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Firgrove –
Wetland and Biodiversity Assessment

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Executive Summary

A request was received from Enkanyini Projects to delineate the wetlands and to determine the importance of the biodiversity associated with a property which is earmarked for the Upgrade of the Firgrove MTS Substation and Palmiet Stikland Loop. The study area is located northwest of Firgrove and next to the R102 between Bellville and Somerset West and falls within the Eerste River catchment. This is partly to comply with Section 21(c) ~ impeding or diverting the flow of water in a watercourse, Section 21(i) ~ altering the bed, banks, course or characteristics of a watercourse.

The scope of work for the study included the following

- Identification of wetlands;
- Delineation of wetlands;
- Classification of wetlands;
- An assessment of the ecosystem services supplied by the wetlands;
- An assessment of the wetlands Present Ecological Status (PES) or integrity;
- Assessment of Ecological Importance and Sensitivity (EIS) of wetlands;
- A characterization of fauna and flora found in the specific wetlands and associated terrestrial area;
- Possible impact assessment; and
- Mitigation proposals.

Based on hydro-geomorphic setting the survey indicated two palustrine wetland types in the study area which can be described as a non-channeled valley bottom and a channeled valley bottom wetland. The wetland soils encountered during the survey displayed signs of wetness within 50cm of the surface. Soils in these wetlands displayed typical hydro-morphic characteristics varying between temporary, permanent and seasonal wet characteristics. Permanent inundation occurred in patches indicating wetlands south (Site 4), east (Site 3) and north east (Site 2) of the existing power station largely associated with the watercourse. The presence of a restrictive clay layer (such as bedrock or dense clay) in the soil slowed or prevents the infiltration of water at Site 3. These sections of the wetland can be described as ”perched wetlands”, receiving water mainly via rainfall or overland runoff, and most likely not from groundwater. The permanent wet soils in this valley bottom wetland are a dark highly organic soil. The wetland soils in Site 4 contained sandy soils within seasonal to permanent wetlands have accumulated high carbon content and reflected a dark chroma. In some areas gleyed soils occurs as a result of prolonged saturated with water, the grey color is due to the absence of iron compounds. The soils outside the wetland area are typical terrestrial soils with a uniform red color indicating well-aerated soils.

The study area falls within the Critically Endangered Renosterveld and the vegetation unit in the study area is classified as Swartland Shale Renosterveld and Swartland Granite Renosterveld. Renosterveld is characterized by the dominance of Asteraceae, Renosterbos being the most important and where the vegetation type gets its name. Unlike Fynbos, grasses may also be abundant in Renosterveld. Another feature of Renosterveld is the high species richness of geophytic plants, mainly Iridaceae, Liliaceae and Orchidaceae.

The terrain associated with the study area is moderately undulating and the vegetation has been completely modified for agricultural lands. This high fertility of Renosterveld meant that most of the area has been converted to agriculture. Less than 10% of Swartland Shale Renosterveld still remains intact, with other Renosterveld types also heavily ploughed or used as augmented pasture. Only remnants of this vegetation unit have remained intact as small islands between agricultural lands and conservation targets are no longer attainable in these areas. As a result of this transformation, the study area has been invaded by a high number of invasive alien species, weeds as well as several volunteer crops and very few indigenous species still occur in this area. Several plants recorded in the study area are classified as high-priority alien invasive species (Category 1b) requiring compulsory control. The dominance and aggressive growth of alien and invasive grasses such as kikuyu in the study area has largely displaced the rich diversity of geophytes expected to occur in the Renosterveld.

Remnants of Swartland Shale Renosterveld vegetation remaining as well as buffer areas around these remnants have therefore a very high conservation priority. However, the study area does not coincide with any of these remnants or high priority conservation areas in the Renosterveld. Extensive transformation of natural habitat in the Renosterveld severely disrupted ecological processes and its evolutionary potential, thereby compromising the future persistence of the biodiversity remaining in these natural areas. To assist the long-term persistence of biodiversity in these areas specific provision for 'spatially fixed' processes, such as river corridors has been identified. The stream running through the study areas has not been demarcated as a corridor and is therefore considered not to be of critical importance for the long term persistence of biodiversity in the Renosterveld.

Undoubtedly the greatest threat to mammalian biodiversity and indeed biodiversity in general is the continuing loss or irreversible transformation of natural habitat due to agricultural and industrial development, mining, urbanization, and the spread of alien biota. All the large game became extinct in the Fynbos Biome. This loss of natural habitat, and the associated fragmentation of what is left, is exacerbated in the case of those remaining specialist mammals with very specific habitat preferences.

Habitat transformation has resulted in subsequent loss of habitat and a reduction in habitat value for remaining small mammal communities by creating a mosaic of optimal and sub-optimal habitats. Fragments of natural habitats may be playing an important role in harbouring rare and possibly endangered species, transformed habitats are also important as secondary habitats providing both cover as well as seasonal food resources.

The sandier portions of the lowland Renosterveld represent important habitats for endemic species such as the Cape gerbil (*Tatera afra*) (Figure 14); the Cape dune molerat (*Bathyergus suillus*); and Van Zyl's golden mole (*Cryptochloris zyli*). Small mammal species richness, diversity and abundance tend to be very low in cultivated and areas invaded by alien plant species compared to the adjacent remnant vegetation. The study area is completely transformed and is unlikely to support a significant diversity of small mammals of concern. Evidence of striped mouse (*Rhabdomys pumilio*), common mole rat (*Cryptomys hottentotus*) (Figure 15) and Cape gerbil (*Tatera afra*) activity were evident in the study area. The introduced grey squirrel (Sciurus carolinensis) has also established in the area.

The study area is not considered to be of critical importance for amphibians or reptiles. Taking into account the transformed state of the study, the majority of the frog species are expected to consist of the common, wide-spread and generalist species such as the common platanna *Xenopus laevis*, the Cape river frog *Afrana fuscigula*, raucous toad *Bufo rangeri*, the clicking stream frog *Strongylopus grayii* and the common caco *Cacosternum boettgeri* (Baard & de Villiers, 2000).

The wetland obtained a very low Present Ecological State (PES) category, meaning this wetland is seriously modified with a loss of natural habitat. The losses of natural habitats and basic ecosystem functions are extensive. This very low evaluation is mainly due to overall degradation and the presence of roads, housing developments in and adjacent to wetland area, channelization, reduced water quality, exotic vegetation, cultivation of land, etc. This wetland was further categorised as having a moderate Ecological Importance and Sensitivity (EIS). The wetland may be considered ecologically important on local scale, but it forms part of a much larger and more important wetland system. The biodiversity in this wetland is not expected to be sensitive to flow and habitat modifications and it may play an important role in moderating the quantity and quality of water of the associated river.

The wetland in the study area attained a moderate score for natural services. Wetlands within a moderate class are moderately modified with some loss of natural habitats. The wetlands catchment is impacted upon by cultivation, orchids, housing, roads, power lines, etc., which extends into the wetland habitat. This contributes towards the restriction of potential natural services. However, this wetland contributes towards maintaining water quality in the form of phosphate trapping, sediment trapping and nitrate removal. The wetland units within the study area didn't significantly contribute to the human services, with the highest class attained only being very low. Local people rarely rely on the wetland and almost never benefit from it. However, the wetland does supply water for human use. Some birdlife does exist in and around the wetland area that can attract bird watchers and tourists.

No information was available in terms of the footprint and type of development proposed. Based on evaluation tables, the impact magnitude and significance of the development depend on where it will take place. If the footprint extent into the wetland areas (Site 2, 3 and 4) the impact can be significant.   Based on the presence of extensive wetlands it is therefore recommended that the footprint of the proposed development should be placed west of the existing power station (Site 1).

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GLOSSARY

Anaerobic	Without air.
Biodiversity	The variety of life: the different plants, animals and micro-organisms, their genes and the ecosystems of which they are a part.
Catchment	Area from which rainfall flows into river.
Connectivity	In this context, referring to either the upstream-downstream or lateral (between the channel and the adjacent floodplain) connectivity of a drainage line. Upstream-downstream connectivity is an important consideration for the movement of sediment as well as migratory aquatic biota. Lateral connectivity is important for the flooplain species dependent on the wetting and nutrients associeated with overbank flooding.
Exotic	From another part of the world; foreign.
Geology	The study of the composition, structure, physical properties, dynamics, and history of Earth materials, and the Processes by which they are formed, moved, and changed.
Gleyed soil	A material that has been or is subject to intense reduction as a result of prolonged saturation with water. Grey colours are due to an absence of iron compounds.
Hydro-geomorphic	Refers to the water source and geology forms.
Invasive	Any species of insects, animals, plants and pathogens, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem.
Palustrine	Relating to a system of inland non-tidal wetlands characterized by the presence of trees, shrubs and emergent vegetation.
Pedology	The branch of soil science that treats soils and all their properties as natural phenomena.
Soils	Dynamic natural body composed of mineral and organic materials as well as living forms in which plants grow. It can also be described as the collection of natural bodies occupying parts of the earth's surface that supports plants and that have properties due to the integrated effect of climate and living matter acting upon parent material, as conditioned by relief, over periods of time.
Topographical maps	Detailed description of land features shown on a map.
Topography	Detailed description of land features.
Un-channelled valley bottom	Linear fluvial, net depositional valley bottom surfaces which do not have a channel. The valley floor is a depositional environment composed of fluvial or colluvial deposited sediment. These systems tend to be found in the upper catchment areas.

1. INTRODUCTION

A request was received from Enkanyini Projects to delineate the wetlands and to determine the importance of the biodiversity associated with a property which is earmarked for the Upgrade of the Firgrove MTS Substation and Palmiet Stikland Loop. This is partly to comply with Section 21(c) ~ impeding or diverting the flow of water in a watercourse, Section 21(i) ~ altering the bed, banks, course or characteristics of a watercourse.

2. SCOPE OF WORK

In assessing the wetland in the study area, the following activities will be conducted:

- Identification of wetlands;
- Delineation of wetlands;
- Classification of wetlands;
- An assessment of the ecosystem services supplied by the wetlands;
- An assessment of the wetlands Present Ecological Status (PES) or integrity;
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- Possible impact assessment; and
- Mitigation proposals.

The findings of the desktop and field surveys is documented in this report including an ecological impact assessment and proposed mitigation measures.

3. LIMITATIONS OF THIS INVESTIGATION

The following limitations were placed on the wetland ecosystem and biodiversity study of this project:

- A single baseline assessment was conducted, thus limiting the amount of biota identified at the site;
- Accuracy of the maps, aquatic ecosystems, routes and desktop assessments were made using the current 1:50 000 topographical map series of South Africa;
- Accuracy of Global Positioning System (GPS) coordinates were limited to 15 m accuracy in the field;

4. THE STUDY AREA

The study area is located below 200 meters above sea level, northwest of Firgrove and next to the R102 between Bellville and Somerset West and falls within the G22H Quaternary Catchment which is part of the Eerste River catchment (Figure 1). The demarcated areas for this study are indicated in Figure 2.

Figure 1: Map indicating the position of the Firgrove MTS Substation and the study area

Figure 2: Google image of the study area indicating the four survey sites

5. METHODOLGY

5.1. Wetland Delineation

The wetland delineation was conducted according to the Guidelines set out by the Department of Water Affairs and Forestry (DWAF, 2005). Due to the transitional nature of wetland boundaries, these boundaries are often not clearly apparent and the delineations should therefore be regarded as of human construct. However, the delineations are based on scientifically defensible criteria that aims to provide a tool to facilitate the decision making process regarding the assessment of the significance of impacts on wetlands that may be associated with proposed developments.

According to DWAF (2005) the following general principals should be applied as the basis to undertake wetland delineation:

> "A wetland is defined as land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water and which under normal circumstances supports or would support vegetation typically adapted to life in saturated soil "(Water Act 36 of 1998 In DWAF, 2005).

A wetland can be defined in terms of hydrology (flooded or saturated soils), plants (adapted to saturated soils) and soil (saturated). Due to the variable nature of South Africa's climate the direct presence of water is often an unreliable indicator of wetland conditions. Prolonged saturation of soil has a characteristic effect on soil morphology, affecting soil matrix chroma and mottling in particular.

The wetlands were delineated by making use of the following wetland indicators (DWAF, 2005):

- **Terrain unit** indicator helps identifying those parts of the landscape where wetlands are most likely to occur. Wetlands occupy characteristic positions in the landscape and can occur on the following terrain units: crest, midslope, footslope and valley bottom (Figure 3).
- The **Soil Form** indicator identifies the soil forms, as defined by the Soil Classification Working group (1991), which are associated with prolonged and frequent saturation.
- **Soil wetness** indicator identifies the morphological signatures developed in the soil profile as a result of prolonged and frequent saturation. Notes were taken on soil chroma to a depth of 50 cm and this was related to hydrological conditions in terms of the criteria for distinguishing different soil saturation zones within a wetland (Table 1) (Kotze, Breen, & Klug, 1994).
- The **vegetation indicator** identifies hydrophytic vegetation associated with frequently saturated soils (Table 1).

Table 1: Criteria for distinguishing different soil saturation zones and hydric vegetation within a wetland (from Kotze, Hughes, Breen & Klug, 1994)			
SOIL	DEGREE OF WETNESS		
	Temporary	Seasonal	Permanent/Semi-permanent
Soil depth 0-20cm	Matrix brown to greyish brown (chroma 0-3, usually 1 or 2). Few/no mottles. Non sulphuric.	Matrix brownish grey to grey (chroma 0-2). Many mottles. Sometimes sulphuric.	Matrix grey (chroma 0-1). Few/no mottles. Often sulphuric.
Soil depth 20-40cm	Matrix greyish brown (chroma 0-2, usually 1). Few/many mottles.	Matrix brownish grey to grey (chroma 0-1). Many mottles.	Matrix grey (chroma 0-1). No/few mottles.
VEGETATION			
If herbaceous:	Predominantly grass species; mixture of species, which occur extensively in non-wetland areas, and hydrophytic plant species, which are restricted largely to wetland areas.	Hydrophytic sedge and grass species which are restricted to wetland areas, usually <1m tall.	Dominated by: (1) emergent plants, including reeds (*Phragmites* sp.), sedges and bulrushes (*Typha* sp.), usually >1m tall (marsh); or (2) floating or submerged aquatic plants.

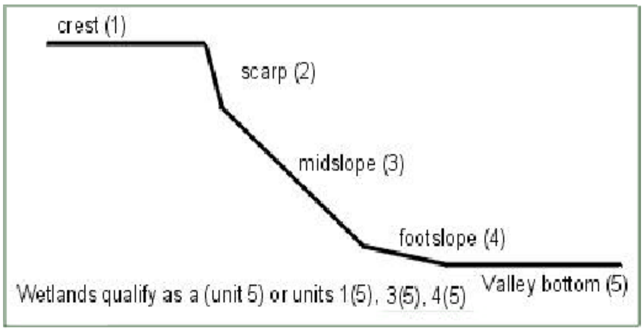


Figure 3: Terrain units

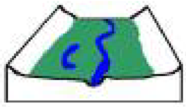
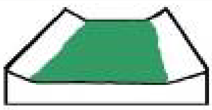
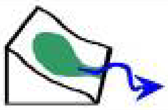
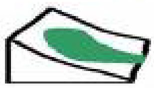
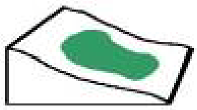
5.2. Wetland Classification

Wetlands are described in terms of their position in the landscape, and the classification was done according to its hydro-geomorphic setting (Table 2) (Kotze D. C., Marneweck, Batchelor, Lindley, & Collins, 2004).

Aerial photos, 150 000 topographic maps, satellite photos and GPS points are used to guide on screen delineation of wetlands in ArcView GIS 3.2. A first estimation of the extent of wet soils can be made from aerial photos, largely based on differences in vegetation and topography, indicating differences in species composition or more vigorous growth. This delineation needs to be verified during field sampling making use of soil samples and vegetation line transects and spot checks in between transects

Field verification consisted of several line transects surveys to ensure representative sampling of the area. In each line transect survey soils and vegetation was used to assess the edge of the wetland. Areas between transects were also assessed by doing soil and vegetation spot checks on the perceived wetland marginal zone. It is important to note that according to the wetland definition used in the South African National Water Act, vegetation is the primary indicator, which must be present under normal circumstances. However, in practise the **soil wetness indicator** tends to be the most important, and the other three indicators are used in the confirmatory role (DWAF, 2005).

Table 2: Wetland Unit types based on hydro-geomorphic characteristics (Adapted from Kotze et al 2005).

Hydro-geomorphic type	Code	Illustration	Description
Flood Plain	FP		Valley bottom areas with a well defined stream channel, gently sloped and characterized by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.
Valley Bottom with a Channel	VBC		Valley bottom areas with a well defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterized by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.
Valley Bottom Without a channel	VB		Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterized by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.
Channelled Hillslope Seepage feeding a Water course	CHSW		Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well defined stream channel connecting the area directly to a watercourse.
Hillslope Seepage feeding a Water course	HSW		Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow connecting the area directly to a watercourse.
Hillslope Seepage not feeding a water course	HS		Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through diffuse sub-surface and/or surface flow but with no direct surface water connection to a watercourse.
Depression	D		A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent.

5.3. Characterisation of the fauna and flora

The area was traversed on foot and all species of plants and fauna seen were recorded. The Shannon Mean Diversity Index was used by means of running survey data in EstimateS software to determine plant species diversity or species richness (Khan, 2001). The Shannon diversity index is commonly used to characterize species diversity in a community. Shannon's index accounts for both abundance and evenness of the species present. The proportion of species relative to the total number of species is calculated and then multiplied by the natural logarithm of this proportion. The value of Shannon diversity is usually found to fall between 1.5 and 3.5 and only rarely it surpasses 4.5. Shannon Mean Index lower than two is regarded as poor diversity, between two and three as reasonable as and higher than three is regarded as good diversity.

A total of 15 X 1-meter square sub-plots will be assessed for selected wetlands. These sub-plots will be surveyed by throwing a 1 m square plot quadrant randomly within the same area as where the line transect is conducted. Abundance of all species within each square metre were then determined and recorded in three abundance classes. These results were then entered into EstimateS software to calculate the index for each of the sites.

5.4. Wetland Integrity Assessments

5.4.1. Present Ecological Status (PES)

The Present Ecological Status (PES) method (DWAF 2005) was used to establish the integrity of the wetlands. This method is based on the modified Habitat Integrity approach (Table 3) developed by

Kleynhans (DWAF 2005). Anthropogenic modification of the criteria and its attributes can have an impact on the ecological integrity of a wetland.

Table 3: Habitat integrity assessment criteria for wetlands (Adapted from DWAF, 2005)

Criteria and Attributes	*Relevance*
Hydrologic	
Flow Modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to or from a wetland.
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.
Water Quality	
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland.
Sediment Load Modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.
Hydraulic/Geomorphic	
Canalization	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities which reduce or changes wetland habitat directly in inundation patterns.
Biota	
Terrestrial Encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.
Indigenous Vegetation Removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.
Invasive Plant Encroachment	Affects habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).
Alien Fauna	Presence of alien fauna affecting faunal community structure.
Over utilization of Biota	Overgrazing, over fishing, etc.
Above attributes are rated and scored as one of the following: Natural/Unmodified 5 — Largely Modified 2 Largely Natural 4 — Seriously Modified 1 Moderately Modified 3 — Critically Modified 0	

The Present Ecological Status Class (PESC) of the wetlands was based on the available information for each of the criteria listed in Table 3 and the mean score determined for each wetland (Table 4). This approach is based on the assumption that extensive degradation of any of the wetland attributes may determine the PESC (DWAF, 2005).

Table 4: Guidelines for the determination of the Present Ecological Status Class (PESC) (DWAF, 2005).

Class Boundary	Class	Class Description
Within generally acceptable range		
>4	Unmodified	Unmodified or approximated natural condition.
>3 and <=4	Largely Natural	Largely natural with few modifications, but with some loss of natural habitats.
>2 and <=3	Moderately Modified	Moderately modified, but with some loss of natural habitats.

2	Largely Modified	A large loss of natural habitats and basic ecosystem functions has occurred.
Outside generally acceptable range		
>0 and <2	Seriously Modified	The losses of natural habitats and basic ecosystem functions are extensive.
0	Critically Modified	Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat.

5.4.2. Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity (EIS) assessment was conducted according to the guidelines as discussed by DWAF (1999c). Here DWAF defines "ecological importance" of a water resource as an expression of its importance to the maintenance of ecological diversity and function on local and wider scales. "Ecological sensitivity", according to DWAF (1999c), refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred.

In the method outlined by DWAF a series of determinants for EIS are assessed for the wetlands on a scale of 0 to 4 (Table 5), where 0 indicates no importance and 4 indicates very high importance. The median of the determinants is used to determine the EIS of the wetland unit (Table 6).

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Table 5: Score sheet for determining ecological importance and sensitivity (DWAF, 1999c)

Determinant
Primary determinants
Rare and endangered species
Species/taxon richness
Diversity of Habitat types or features
Migration route/breeding and feeding site for wetland species
Sensitivity to changes in the natural hydrological regime
Sensitivity to water quality changes
Flood storage, energy dissipation and particulate/element removal
Modifying determinants
Protected status
Ecological integrity

Table 6: Ecological importance and sensitivity categories. Interpretation of median scores for biotic and habitat determinants (DWAF, 1999c_

Range of Median	EIS Category	Category Description
>3 and <=4	Very High	Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.
>2 and <=3	High	Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water in major rivers.
>1 and <=2	Moderate	Wetlands that are to be considered ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.
>0 and <=1	Low/ Marginal	Wetlands that is not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.

5.4.3. Ecosystem Services Supplied by the Wetland (Eco-Services)

The assessment of the ecosystem services supplied by the identified wetland units was conducted according to the guidelines as described by Kotze, et al. (2005). A Level 2 assessment was undertaken which examines and rates Natural and Human services.

Natural Services

The following natural services were assessed:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage; and
- Maintenance of biodiversity.

Scores for each of the above natural service assessments were allocated a class based on those shown in Table 7. These scores were then added to determine the overall level of natural services for the wetland unit using the classes shown in Table 8.

Table 7: Classes for service scores	
Class Boundary	Class Score
0 - 0.99	1
1 - 1.99	2
2 - 2.99	3
3 - 4	4

Table 8: Classes for the overall level of natural services provided by a wetland unit		
Natural Services and Functions		
Class Boundaries	Class	Class Description
30 - 36	Very High	Unmodified or approximated natural condition.
24 - 29.9	High	Largely natural with few modifications, but with some loss of natural habitats.
18 - 23.9	Moderate	Moderately modified, but with some loss of natural habitats.
12 - 17.9	Low	Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred.
6 - 11.9	Very Low	Seriously modified. The losses of natural habitats and basic ecosystem functions are extensive.
0 - 5.9	Non Existent	Critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat.

Human Services

The following human services were assessed:

- Water supply for human use;
- Natural resources;
- Cultivated foods;
- Cultural significance;
- Tourism and recreation; and
- Education and research.

Scores for each of the above human service assessments were allocated a class based on those shown in Table 7. These scores were then added to determine the overall level of human services for the wetland unit using the classes shown in Table 9.

Table 9: Classes for the overall level of human services provided by a wetland unit.		
Human Services and Functions		
Class Boundaries	Class	Class Description
20 - 24	Very High	Local people are extremely dependent on the wetland and benefit from it greatly.
16 - 19.9	High	Local people have a high level of dependence on the wetland and benefit from it considerably.
12 - 15.9	Moderate	Local people are moderately dependent on the wetland and benefit from it from occasionally.
8 - 11.9	Low	Local people have a low dependency on the wetland and seldom benefit from it.
4 - 7.9	Very Low	Local people rarely rely on the wetland and almost never benefit from it.
0 - 3.9	Non Existent	Local people have no interaction with the wetland and never receive any benefits from it.

5.5. Impact Assessment and Mitigation

In order to assess the impacts of the proposed project on the aquatic ecosystems, the following components were included:

- The identification of the main areas of impact associated with the proposed project,
- The assessment of the impacts of the proposed project on the aquatic ecosystems;
- The recommendation of mitigation and management measures to deal with significant impacts; and
- The identification of aspects which may require further study.

The impacts of the proposed project were assessed in terms of impact significance and recommended mitigation measures. The determination of significant impacts relates to the degree of change in the environmental resource measured against some standard or threshold (DEAT, 2002). This requires a definition of the magnitude, prevalence, duration, frequency and likelihood of potential change (DEAT, 2002). The following criteria have been proposed by the Department of Environmental Affairs for the description of the magnitude and significance of impacts (DEAT, 2002):

The consequence of impacts can be derived by considering the following criteria:

- Extent or spatial scale of the impact;
- Intensity or severity of the impact;
- Duration of the impact;
- Potential for Mitigation;
- Acceptability;
- Degree of certainty/Probability;
- Status of the impact; and
- Legal Requirements.

Describing the potential impact in terms of the above criteria provides a consistent and systematic basis for the comparison and application of judgments (DEAT, 2002). The significance of the impact is calculated as:

Significance of Impact = Consequence (magnitude + duration + spatial scale) x Probability

Magnitude relates to how severe the impact is. Duration relates to how long the impact may be prevalent for and the spatial scale relates to the physical area that would be affected by the impact. Having ranked the severity, duration and spatial scale using the criteria outlined in Table 10, the overall consequence of impact can be determined by adding the individual scores assigned in the severity, duration and spatial scale. Overall probability of the impacts must then be determined. Probability refers to how likely it is that the impact may occur.

Table 10: Consequence and probability ranking of impacts

Magnitude/Severity	Duration	Spatial Scale	Probability
10 - Very high/don't know	5 – Permanent	5 - International	5 - Definite/don't know
8 – High	4 - Long-term (impact ceases after operational life)	4 - National	4 - Highly probable
6 – Moderate	3 - Medium-term (5-15 years)	3 - Regional	3 - Medium probability
4 – Low	2 - Short-term (0-5 years)	2 – Local	2 - Low probability
2 – Minor	1 – Immediate	1- Site only	1 – Improbable
0 – None	0 – None	0 – None	0 – None

.
The maximum value, which can be obtained, is 100 significance points (SP). Environmental effects are rated as either of High, Moderate, Low or No Impact significance on the following basis: The descriptors for the ratings are provided in (**Table 11**) (DEAT, 2002).

Table 11: Categories for the rating of impact magnitude and significance

Category	Description
High	Of the highest order possible within the bounds of impacts that could occur, There is no possible mitigation that could offset the impact, or mitigation is difficult.
Moderate	Impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur. Mitigation is both feasible and fairly easily possible.
Low	Impact is of a low order and therefore likely to have little real effect. Mitigation is either easily achieved or little mitigation is required, or both.
No Impact	Zero Impact

6. RESULTS AND DISCUSSION

To cover a representative area of the wetland in the study area, several transect surveys were necessary to assess the wetland (Figure 4). Areas in between these transects were also traversed by foot and spot surveys contributed to a more complete survey.

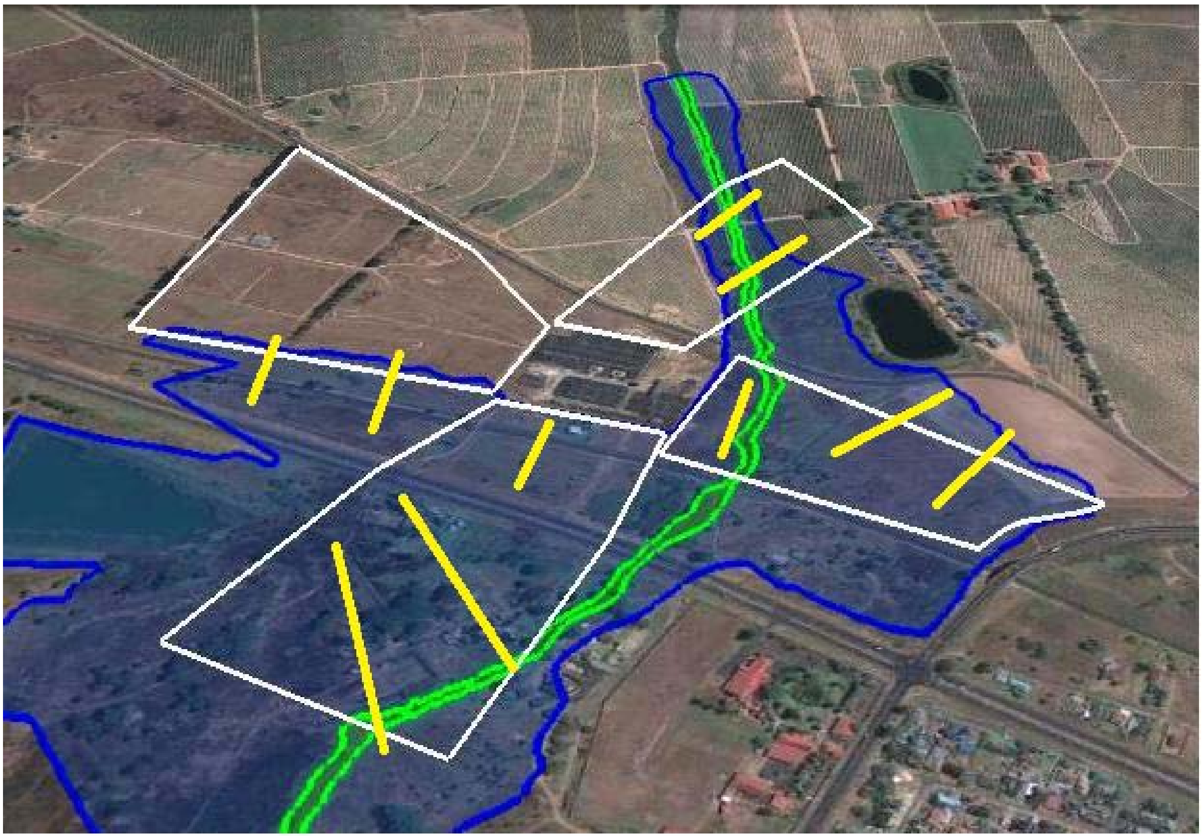


Figure 4: Several line transects (yellow) were surveyed to ensure a complete survey of the wetlands

6.1. Wetland Delineation

In accordance with the Guidelines for delineating the boundaries of a wetland set out by the Department of Water Affairs and Forestry (DWAF) (DWAF, 2005) the wetland identified in the study area was delineated (Figure 5). The wetland delineation excluded infrastructure areas and an effort to delineate wetland areas in old orchids and ploughed land has been done to the best of our ability.

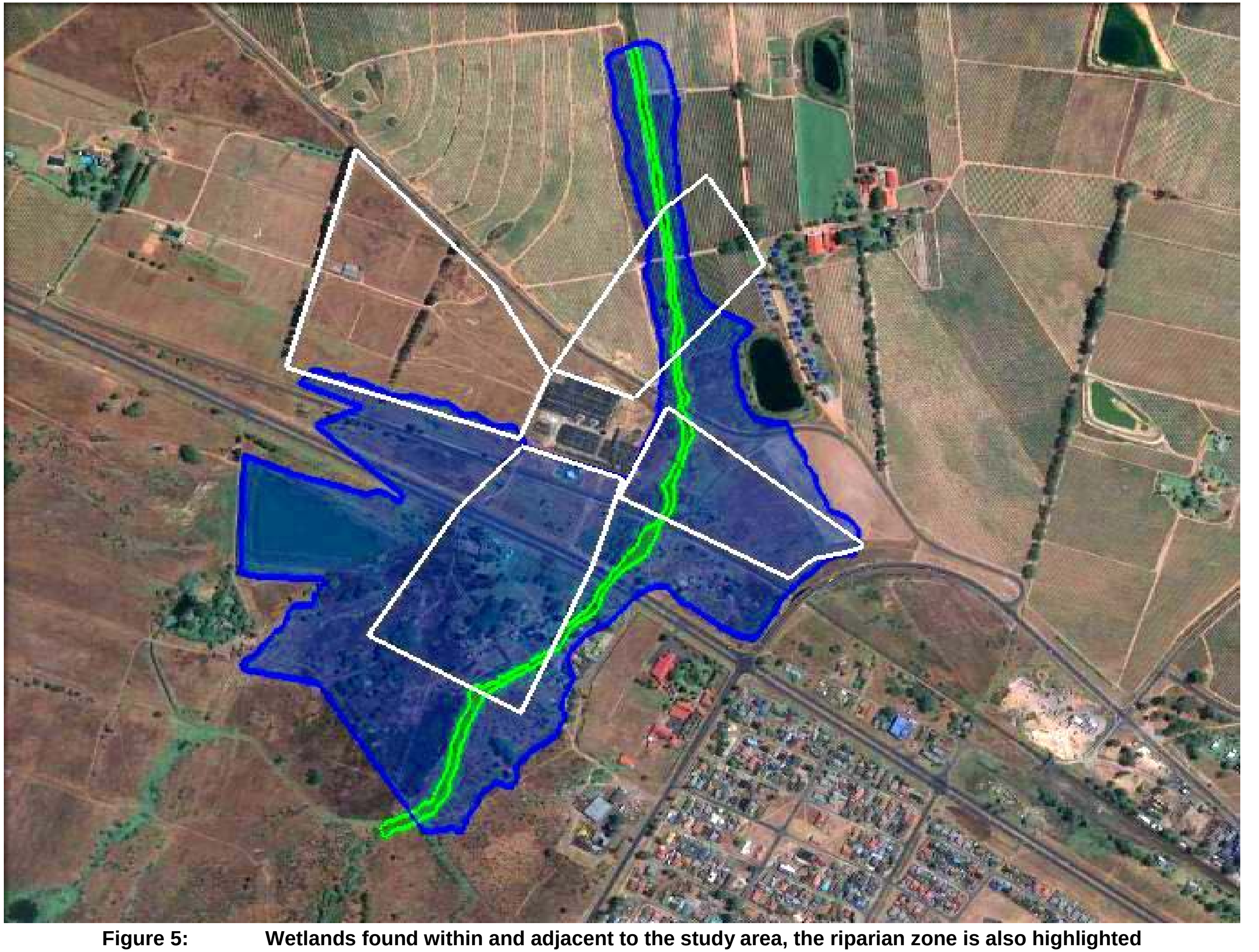


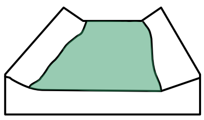
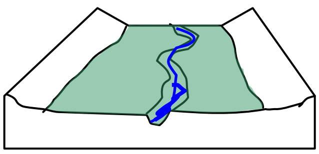
Figure 5: **Wetlands found within and adjacent to the study area, the riparian zone is also highlighted**

6.2. Wetland Classification

The wetlands in the study area can be described as palustrine wetland types. Further classification indicates a total of 2 wetland types occurring in the study area, such as non-channeled valley bottom wetlands and a channeled valley bottom wetland. These wetland types are discussed in Table 12 and its relation to the topography of the area. This classification is based on their hydro-geomorphic setting (Kotze D. C., Marneweck, Batchelor, Lindley, & Collins, 2004).

These wetlands can be described as saturated concave or concave areas on a slope, on a hillside and within a basin. Water mainly comes from subsurface flow. However, surface water does occur in the form of a strongly defined channel in the valley bottom wetland downstream (Table 12).

Table 12: Wetland hydro-geomorphic types found within the study area (modified from Brinson, 1993; Kotze, 1999; and Marneweck and Batchelor, 2002).

HYDRO-GEOMORPHIC TYPES	DESCRIPTION
Valley bottom without a channel 	Valley bottom areas with no clearly defined stream channel usually gently sloped and characterized by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.
	
HYDRO-GEOMORPHIC TYPES	**DESCRIPTION**
Valleybottom with a channel 	Valley bottom areas with a well defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterized by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.

6.3. Wetland Characterization

6.3.1. Wetland Soils

No detailed soil classifications have been completed for the site as it was not of primary concern towards the confirmation of being a wetland or not. However, some baseline soil information is used to confirm wetland and terrestrial properties.

Soils in this wetland have hydro-morphic characteristics with temporary, permanent to seasonal wet variations. The wetland soils encountered during the survey did have signs of wetness within 50cm of the surface. Both permanent and seasonal wet zones have been identified (Figure 6). Permanent inundation occurs patch-patch along the course of the wetland.

In Site 3 the presence of a restrictive clay layer (such as bedrock or dense clay) in the soil slowed or prevents the infiltration of water. This area of the wetland can be described as a “perched wetland”, receiving water mainly via rainfall or overland runoff, and most likely not from groundwater.

The permanent wet soils in this valley bottom wetland are a dark highly organic soil. The wetland soils in Site 4 contained sandy soils within seasonal to permanent wetlands have accumulated a high carbon content and reflected a dark chroma (Figure 6). The soil matrix chroma is 0-1. In some areas gleyed soils occurs as a result of prolonged saturated with water (Figure 6), the grey color is due to the absence of iron compounds. Seasonal wet soils has got mottling due to localization of iron oxides (Figure 6). The soils outside the wetland area are typical terrestrial soils that has got a uniform red color indicated a well-aerated soil (Figure 6).

Seasonal wet soils indicating mottles due to localization of iron oxides

Dark wet soil indicating permanent wet conditions

Terrestrial soil adjacent to wetland area.

Gleyed soils found in permanent wet areas.

Figure 6: Different soil profiles occurring in the study area

6.3.2. Wetland Vegetation

The study area falls within the Critically Endangered Renosterveld (Figure 7) and the vegetation unit is classified by Mucina and Rutherford (2006) as Swartland Shale Renosterveld and Swartland Granite Renosterveld (Figure 8). However the study area is also in close proximity of other vegetation units such as Cape Flats Sand Fynbos (Figure 8). Renosterveld is characterized by the dominance of Asteraceae, Renosterbos (*Elytropappus rhinocerotis*) being the most important and where the vegetation type gets its name. Although Renosterbos is often the dominant species, many other plants may also be prominent – for example Asteraceae (*Felicia, Eriocephalus, Helichrysum, Relhania* and *Pteronia*), Fabaceae (*Aspalathus*), Rubiaceae (*Anthospermum*), Sterculiaceae (*Hermannia*) and Thymelaeaceae (*Passerina*). These shrubs are mostly characterized by their small, tough, grey leaves.

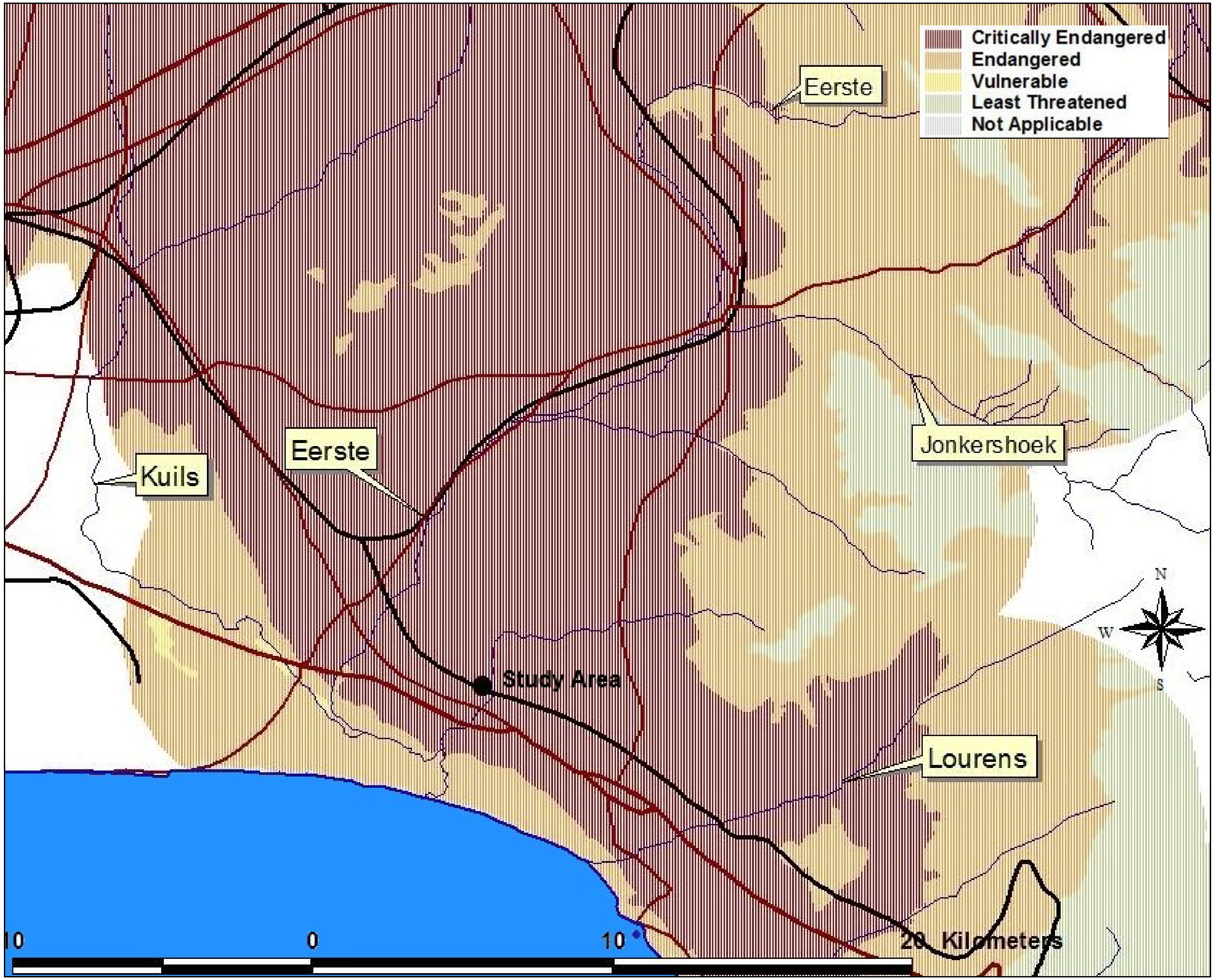

Critically Endangered
Endangered
Vulnerable
Least Threatened
Not Applicable
Eerste
Eerste
Kuils
Jonkershoek
Study Area
Lourens
N
W
S
10
0
10
20 Kilometers

Figure 7: Map indicating the Conservation Status of Renosterveld in relation to the study area

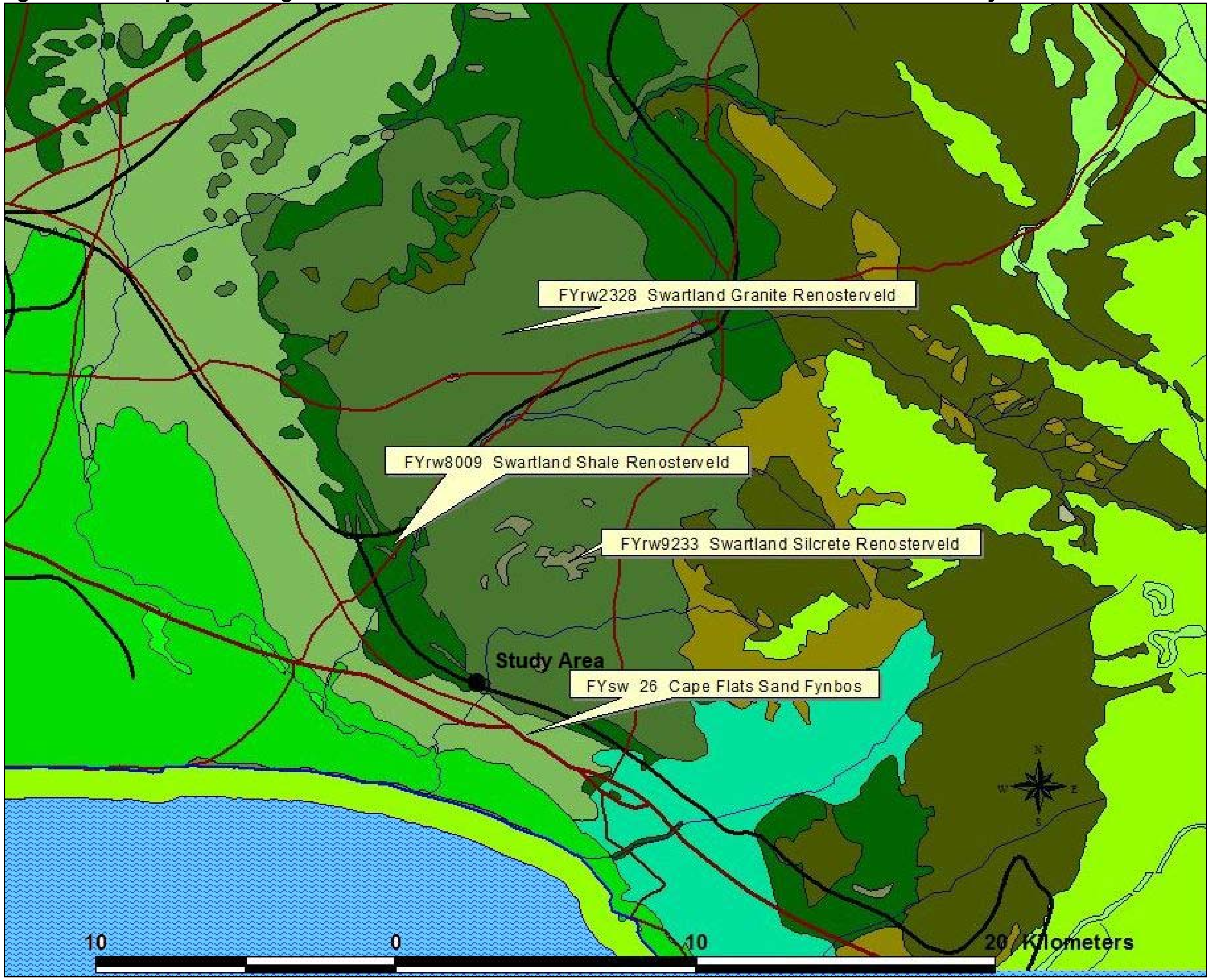


Figure 8: Map indicating the study area in relation to the distribution of Vegetation Units

Unlike Fynbos, grasses may also be abundant in Renosterveld. Another feature of Renosterveld is the high species richness of geophytic plants, mainly Iridaceae, Liliaceae and Orchidaceae. Proteas, Ericas and Restios - typical of Fynbos - tend to be absent in Renosterveld, or are present in very low abundances. There are only a few endemics to Renosterveld vegetation alone, as many of the species occur in Fynbos as well. However, species endemic to the Cape Floral Kingdom comprise about one-third of Renosterveld plant species, and many of these belong to families which are not considered exclusive to the Cape Floral Kingdom.

Typically, Renosterveld is largely confined to fine-grained soils - mainly clays and silts - which are derived from the shales of the Malmesbury and Bokkeveld Groups and the Karoo Sequence. In drier regions it also occurs on Cape Granite Suite-derived soils. Because all these soils are fertile, most of the Renosterveld has been cultivated. Renosterveld tends to occur where rainfall is between 250 (rarely to 200 mm) to 600 mm per year and at least 30% falls in winter. Where the rainfall is higher, the soils become leached and Renosterveld is replaced by Fynbos. Generally, where the rainfall is less than 250 mm Renosterveld is replaced by one of the Succulent Karoo vegetation types.

The terrain associated with the study area is moderately undulating and the vegetation has been completely modified for agricultural lands. This high fertility of Renosterveld has, meant that most of the area has been converted to agriculture. Less than 10% of Swartland Shale Renosterveld still remains intact, with other Renosterveld types also heavily ploughed or used as augmented pasture. Only remnants of this vegetation unit have remained intact as small islands between agricultural lands. As a result the study area has been invaded by a high number of invasive alien species, weeds as well as several volunteer crops and very few indigenous species still occur in this area (Appendix A). Several plants recorded in the study area are classified as high-priority alien invasive species (Category 1b) requiring compulsory control, including Port Jackson (*Acacia saligna*), Water Fern (*Azolla fuliculoides*) Purple echium (*Echium plantaguneum*) blue echium (*Echium vulgare*) Stinkbean (*Paraseriathus lophantha*), Red sesbania (*Sesbania punicea*) Bugweed (*Solanum maurantianum*) and Pampas grass (*Cortedaria selloana*) (Appendix A). Visuals of some of the plants recorded in the study area are depicted in Figure 11. The dominance and aggressive growth of alien and invasive grasses such as kikuyu (*Pennisetum clandestinum*) has largely displaced the rich diversity of geophytes expected to occur in the Renosterveld.

Remnants of Swartland Shale Renosterveld vegetation as well as a buffer area around these remnants therefore have a very high conservation priority. These areas are indicated in Figure 9 which suggests that the study area do not coincide with any of these remnants or priority conservation areas in the Renosterveld.

Extensive transformation of natural habitat in the Renosterveld severely disrupted ecological processes and the evolutionary potential, thereby compromising the future persistence of the biodiversity remaining in these natural areas. To assist the long-term persistence of biodiversity in these areas specific provision for ‘spatially fixed’ processes, such as river corridors has been identified (Von Hase, 2003). The stream running through the study areas has not been demarcated and is therefore considered not to be of critical for long term persistence of biodiversity (Figure 10).

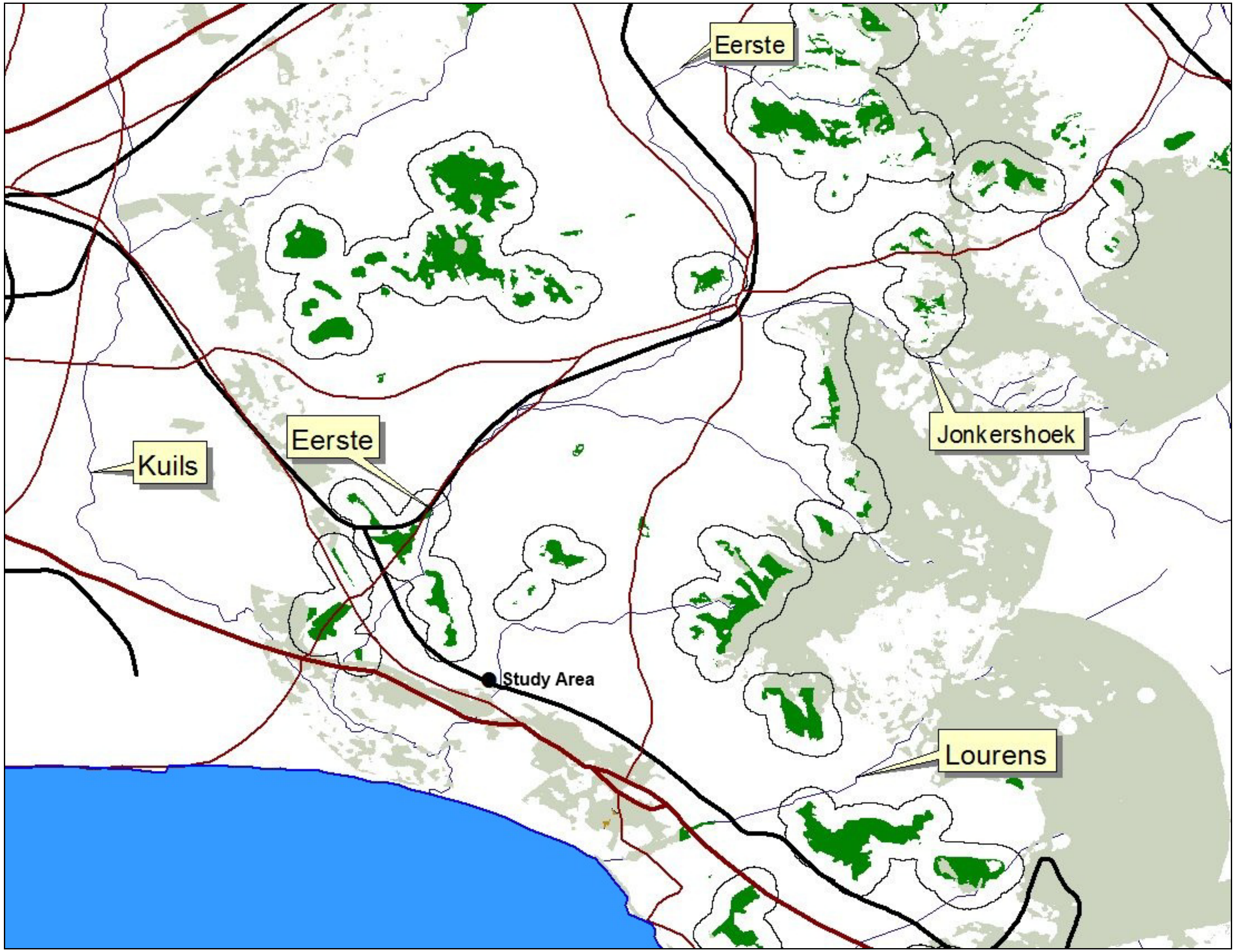


Figure 9: Map indicating remnant pieces of intact Renosterveld (green) with demarcated Priority Conservation Areas

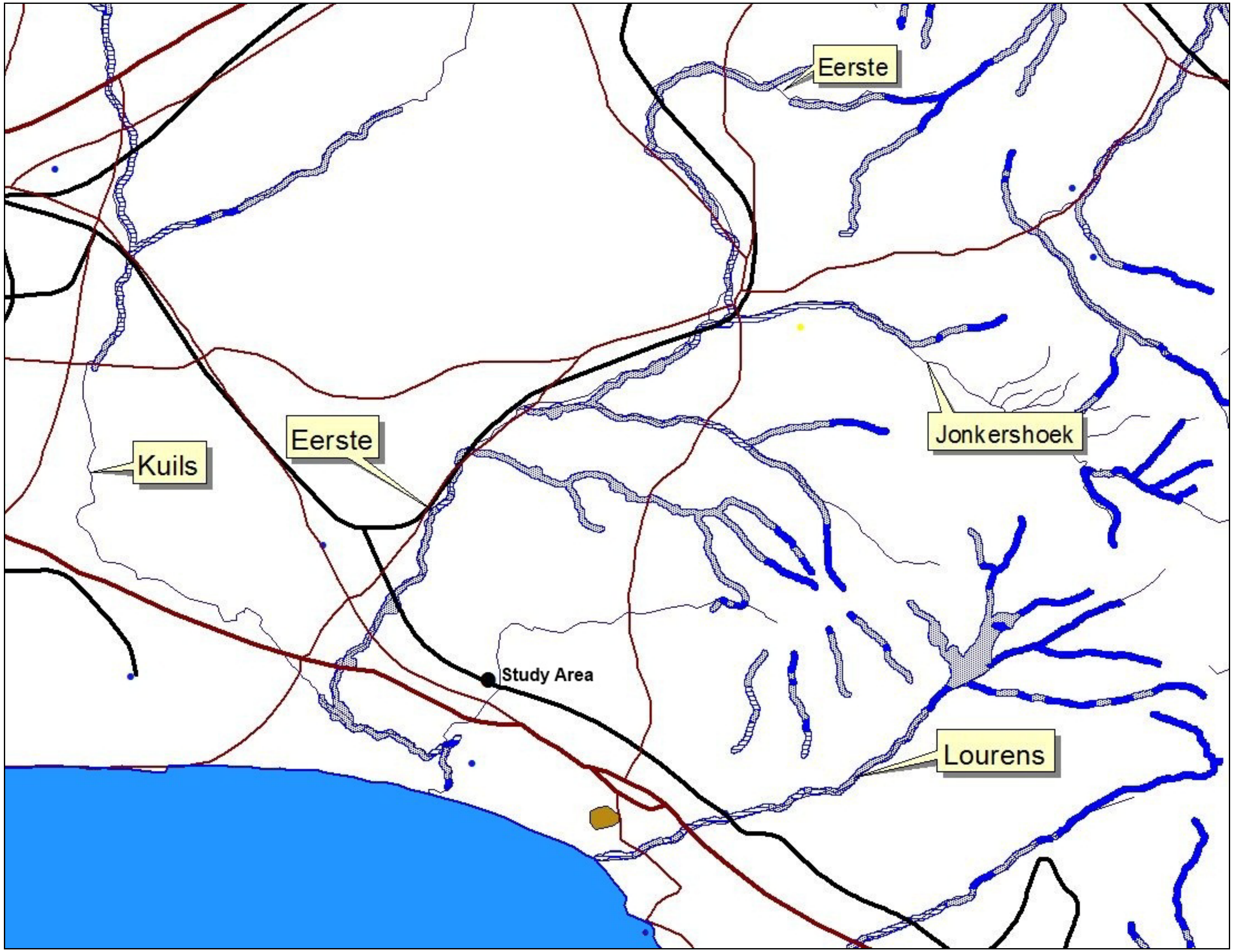


Figure 10: Map indicating river corridors defined to assist the long-term persistence of biodiversity

Cliffortia sp.

Cyperus textilis

Cotula turbinata

Oxalis pes-caprae

Nasturtium officinale

Echium vulgare

Pennisetum macrourum

Stoebe spiralis

Persicaria decipiens

Fumaria muralis

Figure 11: Emergent wetland vegetation found in wetland areas

The Shannon Index of Diversity was use to assess the species diversity for some selected sites (Figure 12) that hosted some natural habitat and the results is expounded in Table 14.

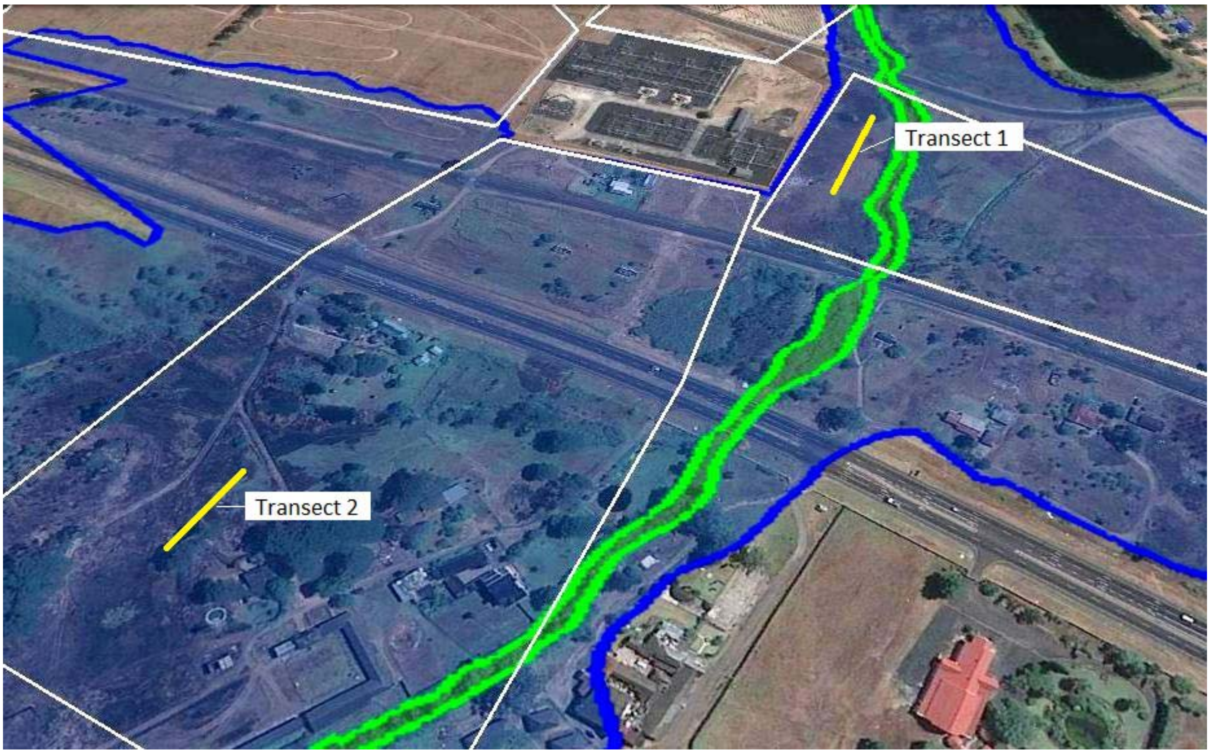
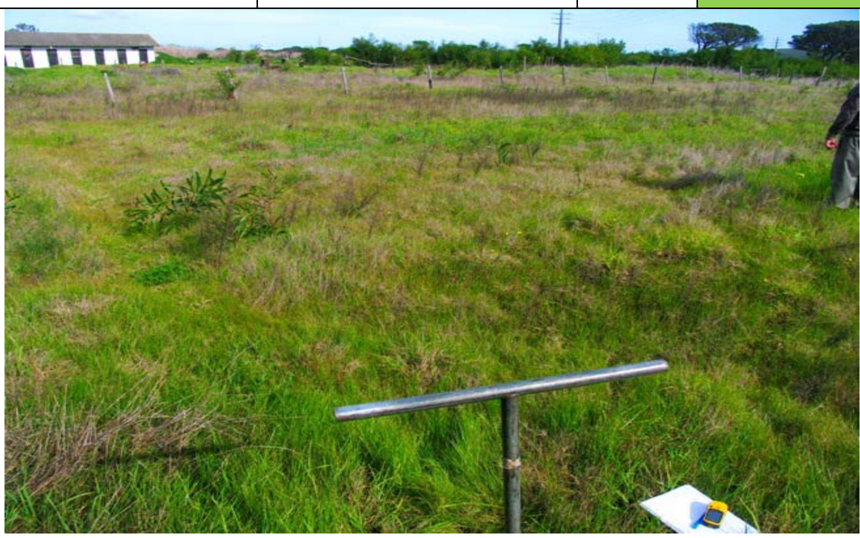


Figure 12: Localities of where the Shannon Mean Index biodiversity assessment took place

Reasonable species diversity was recorded in wetland areas (Table 14). The highest diversity was recorded in transect 1 (Table 14) with an index of 2.27. The lowest index was recorded at Transect 2 (Table 14) with a index of 2.21. However, it should be taken into account that most of this observed diversity can be related to the presence of diversity of alien and/or invasive present in the study area (Appendix A). Both transects were dominated by the presence of aggressive growth of kikuyu (*Pennisetum clandestinum*).

Table 13: The Shannon Index of Diversity indicating diversity status of selected sites in the study area.

<table>
<tr><th>Site</th><th>Wetland Type</th><th>Locality</th><th>Index</th><th>Diversity Status</th></tr>
<tr><td>Transect 1</td><td>Valley Bottom wetland with a channel</td><td>S 34.04900 E 18.78415</td><td>2.27</td><td>Reasonable
Dominated by Kikuyu and other alien species</td></tr>
<tr><td colspan="5">
Visual indicating transect area</td></tr>
<tr><td>Transect 2</td><td>Valley Bottom wetland without a channel</td><td>S 34.05272 E 18.78015</td><td>2.21</td><td>Reasonable
Dominated by Kikuyu and other alien species</td></tr>
<tr><td colspan="5">
Visual indicating transect area</td></tr>
</table>

6.3.3. Avifauna

Birds that were identified on site and that can possibly occur in and around the study area are listed in Appendix B. Species recorded on site are Spur-winged Goose, Egyptian Goose, Grey-headed Gull, Cattle Egret, Reed Cormorant, Black-headed Heron, Grey Heron, Cape Francolin, Yellow-billed Duck, Cape Wagtail, Sacred Ibis, Helmeted Guineafowl, Hadeda Ibis, Cape Turtle-Dove, Glossy Ibis, Little Rush-Warbler, Blacksmith Lapwing, etc.(Appendix A). The riparian zone along the edge of the channel hosted several species such as Little Rush-Warblers, Cape White Eyes, Lesser Swamp-Warbler, Cape Bulbul, etc. with the Fiscal Flycatcher parading the edge of the riparian. It seems like the Spur-winged Goose and the Egyptian Goose were particularly fond of the open water areas in old disturbed agriculture lands in Site 3 and 4 (Figure 13). The study area are not considered to be of critical importance for the protection of avifauna.

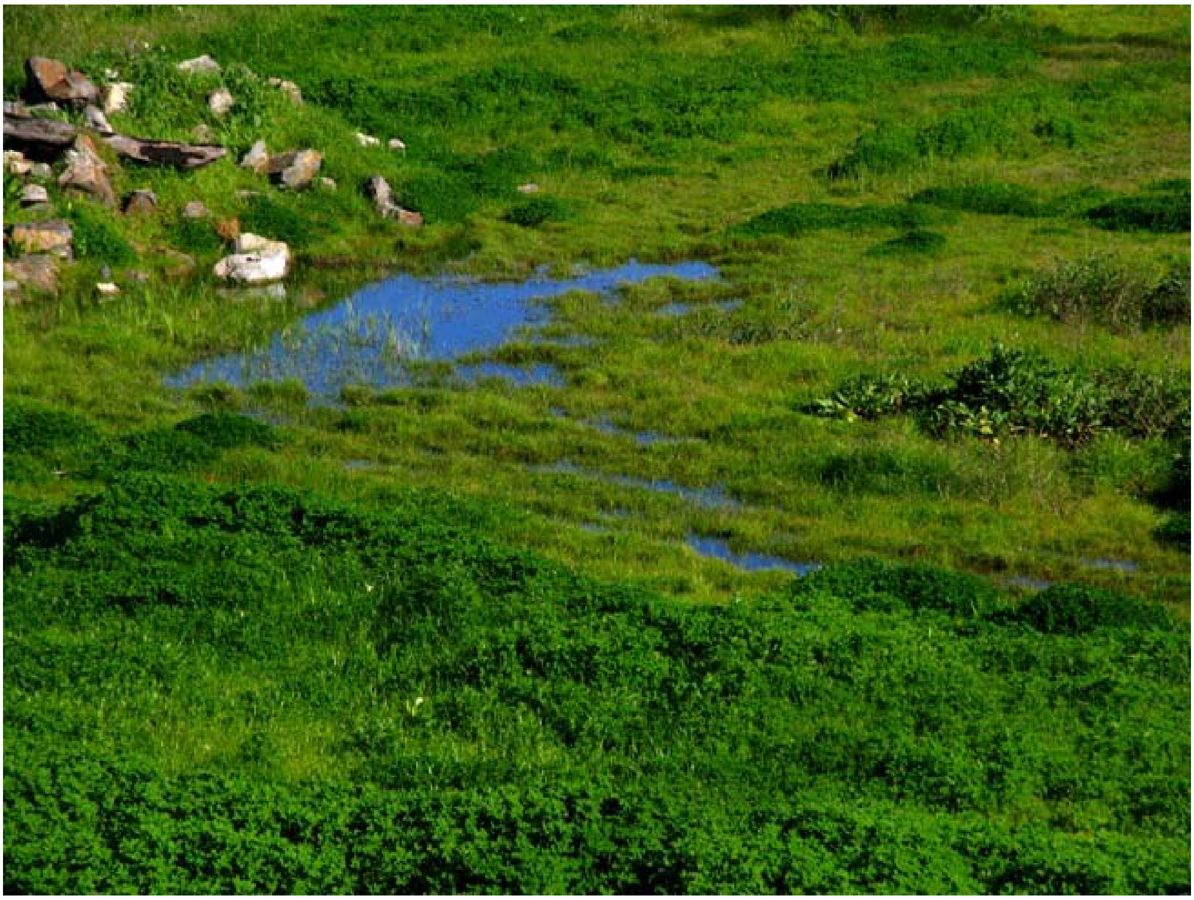


Figure 13: Open water areas providing habitat for water birds and frogs such as common caco

6.3.4. Wetland Mammals

Because of its high soil fertility and possible because of the presence of grass within the lowland renosterveld, it is probable that all the herds of large game in the Fynbos Biome occurred mainly in Renosterveld. Thus Mountain Zebra, Quagga, Bluebuck, Red Hartebeest, Eland, Bontebok, Elephant, Black Rhino and Buffalo were common, as were Lion, Cheetah, Wild Dog, Spotted Hyena and Leopard. Bluebuck and Bontebok only ever occurred within the Fynbos Biome. Only the Mountain Zebra Bontebok and Leopard survived. All the other large game became extinct in the Fynbos Biome. The Quagga and Bluebuck became extinct.

Undoubtedly the greatest threat to mammalian biodiversity and indeed biodiversity in general is the continuing loss or irreversible transformation of natural habitat due to agricultural and industrial development, mining, urbanization, and the spread of alien biota. This loss of natural habitat, and the associated fragmentation of what is left, is exacerbated in the case of those specialist mammals with very specific habitat preferences. Habitat transformation has resulted in subsequent loss of habitat and a reduction in habitat value for small mammal communities by creating a mosaic of optimal and sub-optimal habitats. Fragments of natural habitats may be playing an important role in harbouring rare and possibly endangered species, transformed habitats are also important as secondary habitats providing both cover as well as seasonal food resources.

The sandier portions of the lowland Renosterveld represent important habitats for endemic species such as the Cape gerbil (*Tatera afra*) (Figure 14); the Cape dune molerat (*Bathyergus suillus*); and Van Zyl's golden mole (*Cryptochloris zyli*) in the Western Cape Province. Small mammal species richness, diversity and abundance tend to be very low in cultivated and areas invaded by alien plant species compared to the adjacent remnant vegetation. The study area is unlikely to support a high diversity of small mammals of concern and only evidence of striped mouse (*Rhabdomys pumilio*), common mole rat (*Cryptomys hottentotus*) (Figure 15) and Cape gerbil (*Tatera afra*) were evident in the study area. The introduced grey squirrel (Sciurus carolinensis) has also established in the area and was observed in Site 1.

Figure 14: Cape Gerbil (*Tatera afra*) warren

Figure 15: Mounds of the common mole rat (*Cryptomys hottentotus*)

6.3.5. Amphibia

The Western Cape Province has about 44 species of frog of which 22 species are endemic to the region. Most of these endemic species are habitat specialists and occur in habitats which are by nature unique and often highly susceptible to environmental pressure and change. There appear to be no established non-indigenous (alien) frog species in the Western Cape Province, but it needs to be noted that the painted reed frog (*Hyperolius marmoratus*), a species indigenous to the East Coast, has established in the area. Western Cape Province. contains a total of 145 reptile species and. Only two non-indigenous reptiles, the flower pot snake (*Ramphotyphlops braminus*and the North American redeared terrapin (*Trachemys scripta elegans*), has established in the area.

The study area are not considered of importance for amphibians or reptiles (Figure 16) Taking into account the transformed state of the study, the majority of the frog species are expected to consist of the common, wide-spread and generalist species such as the common platanna *Xenopus laevis*, the Cape river frog *Afrana fuscigula*, raucous toad *Bufo rangeri*, the clicking stream frog *Strongylopus grayii* and the common caco *Cacosternum boettgeri* (Baard & de Villiers, 2000).

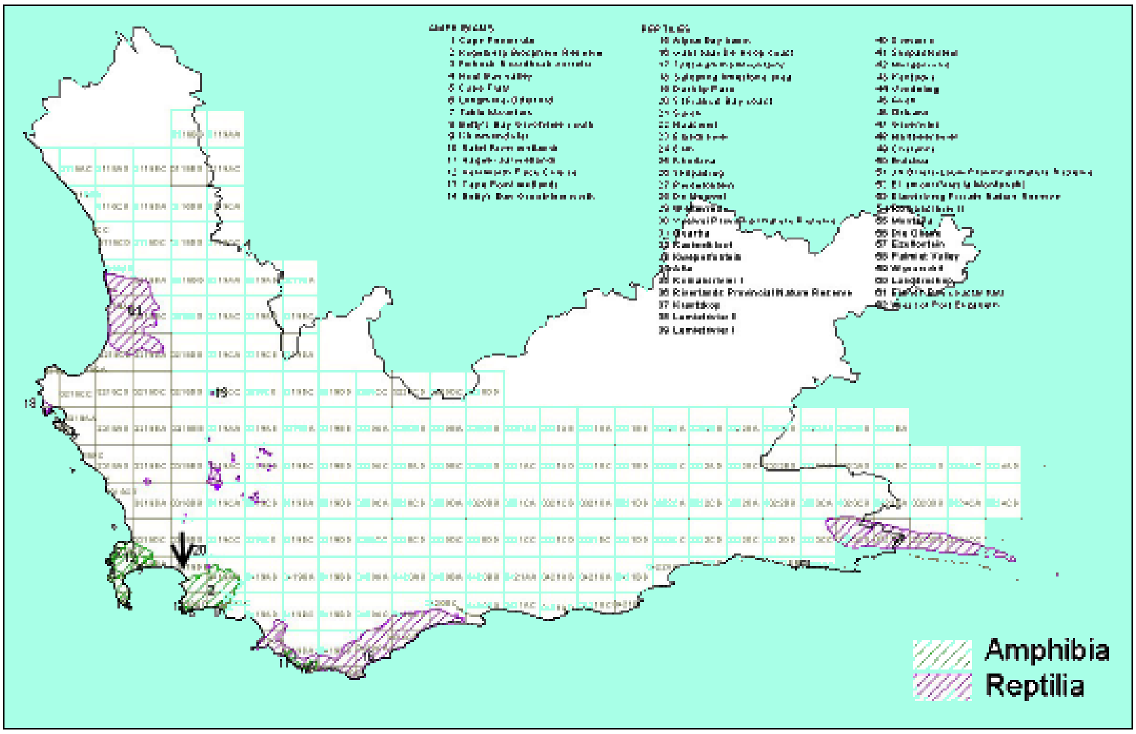


Figure 16: Areas of conservation importance for indigenous amphibians and reptiles of the Western Cape Province (Baard & de Villiers, 2000)

6.4. Wetland Integrity Assessments

In determining the integrity of the wetland the condition of the site and the indirect and direct disturbances, etc. is taken into account. Dumping, roads, orchids, cultivation, power line crossings, alien invasive vegetation species, etc. are present (Figure 17).

The upstream section of the wetland and the catchment consist mainly of orchids, houses and roads with very little natural habitat left (Figure 17). Besides the destruction of wetland area the hardened and disturbed surfaces also contribute towards an increase in the intensity of storm water flow due rapid run-off to occur putting pressure on the wetland downstream.

Alien plant invaders occur in the form of *Populus canescens, Eucalyptus grandis,* etc. (Figure 17). Power lines cross this wetland several times and since these wetlands act at corridors for wild life in this urban environment it can cause disruptions in the flight path and patterns of several species (Figure 17).

Arundo donax (Spanish Reed) growing in wetland area.

Azolla filiculoides (Red water fern) growing in open water area.

Power lines crossing wetland area, possible impact on habitat and the migration of water birds

Vast Kikuyu dominated areas occur in wetlands

Housing development in wetland area

Rubble dumped in riparian area

Orchids in Wetland Area

Cultivation in Wetland Area

Cultivation in catchment area

Roads, orchids and housing in catchment area

Figure 17: Activities in wetland area that can be detrimental towards the integrity of the wetland

6.4.1. Present Ecological Status

The PES scores for the wetland in the study area is shown in Table 15.

Table 14: PES for the study area

Criteria and Attributes	Relevance	Score
Hydrologic		
Flow Modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.	1
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.	2
Water Quality		
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland.	3
Sediment Load Modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.	2

Hydraulic/Geomorphic		
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.	2
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities which reduce or changes wetland habitat directly in inundation patterns.	1
Biota		
Terrestrial Encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.	2
Indigenous Vegetation Removal	Transformation of habitat for farming, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and in increases potential for erosion.	1
Invasive Plant Encroachment	Affects habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).	1
Alien Fauna	Presence of alien fauna affecting faunal community structure.	1
Over utilisation of Biota	Overgrazing, overfishing, etc.	2
Total		18
Mean		1.8
Category		Very Low

The wetland obtained a very low category, meaning this wetland is seriously modified with a loss of natural habitat. The losses of natural habitats and basic ecosystem functions are extensive. This very low evaluation is mainly due to overall degradation and the presence of roads, housing developments in and adjacent to wetland area, channelization, reduced water quality, exotic vegetation, cultivation of land, etc.

6.4.2. Ecological Importance and Sensitivity (EIS)

The EIS scores for the different sites are shown in Table 16.

Table 15: EIS scores for the study area

Determinant	Score
Primary determinants	
Rare and endangered species	1
Species/taxon richness	1
Diversity of Habitat types or features	2
Migration route/breeding and feeding site for wetland species	2
Sensitivity to changes in the natural hydrological regime	2
Sensitivity to water quality changes	2
Flood storage, energy dissipation and particulate/element removal	2
Modifying determinants	
Protected status	0
Ecological integrity	1
Total	13
Median	2.0
EIS Category	C

This wetland was categorised as having a moderate importance and sensitivity (EIS). The wetland associated with the study area may be considered ecologically important on local scale, but it forms part of a much larger and more important wetland system. The biodiversity in this wetland is not expected to be sensitive to flow and habitat modifications and it may play an important role in moderating the quantity and quality of water of the associated river.

6.4.3. Ecosystem Services supplied by the wetland

Below is a discussion on the ecosystem services delivered by the wetland. The overall results are displayed in a graph as indicated in Figure 18.

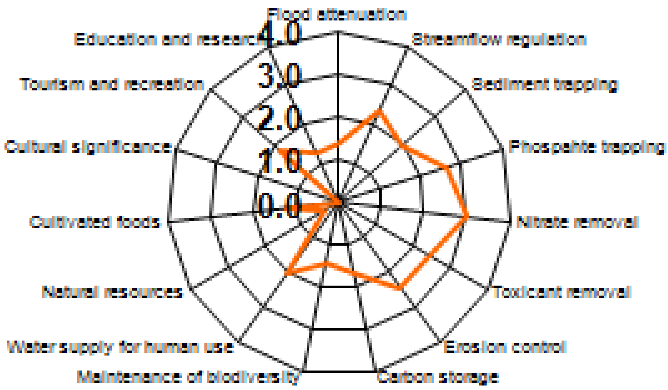


Figure 18: Wet Eco Services Results.

Natural Services

The wetland in the study area attained a moderate score for natural services (Table 17). Wetlands within a moderate class are moderately modified with some loss of natural habitats. The wetlands catchment is impacted upon by urban development in the form of cultivation, orchids, housing, roads, power lines, etc. and which extends into wetland habitat. This contributes towards the restriction of potential natural services. However, this wetland contributes towards maintaining water quality in the form of phosphate trapping, sediment trapping and nitrate removal.

Table 16: Natural services results

Flood attenuation	1.4
Streamflow regulation	2.3
Sediment trapping	2.0
Phospahte trapping	2.7
Nitrate removal	3.0
Toxicant removal	2.4
Erosion control	2.4
Carbon storage	1.7
Maintenance of biodiversity	1.4
Total	19.3
Score	Moderately

Human services

The wetland units within the study area didn't significantly contribute to the human services, with the highest class attained only being very low (Table 18). Local people rarely rely on the wetland and almost never benefit from it. However, the wetland does supply water for human use. Some birdlife does exist in and around the wetland area that can attract bird watchers and tourists.

Table 17: Human services results

Water supply for human use	2.1
Natural resources	0.4
Cultivated foods	1.2
Cultural significance	0.0
Tourism and recreation	1.9
Education and research	1.3
Total	6.9
Score	Very Low

6.5. Impact Assessment and Mitigation

No information was available in terms of the footprint and type of development proposed. Based on evaluation tables (Table 10 and Table 11), the impact magnitude and significance of the development depend on where it will take place. If the footprint extent into the wetland areas (Site 2, 3 and 4) the impact can be significant.

In expanding the power station into wetland areas can have the following impacts:

- Destruction of wetland habitat that can lead to habitat loss
- Increase in flow velocity around the expanded infrastructure in an already fragmented wetland/channel environment
- Initiation of erosion in the form of bank slumping or bank erosion
- Increase in wetland drainage to accommodate infrastructure
- Increase in sediment due to the building of infrastructure that can smother wetland habitat downstream
- Change in water quality

In order to mitigate some of the negative impacts it is important to control flow-rates by means of the following:

- Storm water runoff into the wetland area should make use of energy dissipaters
- Remove all dumped and refuge material in wetland area
- Remove invasive alien vegetation to establish and recreate wetland habitat.
- Because roads can be one of the biggest destroyers of wetlands, care should be taken to construct large enough culverts to cover the area of a wetland or waterway underneath current roads in the study area and downstream thereof. Culverts and or storm water pipes initiate head-cut erosion that can destroy wetlands and waterways.

However, based on the presence of extensive wetlands it is recommended that the footprint of the proposed development should be placed in Site 1.

7. CONCLUSION AND RECOMMENDATION

WETLANDS

Extensive wetlands were present in the study area. Based on hydro-geomorphic setting the survey indicated two palustrine wetland types in the study area which can be described as a non-channeled valley bottom and a channeled valley bottom wetland. The wetland soils encountered during the survey displayed signs of wetness within 50cm of the surface. Soils in these wetlands displayed typical hydro-morphic characteristics varying between temporary, permanent and seasonal wet characteristics. Permanent inundation occurred in patches indicating wetlands south (Site 4), east (Site 3) and north east (Site 2) of the existing power station largely associated with the watercourse. The presence of a restrictive clay layer (such as bedrock or dense clay) in the soil slowed or prevents the infiltration of water at Site 3. These sections of the wetland can be described as "perched wetlands", receiving water mainly via rainfall or overland runoff, and most likely not from groundwater. The permanent wet soils in this valley bottom wetland are a dark highly organic soil. The wetland soils in Site 4 contained sandy soils within seasonal to permanent wetlands have accumulated high carbon content and reflected a dark chroma. In some areas gleyed soils occurs as a result of prolonged saturated with water, the grey color is due to the absence of iron compounds. The soils outside the wetland area are typical terrestrial soils with a uniform red color indicating well-aerated soils.

The wetlands in the study area obtained a very low Present Ecological State (PES) category, meaning this wetland is seriously modified with a loss of natural habitat. The losses of natural habitats and basic ecosystem functions are extensive. This very low evaluation is mainly due to overall degradation and the presence of roads, housing developments in and adjacent to wetland area, channelization, reduced water quality, exotic vegetation, cultivation of land, etc. This wetland was further categorised as having a moderate Ecological Importance and Sensitivity (EIS). The wetland may be considered ecologically important on local scale, but it forms part of a much larger and more important wetland system. The biodiversity in this wetland is not expected to be sensitive to flow and habitat modifications and it may play an important role in moderating the quantity and quality of water of the associated river.

The wetland in the study area attained a moderate score for natural services. Wetlands within a moderate class are moderately modified with some loss of natural habitats. The wetlands catchment is impacted upon by cultivation, orchids, housing, roads, power lines, etc., which extends into the wetland habitat. This contributes towards the restriction of potential natural services. However, this wetland contributes towards maintaining water quality in the form of phosphate trapping, sediment trapping and nitrate removal. The wetland units within the study area didn't significantly contribute to the human services, with the highest class attained only being very low. Local people rarely rely on the wetland and almost never benefit from it. However, the wetland does supply water for human use. Some birdlife does exist in and around the wetland area that can attract bird watchers and tourists.

BIODIVESITY

The study area falls within the Critically Endangered Renosterveld and the vegetation unit in the study area is classified as Swartland Shale Renosterveld and Swartland Granite Renosterveld. Renosterveld is characterized by the dominance of Asteraceae, Renosterbos being the most important and where the vegetation type gets its name. Unlike Fynbos, grasses may also be abundant in Renosterveld. Another feature of Renosterveld is the high species richness of geophytic plants, mainly Iridaceae, Liliaceae and Orchidaceae.

The terrain associated with the study area is moderately undulating and the vegetation has been completely modified towards agricultural lands. This high fertility of Renosterveld meant that most of the area has been converted to agriculture. Less than 10% of Swartland Shale Renosterveld still remains intact, with other Renosterveld types also heavily ploughed or used as augmented pasture. Only remnants of Swartland Shale Renosterveld and Swartland Granite Renosterveld have remained intact as small islands between agricultural lands and conservation targets are no longer attainable in these areas. As a result of this transformation, the study area has been invaded by a high number of invasive alien species, weeds as well as several volunteer crops and very few indigenous species still occur in this area. Several plants recorded in the study area are classified as high-priority alien invasive species (Category 1b) requiring compulsory control. The dominance and aggressive growth of alien and invasive grasses such as kikuyu in the study area has largely displaced the rich diversity of geophytes expected to occur in the Renosterveld.

Remnants of Swartland Shale Renosterveld vegetation remaining as well as buffer areas around these remnants have therefore a very high conservation priority. However, the study area does not coincide with any of these remnants or high priority conservation areas in the Renosterveld. Extensive transformation of natural habitat in the Renosterveld severely disrupted ecological processes and its evolutionary potential, thereby compromising the future persistence of the biodiversity remaining in these natural areas. To assist the long-term persistence of biodiversity in these areas specific provision for 'spatially fixed' processes, such as river corridors has been identified. The stream running through the study areas has not been demarcated as a corridor and is therefore considered not to be of critical importance for the long term persistence of biodiversity in the Renosterveld.

Undoubtedly the greatest threat to mammalian biodiversity and indeed biodiversity in general is the continuing loss or irreversible transformation of natural habitat due to agricultural and industrial development, mining, urbanization, and the spread of alien biota. All the large game became extinct in the Fynbos Biome. This loss of natural habitat, and the associated fragmentation of what is left, is exacerbated in the case of those remaining specialist mammals with very specific habitat preferences.

Habitat transformation has resulted in subsequent loss of habitat and a reduction in habitat value for remaining small mammal communities by creating a mosaic of optimal and sub-optimal habitats. Fragments of natural habitats may be playing an important role in harbouring rare and possibly endangered species, transformed habitats are also important as secondary habitats providing both cover as well as seasonal food resources.

The sandier portions of the lowland Renosterveld represent important habitats for endemic species such as the Cape gerbil (*Tatera afra*) (Figure 14); the Cape dune molerat (*Bathyergus suillus*); and Van Zyl's golden mole (*Cryptochloris zyli*). Small mammal species richness, diversity and abundance tend to be very low in cultivated and areas invaded by alien plant species compared to the adjacent remnant vegetation. The study area is completely transformed and is unlikely to support a significant diversity of small mammals of concern. Evidence of striped mouse (*Rhabdomys pumilio*), common mole rat (*Cryptomys hottentotus*) (Figure 15) and Cape gerbil (*Tatera afra*) activity were evident in the study area. The introduced grey squirrel (Sciurus carolinensis) has also established in the area.

The study area is not considered to be of critical importance for amphibians, reptiles or birds. Taking into account the transformed state of the study, the majority of the frog species are expected to consist of the common, wide-spread and generalist species such as the common platanna (*Xenopus laevis*), the Cape river frog (*Afrana fuscigula*), raucous toad (*Bufo rangeri*), the clicking stream frog (*Strongylopus grayii*) and the common caco (*Cacosternum boettgeri*) (Baard & de Villiers, 2000).

RECOMMENDATION

The biodiversity remaining in the study area is no longer of critical importance to conservation. Extensive wetlands in the area are of some concern. No information was available in terms of the footprint and type of development proposed. Based on evaluation tables, the impact magnitude and significance of the development depend on where it will take place. If the footprint extent into the wetland areas (Site 2, 3 and 4) the impact can be significant. Based on the presence of extensive wetlands it is therefore recommended that the footprint of the proposed development should be placed west of the existing power station (Site 1).

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APPENDIX A

LIST OF PLANTS RECORDED IN THE STUDY AREA

FAMILY	BOTANICAL NAME	COMMON NAME	CARA	NEMBA
Agapanthaceae	*Agapanthus africanus*	Agapanthus		
Anacardiaceae	*Rhus tomentosa*	Real wild currant		
Apiaceae	*Centella affinis*	Centella		
Apocynaceae	*Gomphocarpus fruticosus*	Vleiklapper		
Asteraceae	*Arctotheca calendula*	Cape marigold		
	*Bidens pilosa**	Blackjack	Weed	
	Chrysanthemoides monilifera	Tick berry		
	*Cirsium vulgare**	Spear thistle	1	1b
	*Conyza bonariensis**	Flax-leaf fleabane	Weed	
	Conyza scabrida	Fleabane		
	Cotula turbinata	Ganskos		
	Dimorphotheca spp.	Marguerite		
	*Dittrichia graveolens**	Cape Khakiweed	Weed	
	*Picris echioides**	Bristly oxtongue	Weed	
	Stoebe spiralis	Slangbos		
	*Xanthium strumarium**	Large cocklebur	1	1b
Azollaceae	*Azolla filiculoides*	Water Fern	1	1b
Boraginaceae	*Echium plantagineum**	Purple echium	1	1b
	*Echium vulgare**	blue echium	1	1b
Brassicaceae	*Brassica napus**	Canola	2	2
	*Nasturtium officinale**	Watercress	2	2
	*Raphanus raphanistrum**	Wild radish	Weed	
	*Raphanus rugosum**	Wild mustard	Weed	
	*Sisymbrium capense**	Wild mustard	Weed	
Cactaceae	*Opuntia ficus-indica**	Sweet prickly pear	1	1b
Cannaceae	*Canna indica**	Garden canna	1	1b
Chenopodiaceae	*Chenopodium album**	White goosefoot	Weed	
Convolvulaceae	*Falkia repens*	Falkia		
Cyperaceae	*Cyperus papyrus*	Sedge		
	Cyperus textilis	Sedge		
	Schoenoplectus spp	Sedge		
Euphorbiacaea	*Ricinus communis*	Caster-oil plant	1	1b
Fabaceae	*Acacia saligna**	Port Jackson	1	1b
	*Lupinus angustifolius**	Blue lupin	V	
	*Lupinus luteus**	Yellow lupin	V	
	*Medicago sativa**	Lucerne	V	
	*Myoporum tenuifolium**	Manitoka	3	3
	*Paraserianthes lophantha**	Stinkbean	1	1b
	Sesbania punicea	Red sesbania	1	1b
	*Trifolium repens**	White clover	V	
	*Vicia hirsuta**	Hairy tare	Weed	
	*Vicia villosa**	Russian vetch	Weed	
Fumariaceae	*Fumaria muralis**	Fumitory	Weed	
Geraniaceae	*Erodium moschatum**	Musk heron's bill	Weed	
Hyacinthaceae	*Galtonia spp*	Mountain lily		
Iridaceae	*Gladiolus liliaceus*	Large brown Afrikaner		

Lemnaceae	*Lemna minor*	Duckweed		
Malvaceae	*Malva parvifolium*	Small mallow	1	1b
Myrtaceae	*Eucalyptus camaldulensis**	Red river gum	2	1b
Oxalideae	*Oxalis pes-caprae*	Yellow sorrel		
	Oxalis purpurea	Purple sorrel		
	Oxalis spp.	Sorrel		
Phytolaccaceae	*Phytolacca dioica**	Belhambra	3	3
	*Phytolacca octandrum**	Inkberry	1	1b
Pinaceae	*Pinus pinaster**	Cluster pine	2	
Plantaginaceae	*Plantago lanceolatum**	Buckhorn plantain	Weed	
	*Plantago major**	Broadleaf ribwort	Weed	
Poaceae	*Arundo donax**	Gaint reed	1	1b
	*Avena fatua**	Wild oats		
	*Bromus catharticus**	Rescue grass		
	*Bromus diandrus**	Ripgut grass	1	1b
	*Cortaderia selloana**	Pampas grass	1	1b
	Cynodon dactylon			
	*Ehrharta longiflora**	Oat-seed grass	Weed	
	Eragrostis curvula	Weeping love grass		
	*Lolium multiflorum**	Italian ryegrass	V	
	*Paspalum dilatatum**	Dallis grass		
	*Pennisetum clandestinum**	Kikuyu grass		
	Pennisetum macrourum	Riverbed grass		
	*Phalaris minor**	Small canary grass		
	Phragmites australis	Common reed		
	*Poa annua**	Wintergrass		
	*Polypogon monspeliensis**	Rabbit's foot		
	Typha capensis	Common bullrush		
Polygonaceae	*Persicaria decipiens **	Spotted knotweed		
	*Rumex acetosella**	Sheep sorrel	Weed	
	*Rumex crispus**	Curly dock	Weed	
Pontedariaceae	*Pontederia cordata**	Pickerel weed	3	1b
Rosaceae	*Cliffortia spp*			
	*Cotoneaster franchetii**	Orange coteneaster	3	1b
	*Eriobotrya japonica**	Loquat	1	1b
	Stoebe spiralis			
Salicaceae	*Populus canescens**	Grey popular	2	2
	*Salix babylonica**	Weeping willow	2	
Simaroubaceae	*Ailanthus altissima**	Tree of Heaven	3	1b
Solanaceae	*Datura stramonium**	Common thorn-apple	1	1b
	*Solanum mauritianum**	Bugweed	1	1b
Troppaeolaceae	*Tropaeolum majus**	Nasturtium	2	2

CARA : 1983/2001 Category 1: Plants are prohibited and must be controlled. Category 2: Plants (commercially used plants) may be grown in demarcated areas, providing that there is a permit and that steps are taken to prevent their spread. Category 3: Plants (ornamentally used plants)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.	CARA/NEMBA (Proposed 2009) Category 1a Plants are high-priority emerging species requiring compulsory control. All breeding, growing, moving and selling are banned. Category 1a Plants are widespread invasive species controlled by a management program.. Category 2 Plants are invasive species controlled by area. Can be grown under permit conditions in a demarcated area. All breeding, growing, moving, selling banned without a

			permit.
V =	Volunteer indicating crop or pasture plants that has established outside agricultural lands.	Category 3	Plants are ornamental and other species that are permitted on a property but may no longer be planted or sold.

APPENDIX B

Birds that can be found in and around wetlands and dams in the Firgrove area.

C-Common	U-Uncommon	R-Rare	V-Vagrant	A-All Year	S-Summer	W-Winter

Species	Status	Species	Status	Species	Status
Great Crested Grebe	CA	Turnstone	RS	Redcapped Lark	CA
Black-Necked Grebe	V	Common Sandpiper	CS	European Swallow	CS
Dabchick	CA	Wood Sandpiper	CS	Whitethroated Swallow	CS
Whitebreasted Cormorant	CA	Redshank	V	Greater Striped Swallow	US
Cape Cormorant	UA	Marsh Sandpiper	CS	Sth African Cliff Swallow	V
Reed Cormorant	CA	Greenshank	CS	Pearlbreasted Swallow	US
Crowned Cormorant	V	Whimbrel	V	Rock Martin	RA
Darter	CA	African Jacana	V	House Martin	RS
Grey Heron	CA	Knot	V	European Sand Martin	US
Blackheaded Heron	CA	Curlew Sandpiper	CS	Brownthroated Martin	CA
Purple Heron	CA	Little Stint	CS	Banded Martin	US
Great White egret	V	Pectoral Sandpiper	V	Cape Bulbul	UA
Little Egret	CA	Sanderling	US	Olive Thrush	RA
Yellowbilled Egret	CA	Ruff	CS	Capped Wheatear	RA
Cattle Egret	CA	Bartailed Godwit	V	Familiar Chat	RA
Blackcrowned Night Heron	CA	Curlew	V	Stonechat	RA
Little Bittern	UA	Blackwinged Stilt	CA	Cape Robin	CA
Hamerkop	V	Spotted Dikkop	CA	Karoo Robin	UA
White Stork	V	Water Dikkop	CA	Titbabbler	RA
Black Stork	V	Kelp Gull	CA	African Marsh Warbler	CS
Yellowbilled Stork	V	Greyheaded Gull	UA	Lesser Swamp-Warbler	CA
Sacred Ibis	CA	Blackshouldered Kite	CA	Little Rush-Warbler	CA
Glossy Ibis	CA	African Fish Eagle	UA	Willow Warbler	RS
Hadeda Ibis	CA	Osprey	RS	Bar-throated Apalis	RA
African spoonbill	CS	Steppe Buzzard	US	Longbilled Crombec	CS
Whitefaced Duck	UA	Jackal Buzzard	V	Fantailed Cisticola	CA
Fulvous Duck	UA	African Marsh Harrier	CA	Cloud Cisticola	RA
Egyptian Goose	CA	Peregrine Falcon	UA	Grey-backed Cisticola	CA
South African Shelduck	UA	Pied Crow	CA	Levaillant's Cisticola	CA
Yellowbilled Duck	CA	Lanner Falcon	CA	Cape Batis	RA
Cape Teal	CA	Black Harrier	RA	Spotted Prinia	CA
Hottentot Teal	UA	Rock Kestrel	CA	Fiscal Flycatcher	RA
Redbilled Teal	CA	Hartlaub's Gull	CA	Paradise Flycatcher	US
Whitebacked Duck	UA	Whiskered Tern	RS	Cape Wagtail	CA
Cape Shoveller	CA	Whitewinged Tern	CS	African Pipit	CA
Southern Pochard	UA	Feral Pigeon	CA	Orangethroated Longclaw	CA
Knobbilled Duck	V	Rock Pigeon	CA	Fiscal Shrike	CA
Spurwinged Goose	CA	Redeyed Dove	CA	Bokmakierie	CA
Maccoa Duck	UA	Cape Turtle Dove	CA	Redbacked Shrike	V
Yellowbilled Kite	US	Laughing Dove	CA	Common Starling	CA
Cape Francolin	CA	Namaqua Dove	RA	Pied Starling	RA
Greywinged Duck	UA	Klaas's Cuckoo	CS	Redwing Starling	UA
Common Quail	VW	Diederik Cuckoo	US	Malachite Sunbird	US
Helmeted Guineafowl	CA	Burchell's Coucal	UA	Lesser D/collard Sunbird	CA
African Rail	UA	Barn Owl	UA	Cape White-eye	CA
Black Crake	UA	Marsh Owl	UA	House Sparrow	RA
Purple Gallinule	CA	Spotted Eagle Owl	UA	Cape Sparrow	CA

Moorhen	CA	Flerynecked Nightjar	CA	Cape Weaver	CA
Redknobbed Coot	CA	Black Swift	CA	Southern Masked-Weaver	CA
Painted Snipe	UA	Whiterumped Swift	US	Red Bishop	CA
Ethiopean Snipe	CS	Little Swift	CA	Yellow Bishop	CA
Ringed Plover	UA	Alpine Swift	CA	Common Waxbill	CA
Whitefronted Plover	CA	Speckled Mousebird	CA	Pin-tailed Whydah	CA
Chestnutbanded Plover		Whitebacked Mousebird	CA	Cape Canary	CA
Kittlitz's Plover	RA	Redfaced Mousebird	CA	Yellow Canary	CA
Threebanded Plover	CA	Pied Kingfisher	CA	Whitethroated Canary	UA
Grey Plover	CA	Giant Kingfisher	UA	Cape Bunting	RA
Crowned Lapwing	RS	Malachite Kingfisher	CA		
Blacksmith Lapwing	UA	Hoopoe	RA		
	CA	Pied Barbet	UA		

Bird species encountered during the one day field visit.