Water Resource Assessment for the proposed Mpungose Water Supply Scheme

Empangeni, KwaZulu-Natal

March 2019

CLIENT

IN ASSOCIATION WITH INKANYEZI YETHU

Prepared for:

EnviroPro Environmental Consulting (Pty) Ltd

1A Leinster Place, Gillitts, 3610

www.enviropro.co.za

Prepared by:

The Biodiversity Company

420 Vale Ave. Ferndale, 2194

Cell: +27 81 319 1225

Fax: +27 86 527 1965

info@thebiodiversitycompany.com

www.thebiodiversitycompany

Report Name	**Water Resource Assessment for the proposed Mpungose Water Supply Scheme**	
Reference	**Mpungose WSS**	
Submitted to	EP ENVIROPRO	
Report Writer (Wetlands)	**Wayne Jackson** (Pr. Sci, Nat Pending)	
Report Writer (Aquatics)	**Dale Kindler** (Pr. Sci, Nat 114743)	
Report Reviewer	**Andrew Husted** (Pr. Sci Nat, 400213/11)	

Executive Summary

The Biodiversity Company was commissioned to conduct a water resource assessment, consisting of a baseline aquatic and wetland assessment, as part of the environmental authorisation process and Water Use Licence Application (WULA) for the proposed Mpungose Water Supply Scheme (WSS) near Empangeni, KwaZulu-Natal. A single wetland and aquatic site visit was conducted the week of the 26th of February 2019. The assessments constituted a wet season survey.

Wetland

A total of 101 wetland units were identified with five (5) wetland types being classified. The integrity (or health) of the wetland systems varied from moderately modified (class C) to largely modified (class D). The ecological importance and sensitivity for the wetland types was calculated to have a moderate (class C) level of importance with the exception of the large channelled valley bottom systems which have a high (class B) level of importance.

Conservative buffer zones of 15m (Post-mitigation) were suggested for the construction and operational phases of the pipeline crossing.

Aquatic Ecology

The current state of the river reaches, associated with the proposed Mpungose WSS are in a moderately modified state. The modified conditions were largely attributed to statuses associated with the biotic communities, specifically the macroinvertebrates and the fish populations. During the survey, the water within the Mateku and Mhlatuze rivers was considered adequate to sustain aquatic biota and ecosystem function. The instream habitat integrity in the Mateku River reach is considered to be a class A, or natural with no modification. The instream habitat integrity in the Mhlatuze River reach is considered to be a class B, or largely natural with few modifications. Riparian habitat integrity in the two reaches is considered to be a class B, or largely natural with few modifications. The macroinvertebrate assessment indicates that a largely to seriously modified, and a moderately to largely modified invertebrate community was present in the Mateku River and Mhlatuze River respectively. The results of the fish assessment derived a largely modified (class D) and a moderately modified fish community structure in the Mateku River and Mhlatuze River respectively.

Impacts

The construction of the water pipeline does pose a risk to the identified water resources, with the level of risk predominantly determined to be low. These low risk ratings may largely be attributed to the impacts occurring outside of the resource areas, with the potential to address some of the potential impacts. The use of a spanned pipeline with support piers located outside of aquatic areas was re-allocated a low status due to implementation of additional mitigation methodologies.

The proposed project was determined to have low to moderate impacts on the wetland areas. The proposed project will not have a direct impact on the selected wetland systems. Taking the proposed project and all the risks into consideration, the project itself and the current state and of the local water resources, the risk rating for each of the aspects was determined to vary from low to moderate, pre-mitigation. However, should the prescribed mitigation measures be implemented for the project, the associated risks are all expected to be low.

During the operational phase of the project, no mitigation measures are expected to be required. Taking into account that the pipeline will be transporting water.

Aspect	Sig.	Pre-Mitigation	Post-Mitigation
Clearing of areas for infrastructure	**54**	**Low**	**Low**
Piers located outside of drainage lines	**57.5**	**Moderate**	**Low**
Use of temporary structures for river crossings	**33.75**	**Low**	**Low**
On-site vehicle and machinery activities	**49**	**Low**	**Low**
Ablutions and waste handling	**36**	**Low**	**Low**
Excavation of pipeline route	**78**	**Moderate**	**Low**
Removal and stockpiling of soils	**77**	**Moderate**	**Low**
Compaction of soil profile	**36.75**	**Low**	**Low**
Additional associated infrastructure	**36**	**Low**	**Low**
Operation of pipeline	**47.25**	**Low**	**Low**

It is the opinion of the specialists that the project may be favourably considered and allow for the construction of the pipeline to proceed. Authorisation must be based on the implementation of the prescribed mitigation measures.

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DECLARATION

I, Wayne Jackson declare that:

- I act as an 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 relevant Acts, 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 48 of the EIA Regulations, 2014 (as amended).

Wayne Jackson

Wetland Specialist

The Biodiversity Company

13 March 2019

DECLARATION

I, Dale Kindler declare that:

- I act as an 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 relevant Acts, 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 48 of the EIA Regulations, 2014 (as amended).

Dale Kindler

Aquatic Specialist

The Biodiversity Company

12 March 2019

1 Introduction

The Biodiversity Company was commissioned to conduct a water resource assessment, consisting of a baseline aquatic and wetland assessment, as part of the environmental authorisation process and Water Use Licence Application (WULA) for the proposed Mpungose Water Supply Scheme (WSS) near Empangeni, KwaZulu-Natal.

A single wetland and aquatic site visit was conducted the week of the 27th of February 2019. The assessments constituted 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 Objectives

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

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

2 Key Legislative Requirements

2.1 National Water Act (Act No. 36 of 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 (Act No. 107 of 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.

2.3 Water Management

The National Water Act No 36 of 1998, makes provision for the determination of the Reserve in terms of Section 14 (1) (b) and 17 (1) (b) of the National Water Act, 1998.

The management of national water resources must be compatible with an overarching strategy. In reference to this proposed project, the Preliminary Determination of the Reserve and Resource Class in terms of Section 14 (1) (b) and 17 (1) (b) of the National Water Act, 1998 is the most up to date Reserve that was used in this assessment (DWAF, 2004).

3 Project Area

The Mpungose WSS is situated in the W12D and W12E quaternary catchments, within the Pongola - Mtamvuna Water Management Area (WMA 4) (NWA, 2016) and North Eastern Uplands Ecoregion (Dallas, 2007). The study area is located in the villages of Mashishi, Ntshentshelu, Nomyaca, Khabingwe, Ufasimba and Mkhuphulan Gwenya, near Empangeni in the province of KwaZulu-Natal, South Africa.

The proposed project is for the construction of a new water supply scheme in close proximity to the Mhlatuze and Mhtatuzana River systems (Figure 1). The area surrounding the proposed project site consists of open mountainous land, small scale agricultural and livestock activities, and rural settlements of varying sizes. The activities in the area and local land uses have had impacts to the water resources and there were visible disturbances, with erosion observed during the survey.

The WMA is situated along the eastern coast of South Africa, mainly within the province of KwaZulu-Natal, and borders on Lesotho to the west. The region has a mean annual precipitation rate of 800 to 1 500 mm and is considered humid. The terrain is characterised with rolling hills with the Drakensburg escarpment as the main topographic feature. A number of parallel rivers drain the Mvoti to Umzimkulu WMA, of which two originate in the Drakensberg Mountains at the border with Lesotho. The area is characterised as rural, and activities include subsistence and commercial farming (StatsSA, 2010).

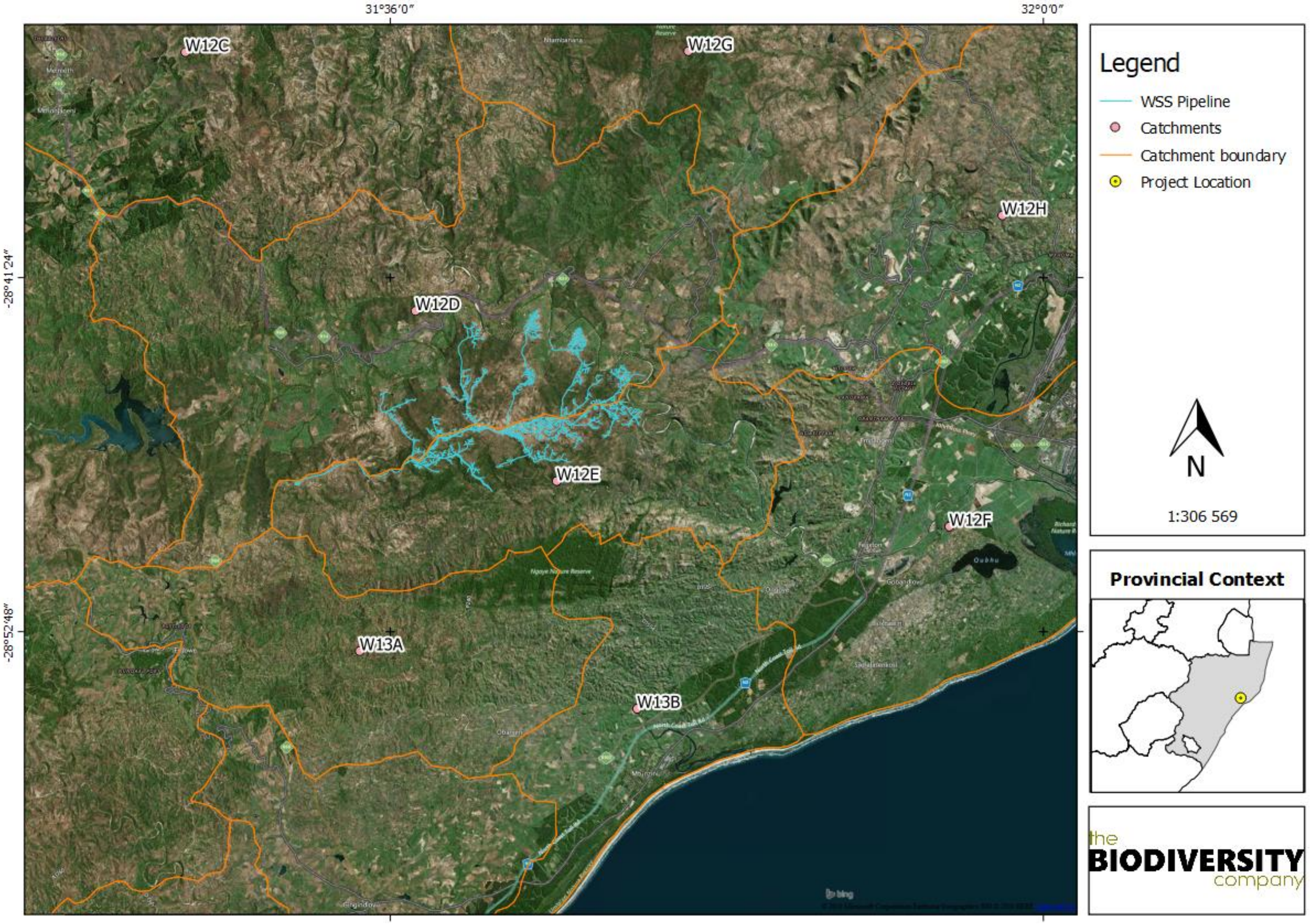


Figure 1: The regional layout of the proposed Mpungose WSS

4 Limitations

The following aspects were considered as limitations;

- This report represents data from a single aquatic and wetland assessment, and should be interpreted accordingly;
- Only wetlands that were likely to be impacted by proposed development activities were assessed in the field. Wetlands located within a 500 m radius of the sites but not in a position within the landscape to be measurably affected by the developments were not considered as part of this assessment;
- Field assessments were completed to assess as much of the site as possible with focus on the proposed directly impacted and downstream areas;
- 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;
- The information regarding the activities to be completed on the site, only allowed for the completion of a general assessment on the impacts and the buffer requirement; and
- Invertebrates were only identified to Family level and thus a defined species list for aquatic invertebrates was not completed.

5 Methodology

5.1 Desktop Assessment

The following information sources were considered for the desktop assessment;

- Aerial imagery (Google Earth Pro);
- Land Type Data (Land Type Survey Staff, 1972 - 2006);
- The National Freshwater Ecosystem Priority Areas (Nel *et al.,* 2011); and
- Contour data (5m).

5.2 Wetland Assessment

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

5.2.1 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 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.

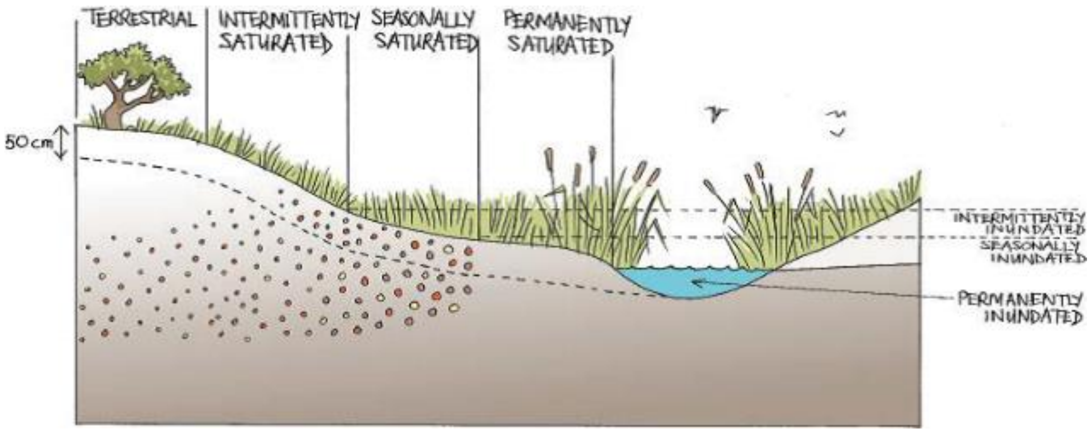


Figure 2: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis, et al. 2013)

5.2.2 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 Present State categories are provided in Table 1.

Table 1: The PES categories (Macfarlane, et al., 2009)

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

5.2.3 Ecosystem Services

Wetland Functionality refers to the ability of wetlands to provide healthy conditions for the wide variety of organisms found in wetlands as well as humans. Eco 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. 2008). 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 (Kotze, et al, 2008)

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

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.

Table 3: Description of EIS categories.

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

5.3 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.

5.4 Aquatic Assessment

5.4.1 Water Quality

Water quality was measured in situ using a handheld calibrated Extech ExStik II meter. The constituents considered that were measured included: pH, electrical conductivity (µS/cm), temperature (°C) and Dissolved Oxygen (DO) in mg/l.

5.4.2 Aquatic Habitat Integrity

The Intermediate Habitat Assessment Index (IHIA) as described in the Procedure for Rapid Determination of Resource Directed Measures for River Ecosystems (Section D), 1999 were used to define the ecological status of the river reach.

The area covered in this assessment included a 10 km reach of the Mateku and Mhlatuze rivers. This habitat assessment model compares current conditions with reference conditions that are expected to have been present.

The IHIA model was used to assess the integrity of the habitats from a riparian and instream perspective. The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region (Kleynhans, 1996). The criteria and ratings utilised in the assessment of habitat integrity in the current study are presented in Table 4 and Table 5 respectively.

Table 4: Criteria used in the assessment of habitat integrity (Kleynhans, 1998)

Criterion	Relevance
Water abstraction	Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
Flow modification	Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
Bed modification	Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment. Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation is also included.

Criterion	Relevance
Channel modification	May be the result of a change in flow, which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included.
Water quality modification	Originates from point and diffuse point sources. Measured directly or alternatively agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Inundation	Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments.
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
Exotic aquatic fauna	The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance.
Solid waste disposal	A direct anthropogenic impact which may alter habitat structurally. Also, a general indication of the misuse and mismanagement of the river.
Indigenous vegetation removal	Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river. Refers to physical removal for farming, firewood and overgrazing.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous organic matter input will also be changed. Riparian zone habitat diversity is also reduced.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

Table 5: Descriptions used for the ratings of the various habitat criteria

Impact Category	Description	Score
None	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.	1-5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.	6-10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.	11-15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.	16-20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21-25

5.4.3 Aquatic Macroinvertebrate Assessment

Macroinvertebrate assemblages are good indicators of localised conditions because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life. They are particularly well-suited for assessing site-specific impacts (upstream and downstream studies) (Barbour *et al.,* 1999). Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects (Barbour *et al.,* 1999). The assessment and monitoring of benthic macroinvertebrate communities forms an integral part of the monitoring of the health of an aquatic ecosystem.

5.4.3.1 South African Scoring System

The South African Scoring System version 5 (SASS5) is the current index being used to assess the status of riverine macroinvertebrates in South Africa. According to Dickens and Graham (2002), the index is based on the presence of aquatic invertebrate families and the perceived sensitivity to water quality changes of these families. Different families exhibit different sensitivities to pollution, these sensitivities range from highly tolerant families (e.g. Chironomidae) to highly sensitive families (e.g. Perlidae). SASS results are expressed both as an index score (SASS score) and the Average Score Per recorded Taxon (ASPT value).

Sampled invertebrates were identified using the "Aquatic Invertebrates of South African Rivers" Illustrations book, by Gerber and Gabriel (2002). Identification of organisms was made to family level (Thirion *et al.,* 1995; Dickens and Graham, 2002; Gerber and Gabriel, 2002).

All SASS5 and ASPT scores are compared with the SASS5 Data Interpretation Guidelines (Dallas, 2007) for the North Eastern Uplands - lower ecoregion (Figure 3). This method seeks to develop biological bands depicting the various ecological states and is derived from data contained within the Rivers Database and supplemented with other data not yet in the database. Ecological categories based on biological banding are presented in Table 6.

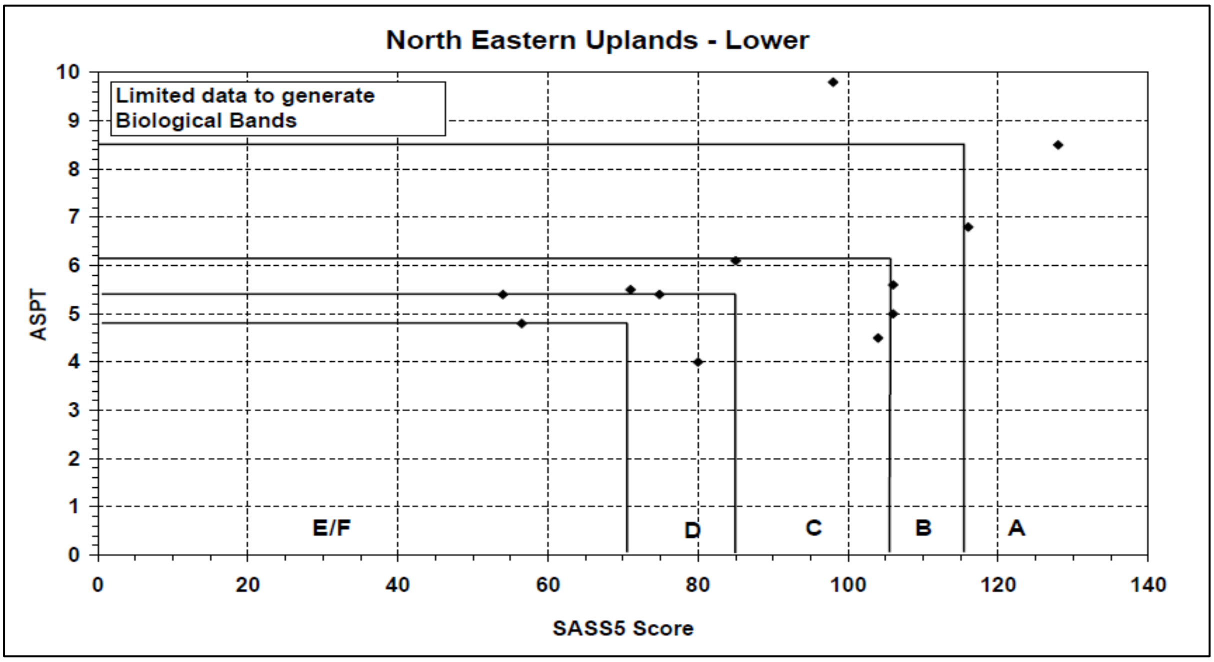


Figure 3: Biological Bands for the North Eastern Uplands - Lower Ecoregion, calculated using percentiles

Table 6: Biological Bands / Ecological categories for interpreting SASS data (adapted from Dallas, 2007)

Class	Ecological Category	Description
A	Natural	Unimpaired. High diversity of taxa with numerous sensitive taxa.
B	Largely natural	Slightly impaired. High diversity of taxa, but with fewer sensitive taxa.
C	Moderately modified	Moderately impaired. Moderate diversity of taxa.

D	Largely modified	Considerably impaired. Mostly tolerant taxa present.
E/F	Seriously Modified	Severely impaired. Only tolerant taxa present.

5.4.3.2 Macroinvertebrate Response Assessment Index

The Macroinvertebrate Response Assessment Index (MIRAI) was used to provide a habitat-based cause-and-effect foundation to interpret the deviation of the aquatic invertebrate community from the calculated reference conditions for the Sub-Quaternary Reach (SQR). This does not preclude the calculation of SASS5 scores if required (Thirion, 2007). The four major components of a stream system that determine productivity for aquatic macroinvertebrates are as follows:

- Flow regime;
- Physical habitat structure;
- Water quality;
- Energy inputs from the watershed; and
- Riparian vegetation assessment.

The results of the MIRAI will provide an indication of the current ecological category and therefore assist in the determination of the PES. Ecological categories for MIRAI are based on those presented in Table 6.

5.4.4 Fish Community Assessment

The information gained using the Fish Response Assessment Index (FRAI) gives an indication of the PES of the river based on the fish assemblage structures observed. Fish were captured through minnow traps, cast nets and electroshocking. All fish were identified in the field and released at the point of capture. Fish species were identified using the guide Freshwater Fishes of Southern Africa (Skelton, 2001). The identified fish species were compared to those expected to be present for the quaternary catchment. The expected fish species list was developed from a literature survey and included sources such as (Kleynhans *et al.,* 2007) and Skelton (2001).

5.4.5 Present Ecological Status

Ecological classification refers to the determination and categorisation of the integrity of the various selected biophysical attributes of ecosystems compared to the natural or close to natural reference conditions (Kleynhans and Louw, 2007). For the purpose of this study ecological classifications have been determined for biophysical attributes for the associated water course. This was completed using the river ecoclassification manual by Kleynhans and Louw (2007).

5.5 Risk Assessment

The risk assessment was conducted in accordance with the DWS risk-based water use authorisation approach and delegation guidelines. The significance of the impact is calculated according to Table 7.

Table 7: 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 Results and Discussion

6.1 Desktop Assessment

6.1.1 Sub-Quaternary Reaches

Table 8 provides further desktop information regarding the Mateku SQR W12E-3530 and the Mhlatuze SQR W12D-3375 with regards to the PES including the Ecological Importance, Ecological Sensitivity and anthropogenic impacts within each SQR. Desktop information was obtained from DWS (2018).

Table 8: Summary of the status of the Sub-Quaternary Reaches

SQRs	W12E-3530 (Mateku)	W12D-3375 (Mhlatuze)
Present Ecological Status	Largely Natural (class B)	Largely Modified (class D)
Ecological Importance	High	Moderate
Ecological Sensitivity	Very High	High

6.1.2 Desktop Soils

According to Mucina & Rutherford (2006) the area has black-clay soils and duplex soils derived from a distinct variety of clastic sediments of the Dwyka, Ecca, Beaufort and igneous rocks of the Lebombo Groups (all of the Karoo Supergroup). Also well-drained soil forms occur especially on stony slopes. Land types Fb and Ea, with some Db and Dc. The geology of the area is shown in Table 9:

Table 9: Geology of the land types (Land Type Survey Staff, 1972 – 2006)

Land Type	Geology
Ea129	Mainly dolerite, with small areas of sandstone of the Vryheid Formation, Ecca Group.
Ea130	Sandstone and shale of the Vryheid Formation, Ecca Group and dolerite.
Fb333	Sandstone and shale of the Emakwezini Formation, shale, siltstone and sandstone of the Volksrust Formation, Ecca Group, and dolerite.
Fb334	Mainly shale, mudstone and sandstone of the Emakwezini Formation, with small areas of dolerite.
Fb335	Mainly sandstone and shale of the Vryheid Formation, Ecca Group, with small areas of dolerite.
Fb342	Shale, siltstone and thin sandstone lenses of the Pietermaritzburg Formation, Ecca Group, with tillite of the Dwyka Formation, and small areas of dolerite.
Fb343	Mainly sandstone of the Vryheid Formation, Ecca Group, with tillite of the Dwyka Formation, sandstone of the Natal Group, and small areas of dolerite.
Db151	Shale, siltstone and thin sandstone lenses of the Pietermaritzburg Formation, Ecca Group, sandstone and shale of the Emakwezini Formation.
Db152	Mainly sandstone and shale of the Emakwezini Formation, with grit of the Ntabeni Formation, with mudstone, sandstone and shale of the Nyoka Formation.
Db153	Mainly sandstone of the Vryheid Formation, Ecca Group, with small areas of shale of the Pietermaritzburg Formation, Ecca Group, tillite of the Dwyka Formation and dolerite.
Ac64	Shale, siltstone and thin sandstone lenses of the Pietermaritzburg Formation, Ecca Group, with small areas of sandstone and shale of the Emakwezini Formation and alluvium.
Ac65	Sandstone and shale of the Emakwezini Formation and alluvium.

According to the land type database (Land Type Survey Staff, 1972 - 2006) the project area falls within twelve (12) Land Type units. These units are summarised in Table 10. The land types are shown in Figure 4.

Table 10: The dominant soil forms and the associated physical attributes (Land Type Survey Staff, 1972 – 2006).

Land Type	Dominant Soil (Crest/ Midslope)	Dominant Soil (Valley Bottom)	Additional Information
Ea129	Mayo, Shortlands, & Bonheim	Rensburg & Dundee	Slopes range from 1 - 20%. Clay content ranges from 20 – 60%
Ea130	Mayo, Shortlands, & Glenrosa	Katspruit, Kroonstad, & Valsrivier	Slopes range from 1 - 12%. Clay content ranges from 6 – 35%
Fb333	Mayo, Mispah, & Glenrosa	Katspruit & Valsrivier	Slopes range from 0 - 10%. Clay content ranges from 15 – 55%
Fb334	Swartland, Mispah, & Glenrosa	Swartland & Valsrivier	Slopes range from 0 - 40%. Clay content ranges from 15 – 45%
Fb335	Swartland, Mispah, & Glenrosa	Katspruit, Kroonstad, & Valsrivier	Slopes range from 1 - 35%. Clay content ranges from 6 – 45%
Fb342	Mayo, Mispah, & Glenrosa	Katspruit & Valsrivier	Slopes range from 0 - 20%. Clay content ranges from 15 – 55%
Fb343	Mispah & Glenrosa	Katspruit, Kroonstad, & Valsrivier	Slopes range from 0 - 25%. Clay content ranges from 6 – 50%
Db151	Swartland & Valsrivier	Dundee, Katspruit, & Oakleaf	Slopes range from 1 - 13%. Clay content ranges from 15 – 45%
Db152	Swartland & Valsrivier	Valsrivier	Slopes range from 1 - 15%. Clay content ranges from 10 – 45%
Db153	Swartland, Valsrivier, & Glenrosa	Katspruit, Kroonstad, & Valsrivier	Slopes range from 1 - 15%. Clay content ranges from 6 – 35%
Ac64	Hutton & Clovelly	Dundee & Fernwood	Slopes are flat from 0 - 4%. Clay content ranges from 5 – 45%
Ac65	Hutton & Clovelly	Dundee	Slopes are flat from 0 - 4%. Clay content ranges from 5 – 45%

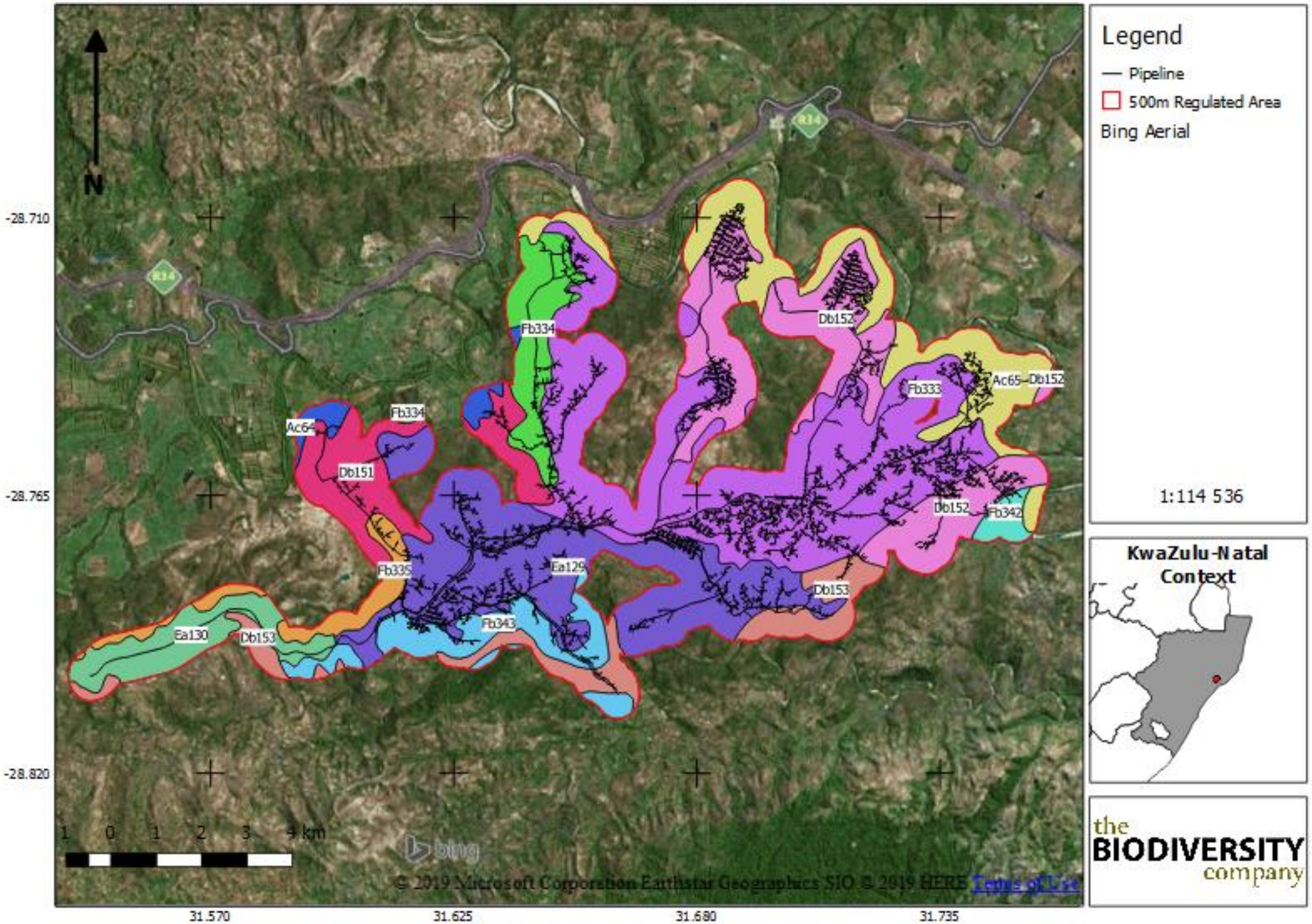


Figure 4: Land types for the Mpungose WSS project

6.1.3 Desktop Vegetation

The project area falls within the Zululand Lowveld (SVl 23) and Eastern Valley Bushveld (SVs 6).

Zululand Lowveld (Vulnerable) is described by Mucina & Rutherford (2006) as slightly undulating landscapes supporting complex of various bushveld units ranging from dense thickets of *Dichrostachys cinerea* and *Acacia* species, through park-like savanna with flat-topped *A. tortilis* to tree-dominated woodland with broadleaved open bushveld with *Sclerocarya birrea* subsp. *caffra* and *A. nigrescens*. Tall grassveld types with sparsely scattered solitary trees and shrubs form a mosaic with the typical savanna thornveld, bushveld and thicket patches.

Eastern Valley Bushveld (Least Threatened) is described by Mucina & Rutherford (2006) as being semideciduous savanna woodlands with pockets of thickets in a mosaic pattern, often succulent and dominated by *Euphorbia* and *Aloes*. Most of the river valleys run along a northwest-southeast axis which results in unequal distribution of rainfall on respective north-facing and south-facing slopes since the rain bearing winds blow from the south. The steep north-facing slopes are sheltered from the rain and also receive greater amounts of insolation adding to xerophilous. The Endemic taxa include the tall shrub *Bauhinia natalensis* and the succulent herb *Huernia pendula* (Mucina and Rutherford 2006).

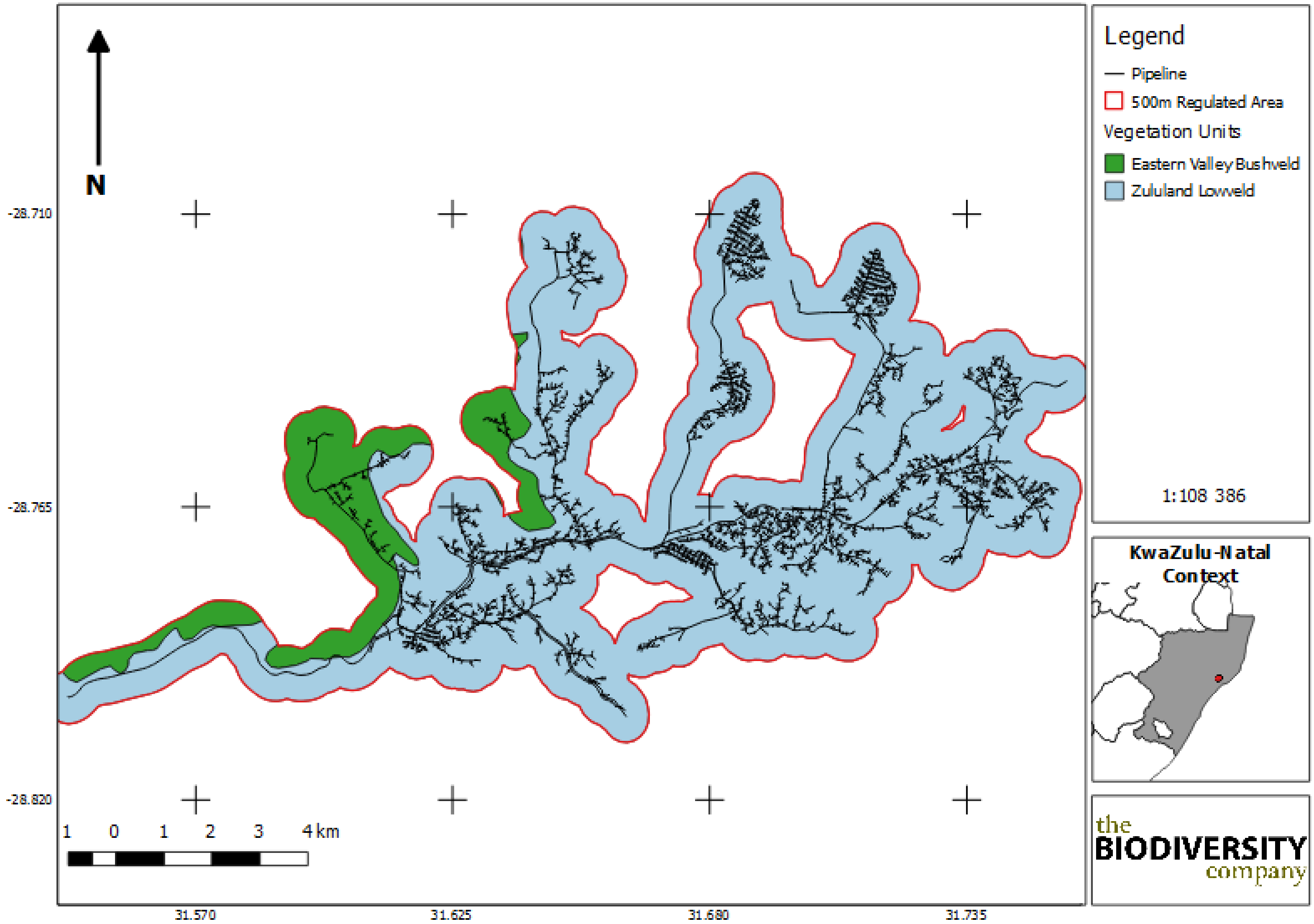


Figure 5: National vegetation groups for the Mpungose WSS project

6.1.4 Wetland NFEPAs

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).

The NFEPA wetlands within the 500m regulated area have been identified and are shown in Figure 6. There was a total of 58 NFEPA wetlands located within the regulated area. For the purpose of this assessment, only the NFEPA's with high importance were to be assessed in field. To achieve this only the following NFEPA wetlands could be considered:

- Natural systems;
- Ranks of better than 4;
- Wetland conditions of better than C; and
- NFEPA wetlands within the 15m buffer (calculated in section 6.6).

Of the 32 natural systems, no wetlands had a rank higher than 4. There was one NFEPA wetland that met all the remaining criteria, however the field verification indicated that there was no wetland.

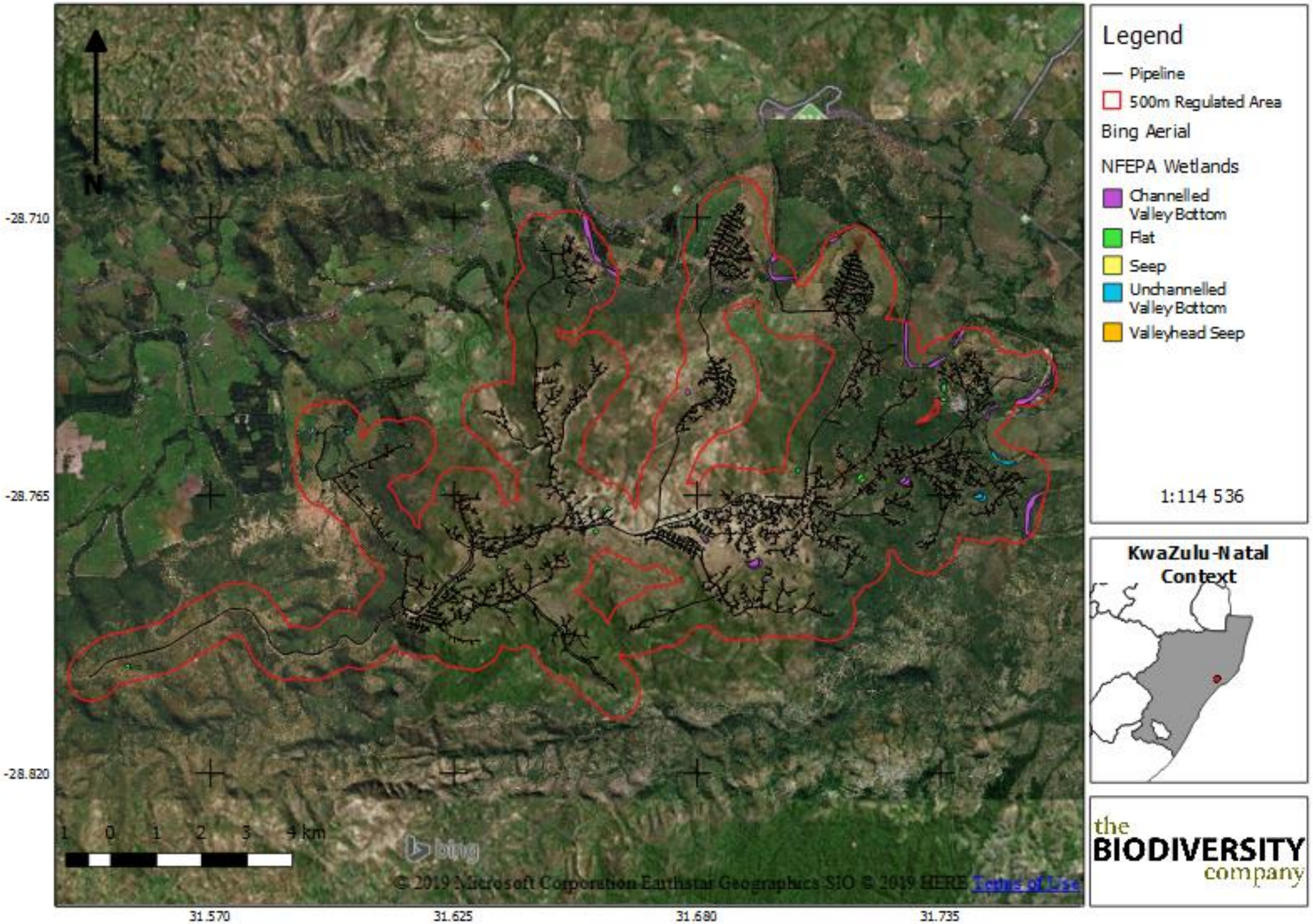


Figure 6: The NFEPA wetlands within the project area

6.2 Wetland Assessment

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

According to DWAF (2005), many riparian areas display wetland indicators and should be classified as wetlands. Some riparian areas are not saturated long or often enough to develop wetland characteristics. In these instances, alluvial deposits can predominate and/or the water table is too deep for most of the year to produce hydromorphic features in the top 50 cm of the soil profile. These conditions do not support vegetation typically adapted to life in saturated soil and it is therefore important to delineate these riparian areas in addition to wetlands (DWAF, 2005).

The wetland areas associated with the project area were identified and delineated (Figure 10). A total of 101 wetland units were identified with five (5) wetland types being classified. The wetland types were;

- Channelled valley bottoms;
- Unchannelled valley bottoms;
- Flats;
- Hillslope seeps; and
- Depressions (Artificial dams).

Of the 5 wetland types discussed the depression (artificial dam) will not be analysed for functionality and health (artificial system), however the importance of dams to provide ecoservices to the environment as well as humans are regarded as important.

The wetland classifications as per SANBI guidelines (Ollis *et al.*, 2013) are shown in Table 11. Two (5) HGM types were identified within the project assessment boundary. The wetlands are described in the subsequent sections.

Table 11: Wetland classification as per SANBI guideline (Ollis et al., 2013).

Level 1	**Level 2**		**Level 3**	**Level 4**		
System	**DWS Ecoregion/s**	**NFEPA Wet Veg Group/s**	**Landscape Unit**	**4A (HGM)**	**4B**	**4C**
Inland	North Eastern Uplands	Sub-Escarpment Savannah & Lowveld Group	Valley Bottom	Channelled Valley Bottom	(N/A)	(N/A)
Inland	North Eastern Uplands	Sub-Escarpment Savannah & Lowveld Group	Valley Bottom	Unchannelled Valley Bottom	(N/A)	(N/A)
Inland	North Eastern Uplands	Sub-Escarpment Savannah & Lowveld Group	Bench	Flat	(N/A)	(N/A)
Inland	North Eastern Uplands	Sub-Escarpment Savannah & Lowveld Group	Slope	Hillslope Seep	With channelled outflow	(N/A)
Inland	North Eastern Uplands	Sub-Escarpment Savannah & Lowveld Group	Valley Bottom	Depression	Dammed	With channelled outflow

6.2.1 Wetland Types

The 5 wetland types are shown in Figure 7. These are described below with the exception of the artificial system (Dam).

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).

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).

Wetland flats are level or near-level wetlands that are not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat (Ollis *et al.* 2013).

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).

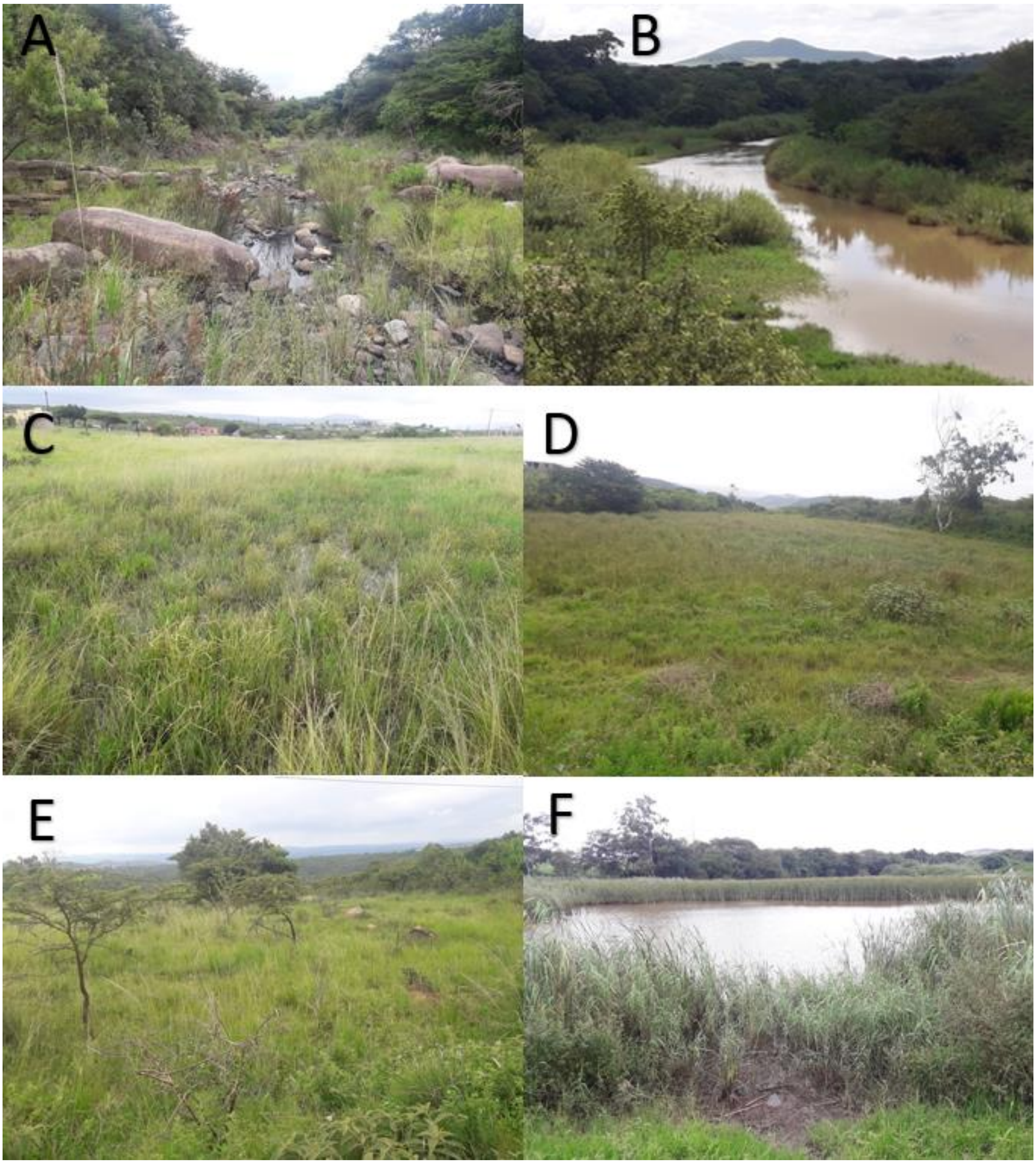


Figure 7: Wetland types identified for the Mpungose WSS project, A) Small channelled valley bottom, B) Large channelled valley bottom, C) Unchannelled valley bottom, D) Bench flat, E) Hillslope seep, F) Depression (Dam)

6.2.2 Soil Indicator

The project area traverses several land types and is geologically diverse, therefor the soils found in the project area were also diverse. The dominant wetland soils were Katspruit, Rensburg, Westleigh and Kroonstad. Some of these are shown in Figure 8.

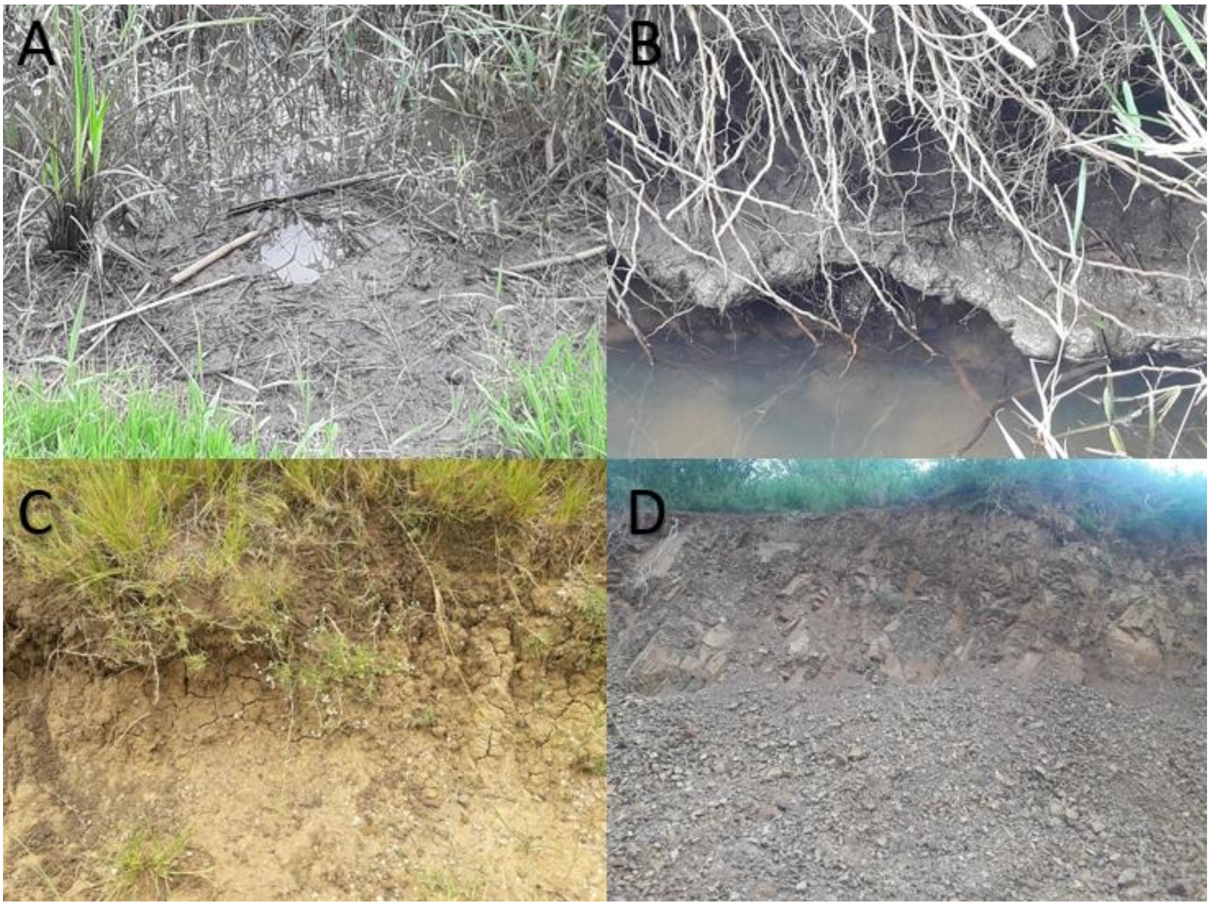


Figure 8: the soils in the Mpungose WSS project area, A) Katspruit, B) Rensburg, C) Westleigh, D) Glenrosa

6.2.3 Vegetation Indicator

The project area traverses a large area and the vegetation component is diverse. The dominant wetland vegetation identified were *Typha capensis, Phragmites australis, Phragmites mauritianus, Juncus effuses, Juncus oxycarpus, Juncus punctorius, Cyperus fastigiatus, Cyperus articulates, Pycreus spp,* and *Schoenoplectus spp*. Some of these are shown in Figure 9.

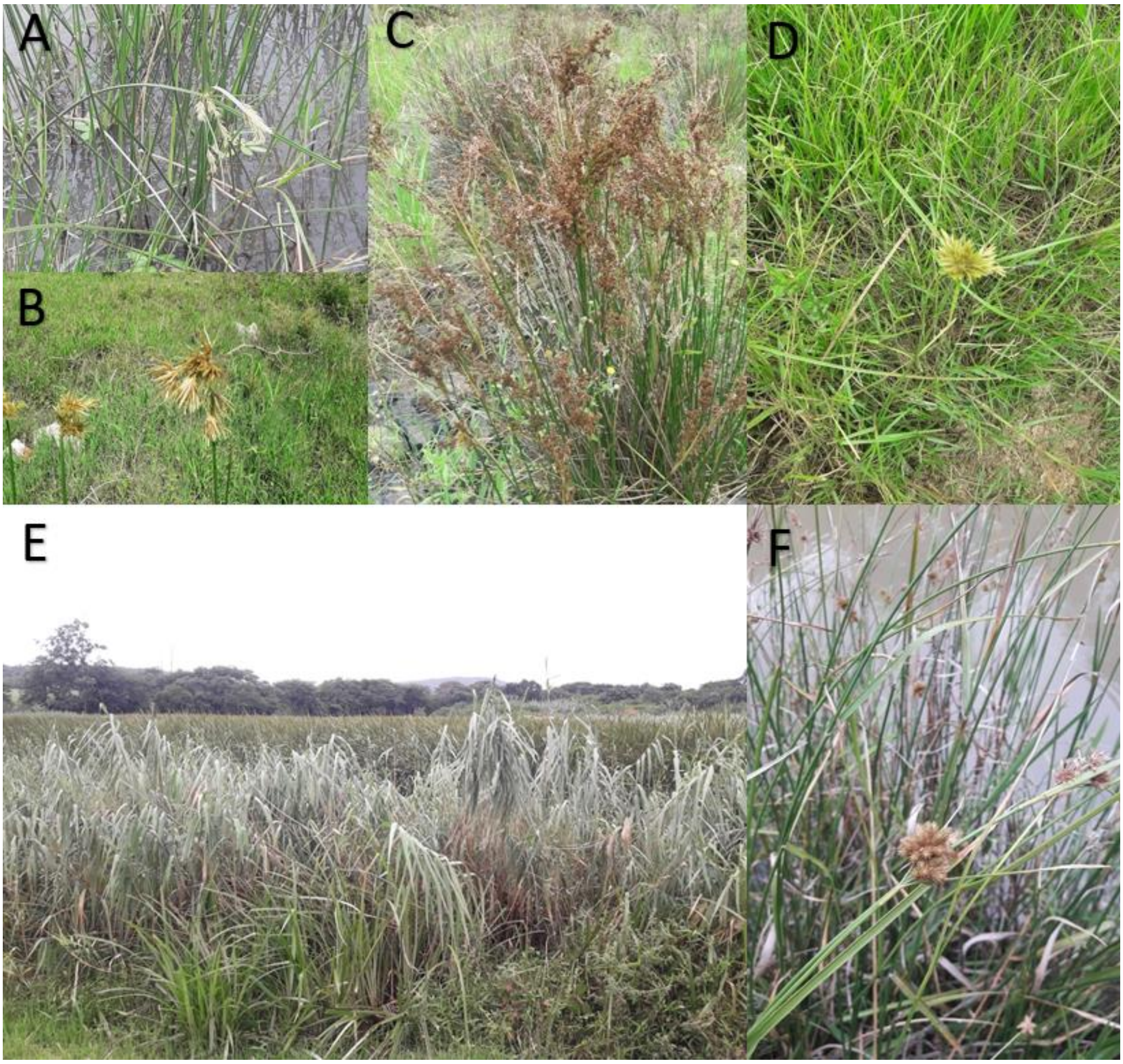


Figure 9: The wetland vegetation identified in the Mpungose WSS project area, A) Cyperus fastigiatus, B) Cyperus articulates, C) Juncus oxycarpus, D) Pycreus spp., E) Typha capensus and Phragmites, F) Schoenoplectus spp.

The wetland buffer assessment results (see section 6.6) were used to narrow the focus of the findings to the wetland areas that are at risk. The wetland buffer for a WSS pipeline project was calculated to be 15m. The wetland areas that fall within or near this 15m buffer are shown in the zoomed maps Figure 11 to Figure 14.

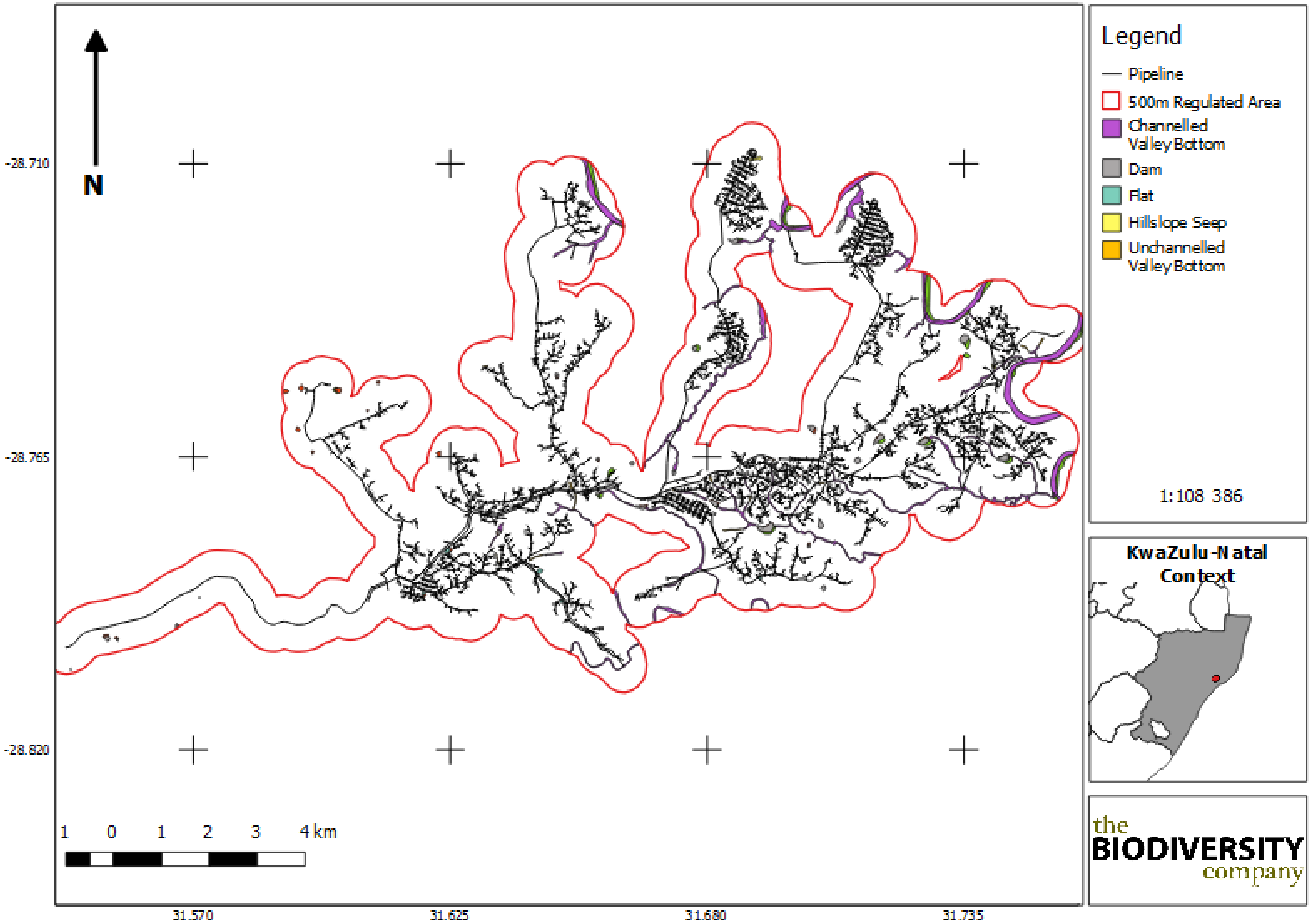


Figure 10: The delineated wetlands within the project area

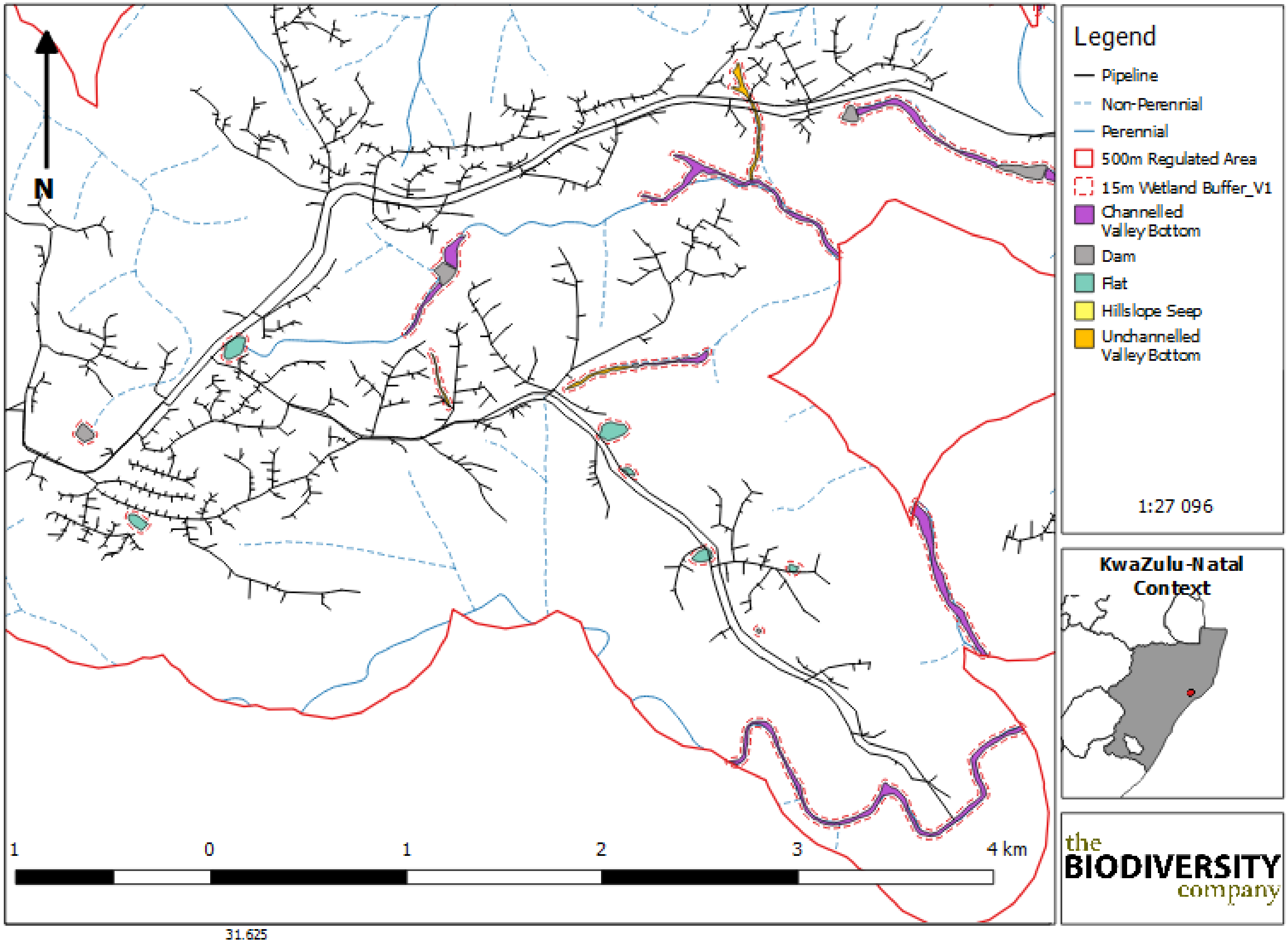


Figure 11: Zoom 1 of the wetland delineation with the 15m buffer

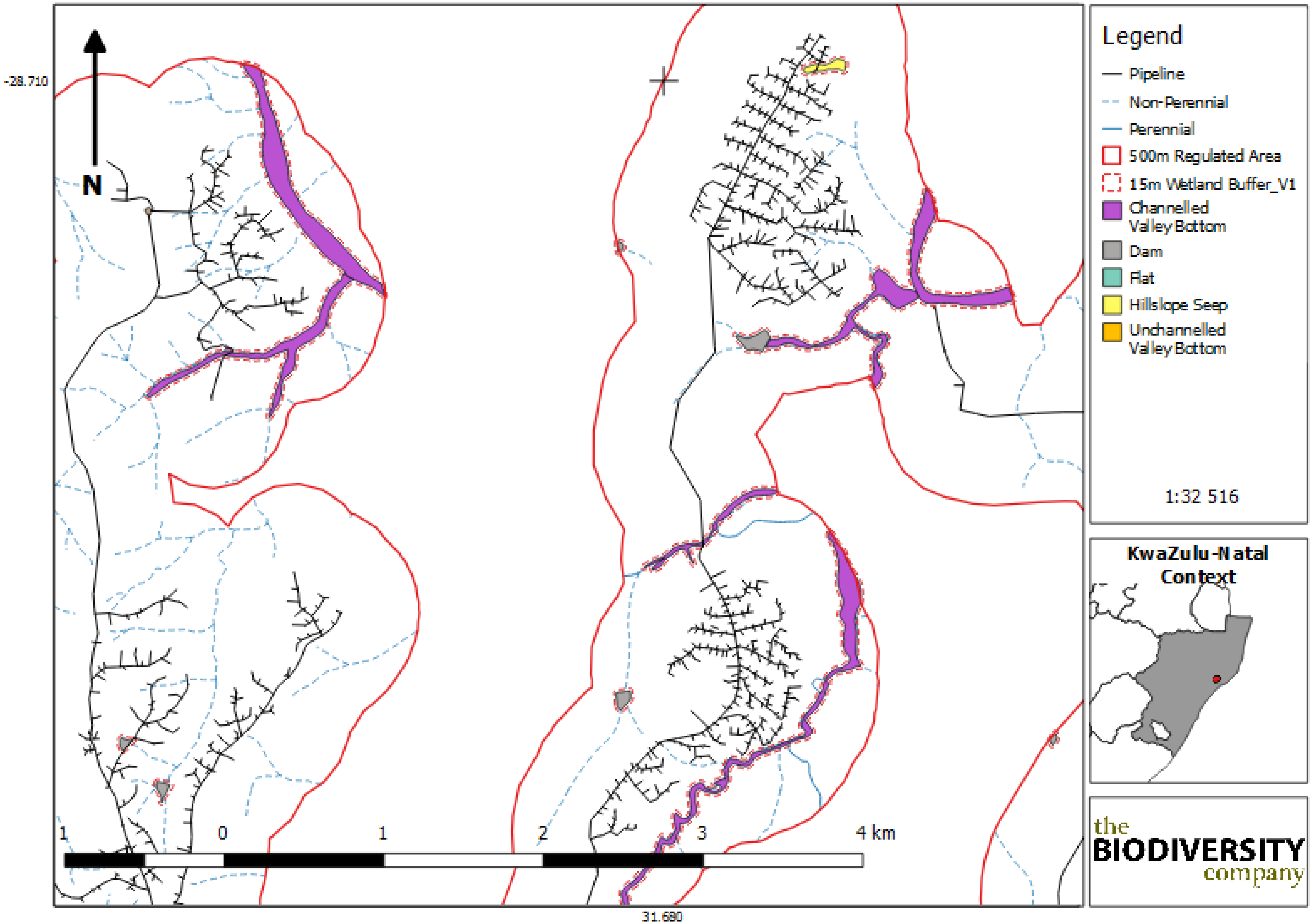


Figure 12: Zoom 2 of the wetland delineation with the 15m buffer

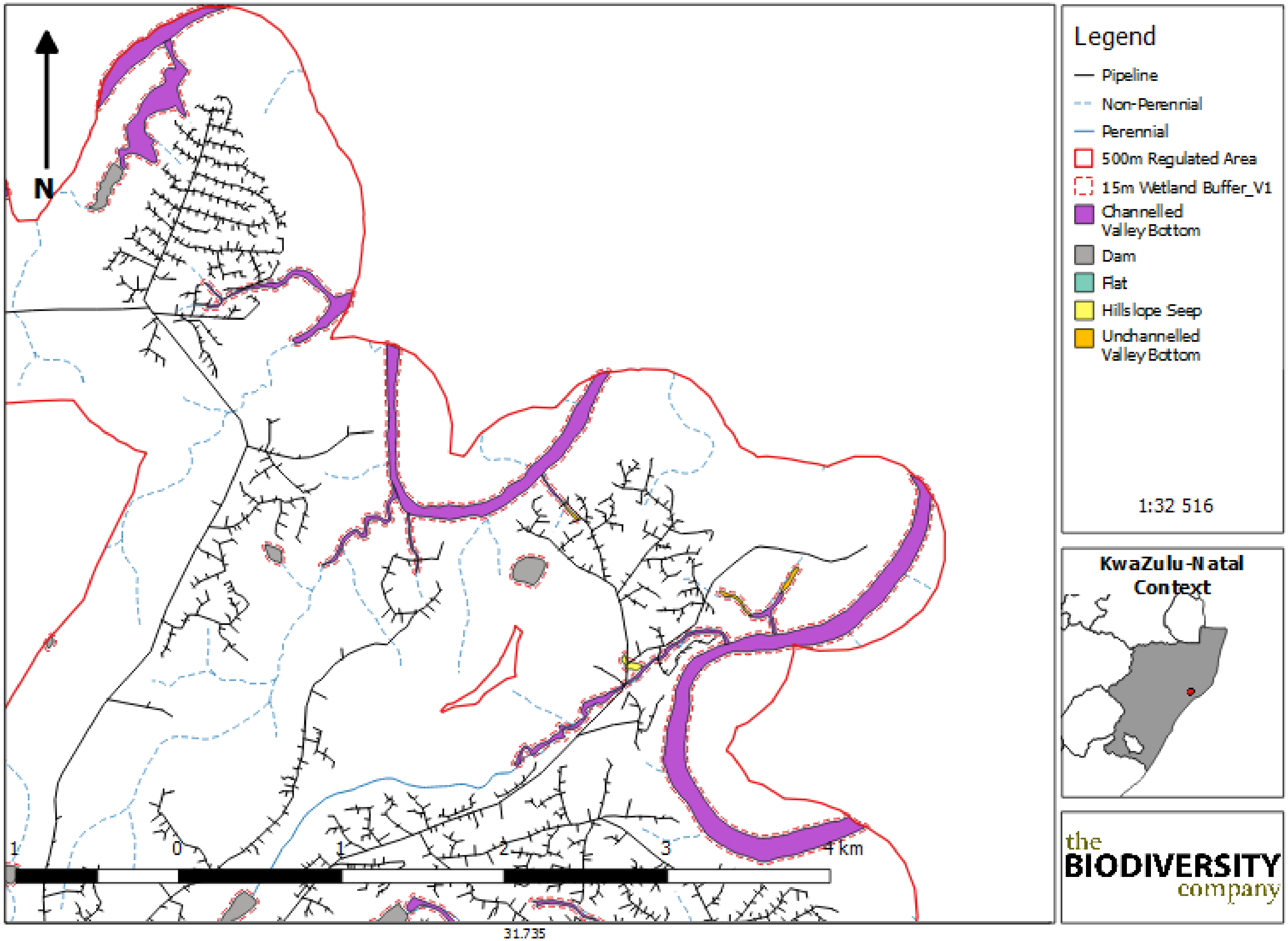


Figure 13: Zoom 3 of the wetland delineation with the 15m buffer

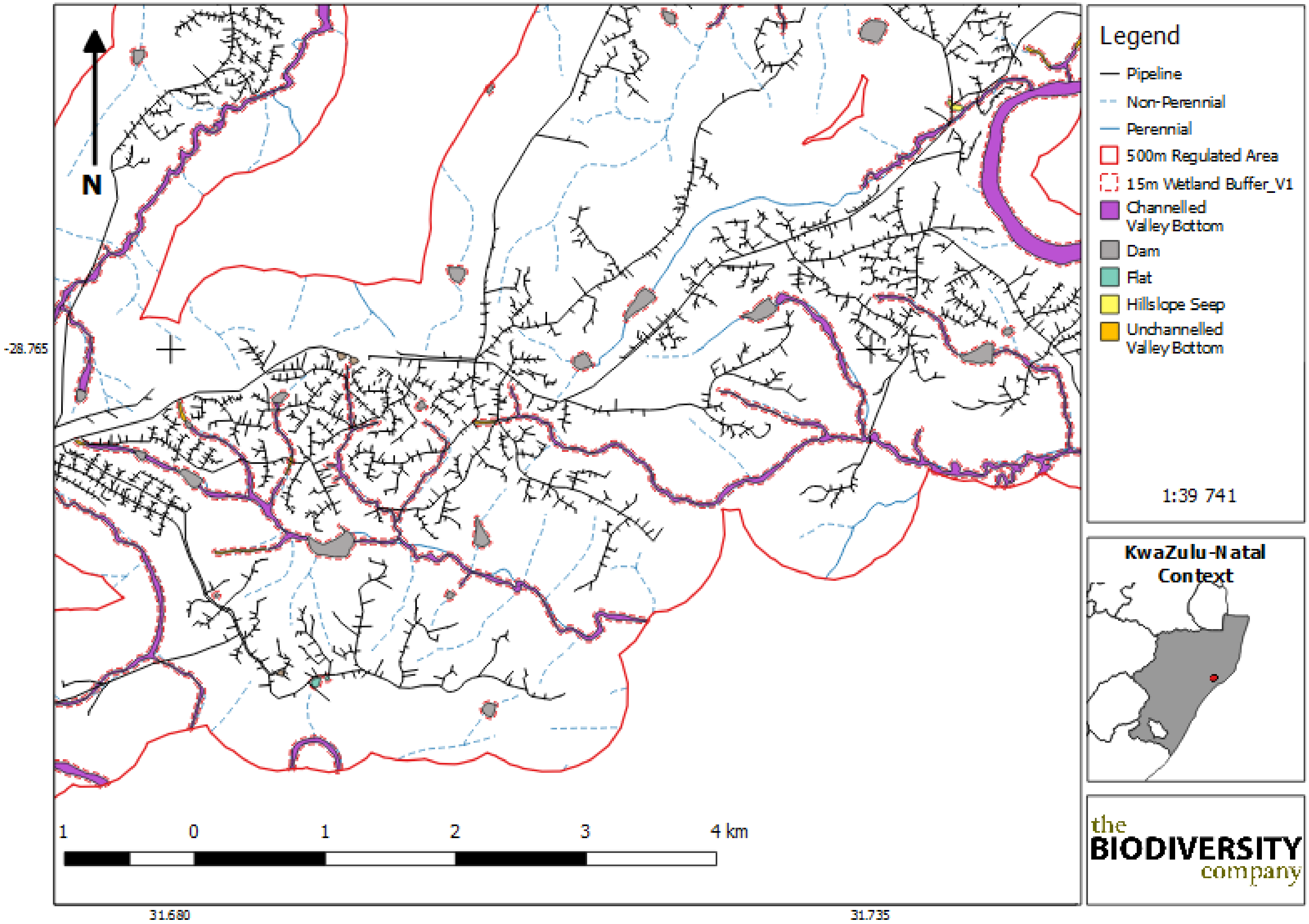


Figure 14: Zoom 4 of the wetland delineation with the 15m buffer

6.3 Present Ecological State

The general features of the identified wetland units within the project area were assessed in terms of impacts on the integrity of these systems using the WET-Health methodology. Wetlands that showed connectivity were grouped as major 'wetland units' according to their links to the landscape and associated impacts. Some of the identified impacts include activities such as dumping, damming, increased hardened surfaces due to the presence of bridges and roads through wetlands (and associated culverts), alien plant species and invasion and trampling by livestock (which promote the processes of erosion). Mining activities, which effect water quality landscape topography and drainage. Damming is the major impact on wetlands within the project area and dams occur throughout the landscape. Culverts, where roads cross wetlands, also contribute to the negative effects on wetlands. The naturally diffuse nature of the water-flow through wetlands is altered, as culverts cause direct/ concentrated flow to occur, reducing the time for infiltration and promoting erosional processes.

Road crossing (culvert or low-level crossings) have similar impacts that dams have, but at a smaller scale. The natural diffuse nature of the water-flow through wetlands is altered, as culverts cause direct flow to occur, reducing the time for infiltration and promoting erosional processes.

The development of infrastructure in the project areas range from small dirt roads to dwellings. These all impact on the wetlands in similar ways, but at varying degrees and intensities. The development of hard structures creates impervious areas, which increase the runoff from areas to surrounding environments. The increased runoff increases erosion risks as discussed earlier. Stormwater structures are often put in place to minimise the impacts of increased runoff. These stormwater systems are generally directed to the lowest point of the developed area, if these discharge locations are not managed or maintained, there is a risk of erosion downslope of these locations. Often developed areas are full of pollutants and these can be washed into stormwater systems entering the wetland systems downstream effecting water quality

Five (5) HGM units were identified and delineated for the study. The PES for the assessed wetland systems is presented in Table 12.

Table 12: Summary of the scores for the wetland PES

Wetland	Hydrology		Geomorphology		Vegetation	
	Rating	Description	Rating	Description	Rating	Description
Small channelled valley bottom	D	Largely Modified	D	Largely Modified	D	Largely Modified
Overall PES Class					**D: Largely Modified**	
Large channelled valley bottom	D	Largely Modified	D	Largely Modified	C	Moderately Modified
Overall PES Class					**D: Largely Modified**	
Unchannelled valley bottom	D	Largely Modified	C	Moderately Modified	D	Largely Modified
Overall PES Class					**D: Largely Modified**	
Wetland flat	D	Largely Modified	C	Moderately Modified	D	Largely Modified
Overall PES Class					**D: Largely Modified**	

Hillslope seep	C	Moderately Modified	C	Moderately Modified	D	Largely Modified
Overall PES Class					C: Moderately Modified	

The PES of the wetland systems varied from moderately modified (class C) to largely modified (class D). The following summaries are provided for the respective classes:

- **Moderately modified:** A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.
- **Largely modified:** A large change in ecosystem processes and loss of natural habitat and biota and has occurred.

The impacts that affected the wetlands are shown in Figure 15.

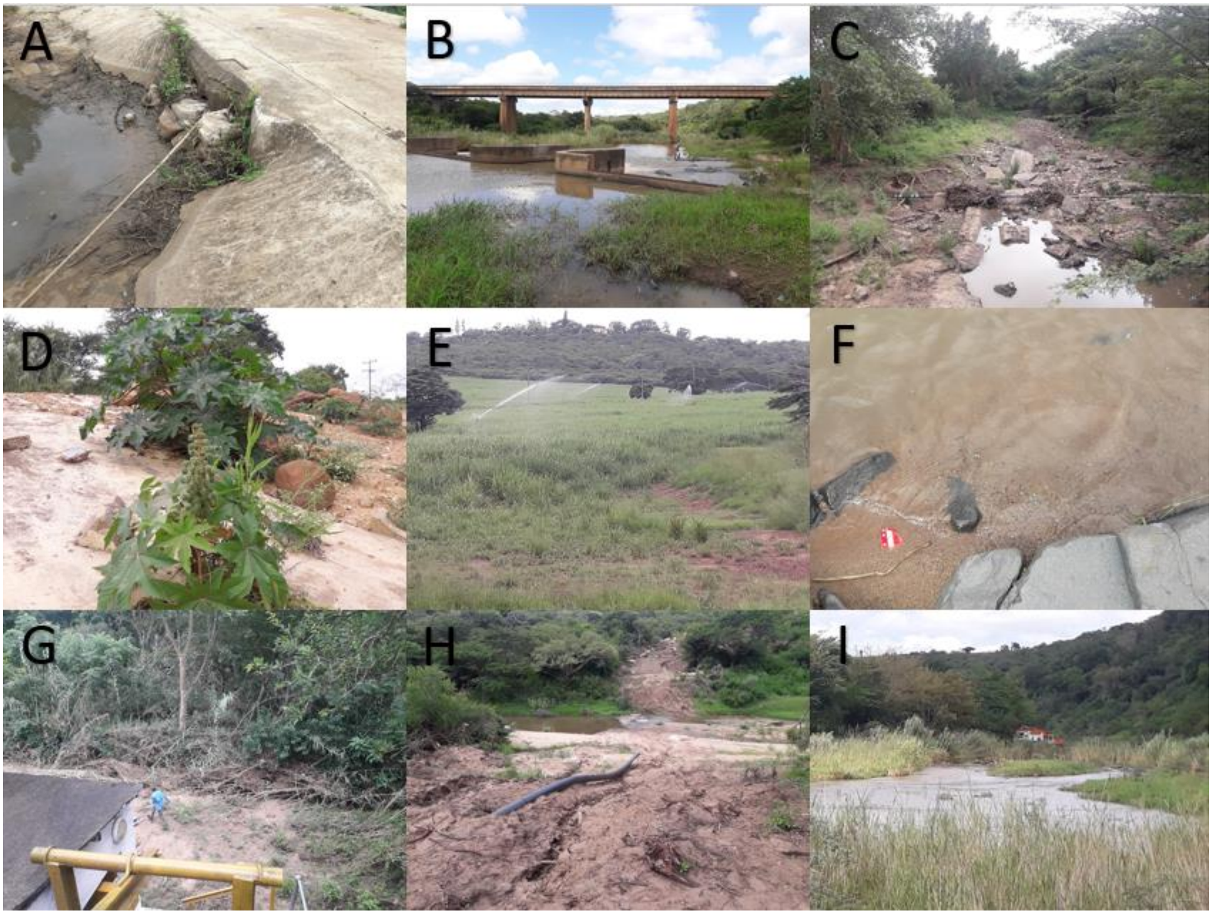


Figure 15: The impacts on the wetland's health of the Mpungose WSS project area, A) Damming, B) Crossing structures and weirs, C) Eroded channels, D) Alien vegetation, E) irrigation, F) Sedimentation of systems, G) Water abstraction works, H) Pipeline installation and crossing activities, I Sand mining.

6.4 Ecosystem Services Assessment

6.4.1 Channelled Valley Bottom

Channelled valley bottom wetlands resemble floodplains, however, they are characterized by less active deposition of sediment and also the absence of oxbows and other floodplain features such as natural levees and meander scrolls (Kotze *et al*., 2007). These systems are generally narrower and have a steeper gradient, with the contribution from lateral groundwater input relative to the main stream channel being generally greater. These systems contribute less towards flood attenuation and sediment trapping. Some nitrate and toxicant removal potential would be expected, particularly from the water being delivered from the adjacent hillslopes.

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.

6.4.2 Unchannelled Valley Bottom

These wetland systems play important functions such as sediment trapping, flood attenuation and nutrient-cycling. The valley bottom without a channel wetland on site receives extensive amounts of sediment and flow from the surrounding slopes. This allows an opportunity for contact between solute-laiden water and the wetland vegetation, thus providing an opportunity for flood and contaminant (nutrients, pesticides, herbicides) attenuation. Extensive areas of these wetlands remain saturated as stream channel input is spread diffusely across the valley bottom, even at low flows (Kotze *et al.,* 2007). These wetlands also tend to have a high organic content (Kotze *et al.,* 2007).

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).

6.4.3 Hillslope seep

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.

6.4.4 Bench Flats

Bench flats occur in flatter portions of the landscape with an impervious layer close to the service. Water often settles or drains inwards towards these systems. They play an important role in sediment trapping and, in some cases, provide water for the maintenance of biodiversity

6.5 Ecological Importance & Sensitivity

The EIS assessment was applied to the HGM unit described in the previous section in order to assess the levels of sensitivity and ecological importance of the wetland. The results of the assessment are shown in Table 13.

The EIS for the wetland types were calculated to have a moderate (class C) level of importance with the exception of the large channelled valley bottom systems which have a high (class B) level of importance. The Hydrological Functionality for the two wetland types were determined to have a moderate (class C) level of importance. The flood attenuation and streamflow regulation 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 marginal / low (class D) level of importance.

Table 13: The EIS results for the delineated wetlands

Wetland Importance and Sensitivity	Channelled Valley bottom (small)	Channelled Valley bottom (large)	Unchannelled Valley bottom	Bench flat	Hillslope seep
Ecological Importance & Sensitivity	C	B	C	C	C
Hydrological/Functional Importance	C	C	C	C	C
Direct Human Benefits	D	D	D	D	D

6.6 Buffer Zones

The wetland buffer zone tool was used to calculate the appropriate buffer required for the Mpungose WSS. The model shows that the largest risks (Moderate) posed by the project during the construction phase is that of increased sediment inputs and turbidity. During the operational phase, the risks identified for the project included were considered low due to the pipeline being for the supply of clean potable water to residents in the area (Table 15).

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 15m (Table 14) for the construction and operational phases.

Table 14: Post-mitigation buffer requirement

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

A conservative buffer zone was suggested of 15 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 lay down yards, storage areas and camp sites, the buffer zone must be implemented.

Table 15: The risk results from the wetland buffer model for the proposed Mpungose WSS project

	Threat Posed by the proposed land use / activity	Specialist Threat Rating	Threat Rating after Mitigation	Recommended Mitigation
Construction Phase	1. Alteration to flow volumes	Very Low	Very Low	
	2. Alteration of patterns of flows (increased flood peaks)	Low	Low	
	3. Increase in sediment inputs & turbidity	Very High	Medium	There are predominantly existing roads / crossings over the wetland areas. Dry season construction, silt traps, managed stockpiles, storm water management will reduce the risk of sedimentation during the construction. The pipeline will be attached to existing infrastructure over the watercourse areas.
	4. Increased nutrient inputs	Low	Low	
	5. Inputs of toxic organic contaminants	Medium	Very Low	
	6. Inputs of toxic heavy metal contaminants	Medium	Low	Off-site equipment vehicle fuelling and maintenance, storage in bunded area, no on-site fabrication, oil spill kits, equipment & vehicle inspections.
	7. Alteration of acidity (pH)	Low	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	Medium	Low	The proposed pipeline will be underground and will not impact on the surface hydrology during the duration of its operation. Furthermore, the proposed pipeline is for the supply of clean potable water to residents in the area, the risk of organic compounds and nutrients will be limited. An infrastructure monitoring plan will be devised to regularly check for leaks and remedy these.
	2. Alteration of patterns of flows (increased flood peaks)	High	Low	
	3. Increase in sediment inputs & turbidity	High	Low	
	4. Increased nutrient inputs	High	Low	
	5. Inputs of toxic organic contaminants	High	Low	
	6. Inputs of toxic heavy metal contaminants	High	Low	
	7. Alteration of acidity (pH)	High	Low	
	8. Increased inputs of salts (salinization)	High	Low	
	9. Change (elevation) of water temperature	Medium	Low	
	10. Pathogen inputs (i.e. disease-causing organisms)	High	Very Low	

6.7 Aquatic Assessment

During, the aquatic assessment the majority of the watercourses (WSS crossings) were expected to be non-perennial, and as a result of this, these ephemeral systems were assessed at a desktop level only. A comprehensive aquatic assessment was conducted for the perennial watercourses namely the Mhlatuze and Mateku rivers. A total of two sites were assessed on the perennial watercourses, as presented in Figure 16. Site photographs and GPS coordinates are provided in Table 16.

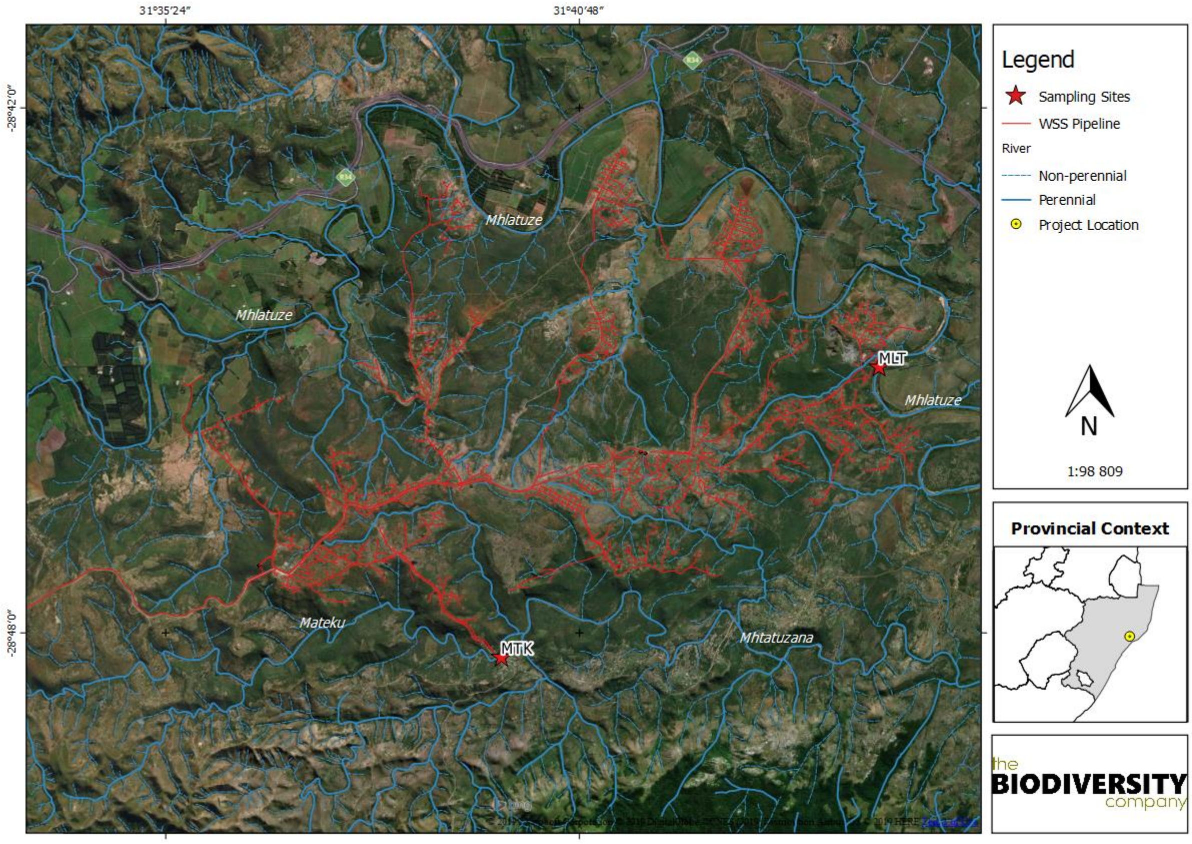


Figure 16: Illustration of sampling points

Table 16: Site photographs and GPS Coordinates for the sites sampled

	Upstream	Downstream
MTK		
GPS	28°48'17.04"S 31°39'46.75"E	
Site n	Site MTK is located on the Mateku River. The site was characterised as a slow flowing river (trickle) over stone in and out of current, bedrock, gravel, sand and mud biotopes, with moderate abundances marginal vegetation present.	

<table>
<tr><td rowspan="2">MLT</td><td>Upstream</td><td>Downstream</td></tr>
<tr><td></td><td></td></tr>
<tr><td>GPS</td><td colspan="2">28°44'58.07"S
31°44'42.71"E</td></tr>
<tr><td>Site</td><td colspan="2">Site MLT is located on the Mhlatuze River. The site was characterised by a diversity of flow classes over stones in and out of current, bedrock, sand, gravel and mud biotopes, with a moderate diversity of marginal vegetation. A weir influences flow and habitat at the site</td></tr>
</table>

6.7.1 *In situ* water quality

In situ water quality analysis was conducted at each sampled site. These results are important to assist in the interpretation of biological results due to the direct influence water quality has on aquatic life forms. Results were compared to the Target Water Quality Range (TWQR) for aquatic ecosystems (DWS, 1996). The results of the survey are presented in Table 17.

Table 17: In situ water quality results for the high flow survey (February 2019)

Site	pH	Conductivity (µS/cm)	DO (mg/l)	Temperature (°C)
TWQR*	**6.5-9.0**	**<700****	**>5.00**	**5-30**
MTK	7.54	-	7.94	26.9
MLT	7.34	-	6.75	24.8

*Target Water quality Range; **Expert opinion conductivity range

In situ water quality analysis of the Mateku and Mhlatuze rivers indicated adequate conditions during the high flow survey. Both watercourses had adequate pH, Dissolved Oxygen (DO) and water temperatures, falling within the TWQR. During the survey, the water within the Mateku and Mhlatuze rivers was considered adequate to sustain aquatic biota and ecosystem function. During the site visit, the water quality meter experienced a probe malfunction, therefore electrical conductivity readings were unreliable and disregarded for this study.

6.7.2 Intermediate Habitat Integrity Assessment

The results for the instream and riparian habitat integrity assessment for the Mateku and Mhlatuze river reaches are presented in Table 18.

Table 18: Results for the instream habitat integrity assessment

Instream	Mateku		Mhlatuze	
	Average	Score	Average	Score
Water abstraction	4	1.6	7	4.9
Flow modification	2	0.4	3	0.9
Bed modification	4	1.6	5	2.5
Channel modification	2	0.4	2	0.4
Water quality	3	0.9	4	1.6
Inundation	0	0	0	0
Exotic macrophytes	1	0.1	2	0.4
Exotic fauna	1	0.1	1	0.1
Solid waste disposal	2	0.4	2	0.4
Total Instream		**94.5**		**88.8**
Category		**A**		**B**
Riparian	**Mateku**		**Mhlatuze**	
	Average	**Score**	**Average**	**Score**
Indigenous vegetation removal	4	1.6	5	2.5
Exotic vegetation encroachment	5	2.5	6	3.6
Bank erosion	3	0.9	4	1.6
Channel modification	4	1.6	4	1.6
Water abstraction	5	2.5	5	2.5
Inundation	3	0.9	3	0.9
Flow modification	2	0.4	2	0.4
Water quality	2	0.4	3	0.9
Total Riparian		**89.2**		**86.0**
Category		**B**		**B**

According to the IHIA results instream habitat integrity in the Mateku River reach is considered to be a class A, or natural with no modification. Riparian habitat integrity in the reach is considered to be a class B, or largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.

According to the IHIA results instream habitat integrity in the Mhlatuze River reach is considered to be a class B, or largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged. Riparian habitat integrity in the reach is also considered to be a class B, or largely natural with few modifications.

6.7.3 Aquatic Macroinvertebrate Assessment

6.7.3.1 Macroinvertebrate Habitat Assessment

A biological assessment was completed at each site in the considered river reaches. The available (sampled) macroinvertebrate habitat at each site was assessed using the SASS5 biotope rating assessment as applied in Tate and Husted (2015). The results of the biotope assessment are provided in Table 19. A rating system of 0 to 5 was applied, 0 being not available, and 5 being highly abundant and diverse. The weighting for typical upper foothills river zonation has been used for the Mateku River and lower foothills was used for the Mhlatuze River (Rountree *et al.,* 2000).

Table 19: Biotope availability at each site

Biotope	Weighting*	MTK	Weighting**	MLT
Stones in current (SIC)	20	0	18	2
Stones out of current (SOOC)	10	3	12	1
Bedrock	5	3	3	4
Aquatic vegetation	0.5	1	1	2
Marginal vegetation in current	2	0	2	3
Marginal vegetation out of current	2	3	2	4
Gravel	3.5	3	4	1.5
Sand	1	2	2	4
Mud	0.5	1.5	1	3
Biotope Score		16.5		24.5
Weighted Biotope Score (%)		29		41
Biotope Category (Tate and Husted, 2015)		**F**		**D**

*Weighting for upper foothills; **Weighting for lower foothills

Habitat availability within the Mateku was rated as class F, indicating a low diversity of biotopes within the system, and that habitat availability would limit the macroinvertebrate assemblage diversity or abundances. Habitat diversity in the Mhlatuze system was rated as class D, indicating a moderate diversity of biotopes within the system, and that habitat availability would not limit the macroinvertebrate assemblage diversity or abundances.

6.7.3.2 South African Scoring System

The aquatic macroinvertebrate results are presented in Table 20. The SASS5 score for the Mateku River was 77, with an ASPT of 5.1, indicating taxa collected during the survey were rated as tolerant (1 - 5 sensitivity score) of water pollution / physico-chemical changes. The SASS5 score for the larger Mhlatuze River was 145, with an ASPT of 6.0, indicating taxa collected during the survey were rated as semi-tolerant (6 - 10 sensitivity score).

Table 20: Macroinvertebrate assessment results

Site	MTK	MLT
SASS Score	77	145
No. of Taxa	15	24
ASPT*	5.1	6.0
Category (Dallas, 2007)**	**D**	**A**

*ASPT: Average score per taxon; **North Eastern Uplands Lower Ecoregion

Biotic integrity for the project area was categorised as largely modified (class D) and natural (class A) for the Mateku and Mhlatuze rivers, respectively. The results of the reach based MIRAI is provided in the section below.

6.7.3.3 Macroinvertebrate Response Assessment Index

Findings from the MIRAI are presented in Table 21 for the two reaches assessed.

Table 21: Macroinvertebrate Response Assessment Index for the rivers based on invertebrate results

Invertebrate Metric Group	Mateku Score	Mhlatuze Score
Flow Modification	28.3	51.0
Habitat	45.3	54.7
Water Quality	44.9	76.4
Ecological Score	**40.1**	**60.9**
Ecological Category	**D/E**	**C/D**

The results of the MIRAI assessment indicates that a largely to seriously modified invertebrate community was present in the Mateku River system based on the survey results. The flow response metric was shown to be the limiting factor for the macroinvertebrate community. A low number of flow sensitive taxa were observed during the assessment and these included Leptophlebiidae and Ancylidae. The modified macroinvertebrate community was thus largely attributed to flow modifications which aligns with the lack of flow in the Mateku system at the time of the survey.

The results of the MIRAI assessment indicates that a moderately to largely modified invertebrate community was present in the Mhlatuze River system. The flow response metric was shown to be the limiting factor for the macroinvertebrate community, although not as large an influence compared to the Mateku River flow modifications. A moderate number of flow sensitive taxa were observed during the assessment and these included Ephemeroptera, Hydropsychidae and Simuliidae. The modified macroinvertebrate community was thus largely attributed to flow modifications with habitat availability further contributing to the lowered ecological score.

6.7.4 Fish Assessment

The list of expected fish species is presented in Table 22 (Skelton, 2001; DWS, 2018). Based on this, a total of 25 fish species are expected to occur in the project area.

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 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, Table 22 should be viewed as a list of potential species rather than an expected species list. Four species of conservation concern are expected to occur within the project area, namely *Anguilla bicolor bicolor, Micropanchax myaposae, Enteromius gurneyi* and *Oreochromis mossambicus* (IUCN, 2019).

Table 22: Expected and observed fish species list for the two sub-quaternary catchments

Scientific name	Common name	IUCN* Status	Observed	
			MTK	MLT
Anguilla bicolor bicolor	Shortfin Eel	NT	No	No
Anguilla marmorata	Giant Mottled Eel	LC	No	No
Anguilla mossambica	Longfin Eel	LC	No	No
Awaous aeneofuscus	Freshwater Goby	LC	No	No
Clarias gariepinus	Sharptooth Catfish	LC	No	Yes
Clarias theodorae	Snake Catfish	LC	No	No
Coptodon rendalli	Redbreast Tilapia	LC	Yes	Yes
Ctenopoma multispine	Manyspined Climbing Perch	LC	No	No
Eleotris melanosoma	Broadhead Sleeper	LC	No	Yes
Enteromius gurneyi	Redtail Barb	VU	No	No
Enteromius paludinosus	Straightfin Barb	LC	Yes	Yes
Enteromius trimaculatus	Three spotted Barb	LC	Yes	Yes
Enteromius viviparus	Bowstripe Barb	LC	Yes	No
Glossogobius callidus	River Goby	LC	Yes	Yes
Glossogobius giuris	Tank Goby	LC	No	No
Labeo cylindricus	Redeye Labeo	LC	No	No
Labeo molybdinus	Leaden Labeo	LC	No	Yes
Labeobarbus natalensis	Natal Yellowfish	LC	No	Yes
Marcusenius pongolensis	Southern Bulldog	DD	No	Yes
Micropanchax johnstoni	Johnston's Topminnow	LC	No	Yes
Micropanchax myaposae	Natal Topminnow	NT	No	Yes
Oreochromis mossambicus	Mozambique Tilapia	NT	Yes	Yes
Pseudocrenilabrus philander	Southern Mouthbrooder	LC	Yes	Yes
Redigobius dewaali	Checked Goby	LC	No	No
Tilapia sparrmanii	Banded Tilapia	LC	Yes	Yes
Total number of fish		**25**	**8**	**15**

*IUCN: International Union for the Conservation of Nature; LC - Least Concern; VU – Vulnerable; NT - Near Threatened; DD – Data Deficient

As can be observed in the table above, a total of 8 fish species were observed in the Mateku River, while 15 fish species were observed in the Mhlatuze River. It is noted however that several of the expected species are catadromous and therefore their anticipated occurrence at the survey points was derived to be low. Two red listed species, namely *Micropanchax myaposae* and *Oreochromis mossambicus* were sampled during the survey. *O. mossambicus* is listed due to the hybridisation with *O. niloticus*. The proposed project does pose a risk to the listed fish species, however not a significant risk due to the size of the river systems and proximity of the pipeline layout to the river systems. The results of the FRAI is presented in Table 23.

Table 23: Fish Response Assessment Index for the two river systems

FRAI% (Automated)	**Mateku**	**Mhlatuze**
	50.1	69.4
Ecological Category FRAI	class D	class C

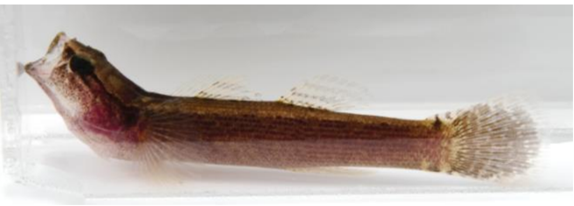
The results of the FRAI derived a largely modified (class D) fish community structure in the Mateku River. Species which were not sampled during the survey are expected to be present within the study area. It is anticipated that should a larger number of sampling sites be selected in the Mateku River, a large portion (approximately 80%) of the expected fish species would likely be sampled. Considering this the sampled fish community is considered to be largely modified.

According to the FRAI results, the Mhlatuze River fish community structure was considered to be moderately modified (class C). Species which were not sampled during the survey are expected to be present within the study area. Owning to high water levels and the potential for crocodiles, sampling effectiveness was limited. It is anticipated that should a larger number of sampling sites be selected in the Mhlatuze River, a large portion majority of the expected fish species would likely be sampled. Considering this the sampled fish community is considered to be moderately modified.

Table 24: Photographs of fish species collected during the survey

Clarias gariepinus

Coptodon rendalli



Eleotris melanosome

Enteromius paludinosus

Enteromius trimaculatus

Enteromius viviparus

Glossogobius callidus

Labeo molybdinus

Labeobarbus natalensis

Marcusenius pongolensis

Micropanchax johnstoni

Micropanchax myaposae

Oreochromis mossambicus

Pseudocrenilabrus philander

Tilapia sparrmanii

The sites sampled for the proposed Mpungose WSS are currently in a moderately modified condition. This is largely due to the limited impacts to instream habitat and moderately modified biotic integrity of the system.

6.7.5 Riverine Present Ecological Status

The results of the PES assessment are provided in the table below (Table 25).

Table 25: Present Ecological Status of the assessed river reaches

Aspect Assessed	Mateku	Mhlatuze
Instream Ecological Category	94.8	88.8
Riparian Ecological Category	89.2	86.0
Aquatic Invertebrate Ecological Category	41.0	60.9
Fish Ecological Category	50.1	69.4
Ecostatus	Class C/D	Class C

The results of the PES assessment derived moderately modified (class C) conditions for the river reaches considered in this assessment. The modified conditions were largely attributed to statuses associated with the biotic communities, specifically the macroinvertebrates and the fish populations.

7 Risk Assessment

The proposed water supply scheme may make use of water pipeline 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.

The proposed WSS will have no direct impact on the Mateku and Mhlatuze rivers, however, the associated tributary network may be impacted on by the proposed project. Impacts on the river systems and drainage channels that may be a result of the pipeline construction are as follows:

- Loss of habitat on riverbanks due to clearing of vegetation. Clearing of indigenous vegetation during construction may also result in the proliferation of alien invasive plant species post construction;
- During the construction phase, there is potential for soil erosion as vegetation is removed, grading activities expose soils and make it more susceptible to erosion; and
- During the construction phase, heavy machinery and vehicles will be operated in close proximity to the two major rivers identified as well as the drainage line crossings, this increases the risk of spills or leaks of hazardous substances (e.g. fuel spills or oil leaks) resulting in decreased water quality.

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

Table 26: Potential risks associated with the project

Activity	Aspect	Impact
Construction & operation of water pipeline	Clearing of areas and digging trenches for infrastructure	Impeding the flow of water. Loss of aquatic habitat Siltation of watercourse. Erosion of watercourse. Sedimentation of the watercourse. Flow sediment equilibrium change Water quality impairment
	Piers located outside of drainage lines	
	Use of temporary structures for river crossings	
	On-site vehicle and machinery activities	
	Ablutions and waste handling	
	Additional associated infrastructure	
	Operation of pipeline	

Table 27: Risk rating assessment

Dale Kindler (Pr. Sci. Nat 114743); Wayne Jackson (Pr. Sci. Nat Pending)								
Severity								
Aspect	**Flow Regime**	**Water Quality**	**Habitat**	**Biota**	**Severity**	**Spatial scale**	**Duration**	**Consequence**
Clearing of areas and digging trenches for infrastructure	2	2	3	1	**2**	2	2	**6**
Piers located outside of drainage lines	0	1	2	0	**0.75**	2	3	**5.75**
Use of temporary structures for river/wetland crossings	2	2	2	1	**1.75**	1	1	**3.75**
On-site vehicle and machinery activities	1	2	2	3	**2**	2	3	**7**
Ablutions and waste handling	1	3	1	3	**2**	1	3	**6**
Excavation of pipeline route	3	2	3	2	**2.5**	2	2	**6.5**
Removal and stockpiling of soils	2	2	2	2	**2**	2	3	**7**
Compaction of soil profile	2	1	1	1	**1.25**	1	3	**5.25**
Additional associated infrastructure	1	1	1	1	**1**	1	2	**4**
Operation of pipeline	2	1	1	1	**1.25**	1	3	**5.25**

Table 28: Risk rating assessment continued

Aspect	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Sig.	Pre-Mitigation	Post-Mitigation
Clearing of areas and digging trenches for infrastructure	1	2	5	1	**9**	**54**	**Low**	**Low**
Piers located outside of drainage lines	2	2	5	1	**10**	**57.5***	**Moderate***	**Low**
Use of temporary structures for river crossings	1	2	5	1	**9**	**33.75**	**Low**	**Low**
On-site vehicle and machinery activities	3	1	1	2	**7**	**49**	**Low**	**Low**
Ablutions and waste handling	2	1	1	2	**6**	**36**	**Low**	**Low**
Excavation of pipeline route	3	1	5	3	**12**	**78***	**Moderate***	**Low**
Removal and stockpiling of soils	3	1	5	2	**11**	**77***	**Moderate***	**Low**
Compaction of soil profile	2	2	1	2	**7**	**36.75**	**Low**	**Low**
Additional associated infrastructure	2	1	5	1	**9**	**36**	**Low**	**Low**
Operation of pipeline	1	2	5	1	**9**	**47.25**	**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 does pose a risk to the identified water resources, with the level of risk predominantly determined to be low. These low risk ratings may largely be attributed to the impacts occurring outside of the resource areas, with the potential to address some of the potential impacts. The use of a spanned pipeline with support piers located outside of aquatic areas was re-allocated a moderate-low status (yellow) due to implementation of additional mitigation methodologies, while a single moderate risk of digging trenches through aquatic areas for the burying of the water pipeline may pose a moderate risk (pre mitigation) to instream areas and should be avoided.

The proposed project was determined to have low to moderate impacts on the wetland areas. The risk assessment considered the current state and functioning of the wetland areas, and the nature of the project which is for the installation of a water pipeline. The wetland areas are in a moderately to largely modified state, and the proposed project will not have a direct impact on the selected wetland systems.

Taking the proposed project and all the risks into consideration, the project itself and the current state and of the local water resources, the risk rating for each of the aspects was determined to vary from low to moderate, pre-mitigation. However, should the prescribed mitigation measures be implemented for the project, the associated risks are all expected to be low.

During the operational phase of the project, no mitigation measures are expected to be required. Taking into account that the pipeline will be transporting water.

7.1 Pipeline installation

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

Site preparation

- Trenches should be side dug (where possible) from the existing access routes / service roads. In the absence of access routes, temporary routes may be considered;
- Temporary access should be constructed to prevent rutting and degradation of the soil, to permit construction to proceed;
- Trenches should be dug on-line (where applicable) creating narrower trenches;
- Where trench breakers are required, these should be imported appropriately and installed by the backfill crew, ahead of backfilling;
- Careful separation of soil types/ strata as identified;
- The soils should be removed in such a way that they can be easily reinstated in the reverse order as detailed below;
- To ensure correct backfilling, the soil that is removed from the trench at its deepest point will be laid closest to the trench;

- It may be necessary to import small amounts of padding material upon which the pipe safely rests in the trench prior to backfilling. This material will be stored outside the wetland buffer (15 m) until it is required to be placed within the trench, and bunded with sandbags;
- Any large boulders encountered during trenching operations should not be returned to the trench, but removed off site; and
- Excess spoil should be temporarily windrowed over the trench to permit natural settling of the material prior to the reinstatement phase.

7.2 Mitigation Measures

The following water pipeline installation specific mitigation measures are provided:

- 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 underground crossing rivers and streams 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;
- If pier support structures are needed for the pipeline to span a wide drainage line, then piers should be placed outside of preferential flow paths with the least number of pier structures used as possible; and
- 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.

The following general mitigation measures are provided:

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

- It is preferable that construction takes place during the dry season to reduce the erosion potential of the exposed surfaces;
- Temporary stormwater channels and preferential flow paths should be filled with aggregate and/or logs (branches included) to dissipate and slow flows limiting erosion;
- Pre-cast piers should be made use of (where possible) to avoid the mixing of these materials on site, reducing the likelihood of cement in the river system;
- Prevent uncontrolled access of vehicles through the watercourses 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;
- Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel throughout the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation);
- Have action plans on site, and training for contractors and employees in the event of spills, leaks and other impacts to the aquatic systems;
- Erosion and sedimentation into the channel must be minimised through the effective stabilisation (gabions and Reno mattresses) and the re-vegetation of any disturbed banks;
- No dumping of construction material on-site may take place; and
- All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported.

8 Conclusion

Wetland

A total of 101 wetland units were identified with five (5) wetland types being classified. The integrity (or health) of the wetland systems varied from moderately modified (class C) to largely modified (class D). The ecological importance and sensitivity for the wetland types was calculated to have a moderate (class C) level of importance with the exception of the large channelled valley bottom systems which have a high (class B) level of importance.

Conservative buffer zones of 15m (Post-mitigation) were suggested for the construction and operational phases of the pipeline crossing.

Aquatics

The current state of the river reaches, associated with the proposed Mpungose WSS are in a moderately modified state. The modified conditions were largely attributed to statuses associated with the biotic communities, specifically the macroinvertebrates and the fish populations. During the survey, the water within the Mateku and Mhlatuze rivers was considered adequate to sustain aquatic biota and ecosystem function. The instream habitat integrity in the Mateku River reach is considered to be a class A, or natural with no modification. The instream habitat integrity in the Mhlatuze River reach is considered to be a class B, or largely natural with few modifications. Riparian habitat integrity in the two reaches is considered to be a class B, or largely natural with few modifications. The macroinvertebrate assessment indicates that a largely to seriously modified, and a moderately to largely modified invertebrate community was present in the Mateku River and Mhlatuze River respectively. The results of the fish assessment derived a largely modified (class D) and a moderately modified fish community structure in the Mateku River and Mhlatuze River respectively.

Impacts

The construction of the water pipeline does pose a risk to the identified water resources, with the level of risk predominantly determined to be low. These low risk ratings may largely be attributed to the impacts occurring outside of the resource areas, with the potential to address some of the potential impacts. The use of a spanned pipeline with support piers located outside of aquatic areas was re-allocated a low status due to implementation of additional mitigation methodologies.

The proposed project was determined to have low to moderate impacts on the wetland areas. The proposed project will not have a direct impact on the selected wetland systems. Taking the proposed project and all the risks into consideration, the project itself and the current state and of the local water resources, the risk rating for each of the aspects was determined to vary from low to moderate, pre-mitigation. However, should the prescribed mitigation measures be implemented for the project, the associated risks are all expected to be low.

During the operational phase of the project, no mitigation measures are expected to be required. Taking into account that the pipeline will be transporting water.

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