GRAHAMSTOWN GOLF CLUB RESIDENTIAL DEVELOPMENT

WETLAND IMPACT ASSESSMENT

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SPECIALIST REPORT DETAILS

This report has been prepared as per the requirements of the Environmental Impact Assessment Regulations and the National Environmental Management Act (Act 107 of 1998), any subsequent amendments and any relevant National and / or Provincial Policies related to biodiversity assessments.

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I, **Dr. Brian Michael Colloty** declare that this report has been prepared independently of any influence or prejudice as may be specified by the National Department of Environmental Affairs

Signed:… ……………… Date:…4 November 2011…………

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EXECUTIVE SUMMARY

Several wetland features, were investigated to assess the potential impact of the proposed new residential development (mixed use) for the Grahamstown Golf Club site.

The wetlands were classified using the National Wetland Classification System, after their respective ecological state and conservation were assessed. This resulted in 6 wetlands being described within the site, all receiving moderate ecological state categories and conservation value ratings due to either being man-made or modified systems. From a catchment management perspective, it would seem that the proposed project could affect a number of wetland areas. These wetlands perform an important role in attenuating surface water flows, while providing a series of differing wetland habitats form part of a wetland network within the region.

During the assessment, it was found however the most significant impact was related to the complete removal of all but one wetland, which has a limited importance without any mitigation. It is thus firmly recommended that the layout be altered to accommodate Wetlands 1 and 5, while recreating new wetland areas in the form of stormwater management features. It was also found that should wetland habitats be recreated, using indigenous grass and sedges species, then project could have a beneficial impact on the environment, as most species would easily re-colonise the area, while a number of alien invasive species could then be excluded. It is also suggested that smaller reed beds are also incorporated, in areas away from the airfield, in order to attract the wetland bird species that nest in these areas.

Furthermore, based on observations and the size of the respective catchments the wetlands would not exceed more than their current visible boundaries, by 15 – 20 m and thus a 32m buffer from the delineated edge is recommended as being more than sufficient in order to protect these systems.

Impacts with regard water quality and water quantity still need to be addressed, but these can only be assessed once a revised layout has been developed.

Further recommendations include:

- Stormwater should be managed using suitable structures such as swales, gabions and rock rip-wrap so that any run-off from the development site is attenuated prior to discharge. Silt and sedimentation should be kept to a minimum, through the use of the above mentioned structures by also ensuring that all structures don’t create any form of erosion.
- Vegetation clearing should occur in parallel with the construction progress to minimise erosion and/or run-off. Large tracts of bare soil will either cause dust pollution or quickly erode and then cause sedimentation in the lower portions of the catchment.
- Only indigenous plant species must be used in the re-vegetation process. The species list mentioned in this and terrestrial vegetation study should be used a guide
- All construction materials including fuels and oil should be stored in demarcated areas that are contained within berms / bunds to avoid spread of any contamination into wetland or rivers. Washing and cleaning of equipment should also be done in berms or bunds, in order to trap any cement and prevent excessive soil erosion. These sites must be re-vegetated after construction has been completed. Mechanical plant and bowsers must not be refuelled or serviced within or directly adjacent to any river channel. It is therefore suggested that all construction camps, lay down areas, batching plants or areas and any stores should be more than 50m from any demarcated wetland or riverine area
- It is also advised that an Environmental Control Officer, with a good understanding of the local flora be appointed during the construction phase. The ECO should be able to make clear recommendations with regards to the re-vegetation of the newly completed / disturbed areas, using selected species detailed in this and the terrestrial vegetation report. All alien plant re-growth must be monitored and should it occur these plants should be eradicated. Where any works (e.g. storm water control measures) near a wetland or river is required specific attention should be paid to the immediate re-vegetation of cleared areas to prevent future erosion of sedimentation issues.

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ACRONYMS

CARA	Conservation of Agricultural Resources Act
CBD	Central Business District
DWA	Department of Water Affairs
EIS	Ecological Importance and Sensitivity
GIS	Geographic Information System
HGM	Hydrogeomorphic Approach
NEMBA	National Environmental Management Act (Act 10 of 2004)
NSBA	National Spatial Biodiversity Assessment
NWA	National Water Act (Act 36of 1998)
NWCS	National Wetland Classification System
PES	Present Ecological State
SABIF	South African Biodiversity Information Facility, a SANBI database that contains both faunal and floral species records
SANBI	South African National Biodiversity Institute
WUL	Water Use License
WULA	Water Use License Application

1 INTRODUCTION

Several wetland features and a small drainage line are located within the study area (Figure 1). This report will assess the potential impact of the proposed housing development on the wetland systems, as well as supplying suitable recommendations where relevant.

It should be noted that the Scoping Report Terms of Reference (TOR) called for a wetland assessment based on the Water Research Commission Wet-Health Level 1 procedure. This study has used a similar approach, but included additional aspects, which are more suited to wetland impact assessment.

For this reason, this report will deal with the following:

- Wetland classification according to the National Wetland Classification System
- Derivation of wetland importance and function
- Relevant wetland legislation & policy
- Wetland delineation
- Wetland Integrated Habitat Integrity Assessment
- Impact assessment
- Potential mitigation and recommendations on no-go areas & suitable buffers

1.1 National Wetland classification System (NWCS 2010)

Since the late 1960's, wetland classification systems have undergone a series of international and national revisions. These revisions allowed for the inclusion of additional wetland types, ecological and conservation rating metrics, together with a need for a system that would allude to the functional requirements of any given wetland (Ewart-Smith *et al*., 2006). Wetland function is a consequence of biotic and abiotic factors, and wetland classification should strive to capture these aspects.

The South African National Biodiversity Institute (SANBI) in collaboration with a number of specialists and stakeholders developed the newly revised and now accepted National Wetland Classification Systems (NWCS 2010). This system comprises a hierarchical classification process of defining a wetland based on the principles of the hydrogeomorphic (HGM) approach at higher levels, with including structural features at the finer or lower levels of classification (SANBI 2009).

Wetlands develop in a response to elevated water tables, linked either to rivers, groundwater flows or seepage from aquifers (Parsons, 2004). These water levels or flows then interact with localised geology and soil forms, which then determines the form and function of the respective wetlands. Water is thus the common driving force, in the formation of wetlands (DWAF, 2005). It is significant that the HGM approach has now been included in wetland classification as the HGM approach has been adopted throughout the water resources management realm with regard the determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) and WET-Health assessments for aquatic environments. All of these systems are then easily integrated using the HGM approach in line with the Ecoclassification process of river and wetland reserve determinations used by the Department of Water Affairs. The Ecological Reserve of a wetland or river is used by DWA to assess the water resource allocations when assessing water use license applications (WULA).

Figure 1: Google Earth image of the study area in red, with the golf course located south east of the airfield

The NWCS process is provided in more detail in the methods section of the report, but some of the terms and definitions used in this document are present below:

Definition Box

Present Ecological State is a term for the current ecological condition of the resource. This is assessed relative to the deviation from the Reference State. Reference State/Condition is the natural or pre-impacted condition of the system. The reference state is not a static condition, but refers to the natural dynamics (range and rates of change or flux) prior to development. The PES is determined per component - for rivers and wetlands this would be for the drivers: flow, water quality and geomorphology; and the biotic response indicators: fish, macroinvertebrates, riparian vegetation and diatoms. PES categories for every component would be integrated into an overall PES for the river reach or wetland being investigated. This integrated PES is called the EcoStatus of the reach or wetland.

EcoStatus is the overall PES or current state of the resource. It represents the totality of the features and characteristics of a river and its riparian areas or wetland that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services. The EcoStatus value is an integrated ecological state made up of a combination of various PES findings from component EcoStatus assessments (such as for invertebrates, fish, riparian vegetation, geomorphology, hydrology and water quality).

Reserve: The quantity and quality of water needed to sustain basic *human needs* and *ecosystems* (e.g. estuaries, rivers, lakes, groundwater and wetlands) to ensure ecologically sustainable development and utilisation of a water resource. The *Ecological Reserve* pertains specifically to aquatic ecosystems.

Reserve requirements: The quality, quantity and reliability of water needed to satisfy the requirements of basic human needs and the Ecological Reserve (inclusive of instream requirements).

Ecological Reserve determination study: The study undertaken to determine Ecological Reserve requirements.

Licensing applications: Water users are required (by legislation) to apply for licenses prior to extracting water resources from a water catchment.

Ecological Water Requirements: This is the quality and quantity of water flowing through a natural stream course that is needed to sustain instream functions and ecosystem integrity at an acceptable level as determined during an EWR study. These then form part of the conditions for managing achievable water quantity and quality conditions as stipulated in the **Reserve Template**

Water allocation process (compulsory licensing): This is a process where all existing and new water users are requested to reapply for their licenses, particularly in stressed catchments where there is an over-allocation of water or an inequitable distribution of entitlements.

Ecoregions are geographic regions that have been delineated in a top-down manner on the basis of physical/abiotic factors. • NOTE: For purposes of the classification system, the 'Level I Ecoregions' for South Africa, Lesotho and Swaziland (Kleynhans *et al.* 2005), which have been specifically developed by the Department of Water Affairs & Forestry (DWAF) for rivers but are used for the management of inland aquatic ecosystems more generally, are applied at Level 2A of the classification system. These Ecoregions are based on physiography, climate, geology, soils and potential natural vegetation.

1.1.1 Wetland definition

Although the National Wetland Classification System (SANBI, 2009) is used to classify wetland types it is still necessary to understand the definition of a wetland. Wetland definitions as with classification systems have changed over the years. Terminology currently strives to characterise a wetland not only on its structure (visible form), but also to relate this to the function and value of any given wetland.

The Ramsar Convention definition of a wetland is widely accepted as **"areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres"** (Davis 1994). South Africa is a signatory to the Ramsar Convention and therefore its extremely broad definition of wetlands has been adopted for the proposed NWCS, with a few modifications.

Whereas the Ramsar Convention included marine water to a depth of six metres, the definition used for the NWCS extends to a depth of ten metres at low tide, as this is recognised seaward boundary of the shallow photic zone (Lombard *et al*., 2005). An additional minor adaptation of the definition is the removal of the term 'fen' as fens are considered a type of peatland. The adapted definition for the NWCS is, therefore, as follows (SANBI, 2009):

WETLAND: an area of marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed ten metres.

This definition encompasses all ecosystems characterised by the permanent or periodic presence of water other than marine waters deeper than ten metres. The only legislated definition of wetlands in South Africa, however, is contained within the National Water Act (Act No. 36 of 1998) (NWA) where wetlands are 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 land in normal circumstances supports, or would support, vegetation adapted to life in saturated soil." This definition is consistent with more precise working definitions of wetlands and therefore includes only a subset of ecosystems encapsulated in the Ramsar definition. It should be noted that the NWA definition is not concerned with marine systems and clearly distinguishes wetlands from estuaries, classifying the later as a water course (SANBI, 2009). The DWA is however reconsidering this position with regard the management of estuaries due the ecological needs of these systems with regard water allocation. Table 1 provides a comparison of the various wetlands included within the main sources of wetland definition used in South Africa.

Although a subset of Ramsar-defined wetlands was used as a starting point for the compilation of the first version of the National Wetland Inventory (i.e. "wetlands", as defined by the National Water Act, together with open waterbodies), it is understood that subsequent versions of the Inventory include the full suite of Ramsar-defined wetlands in order to ensure that South Africa meets its wetland inventory obligations as a signatory to the Convention (SANBI, 2009).

Wetlands must therefore have one or more of the following attributes to meet the above definition (DWAF, 2005):

- A high water table that results in the saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil.
- Wetland or hydromorphic soils that display characteristics resulting from prolonged saturation, i.e. mottling or grey soils
- The presence of, at least occasionally, of hydrophilic plants, i.e. hydrophytes (water loving plants).

It should be noted that riparian systems that are not permanently or periodically inundated are not considered true wetlands, i.e. those associated with the Lusikisiki River, downstream of the CBD, however certain wetlands associated with the Lusikisiki River floodplain are considered wetlands and were assessed here. The Lusikisiki River riparian zones were investigated separately in this study, i.e. vegetation that is supported by deep underground water tables associated with aquifers or rivers.

Table 1: Comparison of ecosystems considered to be 'wetlands' as defined by the proposed NWCS, the National Water Act (Act No. 36 of 1998), and ecosystems are included in DWAF's (2005) delineation manual.

Ecosystem	NWCS "wetland"	National Water Act wetland	DWAF (2005) delineation manual
Marine	YES	NO	NO
Estuarine	YES	NO	NO
Waterbodies deeper than 2 m (i.e. limnetic habitats often describes as lakes or dams)	YES	NO	NO
Rivers, channels and canals	YES	NO[1]	NO
Inland aquatic ecosystems that are not river channels and are less than 2 m deep	YES	YES	YES
Riparian[2] areas that are permanently / periodically inundated or saturated with water within 50 cm of the surface	YES	YES	YES[3]
Riparian[2] areas that are not permanently / periodically inundated or saturated with water within 50 cm of the surface	NO	NO	YES[3]

1.2 Wetland importance and function

South Africa is a Contracting Party to the Ramsar Convention on Wetlands, signed in Ramsar, Iran, in 1971, and has thus committed itself to this intergovernmental treaty, which provides the framework for the national protection of wetlands and the resources they could provide. Wetland conservation is now driven by the South African National Biodiversity Institute, a requirement under the National Environmental Management: Biodiversity Act (No 10 of 2004).

[1] Although river channels and canals would generally not be regarded as wetlands in terms of the National Water Act, they are included as a 'watercourse' in terms of the Act

[2] According to the National Water Act and Ramsar, riparian areas are those areas that are saturated or flooded for prolonged periods would be considered riparian wetlands, opposed to non –wetland riparian areas that are only periodically inundated and the riparian vegetation persists due to having deep root systems drawing on water many meters below the surface.

[3] The delineation of 'riparian areas' (including both wetland and non-wetland components) is treated separately to the delineation of wetlands in DWAF's (2005) delineation manual.

Wetlands are among the most valuable and productive ecosystems on earth, providing important opportunities for sustainable development (Davies and Day, 1998). However wetlands in South Africa are still rapidly being lost or degraded through direct human induced pressures (Nel *et al.,* 2004).

The most common attributes or goods and services provided by wetlands include:

- Improve water quality;
- Impede flow and reduce the occurrence of floods;
- Reeds and sedges used in construction and traditional crafts;
- Bulbs and tubers, a source of food and natural medicine;
- Store water and maintain base flow of rivers;
- Trap sediments; and
- Reduce the number of water borne diseases.

In terms of this study, the wetlands provide ecological (environmental) value to the area between the adjacent residential areas and the remaining wetland areas found at Burnt kraal, northwest of the Grahamstown Airfield (Figure 2). These wetlands thus act as refugia for various wetland associated plants, butterflies and birds, while impeding flow. Impeded flows reduce the occurrence of flooding, while trapping sediment and thus protecting downstream users from environmental degradation.

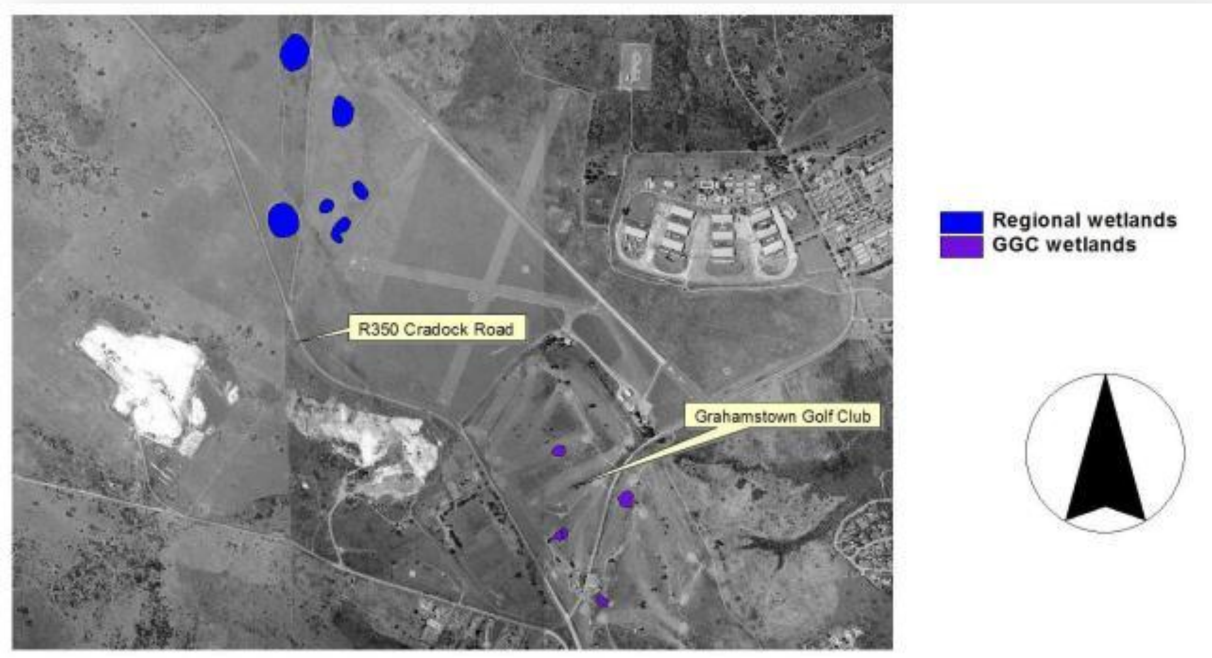

Figure 2: Regional wetlands (blue) similar in structure and function as the study site wetlands (purple)

In the past wetland conservation has focused on biodiversity as a means of substantiating the protection of wetland habitat. However not all wetlands provide such motivation for their protection, thus wetland managers and conservationists began assessing the importance of wetland function within an ecosystem.

Table 2 summarises the importance of wetland function when related to ecosystem services or ecoservices (Kotze *et al*., 2008). One such example is emergent reed bed wetlands that function as transformers converting inorganic nutrients into organic compounds (Mitsch and Gosselink, 2000).

Table 2: Summary of direct and indirect ecoservices provided by wetlands from Kotze *et al.*, 2008.

Ecosystem services supplied by wetlands	Indirect benefits	Hydro-geochemical benefits		Flood attenuation
				Stream flow regulation
			Water quality enhancement benefits	Sediment trapping
				Phosphate assimilation
				Nitrate assimilation
				Toxicant assimilation
				Erosion control
				Carbon storage
				Biodiversity maintenance
	Direct benefits			*Provision of water for human use*
				Provision of harvestable resources[2]
				Provision of cultivated foods
				Cultural significance
				Tourism and recreation
				Education and research

1.3 Relevant wetland legislation and policy

Locally the South African Constitution, seven (7) Acts and two (2) international treaties allow for the protection of wetlands and rivers. These systems are protected from the destruction or pollution by the following:

- Section 24 of The Constitution of the Republic of South Africa;
- Agenda 21 – Action plan for sustainable development of the Department of Environmental Affairs and Tourism (DEAT) 1998;
- The Ramsar Convention, 1971 including the Wetland Conservation Programme (DEAT) and the National Wetland Rehabilitation Initiative (DEAT, 2000);
- National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998) inclusive of all amendments, as well as the NEM: Biodiversity Act;
- National Water Act, 1998 (Act No. 36 of 1998);
- Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983); and
- Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002).
- Nature and Environmental Conservation Ordinance (No. 19 of 1974)
- National Forest Act (No. 84 of 1998)
- National Heritage Resources Act (No. 25 of 1999)

Apart from NEMA, the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983) will also apply to this project. The CARA has categorised a large number of invasive plants together with associated obligations of the land owner. A number of Category 1 & 2 plants were found at all of the sites investigated, thus the contractors must take extreme care further spread of these plants doesn't occur. This should be done through proper stockpile management (topsoil) and suitable rehabilitation of disturbed areas after construction.

A draft amendment of the National Environmental Management: Biodiversity Act or NEM:BA (Act No 10 of 2004) has been gazetted for comment (March 2010), which lists 225 threatened ecosystems based on vegetation type (Vegmap). Should a vegetation type or ecosystem be listed, actions in terms of NEM:BA are triggered when this amendment is promulgated.

None of the listed vegetation types are known to occur within the study area.

Provincial legislation and policy

Various provincial guidelines on buffers have been issued within the province. These are stated below so that the engineers and contractors are aware of these buffers during the planning phase. Associated batch plants, stockpiles, lay down areas and construction camps should avoid of these buffer areas.

Until national guidelines for riverine and wetland buffers are established, the guidelines set out in the Eastern Cape Biodiversity Conservation Plan documentation should be applied (Berliner & Desmet, 2007). Currently there is no accepted priority ranking system for wetlands. Until such a system is developed, it is recommended that a 50m buffer be set for all wetlands.

Other policies that are relevant include:

- Provincial Nature Conservation Ordinance (PNCO) – Protected Flora. Any plants found within the sites are described in the ecological assessment.
- National Freshwater Ecosystems Priority Areas – CSIR 2011 draft. This mapping product highlights potential rivers and wetlands that should be earmarked for conservation on a national basis.

2 PROJECT LOCALITY & DESCRIPTION

The proposed project will see the conversion of the current golf course (Erf 8045), into a mixed use residential and commercial zone (Figure 2 – green layout), located approximately 3 km north west of the Grahamstown CBD. It should be noted that the proposed 65.6ha layout in Figure 3 is currently being revised based on the findings of the ecological assessment and this study, i.e. to incorporate the important natural wetland areas.

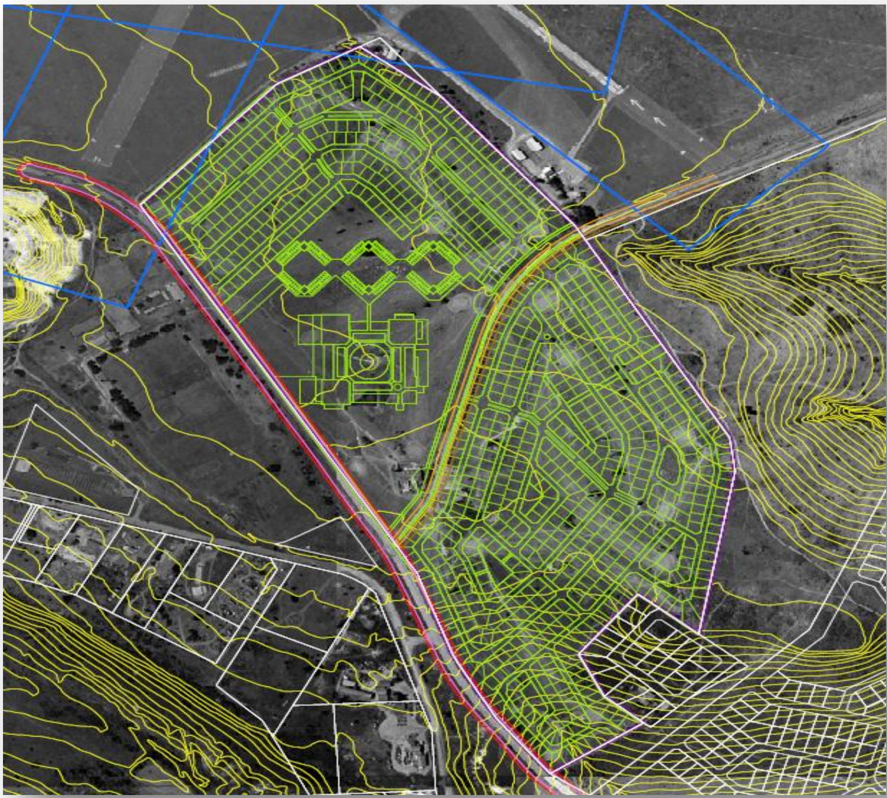

Figure 3: Conceptual layout plant for the proposed development now under revision

The project will also require the extensive development of services (roads, bulk water, electrical and sewer) to establish this development, together with the necessary stormwater management measures. The later will be finalised based on the recommendations of this report.

The study area is currently dominated by secondary grasslands and thorny scrub (Bhisho Thornveld) i.e. manicured fairways and greens, and a number of natural and man-made wetlands that were included as features within the golf course. A large number of exotic trees (*Eucalyptus* and Wattles) are also present within the area.

3 METHODS

3.1 Study terms of reference

Izenzo Outsource appointed Scherman Colloty & Associates to conduct a wetland impact assessment of the areas that could be affected by the proposed mix use development of the Grahamstown Golf Club (Figure 2).

The terms of reference were to provide the following:

- A desktop biodiversity assessment of the study area. This will cover the development footprint in relation to available ecological information related to wetland and riverine ecosystems functioning within the region.
- A map demarcating the relevant local drainage area of the respective wetland/s, i.e. the wetland, its respective catchment and other wetland areas within a 500m radius of the study area. This will demonstrate, from a holistic point of view the connectivity between the site and the surrounding regions, i.e. the zone of influence.
- Maps depicting demarcated wetland areas delineated to a scale of 1:10 000, following the methodology described by the Department of Water Affairs, together with a classification of delineated wetland areas. A detailed methodology is supplied in the Annexure.
- The determination of the ecological state of any wetland and riparian area, estimating their biodiversity, conservation and ecosystem importance. This will be based on the latest Present Ecological State / Ecological Importance & Sensitivity (PES/EIS) methodology being developed by DWA and SC&A for the Eastern Cape Province. Note that this determination will not include avifaunal, herpetological or invertebrate studies; however possible habitat for species of special concern would be commented on.
- Recommend buffer zones and No-go areas around any delineated wetland areas based on the relevant legislation (e.g. Eastern Cape Biodiversity Conservation Plan guidelines) or best practice judgement for those systems that are found to have ecological value, and should be retained.
- Assess the potential impacts, based on a supplied methodology
- Provide mitigations regarding project related impacts, including engineering services that could negatively affect demarcated wetland areas.
- Recommend specific actions that could enhance the wetland functioning in the areas, allowing the potential for a positive contribution by the project, e.g. useful of artificial wetlands in stormwater control
- Supply the client with geo-referenced GIS shape files of the wetland / riverine areas.
- Provide one draft report for comment, with a maximum of two rounds of comments addressed.

3.2 Study methods

This impact assessment was initiated with a survey of the pertinent literature, past reports and the various conservation plans that exist for the study region. Maps and Geographical Information Systems (GIS) were then employed to ascertain, which portions of the proposed development, could have the greatest impact on the wetlands and associated habitats.

A one day site visit was then conducted to ground-truth the above findings, thus allowing critical comment of the development when assessing the possible impacts.

Wetland areas were then assessed on the following basis:

- Vegetation type – verification of type and its state or condition based, supported by species identification using Germishuizen and Meyer (2003), Vegmap (Mucina and Rutherford, 2006 as amended) and the South African Biodiversity Information Facility (SABIF) database. The SABIF database contains older species records for areas, thus allowing to compare present versus past states.
- Plant species were further categorised as follows:
    - Terrestrial: species are not directly related to any surface or groundwater base-flows and persist solely on rainfall
    - Facultative: species usually found in wetlands (inclusive of riparian systems) (67 – 99% of occurrences), but occasionally found in terrestrial systems (non wetland) (DWAF, 2005)
    - Obligate: species that are only found within wetlands (>99% of occurrences) (DWAF, 2005)
- Assessment of the wetland type based on the NWCS method discussed below and the required buffers

- Mitigation or recommendations required

Wetlands were then mapped using GIS software, together with the required buffers, using the relevant guidelines shown in Section 1.2.1 of this report.

3.2.1 National Wetland Classification System method

During this study due to the nature of the wetlands observed, it was decided that the newly accepted National Wetlands Classification System (NWCS) be adopted. This classification approach has integrated aspects of the HGM approached used in the WET-Health system as well as the widely accepted eco-classification approach used for rivers.

The NWCS (SANBI, 2009) as stated previously, uses hydrological and geomorphological traits to distinguish the primary wetland units, i.e. direct factors that influence wetland function. Other wetland assessment techniques, such as the DWAF (2005) delineation method, only infer wetland function based on abiotic and biotic descriptors (size, soils & vegetation) stemming from the Cowardin approach (SANBI, 2009).

The classification system used in this study is thus based on SANBI (2009) and is summarised below:

The NWCS has a six tiered hierarchical structure, with four spatially nested primary levels of classification (Figure 4). The hierarchical system firstly distinguishes between Marine, Estuarine and Inland ecosystems (**Level 1**), based on the degree of connectivity the particular systems has with the open ocean (greater than 10 m in depth). Level 2 then categorises the regional wetland setting using a combination of biophysical attributes at the landscape level, which operate at a broad bioregional scale. This is opposed to specific attributes such as soils and vegetation. **Level 2** has adopted the following systems:

- Inshore bioregions (marine)
- Biogeographic zones (estuaries)
- Ecoregions (Inland)

Level 3 of the NWCS assess the topographical position of inland wetlands as this factor broadly defines certain hydrological characteristics of the inland systems. Four landscape units based on topographical position are used in distinguishing between Inland systems at this level. No subsystems are recognised for Marine systems, but estuaries are grouped according to their periodicity of connection with the marine environment, as this would affect the biotic characteristics of the estuary.

Level 4 classifies the hydrogeomorphic (HGM) units discussed earlier. The HGM units are defined as follows:

(i) Landform – shape and localised setting of wetland
(ii) Hydrological characteristics – nature of water movement into, through and out of the wetland
(iii) Hydrodynamics – the direction and strength of flow through the wetland

These factors characterise the geomorphological processes within the wetland, such as erosion and deposition, as well as the biogeochemical processes.

Level 5 of the assessment pertains to the classification of the tidal regime within the marine and estuarine environments, while the hydrological and inundation depth classes are determined for the inland wetlands. Classes are based on frequency and depth of inundation, which are used to determine the functional unit of the wetlands and are considered secondary discriminators within the NWCS.

Level 6 uses of six descriptors to characterise the wetland types on the basis of biophysical features. As with Level 5, these are non hierarchal in relation to each other and are applied in any order, dependent on the availability of information. The descriptors include:

(i) Geology;
(ii) Natural vs. Artificial;

(iii) Vegetation cover type;
(iv) Substratum;
(v) Salinity; and
(vi) Acidity or Alkalinity.

It should be noted that where sub-categories exist within the above descriptors, hierarchical systems are employed, thus are nested in relation to each other.

The HGM unit (Level 4) is the **focal point of the NWCS**, with the upper levels (Figure 5 – Inland systems only) providing means to classify the broad bio-geographical context for grouping functional wetland units at the HGM level, while the lower levels provide more descriptive detail on the particular wetland type characteristics of a particular HGM unit. Therefore Level 1 – 5 deals with functional aspects, while Level 6 classifies wetlands on structural aspects.

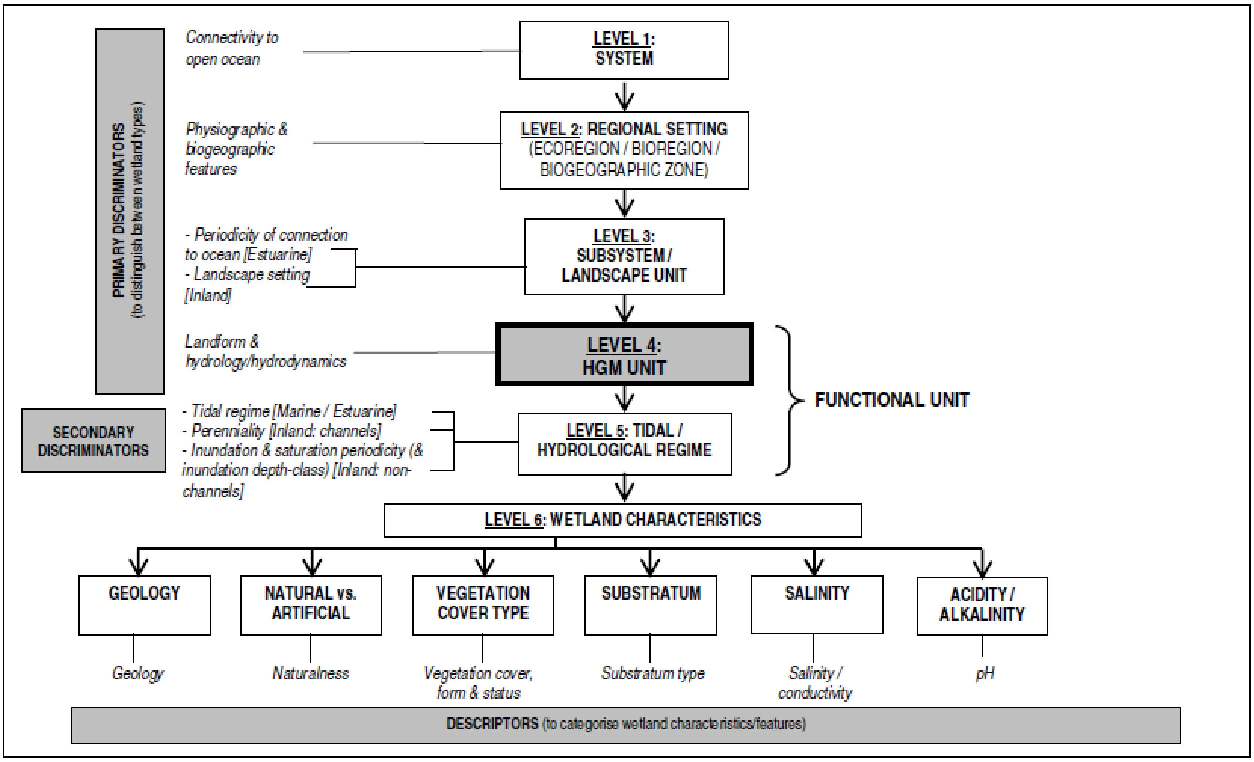

Figure 4: Basic structure of the National Wetland Classification System, showing how 'primary discriminators' are applied up to Level 4 to classify Hydrogeomorphic (HGM) Units, with 'secondary discriminators' applied at Level 5 to classify the tidal/hydrological regime, and 'descriptors' applied at Level 6 to categorise the characteristics of wetlands classified up to Level 5 (From SANBI, 2009).

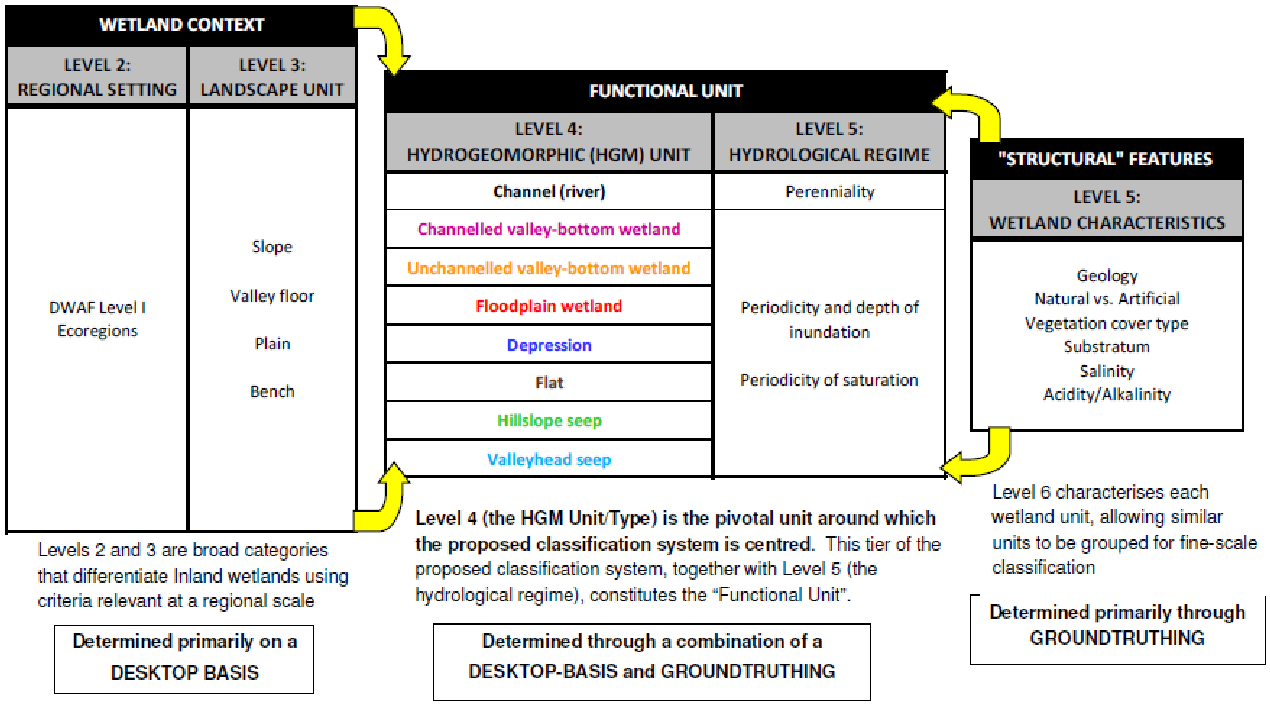

Figure 5 Illustration of the conceptual relationship of HGM Units (at Level 4) with higher and lower levels (relative sizes of the boxes show the increasing spatial resolution and level of detail from the higher to the lower levels) for Inland Systems (from SANBI, 2009).

3.2.2 Wetland condition and conservation importance assessment

To assess the Present Ecological State (PES) or condition of the observed wetlands, a modified Wetland Index of Habitat Integrity (DWAF, 2007) was used. The Wetland Index of Habitat Integrity (WETLAND-IHI) is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the River Health Programme (RHP). The output scores from the WETLAND-IHI model are presented in the standard DWAF A-F ecological categories (Table 4), and provide a score of the Present Ecological State of the habitat integrity of the wetland system being examined. The author has included additional criteria into the model based system to include additional wetland types. This system is preferred when compared to systems such as WET-Health – wetland management series (WRC 2009), as WET-Health (Level 1) was developed with wetland rehabilitation in mind, and is not always suitable for impact assessments. This coupled to degraded state of the wetlands in the study area, a complex study approach was not warranted, i.e. conduct a Wet-Health Level 2 and WET-Ecosystems Services study required for an impact assessment.

Table 3: Description of A – F ecological categories based on Kleynhans *et al*., (2005).

ECOLOGICAL CATEGORY	ECOLOGICAL DESCRIPTION	MANAGEMENT PERSPECTIVE
A	Unmodified, natural.	Protected systems; relatively untouched by human hands; no discharges or impoundments allowed
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	Some human-related disturbance, but mostly of low impact potential
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	**Multiple disturbances associated with need for socio-economic development, e.g. impoundment, habitat modification and water quality degradation**
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	**Often characterized by high human densities or extensive resource exploitation. Management intervention is needed to improve health, e.g. to restore flow patterns, river habitats or water quality**
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	

The WETLAND-IHI model is composed of four modules. The “Hydrology”, “Geomorphology” and “Water Quality” modules all assess the contemporary ***driving processes*** behind wetland formation and maintenance. The last module, “Vegetation Alteration”, provides an indication of the intensity of human landuse activities on the wetland surface itself and how these may have ***modified*** the condition of the wetland. The integration of the scores from these 4 modules provides an overall Present Ecological State (PES) score for the wetland system being examined. The WETLAND-IHI model is an MS Excel-based model, and the data required for the assessment are generated during a rapid site visit.

Additional data may be obtained from remotely sensed imagery (aerial photos; maps and/or satellite imagery) to assist with the assessment. The interface of the WETLAND-IHI has been developed in a format which is similar to DWAF’s River EcoStatus models which are currently used for the assessment of PES in riverine environments.

Conservation importance of the individual wetlands was based on the following criteria:

- Habitat uniqueness
- Species of conservation concern
- Habitat fragmentation with regard ecological corridors
- Ecosystem service (social and ecological)

The presence of any or a combination of the above criteria would result in a HIGH conservation rating if the wetland was found in a near natural state (high PES). Should any of the habitats be found modified the conservation importance would rate as MEDIUM, unless a Species of conservation concern was observed (HIGH). Any systems that was highly modified (low PES) or had none of the above criteria, received a LOW conservation importance rating.

Wetlands with HIGH and MEDIUM ratings should thus be excluded from development with incorporation into a suitable open space system, with the maximum possible buffer being applied. Wetlands which receive a

LOW conservation importance rating could be included into stormwater management features, but should not be developed so as to retain the function of any ecological corridors.

3.2.3 Wetland delineation methodology

The methods employed were based on identifying and ground-truthing aspects that define the wetlands areas and their extent, based on the rules set out in the wetland and riparian area delineation field procedure as prescribed by the Department of Water Affairs (DWAF, 2005).

Sampling was carried out across the study area using a series of transects, where potential wetlands were evident. At each of the transects, soil were sampled at depths of 0, 40, 80 and 100cm, using a hand auger (Photo Plate 1). Any changes in the soil characteristics between these various depths were noted. The hue, value and chroma were also recorded for each sample according to the Munsell Soil Colour Chart, as well as the degree of mottling.

The soil cores were taken at 5m intervals along a transect line. The length of the transect is determined by the width of the potential wetland area, i.e. the final auger sampled showed that the water table was greater than 1.8m or the soil wetness indicators showed that the area being sampled is no longer part of the wetland.

To successfully identify wetland boundaries, particularly in seasonal or ephemeral systems, long term monitoring of wetlands inundation is required to establish the exact extent of any given system. However, due to time and budget constraints, wetland delineation methods have been refined to include a minimum set of indicators that defines the wetland boundary.

These indicators are based on the three criteria listed below, which would define a wetland and were used in this study, i.e.:

- Wetland or hydromorphic soils must display characteristics resulting from prolonged saturation, i.e. mottling or grey soils
- The presence of hydrophytes (water-loving plants)
- A high water table that results in the saturation at or near the surface leading to anaerobic conditions developing in the top 50cm of the soil

The wetland indicators include:

- Terrain unit
- Soil form
- Soil wetness
- Vegetation

Plate 1: One of the soil cores taken along the transect for Wetland 1 at the 100 cm depth (5 m from the edge of the wetland, showing typical wetland soil attributes

4 RESULTS

According to the National Wetland Classification system, all the wetlands identified could be categorised as Inland Systems (Level 1), thus with no direct connection with any drainage lines, rivers and the ocean. All were found within the Southern Folded Mountains Ecoregion (Level 2) within the P10A (New Year's) and P40A (Bloukrans / Kowie) quaternary river catchments. Based on landscape position (Level 3), these wetlands were found within a plain or plateaux topographic setting.

All the observed wetland corresponded to the Depression HGM unit (Level 4) of the NWCS, with short inundation periods associated with the higher rainfall months. Surface water within these depressions could range between 5 and 20 cm in depth. Due to the seasonality of rainfall, only ephemeral plant species were found within the natural Wetlands 1 & 5 (Figure 6 & Plate 2).

Depressions are landforms with closed elevation contours that increase in depth from the perimeter to a central area of greatest depth, where water typically accumulates. Dominant water sources for these wetlands are precipitation, ground water discharge, interflow and (diffuse or concentrated) overland flow (SANBI, 2009).

NOTE:

"At Level 4C of the NWCS, depressions (i.e. the primary HGM Unit captured at Level 4A) are categorised according to their outflow drainage. Depressions can be classified as 'exorheic' (i.e. outward-draining) or 'endorheic' (i.e. inward-draining) in terms of their surface outflow drainage, with the additional option to categorise depressions that occur as a primary HGM Unit in a valley floor setting or on a slope as 'dammed'. The reason that the surface drainage has been used as the basis for distinguishing between "exorheic" and "endorheic" depressions, as opposed to surface and/or subsurface drainage (which would be more technically correct), is that it is often not immediately apparent whether downstream subsurface drainage is present (especially on the basis of remote sources of information such as maps and aerial photography). At Level 4D, depressions can be further subdivided on the basis of their inflow drainage characteristics, into those 'with channelled inflow' and those 'without channelled inflow'. This is a very important distinction for management purposes because the water quality and other characteristics of "depressions with channelled inflow" will be directly related to that of the inflowing channels, which implies that management of these types of depressions will require management and monitoring of the inflowing channels" (from SANBI 2009)

From a functional standpoint, these systems are considered important refugia for aquatic organisms, specially adapted to ephemeral conditions, while forming a network of wetland systems between the various catchments, allowing organisms to "leapfrog" form one catchment to another. A network of wetlands also presents opportunities to organisms when presented with disease or droughts, thus other unaffected catchments allow for the continuation of a species.

Wetlands, 3, 4 and 6 were artificially constructed, and are maintained by artificial means created by run-off or seepage from irrigation systems (some leaking) used in maintaining the fairways and greens (Figure 6). All these wetlands were thus colonised by obligate wetland species, namely:

- *Cyperus papyrus* (Papyrus);
- *Cyperus textilis* (Tall star sedge); and
- *Typha capensis* (Bulrush).

Wetland 2 (Figure 6) was possibly a natural depression, but was found highly modified, by fill material, rock berms and a channel. This wetland now contains standing water and was colonised by *Phragmites australis* (Common Reed), a wetland plant species that requires permanent water or saturated soils. This is not typical of such a wetland in the study area, as a natural system would only contain ephemeral plant species such as hydrophilic grasses and sedges, i.e. Wetlands 1, 5 and those adjacent to the golf club (Figure 2).

The raised fill areas that bisects and surrounds this wetland has been colonised by terrestrial species, such as *Schotia afra*, *Aloe maculata*, *Chrysanthemoides monilifera* and several other garden plant escapees.

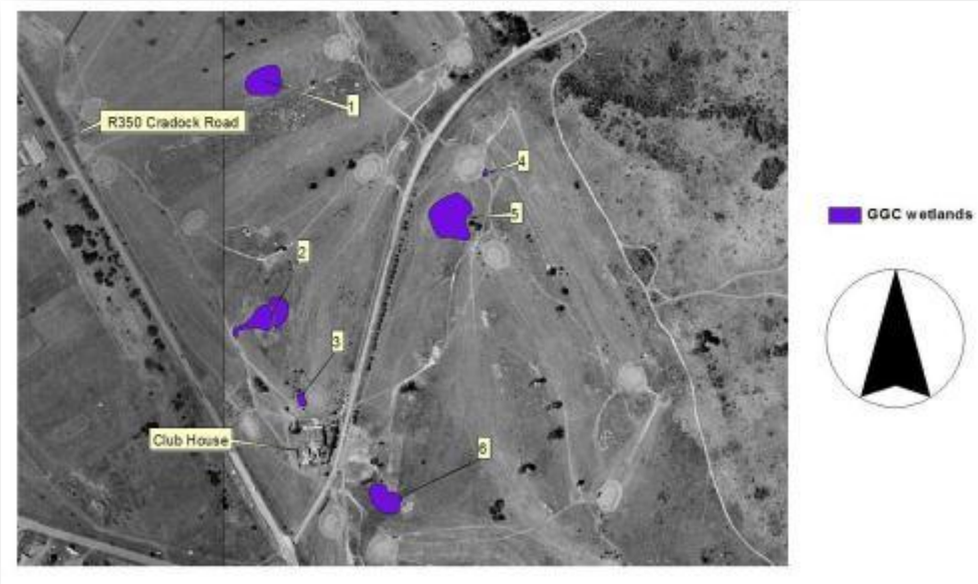

Figure 6: Aerial photograph indicating the 6 delineated wetland areas

Plate 2: A typical representation of the grass and sedge dominated natural wetlands found within the study area (Wetland 1).

Blue Gums (*Eucalyptus* spp) and Black wattles (*Acacia mearnsii*) were the dominant alien invasive plants within the study area, but these populations were being managed by the golf club, by mechanical and chemical means, as well as burning. The only Category 2 aquatic invasive plant evident on site was the Pickerell Weed (*Pontederia cordata*) found in Wetland 3, near the club house.

No protected or species of special concern (fauna & flora) were observed within the wetland areas, although some unidentified bulbs were found in Wetland 1, while the reed beds were favoured by a number of wetland bird associates; namely:

- Southern Red Bishop (*Euplectes orix*);
- Burchell's Coucal (*Centropus burchelli*);
- Yellow Weaver (*Ploceus subaureus*);
- Cape Weaver (*P. capensis*); and
- Southern Masked Weaver (*P. velatus*).

A butterfly species, the Western hillside brown (*Stygionympha vigilans*), favoured the grasslands fringing the *Typha* bed associated with Wetland 6.

Wetland 1 was found in an almost near natural state, dominated by ephemeral hygrophilous grasses and sedges and aquatic bulbs (Figure 6 & Plate 2). The vegetated extent of this wetland is only limited by the grass mowing activities required to maintain the fairways.

Dominant plant species found in Wetland 1 included:

- *Aponogeton junceus;*
- *Ficinia lateralis*
- *Cyperus obtusiflorus var. obtusiflorus*
- *Setaria sphacelata var. sphacelata*
- *Stenotaphrum secundatum*
- *Maricus congestus*

Wetland 1 was also the only depression that corresponded to the natural and near natural wetlands within the study region found at Burnt Kraal, i.e. similar geology, structure, form and plant cover. The wetlands located at Burn Kraal were however larger, and thus their effective catchments greater in size, which resulted deep inundated areas. These larger water bodies were favoured habitat for water birds (Yellow billed ducks) and amphibians (Reed frogs and Cacos). No water fowl or frogs were observed in Wetland 1, however the weather conditions were not conducive (cold and windy) for amphibian calls.

Plate 3: A photo of a man-made wetland observed in the study (Wetland 3)

4.1.1 Present Ecological State and conservation importance

Many wetlands seem almost mono-specific in appearance, dominated by one particular species of reed or sedge. This is not a particularly useful advert, when wetlands are known for their species richness and biodiversity. Wetland biodiversity is thus related to the associated species such as birds, amphibians and invertebrates, with most due to limited distributions or rapid loss of wetland habitat, are now conservation needy species (Kotze *et al*., 2008). The importance of rare or endangered species is usually used in the defence of a conservation needy environment. Where this is not possibly a surrogate species of special concern is then used to promote the need for conserving a wetland habitat (e.g. a rare or endemic bird, frog or plant). This is not always possible for the majority of wetlands, due most wetland species being ubiquitous or widespread.

Recently wetland importance has thus been related to functioning importance or ecosystem services (Kotze *et al*., 2008). This also inferred that the larger the wetland, the more important the system is due to the value it presents in terms of ecological and social services.

Based on the above information, the site visit results and other studies conducted in the area, the conservation importance of the respective depressions were assessed (Appendix 8.1). Of all of the wetlands only Wetlands 1 and 5 would be considered to have higher PES scores, as well as higher conservation importance and sensitivity than the other wetlands (Figure 7). The PES scores for these two wetlands (1 & 5) were B/C and C respectively, while the remainder scored D. It should be noted that the latter scores are not really relevant as the wetlands (Wetlands 2, 3, 4 and 6) were highly modified and maintained artificially. However, Wetland 2 (Figure 7) was rated as having a medium sensitivity and importance due to the unique habitats found (reed beds), thus it is recommended that if this wetland is not retained, then a similar wetland is recreated.

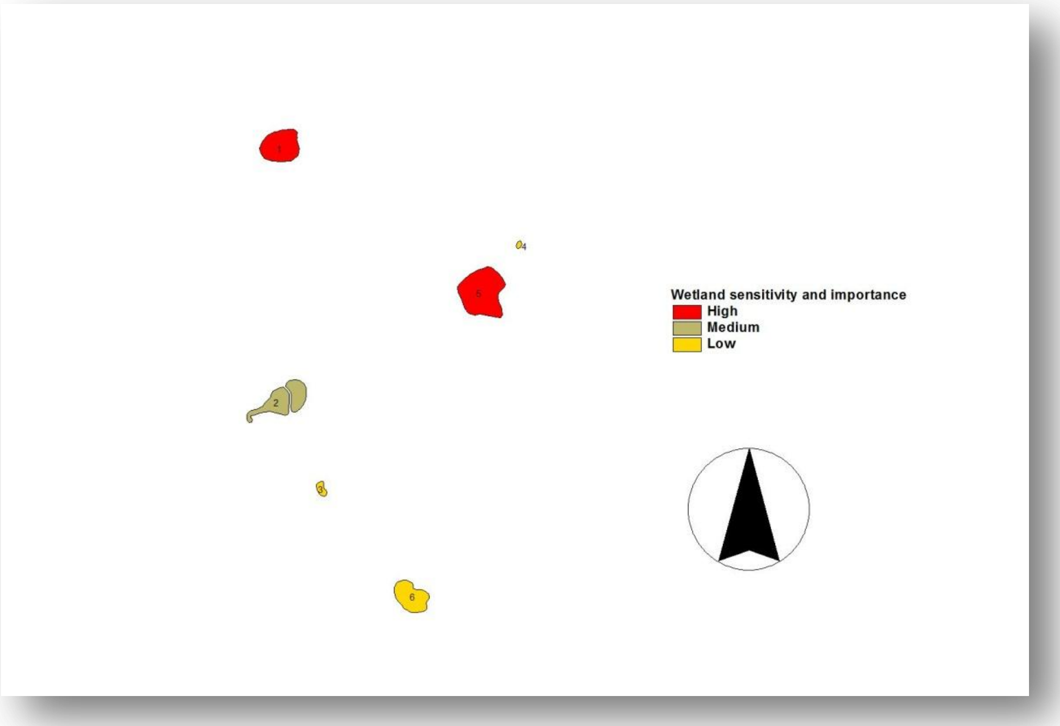

Figure 7: Sensitivity and importance rating of the study area wetlands

4.1.2 Recommended buffers

National and provincial authorities have recommended that a 50m buffer be used for any wetland, as recommended by the Eastern Cape Biodiversity Conservation Plan.

During the survey, the various wetlands were delineated. Thus based on all the parameters discussed in this report, which included soil characteristics (Plate 4), the exact extent of the wetland areas were determined for Wetland 1 and 5, which was determined based on the soil cores to be between 15 – 25m beyond the visible wetland edge (i.e., hydromorphic soil zones). Thus based on these observations and the size of the respective catchments the wetlands would not exceed more than their current visible boundaries and a 32m buffer from the delineated edge would then be sufficient in order to protect these systems. The buffer would thus allow for sufficient space for ecological transition zones to form within the buffer zone and wetland.

Plate 4: Soils cores taken during the survey (100 cm below the surface, 5m from the wetland edge) showing typical wetland soils indicators (mottles and soil wetness)

5 IMPACT ASSESSMENT

The impact assessment was derived from the methodology provided by Coastal & Environmental Services (CES), the proposed project description contained in the Draft Scoping Report and the conceptual design layout. These aspects were then measured against the current state and importance of the observed wetlands. Five major impacts have been highlighted and have been rated based on the direct versus indirect project actions / impacts, as well as any potential cumulative impacts during the construction and operational phases of the project. These were also assessed with and without mitigation. It should be noted that most of the impacts assessed would have a negative impact on the wetland systems, with a high degree of confidence based on the authors understanding of aquatic systems in the region and past experience from assessing similar types of proposals.

5.1 Impact 1: No-go option

Cause and comment

Due to the current land use practices the natural wetland areas were found in a stable and functioning state, with a degree of improvement occurring due to the removal of the alien vegetation and the redirection of small amounts of surface water flows into Wetlands 1 & 2. The remaining modified and man-made wetlands would continue functioning as features within the golf course. This would not alter should the project go ahead, but it is important assess the importance of these wetlands within the overall catchment.

Significance of impact

As there is limited conservation or management of the wetland systems within the region, it is important to retain these wetlands, in order to limit fragmentation between aquatic systems within Grahamstown (streams) and Burnt Kraal (Depressions). Should the project not go ahead, the long-term severity of the impact would be slightly beneficial, resulting in a **MODERATE** (Beneficial) significance within the study area, with or without mitigation, i.e. the wetlands would continue to function, providing a “stepping stone” for mobile aquatic species found in the region (Table 4).

Table 4: No-go impact on the wetlands

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Without Mitigation	Long-term	3	Study Area	2	Slight	1	Probable	3	9	MODERATE BENEFICIAL
With Mitigation	Long-term	3	Study Area	2	Slight	1	Probable	3	9	MODERATE BENEFICIAL

Mitigation and management

The present land owners should be encouraged to continue with the alien plant removal and possibly limit the mowing of the grass around Wetlands 1 & 5, leaving an additional grassland buffer of 5 -10 m between the water’s edge. This would encourage the further use of these natural wetlands by the surrounding frog and butterfly populations, as there is presently limited habitat for these species.

5.2 Impact 2: Physical wetland habitat destruction

Cause and comment

The project footprint, with or without mitigation would result in the loss of all the wetland areas within the study area, with the exception of the manmade Wetland 3, should the present layout design be accepted (Figure 3).

Significance of impact

Should the present layout be constructed all the wetlands **of importance and with a high sensitivity** would be lost. This would result in a **HIGH** overall significance rating without mitigation (Table 5). With mitigation to overall significance would be reduced to **MODERATE**, as wetland habitats would still be lost.

Table 5: Potential impacts as result of physical habitat destruction during the construction phase

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Without Mitigation	Long-term	3	Study Area	2	Severe	4	Definite	4	13	HIGH
With Mitigation	Short-term	1	Study Area	2	Moderate	2	Probable	3	9	MODERATE (Possibly beneficial)

Mitigation and management

It is therefore proposed that the layout plan be revised to include Wetlands 1 and 5 within the open space plan of the development, with a minimum of a 32m buffer. If at all possible Wetland 2 should also be retained due to variety of habitats it contains. The remaining wetlands could be destroyed, as these are either man-made or highly modified systems; however the developer is encouraged to create new wetland areas as part of the stormwater management plan for the development. The use of wetlands and grass swales within the development, would aid in the retention of surface water run-off in the study area, creating additional ephemeral habitat for aquatic species. This would translate into a beneficial impact should the project include the important wetland areas and any additional wetland areas.

It is also a legal requirement (National Water Act) that no stormwater is discharged directly into natural water courses, and any stormwater run-off is captured / managed on site to reduce the downstream effect of pollutants and the potential for flooding. Grass swales and artificial wetlands are ideal in this scenario and are easily created due to the nature of the surrounding soils and geology.

5.3 Impact 3: Loss of habitat function, ecosystem services and associated biodiversity

Cause and comment

This impact is linked to the physical disturbance of the wetland areas and would affect basic habitat function and ecosystem services such as surface flow attenuation (Water quantity issue) and surface flow filtration (W quality risk of surface water / groundwater pollution). Potential impacts posed by the development would be similar during both the construction and operational phases, due to the relationship between wetland disturbance (without mitigation) and the loss in the provision of ecosystem services (e.g. flood attenuation or biodiversity maintenance).

Significance of impact

As all of the **significant** wetlands would be lost due to the proposed layout of the development, all of the above wetland attributes would be lost. However, due to the small size and seasonality of these wetlands, the overall impact severity would be moderate (i.e. they only make a small contribution), as a long term consequence within the study area. Therefor the impact significance would be rated as **MODERATE (negative)** without mitigation and **MODERATE** (possibly beneficial) with mitigation in the short-term (Table 6).

Table 6: Potential impact of losing habitat function, ecosystem services and consequent biodiversity

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Without Mitigation	Long-term	3	Study Area	2	Moderate	2	Definite	4	11	MODERATE
With Mitigation	Short-term	1	Study Area	2	Moderate	2	Definite	4	9	MODERATE (Possibly beneficial)

Mitigation and management

As described for the previous impact, it is advised that Wetlands 1 and 5 are retained (possibly Wetland 2), together with a minimum of a 32m buffer, while new wetland habitats are recreated as part of the stormwater management plan.

5.4 Impact 4: Loss of species of special concern

Cause and comment

Loss of wetlands could possibly result in the loss of species of special concern within the habitats as an indirect result of their destruction based on the present development footprint. However, no flora and fauna species of special concern were evident during the study within the wetland areas. As a precautionary step, it is important that Wetland 1 is retained and allowed to function, as number of unidentified bulb species (plants) were seen in this wetland and could possibly occur on the Provincial Nature Conservation Ordinance as protected.

Significance of impact

The impact would be **HIGH** without mitigation, while with mitigation (avoidance of these areas) the impact would be **LOW** (Table 7).

Table 7: Impact on species of special concern associated with the wetlands

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Without Mitigation	Long-term	3	Regional	3	Severe	3	Probable	4	13	HIGH
With Mitigation	Short-term	1	Regional	3	Slight	1	May occur	2	8	LOW

Mitigation and management

It is advised that Wetlands 1 and 5 are retained (possibly Wetland 2), together with a minimum of a 32m buffer, while new wetland habitats are recreated as part of the stormwater management plan.

5.5 Impact 5: Habitat fragmentation – loss of ecological corridors

Cause and comment

This impact would be categorised as a cumulative impact, as it would impact on the region with regard habitat fragmentation. The permanent loss of any wetlands between the Grahamstown suburbs, which are characterised by numerous streams and other man-made aquatic habitats and the Burnt Kraal wetlands, would be seen as habitat fragmentation. The majority of mobile aquatic organisms require “stepping stones” to leap frog between their required habitats.

Significance of impact

Due to the current land use practices within the area, a degree of habitat fragmentation has already occurred within the site and should the project go ahead without mitigation, possible fragmentation would occur. The significance of this impact would however be **MODERATE**, due to the lower number of species observed in the study areas. Should the important wetland be retained and others created by way of mitigation, then overall significance would be **LOW** (Table 8).

Table 8: Potential loss of ecological corridors

Impact	Effect						Risk or Likelihood		Total Score	Overall Significance
	Temporal Scale		Spatial Scale		Severity of Impact					
Without Mitigation	Long-term	3	Study Area	2	Severe	4	Definite	4	13	HIGH
With Mitigation	Long-term	3	Study Area	2	Moderate	2	Probable	3	10	MODERATE (Possibly beneficial)

Mitigation and management

It is advised that Wetlands 1 and 5 are retained (possibly Wetland 2), together with a minimum of a 32m buffer, while new wetland habitats are recreated as part of the stormwater management plan.

6 CONCLUSION AND RECOMMENDATIONS

From a catchment management perspective, it would seem that the proposed project could affect a number of wetland areas. These wetlands perform an important role in attenuating surface water flows, while providing a series of differing wetland habitats form part of a wetland network within the region.

During the assessment, it was found however the most significant impact was related to the complete removal of all but one wetland, which has a limited importance without any mitigation. It is thus firmly recommended that the layout be altered to accommodate Wetlands 1 and 5, while recreating new wetland areas in the form of stormwater management features. It was also found that should wetland habitats be recreated, using indigenous grass and sedges species, then project could have a beneficial impact on the environment, as most species would easily re-colonise the area, while a number of alien invasive species could then be excluded. It is also suggested that smaller reed beds are also incorporated, in areas away from the airfield, in order to attract the wetland bird species that nest in these areas.

Furthermore, based on observations and the size of the respective catchments the wetlands would not exceed more than their current visible boundaries, by 15 – 20 m and thus a 32m buffer from the delineated edge is recommended as being more than sufficient in order to protect these systems.

Impacts with regard water quality and water quantity still need to be addressed, but these can only be assessed once a revised layout has been developed.

Further recommendations include:

- Stormwater should be managed using suitable structures such as swales, gabions and rock rip-wrap so that any run-off from the development site is attenuated prior to discharge. Silt and sedimentation should be kept to a minimum, through the use of the above mentioned structures by also ensuring that all structures don’t create any form of erosion.
- Vegetation clearing should occur in parallel with the construction progress to minimise erosion and/or run-off. Large tracts of bare soil will either cause dust pollution or quickly erode and then cause sedimentation in the lower portions of the catchment.
- Only indigenous plant species must be used in the re-vegetation process. The species list mentioned in this and terrestrial vegetation study should be used a guide
- All construction materials including fuels and oil should be stored in demarcated areas that are contained within berms / bunds to avoid spread of any contamination into wetland or rivers. Washing and cleaning of equipment should also be done in berms or bunds, in order to trap any cement and prevent excessive soil erosion. These sites must be re-vegetated after construction has been completed. Mechanical plant and bowsers must not be refuelled or serviced within or directly adjacent to any river channel. It is therefore suggested that all construction camps, lay down areas, batching plants or areas and any stores should be more than 50m from any demarcated wetland or riverine area
- It is also advised that an Environmental Control Officer, with a good understanding of the local flora be appointed during the construction phase. The ECO should be able to make clear recommendations with regards to the re-vegetation of the newly completed / disturbed areas, using selected species detailed in this and the terrestrial vegetation report. All alien plant re-growth must be monitored and should it occur these plants should be eradicated. Where any works (e.g. storm water control measures) near a wetland or river is required specific attention should be paid to the immediate re-vegetation of cleared areas to prevent future erosion of sedimentation issues.
- All relevant buffers mentioned in this report should be included into future designs and later engineering diagrams.

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8 APPENDICES

8.1 Results of wetland classification, condition and conservation importance assessment.

Coordinates are DD.ddd WGS84 Geographic

Wetland #	S	E	Wetland type (HGM Unit Level 4 B-D)	Inundation periodicity (Level 5)	Dominant hydrodynamics	Condition (Present Ecological State Score)	Sensitivity & Conservation importance	Comment
1	-33.291733	26.499072	Endorheic Depression with man-made channel inflow	Intermittent	Vertical & bidirectional	B/C	High	Small grass and sedge dominated depression with minimal impacts
2	-33.294483	26.49914	Man-made water feature – possibly a past depression	Permanent	Vertical & bidirectional	D	Medium	Constructed wetland fed by run-off, resulting in permanent inundation, colonised by reeds.
3	-33.295424	26.49955	Endorheic Depression without channel inflow	Intermittent	Vertical & bidirectional	D	Low	Constructed wetland colonised by *Cyperus, Zantedeschia* and *Pontederia* (Alien species)
4	-33.292829	26.502039	Endorheic Depression without channel inflow	Intermittent	Vertical & bidirectional	D	Low	Constructed wetland colonised by *Cyperus*
5	-33.293453	26.501813	Endorheic Depression without channel inflow	Intermittent	Vertical & bidirectional	C	High	Grassy depression containing hygrophilous species
6	-33.296509	26.500703	Man-made seep fed depression	Permanent	Vertical & bidirectional	D	Low	*Typha capensis* bed

8.2 Glossary

(source DWAF – RDM Wetland Ecosystems 1999, unless otherwise stated)

Aerobic: having molecular oxygen (O2) present.

Anaerobic: not having molecular oxygen (O2) present.

Anthropogenic: of human creation

Biota: living things; plants, animals, bacteria

Bottomland: the lowlands along streams and rivers, on alluvial (river deposited) soil.

Chroma: the relative purity of the spectral colour, which decreases with increasing greyness.

Delineation (of a wetland): to determine the boundary of a wetland based on soil, vegetation, and/or hydrological indicators (see definition of a wetland).

Endorheic: closed drainage e.g. a pan.

Floristic: of flora (plants).

Floodplain: Wetland inundated when a river overtops its banks during flood events resulting in the wetland soils being saturated for extended periods of time.

Gley: soil material that has developed under anaerobic conditions as a result of prolonged saturation with water. Grey and sometimes blue or green colours predominate but mottles (yellow, red, brown and black) may be present and indicate localised areas of better aeration.

Groundwater: subsurface water in the zone in which permeable rocks, and often the overlying soil, are saturated under pressure equal to or greater than atmospheric.

Groundwater table: the upper limit of the groundwater.

Horizon: see soil horizons.

Hydric soil: soil that in its undrained condition is saturated or flooded long enough during the growing season to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).

Hydrophyte: any plant that grows in water or on a substratum that is at least periodically deficient in oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.

Hydrology: the study of water, particularly the factors affecting its movement on land.

Hue (of colour): the dominant spectral colour (e.g. red).

Infilling or Fill: dumping of soil or solid waste onto the wetland surface. Infilling generally has a very high and permanent impact on wetland functioning and is similar to drainage in that the upper soil layers are rendered less wet, usually so much so that the area no longer functions as a wetland.

Lacustrine: Lacustrine systems (e.g. lakes & dams) are wetlands that are situated in a topographic depression or a dammed river channel, have a total area greater than 8 ha and surface area coverage by mosses, lichens, trees, shrubs or persistent emergents of less than 30%.

Marsh: a wetland dominated by emergent herbaceous vegetation (usually taller than 1 m), such as the common reed (Phragmites australis) which may be seasonally wet but are usually permanently or semi-permanently wet.

Mottles: soils with variegated colour patters are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.

Munsell colour chart: A standardized colour chart which can be used to describe hue (i.e. its relation to red, yellow, green, blue, and purple), value (i.e. its lightness) and chroma (i.e. its purity). Munsell colour charts are available which show that portion commonly associated with soils, which is about one fifth of the entire range.

Organic soil material: soil material with a high abundance of undecomposed plant material and humus. According to the Soil Classification Working Group (1991) an organic soil horizon must have at least 10% organic carbon by weight throughout a vertical distance of 200 mm and be saturated for long periods in the year unless drained. According to the Soil Survey Staff (1975) definition, in order for a soil to be classed as organic it must have >12% organic carbon by weight if it is sandy and >18% if it is clay-rich.

Permanently wet soil: soil which is flooded or waterlogged to the soil surface throughout the year, in most years.

Riparian: the area of land adjacent to a stream or river that is influenced by stream-induced or related processes. Riparian areas which are saturated or flooded for prolonged periods would be considered wetlands and could be described as riparian wetlands. However, some riparian areas are not wetlands (e.g. an area where alluvium is periodically deposited by a stream during floods but which is well drained).

Runoff: total water yield from a catchment including surface and subsurface flow.

Seasonally wet soil: soil which is flooded or waterlogged to the soil surface for extended periods (>1 month) during the wet season, but is predominantly dry during the dry season.

Sedges: Grass-like plants belonging to the family Cyperaceae, sometimes referred to as nutgrasses. Papyrus is a member of this family.

Soil drainage classes: describe the soil moisture conditions as determined by the capacity of the soil and the site for removing excess water. The classes range from very well drained, where excess water is removed very quickly, to very poorly drained, where excess water is removed very slowly. Wetlands include all soils in the very poorly drained and poorly drained classes, and some soils in the somewhat poorly drained class. These three classes are roughly equivalent to the permanent, seasonal and temporary classes

Soil horizons: layers of soil that have fairly uniform characteristics and have developed through pedogenic processes; they are bound by air, hard rock or other horizons (i.e. soil material that has different characteristics).

Soil profile: the vertically sectioned sample through the soil mantle, usually consisting of two or three horizons (Soil Classification Working Group, 1991).

Soil saturation: the soil is considered saturated if the water table or capillary fringe reaches the soil surface (Soil Survey Staff, 1992).

Temporarily wet soil: The soil close to the soil surface (i.e. within 50 cm) is wet for periods > 2 weeks during the wet season in most years. However, it is seldom flooded or saturated at the surface for longer than a month.

Terrain unit classes: areas of the land surface with homogenous form and slope. Terrain may be seen as being made up of all or some of the following units: crest (1), scarp (2), midslope (3), footslope (4) and valley bottom (5).

Transpiration: the transfer of water from plants into the atmosphere as water vapour

Value (soil colour): the relative lightness or intensity of colour.

Vlei: a colloquial South African term for wetland.

Water regime: When and for how long the soil is flooded or saturated.

Water quality: the purity of the water.

Waterlogged: soil or land saturated with water long enough for anaerobic conditions to develop.

Wetland: 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); land where an excess of water is the dominant factor determining the nature of the soil development and the types of plants and animals living at the soil surface (Cowardin et al., 1979).

Wetland catchment: the area up-slope of the wetland from which water flows into the wetland and including the wetland itself.

Wetland delineation: the determination and marking of the boundary of a wetland on a map