WETLAND ECOLOGICAL ASSESSMENT FOR THE PROPOSED EMERGENCY NONDABULA WATER RETICULATION PROJECT, ILEMBE MUNICIPALITY, KWAZULU-NATAL

Prepared for

Royal Haskoning DHV (Pty) Ltd

June 2015

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EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a wetland and riparian delineation, Present Ecological State (PES) and function assessment for the Emergency Nondabula Reticulation Project (hereinafter referred to as the "study area"). The western boundary of the study is adjacent to the R614 roadway, which is situated south of the Swidi and east of the Gobinsimbi communities in the KwaZulu Natal Province. The Hlathikhulu community is situated within the study area, and the Phambili and Ozwatini communities are situated on the eastern boundary of the study area.

Specific outcomes required from this report in terms of the riparian and wetland assessment include the following:

- To identify Management Units within the study area according to Hydrogeomorphic (HGM) units following the guidelines in the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al*., 2013) and according to location in relation to pipeline infrastructure;
- To delineate all wetland and riparian zones within the study area according to the guidelines for delineation as defined by (DWA, 2005);
- Determine function and service provision of wetland and riparian features according to the method supplied by Kotze *et al* (2005);
- To define the health of the systems within the study area according to the Wetland Index of Habitat Integrity according to the method described by the DWA (2007) and thereby define the Present Ecological State (PES) of the aquatic resources to be affected by the proposed pipeline development;
- To define the Ecological Importance and Sensitivity (EIS) and Recommended Ecological Category (REC) for the features (DWA, 1999);
- To consider potential impacts on the wetland and riparian habitat and the ecological communities likely as a result of the proposed development;
- To present management and mitigation measures in order to minimise the impact on the receiving environment should the proposed expansion proceed; and

The following general conclusions were drawn upon completion of the literature review:

- The study area falls within the North Eastern Coastal Belt Aquatic Ecoregion, and within the U40H and U30A quaternary catchment;
- According to the NFEPA database the study area falls within the Mvoti to Umzimkulu Water Management Area (WMA), and the subWMA indicated for the study area is the Mvoti subWMA;
- The subWMA is not regarded important in terms of fish sanctuaries, rehabilitation or corridors;
- The subWMA is not considered important in terms of translocation and relocation zones for fish;
- The subWMA is not listed as a fish FEPA;
- The NFEPA database indicates the presence of one river namely the Nsuze River; which is classified as having a Present Ecological State (PES) Class B river, with a Rivcon (River condition used by NFEPA) of AB (Largely natural with few modifications);
- The NFEPA database indicates that no wetlands are present within the study area;
- The WetVeg group of the riparian systems are "Sub-Escarpment Savanna" which is classified as "Endangered";
- The NFEPA database indicates that there are no RAMSAR wetlands within the study area or within 500m of the study area;
- According to the National List of Threatened Terrestrial Ecosystems (2011) the study area consists of Patches of endangered KZN Sandstone Sourveld and areas of vulnerable Ngongoni veld in eastern portion of study area
- According to the National Biodiversity Assessment (2011), the study area is not located within either a formal or an informal protected area. The majority of the study area is poorly protected with isolated sections that are currently not protected.

The following general conclusions were drawn upon completion of the riparian and wetland assessment:

Numerous perennial drainage lines with riparian and wetland characteristics were identified during the assessment, in addition to the Nsuze River and its associated unnamed tributaries. A number of hillslope seep wetlands and a bench wetland were identified within the study area. Furthermore, channelled and unchannelled wetlands were observed within the perennial drainage of the study area. These features were assessed during the field assessment and the relevant assessment protocols applied. The following points summarise the results obtained:

- These features were classified according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al.,* 2013), as Inland Systems falling within the Eastern Bankenveld Aquatic Ecoregion, and within the Sub-Escarpment Savanna WetVeg group;
- At Level 4 of the Classification System, the features within the study area were classified as: Rivers, Channels and Seeps;
- The results of the Riparian Vegetation Response Index (VEGRAI) applied to the riparian features (i.e. the Nsuze River and associated unnamed tributaries and the perennial drainage lines which presented riparian characteristics). The results of this assessment indicate that the riparian vegetation associated with these features has undergone significant transformation over the years. The perennial drainage lines were placed in Category D, whilst the Nsuze River and associated tributaries were borderline between Ecostatus Class C and D.
- The Index of Habitat Integrity (IHI) was applied to Nsuze River and tributaries as well as the perennial drainage lines to assess the PES of these features. The riparian features of the Nsuze River and its tributaries were assessed separately to the perennial drainage lines. The hillslope seeps and bench wetlands were also assessed individually;
- The results of the IHI assessment are summarised in the table below, and indicate that the features within the study area have undergone moderate to large modifications to vegetation, hydrology and geomorphology.

Summary of results of the WET-IHI assessments conducted for the Nsuze River and tributaries and the Perennial drainage lines within the study area.

Features	PES Category
Perennial Drainage Lines	D
Nsuze river and tributaries	C/D

- Wetland and riparian ecological functionality and ecological service provision was assessed utilising the method described by Kotze *et al.* (2008). The results of the ecoservices assessment are summarised in the table below.

Summary of the wetland and riparian ecological function and service provision assessments for the Nsuze River and tributaries and the Perennial drainage lines.

Group	Score	Category
Nsuze river and tributaries	1.8	Intermediate
Perennial drainage lines	1.8	Intermediate
Hillslope seeps	1.5	Intermediate
Bench wetland	1.2	Moderately low

- The EIS assessment was applied to all riparian and wetland features within the study area in order to ascertain the levels of sensitive and ecological importance of the features, as well as to assist in informing a suitable REC for each. The results of these assessments are summarised in the table below; and
- The REC for the Nsuze River and its tributaries, the perennial drainage lines and wetland features were determined taking into account the results of the IHI, wetland and riparian function, EIS and the WET-Health assessments. The REC deemed appropriate for the wetland and riparian features are presented in the table below.

Summary of the EIS scores for all wetland and riparian features within the study area.

Group	Score	EIS Category	REC Category
Nsuze and associated tributaries	12	C	C
Perennial drainage lines	1.7	C	C
Hillslope Seeps	1.2	C	C
Bench Wetland	1	D	D

The following general conclusions were drawn upon completion of the Impact Assessment:

Based on the impact assessment it is evident that there are a number of activities which will have varying levels of impacts on the watercourse/riparian and wetland resources within the study area. The findings indicate that should no mitigation measure be put into place the proposed pipeline, notably the construction thereof, will have a relatively high impact on the features within the study area. However, following mitigation measures many of the impacts can be reduced to acceptable levels.

It must be noted that the greatest impacts will occur during the construction phase of the project, when vegetation clearing and earth moving activities will be taking place. During this time it is imperative that well planned and executed mitigation measures and rehabilitation plans are implemented to ensure impacts are reduced as well as ensuring that long term negative impacts are reduced, namely erosion and the proliferation alien invasive vegetation species.

Mitigation measures such as installation of gabions and encouraging growth of indigenous vegetation should be implemented where necessary.

A summary of the results obtained from the impact assessment for the proposed pipeline.

Nature of the Impact	Significance Score
Site clearing, the removal of vegetation, and associated disturbances to soils, leading to increased runoff and erosion with consequent sedimentation of riparian/wetland habitat	**-9 Negative Moderate**
Earthworks within riparian/wetland habitats and in the vicinity of these areas leading to increased runoff and erosion and altered runoff patterns	**-7 Negative Moderate**
Movement of construction vehicles within the drainage line systems	**-7 Negative Moderate**
Proliferation of alien vegetation in disturbed areas	**-12 Negative High**
Dumping of waste, including waste material spills and refuse deposits into the riparian/wetland areas	**-7 Negative Moderate**
Construction of roads. through riparian and drainage line crossings, altering stream and base flow patterns and water velocities	**-7 Negative Moderate**

The results of the impact assessment indicate that whilst the impacts prior to mitigation may potentially be high, strict and effective implementation of mitigation measures will reduce the impact significance to medium-low, low or very levels. Therefore, it is the opinion of the specialists that should the mitigation measures as stipulated in Section 5.2 of this report be adhered to, the proposed pipeline infrastructure may proceed without posing a significant risk to the wetland or riparian resources within the study area.

Key mitigation measures which must be implemented include:

- Ensure that erosion management and sediment controls are strictly implemented from the beginning of site clearing activities, particularly as the soils in the study area are prone to erosion;
- All areas should be resloped and topsoiled where necessary and reseeded with indigenous grasses.
- Edge effects such as erosion must be strictly monitored and managed;

- Proliferation of alien and invasive species is expected within any disturbed areas particularly as there is a high degree of alien and invasive species within the study area at present. These species should be eradicated and controlled to prevent further spread beyond the study area;
- It is suggested that an alien plant removal program be initialised within the study area as part of community involvement in order to help offset impacts as well as reinstate more natural hydrological and ecological functions to within the study area;
- Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled; and
- Species specific and area specific eradication recommendations:
- Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
- Footprint areas should be kept as small as possible when removing alien plant species; and
- No vehicles should be allowed to drive through designated sensitive drainage line and riparian areas during the eradication of alien and weed species.
- Rehabilitation must ensure that riparian structure and function are reinstated in such a way as to ensure the ongoing functionality of the larger riparian systems at pre construction levels.
- Sensitivity maps have been developed for the study area, indicating the drainage lines and riparian systems, and their relevant buffer zones. It is recommended that this sensitivity map be considered during all phases of the development and with special mention of the planning of infrastructure, in order to aid in the conservation of and minimise impact on the riparian and aquatic habitat and resources within the study area;
- The bench and hillslope seep wetlands identified during this study are not considered to be targets of construction and operational related impacts, as they are not located within or very close to the proposed pipeline infrastructure. Planning of infrastructure should focus on conservation of the riparian resources as these are deemed to be of greater importance on a local and regional scale;
- All construction footprint areas should remain as small as possible and should as far as possible not encroach into surrounding more sensitive areas. It must be ensured that the riparian and drainage line systems, and their associated buffer zones are off-limits to construction vehicles and personnel;
- Any activities that take place within 32 meters of a wetland or watercourse or the 1:100 year flood lines will require authorisation in terms of the relevant regulations of NEMA, however as far as possible infrastructure should be placed outside of wetland
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;
- Any areas where bank failure is observed, due to the pipeline infrastructure, should be immediately repaired;
- As far as possible the existing road network should be utilised, minimising the need to develop new access routes resulting in an increased impact on the local environment. Should temporary roads or access routes be necessary and unavoidable, proper planning must take place and the site sensitivity plan must be taken into consideration. If additional roads are required, then wherever feasible such roads should be constructed a distance from the more sensitive riparian areas and not directly adjacent thereto. If crossings are required they should cross the systems at right angles, as far as possible to minimise impacts in the receiving environment;
- All areas of increased ecological sensitivity should be marked as such and be off limits to all unauthorised construction and maintenance vehicles and personnel;
- The duration of impacts on the riverine and perennial drainage line systems should be minimised as far as possible by ensuring that the duration of time in which flow alteration and sedimentation will take place is minimised;
- Appropriate sanitary facilities must be provided for the life of the construction and all waste removed to an appropriate waste facility;
- No informal fires should be permitted in within the study area;
- Ensure that an adequate number of rubbish bins are provided so as to prevent litter and ensure the proper disposal of waste generated during construction activities; and
- Edge effects of activities, particularly erosion and alien/weed control need to be strictly managed.
- All areas of increased ecological sensitivity should be marked as such and kept off limits to all unauthorised construction and maintenance vehicles as well as personnel;

- All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil; and
- All spills, should they occur, should be immediately cleaned up and treated accordingly.
- Ensure that as far as possible all infrastructure is placed outside of drainage lines and riparian areas and their respective buffer zones. Where this is not possible, construction footprints must be kept as small as possible and impacts must be minimized as far as possible. Where it is unavoidable that a pipeline crosses a feature, it is recommended that existing crossings be used such roads;
- Stabilisation of banks in the vicinity of any crossings over riparian or perennial drainage line resources by employing one of the individual techniques below or a combination thereof, is essential, given the inherent susceptibility of the soils to erosion. Such measures include:
  - Re-sloping of banks to a maximum of a 1:3 slope;
  - Revegetation of re-profiled slopes;
  - Temporary stabilisation of slopes using geotextiles; and
  - Installation of gabions and reno mattresses.
- Limit the footprint area of the construction activities to what is absolutely essential in order to minimise environmental damage;
- During the construction phase, no vehicles should be allowed to indiscriminately drive through the drainage lines or riparian areas;
- Implement effective waste management in order to prevent construction related waste from entering the drainage line and riparian environments.
- To prevent the further erosion of soils, management measures may include berms, soil traps, hessian curtains and storm water diversion away from areas particularly susceptible to erosion;
- Install erosion berms during construction to prevent gully formation. Berms every 50m should be installed where any disturbed soils have a slope of less than 2%, every 25m where the track slopes between 2% and 10%, every 20m where the track slopes between 10% and 15% and every 10m where the track slope is greater than 15%;
- Sheet runoff from access roads should be slowed down by the strategic placement of berms and sandbags;
- As far as possible, all construction activities should occur in the low flow season, during the drier winter months;
- All soils compacted as a result of construction activities falling outside of footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout all construction and rehabilitation phases to prevent loss of floral habitat; and
- Monitor all areas for erosion and incision, particularly any riparian/wetland crossings. Any areas where erosion is occurring excessively quickly should be rehabilitated as quickly as possible.
- All soils compacted as a result of construction activities falling outside of project areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout all construction and rehabilitation phases to prevent loss of floral habitat;
- Rehabilitate all drainage line and riparian habitat areas to ensure that the ecology of these areas is re-instated during all phases;
- Edge effects of activities including erosion and alien/ weed control need to be strictly managed in these areas;
- As far as possible, all rehabilitation activities should occur in the low flow season, during the drier winter months.
- All alien vegetation in the riparian zone should be removed upon completion of construction and reseeded with indigenous grasses as as specified by a suitably qualified specialist (ecologist);
- All areas affected by construction should be rehabilitated upon completion of the construction phase of the development; and
- Bank vegetation cover should be monitored to ensure that sufficient vegetation is present to bind the bankside soils and prevent bankside erosion and incision.

Declaration

This report has been prepared according to the requirements as set out in Appendix 6 of the Environmental Impact Assessments EIA Regulations, 2014 (No. R. 982). We / I (the undersigned) declare the findings of this report free from influence or prejudice.

Report Principal:

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_____ Date: 25/06/2015

Stephen van Staden

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GLOSSARY OF TERMS & ACRONYMS

Alien vegetation	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome -usually international in origin.
Alluvial soil	A deposit of sand, mud, etc. formed by flowing water, or the sedimentary matter deposited thus within recent times, especially in the valleys of large rivers.
Base flow	Long-term flow in a river that continues after storm flow has passed.
Biodiversity	The number and variety of living organisms on earth, the millions of plants, animans and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the ecosystems, ecological processes and landscape of which they are integral parts.
Buffer	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area.
Catchment	The area contributing to runoff at a particular point in a river system.
Chroma	The relative purity of the spectral colour which decreases with increasing greyness.
Delineation (of a wetland)	To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.
Ecoregion	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Ephemeral stream	A stream that has transitory or short-lived flow.
Facultative species	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas.
Fluvial	Resulting from water movement.
Gleying	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Groundwater	Subsurface water in the saturated zone below the water table.
Hydromorphic soil	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrology	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Hydromorphy	A process of gleying and mottling resulting from the intermittent or permanent presence of excess water in the soil profile.

Hydrophyte	Any plant that grows in water or on a substratum that is at least periodically deficient of oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.
Intermittent flow	Flows only for short periods.
Indigenous vegetation	Vegetation occurring naturally within a defined area.
Mottles	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Obligate species	Species almost always found in wetlands (>99% of occurences).
Perched water table	The upper limit of a zone of saturation that is perched on an unsaturated zone by an impermeable layer, hence separating it from the main body of groundwater.
Perennial	Flows all year round.
RAMSAR	The Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilisation of wetlands, i.e., to stem the progressive encroachment on and loss of wetlands now and in the future, recognising the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.
RDL (Red Data listed) species	Organisms that fall into the Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU) categories of ecological status.
Seasonal zone of wetness	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50cm of the surface.
Temporary zone of wetness	the outer zone of a wetland characterised by saturation within 50cm of the surface for less than three months of the year.
Indigenous vegetation	Vegetation occurring naturally within a defined area
Riparian system	Riparian wetlands are recognised as boundaries between the terrestrial and riverine systems
Ecoregion	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region

LIST OF ACRONYMS

DMEC	Desired Ecological Management Class
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMC	Ecological Management Class
EAP	Environmental Assessment Practitioner
FEPA	Fresh Water Priority Areas
GIS	Geographic Information System
GPS	Global Positioning System
ha	Hectares
HGM	Hydro-geomorphic
m	Metres
mm	Millimetres
NEMA	National Environmental Management Act
PEMC	Present Ecological Management Class
PES	Present Ecological State
REC	Recommended Ecological Category
RHP	River Health Program
SANBI	South African National Biodiversity Institute
SASS	South African Scoring System

1 INTRODUCTION

Scientific Aquatic Services (SAS) was appointed to conduct a wetland and riparian delineation, Present Ecological State (PES) and function assessment for the Emergency Nondabula Reticulation Project (hereinafter referred to as the "study area"). The western boundary of the study area (Figures 1 and 2) is adjacent to the R614 roadway, which is situated south of the Swidi and east of the Gobinsimbi communities in the KwaZulu Natal Province. The Hlathikhulu community is situated within the study area, and the Phambili and Ozwatini communities are situated on the eastern boundary of the study area.

The applicant intends to develop a network of water reticulation pipelines within the Nondabula rural community located in Ward 9 of the Nodwengu Traditional Council in the llembe Municipality, KwaZulu-Natal, to link into the existing pipeline network and provide potable water to the community. The proposed project will consist of:

- A DN150 Steel / PVC rising main of 4.7km;
- A borehole with a yield capacity of 15 m^3/h at 292m;
- A 500kL prefabricated steel reservoir;
- A secondary booster pump;
- A 50kL elevated prefabricated steel tank; and
- 110mm to 32mm reticulation pipelines of approximately 95km in length and 1420m yard taps.

A site visit was conducted during early June 2015. During the site visit, the wetland and riparian areas were delineated and an assessment was conducted in order to define the PES and Ecostatus (EC) of the features within the study area, with a special focus on those features located within close proximity and/ or being traversed by the proposed pipelines. The wetland and riparian features were characterised according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis et. al., 2013) and system modifiers were noted. In addition aspects which define the Ecological Importance and Sensitivity (EIS) of the system were noted to inform the assessment of EIS.

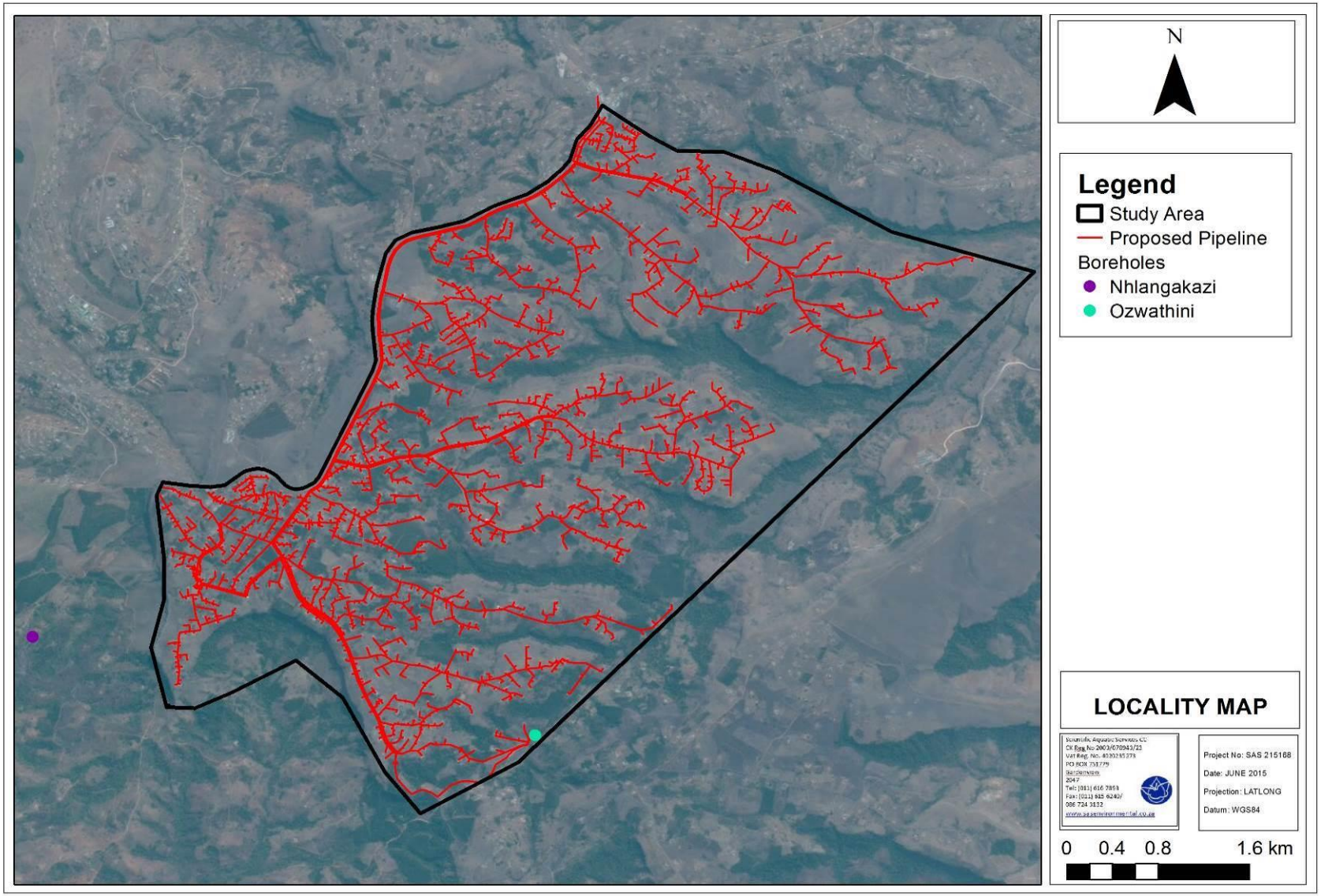

Figure 1: Digital satellite image depicting the location of the study area in relation to surrounding areas.

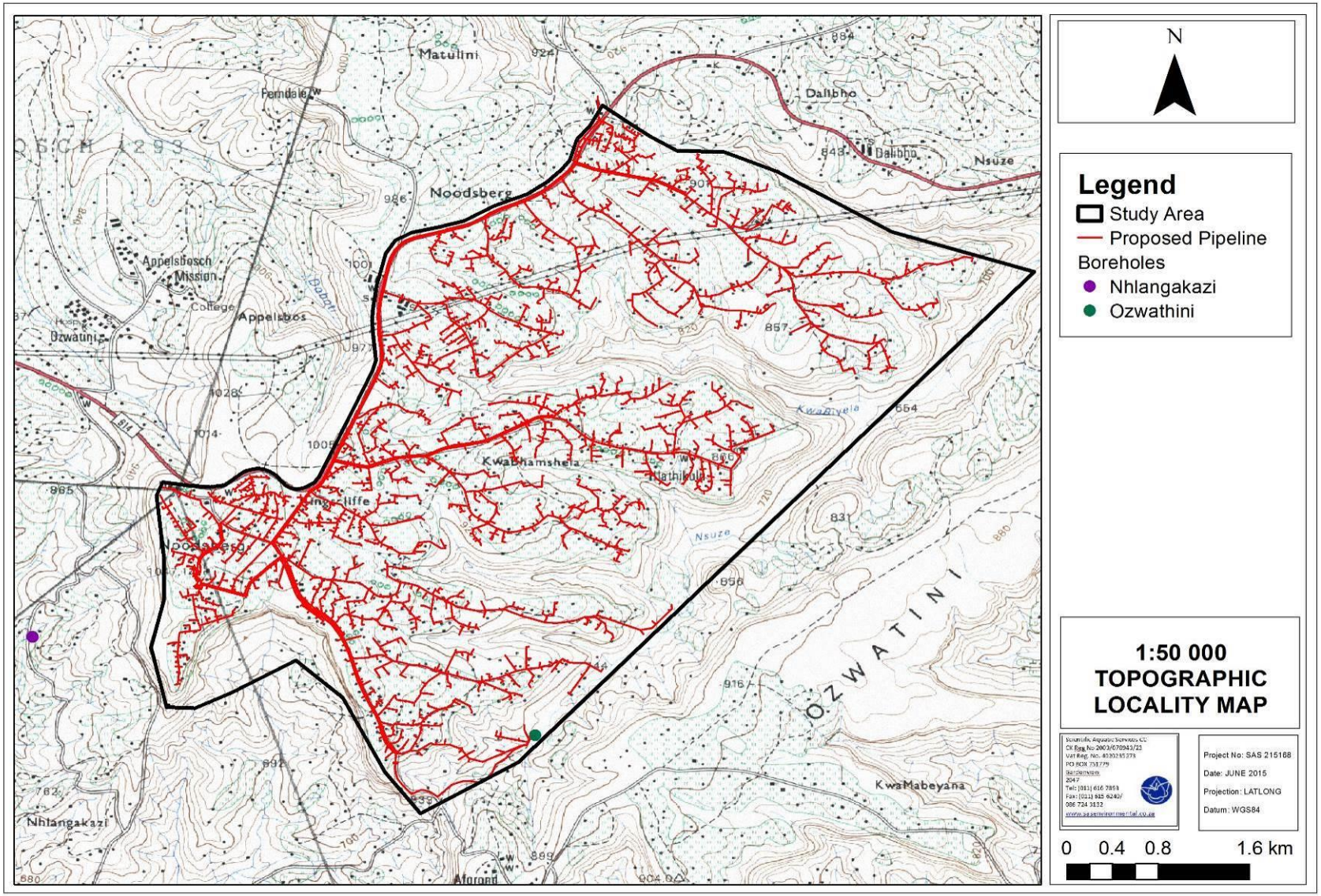

Figure 2: The study area depicted on a 1:50 000 topographical map in relation to the surrounding area.

1.1 Scope

Specific outcomes in terms of this report are as follows:

Wetland and riparian resource assessment

- To identify Management Units within the study area according to Hydrogeomorphic (HGM) units following the guidelines in the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al*., 2013);
- To delineate all wetland and riparian zones within the study area, as well as within a 500m buffer zone of the proposed activity, according to the guidelines as defined by (DWA, 2005);[1]
- Determine function and service provision of wetland and riparian features according to the method supplied by Kotze *et al* (2005);
- To define the health of the systems within the study area according to the Wetland Index of Habitat Integrity according to the method described by the DWA (2007) and thereby define the Present Ecological State (PES) of the aquatic resources to be affected by the proposed pipeline infrastructure;
- To define the Ecological Importance and Sensitivity (EIS) and Recommended Ecological Category (REC) for the features (DWA, 1999);
- To consider potential impacts on the wetland and riparian habitat and the ecological communities likely as a result of the proposed development;
- To present management and mitigation measures in order to minimise the impact on the receiving environment should the proposed development proceed; and

1.2 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- Due to the landscape in some areas being rugged and undeveloped and with many wetlands occurring amongst private dwellings with limited access, some wetlands were inaccessible. Therefore verification points for wetland resources were located at points as close to the wetland resource to be verified as possible and where necessary the conditions at the exact point required were inferred or extrapolated in order to infer the delineation of the larger feature and in order to infer the PES and EIS of the system as a whole;

[1]The Department of Water Affairs (DWA) is currently known as the Department of Water and Sanitation (DWS) and prior to being known as DWA, it was known as the Department of Water Affairs and Forestry (DWAF). For the purposes of referencing in this report, the name under which the Department was known during the time of publication of reference material will be used.

- The riparian zone and wetland delineations as presented in this report are regarded as a best estimate of the riparian / wetland boundaries based on the site conditions present at the time of assessment. Global Positioning System (GPS) technology is inherently inaccurate and some inaccuracies, due to the use of handheld GPS instrumentation, may occur. If more accurate assessments are required the riparian zones and ephemeral drainage line features will need to be surveyed and pegged according to surveying principles. The delineations are however deemed sufficiently accurate to ensure that the wetland and riparian resources are adequately protected if the management and mitigation measures of this report are adhered to and adequate buffers are implemented;
- Due to the extent of the study area, use was made of aerial photographs, digital satellite imagery as well as provincial and national wetland databases to identify areas of interest prior to the field survey. Any additional wetland areas, watercourses and drainage lines noted during the field survey were also assessed and added to the number of survey points. Although all possible measures were undertaken to ensure all wetland features, riparian zones and drainage lines (watercourses) were assessed and delineated, some smaller marginal features may have been overlooked that are not to be directly impacted by the proposed pipeline system. However, if the sensitivity map is consulted during the planning of the proposed pipeline, the majority of watercourse/riparian habitat considered to be of increased EIS will be safeguarded;
- Wetlands and terrestrial areas form transitional areas where an ecotone is formed as vegetation species change from terrestrial species to facultative wetland species. Within this transition zone some variation of opinion on the wetland boundary may occur, however, if the DWA (2005) and DWAF (2008) method is followed, all assessors should get largely similar results; and
- Aquatic, wetland and riparian ecosystems are dynamic and complex. Some aspects of the ecology of these systems, some of which may be important, may have been overlooked. The wetland data presented in this report are based on a single site visit, undertaken in June 2015, at a time when low flows were being experienced. The effects of natural seasonal and long-term variation in the ecological conditions are therefore unknown.

1.3 Indemnity and Terms of use of this report

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available

information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and SAS CC and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

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1.4 Legislative requirements

1.4.1 National Water Act (NWA, Act 36 of 1998)

- The NWA; Act 36 of 1998 recognises that the entire ecosystem and not just the water itself in 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 Department of Water and Sanitation (DWS) formerly (DWA).
- Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from DWS in terms of Section 21 of the NWA.

1.4.2 General Notice (GN) 1199 as published in the Government Gazette 32805 of 2009 as it relates to the NWA, 1998 (Act 36 of 1998)

Wetlands are extremely sensitive environments and as such, the Section 21 (c) and (i) water use General Authorisation does not apply to any wetland or any water resource within a

distance of 500 meters upstream or downstream from the boundary of any wetland and authorisation by means of a WUL is required.

1.4.3 National Environmental Management Act (Act 107 of 1998)

The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations (No R. 544 and No R. 545) as amended, 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 METHOD OF ASSESSMENT

2.1 Literature Review

A desktop study was compiled with all relevant information as presented by the South African National Biodiversity Institutes (SANBI's) Biodiversity Geographic Information Systems (BGIS) website (http://bgis.sanbi.org). Wetland specific information resources taken into consideration during the desktop assessment of the study area included:

- National Freshwater Ecosystem Priority Areas (NFEPAs, 2011)
- NFEPA water management area (WMA)
- FEPA (sub)WMA % area
- Sub water catchment area FEPAs
- Water management area FEPAs
- Fish sanctuaries
- Wetland ecosystem types
- Threatened Terrestrial Ecosystems for South Africa, 2009
- National Protected Area Expansion Strategy, 2011
- KwaZulu Natal Terrestrial Conservation plan, 2010

2.1.1 National Freshwater Ecosystem Priority Areas (NFEPA; 2011)

The NFEPA project is a multi-partner project between the Council of Scientific and Industrial Research (CSIR), Water Research Commission (WRC), South African National Biodiversity Institute (SANBI), Department of Water Affairs (DWA), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The project responds to the reported degradation of freshwater ecosystem condition and associated biodiversity,

both globally and in South Africa. It uses systematic conservation planning to provide strategic spatial priorities of conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development.

The NFEPA project aims to identify a national network of freshwater conservation areas and to explore institutional mechanisms for their implementation. Freshwater ecosystems provide a valuable, natural resource with economic, aesthetic, spiritual, cultural and recreational value. However, the integrity of freshwater ecosystems in South Africa is declining at an alarming rate, largely as a consequence of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (competition between stakeholders for utilisation) and institutional (building appropriate governance and co-management mechanisms).

The NFEPA database was searched for information in terms of conservation status of rivers, wetland habitat and wetland features present within the study area.

2.2 Classification System for Wetlands and other Aquatic Ecosystems in South Africa

All wetland or riparian features encountered within the study area were assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems, hereafter referred to as the "classification system" (Ollis *et al*., 2013). A summary of Levels 1 to 4 of the classification system are presented in Table 1 and 2, below.

Table 1: Proposed classification structure for Inland Systems, up to Level 3.

<table>
<tr><th colspan="3">WETLAND / AQUATIC ECOSYSTEM CONTEXT</th></tr>
<tr><th>LEVEL 1:
SYSTEM</th><th>LEVEL 2:
REGIONAL SETTING</th><th>LEVEL 3:
LANDSCAPE UNIT</th></tr>
<tr><td rowspan="4">Inland Systems</td><td rowspan="4">DWA Level 1 Ecoregions
OR
NFEPA WetVeg Groups
OR
Other special framework</td><td>Valley Floor</td></tr>
<tr><td>Slope</td></tr>
<tr><td>Plain</td></tr>
<tr><td>Bench
(Hilltop / Saddle / Shelf)</td></tr>
</table>

Table 2: Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

2.2.1 Level 1: Inland systems

From the classification system, Inland Systems are defined as aquatic ecosystems that have no existing connection to the ocean[2] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but which are inundated or saturated with water, either permanently or periodically. It is important to bear in mind, however, that certain Inland Systems may have had an historical connection to the ocean, which in some cases may have been relatively recent.

[2] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

2.2.2 Level 2: Ecoregions

For Inland Systems, the regional spatial framework that has been included at Level 2 of the classification system is that of DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et al.,* 2005). There are a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland (figure below). DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

2.2.3 Level 2: NFEPA Wet Veg Groups

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) group's vegetation types across the country according to Biomes, which are then divided into Bioregions. To categorise the regional setting for the wetland component of the NFEPA project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting Bioregions into smaller groups through expert input (Nel *et al*., 2011). There are currently 133 NFEPA WetVeg Groups. It is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

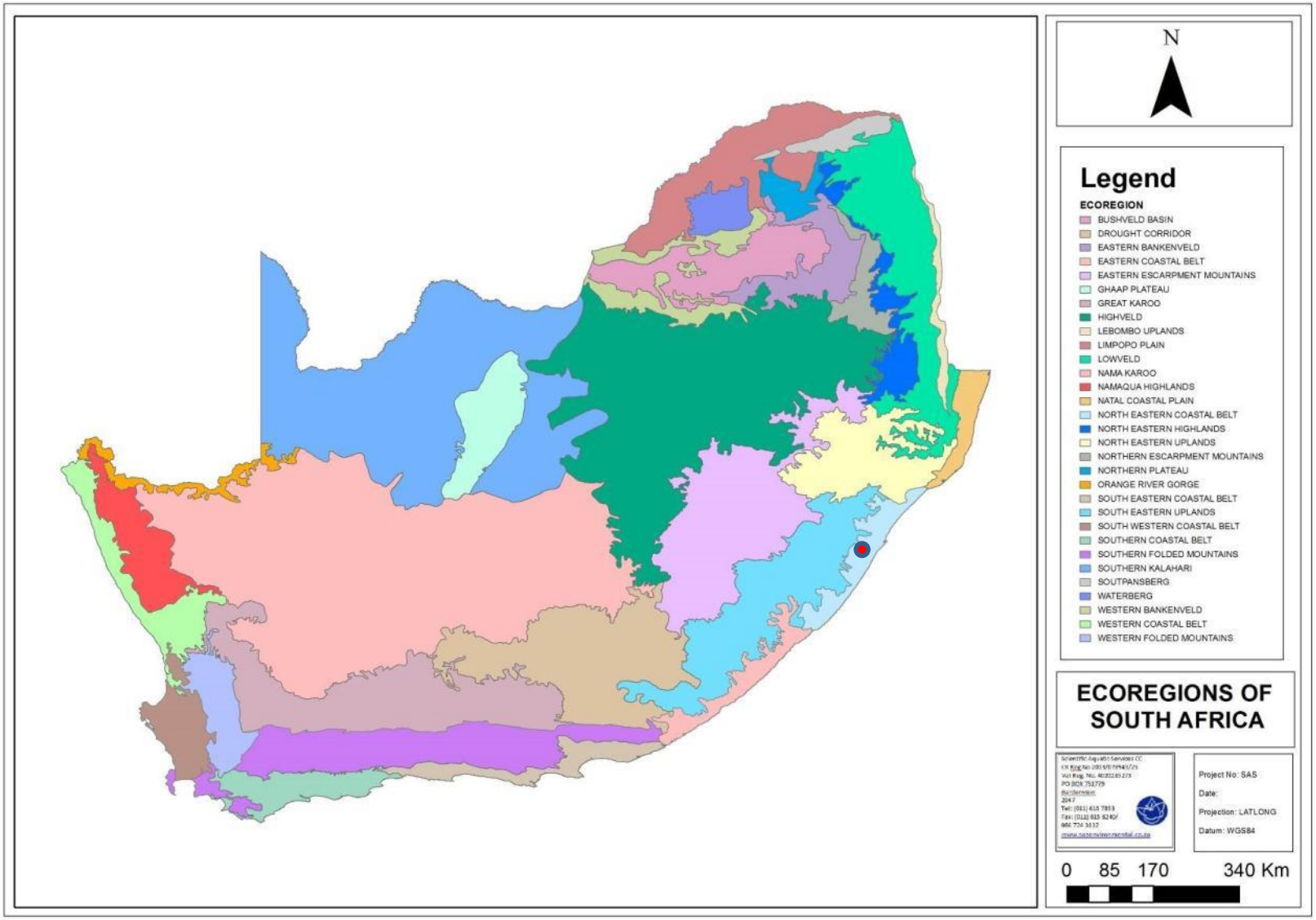

Figure 3: Map of Level 1 Aquatic Ecoregions of South Africa, with the approximate position of the study area indicated in red.

2.2.4 Level 3: Landscape Setting

At Level 3 of the proposed classification System, for Inland Systems, a distinction is made between four Landscape Units (Table 3) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et al.,* 2013):

- **Slope:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley.
- **Valley floor:** The base of a valley, situated between two distinct valley side-slopes.
- **Plain:** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land.
- **Bench (hilltop/saddle/shelf):** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

2.2.5 Level 4: Hydrogeomorphic Units

Eight primary HGM Types are recognised for Inland Systems at Level 4A of the classification system (Table 4), on the basis of hydrology and geomorphology (Ollis *et al*., 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it.
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it.
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank.
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.

- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat
- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for "channel", "flat" and "valleyhead seep") is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane *et al*., 2008), WET-IHI (DWAF, 2007) and WET-EcoServices (Kotze *et al*., 2009).

2.3 Riparian Vegetation Response Assessment Index (VEGRAI)

Riparian vegetation is described in the NWA (Act No 36 of 1998) as follows: 'riparian habitat' includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

The Riparian Vegetation Response Assessment Index (VEGRAI) is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results[3]. Results are defensible because their generation can be traced through an outlined process (a suite of rules that convert assessor estimates into ratings and convert multiple ratings into an Ecological Category).

[3] Kleynhans et al, 2007

Table 3: Descriptions of the A-F ecological categories.

Ecological category	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitat and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat have occurred, but the basic ecosystem functions are still predominately unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible	0-19

2.4 Index of Habitat Integrity (IHI)

To assess the PES of the wetland and riparian features, the IHI for South African floodplain and channelled valley bottom wetland types (Department of Water Affairs and Forestry Resource Quality Services, 2007) was used.

The WETLAND-IHI is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the River Health Programme (RHP). The WETLAND-IHI has been developed to allow the NAEHMP to include floodplain and channelled valley bottom wetland types to be assessed. The output scores from the WETLAND-IHI model are presented in A-F ecological categories (table below), and provide a score of the PES of the habitat integrity of the riparian system being examined.

Table 4: Descriptions of the A-F ecological categories (after Kleynhans, 1996, 1999).

Ecological Category	PES % Score	Description
A	90-100%	Unmodified, natural.
B	80-90%	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	60-80%	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.

Ecological Category	PES % Score	Description
D	40-60%	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred. 20-40% Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
E	20-40%	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	0-20%	Critically/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances, the basic ecosystem functions have been destroyed and the changes are irreversible.

2.5 WET-Health Assessment

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society. Management of these systems is therefore essential if these attributes are to be retained within an ever changing landscape. The primary purpose of this assessment is to evaluate the ecophysical health of wetlands, and in so doing promote their conservation and wise management. Within the study area, the WET-Health of the seepage wetland features was assessed.

2.5.1 Level of Evaluation

Two levels of assessment are provided by WET-Health:

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

2.5.2 Framework for the Assessment

A set of three modules has been synthesised from the set of processes, interactions and interventions that take place in wetland systems and their catchments: hydrology (water inputs, distribution and retention, and outputs), geomorphology (sediment inputs, retention and outputs) and vegetation (transformation and presence of introduced alien species).

2.5.3 Units of Assessment

Central to WET-Health is the characterisation of HGM Units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom and whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled) as described in Section 2.3.

2.5.4 Quantification of Present State of a Wetland

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

Table 5: Impact scores and categories of Present State used by WET-Health for describing the integrity of wetlands.

Impact category	Description	Impact score range	Present State category
None	Unmodified, natural	0-0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E
Critical	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	F

2.5.5 Assessing the Anticipated Trajectory of Change

As is the case with the Present State, future threats to the state of the wetland may arise from activities in the catchment upstream of the unit or within the wetland itself or from

processes downstream of the wetland. In each of the individual sections for hydrology, geomorphology and vegetation, five potential situations exist depending upon the direction and likely extent of change (Table 6).

Table 6: Trajectory of Change classes and scores used to evaluate likely future changes to the present state of the wetland.

Change Class	Description	HGM change score	Symbol
Substantial improvement	State is likely to improve substantially over the next 5 years	2	↑↑
Slight improvement	State is likely to improve slightly over the next 5 years	1	↑
Remain stable	State is likely to remain stable over the next 5 years	0	→
Slight deterioration	State is likely to deteriorate slightly over the next 5 years	-1	↓
Substantial deterioration	State is expected to deteriorate substantially over the next 5 years	-2	↓↓

2.5.6 Overall Health of the Wetland

Once all HGM Units have been assessed, a summary of health for the wetland as a whole needs to be calculated. This is achieved by calculating a combined score for each component by area-weighting the scores calculated for each HGM Unit. Recording the health assessments for the hydrology, geomorphology and vegetation components provides a summary of impacts, Present State, Trajectory of Change and Health for individual HGM Units and for the entire wetland.

2.6 Riparian and Wetland Function Assessment

"The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class".[4] The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by 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 service is provided:

- Flood attenuation
- Stream flow regulation

[4] Department of Water Affairs and Forestry, South Africa Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999

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

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the wetlands. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the wetland.

Table 7: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

2.7 Ecological Importance and Sensitivity (EIS)

The method used for the EIS determination was adapted from the method as provided by DWA (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 8 below.

Table 8: Descriptions of the EIS Categories.

EIS Category	Range of Mean	Recommended Ecological Management Class[5]
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	>1 and <=2	C
Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	D

2.8 Recommended Ecological Category

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability, but carries a higher risk of ecosystem failure." [6]

The REC (Table 9) was determined based on the results obtained from the PES, reference conditions and EIS of the resource (sections above). Followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

A wetland may receive the same class for the PES as the REC if the wetland is deemed in good condition, and therefore must stay in good condition.

Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as enhance the PES of the wetland feature.

Table 9: Description of REC classes.

Class	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

[5] Ed's note: Author to confirm exact wording for version 1.1
[6] Department of Water Affairs and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources 199=* \`

2.9 Wetland and Riparian Resource Delineation

For the purposes of this investigation, a wetland is defined in the National Water Act (1998) as 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.

The wetland zone delineation took place according to the method presented in the DWAF (2005) document “A practical field procedure for identification and delineation of wetlands and riparian areas. An updated draft version of this report is also available and was therefore also considered during the wetland delineation (DWAF, 2008). The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The position in the landscape, which will help identify those parts of the landscape where wetlands are more likely to occur;
- The type of soil form (i.e. the type of soil according to a standard soil classification system), since wetlands are associated with certain soil types;
- The presence of wetland vegetation species; and
- The presence of redoxymorphic soil feature, which are morphological signatures that appear in soils with prolonged periods of saturation.

By observing the evidence of these features in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWAF, 2005 and 2008).

Riparian and wetland zones can be divided into three zones (DWAF, 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant periods of wetness (at least three months of saturation per annum) and the temporary zone surrounds the seasonal zone and is only saturated for a short period of saturation (typically less than three months of saturation per annum), but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation. The object of this study was to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around the wetland / riparian area.

2.10 Ecological Impact Assessment Methodology

In order for the EAP to allow for sufficient consideration of all environmental impacts, impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/ impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/ impacts have been assessed. The method to be used for assessing risks/ impacts is outlined in the sections below.

The following parameters are used to describe the impact/issues in this assessment:

1. **Nature**

This is a brief written statement of the environmental aspect being impacted upon by a particular action or activity.

2. **Extent (E)**

Extent refers to the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment phase of a project in terms of further defining the determined significance or intensity of an impact.

- Site (1) – Within the construction site,
- Local (2) – Within a radius of 2km of the construction site,
- Regional (3) – the scale applies to impacts on a provincial level and parts of neighbouring provinces,
- National (4) – the scale applies to impacts that will affect the whole of South Africa.

3. **Duration (D)**

Duration indicates what the lifetime of the impact will be.

- Short-term (1) – less than 5 years,
- Medium-term (2) – between 5 and 15 years,
- Long-term (3) – between 15 and 30 years,
- Permanent (4) – over 30 years and resulting in a permanent and lasting change that will always be there.

4. **Intensity (I)**

Intensity describes whether an impact id destructive or benign.

- Very high (4) – Natural, cultural and social functions and processes are altered to an extent that they permanently cease,

- High (3) – Natural, cultural and social functions and processes are altered to an extent that they temporarily cease,
- Moderate (2) – Affected environment is altered, but natural, cultural and social functions and processes continue albeit in a modified way,
- Low (1) – Impact affects the environment in such a way that natural, cultural and social functions and processes are not affected.

5. Probability (P)

Probability describes the likelihood of an impact actually occurring.

- Improbable (1) – Likelihood of the impact materializing is very low,
- Possible (2) – Most likely that the impact will occur,
- Highly probable (3) – Most likely that the impact will occur,
- Definite (4) – Impact will certainly occur.

6. Cumulative (C)

In relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.

7. Significance (S)

Significance is determined through a synthesis of impact characteristics. Significance is an indication of importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of the significance of the impact.

Score	Elaboration	
-(13 – 15 points)	NEGATIVE VERY HIGH	Permanent and important impacts. The design of the site may be affected. Intensive remediation is needed during construction and/or operational phases. Any activity which results in a "very high impact" is likely to be a fatal flaw.
-(10 – 12 points)	NEGATIVE HIGH	These are impacts which individually or combined pose a significantly high negative risk to the environment. These impacts pose a high risk to the quality of the receiving environment. The design of the site may be affected. Mitigation and possible remediation are needed during the construction and/or operational phases. The effects of the impact may affect the broader environment.

Score	Elaboration	
-(7 9 points)	NEGATIVE MODERATE	These are impacts which individually or combined pose a moderate negative risk to the quality of health of the receiving environment. These systems would not generally require immediate action but the deficiencies should be rectified to avoid future problems and associated cost to rectify once in HIGH risk. Aesthetically and/or physically non-compliance can be expected over a medium term. In this case the impact is medium term, moderate in extent, mildly intense in its effects and probable. Mitigation is possible with additional design and construction inputs.
-(4 – 6 points)	NEGATIVE LOW	These are impacts which individually or combined pose a deleterious or adverse impact and low negative risk to the quality of the receiving environment, and may lead to potential health, safety and environmental concerns. Aesthetically and/or physical non-compliance can be expected for short periods. In this case the impact is short term, local extent, not intense in it effects and may not be likely to occur. A low impact has no permanent impact of significance. Mitigation measures are feasible and are readily instituted as part of a standing design, construction or operating procedure.
0	NEUTRAL	Impact is neither beneficial nor adverse. These are impacts which cannot be classified as either positive or negative or classified as null and void. In the case of a negative impact being adequately mitigated to a state where it no longer renders a risk.
+(4 – 6 points)	POSITIVE LOW	These are impacts which individually or combined pose a low positive risk to the quality of the receiving environment and health, and may lead to potential health, safety and environmental benefits. In this case the impact is short term, local in extent, not intense in its effect and may not be likely to occur. A low impact has no permanent impact of significance.
+(7 – 9 points)	POSITIVE MODERATE	These are impacts which individually or combined pose a moderate positive effect to the quality of health of the receiving environment. In this case the impact is medium term, moderate in extent, mildly intense in its effect and probable.
+(10 – 12 points)	POSITIVE HIGH	These are impacts which individually or combined pose a significantly high positive impact on the environment. These impacts pose a high benefit to the quality of the receiving environment and health, and may lead to potential health, safety and environmental benefits. In this case the impact is longer term, greater in extent, intense in its effect and highly likely to occur. The effects of the impact may affect the broader environment.

Score	Elaboration	
+(13 – 15 points)	POSITIVE VERY HIGH	These are permanent and important beneficial impacts which may arise. Individually or combined, these pose a significantly high positive impact on the environment. These impacts pose a very high benefit to the quality of the receiving environment and health, and may lead to potential health, safety and environmental benefits. In this case the impact is long term, greater in extent, intense in its effect and highly likely or definite to occur. The effects of the impact may affect the broader environment.

2.10.1 Mitigation measure development

The following points present the key concepts considered in the development of mitigation measures for the proposed construction of the pipeline.

- Mitigation and performance improvement measures and actions that address the risks and impacts[7] are identified and described in as much detail as possible;
- Measures and actions to address negative impacts will favour avoidance and prevention over minimization, mitigation or compensation;
- Desired outcomes are defined, and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, with estimates of the resources (including human resource and training requirements) and responsibilities for implementation.

2.11 Sensitivity Mapping

All the ecological features of the study area were considered and sensitive areas were delineated with the use of a Global Positioning System (GPS). A Geographic Information System (GIS) was used to project these features onto aerial photographs and topographic maps. The sensitivity map should guide the design and layout of the proposed development.

2.12 Recommendations

Recommendations were developed to address and mitigate impacts associated with the proposed development. These recommendations also include general management measures which apply to the proposed development as a whole. Mitigation measures have

[7] Mitigation measures should address both positive and negative impacts.

been developed to address issues in all phases throughout the life of the operation from planning, through construction, operation and closure through to after care and maintenance.

3 GENERAL IMPORTANCE OF THE STUDY AREA

3.1 Ecoregions

The study area falls within the North Eastern Coastal Belt Aquatic Ecoregion, which can be considered to contain irreplaceable and highly significant aquatic biodiversity and a sensitive aquatic community. The main attributes of this Ecoregion are summarised in Table 12 below.

The study area falls within the U40H and U30A quaternary catchments (Figure 4) and the ecological status of this quaternary catchment is summarised in Table 13 below.

Table 10: Summary of the main attributes of the North Eastern Coastal Belt Ecoregion.

MAIN ATTRIBUTES	NORTH EASTERN COASTAL BELT
Terrain Morphology: Broad division (dominant types in bold) (Primary)	Plains; Low Relief (limited) Plains; Moderate Relief (limited) **Closed Hills; Mountains: Moderate and High Relief** Table Lands; Moderate and High Relief
Vegetation types (dominant types in bold) (Primary)	**Coastal Bushveld/Grassland; Coastal Hinterland Bushveld**; Coastal Grassland Subarid Thorn Bushveld; **Valley Thicket;** Short Mistbelt Grassland (limited); Patches Coastal Forest and Patches Afromontane Forest
Altitude (m a.m.s.l) (modifying)	0-700
MAP (mm) (Secondary)	700 to 1000
Coefficient of Variation (% of annual precipitation)	<20 to 30
Rainfall concentration index	15 to 50
Rainfall seasonality	Early to late summer
Mean annual temp. (°C)	16 to 22
Mean daily max. temp. (°C): February	24 to 30
Mean daily max. temp. (°C): July	18 to 24
Mean daily min. temp. (°C): February	14 to >20
Mean daily min temp. (°C): July	4 to >10
Median annual simulated runoff (mm) for quaternary catchment	60 to >250

Table 11: Summary of the ecological status of quaternary catchment U40H and U30A based on Kleynhans 1999

SQ REACH	SQR NAME	PES ASSESSED BY XPERTS? (IF TRUE="Y")	PES CATEGORY MEDIAN	MEAN EI CLASS	MEAN ES CLASS	STREAM ORDER	DEFAULT EC (BASED ON MEDIAN PES AND HIGHEST OF EI OR ES MEANS)

SQ REACH	SQR NAME	PES ASSESSED BY XPERTS? (IF TRUE="Y")	PES CATEGORY MEDIAN	MEAN EI CLASS	MEAN ES CLASS	STREAM ORDER	DEFAULT EC (BASED ON MEDIAN PES AND HIGHEST OF EI OR ES MEANS)
U40H-04064	Mvoti	Y	B	HIGH	VERY HIGH	3,0	A
U40H-04091	Pambela	Y	B	HIGH	HIGH	1,0	B
U40H-04117	Nsuze	Y	B	HIGH	HIGH	2,0	B
U40H-04133	Nsuze	Y	B	HIGH	HIGH	1,0	B
U30A-04228	Mdloti	Y	B	VERY HIGH	VERY HIGH	1,0	A

*SQ = Sub-quaternary
**SQR = Sub-Quaternary Reach
***EI = Ecological Importance
†ES = Ecological Sensitivity
#EC = Ecological Class

As can be seen from the above table which represents historical data and PES scores, the river systems in the region were considered to have be largely intact and were placed in class B in terms of their Present Ecological States. The above data indicates that the Nsuze river was classed in Category B in terms of its PES, however, due to anthropogenic activities since the above listed assessments were conducted, and following the onsite assessments conducted at the time of this study, it was evident that he systems have undergone extensive degradation and will likely receive an lower PES score.

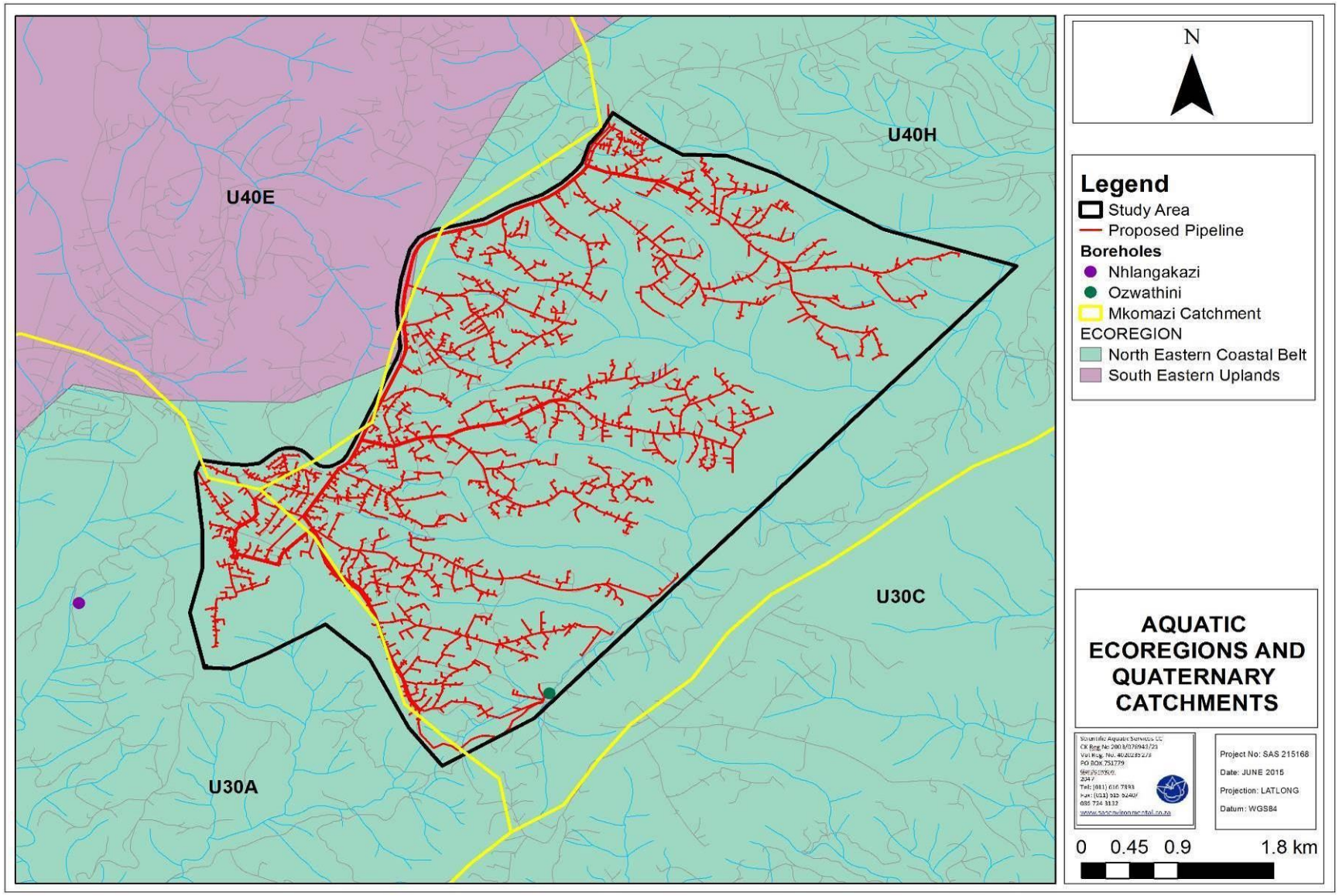

Figure 4: The Aquatic Ecoregion and quaternary catchment associated with the study area.

3.2 National Freshwater Priority Areas (NFEPA)

The FEPA database was consulted with regards to areas in close proximity to or traversed by the study area that may be of ecological importance. Aspects applicable to the study area are discussed below:

- The study area falls within the Mvoti to Umzimkulu Water Management Area (WMA). Each Water Management Area is divided into several SubWater Management Areas (subWMA), where catchment or watershed is defined as a topographically represented area, which is drained by a stream, or river network. The subWMA indicated for the study area is Mvoti;
- The subWMA is not regarded important in terms of fish sanctuaries, rehabilitation or corridors;
- The subWMA is not considered important in terms of translocation and relocation zones for fish;
- The subWMA is not listed as a fish FEPA;
- The NFEPA database indicates the presence of the Nsuze river, not classified as FEPA river (Figure 5); and
- The NFEPA database indicates no wetlands within the study area.

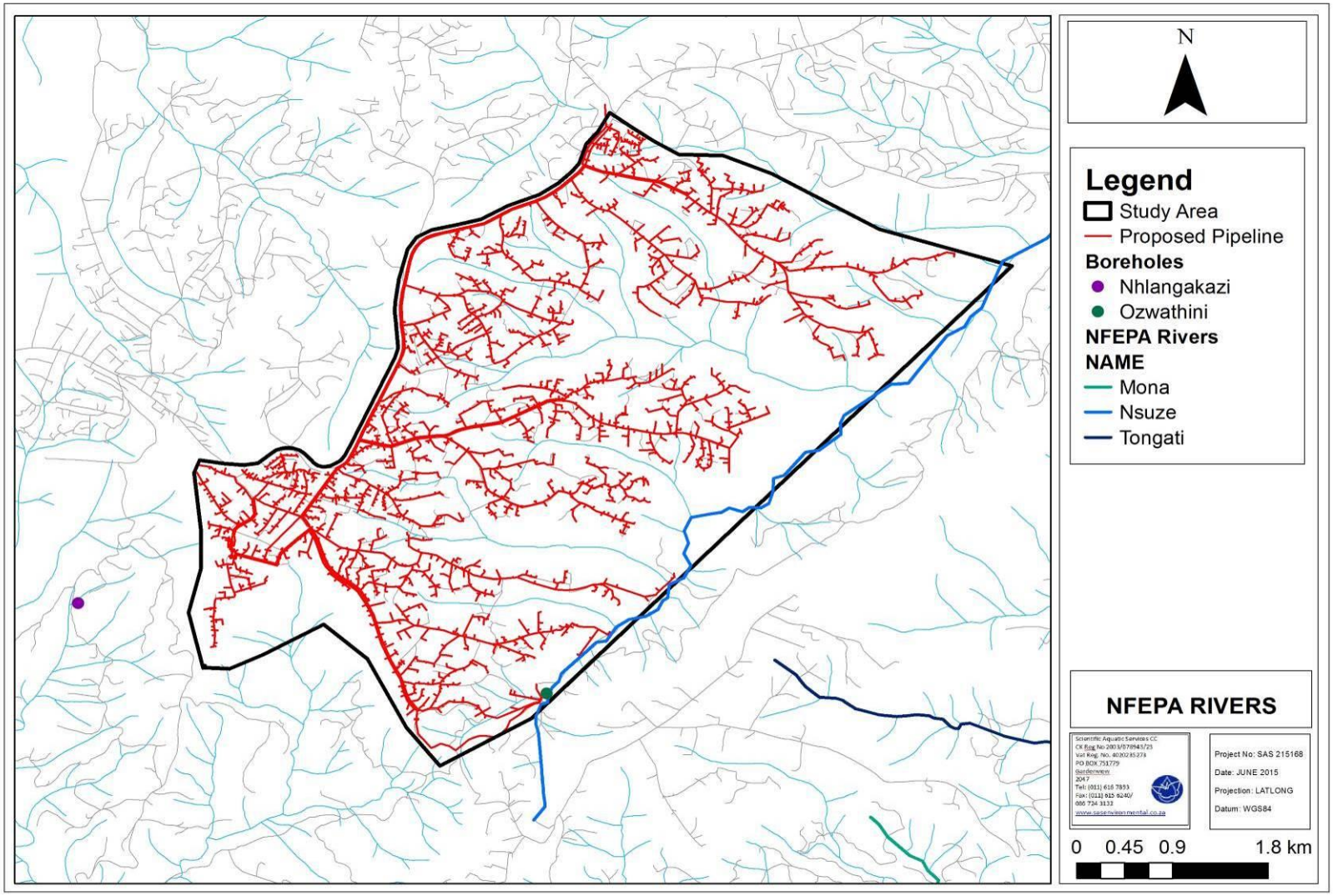

Figure 5: The NFEPA database illustrating the presence of rivers within and adjacent to the study area.

3.3 National List of Threatened Terrestrial Ecosystems for South Africa (2011)

The National Environmental Management: Biodiversity Act (Act 10 of 2004) (NEMBA) provides for listing of threatened or protected ecosystems, in one of four categories: critically endangered, endangered, vulnerable or protected. Threatened ecosystems are listed in order to reduce the rate of ecosystem and species extinction by preventing further degradation and loss of structure, function and composition of threatened ecosystems. The purpose of listing protected ecosystems is primarily to conserve sites of exceptionally high conservation value (SANBI, BGIS).

According to the National List of Threatened Terrestrial Ecosystems (2011) the study area falls within areas of the Endangered Kwa-Zulu Natal Sandstone Sourveld as well as the Vulnerable Ngongoni veld in the eastern portion of the study area (Figure 6).

3.4 National Biodiversity Assessment (NBA, 2011)

The National Biodiversity Assessment (NBA) (2011) provides an assessment of South Africa's biodiversity and ecosystems, including headline indicators such as ecosystem threat status and ecosystem protection level, and national maps for the terrestrial, freshwater, estuarine and marine environments.

According to the NBA (2011), the study area is not located within either a formal or an informal protected area, and is currently not protected.

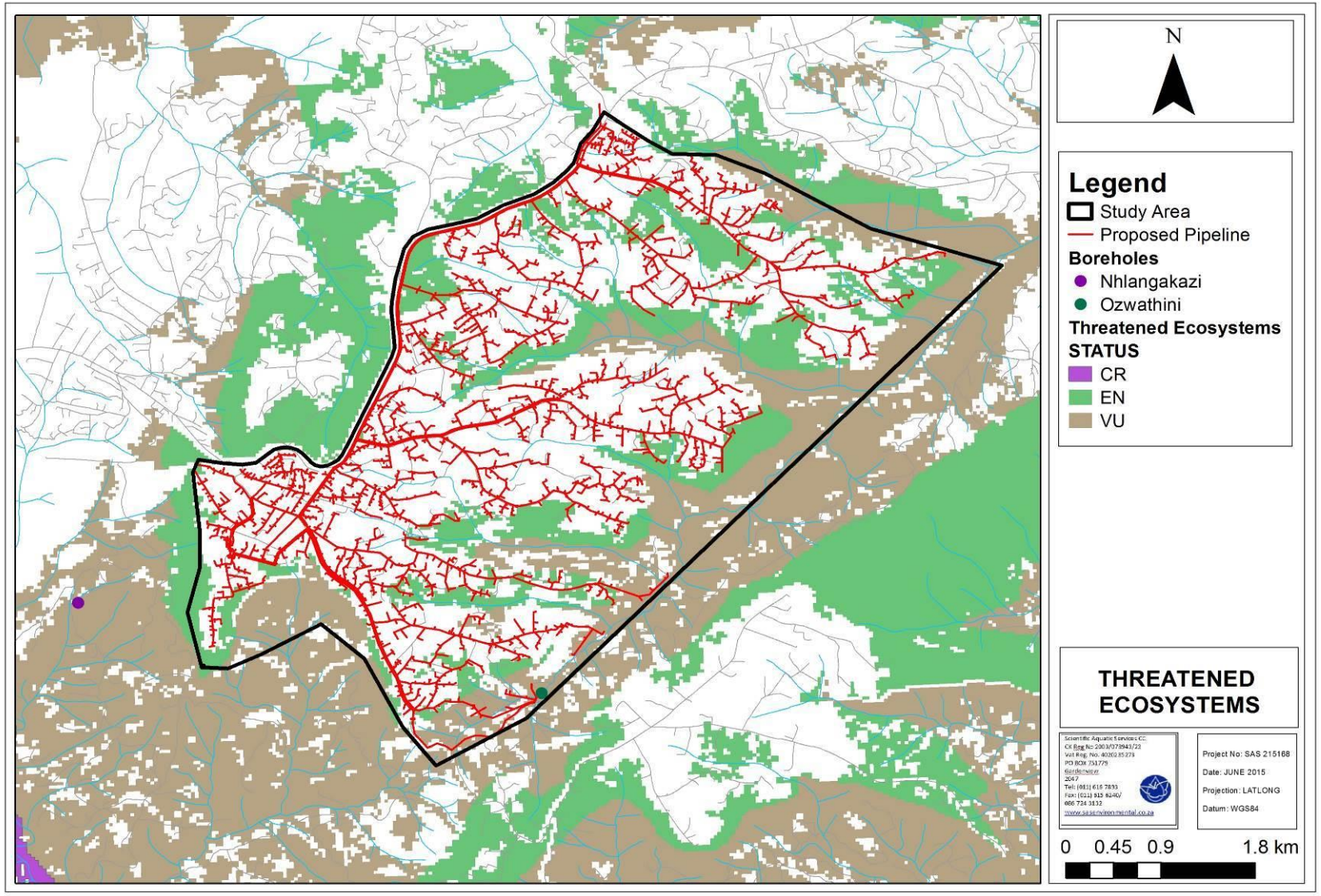

Figure 6: Importance of the study area according to the Threatened Ecosystems (2011).

3.5 KwaZulu Natal Terrestrial Conservation Plan (2010)

According to the KwaZulu-Natal Terrestrial Conservation Plan (Figure 7) the majority of the study area falls within an area that is classified as Biodiversity Areas (CBAs) 1 Mandatory, with isolated portions of Biodiversity Areas and 100% transformed areas.

Biodiversity areas not highlighted in MINSET ARE NOT OPEN for wholesale development. Important species are still located within them and should be accounted for in the EIA process. They are not highlighted as the MINSET highlights the 'choice' areas from a biodiversity point of view only. Should one or more of the CBA2 and CBA3 sites be utilised for development, it is obvious that the target for whatever feature(s) where located within that PU will no longer be met. Ideally, MINSET would have to be re-run to calculate the next optimal solution, the new PUs being 'extracted' from the currently blank/un-defined areas.

The CBA 1 Mandatory areas are based on the C-Plan Irreplaceability analyses. Identified as having an Irreplaceability value of 1, these planning units represent the only localities for which the conservation targets for one or more of the biodiversity features contained within can be achieved i.e. there are no alternative sites available.

3.6 Land Cover of KwaZulu Natal (2008) Version 1

In order to appropriately monitor development and derive useful conservation plans, appropriate measures of the state of the landscape and extent of transformation are needed. The KwaZulu-Natal (KZN) Land Cover Dataset is a single, contiguous land-cover dataset covering the entire KZN Province that has been generated from single date SPOT5 imagery acquired primarily in 2008, and represents the final 2008 KZN Province Land-Cover product. The 2008 KZN Land-Cover dataset represents an update of the previously released 2005 KZN Provincial Land-Cover dataset. The updated dataset contains the same information classes as the previous 2005 dataset, although several new sub-classes have been included in the legend structure.

According to the KZN Land-Cover Dataset the land cover of the study area is a combination of subsistence, low density settlements, dense bush, forest, plantation, grassland/bushclump mix, and grassland, (SANBI BGIS) (Figure 8).

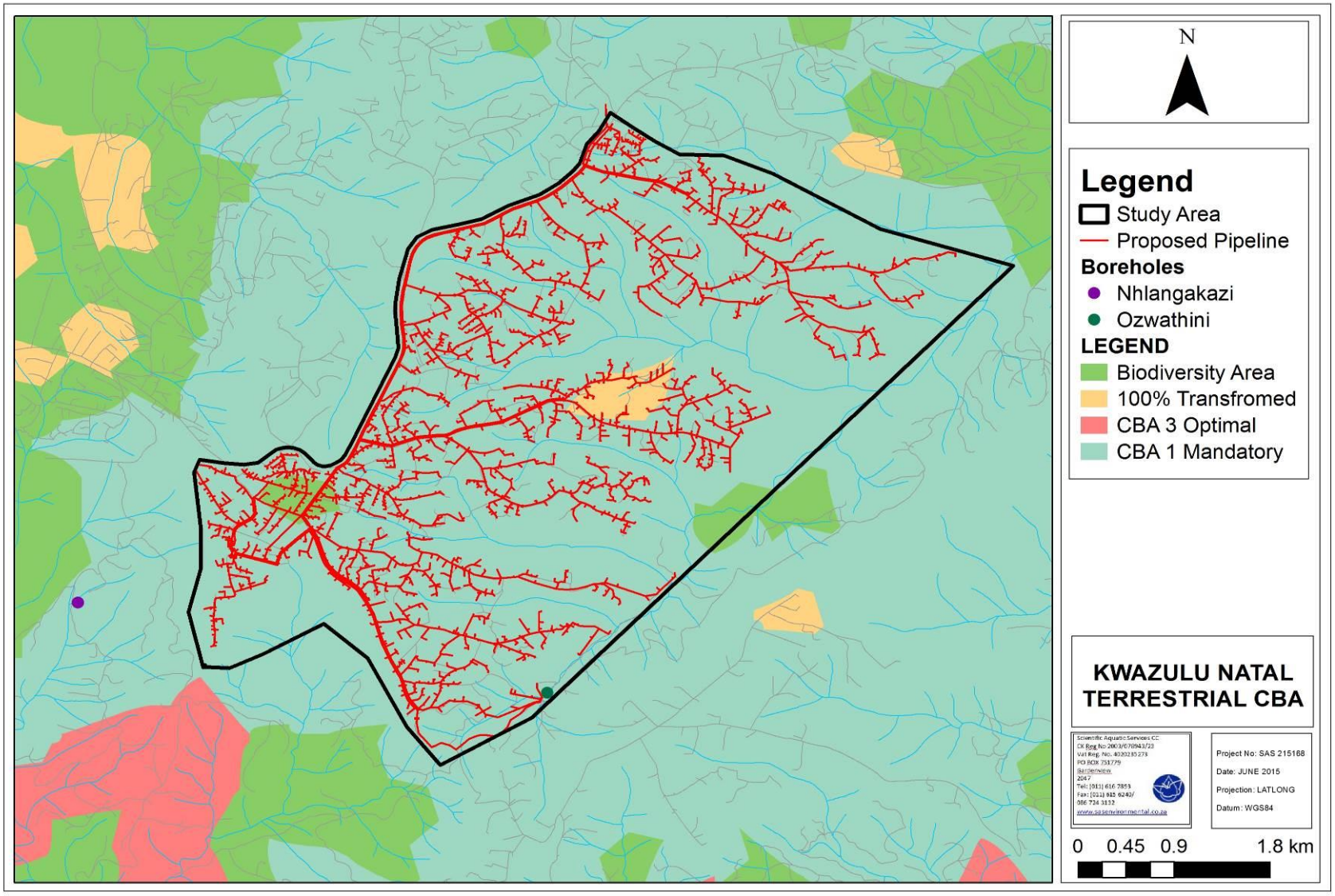

Figure 7: KZN Terrestrial Conservation Plan (2010) indicating the CBAs and ESAs for the study area.

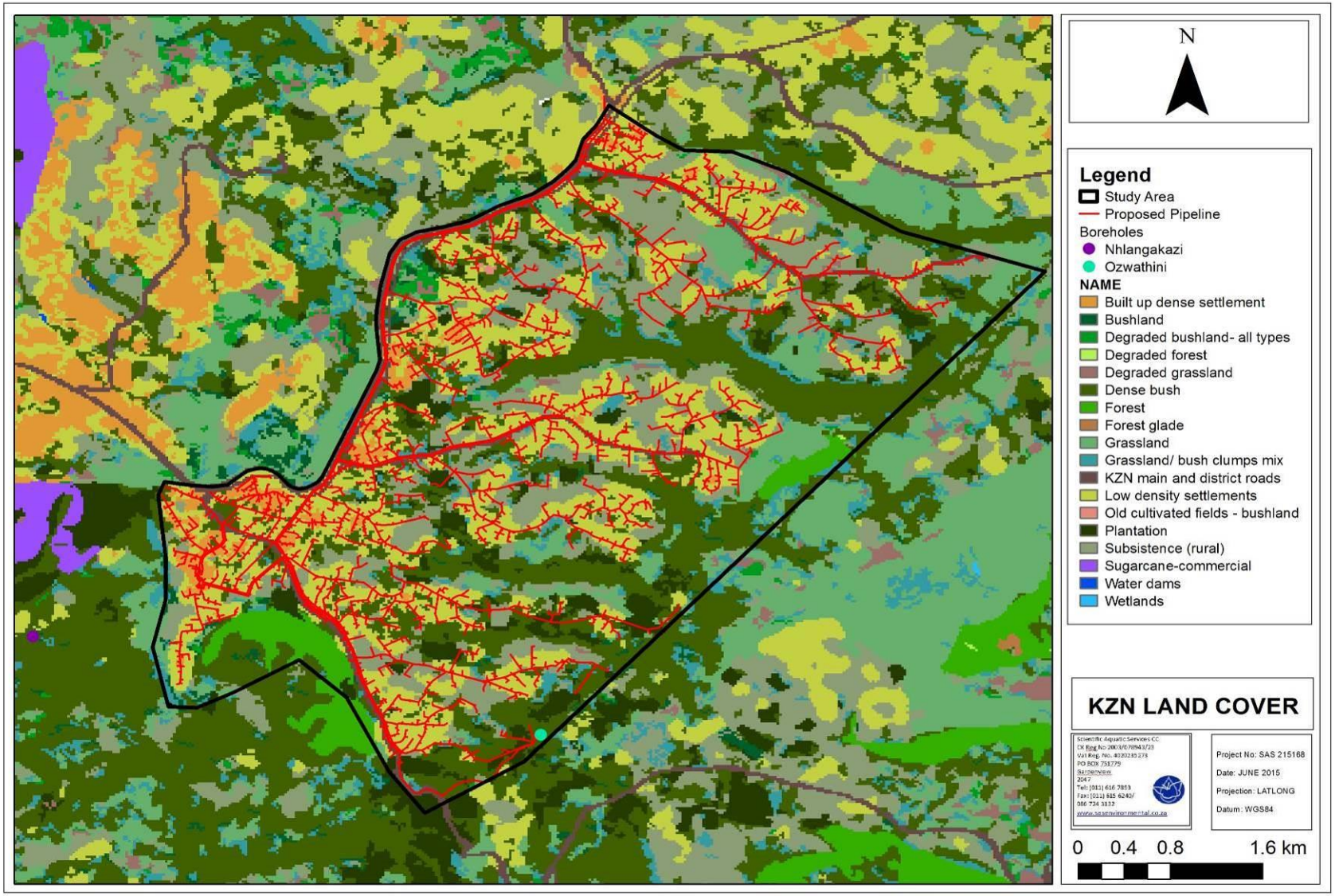

Figure 8: KZN Land-Cover (2008) associated with the study area.

4 RESULTS: RIPARIAN AND WETLAND ASSESSMENT

4.1 Riparian and wetland system characterisation

During the site assessment a number of perennial drainage lines were identified within the various valleys bottom positions within the study area, whilst the Nsuze River is located on the eastern side of the study area. Furthermore Hillslope seeps and Bench wetlands were identified within the study area, as well as channelled and unchannelled valley bottom wetlands located along the perennial drainage line. As such, the hillslope seeps and the bench wetlands were assessed together as a unit and the valley bottom wetlands were assessed in conjunction with the drainage lines due to the interrelatedness. The drainage lines were characterized by the presence of alien invasive riparian vegetation and in some instances an active water channel was also present within the valley bottoms.

For the purpose of this study, riparian areas located along the Nsuze River were assessed separately to the riparian features found in the perennial drainage lines within the study area. The wetlands were all assessed separately according to their various classifications. It should be noted that although the drainage line/riparian features identified may extend beyond the study area, only portions located within the study area (including the 500m buffer) were assessed and ground truthed. Furthermore, the study focused on features located within the study area and features located outside of this area were delineated using digital satellite imagery with limited field verification. Nonetheless, the potential impacts of activities such as subsistence agriculture, plantations for timber production, erosion and clearing of natural vegetation within the greater catchment were taken into consideration during the assessment. It must also be noted that some of the riparian areas assessed were located within deep ravines and direct access was not always possible to these areas. As far as possible the ravines were assessed at accessible points and by viewing the ravines from the adjacent cliffs at strategic points.

All wetland and watercourse/riparian features identified within the study area were classified as Inland Systems falling within the North Eastern Coastal Belt Aquatic Ecoregion, and within the Sub-Escarpment Savanna WetVeg group which is listed as Endangered. The table below presents the classification on level 3 and 4 of the wetland classification system.

Table 12: Characterisation of the riparian and wetland systems within the study area, according to the Classification System (Ollis *et al*., 2013).

Group	Level 3: Landscape unit	Level 4: Hydrogeomorphic Unit	
		HGM Type	Longitudinal zonation / landform / Inflow drainage
Nsuze River	**Valley floor:** The base of a valley, situated between two distinct valley side-slopes.	**River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water	Lower Foothill River
Perennial Drainage lines	**Valley floor:** The base of a valley, situated between two distinct valley side-slopes.	**Channel:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.	Transitional stream
Bench wetlands	**Bench** (hilltop/saddle/shelf): an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).	**Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.	Unchannelled
Hillslope Seeps	**Slope:** an inclined stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley.	**Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.	Not applicable

The features identified during the assessment where further divided into either wetland or riparian habitat based on the characteristics as defined by the NWA No 36 of 1998, provided below.

Wetland habitat is 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 (NWA; Act No. 36 of 1998).

Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure ***distinct*** from those of adjacent land areas. The rivers and non-perennial drainage lines with riparian characteristics are defined as watercourses, whilst the smaller ephemeral drainage lines *without* riparian zones are not considered wetlands or systems with an associated riparian zone but may still be defined as watercourses if the features have floodlines applicable to them.

Much of the functionality of the wetland and riparian features has been altered due to water abstraction, anthropogenic and agricultural activities as well as excessive growth levels of alien vegetation, notably within the drainage lines and channelled valley bottom wetlands. Currently, the highest value to the local community is that of water provision from the. Water is used for both domestic and agricultural purposes; the result of which is that there is a notable decrease in downstream flow as well as an increase in water pollution which can be considered critical in many instances.

Figures 9 below illustrate the approximate localities of the wetland and riparian features in relation to the study area and pipeline infrastructure.

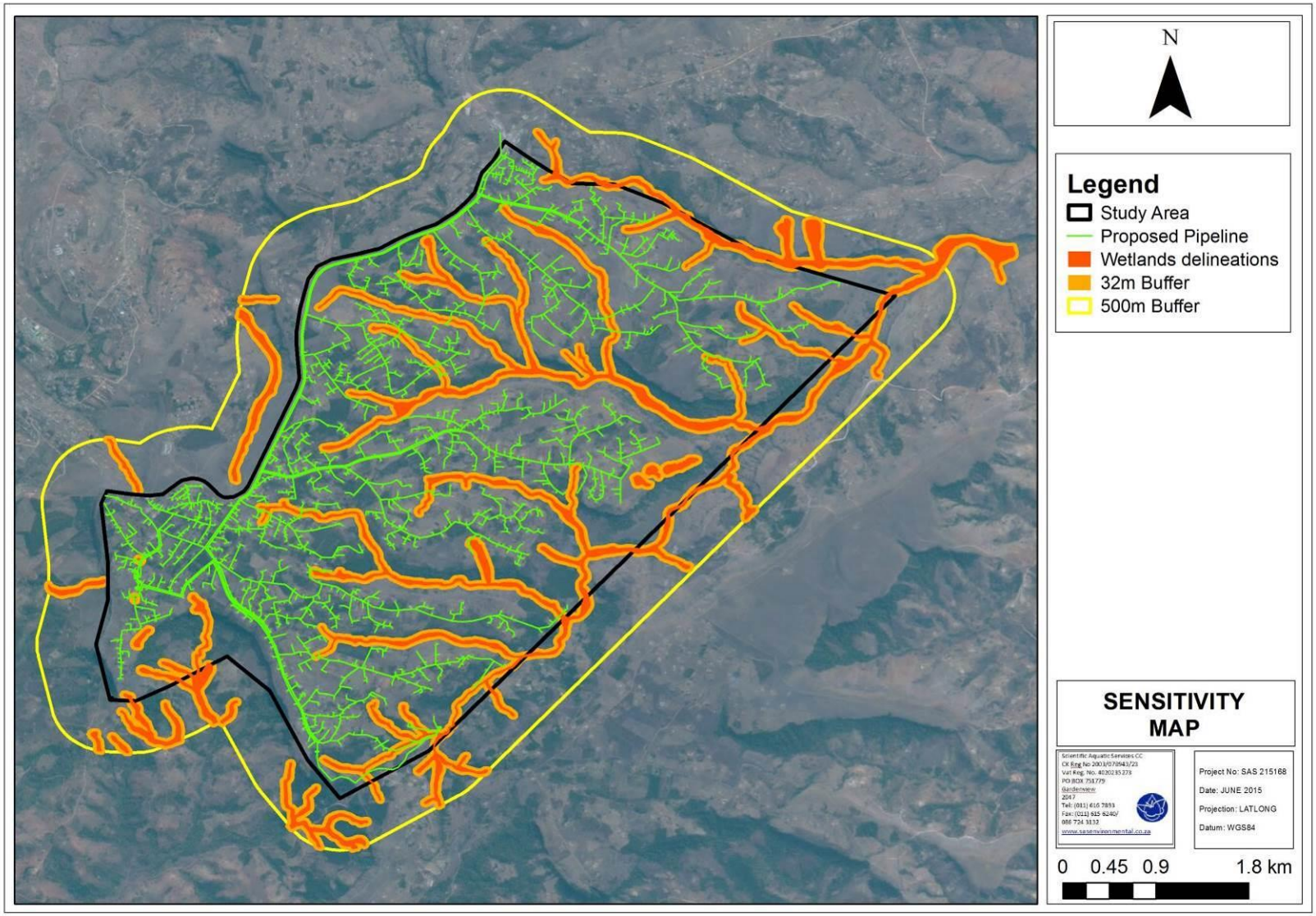

Figure 9: Location of wetland and watercourse/riparian features assessed in relation to the study area.

4.2 Vegetation community considerations

The floral community structure and composition throughout the study area, in both the terrestrial and wetland/riparian ecosystems, has under gone widespread transformation as a result of historical and current subsistence agricultural activities, overgrazing by livestock, community expansion and extensive alien vegetation invasion. Community growth has resulted in large areas of land being cleared of natural vegetation, either being converted into homesteads or agricultural fields, with the remaining areas being used for grazing of livestock. The perennial drainage lines are subject to high levels of bush encroachment by primarily alien vegetation such as *Solanum mauritianum* (Bugweed), *Eucalyptus grandis* (Flooded gum) and *Acacia mearsnii* (Black wattle).

The Nsuze River and its associated tributaries are marginally less disturbed in comparison to the perennial drainage lines, mainly attributed to the greater distance from the local community. However, the Nsuze river system has been impacted upon by the surrounding Eucalyptus plantations. Furthermore, it is evident that alien invasive species that are prolific within the perennial drainage lines are beginning to further colonise areas of the Nsuze river system as seeds are being carried downstream. Currently the Nsuze River is dominated by *Eucalyptus grandis* (Flooded gum) and *Acacia mearsnii* (Black wattle), however the rate of encroachment is less than that of the perennial drainage lines. Furthermore, *Cyathea capensis* (Forest tree fern) was noted in areas along the Nsuze River that are less disturbed.

The hillslope seep and bench wetlands were less impacted upon in comparison to the surrounding vegetation areas, however these are being used as primary grazing areas for livestock. The wetlands observed were mostly along the edges of the upper plateau, making them unsuitable for housing development due to position and slope. Years of grazing within these wetlands, as well as an obvious impact on the areas hydrological functions can be seen within the dried out nature of these wetlands, as well as the species composition. The dominant species were *Aristida congesta* (Tassel three-awn) and *Helichrysum cephaloideum.*

The following tables present the dominant floral species identified within each HGM type, although it should be noted that these lists are not an extensive listing of the floral species found within the study area.

Table 13: Dominant floral species identified within the perennial drainage lines within the study area (alien species are indicated with an asterix)

Trees / Shrubs	Forbs	Grasses / Sedges
*Solanum mauritianum**	*Verbena bonariensis**	*Aristida congesta*
*Senna didymobotrya**	*Xanthium strumarium**	*Setaria sphacelata var. torta*
*Caesalpinia decapetala**	*Zinnea peruviana**	
*Eucalyptus grandis**	*Ricinus communis**	
*Acacia mearsnii**	*Typha capensis*	
	*Pteridium aquilinum**	
	*Verbena bonariensis**	

Table 14: Dominant floral species identified within the riparian zones of the Nsuze River and associated tributaries within the study area (alien species are indicated with an asterisk).

Marginal Zone: Woody	Marginal Zone: Non-woody	Non-Marginal Zone: Woody	Non-Marginal Zone: Non-woody
*Eucalyptus grandis**	*Aristida junciformis*	*Acacia mearsnii**	*Cichorium intybus**
*Acacia mearsnii**	*Cyperus sp*	*Eucalyptus grandis**	*Aristida junciformis*
*Caesalpinia decapetala**	*Setaria sphacelata var torta*	*Solanum mauritianum**	
Cyathea capensis	*Pteridium aquilinum**		

Table 15: Dominant floral species identified within the Hillslope seeps and Bench wetlands within the study area (alien species are indicated with an asterisk).

Trees / Shrubs	Forbs	Grasses / Sedges
*Solanum mauritianum**	*Helichrysum cephaloideum*	*Aristida congesta*
*Acacia mearsnii**	*Tetraselago natalensis*	
	*Tagetes minuta**	

Photographic representation of the vegetation present in these various features is shown in the figures below.

Figure 10: Representative photographs of perennial drainage lines located within the study area, showing examples of the vegetation present.

Figure 11: Representative photographs of riparian zones of the Nsuze River and associated tributaries within the study area, showing examples of the vegetation present

Figure 12: Representative photographs of sections of the Hillslope seeps on the left and Bench wetlands on the right within the study area, showing variations in the vegetation community composition and structure.

4.3 Riparian Vegetation Response Index (VEGRAI)

The VEGRAI method was applied in order to assess the impacts of modifications to the system on the riparian vegetation of the Nsuze River and its tributaries. The riparian zones located along the perennial drainage lines of the study area were assessed separately to the Nsuze river riparian zone. Both the Nsuze River, its tributaries and the perennial drainage lines have been impacted by the growth of alien vegetation. The resultant encroachment of alien vegetation has led to an impediment of water flow and displacement of indigenous floral and faunal species within the riparian areas. Furthermore, all of these systems have been impacted upon by agriculture (small-scale crop cultivation and grazing of domestic livestock). The riparian features found in the perennial drainage lines received a score of 44%, indicating that the VEGRAI Ecological Category falls in Category D (see Appendix A for detailed results). The riparian areas of the Nsuze River received a score of 44.2%,

indicating that the VEGRAI Ecological Category falls in Category D, indicating a largely modified ecostatus.

Loss of marginal and non-marginal vegetation, as a result of afforestation of Eucalyptus trees from upstream and neighbouring forestry plantations, gathering of natural firewood by local communities, grazing by livestock etc. has resulted in encroachment of both invasive alien species in many sections of the riparian zones. Furthermore, bank incision and erosion is evident within the perennial drainage lines and to a smaller extent along the Nsuze River as a result of poor soil stability due to the increase in the alien vegetation component as well as livestock grazing reducing the herbaceous layer.

4.4 Index of Habitat Integrity

The Index of Habitat Integrity (IHI) as described by the DWA (2007) was utilised to assess the PES of the Nsuze River system and its tributaries as well as the smaller perennial drainage lines found in the valley bottom positions of the landscape.

Wetland health is defined as a measure of the similarity of a wetland to a natural or reference condition. “Deviations” from this natural or reference state, particularly the extent of human impacts which may have caused the wetland to differ from this natural state, are considered when ascertaining the “health” of a wetland (Macfarlane *et al.*, 2008).

The table below provides a summary of the IHI results for each group of features and the rivers which are discussed in detail in the sub-sections that follow (please see Appendix B for the detailed results for each group). Figure 13 below illustrates the PES categories of the features.

Table 16: Summary of results of the WET-IHI assessments conducted for the Nsuze River and Perennial Drainage Lines within the study area.

Features	PES Score (%)	PES Category
Perennial Drainage Lines	57.4	D
Nsuze river	57.6	C/D

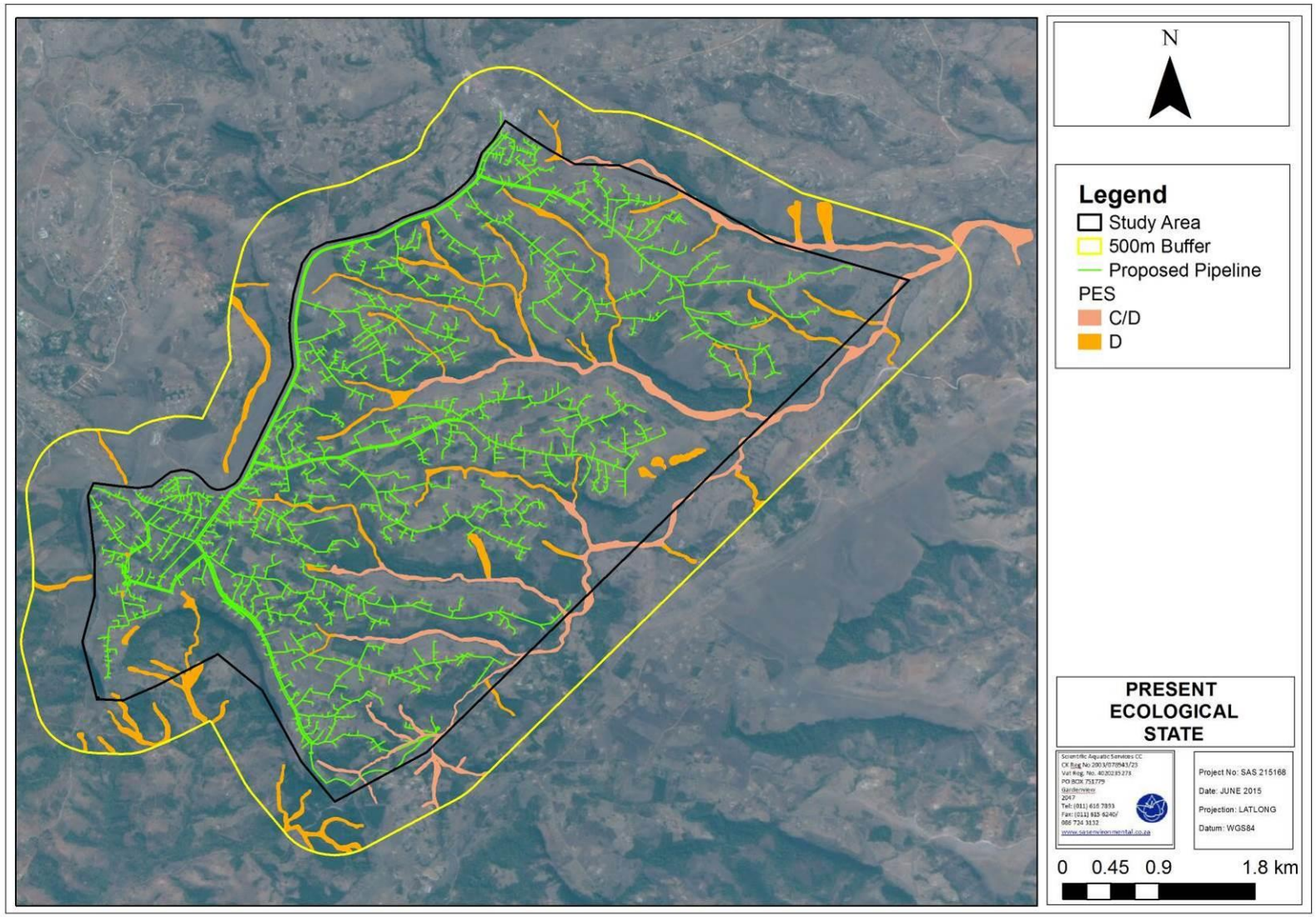

Figure 13: Illustration of the PES categories of the features.

4.4.1 Nsuze River and associated tributaries

The PES score indicates that the Nsuze Rivers and associated tributaries have undergone moderate modification. The system has been exposed to a loss and change in the composition of the natural habitat and biota; however the basic ecosystem functions are still predominantly unchanged.

Small scale Eucalyptus plantations and utilisation of the river and its tributaries for domestic purposes by local communities within the study area are the predominant modifiers to the system. These factors have resulted in a reduction of indigenous riparian vegetation with the resultant influx of alien vegetation contributing to the change in the natural functioning of the riparian zones of the Nsuze River and its associated tributaries. In some instances this loss of natural vegetation has resulted in an increased exposure of soils contributing to an accelerated rate of erosion and incision within the system thus altering the geomorphology of the systems. Additionally, small scale agriculture and extensive dirt road networks within the study area are likely to be responsible for further sediment inputs which will be transported to the rivers in runoff during rainfall events.

The Nsuze River is a perennial river and is subjected to periods of low flow during the drier winter months. These periods of low flow result in an accumulation of sediment within the Nsuze river system leading to sediment deposition and infilling of the channel. During the wetter months increased water flow can result in the removal of these deposits due to the lack of soil stability as a result of the increased alien vegetation within the riparian zones. Additional water inputs originating from such runoff may alter hydrological patterns to some extent. Road crossings of the Nsuze River and the tributaries may lead to an increase rate of erosion within the riparian features, however these are limited in extent and are not utilised extensively by vehicles which will limit the rate of erosion in these areas.

From the above results and based on observations made during the site assessment (local communities utilising the rivers for washing clothing, solid waste disposal within active channels and use by domestic livestock), water quality within the river systems is varied with systems nearer to settlements more impacted than systems which are more remote, such as within the ravines. Particular impacts are from domestic use, especially clothes washing.

Figure 14: Representative photographs of the Nsuze river system with increased sediment deposition in the active channel on the right alien vegetation encroachment in the riparian zone on the left.

4.4.2 Perennial Drainage lines with riparian characteristics

The score obtained for the PES assessment of the non-perennial and perennial drainage indicates that moderate to serious modifications have occurred. Loss of natural habitat, biota and ecosystem functions is not deemed extensive, but is significant in the majority of these features within the study area.

The transformation of the vegetation community composition and structure has been significant within the drainage lines in the valleys. The majority of these features which were surveyed during the site assessment were dominated by alien invasive floral species. The majority of the drainage lines surveyed can be defined as shallow streams heavily encroached with alien vegetation. However, these drainage lines still perform an important ecological function insofar as they transport water to down gradient areas and feed into the Nsuze River. Although the alien vegetation present within these drainage lines is impacting on the natural functionality of the systems, it is likely that without the predominating alien species these drainage lines would possibly be subject to higher impacts from the surrounding communities, as well as subject to increased levels of erosion and incision of the channel.

Figure 15: Representative photographs the perennial drainage lines found within the study area with alien vegetation component.

4.5 Wet-Health Assessment

A Level 1 Wet-Health assessment of the hillslope seep and bench wetland HGM Units was undertaken. Three modules, namely hydrology, geomorphology and vegetation, were assessed as a single unit for the HGM Units and subsequently an area weighted score was obtained for the HGM Units. The potential impacts of activities such as agriculture, altered hydrological functions and clearing of natural vegetation within the greater catchment were taken into consideration during the assessment. If the assessment was applied on a broader scale results may have differed, however the assessment and the scale used is considered the most applicable to the study for the proposed pipeline infrastructure project. These results are summarised in the table below.

Table 17: Summary of the overall health of the wetland HGM Units based on impact score and change score.

Feature	Hydrology		Geomorphology		Vegetation		Overall PES Category
	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score	
Hillslope Seep and Bench Wetland	E	↓↓	C	↓↓	D	↓	D

The overall score for the seep HGM Units which aggregates the scores for the three modules, namely hydrology, geomorphology and vegetation, was calculated using the formula [8] as provided by the Wet-Health methodology. The overall score calculated was 5.4, falling within Category D, which refers to a high level of change in ecosystem processes and

[8] ((Hydrology score) x 3 + (geomorphology score) x2 + (vegetation score) x 2))/ 7 = PES

with the loss natural habitat over large areas, however there are still some natural habitat features remaining within the study area.

Impacts on the hydrology of the HGM Units include the increased runoff volumes from surrounding agricultural and cleared areas associated with the surrounding homesteads as well as the increased abstraction of water for domestic and agricultural purposes, which places this module within a Category E. Topographic alterations associated with surrounding agricultural (crop cultivation, grazing, plantations) activities have also affected the HGM Units, resulting in geomorphological modifications also falling within Category C. The vegetation assemblage of the study area has been undergone extensive impact as a result of natural vegetation clearing practices for community expansion as well as a high level of alien plant proliferation throughout the study area. However, due to the wetlands locations within the study area they have for the time being not undergone such extensive impacts as can be seen in the perennial drainage line. With this in mind the wetlands achieved a score which placed the module in a Category D.

What needs to be considered is that if alien invasive plant proliferation is allowed to continue unchecked and community planning and infrastructure is not planned for properly, it is highly likely that the remaining wetlands in the study area will be further degraded to the point where they are no longer able to fulfil the wetland function capabilities.

4.6 Riparian and Wetland Function Assessment

The ecological functions and service provision for the Nsuze River and drainage line riparian zones as well as the bench and hillslope seep wetlands were assessed utilising the WET-Ecoservices (Kotze *et. al.* 2009) method as described in the methodology (Section 2.5) of this report. The results of the assessments are tabulated and discussed below. This assessment was applied to Nsuze River and its tributaries, the smaller drainage lines found on the upper plateau regions of the study area as well as the bench and hillslope wetlands.

Table 18: Results of the ecological function and service provision assessments applied to the riparian features within the study area.

Ecosystem service	Wetland			
	Perennial Drainage Lines	Hill Slope Seep	Bench Wetland	Nsuze River
Flood attenuation	1.3	1.3	1.3	1.7
Stream flow regulation	1.8	1	0	1.8
Sediment trapping	2.2	2	0	2
Phosphate assimilation	1.7	1.7	1.8	1.9
Nitrate assimilation	2.4	2.4	1.6	2
Toxicant assimilation	1.9	2.1	1.5	2
Erosion control	2.3	2.5	2	2.6
Carbon Storage	1	1.1	1	1.3
Biodiversity maintenance	1.2	1	1.2	2.1
Water Supply	4	0.6	0.6	3.8
Harvestable resources	3.4	2.2	2.2	3.2
Cultural value	0.8	0.8	0.8	0.8
Cultivated foods	2.6	2.6	2.4	1.4
Tourism and recreation	0.3	0.3	0.2	0.2
Education and research	0.8	0.8	0.8	0.8
SUM	**27.7**	**22.4**	**17.4**	**27.6**
Average score	**1.8**	**1.5**	**1.2**	**1.8**

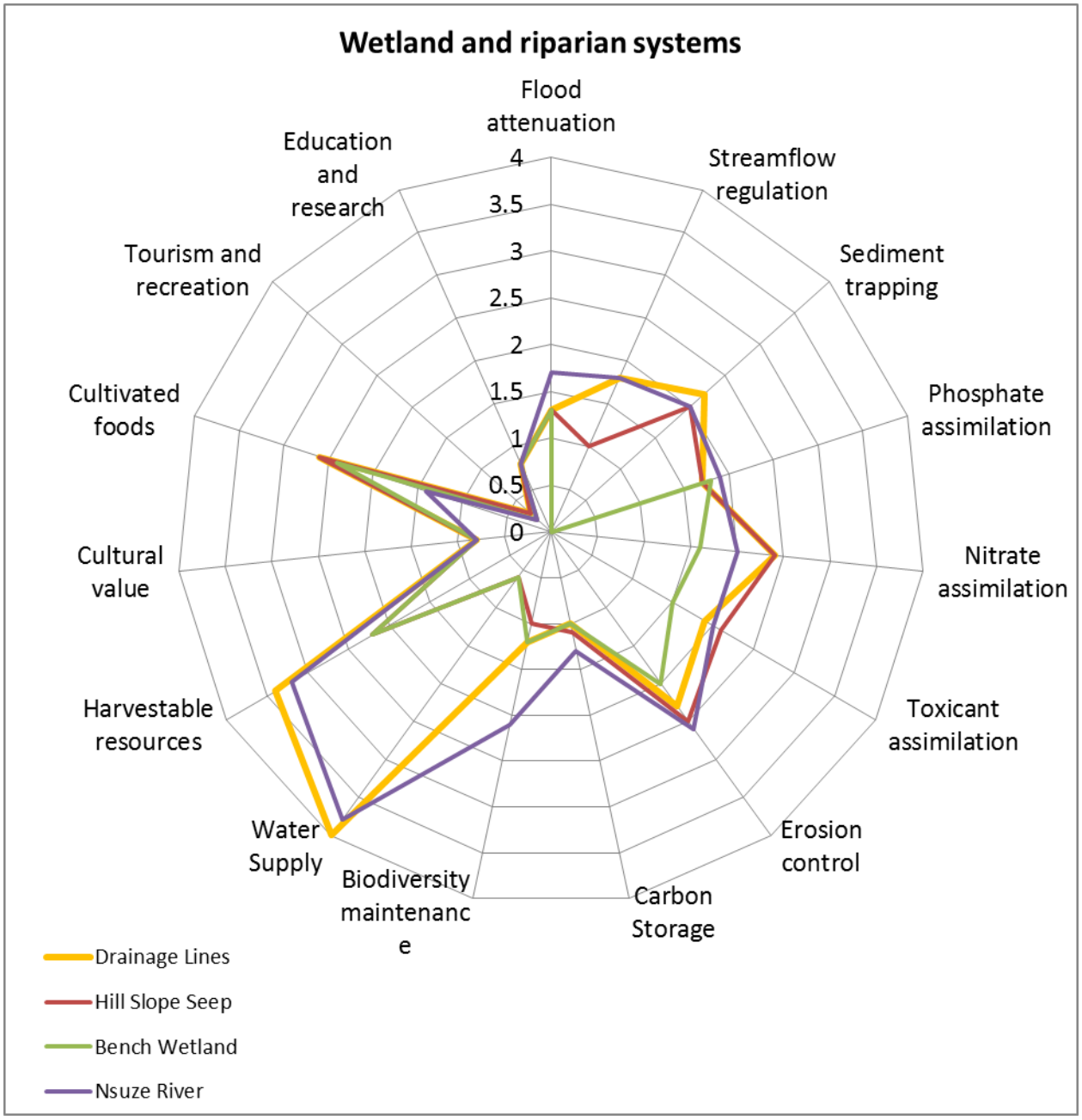

Figure 16: Radar plot of ecological services provided by the various features.

Nsuze River and Perennial Drainage lines

The Nsuze River system and the active drainage lines are important for functions that are dependent on perennial water flow, such as water supply and harvestable resources. It is important to note that from the results and observations within the field it is evident that currently the river system and drainage lines are actively utilised as a permanent source of water for both domestic and agricultural purposes. In the absence of an artificial water supply infrastructure to community households, the further loss or impact of these resources will have a direct and negative impact on a the local community. Due to the permanently saturated conditions observed within the drainage lines and the Nsuze river system and its

associated tributaries, these systems are the most adept systems within the study area to assimilate toxicants in the water. However, low rainfall, increased water abstraction and further degradation of the riparian zones due to alien vegetation encroachment will result in a notable decrease in the rate of toxicant assimilation.

Biodiversity maintenance was considerably higher along the Nsuze River, and can be attributed to fewer disturbances from the local community as it is not less accessible. However, the presence of Eucalyptus plantations along the river has a definite limiting factor in this area in terms of biodiversity maintenance and support. Upstream subsistence farming and proliferation of alien vegetation as a result of removal of indigenous floral species (resulting in habitat loss) also contribute to an increased silt load being carried into the Nsuze river system.

No value in terms of tourism, recreation, education and research appears to be attached to any of these systems, nor was there any evidence that these systems had any form of cultural importance to the surrounding communities.

Bench and Hillslope Seep wetlands

With the exception of the single bench wetland these wetlands are predominately located along the outskirts of the community along the edges of the plateau. As such, they are not connected with any water channels and are fed primarily from water sources below the surface and water runoff from the surrounding area and road network. As there is no accessible water source within most of these wetlands available to the local community, they do not score high in terms of water supply. However, these wetlands are utilised extensively for grazing of cattle. It is likely that there were many more bench wetlands throughout the study area, however as the community has grown it is likely that these wetland areas have been ploughed and used for crop cultivation and that dwellings have been developed in less well developed systems, modifying the wetland to the point where it is no longer able to function as a wetland. Due to the location of these wetlands, especially in terms of the surrounding road and pathway networks spread out over the plateau, during periods of rainfall these wetlands are likely to form an important role in trapping or arresting excessive sediment runoff, limiting the amount top soil loss to the regions at the base of the plateau.

4.7 Ecological Importance and Sensitivity (EIS) Assessment

The EIS assessment was applied to all watercourse/riparian and artificial wetland features within the study area in order to ascertain the levels of sensitive and ecological importance of the features, as well as to assist in informing a suitable REC for each. The results of these assessments are summarised in the table below (please see Appendix C for the detailed results of these assessments).

Table 19: Summary of the EIS scores for all wetland and riparian features within the study area.

Features	Score	EIS Category
Nsuze River and tributaries	2	C
Perrenial Drainage lines	1.7	C
Bench Wetlands	1	D
Hillslope Seep Wetlands	1.2	C

These results indicate that the Nsuze River with its associated tributaries, the perennial drainage lines and the hillslope seeps are deemed to fall within and EIS Category C, indicating that these systems are considered to be ecologically important and sensitive on a provincial and local scale. Historically it is likely that these systems would have been scored as more sensitive than currently. However, although in their current forms they may not be as adept in providing suitable intact habitat to a myriad of species, they still perform an important role in resource provision to the local community and as such should be regarded as important.

The bench wetland obtained a score indicating that it falls within an EIS Category D, and therefore is not ecologically important or sensitive. The EIS of the assessed features is conceptually presented in the figure below.

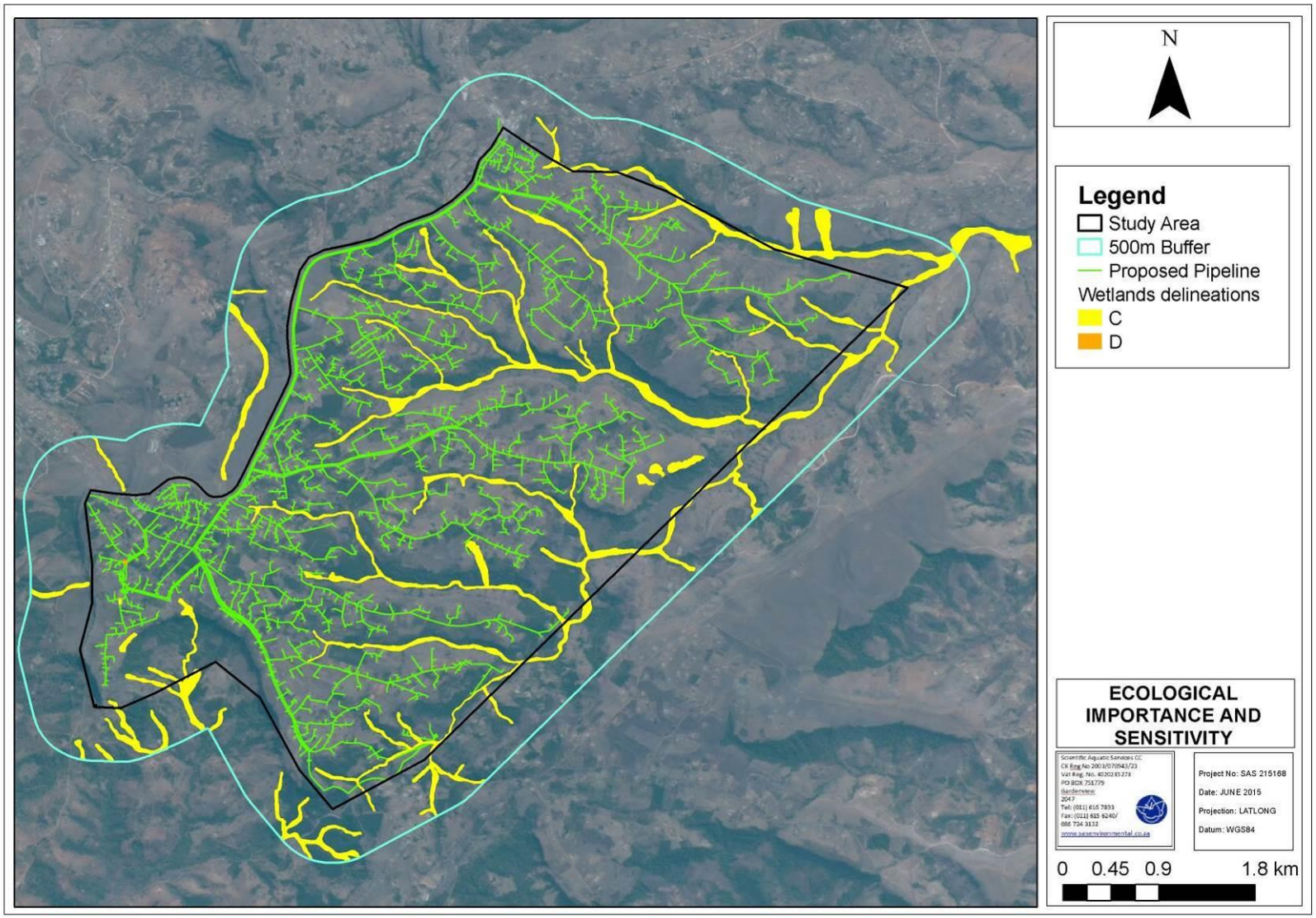

Figure 17: Conceptual presentation of the Ecological Importance and Sensitivity of the features assessed.

4.8 Recommended Ecological Category (REC)

The REC for the perennial drainage lines and riparian features along the Nsuze River and associated tributaries were determined taking into account the results of the IHI, wetland function, and EIS assessments. These assessments show that all riparian and perennial drainage line features within the study area have to an extent undergone fairly significant levels of transformation as a result of historical and current subsistence farming practices, unregulated community expansion activities, disruption of the hydrological cycle and alien vegetation encroachment. Nevertheless, despite the lowered ecological integrity of these systems, they are considered to provide important ecological services. The REC deemed appropriate for the watercourse/riparian and perennial drainage line features are presented in the table below.

Table 20: Summary of the REC categories assigned to the various features within the study area.

Features	REC
Nsuze and associated tributaries	C
Perennial drainage lines	C
Hillslope Seeps	C
Bench Wetlands	D

Where applicable and feasible, mitigation measures to minimise the impacts associated with construction and maintenance of the pipeline infrastructure must be implemented in order to at minimum, retain current levels of ecological integrity and functioning. It is preferable however that suitable rehabilitation measures be implemented, particularly a suitable floral alien invasive removal program to clear the drainage lines and riparian areas in order to improve the Present State of these and to improve the ecological service provision by these systems.

It is also deemed to be of significant value that with the supply of potable water to the area that the local community be educated on its use and management. The wise use of water and the wise use of riverine ecosystems should be communicated in order to improve the degree to which the community manages these resources in the future.

With the supply of potable water also comes an increase in water borne sewage which will need to be managed. It is deemed critical that sufficient planning and budgeting take place to ensure that sanitation can be provided and that the water system is balanced in such a way as to prevent contamination of the receiving environment due to point and diffuse leakage of waterborne sewage.

4.9 Delineation and Sensitivity Mapping

All features were delineated on a desktop level with the use of digital satellite imagery and topographical maps. Portions of the features were then verified during the field survey according to the guidelines advocated by DWA (2005, 2008) and the watercourse/riparian delineations as presented in this report are regarded as a best estimate of the temporary and riparian zone boundaries based on the site conditions present at the time of assessment. Ground-truthing of riparian boundaries focused on those areas that were accessible as well as within the proposed pipeline infrastructure footprint.

During the assessment, the following indicators were used to ascertain the boundaries of the perennial drainage lines with riparian characteristics and the wetland features:

- Terrain units were used as the primary indicator, as the ravines and depressions were the most likely areas through which water will flow. In some of the riparian areas, the presence of alien plant species made it difficult discern riparian / drainage line boundaries;
- Vegetation, although transformed, was considered informative at many features;
- Soil form was considered; and the presence of mottles (soils with variegated colour patterns) was used as an indicator for wetlands and riparian boundaries in some instances. In some areas the mottling of soils did not provide an accurate delineation of boundaries, and as such the above mentioned characteristics were used in conjunction to determine boundaries.

Legislative requirements were used to determine the extent of buffer zone required for each group depending on whether a group is considered wetland/riparian habitat or not. The Nsuze River and its respective associated tributaries, as well as the perennial drainage lines with riparian characteristics are defined as watercourses. As such, if any activities are to take place within 32 meters of a wetland or watercourse or the 1:100 year flood lines authorisation in terms of the relevant regulations of NEMA will be required. In addition the Section 21 of the National Water Act and Regulation 1199 of 2009 as it relates to the NWA will also apply and therefore a Water Use License will be required for the proposed development.

All points where the proposed pipeline crosses a wetland, perennial drainage line or the Nsuzu River and its tributaries has been illustrated on the sensitivity maps and numbered accordingly. The table below indicates the crossing point number indicated on the maps as

well as the GPS coordinates of the centre point of the crossing. The blue lines on the maps indicate the direction of water flow.

Table 21: Summary of the REC categories assigned to the various features within the study area.

Crossing number	South Co-ordinates	East Co-ordinates	HGM Unit	Crossing number	South Co-ordinates	East Co-ordinates	HGM Unit
1	29°24'45.36"S	30°51'4.54"E	Seep (Bench)	**15**	29°24'18.23"S	30°51'56.64"E	Channelled Valley Bottom
2	29°24'33.19"S	30°51'6.21"E	Seep (Bench)	**16**	29°22'52.97"S	30°52'54.88"E	Channelled Valley Bottom
3	29°25'40.46"S	30°52'16.61"E	Riverine	**17**	29°23'16.63"S	30°53'33.23"E	Channelled Valley Bottom
4	29°25'32.80"S	30°52'25.99"E	Riverine	**18**	29°23'21.22"S	30°53'34.95"E	Channelled Valley Bottom
5	29°25'29.82"S	30°52'31.96"E	Riverine	**19**	29°23'29.31"S	30°54'3.67"E	Channelled Valley Bottom
6	29°25'26.04"S	30°52'34.02"E	Riverine	**20**	29°25'12.42"S	30°52'51.39"E	Riverine
7	29°25'27.64"S	30°52'38.95"E	Riverine	**21**	29°24'26.34"S	30°52'49.73"E	Channelled Valley Bottom
8	29°24'50.29"S	30°53'17.90"E	Riverine	**22**	29°23'33.03"S	30°52'39.45"E	Channelled Valley Bottom
9	29°25'3.44"S	30°52'1.22"E	Channelled Valley Bottom	**23**	29°23'34.95"S	30°52'40.95"E	Channelled Valley Bottom
10	29°24'17.81"S	30°51'45.96"E	Channelled Valley Bottom	**24**	29°23'3.06"S	30°52'27.73"E	Channelled Valley Bottom
11	29°24'11.35"S	30°52'36.85"E	Channelled Valley Bottom	**25**	29°23'11.75"S	30°52'53.81"E	Channelled Valley Bottom
12	29°23'21.86"S	30°52'27.29"E	Channelled Valley Bottom	**26**	29°22'42.08"S	30°52'59.56"E	Channelled Valley Bottom
13	29°23'17.90"S	30°52'43.13"E	Channelled Valley Bottom	**27**	29°22'47.92"S	30°53'10.71"E	Channelled Valley Bottom
14	29°23'32.00"S	30°52'38.53"E	Channelled Valley Bottom	**28**	29°22'46.18"S	30°53'46.82"E	Channelled Valley Bottom

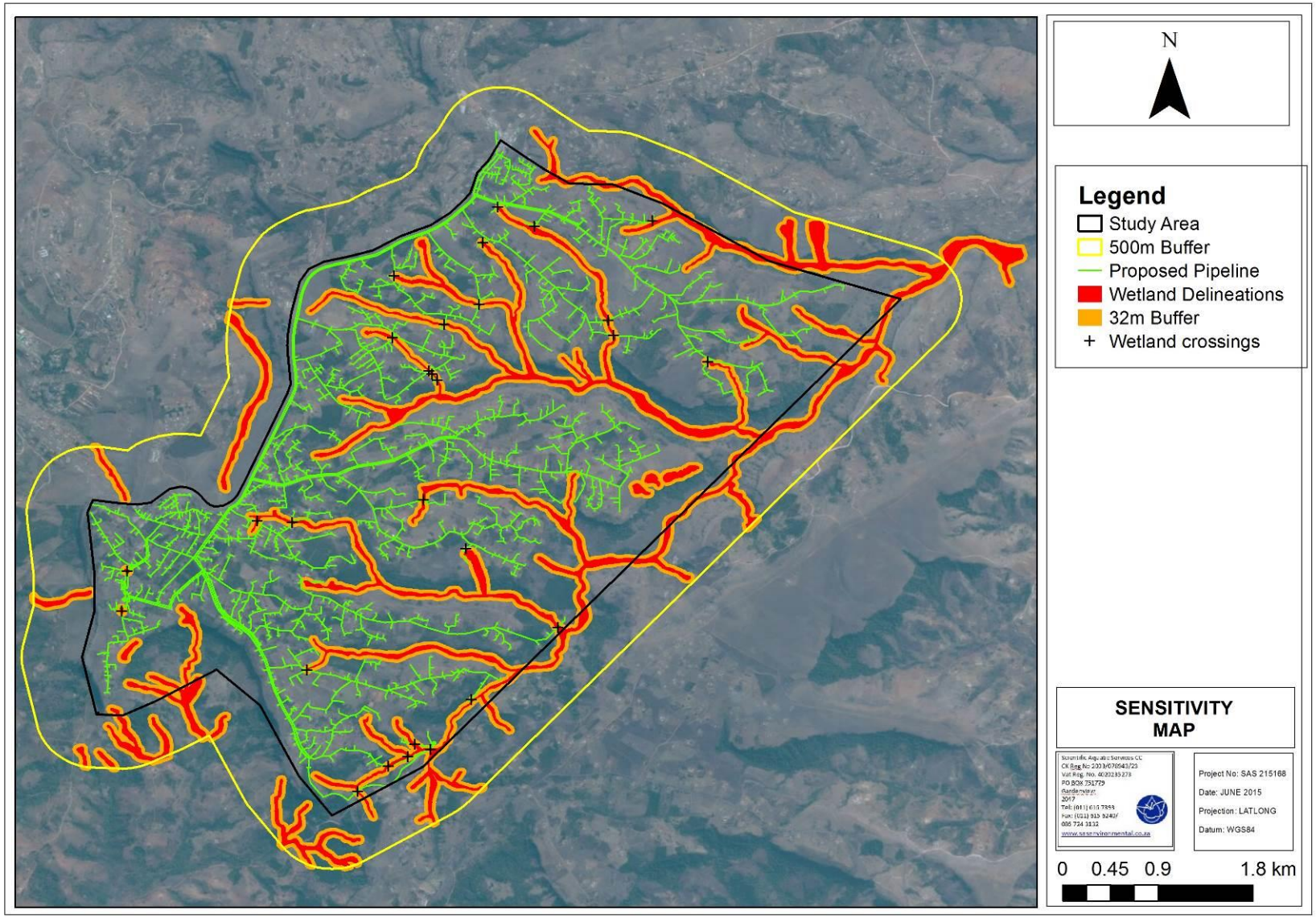

Figure 18: Conceptual presentation of the wetland and watercourse/riparian features within the study area and their associated buffer zones.

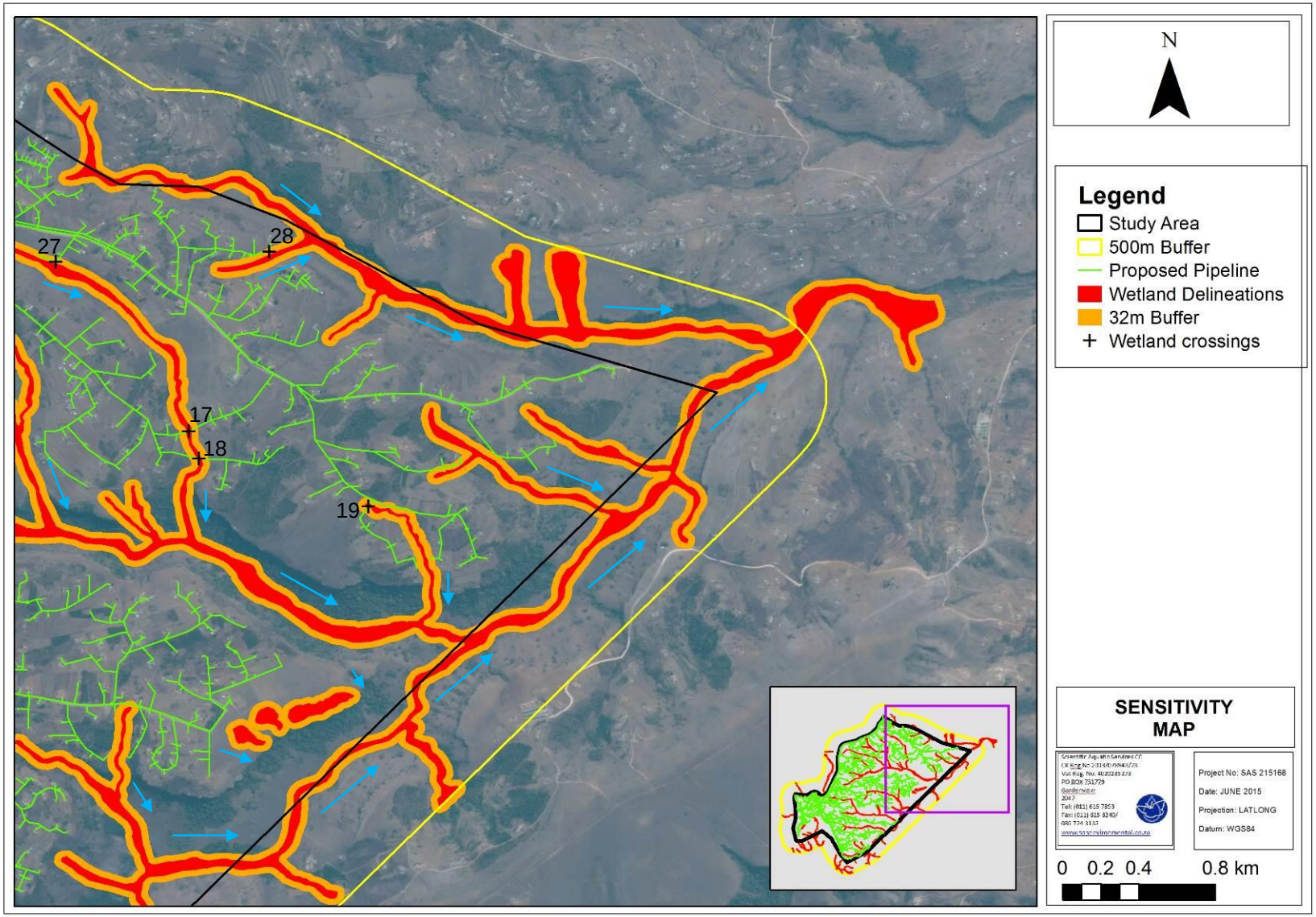

Figure 19: Conceptual presentation of the wetland and watercourse/riparian features within the study area and their associated buffer zones.

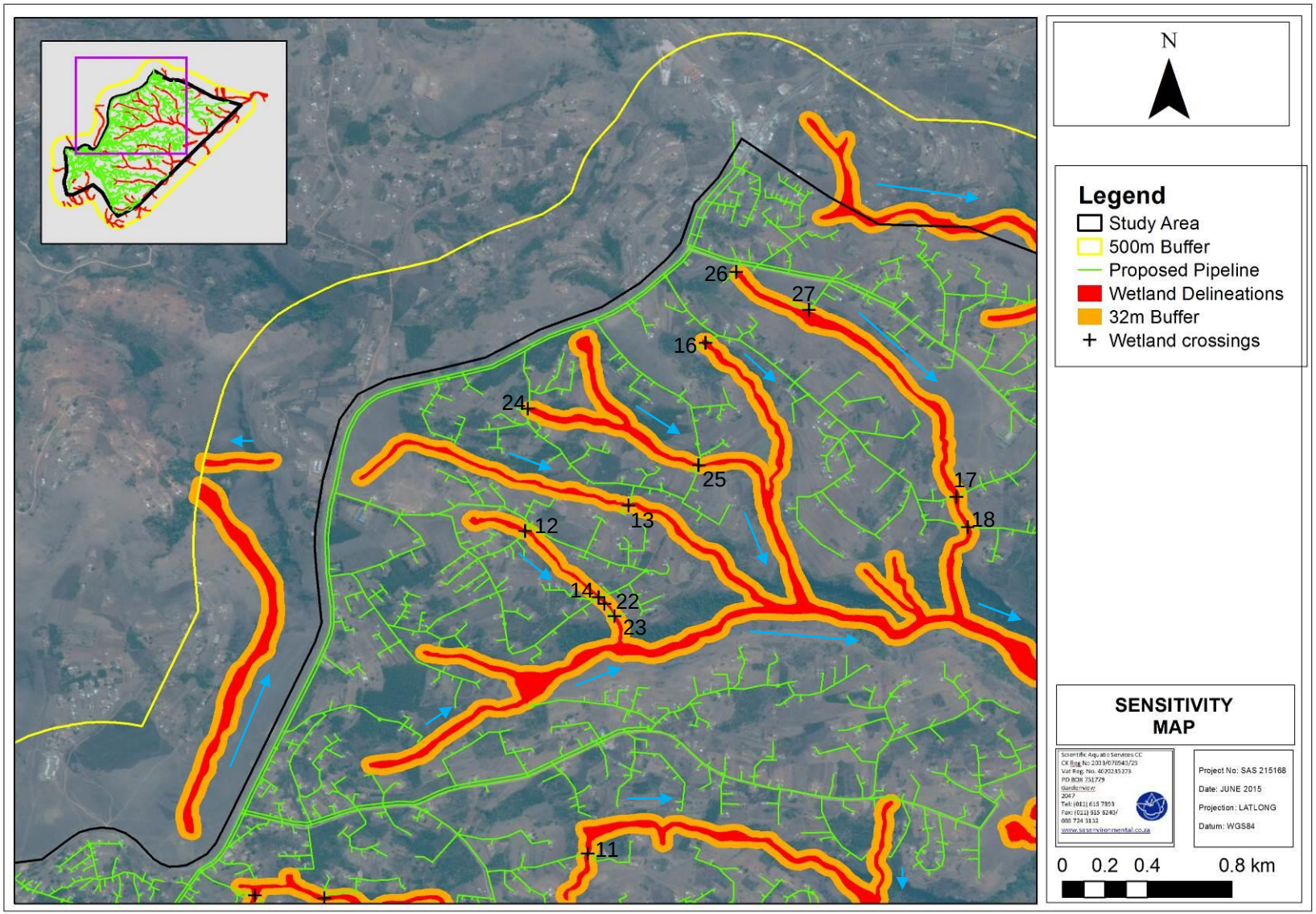

Figure 20: Conceptual presentation of the wetland and watercourse/riparian features within the study area, and their associated buffer zones.

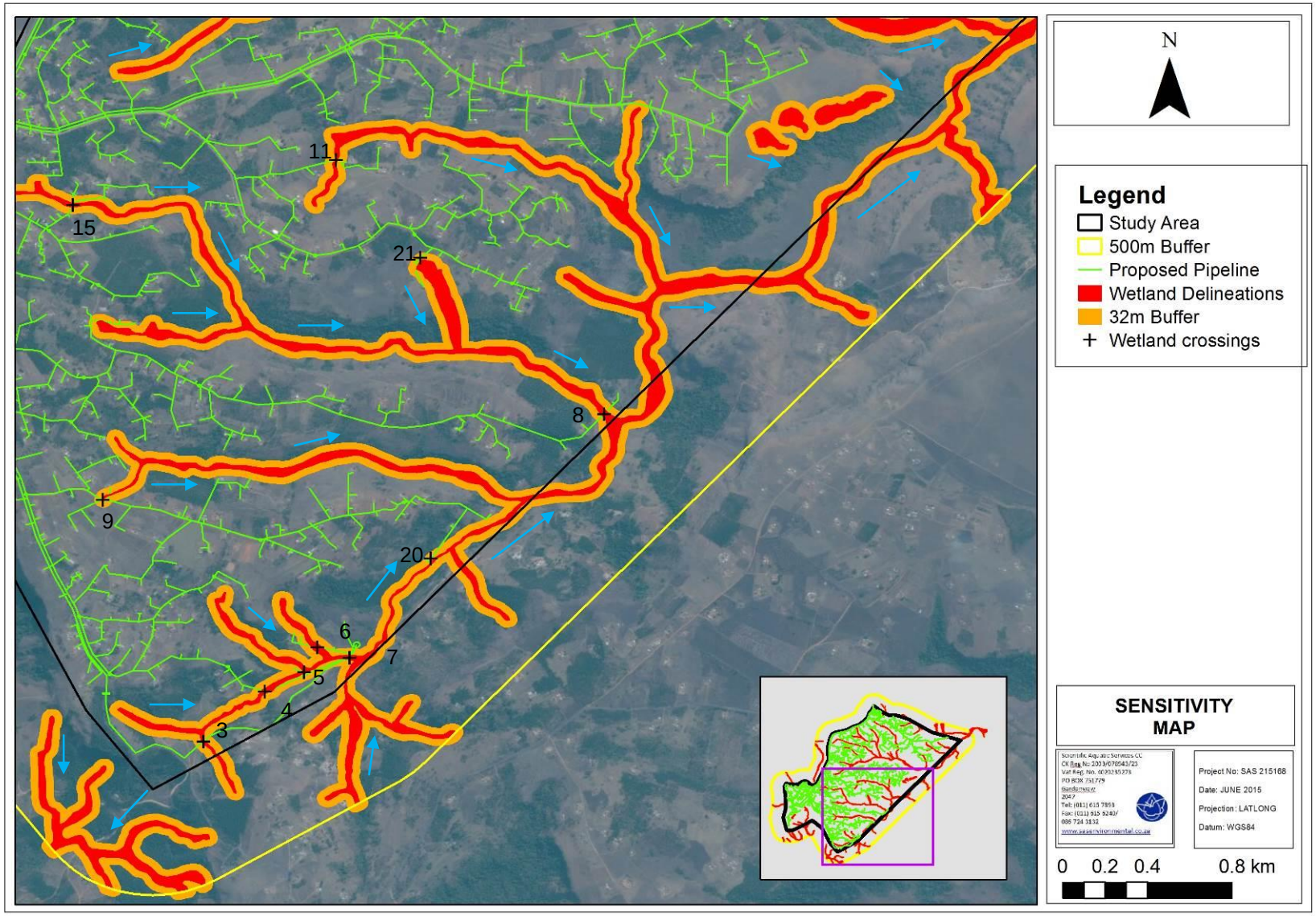

Figure 21: Conceptual presentation of the wetland and watercourse/riparian features within the study area, and their associated buffer zones.

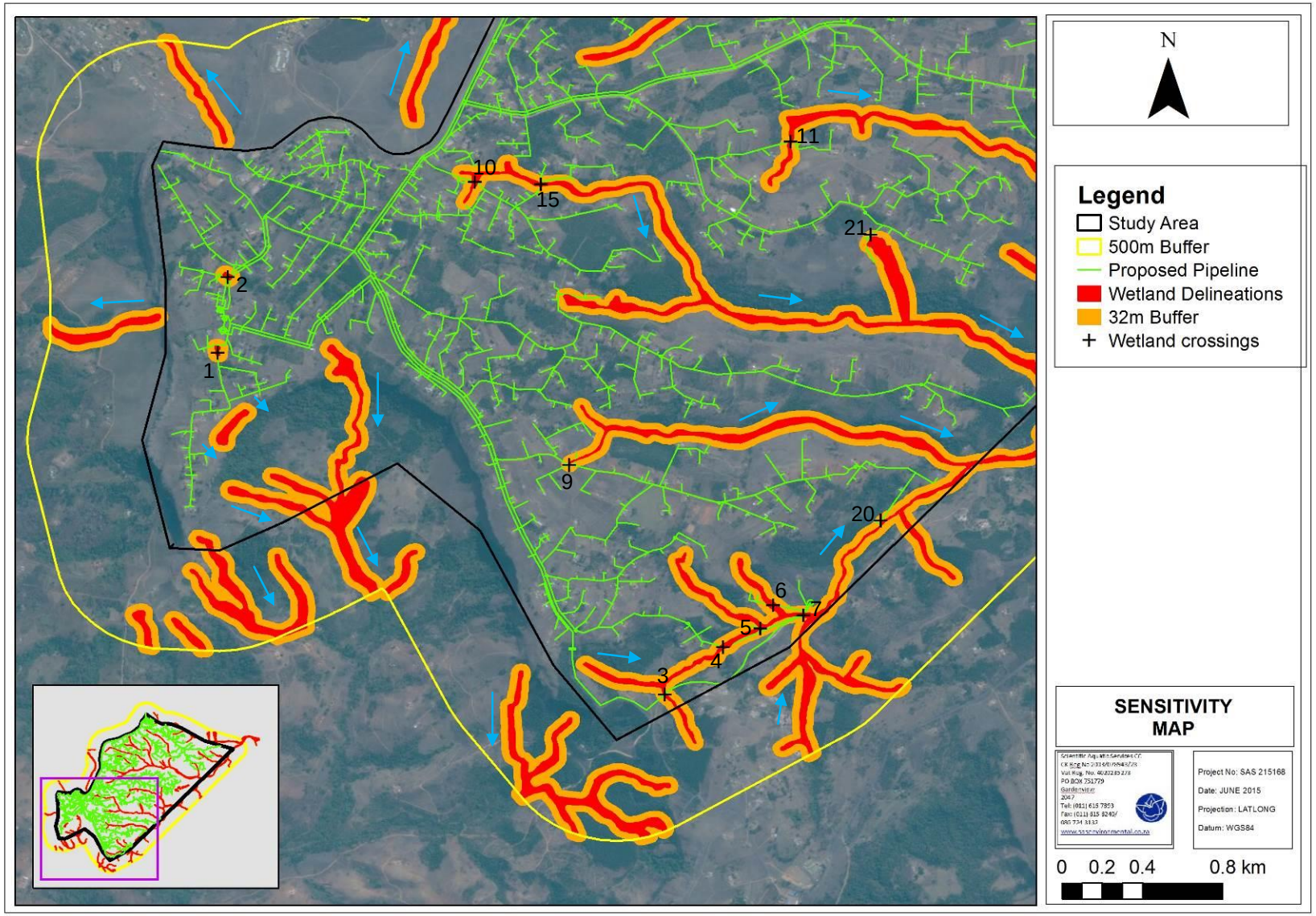

Figure 22: Conceptual presentation of the wetland and watercourse/riparian features within the study area, and their associated buffer zones.

5 IMPACT ASSESSMENT

The tables below serve to summarise the significance of potential impacts on the wetland and aquatic integrity of the existing and proposed mining activities.
The sections below present the impact assessment according to the method described in Section 2.10. In addition, it also indicates the required mitigatory measures needed to minimise the impact and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures and assuming that they are fully implemented.

5.1 Impact Analyses

Discussion on the Nature of the Impacts
Three aspects of riparian ecology are considered when assessing the impacts of the proposed construction of the pipeline infrastructure: loss of riparian habitat and ecological structure, changes to riparian ecological and sociocultural service provision, and riparian hydrological function and sediment balance.

Riparian and wetland areas more often than not undergo habitat loss and transformation as a result of clearing for agricultural purposes or as a result of an influx of alien invasive species outcompeting indigenous plants and changing the overall species composition. Wetland and riparian features are particularly susceptible to habitat modifications, as they are key resources for human development, and many alien invasive species seeds are transported down streams of via birds that roost around wetland and riparian zones. These modifications further impact upon the sociocultural provision abilities of the riparian and wetland zones as well the hydrological functions of the systems. Impacts can result in the loss or change of water flow within the water courses, directly impacting on the habitat structure as well as the provision of resources to the local community. Changes in hydrological functions of wetland and riparian zones further impact on the ability of these systems to assimilate toxins, trap sediments and help with flood control during periods of high flow.

The proposed pipeline infrastructure and the construction thereof is not perceived to have a significant impact upon the riparian systems within the study area, primarily as many of these areas have already undergone habitat changes as a result of human activities in the area and colonisation of alien vegetation. Furthermore, the pipeline is deemed to have a

very low impact on the wetlands within the study area, as the wetlands are positioned outside of the proposed pipeline layout, and are not deemed to be affected by any edge effects resulting from the construction or maintenance of the pipeline. The proposed pipeline infrastructure follows pre-existing roads further minimising construction impacts and the need to develop new access routes through existing features. Much of the current and foreseeable future impacts are a result of the overuse of resources by the surrounding community and historical impacts related to agricultural activities.
However, should mitigation measures not be adhered to, construction related activities may result in further erosion of the riparian areas, as well as causing an increased flow of sediments into the wetlands, resulting in siltation of downstream and wetland features. The eroded and resultant bare patches will provide ideal colonisation habitats for alien plant species, compounding measures to mitigate alien invasive proliferation.

From the table below it is evident that the impacts from the construction are deemed to be “Negative-moderate” to “Negative-high”, however with proper mitigation measures in place much of these impacts can be minimised. All disturbed areas should be properly rehabilitated and alien vegetation removed during the construction period. Furthermore, the operational phase relates to a static underground water supply pipe with minor aboveground infrastructure, therefore provided that adequate mitigation measures were implemented during the construction phase, and rehabilitation processes were carried out, the operational phase is deemed to have a very low impact on the surrounding habitat

It is deemed that any infilling and changes to the overall geomorphology of the water courses will be insignificant due to their low sensitivity, provided that construction activities as stated within the Construction Methodology document and recommended mitigation measures are adhered to. Due to the variable size of the pipeline and the resultant variation in construction needs, it is not feasible to recommend an exact servitude width, as this may conflict with construction needs in certain areas. As such, it is recommended that as far as possible the servitude for the proposed pipeline be maintained as small as possible, keeping in line with the Construction Methodology document as well as adhering to the proposed mitigation measures supplied. Again due to the limited sensitivity and poor current condition of the systems crossed, no highly constraining servitude width is deemed necessary; however strict control of edge effects must take place throughout the entire construction process.

Table 22: Table representing the different impacts and the impact scores and significance rating thereof.

Nature of the Impact	Extent	Duration	Intensity	Probability	Significance Score
Site clearing, the removal of vegetation, and associated disturbances to soils, leading to increased runoff and erosion with consequent sedimentation of riparian/wetland habitat	-2	-2	-2	-3	-9 Negative Moderate
Earthworks within riparian/wetland habitats and in the vicinity of these areas leading to increased runoff and erosion and altered runoff patterns	-2	-1	-2	-2	-7 Negative Moderate
Movement of construction vehicles within the drainage line systems	-2	-1	-2	-2	-7 Negative Moderate
Proliferation of alien vegetation in disturbed areas	-2	-4	-3	-3	-12 Negative High
Dumping of waste, including waste material spills and refuse deposits into the riparian/wetland areas	-2	-1	-2	-2	-7 Negative Moderate
Construction of roads. through riparian and drainage line crossings, altering stream and base flow patterns and water velocities	-1	-2	-2	-2	-7 Negative Moderate

The above tabulated impacts that are likely to occur can be narrowed down into three areas of cumulative impacts that the study area will experience, namely:

- The loss of riparian habitat and ecological structure;
- Changes to riparian ecological and sociocultural service provision, and
- Changes to the riparian hydrological function and sediment balance.

Following these impacts, listed below are mitigation measures and actions that can be taken to help minimise and mitigate the above tabulated impacts within the study area.

5.2 Mitigation measures

The following essential mitigation measures are considered to be standard best practice measures applicable, and must be implemented during all phases of the proposed development activities in order to the minimise the impacts on the wetland and riparian resources.

Development and operational footprint

- Sensitivity maps have been developed for the study area, indicating the drainage lines and riparian systems, and their relevant buffer zones. It is recommended that this sensitivity map be considered during all phases of the development and with special mention of the planning of infrastructure, in order to aid in the conservation of and minimise impact on the riparian and aquatic habitat and resources within the study area;

- The bench and hillslope seep wetlands identified during this study are not considered to be targets of construction and operational related impacts, as they are not located within or very close to the proposed pipeline infrastructure. Planning of infrastructure should focus on conservation of the riparian resources as these are deemed to be of greater importance on a local and regional scale;
- All construction footprint areas should remain as small as possible and should as far as possible not encroach into surrounding more sensitive areas. It must be ensured that the riparian and drainage line systems, and their associated buffer zones are off-limits to construction vehicles and personnel;
- Any activities that take place within 32 meters of a wetland or watercourse or the 1:100 year flood lines will require authorisation in terms of the relevant regulations of NEMA, however as far as possible infrastructure should be placed outside of wetland
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;
- Any areas where bank failure is observed, due to the pipeline infrastructure, should be immediately repaired;
- As far as possible the existing road network should be utilised, minimising the need to develop new access routes resulting in an increased impact on the local environment. Should temporary roads or access routes be necessary and unavoidable, proper planning must take place and the site sensitivity plan must be taken into consideration. If additional roads are required, then wherever feasible such roads should be constructed a distance from the more sensitive riparian areas and not directly adjacent thereto. If crossings are required they should cross the systems at right angles, as far as possible to minimise impacts in the receiving environment;
- All areas of increased ecological sensitivity should be marked as such and be off limits to all unauthorised construction and maintenance vehicles and personnel;
- The duration of impacts on the riverine and perennial drainage line systems should be minimised as far as possible by ensuring that the duration of time in which flow alteration and sedimentation will take place is minimised;
- Appropriate sanitary facilities must be provided for the life of the construction and all waste removed to an appropriate waste facility;
- No informal fires should be permitted in within the study area;
- Ensure that an adequate number of rubbish bins are provided so as to prevent litter and ensure the proper disposal of waste generated during construction activities; and
- Edge effects of activities, particularly erosion and alien/weed control need to be strictly managed.

Vehicle access

- All areas of increased ecological sensitivity should be marked as such and kept off limits to all unauthorised construction and maintenance vehicles as well as personnel;
- All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil; and
- All spills, should they occur, should be immediately cleaned up and treated accordingly.

Alien plant species

- Proliferation of alien and invasive species is expected within any disturbed areas particularly as there is a high degree of alien and invasive species within the study area at present. These species should be eradicated and controlled to prevent further spread beyond the study area;
- Alien vegetation along the proposed pipeline should be removed and care taken to ensure no more alien plant growth occurs within the newly disturbed areas;
- Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled; and
- Species specific and area specific eradication recommendations:
    - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
    - Footprint areas should be kept as small as possible when removing alien plant species; and
    - No vehicles should be allowed to drive through designated sensitive drainage line and riparian areas during the eradication of alien and weed species.

Riparian and drainage line habitat

- Ensure that as far as possible all infrastructure is placed outside of drainage lines and riparian areas and their respective buffer zones. Where this is not possible, construction footprints must be kept as small as possible and impacts must be minimized as far as possible. Where it is unavoidable that a pipeline crosses a feature, it is recommended that existing crossings be used such roads;
- Stabilisation of banks in the vicinity of any crossings over riparian or perennial drainage line resources by employing one of the individual techniques below or a combination thereof, is essential, given the inherent susceptibility of the soils to erosion. Such measures include:
    - Re-sloping of banks to a maximum of a 1:3 slope;

- Revegetation of re-profiled slopes;
- Temporary stabilisation of slopes using geotextiles; and
- Installation of gabions and reno mattresses.

- Limit the footprint area of the construction activities to what is absolutely essential in order to minimise environmental damage;
- During the construction phase, no vehicles should be allowed to indiscriminately drive through the drainage lines or riparian areas;
- Implement effective waste management in order to prevent construction related waste from entering the drainage line and riparian environments.

Soils

- To prevent the further erosion of soils, management measures may include berms, soil traps, hessian curtains and storm water diversion away from areas particularly susceptible to erosion;
- Install erosion berms during construction to prevent gully formation. Berms every 50m should be installed where any disturbed soils have a slope of less than 2%, every 25m where the track slopes between 2% and 10%, every 20m where the track slopes between 10% and 15% and every 10m where the track slope is greater than 15%;
- Sheet runoff from access roads should be slowed down by the strategic placement of berms and sandbags;
- As far as possible, all construction activities should occur in the low flow season, during the drier winter months;
- All soils compacted as a result of construction activities falling outside of footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout all construction and rehabilitation phases to prevent loss of floral habitat; and
- Monitor all areas for erosion and incision, particularly any riparian/wetland crossings. Any areas where erosion is occurring excessively quickly should be rehabilitated as quickly as possible.

Rehabilitation

- All soils compacted as a result of construction activities falling outside of project areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take

place throughout all construction and rehabilitation phases to prevent loss of floral habitat;

- Rehabilitate all drainage line and riparian habitat areas to ensure that the ecology of these areas is re-instated during all phases;
- Edge effects of activities including erosion and alien/ weed control need to be strictly managed in these areas;
- As far as possible, all rehabilitation activities should occur in the low flow season, during the drier winter months.
- All alien vegetation in the riparian zone should be removed upon completion of construction and reseeded with indigenous grasses as as specified by a suitably qualified specialist (ecologist);
- All areas affected by construction should be rehabilitated upon completion of the construction phase of the development; and
- Bank vegetation cover should be monitored to ensure that sufficient vegetation is present to bind the bankside soils and prevent bankside erosion and incision.

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APPENDIX A:

RESULTS OF THE VEGRAI ASSESSMENT APPLIED TO THE RIPARIAN FEATURES

Results of the VEGRAI assessment applied to the perennial drainage lines

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	27.3	2.5	2.7	2.0	10.0
NON MARGINAL	45.7	41.6	0.0	1.0	100.0
	2.0				110.0
LEVEL 3 VEGRAI (%)				44.0	
VEGRAI EC				**D**	
AVERAGE CONFIDENCE				1.3	

Results of the VEGRAI assessment applied to the Nsuze River and tributaries

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	40.0	3.6	3.3	2.0	10.0
NON MARGINAL	44.6	40.6	0.0	1.0	100.0
	2.0				110.0
LEVEL 3 VEGRAI (%)				44.2	
VEGRAI EC				**D**	
AVERAGE CONFIDENCE				1.7	

APPENDIX B:

RESULTS OF THE IHI ASSESSMENTS APPLIED TO THE RIPARIAN FEATURES

Results of the IHI assessment applied to the Nsuze River and associated tributaries

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**2.2**		
Hydrology	1	100	2.7	*3.8*	**D**
Geomorphology	2	80	1.8	*3.5*	**C**
Water Quality	3	30	1.5	*3.5*	**C**
WETLAND LANDUSE ACTIVITIES:		**80**	**2.0**	***3.9***	
Vegetation Alteration Score	1	100	2.0	*3.9*	**C/D**
OVERALL SCORE:			**2.1**		
	PES %		**57.6**	***Confidence Rating***	
	PES Category:		**C/D**	***1.7***	

Results of the IHI assessment applied to the Perennial drainage lines

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**2.2**		
Hydrology	1	100	2.6	*3.8*	**D**
Geomorphology	2	80	2.2	*3.5*	**D**
Water Quality	3	30	1.2	*3.9*	**C**
WETLAND LANDUSE ACTIVITIES:		**80**	**2.0**	***3.9***	
Vegetation Alteration Score	1	100	2.0	*3.9*	**C/D**
OVERALL SCORE:			**2.1**		
	PES %		**57.4**	***Confidence Rating***	
	PES Category:		**D**	***1.7***	

APPENDIX C

RESULTS OF THE EIS ASSESSMENTS APPLIED TO THE WETLAND AND RIPARIAN FEATURES

Results of the EIS assessments applied to the features within the study area

Determinant	Nsuze River and Tributaries	Perennial Drainage line	Hillslope seeps	Bench Wetland	Confidence
PRIMARY DETERMINANTS					
1. Rare & Endangered Species	2	1	0	0	3
2. Populations of Unique Species	1	1	0	0	3
3. Species/taxon Richness	2	2	1	1	3
4. Diversity of Habitat Types or Features	2	1	2	1	3
5. Migration route/breeding and feeding site for wetland species	2	1	0	0	3
6. PES as determined by WET-Health assessment	2	2	2	2	3
7. Importance in terms of function and service provision	2	2	2	2	3
MODIFYING DETERMINANTS					
8. Protected Status according to NFEPA Wetveg	3	3	3	2	3
9. Ecological Integrity	2	2	2	2	3
TOTAL	18	15	11	10	
MEAN	2	1.7	1.2	1	
OVERALL EIS	**D**	**C**	**C**	**D**	