TONGAAT HULETT DEVELOPMENTS

Sibaya Nodes 1 & 5, and Ancillary Infrastructure

Wetland Functional, Ecological and Importance Assessment

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I, **Stephen Burton**, declare that --

General declaration:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.

Signature of the specialist

SiVEST Environmental

Name of company (if applicable)

05th October 2015

Date

TONGAAT HULLET DEVELOPMENTS
SIBAYA NODES 1 & 5, AND ANCILLARY INFRASTRUCTURE
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1 INTRODUCTION

SiVEST SA (Pty) Ltd was appointed by **Tongaat Hulett Developments (PTY) Ltd** to undertake a wetland assessment for the proposed development of Sibaya nodes 1 & 5, and ancillary infrastructure, near Umhlanga situated within the KwaZulu-Natal Province. As the proposed development will be in and near to water resources, the need for a wetland assessment has been identified.

2 TERMS OF REFERENCE

The terms of reference of this assessment are to:

- Undertake a level 1 WET-health assessment to determine the present ecological status (PES) of the delineated wetland units;
- Under take a level 2 WET-EcoServices assessment to determine wetland functionality of each the delineated wetland units;
- Undertake a Wetland Ecological Importance and Sensitivity (EIS) Assessment for each wetland unit;

3 PROJECT OVERVIEW

Further to the Terms of Reference, the following protocol is extracted from the National Environmental Management Act, Act 108 of 1998 (NEMA). The relevant Section is Section 32 and is included below for your ease of reference:

32. Specialist reports and reports on specialised processes

(1) An applicant or the EAP managing an application may appoint a person who is independent to carry out a specialist study or specialised process.
(2) The Person referred to in sub-regulation (1) must comply with the requirements of Regulation 17.
(3) A specialist report or a report on a specialised process prepared in terms of these Regulations must contain –
  (a) details of –
    (i) the person who prepared the report; and
    (ii) the expertise of that person to carry out the specialist study or specialised process;
  (b) a declaration that the person is independent in a form as may be specified by the competent authority;
  (c) an indication of the scope of, and the purpose for which, the report was prepared;
  (d) a description of the methodology adopted in preparing the report or carrying out the specialised process;

(e) a description of any assumptions made and any uncertainties or gaps in knowledge;
(f) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment;
(g) recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority;
(h) a description of any consultation process that was undertaken during the course of carrying out the study;
(i) a summary and copies of any comments that were received during any consultation process; and
(j) any other information requested by the competent authority.

In addition there are various Sections of the legislation that would be applicable to the proposed development and / or the land as it currently is.

3.1 National Environmental Management Act, Act No. 107 of 1998 (NEMA)

NEMA requires, *inter alia*, that:

- *"Development must be socially, environmentally, and economically sustainable",*
- *"Disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied."*
- *"A risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions",*

NEMA also states that;
"The environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage."

3.2 National Water Act (Act 36 of 1998)

Water use

21. For the purposes of this Act water use includes—

a. taking water from a water resource:
b. storing water:
c. impeding or diverting the flow of water in a watercourse:
d. engaging in a stream flow reduction activity contemplated in section 36;
e. engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1):
f. discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit:
g. disposing of waste in a manner which may detrimentally impact on a water resource;
h. disposing in any manner of water which contains waste from or which has been heated in any industrial or power generation process;
i. altering the bed, banks course or characteristics of a watercourse:
j. removing, discharging or disposing ot' water found underground if it is necessary for the efficient continuation of an activity or for the safety of people: and
k. using water for recreational purposes,

4 STUDY AREA

4.1 Overview

Sibaya Nodes 1-5 covers some 124 ha, of which most is planted to sugar cane with the exception of the most prevalent drainage lines, or where soil or topography is unsuitable for sugar cane production. The site also includes limited stands of woody vegetation and some forestry plantations along the eastern boundary.

4.2 Climate

The site falls within the KwaZulu-Natal Coastal Belt (CB 3) vegetation unit as defined by **Mucina and Rutherford** (**2006**). This vegetation unit experiences summer rainfall with some rain in winter. The area is characterised by high air humidity and no frost. Mean annual precipitation is approximately 973 mm and mean annual potential evaporation is 1650 mm. The rainfall average is 973 mm of rainfall. The mean temperature is 20.5 0C and the climate rating is C1, which has a none to slight limitation on crop growing (**Camp, 1995**).

4.3 Geology and Soils

The ENPAT GIS Database (**DEAT, 2001**) indicates that Sibaya Nodes 1 & 5 are predominantly underlain by Red Dune Cordon Sand of the Berea formation. This has given rise to the formation of red apedal soils. Apedal soils lack well formed peds other than porous micro-aggregates and are weakly structured. Apedal soils tend to be freely drained, and due to overriding climatic conditions, these soils will tend to be dystrophic (low base status). The soils across most of the estate have been highly disturbed for as long as it has been utilised as a commercial sugar cane farm. Regular ploughing along with the sugar cane production cycle has resulted in extensive disruption to the wetland soils. Some compaction of soils has occurred in those wetland areas with roads or tracks running through them. According to the BRU Unit Information the erosion rating for the site translates to a very high risk of erosion (**Camp, 1995**).

4.4 Topography and Drainage

The Sibaya site is undulating with rounded hilltops and ridge lines separated by broad, moderately sloping valleys and valley heads. Elevation ranges from around 130 m down to 58 m amsl. Mean average slope is approximately 12% and a maximum slope of 30%. The southern half of the site (affected by the proposed sewer lines) drains towards the Ohlanga River, to the south. The north eastern portion of the site (Nodes 1 & 5) drain towards Umdloti Beach. And the western portions (affected by the proposed water pipeline) drain towards the M4, N2 and towards the Ohlanga River. Artificial drainage channels have been established within the valley thalwegs (lowest elevation of a valley bottom) to lower the local water table and drain the wetlands within the valley bottom areas for use as sugar cane cultivation areas.

At present, the drainage within Sibaya has been modified in order to maximise the cultivated area. This modification stems from the diversion and canalisation of flow into central channels through the formation of artificial drainage channels, gully formation or channel incision. Unnatural channels are identified as straight or angular lines following the courses of valleys, as opposed to the usually sinuous, irregular lines made by natural channels. Drainage channels are also associated with the N2 and M4 road servitudes.

Hydro-geomorphic (HGM) units within this land use class include channelled and un-channelled valley bottoms (these were labelled as per the LRI Delineations).

4.5 Vegetation Cover

At a broad-scale, the site is situated within the KZN Coastal Belt vegetation unit, as defined by **Mucina and Rutherford** (**2006**). The KwaZulu-Natal Coastal Belt is distributed in a long, and in places broad, coastal strip along the KwaZulu-Natal coast, from near Mtunzini in the north, via Durban to Margate and just short of Port Edward in the south. Altitude ranges from about 20–450 m.

This vegetation unit predominantly comprises subtropical coastal forest with patches of primary grassland prevailing in hilly, high rainfall areas where pressure from natural fire and grazing regimes prevailed (**Mucina and Rutherford, 2006**).

This vegetation unit is considered endangered by **Mucina and Rutherford** (**2006**) with only a very small part conserved in Ngoye, Mbumbazi and Vernon Crookes Nature Reserves. About 50% of this veld type has already been transformed for cultivation and by urban sprawl. In these areas much of the remaining vegetation has been severely encroached upon by alien invasive species that include *Chromolaena odorata, Lantana camara, Melia azedarach* and *Solanum mauritianum.*

At present, the majority of the site has been cleared for sugar cane cultivation. Remnants of invaded and highly disturbed coastal and riparian bush remain where cane cultivation was not feasible. These areas include the lowest portion of the identified drainage lines and bottomlands. Natural communities that still exist appear to be maintained annually, as part of the estates maintenance. The wetlands to be rehabilitated have all been cleared for cane cultivation. Typical wetland species such as of *Typha capensis, Phragmites australis* and *Cyperus textilis* are confined to the beds and banks of the artificial drainage channels dug along these in-land wetlands units.

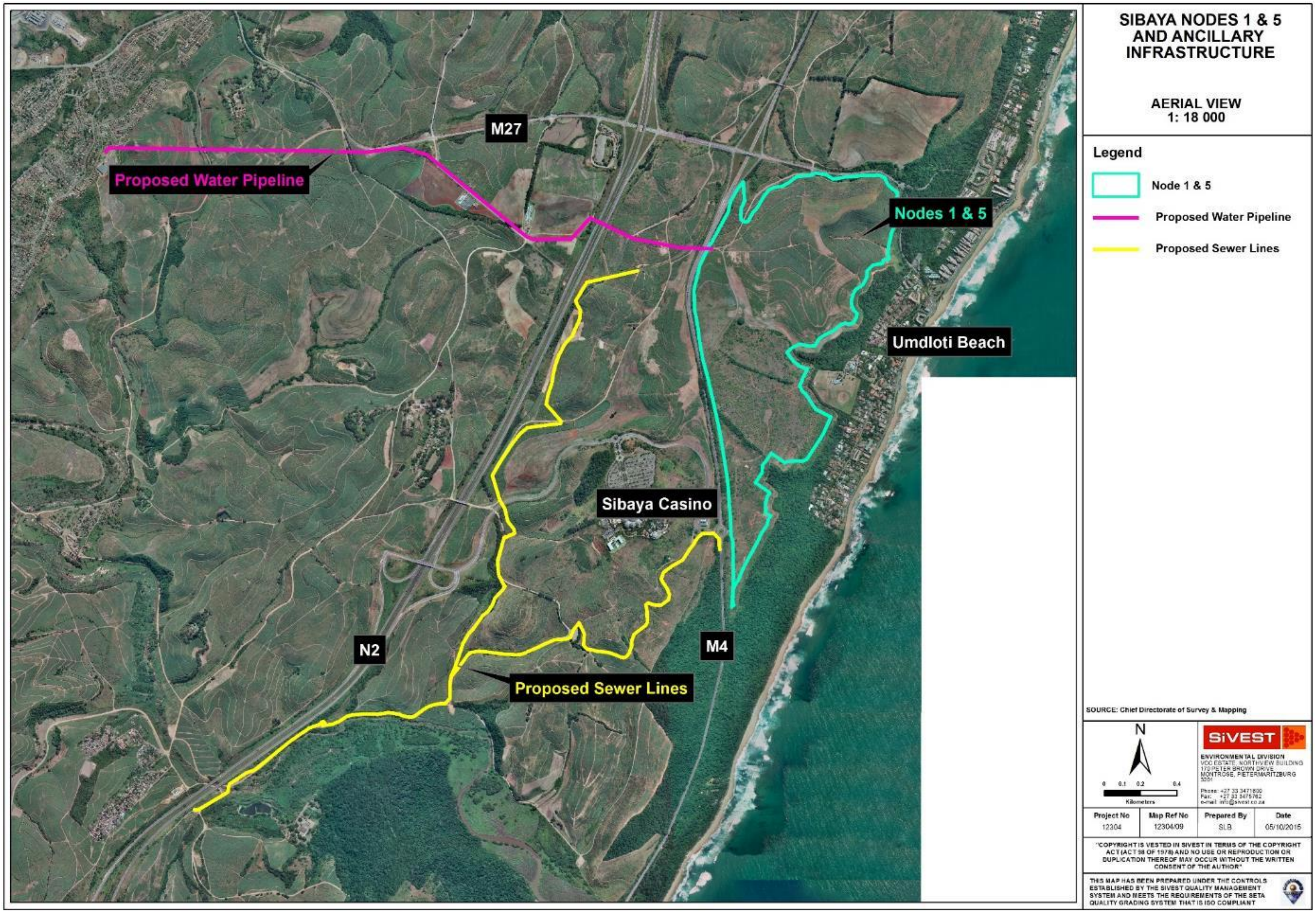

Figure 1: Aerial map of Sibaya Nodes 1 & 5 and ancillary infrastructure

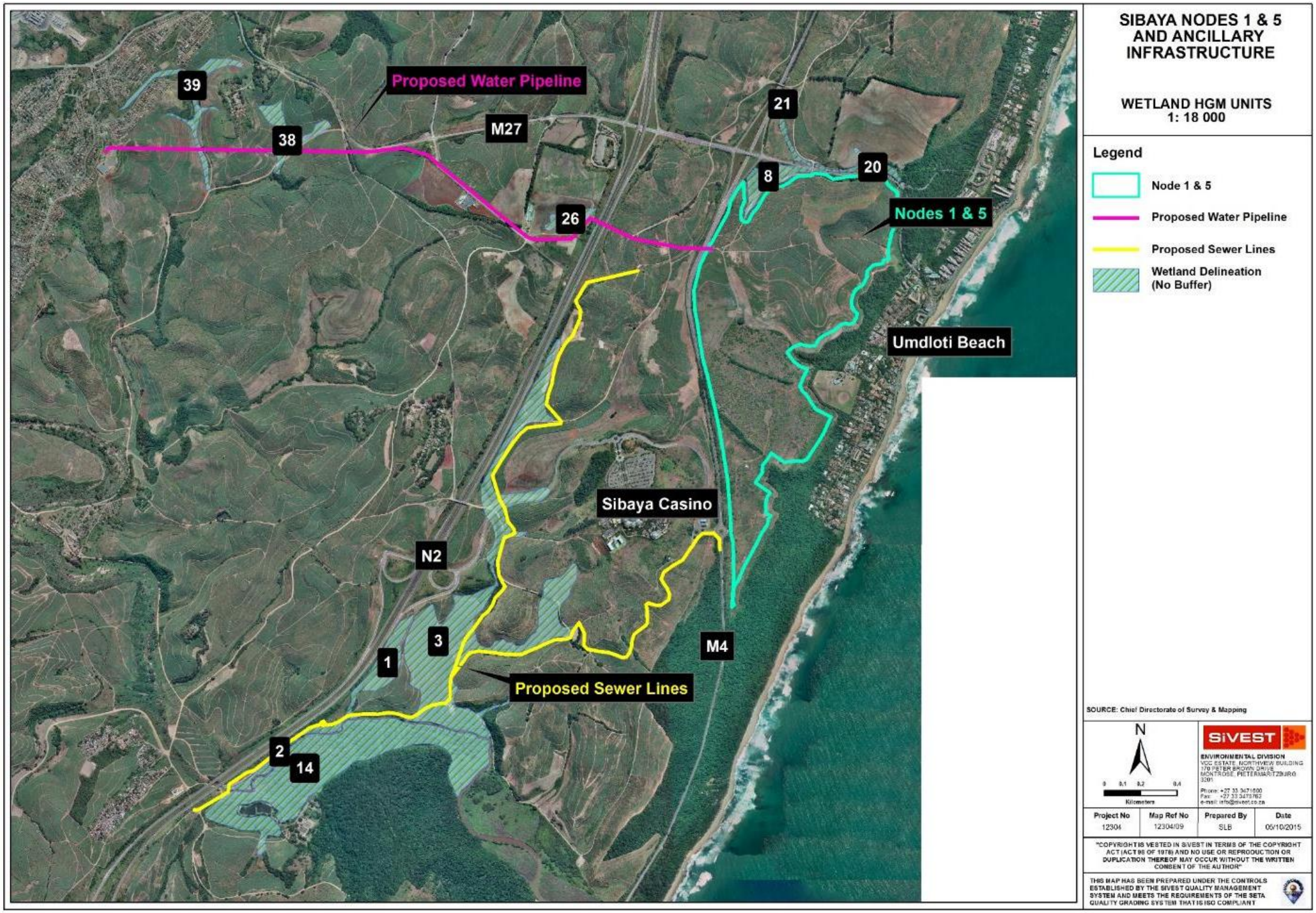

Figure 2: Map showing wetlands delineated within Sibaya Nodes 1 & 5 and ancillary infrastructure.

5 CONCEPTUAL FRAMEWORK

5.1 Wetland Delineation

Wetlands are defined as those areas that have water on the surface or within the root zone for long enough periods throughout the year to allow for the development of anaerobic soil conditions that favour the growth and regeneration of hydrophytic vegetation (plants adapted to saturated and anaerobic soil conditions).

In terms of Section 1 of the National Water Act (Act No. 36 of 1998), wetlands are legally defined as:

(1)…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 typically adapted to life in saturated soil.

Soils characterised by prolonged anaerobic soil conditions are referred to as hydric or hydromorphic soils. Hydric soils develop and occur under anaerobic conditions and are characterised by the chemical reduction of common soil minerals (e.g. iron and manganese) under saturated conditions that results in the gleying (loss of mineral colours) of the soil matrix and under temporarily and seasonally saturated conditions, the formation of mottles, which are mineral oxide precipitates of formerly reduced minerals that precipitate out of solution during the drying of the soil in the dry season. These soil wetness features are referred to as redoximorphic features. Wetland delineations are based primarily on the presence of soil wetness indicators/redoximorphic features. These features must occur within 50 cm of the surface soil profile for an area to be considered a wetland (**Collins, 2005**).

Typical redoximorphic features are (**Collins, 2005**):

- A reduced matrix - occurs when the iron and manganese in soils are reduced and the soils appears grey/pale (colour appears washed out).
- Redox depletions - the “grey” (low chroma) bodies within the soil where Fe-Mn oxides have been stripped out, or where both Fe-Mn oxides and clay have been stripped. Iron depletions and clay depletions can occur. These can occur as:
    - Iron depletions - low chroma bodies with clay contents similar to that of the adjacent matrix. Iron depletions are often referred to as grey mottles.
    - Clay depletions - low chroma bodies containing less iron, manganese and clay than the adjacent soil matrix.
- Redox concentrations - Accumulation of iron and manganese oxides. These can occur as:
    - Nodules - firm, irregular shaped bodies that are uniform when broken.
    - Concretions - harder, regular shaped bodies;
    - Mottles - soft bodies of varying size, mostly within the matrix, with variable shape appearing as blotches or spots of high chroma colours;
    - Pore linings - zones of accumulation that may be either coatings on a pore surface, or impregnations of the matrix adjacent to the pore. They are recognized as high chroma colours that follow the route of plant roots, and are also referred to as oxidised rhizospheres.

It is important to note that there are normally three wetness or saturation zones to every wetland namely, the permanent zone, the seasonal zone and the temporary zone. Each zone is based on the degree and duration of inundation and saturation of the soils. The permanent zone usually reflects soils that indicate inundation and/or saturation cycles that last more or less throughout the year, whilst the seasonal zone may only reflect soils that indicate inundation and/or saturation cycles for a significant period during the rainy season. The temporary zone reflects soils that indicate the shortest period(s) of inundation/saturation that are long enough, under normal circumstances, for the formation of hydromorphic soils and the growth of wetland vegetation (**DWAF, 2005**). The diagnostic criteria for the identification of the three wetness zones are summarised in **Table 1** below.

Table 1: Relationship between degree of wetness (wetland zone), soil-physio-chemistry and vegetation (*after* Kotze *et al*, 1994)

	Degree of wetness		
	Temporary	**Seasonal**	**Permanent / Semi-permanent**
Soil Depth (0cm –10cm)	Matrix chroma: 1-3 Few / no mottles Low / intermediate OM Non-sulphuric	Matrix chroma: 0-2 Many mottles Intermediate OM Seldom sulphuric	Matrix chroma: 0-1 Few / no mottles High OM Often sulphuric
Soil Depth (40cm – 50cm)	Few / many mottles Matrix chroma: 0-2	Many mottles Matrix chroma: 0-2	No / few mottles Matrix chroma: 0-1
Vegetation	Predominantly grass species	Predominantly sedges and grasses	Predominantly reeds and sedges

Vegetation distribution within wetlands is very closely linked to the flooding regime. Terrestrial plants are not tolerant of flooding and saturation within the root zone for periods long enough to cause anaerobic conditions, and are thus found on higher ground. The distribution of wetland plants is related to their tolerance of different flooding conditions, and their distribution within a system can be used as an indication of the wetness of an area.

Wetland plants are divided into 5 categories based on their expected frequency of occurrence in wetlands. These groups are:

- **Obligate Wetland Plants** - occur almost always in wetlands under natural conditions (>99% of occurrences);
- **Facultative Wetland Plants** - usually occur in wetlands but can occasionally be found on dry land (67-99% of occurrences);
- **Facultative Plants** - equally likely to grow in wetlands and non-wetlands (34-66% of occurrences);
- **Facultative Upland/Dry-land Plants** - usually occur outside of wetlands but occasionally found in wetlands (1-34% of occurrences); and
- **Obligate Upland/Dry-land Plants** - occur almost always outside of wetlands under natural conditions (<1% of occurrences).

Typically, indicators of soil wetness based on soil morphology correspond closely with vegetation distribution, since hydrology affects soils and vegetation in systematic and predictable ways. However, in systems where the hydrological regime has been modified due to human activities, vegetation distribution will not vary systematically with soil morphology. The response of vegetation to alteration of hydrological conditions is rapid (months/years), whereas the response of soil morphology to such alteration is slow (centuries). Therefore, the lowering of the water table or reduction of surface flows, may lead to rapid establishment of terrestrial vegetation, whereas the soil morphology will retain indicators of wetness for a lengthy period.

For this reason, soil morphology forms the basis of wetland delineation nationally, following international protocols, mainly because it provides a long-term indication of the "natural" hydrological regime. However, it is important to note that where soil wetness indicators cannot be used to identify the current hydrological conditions either through extensive disturbance or through certain soil types that do not retain clear redoximorphic features, the terrain and vegetation indicators will have to be used.

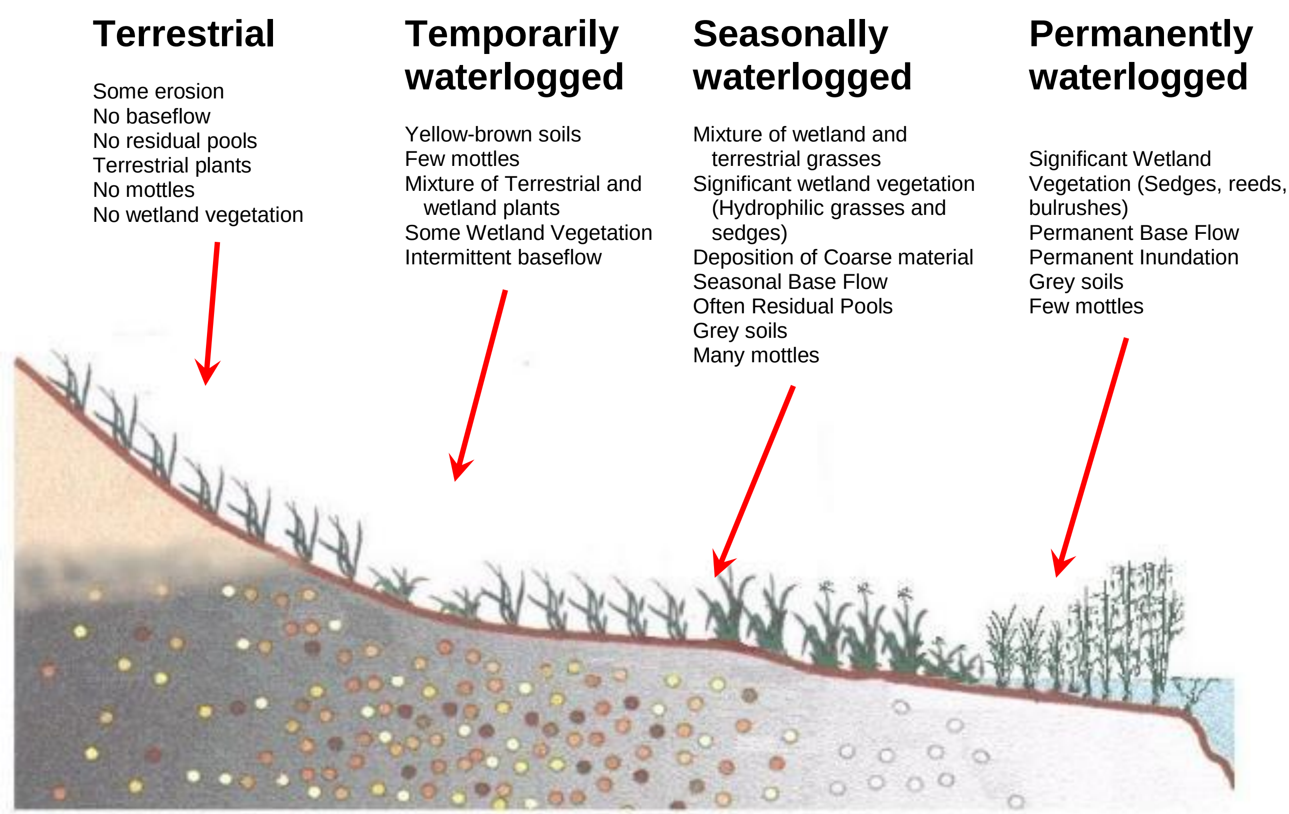

Figure 3: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change along a gradient of decreasing wetness, from the middle to the edge of the wetland. (Reproduced from Kotze (1996), DWAF Guidelines)

5.2 Wetland Classification

Central to the assessment of the health and ecosystem services value of wetlands is the characterisation of wetland hydro-geomorphic types which are defined based on the geomorphic setting of the wetland in the landscape, water source, how water flows through the wetland and how water exits the wetland (**Kotze et al., 2009**). In this regard, a proposed National Wetland Classification System has been developed by the South African National Biodiversity Institute (**SANBI**). The classification system identifies eleven broad hydro-geomorphic units:

1. Channel
2. Channelled valley bottom wetland
3. Un-channelled valley bottom wetland
4. Floodplain wetland
5. Exorheic depression with channelled inflow
6. Exorheic depression without channelled inflow
7. Endorheic depression with channelled inflow
8. Endorheic depression without channelled inflow
9. Flat
10. Valley head seep with channelled outflow
11. Valley head seep without channelled outflow
12. Valley head seep

A brief description of the key elements of each HGM type is provided below in **Table 2** below.

Table 2: **Characteristics of different hydro-geomorphic (HGM) types included in the proposed National Wetland Classification System (SANBI, 2009)**

HGM Type	Landscape Setting	Hydrological Characteristics		
		Inputs	Throughputs	Outputs
1. Channel	Slope / Valley floor / Plain	• Overland flow from catchment runoff, • Concentrated surface flow from upstream channels and tributaries • Diffuse surface flow from an unchannelled upstream drainage line • Seepage	• Concentrated surface flow	• Concentrated surface flow, generally, but can be diffuse surface flow
2. Channelled Valley Bottom Wetland	Valley floor	• Overland flow from adjacent valley-side slopes • Lateral seepage from adjacent valley head seeps • Channel overspill during flooding	• Diffuse surface flow • Temporary storage in depressions • Short-lived concentrated flows during flood events	• Diffuse surface flow and interflow into adjacent channel • Infiltration and evaporation
3. Un-channelled Valley Bottom Wetland	Valley floor / plain	• Concentrated or diffuse surface flow from upstream • Channels and tributaries • Overland flow from adjacent valley-side slopes • Lateral seepage from adjacent valley head seeps • Groundwater	• Diffuse surface flow, • interflow, temporary storage of water in depressions, • Possible short-lived concentrated flows during high-flow events	• Diffuse or concentrated surface flow, • Infiltration and evaporation (particularly from depressional areas)
4. Floodplain Wetland	Valley floor / plain	• Channel overspill during flooding	• Diffuse surface flow • interflow temporary	• Diffuse surface flow and interflow into

HGM Type	Landscape Setting	Hydrological Characteristics		
		Inputs	Throughputs	Outputs
		(predominantly) • Some overland flow from adjacent valley-side slopes (if present) • Lateral seepage from adjacent valley head seeps (if present)	storage of water in depressions • possible short-lived concentrated flows during flooding events	adjacent channel • Infiltration and evaporation (particularly from depressional areas)
5. Exorheic Depression with channelled inflow	Slope / valley floor / plain / bench	• Precipitation • Concentrated and (possibly) diffuse surface flow • Interflow • Groundwater	• Storage of water • Slow through-flow	• Concentrated surface flow
6. Exorheic Depression without channelled inflow	Slope / valley floor / plain / bench	• Precipitation • Diffuse surface flow • Interflow • Groundwater	• Storage of water • Slow through-flow	• Concentrated surface flow
7. Endorheic Depression with channelled inflow	Slope / valley floor / plain / bench	• Precipitation • Concentrated and (possibly) diffuse surface flow • Interflow • Groundwater	• Containment and storage of water	• Evaporation • Infiltration
8. Endorheic Depression without channelled inflow	Slope / valley floor / plain / bench	• Precipitation • Diffuse surface flow • Interflow • Groundwater	• Containment and storage of water	• Evaporation • Infiltration
9. Flat	Plain / bench	• Precipitation • Groundwater	• Containment of water • Some diffuse surface flow and/or interflow	• Evaporation • infiltration
10. Valley head Seep with channelled outflow	Slope	• Groundwater • Precipitation (perched)	• Diffuse surface flow • Interflow	• Concentrated surface flow
11. Valley head Seep without channelled outflow	Slope	• Groundwater • Precipitation (perched)	• Diffuse surface flow • Interflow	• Diffuse surface flow • Interflow • Evaporation • Infiltration
12. Valley Head Seep	Valley floor	• Groundwater • Diffuse surface flow • Precipitation	• Diffuse surface flow • Interflow	• Concentrated surface flow

5.3 Wetland Health Assessment

For the purposes of this study, wetland health is defined as a measure of the deviation of a wetland from its natural or reference condition (**Macfarlane et al., 2009**) and is designed to provide a rapid assessment of the present ecological status of a wetland.

The health of a wetland from an ecological perspective is generally dependent on the hydrological and geomorphological health as well as the state of the vegetation, and these three components are inextricably linked. Thus, when describing wetland health, it is beneficial to discuss the hydrological, geomorphological and ecological health of the wetland separately and then explain how these three components contribute to an overall rating of the system.

In South Africa, the WET-Health tool (**Macfarlane et al., 2009**) has been developed to assess wetland health. WET-Health assesses the impacts of human activities on three components of wetland health; hydrology, geomorphology and vegetation. These components are assessed separately to produce three scores which indicate how much the wetland deviates from the natural reference condition.

WET-Health uses a method that calculates the magnitude of an impact of an activity as the product of the extent of the impact and the intensity of the impact. The magnitude of impact scores for different activities is combined in a structured way to produce an overall magnitude of impact score for hydrology, geomorphology and vegetation.

5.4 Wetland Ecosystem Services Assessment

Wetlands are among the most globally threatened and important ecosystems, providing a number of important ecosystem goods and services (EG&S) to society (**Millennium Ecosystem Assessment, 2005**). **Table 3** below lists the common direct and indirect ecosystem goods and services typically provided by South African wetlands.

Table 3: Table of the wetland functions included in WET-EcoServices (Kotze *et al*., 2009)

<table>
<tr><td rowspan="15">Ecosystem services supplied by wetlands</td><td rowspan="9">Indirect benefits</td><td rowspan="8">Hydro-geochemical benefits</td><td colspan="2">Flood attenuation</td></tr>
<tr><td colspan="2">Stream flow regulation</td></tr>
<tr><td rowspan="5">Water quality enhancement benefits</td><td>Sediment trapping</td></tr>
<tr><td>Phosphate assimilation</td></tr>
<tr><td>Nitrate assimilation</td></tr>
<tr><td>Toxicant assimilation</td></tr>
<tr><td>Erosion control</td></tr>
<tr><td colspan="2">Carbon storage</td></tr>
<tr><td colspan="3">Biodiversity maintenance</td></tr>
<tr><td rowspan="6">Direct benefits</td><td colspan="3">Provision of water for human use</td></tr>
<tr><td colspan="3">Provision of harvestable resources[2]</td></tr>
<tr><td colspan="3">Provision of cultivated foods</td></tr>
<tr><td colspan="3">Cultural significance</td></tr>
<tr><td colspan="3">Tourism and recreation</td></tr>
<tr><td colspan="3">Education and research</td></tr>
</table>

[2] Many different resources may be derived from wetlands, including the following:

- **Grazing for livestock;**
- **Plants for crafts and construction;**
- **Food, with fish being particularly important; and**
- **Medicines**

In environmental decision making worldwide it has become important to determine the level and importance of the Goods and Services provided by individual ecosystems under threat; in order to evaluate the importance of said systems to society. Within the South African context the WET-EcoServices tool developed by **Kotze et al. (2009)** has been designed to rapidly assess the ecosystem services of individual wetlands in South Africa.

WET-EcoServices assesses a wide range of ecosystem services based on a range of wetland characteristics that are likely to affect the extent to which the wetland modifies flow and alters biogeochemical processes. The assessment is undertaken by determining the likely "effectiveness" or ability of a wetland to deliver an ecosystem service as well as providing a measure of the extent to which the wetland is delivering an ecosystem service referred to as "opportunity".

6 METHODS

6.1 Wetland Health Description and Present Ecological Status (PES)

The current (pre-development) and post-development health of the affected wetland systems was determined using the WET-Health tool developed by **Macfarlane et al. (2009)**. A Level 1 assessment was utilised in accordance with the requirements set out by DWA.

Firstly, the wetlands identified onsite were classified into individual hydro-geomorphic units as per the proposed National Wetland Classification System (**SANBI, 2009**). Thereafter, specific information required to be entered into the predesigned Level 1 WET-Health spread sheet was gathered during the site visit and desktop analysis using ArcView GIS 10.

Once all the required information was entered into the spread sheet, the magnitude of the all the impacts on the hydrological, geomorphological and vegetation health of the individual wetlands were calculated. The WET-Health tool scores wetland health for each component of health on a scale of 0 (no discernible modifications) to 10 (critically impacted), which is subsequently translated into one of six PES Categories ranging from A to F, with A representing completely unmodified and F representing modifications that have reached a critical level (**Macfarlane et al., 2009**) (**Table 4**).

Changes in hydrology are evaluated by assessing:

(i) changes to water input volumes and pattern (effects on the alteration of the wetland's catchment), and

(ii) changes to water distribution and retention patterns of water passing through the wetland (effects of onsite alterations) (**Macfarlane *et al*., 2009**).

Water inputs to a wetland from the catchment are considered in terms of the <u>quantity of water</u> inputs and the <u>size of the flood peaks</u> which are combined to provide an indication of the impacts of catchment activities on wetland water inputs.

Present geomorphic state is assessed by evaluating:

(i) Activities and impacts which are known to commonly influence geomorphic process (i.e. activities that alter geomorphic processes), and

(ii) Direct on-site impacts which provide clues to changes in geomorphic processes (indicators of geomorphic change) (**Macfarlane *et al*., 2009**).

Present vegetative state is assessed by evaluating the degree to which current vegetation composition has deviated from the perceived natural or reference condition (**Macfarlane *et al*., 2009**). The assessment of the deviation is based on what '*should not be there*' rather than on the composition of indigenous plants that '*should be there*' (**Macfarlane *et al*., 2009**). The evaluation is simplified by defining '*disturbance classes*' which represent areas of similar vegetation characteristics and disturbance history (**Macfarlane *et al*., 2009**).

The overall health was determined by combining the three health scores into one health value. This is calculated from the formula that weighs hydrology higher than geomorphology and vegetation where the hydrology score is multiplied by 3 while the other scores are multiplied by 2 and the sum of the three is divided by 7. The anticipated trajectory of change in hydrological, geomorphological and ecological health is then calculated.

Table 4: Impact scores and categories of Present State used by WET-Health for describing the integrity of wetlands (Source: Macfarlane *et al*., 2009)

Description	Impact Score Range	PES Category
Unmodified, natural.	**0-0.9**	**A**
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	**1-1.9**	**B**
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	**2-3.9**	**C**
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	**4-5.9**	**D**
Seriously modified. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	**6-7.9**	**E**
Citically modified. Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	**8-10**	**F**

6.2 Wetland Ecosystem Services Assessment

The current (pre-development) and post-development value of the affected wetland units was determined using the WET-EcoServices tool developed by **Kotze et al.** (**2009**). Specific information required to be entered into the predesigned WET-EcoServices spread sheet was gathered during the field visit and during a desktop analysis using ArcView GIS 10. Once all the required information was entered into the spread sheet, the effectiveness, opportunity and overall functional scores for each the ecosystem services provided by the wetland units was generated. Each overall functional score was then rated according to the rating scale in **Table 5** below.

Table 5: Ranking scale for wetland services based on WET-EcoServices scores

Score	0-0.8	0.9-1.6	1.7-2.4	2.5-3.2	3.3-4.0
Level at which a service is being provided	Low	Moderately Low	Intermediate	Moderately High	High

Thereafter, the overall functional scores were contextualised in light of the size of the wetland and the wetland's catchment to provide an indication of the importance of the wetland systems.

The overall importance of the surface water management and water quality enhancement services was determined by combining the WET-EcoServices 'level of service' score with the size of the wetland and its catchment. The individual size of the wetland units and their catchments are rated separately on a scale of 1-5 (**Table 6**) and averaged to provide a wetland: catchment size ratio (**Table 7**). The wetland: catchment size rating is then combined with the 'level of service' rating to provide an overall importance rating (**Table 8**). The carbon storage score is considered independent of catchment size and therefore only combined with wetland size (**Table 9**). The biodiversity maintenance score is considered independent of wetland and catchment size. Thus, for biodiversity, the WET-EcoServices score is considered to give a true reflection of the importance score.

Table 6: Wetland and catchment size rating categories

Score	Rating	Wetland Size	Catchment Size
1	Small	<1ha	<10ha
2	Medium-Small	1-5ha	10-100ha
3	Medium	5-10ha	100-1000ha
4	Medium-Large	10-20ha	1000-10000ha
5	Large	>20ha	>100 000ha

Table 7: Ranking scale for the Wetland: catchment size ratio scores

		Catchment Size				
		Low (1)	Moderately -low (2)	Intermediate (3)	Moderately-high (4)	High (5)
Wetland Size	Small (1)	1	1.5	2	2.5	3
	Medium-small (2)	1.5	2	2.5	3	3.5
	Moderate (3)	2	2.5	3	3.5	4
	Medium-large (4)	2.5	3	3.5	4	4.5
	Large (5)	3	3.5	4	4.5	5

Table 8: Ranking scale for the importance of the surface water and water quality enhancement services

Score	2-3	3.5-5	5.5-6.5	7-8.5	9-10
Importance Ratings	Low	Moderately Low	Intermediate	Moderately High	High

Table 9: Ranking scale for the importance of carbon storage services

Score	1-1.5	1.6-2.5	2.6-3.4	3.5-4.4	4.5-5
Importance Ratings	Low	Moderately Low	Intermediate	Moderately High	High

6.3 Wetland Ecological Importance and Sensitivity (EIS)

The ecological importance of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales (**DWAF, 1999**). While the ecological sensitivity refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (**DWAF, 1999**). The ecological importance and sensitivity (EIS) can be calculated according to the determinants listed in **Table 10** below and attributing a score[1] to each. Once calculated the **EIS Category** (EISC) can be determined (**Table 11**). The **Category** ranges from A to D, with A being Very High and D being Low/Marginal.

Table 10: EIS Score sheet (after DWAF, 1999)

Determinant	Score	Confidence
Primary Determinants		
1. Rare & Endangered Species		
2. Populations of Unique Species		
3. Species/taxon Richness		
4. Diversity of Habitat Types or Features		
5. Migration route/breeding and feeding site for wetland species		
6. Sensitivity to Changes in the Natural Hydrological Regime		
7. Sensitivity to Water Quality Changes		
8. Flood Storage, Energy Dissipation & Particulate/Element Removal		
Modifying Determinants		
9. Protected Status		
10.Ecological Integrity		
TOTAL		
MEDIAN		
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE		

[1] **Score guideline:** Very high = 4; High = 3, Moderate = 2; Marginal/Low = 1; None = 0

Confidence rating: Very high confidence = 4; High confidence = 3; Moderate confidence = 2; Marginal/low confidence = 1

Table 11: Environmental Importance and Sensitivity categories for biotic and habitat determinants (after DWAF, 1999)

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level.	**>3 and <=4**	**A**
High Wetlands that are considered to be ecologically important and sensitive.	**>2 and <=3**	**B**
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale.	**>1 and <=2**	**C**
Low/marginal Wetlands that are not ecologically important and sensitive at any scale.	**>0 and <=1**	**D**

7 RESULTS

In order to predict the potential impacts that a particular activity will have on a wetland system, it is important to first obtain a clear understanding of the current baseline health of the affected wetland.

Thereafter, the effect of potential impacts i.e. the degree of change in a system, can be more scientifically and pragmatically assessed. In this case, where the wetlands under assessment may be in-filled by the applicant, the assessment of wetland health also enables one to quantitatively measure what is being lost and thus calculate the offset requirements.

A summary of the present hydrological, geomorphic and vegetation states and associated impacts are tabularised below:

Table 12. Summary of the impacts on wetland hydrology, geomorphology and vegetation for each HGM Unit

Wetland Unit	HGM	Impacts on Wetland Hydrology	Impacts On Wetland Geomorphology	Impacts On Wetland Vegetation
1	Channelled Valley Bottom	• Cultivation in wetland • Road Runoff (Cane and Highway) • Channel incisement • Change in runoff characteristics • Artificial drainage • Decrease in wetland saturation (zonation)	• Canalisation (increased erosion in the channel) • Areas outside channel starved of sediment • Dirt Roads (Source of Sediment) • Scour • Bare soils (increased erosion and sediment yield) • General disturbance, crossings	• Moderate prevalence of alien vegetation (thalweg) • Cultivation (removal and reduction number of spp.)
2	Un-Channelled Valley Bottom	• Road Runoff, • Change in runoff characteristics	• Roads (hardening) • Dirt Roads (Source of Sediment) • General disturbance, crossings	• High prevalence of alien vegetation (road enbankment)
3	Channelled Valley Bottom	• Cultivation in wetland • Road Runoff (Cane and Highway) • Channel incisement • Change in runoff characteristics • Artificial drainage • Decrease in wetland saturation (zonation)	• Canalisation (increased erosion in the channel) • Areas outside channel starved of sediment • Roads (hardening) • Dirt Roads (Source of Sediment) • Scour • Bare soils (increased erosion and sediment yield) • General disturbance, crossings	• Moderate prevalence of alien vegetation (thalweg) • Cultivation (removal and reduction number of spp.)
8	Channelled Valley Bottom	• Cultivation in wetland • Flow Confinement (Culvert under road) • Artificial drains • Scour • Road Runoff • Steep road embankments (increased runoff)	• Roads (Hardening and source of sediment) • Road embankment (source of sediment) • Scour • General disturbance	• Moderate prevalence of alien vegetation (thalweg) • Cultivation (removal and reduction number of spp.)

Wetland Unit	HGM	Impacts on Wetland Hydrology	Impacts On Wetland Geomorphology	Impacts On Wetland Vegetation
14	Floodplain	• Flow Confinement (Culverts) • Road Runoff • Crossings • Artificial drainage • Increase in flood peaks • Effluent from upstream • Increase in nutrient load • Pollution	• General disturbance, crossings • Alteration of erosion and deposition regime • Roads crossings (deactivation of processes) •	• Cultivation (removal and reduction number of spp.) • Decrease in ecological complexity. • Moderate alien prevalence • Fragmentation •
20	Channelled Valley Bottom	• Cultivation in wetland • Flow Confinement (Culvert under road) • Artificial drains • Scour • Road Runoff • Steep road embankments (increased runoff)	• Roads (Hardening and source of sediment) • Road embankment (source of sediment) • Scour • General disturbance	• Moderate prevalence of alien vegetation (thalweg) • Cultivation (removal and reduction number of spp.)
21	Channelled Valley Bottom	• Cultivation in wetland • Flow Confinement (Culvert under road) • Artificial drains • Scour • Road Runoff • Steep road embankments (increased runoff)	• Roads (Hardening and source of sediment) • Road embankment (source of sediment) • Scour • General disturbance	• Moderate prevalence of alien vegetation (thalweg) • Cultivation (removal and reduction number of spp.)
26	Channelled Valley Bottom	• Cultivation in wetland • Flow Confinement (Culvert under road) • Artificial drains • Scour • Road Runoff • Steep road embankments (increased runoff)	• Roads (Hardening and source of sediment) • Road embankment (source of sediment) • Scour • General disturbance	• Moderate prevalence of alien vegetation (thalweg) • Cultivation (removal and reduction number of spp.)
38	Un-Channelled Valley Bottom	• Road Runoff, • Change in runoff characteristics	• Roads (hardening) • Dirt Roads (Source of Sediment) • General disturbance, crossings	• High prevalence of alien vegetation (road enbankment)

Wetland Unit	HGM	Impacts on Wetland Hydrology	Impacts On Wetland Geomorphology	Impacts On Wetland Vegetation
39	Channelled Valley Bottom	• Flow Confinement (Culvert under road) • Artificial drains • Scour • Road Runoff • Steep road embankments (increased runoff)	• Roads (Hardening and source of sediment) • Road embankment (source of sediment) • Scour • General disturbance	• Moderate prevalence of alien vegetation (thalweg) • Cultivation (removal and reduction number of spp.)

The following wetland hydrogeomorphic units were identified in the study area:

- Six channelled valley bottom wetlands;
- Three unchannelled valley bottom wetlands; and
- One Floodplain wetland.

A wetland catchment area analysis was undertaken to delineate each wetlands catchment area as well as to determine the extent of the wetlands.

Table 13. Wetland areas and hydro-geomorphic type.

Wetland HGM Unit	Hydro-Geomorphic Type (Under natural conditions)	Area (ha)
1	Channelled Valley Bottom	5.77
2	Un-Channelled Valley Bottom	1.43
3	Channelled Valley Bottom	39.70
8	Un-Channelled Valley Bottom	3.49
14	Floodplain	33.24
20	Channelled Valley Bottom	1.66
21	Channelled Valley Bottom	1.44
26	Channelled Valley Bottom	1.74
38	Un-Channelled Valley Bottom	3.84
39	Channelled Valley Bottom	4.88

The channelled valley bottom wetlands ranged in size from 1.44 hectares to 39.70 hectares. The unchannelled valley bottom wetlands were more limited in extent ranging from a minimum of 1.43 hectares to 3.84 hectares. The affected floodplain wetland is 33.24 hectares in extent.

Overall, it can be stated that the wetlands falling within the study area are generally not extensive systems with the exception of the one channelled valley wetland , and one floodplain wetland adjacent to the southern boundary of the site. Most are quite small (<5 hectares) in size, and have localised and limited catchment areas that are contained within the study area. The topography is a strong factor dictating the wetland type and characteristics in the study area. Drainage into the valley bottom areas gives rise to the occurrence of the channelled and unchannelled valley bottom wetlands. The valley bottom wetlands are generally narrow and constrained by hilly topography. The wetlands are seasonal to permanently inundated. The Ohlanga River is the primary water input to the Ohlanga floodplain wetlands that exist to the south of the study site.

7.1 Present Ecological Status

A summary of the Present Ecological Status (PES) based on results from the WET-Health Tool is provided in **Table 14** below.

The health assessment of the wetland units within the project site indicates that the majority of the wetland units are **seriously modified** resulting from past and current land uses, and activities.

Table 14. Wetlands PES

HGM Unit	Hydrology		Geomorphology		Vegetation		Overall Health Score for entire Wetland	
	Impact Score	Category	Impact Score	Category	Impact Score	Category	Impact Score	Category
1	8	E	2.6	C	6.8	E	6.11	E (Seriously modified)
2	4	C	5.5	D	6.9	E	5.26	D (Largely modified)
3	8	E	2.1	C	9.1	F	6.63	E (Seriously modified)
8	8	E	2.8	C	7.7	E	6.43	E (Seriously modified)
14	6.3	E	2.2	C	6.1	E	5.07	D (Largely modified)
20	6.5	E	3.2	C	9	F	6.27	E (Seriously Modified)
21	8.5	F	5	D	9.1	F	7.67	E (Seriously Modified)
26	6.2	E	5.7	D	9	F	6.86	E (Seriously Modified)
38	3.2	C	5.7	D	7.1	E	5.03	D (Largely modified)
39	7.6	E	3.4	C	7.6	E	6.4	E (Seriously modified)

7.1.1 Channelled Valley Bottom Wetlands

The present ecological status for the channelled valley bottom wetlands are shown in **Table 14** above. The general present ecological state of the channelled valley bottom wetlands was found to be Seriously Modified (**Category E**). Despite differences in the sizes of the wetlands, many of the same impacts were found to affect all of the wetlands with varying degrees of severity. Factors that were found to be impacting on the present ecological status are elaborated on below.

7.1.1.1 *Hydrological Factors affecting PES*

The majority of the channelled valley-bottom wetlands in the catchment have been almost completely transformed by sugar cane cultivation which is the predominant land use for the greater area. Access routes by means of farm dirt roads are pervasive and were also found to be a significant factor affecting the wetlands. Additionally, artificial drainage channels have been excavated within the wetlands for drainage purposes, creating the channel structure within the wetlands. Vegetation was found to have established within some of the artificial channels. However, in other cases, channels were found to be free draining with no vegetative cover. As a result, the hydrology of the wetlands is severely impacted.

At a general level, altered hydrology in terms of a reduction in water inputs resulting from efficient drainage systems as well as altered flood peaks were found to impact negatively on the present ecological condition. Altered flood peaks can vary from increased flood peaks following rain events when crops have been harvested and the ground is left exposed. Conversely, reduced flood peaks can occur when crops are growing and there is increased surface roughness. As previously mentioned, roads (farm/dirt roads) are also present throughout the study area which contribute to altered hydrological impacts by means of increased run-off which has an effect on flood peaks. This impact however was a relatively minor factor by comparison to the other earlier stated impacts affecting the wetlands.

The present ecological status for the hydrological component is mostly **Category E** (Seriously modified) with one wetland unit **Category F** (Critically modified).

7.1.1.2 *Geomorphological Factors affecting PES*

The hydrological impacts were found to have major effects on the geomorphology component. The geomorphological component of the wetlands generally scored poorly and the wetlands were found to be impacted. As previously stated road infrastructure is present, and the associated impacts (such as erosion/deposition features) were evident. Increased run-off is likely to contain additional sediment and pollution (especially during seeding times when the ground is left exposed) thereby impacting on the geomorphology of the wetland. This was assessed to be a relatively moderate impact factor.

The geomorphological present ecological status ranged from **Category C** (Moderately Modified) to **Category D** (Largely Modified).

7.1.1.3 *Vegetation Factors affecting PES*

The greatest impact on the wetlands was the transformation from natural vegetation to sugar cane. Patches of natural vegetation was present for some wetlands. The presence and colonisation of the area by a few alien vegetation species was evident in most instances including the following *Chromolaena odorata*, *Ipomoea purpurea*, *Lantana camara*, *Melia azedarach, Solanum lycopersicon* and *Sorghum halepense* being present. The hydrological and geomorphological impacts in turn were anticipated to influence vegetation composition. Altered throughputs and flood peaks as well as sediment and water quality impacts are likely to have contributed to alien plant invasion in-stream and on the banks of the wetlands.

The vegetation present ecological state for all the channelled valley bottom wetlands was attributed to **Category** E & **F** (Seriously & Critically modified).

7.1.2 Unchannelled Valley Bottom Wetlands

The present ecological status for the unchannelled valley bottom wetlands are shown in Error! Reference source not found.**4** above. The present ecological state of the unchannelled valley bottom wetlands was found to be largely modified (**Category D**). Again, many of the same impacts were found to affect all of the wetlands with varying degrees of severity impacting on the overall present ecological status. Factors that were found to be impacting on the present ecological status are elaborated on below.

7.1.2.1 *Hydrological Factors affecting PES*

From a hydrological perspective, the same impacts as highlighted in the hydrological component for the channelled valley bottom wetlands in the previous section (**Section 7.1.1.1**) apply. These include:

- Altered water supply and throughputs;
- Altered flood peaks; and
- Increased run-off from hardened surfaces (farm/dirt roads).

Unchannelled valley bottom wetlands were affected by drainage channels. The hydrological present ecological state was **Category C** (Moderately modified).

7.1.2.2 *Geomorphological Factors affecting PES*

Again the hydrological impacts were found to have major effects on the geomorphology component. The geomorphological component of the wetlands generally scored poorly and the wetlands were found to be impacted. As previously stated road infrastructure is present, and the associated impacts (such as erosion/deposition features) were evident.

The geomorphological present ecological state was **Category C** (Moderately modified).

7.1.2.3 *Vegetation Factors affecting PES*

Complete transformation of the cover within the wetland from natural vegetation to sugar cane again was considered to be the most significant impact affecting the state of the wetlands. The hydrological and geomorphological impacts again have bearing on the vegetation state of the wetlands contributing to alien plant invasion in the wetlands.

The vegetation present ecological state for the channelled valley bottom wetlands attributed with **Category E** (Seriously modified).

7.1.3 Floodplain Wetlands

The present ecological status for the floodplain wetlands is shown in Error! Reference source not found.**14** Above. The general present ecological state of the wetlands is a **Category D** (Largely modified). Factors that were found be impacting on the present ecological status are elaborated on below.

7.1.3.1 *Hydrological Factors affecting PES*

The floodplain wetland was found to be mainly impacted on by a reduction in water supply input as a result of alien vegetation and crop cultivation in the floodplain areas. Extent of areas of bare soil on the other hand was found to have an influence on the level of floodpeak increase. Road crossings through the wetland additionally affected the hydrology of the systems and the natural flows through the wetlands. A reduction in surface roughness also had an influence in affecting the present ecological state of the floodplain wetlands.

The hydrological present ecological state for the wetland is a **Category E** (Greatly modified).

7.1.3.2 *Geomorphological Factors affecting PES*

The geomorphological state of the floodplain wetland was relatively intact. However, the main factor affecting the present ecological state was due to the impact of artificial infilling as a result of the roads bisecting the wetlands.

The geomorphological present ecological state for the floodplain wetlands was attributed to a **Category C** (Moderately modified).

7.1.3.3 *Vegetation Factors affecting PES*

On the flood benches of the wetlands, patches of sugar cane cultivation transformed previously natural vegetation. Additionally, alien vegetation encroachment presumably due to altered hydrological impacts as well as human disturbance affected the present ecological condition of the wetlands. Some of the main alien vegetation species identified in the floodplain wetlands consisted of *Ageratum conyzoides*, *Asystasia gangetica*, *Arundo donax*, Bambusoideae, *Cyperus rotundus*, *Ipomoea cairica*, *Indigofera suffruticosa*, *Melia azedarach*, *Shinus terebinthifolius* and *Stenotaphrum secundatum*.

The vegetation present ecological state of the floodplain wetland was attributed to a **Category E** (Seriously modified).

7.2 WET-Ecoservices Assessment

Due to the high number of wetlands and the similar characteristics shared between the wetland HGM types, the ecosystem services assessment has been grouped per HGM unit type.

7.2.1 Channelled Valley Bottom Wetlands

According to the results of the assessment (**Figure 4**), the ecosystem service offered by the channelled valley bottom wetlands which scored the highest (**moderately high**) was the sediment trapping ability of the wetlands. Other ecosystem services which scored at an **intermediate level** include erosion control, toxicant removal, nitrate removal, phosphate trapping, flood attenuation and water supply for human use. The ecosystem services which scored **below intermediate** levels include stream flow regulation, maintenance of biodiversity, carbon storage, tourism and recreation, education and research, cultural significance, cultivated foods and natural resources. The current transformed state of the wetlands has bearing on the degree of ecosystem services offered by the wetland. As a result of the level of transformation, the ecosystem services are limited to intermediate to low scores.

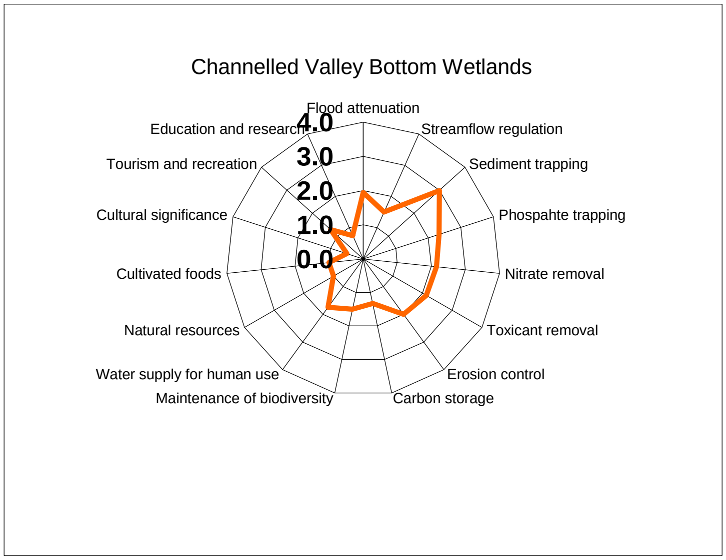

Figure 4. WET-Ecoservices results for Channelled Valley Bottom Wetlands

7.2.2 Unchannelled Valley Bottom Wetlands

The ecosystem services (**Figure 5**) provided by the channelled valley bottom wetlands were very similar to the channelled valley bottom wetlands given similar impacts and a similar ecological state. However, the unchannelled valley bottom wetlands were found to provide a higher level of ecosystem services for a greater range functions. Accordingly, the wetlands were assessed as providing a **moderately high** level of ecosystem services in terms of sediment trapping ability, phosphate trapping, nitrate removal, toxicant removal and erosion control. The only ecosystem service with an **intermediate** score was flood attenuation ability. The remaining ecosystem services that scored **below intermediate** included carbon storage, maintenance of biodiversity, water supply for human use, natural resources, cultivated foods, cultural significance, tourism and recreation, education and research as well as stream flow regulation. Transformation of the wetland for agricultural purposes and the resultant effect on alteration of flow can once more be considered to be a significant factor affecting the ability of wetlands to contribute to a higher degree of ecosystem services provided.

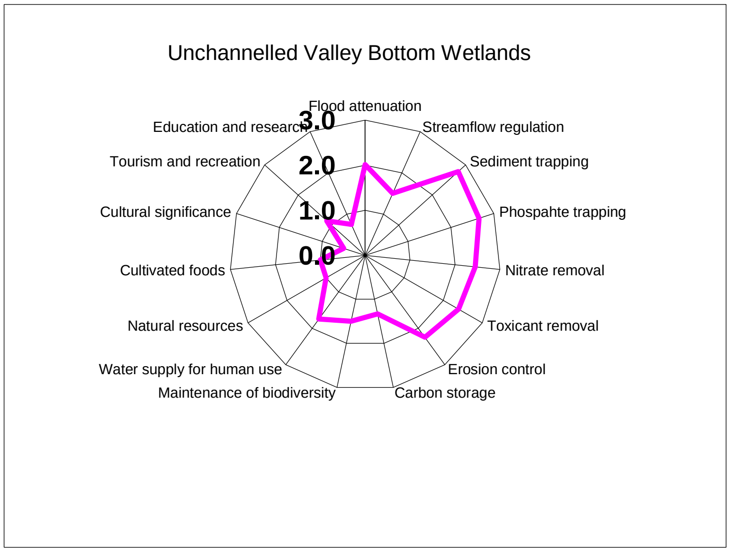

Figure 5. WET-Ecoservices results for Unchannelled Valley Bottom Wetlands

7.2.3 Floodplain Wetlands

According to the results of the ecosystem services assessment for the floodplain wetlands (**Figure** 6**6**), the highest scoring ecosystem services and assessed at a **moderately high** level included maintenance of biodiversity, sediment trapping, phosphate trapping, nitrate removal, toxicant removal, erosion control and as well as tourism and recreation. At an **intermediate** level, ecosystems services included carbon storage and flood attenuation. **Below intermediate** level of ecosystems services provided include stream flow regulation, water supply for human use, natural resources, cultivated foods and, education and research. The **lowest** scoring ecosystem services provided by the floodplain wetlands are cultural significance. Land use impacts associated with the wetlands catchment for the purposes of agriculture can be considered to be a factor affecting the ability of the wetland to provide a higher degree of wetland ecosystem services.

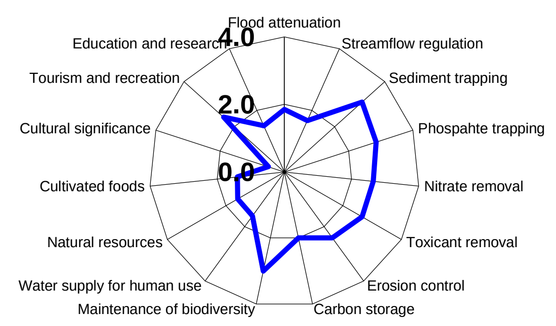

Figure 6. WET-Ecoservices results for the Flooplain Wetlands

7.3 Wetland Ecological Importance and Sensitivity

The ecological importance and sensitivity was assessed for each wetland HGM unit. The scores are given below.

7.3.1 Channelled Valley Bottom Wetlands

The wetland ecological importance and sensitivity of each of the wetland HGM units is provided in **Table 15** below. The channelled valley bottom wetlands all scored a **Class D (Low)** level of ecological importance and sensitivity. Contributing factors to the low level of ecological importance and sensitivity for most of the wetlands include transformation and channelization impacts, which have a bearing on habitat quality and the potential occurrence of wetland fauna.

7.3.2 Unchannelled Valley Bottom Wetlands

The wetland ecological importance and sensitivity of each of the unchannelled valley bottom wetlands is provided in **Table 16** below. The unchannelled wetlands scored a **Class D (Low)** level of ecological importance and sensitivity. Transformation and channelization impacts again had a major influence decreasing the sensitivity. The wetlands were impacted by artificial drainage ditches which further degraded the ecological condition and therefore sensitivity of the wetlands.

7.3.3 Floodplain Wetland

The wetland ecological importance and sensitivity for the floodplain wetlands (**Table 17**) was categorised as a **Class B (High)**. The floodplain has been impacted on by three main factors including cultivation on the banks of the River, roads through the wetland and a degree of alien vegetation species encroachment. Nonetheless, functionality of the wetland and habitat quality is still good with a riparian habitat associated with the wetland. Assemblages of protected tree species were observed. Fish, amphibian and avifaunal occurrence and activity were also observed although the species could not be identified.

Table 15. Ecological Importance and Sensitivity Category for Channelled Valley Bottom Wetlands

	HGM UNIT											
	1		**3**		**20**		**21**		**26**		**39**	
	Score	**Conf**	**Score**	**Conf**	**Score**	**Conf**	**Score**	**Conf**	**Score**	**Conf**	**Score**	**Conf**
PRIMARY DETERMINANTS												
1. Rare & Endangered Species	0	2	0	2	0	2	0	2	0	2	0	2
2. Populations of Unique Species	0	2	0	2	0	2	0	2	0	2	0	2
3. Species/taxon Richness	1	3	1	3	1	3	1	3	1	3	1	3
4. Diversity of Habitat Types or Features	1	3	2	3	1	3	1	3	1	3	2	3
5. Migration route/breeding and feeding site for wetland species	1	3	1	3	1	3	1	3	1	3	1	3
6. Sensitivity to Changes in the Natural Hydrological Regime	3	3	3	3	3	3	3	3	3	3	3	3
7. Sensitivity to Water Quality Changes	3	3	3	3	3	3	3	3	3	3	3	3
8. Flood Storage, Energy Dissipation & Particulate/Element Removal	1	3	1	3	1	3	1	3	1	3	1	3
MODIFYING DETERMINANTS												
9. Protected Status	0	4	0	4	0	4	0	4	0	4	0	4
10. Ecological Integrity	1	3	1	3	1	3	1	3	1	3	1	3
TOTAL	**11**	**29**	**12**	**29**	**11**	**29**	**11**	**29**	**11**	**29**	**12**	**29**
MEDIAN	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**D**		**D**		**D**		**D**		**D**		**D**	

Table 16. Ecological Importance and Sensitivity Category for Unchannelled Valley Bottom Wetlands

	HGM UNIT					
	2		8		38	
	Score	Conf	Score	Conf	Score	Conf
PRIMARY DETERMINANTS						
1. Rare & Endangered Species	0	2	0	2	0	2
2. Populations of Unique Species	0	2	0	2	0	2
3. Species/taxon Richness	1	3	1	3	1	3
4. Diversity of Habitat Types or Features	2	3	2	3	2	3
5. Migration route/breeding and feeding site for wetland species	1	3	1	3	1	3
6. Sensitivity to Changes in the Natural Hydrological Regime	3	3	3	3	3	3
7. Sensitivity to Water Quality Changes	3	3	3	3	3	3
8. Flood Storage, Energy Dissipation & Particulate/Element Removal	1	3	1	3	1	3
MODIFYING DETERMINANTS						
9. Protected Status	0	4	0	4	0	4
10. Ecological Integrity	1	3	1	3	1	3
TOTAL	**12**	**29**	**12**	**29**	**12**	**29**
MEDIAN	**1**	**3**	**1**	**3**	**1**	**3**
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**D**		**D**		**D**	

Table 17. Ecological Importance and Sensitivity Category for the Ohlanga Floodplain Wetlands

	HGM UNIT	
	14	
	Score	Conf
PRIMARY DETERMINANTS		
1. Rare & Endangered Species	0	2
2. Populations of Unique Species	3	2
3. Species/taxon Richness	2	3
4. Diversity of Habitat Types or Features	2	3
5. Migration route/breeding and feeding site for wetland species	3	3
6. Sensitivity to Changes in the Natural Hydrological Regime	3	3
7. Sensitivity to Water Quality Changes	3	3
8. Flood Storage, Energy Dissipation & Particulate/Element Removal	2	3
MODIFYING DETERMINANTS		
9. Protected Status	3	4
10. Ecological Integrity	**2**	**3**
TOTAL	**23**	**29**
MEDIAN	2.5	3
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**B**	

8 WETLANDS WITHIN 500M OF THE STUDY SITE (WETLAND HEALTH)

In order to allow the Department of Water and Sanitation to make an informed decision regarding the changes in the wetlands within the study site, it is important to provide information regarding the wetlands in the area surrounding the study site. To this end the wetlands that fall within 500 meters of the study site have been identified and the health of these systems has been assessed. There are 30 systems within 500m of the study site (see **Figure 7** below), and these wetland systems comprise channelled and unchannelled valley bottom wetlands, some floodplain wetlands and hillside seeps.

Table 18: HGM units and area of wetlands within the 500m buffer of the project site

Wetland HGM Unit	Hydro-Geomorphic Type (Under natural conditions)	Area (ha)
4	Channelled Valley Bottom	12.92
5	Un-Channelled Valley Bottom	0.46
6	Un-Channelled Valley Bottom	0.75
7	Channelled Valley Bottom	0.48
9	Channelled Valley Bottom	1.49
10	Un-Channelled Valley Bottom	0.40
11	Channelled Valley Bottom	0.39
13	Floodplain	21.14
19	Channelled Valley Bottom	0.12
22	Channelled Valley Bottom	1.19
23	Channelled Valley Bottom	1.34
23a	Seep	0.32
25	Channelled Valley Bottom	0.11
27	Channelled Valley Bottom	2.35
28	Channelled Valley Bottom	0.89
30	Seep	0.72
31	Channelled Valley Bottom	0.96
32	Channelled Valley Bottom	0.75
33	Channelled Valley Bottom	0.79
36	Channelled Valley Bottom	0.40
37	Channelled Valley Bottom	1.30
40	Channelled Valley Bottom	5.88
41	Un-Channelled Valley Bottom	0.97
42	Un-Channelled Valley Bottom	0.52
43	Channelled Valley Bottom	0.96
44	Un-Channelled Valley Bottom	2.41
45	Channelled Valley Bottom	0.53
46	Un-Channelled Valley Bottom	0.73
47	Channelled Valley Bottom	15.3
48	Floodplain	12.05

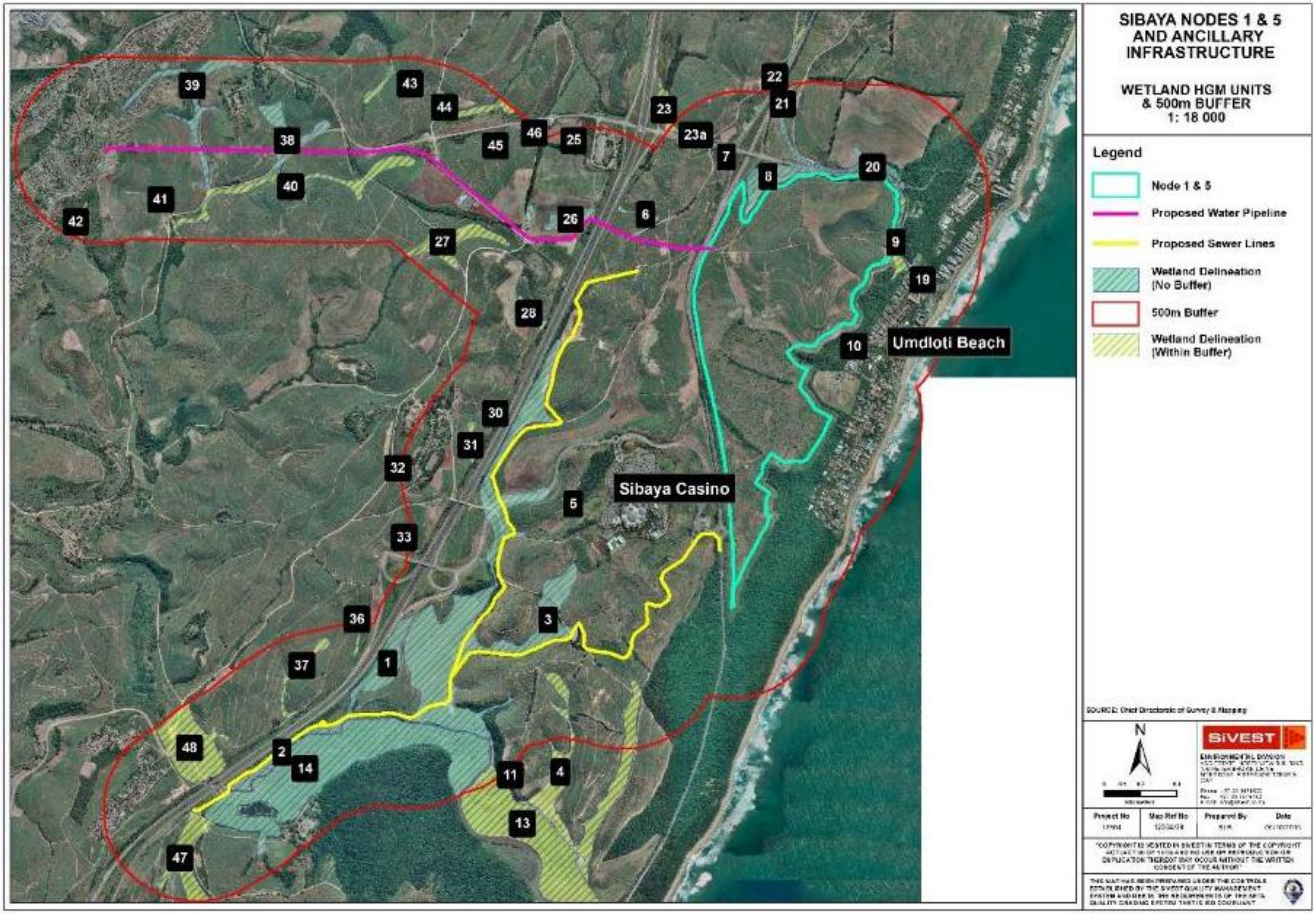

Figure 7: Map showing a 500m buffer around Sibaya Nodes 1 & 5 and ancillary infrastructure and wetlands within that buffer.

The formal health assessment of the wetland units within the 500m buffer of the project site indicates that the majority of wetland units are **seriously modified** resulting from past and current land uses and activities, while the floodplain wetlands are all **largely modified**.

A summary of the Present Ecological Status (PES) based on results from the WET-Health Tool is provided in **Table 19** below.

Table 19: WET-Health Scores for all wetlands within 500m of the site

Wetland Name	Hydrology		Geomorphology		Vegetation		Overall Health Score for entire Wetland	
	Impact Score	Category	Impact Score	Category	Impact Score	Category	Impact Score	Category
4	9.5	F	3.2	C	9	F	7.56	E (Seriously modified)
5	4	C	1.7	B	4	C	3.34	C (Moderately modified)
6	7	E	2.9	C	7.2	E	5.89	D (Largely modified)
7	8	E	6.6	E	7.7	E	7.51	E (Seriously modified)
9	8	E	3	C	5.2	D	5.77	D (Largely modified)
10	3	C	1.1	B	0.7	A	1.80	B (Largely natural)
11	8	E	2.3	C	8.7	F	6.57	E (Seriously modified)
13	6.7	E	2.6	C	6.5	E	5.47	D (Largely modified)
19	6.5	E	3.2	C	10	F	6.56	E (Seriously Modified)
22	6.5	E	3.2	C	9.4	F	6.39	E (Seriously Modified)
23	6.7	E	2.2	C	6.5	E	5.36	D (Largely modified)
23a	8.5	F	4.1	D	10	F	7.67	E (Seriously Modified)
25	6.3	E	5.3	D	8	F	6.50	E (Seriously Modified)
27	6.7	E	4.3	D	7.8	E	6.33	E (Seriously Modified)
28	6.1	E	4.1	D	9	F	6.36	E (Seriously Modified)
30	8.5	F	5	D	10	F	7.93	E (Seriously Modified)
31	6.2	E	5.1	D	8	F	6.40	E (Seriously Modified)
32	6.5	E	5.5	D	9.4	F	7.04	E (Seriously Modified)
33	6.6	E	5.3	D	10	F	7.20	E (Seriously Modified)
36	6.1	E	3.3	C	9	F	6.13	E (Seriously Modified)
37	6.4	E	3.7	C	10	F	6.66	E (Seriously Modified)
40	6.6	E	3.2	C	9.4	F	6.43	E (Seriously Modified)
41	6.2	E	3.2	C	9.1	F	6.17	E (Seriously Modified)
42	6.9	E	2.6	C	7.2	E	5.76	D (Largely modified)
43	6.8	E	3.5	C	8.3	F	6.29	E (Seriously Modified)
44	6.1	E	3.7	C	9.2	F	6.30	E (Seriously Modified)
45	6.4	E	3.3	C	9.0	F	6.26	E (Seriously Modified)
46	6.7	E	2.9	C	6.6	E	5.59	D (Largely modified)

Wetland Name	Hydrology		Geomorphology		Vegetation		Overall Health Score for entire Wetland	
	Impact Score	Category	Impact Score	Category	Impact Score	Category	Impact Score	Category
47	6.5	E	3.2	C	9	F	6.27	E (Seriously Modified)
48	6.7	E	2.2	C	6.5	E	5.36	D (Largely modified)

8.1 *Wetland Ecological Importance and Sensitivity*

The ecological importance and sensitivity was assessed for each wetland HGM unit. The scores are given below.

8.1.1 Channelled Valley Bottom Wetlands

The wetland ecological importance and sensitivity of each of the wetland HGM units is provided in **Table 20** below. The channelled valley bottom wetlands all scored a **Class D (Low)** level of ecological importance and sensitivity. Contributing factors to the low level of ecological importance and sensitivity for most of the wetlands include transformation and channelization impacts, which have a bearing on habitat quality and the potential occurrence of wetland fauna.

8.1.2 Unchannelled Valley Bottom Wetlands

The wetland ecological importance and sensitivity of each of the unchannelled valley bottom wetlands is provided in **Table 21** below. Transformation and channelization impacts again had a major influence decreasing the sensitivity of wetlands, and thus all wetlands units were assigned a **Class D (Low)** ecological importance and sensitivity. All the wetlands were impacted by artificial drainage ditches which further degraded the ecological condition and therefore sensitivity of the wetlands.

8.1.3 Valley head Seep Wetlands

The wetland ecological importance and sensitivity of each of the wetland HGM units is provided in **Table 222** below. Due to the similar ecological state for many of the valley head seep wetlands, most of the valley head seep wetlands were scored to have a **Class D (Low)** level of ecological importance and sensitivity.

8.1.4 Floodplain Wetland

The wetland ecological importance and sensitivity for the floodplain wetlands (**Table 23**) was categorised as a **Class B (High)**. The floodplains have been impacted on by three main factors including cultivation on the banks of the River, roads through the wetland and a degree of alien vegetation species encroachment. Nonetheless, functionality of the wetland and habitat quality is still good with a riparian habitat associated with the wetland. Assemblages of protected tree species were observed. Fish, amphibian and avifaunal occurrence and activity were also observed although the species could not be identified.

Table 20. Ecological Importance and Sensitivity Category for Channelled Valley Bottom Wetlands

	HGM UNIT															
	4		7		9		11		19		22		23		25	
	Score	Conf	Score	Conf	Score	Conf	Score	Conf	Score	Conf	Score	Conf	Score	Conf	Score	Conf
PRIMARY DETERMINANTS																
1. Rare & Endangered Species	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2
2. Populations of Unique Species	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2
3. Species/taxon Richness	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
4. Diversity of Habitat Types or Features	1	3	2	3	1	3	1	3	1	3	2	3	1	3	2	3
5. Migration route/breeding and feeding site for wetland species	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
6. Sensitivity to Changes in the Natural Hydrological Regime	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
7. Sensitivity to Water Quality Changes	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
8. Flood Storage, Energy Dissipation & Particulate/Element Removal	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
MODIFYING DETERMINANTS																
9. Protected Status	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4
10. Ecological Integrity	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
TOTAL	**11**	**29**	**12**	**29**	**11**	**29**	**11**	**29**	**11**	**29**	**12**	**29**	**11**	**29**	**12**	**29**
MEDIAN	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**D**		**D**		**D**		**D**		**D**		**D**		**D**		**D**	

	HGM UNIT															
	27		28		31		32		33		36		37		40	
	Score	Conf	Score	Conf	Score	Conf	Score	Conf	Score	Conf	Score	Conf	Score	Conf	Score	Conf
PRIMARY DETERMINANTS																
1. Rare & Endangered Species	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2
2. Populations of Unique Species	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2
3. Species/taxon Richness	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
4. Diversity of Habitat Types or Features	1	3	2	3	1	3	1	3	1	3	2	3	1	3	2	3
5. Migration route/breeding and feeding site for wetland species	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
6. Sensitivity to Changes in the Natural Hydrological Regime	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
7. Sensitivity to Water Quality Changes	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
8. Flood Storage, Energy Dissipation & Particulate/Element Removal	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
MODIFYING DETERMINANTS																
9. Protected Status	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4
10. Ecological Integrity	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
TOTAL	**11**	**29**	**12**	**29**	**11**	**29**	**11**	**29**	**11**	**29**	**12**	**29**	**11**	**29**	**12**	**29**
MEDIAN	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**D**		**D**		**D**		**D**		**D**		**D**		**D**		**D**	

	HGM UNIT					
	43		45		47	
	Score	Conf	Score	Conf	Score	Conf
PRIMARY DETERMINANTS						
1. Rare & Endangered Species	0	2	0	2	0	2
2. Populations of Unique Species	0	2	0	2	0	2
3. Species/taxon Richness	1	3	1	3	1	3
4. Diversity of Habitat Types or Features	1	3	2	3	1	3
5. Migration route/breeding and feeding site for wetland species	1	3	1	3	1	3
6. Sensitivity to Changes in the Natural Hydrological Regime	3	3	3	3	3	3
7. Sensitivity to Water Quality Changes	3	3	3	3	3	3
8. Flood Storage, Energy Dissipation & Particulate/Element Removal	1	3	1	3	1	3
MODIFYING DETERMINANTS						
9. Protected Status	0	4	0	4	0	4
10. Ecological Integrity	1	3	1	3	1	3
TOTAL	**11**	**29**	**12**	**29**	**11**	**29**
MEDIAN	**1**	**3**	**1**	**3**	**1**	**3**
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**D**		**D**		**D**	

Table 21. Ecological Importance and Sensitivity Category for Unchannelled Valley Bottom Wetlands

	HGM UNIT													
	5		6		10		41		42		44		46	
	Score	Conf	Score	Conf	Score	Conf	Score	Conf	Score	Conf	Score	Conf	Score	Conf
PRIMARY DETERMINANTS														
1. Rare & Endangered Species	0	2	0	2	0	2	0	2	0	2	0	2	0	2
2. Populations of Unique Species	0	2	0	2	0	2	0	2	0	2	0	2	0	2
3. Species/taxon Richness	1	3	1	3	1	3	1	3	1	3	1	3	1	3
4. Diversity of Habitat Types or Features	1	3	1	3	2	3	1	3	1	3	1	3	2	3
5. Migration route/breeding and feeding site for wetland species	1	3	1	3	1	3	1	3	1	3	1	3	1	3
6. Sensitivity to Changes in the Natural Hydrological Regime	3	3	3	3	3	3	3	3	3	3	3	3	3	3
7. Sensitivity to Water Quality Changes	3	3	3	3	3	3	3	3	3	3	3	3	3	3
8. Flood Storage, Energy Dissipation & Particulate/Element Removal	1	3	1	3	1	3	1	3	1	3	1	3	1	3
MODIFYING DETERMINANTS														
9. Protected Status	0	4	0	4	0	4	0	4	0	4	0	4	0	4
10. Ecological Integrity	1	3	1	3	1	3	1	3	1	3	1	3	1	3
TOTAL	**11**	**29**	**11**	**29**	**12**	**29**	**11**	**29**	**11**	**29**	**11**	**29**	**12**	**29**
MEDIAN	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**3**
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**D**		**D**		**D**		**D**		**D**		**D**		**D**	

Table 22. Ecological Importance and Sensitivity Category for Valley head Seep Wetlands

	HGM UNIT			
	23a		30	
	Score	Conf	Score	Conf
PRIMARY DETERMINANTS				
1. Rare & Endangered Species	0	2	0	2
2. Populations of Unique Species	0	2	0	2
3. Species/taxon Richness	1	3	1	3
4. Diversity of Habitat Types or Features	2	3	2	3
5. Migration route/breeding and feeding site for wetland species	1	3	1	3
6. Sensitivity to Changes in the Natural Hydrological Regime	3	3	3	3
7. Sensitivity to Water Quality Changes	3	3	3	3
8. Flood Storage, Energy Dissipation & Particulate/Element Removal	1	3	1	3
MODIFYING DETERMINANTS				
9. Protected Status	0	4	0	4
10. Ecological Integrity	1	3	1	3
TOTAL	**12**	**29**	**12**	**29**
MEDIAN	**1**	**3**	**1**	**3**
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	D		D	

Table 23. Ecological Importance and Sensitivity Category for the Ohlanga Floodplain Wetlands

	HGM UNIT			
	13		48	
	Score	Conf	Score	Conf
PRIMARY DETERMINANTS				
1. Rare & Endangered Species	0	2	0	2
2. Populations of Unique Species	3	2	3	2
3. Species/taxon Richness	2	3	2	3
4. Diversity of Habitat Types or Features	2	3	2	3
5. Migration route/breeding and feeding site for wetland species	3	3	3	3
6. Sensitivity to Changes in the Natural Hydrological Regime	3	3	3	3
7. Sensitivity to Water Quality Changes	3	3	3	3
8. Flood Storage, Energy Dissipation & Particulate/Element Removal	2	3	2	3
MODIFYING DETERMINANTS				
9. Protected Status	3	4	3	4
10. Ecological Integrity	**2**	**3**	**2**	**3**
TOTAL	**23**	**29**	**23**	**29**
MEDIAN	2.5	3	2.5	3
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**B**		**B**	

9 POTENTIAL IMPACTS AND RECOMMENDED MITIGATION MEASURES

The following potential impacts and mitigations are predicted based on the layout for the proposed project.

9.1 Loss of Wetland Area

The layout for the project proposes to encroach into the wetlands and associated buffers of HGM units 8, 20, and 21 (see **Figure 8** below). This impact has the possibility of reducing the ability of the wetland to perform many of the functions typically associated with such ecosystems. Loss of wetland area has implications for storm water management and control, sediment trapping and the treatment or trapping of pollutants and sediments. Loss of wetland area also has the potential to reduce the biodiversity value of a system further.

Table 24. Impact Assessment of Wetland Loss before Mitigation

Criteria	Description	Score
Extent	The loss of wetlands is likely to have a Local impact, as the catchments found within the proposed development property feed directly into the system that spills into the sea at Umdloti Beach	2
Duration	The loss of wetland is likely to be permanent, as the portions of wetlands in question will be entirely destroyed.	4
Intensity	Given the degraded nature of the wetlands on site, it is likely that the intensity will be moderate	2
Probability of Occurrence	The proposed layout will definitely destroy wetland habitat	4
Significance of Impact	**The impact of the destruction of wetlands on site is likely to have a very high negative impact.**	**-12**

9.1.1 OFFSETTING WETLAND LOSS VIA REHABILITATION

The proposed Sibaya Development will result in a permanent loss of some wetland areas. For wetland offsets, the no-net wetland loss principle is generally accepted as best practice when dealing with the issues of wetland loss. This means that wetland loss must be replaced by wetland gain so that the net wetland loss is zero. The replacement of wetlands at a ratio of 1:1 is generally regarded as being insufficient to mitigate wetland loss as wetland rehabilitation cannot reproduce pristine wetlands. Internationally, a minimum ratio of 1:1.5 is generally required to achieve 1:1 compliance on the ground. However, this minimum ratio is only considered appropriate in situations where rehabilitation has a low risk of failure, especially if the wetlands in question are degraded and of low conservation value from an ecosystem services perspective. Following a review of the NFEPA wetland database, an appropriate offset calculation was undertaken after the method outlined by Macfarlane *et al* (2014). This calculation noted that

HGM unit 8 is classified as being an Indian Ocean Coastal Belt Group 2 wetland, and these wetlands are considered as critically endangered. The offset is therefore calculated by multiplying the area being lost by 15, and corrected by a multiplier of 1. The functional offset ratio is therefore 1:15. The area for area approach involves rehabilitating or reinstating an area of wetland equal to the wetland area being lost at the required offset ratio.

Given the above, SiVEST have completed a Rehabilitation Plan (**October 2015**) that aims to guide the rehabilitation of wetlands across the site, and thus fulfil the offset requirements mentioned above. **Table 25**, below summarises the current wetland losses and rehabilitation potential for the entire Sibaya Project.

The current layout for Sibaya Nodes 1 & 5 indicates that **3.48 ha** of wetland area is required to be rehabilitated to offset the direct loss of wetland area, whilst the total wetland area available for rehabilitation is **68.29 ha,** this is some **64.81 ha** more than the required minimum. This equates to a **1:297** offset ratio, which is greater than the calculated 1:15 offset ratio. Thus the overall wetland losses can be can be considered to be adequately offset and the significance of the impact reduced to acceptable levels.

Table 25. Wetland Loss and Offset Calculations for Sibaya

Phase	Wetland Area (ha)	Wetland Loss (ha)	Required Wetland Area to be Rehabilitated at the 1:15 offset Ratio (ha)	Wetland Area Available for Rehabilitation
Sibaya	68.52	0.23	3.48	68.29

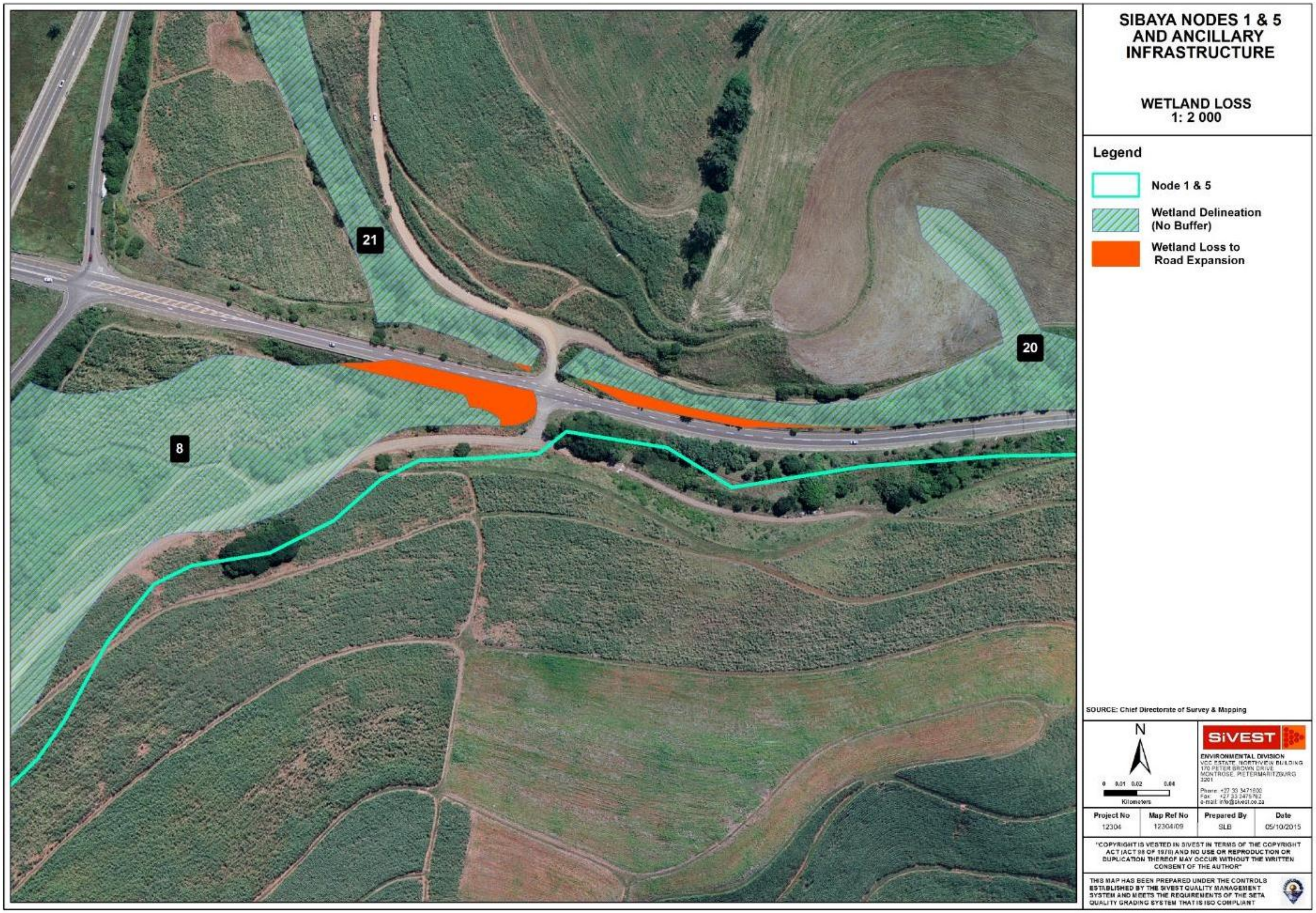

Figure 8: Wetland Loss Map

Table 26. Impact Assessment of Wetland Loss after Mitigation

Criteria	Description	Score
Extent	The loss of wetlands is likely to have a site impact, as the catchments will be rehabilitated.	1
Duration	The loss of wetland is likely to be short-term, as the wetlands in question will be offset by the rehabilitation of degraded wetlands on site.	1
Intensity	Given the degraded nature of the wetlands on site, it is likely that the intensity will be moderate	2
Probability of Occurrence	The proposed offset will possibly negate the impact of the loss of wetlands.	2
Significance of Impact	**The impact of the destruction of wetlands on site is likely to have a low negative impact should the rehabilitation of offset wetlands on site be undertaken correctly.**	**-6**

9.2 Stormwater Runoff Impacts

9.2.1 Construction phase impacts

During the construction phase, portions of the catchment supplementing the wetland units will be cleared for construction. The removal of the current vegetation will temporarily increase surface runoff throughout the cleared site and increase the erosion potential of the soils on site. If stormwater runoff and erosion control measures are not implemented during the construction phase, the exposure of the bare soils to the elements will likely lead to the erosion of the soils on site. This is especially true during heavy rainfall events, which will encourage the formation of rills and dongas -thus concentrating flow down-slope. The concentration of runoff down-slope within rills and dongas will increase the likelihood of the erosion and/or sedimentation of the wetlands.

The negative effects of erosion and scouring on the wetlands will include; increased concentration and canalisation of flow within the wetlands, the reduction in diffuse flow and the extent of wetness within the wetland, the alteration of the vegetation communities due to decreased wetness and erosion disturbances and ultimately the reduction in the wetland's functionality and health. In addition to erosion within the wetland, sediment plumes/fans are likely to impinge on the wetland area if no erosion and stormwater control measures are implemented. The unnatural sedimentation of the wetland area will disturb the in wetland vegetation and encourage the proliferation of pioneers and alien invasive species ultimately reducing the health and functionality of the wetland.

Table 27. Impact Assessment of Stormwater Impacts (during Construction) before Mitigation

Criteria	Description	Score
Extent	The stormwater impacts are likely to have a Local impact, as the catchments found with the proposed development property feed directly into a system that outfalls at Umdloti Beach.	2
Duration	The construction phase stormwater impacts are likely to be medium-term.	2
Intensity	Given the degraded nature of the wetlands on site, it is likely that the intensity of excess stormwater entering these systems will be high.	3
Probability of Occurrence	There is a high probability that construction will lead to stormwater impacts during construction.	3
Significance of Impact	**The impact of construction phase stormwater on site is likely to have a high negative impact.**	**-10**

Recommended mitigation measures:

To reduce the erosion risks on site during the construction phase, stormwater and erosion control measures must be implemented by the contractor to ensure that the erosion and sedimentation of the wetlands and streams do not occur during the establishment phase. The recommended stormwater and erosion control measures include:

- Clearing activities must only be undertaken during agreed working times and permitted weather conditions. If heavy rains are expected clearing activities should be put on hold. In this regard, the contractor must be aware of weather forecasts.
- If possible, construction activities should be scheduled to minimise the duration of exposure of bare soils on site, especially steep slopes. The full extent of works shall NOT be stripped of vegetation prior to commencing other activities.
- A row of silt fences and sandbags must be established along the wetland buffer edge prior to construction commencing. These silt fences and sandbags must be regularly checked and maintained and should only be removed once vegetation has successfully colonised the embankments.
- Any steep or large embankments expected to be exposed during the 'rainy' months should either be armoured with fascine like structures/silt fences or grassed immediately with strip sods established at regular intervals (50-100 cm) down the bank with hydro-seeding between the strip sods.
- Where the bare surface of platforms slope towards the edge of an embankment, silt fences and sandbags must be established along the crest of the embankment. If preferential flow routes on the sloped platform occur, these flow routes must be intercepted with a series of sandbags.

- All platforms above buffer zones must have a slight back-fall to divert runoff away from the fill embankments. Platform runoff must be diverted away from the platforms via some sort of diversion structure, preferably a grassed swale or open drain. This runoff must be diverted into the formal stormwater network where possible. If no formal stormwater system is possible, the diverted runoff must be diverted to a temporary detention pond or temporary outlets armoured against erosion.
- Once the roads and platforms formal stormwater reticulation network are established, silt traps and sand bags should be used throughout the construction site to prevent eroded sediment from being washed into the wetlands from un-grassed, bare/exposed areas. This applies particularly to areas where earthworks occur directly above or in the vicinity of the wetlands.
- After every rainfall event, the contractor must check the site for erosion damage and rehabilitate this damage immediately. Erosion rills and gullies must be filled-in with appropriate material and silt fences or fascine work must be established along the gulley for additional protection until grass has re-colonised the rehabilitated area.
- It is important that all of the above-listed mitigation measures are costed for in the construction phase financial planning and budget so that the contractor and/or developer cannot give financial budget constraints as reasons for non-compliance. Proof of financial provision of these mitigation measures must be submitted to the ECO prior to construction commencing.

Table 28. Impact Assessment of Stormwater Impacts (during Construction) after Mitigation

Criteria	Description	Score
Extent	The stormwater impacts are likely to have a site impact.	1
Duration	The construction phase stormwater impacts are likely to be short-term should mitigation be instituted correctly.	1
Intensity	Mitigation of stormwater impacts should reduce the intensity to a moderate level.	2
Probability of Occurrence	It is improbable that construction will lead to stormwater impacts during construction, should mitigation measures be implemented.	1
Significance of Impact	**Should mitigation measures be implemented correctly, the impact of the stormwater during construction on site is likely to have a low negative impact.**	**-5**

9.2.2 Operational phase impacts

Although there is likely to be some attenuation onsite and all outlets will have erosion protection, the amount of surface runoff inputs entering the onsite wetland during a storm event may still increase and the magnitude of the flood peak[2] within this system will also increase as a result of

[2] **Flood peak: The highest discharge that occurs within a watercourse following a rainfall event.**

the general increase in the rate of flow. The surface runoff inputs and the increased peak discharge will increase the risk of erosion within the wetland over time as the systems adjust to the modified mean and peak flows.

Table 29. Impact Assessment of Stormwater Impacts (during Operation) before Mitigation

Criteria	Description	Score
Extent	The stormwater impacts are likely to have a Local impact, as the catchments found with the proposed development property feed directly into the Ohlanga River System.	2
Duration	The operational phase stormwater impacts are likely to be long-term.	3
Intensity	Given the nature of the wetlands on site, it is likely that the intensity will be high.	3
Probability of Occurrence	There is a high probability that the operational phase will lead to stormwater impacts.	3
Significance of Impact	**The impact of the destruction of wetlands on site is likely to have a high negative impact.**	**-11**

Recommended mitigation measures:

Stormwater design recommendations:

- At the site of all infrastructure, stormwater should be attenuated locally at critical points through the use of many smaller stormwater outlets that should be favoured over a few large stormwater outlets. The stormwater outlets must be constructed at regular intervals to spread out surface flow and avoid flow concentration;
- Stormwater runoff onsite should be directed into open grass-lined channels or stone filled infiltration ditches. This will encourage infiltration where possible, and provide some attenuation and assist in reducing the energy of flows;
- Grassed swales should be established wherever possible to provide additional attenuation before discharge via outlets.

Given the above recommendations, and the Stormwater Management Plan prepared by SMEC October 2015, we feel that the operational phase stormwater management has been thoroughly investigated, and no stormwater attenuation structures have been planned within the wetlands onsite

Should the above mitigation be instigated, we feel that the impacts of stormwater on site can be significantly reduced, as noted in the impact assessment table below.

Table 30. Impact Assessment of Stormwater Impacts (during Operation) after Mitigation

Criteria	Description	Score
Extent	The current stormwater impacts are likely to have a site impact if amended designs are utilised.	1
Duration	The operational phase stormwater impacts are likely to be medium-term should amended designs be implemented.	2
Intensity	Mitigation of stormwater impacts should reduce the intensity to a moderate level.	2
Probability of Occurrence	It is improbable that operation of the site will lead to stormwater impacts, should the mitigation measures be implemented.	1
Significance of Impact	**Should currently proposed mitigation measures be implemented, the impact of the stormwater during operational phase is likely to have a low negative impact.**	**-6**

9.3 Pipe and Road Crossing Impacts

9.3.1 Construction phase impacts

The construction of roads within and across the wetlands may result in the filling in of a portion of wetland along the road surface and fill footprint and the permanent loss of wetland (as assessed above). In addition, pipes will need to be installed across wetlands. Other impacts include the compaction and clearing of areas outside of the road fill footprint during the construction phase and associated indirect impacts that include erosion and alien plant encroachment into the wetland.

Table 31. Impact Assessment of Construction Road and Pipe Wetland Crossing Impacts before Mitigation

Criteria	Description	Score
Extent	The impacts are likely to have a local impact, as the catchments found with the proposed development property feed directly into the Ohlanga River System, and the system out falling at Umdloti Beach.	2
Duration	The construction of pipes and roads within wetlands is likely to impart medium-term impacts.	2
Intensity	Given the nature of the wetlands on site, it is likely that the intensity will be high.	3
Probability of Occurrence	There is a high probability that the construction of roads and pipes across the wetlands will lead to impacts.	3
Significance of Impact	**The impact of roads and pipelines being constructed across wetlands on site is likely to be highly negative.**	**-10**

Recommended mitigation measures:

Approvals:

A water use license process will be required to establish the necessary infrastructure within the wetland as per Section 21 (c) and (i) of the National Water Act. This license is required prior to construction commencing.

Site setup and construction phase:

- Construction should ideally be undertaken between the months of April and August.
- The wetland boundaries either side of the road and pipe crossings must be demarcated using shade cloth or snow fencing prior to the construction commencing.
- Disturbance to the wetland soils along the crossing footprint should be restricted to an established construction right-of-way (ROW) corridor. The ROW corridor within the wetland should be as narrow as practically possible and should be demarcated and fenced off during the site setup phase to the satisfaction of the ECO.
- The construction ROW should comprise the road and embankment footprint, and the pipe routing only.
- All wetland areas outside of the demarcated ROW must be considered no-go areas.

Rehabilitation and monitoring:

- Disturbed and bare soils resulting from the construction must be prepared and re-vegetated to the satisfaction of the ECO.

Table 32. Impact Assessment of Construction of Road and Pipe Wetland Crossing Impacts after Mitigation

Criteria	Description	Score
Extent	Should mitigation measure be implemented correctly, the impacts are likely to have a site impact only.	1
Duration	The construction of pipes and roads within wetlands is likely to impart short-term impacts.	1
Intensity	With appropriate mitigation, it is likely that the intensity will be moderate.	2
Probability of Occurrence	There is a possibility that the construction of roads and pipes across the wetlands will lead to impacts.	2
Significance of Impact	**The construction of roads and pipelines across wetlands on site is likely to have a low negative impact, should mitigation**	**-6**

	measures be implemented.	

9.3.2 Operational phase impacts

Besides the permanent loss of wetland below the road fill, the road will have a number of indirect impacts on the health of the wetland. These include:

- The concentration of wetland flow through culverts and the erosion and scouring of the wetland below the culvert(s); and
- The fragmentation of the wetland by the road, which represents a serious barrier to faunal movement along the wetland.

Table 33. Impact Assessment of Operation of Road and Pipe Wetland Crossings before Mitigation

Criteria	Description	Score
Extent	The impacts are likely to have a local impact, as faunal movements can make use of entire catchment systems.	2
Duration	The operation of pipes and roads within wetlands is likely to impart long-term impacts.	3
Intensity	Given the nature of the wetlands on site, it is likely that the intensity will be moderate.	2
Probability of Occurrence	There is a high probability that the operation of roads and pipes across the wetlands will lead to impacts.	3
Significance of Impact	**The impact of the operation of roads and pipelines across wetlands on site is likely to be highly negative.**	**-10**

Recommended mitigation measures:

- With regards to the wetland crossing only, the road fill foundation and base should be permeable to water flow to ensure low flow seepage is maintained and that water does not dam up behind the road during heavy rainfall.
- Erosion protection measures (e.g. Reno-mattresses) must be established below any box culverts.
- The final design for the wetland crossing must be approved by the wetland specialist prior to construction commencing.

Table 34. Impact Assessment of Operation of Road and Pipe Wetland Crossings after Mitigation

Criteria	Description	Score
Extent	Should mitigation measure be implemented correctly, the impacts	1

	are likely to have a site impact only.	
Duration	The operation of pipes and roads within wetlands is likely to impart short-term impacts.	1
Intensity	With appropriate mitigation, it is likely that the intensity will be low.	1
Probability of Occurrence	It is improbable that the operation of roads and pipes across the wetlands will lead to impacts.	1
Significance of Impact	**The operation of roads and pipelines across wetlands on site is likely to have a low negative impact, should mitigation measures be implemented.**	**-4**

9.4 Direct Disturbance Impacts

Continued disturbance and a lack of management over the lifetime of a project is a problem that exists throughout South Africa where there is limited budget for the management and preservation of wetlands and often no 'buy-in' is achieved from local residents in terms of the conservation of important environmental systems and habitats.

Some direct impacts on wetlands arising from a lack of management and protection within open spaces onsite include the establishment of informal crossings, illegal refuse dumping, wood harvesting and vegetation clearing and trampling. These disturbances result in the disturbance of the wetland soils and plants which encourages the proliferation of alien invasive and pioneer species that are better adapted to survive in disturbed soil and moisture conditions. In addition, the extermination and/or hunting of fauna (e.g. frogs, chameleons, snakes and antelope) is a common impact where access to open spaces is unrestricted. Over time, these impacts left unattended will contribute to the gradual reduction in the health and value of the wetlands onsite.

Recommendations:

Any remaining wetland area should be clearly demarcated to inform the local residents of the wetland boundaries.

10 ADDITIONAL RECOMMENDATIONS

Further to the above specific recommendations related to specific impacts, the following general recommendations are suggested:

- It is recommended that no cement mixing take place on site. Ready mix concrete should be used instead.
- Contaminated water must be contained & disposed of offsite at an approved landfill.
- If oil spills occur the contaminated soil should be disposed of at an approved landfill site.
- No impacts on quality of surface and ground water should be allowed.
- Chemical toilets shall not be placed on steep areas and areas with intact vegetation. Exact location of toilets to be approved with the Engineer and ECO prior to construction and must be located at least 50 meters away from watercourses.

- Topsoil and subsoil seepage shall be protected from contamination
- To prevent storm water damage, the increase in storm water run-off resulting from clearing activities must be estimated and a drainage system assessed accordingly. A drainage plan must be submitted for approval and must include the location and design criteria of any temporary stream crossings (siting, proposed measures etc.). Serious financial and environmental impacts can be caused by unmanaged storm water.
- During site establishment temporary cut-off drains and berms may be required to capture storm water and promote infiltration
- The extent of dewatering measures in poorly drained areas must be finalised by the designer in discussion with the geotechnical representative as deemed necessary during the construction programme.
- The time that stripped areas are left open to exposure should be minimised wherever possible.
- Care should be taken to ensure that lead times are not excessive. The stripping of vegetation directly preceding activities on site greatly reduce the risk of erosion.
- Wind screening and stormwater control should be undertaken to prevent soil loss from the site.
- Procedures that are in place to conserve topsoil during the construction phase of the project are to be applied to the set up phase i.e. topsoil is to be conserved while providing access to the site and setting up the camp.
- No impediment to the natural water flow other than approved erosion control works is permitted, especially in the river or drainage lines located on the property.
- Stormwater runoff must be appropriately channeled and discharged in a safe manner thus reducing environmental impacts to the vegetation and aquatic communities.
- Solid waste is to be stored onsite in an appropriate manner until it can be disposed of at the nearest identified waste fill site
- Material spoiling shall not take place on site particularly within the watercourse. Any excavated materials for the pipeline shall be taken out of the watercourse immediately.
- Location for spoiling of excavated material shall be confirmed with the Engineer and ECO prior to construction.
- Contractor is to exercise strict care in the disposal of construction waste, with proof of disposal at an approved site provided after off-loading each waste load and this logged/registered within the environmental file that must be maintained at the contractor's camp for the duration of construction.

11 ASSUMPTIONS, UNCERTAINTIES AND LIMITATIONS

This study has only focused on the functional, ecological importance and sensitivity, and ecosystem services assessment of wetlands. A wetland delineation study has previously been conducted and does not fall within the scope of this assessment. Aquatic studies of fish, invertebrates, amphibians etc. have not been included in this report. Hydrological or groundwater studies have also not been included.

All shapefiles of the previous wetland assessment were provided. The classification exercise of the wetland HGM units was undertaken based on the wetland shapefiles that were provided.

As the study was limited to the study area (boundaries of the property and a 500m buffer), some wetlands may have extended further than the boundary of the study site where delineation did not take place, and therefore did not form part of the functional assessment.

A thorough vegetation identification exercise was not undertaken. Recorded vegetation species was based on general observation during the field survey and can be found in **Appendix A**.

With regards to the assessment of the importance of the wetland unit, it is important to note that the WET-EcoServices tool utilised in this assessment is a rapid assessment that gives a general indication of the level of ecosystem services provided by a wetland.

This assessment is considered satisfactory for the level of assessment required for inclusion in the EIA Process and for the purposes of feeding into an application brought for obtaining a Water Use Licence.

Similarly, the WET-Health assessment tool utilised to determine the present state of the wetland units is also a rapid assessment tool. This assessment is also considered satisfactory for the purposes of this assessment particularly as the wetland units are in a moderate to poor state.

12 CONCLUSION

A wetland functional assessment is provided in this report for the proposed Sibaya development. This was undertaken in order to determine the present ecological state, functionality (in terms of ecosystem services provided by the wetlands), as well as the ecological importance and sensitivity provided by the wetlands on the study site.

To determine the present ecological state, the methodology as stipulated by **Macfarlane *et al*. (2009**) was followed. For the functionality assessment of the wetlands, the methodology as specified by **Kotze *et al*. (2009)** was undertaken. Finally, to determine that ecological importance and sensitivity, the **DWAF, 1999** was utilised.

The above assessments were applied to all the wetlands identified in the previous wetland delineation assessment report (**INR, 2005**). The following wetlands formed part of the scope for the functional assessment:

- Six channelled valley bottom wetlands;
- Three unchannelled valley bottom wetlands; and
- One floodplain wetland.

In terms of the findings for the present ecological state of the wetlands, hydrological impacts as a result of sugar cane cultivation transformation, drainage ditches and roads had the largest influence in altering the natural hydrology of the wetlands. Geomorphologically, the wetlands were found for the most part to be impacted upon by the changes in the hydrological regime, and there was evidence of erosion. Structural impacts to the wetlands (for the purpose of drainage ditches for agriculture) were the main factor degrading most wetlands.

From a vegetation perspective, transformation of the vegetation to sugar cane was the main factor affecting the vegetation state. However, alien vegetation was also a factor affecting some wetlands. The general present ecological state of the channelled valley bottom wetlands was found to be Seriously modified (**Category E**). The general present ecological state of the unchannelled valley bottom wetlands were found to be largely modified (**Category D**).

From a functionality perspective, ecosystem services offered by the channelled valley bottom wetlands which scored the highest (**moderately high**) was the sediment trapping ability of the wetlands. Other ecosystem services which scored at an **intermediate level** include erosion control, toxicant removal, nitrate removal, phosphate trapping, flood attenuation and water supply for human use. The ecosystem services which scored **below intermediate** levels include stream flow regulation, maintenance of biodiversity, carbon storage, tourism and recreation, education and research, cultural significance, cultivated foods and natural resources.

In terms of the unchannelled valley bottom wetlands, the wetlands were assessed as providing a **moderately high** level of ecosystems services in terms of sediment trapping ability, phosphate trapping, nitrate removal, toxicant removal and erosion control. The only ecosystem service with an **intermediate** score was flood attenuation ability. The remaining ecosystem services that scored **below intermediate** included carbon storage, maintenance of biodiversity, water supply for human use, natural resources, cultivated foods, cultural significance, tourism and recreation, education and research as well as stream flow regulation.

The functionality of all the wetlands (to a greater or lesser extent) was primarily limited by current impacts relating to the transformation of the wetlands for sugar cane production.

In terms of ecological importance and sensitivity, the channelled valley bottom wetlands all scored a **Class D (Low)** level of ecological importance and sensitivity. Unchannelled valley bottom wetlands were fairly similar to the channelled valley bottom wetlands and unchannelled valley bottom wetlands scored a **Class D (Low)** level of ecological importance and sensitivity.

It must be noted that the proposed wetland losses that will occur across the site will be offset through the rehabilitation of wetlands across the Sibaya site, and that this rehabilitation will be guided by a Wetland Rehabilitation Plan (**SiVEST, 2015**).

Given the extremely degraded state of most of the wetland units across the site, it is this specialist's opinion that the rehabilitation of the wetlands on site will lead to a significant improvement in the ecological goods and services being provided by the wetlands going forward. The loss of some degraded wetland, in order to unlock the development potential of the site and thus the funding for rehabilitation of the greater proportion of wetland, is considered acceptable in this instance.

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APPENDIX A:
Flora Species List

Flora Species List

Species	Growth Form	Status
Acacia ataxacantha	Creeper	N/A
Acacia caffra	Tree	N/A
Acacia natalitia	Tree	N/A
Acacia robusta var. *clavigera*	Tree	N/A
Agave sisalana	Succulent	Alien Cat 2
Ageratum conyzoides	Herb	Alien Cat 1
Albizia adianthifolia	Tree	N/A
Albizia lebbeck	Tree	Alien N/A
Aloe arborescens	Succulent	N/A
Ambrosia artemisiifolia	Herb	Alien N/A
Antidesma venosum	Tree	N/A
Apodytes dimidiata	Tree	N/A
Araucaria heterophylla	Tree	Alien N/A
Asystasia gangetica	Creeper	N/A
Barringtonia racemosa	Tree	Protected (National)
Bauhinia sp.	Tree	Alien N/A
Bidens pilosa	Herb	Alien N/A
Bothriochloa insculpta	Grass	N/A
Brachylaena discolor	Tree	N/A
Bridelia micrantha	Tree	N/A
Calpurnia aurea	Tree	N/A
Canna indica	Herb	Alien Cat 1
Canthium inerme	Tree	N/A
Canthium spinosum	Shrub	N/A
Cardiospermum grandiflorum	Creeper	Alien Cat 1
Casuarina equisetifolia	Tree	Alien Cat 2
Celtis africana	Tree	N/A
Cestrum laevigatum	Tree	Alien Cat 1
Chromolaena odorata	Shrub	Alien cat 1
Clerodendrum glabrum	Tree	N/A

Species	Growth Form	Status
Commelina bengalensis	Creeper	N/A
Commelina erecta	Creeper	N/A
Commiphora harveyi	Tree	N/A
Cordia caffra	Tree	N/A
Crinum macowanii	Bulb	Protected (Provincial)
Crotalaria macrocarpa	Shrub	N/A
Cussonia nicholsonii	Tree	N/A
Cussonia sphaerocephala	Tree	N/A
Cyperus sexangularis	Sedge	N/A
Cyphostemma natalitium	Creeper	N/A
Dalbergia obovata	Creeper	N/A
Deinbollia angustifolia	Tree	N/A
Delonix regia	Tree	Alien N/A
Desmodium dregeanum	Herb	Indigenous Invader
Dichrostachys cinerea	Tree	Indigenous Invader
Digitaria eriantha	Grass	N/A
Dioscorea cotinifolia	Creeper	N/A
Dovyalis caffra	Tree	N/A
Duranta sp.	Tree	Alien N/A
Ekebergia capensis	Tree	N/A
Eragrostis curvula	Grass	N/A
Eriobotrya japonica	Tree	Alien Cat 3
Erythrina lysistemon	Tree	N/A
Eucalyptus grandis	Tree	Alien Cat 2
Family: Palmaceae	Tree	Alien N/A
Ficus burkei	Tree	N/A
Ficus burtt-davyi	Tree	N/A
Ficus lutea	Tree	N/A
Ficus natalensis	Tree	N/A
Ficus polita	Tree	N/A
Gladiolus dalenii	Corm	Protected (Provincial)
Grevillea robusta	Tree	Alien Cat 3
Grewia occidentalis	Tree	N/A
Gymnosporia heterophylla	Tree	N/A
Harveya speciosa	Herb	N/A
Heteropyxis natalensis	Tree	N/A
Hewittia malabarica	Creeper	N/A
Hibiscus calyphyllus	Shrub	N/A

Species	Growth Form	Status
Hibiscus sp.	Tree	Alien N/A
Hibiscus tiliaceus	Tree	Protected (Provincial)
Hippobromus pauciflorus	Tree	N/A
Imperata cylindrica	Grass	N/A
Ipomoea alba	Creeper	Alien Cat 1
Ipomoea purpurea	Creeper	Alien Cat 3
Isoglossa woodii	Shrub	N/A
Jacaranda mimosifolia	Tree	Alien Cat 3
Lantana camara	Shrub	Alien Cat 1
Leucaena leucocephala	Tree	Alien Cat 2
Lepidium bonariense	Herb	Alien N/A
Litsea glutinosa	Tree	Alien Cat 1
Mangifera indica	Tree	Alien N/A
Melia azedarach	Tree	Alien Cat 3
Morus alba	Tree	Alien Cat 3
Nerium oleander	Tree	Alien Cat 1
Nidorella auriculata	Herb	N/A
Opuntia ficus-indica	Succulent	Alien Cat 1
Ornithogalum tenuifolium	Bulb	Protected (Provincial)
Panicum maximum	Grass	N/A
Paspalum urvillei	Grass	N/A
Passiflora subpeltata	Creeper	Alien Cat 1
Pavetta lanceolata	Tree	N/A
Persea sp.	Tree	Alien N/A
Phoenix reclinata	Tree	N/A
Phylica viscosa	Herb	Alien N/A
Podocarpus falcatus	Tree	Protected (National)
Protorhus longifolia	Tree	N/A
Psidium guajava	Tree	Alien Cat 2
Psychotria capensis	Shrub	N/A
Psydrax locuples	Tree	N/A
Ptaeroxylon obliquum	Tree	N/A
Rauvolfia caffra	Tree	N/A
Rhoicissus tomentosa	Creeper	N/A
Rhoicissus tridentata	Shrub	N/A
Rhus chirindensis	Tree	N/A
Rhus pyroides	Tree	N/A
Rhynchosia totta	Creeper	N/A

Species	Growth Form	Status
Ricinus communis	Shrub	Alien Cat 2
Rinorea angustifolia	Tree	N/A
Rivina humilis	Herb	Alien Cat 1
Sansevieria hyacinthoides	Herb	N/A
Scadoxus puniceus	Bulb	Protected (Provincial)
Schinus terebinthifolius	Tree	Alien Cat 1
Schotia brachypetala	Tree	N/A
Sclerocarya birrea subsp. caffra	Tree	Protected (National)
Senna didymobotrya	Tree	Alien Cat 2
Setaria megaphylla	Grass	N/A
Sideroxylon inerme	Tree	Protected (National)
Smilax anceps	Creeper	N/A
Solanum mauritianum	Tree	Alien Cat 1
Sorghum versicolor	Grass	N/A
Strelitzia nicholii	Tree	N/A
Super Tribe: Bambuseae	Tree	Alien N/A
Syzygium cordatum	Tree	N/A
Syzygium cumini	Tree	Alien Cat 3
Tagetes minuta	Herb	Alien N/A
Tarenna pavettoides	Tree	N/A
Tecoma stans	Tree	Alien Cat 1
Thelypteris interrupta	Fern	N/A
Thespesia acutiloba	Tree	N/A
Thevetia peruviana	Tree	Alien Cat 1
Thunbergia atriplicifolia	Creeper	N/A
Tipuana tipu	Tree	Alien Cat 3
Trema orientalis	Tree	N/A
Trichilia emetica	Tree	N/A
Trimeria grandiflora	Tree	N/A
Vepris lanceolata	Tree	N/A
Vigna vexillata	Creeper	N/A
Wedelia trilobata	Creeper	Alien N/A

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