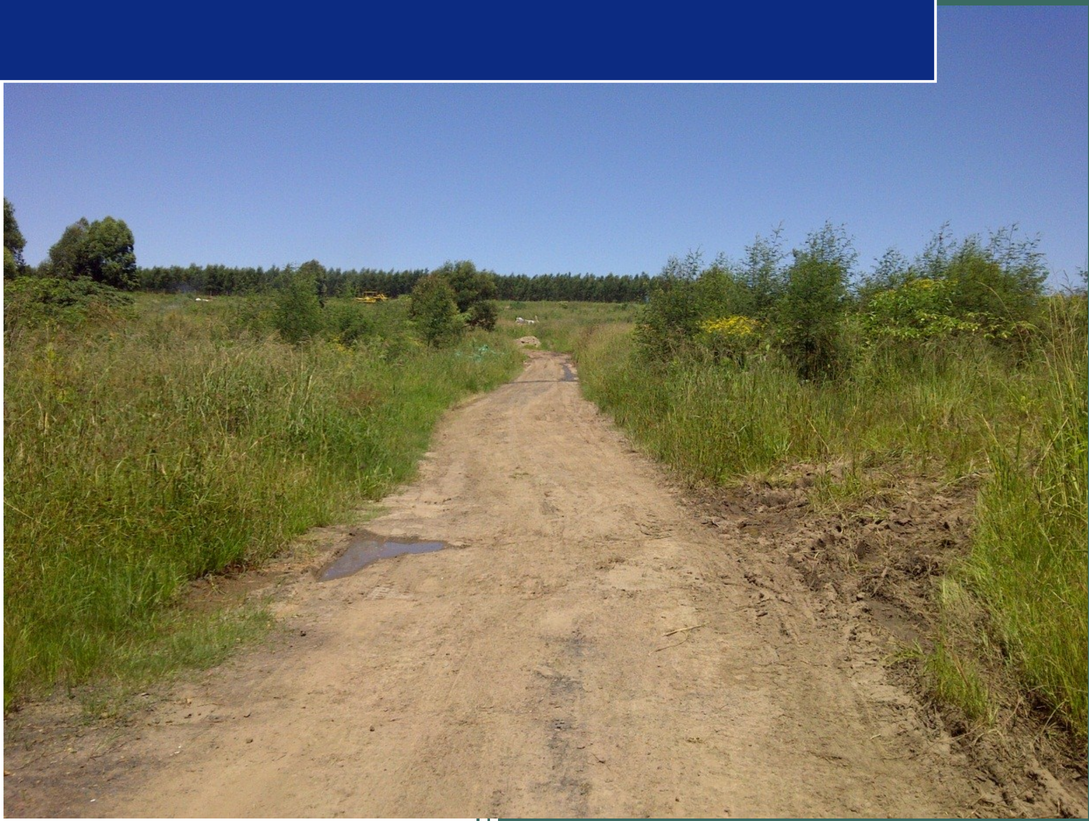
Wetland Study

Harding Landfill Site



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List of acronyms

Acronym	Explanation
CARA	Conservation of Agricultural Resources Act (No. 43 of 1983)
DAEA	Department of Agriculture and Environmental Affairs
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
HGM	Hydrogeomorphic unit
KZN	KwaZulu-Natal
MAP	Mean Annual Precipitation
NFEPA	National Freshwater Ecosystem Priority Areas
PES	Present Ecological State
PET	Potential Evapotranspiration
PGS	Present Geomorphic State
PHS	Present Hydrological State
PVS	Present Vegetation State
SANBI	South African National Biodiversity Institute
SVs	Sub-Escarpment Savanna
SVs 4	Ngongoni Veld

1. INTRODUCTION

Local, regional and national regulatory bodies, such as the Departments of Water Affairs (DWA) and Agriculture and Environmental Affairs (DAEA), have adopted legislation, policies and guidelines that regulate the use of freshwater ecosystems to protect and maintain these systems' benefits and services to society and the natural environment. In order to be regulated, these systems must first be identified, delineated and assessed. The objective of the delineation procedure is to identify the boundary between the wetland habitat and adjacent terrestrial areas.

The delineation process identifies the boundary between the wetland habitat and the adjacent terrestrial areas, based on the periphery of the temporary wetness zone. The legal definition[2] is as follows:

- *"Wetland means 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."*

Hydrology is considered to be the primary biophysical driver of freshwater ecosystems, but due to its variability, it is not possible to efficiently and accurately delineate these systems based on water levels (Richardson & Vepraskas, 2001). The delineation of wetland habitat therefore, relies on indirect indicators, such as wetland vegetation and soil characteristics.

The study area for this project is the landfill site located on the outskirts of Harding, KwaZulu-Natal (**Figure 1-1**). To minimise impacts on the freshwater ecosystems, GroundTruth was requested to delineate and assess the wetland habitat within the study area. The delineation and assessment of the wetland habitat in and around the development site are outlined in this report.

[2] As per the National Water Act (Act No. 36 of 1998)

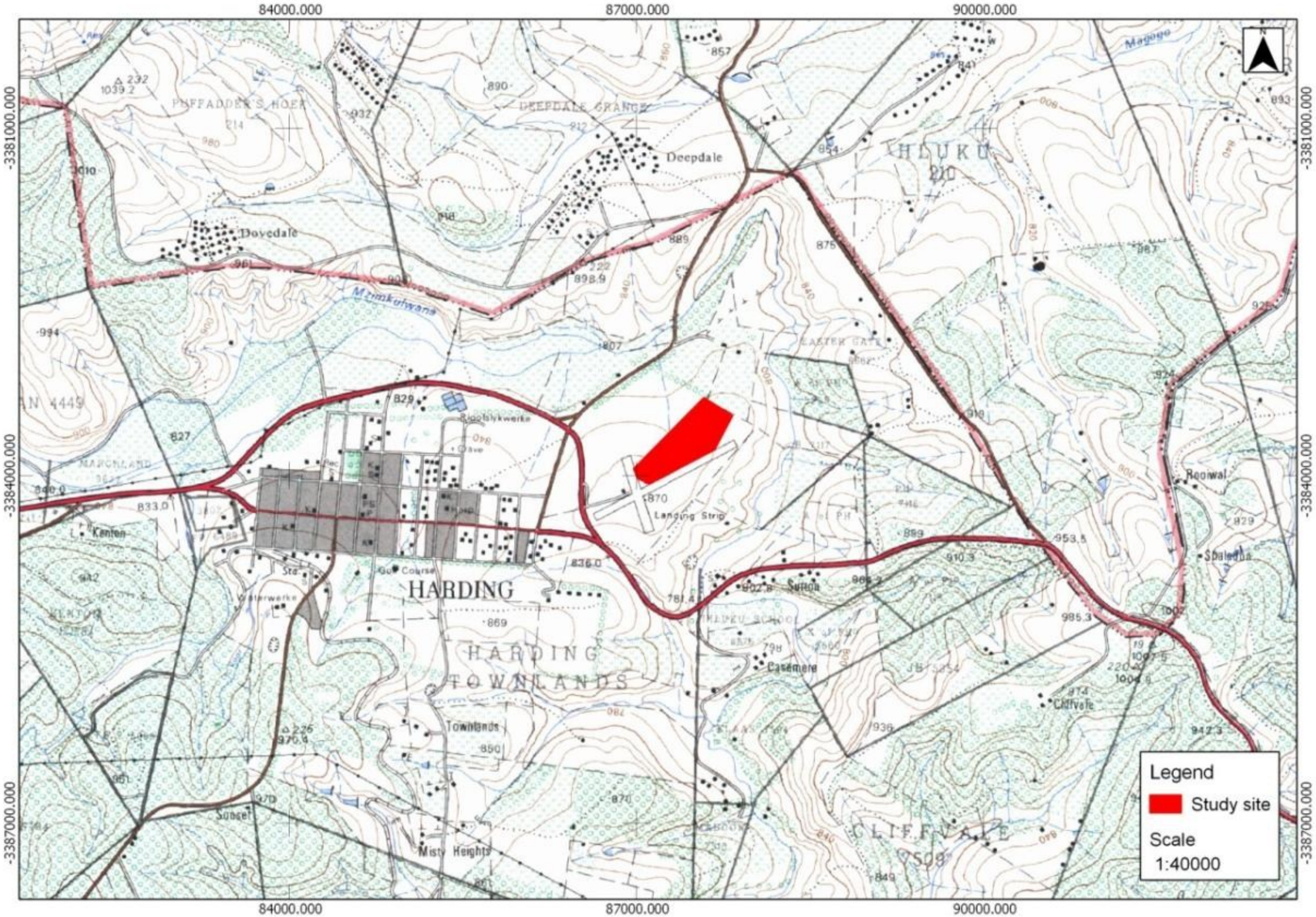


Figure 1-1. Locality of the study site

2. STUDY SITE

The following section provides an overview of the greater study site, focusing on the regional context, climate, geology and wetland types.

2.1. Regional/landscape context

South Africa is a semi-arid country, and thus wetlands are important features within the landscape as they provide ecosystem services directly related to water quantity and quality. Approximately 300'000 ha of wetlands or 2.4% of South Africa's surface area remain. It is estimated that over 50% of South Africa's wetlands have been lost (Kotze *et al.,* 1995). Nel and Driver (2012) estimate that in excess of 65% of South Africa's wetlands are under threat, of which 48% of these are critically endangered.

Within the KwaZulu-Natal region, wetlands have been subjected to high levels of modification and destruction (Kotze *et al*, 1995; Macfarlane *et al*., 2012a). The factors contributing towards the degradation of the systems vary greatly, but the predominant impacts include urbanisation, abstraction, dams, cultivation, drainage and over-grazing (Macfarlane *et al*., 2012a). The loss of wetland habitat within KwaZulu-Natal is considered to be of concern due to the value of wetlands in terms of contributions to water quantity and quality, supporting unique biological diversity and other ecosystem services (Kotze *et al*, 2007). Taking into consideration the above-mentioned degradation of freshwater ecosystems, it is important that the proposed development attempt to maintain the current levels of ecosystem service delivery, and where possible, enhance the systems' ability to supply these benefits and services.

2.2. Climate

The study area falls within the T52K quaternary catchment, as defined by Midgley *et al.* (1994). The mean annual precipitation (MAP) for the T52K catchment is 865.6mm and Potential Evapo-transpiration (PET) is 1573.9mm, which suggests that the wetlands within these catchments would have a **Moderately Low** sensitivity to hydrological impacts within the catchment (Schulze, 2007).

2.3. Geology

Mucina and Rutherford (2006) describe the geology for the greater region to be underlain by Ordovician Natal Group sandstone, Ecca Shale, Dwyka tillite and Mapumulo gneiss which are dominated by red soils due to the weathering of old dunes.

2.4. Vegetation types

Under pristine conditions the surrounding landscape and study site would have been characterised by particular vegetation types. The historical dominant vegetation type present would have been the Ngongoni Veld (SVs 4), which falls under the Sub-Escarpment Savanna (SVs) bioregion (Nel *et al.,* 2011; Mucina and Rutherford, 2006).

The Ngongoni Veld (SVs4) has been classified as 'vulnerable', with less than 1% receiving formal protection. Approximately 61% remains, whilst the other 39% has been transformed by agriculture, forestry, and urbanization. This vegetation type stretches across KwaZulu-Natal and the Eastern Cape and generally occurs at altitudes of 400-900 m above sea level.

2.5. Wetland classification

The South African National Biodiversity Institute (SANBI, 2009) has developed a wetland classification system for all wetlands in South Africa, allowing for the differentiation between the systems and the prioritisation of these systems either for conservation or management purposes. Various classification systems existed, however; South Africa lacked a broad classification system. The SANBI (2009) classification system categorises the wetland systems according to their abiotic features (main biophysical drivers) of these systems, which influences the functionality of the wetlands.

The definition of a wetland, particularly relating to this classification system has to be understood. The definitions informing the classification system included:

- "*Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres"*[3]
- *"Land which is transitional between terrestrial and aquatic systems, where the water table is usually at, or near the surface, or the land is periodically covered with shallow water and which land in normal circumstances supports, or would support, vegetation adapted to life in saturated soil.*"[4]

The result was SANBI's adapted version for the definition of a wetland (SANBI, 2009):

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

The SANBI classification system uses a hierarchical system based on six levels to differentiate between the various wetland types, with the first level dividing wetlands according to their system (*e.g.* marine, estuarine or inland systems) and the sixth level grouping the wetlands according to their wetland characteristics, namely geology, natural vs. artificial, vegetation cover type, substratum, salinity and acidity/alkalinity.

[3] Ramsar Convention (Davis, 1994)
[4] National Water Act (Act No. 36 of 1998)

In terms of the assessment of ecosystem functioning and health, the fourth level classifies wetland systems based on the principles of the hydrogeomorphic (HGM) approach (Ewart-Smith *et al.*, 2006) with eight primary HGM unit types:

- Channel (river, including the banks);
- Channelled valley-bottom wetland;
- Unchannelled valley-bottom wetland;
- Floodplain wetland;
- Depression;
- Flat;
- Hillslope seep; and
- Valleyhead seep (SANBI, 2009).

For the purpose of this study the HGM unit classification in Kotze *et al*. (2007) was used to classify the wetland systems into six different HGM units (**Appendix 1**) and assess the system. The HGM unit types defined by Kotze *et al*. (2007) differ from the SANBI (2009) types, with the river classification being excluded and flat wetlands being grouped with the depression wetlands. An unchannelled valley-bottom wetland was identified within the study site (**Table 2-1**).

Table 2-1 A description of the wetlands based on the SANBI classification to Level 4

System (Level 1)	Bioregion (Level 2)	Landscape Unit (Level 3)	HGM Unit (Level 4)	Description of HGM Units (Kotze *et al*, 2007)
Inland systems	Sub-Escarpment Savanna (SVs) Bioregion	Valley floor landscape units	**Valley-bottom**	
			Unchannelled	Valley-bottom areas with no clearly defined stream channel usually gently sloped and characterised by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.

2.6. Threat status of the wetlands

The wetland type, as described in **Section 2.5**, falls within the Sub-Escarpment Savanna Bioregion. Based on the wetland and vegetation type, and the level of protection this system receives, the ecosystem threat status can be assessed (Nel *et al*., 2011). **Table 2-2** depicts the HGM unit found within the study site and the corresponding threat status.

Table 2-2. HGM units classified according to their threat status and level of protection (adapted from Net *et al.,* 2011 and Macfarlane *et al.,* 2012b)

Wetland Type (WT) / HGM Unit	Ecosystem Threat Status (ETS) perWT	Level of Protection (WT)	ETS per Wetland Vegetation Group
Unchannelled valley-bottom	Critically Endangered (CR)	Not Protected (NP)	CR

For the wetland type the ecosystem threat status is considered to be "critically endangered". This is mostly related to minimal protection this vegetation unit receives and the level of transformation that has occurred, as described in **Section 2.4**. It should be noted that Ezemvelo KZN Wildlife (2009) makes reference to the fact that transformed systems, such as the system within the study site, are weighted differently. The rehabilitation of transformed wetland systems allows for the provisioning of wetland habitat that previously was non-existent.

2.7. National Freshwater Ecosystem Priority Areas

The National Freshwater Ecosystem Priority Areas (NFEPA) is a tool that has recently been developed to assist in the conservation and sustainable use of South Africa's freshwater ecosystems, including rivers, wetlands and estuaries. The maps and supporting documentation offer a comprehensive suite of information promoting suitable water resource planning. In addition, they provide a spatial overview of these systems, assisting in the implementation of the National Water Act, the Biodiversity Act and the Protected Areas Act (Nel *et al.,* 2011).

The freshwater ecosystems have been classified according to their Present Ecological State (PES). Wetlands are classified as 'AB', 'C', and 'DEF' or 'Z' categories (**Table 2-3**); depending on whether the systems are considered to be in good, moderately modified or heavily modified condition, respectively (Nel *et al.,* 2011). These categories have not been based on field data, as there is insufficient data at a national scale. Thus, the process modelled the ecological categories to serve as a guideline to inform the selection of NFEPA wetlands.

Table 2-3. Description of NFEPA wetland condition categories
(Nel *et al.,* 2011)

PES equivalent	**NFEPA condition**	**Description**	**% of total wetland area***
Natural or Good	AB	Percentage natural land cover ≥ 75%	47
Moderately modified	C	Percentage natural land cover 25-75%	18
Heavily to critically modified	DEF	Riverine wetland associated with a D, E, F or Z ecological category river	2
	Z1	Wetland overlaps with a 1:50 000 'artificial' inland water body from the Department of Land Affairs: Chief Directorate of Surveys and Mapping (2005-2007)	7
	Z2	Majority of the wetland unit is classified as 'artificial' in the wetland locality GIS layer	4
	Z3	Percentage natural land cover ≤ 25%	20

*this percentage excludes unmapped wetlands, including those that have been irreversibly lost at a national level

According to the available NFEPA coverage, the wetland habitats and Mzimkhulwana River in close proximity to the study site have been classified as NFEPA systems (**Figure 2-2**). The portion of the wetland habitat described as NFEPA system occurs within a sub-quaternary catchment containing records of breeding and/or sightings of crane species. The utilisation of the identified wetland habitat within the region by crane species would need to be further investigated during the environmental authorisation process, to be able to motivate for the development layout to be planned in close proximity to the wetland habitat. In addition, any development in close proximity to NFEPA freshwater ecosystems, within or directly adjacent to the study site, should be given special consideration, in terms of the layout planning, for example, the adoption of buffer zones in excess of 50m. However, the assessment of the functioning and integrity of these wetlands serves to confirm the condition reflected by the NFEPA study and guide the development layout and mitigation of impacts (**Section 7**).

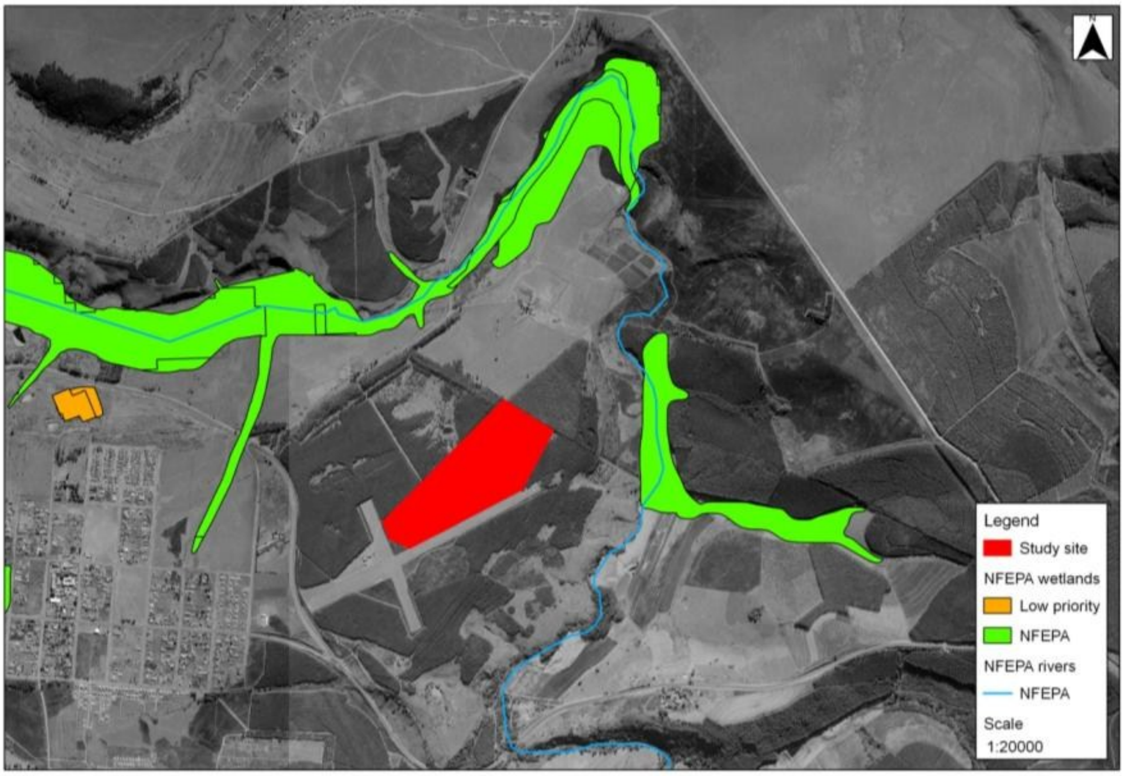


Figure 2-1. View of NFEPA systems and their classification

3. STUDY TEAM

The project team consisted of two team members, with experience in the assessment of wetland habitats within KwaZulu-Natal (**Table 3-1**).

Table 3-1 Team members, roles, experience levels and qualifications

Wetland Practitioner	Role in the Study	Experience Levels	Qualifications
Craig Cowden	• Review of the mapping and project report	13 years' experience, with input into various wetland studies, including: • delineation, • assessments, • rehabilitation planning and • mitigation & offset requirements	B.Sc. (Agric) Pr.Sci.Nat - Ecology
Brad Graves	• Conducting the infield wetland assessments • GIS mapping • Conducting the wetland assessments • Compilation of the project report	7 years' experience, with input into various wetland studies, including: • Delineation, • Assessments, and • Rehabilitation planning.	B.Sc. (Hons)

4. STUDY METHODOLOGY

The following methodology was adopted to inform the assessment of the wetland habitat potentially impacted upon by the proposed development.

4.1. Site visit

A site visit was conducted on the 23rd January 2013 to map and verify the extent of the wetland habitat potentially impacted upon by the proposed development; and assess the current level of ecological integrity, and ecosystem services provided by the wetland.

4.2. Delineation of freshwater ecosystems

The wetland habitat within the study area was delineated in accordance with the DWA guideline document (DWAF, 2005). The boundary of the wetland habitat was determined infield using handheld soil augers to obtain soil samples (**Appendix 2**), with on-going assessments of the vegetation and landscape setting. The derived points were recorded using a mapping grade Global Positioning System (GPS)[5]. The subsequent information was used to inform the production of a Geographical Information System (GIS) spatial coverage of the boundaries of the wetland habitat.

In accordance with the preferences of the regional DWA, the study also attempted to:

- Identify and/or describe the seasonal and permanent zones of wetness within the study site (**Figure 4-1**), based on the infield interpretation of site characteristics (DWAF, 2005), including:
  - Soil profile characteristics;
  - Vegetation; and
  - Position within the landscape.

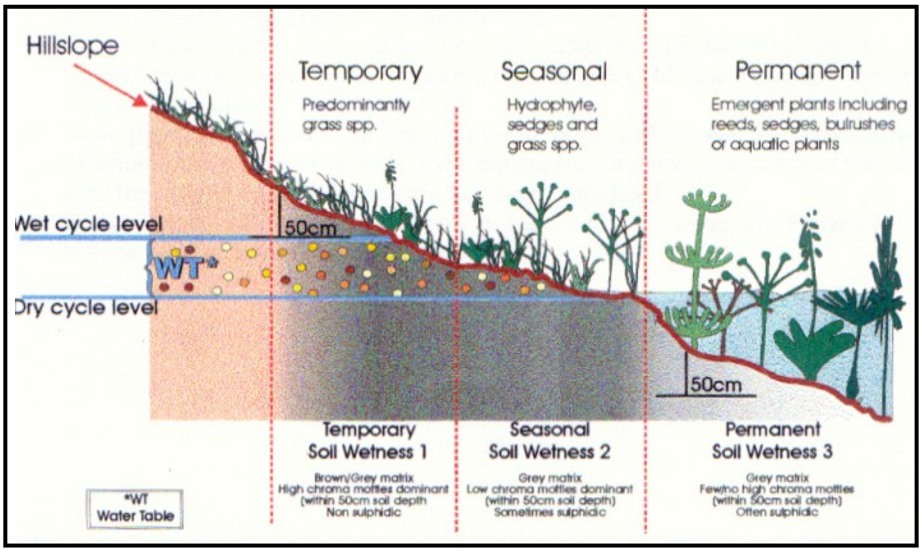


Figure 4-1. Wetness zones within wetland ecosystems (DWAF, 2005)

5 Trimble Nomad handheld unit, high performance GPS receiver.

4.3. Assessment of wetland functioning and condition

The assessment of the potential impacts of the proposed development was derived by evaluating the level of ecosystem functioning and ecological integrity/condition of the identified wetlands as outlined in the following sections.

4.3.1. Assessment of wetland functioning

At the outset of the assessment, the wetland system identified during the delineation was classified as a specific hydrogeomorphic (HGM) unit. To quantify the level of functioning of the wetland system, and to highlight its relative importance in providing ecosystem benefits and services at a landscape level, a WET-EcoServices (Kotze *et al.,* 2007) assessment was performed for the HGM unit. The WET-EcoServices assessment technique focuses on assessing the extent to which a benefit is being supplied by the wetland habitat, based on both:

- The opportunity for the wetland to provide the benefits; and
- The effectiveness of the particular wetland in providing the benefit.

Ecosystem services, which include direct and indirect benefits to society and the surrounding landscape, were assessed by rating various characteristics of the wetland and its surrounding catchment, based on the following scale:

- Low (0);
- Moderately Low (1);
- Intermediate (2);
- Moderately High (3); and
- High (4)

The scores obtained from these ratings for the wetland HGM unit was then incorporated into WET-EcoServices scores for each of the fifteen ecosystem services that the wetland is capable of providing (**Table 4-1**):

Table 4-1 Ecosystem services supplied by wetlands
(Kotze *et al.,* 2007, p14)

Ecosystem services supplied by wetlands	**Indirect benefits**	**Regulating and supporting benefits**		Flood attenuation	The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream
				Stream flow regulation	Sustaining stream flow during low flow periods
			Water quality enhancement benefits	Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters
				Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters
				Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters
				Toxicant assimilation	Removal by the wetland of toxicants (*e.g.* metals, biocides and salts) carried by runoff waters
				Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation
				Carbon storage	The trapping of carbon by the wetland, principally as soil organic matter
	Direct benefits	**Biodiversity maintenance**			Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity
		Provisioning benefits		Provision of water for human use	The provision of water extracted directly from the wetland for domestic, agricultural or other purposes
				Provision of harvestable resources	The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.
				Provision of cultivated foods	The provision of areas in the wetland favourable for the cultivation of foods
		Cultural benefits		Cultural heritage	Places of special cultural significance in the wetland, e.g. for baptism or gathering of culturally significant plants
				Tourism and recreation	Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife
				Education and research	Sites of value in the wetland for education or research

4.3.2. Assessment of wetland condition/integrity

To determine the level of ecological integrity, a WET-Health (MacFarlane *et al.*, 2007) assessment was performed for the HGM unit within the site. The WET-Health assessment technique gives an indication of the deviation of the system from the wetland's natural reference condition for the following biophysical drivers:

- Hydrology - defined as the supply of water to wetland and the distribution and movement of water through a wetland.
- Geomorphology - defined as the distribution and retention patterns of sediment within the wetland.
- Vegetation - defined as the vegetation structural and compositional state.

The impacts on the wetland, determined by features of the wetland and its catchment, were scored based on the impact scores and then represented as Present State Categories as outlined in WET-Health (**Table 4-2**).

Table 4-2 Impact scores and present state categories for describing wetland integrity (MacFarlane *et al.*, 2007)

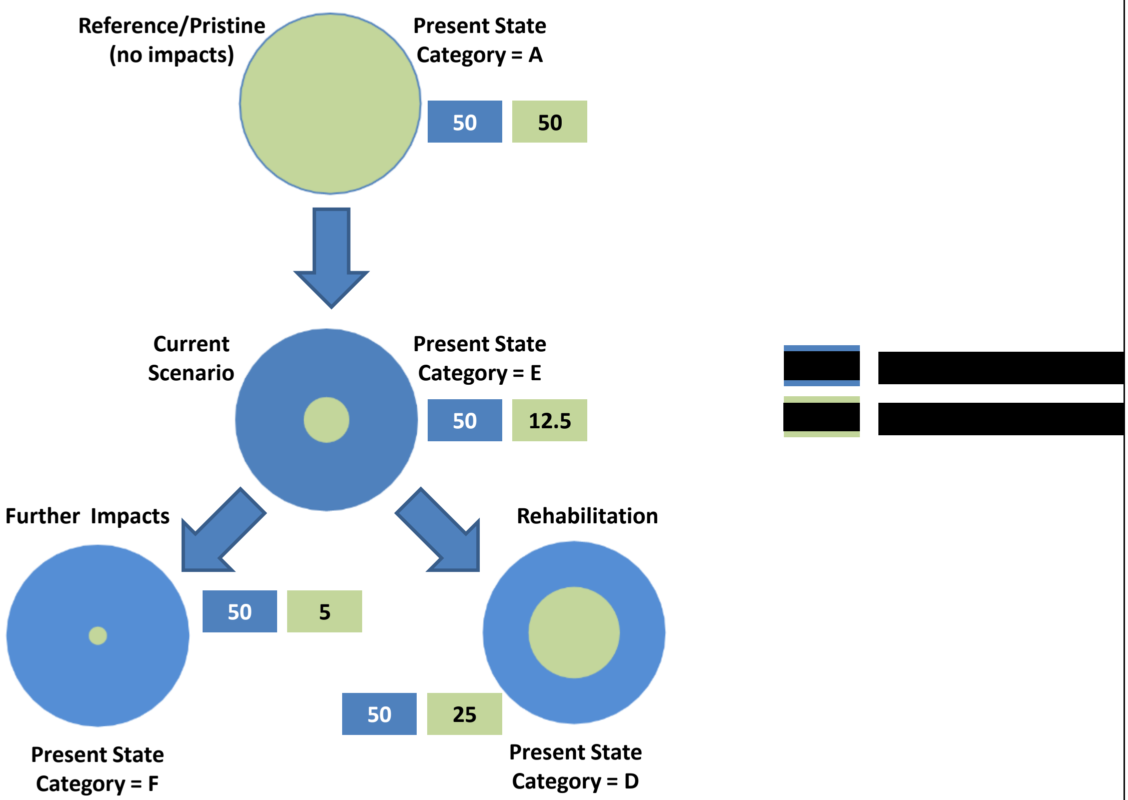
Impact Category	Description	Impact Score Range (0-10)	Present State Category
None	Unmodified, natural.	0-0.9	**A**
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	**B**
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	**C**
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	**D**
Serious	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**
Critical	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**

The scores for hydrology, geomorphology and vegetation were simplified into a composite impact score, using the predetermined ratio of 3:2:2 (MacFarlane *et al,* 2007), respectively for the three components. The composite impact score was used to derive a health score that then provided the basis for the calculation of hectare equivalents (also referred to as functional area), which can be described as the health of a wetland expressed as an area. Cowden & Kotze (2007) make use of a simple example to explain the concept of hectare equivalents conceptually illustrated in **Box 4-1**.

Box 4-1. Example of the use of hectare equivalents to represent changes in wetland health.

The assessment of wetland health is based on comparisons to a reference state *i.e.* where the wetland's health is unmodified and the functional area of wetland is equivalent to the full extent of the system. For example, if the health of a 50ha wetland is 100% (*Present State Category=A*) this equates to 50 hectare equivalents. In many instances the current scenario for a particular system reflects some form of historical degradation. If the abovementioned wetland was *seriously* degraded, the health would be reduced from the reference state to 25% (*reflecting a wetland health score of 2.5*); a drop in hectare equivalents from 50 to 12.5 (50ha x 0.25) hectare equivalents would be recorded. The following would therefore be expected if the wetland in the above scenario was subject to the following two future options:

a) Further degradation of the wetland linked to development, with the system's health being further reduced to 10% would result in a drop in hectare equivalents to 5 hectare equivalents; and
b) Rehabilitation of the wetland habitat, with the system's health being increased to 50% would result in a gain in hectare equivalents to 25 hectare equivalents.



NOTE:
The sizes of the circles are directly related to the extent of wetland habitat and functional wetland area in the landscape

5. ASSUMPTIONS AND LIMITATIONS

Studies that focus on the potential impacts of a proposed development rely on various assumptions, with the following assumptions being made during the assessment of these particular wetland systems:

- The reference benchmark vegetation of the wetland onsite is considered to be Ngongoni Veld (SVs 4) (Mucina and Rutherford, 2006), and sedge meadow.
- The bioregion is considered to be Sub-Escarpment Savanna (SVs) (Nel *et al.,* 2011), which has been classified as being critically endangered.
- The extent of wetland as determined in the delineation was used for the assessment of wetland within the potential development site;
- The hydrogeomorphic unit was assessed in its entirety, even if it included sections of artificial wetland or extends beyond the boundary of the development site;
- It is assumed that the wetland habitat within the chosen development site will be appropriately rehabilitated.

The following limitations apply to the studies undertaken for this report:

- The extent of hydrogeomorphic unit, beyond the study area, was derived from aerial imagery with limited infield verification. Due to the level of modification within the landscape the accuracy of the derived information is limited.
- The wetland assessment techniques used in this study were developed relatively recently and in some instances, such as highly modified/transformed systems, they may have shortfalls. These techniques, however, have been compiled based on international best practice to apply to South African conditions, undergoing a peer-review process during their development. These assessment techniques should therefore, be seen as the most appropriate tools for wetland assessments at this time.
- The assessment of the wetland systems' ecological integrity includes catchment conditions and it should be noted that changes in the HGM unit's catchment, beyond those linked to the development, could also have an adverse effect on the system's integrity.
- Due to time constraints, soil descriptions are based on moist conditions, rather than the dry conditions stipulated in the DWA guidelines (DWAF, 2005). Generally, the recorded Munsell colour values would increase as the soil dried and this is taken into consideration during the infield studies.

6. STUDY RESULTS

The results of the assessment of the wetland ecosystems within the study area are outlined in the following sections.

6.1. Characteristics of the freshwater ecosystems

The study site is characterised by an unchannelled valley-bottom wetland system (**Map GTW265-140313-01**). The HGM unit that flows from within the study site covers an area of approximately 7.94ha, which includes the wetland habitat extending beyond the boundary of the study site. The study site drains into a freshwater dam, and ultimately the Mzimkhulwana River (NFEPA River). The freshwater ecosystems within the study site are fed by both surface and sub-surface water inputs.

The wetland habitat is characterised mostly by seasonal zones of wetness. The entire site has undergone significant changes, from a diverse landscape to an agricultural and forestry setting. These changes in the landscape have led to the infestation of alien invasive plants species including *inter alia* Lantana (*Lantana camara*), Bramble (*Rubus cuneifolius*), Bugweed (*Solanum mauritianum*), Canna (*Canna indica*), Wattle (*Acacia mearnsii)* and Gum trees (*Eucalyptus sp.*).

The wetland is further impacted upon by the existing landfill trenches that have been excavated directly adjacent to the system. The close proximity of these excavations is a cause for concern, as they may be directly impacting on the quality of water within the systems. Furthermore, the disposal of waste has resulted in the accumulation of waste within the freshwater ecosystem, which poses a health risk to the neighbouring and downstream users.

6.2. Wetland ecological functioning

The general features of the HGM unit were assessed in terms of the ecosystem functioning at a landscape level for the current scenario. The score for each ecosystem service represents the likely extent to which that benefit is being supplied by the specific wetland and was interpreted based on the following rating outlined by Kotze *et al.* (2007):

- <0.5 Low
- 0.5-1.2 Moderately low
- 1.3-2.0 Intermediate
- 2.1-2.8 Moderately high
- >2.8 High

Generally the HGM Unit is supplying ecosystem services at an ***Intermediate*** to ***Moderately high*** level (**Figure 6-1** and **Table 6-1**). The HGM unit is considered to be important in terms of enhancing water quality within the landscape and contributing towards streamflow regulation. The importance of this wetland in terms of enhancing water quality is primarily linked to the high opportunity that exists for the wetland to provide these services associated with the potential of elevated levels of pollutants entering the system, rather than the effectiveness of the wetland providing these services. The effectiveness of the wetland, in terms of enhancing water quality, has been greatly reduced by the transformation of the system to forestry and the encroachment of alien invasive plant species. The modified nature of the wetland limits its integrity in terms of biodiversity and therefore limits the system's ability to provide undisturbed wetland habitat within the landscape. The system's provision of direct benefits and services, such as harvestable natural resources and use for education, is limited.

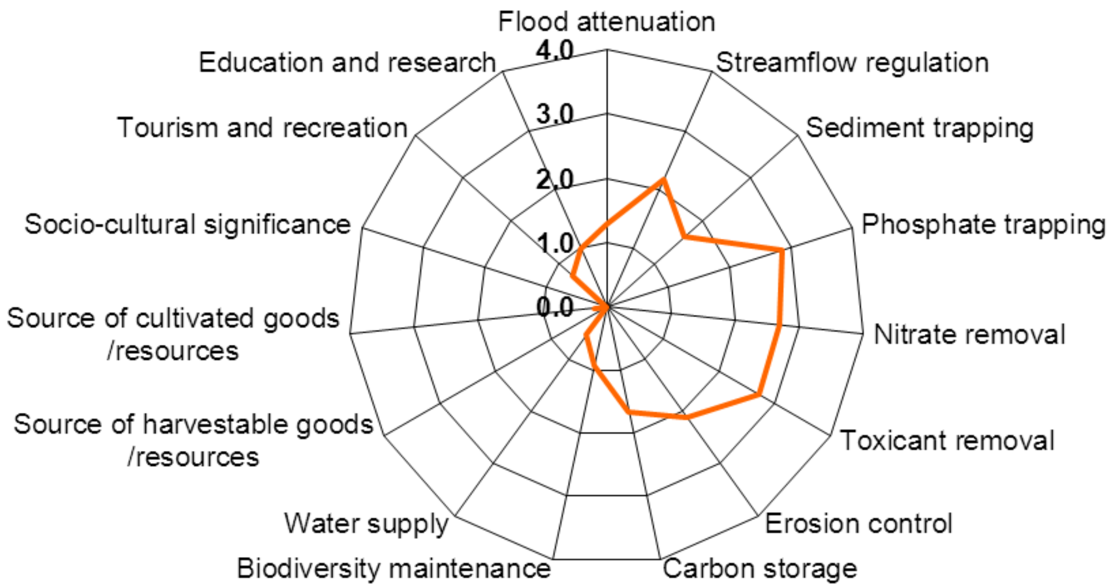


Figure 6-1 Graphic representation of the wetland ecosystem services for the HGM unit.

Table 6-1 Summary of Ecosystem Services Scores[6] for the HGM unit

Ecosystem Services	Harding Landfill Wetland
Flood attenuation	**1.3**
Score for effectiveness:	*1.2*
Score for opportunity:	*1.4*
Stream flow regulation	**2.5**
Sediment trapping	**2.0**
Score for effectiveness:	*0.6*
Score for opportunity:	*3.3*
Phosphate trapping	**3.2**
Score for effectiveness:	*2.4*
Score for opportunity:	*4.0*
Nitrate removal	**3.2**
Score for effectiveness:	*2.4*
Score for opportunity:	*4.0*
Toxicant removal	**3.1**
Score for effectiveness:	*2.1*
Score for opportunity:	*4.0*
Erosion control	**2.1**
Score for effectiveness:	*3.0*
Score for opportunity:	*1.3*
Carbon storage	**1.7**
Biodiversity maintenance	**0.9**
Score for noteworthiness:	*1.0*
Score for integrity:	*0.9*
Water supply	**0.6**
Source of harvestable goods /resources	**0.0**
Source of cultivated goods /resources	**0.2**
Socio-cultural significance	**0.0**
Tourism and recreation	**0.7**
Education and research	**1.0**

6.3.Wetland ecological condition/integrity assessment results

The ecological integrity or Present Ecological State (PES) of the HGM unit associated with the study site was assessed for the hydrology, geomorphology and vegetation components. The integrity of the biophysical components of the wetland was assessed for the current scenario. The results for the three components for the study site and a summary are outlined in the following sections. The results are summarized in **Table 6-2**.

[6] Where applicable the scores for opportunity and effectiveness have been presented to ensure understanding of effectiveness of the system due to its modified state.

Table 6-2 Overall ecological integrity of the HGM unit for the current scenario

	Hydrology	Geomorphology	Vegetation
Impact Score	8.0	0.6	8.6
PES Category	F	A	F

Description	Impact score	Present state 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 has occurred.	4 – 5.9	D
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
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

6.3.1. Assessment of impacts on hydrology

The impact score recorded for the hydrological component for the site was greater than **8**, translating into a Present Hydrological State (PHS) category of **F** – "Modifications are so great that the hydrological functioning has been drastically altered. 80% or more of the hydrological integrity has been lost." The modifications to the wetland's PHS are linked primarily to the following factors:

- Extensive forestry cultivation within the wetland habitat and its catchment;
- Alien invasive vegetation within the wetland habitat, increasing the direct uptake of water;
- Impeding features/infilling within the wetland habitat, including the presence of a dam and dirt roads leading to the waste dump site, and
- Altered water flows into the wetlands linked to catchment changes.

6.3.2. Assessment of impacts on geomorphology

The impact score recorded for the geomorphic component for the site was less than **1**, translating into a Present Geomorphic State (PGS) category of **A** – "Unmodified, natural." In this instance the limited modifications to the wetlands' PGS were evident due to impacts linked primarily to the following factors:

- Infilling of portions of the wetland habitat, associated with the access road to the waste dump site, resulting in the deactivation of downstream areas; and
- Altered water flows into the wetlands linked to extensive catchment changes.

The reduction in water inputs as a result of the land use within the wetland's relatively small catchment has reduced any risks to the systems geomorphology.

6.3.3. Assessment of impacts on vegetation

The impact score recorded for the vegetation component was greater than **8**, translating into a Present Vegetation State (PVS) category of **F** – "Vegetation composition has been totally or almost totally altered, and if any characteristic species still remain, their extent is very low." The modifications to the wetlands' PVS are linked primarily to the following factors:

- Complete removal of wetland vegetation through the cultivation of plantations;
- Encroachment of alien invasive vegetation into portions of the wetland habitat;
- The access road leading to the waste dump site; and
- The presence of a dam within the HGM unit.

6.3.4. Overall ecosystem integrity

The historical activities have resulted in modifications to the system's ecological integrity. For ease of interpretation the scores for hydrology, geomorphology and vegetation are able to be simplified into a composite score for the HGM unit, as outlined in Macfarlane *et al* (2007). The score was then used to derive hectare equivalents, which was used as the 'currency' for assessing the loss and gains in wetland integrity (Cowden & Kotze, 2007; Kotze & Ellery, 2009).

Based on the current PES score for the HGM unit, the approximately 7.94ha of wetland habitat, is considered to be the equivalent to 3.13ha of intact wetland habitat (**Table 6-3** and **Figure 6-2**). The graphical representation of the functional wetland area versus the total extent of the wetland habitat onsite, clearly illustrates that the wetland habitat is only functioning at approximately 39% (**Figure 6-2**).

Table 6-3. Ecological integrity and hectare equivalents

Harding Landfill Wetland			
	Hydrology	**Geomorphology**	**Vegetation**
Area weighted impact scores	**8.0**	**0.6**	**8.6**
PES Categories	**F**	**A**	**F**
Overall Impact Score	**6.06**		
Overall PES Category	**E**		
Hectares of Wetland	**7.94**		
Hectare Equivalents	**3.13**		

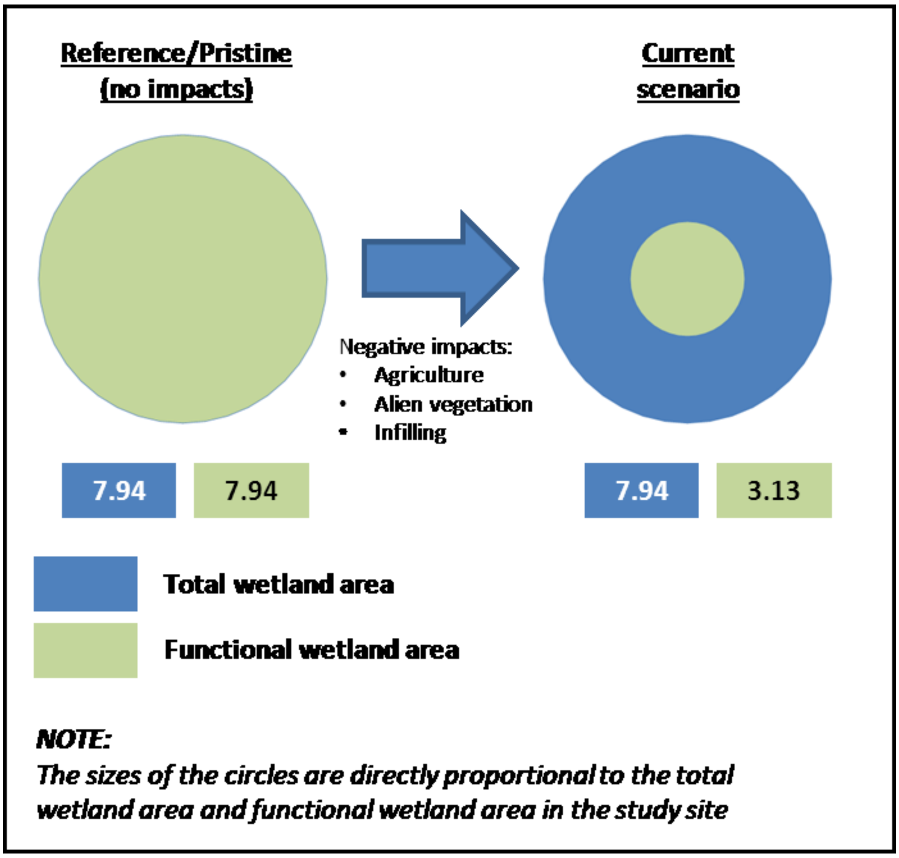


Figure 6-2. A graphic representation of the wetland habitat in terms of spatial extent and functional area.

7. RECOMMENDATIONS

Considering the loss of wetland habitat within KwaZulu-Natal, it is recommended that the planning and implementation of the proposed development should adopt a 'no-net-loss' approach. This would include the following options for the proposed development:

- Maintaining the current levels of ecosystem integrity and service delivery of the systems within the study area; and/or
- Mitigating and offsetting impacts of the proposed development on the systems by rehabilitating the habitat within the study area.

7.1. Buffer zones

In this instance, the wetland habitat within the development site has been significantly modified, with the alteration of the system's integrity associated with historical disturbance of the vegetation and hydrology. The wetland habitat onsite should be avoided as far as possible and it is generally recommended that developments incorporate a buffer zone from the edge of the wetland to assist in protecting the wetland system from further degradation. For example, the following buffer zones have been advocated for the following land uses:

- In an urban setting : 15m to 30m (KZN Department of Agriculture, Environmental Affairs and Rural Development, KZN Department of Water Affairs & *Ezemvelo* KZN Wildlife);
- In a plantation forestry setting : 20m;
- In an agricultural setting : 10m from edge of the river (CARA, Act 84 of 1983);
- In an urban landscape : 30m (Gauteng Department of Agriculture, Conservation and Environment); and
- In a rural landscape: 50m (Gauteng Department of Agriculture, Conservation and Environment).
- For locating wastewater storage dams and wastewater disposal sites: above the 100 year flood line, or alternatively, more than 100 metres from the edge of a water resource or a borehole which is utilised for drinking water or stock watering, whichever is further (Section 39 of the National Water Act, 1998).

In this instance, although the proposed landfill is not likely to be utilised for wastewater disposal purposes, there is a risk associated with leaching of effluent from the waste materials into the wetland. The Mzimkhulwana River, which is a priority wetland system, is also located directly downstream of the HGM unit affected by the landfill. Based on these facts, and the above norms and standards, a natural buffer of 50m would be recommended to reduce the risk of contamination of the wetland system both from leaching and solid waste polluting the wetland directly.

A buffer zone of 50m has been included in **Map GTW265-140313-01** to illustrate the remaining developable area within the development site, should the recommended buffer be adopted by the authorities. Adoption of the following best management practices to further promote the protection of the wetland system, should be considered:

- Rehabilitation of the buffer zone, with the removal of alien invasive vegetation species; to ensure an undisturbed vegetative community;

- Ideally, the establishment of indigenous vegetative cover within the buffer should take place prior to the implementation of construction activities to filter runoff before it enters the wetland habitat (Valparaiso City, 2004). However, if practical limitations exist to achieve this, the existing vegetation should be maintained to fulfil the buffer role during the construction phases. This would require a commitment from the developer to undertake the rehabilitation of the buffer zone upon completion of the construction activities;
- Implementation of engineering solutions designed to ensure that the risks of effluent leaching into the system are eliminated; and
- Enforcement and management of the buffer zone to ensure that there is no encroachment that would reduce the efficacy of the buffer zone.

7.2. Wetland management and rehabilitation

In order to mitigate the potential impacts of the proposed landfill on the identified wetland ecosystems, rehabilitation of the HGM unit onsite and downstream of the site until it joins the Mzimkhulwana River, is recommended. The rehabilitation of the wetland habitat would include the following activities:

- Rehabilitation/enhancement of the wetland habitat onsite where feasible, promoting the effectiveness and opportunity for the system to provide benefits and services, including:
    - Deactivation of the drains and berms identified within the system, ensuring that diffuse flow is maintained, and reducing the risks of erosion occurring; and
    - Eradication of alien invasive plant species within the wetland;
- The removal of excess vegetative material within the wetland at regular intervals (every 2-3 years depending on growth) to promote new growth and prevent the further encroachment of ruderal or weedy species; and
- Active re-vegetation of the wetland habitat with appropriate plant species, encouraging the re-establishment of near-natural conditions.

8. CONCLUSION

Despite the modifications to the identified freshwater ecosystems, they have the potential to supply a level of ecosystem services, and form an important linkage and function in the landscape in terms of aquatic ecosystems. Specific planning and mitigation activities should be adopted to reduce the impacts associated with the proposed landfill, including:

- Buffer zones;
- Engineering solution designs to protect the system from being contaminated (surface and sub-surface pollution) by the waste dump site;
- Appropriate buffer zone management; and
- Appropriate wetland habitat rehabilitation.

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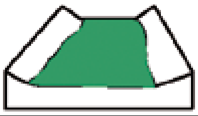
10. APPENDICES

Appendix 1:

Hydrogeomorphic (HGM) types (as per Kotze et al., 2007, p 27)

Hydrogeomorphic types	Description	Source of water maintaining the wetland[1]	
		Surface	Sub-surface
Floodplain 	Valley-bottom areas with a well defined stream channel, gently sloped and characterized by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*
Valley-bottom, channelled 	Valley-bottom areas with a well defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterized by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*/ ***
Valley-bottom, unchannelled 	Valley-bottom areas with no clearly defined stream channel, usually gently sloped and characterized by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.	***	*/ ***
Hillslope seepage linked to a stream 	Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well defined stream channel connecting the area directly to a stream channel.	*	***
Isolated Hillslope seepage 	Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through diffuse sub-surface and/or surface flow but with no direct surface water connection to a stream channel	*	***
Depression (includes Pans) 	A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream channel network	*/ ***	*/ ***

Appendix 2

Sample plot descriptions and photographs collected during the field component of the study using a data collection sheet adapted from Job (2009).

Project/Site: Harding landfill site
Sample Plot No.: 1
Date: 23 January 2013
Lat: -3383560.73070349
Long: 87412.860389
(WGS84 Lo29)

Do normal circumstances exist on the site? Yes ~~No~~
Is the site significantly disturbed (difficult site)? ~~Yes~~ No
Is the area a Specific Case per Appendix A of the delineation manual? ~~Yes~~ No

TERRAIN UNIT INDICATOR

Position in the landscape:
☐ crest ☐ footslope
☐ scarp ☒ valley bottom
☐ midslope

Local relief:
☐ flat
☒ concave
☐ convex

VEGETATION INDICATOR

Dominant or indicator species within sample plot	Indicator Category	% Cover
Eragrostis spp	Terrestrial	70
Andropogon spp	Terrestrial	20
Bare soil	N/A	10

Are more than 50% of dominant species (> 50% cover) obligate, facultative positive or facultative negative? ~~Yes~~ No

SOIL WETNESS INDICATORS

Soil Profile Description:

Depth (cm)	Matrix Color (Munsell)	Mottle Colors (Munsell)	Texture, Concretions, Rhizospheres, etc.
0 - 15cm	10Y/R 3/2	N/A	N/A
15-45cm	10Y/R 3/3	N/A	N/A
45-50cm	10Y/R 4/6	N/A	N/A

Zone of Wetness:
☐ Permanent Wetness Zone
☐ Seasonal Wetness Zone
☐ Temporary Wetness Zone
☒ Non-Wetland or Dryland

Features present within 50cm of the soil surface:
☐ Organic soil ☐ High organic content in surface layer
☐ Grey/gleyed matrix ☐ Mottle / concretions
☐ Organic streaking ☐ Sulfidic odour
☐ Other

Munsell colour one of the following? ~~Yes~~ No

Gley 1:
☐

Gley 2:
☐

Hue 5YR:
☐ value 5 or more/chroma 2 or less OR
☐ value 6 or more/chroma 4 or less

Hue 7.5YR:
☐ value 5 or more/chroma 2 or less OR
☐ value 6 or more/chroma 4 or less.

Hue I0YR:
☐ value 4 or more/chroma 2 or less OR
☐ value 5 or more/chroma 3 or less OR
☐ value 6 or more/chroma 4 or less

Hue 2.5Y:
☐ value 5 or more/chroma 2 or less OR
☐ value 6 or more/chroma 4 or less

Hue 5Y:
☐ value 5 or more/chroma 2 or less

HYDROLOGY INDICATORS (Generally applicable to Permanent/Seasonal Zones of Wetness)
☐ Inundated
Depth of Surface Water: N/A
☐ Evidence of bedrock or other impermeable layer within 30-50 cm of the soil surface.
☐ Saturated within 50 cm of surface
Depth to Saturated Soil: N/A
☐ Sediment Deposits
☐ Aquatic invertebrates
☐ Salt Crust
☐ Oxidized Root Channels
☐ Water-Stained Leaves
☐ Water Marks

WETLAND DETERMINATION

Terrain unit indicators present?	~~Yes~~	No
Vegetation indicators present?	~~Yes~~	No
Soil wetness indicators present?	~~Yes~~	No
Hydrology indicators present?	~~Yes~~	No
Is this sampling plot within wetland?	~~Yes~~	No

Sample Plot Photographs

Overview of the Soil Profile	View of Soil Features	
	**Dark brown soil** 	**Dark yellowish brown soil** 
	Location of the sample site 	

Project/Site: Harding landfill site
Sample Plot No.: 2
Date: 23 January 2013
Lat: -3383579.83497248
Long: 87354.879893
(WGS84 Lo29)

Do normal circumstances exist on the site? Yes ~~No~~
Is the site significantly disturbed (difficult site)? ~~Yes~~ No
Is the area a Specific Case per Appendix A of the delineation manual? ~~Yes~~ No

TERRAIN UNIT INDICATOR

Position in the landscape:
☐ crest ☐ footslope
☐ scarp ☒ valley bottom
☐ midslope
Local relief:
☐ flat
☒ concave
☐ convex

VEGETATION INDICATOR

Dominant or indicator species within sample plot	Indicator Category	% Cover
Paspalum urvillei	Facultative positive	30
Kylinga erecta	Obligate	35
Cyperus longus	Obligate	35

Are more than 50% of dominant species (> 50% cover) facultative positive or facultative negative? Yes ~~No~~

SOIL WETNESS INDICATORS

Soil Profile Description:

Depth (cm)	Matrix Color (Munsell)	Mottle Colors (Munsell)	Texture, Concretions, Rhizospheres, etc.
0 - 25cm	10Y/R 2/2	N/A	N/A
25-40cm	10Y/R 3/1	N/A	N/A
40-50cm	10Y/R 4/2	10Y/R 4/6	N/A

Zone of Wetness:
☐ Permanent Wetness Zone
☐ Seasonal Wetness Zone
☒ Temporary Wetness Zone
☐ Non-Wetland or Dryland

Features present within 50cm of the soil surface:
☐ Organic soil ☐ High organic content in surface layer
☒ Grey/gleyed matrix ☒ Mottle / concretions
☐ Organic streaking ☒ Sulfidic odour
☐ Other
Munsell colour one of the following? Yes ~~No~~
Gley 1:
☐
Gley 2:
☐
Hue 5YR:
☐value 5 or more/chroma 2 or less OR
☐value 6 or more/chroma 4 or less
Hue 7.5YR:
☐ value 5 or more/chroma 2 or less OR
☐ value 6 or more/chroma 4 or less.
Hue I0YR:
☒value 4 or more/chroma 2 or less OR
☐ value 5 or more/chroma 3 or less OR
☐ value 6 or more/chroma 4 or less
Hue 2.5Y:
☐value 5 or more/chroma 2 or less OR
☐value 6 or more/chroma 4 or less
Hue 5Y:
☐value 5 or more/chroma 2 or less

HYDROLOGY INDICATORS (Generally applicable to Permanent/Seasonal Zones of Wetness)
☐ Inundated
Depth of Surface Water: N/A
☐ Evidence of bedrock or other impermeable layer within 30-50 cm of the soil surface.
☒ Saturated within 50 cm of surface
Depth to Saturated Soil: 40cm
☐ Sediment Deposits
☐ Aquatic invertebrates
☐ Salt Crust
☐ Oxidized Root Channels
☐ Water-Stained Leaves
☐ Water Marks

WETLAND DETERMINATION

Terrain unit indicators present?	Yes	~~No~~
Vegetation indicators present?	Yes	~~No~~
Soil wetness indicators present?	Yes	~~No~~
Hydrology indicators present?	Yes	~~No~~
Is this sampling plot within wetland?	Yes	~~No~~

Sample Plot Photographs

<table>
<tr><td colspan="1">Overview of the Soil Profile</td><td colspan="2">View of Soil Features</td></tr>
<tr><td rowspan="2"></td><td>Very dark brown soil
</td><td>Dark greyish brown soil
</td></tr>
<tr><td colspan="2">Location of the sample site
</td></tr>
</table>

Appendix 3

Map

The following map shows the extent of the wetland habitat identified within the study area and an illustrative buffer distance.