WATER RESOURCE ASSESSMENT FOR THE BULK WATER SUPPLY SCHEME AT THOKOZANI & MPOLWENI

Albert Falls, KwaZulu-Natal

February 2020

Client

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Report Name	Water Resource Assessment for The Bulk Water Supply Scheme at Thokozani & Mpolweni Albert Falls, Kwazulu-Natal	
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Declaration	The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Environmental Impact Assessment Regulations, 2017. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science.	

River crossing at the Mpolweni area (February 2020)

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Declaration

I, Wayne Jackson 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.

Wayne Jackson

Soils & Wetland Specialist

The Biodiversity Company

20th February 2020

1 Introduction

The Biodiversity Company (TBC) was appointed to conduct a water resource baseline and risk assessment, as part of the environmental authorisation process for the proposed Bulk Water Supply Scheme (BWSS) and water reticulation system of Thokozani and Mpolweni areas near Albert Falls Dam, KwaZulu-Natal. A site visit was conducted in February 2020, which would constitute a wet season survey.

This report, after taking into consideration the findings and recommendations provided by the specialist herein, should inform and guide the Environmental Assessment Practitioner (EAP), enabling informed decision making as to the ecological viability of the proposed development and to provide an opinion on the whether any environmental authorisation process or licensing is required for the proposed activities.

1.1 Aim and Objectives

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

- A desktop description of local rivers and catchment areas;
- The delineation and assessment of wetlands within 500 m of the project area;
- A risk assessment for the proposed project; and
- The prescription of mitigation measures and recommendations for identified risks.

The reticulation will consist of mains pipelines varying in diameter from 25mm to 250mm. The layout was chosen to follow the alignment of the access roads as far as possible, to mitigate the environmental impact. The Mpolweni reticulation totals at 203,770m and the Thokozani reticulation is 48,260m.

2 Project Area

The project area is located approximately 13 km north of Pietermaritzburg and directly to the east of Albert Falls Dam, in the KwaZulu-Natal Province, (Figure 2-1).

The project area is located within the Pongola - Mtamvuna Water Management Area (WMA 4) (NWA, 2016). The region has a mean annual precipitation rate of 800 to 1 500 mm and is considered humid. The bulk of the services are located across 2 quaternary catchments:

- U20F; and
- U20G.

Watercourses within the above presented quaternary catchments form tributaries or are the mainstem of the larger uMngeni River system. The Sub Quaternary Reaches (SQR's) associated with the project area were the following:

- U20F-4224;
- U20F-4204;

- U20G-4240;
- U20G-4259; and
- U20G-4215.

The layout of the proposed project will result in several direct crossing points, and indirect impacts in the above mentioned SQR's. A summary of the ecological classifications and impact nature are presented below (Table 2-1).

Table 2-1 Details of relevant Sub Quaternary Reaches (DWS, 2013)

SQR	Name	Present Ecological State	Default Ecological Category	Ecological Importance	Ecological Sensitivity	Impact of Proposed Project
U20F-4224	Mpolweni	C	B	High	High	Direct crossing
U20F-4204	Sterkspruit	C	B	High	High	Direct crossing
U20G-4240	uMngeni	C	A	High	Very High	Direct crossing
U20G-4259	uMngeni	C	A	High	Very High	Indirect
U20G-4215	uMngeni	C	A	High	Very High	Direct crossing

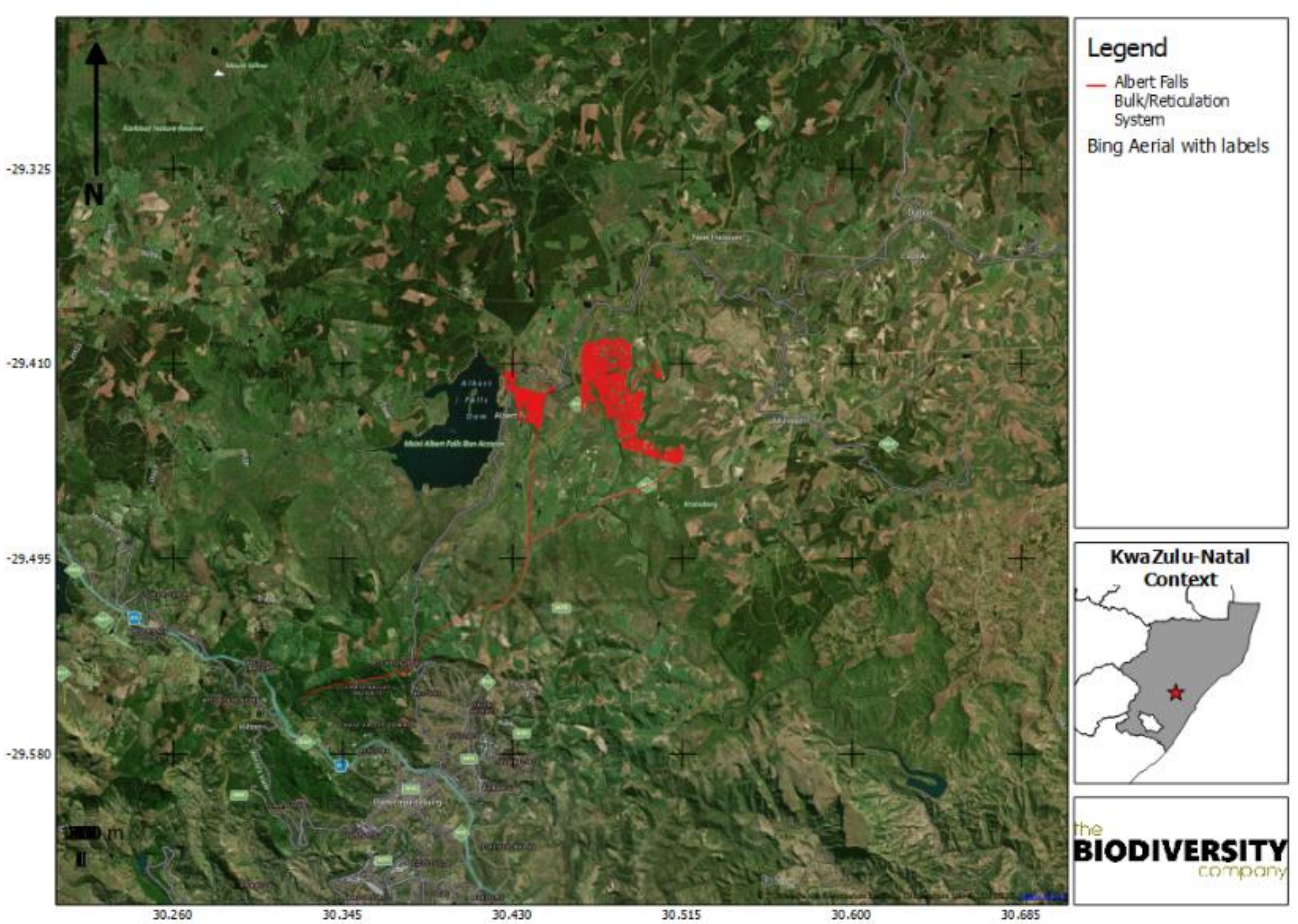

Figure 2-1 Project locality for the Albert Falls BWSS

3 Methodology

3.1 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);
- South African Inventory of Inland Aquatic Ecosystems (SAIIAE) (Van Deventer, H., et al., 2018); and
- Contour data (5 m).

3.2 Wetland Assessment

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

3.2.1 Wetland Delineation

The wetland areas are delineated in accordance with the DWAF (2005) guidelines, a cross section is presented in Figure 3-1. The outer edges of the wetland areas were identified by considering the following four specific indicators:

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

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

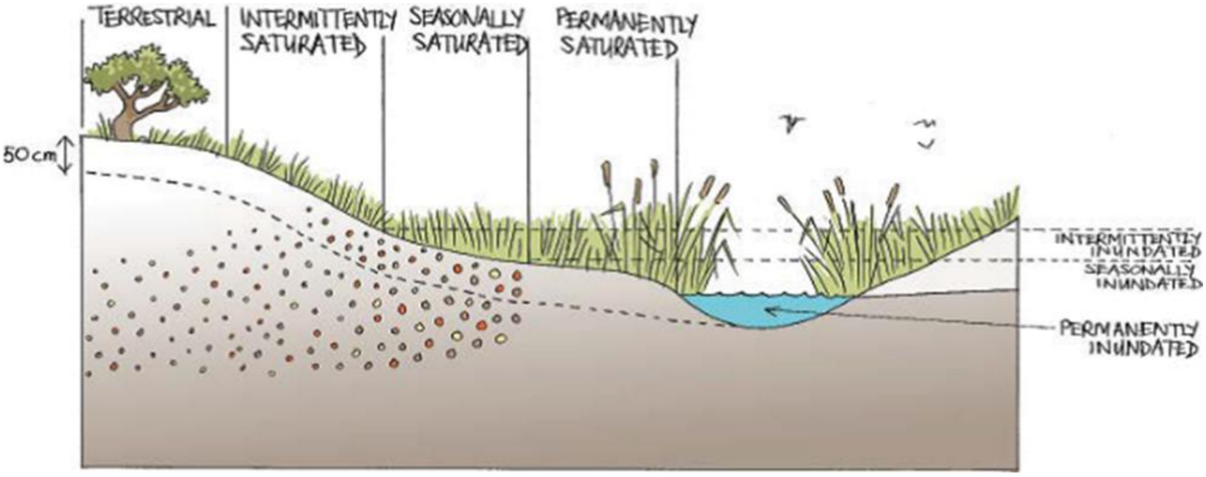

Figure 3-1 Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis, et al., 2013)

3.2.2 Wetland Functional Assessment

Wetland Functionality refers to the ability of wetlands to provide healthy conditions for the wide variety of organisms found in wetlands, as well as for humans. Ecosystem services serve as the main factor contributing to wetland functionality.

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 3-1).

Table 3-1 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

3.2.3 Determining the Present Ecological Status

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 Present Ecological Status (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 PES categories are provided in Table 3-2.

Table 3-2 The Present Ecological Status categories (Macfarlane, et al., 2009)

Impact Category	Description	Impact Score Range	PES
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**

3.2.4 Determining the Ecological Importance and Sensitivity

The method used for the Ecological Importance and Sensitivity (EIS) determination was adapted from the method as provided by DWS (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed. A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The mean of the determinants is used to assign the EIS category as listed in Table 3-3, (Rountree, M. & Kotze, D. 2013).

Table 3-3 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**

3.2.5 Ecological Classification and Description

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

3.2.6 Recommended Ecological Category

The Recommended Ecological Category (REC) is determined by the PES of the water resource and the importance and/or sensitivity of the water resource.

Water resources which have Present Ecological State categories in an E or F ecological category are deemed unsustainable by the DWA. In such cases the REC must automatically be increased to a D (Rountree *et.al.* 2013).

Where the PES is in the A, B, C or D ecological category, then the EIS components must be checked to determine if any of the aspects of importance and sensitivity (Ecological Importance; Hydrological Functions and Direct Human Benefits) are high or very high. If this is the case, the feasibility of increasing the PES (particularly if the PES is in a low C or D category) should be evaluated. This is recommended to enable important and/or sensitive wetland water resources to maintain their functionality and continue to provide the goods and services for the environment and society.

The REC is determined as follows with

Table 3-3 showing the summarised selection criteria.

- If PES is in an E or F category, then the EIS is not important and the REC is set to at least a D (since E and F ecological categories are considered unsustainable);
- If PES is in an A, B, C or D category, ***AND*** the EIS is Moderate to Low ***OR*** the EIS criteria is High or even Very High, ***AND*** It is ***not feasible*** or practicable for the PES to be improved ***THEN*** the REC is set to the current PES;
- If PES is in a B, C or D category, ***AND*** the EIS is High or Very High. ***AND*** It is ***feasible*** or practicable for the PES to be improved ***THEN*** the REC is set to at least one category higher than the current PES.

Table 3-4 Summary of selection criteria

PES	EIS	Condition	REC
E or F	N/A	N/A	At least a D
A, B, C, or D	Moderate to Low OR the EIS criteria is High or even Very High	It is not feasible or practicable for the PES to be improved	Set to current PES
B, C, or D	High or Very High	It is feasible or practicable for the PES to be improved	Set at least one category higher than the current PES

4 Buffer Determination

The "Buffer zone guidelines for wetlands, rivers, and estuaries" (Macfarlane, *et al.,* 2014) was used to determine the appropriate buffer zone for the proposed activity.

5 Risk Assessment

The risk assessment will be completed in accordance with the requirements of the DWS General Authorisation (GA) in terms of Section 39 of the NWA for water uses as defined in Section 21(c) or Section 21(i) (GN 509 of 2016). The significance of the impact is calculated according to Table 5-1.

Table 5-1 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

The following aspects were considered as limitations;

- The GPS used for water resource delineations is accurate to within five meters. Therefore, the wetland delineation plotted digitally may be offset by at least five meters to either side;
- No riverine assessment was completed for this study;
- No water quality was assessed during this study;

- No riparian habitat assessment was completed for this study;
- Only wetlands that were likely to be impacted by proposed upgrade were assessed in the field. Wetlands located within a 500 m radius of the road but not in a position within the landscape to be measurably affected by the developments were not considered as part of this assessment; and
- Field assessments were completed to assess as much of the site as possible with focus on the proposed directly impacted and downstream areas.

7 Results and Discussion

7.1 Desktop Assessment

7.1.1 Land Type

Existing Land Type data was used to obtain generalised soil patterns and terrain types for the site. Land Type data exists in the form of published 1:250 000 maps. These maps indicate delineated areas of similar terrain types, pedosystems (uniform terrain and soil pattern) and climate (Land Type Survey Staff, 1989).

The Thokozani area falls within land type Ba59. This land type is dominated by the midslope landscape position and consists largely of deep well drained Hutton soils. The valley bottoms are mainly Katspruit soils.

The Ba59 geology is mainly shale of the Pietermaritzburg Formation, Ecca Group and dolerite.

The Mpolweni reticulation system falls within Bb111, Ac198, Ab115 and Fa461. These land types are dominated by the midslope landscape position and consists largely of Hutton and Glenrosa soil forms. The valley bottoms are mainly Katspruit and Dundee soil forms.

The Bb111 geology is mainly tillite of the Dwyka Formation with small areas of dolerite and sandstone of the Natal Group. The Ab115 geology is mainly sandstone of the Natal Group with small areas of tillite of the Dwyka Formation. The Ac198 geology is mainly shale of the Pietermaritzburg Formation, Ecca Group and dolerite. The Fa461 geology is mainly Granite/gneiss.

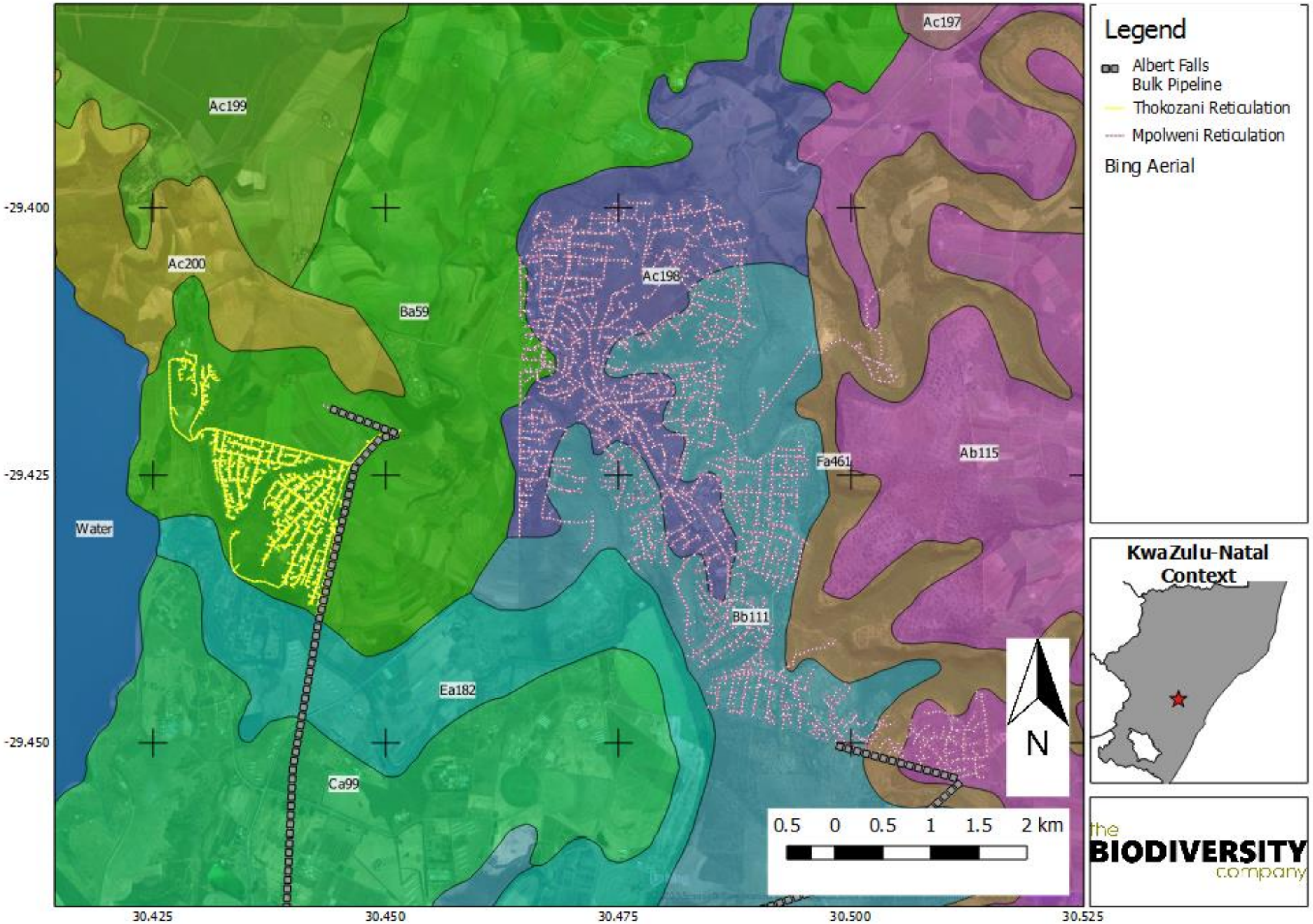

Figure 7-1 Land type map for the BWSS

7.1.2 South African Inventory of Inland Aquatic Ecosystems

The South African Inventory of Inland Aquatic Ecosystems (SAIIAE) (Van Deventer, H., *et al*., 2018) has updated the previous NFEPA maps to give a more comprehensive desktop data set of the wetlands at a national level.

Based on the desktop information, the reticulation systems for Thokozani and Mpolweni only had riverine systems associated with them (Figure 7-2). These systems do not fall within the wetland assessment ecological health categorisation.

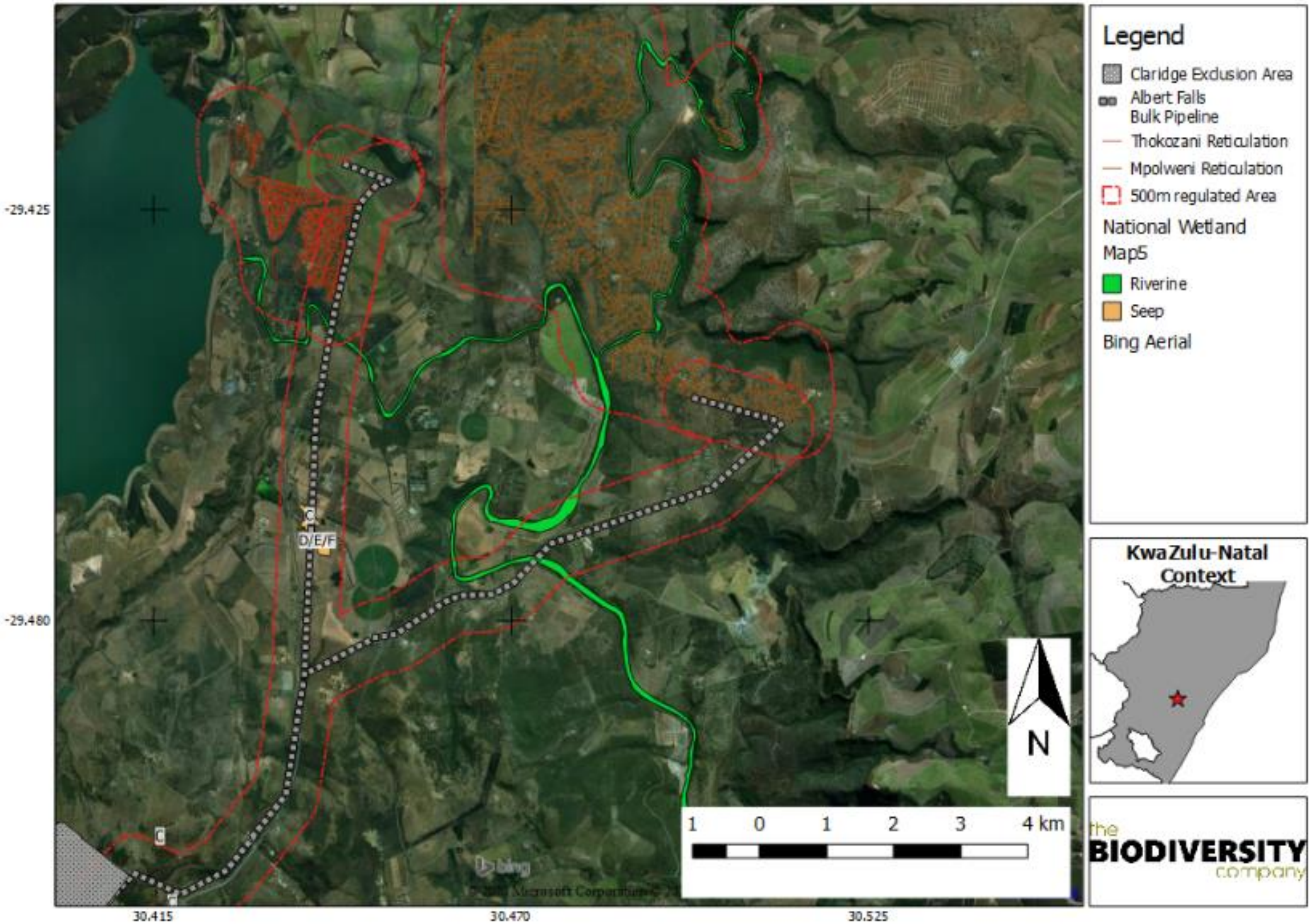

Figure 7-2 The SAIIAE wetlands and the associated wetland conditions within the BWSS area

7.1.3 National Freshwater Ecosystem Priority Area Status

The National Freshwater Ecosystem Priority Areas (NFEPA) database forms part of a comprehensive approach to the sustainable and equitable development of South Africa's scarce water resources. This database provides guidance on how many rivers, wetlands and estuaries, and which ones, should remain in a natural or near-natural condition to support the water resource protection goals of the National Water Act (Act 36 of 1998). This directly applies to the National Water Act, which feeds into Catchment Management Strategies, water resource classification, reserve determination, and the setting and monitoring of resource quality objectives (Nel *et al*. 2011). The NFEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the National Environment Management Biodiversity Act's biodiversity goals (NEM:BA) (Act 10 of 2004), informing both the listing of threatened freshwater ecosystems and the process of bioregional planning provided for by this Act (Nel *et al*., 2011). No freshwater priority areas (river ecosystem types) are designated to the SQRs associated with this project.

7.1.4 Expected Fish Species

An expected fish species list for the SQR's was obtained from the following sources: Skelton (2001) and DWS (2013). Based on this, 14 fish species are expected to occur in the project area (Table 7-1).

It should be noted that these expected species lists are compiled on a SQR basis and not on a site specific basis. It is therefore highly unlikely that all of the expected species will be present at every site in the SQR with habitat type and availability being the main driver of species present. Therefore, the table below should be viewed as a list of potential species rather than an expected species list.

Table 7-1 Expected fish species list for the 2 sub-quaternary catchments

Scientific name	Common name	IUCN Status
Amphilius natalensis	Natal Mountain Catfish	LC
Anguilla bengalensis labiata	African mottled eel	NT
Anguilla marmorata	Giant mottled eel	LC
Anguilla mossambica	African longfin eel	LC
Awaous aeneofuscus	Freshwater goby	LC
Enteromius gurneyi	Red tail barb	VU
Enteromius pallidus	Goldie Barb	LC
Enteromius viviparus	Bowstripe barb	LC
Clarias gariepinus	Sharptooth catfish	LC
Labeobarbus natalensis	Natal yellowfish	LC
Oreochromis mossambicus	Mozambique tilapia	VU
Pseudocrenilabrus philander	Southern mouthbrooder	LC
Coptodon rendalli	Blue tilapia	LC
Tilapia sparrmanii	Banded tilapia	LC
Total number of fish		**14**

LC- Least Concern NT- Near Threatened VU- Vulnterable

7.1.1 The National Biodiversity Assessment

The purpose of the National Biodiversity Assessment (NBA) is to assess the state of South Africa's biodiversity based on best available science, with a view to understanding trends over time and informing policy and decision-making across a range of sectors. The NBA is central to fulfilling SANBI's mandate to monitor and report regularly on the status of the country's biodiversity, in terms of the National Environmental Management: Biodiversity Act (NEMBA, Act 10 of 2004). The NBA endeavours to capture the challenges and opportunities embedded in South Africa's rich natural heritage by looking at biodiversity in the context of social and economic change and recognising the relationship between people and their environment. The NBA deals with all three components of biodiversity: genes, species and ecosystems; and assesses biodiversity and ecosystems across terrestrial, freshwater, estuarine and marine environments.

The two headline indicators assessed in the NBA are ecosystem threat status and ecosystem protection level (Driver *at al*., 2012).

7.1.1.1 Ecosystem Threat Status

Ecosystem threat status (ETS) outlines the degree to which ecosystems are still intact or alternatively losing vital aspects of their structure, function and composition, on which their ability to provide ecosystem services ultimately depends (Driver *et al*., 2011).

Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Least Threatened (LT), based on the proportion of each ecosystem type that remains in good ecological condition (Driver *et al.,* 2011).

The SAIIAE (Van Deventer, H., *et al*., 2018) was used to show the ETS of the wetlands within the 500m regulated area (Figure 7-3). All the wetlands were classified as critically endangered. These wetlands are only classified at the existing bulk water pipeline and not at the proposed reticulation system.

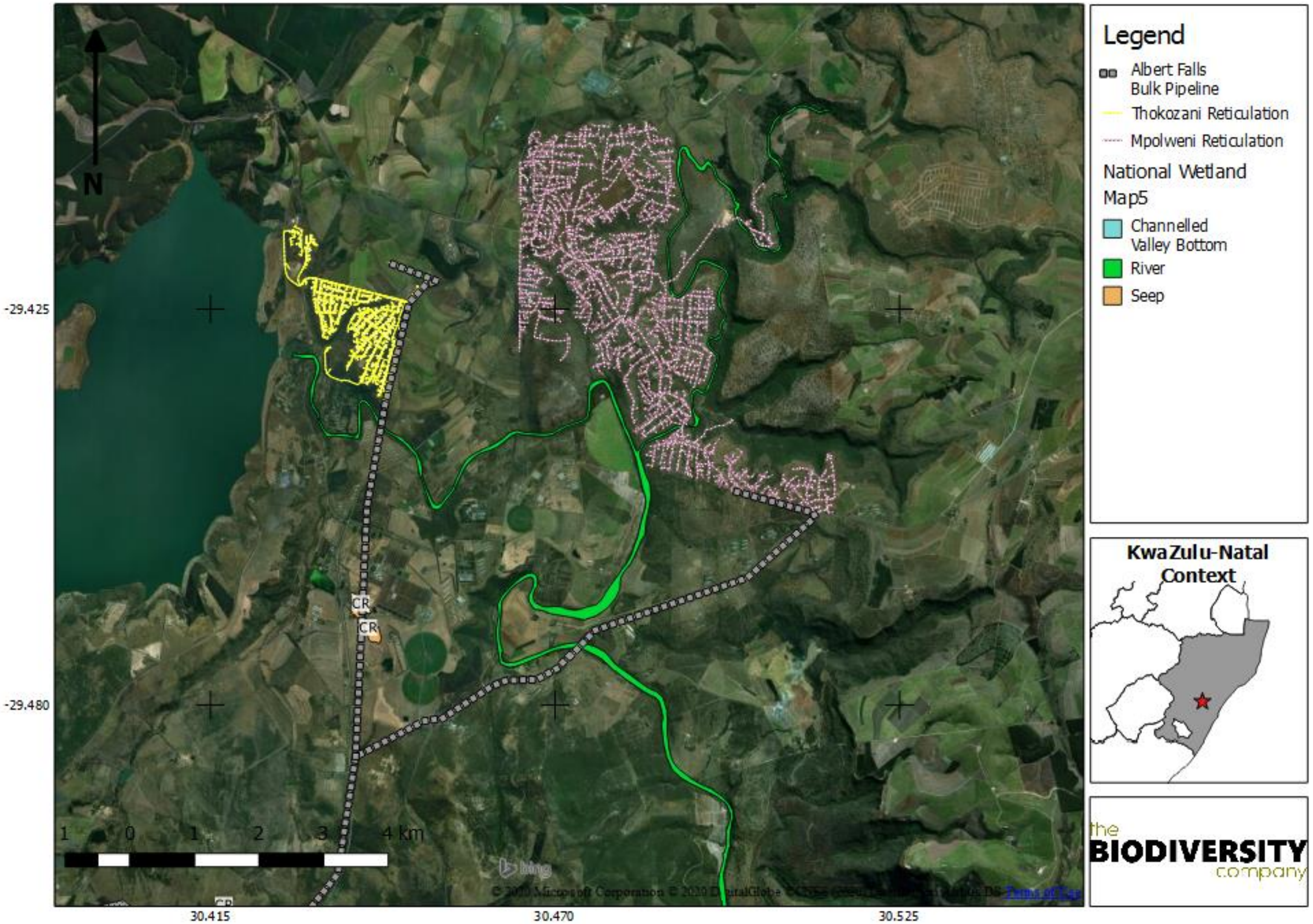

Figure 7-3 The ecosystem threat status of the wetlands within the BWSS area

7.1.1.2 Ecosystem Protection Level

Ecosystem protection level (EPL) tells us whether ecosystems are adequately protected or under-protected. Ecosystem types are categorised as not protected, poorly protected, moderately protected or well protected, based on the proportion of each ecosystem type that occurs within a protected area recognised in the Protected Areas Act (Driver *at al*., 2012).

The SAIIAE (Van Deventer, H., *et al*., 2018) was used to show the EPL of the wetlands within the 500m regulated area (Figure 7-4). The wetlands are not protected within this region. These wetlands are only classified at the existing bulk water pipeline and not at the proposed reticulation system.

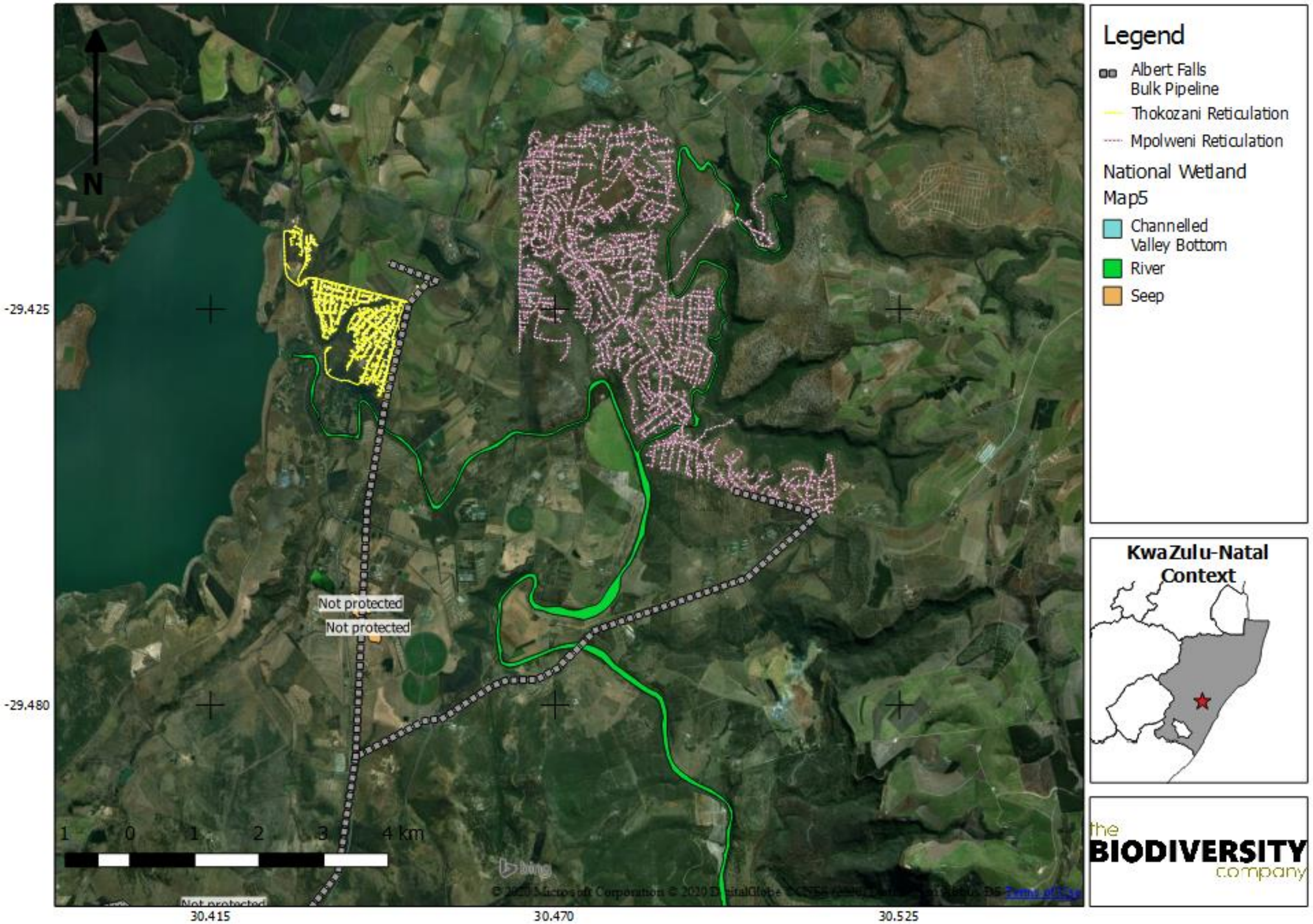

Figure 7-4 The ecosystem protection levels of the wetlands within the BWSS Area

7.2 Wetland Assessment

The survey included assessing all the wetland indicators as well as determining the PES or health of the wetland, the wetland's ability to provide goods and services (eco-services) and the EIS of the wetlands.

7.2.1 Wetland Delineation

The wetland survey was conducted in February 2020. A hand-held auger and a GPS tablet were used to log all information in the field. The soils were classified to the family level as per the "Soil Classification - A Taxonomic System for South Africa" (Soil Classification Working Group, 1991).

The dominant land use in the project area was that of urban settlements with many dirt roads. The remaining area is farmed with sugarcane and timber. The wetland delineation is shown in Figure 7-8 and Figure 7-9. Table 7-2 shows the wetland classification as per SANBI guidelines (Ollis *et al.* 2013). Four wetland types were identified within the project area (Figure 7-5), namely;

- Channelled valley bottom;
- Hillslope seep;
- Unchannelled valley bottom; and
- Artificial dams.

The wetlands are described in the following sections in more detail.

It must be noted that the HGM unit allocation is from HGM 3 to HGM 9. HGM 1 and HGM 2 were classified on the existing bulk water pipeline area and do not form part of this assessment.

The dominant wetland vegetation identified within the BWSS project area includes; *Typha capensis, Juncus effuses, Pycreus nitidus, Cyperus digitatus, Cyperus dives, Cyperus longus, Imperata cylindrica, Chloris gayana, Leersia Hexandra* and *Phragmites australis* (Figure 7-6).

The dominant soils in the wetland areas were the Katspruit and Westleigh soil forms. The river banks were comprised of Dundee soil forms with the dominant soils in the midslope landscape positions being the Hutton soil form (Figure 7-7).

Figure 7-5 Wetland types within the BWSS area, A) Channelled valley bottom, B) Seeps, C) Unchannelled valley bottom, D) drainage lines.

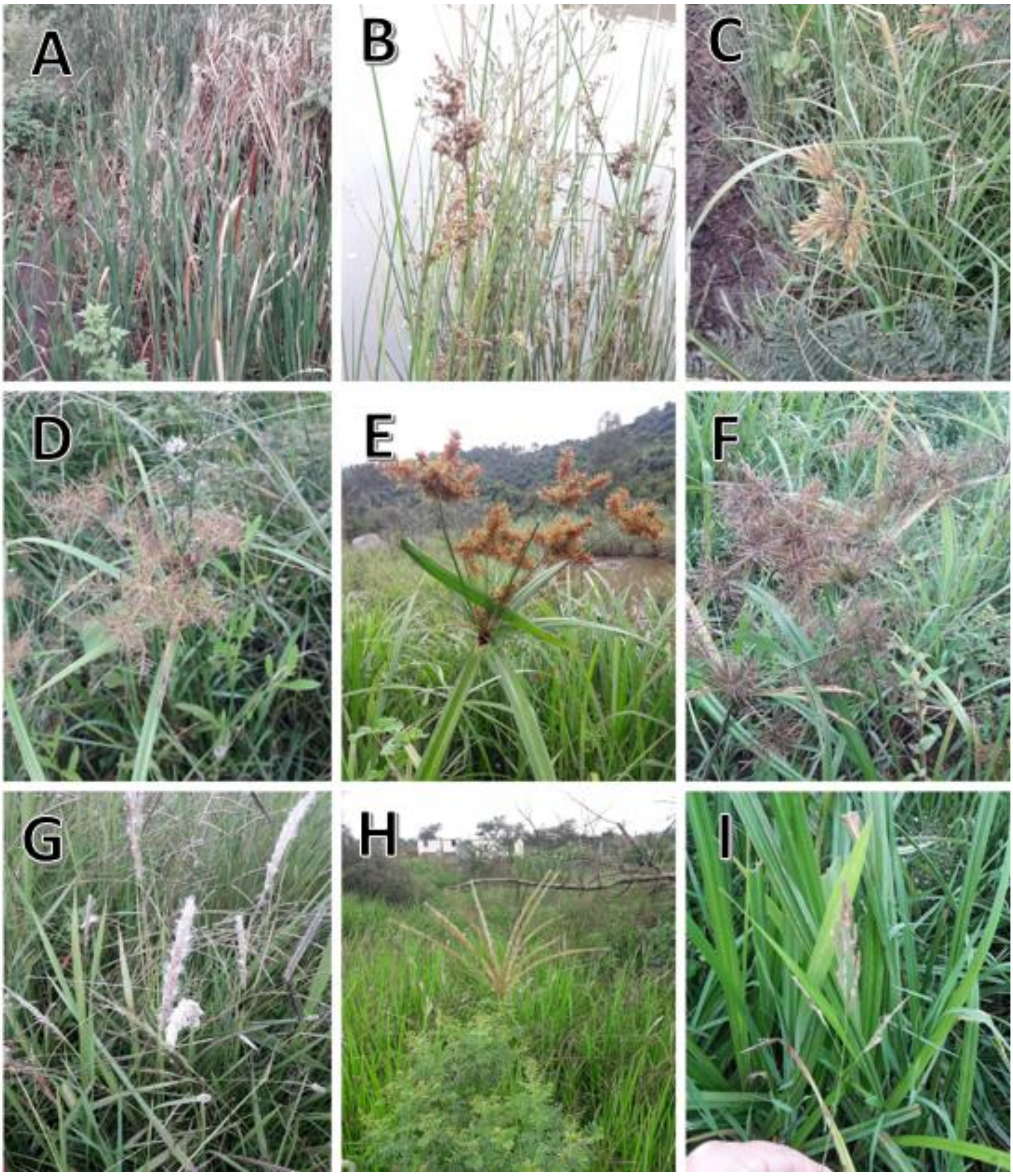

Figure 7-6 Wetland plants photographed within the BWSS area. A) Typha capensis, B) Juncus effuses, C) Pycreus nitidus, D) Cyperus digitatus, E) Cyperus dives, F) Cyperus longus, G) Imperata cylindrica, H) Chloris gayana, I) Leersia Hexandra.

Figure 7-7 Wetland soils photographed within the BWSS project area. A & B) Katspruit, C & E) Dundee, D &F) Westleigh, G) well drained Hutton soils.

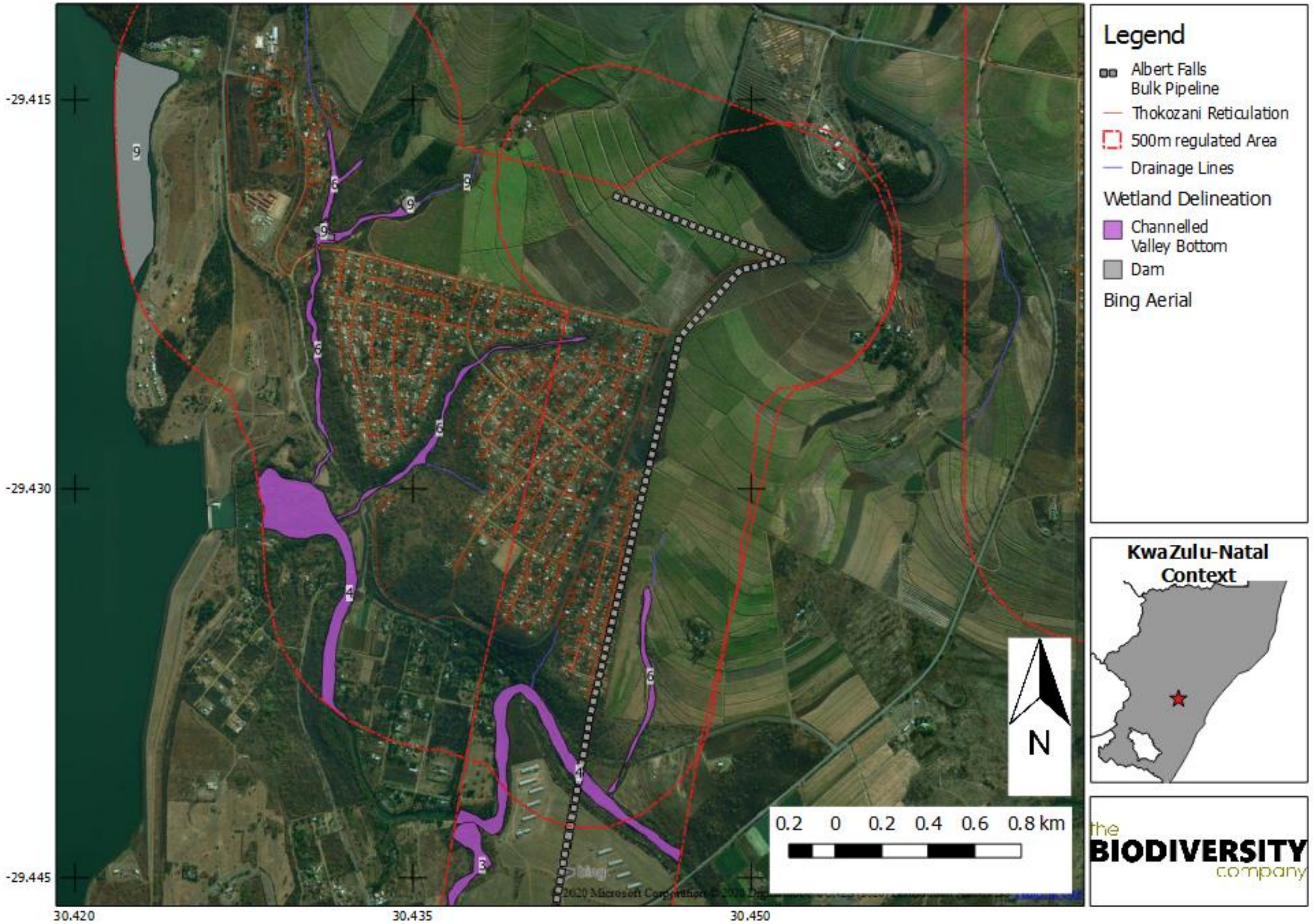

Figure 7-8 Thokozani area wetland delineation and the corresponding HGM units

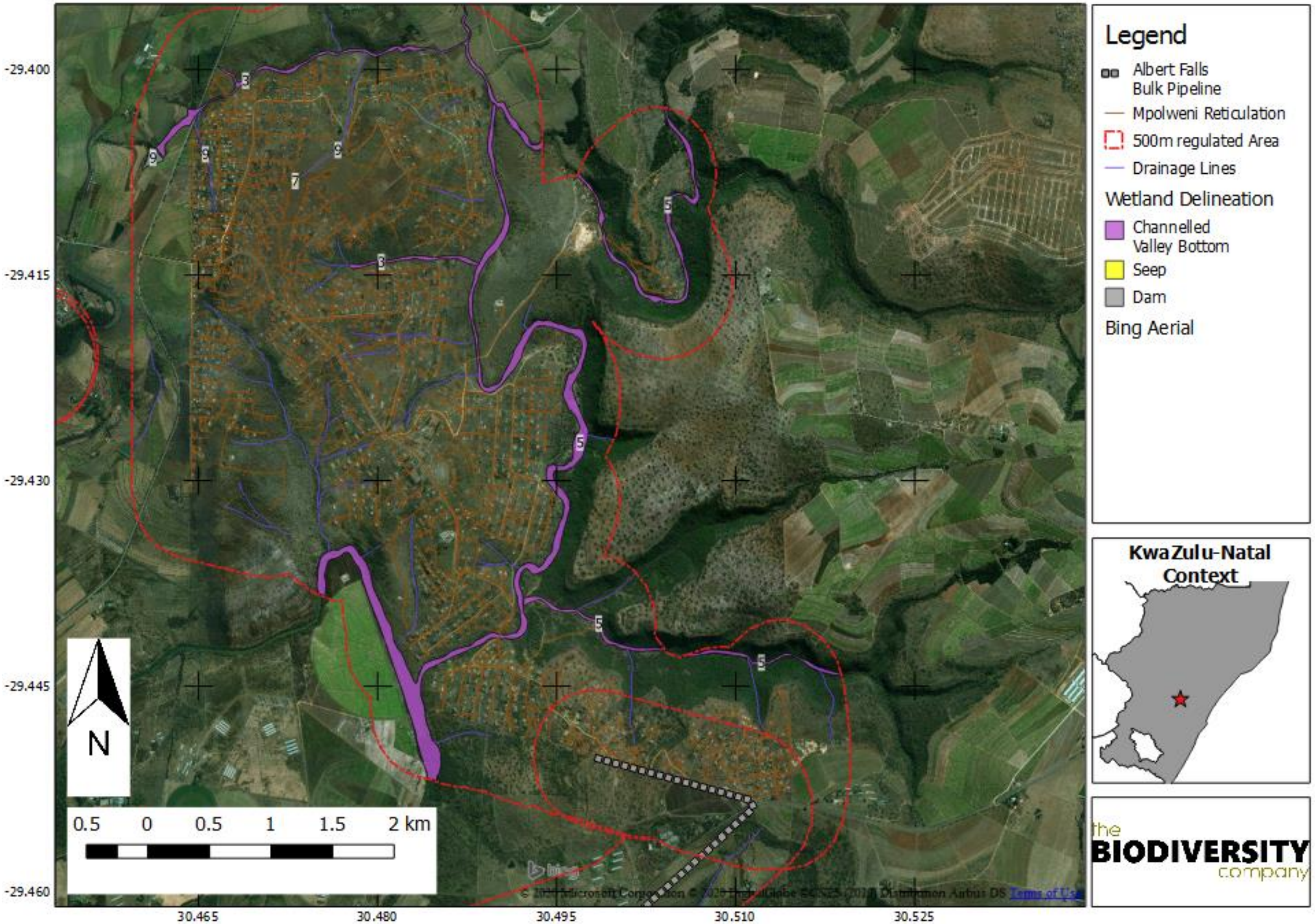

Figure 7-9 Mpolweni area wetland delineation and the corresponding HGM units

Table 7-2 Wetland classification as per SANBI guideline (Ollis et al. 2013).

HGM No.	Level 1	Level 2		Level 3	Level 4		
	System	**DWS Ecoregion**	**SAIIAE Wet Veg Group**	**Landscape Unit**	**4A (HGM)**	**4B**	**4C**
3	Inland	South Eastern Uplands	Sub-Escarpment Savanna	Valley Floor	Channelled valley bottom	N/A	N/A
4				Valley Floor	Channelled valley bottom	N/A	N/A
5				Valley Floor	Channelled valley bottom	N/A	N/A
6				Valley Floor	Channelled valley bottom	N/A	N/A
7				Slope	Seep	With Channelled outflow	N/A
8				Valley Floor	Unchannelled valley bottom	N/A	N/A
9				Valley Floor	Depression	Dammed	With Channelled Inflow

7.2.2 Wetland Unit Setting

Four (4) wetland types were identified during the field assessment. These were the;

- Channelled valley bottom;
- Hillslope seep;
- Unchannelled valley bottom; and
- Artificial dams.

The dams are artificial systems and were not assessed for wetland health conditions.

7.2.2.1 Channelled Valley Bottom

Channelled valley bottom wetlands are characterised by their location on valley floors, the absence of characteristic floodplain features and the presence of a river channel flowing through the wetland (Ollis *et al*. 2013). This has been illustrated in Figure 7-10.

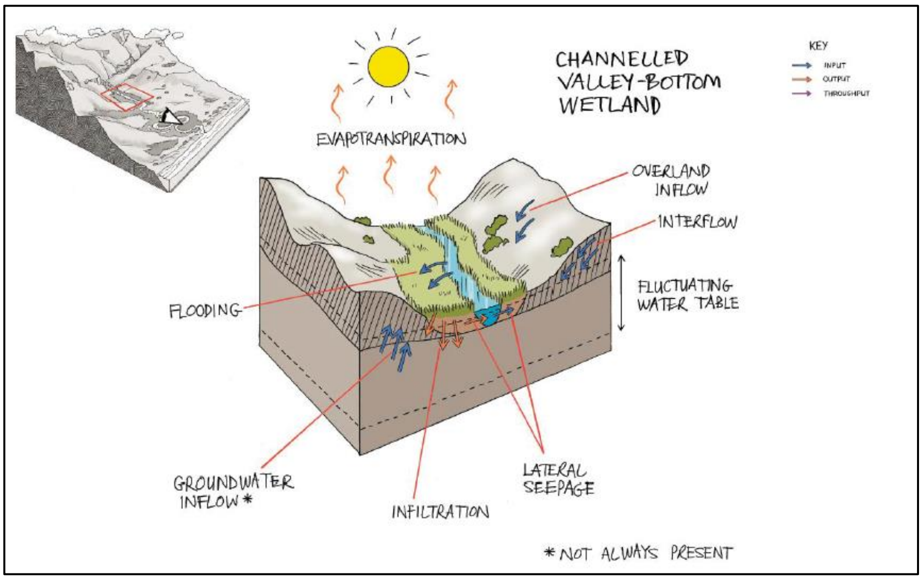

Figure 7-10 Illustration of channelled valley bottom flow dynamics (Ollis et al. 2013)

7.2.2.2 Unchannelled Valley Bottom

Unchannelled valley bottom wetland is a valley bottom wetland without a river channel running through it. Unchannelled valley bottom wetlands are characterised by their location on valley floors, an absence of distinct channel banks, and the prevalence of diffuse flows (Ollis *et al.* 2013). This has been illustrated in Figure 7-11.

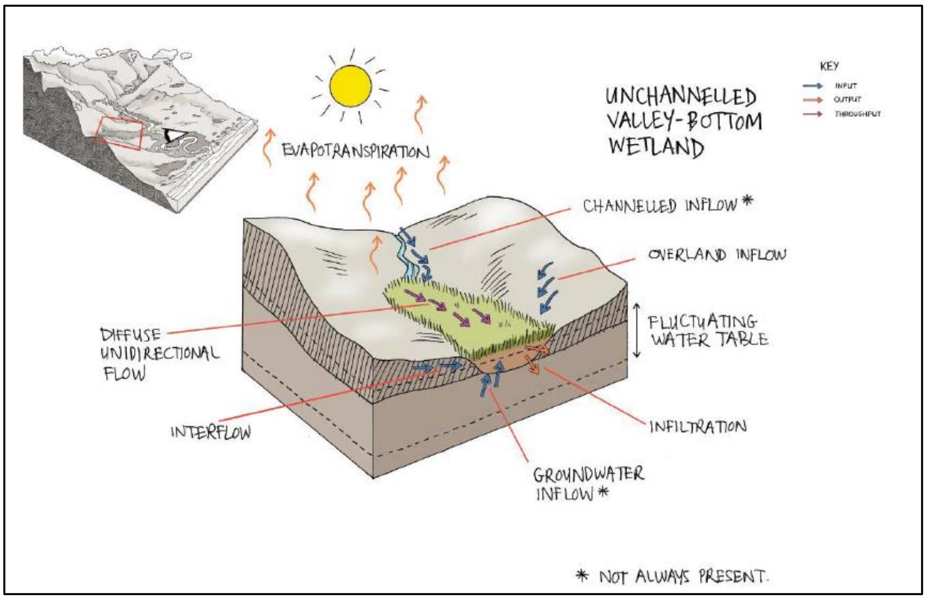

Figure 7-11 Illustration of unchannelled valley bottom flow dynamics (Ollis et al. 2013)

7.2.2.3 Hillslope Seep

Hillslope seep are wetland areas located on gently to steeply sloping land and dominated by colluvial (i.e. gravity-driven), unidirectional movement of water and material down-slope. Seeps are often located on the side-slopes of a valley, but they do not, typically, extend onto a valley floor. Water inputs are primarily via subsurface flows from an up-slope direction. Water movement through the seep is mainly in the form of interflow, with diffuse overland flow often being significant during and after rainfall events (Ollis *et al.* 2013). A conceptual diagram of a seep, showing the dominant movement of water into, through and out of a typical seep is provided in Figure 7-12.

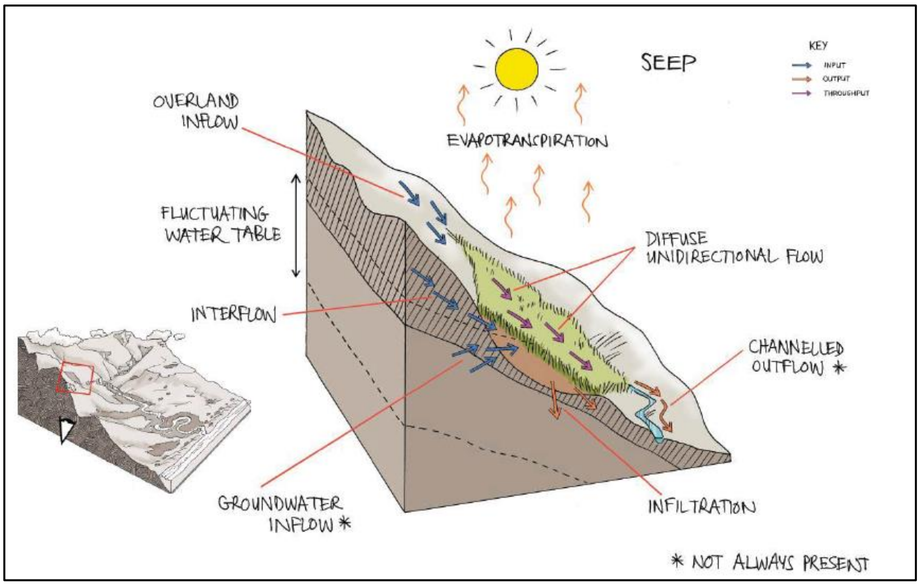

Figure 7-12 Illustration of hillslope seep flow dynamics (Ollis et al. 2013)

7.2.3 Present Ecological State

The PES for the assessed HGM units are presented in Table 7-3 to Table 7-8. The overall wetland health for HGM 3 to HGM 5 was determined to be that of Moderately Modified (class C) systems and HGM 6 to HGM 8 was determined to be Largely Modified (class D). Although the wetlands are impacted upon, the wetlands maintained the habitat structure and functioning.

The impacts on the health of these wetlands are described in the tables below. The impacts on the HGM units directly associated with the developed area include crossing structures, which alter flows and cause erosion downstream. These developed areas also have large areas of bare surfaces, which increases runoff and peak discharges into wetland systems. The seeps are overgrazed, and erosion has occurred in some places (Figure 7-13).

Table 7-3 Summary of the scores for the wetland PES: HGM 3

Component	PES Rating	Description
Hydrology	C	**Moderately Modified**: The catchment is within a rural setting where livestock graze the landscape. This increases the impervious/bare area within the catchment and increases the runoff that enters the wetland systems. The increased runoff increases erosion at the high velocity inflow areas but increases sedimentation within the wetland systems further downstream. The dense alien vegetation also reduces daily low flows as these plants tend to utilize more water.
Geomorphology	B	**Largely Natural**: the valley bottoms have been altered slightly with increased runoff and slight erosion in places.
Vegetation	C	**Moderately Modified:** The vegetation cover is a mix of alien vegetation and natural vegetation. Erosion in some places has also impacted on this component.
Overall	C	**Moderately Modified**. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.

Table 7-4 Summary of the scores for the wetland PES: HGM 4

Component	PES Rating	Description
Hydrology	C	**Moderately Modified**: The HGM unit is part of the Umgeni River which flows away from Albert Falls Dam. The hydrology is altered by the dam as well as additional inputs from increased runoff from developed areas.

Geomorphology	C	**Moderately Modified**: The Albert Falls dam is directly upstream of the HGM unit and alters the flow dynamics of the system. The river also shows signs of erosion and the existing crossing structures impact on the shape of the wetland.
Vegetation	C	**Moderately Modified:** The vegetation cover is a mix of alien vegetation and natural vegetation. Erosion in some places has also impacted on this component.
Overall	C	**Moderately Modified**. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.

Table 7-5 Summary of the scores for the wetland PES: HGM 5

Component	PES Rating	Description
Hydrology	C	**Moderately Modified**: The HGM unit is part of the Mpolweni River which flows into the into the Umgeni River. The catchment is fairly natural, with the hydrology being impacted on by the Mpolweni development. The hydrology is altered by the dam as well as additional inputs from increased runoff from developed areas.
Geomorphology	B	**Largely Natural**: The channeled valley bottom is largely natural with little change to the structure of the wetland.
Vegetation	C	**Moderately Modified:** The vegetation cover is a mix of alien vegetation and natural vegetation. Erosion in some places has also impacted on this component.
Overall	C	**Moderately Modified**. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.

Table 7-6 Summary of the scores for the wetland PES: HGM 6

Component	PES Rating	Description
Hydrology	C	**Moderately Modified**: The wetland unit is affected by development of the community and farming on all sides and the change in the hydrological input is derived from the land uses. The increased runoff from bare and compacted areas as well as the stormwater inputs from the stormwater systems in these land uses.
Geomorphology	C	**Moderately Modified**: The unit is impacted on by small dams and several road crossings altering the natural shape of the wetland as well as the hydrodynamics.
Vegetation	E	**Seriously Modified:** These wetlands have been modified by alien vegetation as well as the weirs and dams within the unit.
Overall	D	**Largely Modified**. A large change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains intact.

Table 7-7 Summary of the scores for the wetland PES: HGM 7

Component	PES Rating	Description
Hydrology	E	**Seriously Modified**: The catchment of the seep is surrounded by the rural development and the stormwater systems have increased flows into the wetland. The area is grazed heavily, and the hydrological flow drivers have been altered.
Geomorphology	C	**Moderately Modified**: The increased hydrology through impervious areas has affected this component, by reducing infiltration and the natural flow dynamics and functioning of the geomorphic layout of the wetland. The altered flows change the shape of the wetland overtime.
Vegetation	C	**Moderately Modified:** The vegetation cover has been reduced by grazing with alien vegetation growing in areas
Overall	D	**Largely Modified**. A large change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains intact.

Table 7-8 Summary of the scores for the wetland PES: HGM 8

Component	PES Rating	Description
Hydrology	E	**Seriously Modified**: This unit has two dams within it, and these severely alter the natural hydrology of the system, by slowing natural storm flows as well as capturing sediment that would have been deposited in the channel. The released flow has a higher carrying capacity with regards to sediment and thus erosion occurs downstream of these dams.
Geomorphology	C	**Moderately Modified**: The hydrological change of this unit has affected the geomorphology. The dams within the unit has changed the shape of the wetland as well as the hydrodynamics.

Vegetation	D	**Largely Modified:** These wetlands have been modified by alien vegetation as well as the weirs and dams within the unit. The constructed dams also alter the vegetative component of the unit.
Overall	D	**Largely Modified**. A large change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains intact.

Figure 7-13 Impacts affecting the wetland health ratings. A) Compacted soccer field in drainage line. B) Preferential flow path over road causing erosion. C) Alien vegetation. D) Sediment sources. E) Excavation in drainage lines. F & H) Crossing structures. G) Diversion for construction on new bridge.

7.2.4 Ecosystem Service Assessment

The ecosystem services provided by the HGM units present were assessed and rated using the WET-EcoServices method (Kotze, *et al*. 2009). The summarised results for the HGM units are shown in Table 7-9.

General services provided by HGM unit types

Channelled valley bottoms provide an important link between the upper slopes of a catchment and the floodplains of the lower catchment. These wetlands are often on steeper gradients and play a moderate role in flood attenuation and erosion control. The assimilation of phosphates, nitrates and toxicants can be significant if the wetlands are in a healthy state. They provide a link within the landscape for fauna as these areas are often the only areas that have not been transformed.

Hillslope seeps are mainly fed from soil/bedrock interface zones source whether it be the accumulation of water at the subsurface from the upslope catena positions or the emergence of a spring from the rock aquifers. The play an important role in the assimilation of nutrients and regulate streamflow by holding water in the landscape to be released during and after the wet season. The areas were farming has encroached the seepage wetlands have a low biodiversity component with the more natural seeps with lots of vegetative cover.

Unchannelled valley bottoms play a significant role in streamflow regulation and erosion control. These wetlands are on flatter slopes and flow velocity is reduced. Water often moves laterally in the soil vadose zones assimilating various nutrients and toxicants in the process. They are also often cultivated due to an increased fertility through sediment trapping and a water source close to the surface (subsistence agriculture).

Site Specific services provided by HGM unit types

The two (2) channelled valley bottoms (HGM 4 & HGM 5) associated with the main river systems are rated as providing the highest levels of service to the project area. The service that rated as moderately-high were associated with the Indirect benefits of; flood attenuation, assimilation of toxicants and nutrients, and the control of erosion. These two HGM units also provided the highest benefit to the maintenance of biodiversity.

The remaining channelled valley bottom wetlands (HGM 3 and HGM 6) were associated with smaller systems which have been altered by urban development or farming practices. The levels of services were lower with flood attenuation being the main benefit. HGM 3 aided in erosion control as well.

The hillslope seep and unchanneled valley bottoms were altered by farming and urban development and no moderate-high benefits were identified.

Table 7-9 The EcoServices being provided by the wetlands of the Albert Falls BWSS

<table>
<tr><th colspan="5">Wetland Unit</th><th>HGM 3</th><th>HGM 4</th><th>HGM 5</th><th>HGM 6</th><th>HGM 7</th><th>HGM 8</th></tr>
<tr><td rowspan="11">Ecosystem Services Supplied by Wetlands</td><td rowspan="8">Indirect Benefits</td><td rowspan="8">Regulating and supporting benefits</td><td colspan="2">Flood attenuation</td><td>2.1</td><td>2.2</td><td>2.4</td><td>2.2</td><td>1.7</td><td>1.9</td></tr>
<tr><td colspan="2">Streamflow regulation</td><td>1.2</td><td>1.7</td><td>1.8</td><td>1.7</td><td>1.0</td><td>1.0</td></tr>
<tr><td rowspan="5">Water Quality enhancement benefits</td><td>Sediment trapping</td><td>1.9</td><td>2.4</td><td>2.3</td><td>2.0</td><td>0.9</td><td>1.7</td></tr>
<tr><td>Phosphate assimilation</td><td>1.7</td><td>2.2</td><td>2.1</td><td>1.9</td><td>1.5</td><td>1.6</td></tr>
<tr><td>Nitrate assimilation</td><td>1.5</td><td>2.2</td><td>2.2</td><td>1.9</td><td>1.6</td><td>1.5</td></tr>
<tr><td>Toxicant assimilation</td><td>1.6</td><td>2.1</td><td>2.3</td><td>1.9</td><td>1.5</td><td>1.6</td></tr>
<tr><td>Erosion control</td><td>2.1</td><td>1.9</td><td>2.5</td><td>1.6</td><td>1.8</td><td>1.5</td></tr>
<tr><td colspan="2">Carbon storage</td><td>1.7</td><td>1.3</td><td>2.0</td><td>1.0</td><td>1.7</td><td>1.0</td></tr>
<tr><td rowspan="3">Direct Benefits</td><td colspan="3">Biodiversity maintenance</td><td>2.0</td><td>2.1</td><td>2.1</td><td>0.9</td><td>0.9</td><td>1.1</td></tr>
<tr><td rowspan="2">Provisioning benefits</td><td colspan="2">Provisioning of water for human use</td><td>0.7</td><td>1.3</td><td>1.6</td><td>0.6</td><td>0.5</td><td>0.5</td></tr>
<tr><td colspan="2">Provisioning of harvestable resources</td><td>0.0</td><td>2.2</td><td>2.0</td><td>2.0</td><td>1.8</td><td>1.8</td></tr>
</table>

			Provisioning of cultivated foods	0.0	2.0	2.0	1.6	2.0	1.6
		Cultural benefits	Cultural heritage	0.0	1.0	1.0	1.0	1.0	1.0
			Tourism and recreation	1.1	1.7	1.9	0.1	0.0	0.0
			Education and research	0.5	1.3	0.5	0.8	0.8	0.8
Overall				17.9	27.4	28.6	21.2	18.7	18.5
Average				1.2	1.8	1.9	1.4	1.2	1.2

7.2.5 Ecological Importance & Sensitivity

The 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 wetlands. The results of the assessment are shown in Table 7-10.

The wetland ETS and EPL are discussed in the desktop section and shows that the wetlands in this region are generally critically endangered and not protected.

The EIS for the channelled valley bottoms (river systems – HGM 4 and HGM 5) were calculated to be High (class B) importance. This rating can be attributed to the ecological importance of the riverine systems to regional ecological integrity and functionality of the wetlands. The remaining wetlands were smaller, disturbed or altered and were rated as Moderate (class C) importance.

The Hydrological Functionality of all the HGM units were rated as Moderate (class C) importance, with the exception of HGM 5 (class B) which has a relatively undisturbed upper catchment. The wetland's hydrology ensured that there was a constant water source within the area. Furthermore, the flood attenuation offered by the wetland contributes to the protection of the local area from flooding and drought.

The Direct Human Benefits were calculated to have a have a Low (class D) level of importance for all HGM units.

Table 7-10 The EIS assessment results for the project area

Wetland Importance and Sensitivity	HGM 3	HGM 4	HGM 5	HGM 6	HGM 7	HGM 8
Ecological Importance & Sensitivity	C	B	B	C	C	C
Hydrological/Functional Importance	C	C	B	C	C	C
Direct Human Benefits	D	D	D	D	D	D

7.2.6 Recommended Ecological Category

The REC is set based on the combination of the PES and EIS values and is determined to set targets for the ecological state of the identified wetlands during and after the project has occurred. Table 7-11 shows the PES, EIS as well as the determined REC for the project area.

All the wetlands identified have a REC of class C. The pipeline construction must aim to not reduce these ratings.

Table 7-11 Wetland recommended ecological categories based on the PES and EIS results

HGM	Wetland Type	Overall PES	Overall EIS	REC
3	Channelled valley bottom	C	C	C
4	Channelled valley bottom	C	B	C
5	Channelled valley bottom	C	B	C
6	Channelled valley bottom	D	C	C

7	Seep	D	C	C
8	Unchannelled valley bottom	D	C	C

8 Buffer Zones

According to Ezemvelo KZN Wildlife (EKZNW, 2013) a minimum recommended buffer size of 30 m is required for wetlands within the province. The wetland buffer zone tool was used to calculate the appropriate buffer required for the construction of the pipelines. The model shows that the largest threat (High) posed during the construction phase is that of "increased sediment inputs and turbidity". The operational phase will not pose any significant risks due to this being a water pipeline (Table 8-2).

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.

The risks were then reduced to Low with the prescribed mitigation measures and therefore the recommended buffer was calculated to be 22m (Table 8-1) for the construction and operational phases.

Table 8-1 Post-mitigation buffer requirement

Required Buffer after mitigation measures have been applied	
Construction Phase	22 m
Operational Phase	15 m

A conservative buffer zone was suggested of 22 m for the construction and operation phases respectively, this buffer is calculated assuming mitigation measures are applied.

The buffer zone will not be applicable for areas of the project that traverse wetland areas, however, for all secondary activities such as laydown yards, storage areas and camp sites, the buffer zone must be implemented.

Table 8-2 The risk results from the wetland buffer model for the proposed Albert Falls BWSS project

	Threat Posed by the proposed land use / activity	Specialist Threat Rating	Description of any additional mitigation measures	Refined Threat Class
Construction Phase	1. Alteration to flow volumes	Very Low		Very Low
	2. Alteration of patterns of flows (increased flood peaks)	Very Low		Very Low
	3. Increase in sediment inputs & turbidity	High	The wetland crossings will utilise existing crossing structures.	Medium
	4. Increased nutrient inputs	N/A		N/A
	5. Inputs of toxic organic contaminants	Medium	Provide ablution facilities for staff, and collect, separate and dispose of all on-site waste. Vehicles must be kept in a good condition with no oil leaks.	Low
	6. Inputs of toxic heavy metal contaminants	Low		Low
	7. Alteration of acidity (pH)	Very Low		Very Low
	8. Increased inputs of salts (salinization)	N/A		N/A
	9. Change (elevation) of water temperature	Very Low		Very Low
	10. Pathogen inputs (i.e. disease-causing organisms)	Very Low		Very Low
Operational Phase	1. Alteration to flow volumes	Low		Low
	2. Alteration of patterns of flows (increased flood peaks)	Low		Low
	3. Increase in sediment inputs & turbidity	Very Low		Very Low
	4. Increased nutrient inputs	Low		Low
	5. Inputs of toxic organic contaminants	Low		Low
	6. Inputs of toxic heavy metal contaminants	Low		Low
	7. Alteration of acidity (pH)	Very Low		Very Low
	8. Increased inputs of salts (salinization)	Very Low		Very Low
	9. Change (elevation) of water temperature	Very Low		Very Low
	10. Pathogen inputs (i.e. disease-causing organisms)	Very Low		Very Low

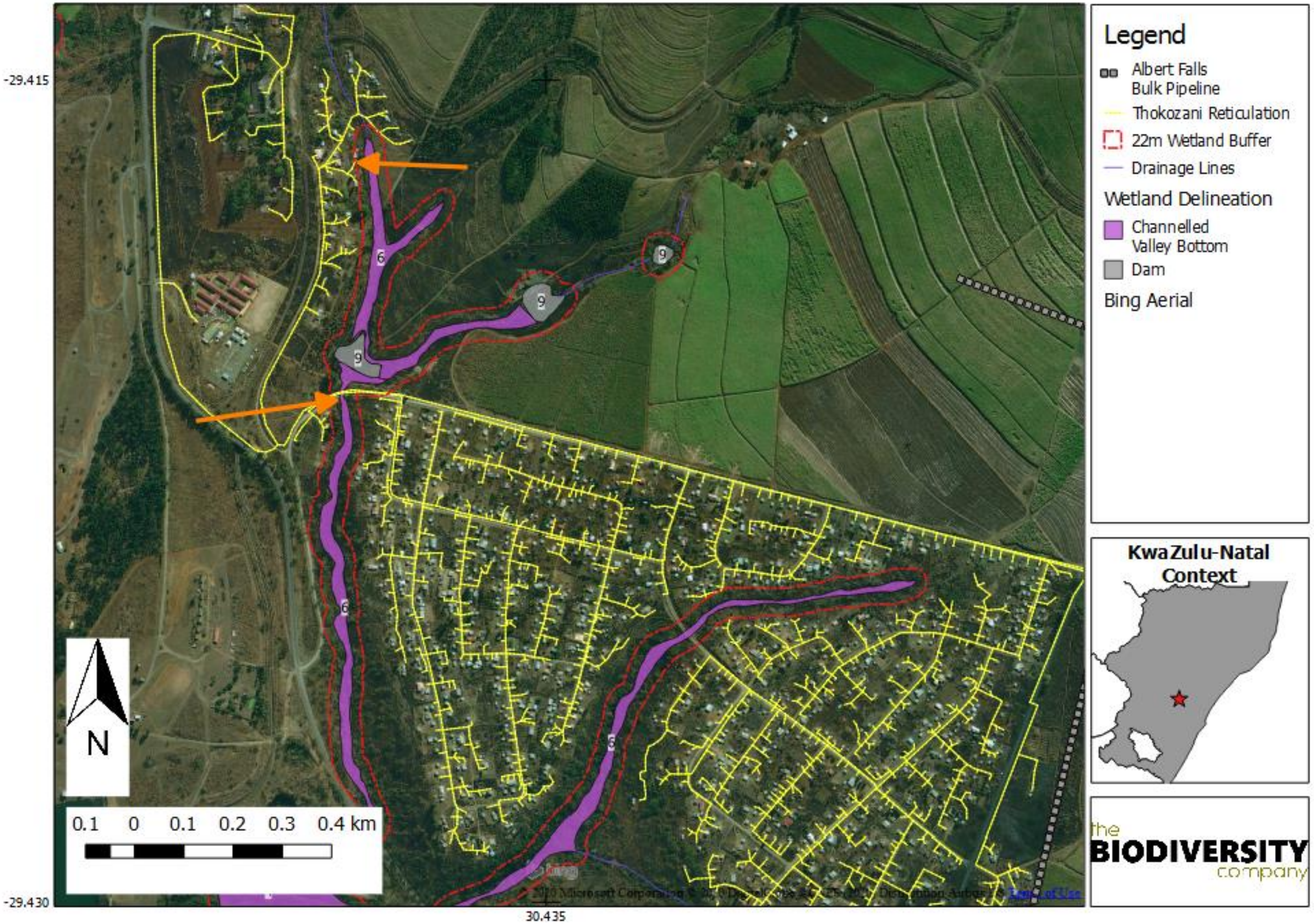

Figure 8-1 Thokozani area 22m wetland buffer and the areas were the pipeline crosses the wetland or the buffer zone

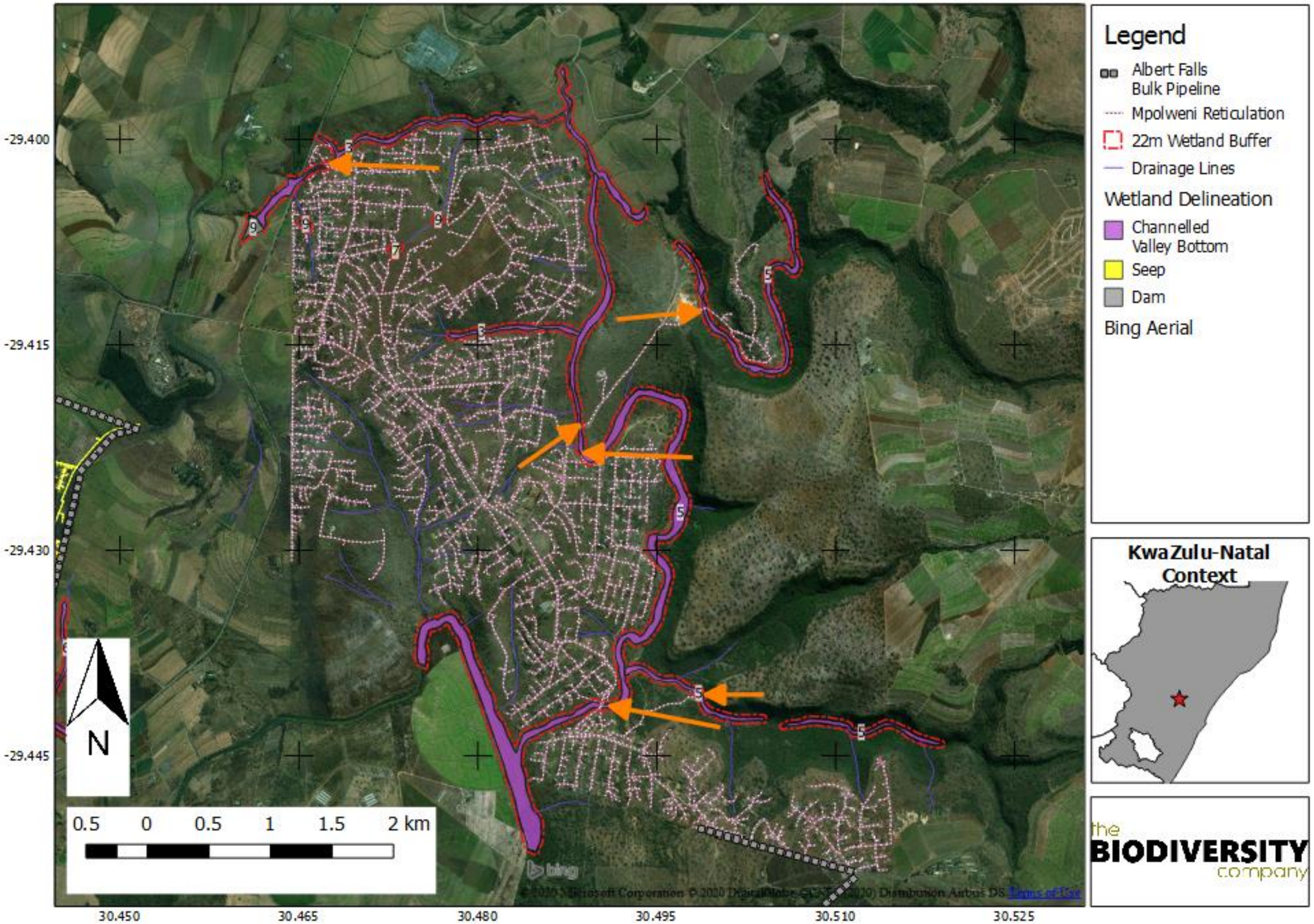

Figure 8-2 *Mpolweni area 22m wetland buffer and the areas were the pipeline crosses the wetland or the buffer zone*

9 Risk Assessment

The reticulation will consist of mains pipelines varying in diameter from 25mm to 250mm. The layout was chosen to follow the alignment of the access roads as far as possible, to mitigate the environmental impact. The Mpolweni reticulation totals at 203,770m and the Thokozani reticulation is 48,260m.

The proposed water supply scheme may make use of existing structures that cross drainage channels and wetland systems. These drainage channels may be inundated during periods of high flow. It is recommended that the pipeline span the drainage channel and not use 'instream' support piers.

Findings from the DWS aspect and impact register / risk assessment are provided below:

Table 9-1 Potential risks associated with the project

<table>
<tr><th>Activity</th><th>Aspect</th><th>Impact</th></tr>
<tr><td rowspan="9">Construction of water pipeline and crossings</td><td>Drainage patterns change due to pipeline extent and levels</td><td rowspan="9">Disturbance of interflow of water.
Loss of habitat.
Erosion of watercourse.
Sedimentation and siltation of the watercourse.
Flow sediment equilibrium change.
Water quality impairment.
Pollution of watercourse.</td></tr>
<tr><td>Clearing of areas for infrastructure</td></tr>
<tr><td>Attachment to culverts and bridges</td></tr>
<tr><td>Cutting/reshaping of embankments</td></tr>
<tr><td>Digging works</td></tr>
<tr><td>Soil stockpile management</td></tr>
<tr><td>Additional Associated Infrastructure</td></tr>
<tr><td>Operation of equipment and machinery</td></tr>
<tr><td>Construction material and fuel storage/management</td></tr>
<tr><td rowspan="2">Operation of water pipeline and crossings</td><td>Potential bursts or leaks of treated water</td><td rowspan="2">Altered flow dynamics.
Damage to wetlands (or loss).
Damage to wetland areas.
Physico-chemical modifications.</td></tr>
<tr><td>Conducting routine maintenance</td></tr>
</table>

Table 9-2 Risk rating assessment

Wayne Jackson (Pr.Sci.Nat: 119037)								
Aspect	**Flow Regime**	**Water Quality**	**Habitat**	**Biota**	**Severity**	**Spatial scale**	**Duration**	**Consequence**
Construction Phase								
Drainage patterns change due to pipeline extent and levels	2	2	2	1	**1.75**	2	2	**2.75**
Clearing of areas for infrastructure	2	2	2	1	**1.75**	2	2	**5.75**
Attachment to culverts and bridges	0	3	1	1	**1.25**	1	2	**4.25**
Cutting/reshaping of embankments	3	3	3	3	**3**	1	2	**6**
Digging works	3	3	2	2	**2.5**	2	3	**7.5**
Soil stockpile management	1	3	2	2	**2**	1	2	**5**
Additional Associated Infrastructure	1	2	2	1	**1.5**	1	2	**4.5**
Operation of equipment and machinery	2	2	2	2	**2**	2	2	**6**
Construction material and fuel storage/management	1	2	1	1	**1.25**	1	2	**4.25**
Operational Phase								
Potential bursts or leaks of treated water	1	2	2	1	**1.5**	1	2	**4.5**
Conducting routine maintenance	0	0	0	0	**0**	2	3	**5**

Table 9-3 Risk rating assessment continued

Aspect	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Sig.	Without Mitigation	With Mitigation
Construction Phase								
Drainage patterns change due to pipeline extent and levels	1	2	1	2	**6**	**34.5**	Low	Low
Clearing of areas for infrastructure	1	2	1	2	**6**	**34.5**	Low	Low
Attachment to culverts and bridges	1	2	5	1	**9**	**21.25**	Low	Low
Cutting/reshaping of embankments	1	2	5	2	**10**	**60**	Moderate*	Low
Digging works	1	2	5	2	**10**	**75**	Moderate*	Low
Soil stockpile management	4	4	1	3	**12**	**60**	Moderate*	Low
Additional Associated Infrastructure	1	2	1	2	**6**	**27**	Low	Low
Operation of equipment and machinery	5	4	1	1	**11**	**66**	Moderate*	Low
Construction material and fuel storage/management	1	2	1	2	**6**	**25.5**	Low	Low
Operational Phase								
Potential bursts or leaks of treated water	1	2	1	2	**6**	**27**	Low	Low
Conducting routine maintenance	3	4	1	3	**11**	**55**	Low	Low

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

The construction of the water pipeline will entail the clearing of areas and digging of trenches, laying of pipeline and attachment of the pipeline to the existing crossing structures which will pose risks to the identified wetlands, with the level of risk determined to vary from low to moderate.

The moderate risks determined for the study are associated with the cutting/reshaping of embankments, digging works, soil stockpile management and operation of equipment and machinery. Notable expected risks include the potential for erosion and increased sedimentation of the wetlands as the soils in the area are susceptible to dispersion and the impairment of water quality during the attachment of the pipeline to existing crossing structures.

The operation of the pipeline does pose a Low risk to the identified wetlands. The low risks are largely attributed to the study being aligned with existing disturbed routes.

Taking into consideration that the project is for bulk water supply, and that pipelines are generally aligned in road reserves, the risks posed to wetlands are considered to be negligible. This is supported by the fact that the proposed pipeline will also tie into existing structures.

The moderate risk ratings were re-allocated a low status due to implementation of additional mitigation methodologies.

9.1 Unplanned Events

The planned activities will have known impacts as discussed above; however, unplanned events may occur on any project and may have potential impacts which will need mitigation and management. Table 9-4 is a summary of the findings from a wetland ecology perspective. Please note not all potential unplanned events may be captured herein and this must therefore be managed throughout all phases.

Table 9-4 Unplanned Events, Low Risks and their Management Measures

Unplanned Event	Potential Impact	Mitigation
Hydrocarbon spill into wetland habitat	Contamination of sediments and water resources associated with the spillage.	A spill response kit must be available at all times. The incident must be reported on and if necessary, a wetland specialist must investigate the extent of the impact and provide rehabilitation recommendations.
Uncontrolled erosion	Sedimentation of downstream reaches.	Erosion control measures must be put in place.
Pipeline burst	Altered flows, erosion and sedimentation.	A spill/burst emergency response plan and the installation of a sufficiently long section of pipeline to ensure that the entirety of the watercourse is crossed over.

9.2 Pipeline installation

The excavation of a trench will be required for the installation of pipelines. Additionally, excavations will be required for the installation of junction boxes. A summary of the construction activities is presented below:

The following pipeline installation specific mitigation measures are provided:

- The footprint area of the pipeline must be kept a minimum. The footprint area must be clearly demarcated to avoid unnecessary disturbances to adjacent areas;

- The footprint area must be aligned in existing road reserves wherever possible. Disturbed areas should be sought as the preferred alignment area;
- The pipeline must be aligned as close to the road as possible;
- Pipeline trenches and sandy bedding material may produce preferential flow paths for water across the project area perpendicular to the general direction of flow instead of angle. This risk can be reduced by installing clay plugs at intervals down the length of the trench to force water out of the trench and down the natural topographical gradient;
- Pipelines crossing drainage areas, should preferably span the drainage lines above ground. This prevents disruptions to sub surface flow dynamics and allows the pipeline to be monitored for leaks. Pipelines buried underground should be buried at a sufficient depth below ground level such that the pipelines do not interfere with surface water movement or create obstructions, where flows can cause erosion;
- When a pipeline spans a drainage line or wetland, it should be attached to any existing crossing or bridge structures. This will limit the need to disturb new areas of the system with the construction of new structures;
- The pipeline must be attached to existing infrastructure at all crossing structures, where the pipeline is not aligned with infrastructure it must be re-aligned to follow existing infrastructure;
- If pier support structures are needed for the pipeline to span a wide drainage line or wetland, then piers should be placed outside of preferential flow paths with the least number of pier structures used as possible;
- Pre-cast structures should be made use of (where possible) to avoid the mixing of these materials on site, reducing the likelihood of cement in the systems;
- During the excavation of trenches, flows should be diverted around active work areas where required. Water diversion must be temporary and re-directed flow must not be diverted towards any stream banks that could cause erosion; and
- The pipeline should be regularly inspected (quarterly) for any signs of failure, damage or leaks. Adequate maintenance measures need to be implemented upon finding pipeline issues and failures.

9.3 General Mitigation Measures

The following general mitigation measures are provided:

- The wetland areas outside of the specific project site area must be avoided where possible;
- The construction vehicles and machinery must make use of existing access routes as much as possible, before adjacent areas are considered for access;
- Laydown yards, camps and storage areas must be beyond the water resource areas. Where possible, the construction of the pipeline and crossings must take place from the existing road servitudes and not from within the water resources;
- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly;

- It is preferable that construction takes place during the dry season to reduce the erosion potential of the exposed surfaces;
- Temporary storm water channels and preferential flow paths should be filled with aggregate and/or logs (branches included) to dissipate and slow flows limiting erosion;
- Prevent uncontrolled access of vehicles through the wetland systems that can cause a significant adverse impact on the hydrology and alluvial soil structure of these areas;
- All chemicals and toxicants to be used for the pipeline construction must be stored outside the channel system and in a bunded area;
- All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site;
- All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good “housekeeping”;
- Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel throughout the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation and water resources);
- Have action plans on site, and training for contactors and employees in the event of spills, leaks and other impacts to the water resource systems;
- All removed soil and material must not be stockpiled within the system. Stockpiling should take place outside of the watercourses. All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds;
- Erosion and sedimentation into drainage channels must be minimised through the effective stabilisation (gabions and Reno mattresses) and the re-vegetation of any disturbed banks;
- Temporary and permanent erosion control methods may include silt fences, flotation silt curtains, retention basins, detention ponds, interceptor ditches, seeding and sodding, riprap of exposed embankments, erosion mats, and mulching;
- Any exposed earth should be rehabilitated promptly by planting suitable vegetation (vigorous indigenous grasses) to protect the exposed soil;
- The cleared surfaces should be re-vegetated with *Cynodon dactylon, Sporobolus aficana* and *Eragrostis curvula.*
- No dumping of construction material on-site may take place;
- All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported;
- Quarterly vegetation rehabilitation surveys need to be conducted of the vegetation within the project footprint for a period of at least a year after construction has been completed to assess vegetation regrowth and recovery; and

- An alien invasive plant management plan needs to be compiled and implemented post construction to control current invaded areas and prevent the growth of invasive on cleared areas.

9.4 Recommendations

The following are recommendations made in support of the water resource assessment:

- An aquatic ecology, including riparian assessment and water quality study must be completed prior to the commencement of this activity;
- Water quality monitoring and a once off riverine ecology study must be completed within 3 months of completing the activity;
- A soil management strategy must be compiled and implemented for the excavation and back-filling of trenches. A proposed soil handling sequence is presented in Figure 9-1;
- An infrastructure monitoring and service plan must be compiled and implemented during the operational phase; and
- An Environmental Control Officer (ECO) must oversee the construction phase of the project, with wetland areas as a priority.

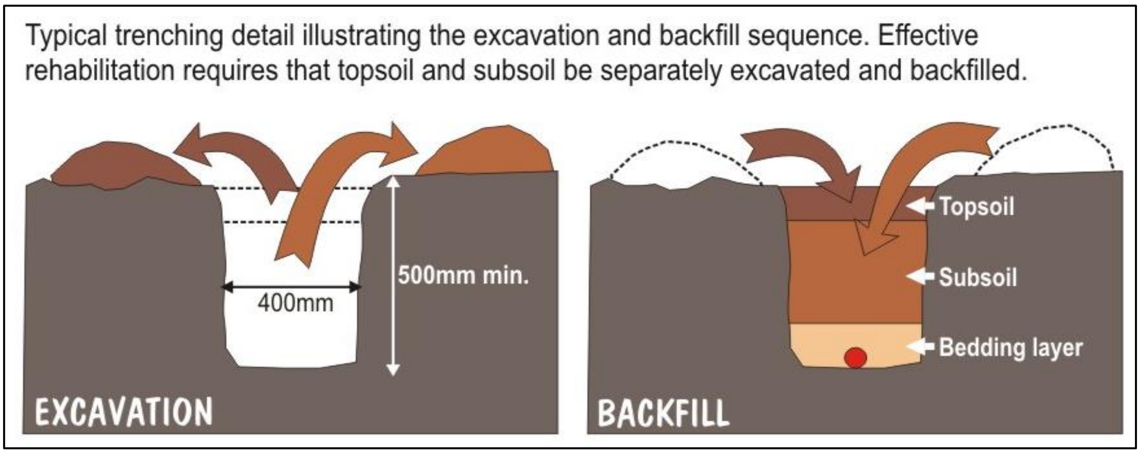

Figure 9-1 The proposed excavation and back-filling handling of soil

10 Conclusion

The BWSS crosses the wetland areas in two (2) places in the Thokozani area and in six (6) places in the Mpolweni area. As long as the mitigation measures are followed which include the 22m buffer, the risk to the wetlands is expected to be low. No fatal flaws were identified for this assessment. The following must be adhered to, too ensure the low rating.:

- The crossing points must be built above ground and the pipeline must be attached to existing crossing structures;
- The construction of the pipeline crossings (in particular) must be done in the dry season; and
- The 22m buffer must be adhered to for all aspects that do not require the pipeline to cross the wetlands.

In accordance with Section 21(c) or Section 21(i) (GN 509 of 2016) in terms of Section 39 of the NWA, a General Authorisation is permissible for this project.

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