Wetland Assessment for the proposed Newcastle Greenwich Landfill Development

Newcastle, KwaZulu-Natal Province

March 2018

CLIENT

Prepared for:

GCS Water & Environmental Consultants

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Report Name	**Wetland Assessment for the proposed Newcastle Greenwich Landfill Development**	
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Report Reviewer	**Andrew Husted (Pr. Sci. Nat. 400213/11)**	

Executive Summary

The Biodiversity Company was commissioned to conduct a wetland assessment as part of a Water Use Licence Application (WULA) and environmental authorisation processes for the proposed Landfill site development on the Greenwich Farm in the Newcastle area within the KwaZulu-Natal Province. A single site visit was conducted on the 21st of February 2018, which would constitute a wet season survey.

The proposed project is situated in the quaternary catchments V31J and V31K, the Pongola-Mtamvuna Water Management Area (WMA 4). The project area lies in the North Eastern Uplands Ecoregion. The project is situated 10km south of the town of Newcastle in the Amajuba District Municipality.

Standard methodologies were used to determine the Present Ecological Status, Ecological Importance and Sensitivity for the wetland ecology components of this study.

Two (2) HGM units were identified within the 500m project assessment boundary, namely the Channelled Valley Bottom (HGM 1) and Wetland Flat (HGM 2).

The Present Ecological State (PES) for the HGM units was determined to be that of a Moderately Modified (C) for HGM 1and Largely Modified (D) for HGM 2. The most significant impact was that of alien invasive plants within the wetland catchment and encroaching within the wetland areas. Both HGM units had an overall intermediate level of service. Both HGM units showed a Moderate (C) level of importance for the Ecological Integrity & Sensitivity and the Direct Human Benefits were rated as Marginally (D) important. The Hydrological Functional Importance was rated as High (B) for HGM 2 and Moderate (C) for HGM 1.

The required buffer zones are 17 m and 58 m for the construction and operational phases respectively. It is recommended that the larger buffer width of 58 m be implemented from the onset of the construction phase of the project.

Impact Assessment

The project is for the proposed development of a landfill site on the Greenwich Farm just outside Newcastle. A site development plan has not been established and it has been assumed that the entire project area will be utilised for the landfill. The impact assessment assessed impacts based on the activities provided in the Impact Matrix.

Several moderate impacts were identified for the construction phase of the project. The most notable risks identified to wetlands during the construction phase of the project pertaining to the removal of vegetation and excavations required for the proposed landfill site. The input of toxic heavy metal and salt contaminants, arising from activities related to the establishment of phase was identified as a moderate risk. The majority of the risks were re-allocated a low risk rating, assuming that the prescribed mitigation measures will be implemented and taking into consideration that the wetland areas and buffer zones would be avoided. The excavation of soils remained a moderate impact after mitigation measures were applied due to the fact that the excavation of soils may lead to decreased sub-surface and groundwater inputs into the wetland areas.

The impacts identified during the operational and decommissioning phases of the project were mostly determined to be low. The most notable risks were that of the alteration of surface runoff flow paths and flows in nearby drainage lines and inputs of toxic heavy metal and salt

contaminants which were determined to be moderate risks before mitigation. These risks related to the movement of vehicles and machinery in area and the possible indirect (accidental) contamination of the nearby watercourse areas. The impact of altered surface flows remained moderate after mitigation due to the prolonged duration of the activities giving rise to the impacts. The re-shaping and landscaping during the decommissioning phase remained moderate after mitigation as this will impact on groundwater and sub-surface flows into the wetland areas. Wetlands areas and buffer zones would be avoided during the construction phase and also the operational phase; this was able to reduce the risks to low/negligible.

Specialist Opinion

It is the opinion of the specialist that the proposed project be authorised provided that all mitigation measures are implemented, and the following conditions be included in the environmental authorisation for this project:

- The wetland areas and buffer zones must be avoided for the duration of the project and the proposed landfill pit must be outside the wetland and buffer zones;
- A water quality monitoring plan must be compiled and implemented for the duration of the landfill site project, starting at the construction phase;
- A Hydropedology assessment is to be conducted to confirm the wetland buffers and to assess any subsurface impacts within the vadose zone to the wetlands;
- An alien plant removal and management strategy must be implemented for the landfill site area with specific attention to wetland and buffer zone areas. The alien plant management strategy must be carried out for the duration of the project including the post-closure maintenance; and
- A rehabilitation plan must be compiled and implemented for the landfill site area for all phases of the project. The rehabilitation plan must make provision for the rehabilitation and/or remediation of wetland areas, include an action plan and include a maintenance schedule for the post-closure phase of the landfill site area.

Table A: NEMA Appendix 6

REQUIREMENT	STATUS
1. A specialist report prepared in terms of these Regulations must contain—	Section 1.5
(a) details of—	
(i) the specialist who prepared the report; and	Section 4
(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Section 11
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Page ix
(c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1
(cA) an indication of the quality and age of base data used for the specialist report;	Section 1

REQUIREMENT	STATUS
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 8.1 and 8.2
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 1
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 5
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 8.3
(g) an identification of any areas to be avoided, including buffers;	Section 7.3 and 8.3
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 6
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 7
(k) any mitigation measures for inclusion in the EMPr;	Section 8.3 & 8.4
(l) any conditions for inclusion in the environmental authorisation;	Section 9.1
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 9.1
(n) a reasoned opinion—	
(i) whether the proposed activity, activities or portions thereof should be authorised;	Section 9.1
(iA) regarding the acceptability of the proposed activity or activities; and	Section 9.1
(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 7.3, 8.3, 8.4 & 9.1.1
(o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	N/A
(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
(q) any other information requested by the competent authority.	N/A

	REQUIREMENT	STATUS
2.	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

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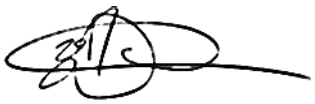
DECLARATION

I, Ndumiso Dlamini 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.



Ndumiso Dlamini

Wetland Ecologist

(Pr. Sci. Nat. 116579)

The Biodiversity Company

7 March 2018

1 Introduction

The Biodiversity Company was commissioned to conduct a wetland assessment as part of a Water Use Licence Application (WULA) and environmental authorisation processes for the proposed Landfill site development on the Farm Greenwich 8784 in the Newcastle area within the KwaZulu-Natal Province. A single site visit was conducted on the 21st of February 2018, which would constitute a wet season survey.

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 landfill development and associated infrastructure with respect to the current state of the associated wetlands in proximity the area of study. This was achieved through the following:

- The delineation and assessment of wetlands within 500m of the project area;
- The characterisation of the current state of the local wetland systems;
- 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 April 2017, 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 Description of the Project Area

The project is situated in the quaternary catchments V31J and V31K, the Pongola-Mtamvuna Water Management Area (WMA 4). It is noted that the Thukela WMA was reclassified into the larger Pongola-Mtamvuna Water Management Area (WMA 4) (NWA, 2016). The project area lies in the North Eastern Uplands Ecoregion. The project is situated 12km south of the town of Newcastle in the Amajuba District Municipality (Figure 1).

The Pongola-Mtamvuna WMA lies within the province of KwaZulu-Natal, the catchment is composed of tributaries draining from the Drakensberg mountain range and is characterized by mountain streams in the upper reaches. Rainfall is concentrated along the mountains with a mean annual precipitation rate of 600 to 1500mm. Main impacts associated with the system are forestry and agriculture, Newcastle is the main area of industrial activity within the catchment (StatsSA, 2010).

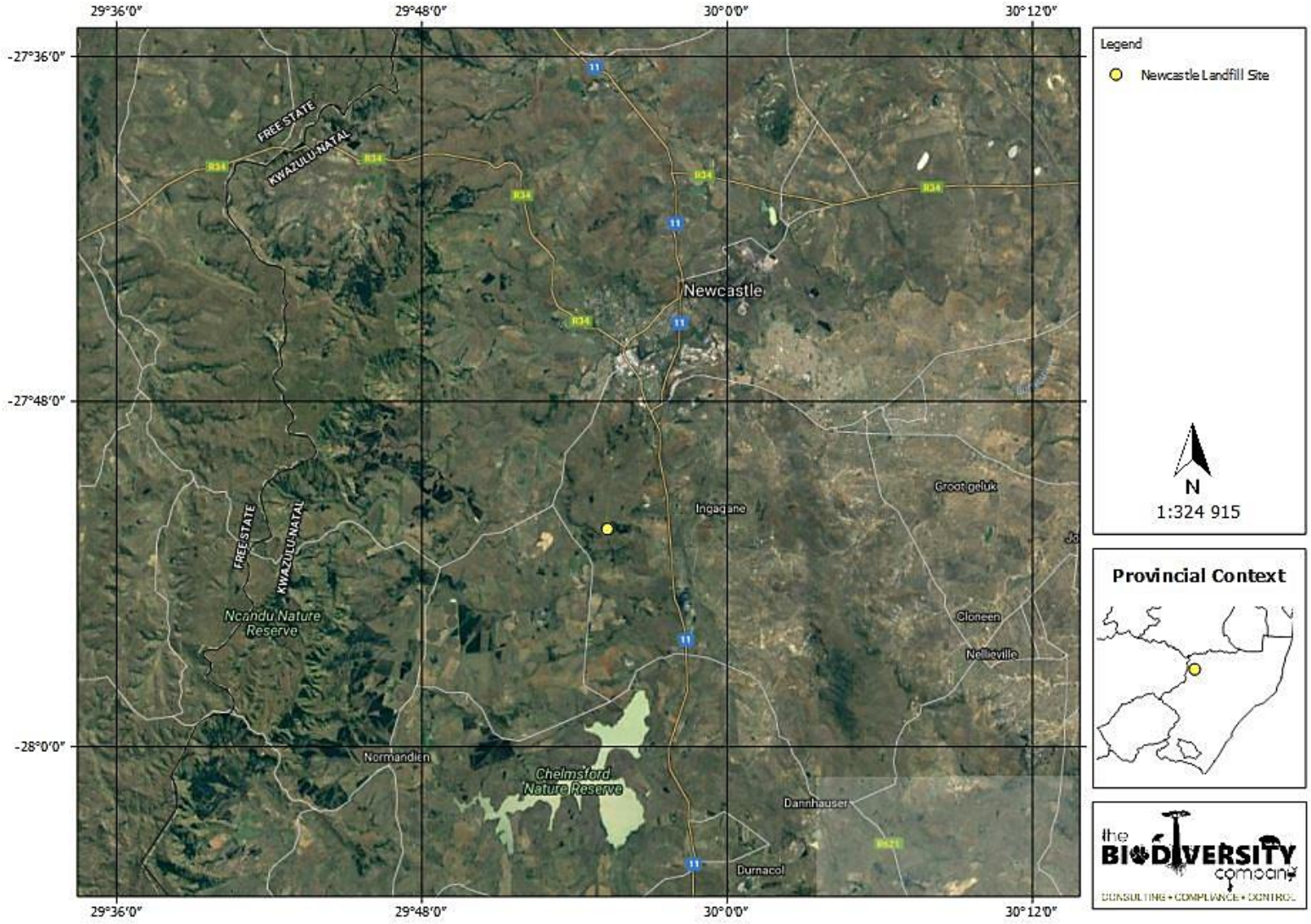


Figure 1: Location of the proposed landfill site in relation to Newcastle

4 Details of Specialist

Ndumiso Dlamini obtained his BSc Hons degree in Botany in 2011 at the University of Johannesburg. Ndumiso has been conducting wetland assessments as a Wetland Ecologist for over 4 years. He has performed numerous wetland impact assessments for various projects which include mining, housing developments, roads and infrastructure and rehabilitation.

Additionally, Ndumiso is registered with the South African Council for Natural Scientific Professions as Pr. Sci. Nat and has completed training in Tools for Wetland Delineation and Wetland Rehabilitation Methods.

5 Methodology

5.1 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).

5.2 Wetland Assessment

The National Wetland Classification Systems (NWCS) developed by the South African National Biodiversity Institute (SANBI) was 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. In addition, the method also includes the assessment of structural features at the lower levels of classification (Ollis *et al*., 2013).

5.2.1 Wetland Delineation

The wetland areas are delineated in accordance with the DWAF (2005) guidelines, a cross section is presented in Figure 2. 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 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.

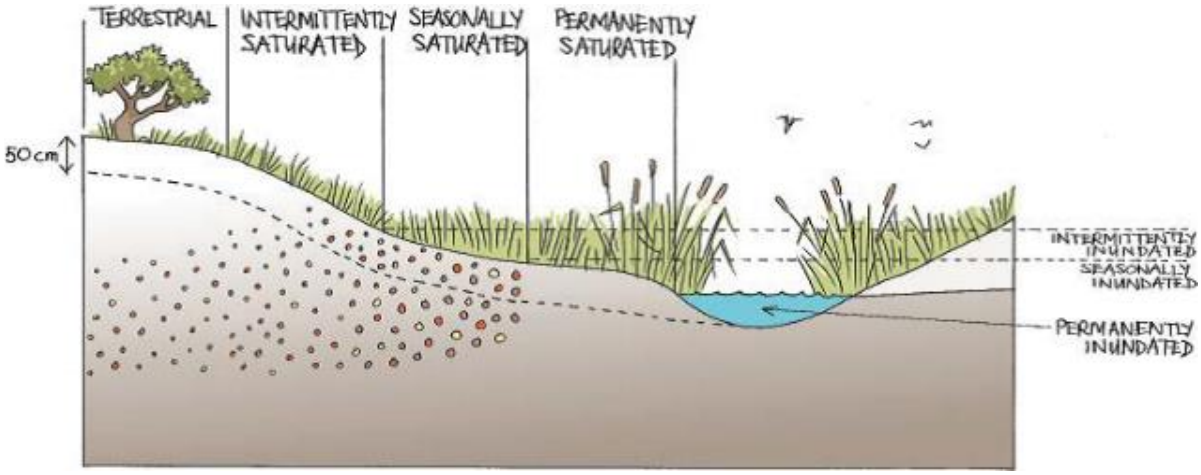


Figure 2: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis et al., 2013)

5.2.2 Wetland Present Ecological Status (PES)

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 Present State categories are provided in Table 1.

Table 1: The Present Ecological Status 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**

5.2.3 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 *et al*., 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 2).

Table 2: Classes for determining the 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

5.2.4 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 range of the determinants is used to assign the EIS category as listed in Table 3.

Table 3: Description of Ecological Importance and Sensitivity 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**

5.2.5 Buffer Determination

The “Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries” (Macfarlane *et al*., 2014) was used to determine the appropriate buffer zone for the proposed activity.

5.3 Impact Assessment

The risk assessment was conducted in accordance with the Impact Matrix provided which considers the water use authorisation approach and delegation guidelines. The significance of the impact is calculated according to Table 4. The complete Impact Assessment Methodology (GCS Impact Methodology) is provided as an Annexure to this report.

Table 4: 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.

6 Limitations and Assumptions

The following aspects were considered as limitations:

- A single wetland ecology site survey was completed for this assessment. Thus, temporal trends were not investigated.
- It was assumed that the entire project area is proposed as a landfill site.
- No detailed activity list for the proposed project was provided and therefore the risk assessment has been completed based on presumptions for the proposed activities.
- 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.
- Wetland systems identified at desktop level within 500 m of the project area were considered for the identification and desktop delineation, with wetland areas expected to be at risk being the focus for ground truthing.

7 Results & Discussions

7.1 Desktop Assessment

7.1.1 Climate

The area is characterised by summer rainfall climate with an overall Mean Annual Precipitation (MAP) of 840mm; however, it can range between (710mm – 1120mm). Summer droughts are frequent in the area with mist found on higher parts in spring and early summer.

7.1.2 Geology & Soils

The larger area is characterised by red to yellow sandy soils of the Ac land types found on shales and sandstones of the Madzaringwe Formation (Karoo Supergroup).

According to the land type database (Land Type Survey Staff, 1972 - 2006) the project falls within the Ac5 and EA34 land types (Table 5). The dominant soil types are Glenrosa and Mispah soil forms. Katspruit and Glencoe soil forms may occur in valley bottom areas.

Table 5: The land type data for the area

Land type	Description
Ac5	RED-YELLOW APEDAL, FREELY DRAINED SOILS; Red and yellow dystrophic and/or mesotrophic
Ea34	ONE OR MORE OF: VERTIC, MELANIC, RED STRUCTURED DIAGNOSTIC HORIZONS; Undifferentiated

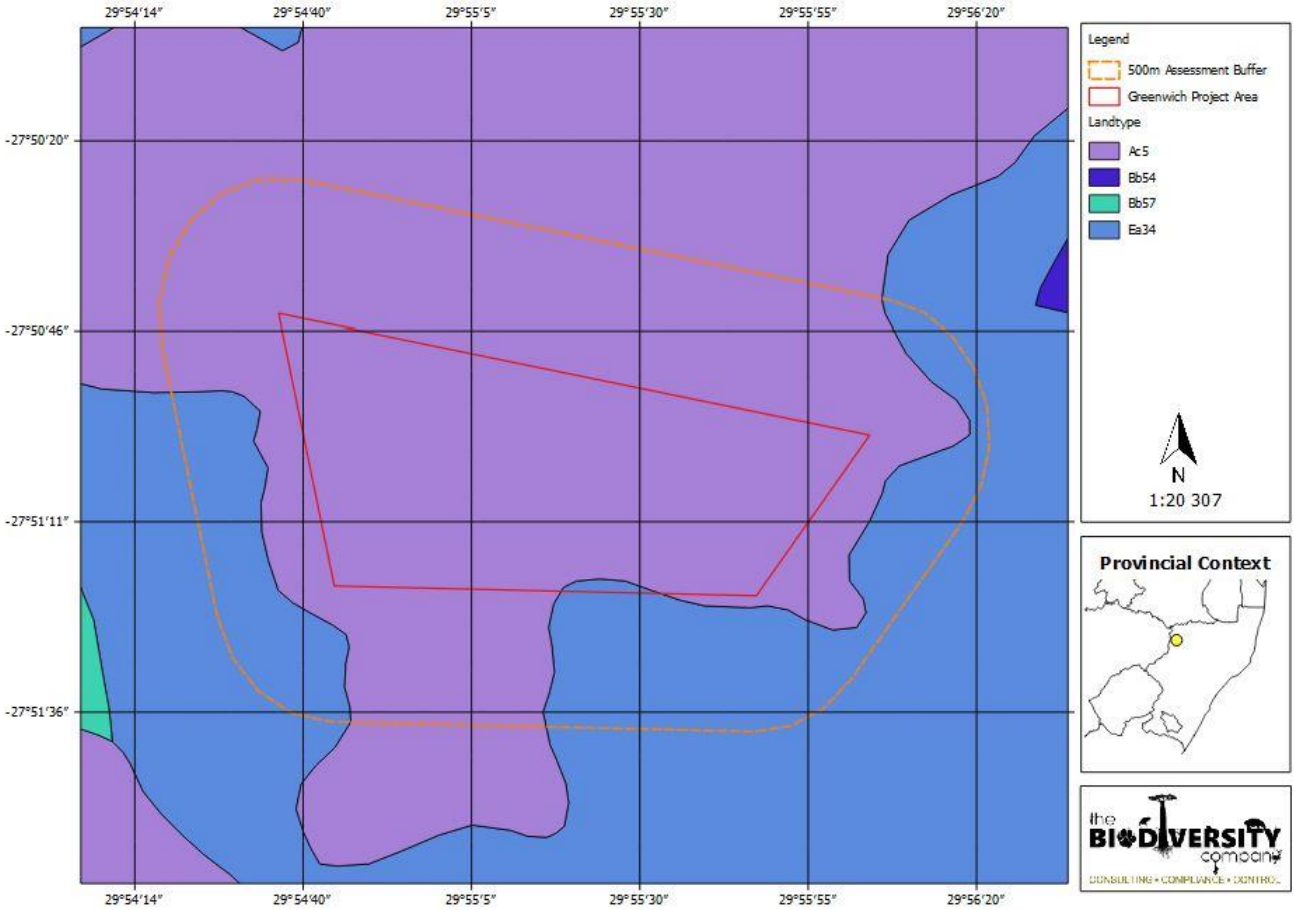


Figure 3: The land type associated with the project area

7.1.3 Desktop Vegetation

The regional vegetation in project area was the Northern KwaZulu-Natal Moist Grassland Vegetation unit. The vegetation unit is found within the northern parts of the KwaZulu-Natal province. The landscape is dominated by moderately undulating plains at altitudes that range between 1040m – 1440m. The status of the vegetation, as at the time of publishing (2006), is summarised in Table 6 and the dominant plant species within each vegetation unit are shown in Table 7.

This vegetation type occurs on moderately undulating plains, including some low hills and pan depressions. The vegetation is a short dense grass land dominated by the usual Highveld grass composition (*Arsitida, Digitaria, Eragrostsis, Themeda, Tristachya* etc.) with small scattered rocky outcrops with, wiry sour grasses and some woody species. Over a quarter (25%) has been transformed primarily by cultivation, plantations, mines, urbanisation and by building of dams. No serious alien invasions are reported (Mucina & Rutherford, 2006).

Table 6: Vegetation Status

Vegetation Name	Ecological Status	Conservation Status	% of Project Area
Northern KwaZulu-Natal Moist Grassland	Moderately Modified	Vulnerable	40%

Table 7: Dominant Plant Species

Vegetation Unit	Dominant Plant Species
Northern KwaZulu-Natal Moist Grassland	*Hyparrhenia hirta, Themeda triandra, Cynodon dactylon, Aristida congesta, Vachelia sieberiana var. woodii*

7.1.4 Wetland NFEPAs

There were only two (2) NFEPA wetlands identified within 500m of the proposed project site. These were classified as a seepage wetland and a wetland flat. The seepage wetland was classified as natural system with a wetland condition of AB (Largely Natural). The wetland flat was classified as an artificial system with a wetland condition of Z3 (Severely Modified). The wetlands were classified according the NFEPA database as a Rank 5 and Rank 6 FEPA wetland, respectively. The classification of the wetland is presented in Table 8 and the wetland areas are presented in Figure 4.

Table 8: The wetland classification of the FEPA wetlands

FEPA Wetland	Classification Levels				Wetland Vegetation Class	Natural / Artificial	Condition	Rank
	L1 (System)	L2 (Ecoregion)	L3 Landscape Position	L4 HGM Class				
Seepage	Inland System	North Eastern Uplands	Slope	Seep	Sub-Escarpment Grassland Group 4	Natural	AB	5
Flat	Inland System	North Eastern Uplands	Bench	Flat	Sub-Escarpment Grassland Group 4	Artificial	Z3	6

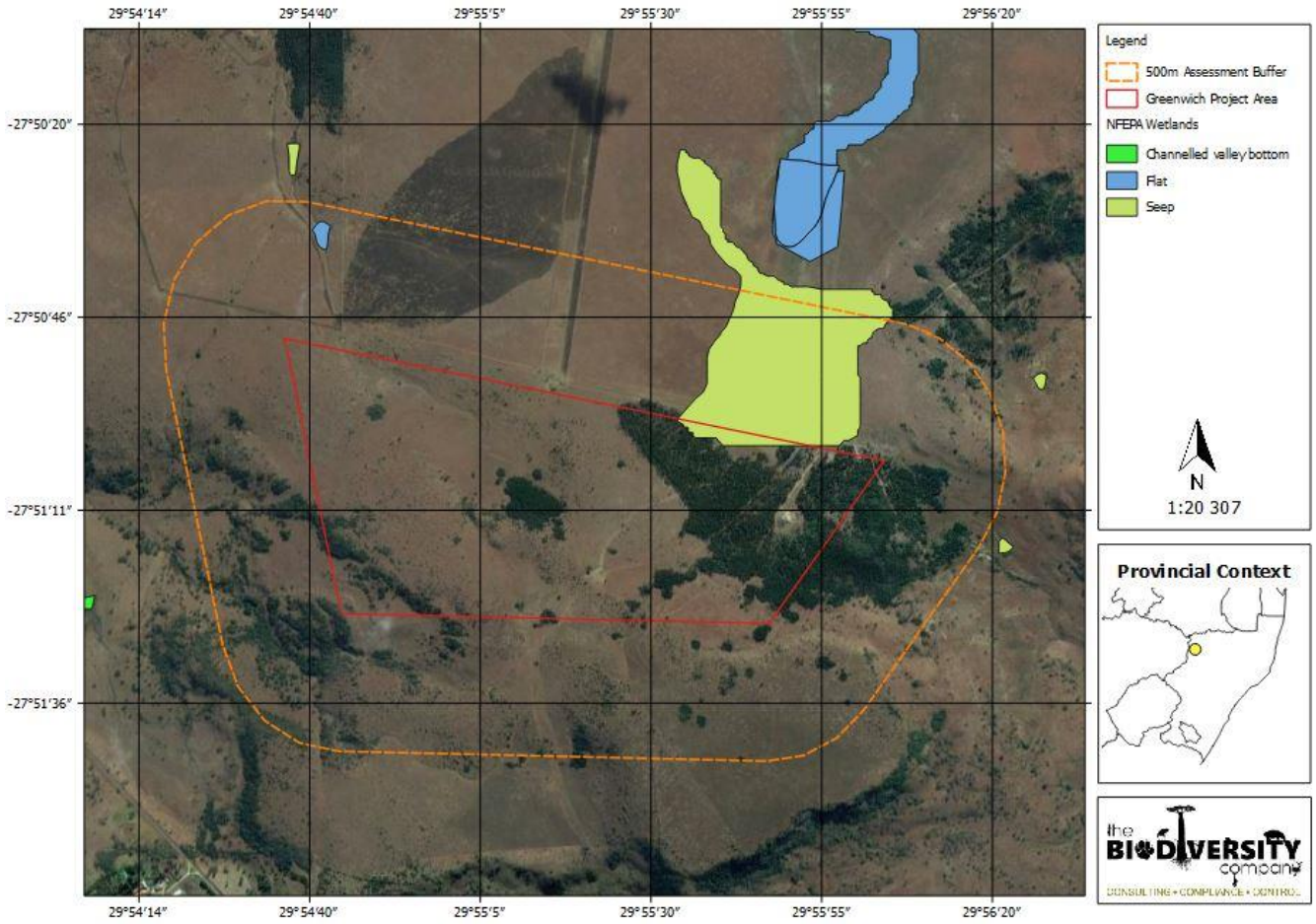


Figure 4: FEPA wetlands within 500m of the proposed landfill project area

7.2 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.

The wetland delineation is shown in Figure 6. The classified wetland HGM units as per SANBI guidelines (Ollis *et al.*, 2013) are presented in Table 9.

Two (2) HGM types were identified within the 500m project assessment boundary, namely;

- Channelled Valley Bottom (HGM 1); and
- Wetland Flat (HGM 2).

Figure 5 presents the depictions of the identified HGM as per the SANBI Wetland Classification (Ollis *et. al.,*2012).

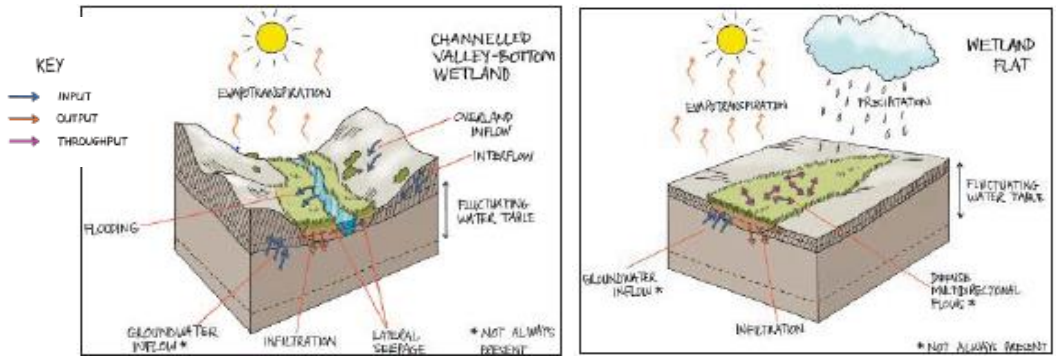


Figure 5: Ollis et al depiction of HGM unit settings and flow paths

Table 10 presents a summary of the findings for each of the wetland units. Photographs of the wetland indicators are presented in Figure 7 and soils are presented in Table 11.

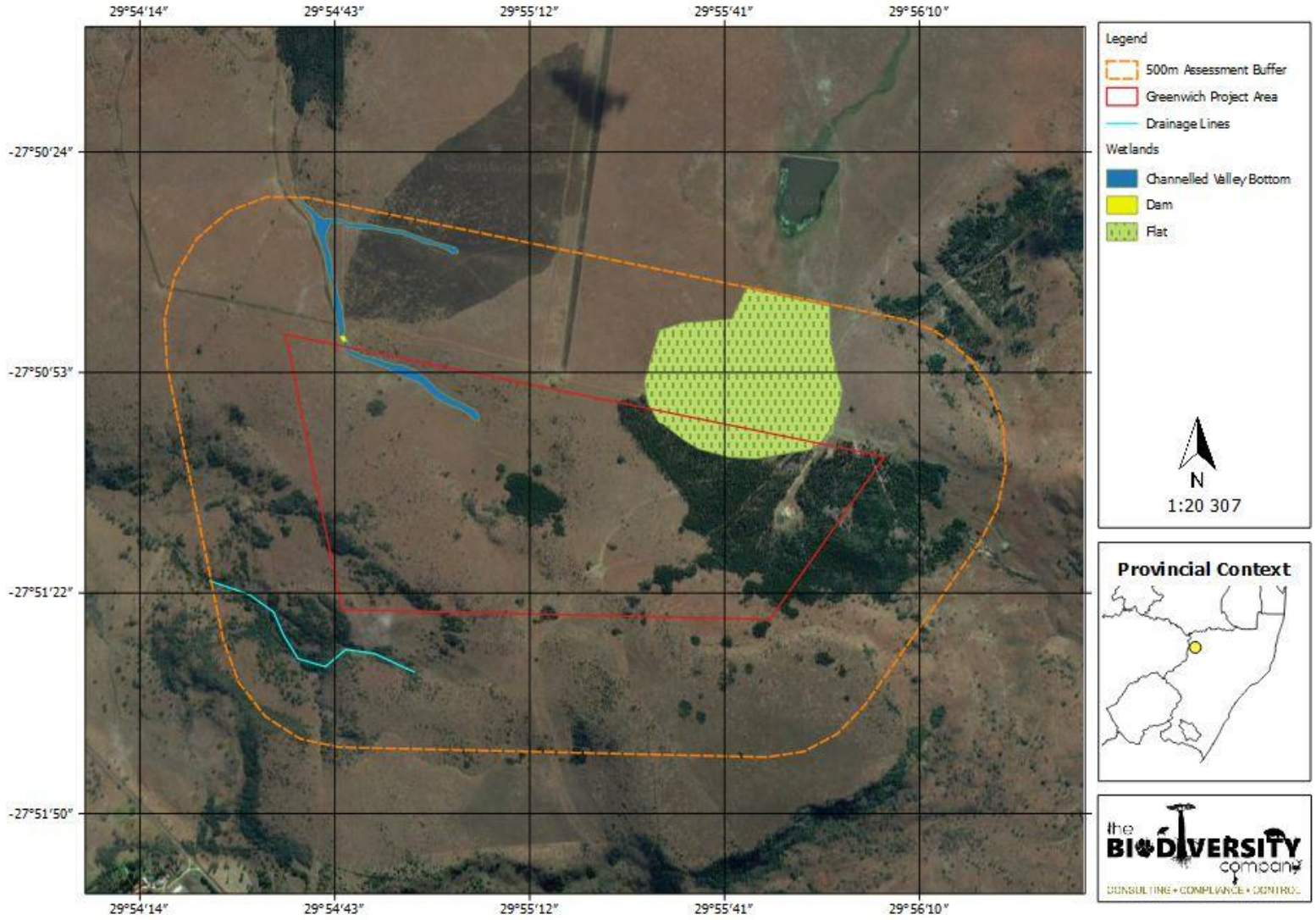


Figure 6: The delineated HGM units within 500m of the project area

Table 9: Wetland classification as per SANBI guideline (Ollis et al., 2013)

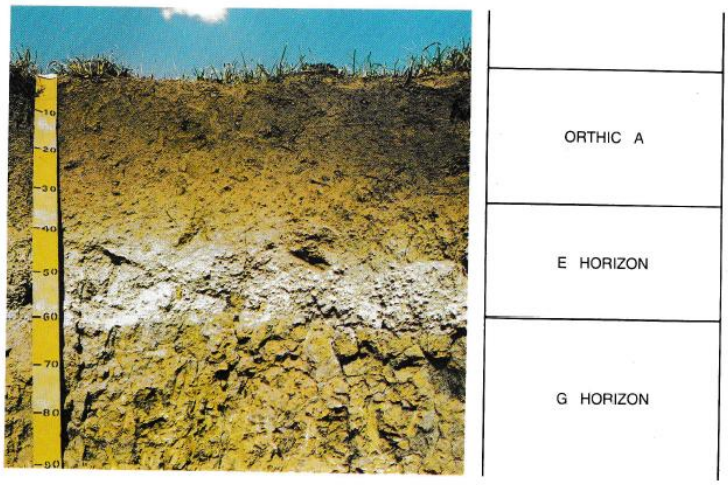
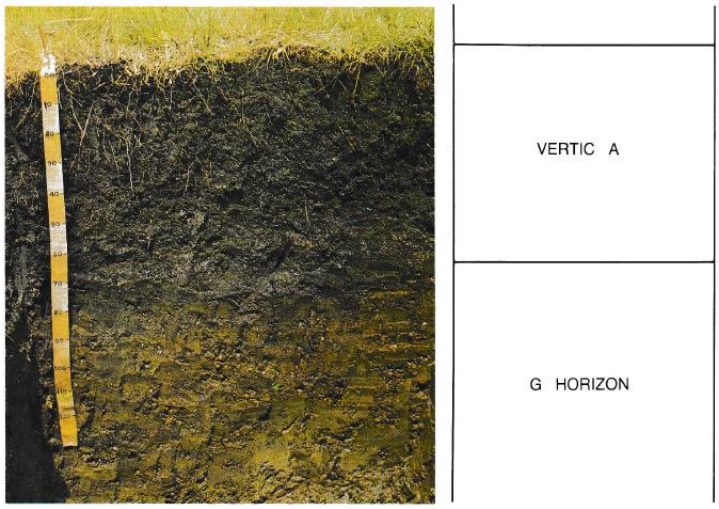
Wetland Name	Level 1	Level 2		Level 3	Level 4		
	System	DWS Ecoregion/s	NFEPA Wet Veg Group/s	Landscape Unit	4A (HGM)	4B	4C
HGM 1	Inland	North Eastern Uplands	Sub-Escarpment Grassland Group 4	Valley Bottom	Channelled Valley Bottom	N/A	N/A
HGM 2	Inland	North Eastern Uplands	Sub-Escarpment Grassland Group 4	Bench	Flat	N/A	N/A

Table 10: A summary of the results for HGM units

	HGM 1 – Channelled Valley Bottom	HGM 2 – Wetland Flat
Description:	The channelled valley bottom wetland was found in the north-western corner of the project area. The wetland was a narrow channel with the slopes comprised of rocky outcrops and shallow soils. The wetland was well vegetated with species of *Aristida, Juncus, Cyperus* and *Eragrostis.* The Rensburg soil form was identified within the wetland.	The wetland flat was found on the northern border of the project area. The wetland was largely intact with exception of an upstream dammed area. The wetland was well vegetated with species of *Aristida, Juncus, Cyperus* and *Eragrostis.* The Kroonstad/ Katspruit soil form was identified within the wetland area. *Hypocharis radiata* was identified within the wetland which suggested an elevated clay content in the soil.
Photograph:		
Overall Present Ecological State	**Moderately Modified (C)**	**Largely Modified (D)**
Hydrology	**Largely Modified (D)**	**Seriously Modified (E)**
Geomorphology	**Largely Natural (B)**	**Moderately Modified (C)**
Vegetation	**Moderately Modified (C)**	**Largely Modified (D)**
WET-EcoServices rated as high:	• Toxicant Assimilation • Erosion control	• Sediment trapping • Phosphate assimilation • Nitrate assimilation • Toxicant Assimilation
EIS	**Moderate (C)**	**Moderate (C)**
Hydrological/Functional Benefit	**Moderate (C)**	**High (B)**
Direct Human Benefits	**Low (D)**	**Low (D)**

Figure 7: The identified wetland systems and a) Channelled Valley Bottom wetland – HGM 1 b) Wetland Flat – HGM 2 c) Koeleria capensis. d) Cyperus effusus e) Schoenoplectus spp f) Kroonstad soil form

Table 11: The identified soil forms within the wetland areas

Image	Soil Classification profile
	KROONSTAD FORM — Kd 
	RENSBURG FORM — Rg 

7.2.1 Present Ecological State

The PES for the assessed HGM units are presented in Table 12. The overall wetland health for HGM units was determined to be that of a Moderately Modified (C) for HGM 1 and Largely Modified (D) for HGM 2.

The most significant impacts to HGM 1 were determined to arise from the increased hard surfaces in the wetland catchment which would increase flows. The extent of alien invasive plants in the upper reaches contributes to decreased water flows into the wetland. The geomorphology of the wetland remained largely intact due to the good vegetation cover and low slope of the wetland. The vegetation was moderately impacted upon by the presence of invasive plant species and shallow soils which did not allow for adequate cover in certain areas.

The hydrology of HGM 2 was most significantly impacted upon by the impoundment which caused prolonged unnatural inundation and decreases downstream flows. The presence of the large Wattle and Eucalyptus reduced the volumes of water into the downstream areas of the wetland. The geomorphology was largely impacted by large bare areas of soil susceptible to loosening and erosion, compaction and exportation. The vegetation was degraded to due to drying out of downstream areas and the presence of invasive trees in the wetland areas.

Table 12: Summary of the scores for the wetland PES

Wetland	Hydrology		Geomorphology		Vegetation	
	Rating	Score	Rating	Score	Rating	Score
HGM 1	D: Largely Modified	4.0	B: Largely Natural	1.9	C: Moderately Modified	2.4
Overall PES Score	2.9		Overall PES Class		C: Moderately Modified	
Wetland	**Hydrology**		**Geomorphology**		**Vegetation**	
	Rating	**Score**	**Rating**	**Score**	**Rating**	**Score**
HGM 2	E: Seriously Modified	7.5	C: Moderately Modified	2.3	D: Largely Modified	4.2
Overall PES Score	5.1		Overall PES Class		D: Largely Modified	

A summary for the respective modules is as follows:

Hydrology

- HGM 1 – The hydrology of the wetland was altered as a result of the shallow soils and rocky outcrops on the slopes of the wetland which increase flow velocities and decrease the water retention capabilities of the wetland. The wetland flood peaks have been altered which could result in erosion as seasonal changes could result in reduced vegetation cover in times of high flows.
- HGM 2 – The flows have been altered as a result of a dam/excavation to catch water was erected within the wetland. Large invasive trees further decrease the supply of

water to the wetland areas. The downstream areas of the wetland are semi-desiccated which reduces the functional wetland areas.

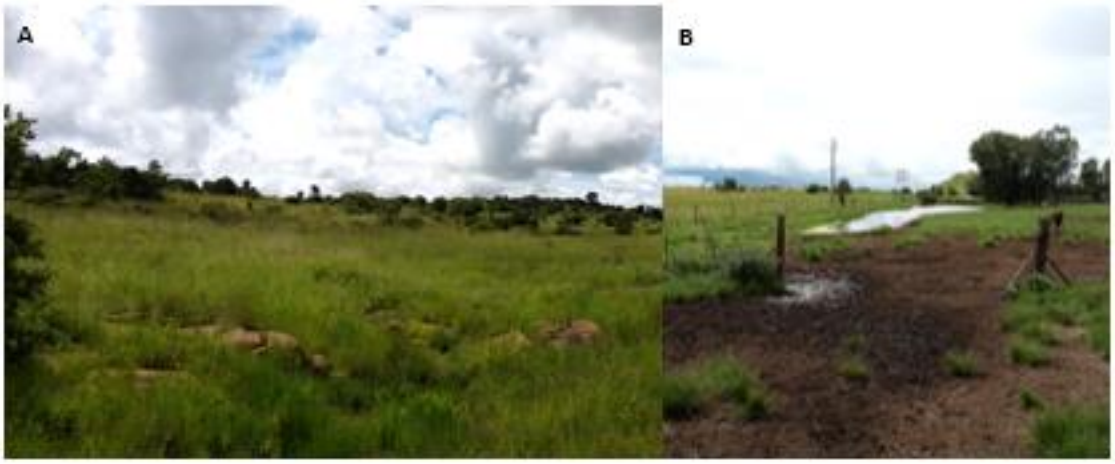


Figure 8: Impacts to the hydrology of the wetlands a) Steep, shallow and rocky slopes of HGM 1 b) Dam and invasive trees within HGM 2

Geomorphology

- HGM 1 – The geomorphology of the wetland was largely natural, despite the hydrological changes, with a few areas where erosion was evident. The vegetation cover and low slope of the wetland enable the wetland to retain much of the geomorphology. Furthermore; water inputs are reduced as a result of upper catchment water losses to alien trees.
- HGM 2 – The geomorphology of the wetland was altered due to the hydrological impacts. The geomorphology was altered as a result of the dam, bare areas and livestock trampling within the wetland. The soils showed signs of physical disturbances due to livestock movements. The soils are susceptible to compaction, loosening, erosion and exportation out of the wetland.

Figure 9: Geomorphology impacts to HGM 2 a) Livestock activity within the wetlands b) damming and bare areas

Vegetation

- HGM 1 and HGM 2 – The vegetation of the wetlands was modified as a result of the alien invasion encroaching into the wetland areas. Grazing and lack of water has also led to the wetland areas transforming into moist grassland in areas. the wetlands are desiccating as a result of water shortages; this leaves the wetland areas unable to support hydrophytic vegetation which drives the transformation to facultative grass species which are often referred to as moist-grassland species.

Figure 10: Large trees within wetland areas and wetland catchment a) Eucalyptus camaldulensis b) Acacia mearnsii

The alien invasive plants that were identified within the wetland areas and presented in Figure 11. The invasive category is indicated in brackets.

Figure 11: Observed alien invasive plants a) Xanthium spinosum (1b) b) Solanuma syssimbrifolium (1b) c) Eucalyptus camaldulensis (1b) d) Acacia mearnsii (1b)

7.2.2 Ecosystem Services Assessment

The Ecosystem services provided by the HGM units present at each site were assessed and rated using the WET-EcoServices method (Kotze *et al.*, 2009). The summarised results for the HGM units are shown in Table 14. The indirect services associated with both HGM units are considerably more beneficial when compared to the direct services. This emphasises the importance and need to conserve these systems to provide effective services which includes water quality enhancement.

HGM 1 and HGM 2 had an overall intermediate level of service with the following services showing moderately high or high levels of services.

- Sediment trapping
- Phosphate assimilation
- Nitrate assimilation
- Toxicant Assimilation
- Erosion control.

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

HGM 2, despite being altered, showed high levels of service for sediment trapping, phosphate, nitrate and toxicant assimilation as a result of the alterations. The impoundment of water flows in the wetland allowed sediment trapping which may not have been the case without the impoundment. The livestock activities within the wetland produce nitrates, phosphates, and toxicants that the wetland is now assimilating. Figure 9 presents the damming and livestock activities. Figure 12 presents the Spider Diagrams for the HGM Ecoservices.

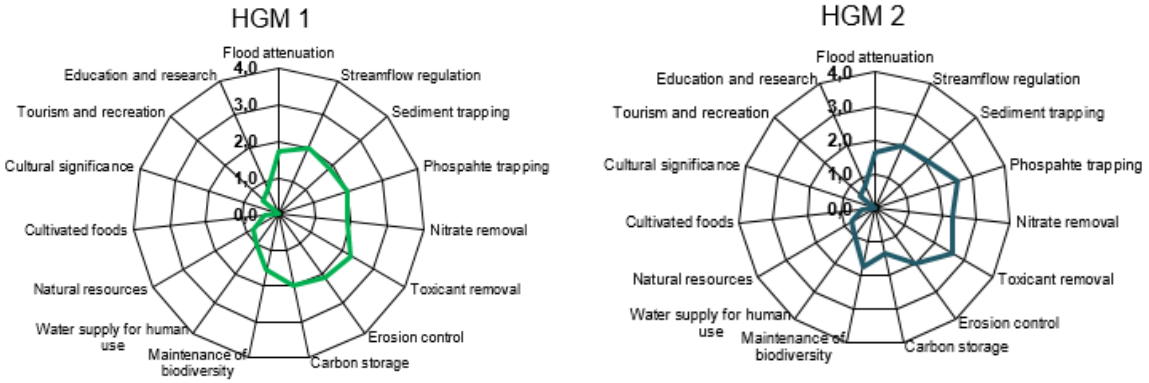


Figure 12: The EcoServices Spider Diagrams for HGM 1 and HGM 2

The indirect benefits had a moderately high level of service for HGM 2 intermediate level of service for HGM 1. The level of service for the direct benefits was determined to be moderately-low for both HGM units. The findings show that the benefits associated with the maintenance of biodiversity were rated as intermediate for all HGM units (Table 13).

Table 13: A summary of the indirect and indirect benefits provided by the wetlands

Wetland Unit	HGM 1	HGM 2
Indirect Benefits	2,0	2,2
Direct Benefits	0,6	0,6
Biodiversity Maintenance	1,6	1,8

Table 14: The EcoServices being provided by the wetlands at the project site

Wetland Unit					HGM 1	HGM 2
Ecosystem Services Supplied by Wetlands	Indirect Benefits	Regulating and supporting benefits	Flood attenuation		1,7	1,7
			Streamflow regulation		2,0	2,0
			Water Quality enhancement benefits	Sediment trapping	1,9	2,1
				Phosphate assimilation	2,0	2,6
				Nitrate assimilation	1,9	2,3
				Toxicant assimilation	2,3	2,6
				Erosion control	2,1	2,0
			Carbon storage		2,0	1,3
	Direct Benefits	Biodiversity maintenance			1,6	1,8
		Provisioning benefits	Provisioning of water for human use		1,0	1,0
			Provisioning of harvestable resources		0,8	0,8
			Provisioning of cultivated foods		0,4	0,4
		Cultural benefits	Cultural heritage		0,0	0,0
			Tourism and recreation		0,6	0,6
			Education and research		0,8	0,8
Overall					21,0	21,8
Average					1,4	1,5

7.2.3 Ecological Importance & Sensitivity

The Ecological Importance & Sensitivity (EIS) assessment was applied to the HGM units 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 13.

HGM 1 and HGM 2 showed a Moderate (C) level of importance for the Ecological Integrity & Sensitivity. The wetlands are located on a crest and have been impacted on by alien invasion. The wetland ecological support is considered low as a result of the modifications and the anthropogenic activities in the local area.

HGM 1 showed a Moderate (C) level of importance for the Hydrological Functional Importance. The wetland is supplied by the upper catchment over the shallow rocks and is largely seasonal. HGM 2 showed a High (B) level of importance for the Hydrological Functional Importance was rated as High (B) owing to the downstream water contribution of the wetland. The wetland catches a large volume of water and directs towards streams and watercourses.

Both the HGM units showed a Low (D) level of importance for the Direct Human Benefits. The wetlands do not provide any direct human uses, although they contribute to greater area through the watercourse network.

Table 15: The EIS results for the HGM units within the project area

HGM 1	
	Importance
ECOLOGICAL IMPORTANCE & SENSITIVITY	**1,8 (C)**
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**2,0 (C)**
DIRECT HUMAN BENEFITS	**0,6 (D)**
HGM 2	
	Importance
ECOLOGICAL IMPORTANCE & SENSITIVITY	**1,3 (C)**
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**2,1 (B)**
DIRECT HUMAN BENEFITS	**0,6 (D)**

7.3 Buffer Zones

The DWS buffer tool recommends at a desktop level that the required buffer for the development of a landfill site be 180 m. The scenario used to determine the buffer requirements was the *Disposal of Hazardous Waste*, this will cater for the worst possible impacts/risks.

The model shows that the largest risks (Very High) posed by the project during the construction phase is that of *increased sediment inputs and turbidity*. This impact would arise due to excavation and vehicular movements in proximity to or within wetland areas.

During the operational phase Very High risks were flagged for *inputs of toxic organic contaminants, inputs o heavy metal contaminants* and *alteration of acidity (pH)*. A number of High risks are also expected for the operational phase of the project (Table 18). These risks are calculated with no prescribed mitigation and the calculated buffer requirement (without mitigation) is presented in Table 16.

Table 16: Pre-mitigation buffer requirement

Required buffer before mitigation measures have been applied	
Construction Phase	**57 m**
Operational Phase	**100 m**

According to the buffer guideline (Macfarlane *et al.* 2014) a high risk activity would require a buffer that is 95% effective to reduce the risk of the impact to a low level threat. However, the prescribed mitigation measures will reduce the risks for some aspects and the required buffer is then 17 m and 58 m (Table 17) for the construction and operational phases respectively. It is recommended that the larger buffer width of 58 m be implemented from the onset of the construction phase of the project (Figure 13).

The mitigation measures applied included the assumption that there will be no working within wetland areas. All excavation, dumping and roads would be beyond the wetland and buffer zone. The highest risks after mitigations measures were applied were determined to be medium risks.

Table 17: Post-mitigation buffer requirement

Required buffer after mitigation measures have been applied

Construction Phase	**17 m**
Operational Phase	**58 m**

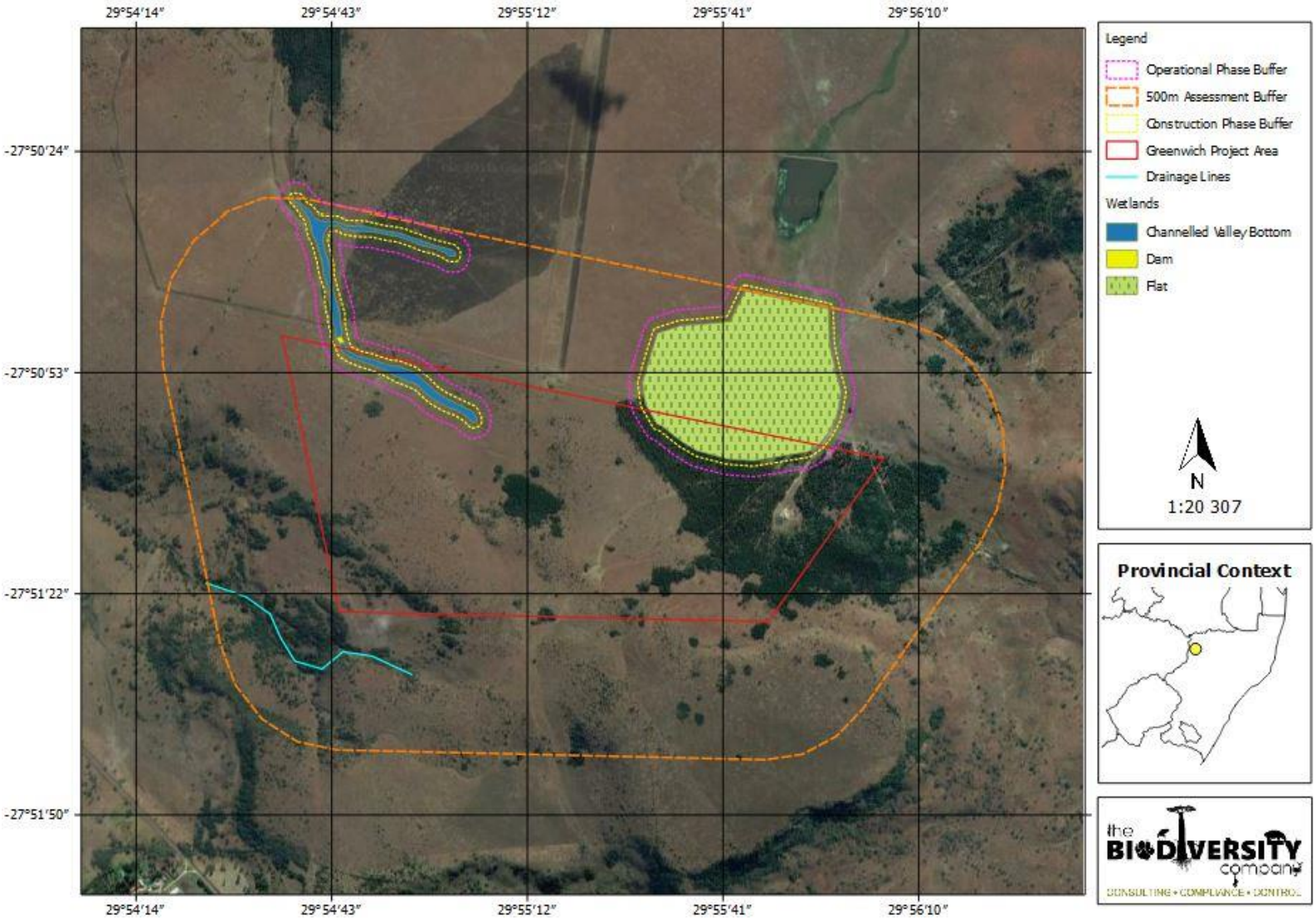


Figure 13: The Construction and Operational Phase buffer zones for the proposed project

Table 18: The risk results from the wetland buffer model for the proposed landfill project

Threat Posed by the proposed land use / activity		Specialist Threat Rating	Refined Threat Class	Specialist justification for refined threat ratings.
Construction Phase	1. Alteration to surface runoff flow volumes	Very Low		
	2. Alteration of patterns of flows (increased flood peaks)	Low		
	3. Increase in sediment inputs & turbidity	Very High	Medium	Avoidance of wetland area and buffer. Limit (and demarcate) the disturbance footprint area. Work away from the wetland areas, beginning closest to the wetland and moving outwards. Clear vegetation on a need only basis. Managed stockpiles, storm water management.
	4. Increased nutrient inputs	N/A		
	5. Inputs of toxic organic contaminants	Medium	Low	
	6. Inputs of toxic heavy metal contaminants	Medium	Low	Off-site equipment and vehicle fuelling and maintenance, storage of chemicals and fuel in bunded area, no on-site fabrication, oil spill kits, equipment & vehicle inspections. No traversing or working within wetland or buffer zones.
	7. Alteration of acidity (pH)	Very Low		
	8. Increased inputs of salts (salinization)	N/A		
	9. Change (elevation) of water temperature	Very Low		
	10. Pathogen inputs (i.e. disease-causing organisms)	Very Low		
Operational Phase	1. Alteration to flow volumes	Medium	Medium	Avoidance of wetland area and buffer. Maintenance of the vegetation within the buffer areas.
	2. Alteration of patterns of flows (increased flood peaks)	High	Medium	
	3. Increase in sediment inputs & turbidity	High	Low	Stockpiling of soils and materials within the existing working area, and not within preferential flow paths. Compile a stormwater management plan for the area. Separate clean and dirty water, intercept surface run-off and direct this around the working area.
	4. Increased nutrient inputs	Medium	Low	Provide sanitation, and waste storage area. Service waste depots and facilities regularly and dispose of waste in demarcated areas.
	5. Inputs of toxic organic contaminants	Very High	High	Cut off drain at foot of landfill. Capping of landfill once each layer has been completed to reduce windblown contamination.
	6. Inputs of toxic heavy metal contaminants	Very High	High	Cut off drain at foot of landfill. Capping of landfill once each layer has been completed to reduce windblown contamination.
	7. Alteration of acidity (pH)	Very High	High	Cut off drain at foot of landfill. Capping of landfill once each layer has been completed to reduce windblown contamination.
	8. Increased inputs of salts (salinization)	High	Medium	
	9. Change (elevation) of water temperature	Medium	Low	
	10. Pathogen inputs (i.e. disease-causing organisms)	Medium		.

8 Impact Assessment

The project is for the proposed development of a landfill site on the Greenwich Farm just outside Newcastle. A site development plan has not been established and it has been assumed that the entire project area will be utilised for the landfill. The impact assessment assessed impacts based on the activities list provided in the Impact Assessment Matrix.

8.1 Current Impacts

Several impacts were identified within the wetlands on the proposed landfill site. These impacts, observed within the wetlands are presented in Table 17.

Table 19: Impacts currently observed and their result

Impact	Image	Result
Alien Invasive plant species		• Reduction in available water for wetland • Desiccation and transformation of wetland • Decrease in wetland biodiversity • Alteration of habitat
Impoundment		• Transformation of wetland • Decrease in wetland biodiversity • Alteration of habitat • Loss of EcoServices
Livestock grazing and trampling		• Degradation of wetland vegetation • Loosening of soil and alteration of geomorphology • Disturbance and alteration of water flows

8.2 Potential Impacts

The potential impacts arising from the proposed landfill are summarised and provided below (Table 20).

Table 20: Impacts assessed for the proposed project

Pr Sci Nat	**Ndumiso Dlamini**		**No. 116579**
Activity	**Threat Posed by the proposed activity**		**Impact Causing Aspect**
Establishment of Landfill Site	**Construction Phase**	Alteration to surface runoff flow paths	• Hardened surfaces (compaction) • Excavations • Storm water runoff • Site drainage • Releases from pit & return water dams • Clearing vegetation • Excavations and roads • Stripping and stockpiling of soils • Construction of new infrastructure • Operation of machinery & equipment (driving and site access) • Erosion and sedimentation • Construction of infrastructure • Staff ablutions • Operation of machinery & equipment (hydrocarbon spills)
		Increase in sediment inputs & turbidity	
		Inputs of toxic heavy metal and salt contaminants	
	Operational Phase	Alteration of surface runoff flow paths and flows in nearby drainage lines	• Hardened surfaces (compaction & new road surfaces) • Storm water runoff • Vehicular movement • Storm water runoff • Increased flow velocities from waste water discharge • Storm water runoff from pit areas and roads • Operation of landfill – dumping of hazardous substances (organic and chemical)
		Increase in sediment inputs & turbidity	
		Inputs of toxic heavy metal and salt contaminants	
		Inputs of toxic organic compounds	

Pr Sci Nat	Ndumiso Dlamini		No. 116579
Activity	**Threat Posed by the proposed activity**		**Impact Causing Aspect**
		Pathogens	
	Decommissioning and Closure Phase	Increase in sediment inputs & turbidity	• Removal of infrastructure • Shaping and landscaping (movement of soil) • Revegetation
		Alteration to surface runoff flow paths	
		Inputs of toxic heavy metal and salt contaminants	
	Post-Closure (Residual) Phase	Wetland health improvement	• Post Closure Monitoring and Maintenance

Table 21: Impact Matrix for the proposed project

Impact description					Significance before mitigation		Significance after mitigation		Mitigation measures	Action plan	Responsible person
No.	**Phases**	**Activity**	**Aspect**	**Impact**							
1	Construction	Site clearing / preparation	Removal of vegetation	Loss of wetland plants and decrease surface roughness	44,3	L	28	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
2	Construction	Site clearing / preparation	Stripping and stockpiling/transporting of top soil	Sedimentation of wetland areas	36,2	L	27,6	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
3	Construction	Infrastructure establishment	Storm water run-off	Erosion from increased flow velocities into wetland areas	49,3	L	28	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
4	Construction	Earth Excavation	Excavation of subsoil	Loss of wetland area and soils	70,0	M	55,8	M	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
5	Construction	Infrastructure establishment	Clearing of areas for infrastructure	Sedimentation of wetland areas	43,2	L	32,4	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer

Impact description					Significance before mitigation		Significance after mitigation		Mitigation measures	Action plan	Responsible person
No.	Phases	Activity	Aspect	Impact							
6	Construction	Site clearing / preparation	Alteration to surface runoff flow paths	Erosion, Sedimentation and Desiccation of wetland areas	36,2	L	32,2	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
7	Construction	Site clearing / preparation	Increase in sediment inputs & turbidity	Water quality impairment and habitat loss/alteration	40,8	L	36,4	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
8	Construction	Infrastructure establishment	Inputs of toxic heavy metal and salt contaminants	Water quality impairment	64,5	M	38,4	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
9	Operation	Heavy machinery and vehicle movement	Operation of equipment and machinery vehicles	Compaction, erosion and sedimentation of wetland areas	66,0	M	28	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
10	Operation	Heavy machinery and vehicle movement	Vehicle activity	Compaction, erosion and sedimentation of wetland areas	67,8	M	28	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer

Impact description					Significance before mitigation		Significance after mitigation		Mitigation measures	Action plan	Responsible person
No.	Phases	Activity	Aspect	Impact							
11	Operation	Waste site operation	Dumping of domestic and industrial waste	Water quality Impairment	62,3	M	26	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
12	Operation	Waste site operation	Dumping of chemicals, mixes and fuel	Water quality Impairment	62,3	M	27	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
13	Operation	Chemical spills	Spills and leaks	Water quality Impairment	64,2	M	27	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
14	Operation	Waste site operation	Alteration of surface runoff flow paths and flows in nearby drainage lines	Erosion, Sedimentation and Desiccation of wetland areas	126,0	M	75,6	M	The wetland areas and 58 buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
15	Operation	Heavy machinery and vehicle movement	Increase in sediment inputs & turbidity	Water quality impairment and habitat loss/alteration	93,5	M	40	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer

Impact description					Significance before mitigation		Significance after mitigation		Mitigation measures	Action plan	Responsible person
No.	Phases	Activity	Aspect	Impact							
16	Operation	Waste site operation	Inputs of toxic heavy metal and salt contaminants	Water quality Impairment	98,0	M	46,8	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
17	Decommissioning and Closure	Infrastructure removal	Removal of infrastructure	Sedimentation of wetland areas	31,7	L	28	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
18	Decommissioning and Closure	Infrastructure removal	Shaping and landscaping (movement of soil)	Sedimentation of wetland areas	92,0	M	61,2	M	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
19	Decommissioning and Closure	Revegetation	Revegetation	Loss of wetland plant diversity. Increased surface roughness	37,0	L	29	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer
20	Residual	After closure rehabilitation	Post Closure Monitoring and Maintenance	Wetland health improvement	32,5	L	37,2	L	The wetland areas and 58m buffer zones are no go areas and must be avoided	Refer to Wetland Impact Mitigation (Section 8.4 in Wetland Impact Assessment Report)	Environmental Control Officer

Several moderate impacts were identified for the construction phase of the project. The most notable risks identified to wetlands during the construction phase of the project pertaining to the removal of vegetation and excavations required for the proposed landfill site. The input of toxic heavy metal and salt contaminants, arising from activities related to the establishment of phase was identified as a moderate risk. The majority of the risks were re-allocated a low risk rating, assuming that the prescribed mitigation measures will be implemented and taking into consideration that the wetland areas and buffer zones would be avoided. The excavation of soils remained a moderate impact after mitigation measures were applied due to the fact that the excavation of soils may lead to decreased sub-surface and groundwater inputs into the wetland areas.

The impacts identified during the operational and decommissioning phases of the project were most notably that of the alteration of surface runoff flow paths and flows in nearby drainage lines and inputs of toxic heavy metal and salt contaminants which were determined to be moderate risks before mitigation. These risks related to the movement of vehicles and machinery in area and the possible indirect (accidental) contamination of the nearby watercourse areas. The impact of altered surface flows remained moderate after mitigation due to the prolonged duration of the activities giving rise to the impacts. The re-shaping and landscaping during the decommissioning phase remained moderate after mitigation as this will impact on groundwater and sub-surface flows into the wetland areas. Wetlands areas and buffer zones would be avoided during all the phases of the project; this was able to reduce the risks to low/negligible.

The most significant mitigation measure has been included in the impact table, the wetland buffer zone and working outside this buffer. This mitigation must be implemented as, according to the buffer guideline (Macfarlane *et al*. 2014) a high risk activity would require a buffer that is 95% effective to reduce the risk of the impact to a low level threat.

8.3 Recommendations

The following recommendations made for the project:

- It is recommended that an alien invasive management plan be devised and implemented for the wetland areas.
- The recommended buffer width is 17 m and 58 m for the construction and operational phases respectively. It is recommended that the larger buffer width of 58 m be implemented from the onset of the construction phase of the project
- Activities and aspects associated with the proposed landfill must be included into an updated rehabilitation (and closure) plan.
- The 58m Buffer zone and the wetland areas within the proposed site development must be treated as no areas (Figure 14). Any impact to these wetlands would result in regional water loss and contamination.
- A Hydropedological study must be carried out to assess the possible loss of groundwater recharge zone and possible water contamination.
- A site rehabilitation plan must be compiled and implemented.

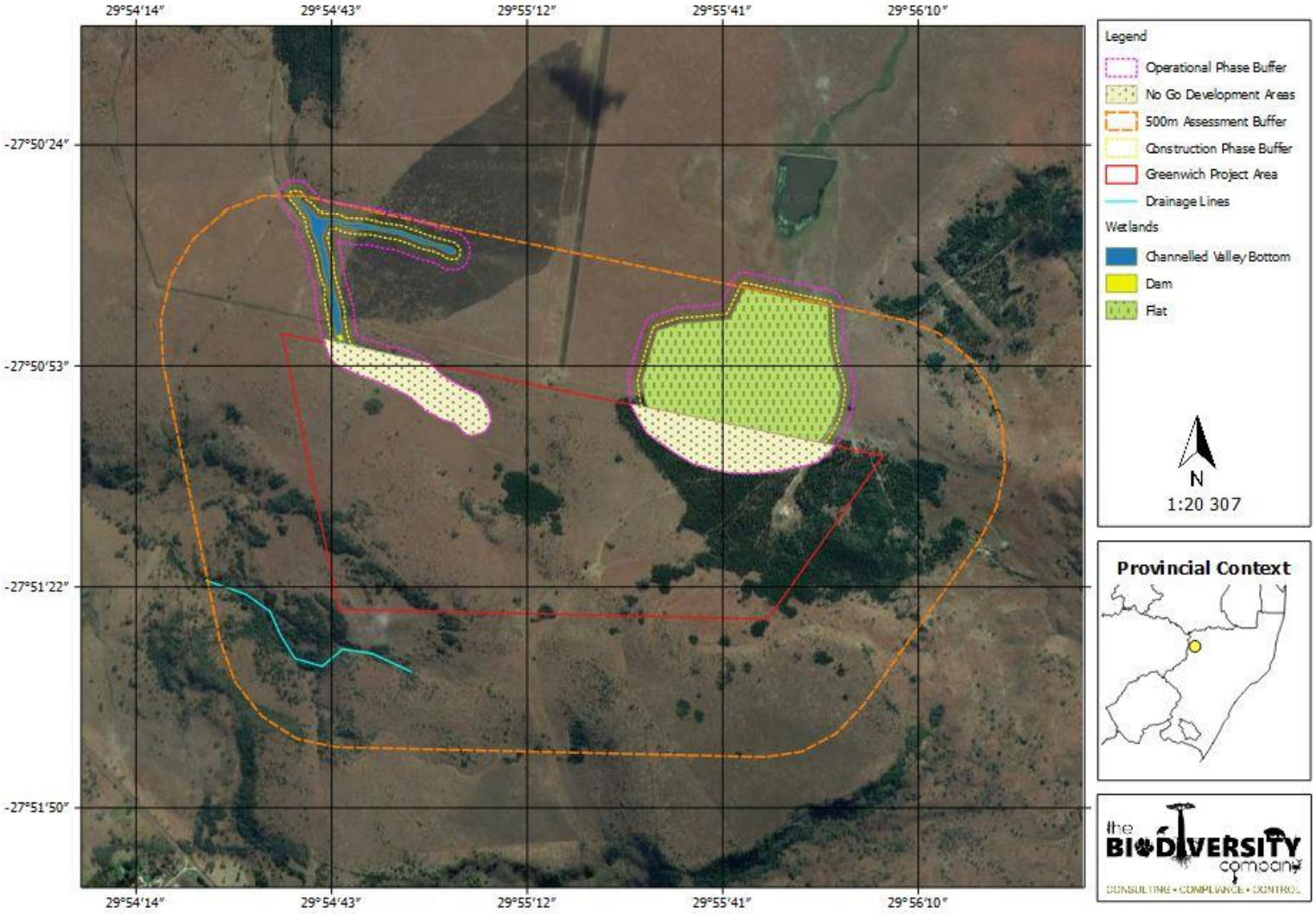


Figure 14: Identified No-Go Areas within the Greenwich Farm area

8.4 Mitigation Measures

The nature of the project is likely to be continuous work from the construction phase right through to the decommissioning phase. The impacts identified for the project are linked and as such cannot be mitigated in isolation; however, must be mitigated with an overall wetland protection approach. The most significant mitigation is the avoidance of the wetland and 58m buffer zone, the following are the mitigation measures that will supplement and look to further reduce impacts to wetland areas during the construction, operational and decommissioning phases of the project:

- All construction activities and access must make use of the existing roads.
- Signs of erosion must be addressed immediately to prevent further erosion;
- 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 to dissipate high energy flows.
- The contractors used for the project must have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly.
- A suitable storm water management plan must be compiled for the construction phase. This plan must attempt to displace and divert storm water 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.
- Laydown yards, camps and storage areas must be beyond the watercourse areas. Where possible, the construction of the crossings must take place from the existing road and not from within the watercourse and associated buffer.
- All chemicals and construction materials to be used must be stored in a bunded area.
- All machinery and equipment must be inspected regularly for faults and possible leaks, these must be serviced off-site.
- All contractors and employees must 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 construction site 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 watercourses.
- All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds.
- Any exposed earth should be rehabilitated promptly by planting suitable vegetation (vigorous indigenous grasses) to protect the exposed soil.
- All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported.

- The implementation of an effective integrated water management plan should be adopted and to further ensure clean and dirty water are separated.
- Sediment trapping berms and erosion control measures must be implemented for the duration of the project.
- No water must be discharged into the natural environment; any leaks, spills and indirect (accidental) discharge must be ceased and managed.
- Roads and access routes must be monitored and maintained throughout the lifespan of the landfill.
- Cut off drain at foot of landfill.
- Capping of landfill once each layer has been completed to reduce windblown contamination.
- Water monitoring points must be established to monitor any contamination, A baseline reading must be taken prior to any activities on the site.
- Post closure monitoring and maintenance must be conducted to assess the success of rehabilitation and address areas that need mending.

9 Conclusions

Two (2) HGM units were identified within the 500m project assessment boundary, namely the Channelled Valley Bottom (HGM 1) and Wetland Flat (HGM 2).

The Present Ecological State (PES) for the HGM units was determined to be that of a Moderately Modified (C) for HGM 1and Largely Modified (D) for HGM 2. The most significant impact was that of alien invasive plants within the wetland catchment and encroaching within the wetland areas. Both HGM units had an overall intermediate level of service. Both HGM units showed a Moderate (C) level of importance for the Ecological Integrity & Sensitivity and the Direct Human Benefits were rated as Marginally (D) important. The Hydrological Functional Importance was rated as High (B) for HGM 2 and Moderate (C) for HGM 1.

The required buffer is 17 m and 58 m for the construction and operational phases respectively. It is recommended that the larger buffer width of 58 m be implemented from the onset of the construction phase of the project.

Impact Assessment

The project is for the proposed development of a landfill site on the Greenwich Farm just outside Newcastle. A site development plan has not been established and it has been assumed that the entire project area will be utilised for the landfill. The impact assessment assessed impacts based on the activities provided in the Impact Matrix.

Several moderate impacts were identified for the construction phase of the project. The most notable risks identified to wetlands during the construction phase of the project pertaining to the removal of vegetation and excavations required for the proposed landfill site. The input of toxic heavy metal and salt contaminants, arising from activities related to the establishment of phase was identified as a moderate risk. The majority of the risks were re-allocated a low risk rating, assuming that the prescribed mitigation measures will be implemented and taking into consideration that the wetland areas and buffer zones would be avoided. The excavation of soils remained a moderate impact after mitigation measures were applied due to the fact that the excavation of soils may lead to decreased sub-surface and groundwater inputs into the wetland areas.

The impacts identified during the operational and decommissioning phases of the project were mostly determined to be low. The most notable risks were that of the alteration of surface runoff flow paths and flows in nearby drainage lines and inputs of toxic heavy metal and salt contaminants which were determined to be moderate risks before mitigation. These risks related to the movement of vehicles and machinery in area and the possible indirect (accidental) contamination of the nearby watercourse areas. The impact of altered surface flows remained moderate after mitigation due to the prolonged duration of the activities giving rise to the impacts. The re-shaping and landscaping during the decommissioning phase remained moderate after mitigation as this will impact on groundwater and sub-surface flows into the wetland areas. Wetlands areas and buffer zones would be avoided during the construction phase and also the operational phase; this was able to reduce the risks to low/negligible.

9.1 Specialist Opinion

It is the opinion of the specialist that the proposed project be authorised provided that all mitigation measures are implemented, and the following conditions be included in the environmental authorisation for this project:

9.1.1 Conditions for Environmental Authorisation

- The wetland areas and buffer zones must be avoided for the duration of the project and the proposed landfill pit must be outside the wetland and buffer zones;
- A water quality monitoring plan must be compiled and implemented for the duration of the landfill site project, starting at the construction phase to determine the baseline water quality;
- An alien plant removal and management strategy must be implemented for the landfill site area with specific attention to wetland and buffer zone areas. The alien plant management strategy must be carried out for the duration of the project including the post-closure maintenance; and
- A rehabilitation plan must be compiled and implemented for the landfill site area for all phases of the project. The rehabilitation plan must make provision for the rehabilitation and/or remediation of wetland areas, include an action plan and include a maintenance schedule for the post-closure phase of the landfill site area.

10 References

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Statistics South Africa (StatsSA). 2010. Water Management Areas in South Africa. http://www.statssa.gov.za/publications/d04058/d04058.pdf. Accessed 20th February 2016.

11 Curriculum Vitae of Specialist

Ndumiso Dlamini

BSc Hons Botany (*Pri. Sci. Nat.)*

Cell: +27 71 343 1503

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Date of birth: 17 January 1990

Profile Summary

Experience with mining projects in South Africa, parts of Africa and providing specialist input into ESHIAs and EMPs.

Specialist guidance, support and facilitation for the compliance with legislative processes, in South Africa as well as with IFC

Provide specialist and technical input for faunal, terrestrial (fauna and flora) ecology and wetland studies.

Areas of Interest

Renewable Energy and Urban & Infrastructure Development Projects, Sustainability and Conservation.

Rehabilitation of Wetlands and Land

Conservation of Water Resources

Publication of scientific journals and articles.

Key Experience

- Familiar with International Finance Corporation requirements
- Environmental, Social and Health Impact Assessments (ESHIA)
- Environmental Management Programmes (EMP)
- Ecological Water Requirement determination experience
- Wetland Ecological Assessments
- Fauna and Flora Assessments
- Biodiversity Assessments
- Protected Plant Relocation
- Wetland Rehabilitation
- Mine Rehabilitation
- Monitoring Programmes

Countries worked in

South Africa

Malawi

Mozambique

Zambia

Nationality

South African

Qualifications

- BSc Honours (University of Johannesburg) – Botany
- BSc Life and Environmental Science
- Tools for a Wetland Assessment (Certificate of Competence) – Rhodes University 2015
- Wetland Rehabilitation (Certificate of Competence) – University of Free Sate 2015

RELEVANT PROJECT EXPERIENCE

Project Name: The Baseline Environmental Assessment and Rehabilitation of Anker Coal Mining Operation (Golfview and Elandsfontein Operations)

Client: Anker Coal

Personal position / role on project: Terrestrial Ecology Specialist and Wetland Rehabilitation

Location: Ermelo, South Africa (2015).

Main project features: To identify and map the ecological factors and provide input and guidance for the rehabilitation of wetland areas and to support contractor activities.

Project Name: Environmental Studies for the Liwonde Dry Port

Client: Mota Engil.

Personal position / role on project: Terrestrial Ecology specialist.

Location: Liwonde, Malawi (2015).

Main project features: To determine the current status of the environment and assess potential risks to the environment.

Project Name: The relocation and post-relocation monitoring of *Khadia carolinensis* plants at the Exxaro Eerstelingsfontein Coal Mine.

Client: Exxaro.

Personal position / role on project: Botanist.

Location: Belfast, South Africa (2014 – 2015).

Main project features: Determine suitable relocation habitat for plants and monitor the success of the relocation of the plants.

Project Name: Wetland Impact Assessment for the Northern Coal Jagust Colliery

Client: Northern Coal

Personal position / role on project: Wetland Specialist.

Location: Carolina, South Africa (2015).

Main project features: Delineate and assess the health of wetland areas and provide mitigation measures for potential impacts on wetland areas.

Project Name: Environmental Impact Assessment for the Ixia Imvula Opencast Coal Mine

Client: Ixia Coal.

Personal position / role on project: Wetland Specialist

Location: Secunda, South Africa (2015 – 2016).

Main project features: Conduct a wetland delineation and impact assessment for the proposed opencast mine and river diversion.

Project Name: Water Resource Risk Assessment for several infrastructure development projects (Pipelines, Roads, Residential and Commercial Housing)

Client: Department of Roads and Transport, Various Municipalities

Personal position / role on project: Wetland Specialist.

Location: KwaZulu-Natal, Gauteng, Limpopo, South Africa (2016 – 2018).

Main project features: Delineate and assess the health of wetland areas and provide mitigation measures for potential impacts on wetland areas.

OVERVIEW

An overview of the specialist technical expertise includes the following:

- Conducting onsite investigations of Flora, Fauna and Wetlands;
- Conducting research on ecology and compile technical reports;
- Conduct assessments for rehabilitation of wetlands, compile reports and monitor the progress of rehabilitation of wetlands;
- Conduct and complete Alien Invasive Plant Management Plans;
- Project and budget management;
- Proposal compilation and client liaison;
- Compile integrated biodiversity reports; and
- Complete legislative and regulatory authorisation processes for various projects, which include Environmental Impact Assessments, Basic Assessments and Water Use License Applications, Environmental Management Plans and consult with state departments on legal frameworks.

TRAINING

Some of the more pertinent training undergone include the following:

- Tools for Wetland Delineation Course (Certificate of Competence) – Rhodes University 2015
- Wetland Rehabilitation Methods and Techniques – University of Free State 2015
- Alien Invasive Species Identification and Management – 2016
- Grass Identification – 2017 Land-Use Management Training

EMPLOYMENT EXPERIENCE

CURRENT EMPLOYMENT: The Biodiversity Company (March 2016 – Present)

I am currently employed with The Biodiversity Company as an Environmental Consultant. My key responsibilities are to conduct specialist studies of Wetland Assessments, Ecological Assessments and Biodiversity Assessments. Key focus areas include:

- Wetland and Riparian Assessments;
- Wetland Rehabilitation;
- Vegetation Assessments;
- Alien Invasive Plant Management; and
- Biodiversity Assessments.

EMPLOYMENT: Digby Wells Environmental (May 2014 – February 2016

I was employed in role of Junior Ecologist and was tasked with providing specialist input into Environmental Impact Assessments and other biodiversity projects. Key focus areas included:

- Wetland Assessments;
- Wetland Rehabilitation;
- Fauna and Flora Assessments;
- Alien Invasive Plant Management; and
- Biodiversity Assessments.

PREVIOUS EMPLOYMENT: University of Pretoria – Genetics Department

- October 2012 – April 2014: Junior Genetic Researcher
    - Researcher
    - Technical assistant for fieldwork
    - Reporting writing
    - Project management

GENERAL SKILLS

Literacy	Read, write and speak English fluently. Read, write and speak Afrikaans. Read, write and speak IsiZulu fluently. Speak and understand other indigenous South African languages.
Generic	Advanced user of Microsoft Office applications.
Mapping	Introductory skill level for ArcGIS and Quantum GIS.

ADDITIONAL EXPERIENCE

Control officer	Acting as an independent Environmental Control Officer (ECO), acting as a quality controller and monitoring agent regarding all environmental concerns and associated environmental impacts
Public consultation	The provision of specialist input in order to communicate project findings as well as assist with providing feedback if and when required.
Water use licenses	Consultation with the relevant authorities in order to establish the project requirements, as well as provide specialist

(aquatics/wetland) input for the application in order to achieve authorisation.

ACADEMIC QUALIFICATIONS

University of Johannesburg (UJ), Johannesburg, South Africa (2011): BACCALAUREUS SCIENTIAE HONORIBUS (Hons) – Botany

University of Johannesburg (UJ), Johannesburg, South Africa (2008 - 2010): BACCALAUREUS SCIENTIAE IN LIFE AND ENVIRONMENTAL SCIENCES. Majors: Biochemistry and Botany.