floral species and foraging habitat for avifaunal species.

4.7 Alien and Invasive Floral Species

Alien invaders 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.

The table below indicated the alien and invader species identified during the site assessment.

Table 10: Exotic or invasive species within the subject property.

Species	English name	Type or Origin	Category*
Acacia mearnsii	Black wattle	Eurasia	2
Acacia podalyriifolia	Pearl acacia	Australia	3
Cynodon dactylon	Couch grass	Tropical Africa / Asia	N/A
Cyperus esculentis	Yellow nutsedge	Unknown	N/A
Eucalyptus grandis	Saligna gum	Australia and nearby Asia	2
Eucalyptus camaldulensis	Red river gum	Australia and nearby Asia	2
Eucalyptus cinerea	Florist's gum	Australia and nearby Asia	2
Imperata cylindrica	Cotton wool grass	Indigenous invader	N/A
Siriphium plumosum	Bankrupt bush	Indigenous invader	N/A
Taraxacum officinale	Common dandelion	Europe	
Tagetes minuta	Tall khakiweed	Native to S America	NA
Verbena bonariensis	Wild Verbena	Native to S America	1

The largest extent of the subject property was impacted by stands of alien and invasive vegetation, which include the woody species *Eucalyptus camaldulensis, Pinus patula* and *Acacia mearnsii*. Invader species also encroached into the grassland habitat unit due to the edge effects from agricultural activities and plantations.

Removal and control of invasive floral species should take place throughout the pre-construction, construction, operational and decommissioning and closure phase of the mine.

4.8 Medicinal Floral Species

Medicinal floral species are not necessarily indigenous species, with many of them regarded as alien invasive weeds. The majority of the medicinal species identified within the subject property are commonly occurring species.

The table below presents a list of 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 identified during the field assessment. Medicinal applications and application methods are also presented (van Wyk, et al., 1997; van Wyk and Gericke, 2000; van Wyk and Wink, 2004; van Wyk, Oudtshoorn, Gericke, 2009).

Species	Name	Plant parts used	Medicinal uses
Eucalyptus grandis	Saligna gum	Leaves	Oils are used in medicinal preparations (inhalants and ointments), soaps, detergents, food, dentistry and veterinary products.
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.
Tagetes minuta	Tall khakiweed	Leaves	The essential oils are used in perfumery and as a flavourant in food, beverages and tobacco. Some gardeners use warm water extracts of the fresh plant to keep roses and other plants free from insects and fungal diseases

Of these medicinal species listed above, none is listed as protected or conservational concern species. No important medicinal floral communities will be lost or impacted upon by the proposed development activities.

5 SENSITIVITY MAPPING

The subject property has been transformed due to numerous current and historic anthropogenic activities such as tree plantations resulting in alien encroachment and a decrease in the natural floral asseblage. As a result, vegetation transformation has occurred throughout the subject property and can be considered irreversible in some portions.

The figure below illustrates the sensitivity of the subject property. High and medium sensitivity areas included pan feature 1 and 3 and 6 and the Selons River with associated 100m buffers. Low sensitivity was allocated to the seasonal wetland sections. The

remainder of the site is considered very low due to the complete vegetation transformation of agricultural and plantation activities.

It can be concluded that the mining footprint and activities will have a significant effect on the wetland features with permanent zones (Pan 1-3, 6 and the Selons River) specifically referring to the highly sensitive features should mitigation measures not be implemented. Thus, layout planning of the mine footprint should consider higher sensitivity areas as “no-go” areas. Based on the observations of the study, mining infrastructure should, as far as possible, be limited to the previously disturbed areas, such as the crop fields and plantation areas. Should mining activity occur within any of the wetland features, relevant authorisation should be acquired according to the National Environmental Management Act (NEMA) 107 of 1998 and Sections 21 c and i of the National Water Act 36 of 1998.

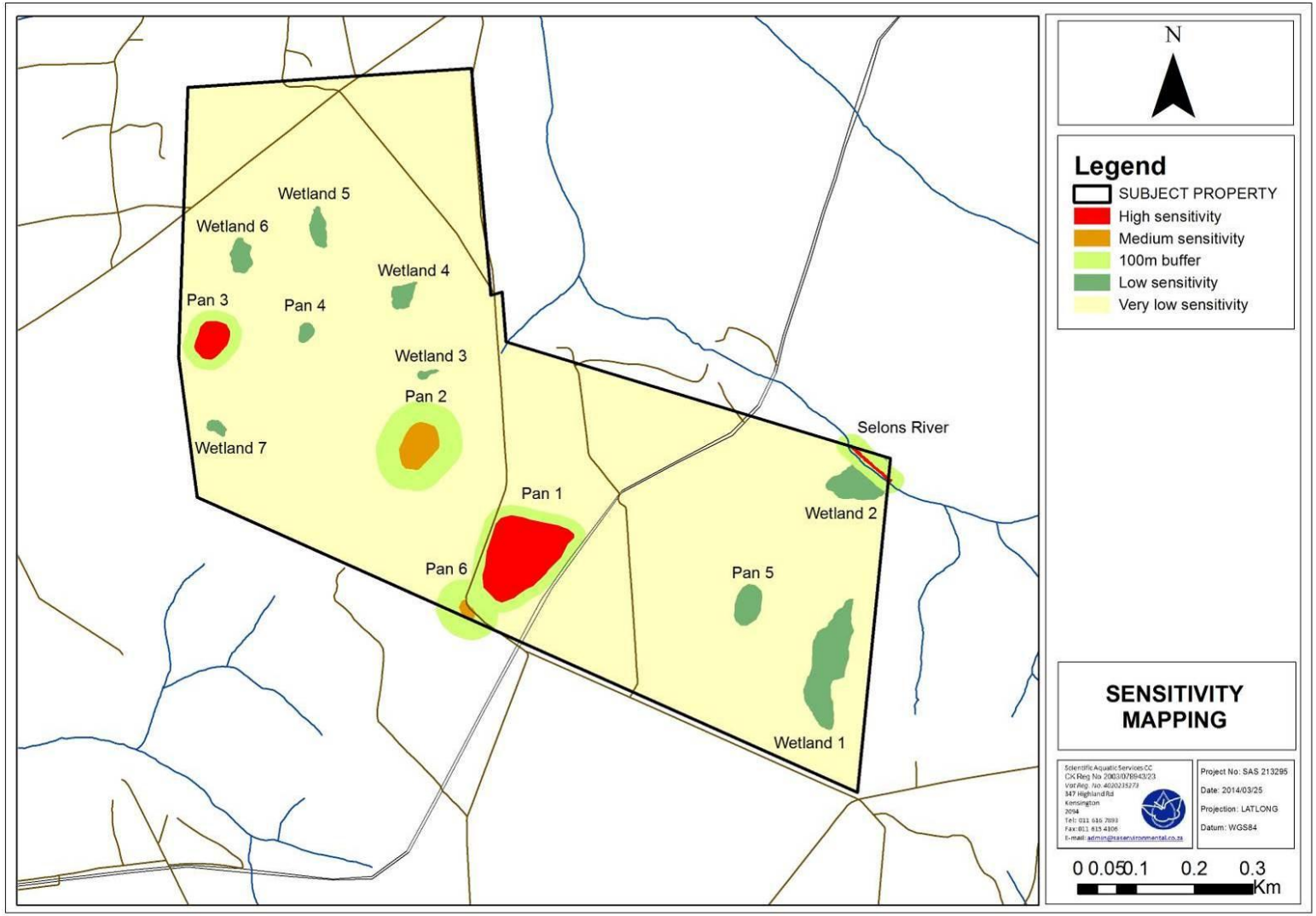


Figure 13: The overall sensitivity map of the subject property.

6 IMPACT ASSESSMENT

The tables below serve to summarise the significance of potential impacts on the floral communities occurring on or directly adjacent to the subject property. A summary of all potential pre-construction, construction, operational and decommissioning and closure phase impacts is provided. 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.

6.1 Impact Discussion

All proposed development activities that may result in an impact on the floral communities of the subject property are discussed below.

6.1.1 IMPACT 1: Impacts on habitat for floral species

Activities leading to impact

Pre-Construction	Construction	Operational	Decommissioning & Closure
Planning of mine infrastructure placement and design leading to overall loss of floral habitat within areas of increased ecological sensitivity	Site clearing and the removal of vegetation	Ongoing disturbance of soils with general operational activities leading to altered floral habitat	Ineffective rehabilitation of exposed and impacted areas and failure to implement an alien floral control plan may lead to ongoing loss of floral habitat
Inadequate design of infrastructure leading to pollution of soils and ground water	Encroachment of construction activities into more sensitive areas within the subject property could lead to loss of indigenous floral habitat	Discharge and contamination from operational facilities may pollute receiving environment	Disturbance of soils as part of demolition activities may alter floral habitat
Inadequate design of infrastructure leading changes in floral habitat	Site clearing and the disturbance of soils	Seepage affecting soils and the groundwater regime	Ongoing seepage and runoff may affect the groundwater regime beyond closure
	Movement of construction vehicles and access road construction impacting on floral habitat	Runoff and seepage from operational facilities may lead to habitat loss	Ongoing risk of discharge from mining facilities beyond closure

	Dumping of construction material leading to loss of floral habitat	Ongoing disturbance may lead to erosion and sedimentation of wetland features	Ineffective rehabilitation of exposed and impacted areas and failure to control alien floral species may lead to ongoing loss of floral habitat
	Compaction of soils due to construction activities affecting floral habitat	Ineffective monitoring during operational activities due to poor management	Insufficient aftercare and maintenance leading to post closure impacts on floral habitat due to poor management
			Insufficient aftercare and maintenance leading to unchecked erosion and sedimentation
			Ineffective monitoring of rehabilitation due to poor management

Aspects of floral ecology affected

Construction	Operational	Decommissioning & Closure
Impact on floral wetland habitat	Impact on floral wetland habitat	Direct impact on floral habitat during decommissioning
Loss of floral biodiversity	Loss of floral biodiversity	Loss of floral biodiversity
Contamination of soils	Contamination of soils	Ongoing contamination of soils
Contamination of ground and surface water	Contamination of ground and surface water	Ongoing contamination of ground and surface water after decommissioning
Compaction and loss of soils	Compaction and loss of soils	Compaction and loss of soils during decommissioning
Sedimentation and erosion	Sedimentation and erosion	Sedimentation and erosion
		Changes to the floral communities due to alien invasive vegetation leading to altered habitat conditions

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
	4	3	3	3	5	7	11	77 (Medium-High)

Essential mitigation measures:

- A sensitivity map has been developed for the subject property, indicating the Wetland habitat units, which are considered to be of increased ecological importance. It is recommended that this sensitivity map be considered during all development phases to aid in the conservation of floral habitat within the subject property.
- No activities are to infringe upon these sensitive areas or associated buffer zones.
- The boundaries of the development footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas.
- Edge effects of all construction and operational activities, such as erosion and alien plant species proliferation, which may affect floral habitat, need to be strictly managed in all areas of increased ecological sensitivity.
- 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.
- 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.
- It must be ensured that mining related waste or spillage and effluent do not affect the sensitive habitat boundaries and associated buffer zones.
- It must be ensured that the mine process water system is managed in such a way as to prevent discharge to the receiving environment.
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss.
- Proliferation of alien and invasive species is expected within any disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the mine expansion and development footprint areas. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled.
- All soils compacted as a result of construction activities falling outside of development footprint 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 including

decommissioning phases to prevent loss of floral habitat.

- To prevent the erosion of top soils, management measures may include berms, soil traps, hessian curtains and stormwater 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.
- All disturbed habitat areas must be rehabilitated and planted with indigenous floral species as soon as possible to ensure that floral ecology is re-instated.

Recommended mitigation measures

- During the construction and operational phases of the proposed mining expansion, erosion berms may 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% and 15%, berms every 20m should be installed.
    - Where the track has a slope greater than 15%, berms every 10m should be installed.

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
	3	3	3	4	4	6	11	66 (Medium-Low)

Probable latent impacts:

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

6.1.2 IMPACT 2: Impacts on floral diversity

Activities leading to impact

Pre-Construction	Construction	Operational	Decommissioning & Closure
Poor planning of mine infrastructure placement and design	Site clearance and removal of vegetation	An increase in alien plant species leading to altered plant community structure and composition within wetland features	

Inadequate design of infrastructure leading to pollution of soils and ground water	Construction of infrastructure and access roads through more sensitive wetland areas	Erosion and sedimentation as a result of operational activities	Ineffective rehabilitation of exposed and impacted areas and failure to implement alien floral control
	Proliferation of alien species may alter plant community structure within wetland features.	Increased fire frequency and intensity, as well as uncontrolled fires during mining operations due to increased human activity	Erosion and sedimentation as a result of closure and decommissioning activities
	Soil compaction as a result of construction activities	Potential blasting and drilling during the construction phase will lead to an increase in dust	Failure to monitor rehabilitation efforts and implement an alien floral control plan
	Heavy vehicle movement		Increased fire frequency and intensity, as well as uncontrolled fires during closure and decommissioning
	Increased fire frequency and intensity, as well as uncontrolled fires due to increased human activity		
	Potential blasting and drilling during the construction phase will lead to an increase in dust		

Aspects of floral ecology affected

Construction	Operational	Decommissioning & Closure
Loss of floral biodiversity	Loss of floral biodiversity	Loss of floral biodiversity
Contamination of ground and surface water on which wetland floral species are reliant	Contamination of soils due to a lack of infrastructure maintenance	Alteration of floral community structure due to alien invasion vegetation leading to loss of floral biodiversity
Compaction and loss of soils leading to loss of floral biodiversity	Contamination of ground and surface water	
	Alteration of floral community structure due to alien invasion vegetation leading to loss of floral biodiversity	

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
	4	3	4	3	5	7	12	84 (Medium-High)

Essential mitigation measures:

- A sensitivity map has been developed for the subject property, indicating wetland areas which are considered to be of increased ecological importance. It is recommended that this sensitivity map be considered during all development phases to aid in the conservation of floral habitat within the subject property.
- All development footprint areas and areas affected by the proposed mine development should remain as small as possible and should not encroach onto surrounding more sensitive wetland areas and the associated buffer zones. It must be ensured that these areas are off-limits to construction vehicles and personnel.
- Removal of the alien and weed species encountered during the operational and decommissioning and closure phase must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). 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 areas during the eradication of alien and weed species.
- Informal fires in the vicinity of mining areas should be prohibited during all development phases.

Recommended mitigation measures

- 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 into waterways and drainage lines in the vicinity of the subject property.
- The local communities residing within and in the vicinity of the subject property, as well as mining and construction personnel, should be informed about fire control and prevention measures to reduce the frequency of uncontrolled veld fires in areas surrounding and within the subject property.

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
	3	3	3	3	3	6	9	54 (Medium-Low)

Probable latent impacts

- Loss of floral habitat may lead to altered floral biodiversity.
- Ineffective rehabilitation may lead to permanent loss of floral biodiversity.

6.1.3 IMPACT 3: Impact on floral species of conservational concern

Activities leading to impact

Pre-Construction	Construction	Operational	Decommissioning & Closure
Inadequate design of infrastructure leading to pollution of soils and ground water	Site clearance and removal of vegetation	An increase in alien plant species leading to loss of medicinal, protected and potential RDL floral species by outcompeting these species	Ineffective rehabilitation of exposed and impacted areas and failure to implement a comprehensive alien floral control plan
	Construction of infrastructure and access roads through wetlands, areas	Erosion and sedimentation as a result of operational activities leading	Continued erosion and sedimentation during closure and decommissioning
	Poor control of vehicular movement and management of edge effects		

Aspects of floral ecology affected

Construction	Operational	Decommissioning & Closure
Sedimentation and erosion leading to loss of important plant species	Sedimentation and erosion leading to loss of important plant species	Sedimentation and erosion leading to loss of important plant species
Alteration of floral community structure	Alteration of floral community structure due to alien invasion vegetation leading to loss of important plant species	Alteration of floral community structure due to alien invasion vegetation leading to loss of important plant species

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
	3	2	3	1	5	5	9	45 (Low)

Essential mitigation measures:

- A sensitivity map has been developed for the subject property, indicating wetland areas which are considered to be of increased ecological importance. It is recommended that this sensitivity map be considered during all development phases to aid in the conservation of floral habitat within the subject property.

- All development footprint areas and areas affected by the proposed mine development should remain as small as possible and should not encroach onto surrounding more sensitive wetland areas and the associated buffer zones. It must be ensured that these areas are off-limits to construction vehicles and personnel.
- Sensitive floral species, if discovered, are to be handled with care and the relocation of sensitive plant species is to be overseen by a botanist.
- Should any RDL or protected plant species 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 permit applications are required from the relevant authorities before construction activities commence.
    - All rescue and relocation plans should be overseen by a suitably qualified specialist.

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
	2	2	2	2	4	4	8	32 (Low)

6.2 Impact Assessment Conclusion

Based on the above assessment it is evident that there are three possible impacts on the floral ecology within the subject property. The table below summarises the findings indicating the significance of the impact before management takes place and the likely impact if management and mitigation takes place. In the consideration of mitigation it is assumed that a high level of mitigation takes place but which does not lead to prohibitive costs.

From the table it is evident that prior to management measures being put in place, two of the impacts are medium-high level impacts and one impact is a low level impact. If effective management takes place, all impacts could be reduced to a lower level impact.

Table 12: A summary of the results obtained from the assessment of floral ecological impacts.

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

6.3 Cumulative impacts

Due to extensive mining and beneficiation of minerals occurring in Middelburg and surrounding areas, along with extensive agriculture, the regional cumulative impacts as a result of loss of natural vegetation and plant life is considered to be highly significant.

Cumulative impacts include:

- The loss of the Rand Highveld Grassland, which is considered to be an endangered vegetation type with a small fraction currently statutorily conserved.
- The spread of alien plant species within this vegetation type is considered to be significant and disturbance of natural vegetation as a result of forestry and loss of vegetation structure in the region may contribute towards lowering of the overall sensitivity of plant communities within this vegetation type.
- The cumulative impact from alien plant species proliferation in the region is considered to be high as these species replace indigenous vegetation and contribute to an overall loss of biodiversity.

Effective rehabilitation and well executed closure of the mining operation during the closure and decommissioning phase is essential in order to minimise cumulative impacts resulting from the mining activities.

7 RECOMMENDATIONS

After conclusion of this ecological assessment, it is the opinion of the ecologists that the proposed activity be considered favourably provided that the following essential mitigation measures as listed below are adhered to:

Development and footprint

- A sensitivity map has been developed for the subject property, indicating the Wetland habitat units, which are considered to be of increased ecological importance. It is recommended that this sensitivity map be considered during all development phases to aid in the conservation of floral habitat within the subject property.
- The boundaries of the development footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas.
- Edge effects of all construction and operational activities, such as erosion and alien plant species proliferation, which may affect floral habitat, need to be strictly managed.
- Planning of temporary roads and access routes should take the site sensitivity plan into consideration. Such roads should be constructed a distance from the more sensitive wetland areas and not directly adjacent thereto.
- It must be ensured that mining related waste or spillage and effluent do not affect the sensitive habitat boundaries and associated buffer zones.

Vegetation

- Proliferation of alien and invasive species is expected within any disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the development footprint areas.
- 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 areas during the eradication of alien and weed species.

- Informal fires in the vicinity of development area should be prohibited during all development phases.
- Should any other RDL or protected plant species 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 that permit application are obtained where necessary from the relevant authorities.
- All rescue and relocation plans should be overseen by a suitably qualified specialist.

Vehicle access

- Vehicles should be restricted to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss.
- 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 subject property.

Soils

- It must be ensured that the mine process water system is managed in such a way as to prevent discharge to the receiving environment.
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss.
- To prevent the erosion of topsoil, management measures may include berms, soil traps, hessian curtains and stormwater diversion away from areas susceptible to erosion.
- All soils compacted as a result of construction activities falling outside of development footprint 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 in surrounding areas.

- During the construction and operational phases of the proposed mining expansion erosion berms may 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% and 15%, berms every 20m should be installed.
    - Where the track has a slope greater than 15%, berms every 10m should be installed.

Rehabilitation

- All disturbed habitat areas must be rehabilitated as soon as possible to ensure that floral ecology is re-instated.
- Reseeding with indigenous grasses should be implemented in all affected areas and strategic planting of bushveld tree species should take place to re-establish microclimates and niche habitats.

RDL and Protected floral species

- Sensitive floral species, if discovered, are to be handled with care and the relocation of sensitive plant species is to be overseen by a botanist.
- Should any RDL or protected plant species 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 permit applications are required from the relevant authorities before construction activities commence.
    - All rescue and relocation plans should be overseen by a suitably qualified specialist.

8 REFERENCES

Bromilow, C. (2001) **Problem Plants of South Africa.** Briza Publications, Pretoria.

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

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.

SANBI (2007) The South African National Biodiversity Institute is thanked for the use of data from the National Herbarium, Pretoria (PRE) Computerised Information System (PRECIS).

Tainton, N. (Editor) (1999) **Veld Management in South Africa.** University of Natal Press, Pietermaritzburg.

Threatened Species Programme (2005) Red **Data List of South African Plant Species.** Available online: http://www.redlist.org.

Van Oudtshoorn, F. (1999) **Guide to Grasses of Southern Africa.** 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 Oudtshoorn, B. and Gericke, N. (1997) **Medicinal Plants of South Africa.** Briza Publications, Pretoria.

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

Appendix A

Expected floral species list for 2529DA

(Available on request)

Appendix B

Vegetation Index Score

Vegetation Index Score – Transformed 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

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score					X	
EVC 2 score	5	4	3	2	1	0

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

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
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
Scattered				X				
Sparse			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**
				X		
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+(SI x PVC)+(RIS)] = 6

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

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	X
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score				X		
EVC 2 score	5	4	3	2	1	0

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

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
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	X	X
Scattered								
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**
				X		
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+(SI x PVC)+(RIS)] = 16

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

Vegetation Index Score – Transformed 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

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score						X
EVC 2 score	5	4	3	2	1	0

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

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
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			
Scattered	X		X			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**
	X					
RIS	**0**	**1**	**2**	**3**	**4**	**5**

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