Wetland Assessment for the Proposed Mixed Housing Typologies on Ptn 15 of the Farm Ledig, No. 909

North West Province

February 2017

REFERENCE

Bakubung

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Report Name	**Wetland Assessment for the Proposed Mixed Housing Typologies on Ptn 15 of the Farm Ledig, No. 909**	
Reference	**Bakubung**	
Submitted to	**K2M Environmental (Pty) Ltd**	
Report writer	**Andrew Husted**	
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EXECUTIVE SUMMARY

The Biodiversity Company was commissioned to conduct a wetland baseline and impact (risk) assessment for the proposed establishment of mixed housing typologies on Portion 15 of the Farm Ledig, No. 909, North West province.

The report has been completed in order to supplement the Basic Assessment (BA) environmental authorisation process and Water Use Licence Application (WULA) for the proposed development. A site visit was conducted on the 25-26th of January 2017.

The aim of the study was to complete a wetland assessment for the project area, ensuring that all legislative and provincial requirements area achieved.

Results for the 2017 Assessment

Deliverable	Yes / No	Comment
Wetlands within 500m of the project area	Yes	Channelled valley bottom and Unchannelled valley bottom
Presence of NFEPA wetlands	Yes	Rank 6, lowest ranking. No ecological priority areas
Wetland within 100m of the project area	Yes	Channelled valley bottom and Unchannelled valley bottom
Wetlands upstream of the project area	Yes	Channelled valley bottom and Unchannelled valley bottom
Wetlands downstream of the project area	Yes	Channelled valley bottom and Unchannelled valley bottom
Present Ecological State (PES) of the wetlands determined	Yes	C - Moderately modified (HGM 2) E – Seriously Modified (HGM 1 & 3)
Eco-Services that were rated as moderately-high or very high.	Yes	• Sediment trapping; and • Phosphate/Nitrate/Toxicant assimilation.
EIS assessment with results of A or B.	No	Highest rating was a C, moderate

A number of NFEPA wetlands were identified within 500m of the project area. These include channelled and unchanneled valley bottom wetlands. All of the NFEPA wetlands within 500m of the project area are classified as critically modified, with these systems having a percentage natural cover of <25%.

Four (4) HGM units were identified within the 500m project assessment boundary, namely;

- Channelled Valley Bottom (HGM 1);
- Unchannelled Valley Bottom (HGM2);
- Unchannelled Valley Bottom (HGM3); and
- Depressions (dam) (HGM 4).

Two dams were identified for the project. These dams are considered to be endorheic, with no outflow. These systems are thought to be old borrow pits, and are not regarded as natural

wetland systems. Based on this, the depressions will not be considered for the ecological assessment and risk study components.

The PES results for the wetlands associated with the project area.

HGM 1	Channelled valley bottom	Overall PES Class	E: Seriously Modified
HGM 2	Unchannelled valley bottom	Overall PES Class	C: Moderately Modified
HGM 3	Unchannelled valley bottom	Overall PES Class	E: Seriously Modified

HGM 1 had an overall intermediate level of service with the following showing moderately high levels of services;

- Sediment trapping; and
- Phosphate/Nitrate/Toxicant assimilation.

HGM 2 had an overall intermediate level of service with the following showing moderately high levels of services;

- Phosphate/Nitrate/Toxicant assimilation.

HGM 3 had an overall intermediate level of service with the following showing moderately high levels of service;

- Nitrate assimilation.

The remaining services for the HGM unit were scored as intermediate or lower.

HGM 1 and HGM 2 showed Moderate (C) level of importance for the Ecological Integrity & Sensitivity as well as for the Hydrological Importance. The Direct Human benefits were rated to be moderate and marginally important for HGM 1 and HGM respectively.

HGM 3 showed Marginal / Low (D) level of importance for the Ecological Integrity & Sensitivity as well as for the Direct Human benefits. The Hydrological / Functional benefits were rated to be moderate.

The EIS results for the Project.

WETLAND IMPORTANCE AND SENSITIVITY	
HGM 1	
	Importance
ECOLOGICAL IMPORTANCE & SENSITIVITY	1.3
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	1.9
DIRECT HUMAN BENEFITS	1.1
HGM 2	
	Importance
ECOLOGICAL IMPORTANCE & SENSITIVITY	1.7
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	1.7
DIRECT HUMAN BENEFITS	1.0
HGM 3	
	Importance
ECOLOGICAL IMPORTANCE & SENSITIVITY	0.4
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	1.5
DIRECT HUMAN BENEFITS	0.9

Buffer zones were suggested for the various HGM units to address the vulnerability of the wetlands to impacts. A buffer zone of between 16 – 18m during the construction phase of the project was determined for the three (3) units. Additionally, a buffer zone of 15m during the operational phase, is recommended for all three HGM units.

PHASES	BUFFER		
	HGM 1	HGM 2	HGM 3
Construction Phase	18m	16m	17m
Operational Phase	15m	15m	15m

The project is for the proposed mixed housing typologies on Ptn 15 of the farm Ledig, No. 909. The proposed site development plan will have a limited impact on the channelled and unchanneled valley bottom wetlands, with a key focus on the roads which will traverse these systems.

The unchannelled valley bottom wetland identified for the study that occurs in the south-western section of the site has been extensively modified. This area still represents a wetland system although this area should rather be managed in a grass stormwater canal considering that the residences in the area.

This project has the potential address a number of aspects identified during the study that may be impacting on the status and function of these systems. Aspects that may be improved upon for the development include the following:

- Improved storm water management to prevent sedimentation of the receiving wetland systems.
- An improved storm water management system will also address the formation of gullies and head cuts in the catchment area. It will also likely reduce the extensive erosion of the wetland systems.
- Improved services will provide a formal means for the dumping and disposal of waste for the area. Waste that has been dumped within the systems must be removed and disposed of in designated areas.
- Drains and channels that have been dig within the wetlands and catchment to divert flows can be backfilled to restore the hydrological functioning of the systems.

The proposed development, specifically the construction of crossings (or bridges) does pose a risk to the identified wetlands, with the level of risk determined to vary from low to moderate. The low risk ratings may largely be attributed to the current state of the local wetland systems.

Any direct impact to the water resources as a result of the project	Yes	Construction of crossings, and the placement of households in the south-western wetland area
Any indirect impact to the water resources as a result of the project	Yes	Likely low risks (with mitigation)
Mitigation measures prescribed	Yes	Specific measures for bridges and road construction
Opportunities to improve the water resource	Yes	Improved hydrology, and addressing erosion

The moderate risks determined for the study are associated with both phases of the project, which are largely associates with direct risks to the wetland areas, and then the operational phase of the project. The moderate risks associated with the operation phase of the project is largely due to the lifespan of these risks, being for the life of the project. The project does have the potential to address existing aspects that are impacting on the wetland systems. The moderate risk ratings were all re-allocated a low status due to implementation of additional mitigation methodologies.

Aspect	Without Mitigation	With Mitigation
CONSTRUCTION PHASE		
Clearing of areas for development	**Low**	**Low**
Compaction of soils & sedimentation	**Low**	**Low**
Drainage patterns change due to crossing construction	**Low**	**Low**
Bridge constructions	**Moderate**	**Low**
Cutting/reshaping of river banks	**Moderate**	**Low**
Additional Associated Infrastructure	**Low**	**Low**
Borrow Pits	**Moderate**	**Low**
Operation of equipment and machinery	**Low**	**Low**
Construction and upgrade of the roads	**Low**	**Low**
OPERATION PHASE		
Drainage patterns change due to increased hardened surfaces	**Moderate**	**Low**
Drainage patterns change due to crossing structures	**Moderate**	**Low**
Storm water management	**Moderate**	**Low**
Traffic / vehicle activity	**Moderate**	**Low**

The wetland identified in the south-western section of the site should rather be managed in a grass stormwater canal considering that the residences in the area have modified most of the wetland from its original state. Additionally, a wetland rehabilitation plan should be compiled for the project, with a key focus being the rehabilitation of the channelled valley bottom wetland. The plan should include measures to rehabilitated gullies and head cuts, and also include measures to prevent further erosion of the system.

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DECLARATION

I, Andrew Husted declare that:

- 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.

Andrew Husted

Wetland Ecologist

The Biodiversity Company

14 February 2017

1 INTRODUCTION

The Biodiversity Company was commissioned to conduct a wetland baseline and impact (risk) assessment for the proposed establishment of mixed housing typologies on Portion 15 of the Farm Ledig, No. 909, North West province.

The total extend of the project area is approximately 364,37ha and is a "Greenfield development". The project is planned to deliver an integrated mix of housing typologies totalling 5220 units, which includes:

- 2500 subsidised units (for the indigent),
- 500 institutional units (affordable social housing)
- 2000 bonded units (affordable bonded housing for rental on the basis of a registered long term lease which is capable of being repeatedly renewed, providing secure land tenure to the holder thereof.)
- 220 units (Security Village).

The report has been completed in order to supplement the Basic Assessment (BA) environmental authorisation process and Water Use Licence Application (WULA) for the proposed development. A site visit was conducted on the 25-26th of January 2017.

This report, after taking into consideration the findings and recommendation provided by the specialist herein, should inform and guide the Environmental Assessment Practitioner (EAP) and regulatory authorities, enabling informed decision making, as to the ecological viability of the proposed project.

1.1 Objectives

The aim of the assessment is to provide information to guide the proposed mixed development project with respect to the current state of the associated water resources in the area of study. This was achieved through the following:

- The delineation and assessment of wetlands within 500m of the project area;
- A risk assessment for the proposed development; and
- The prescription of mitigation measures and recommendations for identified risks.

2 KEY LEGISLATIVE REQUIREMENTS

2.1 National Water Act (NWA, 1998)

The Department of Water & Sanitation (DWS) is the custodian of South Africa's water resources and therefore assumes public trusteeship of water resources, which includes watercourses, surface water, estuaries, or aquifers. The National Water Act (NWA) (Act No. 36 of 1998) allows for the protection of water resources, which includes:

The maintenance of the quality of the water resource to the extent that the water resources may be used in an ecologically sustainable way;

- The prevention of the degradation of the water resource; and
- The rehabilitation of the water resource.
- A watercourse means:
- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

The NWA recognises that the entire ecosystem, and not just the water itself, and any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the DWS.

For the purposes of this project, a wetland area is defined according to the NWA (Act No. 36 of 1998): “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”.

Wetlands have one or more of the following attributes to meet the NWA wetland definition (DWAF, 2005):

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

2.2 National Environmental Management Act (NEMA, 1998)

The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations as amended in December 2014, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact.

3 PROJECT AREA

The proposed mixed use development is located in the Moses Kotane Local Municipality in the Bojanala Platinum District Municipality. The project area is south of the Pilansberg National Park, and west of the Sun Village Shopping Centre. The township area of Ledig is west of the project area. The location of the project area in relation to the general setting is presented in Figure 1.

Figure 1: Locality map showing the project area in relation to the general setting

4 LIMITATIONS

The following aspects were considered as limitations for the wetland study:

- Due to the level of development within the project area, the ability to delineate wetlands by means of the required indicators has been somewhat compromised. The local agricultural land uses and extent of housing development has resulted in vegetation being removed, and as a result of this, the remaining indicators were focussed on the project delineation (Figure 2).
- An unchannelled valley bottom wetland identified for the study that occurs in the south-western section (Figure 2) of the site has been extensively modified through canalization of the wetland, building of residences in the wetland area, soil modification, rubble dumping etc.
- The GPS used for wetland delineations is accurate to within five meters. Therefore, the wetland delineation plotted digitally may be offset by at least five meters to either side.
- The information regarding the activities to be completed on the site, allowed us to do a general assessment on the impacts and the buffer requirement.
- Wetland systems identified at desktop level within 500 m of the project area were considered for the identification and desktop delineation, with wetland areas within the project area being the focus for ground truthing.

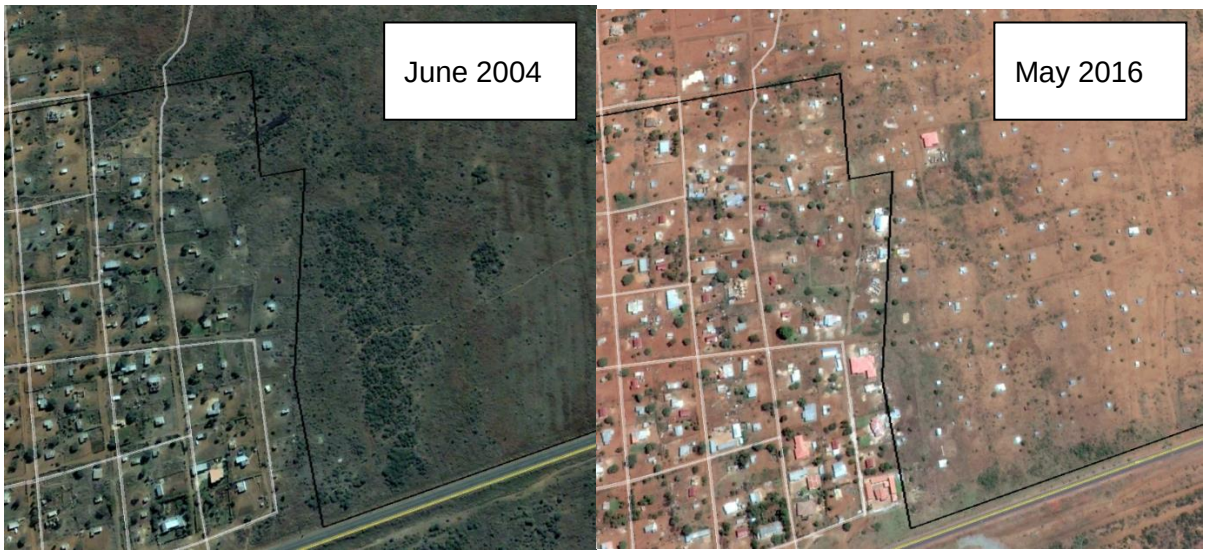

Figure 2: A Google Earth image depicting the extent of development in the area.

5 METHODOLOGY

5.1 Wetland Assessment

The National Wetland Classification Systems (NWCS) developed by the South African National Biodiversity Institute (SANBI) will be considered for this study. This system comprises a hierarchical classification process of defining a wetland based on the principles of the hydrogeomorphic (HGM) approach at higher levels, and also then includes structural features at the lower levels of classification (Ollis, Snaddon, Job, & Mbona, 2013).

5.1.1 Wetland Classification System

A distinction is made between four Landscape Units for Inland Systems on the basis of the landscape setting in which a HGM is situated, which broadly considers (Ollis, Snaddon, Job, & Mbona, 2013):

- Slope;
- Valley floor;
- Plain; and
- Bench.

The HGM Units, which are defined primarily according to:

- Landform, which defines the shape and localised setting of a wetland;
- Hydrological characteristics, which describe the nature of water movement into, through and out of the wetland; and
- Hydrodynamics, which describe the direction and strength of flow through the wetland.

Seven primary HGM units are recognised for Inland Systems on the basis of hydrology and geomorphology (Ollis, Snaddon, Job, & Mbona, 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates;
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat; and
- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvium (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used in order to ensure consistency with the wetland classification terms in South Africa.

5.1.2 Desktop assessment

The following information sources were considered for the desktop assessment;

- Information as presented by the South African National Biodiversity Institutes (SANBI's) Biodiversity Geographic Information Systems (BGIS) website (http://bgis.sanbi.org);
- Aerial imagery (Google Earth Pro);
- Land Type Data (Land Type Survey Staff, 1972 - 2006)
- The National Freshwater Ecosystem Priority Areas (Nel, et al., 2011);
- Contour data (5m).

5.1.3 Wetland Delineation

The wetland areas are delineated in accordance with the DWAF (2005) guidelines, a cross section is presented in Figure 3. The outer edges of the wetland areas were identified by considering the following four specific indicators:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur;
- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
- The soil forms (types of soil) found in the landscape were identified using the South African soil classification system namely; Soil Classification: A Taxonomic System for South Africa (Soil Classification Working Group, 1991);
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation; and
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

Vegetation is used as the primary wetland indicator. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role.

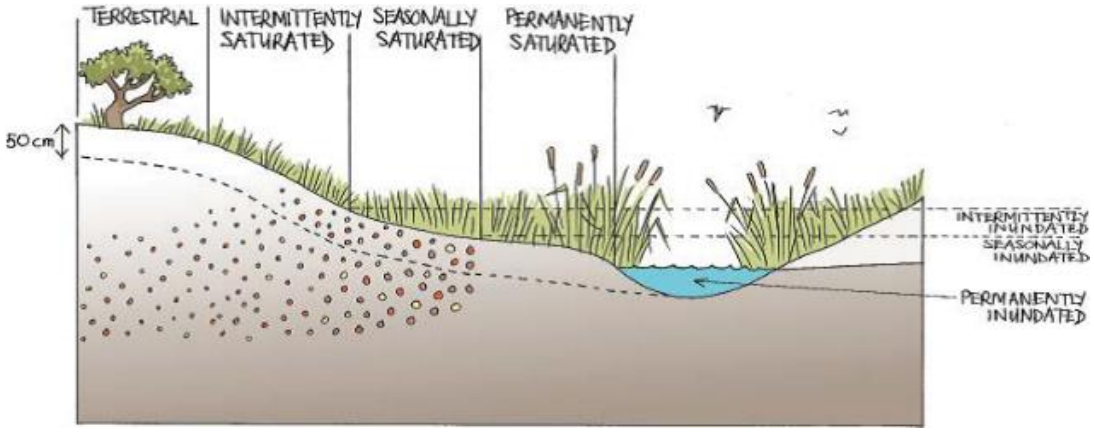

Figure 3: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis, Snaddon, Job, & Mbona, 2013).

5.1.4 Present Ecological Status (PES)

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society (ecosystem services). Management of these systems is therefore essential if these attributes are to be retained within an ever-changing landscape. The primary purpose of this assessment is to evaluate the eco-physical health of wetlands, and in so doing promote their conservation and wise management.

5.1.4.1 Level of Evaluation

WET-Health provides two levels of assessment:

- Level 1: Desktop evaluation, with limited field verification. This is generally applicable to situations where many wetlands need to be assessed at a very low resolution; or
- Level 2: On-site evaluation. This involves structured sampling and data collection in a single wetland and its surrounding catchment.

5.1.4.2 Units of Assessment

Central to WET-Health is the characterisation of HGM Units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom and whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled).

5.1.4.3 Quantification of Present Ecological State (PES) of a Wetland

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a PES score. This takes the form of assessing the spatial extent of impact of individual activities/occurrences and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The impact scores and Present State categories are provided in Table 1 and Table 2.

Table 1: The magnitude of impacts on wetland functionality (Macfarlane, et al., 2009)**.**

Impact Category	Description	Score
None	No Discernible modification or the modification is such that it has no impacts on the wetland integrity	**0 to 0.9**
Small	Although identifiable, the impact of this modification on the wetland integrity is small.	**1.0 to 1.9**
Moderate	The impact of this modification on the wetland integrity is clearly identifiable, but limited.	**2.0 to 3.9**
Large	The modification has a clearly detrimental impact on the wetland integrity. Approximately 50% of wetland integrity has been lost.	**4.0 to 5.9**
Serious	The modification has a highly detrimental effect on the wetland integrity. More than 50% of the wetland integrity has been lost.	**6.0 to 7.9**

Critical	The modification is so great that the ecosystem process of the wetland integrity is almost totally destroyed, and 80% or more of the integrity has been lost.	**8.0 to 10**

Table 2: The PES categories (Macfarlane, et al., 2009).

Impact Category	Description	Impact Score Range	Present State Category
None	**Unmodified, natural**	**0 to 0.9**	**A**
Small	**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.	**1.0 to 1.9**	**B**
Moderate	**Moderately Modified.** A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	**2.0 to 3.9**	**C**
Large	**Largely Modified.** A large change in ecosystem processes and loss of natural habitat and biota has occurred.	**4.0 to 5.9**	**D**
Serious	**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.	**6.0 to 7.9**	**E**
Critical	**Critical Modification.** The modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	**8.0 to 10**	**F**

5.1.4.4 Overall Health of the Wetland

Once all HGM Units have been assessed, a summary of health for the wetland as a whole is calculated. Since hydrology, geomorphology and vegetation are interlinked their scores are aggregated to obtain an overall PES health score using the following formula (Macfarlane, et al., 2009):

Health = ((Hydrology score) x3 + (Geomorphology score) x2 + (Vegetation score) x2)) ÷ 7

5.1.5 Wetland Ecosystem Services

The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices (Kotze, Marneweck, Batchelor, Lindley, & Collins, 2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the services are provided (Table 3):

- Flood attenuation
- Stream flow regulation
- Sediment trapping
- Phosphate trapping
- Nitrate removal
- Toxicant removal

- Erosion control
- Carbon storage
- Maintenance of biodiversity
- Water supply for human use
- Natural resources
- Cultivated foods
- Cultural significance
- Tourism and recreation
- Education and research

Table 3: Classes for determining the likely extent to which a benefit is being supplied (Kotze, Marneweck, Batchelor, Lindley, & Collins, 2009).

Score	Rating of likely extent to which a benefit is being supplied
< 0.5	Low
0.6 - 1.2	Moderately Low
1.3 - 2.0	Intermediate
2.1 - 3.0	Moderately High
> 3.0	High

5.1.6 Ecological Importance and Sensitivity (EIS)

The method used for the EIS determination was adapted from the method as provided by DWS (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed. A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The mean of the determinants is used to assign the EIS category as listed in Table 4.

Table 4: Description of EIS categories

EIS Category	Range of Mean	Recommended Ecological Management Class
Very High	3.1 to 4.0	**A**
High	2.1 to 3.0	**B**
Moderate	1.1 to 2.0	**C**
Low Marginal	< 1.0	**D**

5.2 Risk assessment

The risk assessment was conducted in accordance with the DWS risk-based water use authorisation approach and delegation guidelines. The matrix assesses impacts in terms of consequence and likelihood. Consequence is calculated based on the following formula:

Consequence = Severity + Spatial Scale + Duration

Whereas likelihood is calculated as:

Likelihood=Frequency of Activity + Frequency of Incident +Legal Issues + Detection.

Significance is calculated as:

Significance \Risk= Consequence X Likelihood.

The significance of the impact is calculated according to Table 5.

Table 5: Significance ratings matrix

Rating	Class	Management Description
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands may be excluded.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Wetlands are excluded.
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s)impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.

5.3 Buffer Determination

A buffer zone is defined as “A strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another.” (Macfarlane, et al., 2015).

Buffer zones protect water resources in a variety of ways, such as;

- Maintenance of basic aquatic processes;
- The reduction of impacts on water resources from activities and adjoining land uses;
- The provision of habitat for aquatic and semi-aquatic species;
- The provision of habitat for terrestrial species; and
- The provision of societal benefits.

The “Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries” (Macfarlane, et al., 2015) was used to determine the appropriate buffer zone for the proposed activity.

6 RESULTS & DISCUSSIONS

6.1 Desktop Assessment

6.1.1 Geology & Soils

The geology of the area is predominantly norite, pyroxenite, red granite and diabase of the Bushveld Complex. Hornfels, slate, shale and quartzite of the Pretoria Group also occur in the area.

According to the land type database (Land Type Survey Staff, 1972 - 2006) the development falls within the Ae64 land type. It is expected that the dominant soils in the crest and midslope positions will be soils of the Hutton and Mispah forms. The soils that dominated the footslopes and the valley bottoms are Bonheim, Willowbrook and Valsrivier soil forms.

6.1.2 Wetland NFEPAs

A number of NFEPA wetlands were identified within 500m of the project area. These include channelled and unchanneled valley bottom wetlands. The FEPA sites within 500m are listed in Table 6.

All of the NFEPA wetlands within 500m of the project area are classified as critically modified, with these systems having a percentage of natural cover of <25%. Additionally, none of these systems are recognised as ecological priority areas. All of the wetlands are a Rank 6, indicating no level of protection or importance on a national or provincial scale.

Table 6: NFEPA description for the FEPA sites near the proposed development.

FEPA Wetland	Wetland Vegetation Class	Natural / Artificial	Wetland Condition	Wetland Rank
Channelled Valley Bottom	Central Bushveld Group 2	Natural & Artificial	Z3 – <25% Natural Vegetation	6 – Worst ranking
Unchannelled Valley Bottom	Central Bushveld Group 2	Artificial	Z3 – <25% Natural Vegetation	6 – Worst ranking

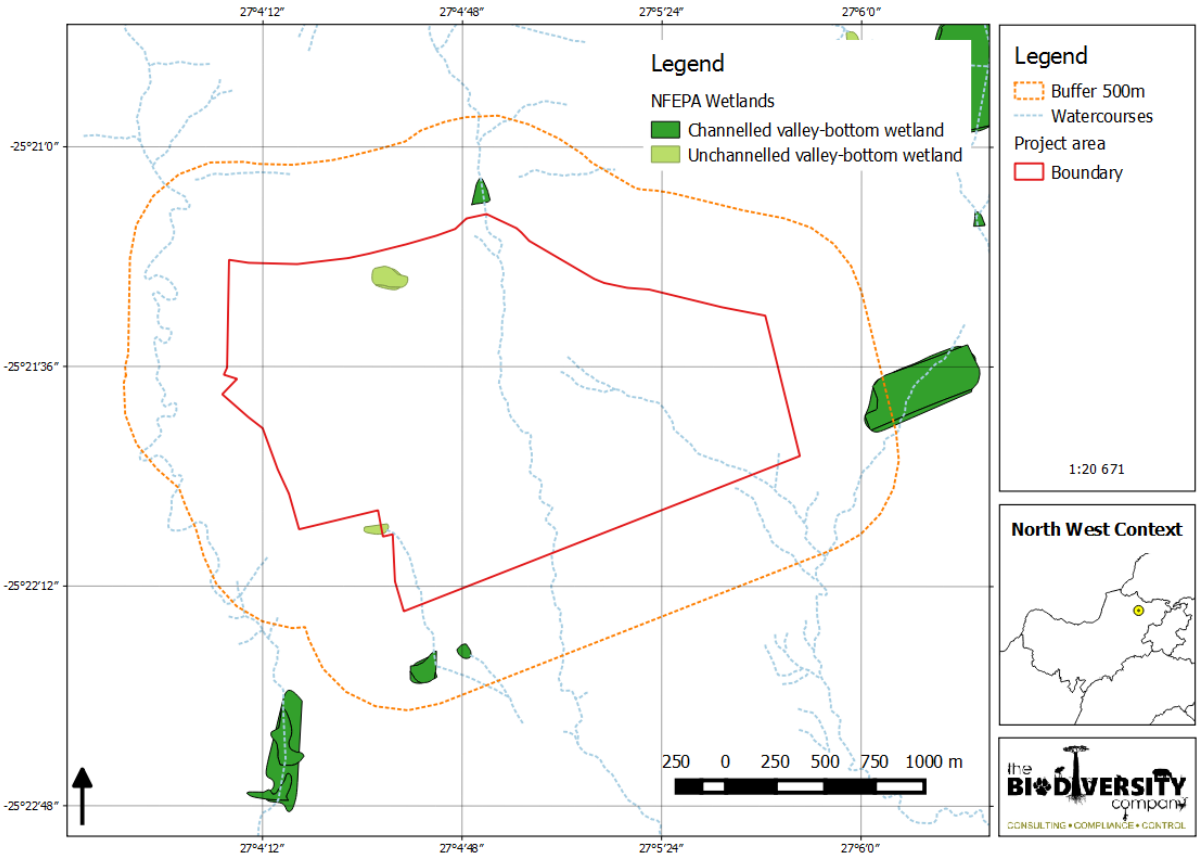

Figure 4: The NFEPA wetlands associated with the project area

6.2 Wetland Assessment

The survey included assessing all the wetland indicators as well as assessing the Present Ecological Score (PES) or health of the wetland, the wetland's ability to provide goods and services (Eco-Services) and the Ecological Importance and Sensitivity (EIS) of the wetlands.

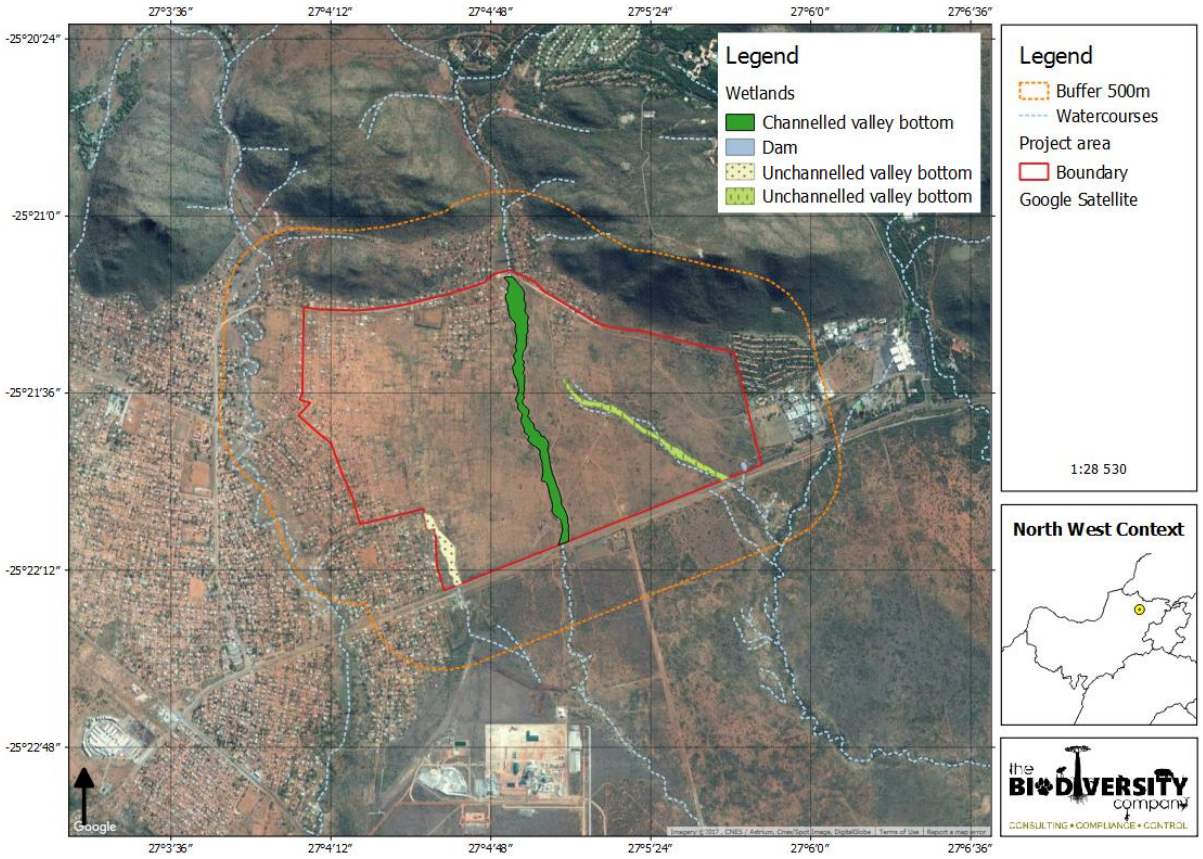

Figure 5: The project wetland delineation and HGM unit classification

The wetland delineation is shown in Figure 5 and the HGM units in with the wetland classification as per SANBI guidelines (Ollis, Snaddon, Job, & Mbona, 2013) in Table 7.

Four (4) HGM units were identified within the 500m project assessment boundary, namely;

- Channelled Valley Bottom (HGM 1);
- Unchannelled Valley Bottom (HGM2);
- Unchannelled Valley Bottom (HGM3); and
- Depressions (dam) (HGM 4).

The wetlands are described in the following sections.

Table 7: Wetland classification as per SANBI guideline (Ollis, Snaddon, Job, & Mbona, 2013).

Unit	Level 1	Level 2		Level 3	Level 4		
	System	DWS Ecoregion/s	NFEPA Wet Veg Group/s	Landscape Unit	4A (HGM)	4B	4C
HGM 1	Inland	Western Bankenveld	Central Bushveld Group 2	Valley Floor	Channelled Valley Bottom	N/A	N/A
HGM 2	Inland	Western Bankenveld	Central Bushveld Group 2	Valley Floor	Unchannelled Valley Bottom	N/A	N/A
HGM 3	Inland	Western Bankenveld & Bushveld Basin	Central Bushveld Group 2	Valley Floor	Unchannelled Valley Bottom	N/A	N/A
HGM 4	Inland	Western Bankenveld	Central Bushveld Group 2	Plain	Endorheic	Without channel outflow	N/A

6.2.1 (HGM 1) Channelled Valley Bottom

The channelled valley bottom wetland was characterised by incised channels, susceptible to erosion. Erosion gullies and headcuts are evident throughout the system. The of wetland vegetation included *Juncus spp* and *Cyperus spp.*

Figure 6: The channelled valley bottom wetland with steep embankments

6.2.2 (HGM 2) Unchannelled Valley Bottom

The unchannelled valley bottom wetland was characterised by a relatively flat system with no defined channel. The slope of the embankments was also gentle. The system is dominated by freely draining soil, and is classified as a temporary wetland system.

Figure 7: The unchannelled valley bottom wetland

6.2.3 (HGM 3) Unchannelled Valley Bottom

The wetland was located in a flat area which has been developed to accommodate access routes and homesteads. The unchannelled valley bottom wetland has been extensively modified through canalization of the wetland, building of residences in the wetland area, soil modification, rubble dumping etc. This area still represents a wetland system although this area should rather be managed in a grass stormwater canal considering that the residences in the area have modified most of the wetland from its original state.

Figure 8: The unchanneled valley bottom wetland with signs of surface wetness

6.2.4 (HGM 4) Depression

Two dams were identified for the project. These dams are considered to be endorheic, with no outflow. These systems are thought to be old borrow pits, and are not regarded as natural wetland systems. Based on this, the depressions will not be considered for the ecological assessment and risk study components.

Figure 9: The depressions identified for the study

6.2.5 Present Ecological State (PES)

The PES results are described in the sections below with Table 8 showing the combined results and Figure 10 showing the PES results for the area in the map.

6.2.5.1 (HGM 1) Channelled Valley Bottom

The overall PES score for the channelled valley bottom was that of a E (Seriously Modified) as shown in Table 8. The individual drivers were assessed and described below.

HYDROLOGY

The hydrological component of the HGM unit was categorised as a E (Seriously Modified). The wetland has been altered by the infilling of small portions of the system, the formation of gullies and head cuts across the system, and the surface water inputs from the adjacent areas. The placement of a dam in the upper reaches of the catchment has also had an effect on the hydrology of the system.

GEOMORPHOLOGY

The geomorphology of the wetland was categorised as a E (seriously Modified). The system is characterised by a deep and wide channel system, with eroding embankments and head cuts throughout the system. The structure of the system has been altered extensively.

VEGETATION

The vegetation component was categorised as a D (Largely Modified). The vegetation component was affected by the encroachment and establishment of alien vegetation in places, with a reduced amount of cover.

6.2.5.2 (HGM 2) Unchannelled Valley Bottom

The overall PES score for the unchannelled valley bottom was that of a C (Moderately Modified) as shown in Table 8. The individual drivers were assessed and described below.

HYDROLOGY

The hydrological component of the HGM unit was categorised as a C (Moderately Modified). Despite the level of development within the catchment, consisting of access routes and homesteads, the hydrology through the system has only been affected moderately. Due to these developments, isolated areas of erosion were identified.

GEOMORPHOLOGY

The geomorphology of the wetland was categorised as a C (Moderately Modified). The system is characterised by a relatively wide channel system, with a gentle slope. Areas of erosion were identified within the system. The encroachment of homesteads within the system has also affected the structure of the unit.

VEGETATION

The vegetation component was categorised as a C (Moderately Modified). The vegetation is predominantly intact, with the establishment of alien vegetation in places. The extent of ground cover is still considered to be adequate.

6.2.5.3 (HGM 3) Unchannelled Valley Bottom

The overall PES score for the channelled valley bottom was that of a E (Seriously Modified). as shown in Table 8. The individual drivers were assessed and described below.

HYDROLOGY

The hydrological component of the HGM unit was categorised as a C (Moderately Modified), and this is due to the seepage associated with the system being a result of the expression of

water at the ground surface. The development of the area has impacted on the surface flow dynamics.

GEOMORPHOLOGY

The geomorphology of the wetland was categorised as a E (Seriously Modified). The geomorphological health has been impacted on the development of the area, resulting in altered hydrological conditions and the disturbances of the area. At the current conditions, it is expected that the geomorphology may deteriorate further.

VEGETATION

The vegetation component was categorised as a F (Critically Modified). The vegetation component was affected by the removal of vegetation to accommodate the placement of homesteads and subsistence agriculture. The remaining extent of vegetation has been impacted on by grazing by livestock.

Table 8: The PES results for the wetlands associated with the project area.

Wetland	Area (ha)	Hydrology		Geomorphology		Vegetation	
		Rating	Score	Rating	Score	Rating	Score
HGM 1	11	E: Seriously Modified	6.5	E: Seriously Modified	6.0	D: Largely Modified	5.9
Overall PES Score		6.2		Overall PES Class		E: Seriously Modified	
Wetland	Area (ha)	Hydrology		Geomorphology		Vegetation	
		Rating	Score	Rating	Score	Rating	Score
HGM 2	4.00	C: Moderately Modified	3.5	C: Moderately Modified	2.4	C: Moderately Modified	3.1
Overall PES Score		3.1		Overall PES Class		C: Moderately Modified	
Wetland	Area (ha)	Hydrology		Geomorphology		Vegetation	
		Rating	Score	Rating	Score	Rating	Score
HGM 3	2.5	C: Moderately Modified	3.5	E: Seriously Modified	6.9	F: Critically Modified	9.4
Overall PES Score		6.2		Overall PES Class		E: Seriously Modified	

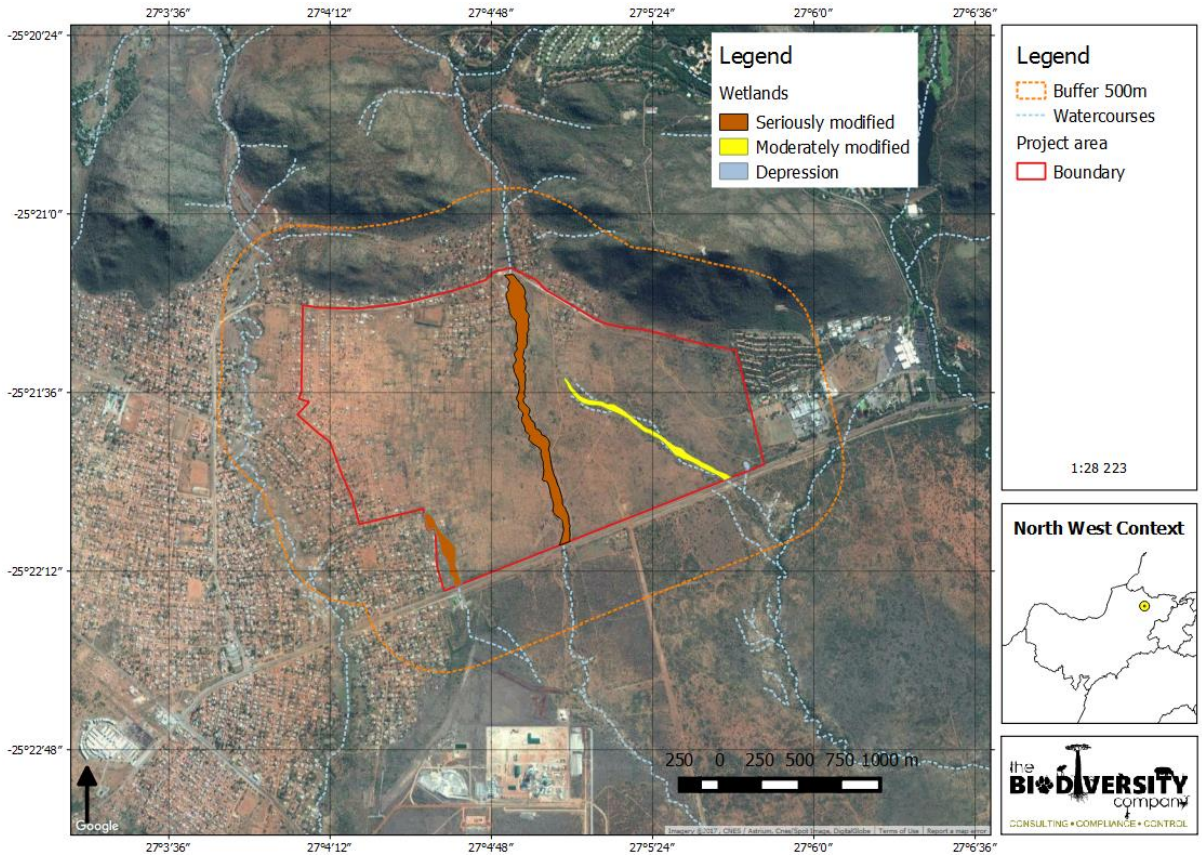

Figure 10: PES ratings for the wetlands for the project area

6.2.6 Ecosystem Services Assessment

The Ecosystem services provided by the HGM units present at the site were assessed and rated.

Table 9 using the WET-EcoServices method (Kotze, Marneweck, Batchelor, Lindley, & Collins, 2009). The summarised results for the HGM units are shown in Table 10.

HGM 1 had an overall intermediate level of service with the following showing moderately high levels of services;

- Sediment trapping; and
- Phosphate/Nitrate/Toxicant assimilation.

HGM 2 had an overall intermediate level of service with the following showing moderately high levels of services;

- Phosphate/Nitrate/Toxicant assimilation.

HGM 3 had an overall intermediate level of service with the following showing moderately high levels of service;

- Nitrate assimilation.

The remaining services for the HGM unit were scored as intermediate or lower.

Table 9: Eco-Services rating of likely extent to which a benefit is being supplied.

Score	Rating of likely extent to which a benefit is being supplied
< 0.5	Low
0.6 - 1.2	Moderately Low
1.3 - 2.0	Intermediate
2.1 - 3.0	Moderately High
> 3.0	High

Table 10: The EcoServices being provided by the wetlands at the project site.

Wetland Unit					HGM 1	HGM 2	HGM 3
Ecosystem Services Supplied by Wetlands	Indirect Benefits	Regulating and supporting benefits	Flood attenuation		1.4	1.4	1.1
			Streamflow regulation		1.5	1.3	1.7
			Water Quality enhancement benefits	Sediment trapping	2.6	1.9	1.2
				Phosphate assimulation	2.5	2.7	1.8
				Nitrate assimulation	2.0	2.2	2.1
				Toxicant assimulation	2.3	2.1	1.5
				Erosion control	1.9	1.5	1.0
			Carbon storage		1.3	0.7	1.7
	Direct Benefits	Biodiversity maintanance			1.1	1.1	1.1
		Provisioning benefits	Provisioning of water for human use		1.1	0.4	0.6
			Provisioning of harvestable resources		2.0	1.6	1.6
			Provisioning of cultivated foods		1.4	1.4	1.4
		Cultural benefits	Cultural heritage		1.0	1.0	1.0
			Tourism and recreation		0.9	1.0	0.1
			Education and research		0.5	0.5	0.8
Overall					23.4	20.7	18.6
Average					1.6	1.4	1.2

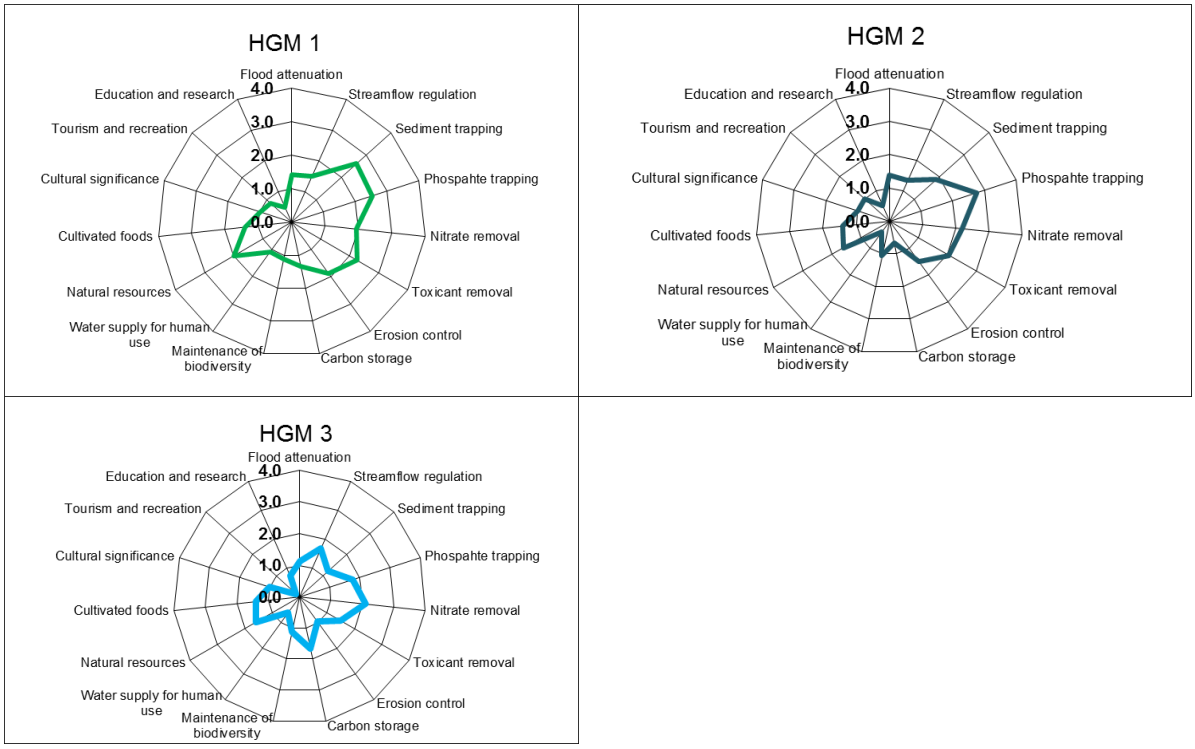

Figure 11: The spider diagram for Eco-Services rendered by HGM 1, 2 and 3

6.2.7 Ecological Importance & Sensitivity (EIS)

The EIS assessment was applied to the HGM unit described in the previous section in order to assess the levels of sensitivity and ecological importance of the wetland. The results of the assessment are shown in

Table 11.

HGM 1 and HGM 2 showed Moderate (C) level of importance for the Ecological Integrity & Sensitivity as well as for the Hydrological Importance. The Direct Human benefits were rated to be Moderate (C) and Low (D) importance for HGM 1 and HGM 2 respectively.

HGM 3 showed Low (D) level of importance for the Ecological Integrity & Sensitivity as well as for the Direct Human benefits. The Hydrological / Functional benefits were rated to be moderate.

Table 11: The EIS results for the Project.

WETLAND IMPORTANCE AND SENSITIVITY	
HGM 1	
	Importance
ECOLOGICAL IMPORTANCE & SENSITIVITY	1.3
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	1.9
DIRECT HUMAN BENEFITS	1.1
HGM 2	
	Importance
ECOLOGICAL IMPORTANCE & SENSITIVITY	1.7
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	1.7
DIRECT HUMAN BENEFITS	1.0
HGM 3	
	Importance
ECOLOGICAL IMPORTANCE & SENSITIVITY	0.4
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	1.5
DIRECT HUMAN BENEFITS	0.9

6.3 Buffer Zones

The wetland buffer zone tool was used to calculate the appropriate buffer required for the proposed mixed use development. The model shows that the largest risk posed by the project during the construction phase is that of “increased sediment inputs and turbidity”. During the operational phase a very high risk is posed by the altered flow patterns.

Buffer zones were suggested for the various HGM units to address the vulnerability of the wetlands to impacts. A buffer zone of between 16 – 18m during the construction phase of the project was determined for the three units. Additionally, a buffer zone of 15m during the operational phase, is recommended for all three HGM units.

Table 12: The risk results from the wetland buffer model for the proposed project.

Threat Posed by the proposed land use / activity		Desktop Threat Rating
Construction Phase	1. Alteration to flow volumes	VL
	2. Alteration of patterns of flows (increased flood peaks)	L
	3. Increase in sediment inputs & turbidity	H
	4. Increased nutrient inputs	VL
	5. Inputs of toxic organic contaminants	VL
	6. Inputs of toxic heavy metal contaminants	M
	7. Alteration of acidity (pH)	N/A
	8. Increased inputs of salts (salinization)	N/A
	9. Change (elevation) of water temperature	VL
	10. Pathogen inputs (i.e. disease-causing organisms)	VL
Operational Phase	1. Alteration to flow volumes	M
	2. Alteration of patterns of flows (increased flood peaks)	VH
	3. Increase in sediment inputs & turbidity	L
	4. Increased nutrient inputs	L
	5. Inputs of toxic organic contaminants	M
	6. Inputs of toxic heavy metal contaminants	M
	7. Alteration of acidity (pH)	L
	8. Increased inputs of salts (salinization)	L
	9. Change (elevation) of water temperature	L
	10. Pathogen inputs (i.e. disease-causing organisms)	L

PHASES	BUFFER		
	HGM 1	HGM 2	HGM 3
Construction Phase	18m	16m	17m
Operational Phase	15m	15m	15m

7 CURRENT IMPACTS

Photographs of some aspects identified on site that are impacting on the status and functioning of the wetland systems (Figure 12). Some of these impacts can and must be addressed should the project be approved for development.

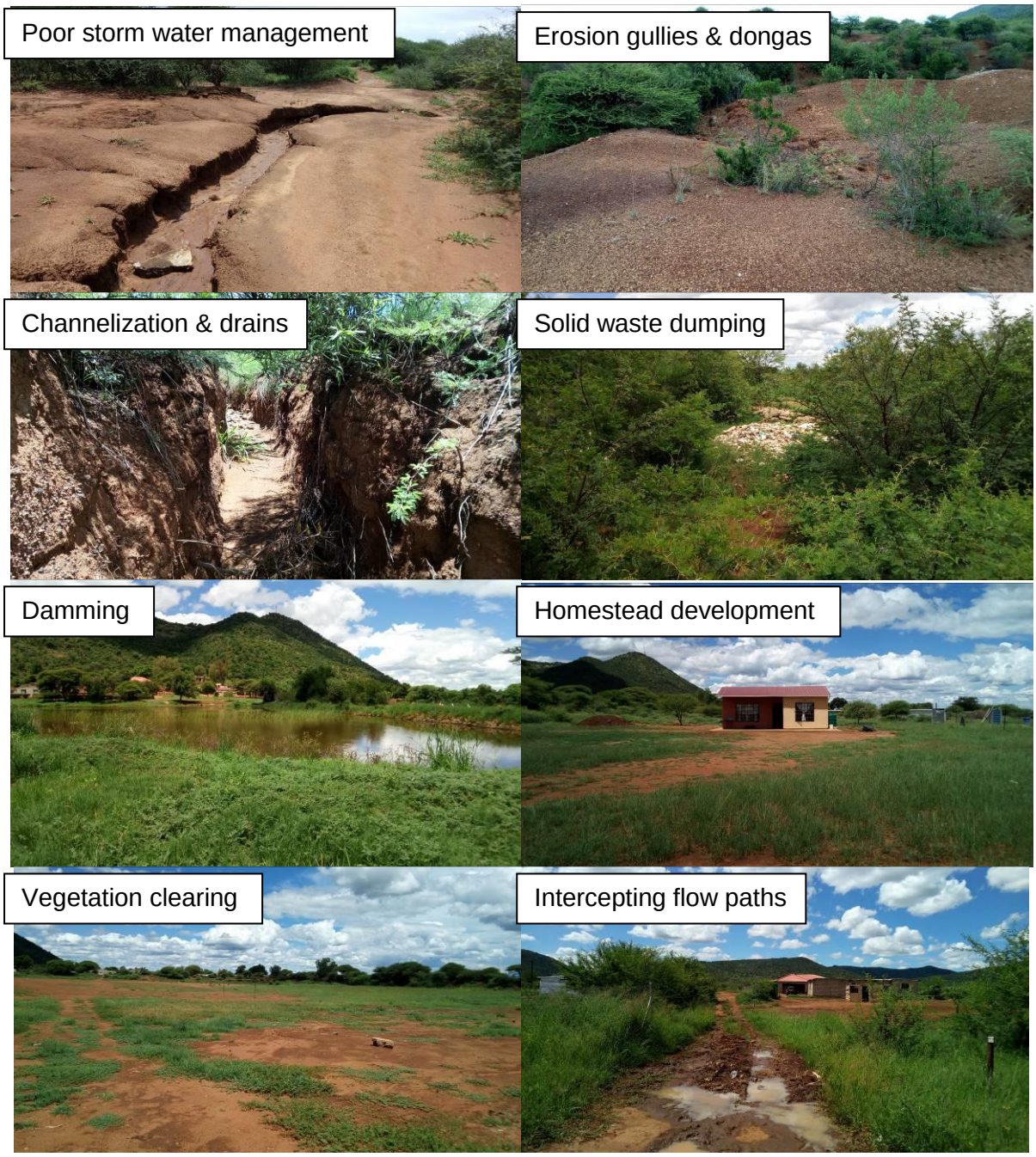

Figure 12: Photographs of potential impact sources

8 RISK ASSESSMENT

The project is for the proposed mixed housing typologies on Ptn 15 of the farm Ledig, No. 909. The proposed site development plan will not have an impact on the channelled and unchanneled valley bottom wetlands, with the exception of roads which will traverse these systems. The proposed development plan is beyond the 15m operational buffer determined for this project (Figure 13). A portion of the proposed development footprint, consisting of housing units does encroach into the south-western wetland area area and associated buffer zone. Development within the wetland area will result in the loss of this wetland system, and the loss of wetland areas cannot be mitigated.

This project has the potential address a number of aspects identified during the study that may be impacting on the status and function of these systems. Aspects that may be improved upon for the development include the following:

- Improved storm water management to prevent sedimentation of the receiving wetland systems.
- An improved storm water management system will also address the formation of gullies and head cuts in the catchment area. It will also likely reduce the extensive erosion of the wetland systems.
- Improved services will provide a formal means for the dumping and disposal of waste for the area. Waste that has been dumped within the systems must be removed and disposed of in designated areas.
- Drains and channels that have been dig within the wetlands and catchment to divert flows can be backfilled to restore the hydrology of the systems.

The total extend of the project area is approximately 364,37ha and is a “Greenfield development”. The project is planned to deliver an integrated mix of housing typologies totalling 5220 units, which includes:

- 2500 subsidised units (for the indigent),
- 500 institutional units (affordable social housing)
- 2000 bonded units (affordable bonded housing for rental on the basis of a registered long term lease which is capable of being repeatedly renewed, providing secure land tenure to the holder thereof.)
- 220 units (Security Village).

Findings from the DWS aspect and impact register / risk assessment are provided in Table 13, Table 14 and Table 15.

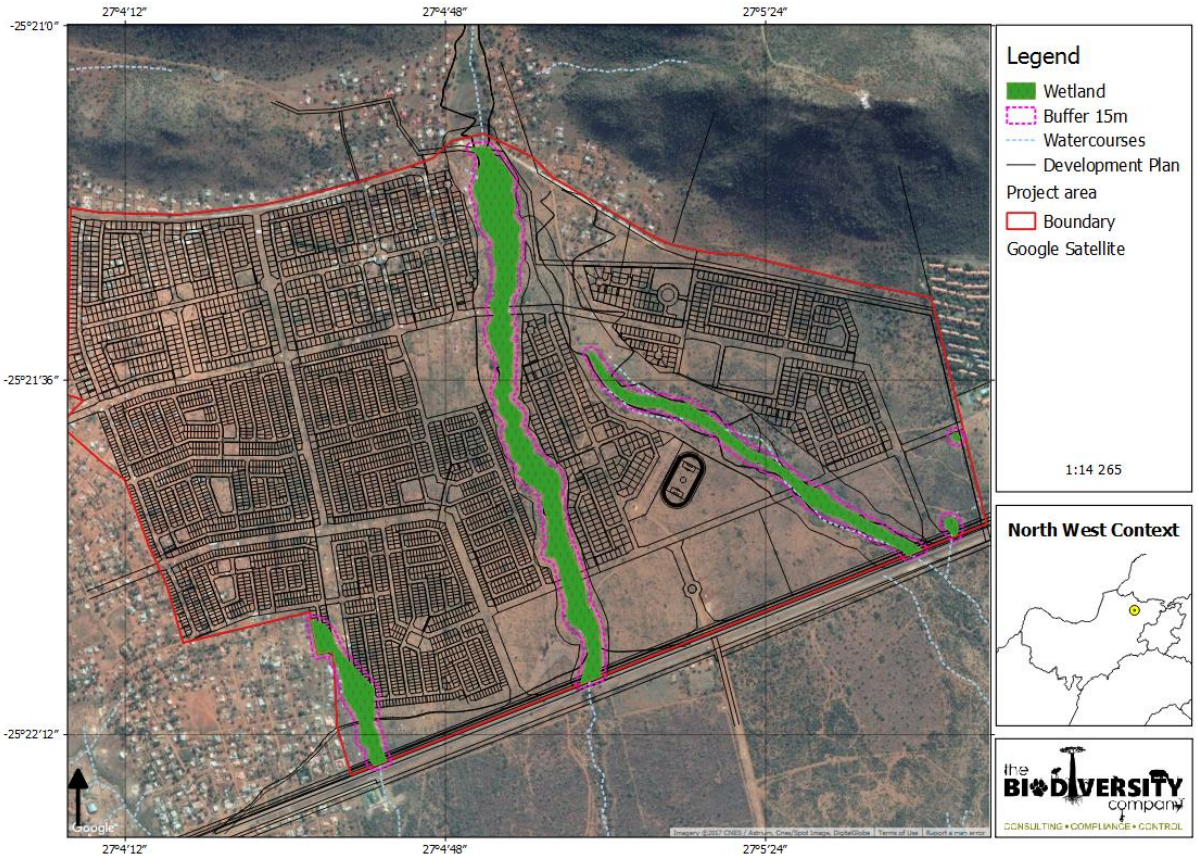

Figure 13: The proposed site development plan (georeferenced) in relation to the delineated wetlands, and associated 15m operational buffer zone.

Table 13: Impacts assessed for the proposed project

Activity	Aspect	Impact
Construction and operation of the mixed development	Clearing of areas for development	Impeding the flow of water. Loss of aquatic habitat Siltation of watercourse. Erosion of watercourse. Sedimentation of the watercourse. Flow sediment equilibrium change Water quality impairment
	Compaction of soils & sedimentation	
	Drainage patterns change due to increased hardened surfaces	
	Drainage patterns change due to crossings	
	Stormwater management	
	Construction and upgrade of the roads	
	Bridge constructions	
	Additional Associated Infrastructure	
	Borrow Pits	
	Cutting/reshaping of embankments	
	Traffic / vehicle activity	

Table 14: DWS Risk Impact Matrix for the proposed project

Aspect	Severity							
	Flow Regime	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Consequence
Construction Phase								
Clearing of areas for development	3	**2**	**2**	**2**	2.25	**2**	**2**	6.25
Compaction of soils & sedimentation	2	1	1	1	1.25	2	3	6.25
Drainage patterns change due to crossing construction	2	**2**	**1**	**1**	1.5	**2**	**2**	5.5
Bridge constructions	2	2	2	2	2	2	2	6
Cutting/reshaping of river banks	2	2	2	1	1.75	2	2	5.75
Additional Associated Infrastructure	1	1	1	1	1	2	3	6
Borrow Pits	2	1	1	1	1.25	2	5	8.25
Operation of equipment and machinery	1	2	2	2	1.75	2	3	6.75
Construction and upgrade of the roads	2	2	1	2	1.75	2	2	5.75
Operational Phase								
Drainage patterns change due to increased hardened surfaces	3	1	1	1	1.5	2	5	8.5
Drainage patterns change due to crossing structures	2	1	1	1	1.25	2	5	8.25
Storm water management	2	2	1	1	1.5	2	5	8.5
Traffic / vehicle activity	1	3	1	2	1.75	1	5	7.75

Table 15: DWS Risk Impact Matrix for the proposed project continued

Aspect	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Sig.	Without Mitigation	With Mitigation
Construction Phase								
Clearing of areas for development	**1**	**2**	**1**	**2**	**6**	**37.5**	**Low**	**Low**
Compaction of soils & sedimentation	1	2	1	2	**6**	**37.5**	**Low**	**Low**
Drainage patterns change due to crossing construction	**2**	**2**	**1**	**3**	**8**	**44**	**Low**	**Low**
Bridge constructions	2	2	5	3	**12**	**72**	**Moderate***	**Low**
Cutting/reshaping of river banks	2	2	5	2	**11**	**63.25**	**Moderate***	**Low**
Additional Associated Infrastructure	1	1	1	2	**5**	**30**	**Low**	**Low**
Borrow Pits	3	1	1	2	**7**	**57.75**	**Moderate***	**Low**
Operation of equipment and machinery	2	1	1	2	**6**	**40.5**	**Low**	**Low**
Construction and upgrade of the roads	2	1	1	3	**7**	**40.25**	**Low**	**Low**
Operational Phase								
Drainage patterns change due to increased hardened surfaces	3	2	1	3	**9**	**76.5**	**Moderate***	**Low**
Drainage patterns change due to crossing structures	3	2	1	3	**9**	**74.25**	**Moderate***	**Low**
Storm water management	3	2	1	3	**9**	**76.5**	**Moderate***	**Low**
Traffic / vehicle activity	3	2	1	3	**9**	**78.75**	**Moderate***	**Low**

(*) denotes - In accordance with General Notice 509 “Risk is determined after considering all listed control / mitigation measures. Borderline Low / Moderate risk scores can be manually adapted downwards up to a maximum of 25 points (from a score of 80) subject to listing of additional mitigation measures detailed below.”

The proposed development, specifically the construction of crossings (or bridges) does pose a risk to the identified wetlands, with the level of risk determined to vary from low to moderate. The low risk ratings may largely be attributed to the current state of the local wetland systems.

The moderate risks determined for the study are associated with both phases of the project, which are largely associates with direct risks to the wetland areas, and then the operational phase of the project. The moderate risks associated with the operation phase of the project is largely due to the lifespan of these risks, being for the life of the project. The project does have the potential to address existing aspects that are impacting on the wetland systems. The moderate risk ratings were all re-allocated a low status due to implementation of additional mitigation methodologies.

8.1 Road construction mitigation measures

The following road construction specific mitigation measures are provided:

- To minimise the impact on both surface water flow and interflow, portions of the road must include a coarse rock layer that has been specifically incorporated to increase the porosity and permeability of the sub-layers of the road;
- Concrete pipes must be strategically positioned under the road to drain surface water, this will ensure the road prism does not act as a barrier to water flow;
- The footprint area of the road should be kept a minimum. The footprint area must be clearly demarcated to avoid unnecessary disturbances to adjacent areas;
- All construction activities and access must make use of the existing road;
- Exposed road surfaces awaiting grading must be stabilised to prevent the erosion of these surfaces. Signs of erosion must be addressed immediately to prevent further erosion of the road;
- Silt traps and fences must be placed in the preferential flow paths along the road to prevent sedimentation of the watercourse;
- Temporary storm water channels should be filled with aggregate and/or logs (branches included) to dissipate flows;
- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly; and
- A suitable storm water plan must be compiled for the road. This plan must attempt to displace and divert storm water from the road, and discharge the water into adjacent areas without eroding the receiving areas. It is preferable that run-off velocities be reduced with energy dissipaters and flows discharged into the local watercourses.

8.2 Bridge upgrade mitigation measures

The following bridge upgrade specific mitigation measures are provided:

- The footprint area of the bridge must be kept to a minimum. The designated area should be demarcated to avoid unnecessary disturbances and encroachment into adjacent areas.
- Portions of the entry/exit road for the bridge must include a coarse rock layer that has been specifically incorporated to increase the porosity and permeability to accommodate flooding.

- The crossing should make use of a spanned piers with minimal instream piers. No structures must be placed within preferential flow paths.
- Piers should be constructed on the bedrock (if possible) and not within the channel bed, nor within the preferential flow path of the systems to avoid obstructing flows.
- The height of the bridge should accommodate the 1:100yr flood events.
- The bridge crossing must be aligned along the existing routes of disturbance i.e. where river bed and banks have already been modified.
- Embankments should be stabilised with gabions and mattresses to secure these areas and prevent further erosion.

8.3 General mitigation measures

The following general mitigation measures are provided:

- The wetland areas outside of the specific project site area must be avoided where possible;
- The construction vehicles and machinery must make use of existing access routes as much as possible, before adjacent areas are considered for access;
- Laydown yards, camps and storage areas must be beyond the aquatic areas. Where possible, the construction of the road and crossings must take place from the existing footpath and not from within the aquatic systems;
- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly;
- It is preferable that construction takes place during the dry season to reduce the erosion potential of the exposed surfaces;
- Temporary storm water channels and preferential flow paths should be filled with aggregate and/or logs (branches included) to dissipate and slow flows limiting erosion;
- Prevent uncontrolled access of vehicles through the river system that can cause a significant adverse impact on the hydrology and alluvial soil structure of these areas;
- All chemicals and toxicants to be used for the construction must be stored outside the channel system and in a bunded area;
- All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site;
- All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good “housekeeping”;
- Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel throughout the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation);
- Have action plans on site, and training for contactors and employees in the event of spills, leaks and other impacts to the aquatic systems;
- All removed soil and material must not be stockpiled within the system. Stockpiling should take place outside of the watercourse. All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds;

- Erosion and sedimentation into the channel must be minimised through the effective stabilisation (gabions and Reno mattresses) and the re-vegetation of any disturbed banks;
- Temporary and permanent erosion control methods may include silt fences, flotation silt curtains, retention basins, detention ponds, interceptor ditches, seeding and sodding, riprap of exposed embankments, erosion mats, and mulching;
- Any exposed earth should be rehabilitated promptly by planting suitable vegetation (vigorous indigenous grasses) to protect the exposed soil;
- Large trees and other debris often collect upstream against the culverts, damming up the channel with risk of flooding and damaging the river crossing and its banks. This debris should be cleared routinely with appropriate disposal of the debris. Timber can be sold or donated to local communities;
- No dumping of construction material on-site may take place; and
- All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported.

9 RECOMMENDATIONS

The following recommendations are provided for the study:

- The unchannelled valley bottom wetland identified for the study that occurs in the south-western section of the site has been extensively modified through canalization of the wetland, building of residences in the wetland area, soil modification, rubble dumping etc. This area still represents a wetland system although this area should rather be managed in a grass stormwater canal considering that the residences in the area have modified most of the wetland from its original state. The section to the south of the R556 road has been canalised to divert water further south towards the Elands River."
- A wetland rehabilitation plan should be compiled for the project, with a key focus being the rehabilitation of the channelled valley bottom wetland. The plan should include measures to rehabilitated gullies and head cuts, and also include measures to prevent further erosion of the system.

10 CONCLUSIONS

A number of NFEPA wetlands were identified within 500m of the project area. These include channelled and unchanneled valley bottom wetlands. All of the NFEPA wetlands within 500m of the project area are classified as critically modified, with these systems having a percentage of natural cover of <25%.

Four (4) HGM units were identified within the 500m project assessment boundary, namely;

- Channelled Valley Bottom (HGM 1);
- Unchannelled Valley Bottom (HGM2);
- Unchannelled Valley Bottom (HGM3); and
- Depressions (dam) (HGM 4).

Two dams were identified for the project. These dams are considered to be endorheic, with no outflow. These systems are thought to be old borrow pits, and are not regarded as natural wetland systems. Based on this, the depressions will not be considered for the ecological assessment and risk study components.

The PES results for the wetlands associated with the project area.

HGM 1	Channelled valley bottom	Overall PES Class	E: Seriously Modified
HGM 2	Unchannelled valley bottom	Overall PES Class	C: Moderately Modified
HGM 3	Unchannelled valley bottom	Overall PES Class	E: Seriously Modified

HGM 1 had an overall intermediate level of service with the following showing moderately high levels of services;

- Sediment trapping; and
- Phosphate/Nitrate/Toxicant assimilation.

HGM 2 had an overall intermediate level of service with the following showing moderately high levels of services;

- Phosphate/Nitrate/Toxicant assimilation.

HGM 3 had an overall intermediate level of service with the following showing moderately high levels of service;

- Nitrate assimilation.

The remaining services for the HGM unit were scored as intermediate or lower.

HGM 1 and HGM 2 showed Moderate (C) level of importance for the Ecological Integrity & Sensitivity as well as for the Hydrological Importance. The Direct Human benefits were rated to be Moderate (C) and Low (D) for HGM 1 and HGM 2 respectively.

HGM 3 showed Low (D) level of importance for the Ecological Integrity & Sensitivity as well as for the Direct Human benefits. The Hydrological / Functional benefits were rated to be moderate.

The EIS results for the Project.

WETLAND IMPORTANCE AND SENSITIVITY	
HGM 1	
	Importance
ECOLOGICAL IMPORTANCE & SENSITIVITY	1.3
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	1.9
DIRECT HUMAN BENEFITS	1.1
HGM 2	
	Importance
ECOLOGICAL IMPORTANCE & SENSITIVITY	1.7
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	1.7
DIRECT HUMAN BENEFITS	1.0
HGM 3	
	Importance
ECOLOGICAL IMPORTANCE & SENSITIVITY	0.4
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	1.5
DIRECT HUMAN BENEFITS	0.9

Buffer zones were suggested for the various HGM units to address the vulnerability of the wetlands to impacts. A buffer zone of between 16 – 18m during the construction phase of the project was determined for the three units. Additionally, a buffer zone of 15m during the operational phase, is recommended for all three HGM units.

PHASES	BUFFER		
	HGM 1	HGM 2	HGM 3
Construction Phase	18m	16m	17m
Operational Phase	15m	15m	15m

The project is for the proposed mixed housing typologies on Ptn 15 of the farm Ledig, No. 909. The proposed site development plan will have a limited impact on the channelled and unchanneled valley bottom wetlands, with a key focus on the roads which will traverse these systems.

The unchannelled valley bottom wetland identified for the study that occurs in the south-western section of the site has been extensively modified. This area still represents a wetland system although this area should rather be managed in a grass stormwater canal considering that the residences in the area.

This project has the potential address a number of aspects identified during the study that may be impacting on the status and function of these systems. Aspects that may be improved upon for the development include the following:

- Improved storm water management to prevent sedimentation of the receiving wetland systems.
- An improved storm water management system will also address the formation of gullies and head cuts in the catchment area. It will also likely reduce the extensive erosion of the wetland systems.

- Improved services will provide a formal means for the dumping and disposal of waste for the area. Waste that has been dumped within the systems must be removed and disposed of in designated areas.
- Drains and channels that have been dig within the wetlands and catchment to divert flows can be backfilled to restore the hydrology of the systems.

The proposed development, specifically the construction of crossings (or bridges) does pose a risk to the identified wetlands, with the level of risk determined to vary from low to moderate. The low risk ratings may largely be attributed to the current state of the local wetland systems.

The moderate risks determined for the study are associated with both phases of the project, which are largely associates with direct risks to the wetland areas, and then the operational phase of the project. The moderate risks associated with the operation phase of the project is largely due to the lifespan of these risks, being for the life of the project. The project does have the potential to address existing aspects that are impacting on the wetland systems. The moderate risk ratings were all re-allocated a low status due to implementation of additional mitigation methodologies.

The wetland identified in the south-western section of the site should rather be managed in a grass stormwater canal considering that the residences in the area have modified most of the wetland from its original state. Additionally, a wetland rehabilitation plan should be compiled for the project, with a key focus being the rehabilitation of the channelled valley bottom wetland. The plan should include measures to rehabilitated gullies and head cuts, and also include measures to prevent further erosion of the system.

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