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Environmental Impact Assessment

for the proposed

MZIMVUBU WATER PROJECT

DEA Ref. No.: 14/12/16/3/3/2/677 (Dam construction)
14/12/16/3/3/2/678 (Electricity generation)
14/12/16/3/3/1/1169 (Roads)

WETLAND ASSESSMENT

SEPTEMBER 2014

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ENVIRONMENTAL IMPACT ASSESSMENT FOR THE MZIMVUBU WATER PROJECT

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ENVIRONMENTAL IMPACT ASSESSMENT FOR THE MZIMVUBU WATER PROJECT

LIST OF REPORTS

REPORT TITLE	DWS REPORT NUMBER
Inception Report	P WMA 12/T30/00/5314/1
Scoping Report	P WMA 12/T30/00/5314/2
Environmental Impact Assessment Report	P WMA 12/T30/00/5314/3
Environmental Management Programme	P WMA 12/T30/00/5314/14
Water Use Licence Application Supporting Documents	P WMA 12/T30/00/5314/4
Ntabelanga Dam borrow pits and quarry Environmental Management Plan	P WMA 12/T30/00/5314/5
Lalini Dam borrow pits and quarry Environmental Management Plan	P WMA 12/T30/00/5314/6
SUPPORTING REPORTS	
Social Impact Assessment	P WMA 12/T30/00/5314/7
Economic Impact Assessment	P WMA 12/T30/00/5314/8
Visual Impact Assessment	P WMA 12/T30/00/5314/9
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Water Quality Study	P WMA 12/T30/00/5314/13
Aquatic Ecology Study	P WMA 12/T30/00/5314/15
Wetland Assessment	**P WMA 12/T30/00/5314/16**

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DECLARATION OF INDEPENDENCE

I, Stephen van Staden, as authorised representative of Scientific Aquatic Services cc hereby confirm my independence as a specialist and declare that neither I nor Scientific Aquatic Services cc have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Scientific Aquatic Services cc was appointed as social impact assessment specialists in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Social Impact Assessment for the Mzimvubu Water Project Environmental Impact Assessment. I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in my attached report.

Signed:  Date: 19/08/2014

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE MZIMVUBU WATER PROJECT

WETLAND ASSESSMENT

EXECUTIVE SUMMARY

BACKGROUND

The Department of Water and Sanitation (DWS) commissioned the Mzimvubu Water Project, an integrated multi-purpose (domestic water supply, agriculture, power generation, transport, tourism, conservation and industry) project, with the intention of providing socio-economic development opportunities for the region.
The proposed Ntabelanga Dam site is located approximately 25 km east of the town of Maclear and north of the R396 Road. The proposed Lalini Dam site is situated approximately 17 km north east of the small town Tsolo. Both are situated on the Tsitsa River.

The purpose of this report is to provide a summary of the wetland resource delineation, Present Ecological State (PES), Ecological Importance and Sensitivity (EIS) and function, as well as to conduct an impact assessment and develop mitigation measures, as part of the Environmental Assessment and authorisation process for the Mzimvubu Water Project. This is in order to inform the Environmental Assessment Practitioners (EAP) as well as the proponent and relevant authorities as to the best use of the resources in the area, and in order to ensure that adequate impact mitigation is implemented into the project plan, should the proposed development proceed.

<u>Outcomes</u>

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

- Identify and map 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);
- Delineate wetland resources and riparian zones within the focus study area. Due to the scale of the project, delineation was undertaken using desktop methods and digital satellite imagery. In the field, verification of the wetland delineation took place according to the guidelines as defined by (DWA, 2005);
- Determine function and service provision of wetland systems according to the method supplied by Kotze et al (2009);
- Define the wetland health of the systems within the study area according to the resource directed measures guideline described by Macfarlane et al. (2008) or the WET-IHI method described by the DWA (2007) (as applicable) and thereby define PES of the wetland resources to be affected by the proposed Mzimvubu Water Project;
- Define the wetland EIS and Recommended Ecological Category (REC) for the wetland systems (DWA, 1999);
- Consider potential impacts on the wetland habitat and the ecological communities likely as a result of the proposed development; and
- Present management and mitigation measures in order to minimise the impacts that the proposed expansion will have on the wetland resources in line with the mitigation Hierarchy, as defined by the DMR (2013), followed by an assessment of the significance of the impacts after mitigation, assuming that they are fully implemented.

Conclusions from literature review

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

The study area falls within the South Eastern Uplands Aquatic Ecoregion and the Mzimvubu to Kieskamma Water Management Area (WMA). The subWMA indicated for the study area is Mzimvubu. The Tsitsa River is a tributary of the Mzimvubu River and will be partially inundated by both proposed dams. The Tsitsa River is a large perennial river that is classified in Category C condition (Moderately modified) according to Kleynhans (2007) and NFEPA (2011).

The Lalini Dam is located within the T35L and T35K Quaternary Catchments, whilst the Ntabelanga Dam and road upgrades are located within the T35E quaternary catchment, and the particular river resource in the area is the Upper Ntata, Mzimvubu River.

The pipelines traverse over several quaternary catchments, namely T20B, T34H, T34 J, T35E, T35H and T35K. The PES Category of the various river systems in these quaternary catchments varies between PES B and PES C. Specifically, the Tsitsa River is classified as a PES Category B river, whilst the Inxu is considered to be in a PES Category C. All systems are considered to have a 'moderate' Ecological Importance (EI) whilst the Ecological Sensitivity (ES) varies between High to Medium sensitivity. The Tsitsa River is considered to be of moderate sensitivity whilst the Inxu River is deemed to be highly sensitive. The default Ecological Class (EC) of the river systems in these quaternary catchments, based on the median PES and highest of EI or ES means is considered to be either a Class B or a Class C. The Tsitsa River is deemed to be a Class C, and the Inxu is deemed to be a Class B system.

The Freshwater Ecosystem Priority Areas (FEPAs) database was consulted to define the aquatic ecology of the wetland systems close to or within the study area that may be of ecological importance.

Lalini Dam

Aspects applicable to the Lalini Dam are discussed below:

- The subWMA is regarded as important with regards to fish corridors for movement of threatened fish between habitats and for the conservation of crane species. However it must be noted that the specific section of the Tsitsa river is considered less important based on the findings of the aquatic assessment and the migratory barriers created by the waterfalls on the system;
- The subWMA is indicated as a fish corridor management area therefore effective management of activities near and between corridors are of upmost importance. The Tsitsa River can however be considered of less importance due to the reasons presented above although the system is still considered important in terms of eel migration;
- The wetland vegetation group is identified as Sub-escarpment Savanna; and
- According to the NFEPA Database (2011), the wetlands in the region of the proposed Lalini Dam are classified as FEPA wetlands, with a rank of 2, indicating that the majority of its area is within a sub-quaternary catchment that has sightings or breeding areas for threatened *Balearica regulorum (*Grey Crowned Crane) and *Anthropoides paradiseus (*Blue Crane).

Ntabelanga Dam

Aspects of the results from the FEPA (2011) database applicable to the Ntabelanga Dam include:

- The subWMA is regarded as important in terms of the conservation of crane species;
- The subWMA is indicated as an upstream management area therefore effective management of activities near resources are of upmost importance;
- The subWMA is not considered to be a high groundwater recharge area nor a River FEPA; and
- The wetland vegetation group is identified as Sub-escarpment Grassland Group 6.

Pipelines

Aspects concerning the pipelines according to the NFEPA (2011) database are as follows:

- The northern pipelines cross the Thina River which is classified as being in Category C condition (moderately modified); and
- The Thina River is regarded as an important fish sanctuary, translocation and relocation zone and is classified as being a fish support area according to the NFEPA Database (2011).

CONCLUSIONS OF WETLAND AND RIPARIAN ASSESSMENT

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

Features within the study area were categorised with the use of the *Classification System for Wetlands and other Aquatic Ecosystems in South Africa* (Ollis, 2013). After the field assessment it can be concluded that five main feature groups are present within the study area, namely rivers, channelled valley bottom wetlands, seeps, depressions and drainage lines. The features identified during the assessment were further divided into either wetland or riparian habitat based on the characteristics as defined by the NWA No 36 of 1998. Riparian habitat was assessed with use of the VEGRAI, Wetland Function Assessment, and Wetland IHI, whilst wetland habitat was assessed with the use of Wet-Health and the Wetland Function Assessment.

Riparian Habitat

- The results of the VEGRAI assessment indicate that the riparian vegetation of the Tsitsa River and several of its unnamed tributaries, as well as the Inxu River, can be considered to be in a Present Ecological State (PES) Category C. One unnamed tributary, which passes through the town of Tsolo, has undergone marginally higher levels of transformation and can be considered to be in a PES Category D;
- The results of the wetland function assessment indicate that the Tsitsa River and the various tributaries provide moderately high levels of ecological and socio-cultural services;
- The WET-IHI method as described by DWA (2005) was applied to the Tsitsa River and the various tributaries in order to ascertain the PES of the riparian resources. The results of these assessments indicate that the riparian resources are in a PES Category C;
- The ecological importance and sensitivity (EIS) assessment of the riparian features indicates that they are considered to be highly sensitive. However, although all riparian features assessed were placed within the same EIS category, it should be noted that each feature obtained different scores indicating that some – such as the Tsitsa River – may be deemed more ecologically important and sensitive to modifications than the others; and
- A Recommended Ecological Category (REC) B/C was assigned to the riparian features based on the outcomes of the wetland functionality, PES and EIS assessments.

Wetland Habitat

Each group of wetland HGM units were assessed to ascertain levels of ecological functioning and service provision, present ecological state, and ecological importance and sensitivity. The results of these assessments are summarised below:

Numerous drainage lines were identified within the study area, particularly in the regions associated with the proposed Ntabelanga and Lalini dam sites.

- The results of the wetland function assessment applied to these drainage lines indicate intermediate levels of ecological and socio-cultural service provision;
- The PES of the drainage lines was assessed using the WET-IHI method (DWA, 2005) and was found to fall within a PES Category C (moderately modified);

- The drainage line features were found to fall within an EIS Category C (ecologically important and sensitive on a localised scale); and
- After consideration of the above results, an REC C was assigned to the drainage line features.

Channelled Valley Bottom Wetlands

Several channelled valley bottom wetland features were noted during the site assessment. The results of the assessments applied to these features are as follows:

- The channelled valley bottom wetland features were found to have moderately high levels of ecological and socio-cultural service provision;
- The PES of these wetland features was calculated using the Wet-Health method as described by Macfarlane *et al.* (2008) and were found to fall within a PES Category C (moderately modified);
- The results of the EIS assessment indicate that the channelled valley bottom wetlands are considered highly ecologically important and sensitive, and were placed in an EIS Category B; and
- Following consideration of the results of the assessments the channelled valley bottom wetlands were assigned an REC C.

Seep Wetlands

A few small seep wetlands were identified. The results of these assessments are as follows:

- The wetland functionality assessment indicated intermediate levels of ecological and socio-cultural service provision and functionality;
- Using Wet-Health, the PES of the seep wetland features was calculated, and found to fall within a PES Category C (moderately modified);
- The seep wetlands are considered to be ecologically important and sensitive on a local or provincial scale, although biodiversity is unlikely to be sensitive to habitat and flow modifications, and the results of the EIS assessment indicate that these wetlands fall within an EIS Category C; and
- An REC C was assigned to the seep wetlands based on the results of the various assessments applied to the features.

Depression Wetlands

No depression wetlands were identified during the site assessment, however, a few small depression wetlands were identified using digital satellite imagery. The assessments of these features was therefore based on available background information relevant to the study area and catchment as well as wetland-specific information obtained for the other wetland features evaluated. The results of the assessments are summarised below:

- The depression wetland features obtained a score in the wetland functionality assessment which indicates that they provide intermediate levels of ecological and socio-cultural services;
- The PES of the features was calculated using Wet-Health and was found to be in a PES Category C (moderately modified);
- As with the seep wetland features, these wetlands may be considered ecologically important and sensitive on a local or provincial scale, however the biodiversity is unlikely to be sensitive to habitat and flow modifications. The depression wetlands obtained a score placing them in an EIS Category C; and
- Based on the above, an REC C was assigned to the depression wetlands.

Summary

In summary, the results of the wetland and riparian assessments indicate that overall, the various riparian and wetland resources can be considered to be in **moderately modified** condition, indicating that loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.

Impacts on the resources include:

- Altered hydrology due to changing catchment uses such as subsistence agriculture (abstraction, increased run-off due to vegetation losses), small-scale and localised abstraction of water for domestic purposes, and localised increased on-site water usage by alien invasive vegetation such as *Acacia mearnsii* and *Eucalyptus cameldulensis*;
- Increased sediment inputs as a result of extensive and often severe erosion within the study area and greater catchment are anticipated, thus altering the sediment loads within riparian and wetland features;
- Incision and erosion of stream banks is considered severe in some sections of the tributaries of the Tsitsa; and
- Wetland and riparian floral communities have undergone varying degrees of transformation due to removal for small-scale agriculture, overgrazing and trampling by domestic livestock, and alien vegetation encroachment.

DELINEATION AND SENSITIVITY MAPPING

All features were delineated on a desktop level with the use of aerial photographs, digital satellite imagery and topographical maps. As described in Section 3.2.1 of this report, points of interest were identified prior to the site assessments in order to guide the field assessment. Where wetland features were identified during the field survey at these points of interest, portions of the features were verified according to the guidelines advocated by DWA (2005) utilising terrain units, soil form indicators and vegetation indicators.

The use of buffer zones for wetlands is alluded to in: Environmental Best Practice Guidelines: Planning (Water supply and water resource infrastructure) as published by DWA in 2005, and the legislative principles as enshrined in the National Environmental Management Act (NEMA) (Activity 9 and 11 listing 1 of Government Notice R544 and Activity 16 Listing 3 of Government Notice R546 of 2010) prescribe a minimum 32m buffer around the wetland and riparian resource. Any activities proposed within the wetland or riparian boundaries, including rehabilitation, must be authorised by the DWS in terms of Section 21 (c) & (i) of the National Water Act (Act 36 of 1998). Since a Section 21 c & i WUL will be applied for, and due to the vast extent of the various components of the project, detailed mapping of unaffected wetlands within 500m of the proposed infrastructure did not take place in the field but were delineated with the aid of digital satellite imagery.

It is recognised however that due to the nature of the Mzimvubu Water Project, avoidance of construction or impact within a wetland or riverine resource is not possible for all riparian and wetland features identified within the study area, as the construction of the dams will entail inundating several wetland features. Additionally, roads and pipelines may be planned to traverse wetland features; thus it will not be feasible to implement a buffer zone around all wetland features affected by the project. Effective mitigation must be implemented in order to reduce the level of impacts on the wetland features which will be negatively impacted by the construction of the proposed Ntabelanga and Lalini Dams in particular, as it is anticipated that this will result in the loss of wetland habitat and service provision in those areas. Furthermore, due to the linear nature of roads and pipelines, it is acknowledged that a buffer zone cannot be effectively implemented around the wetland features which will be crossed by such infrastructure. Nevertheless, mitigation measures must be implemented in order to, where possible, avoid and minimise impacts on such features.

Based on the results of the study, it is clear that the wetlands which will be directly impacted by the project provide important ecological services in the way of sediment trapping, nutrient cycling and toxicant assimilation, flood attenuation and biodiversity maintenance. In view of the extensive, and often severe, erosion within the study area and greater catchment, sediment trapping is especially important. The proposed Mzimvubu Water Project has the potential to lead to loss of niche habitat for wetland-dependent faunal and floral taxa and/or alteration of the aquatic and riparian resources on the study area, with particular mention of the impacts that the two dams will have on the Tsitsa River and its tributaries, as well as the associated wetland and riparian resources.

The anticipated cumulative loss of riparian and wetland habitat arising from the construction of the dams is estimated to be 1034.30 hectares; overall this is deemed to be a relatively insignificant fraction of the wetland resources within the Mzimvubu subWMA. The approximate loss of wetlands as a result of the construction of each dam is presented in the table below:

Anticipated approximate loss of riparian and wetland habitat as a result of the construction of the dams.

Ntabelanga Dam		Lalini Dam	
Resource	**Hectares lost**	**Resource**	**Hectares lost**
Tsita River	246.09	Tsitsa River	550.91
Tributaries	23.20	Tributaries	0
Seeps	15.11	Seeps	0
Channelled Valley Bottom	37.20	Channelled Valley Bottom	0
Drainage Lines	89.93	Drainage Lines	71.85
TOTAL	**411.53**	**TOTAL**	**622.76**

IMPACT ASSESSMENT

The following table summarises the perceived impacts before and after the implementation of mitigation measures. The Ntabelanga and Lalini Dams will have the greatest impact on wetland and riparian habitat, as wetland habitat will be permanently lost during the first filling.

Summary of perceived impacts of the construction and operation of the two dams and their associated infrastructure on wetland and riparian ecology.

Impact	Construction and First Filling		Operational Phase	
Mitigation Status	**Unmitigated**	**Mitigated**	**Unmitigated**	**Mitigated**
Roads and pipelines: impact on habitat	Low	Very Low	Low	Very Low
Roads and pipelines: impact on ecoservices	Low	Very Low	Low	Very Low
Roads and pipelines: impact on hydrology and sediment balance	Low	Very Low	Low	Very Low
Electricity generation and distribution: impact on habitat	Low	Very Low	Medium Low	Very Low
Electricity generation and distribution: impact on ecoservices	Low	Very Low	Medium Low	Very Low
Electricity generation and distribution: impact on hydrology and sediment balance	Low	Very Low	Medium Low	Very Low
Ntabelanga and Lalini Dams: impact on habitat	High	High	Medium High	Medium High
Ntabelanga and Lalini Dams: impact on ecoservices	High	High	Medium High	Medium High

Ntabelanga and Lalini Dams: impact on hydrology and sediment balance	High	High	Medium High	Medium High

Key Mitigation Measures

The essential mitigation measures referred to in Section 6: General Management and Good Housekeeping Practices must be adhered to, in addition to the key mitigation measures presented in Sections 7 to 9. These key mitigation measures are:

- Areas of increased sensitivity as shown in the sensitivity and buffer zone maps developed (**Figures 22-23 and 30-31**) should ideally be avoided in terms of the placement of infrastructure in order to minimise the footprints within wetland features. However, it is acknowledged that due to the scale of this project and the mountainous terrain within which much of the infrastructure is planned, it will not always be possible to completely avoid all wetland or riparian habitat. In such instances, mitigation measures to limit the impacts (such as ensuring the design of crossings allows for the retention of wetland soil conditions as discussed in Section 9 of this report) must be implemented;
- Quarries and borrow pits should ideally be placed within the dam footprints in order to preserve wetland and riparian habitat outside of the dam footprints, and to reduce sedimentation of the riparian resources. According to the EAP this has been achieved;
- Minimise the construction footprints and implement strict controls of edge effects;
- Erosion management and sediment controls such as the use of gabions or reno mattresses, revegetation of profiled slopes, erosion berms, drift fences with hessian and silt traps must be strictly implemented from the outset of construction activities;
- It is critical that an alien vegetation control programme is implemented, as encroachment of alien vegetation is already apparent in the study area and is expected to increase as a result of the disturbances resulting during the construction process. Rehabilitation of disturbed areas, utilising indigenous wetland vegetation species, will assist in retaining essential wetland ecological services, particularly flood attenuation, sediment trapping and erosion control, and assimilation of nutrients and toxicants, thus reducing the impacts of construction related activities;
- Implement measures such as sediment control, and prevention of pollution (solid wastes, oil spills, discharge of sewage) to minimise impacts on the water quality of nearby adjacent rivers;
- Support structures for pipelines must be placed outside of riparian features, channelled valley bottom wetlands and drainage lines. Should it be essential to place such support structures within these features, the designs of such structures must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels. In order to achieve this all crossings of wetlands should take place at right angles wherever possible;
- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- During operations and maintenance of infrastructure, vehicles must remain on designated roads and not be permitted to drive through sensitive wetland / riparian habitat, particularly on the edges of the dams where loss of wetland habitat and therefore ability of the wetlands to provide ecological services, is already compromised.
- Maintenance personnel must ensure that any tools and/or waste products resulting from maintenance activities are removed from the site following completion of maintenance.
- Wherever possible, it is preferable that existing roads be upgraded, rather than constructing new roads, in order to minimise the impact of construction on wetland / riparian habitat;

- Where it is necessary to traverse features such as drainage lines, channelled valley bottom wetlands and riparian habitat, the crossing designs of bridges must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels. In order to achieve this all crossings of wetlands should take place at right angles wherever possible;
- If it is absolutely unavoidable that wetland / riparian habitat is affected during the construction of new roads, especially during bridge or culvert construction, disturbance to any wetland crossings must be minimised and suitably rehabilitated. The design of such culverts / bridges should allow for wetland soil conditions to be maintained both upstream and downstream of the crossing to such a degree that wetland vegetation community structures upstream and downstream of the crossing are maintained. In this regard, special mention is made of:
    - The design of such culverts and/or bridges should ensure that the permanent wetland zone should have inundated soil conditions throughout the year extending to the soil surface;
    - The design of such culverts and/or bridges should ensure that the seasonal wetland zone should have water-logged soils within 500mm of the soil surface during the summer rainfall period;
    - Temporary wetland zone areas should have waterlogged soil conditions occurring to within 300m of the land surface during the summer rainfall period;
- Ensure that no incision and canalisation of the wetland system takes place as a result of the construction of the culverts;
- It must be ensured that flow connectivity along the wetland features is maintained;
- Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles;
- Monitor all systems for incision and sedimentation;
- As much vegetation growth as possible should be promoted within the wetland areas in order to protect soils. In this regard, special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting (where applicable) are to be implemented;
- Regular maintenance of all roads, with specific mention of wetland / riparian crossings, must take place in order to minimise the risk of further degradation to wetland / riparian habitat.

The first filling of the dams will result in the permanent loss of wetland habitat; due to the nature of the development, this cannot be avoided. It is therefore imperative that measures are taken in order to minimise the impact on those portions of the **affected wetland features which will not be inundated with special mention of areas downstream of the proposed dams.**

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE MZIMVUBU WATER PROJECT – WETLAND ASSESSMENT

DEA REF No. 14/12/16/3/3/2/677 (Dam construction application)
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ACRONYMS AND ABBREVIATIONS

BGIS	Biodiversity Geographic Information System
DEAT	Department of Environmental Affairs and Tourism
DEMC	Desired Ecological Management Class
DMs	District Municipalities
DWA	Department of Water Affairs (former DWS)
DWS	**Department of Water and Sanitation**
EAP	Environmental Assessment Practitioner
EC	Ecological Class
EI	Ecological Importance
EIA	Environment Impact Assessment
EIS	Ecological Importance and Sensitivity
EMC	Ecological Management Class
EMPR	Environmental Management Programme
ES	Ecological Sensitivity
FEPA	Freshwater Ecosystem Priority Areas
GIS	Geographic Information System
GPS	Global Positioning System
HGM	Hydrogeomorphic
IHI	Index of Habitat Integrity
IAIA	International Affiliation for Impact Assessments
MPRDA	Mineral and Petroleum Resources Development Act
NAEHMP	National Aquatic Ecosystem Health Monitoring Programme
NEMA	National Environmental Management Act
NEMBA	National Environmental Management: Biodiversity Act
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
PES	Present Ecological State
PEMC	Present Ecological Management Class
PES	Present Ecological State
QDS	Quarter Degree Square
REC	Recommended Ecological Category
RHP	River Health Program
SACNASP	South African Council for Natural Scientific Professions
SANBI	South African National Biodiversity Institute
SAS	Scientific Aquatic Services
WMA	Water Management Area

LIST OF UNITS

MW	Mega Watt
m	Meters

km^2	Square Kilometre
ha	Hectare
°C	Degrees Celsius
%	Percentage
m^3	Cubic meter
km	Kilometre

1 INTRODUCTION

1.1 BACKGROUND

The Department of Water and Sanitation (DWS) commissioned the Mzimvubu Water Project, an integrated multi-purpose (domestic water supply, agriculture, power generation, transport, tourism, conservation and industry) project, with the intention of providing a socio-economic development opportunity for the region.

Environmental authorisation is required for the infrastructure components of the project. The purpose of the Environmental Impact Assessment (EIA) is to assess the components of the project that are listed activities by the National Environmental Management Act (NEMA) for which the DWS has the mandate and intention to implement. The EIA process will provide the information that the environmental authorities require to decide whether the project should be authorised or not, and if so then under what conditions.

As part of this EIA process Scientific Aquatic Services have been contracted to undertake a Wetland Assessment for the proposed development of:

- the Ntabelanga Dam;
- the Lalini Dam;
- associated infrastructure, including gauging weirs, reservoirs, Waste Water Treatment Works (WWTWs), accommodation for operational staff, borrow pits and construction materials quarries, information centres, river intake structures, hydro tunnels and pipelines;
- miscellaneous construction camps, lay down areas and storage sites;
- road and bridge upgrades, construction and relocation; and
- irrigation, primary and secondary bulk potable water infrastructure.

Reference will be made to the specific developments accordingly (hereinafter collectively referred to as the “study area”).

The Lalini Dam, fed by the Tsitsa River, is situated approximately 17km north east of the small town Tsolo. The Ntabelanga Dam, located approximately 25km east of the town Maclear and north of the R396, has an inundation extent of 2333.45ha (**Figure 1**). The road upgrades run along the northern and southern boundaries of Ntabelanga Dam, passing through the settlements of Mpetsheni in the north and near the town Waca in the south. The secondary and primary pipelines traverse the study area crossing the N2 and R396 at different points, with the northern most pipelines crossing the Thina River.

The study area is surrounded by land used for agricultural, forestry and rural settlements. The ecological assessment was confined to the study area and did not include an ecological assessment of surrounding properties. The surrounding area was however considered as part of the desktop assessment of the area as well as during general movement through the area by road and on foot.

1.2 PURPOSE OF THIS REPORT

This report, after consideration of the ecological integrity of the study area, must guide the Environmental Assessment Practitioner (EAP) and regulatory authorities, by means of the presentation of results and recommendations, as to the ecological viability of the proposed development activities.

1.3 DETAILS AND EXPERTISE OF THE SPECIALISTS

Stephen van Staden

Stephen van Staden completed an undergraduate degree in Zoology, Geography and Environmental Management at RAU. On completion of this degree, he undertook an honours course in Aquatic health through the Zoology department at RAU. In 2002 he began a Master's degree in environmental management, where he did his mini dissertation in the field of aquatic resource management, also undertaken at RAU. At the same time, Stephen began building a career by first working at an environmental consultancy specialising in town planning developments, after which he moved to a larger firm in late 2002. From 2002 to the end of 2003, he managed the monitoring division and acted as a specialist consultant on water resource management issues and other environmental processes and applications. In late 2003, Stephen started consulting as an independent environmental scientist, specialising in water resource management under the banner of Scientific Aquatic Services. In addition to aquatic ecological assessments, clients started enquiring about terrestrial ecological assessments and biodiversity assessments. Stephen, in conjunction with other qualified ecologists, began facilitating these studies as well as highly specialised studies on specific endangered species, including grass owls and arachnids and invertebrates and various vegetation species. Scientific Aquatic Services soon became recognised as a company capable of producing high quality terrestrial ecological assessments. Stephen soon began diversifying into other fields, including the development of EIA process, EMPR activities and mine closure ad rehabilitation studies.

Stephen has experience on well over 1000 environmental assessment projects with specific mention of aquatic and wetland ecological studies as well as terrestrial ecological assessments and project management of environmental studies. Stephen has a professional career spanning more than 10 years, of which almost ten years have been as the owner and Managing member of Scientific Aquatic Services and the project manager on most projects undertaken by the company. Stephen has undertaken studies throughout Africa with work having been undertaken in South Africa; Lesotho; Angola; Botswana; Tanzania; Liberia; Guinea Bissau; Ghana; Democratic Republic of Congo and Mozambique.

Stephen is registered by the SA RHP as an accredited aquatic biomonitoring specialist and is also registered as a Professional Natural Scientist with the South African Council for Natural Scientific Professions (SACNASP) in the field of ecology. Stephen is also a member of the Gauteng Wetland Forum and South African Soil Surveyors Association (SASSO).

Amanda Mileson

Born and raised in Zimbabwe, Amanda's fascination with, and love for the natural world was ignited at an early age, with a particular interest in zoology. After completing secondary school in

1994, Amanda participated in an exchange year in Australia, sponsored by Rotary International. Upon her return to Zimbabwe, Amanda's professional career commenced in retail photography before moving on to a two year stint as an Account Executive with a well-known advertising agency. The ever deteriorating situation in Zimbabwe led Amanda to seek opportunities overseas, and she spent two years in Birmingham, England, during which time Amanda made the decision to return to Africa.

Upon her relocation to South Africa in 2007, Amanda volunteered part-time at FreeMe Wildlife Rehabilitation Centre in Johannesburg (2007-2009), gaining experience in the general husbandry, nutrition and basic veterinary treatment of avian and mammal species. This strengthened her resolve to study further, and in 2010 she enrolled with UNISA to study a National Diploma in Nature Conservation. In order to align her career with her studies, Amanda took up the position of PA to the CEO of the Johannesburg Zoo in October 2011, rapidly learning the ins and outs of one of the most unique businesses in the world. Driven to gain as much relevant experience as possible, Amanda job shadowed curatorial staff and veterinarians in her spare time, organised a volunteer programme for other Nature Conservation students to gain practical experience, and even spent a few icy winter nights at the Zoo feeding Wattled Crane chicks throughout the night.

Additionally, Amanda has participated in field work on projects which seek to ascertain the effect of wind farms on bats in South Africa, and provided administrative support to the Jane Goodall Institute South Africa and the African Association of Zoos and Aquaria on a volunteer basis.

Amanda joined Scientific Aquatic Services in September 2013 as a Junior Field Ecologist focusing on wetland ecology and zoology, building a career as a scientist.

Amanda is a member of the Gauteng Wetland Forum and the South African Wetland Society.

1.4 STRUCTURE OF THIS REPORT

This specialist study is undertaken in compliance with Regulation 32 of GN 543. **Table 1** below indicates how the requirements of Regulation 32 of GN 543 have been fulfilled in this report.

Table 1: Report content requirements in terms of Regulation 32 of GN 543

Regulatory Requirements in terms of Regulation 32 of GN 543	Section of Report
(a) The person who prepared the report; and the expertise of that person to carry out the specialist study or specialised process.	Chapter 1
(b) a declaration that the person is independent	Page iv
(c) an indication of the scope of, and the purpose for which, the report was prepared	Chapters 1 and 3
(d) a description of the methodology adopted in preparing the report or carrying out the specialised process	Chapter 3
(e) a description of any assumptions made and any uncertainties or gaps in knowledge	Chapter 4
(f) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Chapters 6 to 9
(g) recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority	Chapters 6 to 9
(h) a description of any consultation process that was undertaken during the course of	Chapter 11

Regulatory Requirements in terms of Regulation 32 of GN 543	Section of Report
carrying out the study	
(i) a summary and copies of any comments that were received during any consultation process	Chapter 11
(j) any other information requested by the competent authority.	Chapter 12

2 PROJECT BACKGROUND SUMMARY

2.1 LOCALITY

The project footprint spreads over three District Municipalities (DMs) namely the Joe Gqabi DM in the north west, the OR Tambo DM in the south west and the Alfred Nzo DM in the east and north east.

The proposed Ntabelanga Dam site is located approximately 25 km east of the town of Maclear and north of the R396 Road. The proposed Lalini Dam site is situated approximately 17 km north east of the small town Tsolo. Both are situated on the Tsitsa River.

2.2 MAIN PROJECT COMPONENTS

The project forms a large integrated project with several components. The proposed water resource infrastructure includes:

- A dam at the Ntabelanga site with a storage capacity of 490 million m^3;
- A dam at the Lalini site with a storage capacity of approximately 150 million m^3;
- A pipeline and tunnel, and a power house at the Lalini Dam site for generating hydropower;
- Five new flow measuring weirs will be required in order to measure the flow that is entering and released from the dams. These flow gauging points will be important for monitoring the implementation of the Reserve and for operation of the dams.
- Wastewater treatment works at the dam sites;
- Accommodation for operations staff at the dam sites; and
- Two information centres at the dam sites.

The Ntabelanga Dam will supply potable water to 539 000 people, rising to 730 000 people by year 2050. The domestic water supply infrastructure will include:

- A river intake structure and associated works;
- Water treatment works;
- Potable bulk water distribution infrastructure for domestic and industrial water requirements (primary and secondary distribution lines);
- Bulk treated water storage reservoirs strategically located; and
- Pumping stations.

The Ntabelanga Dam will also provide water to irrigate approximately 2 900 ha. of arable land. This project includes bulk water conveyance infrastructure for raw water supply to edge of field.

About 2 450 ha of the high potential land suitable for irrigated agriculture are in the Tsolo area and the rest near the proposed Ntabelanga Dam and along the river, close to the villages of Machibini, Nxotwe, Culunca, Ntshongweni, Caba, Kwatsha and Luxeni.

There will be a small hydropower plant at the Ntabelanga Dam to generate between 0.75 MW and 5 MW (average 2.1 MW). This will comprise a raw water pipeline from the dam to a building containing the hydropower turbines and associated equipment, and a discharge pipeline back to the river just below the dam wall. The impact is expected to be similar to that of a pumping station.

The hydropower plant at the proposed Lalini Dam and tunnel (used conjunctively with the Ntabelanga Dam) will generate an average output of 35 MW when operated as a base load power station and up to 180 MW if operated as a peaking power station. The power plant will require a pipeline (approximately 4.6 km) and tunnel (approximately 3.2 km) linking the dam to the power plant downstream of the dam and below the gorge.

The power line to link the Lalini power station to the existing Eskom grid will be approximately 18.5 km and the power line linking the Ntabelanga Dam to the Eskom grid will be approximately 13 km. Power lines will be constructed to supply power for construction at the two dam sites and for operating five pumping and booster stations along the bulk distribution infrastructure.

The area to be inundated by the dams will submerge some roads. Approximately 80 km of local roads will therefore be re-aligned. Additional local roads will also be upgraded to support social and economic development in the area. The road design will be very similar to the existing roads as well as be constructed using similar materials.

The project is expected to cost R 12.45 billion and an annual income of R 5.9 billion is expected to be generated by or as a result of the project during construction and R 1.6 billion per annum during operation. It will create 3 880 new skilled employment opportunities and 2 930 un-skilled employment opportunities during construction.

2.3 ALTERNATIVES

The following project level alternatives will be assessed:

- Three hydro power tunnel positions and associated power lines;
- Peak versus Base load power generation;
- Three different dam sizes for the Lalini Dam; and
- The no project option.

For the construction camps, pipeline routes and new roads, the specialist will identify any sensitive areas and deviations to avoid these will be proposed in consultation with the technical team.

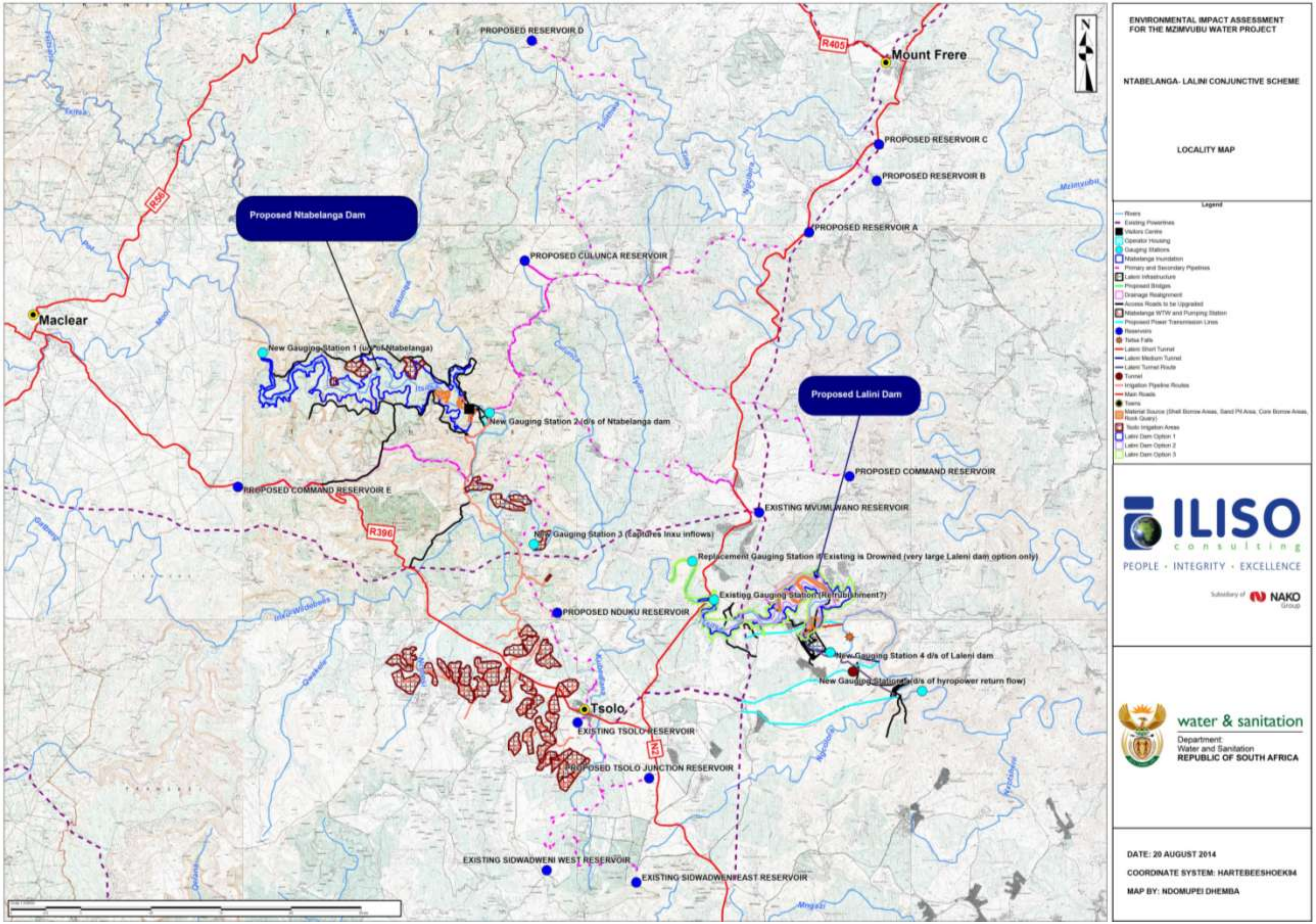

Figure 1: Locality map

3 TERMS OF REFERENCE

3.1 SCOPE OF THE STUDY

The purpose of this report is to provide a summary of the wetland resource delineation, Present Ecological State (PES) and function, as well as to conduct an impact assessment and develop mitigation measures, as part of the Environmental Assessment and authorisation process for the Mzimvubu Water Project in order to inform the Environmental Assessment Practitioners (EAP) as well as the proponent and relevant authorities as to the best use of the resources in the area, and in order to ensure that adequate impact mitigation is implemented into the project plan, should the proposed development proceed.

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

- Identify and map 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);
- Delineate wetland resources and riparian zones within the focus study area. Due to the scale of the project, delineation was undertaken using desktop methods and digital satellite imagery. In the field, verification of the wetland delineation took place according to the guidelines as defined by (DWA, 2005);
- Determine function and service provision of wetland systems according to the method supplied by Kotze *et al* (2009);
- Define the wetland health of the systems within the study area according to the resource directed measures guideline described by Macfarlane *et al.* (2008) or the WET-IHI method described by the DWA (2007) (as applicable) and thereby define the PES of the wetland resources to be affected by the proposed Mzimvubu Dam Project;
- Define the wetland Ecological Importance and Sensitivity (EIS) and Recommended Ecological Category (REC) for the wetland systems (DWA, 1999);
- Consider potential impacts on the wetland habitat and the ecological communities likely as a result of the proposed development; and
- Present management and mitigation measures in order to minimise the impacts that the proposed expansion will have on the wetland resources in line with the mitigation Hierarchy, as defined by the DMR (2013), followed by an assessment of the significance of the impacts after mitigation, assuming that they are fully implemented.

3.2 METHODOLOGY

3.2.1 Wetland Site Selection and Field Verification

Use was made of digital satellite imagery as well as provincial and national wetland databases to identify points of interest prior to the field survey. Points of interest were defined taking the following into consideration:

- Ensuring that detailed assessments took place in the vicinity of the Ntabelanga and Lalini dams footprints;

- As far as possible assessing crossings where proposed road infrastructure and pipelines will cross wetland resources;
- Ensuring a geographic spread of points to ensure that conditions in all areas were addressed; and
- Ensuring that features displaying a diversity of digital signatures were identified in order to allow for field verification. In this regard specific mention is made of the following:
  - Riparian vegetation: a distinct increase in density as well as tree size near drainage lines;
  - Hue: with drainage lines and outcrops displaying soils of varying chroma created by varying vegetation cover and soil conditions identified;
  - Surface water: to aid with the identification of artificial impoundments that may sustain wetland habitat the presence of surface water were considered informative; and
  - Texture: with areas displaying various textures, created by varying vegetation cover and soil conditions being identified.

Two site visits were undertaken during April and June 2014 to assess points of interest which were identified during the desktop assessment phase. The presence of any wetland characteristics as defined by the DWA (2005) or riparian habitat as defined by the NWA (Act 36 of 1998) was noted at each river, drainage line, and seepage area to determine if features can be considered to contain areas displaying wetland or riparian characteristics. Any additional wetland areas encountered during the site visit were noted and mapped. Factors influencing the habitat integrity of each feature group identified during the field survey was noted, and the functioning and the ecological and socio-cultural services provided by the various features was determined.

3.2.2 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)
  - NFEPA wetlands/National wetlands map
  - Wetland and estuary FEPA
  - 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

3.2.3 Classification System for Wetlands and other Aquatic Ecosystems in South Africa (2013)

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 2 and 3**, below.

Table 2: Classification structure for Inland Systems, up to Level 3.

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	LEVEL 2: REGIONAL SETTING	LEVEL 3: LANDSCAPE UNIT
Inland Systems	DWS Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain
		Bench (Hilltop / Saddle / Shelf)

Table 3: Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

<table>
<tr><th colspan="3">FUNCTIONAL UNIT</th></tr>
<tr><th colspan="3">LEVEL 4:
HYDROGEOMORPHIC (HGM) UNIT</th></tr>
<tr><td>HGM type</td><td>Longitudinal zonation/ Landform / Outflow drainage</td><td>Landform / Inflow drainage</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td rowspan="18">River</td><td rowspan="2">Mountain headwater stream</td><td>Active channel</td></tr>
<tr><td>Riparian zone</td></tr>
<tr><td rowspan="2">Mountain stream</td><td>Active channel</td></tr>
<tr><td>Riparian zone</td></tr>
<tr><td rowspan="2">Transitional</td><td>Active channel</td></tr>
<tr><td>Riparian zone</td></tr>
<tr><td rowspan="2">Upper foothills</td><td>Active channel</td></tr>
<tr><td>Riparian zone</td></tr>
<tr><td rowspan="2">Lower foothills</td><td>Active channel</td></tr>
<tr><td>Riparian zone</td></tr>
<tr><td rowspan="2">Lowland river</td><td>Active channel</td></tr>
<tr><td>Riparian zone</td></tr>
<tr><td rowspan="2">Rejuvenated bedrock fall</td><td>Active channel</td></tr>
<tr><td>Riparian zone</td></tr>
<tr><td rowspan="2">Rejuvenated foothills</td><td>Active channel</td></tr>
<tr><td>Riparian zone</td></tr>
<tr><td rowspan="2">Upland floodplain</td><td>Active channel</td></tr>
<tr><td>Riparian zone</td></tr>
<tr><td>Channelled valley-bottom wetland</td><td>(not applicable)</td><td>(not applicable)</td></tr>
<tr><td>Unchannelled valley-bottom wetland</td><td>(not applicable)</td><td>(not applicable)</td></tr>
<tr><td rowspan="2">Floodplain wetland</td><td>Floodplain depression</td><td>(not applicable)</td></tr>
<tr><td>Floodplain flat</td><td>(not applicable)</td></tr>
<tr><td rowspan="6">Depression</td><td rowspan="2">Exorheic</td><td>With channelled inflow</td></tr>
<tr><td>Without channelled inflow</td></tr>
<tr><td rowspan="2">Endorheic</td><td>With channelled inflow</td></tr>
<tr><td>Without channelled inflow</td></tr>
<tr><td rowspan="2">Dammed</td><td>With channelled inflow</td></tr>
<tr><td>Without channelled inflow</td></tr>
<tr><td rowspan="2">Seep</td><td>With channelled outflow</td><td>(not applicable)</td></tr>
<tr><td>Without channelled outflow</td><td>(not applicable)</td></tr>
<tr><td>Wetland flat</td><td>(not applicable)</td><td>(not applicable)</td></tr>
</table>

3.2.3.1 Level 1: Inland systems

From the classification system, Inland Systems are defined as **an aquatic ecosystem that have no existing connection to the ocean**[1] (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.

[1] 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.

3.2.3.2 Level 2: Ecoregions & NFEPA Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that will be included at Level 2 of the classification system is that of DWS'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 2** below). DWS Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) groups 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) will be 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.

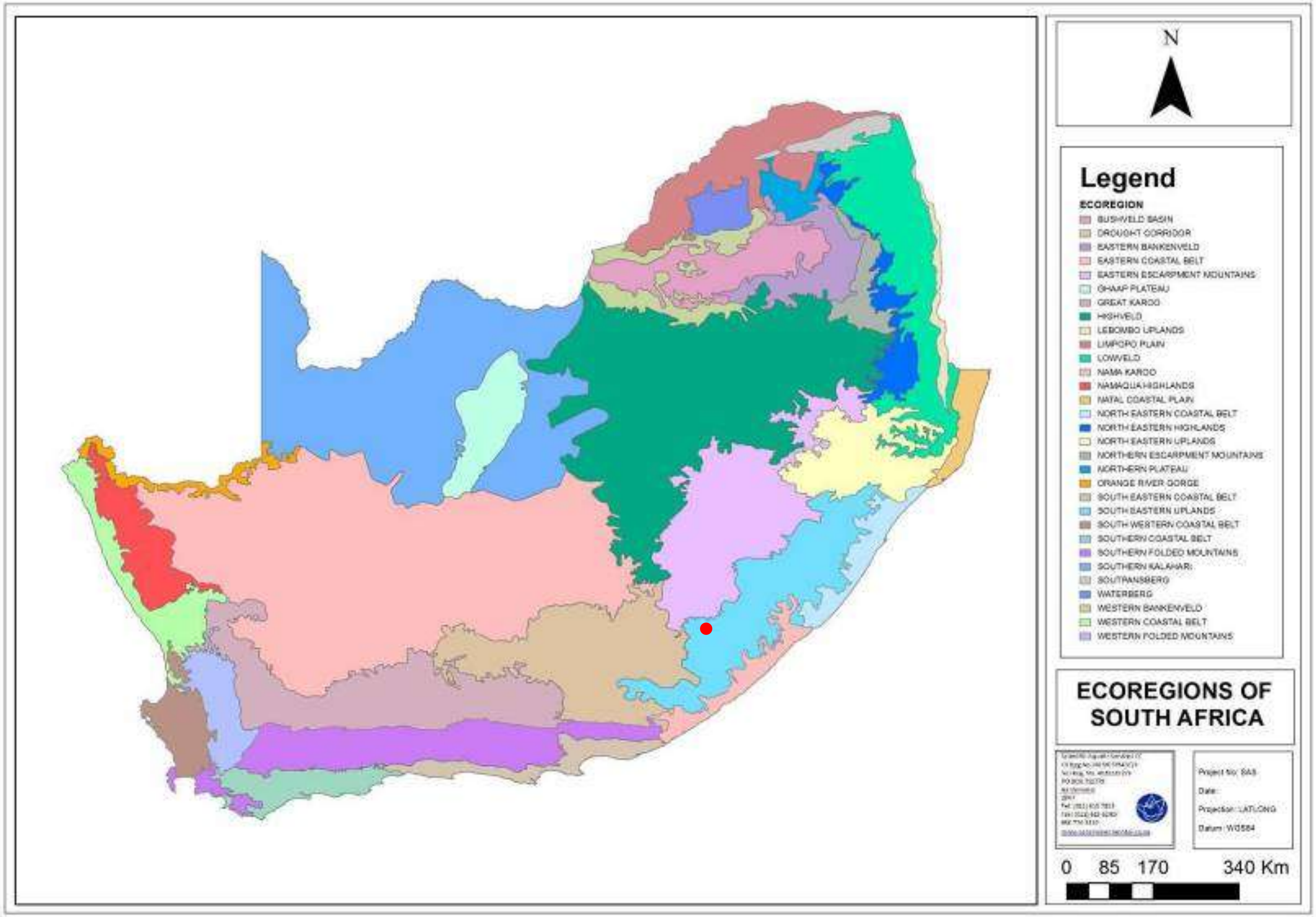

Figure 2: Map of Level 1 Ecoregions of South Africa, with the approximate position of the study area indicated in red.

3.2.3.3 Level 3: Landscape Setting

At Level 3 of the proposed classification System, for Inland Systems, a distinction will be made between four Landscape Units 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; and
- **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).

3.2.3.4 Level 4: Hydrogeomorphic Units

Eight primary HGM Types are recognised for Inland Systems at Level 4A of the classification system, 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; and
- **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 will be 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*., 2008).

3.2.4 Wet-Ecoservices (2008)

"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".[2] The assessment of the ecosystem services supplied by the identified wetlands will be conducted according to the guidelines as described by Kotze *et al* (2008). An assessment will be undertaken to examine and rate the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation;
- Stream flow regulation;
- 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; and
- Education and research.

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

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

Table 5: 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.
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.

3.2.5 Index of Habitat Integrity (IHI)

To assess the Present Ecological State (PES) of the drainage feature the Index of Habitat Integrity (IHI) for South African floodplain, channelled and channelled valley bottom wetland types (DWAF Resource Quality Services, 2007) will be 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 6** below), and provide a score of the PES of the habitat integrity of the wetland system being examined.

Table 6: 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.
D	40-60%	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred. E 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.

3.2.6 WET-Health

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[3] is to evaluate the ecophysical health of wetlands, and in so doing promote their conservation and wise management.

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; and
- Level 2: On-site evaluation. This involves structured sampling and data collection in a single wetland and its surrounding catchment.

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).

Units of Assessment

[3] Kleynhans et al., 2007

Central to WET-Health is the characterisation of HGM units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom; 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 under the *Classification System for Wetlands and other Aquatic Ecosystems*.

Quantification of Present State of a wetland

The overall approach will be 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 will take 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 will then be combined to determine an overall *magnitude* of impact. The impact scores and Present State categories are provided in **Table 7.**

Table 7: 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

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 from 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 8**).

Table 8: 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	↓↓

Overall health of the wetland

Once all HGM units have been assessed, a summary of health for the wetland as a whole will 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 will provide a summary of impacts, Present State, Trajectory of Change and Health for individual HGM units and for the entire wetland.

3.2.7 Ecological Importance and Sensitivity (EIS)

The method that will be used for the EIS determination was adapted from the method as provided by DWA (1999) for wetlands. 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 will be assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The median of the determinants will then be used to assign the EIS category as listed in **Table 9** below.

Table 9: Descriptions of the EIS Categories.

EIS Category	Range of Mean	Recommended Ecological Management Class[4]
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

3.2.8 Riparian Vegetation Response Assessment Index (VEGRAI; 2007)

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.

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[5]. 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).

[4] Ed’s note: Author to confirm exact wording for version 1.1
[5] Kleynhans *et al*, 2007

Table 10: 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

3.3 IMPACT CRITERIA AND RATING SCALE

The wetland impacts are rated in accordance with the Environmental Impact Assessment Regulations, 2010 and the criteria drawn from the IEM Guidelines Series, Guideline 5: Assessment of Alternatives and Impacts, published by the (DEAT, 2006) as well as the Guideline Document on Impact Significance (DEAT, 2002).

The key issues identified during the Scoping Phase inform the terms of reference of this specialist study. Each issue consists of components that on their own or in combination with each other give rise to potential impacts, either positive or negative, from the project onto the environment or from the environment onto the project. The significance of the potential impacts is considered before and after identified mitigation is implemented, for direct, indirect, and cumulative impacts, in the short and long term.

A description of the nature of the impact, any specific legal requirements and the stage (construction/decommissioning or operation) is given. Impacts are considered to be the same during construction and decommissioning.

The following criteria has been used to evaluate significance:

- **Nature:** This is an appraisal of the type of effect the activity is likely to have on the affected environment. The description includes what is being affected and how. The nature of the impact will be classified as positive or negative, and direct or indirect.

- **Extent and location:** This indicates the spatial area that may be affected (**Table 11**:)

Table 11: Geographical extent of impact

Rating	Extent	Description
1	Site	Impacted area is only at the site – the actual extent of the activity.
2	Local	Impacted area is limited to the site and its immediate surrounding area
3	Regional	Impacted area extends to the surrounding area, the immediate and the neighbouring properties.
4	Provincial	Impact considered of provincial importance
5	National	Impact considered of national importance – will affect entire country.

- **Duration:** This measures the lifetime of the impact (**Table 12**).

Table 12: Duration of Impact

Rating	Duration	Description
1	Short term	0 – 3 years, or length of construction period
2	Medium term	3 – 10 years
3	Long term	> 10 years, or entire operational life of project.
4	Permanent – mitigated	Mitigation measures of natural process will reduce impact – impact will remain after operational life of project.
5	Permanent – no mitigation	No mitigation measures of natural process will reduce impact after implementation – impact will remain after operational life of project.

- **Intensity/severity:** This is the degree to which the project affects or changes the environment; it includes a measure of the reversibility of impacts (**Table 13**).

Table 13: Intensity of Impact

Rating	Intensity	Description
1	Negligible	Change is slight, often not noticeable, natural functioning of environment not affected.
2	Low	Natural functioning of environment is minimally affected. Natural, cultural and social functions and processes can be reversed to their original state.
3	Medium	Environment remarkably altered, still functions, if in modified way. Negative impacts cannot be fully reversed.
4	High	Cultural and social functions and processes disturbed – potentially ceasing to function temporarily.
5	Very high	Natural, cultural and social functions and processes permanently cease, and valued, important, sensitive or vulnerable systems or communities are substantially affected. Negative impacts cannot be reversed.

- **Potential for irreplaceable loss of resources:** This is the degree to which the project will cause loss of resources that are irreplaceable (**Table 14**).

Table 14: Potential for irreplaceable loss of resources

Rating	Potential for irreplaceable loss of resources	Description
1	Low	No irreplaceable resources will be impacted.
3	Medium	Resources can be replaced, with effort.
5	High	There is no potential for replacing a particular vulnerable resource that will be impacted.

- **Probability:** This is the likelihood or the chances that the impact will occur (**Table 15**).

Table 15: Probability of Impact

Rating	Probability	Description
1	Improbable	Under normal conditions, no impacts expected.
2	Low	The probability of the impact to occur is low due to its design or historic experience.
3	Medium	There is a distinct probability of the impact occurring.
4	High	It is most likely that the impact will occur
5	Definite	The impact will occur regardless of any prevention measures.

- **Confidence:** This is the level of knowledge or information available, the environmental impact practitioner or a specialist had in his/her judgement (**Table 16**).

Table 16: Confidence in level of knowledge or information

Rating	Confidence	Description
	Low	Judgement based on intuition, not knowledge / information.
	Medium	Common sense and general knowledge informs decision.
	High	Scientific / proven information informs decision.

- **Consequence:** This is calculated as extent + duration + intensity + potential impact on irreplaceable resources.

- **Significance:** The significance will be rated by combining the consequence of the impact and the probability of occurrence (i.e. consequence x probability = significance). The maximum value which can be obtained is 100 significance points (**Table 17**).

Table 17: Significance of issues (based on parameters)

Rating	Significance	Description
1-14	Very low	No action required.
15-29	Low	Impacts are within the acceptable range.
30-44	Medium-low	Impacts are within the acceptable range but should be mitigated to lower significance levels wherever possible.
45-59	Medium-high	Impacts are important and require attention; mitigation is required to reduce the negative impacts to acceptable levels.
60-80	High	Impacts are of great importance, mitigation is crucial.
81-100	Very high	Impacts are unacceptable.

- **Cumulative Impacts:** This refers to the combined, incremental effects of the impact. The possible residual impacts will also be considered.

- **Mitigation:** Mitigation for significant issues will be incorporated into the EMP.

3.4 LEGISLATION AND GUIDELINES CONSIDERED

3.4.1 National Environmental Management Act (ACT 107 OF 1998)

The National Environmental Management Act (Act 107 of 1998) and the associated Regulations (Listing No R. 544, No R. 545 and R. 546) as amended, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation needs to be obtained. This could follow either the Basic Assessment process or the Environmental Impact Assessment (EIA) process depending on the nature of the activity and scale of the impact. In the case of this project, the EIA process has been followed.

3.4.2 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).

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.

3.4.3 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.

3.4.4 GN 704 – Regulations on use of water for mining and related activities aimed at the protection of water resources, 1999

These Regulations, promulgated in terms of the NWA, were put in place in order to prevent the pollution of water resources and protect water resources in areas where mining activity is taking place.

It is recommended that the proposed project complies with Regulation GN 704 of the NWA which contains regulations on use of water for mining, including borrowing activities and related activities aimed at the protection of water resources. GN 704 states that:
No person in control of a mine or activity may:

- locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year flood line or within a horizontal distance of 100 metres, whichever is the greatest, from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on waterlogged ground, or on ground likely to become waterlogged, undermined, unstable or cracked.

According to the above, the borrow areas must fall outside of the 1:100 year flood line of the drainage feature or 100m from the edge of the feature, whichever distance is the greatest. Therefore an exemption will be required from DWS since the borrow areas will be located within the 1:100 year flood line.

3.5 RESULTS OF ECOREGIONS LITERATURE REVIEW

The study area falls within the South Eastern Uplands Aquatic Ecoregion and the Mzimvubu to Kieskamma Management Area (WMA). The Present Ecological State, Ecological Importance and Ecological Sensitivity database[6] as developed by the Resource Quality Services (RQS) department of the Department of Water and Sanitation (DWS) (formerly the DWA) was used as reference for the catchment of concern in order to define the EIS, PEMC and DEMC. **Figures 3 to 5** indicate the aquatic ecoregion and quaternary catchments of the different developments of the study area.

The Lalini Dam is located within the T35L and T35K Quaternary Catchments (**Figure 3**), whilst the Ntabelanga Dam and road upgrades are located within the T35E quaternary catchment and the particular river resource in the area is the Upper Ntata, Mzimvubu River (**Figure 4**). The pipelines traverse over several quaternary catchments, namely T20B, T34H, T34 J, T35E, T35H and T35K (**Figure 5**).

The ecological status of these quaternary catchments are summarised in **Table 18**.

Table 18: Summary of the Ecological Status of the quaternary catchments associated with the study area (DWS, 2012).

SQ* REACH	SQR** NAME	PES ASSESSED BY EXPERTS? (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)
T34H-05598	Thina	Y	C	MODERATE	MODERATE	3,0	C
T34H-05699	Mvuzi	Y	C	MODERATE	MODERATE	1,0	C
T34H-05714	Qhanqu	Y	C	MODERATE	MODERATE	1,0	C
T34H-05738	Ngcibira	Y	B	MODERATE	MODERATE	2,0	C
T34H-05769	Tsilithwa	Y	B	MODERATE	MODERATE	2,0	C
T34H-05772	Thina	Y	B	MODERATE	MODERATE	3,0	C
T34H-05791	Tsilithwa	Y	B	MODERATE	MODERATE	1,0	C

[6]Present Ecological State, Ecological Importance and Ecological Sensitivity database for Primary Drainage Region T as developed by the RQS Department of the DWS. Available at http://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx retrieved 28th July 2014.

SQ* REACH	SQR** NAME	PES ASSESSED BY EXPERTS? (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)
T34H-05809	Mvumvu	Y	B	MODERATE	HIGH	1,0	B
T34H-05826	Ngcothi	Y	B	MODERATE	MODERATE	1,0	C
T34H-05838	Thina	Y	C	MODERATE	MODERATE	3,0	C
T35E-05780	Gqukunqa	Y	B	MODERATE	MODERATE	1,0	C
T35E-05908	Tsitsa	Y	B	MODERATE	MODERATE	3,0	C
T35E-05977	Tsitsa	Y	B	MODERATE	MODERATE	3,0	C
T35H-06024	Inxu	Y	C	MODERATE	HIGH	3,0	B
T35H-06053	Inxu	Y	C	MODERATE	HIGH	3,0	B
T35H-06158	Qwakele	Y	C	MODERATE	HIGH	1,0	B
T35H-06186	Umnga	Y	C	MODERATE	MODERATE	2,0	C
T35H-06240	KuNgindi	Y	B	MODERATE	MODERATE	1,0	C
T35H-06282	Umnga	Y	B	MODERATE	MODERATE	1,0	C
T35J-06088	Inxu	Y	C	MODERATE	HIGH	3,0	B
T35J-06106	Ncolosi	Y	C	MODERATE	HIGH	1,0	B
T35K-05897	Culunca	Y	B	MODERATE	HIGH	1,0	B
T35K-05904	Tyira	Y	C	MODERATE	MODERATE	1,0	C
T35K-06037	Tsitsa	Y	B	MODERATE	MODERATE	4,0	C
T35K-06098	Tsitsa	Y	B	MODERATE	MODERATE	4,0	C
T35K-06167	Xokonxa	Y	C	MODERATE	MODERATE	1,0	C
T35L-05976	Tsitsa	Y	B	MODERATE	MODERATE	4,0	C
T35L-06190	Tsitsa	Y	B	MODERATE	MODERATE	4,0	C
T35L-06226	Ngcolora	Y	C	MODERATE	MODERATE	1,0	C

*SQ = Sub-quaternary

**SQR = Sub-Quaternary Reach

From **Table 18**, it is apparent that the PES Category of the various river systems varies between PES B and PES C. Specifically, the Tsitsa River is classified as a PES Category B river, whilst the Inxu is considered to be in a PES Category C. All systems are considered to have a ‘moderate’ Ecological Importance (EI) whilst the Ecological Sensitivity (ES) varies between High to Medium sensitivity. The Tsitsa River is considered to be of moderate sensitivity whilst the Inxu River is deemed to be highly sensitive. The default Ecological Class (EC) of the river systems in these quaternary catchments, based on the median PES and highest of EI or ES means is considered to be either a Class B or a Class C. The Tsitsa River is deemed to be a Class C, and the Inxu is deemed to be a Class B system.

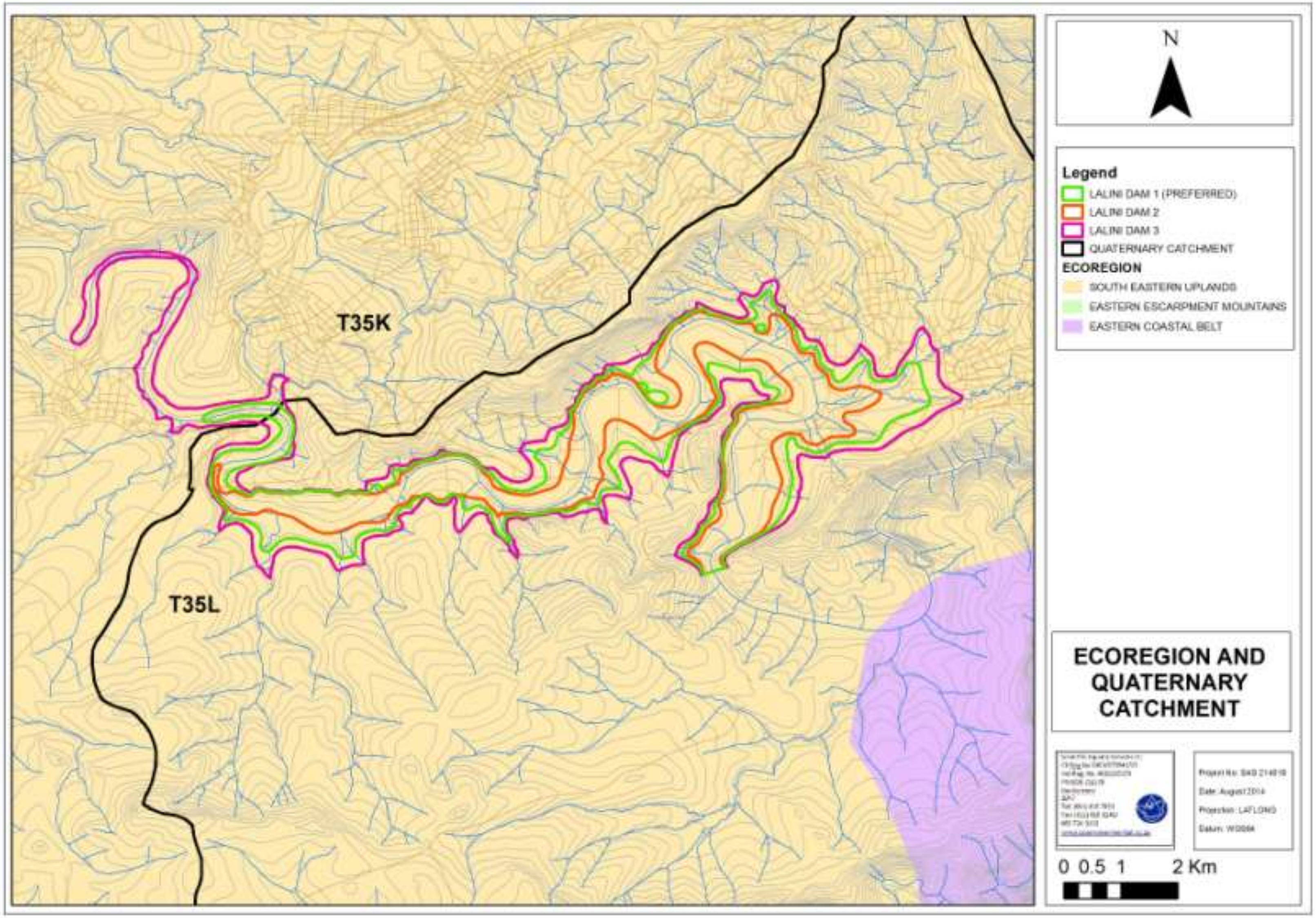

Figure 3: Ecoregion and quaternary catchment associated with the Lalini Dam.

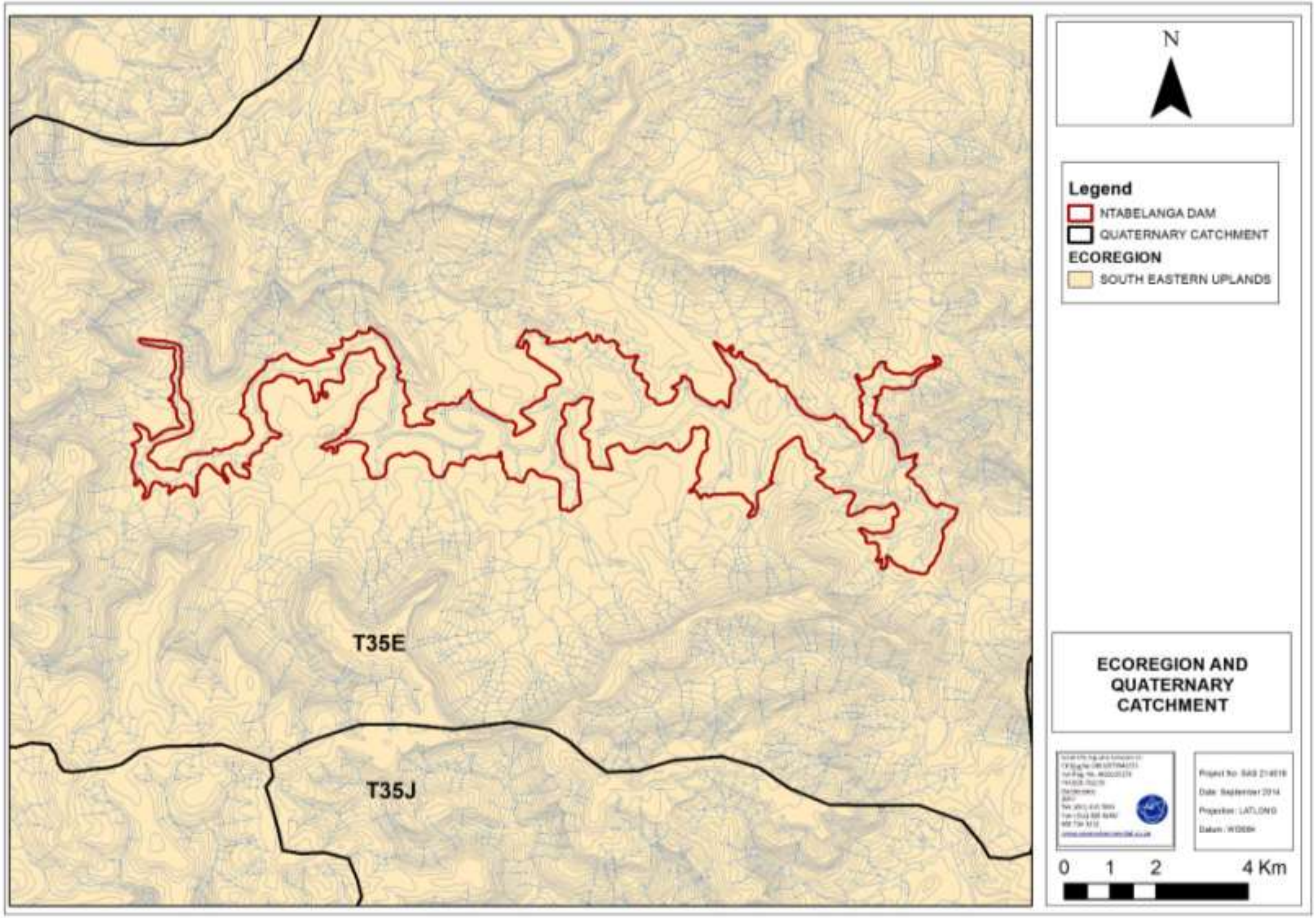

Figure 4: Ecoregion and quaternary catchment associated with the Ntabelanga Dam.

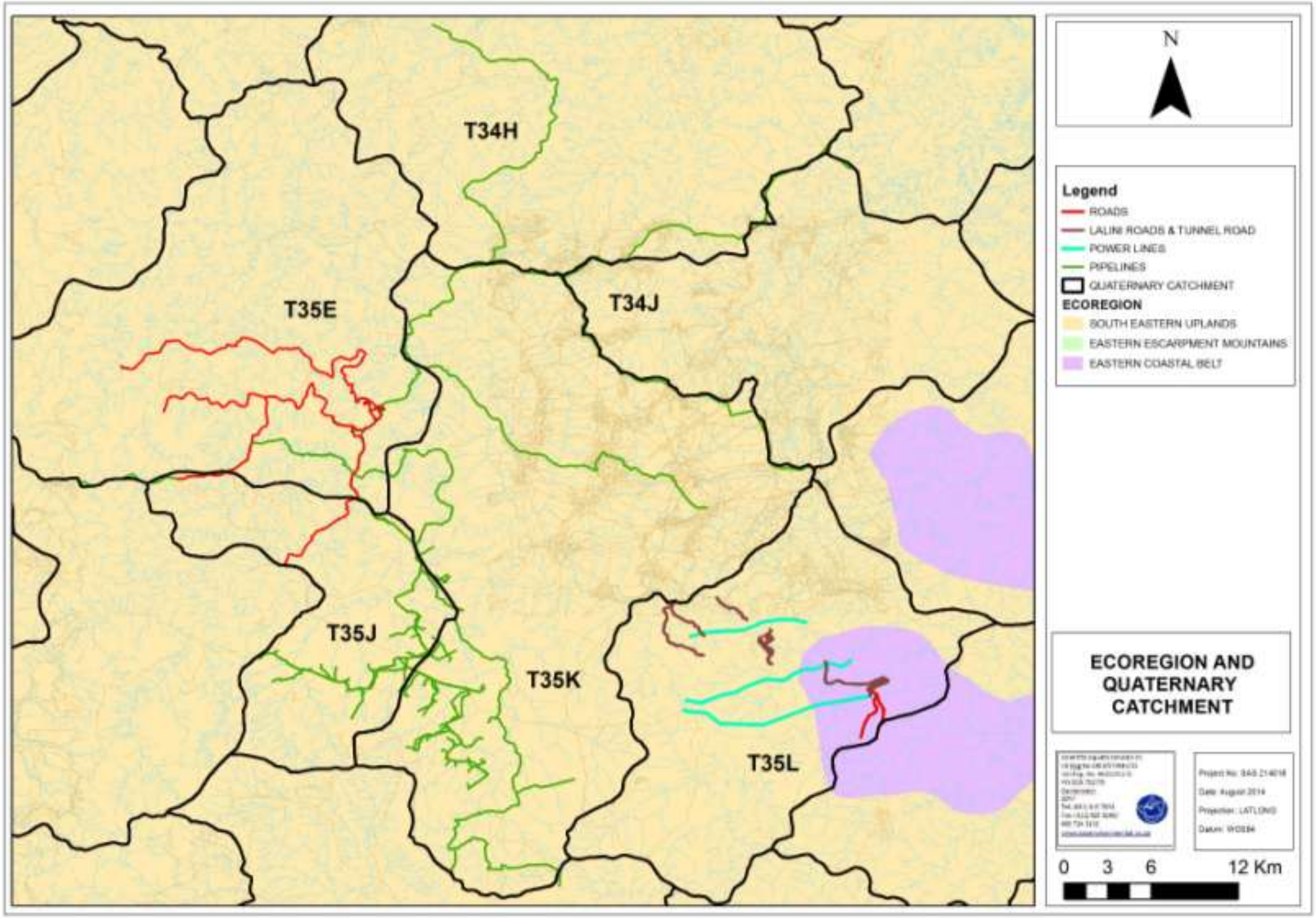

Figure 5: Ecoregion and quaternary catchments associated with the roads, pipelines and power lines.

4 ASSUMPTIONS AND LIMITATIONS

- The wetland assessment is confined to the study area as well as the immediate adjacent areas of relevance and does not include the neighbouring and adjacent properties;
- Due to the extent of the area that forms part of the total Mzimvubu Water Project area as well as the inaccessibility of some portions of the project area it was not practical to delineate the entire extent of the total project area in the field according to the DWA (2005) methodology. For this reason the study took a two tiered approach as follows:
  - The wetland resources in the vicinity of the proposed Ntabelanga and Lalini dam footprints were assessed in detail and delineated according to the DWA (2005) methodology;
  - The wetland areas affected by the proposed roads and pipelines were delineated in less detail with more accessible areas being assessed and delineated in the field while less accessible areas, especially in the remote areas at high altitude assessed at a desktop level; and
  - The level of detail undertaken in this study is deemed adequate to ensure that informed planning and decision making pertaining to the wetland resources within the study area can be made and no further detailed field delineation is deemed necessary.
- Due to the extent of the area that forms part of the total Mzimvubu Water Project area, use was made of aerial photographs and 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 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 were assessed and delineated by either desktop techniques with field verification or field delineated, some smaller ephemeral drainage lines as well as areas of hillslope seepage wetlands may have been overlooked, especially in the remote areas at elevated altitude. However, if the sensitivity map as presented in this report is consulted during the planning phases of the project, the majority of wetland habitat considered to be of increased EIS will be safeguarded, and no further detailed field delineation is deemed necessary.
- Due to the scale of the remote imagery used, the accuracy of the handheld GPS unit used to delineate the wetland boundary cannot be definitively defined. The mapping presented reflects the delineated wetland and riparian zones with reasonable accuracy;
- Therefore, the wetland delineation as presented in this report is regarded as a best estimate of the wetland boundary based on the site conditions present at the time of assessment and based on the level of detail applied to each specific area;
- 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 or riparian zone boundary and the occurrence of a true riparian zone may occur. However, if the DWA 2005 method is followed, all assessors should get largely similar results; and

- Aquatic, wetland and riparian ecosystems are dynamic and complex. The studies undertaken by SAS in April and June 2014 took place during low flow (dry) periods, limiting the use of vegetation indicators for the assessment. Furthermore, some aspects of the ecology of these systems, some of which may be important, may have been overlooked as a result of the season in which the field surveys were conducted. A more reliable assessment would have required that at least one assessment of the greater proposed development area be undertaken during the high flow (rainy) season, when certain aspects of hydrology and vegetation communities may be more accurately assessed.

5 DESCRIPTION OF THE AFFECTED ENVIRONMENT

5.1 ECOLOGICAL DESKTOP DESCRIPTION

The following sections present data accessed as part of the desktop assessment. It is important to note, that although all data sources used provide useful and often verifiable, high quality data, the various databases used not always provide an entirely accurate indication of the study area's actual site characteristics. This information is however considered to be useful as background information to the study. Thus, this data was used as a guideline to inform the assessment and special attention will be afforded to areas indicated to be of higher conservation importance.

5.1.1 Freshwater Ecosystem Priority Areas (FEPAs; 2011)

The Freshwater Ecosystem Priority Areas (FEPAs) database was consulted to define the aquatic ecology of the wetland systems close to or within the study area that may be of ecological importance.

Aspects applicable to the study area are discussed below:

- The study area falls within the Mzimvubu to Kieskamma Water Management Area (WMA). Each Water Management Area is divided into several sub-Water Management Areas (subWMA), where catchment or watershed is defined as a topographically defined area, which is drained by a stream, or river network. The subWMA indicated for the study area is Mzimvubu;
- The Tsitsa River is tributary of the Mzimvubu River and will be partially inundated by both dams. It is a perennial river that is classified in Category C condition (Moderately modified).

5.1.1.1 Lalini Dam

Aspects applicable to the Lalini Dam and surroundings are discussed below:

- The subWMA is regarded by the FEPA database (2011) as important with regards to fish corridors for movement of threatened fish between habitats and for the conservation of crane species (**Figure 6**).
- The subWMA is indicated by the FEPA database (2011) as a fish corridor management area therefore effective management of activities near and between corridors are of upmost importance;
- The wetland vegetation groups is identified by the FEPA database (2011) as Sub-escarpment Savanna.
- The wetlands in the vicinity of the Lalini Dam are classified by the FEPA database (2011) as channelled-valley bottom wetlands in Category Z1 condition (critically modified).
- According to the FEPA database (2011), the sub-WMA is classified as a FEPA system, with a rank of 2 indicating that the majority of its area is within a sub-quaternary catchment that has sightings or breeding areas for threatened *Balearica regulorum (*Grey Crowned Crane) and *Anthropoides paradiseus (*Blue Crane).

5.1.1.2 Ntabelanga Dam and road upgrades

Aspects applicable to the Ntabelanga Dam and surroundings are discussed below:

- The subWMA is regarded by the FEPA database (2011) as important in terms of the conservation of crane species (**Figure 7**).
- The subWMA is indicated by the FEPA database (2011) as an upstream management area therefore effective management of activities near resources are of upmost importance.
- The subWMA is not considered by the FEPA database (2011) to be a high groundwater recharge area nor a River FEPA.
- The wetland vegetation group is identified by the FEPA database (2011) as Sub-escarpment Grassland Group 6.

5.1.1.3 Pipelines

Aspects applicable to the pipelines and surroundings are discussed below:

- The northern pipelines cross the Thina River which is classified by the FEPA database (2011) as being in Category C condition (moderately modified).
- The Thina River is regarded as an important fish sanctuary, translocation and relocation zone and is classified as being a fish support area according to the FEPA database (2011).

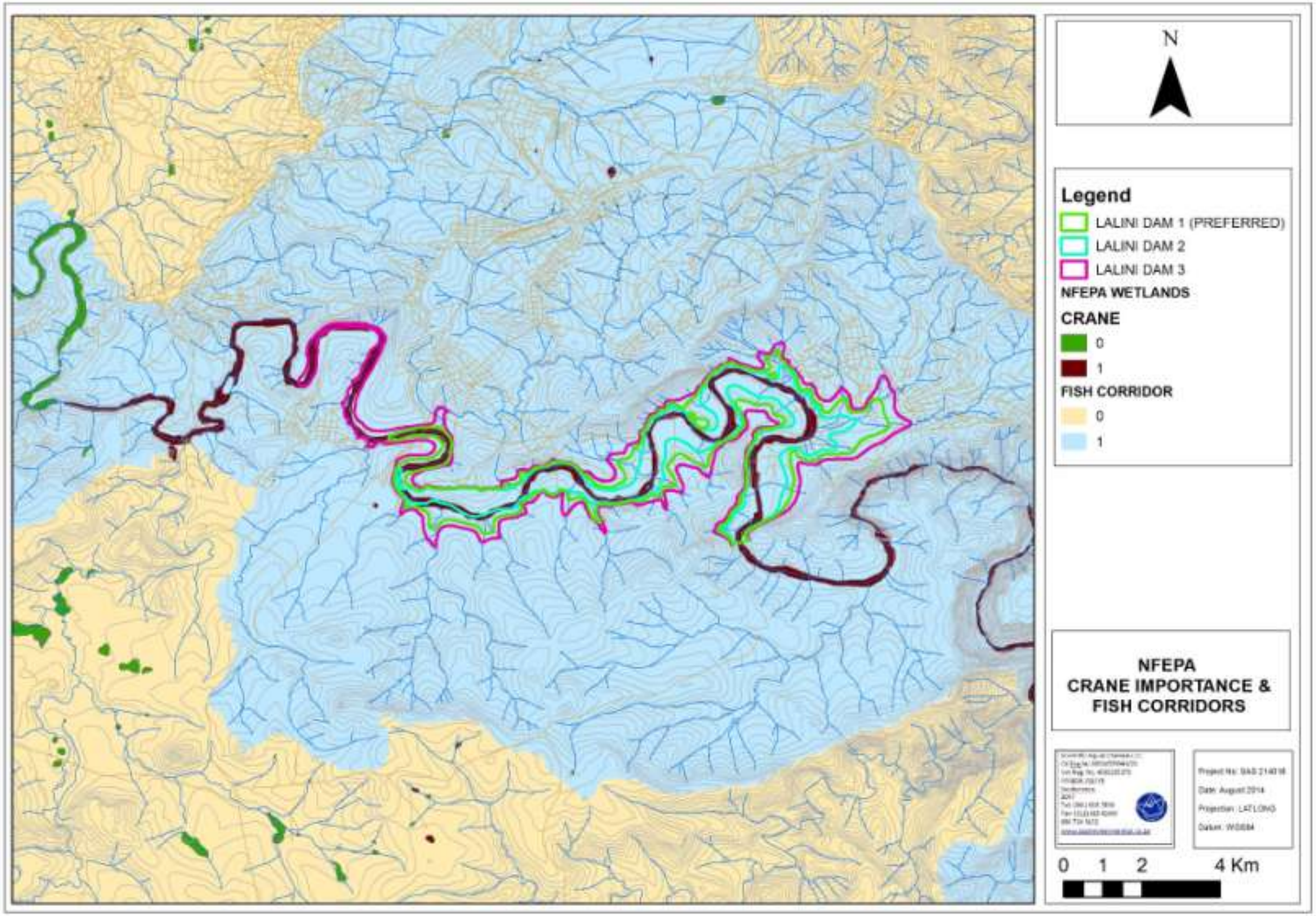

Figure 6: Important areas for the conservation of cranes and fish corridors in the Tsitsa River by Lalini Dam (0 = No Importance; 1 = Important).

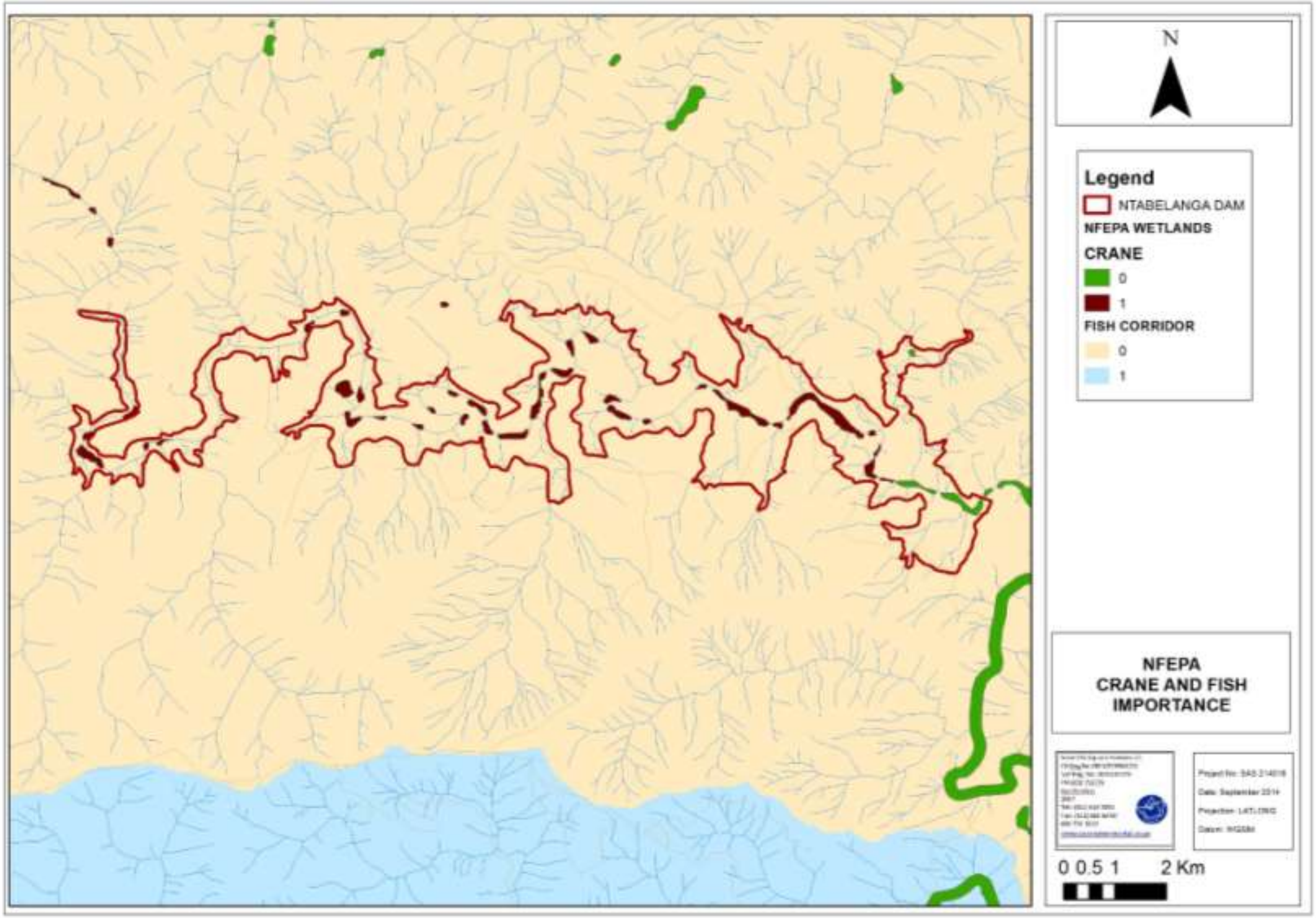

Figure 7: Important areas for the conservation of cranes in the Tsitsa River by Ntabelanga Dam (0 = No Importance; 1 = Important).

5.1.2 WETLAND ECOLOGICAL ASSESSMENT RESULTS

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

Features within the study area were categorised with the use of the *Classification System for Wetlands and other Aquatic Ecosystems in South Africa* (Ollis, 2013). After the field assessment it can be concluded that four main feature groups are present within the study area, namely rivers, channelled valley bottom wetlands, seeps, depressions and drainage lines. These are all considered to be Inland Systems, and fall within the South Eastern Uplands Aquatic Ecoregion. Four WetVeg groups apply to the proposed Mzimvubu Water Project area, namely Sub-Escarpment Grassland Group 5 (endangered), Sub-Escarpment Grassland Group 6 (least concern), Sub-Escarpment Grassland Group 7 (critically endangered) and Sub-Escarpment Savanna (endangered). These WetVeg groups are depicted in **Figure 8**.

The results of the classification of the systems are illustrated in the table below.

Table 19: Classification system for the wetland and riparian features within the study area.

Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit	
	HGM Type	**Longitudinal zonation / landform / Inflow drainage**
Valley floor: The base of a valley, situated between two distinct valley side-slopes.	**Channelled valley-bottom wetland*:*** a valley-bottom wetland with a river channel running through it.	Not applicable
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.	**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.	Without channelled outflow
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.	Not applicable
Valley floor: The base of a valley, situated between two distinct valley side-slopes; and **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,	**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.	Unknown

Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit	
representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).		

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 assessed (Tsitsa River, Inxu River and the unnamed tributaries of the Tsitsa River) were defined as systems containing riparian habitat due to the presence of alluvial soil as well as the presence of vegetation, with a composition and physical structure, distinct from adjacent areas.

Although seep wetlands do not characteristically extend into a valley floor, they can be further categorised at Level 4B by their outflow drainage characteristics, i.e. they can be categorised into those “with channelled outflow” and those “without channelled outflow” (Ollis *et al*., 2013). The seeps associated with the channelled valley bottom wetlands identified within the study area are classified as “seeps without a channelled outflow”; according to Ollis *et al*., (2013) seeps which abut a distinct river channel and which feed into the channel via diffuse surface flow or subsurface flow without having a channelised outlet from the seepage area to the adjacent channel should be classified as such.

In the sections that follow riparian habitat was assessed with use of the VEGRAI, Wetland Function Assessment, and Wetland IHI. Wetland habitat was assessed with the use of Wet-Health and the Wetland Function Assessment as described in Section 3.2 of this report.

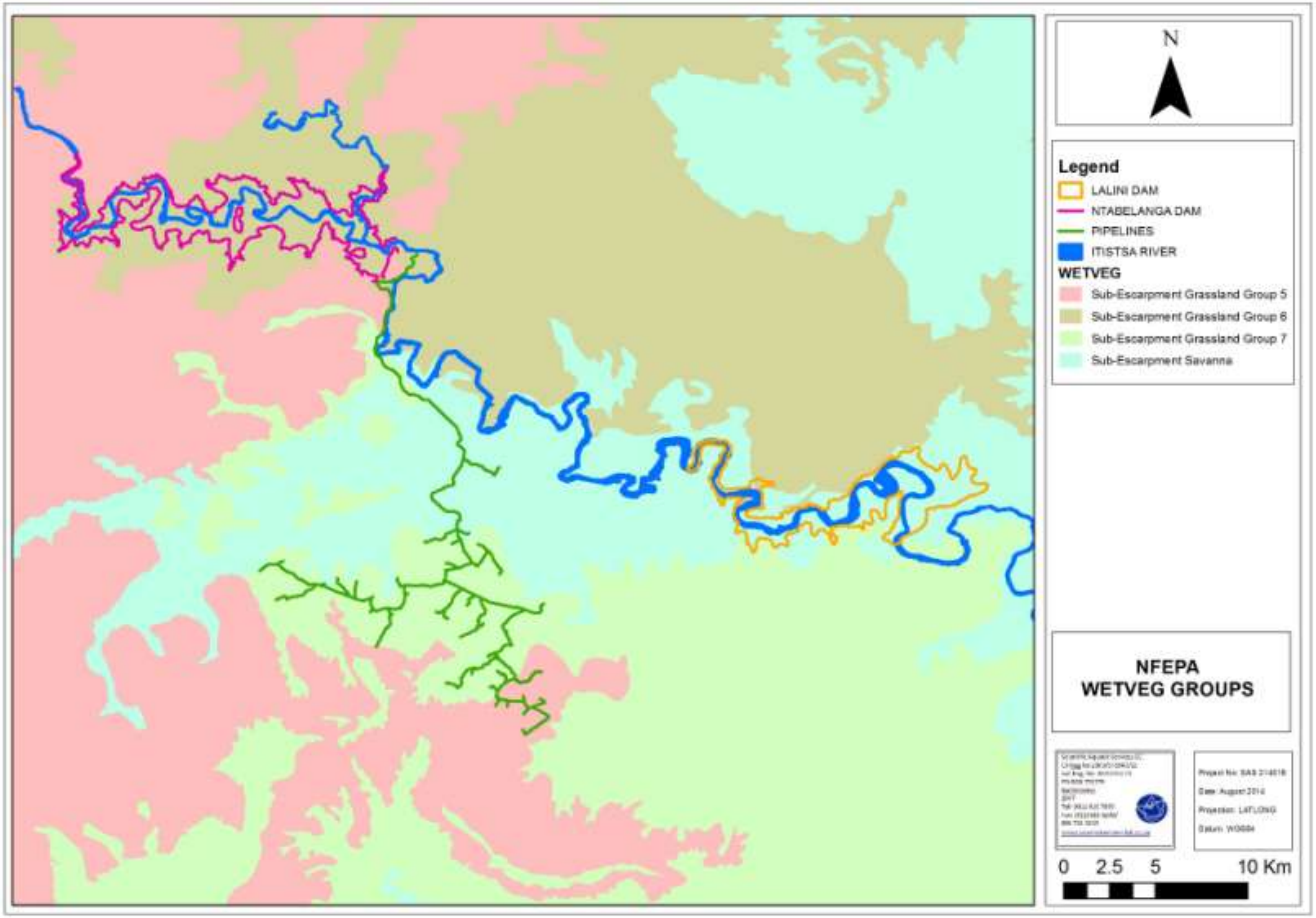

Figure 8: NFEPA WetVeg Groups applicable to the proposed Mzimvubu Water Project.

5.1.3 RIPARIAN HABITAT

5.1.3.1 Riparian Vegetation Response Index (VEGRAI)

The abundance and diversity of vegetation associated with the Tsitsa River and its various tributaries was assessed at several sites along the river courses. In order to obtain an overall VEGRAI rating for the Tsitsa River, the method was applied to all aquatic biomonitoring points assessed, and a mean score was then calculated. In addition, VEGRAI was applied at each of the aquatic sampling points along the Inxu River and the smaller unnamed tributaries of the Tsitsa River. The results of these assessments are presented in **Table 20** below.

Table 20: Summary of results obtained from the VEGRAI assessment.

Riparian System / Sampling Point	VEGRAI Score (%)	Riparian Vegetation PES
Tsitsa River	75.6	C
Inxu River (TS 5)	63.7	C
TS 2 & TS 3	75.0	C
TS 6	63.7	C
TS 9	57	D

The floral species composition of the riparian zone has undergone varying degrees of modification, principally as a result of anthropogenic activities such as grazing of cattle, harvesting of thatching grass and firewood, and sand winning. Incision and erosion of the river banks in some areas has resulted in a loss of vegetation cover; in some areas the loss is considered severe. Disturbances to the natural vegetation composition has resulted in the proliferation of alien species such as *Acacia mearnsii* and *Eucalyptus cameldulensis* in many sites although some indigenous woody species such as *Salix mucronata* remain in the less disturbed areas. The non-woody component consisted of largely indigenous species such as *Arundinella nepalensis*, *Miscanthus junceus* and *Cyperus spp*. **Figures 9 to 11** show representative photographs of the riparian vegetation along the Tsitsa River.

Figure 9: Representative photographs of portions of the Tsitsa River, showing the proliferation of *Acacia mearnsii* within the riparian zone.

Figure 10: Representative photographs of portions of the Tsitsa River, showing largely natural vegetation cover.

Figure 11: Representative photographs showing severe incision and erosion of river banks (left) and sediment winning (right).

Riparian floral species composition was relatively homogenous along the Tsitsa and Inxu Rivers, as well as along the unnamed tributaries of the Tsitsa River. Community structure varied depending on the nature of impacts experienced at each site as discussed above. Species identified in the regions of the proposed Ntabelanga and Lalini Dams are presented in the tables below. Floral species composition was similar along the tributaries, and therefore it is not presented separately.

Table 21: Riparian floral species identified in the Ntabelanga Dam site. Alien species are indicated with an asterisk.

Terrestrial zone	Seasonal / temporary zone	Permanent zone
**Acacia baileyana*	*Andropogon contortus*	*Phragmites australis*
Acacia karroo	**Cynodon dactylon*	*Schoenoplectus corymbosus*
**Acacia dealbata*	*Eragrostis curvula*	*Typha capensis*
**Acacia mearnsii*	*Eragrostis gummiflua*	*Bulbostylis hispidula*
Acacia polycantha	*Hyparrhenia hirta*	

Terrestrial zone	Seasonal / temporary zone	Permanent zone
Helichrysum cerastioides	*Paspalum dilatatum*	
Helichrysum nudifolium	*Persicaria serrulata*	
Helichrysum krebsianum	*Persicaria attenuata*	
Hyparrhenia hirta	*Phragmites australis*	
Senecio decurrens	*Schoenoplectus corymbosus*	
**Taraxicum officinale*	*Sporobulus africanus*	
	Typha capensis	

Table 22: Riparian floral species identified in the Lalini Dam site. Alien species are indicated with an asterisk.

Terrestrial zone	Seasonal / temporary zone	Permanent zone
Acacia karroo	**Cynodon dactylon*	*Phragmites australis*
**Acacia mearnsii*	*Hypoxis hemerocallidea*	*Schoenoplectus corymbosus*
Acacia polycantha	*Persicaria serrulata*	*Typha capensis*
Asparagus laricinus	*Persicaria attenuata*	
Combretum erythrophyllum	*Phragmites australis*	
**Eucalyptus grandis*	*Schoenoplectus corymbosus*	
**Eucalyptus camaldulensis*	*Typha capensis*	
Gynmosporia senegalensis		
Searsia pyroides		
Senecio decurrens		
**Taraxicum officinale*		

5.1.3.2 Wetland Function Assessment

The function and service provision was calculated for the Tsitsa River and the various tributaries according to the characteristics discussed in Section 3.2.3 of this report. The detailed results of the assessment are presented in Appendix A of this report. **Table 23** presents a summary of the results obtained.

Table 23: Summary of wetland function (Wet-Ecoservices) results obtained for the Tsitsa River and tributaries.

Riparian System / Sampling Point	Ecoservices score	Ecoservices Category
Tsitsa River	2.3	Moderately High
TS 2 & TS3	2.2	Moderately High
Inxu River (TS5 site)	2.2	Moderately High
TS 6	2.2	Moderately High
TS 9	2.2	Moderately High

The results of this assessment indicate that the Tsitsa River and the tributaries assessed are considered to have moderately high levels of ecological service provision, with specific mention of sediment trapping capabilities. It is also clear that the rivers are considered to be of value in terms of erosion control, assimilation of nutrients and toxicants originating in the catchment, and for its flood attenuation capabilities.

The most important socio-cultural service provided by the rivers at present is their potential to provide water to the surrounding communities, as the supply of potable water is currently very limited due to the remoteness of many of these communities. It should be noted that the scores obtained in the assessments for water supply for human use, harvestable resources and cultivated foods were increased due to the location of the rivers within rural communal areas, where substitutability for these resources is deemed to be relatively low under present conditions.

Wetlands (and riparian areas) contribute to the maintenance of biodiversity through the provision of habitat and maintenance of natural processes. The integrity of a wetland or riparian feature contributes strongly to the capacity of such a feature to provide this benefit, in addition to specific attributes such as the presence of threatened faunal or floral species (Kotze *et al.,* 2009). The Tsitsa River and its tributaries are considered to have marginally high levels of biodiversity maintenance primarily due to the presence of threatened species such as *Balearica pavonina* (Grey Crowned Crane), *Sagittarius serpentarius* (Secretary Bird) and *Podocarpus sp.* as observed during the site assessments. Furthermore the potential of the river to provide breeding and foraging habitat for a number of faunal species is considered relatively high due to the connectivity of the river to other natural features within the catchment.

In summary the Tsitsa River and the tributaries assessed are deemed to have conservation value due to the moderately high levels of ecological and socio-cultural services provided by the feature.

5.1.3.3 WET-IHI

The WET-IHI method (as discussed in Section 3.2.4) was applied to the Tsitsa River and the tributaries in order to ascertain the PES of the river systems. WET-IHI assesses four modules, namely hydrology, geomorphology, water quality and vegetation (Appendix B). The results of the assessments are summarised in **Table 24.**

Table 24: Results of the WET-IHI assessment applied to the Tsitsa River.

Riparian System / Sampling Point	WET-IHI Score (%)	PES Category
Tsitsa River	76.7	C
TS2 & TS3	73.3	C
Inxu River (TS5)	75.9	C
TS6	76.2	C
TS9	76.7	C

These results indicate that the PES of the Tsitsa River as well as that of the tributaries assessed is Category C (moderately modified; loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged).

Geomorphology is considered to have undergone greater levels of transformation than hydrology, water quality and vegetation. This is attributed to the severity of river bank incision observed in sections of the river courses both during the site assessments and on digital satellite imagery, and the increased sediment inputs as a result of this erosion. Furthermore, it is deemed highly likely that due to the extensive erosion within the catchment, particularly within the drainage lines feeding into the rivers, that the sediment regime is significantly altered (**Figure 12**).

Figure 12: Representative photographs showing examples of the typical erosion patterns within the catchment.

The hydrology of the systems are deemed to be in a relatively natural state, having obtained scores in all assessments which placed it in a PES Category B/C. Primary impacts on the rivers include altered channel size and competency as a result of erosion of the banks, and stands of alien invasive species such as *Acaci mearnsii* and *Eucalyptus cameldulensis* resulting in localised reduction of water inputs to the river due to on site water usage by these species. Small scale abstraction for domestic use in neighbouring rural homesteads and for subsistence farming is also responsible for a slight reduction of water although the levels of abstraction are not considered significant within the context of the catchment. Additional modifications to the hydrology include flow-modifying infrastructure within the river, such as weirs, support structures for bridges and gabions (**Figure 13**).

Figure 13: Representative photographs of the Tsitsa River showing flow modifying infrastructure such as gabions (left) and bridges (right).

The water quality and physico-chemical characteristics of the Tsitsa River is discussed in greater detail in the Water Quality Study (SAS, 2014); however based on the information in that report and for the purposes of this assessment, the water quality was considered to be relatively good, and therefore obtained a score placing it in a PES Category B/C. Impacts on water quality are considered to be relatively low and are primarily domestic in nature, as the rivers are utilised by the surrounding communities for washing and bathing. The water can be considered suitable for use for domestic supply, if treated, and in support of an aquatic community of high diversity and sensitivity.

The riparian vegetation, as discussed in Section 5.1.2 of this report, has undergone varying degrees of modification due to factors such as grazing, trampling by domestic livestock, and harvesting of woody species for use as firewood or fencing. As a result, floral species composition of the vegetation communities has been altered, and encroachment by alien invasive species is considered serious in some sections of the rivers, although in relation to the catchment size the encroachment is not considered severe.

5.1.3.4 Ecological Importance and Sensitivity (EIS)

The EIS assessment was applied to the Tsitsa River in order to determine the ecological importance and sensitivity of the river. The results obtained indicate that due to the presence of suitable breeding and foraging habitat for a number of faunal species of conservation concern, the high level of integrity of the river and levels of ecological service provision, the Tsitsa River and the tributaries assessed are deemed to be in an EIS Category B. Systems in this category are considered to be highly ecologically important and sensitive on a national – sometimes international – level. Biodiversity of these systems are usually highly sensitive to habitat and flow modifications. The results of the assessment are summarised in **Table 25** and are presented in detail in Appendix D.

Table 25: Results of the EIS Assessments applied to the Tsitsa River and the tributaries.

Riparian System / Sampling Point	EIS Score	EIS Category
Tsitsa River	2.89	B
TS2 & TS3	2.67	B
Inxu River (TS5)	2.67	B
TS6	2.67	B
TS9	2.56	B

5.1.3.5 Recommended Ecological Category (REC)

The results of the VEGRAI, wetland function, WET-IHI and EIS assessments were used to determine the REC of the Tsitsa River. The results obtained from these assessments indicate that the Tsitsa River is considered to be in a largely natural condition, although impacts to the riparian zone arising from anthropogenic activities have resulted in modifications on a localised scale. Furthermore, the relatively high integrity of the river increases its ability to provide essential ecological and socio-cultural services. For these reasons, an REC B/C was assigned to the Tsitsa River; however it should be noted that the aquatic ecological integrity of the resource is deemed to have undergone lower levels of transformation than the riparian zone, thus should be managed accordingly to maintain the good condition of the river.

The tributaries of the Tsitsa River which were assessed were shown to be in a PES C, and due to their importance in terms of providing important ecological functions such as suitable habitat for a number of faunal and floral species, are considered to be in an EIS Category B. An REC B/C was therefore assigned to these systems, and suitable management measures should be implemented to prevent further deterioration, and where possible improve the condition, of these systems.

5.1.4 WETLAND HABITAT

Aside from the rivers, four basic HGM units were identified within the study area, namely channelled valley bottom, hillslope seeps, depressions and drainage lines. A few artificial dams were identified during desktop inspection of digital satellite imagery; however as these are unlikely to be impacted upon by the construction of the proposed Ntabelanga and Lalini dams and their associated infrastructure, the artificial dams were not assessed. The wetland features in relation to the Ntabelanga and Lalini dam sites, and in relation to the roads and pipelines, are conceptually presented in **Figures 14 to 16** below.

Due to the extent of the study area, the numerous wetland features present, and the relatively homogeneous characteristics of the wetland features, the features were grouped into HGM units for the purposes of assessment, and were not assessed as individual wetland features. It should be noted that although the wetland features identified may extend outside of the study area, only the portions located within the study area were assessed and ground truthed. Nonetheless, the potential impacts of activities such as irrigation agriculture, extensive erosion 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 Mzimvubu Water Project and the assessment addresses all habitat units and wetland resources to be directly affected by the project. Since a Section 21 c & i WUL will be applied for and due to the vast extent of the various components of the project mapping of wetlands did not take place to inform regulation GN1199 of the NWA.

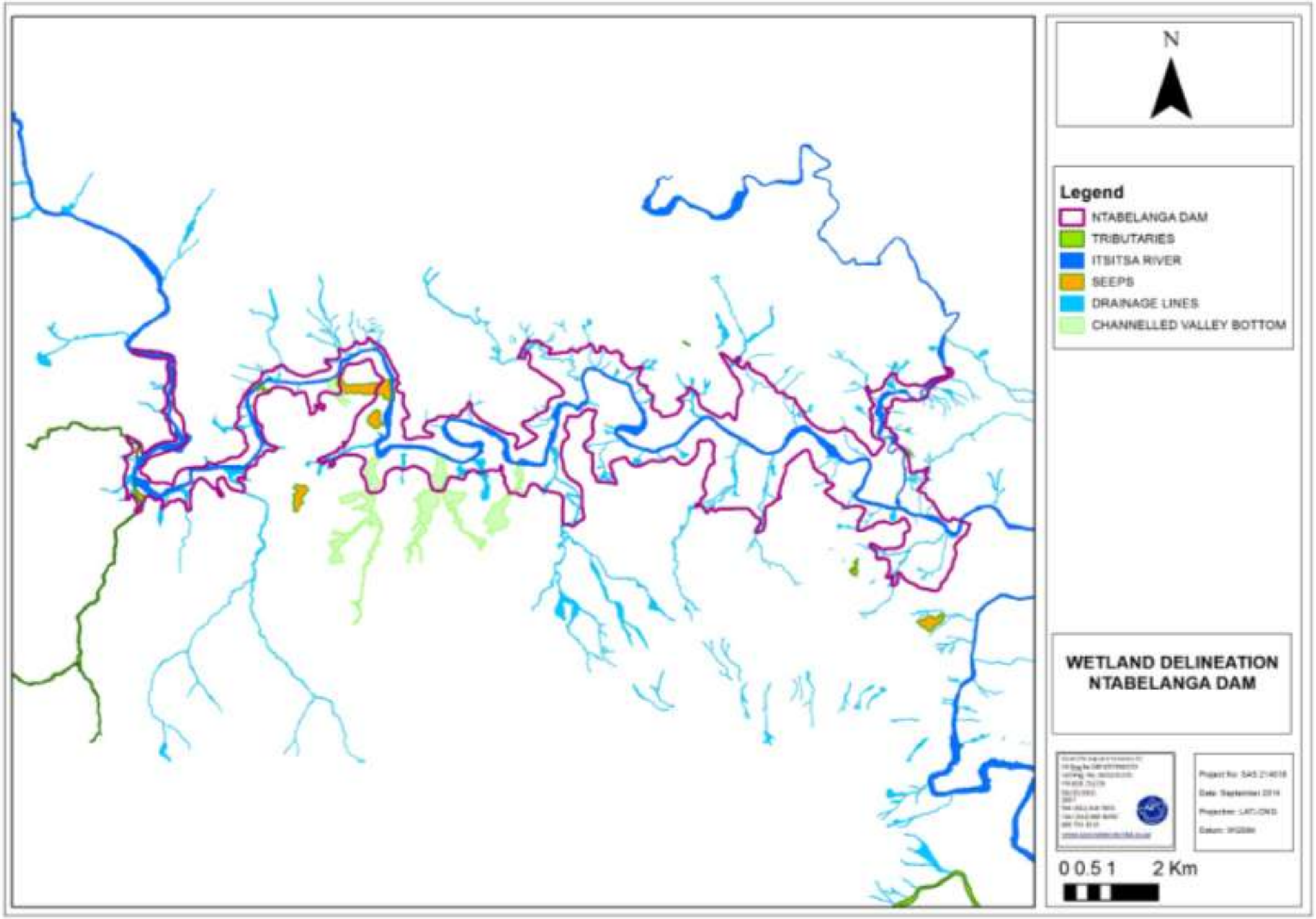

Figure 14: Wetland features identified within the study area, in relation to the proposed Ntabelanga Dam site.

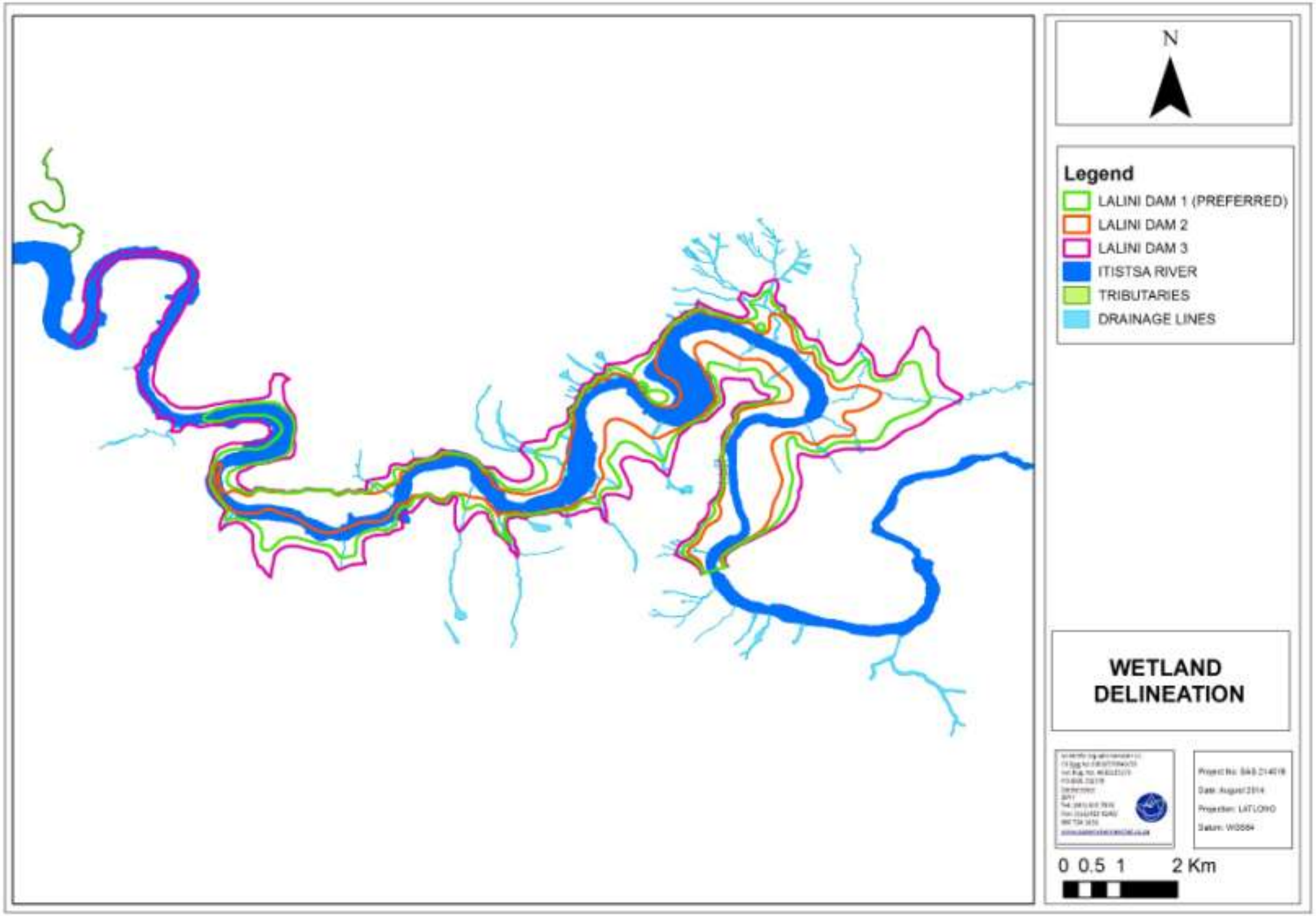

Figure 15: Wetland features identified within the study area, in relation to the proposed Lalini Dam site.

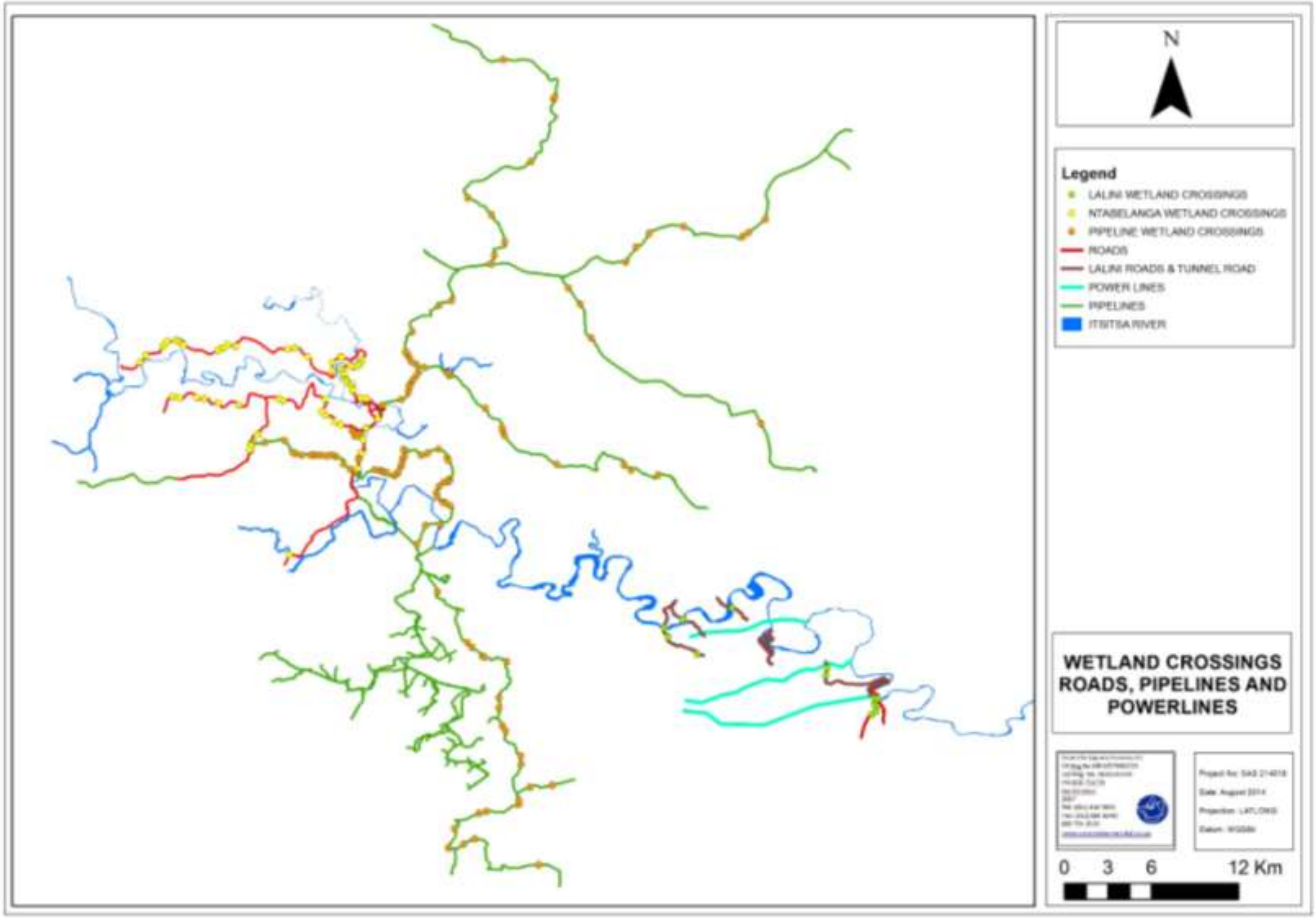

Figure 16: Wetland features identified within the study area, in relation to the proposed roads and pipelines associated with the Mzimvubu Water Project.

5.1.4.1 Wetland Vegetation

Wetland vegetation was relatively homogenous throughout the study area, with many species common to all HGM units, regardless of factors such as altitude, local topography, etc. Differences in species composition were however noticeable where wetlands had been subjected to disturbances such as historical and/or current agricultural activities, sand winning or over-utilisation of vegetation by domestic livestock.

The wetland species identified in the wetland areas throughout the study area are presented in **Table 26**.

Table 26: Wetland floral species identified in the wetland areas throughout the study area. Alien species are indicated with an asterisk.

Terrestrial	Temporary	Seasonal	Permanent
Aristida congesta subsp. congesta	*Arundinella nepalensis*	*Brachyaria sp.*	*Cyperus longus*
Aristida congesta subsp. barbicolus	*Andropogon contortus*	*Cyperus mariscus*	*Leersia hexandra*
Berkheya bergiana	*Cymbopogon sp.*	*Cyperus longus*	*Miscanthus junceus*
Chloris virgata	*Cyperus mariscus*	*Helichrysum sp.*	*Miscanthus capensis*
**Cynodon dactylon*	*Eragrostis chloromelas*	*Imperata cylindrica*	*Phragmites australis*
Dactyloctenium giganteum	*Eragrostis gummiflua*	*Miscanthus junceus*	*Schoenoplectus corymbosus*
Datura sp	*Eragrostis plana*	*Persicaria attenuata*	*Typha capensis*
Helichrysum cerastioides	*Imperata cylindrica*	*Persicaria serrulata*	
Helichrysum krebsianum	*Paspalum dilatatum*	*Phragmites australis*	
Helichrysum nudifolium	*Setaria sphacelata var. sericea*	*Schoenoplectus brachycerus*	
Hyparrhenia hirta	*Sporobulus festivus*	*Schoenoplectus corymbosus*	
Hyparrhenia hirta		*Sporobuls africana*	
Paspalum dilitatum		*Typha capensis*	
Senecio decurrens			

5.1.4.2 Drainage Lines

Numerous drainage line features were identified throughout the study area, and were considered to be wetland features due to the prolonged presence of water throughout the year, which has resulted in the formation of wetland characteristics as defined by the NWA (1998). This includes the presence of obligate and facultative vegetation, the presence of gleyed soils, and the degree of soil saturation noted within the soil samples. Representative photographs of the drainage lines are presented in **Figure 17** below.

Figure 17: Representative photographs of drainage line features within the study area.

Wetland Function Assessment

The drainage line features are considered particularly important in terms of sediment trapping, and obtained a score of 3.2 (High) for this function. This capacity to filter sediment prior to water entering the river system is especially important in the context of the extensive and often severe erosion in the catchment. Furthermore, the drainage lines are considered valuable in terms of water supply into the river systems. The potential capacity of the drainage lines to assimilate phosphate, nitrates and other toxicants is deemed to be moderately high.

The drainage lines are not necessarily suitable hosts for a diverse faunal assemblage; however they are nonetheless deemed to be important for biodiversity maintenance as they provide suitable habitat for smaller faunal species such as amphibians and avifauna. Furthermore, they contribute to the overall integrity of the site through the provision of essential ecological services such as streamflow regulation. These systems are deemed to be of conservation value.

Whilst some of the drainage line features may be ephemeral, those observed during the site assessments in April and June 2014 contained surface water. Local residents were observed utilising this water for domestic purposes, and therefore the features are considered to hold socio-cultural value. Additionally, their potential to provide harvestable resources such as reeds for weaving, and where the terrain allows, to grow subsistence crops, is considered moderately high.

In summary, the drainage line features obtained an overall score of 1.9 in the wetland function assessment, indicating intermediate importance for the provision and maintenance of ecological and socio-cultural services. The detailed results of the wetland function assessment are presented in Appendix A of this report.

WET-IHI Assessment

The WET-IHI method as described by DWAF (2007) was applied to ascertain the PES of the drainage line features. **Table 27** below illustrates the results of this assessment.

Table 27: Summary of results obtained from the WET-IHI assessment applied to the drainage line features.

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	Confidence Rating	PES Category
DRIVING PROCESSES:		**100**	**1,7**		
Hydrology	1	100	1,1	*3,0*	**B/C**
Geomorphology	2	80	2,8	*3,8*	**D**
Water Quality	3	30	0,8	*2,0*	**B**
WETLAND LANDUSE ACTIVITIES:		**80**	**0,9**	***3,7***	
Vegetation Alteration Score	1	100	0,9	*3,7*	**B/C**
OVERALL SCORE:			**1,4**	***Confidence Rating***	
	PES %		**72,8**		
	PES Category:		**C**	***1,6***	

The results of the assessment indicates that the drainage lines can be considered to be in a PES Category C, indicating that they have undergone moderate levels of modification; however basic ecosystem functions and process remain. Due to the scale at which the assessment was applied, and the variability of conditions in different sections of the study area, it should be noted that some features may be considered to be in a slightly healthier or inferior condition in comparison to others. Nonetheless, the result obtained is considered to be an accurate indication of the overall condition of the drainage line features observed and evaluated during both site assessments.

As shown in **Table 27** above, the hydrology of the drainage lines is considered overall to be in a relatively natural state, having obtained a score placing it in a PES Category B/C.

Ecological Importance and Sensitivity (EIS)

The EIS assessment was applied to the drainage lines to ascertain their perceived ecological importance and sensitivity to habitat and flow modifications. The results of the assessment are presented in **Table 28** below.

Table 28: Results of the EIS Assessment applied to the drainage line features.

Determinant	Score	Confidence
PRIMARY DETERMINANTS		
1. Rare & Endangered Species	2	4
2. Populations of Unique Species	1	4
3. Species/taxon Richness	1	3
4. Diversity of Habitat Types or Features	1	3
5. Migration route/breeding and feeding site for wetland species	2	3
6. PES as determined by WET-Health assessment	3	4
7. Importance in terms of function and service provision	2	4
MODIFYING DETERMINANTS		
8. Protected Status according to NFEPA Wetveg	4	4
9. Ecological Integrity	2	4

Determinant	Score	Confidence
TOTAL	18	
MEAN	2	
OVERALL EIS	**C**	

The score obtained indicates that the drainage lines fall within an EIS Category C; i.e. they are considered ecologically important and sensitive on a localised or potentially provincial scale. Biodiversity of these features is unlikely to be sensitive to flow and habitat modifications.

Recommended Ecological Category (REC)

Whilst the EIS assessment indicated that the drainage lines are considered highly ecologically important and sensitive, the ecological integrity of the features has undergone transformation, lowering the integrity of the features. Thus, an REC C is deemed appropriate to maintain the features in their Present State.

5.1.4.3 Channelled Valley Bottom Wetlands

Several channelled valley bottom wetlands were identified, primarily in the region of the proposed Ntabelanga Dam footprint, although a large channelled valley bottom wetland feature was identified approximately 4.5km south of Tsolo, within the commercial pine plantation. Additional features associated with the secondary pipelines were identified using digital satellite imagery.

Figure 18: Representative photographs of channelled valley bottom wetland features within a communal area (left) and in the commercial forestry south of Tsolo (right).

Wetland Function Assessment

Although channelled valley bottom wetlands are generally considered to contribute less towards sediment trapping when compared to other HGM units such as floodplains (Kotze *et al.*, 2009), the extent and severity of erosional features within the study area and the greater catchment increases the potential to provide this function. Thus, sediment trapping is considered to be the most important ecological service provided by the channelled valley bottom wetland features identified in the study area. Their potential capacity in terms of nutrient cycling and toxicant assimilation was also considered to be moderately high. Due to the steep terrain on which many of these features are located, flood attenuation is deemed an important function of these wetland features.

As with the drainage lines, these wetland features are deemed to have conservation value in terms of their contribution to streamflow regulation, contributing to the sustenance of downstream flow of the Tsitsa River and its tributaries during low flow periods.

Biodiversity maintenance obtained a moderately high score, largely due to the presence of suitable habitat within the wetland features for water-dependent species, particularly water birds. These features are located within a catchment area identified by NFEPA as having sightings and/or suitable breeding habitat for the threatened *Anthropoides paradiseus (*Blue Crane) and *Balearica pavonina* (Grey Crowned Crane) thus increasing their conservation value and contribution towards biodiversity maintenance.

Socio-cultural functions supplied by the channelled valley bottom wetland features include provision of water for domestic use by surrounding communities, harvestable resources and cultivated foods such as *Zea mays*. Whilst tourism and education and research did not obtain high scores during the assessment, the aesthetic value and relatively natural condition of the wetlands means that they do have potential to be utilised for these purposes.

In summary, the overall score obtained for the wetland function assessment of the channelled valley bottom wetland features was 2.1, indicating a moderately high contribution towards ecological and socio-cultural service provision. The results of this assessment are contained in Appendix A of this report.

Wet-Health Assessment

As described in Section 3.2.5 of this report, the PES of the channelled valley bottom wetland features was assessed using the method described by Macfarlane *et al.* (2008). The method evaluates three modules, namely hydrology, geomorphology and vegetation, in order to obtain an indication of the 'health' of the features, and an area weighted score obtained. The results of this assessment are illustrated in **Table 29**.

Table 29: Summary of results obtained from the Wet-Health assessment of the channelled valley bottom wetland features.

Hydrology		Geomorphology		Vegetation	
Impact Score	Trajectory of change	Impact Score	Trajectory of change	Impact Score	Trajectory of change
C	↓	C	↓	C	↓

The overall score which aggregates the scores for the three modules, namely hydrology, geomorphology and vegetation, was calculated using the formula [7] as provided by the Wet-Health methodology. These wetland features obtained a score of 3.3, placing them in a PES Category C (moderately modified; a moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact).

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

Hydrology in the features has been modified as a result of flow-modifying structures such as weirs within the channels, as well as anthropogenic activities such as abstraction of water for crop growing. Small-scale abstraction of water from the features associated with the proposed Ntabelanga Dam for subsistence farming is considered likely, as is increased on-site water usage by the commercially grown *Pinus spp* from the feature located within the forestry south of Tsolo. Further, the inherent susceptibility of the soils to erosion combined with sand winning have resulted in channel widening, thus altering the transport capacity of the wetlands. However, changes to water input volumes and distribution and retention of water passing through the wetlands are not considered to be greatly changed from natural conditions.

Geomorphology of the features has been impacted by erosional processes, as evidenced by stream bank incision in several locations. These processes contribute to increased sediment inputs to the wetland features, altering channel size as discussed above. These processes along with activities such as sediment mining, are also responsible for modifications to existing channels, such as stream shortening and creation of artificial drainage channels to divert water to crops.

The structure and species composition of floral communities associated with the channelled valley bottom wetland features has been altered to some extent by removal of vegetation, grazing, and trampling by domestic livestock. As with the riparian vegetation, encroachment by alien invader species such as *Acacia mearnsii* is evident in some areas of the wetland features although it is not extensive at this time.

The anticipated trajectory of change in integrity for all three modules based on current conditions is a gradual, slight decrease over the next five years. Activities related to the construction of the proposed Ntabelanga Dam and the infrastructure associated with both this and the Lalini Dam, do however pose a threat to the overall integrity and condition of the wetland features particularly those in the vicinity of the proposed Ntabelanga Dam footprint.

Ecological Importance and Sensitivity (EIS)

The EIS assessment applied to the channelled valley bottom wetland features indicates that the features fall within an EIS Category B. Such features are considered to be highly ecologically important and sensitive, and biodiversity of these features is likely to be sensitive to flow and habitat modifications. The results of this assessment are presented below.

Table 30: Results of the EIS Assessment applied to the channelled valley bottom wetland features.

Determinant	Score	Confidence
PRIMARY DETERMINANTS		
1. Rare & Endangered Species	3	4
2. Populations of Unique Species	2	4
3. Species/taxon Richness	2	3
4. Diversity of Habitat Types or Features	2	3
5. Migration route/breeding and feeding site for wetland species	2	3
6. PES as determined by WET-Health assessment	3	4
7. Importance in terms of function and service provision	3	4
MODIFYING DETERMINANTS		

Determinant	Score	Confidence
8. Protected Status according to NFEPA Wetveg	4	4
9. Ecological Integrity	2	4
TOTAL	23	
MEAN	2,56	
OVERALL EIS	**B**	

Recommended Ecological Category (REC)

Whilst the ecological importance and sensitivity of the channelled valley bottom wetland features is deemed to be slightly higher than their PES, an REC C was assigned. Appropriate management measures should be implemented in order to prevent further degradation to the ecological integrity and overall condition of these features, and where possible, to improve their condition.

5.1.4.4 Hillslope and Seasonal Seep Wetlands

According to Ollis *et al.*, (2013) seeps are characterised by their association with geological formations and topographic positions, which result in groundwater discharging to the land surface, or rain-derived water "seeping" down-slope as subsurface interflow. Seeps can occur in relatively flat or very gently sloping landscapes, provided that there is sufficient slope for there to be a uni-directional subsurface flow of water. Several such seeps were identified within the study area; the majority are associated with the pipelines or roads. However, two seep wetlands were identified within the proposed Ntabelanga Dam footprint towards the western end of the dam and careful mitigation should be implemented to limit the impacts on the portions of these wetlands that are not submerged.

Figure 19: Representative photographs of hillslope seep wetland features within the study area.

Wetland Function Assessment

Seep wetlands are considered to provide important benefits related to water quality, such as removal of excess nutrients and inorganic pollutants. Hillslope seepages in particular are considered to have especially high potential for removal of nitrogen. However, they are generally not considered to be important for erosion control due to their relatively steep slopes which increase the risk of erosion, particularly if vegetation is removed. (Kotze *et al.*, 2009). Several seep wetland features were identified during the site assessment in April 2014, and additional features were identified by means of digital satellite imagery.

The wetland function assessment resulted in an overall score of 2.0 indicating intermediate levels of ecological and socio-cultural service provision by these wetlands. In particular, the assessment indicated that these wetlands possess a high capacity to trap sediment, an important attribute due to the extensive erosion in the catchment as mentioned previously. Furthermore, as noted above, the scores obtained for nutrient and toxicant assimilation indicate high levels of service provision in this regard.

In terms of socio-cultural services, the seep wetlands were indicated to provide high levels of opportunity for the cultivation of crops, as observed in several areas. Whilst harvestable resources obtained a moderately high score, this is attributed to the location of the wetland features within a rural communal area; thus the potential to provide such a service is considered high, although evidence of the communities taking advantage of this potential was not observed.

Wet-Health Assessment

The results of the Wet-Health assessment indicate that the seep wetlands fall within a PES Category C, having obtained an overall score of 3.05. The results of the assessment in which the three modules (hydrology, geomorphology and vegetation) are presented in **Table 31.**

Table 31: Summary of results obtained from the Wet-Health assessment of the seep wetland features.

Hydrology		Geomorphology		Vegetation	
Impact Score	Trajectory of change	Impact Score	Trajectory of change	Impact Score	Trajectory of change
C	↓	B	↓	C	↓

As illustrated, the hydrology module calculated a score which placed it in a PES Category C. Modifications to the hydrology of the seep wetlands include increased on-site water usage as a result of crops being planted within the wetland areas, reduced surface roughness (therefore decreased infiltration of runoff) due to the removal of natural vegetation, and the presence of erosion gullies and/or artificial drainage channels. Infrastructure such as roads and housing placed within wetland areas contribute to changes in flow patterns and water retention patterns within the wetlands.

Geomorphology of the seep wetlands is less impacted than the drainage line and channelled valley bottom wetland features. This is attributed to the relatively minor impacts of erosion within the seeps (when compared to the severe erosion present within other HGM units). Nonetheless, disturbances as a result of ploughing, increased sediment loads and placement of infrastructure within the wetland areas have all impacted negatively on the integrity of the geomorphology of the seep wetlands.

The vegetation, as with the other wetland features, has been transformed as a result of anthropogenic activities, particularly the removal of natural vegetation in favour of crops, and grazing and trampling by domestic livestock.

The anticipated trajectory of change in integrity for all three modules based on current conditions is a gradual, slight decrease over the next five years. Seep wetlands located within the proposed Ntabelanga Dam footprint are however threatened by the development.

Ecological Importance and Sensitivity (EIS)

The results of the EIS assessment are presented in **Table 32**.

Table 32: Results of the EIS assessment applied to the seep wetland features.

Determinant	Score	Confidence
PRIMARY DETERMINANTS		
1. Rare & Endangered Species	2	4
2. Populations of Unique Species	1	4
3. Species/taxon Richness	1	3
4. Diversity of Habitat Types or Features	1	3
5. Migration route/breeding and feeding site for wetland species	2	3
6. PES as determined by WET-Health assessment	3	4
7. Importance in terms of function and service provision	2	4
MODIFYING DETERMINANTS		
8. Protected Status according to NFEPA Wetveg	4	4
9. Ecological Integrity	2	4
TOTAL	18	
MEAN	2,00	
OVERALL EIS	**C**	

As shown above, the seep wetlands are considered to be in an EIS Category C. Wetlands in this category are likely to be considered ecologically important and sensitive on a local or provincial scale, although biodiversity is unlikely to be sensitive to habitat and flow modifications.

Recommended Ecological Category (REC)

The results of the wetland function, WET-Health and EIS assessments indicate that the seep wetland features are considered to be of a lower integrity and sensitivity in comparison to the drainage lines and channelled valley bottom wetland features. It was therefore deemed appropriate to assign an REC C to the seep wetland features.

5.1.4.5 Depression Wetlands

Depression wetlands are characterised by their closed (or near-closed) contour shape, making them relatively easy to identify on topographic maps (Ollis *et al.*, 2013) and digital satellite imagery. Whilst only no depression wetlands were identified during the course of the two site assessments in April and June 2014, several small depression wetland features were identified with the aid of digital satellite imagery. For this reason, the wetland function and WET-Health assessments were applied utilising the background information relevant to the study area and catchment as well as wetland-specific information obtained for the other wetland features evaluated (e.g. floral species composition). Digital satellite imagery was utilised to ascertain the presence of modifying factors such as erosion gullies or infrastructure within the depression wetland features.

Wetland Function Assessment

The depression wetland features obtained an overall score of 1.8 in the assessment, indicating that they provide intermediate levels of ecological and socio-cultural services. Due to the closed or near-closed contour characteristics of depression wetlands, they do not contribute to streamflow regulation, however they are considered of value in terms of flood attenuation capabilities, nutrient cycling and toxicant assimilation, and to some extent, sediment trapping and erosion control.

The contribution of the depression wetlands to biodiversity maintenance, as with the other HGM units assessed, is considered to be moderately high, due to the relatively widespread “buffer zone” around the wetlands affording smaller wetland faunal species suitable breeding and foraging habitat. Due to the small size of the depression wetlands they are however considered unlikely to support large populations of conservation important species.

Wet-Health Assessment

The results of the Wet-Health assessment indicate that the depression wetland features fall in a PES Category C, having obtained an overall area-weighted score of 2.4. The summary of results for each module assessed are illustrated in **Table 33**.

Table 33: Summary of results obtained from the Wet-Health assessment of the depression wetland features.

Hydrology		Geomorphology		Vegetation	
Impact Score	Trajectory of change	Impact Score	Trajectory of change	Impact Score	Trajectory of change
C	↓	B	↓	C	↓

The hydrology of the depression wetlands is likely to be impacted by factors such as small-scale abstraction for domestic and agricultural use and increase on-site water use due to alien vegetation encroachment.

Geomorphology, as with the seep wetland features, is considered to be in a largely natural condition, as few modifications are apparent. It is however considered likely that the severe erosion within the study area and greater catchment will have an effect on these wetland features, particularly increased sediment load entering the wetland features with runoff.

Based on information gleaned through the assessment of the other wetland features such as the seeps and channelled valley bottoms, floral species composition and vegetation community structure is deemed likely to have undergone transformation. Many of the depression features are located within close proximity to rural settlements, thus is it probable that natural vegetation removal in favour of crops will have occurred, as well as grazing and trampling by domestic livestock.

The anticipated trajectory of change for these features is a slight deterioration in integrity over the next five years, under current conditions. It is deemed unlikely that any of these features will be negatively impacted by the proposed dam construction, provided suitable mitigation measures are taken.

Ecological Important and Sensitivity (EIS)

The results of the EIS assessment applied to the depression wetland features are presented in **Table 34**.

Table 34: Results of the EIS assessment applied to the depression wetland features.

Determinant	Score	Confidence
PRIMARY DETERMINANTS		
1. Rare & Endangered Species	1	4
2. Populations of Unique Species	1	4
3. Species/taxon Richness	1	3
4. Diversity of Habitat Types or Features	1	3
5. Migration route/breeding and feeding site for wetland species	1	3
6. PES as determined by WET-Health assessment	3	4
7. Importance in terms of function and service provision	2	4
MODIFYING DETERMINANTS		
8. Protected Status according to NFEPA Wetveg	4	4
9. Ecological Integrity	2	4
TOTAL	16	
MEAN	1,78	
OVERALL EIS	**C**	

As seen in the table, the results indicate that the depression wetlands are considered to be in an EIS Category C. As with the seep wetland features, these wetlands may be considered ecologically important and sensitive on a local or provincial scale, however the biodiversity is unlikely to be sensitive to habitat and flow modifications.

Recommended Ecological Category (REC)

As with the seep wetlands, the depression wetland features are deemed to be of a lower ecological integrity and sensitivity than the drainage lines and channelled valley bottom features. Thus, an REC C was assigned to the depression wetland features.

5.1.5 SUMMARY OF RIPARIAN AND WETLAND HABITAT ASSESSMENTS

The results of the various assessments applied to the Tsitsa River and the wetland features identified within the study area are summarised in **Table 35**. The PES and sensitivity of the features are conceptually presented in **Figures 20 to 24**.

Table 35: Summary of all assessment results applied to the riparian and wetland features.

Wetland / Riparian Feature	VEGRAI	Wetland Function Assessment	PES (IHI / Wet-Health)	EIS	REC
Tsitsa River	C (75.6%)	Moderately High (2.3)	C (76.7%)	B (2.89)	B/C
TS2 & TS3	C (75%)	Moderately High (2.2)	C (73.3%)	B (2.67)	B/C
Inxu River (TS5)	C (63.7%)	Moderately High (2.2)	C (75.9%)	B (2.67)	B/C
TS6	C (63.7%)	Moderately High (2.2)	C (76.2%)	B (2.67)	B/C
TS9	C (57%)	Moderately High (2.2)	C (76.7%)	B (2.56)	B/C
Drainage Lines	N/A	Intermediate (1.9)	C (72.8%)	B (2.22)	C
Channelled Valley Bottom Wetlands	N/A	Moderately High (2.1)	C (3.3)	B (2.67)	C
Seep Wetlands	N/A	Intermediate (2.0)	C (3.05)	C (2.00)	C
Depression Wetlands	N/A	Intermediate (1.8)	C (2.4)	C (1.78)	C

Although all riparian and wetland features were categorised as PES C, there are localised variations of conditions with some systems being slightly more impacted by rural settlements and small urban centres. However, the significance of the variations in relation to the scale of this project is considered low.

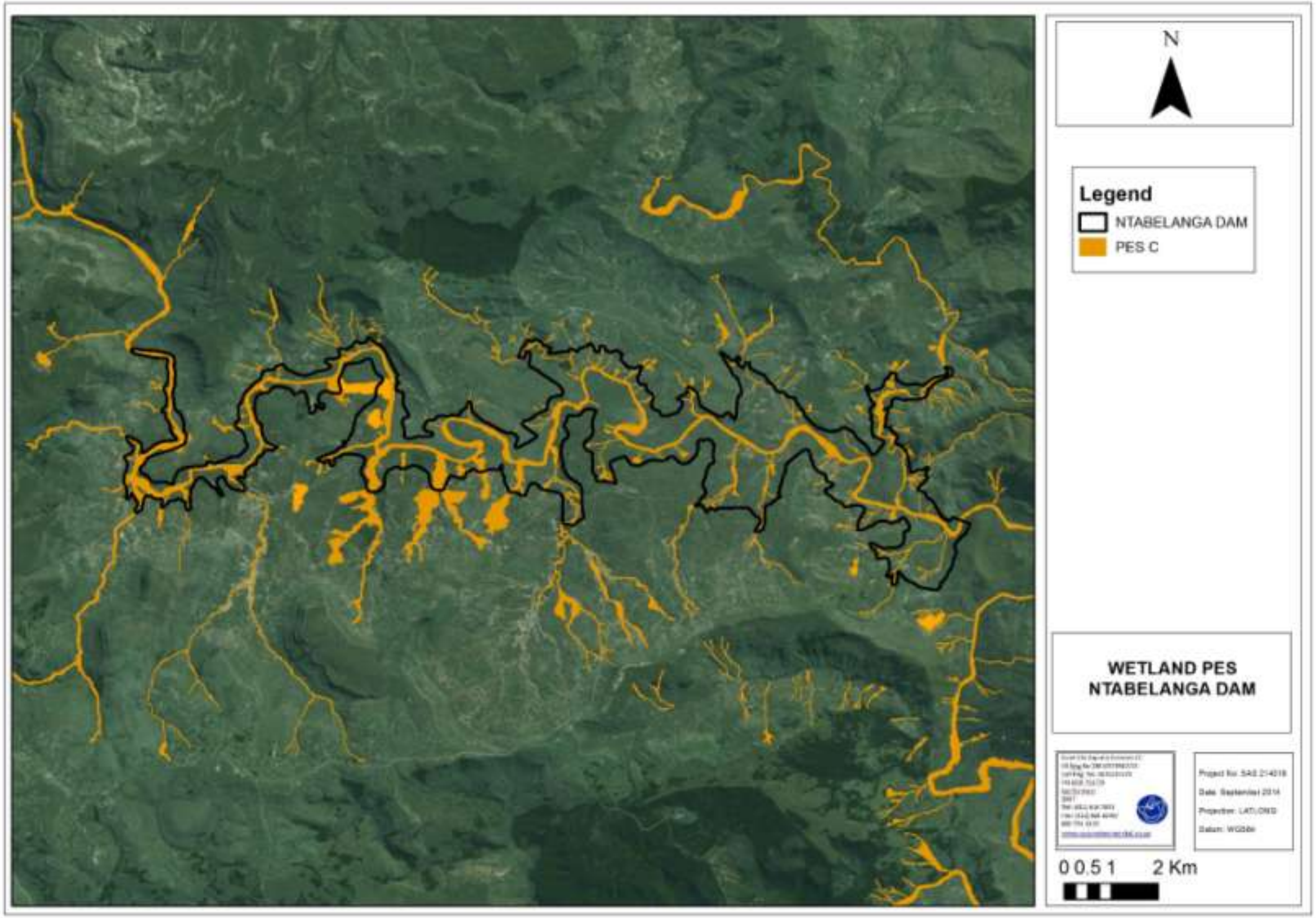

Figure 20: Conceptual presentation of the PES of the wetland and riparian features associated with the proposed Ntabelanga Dam site.

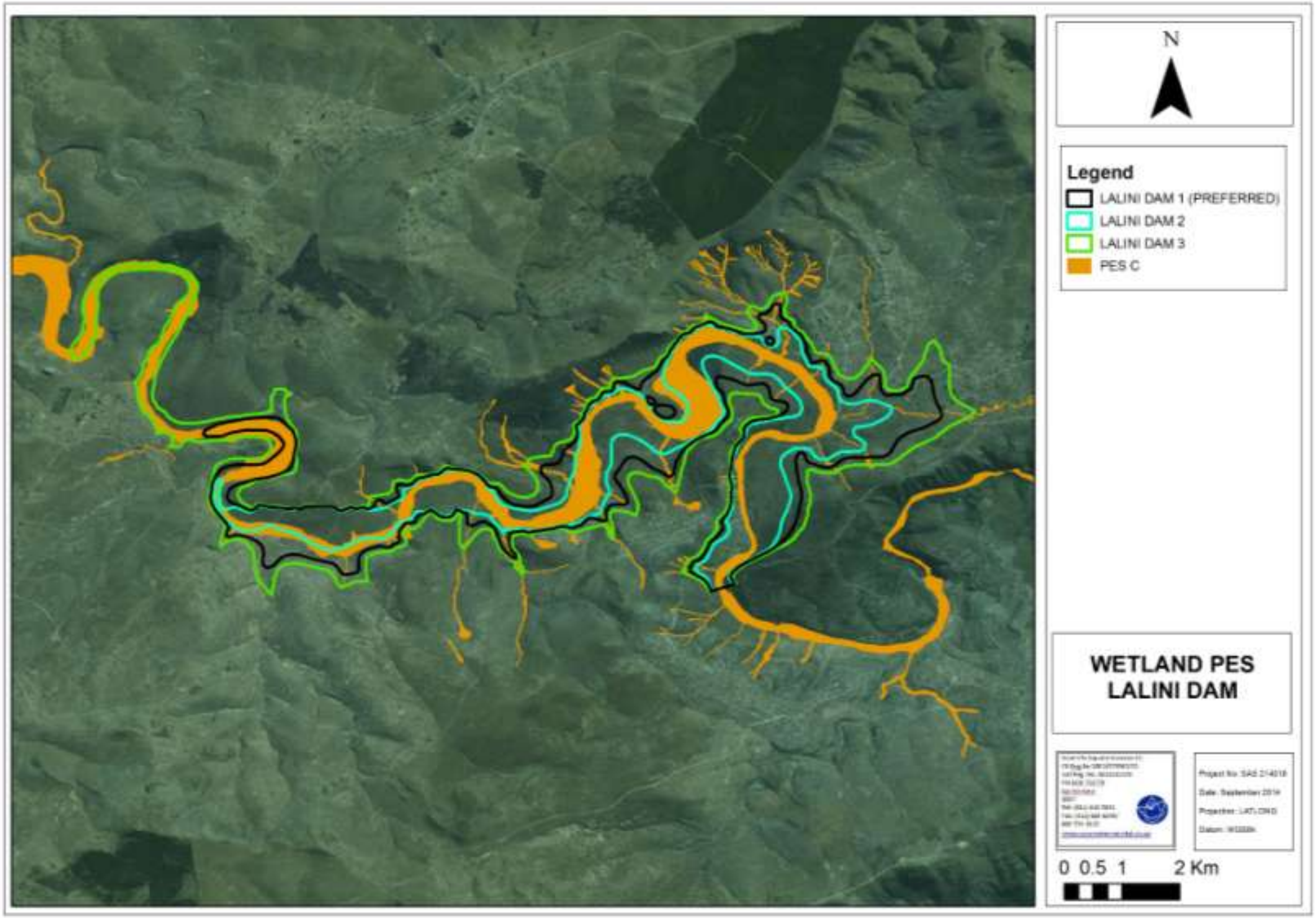

Figure 21: Conceptual presentation of the PES of the wetland and riparian features associated with the proposed Lalini Dam site.

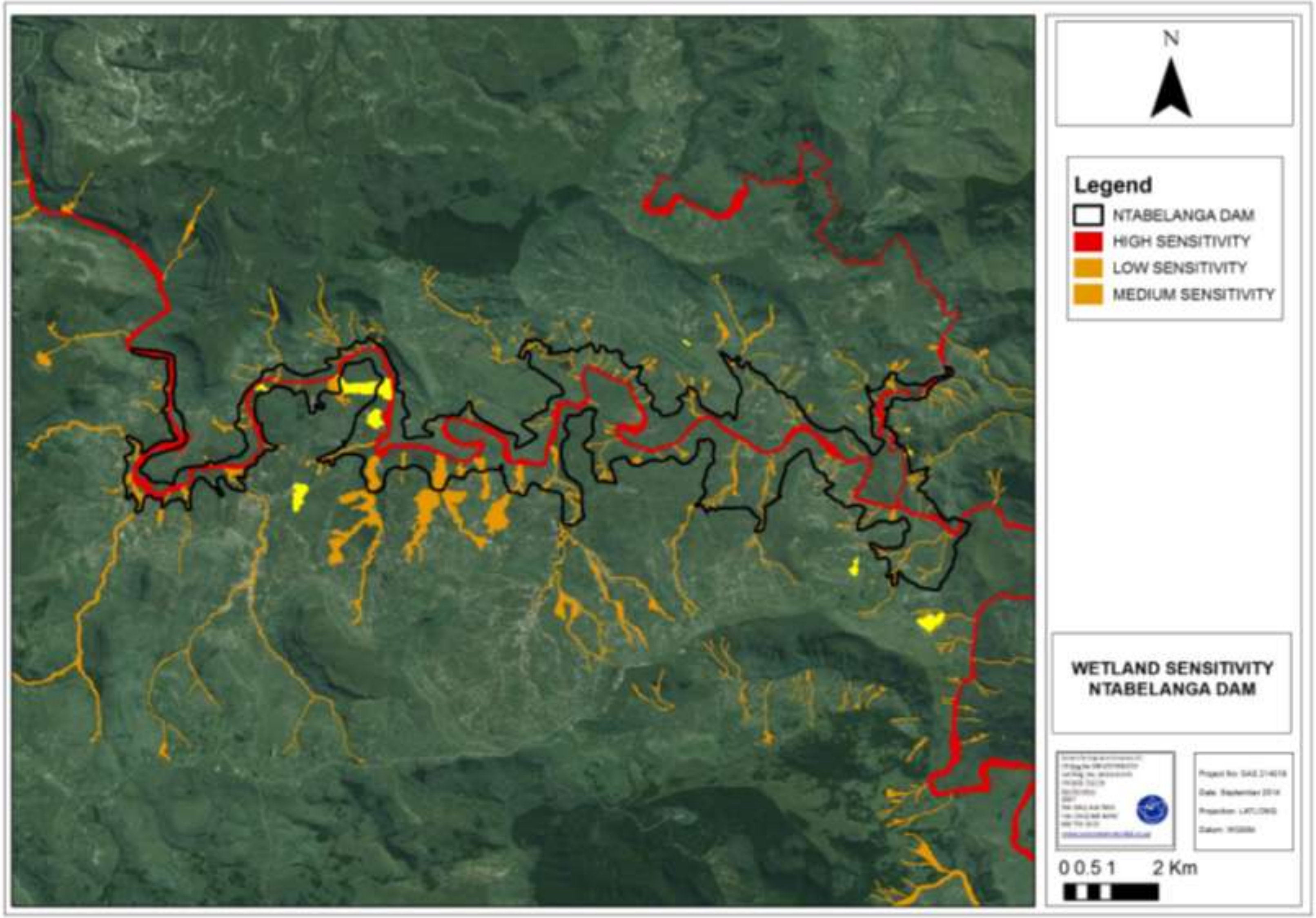

Figure 22: Conceptual presentation of the sensitivity of the wetland and riparian features associated with the proposed Ntabelanga Dam site.

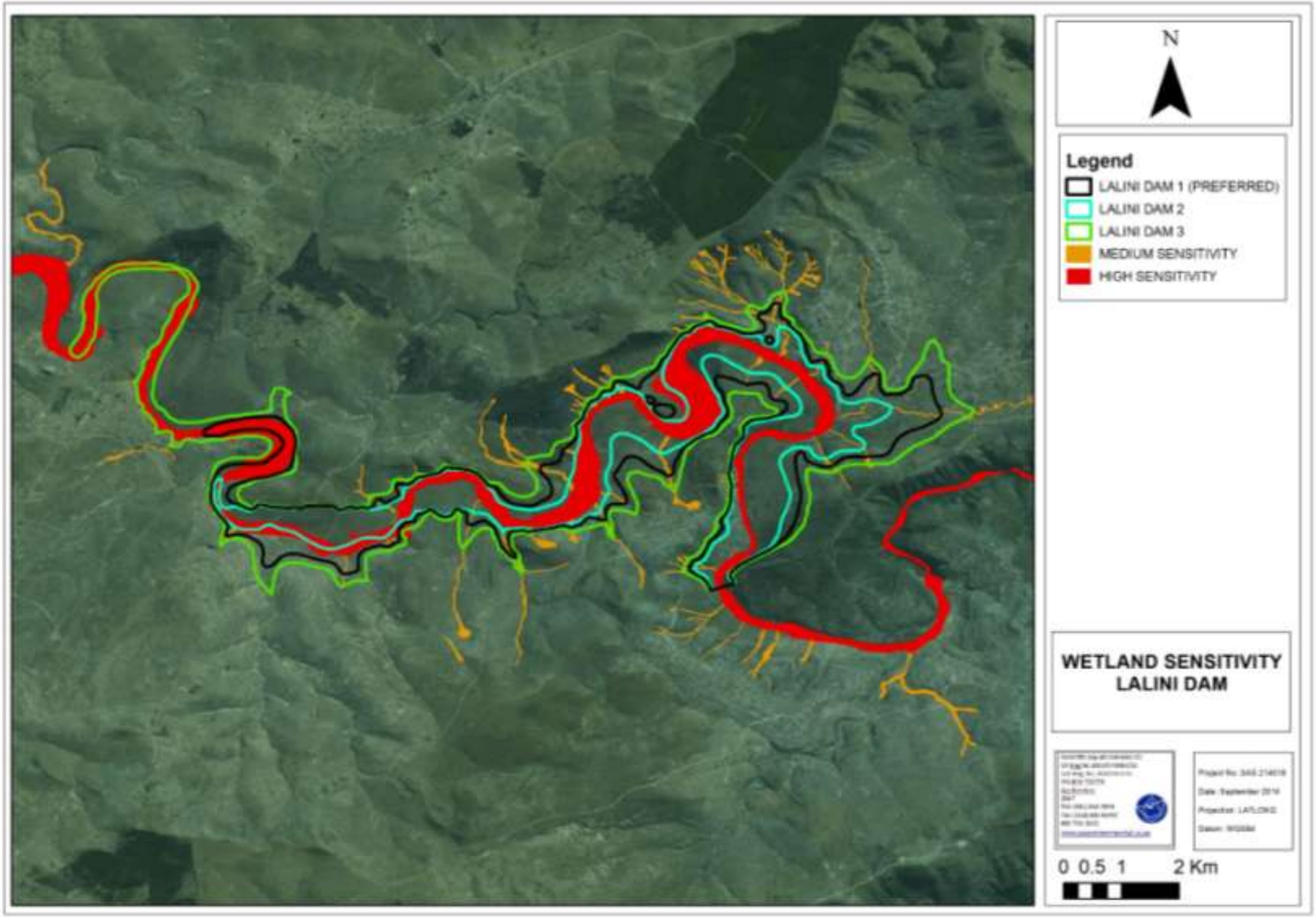

Figure 23: Conceptual presentation of the sensitivity of the wetland and riparian features associated with the proposed Lalini Dam site.

5.1.6 DELINEATION AND BUFFER ZONES

All features were delineated on a desktop level with the use of aerial photographs, digital satellite imagery and topographical maps. As described in Section 3.2.1 of this report, points of interest were identified prior to the site assessments in order to guide the field assessment. Where wetland features were identified during the field survey at these points of interest, portions of the features were verified according to the guidelines advocated by DWA (2005) and the wetland delineations as presented in this report are regarded as a best estimate of the temporary zone boundaries based on the site conditions present at the time of assessment.

- Terrain units (**Figure 24**) were used to determine in which parts of the landscape the wetland feature is most likely to occur, as wetlands occupying the valley bottom landscape unit are easily distinguishable, and the extent of the associated wetland area can often readily be determined.
- The soil form indicator (**Figure 25**) was used to determine the presence of soils that are associated with prolonged and frequent saturation, as well as variation in the depth of the saturated soil zone within 50cm of the soil surface. This indicator was used to identify gleyed soils where the soil is a greyish/greenish/bluish colour due to the leaching out of iron. Whilst mottling was not extensive, it was present in the temporary zone. These factors were utilised to aid in determining the location of the wetland zones and their boundaries.
- The vegetation indicator (**Figure 26**) was used where possible in the identification of the wetland boundary through the identification of the distribution of both facultative and obligate wetland vegetation associated with soils that are frequently saturated. Key species utilised, particularly in the seep wetlands, included *Schoenoplectus brachycerus, Eragrostis chloromelas, Sporobulus africanus* and *Arundinella nepalensis*. Changes in vegetation density and levels of greening were also considered during the delineation process, particularly in instances such as in the seep wetlands where terrestrial species are more abundant.

Figure 24: Representative photographs of slope (left) and valley bottom (right) terrain units found within the study area.

Figure 25: Representative photographs of soil samples taken within two different seep wetland features.

Figure 26: The presence and distribution of hydrophytic wetland vegetation such as *Schoenoplectus brachycerus* (left) aids in determining the boundaries of the wetland (right).

The use of buffer zones for wetlands is alluded to in: Environmental Best Practice Guidelines: Planning (Water supply and water resource infrastructure) as published by DWA in 2005, and the legislative principles as enshrined in the National Environmental Management Act (NEMA) (Activity 9 and 11 listing 1 of Government Notice R544 and Activity 16 Listing 3 of Government Notice R546 of 2010) prescribe a minimum 32m buffer around the wetland and riparian resource. Any activities proposed within the wetland or riparian boundaries, including rehabilitation, must be authorised by the DWA in terms of Section 21 (c) & (i) of the National Water Act (Act 36 of 1998). Since a Section 21 c & i WUL will be applied for, and due to the vast extent of the various components of the project, detailed mapping of unaffected wetlands within 500m of the proposed infrastructure did not take place in the field, but were mapped utilising digital satellite imagery and are presented in **Figures 27 to 29**.

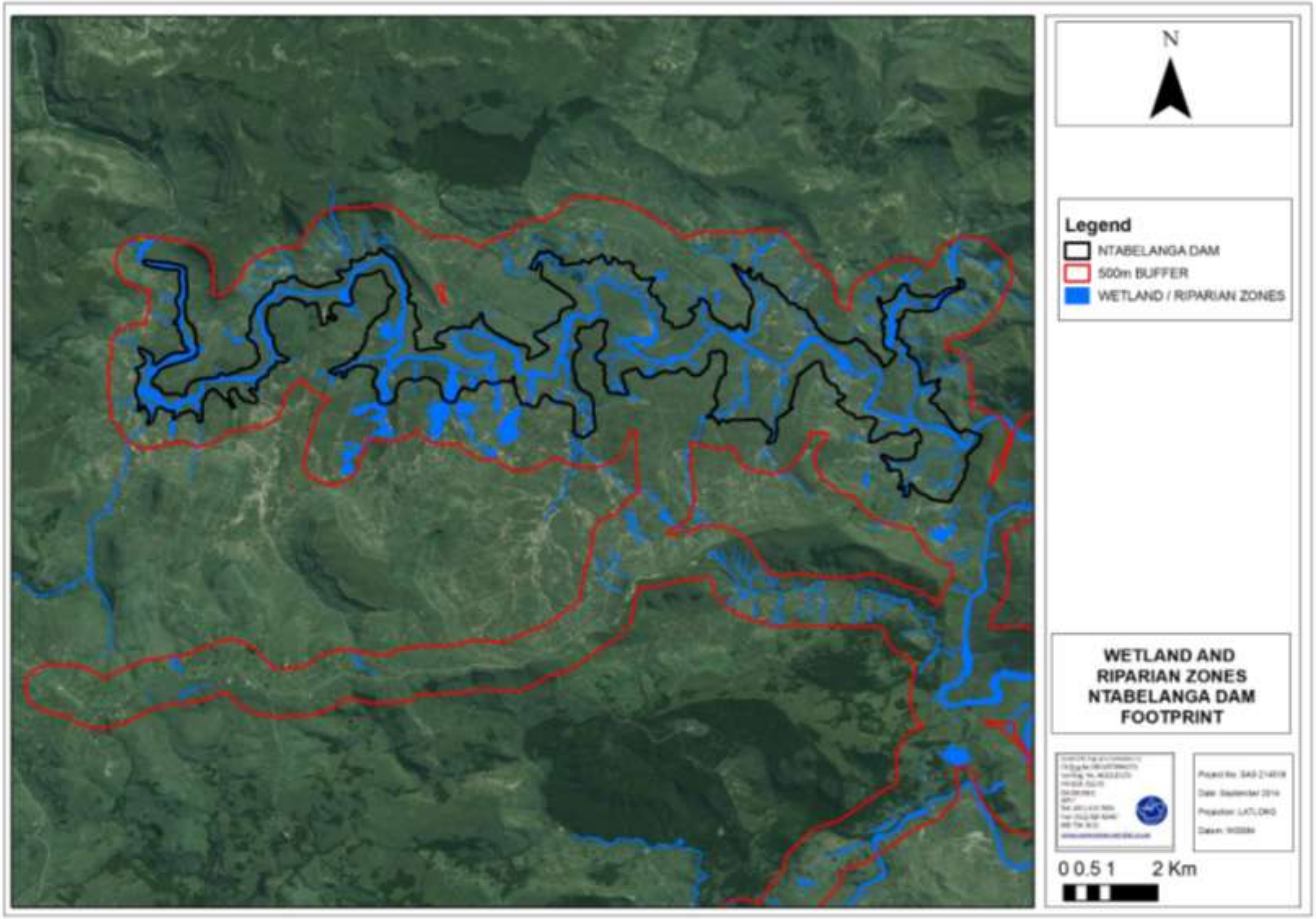

Figure 27: Conceptual representation of wetland and riparian resources located within 500m of the Ntabelanga Dam and its associated infrastructure footprint.

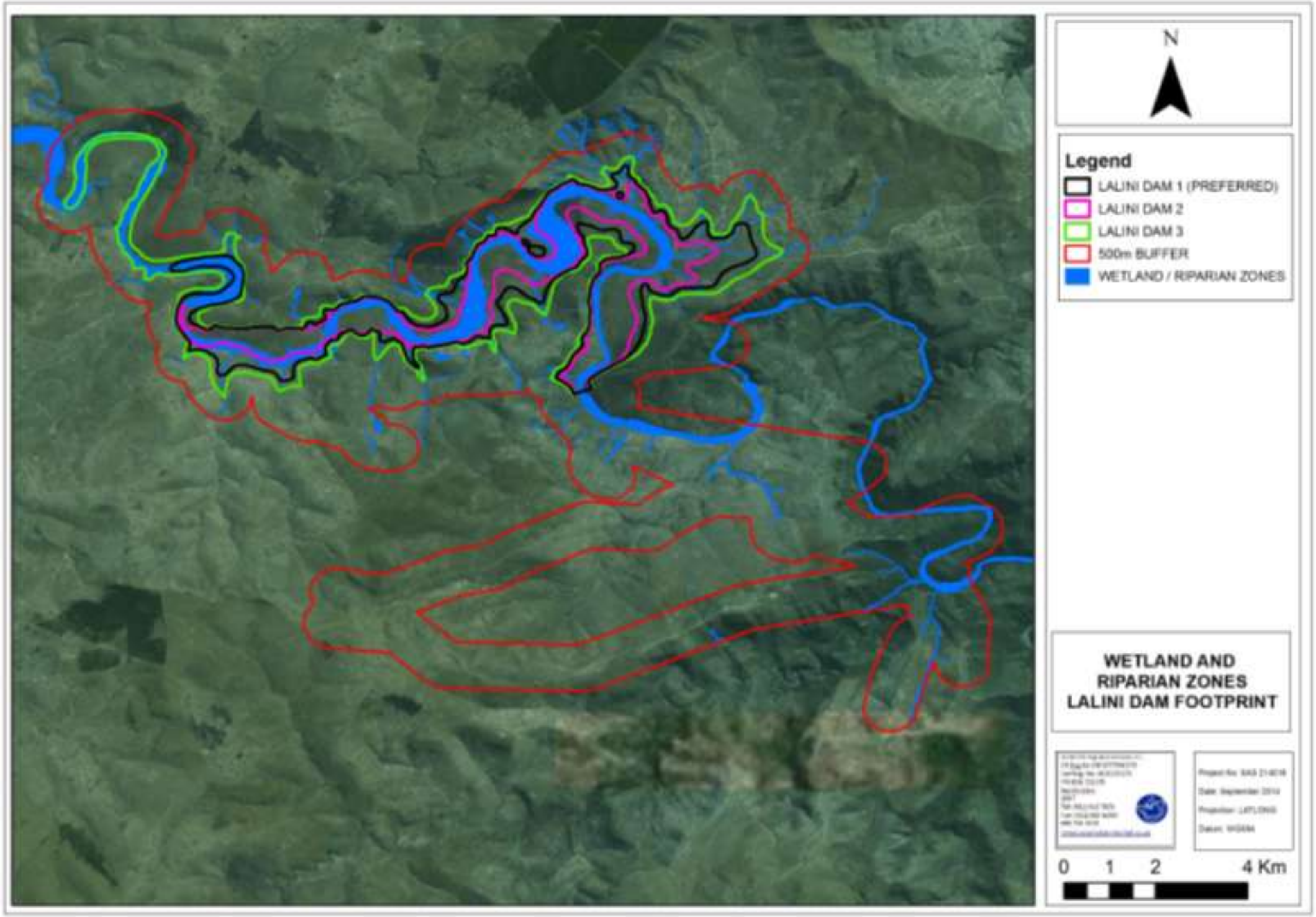

Figure 28: Conceptual representation of wetland and riparian resources located within 500m of the Lalini Dam and its associated infrastructure footprint.

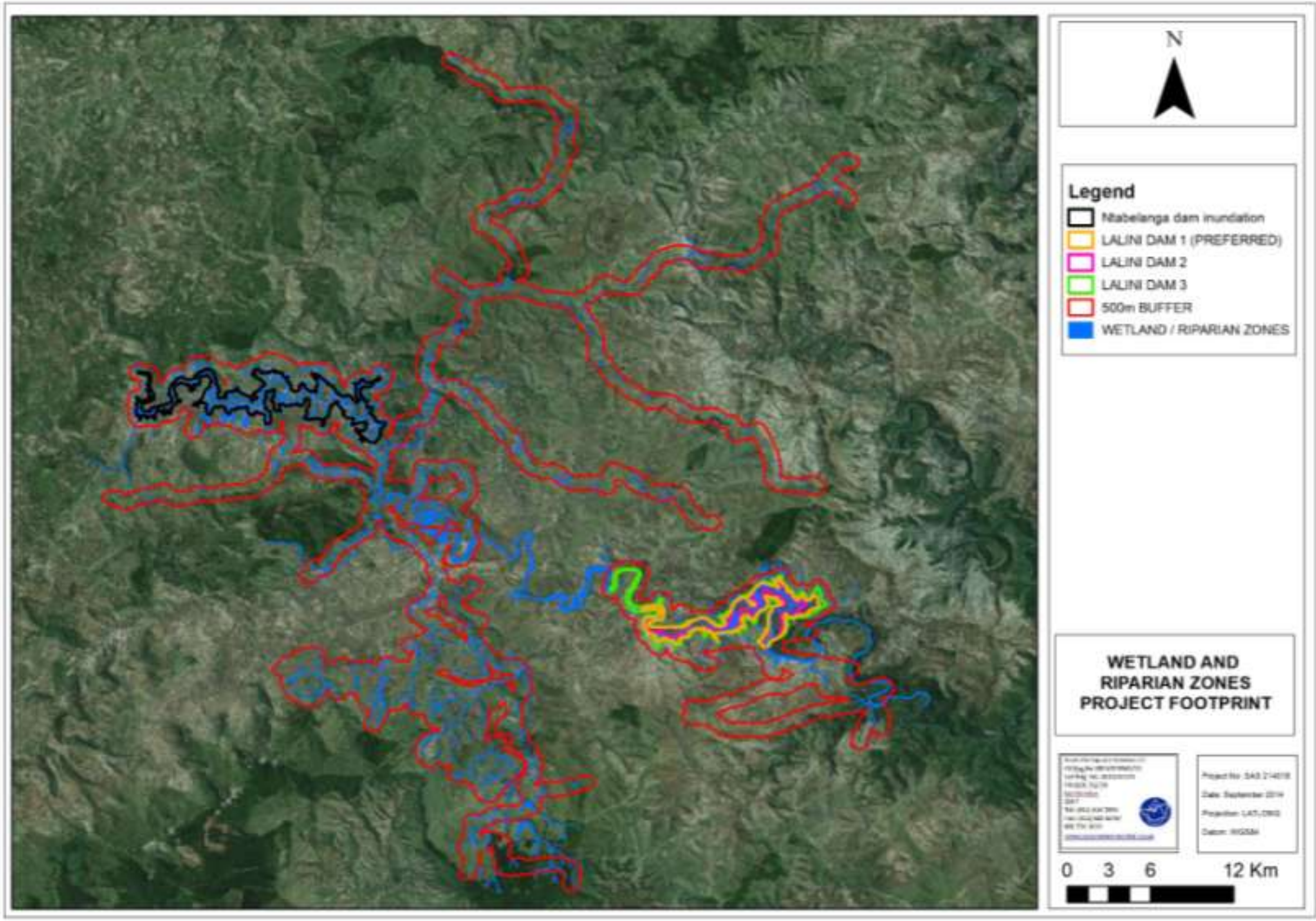

Figure 29: Conceptual representation of wetland and riparian resources located within 500m of the Mzimvubu Water Project footprint.

It is recognised however that due to the nature of the Mzimvubu Water Project, adherence to the stipulation of a 32m buffer zone is not feasible for all riparian and wetland features identified within the study area, as the construction of the dams will entail inundating several wetland features. Additionally, roads and pipelines may be planned to traverse wetland features; thus it will not be feasible to implement a buffer zone around all wetland features affected by the project. Effective mitigation must be implemented in order to reduce the level of impacts on the wetland features which will be negatively impacted by the construction of the proposed Ntabelanga Dam in particular, as it is anticipated that this will result in the loss of wetland and drainage line features or portions thereof. Furthermore, due to the linear nature of roads and pipelines, it is acknowledged that a buffer zone cannot be effectively implemented around the wetland features which will be crossed by such infrastructure. Nevertheless, mitigation measures must be implemented in order to decrease impacts on such features.

Based on the above discussion, it is clear that the wetlands which will be directly impacted by the proposed development, provide important ecological services in the way of sediment trapping, nutrient cycling and toxicant assimilation, flood attenuation and biodiversity maintenance. In view of the extensive, and often severe, erosion within the study area and greater catchment, sediment trapping is especially important. Wetlands can be seen as one of the most valuable ecosystems in the world. In 1980 the International Union for the Conservation of Nature (IUCN) identified wetlands as being the third most vital life support systems on the planet (Emery *et. al.* 2002). Thus, preservation of the water quality, habitats, vegetation and soils of wetlands is as essential as preservation of the ecological services they provide. The wetland features present in the study area are considered to be ‘ecologically sensitive’ to changes such as flow modifications, floral composition and structure of vegetation communities, as such modifications will impact on faunal composition and community structures as well.

Habitat destruction is the alteration of a natural habitat to the point that it is rendered unfit to support the species dependent upon it as their home territory. Many organisms previously using the area are displaced or destroyed, reducing biodiversity. Globally modification of habitats for agriculture is the chief cause of such habitat loss. Other causes of habitat destruction include surface mining, deforestation, slash and burn practices and urban development. Habitat destruction is presently ranked as the most significant cause of species extinction worldwide. Additional causes of habitat destruction include water pollution, introduction of alien species, overgrazing and overfishing. Riverine systems and particularly ephemeral riverine systems or river systems that have very low flows as part of their annual hydrological cycles are particularly susceptible to changes in habitat condition. The proposed Mzimvubu Water Project has significant potential to lead to loss of loss of niche habitat and/or alteration of the aquatic and riparian resources on the study area, with particular mention of the impacts that the two dams will have on the Tsitsa River and its tributaries, as well as the wetland resources.

The anticipated cumulative loss of riparian and wetland habitat arising from the construction of the dams is estimated to be 1034.30 hectares; overall this is deemed to be a relatively insignificant fraction of the wetland resources within the Mzimvubu subWMA. It should be noted that the ultimate loss is dependent on the final full supply level. The approximate loss of wetlands as a result of the construction of each dam is presented in the table below:

Table 36: Anticipated approximate loss of riparian and wetland habitat as a result of the construction of the dams.

Ntabelanga Dam		Lalini Dam	
Resource	**Hectares lost**	**Resource**	**Hectares lost**
Tsita River	246.09	Tsita River	550.91
Tributaries	23.20	Tributaries	0
Seeps	15.11	Seeps	0
Channelled Valley Bottom	37.20	Channelled Valley Bottom	0
Drainage Lines	89.93	Drainage Lines	71.85
TOTAL	**411.53**	**TOTAL**	**622.76**

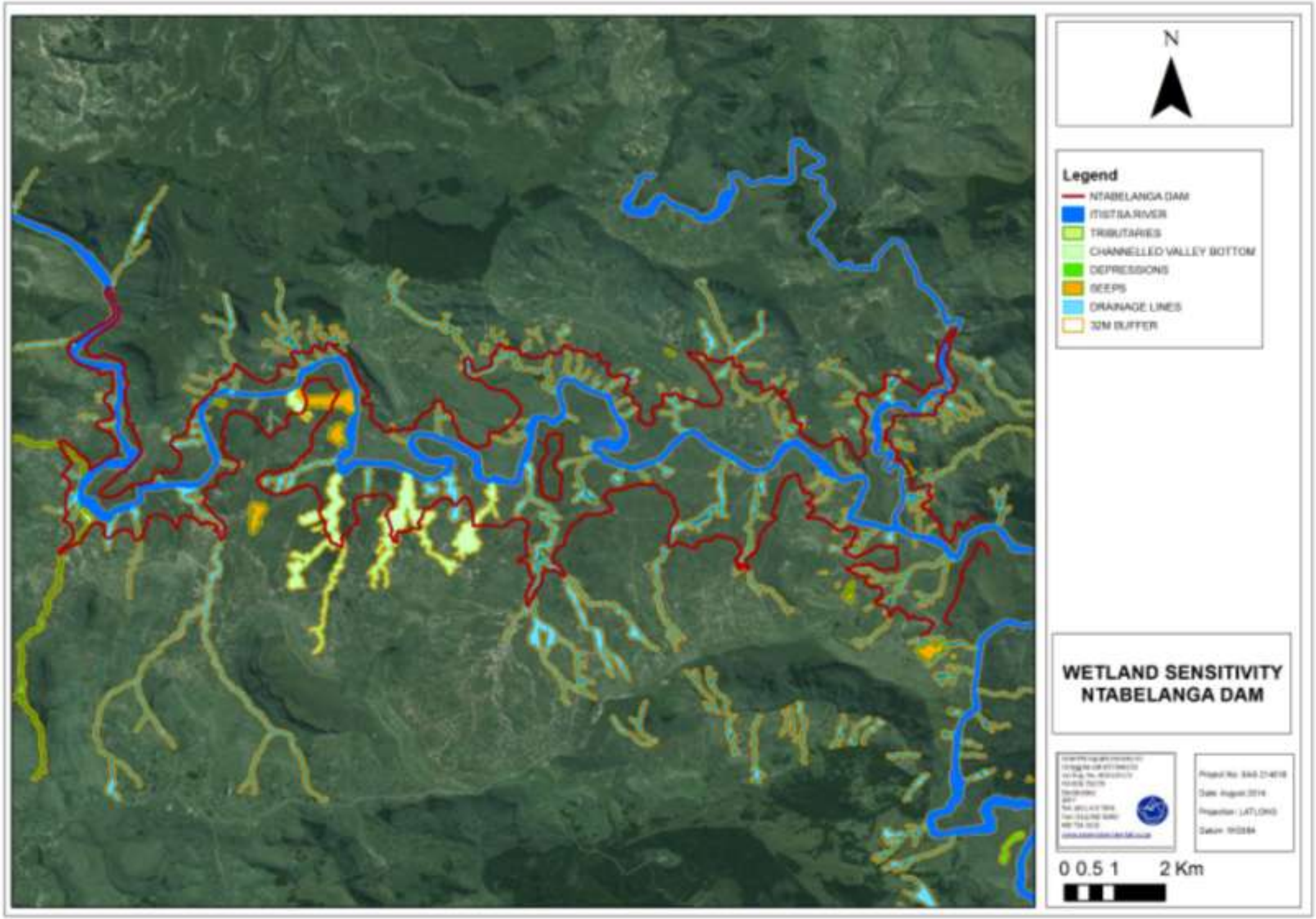

Figure 30: Conceptual presentation of the riparian and wetland delineations, with the associated buffer zone, in the Ntabelanga Dam vicinity.

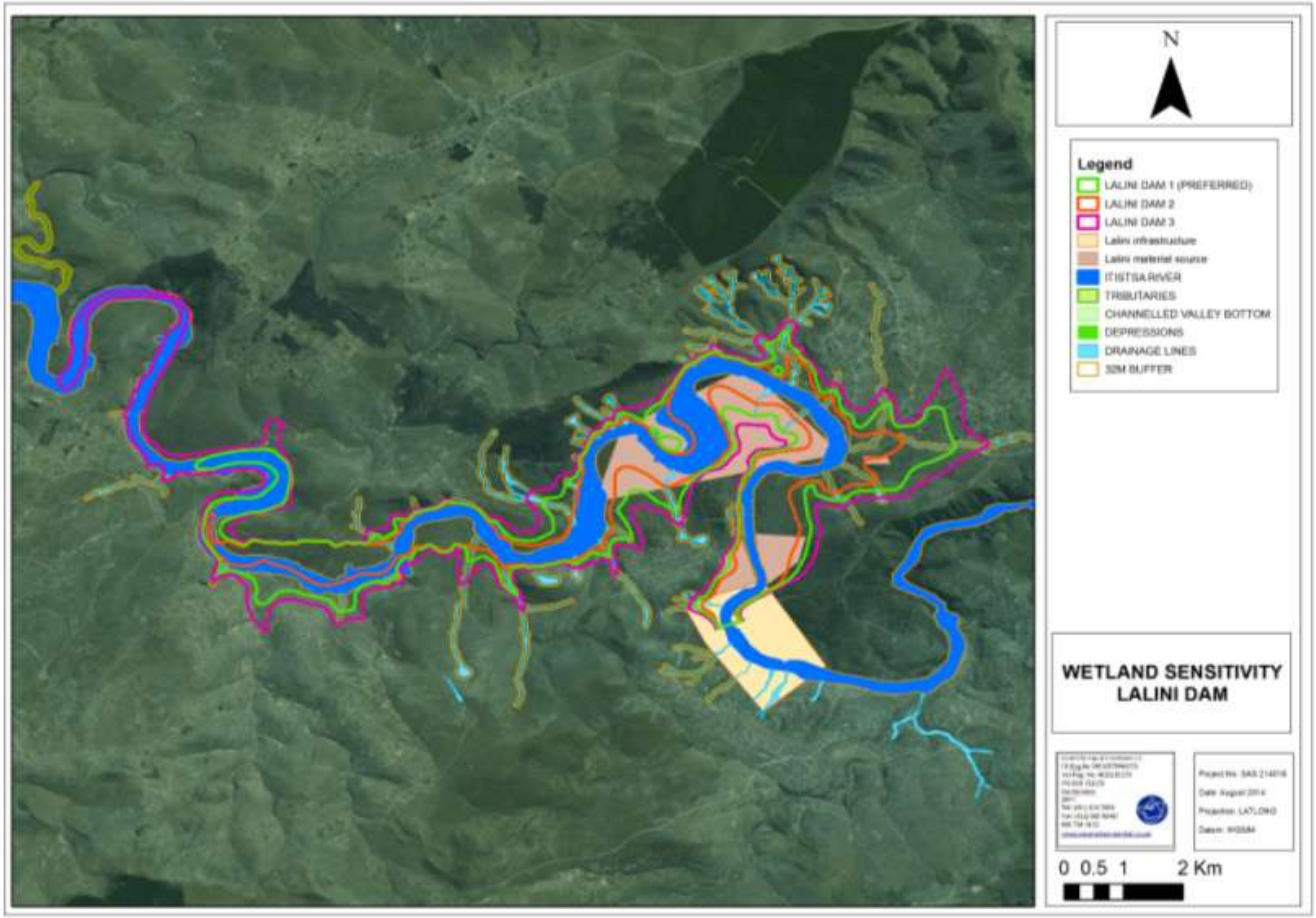

Figure 31: Conceptual presentation of the riparian and wetland delineations, with the associated buffer zones, in the Lalini Dam vicinity.

6 IMPACT ASSESSMENT

In the sections that follow (Sections 7 to 10), the significance of potential impacts on the wetland and riparian integrity of the proposed development are presented, along with essential and recommended mitigation measures to minimise the perceived impacts on the wetland and riparian resources within the study area.

Three main aspects of wetland and riparian ecology were considered in the impact assessments of each phase of the project: loss of wetland / riparian habitat and ecological structure, loss of wetland / riparian ecoservices, and impacts on wetland / riparian hydrology and sediment balance.

Habitat destruction is the alteration of a natural habitat to the point that it is rendered unfit to support the species dependent upon it as their home territory. Many organisms previously using the area are displaced or destroyed, reducing biodiversity. Globally modification of habitats for agriculture is the chief cause of such habitat loss. Other causes of habitat destruction include surface mining, deforestation, slash and burn practices and urban development. Habitat destruction is presently ranked as the most significant cause of species extinction worldwide. Additional causes of habitat destruction include water pollution, introduction of alien species, overgrazing and overfishing.

Riverine systems and particularly ephemeral riverine systems (such as some of the drainage lines present within the study area) or river systems that have very low flows as part of their annual hydrological cycles are particularly susceptible to changes in habitat condition. The construction of the proposed Ntabelanga and Lalini Dams will lead to the loss of wetland / riparian habitat and/or alteration of the aquatic, wetland and riparian resources within the study area, particularly of breeding and foraging habitat utilised by threatened avifaunal species such as *Balearica regulorum (*Grey Crowned Crane) as well as a variety of amphibian species. In addition, impacts on the larger systems such as the Tsitsa River and its tributaries could lead to impacts on aquatic macro-invertebrates and riparian vegetation. Due to the nature of the development, it is deemed definite that it would not be possible to rehabilitate the drainage line and channelled valley bottom wetland features which will be flooded when the dams are commissioned. Thus, it is critical to ensure that mitigation takes place in order to preserve as much of these habitats as possible.

The Tsitsa River and its tributaries, along with the drainage lines and channelled valley bottom wetland features were considered to be of a marginally higher importance than the seep and depression wetlands, in terms of function and ecological service provision. Important eco-services provided by these features include erosion control, sediment trapping, and nutrient and toxicant assimilation capabilities; capabilities which will be reduced by the loss of the wetlands in the region of the dams. In addition, the rivers are considered to have moderate levels of socio-cultural value, specifically provision of water for domestic use and tourism and recreational value. The Tsitsa River, its tributaries and the channelled valley bottom wetlands are deemed to have intermediate levels of biodiversity maintenance provision, primarily due to the presence of threatened avifaunal and floral species as observed during the site assessment.

The hydrological function and sediment balance of the Tsitsa River, the drainage lines and channelled valley bottom wetland features in particular will be impacted by the construction activities associated with the dams. As noted during the site assessment, the study area is prone to extensive and severe erosion. In the present state of the project site, natural vegetation cover reduces flow velocities by causing friction to rainfall runoff, consequently reducing forces between the water and ground surface, resulting in the ground surface remaining intact and therefore reducing the incidence of erosion. Increased flow velocities for any reason increase the potential for further erosion to occur. Increased erosion of disturbed surfaces means that the runoff contains a higher silt or sediment load, which is discharged to the surrounding river systems. A component of this sediment load is particles fine enough to remain in suspension, ‘clouding’ or ‘muddying’ the water, which can negatively affect biological life, for example by smothering.

Additionally, changed sediment loads can change channel character or dimensions, or have an effect on bed roughness; this was observed in several localities during the site assessments. Increased sediment in the drainage line and channelled valley bottom wetland features could result in altered streamflow patterns or altered vegetation communities as the boundaries shift or soil profile is changed as a result, particularly in those features which will be partially inundated by the dams.

The following activities are likely to cause an increase in flow velocities, or directly increase erosion:

- Stripping (vegetation clearance) of constructor laydown areas;
- Construction of hard standing areas that increase runoff volumes, including roads, buildings and paved areas;
- Construction activities that loosen the ground surface.

6.1 GENERAL MANAGEMENT AND GOOD HOUSEKEEPING PRACTICES

The following essential mitigation measures are considered to be standard best practice measures applicable to a development of this nature, and must be implemented during all phases of the proposed development activities, in conjunction with those stipulated in the following sections which define the mitigatory measures specific to the minimisation of impacts on wetland / riparian resources.

Essential mitigation:

- Minimise construction footprints prior to commencement of construction and control all edge effects of construction activities (proliferation of alien vegetation, disturbances of soils, dumping of construction waste);
- Ensure that contractor laydown areas are included in the initial areas demarcated for clearing in order to minimise vegetation loss, and ensure that as much as possible, they do not encroach into wetland / riparian zones or their respective buffer zones;
- Planning of temporary roads and access routes should take the site sensitivity plan into consideration. If possible, such roads should be constructed a distance from the more sensitive wetland area and not directly adjacent thereto;

- Contractor laydown areas should be outside of wetland areas as far as possible;
- Construction vehicles must remain on demarcated roads and should not encroach into the wetland areas or their respective buffer zones;
- Clearly demarcate sensitive wetland areas into which no construction activities should encroach;
- Measures to minimise impacts on water quality on the tributaries of the Tsitsa River must be ensured;
- Install erosion berms during construction to prevent gully formation. Berms every 50m should be installed where the track has a slope of less than 2%, every 25m where the track slopes between 2% and 10%, every 20m where the track slope between 10% and 15% and every 10m where the track slope is greater than 15%;
- Any areas where bank failure is observed, due to the effects of bridge crossings, should be immediately repaired by reducing the gradient of the banks to a 1:3 slope;
- Access roads to the construction sites should be planned as close as possible to existing roads in order to minimise loss of wetland habitat;
- No fires whatsoever should be allowed within the study area during the construction phase;
- Appropriate sanitary facilities must be provided and all waste removed to an appropriate waste facility;
- Implement alien vegetation control program within wetland areas associated with the proposed development;
- No vehicles should be allowed to drive through designated sensitive wetland areas during the eradication of alien and weed species;
- In the event of a breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced to prevent the ingress of hydrocarbons into the topsoil;
- It must be ensured that all roads and construction areas are regularly sprayed with water in order to curb dust generation. This is particularly necessary during the dry season when increased levels of dust generation can be expected. These areas should not be over-sprayed causing water run-off and subsequent sediment loss in the vicinity of the subject property;
- Ensure that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage. Regularly inspect all vehicles for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil;
- Storage of construction material used during the road upgrade should be localised within designated or selected areas, if possible, to ensure the minimisation of the ecological footprint area and prevent loss of natural habitat along the road;
- All soils compacted as a result of construction activities at the dam walls should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control within and around wetland / riparian areas should take place to prevent further loss of wetland / riparian habitat;
- No dumping of waste should take place. If any spills occur, they should be immediately cleaned up;

Recommended mitigation:

- As far as possible, restrict construction activities to the drier months wherever feasible, in order to avoid sedimentation and erosion of wetland / riparian features associated with the activities due to the soils of the area being highly susceptible to erosion.

7 IMPACT ASSESSMENT FOR DAMS AND ASSOCIATED WATER INFRASTRUCTURE

This Chapter presents the findings of the environmental impact assessment for the dams and associated activities (DEA Ref no. 14/12/16/3/3/2/677).

The activities assessed under this chapter are listed below:

- The Ntabelanga and Lalini Dams;
- Five flow gauging weirs;
- Primary and secondary bulk potable water infrastructure:
  - Primary infrastructure: main water treatment works, including four major treated water pumping stations and three minor treated water pumping stations, main bulk treated water rising mains, and eight Command Reservoirs that will supply the whole region;
  - Secondary distribution lines: conveying bulk treated water from Command Reservoirs to existing and new District Reservoirs;
- Bulk raw water conveyance infrastructure (abstraction, pipelines, one raw water pumping station, one reservoir and two booster pumps) for irrigated agriculture (raw water supply up to field edge);
- Impact of commercial agriculture in earmarked irrigation areas;
- WWTWs at the Ntabelanga and Lalini Dam sites;
- Accommodation for operational staff at the Ntabelanga and Lalini Dam sites;
- Ten construction materials quarries and borrow pits;
- River intake structures and associated works;
- Information centres at the two dam sites; and
- Miscellaneous construction camps, lay down areas, and storage sites.

7.1 CONSTRUCTION AND FIRST FILLING PHASES

7.1.1 Ntabelanga Dam

Construction of the Ntabelanga Dam entails the construction of the dam wall and river intake structures, as well as associated infrastructure such as the gauging weirs, camp sites, quarries and borrow pits, accommodation for operational staff, waste water treatment works (WWTWs), information centre, and the first filling of the dam.

Construction of the dam wall not only necessitates the removal of riparian vegetation, but also requires the movement of construction vehicles in the vicinity of or through wetland features (existing roads, earmarked for upgrades, currently traverse several wetland features). The first filling of the dam will result in the permanent loss of wetland habitat; due to the nature of the development, this cannot be avoided. It is therefore imperative that measures are taken in order to minimise the impact on those portions of the affected wetland features which will not be inundated. Construction of associated infrastructure such as accommodation, WWTW and the information centre has the potential to result in the loss of wetland habitat, although these impacts may be reduced with careful planning of the placement of these to minimise the footprint of these structures.

7.1.2 Lalini Dam

It is anticipated that the impacts on wetland and riparian habitat as a result of the construction and first filling of the Lalini Dam will be similar in nature to the impacts of the construction of the Ntabelanga Dam, i.e. loss of vegetation, sedimentation of features and permanent loss of habitat due to inundation.

7.1.3 Primary and secondary pipelines, and irrigation pipelines

During the site assessment, it was apparent that there are existing pipelines in certain areas of the study area, for example in the vicinity of Tsolo, within the existing pine plantation south of Tsolo, and where the proposed irrigation pipelines are to be located. It is therefore highly recommended that in order to minimise the impacts of the installation of these pipelines on wetland / riparian habitat, the routes of existing corridors of disturbance be followed. It is further recommended that pipeline routing be planned very carefully in order to avoid wetland / riparian habitat and should preferably not traverse drainage lines, channelled valley bottom wetlands or riparian zones. However, it is acknowledged that it may be unavoidable in some areas to prevent pipelines to crossing wetland / riparian habitat due to the nature of the terrain. Therefore, where it is essential that pipelines cross wetland / riparian habitat, with specific mention of drainage lines and channelled valley bottom wetlands, wherever feasible support structures should not be constructed within the active channels and must be placed outside of wetland / riparian habitat. In order to achieve this wetland crossings should take place at 90 degree angles wherever possible.

The construction of the infrastructure associated with the pipelines, including but not limited to main water treatment works, pumping stations, command reservoirs, rising mains and booster pumps must not take place within the wetland resources or their respective buffer zones in order to prevent further losses of wetland resources within the study area.

The following tables present the impact ratings of the various activities to take place during the construction, operational, commissioning and decommissioning phases on the wetland / riparian habitats and ecological structure, ecological service provision, and wetland hydrology and sediment budget.

Loss of wetland / riparian habitat and ecological structure

Essential mitigation:

- Areas of increased sensitivity as shown in the sensitivity and buffer zone maps developed (**Figures 22-23 and 30-31**) should ideally be avoided in terms of the placement of infrastructure in order to minimise the footprints within wetland features. However, it is acknowledged that due to the scale of this project and the mountainous terrain within which much of the infrastructure is planned, it will not always be possible to completely avoid all wetland or riparian habitat. In such instances, mitigation measures to limit the impacts (such as ensuring the design of crossings allows for the retention of wetland soil conditions as discussed in Section 9 of this report) must be implemented;

- Quarries and borrow pits should ideally be placed within the dam footprints in order to preserve wetland and riparian habitat outside of the dam footprints, and to reduce sedimentation of the riparian resources. According to the EAP, this has been achieved;
- Minimise the construction footprints and implement strict controls of edge effects;
- It is critical that an alien vegetation control programme is implemented, as encroachment of alien vegetation is apparent and is expected to increase as a result of the disturbances resulting during the construction process. Rehabilitation of disturbed areas, utilising indigenous wetland vegetation species, will assist in reducing the impact of construction.

Recommended mitigation:

- Restrict preparation (e.g. vegetation clearance) of the construction sites to the drier months to decrease the potential for erosion caused by rainfall;

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	3 (Medium)	3 (medium)	3 (medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (low)	High	Very Low
Residual Impact: • Permanent loss, or transformation of wetland / riparian habitat leading to a reduced ability to support wetland / riparian vegetation and faunal species naturally occurring within the system; • Proliferation of alien vegetation as a result of disturbances to the soil profile during construction, leading to transformed wetland / riparian habitat.							

• Erosion and sedimentation of wetland resources downstream of pipelines and dams.

Loss of wetland / riparian ecoservices

Essential mitigation:

- Erosion management and sediment controls such as the use of gabions or reno mattresses, revegetation of profiled slopes, erosion berms, drift fences with hessian and silt traps must be strictly implemented from the outset of construction activities;
- It is critical that an alien vegetation control programme is implemented, as encroachment of alien vegetation is already apparent in the study area, and is expected to increase as a result of the disturbances resulting during the construction process. Rehabilitation of disturbed areas during and post-construction, utilising indigenous wetland vegetation species, will assist in retaining essential wetland ecological services, particularly flood attenuation, sediment trapping and erosion control, and assimilation of nutrients and toxicants.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (low)	High	Very Low
Residual Impact: • Permanent loss of wetland / riparian habitat leading to a reduction in the capability of wetland resources to provide ecological							

services and functions such as flood attenuation, sediment trapping, nutrient and toxicant assimilation etc.

Impacts on wetland / riparian hydrology and sediment balance

Essential mitigation:

- Erosion management and sediment controls such as the use of gabions or reno mattresses, revegetation of profiled slopes, erosion berms, drift fences with hessian and silt traps must be strictly implemented from the outset of construction activities;
- Implement measures such as sediment control, and prevention of pollution (solid wastes, oil spills, discharge of sewage) to minimise impacts on the water quality of nearby adjacent rivers;
- Support structures for pipelines must be placed outside of riparian features, channelled valley bottom wetlands and drainage lines. Should it be essential to place such support structures within these features, the designs of such structures must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels and infrastructure should cross wetlands at right angles.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (low)	High	Very Low
Residual Impact: • Increased sedimentation of rivers and wetland features as a result of increased erosion due to vegetation loss and due to increased runoff arising from increase impermeable surfaces; • Altered flow patterns within wetland / riparian features, particularly within drainage lines, channelled valley bottom wetlands and rivers							

due to support structures placed within active channels;

- Earthworks within wetland / riparian habitats and in the vicinity of highly sensitive wetland / riparian areas leading to increased runoff and erosion and altered runoff patterns;
- Reduced ability to provide ecological services such as streamflow regulation, flood attenuation and sediment trapping as a result of altered habitat.

7.2 OPERATIONAL PHASE

7.2.1 Ntabelanga and Lalini Dams

Perceived impacts on wetland / riparian habitat will be of a considerably lower intensity during the operational phase of the project in comparison to the construction phase. This is attributed to the anticipated loss of habitat which will occur during the first filling of the dams. Thus, although the duration of the impact is considered to be permanent without the possibility of rehabilitation of those features which will be inundated, the intensity of the impact is considered low.

Fluctuations in the levels of water downstream of the dams as a result of incorrect environmental flow releases of water from the dams may have an impact on riparian vegetation. Prolonged exposure to dry conditions may result in the long-term loss of riparian vegetation, and subsequent increased incision and erosion of river banks leading to increased sedimentation of the river system. In addition rapid releases of large water volumes may lead to scouring of the riparian zone and a loss of some riparian zone cover and species.

7.2.2 Primary, secondary and irrigation pipelines

Major impacts on wetland / riparian features during the operational phases of the pipelines are not anticipated, provided that the impacts on these features are minimised during the construction phase, and that any wetland / riparian areas which were impacted during construction are monitored regularly for proliferation of alien vegetation and sedimentation in the areas of disturbance. During maintenance of pipelines, it is essential that maintenance vehicles remain on designated roads in order to limit the ecological footprint of maintenance activities and reduce further degradation of the wetland / riparian habitat.

Loss of wetland / riparian habitat and ecological structure

Essential mitigation:

- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- During operational use and maintenance of infrastructure, vehicles must remain on designated roads and not be permitted to drive through sensitive wetland / riparian habitat, particularly on the edges of the dams where loss of wetland habitat is already severe due to the dam footprints;

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (Medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (Low)	High	Very Low

Residual Impact:

- Fluctuating water levels downstream of the dams as a result of periodic release of water from the dams, leading to altered wetland / riparian species composition and community structure, in turn resulting in altered habitats and decreased ability to support biodiversity;
- Increased water inputs to wetland features as a result of runoff arising from increased impermeable surfaces (paving, roofs, dam walls, etc);

• Increased sediment inputs to wetland / riparian habitat due to increased traffic volumes in the vicinity;

Loss of wetland / riparian ecoservices

Essential mitigation measures:

- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- During operation and maintenance of infrastructure, vehicles must remain on designated roads and not be permitted to drive through sensitive wetland / riparian habitat, particularly on the edges of the dams where loss of wetland habitat and therefore ability of the wetlands to provide ecological services, is already compromised.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (Medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (Low)	High	Very Low
Residual Impact: • Wetland / riparian functionality and capacity to provide ecological services, already compromised as a result of the construction of the dams, may be further reduced as a result of continued disturbances during operations;							

Impacts on wetland / riparian hydrology and sediment balance

Essential mitigation measures:

- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (Medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (Low)	High	Very Low
Residual Impact: • Increased sediment inputs arising from increased run-off into wetland / riparian features; • Sedimentation of the wetland / riparian habitat may lead to altered habitat, resulting in decreased ability to support biodiversity; • Loss of riparian zone cover and species due to desiccation or flooding as a result of fluctuations in downstream water volumes.							

8 IMPACT ASSESSMENT FOR ELECTRICITY GENERATION AND DISTRIBUTION INFRASTRUCTURE

This Chapter presents the findings of the environmental impact assessment for the electricity generation and distribution related activities (DEA Ref no. 14/12/16/3/3/2/678).

The activities assessed under this chapter are listed below:

- Pipeline and tunnel (including tunnel alternatives) at the proposed Lalini Dam;
- Generation of hydro power and feeding of this power into the existing grid; and
- 18.5km power line from the Lalini Dam tunnel.

8.1 CONSTRUCTION PHASE

Power lines will be constructed to supply power for construction at the two dam sites and for operating five pumping and booster stations along the bulk distribution infrastructure. The construction of power lines is considered to be a moderately low risk activity in terms of wetland and riparian habitat conservation. The primary concern associated with this activity is the placement of support towers. Care should be taken to ensure that these structures are not placed within wetland or riparian habitat, or within their respective buffer zones. As with the construction of the pipelines, should it be necessary to place pylons within wetland habitat, it is highly recommended that these structures be placed outside of the active channels (in the case of the drainage lines or channelled valley bottom wetland features), in order to minimise the impacts on the hydrology of these systems.

Loss of wetland / riparian habitat and ecological structure

Essential mitigation:

- Areas of increased sensitivity as shown in the sensitivity maps developed (**Figures 22-23 and 30-31**) should ideally be avoided in terms of the placement of infrastructure in order to minimise the footprints within wetland features. However, it is acknowledged that due to the scale of this project and the mountainous terrain within which much of the infrastructure is planned, it will not always be possible to completely avoid all wetland or riparian habitat. In such instances, mitigation measures to limit the impacts (such as ensuring that support towers for power lines are not placed within wetland / riparian habitat) must be implemented;
- Construction vehicles must not be permitted to drive through wetland / riparian habitat, and must remain on designated roads; and
- Edge effects of construction, such as proliferation of alien vegetation and increased sedimentation due to soil disturbances must be strictly controlled, particularly in the vicinity of wetland resources, in order to minimise the loss of wetland habitat.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Loss of wetland / riparian habitat will lead to an overall reduction in biodiversity and functionality of the wetlands / riparian areas.							

Loss of wetland / riparian ecoservices

Essential mitigation measures:

- Construction vehicles must not be permitted to drive through wetland / riparian habitat, and must remain on designated roads; and
- Edge effects of construction, such as proliferation of alien vegetation and increased sedimentation due to soil disturbances must be strictly controlled, particularly in the vicinity of wetland resources, in order to minimise the loss of wetland habitat.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Loss of ecological service provision arising from alteration or loss of habitat leading to increased erosion and sedimentation of the wetland / riparian features; • Habitat alteration or loss arising during construction activities leading to a decreased capacity to support a variety of wetland faunal and floral species; • Proliferation of alien vegetation due to soil disturbances during construction leading to altered habitat, thus a reduction in the ability of the wetland / riparian features to provide essential ecological services.							

Impacts on wetland / riparian hydrology and sediment balance

Essential mitigation measures:

- Areas of increased sensitivity as shown in the sensitivity maps developed (**Figures 22-23 and 30-31**) should ideally be avoided in terms of the placement of infrastructure in order to minimise the footprints within wetland features. However, it is acknowledged that due to the scale of this project and the mountainous terrain within which much of the infrastructure is planned, it will not always be possible to completely avoid all wetland or riparian habitat. In such instances, mitigation measures to limit the impacts (such as ensuring that support towers for power lines are not placed within wetland / riparian habitat, particularly within active channels of drainage lines, channelled valley bottom wetlands and active river channels) must be implemented; and

- Strict control of edge effects of the construction of the power line infrastructure must be implemented in order to minimise sedimentation and erosion as a result of vegetation clearing and disturbances to the soil profile.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Poor planning, leading to placement of pylons within wetland / riparian areas, leading to altered flow patterns within active channels; • Altered hydrology as a result of the above, leading to increased incision of channels, and increased sedimentation of the system as a result.							

8.2 OPERATION PHASE

Loss of wetland / riparian habitat and ecological structure

Release of water in the generation tunnels, and maintenance of the power line infrastructure will be the primary impacting factors on wetland / riparian habitat during the operational phase. Species composition and community structure of riparian vegetation may be influenced by the release of water in the generation tunnels if the EWR is not managed properly.

Essential mitigation:

- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- Maintenance vehicles must remain on designated roads, and must not be permitted to traverse wetland / riparian habitat; and
- Maintenance personnel must ensure that any tools and/or waste products resulting from maintenance activities are removed from the site following completion of maintenance.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Periodic disturbances to vegetation and soil profile in the immediate vicinity of each pylon during maintenance activities leading to altered wetland vegetation community structure and species composition, and increased sedimentation;							

Loss of wetland / riparian habitat ecoservices

Essential mitigation:

- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- Maintenance vehicles must remain on designated roads, and must not be permitted to traverse wetland / riparian habitat; and
- Maintenance personnel must ensure that any tools and/or waste products resulting from maintenance activities are removed from the site following completion of maintenance.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Periodic disturbances to the soil profile and natural wetland / riparian vegetation as a result of routine maintenance activities leading to reduced ability to provide essential wetland ecological services such as flood attenuation, sediment trapping and erosion control, etc.							

Impacts on wetland / riparian hydrology and sediment balance

Essential mitigation:

- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- Maintenance vehicles must remain on designated roads, and must not be permitted to traverse wetland / riparian habitat; and
- Maintenance personnel must ensure that any tools and/or waste products resulting from maintenance activities are removed from the site following completion of maintenance.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact:							

9 IMPACT ASSESSMENT FOR ROADS INFRASTRUCTURE

This Chapter presents the findings of the environmental impact assessment for the road infrastructure (DEA Ref no. 14/12/16/3/3/1/1169).

The activities included under this chapter are listed below:

- Upgrading and relocation of roads and bridges;
- Construction of new access roads around the Lalini Dam site.

9.1 CONSTRUCTION PHASES

The construction of the dams will require the upgrade of existing roads, and in some areas around the Lalini Dam, construction of new roads. Existing roads currently traverse some wetland or riparian habitat, and thus these habitats have already undergone some transformation as a result. The construction of new roads therefore poses a greater threat to the integrity of wetland or riparian habitats, particularly in the vicinity of the Lalini Dam where few roads presently exist. It is highly recommended that access roads to both construction sites be planned along existing roads wherever possible in order to minimise further impacts on wetland or riparian habitat. Should it not be feasible to do this, new roads should be planned in areas of lowered sensitivity and should preferably not traverse drainage lines, channelled valley bottom wetlands or riparian habitat. It is however acknowledged that in some instances, it will be necessary for roads to cross wetland / riparian habitat. Where this is necessary, the crossing designs of bridges must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels.

Loss of wetland / riparian habitat and ecological structure

Essential mitigation:

- Wherever possible, it is preferable that existing roads be upgraded, rather than constructing new roads, in order to minimise the impact of construction on wetland / riparian habitat;
- Where it is necessary to traverse features such as drainage lines, channelled valley bottom wetlands and riparian habitat, the crossing designs of bridges must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels. In order to achieve this all crossings of wetlands should take place at right angles wherever possible;
- If it is absolutely unavoidable that wetland / riparian habitat is affected during the construction of new roads, especially during bridge or culvert construction, disturbance to any wetland crossings must be minimised and suitably rehabilitated. The design of such culverts / bridges should allow for wetland soil conditions to be maintained both upstream and downstream of the crossing to such a degree that wetland vegetation community structures upstream and downstream of the crossing are maintained. In this regard, special mention is made of:
    - The design of such culverts and/or bridges should ensure that the permanent wetland zone should have inundated soil conditions throughout the year extending to the soil surface;

- The design of such culverts and/or bridges should ensure that the seasonal wetland zone should have water-logged soils within 300mm of the soil surface during the summer rainfall period;
- Temporary wetland zone areas should have waterlogged soil conditions occurring to within 300m of the land surface during the summer rainfall period;

- Stabilisation of river banks in the vicinity of any bridge crossings over the Tsitsa River or any of its tributaries by either employing one of the individual techniques below or a combination thereof, including:
  - 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.
- Construction vehicles must be restricted to designated access roads and should not be permitted to drive through sensitive wetland / riparian habitat;
- Strict controls of edge effects such as proliferation of alien vegetation and increased sedimentation due to disturbances to the soil profile must be implemented;
- Ensure that no incision and canalisation of the wetland system takes place as a result of the construction of the culverts;
- It must be ensured that flow connectivity along the wetland features is maintained;
- Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles; and
- Monitor all systems for incision and sedimentation.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Permanent loss of wetland habitat during construction phases							

Loss of wetland / riparian ecoservices

Essential mitigation:

- Edge effects of activities including erosion and alien / weed control need to be strictly managed in the wetland areas;
- As much vegetation growth as possible should be promoted within the wetland areas in order to protect soils. In this regard, special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting (where applicable) are to be implemented.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance

Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Reduction in the ability of wetland / riparian features to provide ecological services due to altered habitat arising from construction-related activities.							

Impacts on wetland / riparian hydrology and sediment balance

Essential mitigation:

- Wherever possible, it is preferable that existing roads be upgraded, rather than constructing new roads, in order to minimise the impact of construction on wetland / riparian habitat;
- It is preferable that new road routes are planned in such a way as to avoid traversing wetland / riparian habitats, with special mention of drainage lines, channelled valley bottom wetlands and riparian habitat. Where it is necessary to traverse such features, the crossing designs of bridges must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels;
- If it is absolutely unavoidable that wetland / riparian habitat is affected during the construction of new roads, especially during bridge or culvert construction, disturbance to any wetland crossings must be minimised and suitably rehabilitated. The design of such culverts / bridges should allow for wetland soil conditions to be maintained both upstream and downstream of the crossing to such a degree that wetland vegetation community structures upstream and downstream of the crossing are maintained. In this regard, special mention is made of:
  - The design of such culverts and/or bridges should ensure that the permanent wetland zone should have inundated soil conditions throughout the year extending to the soil surface;
  - The design of such culverts and/or bridges should ensure that the seasonal wetland zone should have water-logged soils within 500mm of the soil surface at all times;
  - Temporary wetland zone areas should have waterlogged soil conditions occurring to within 300m of the land surface during the summer season;
- Construction vehicles must be restricted to designated access roads and should not be permitted to drive through sensitive wetland / riparian habitat;
- Strict controls of edge effects such as proliferation of alien vegetation and increased sedimentation due to disturbances to the soil profile must be implemented;
- Ensure that no incision and canalisation of the wetland system takes place as a result of the construction of the culverts;
- It must be ensured that flow connectivity along the wetland features is maintained;
- Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles; and
- Monitor all systems for incision and sedimentation.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Construction of roadways through wetlands, altering stream and baseflow patterns and water velocities; • Increased water and sedimentation inputs to wetlands / riparian habitat due to runoff resulting from increased impermeable surface area.							

9.2 OPERATION PHASE

As with the pipelines and power lines, the primary impact on wetland / riparian habitat during the operational phase of the roads is that of maintenance. Additionally, the anticipated increased volume of traffic on the roads due to the continued operations of the dams escalates the risk of toxicants such as motor vehicle oil reaching the wetlands and river systems in runoff from the roads. In the same manner, the likelihood of increased sediment and water inputs to the wetlands and river systems is increased.

Loss of wetland / riparian habitat and ecological structure

Essential mitigation:

- Regular maintenance of all roads, with specific mention of wetland / riparian crossings, must take place in order to minimise the risk of further degradation to wetland / riparian habitat;
- Regularly inspect wetland and riparian crossings for sedimentation and incision;
- Monitor wetland crossings for proliferation of alien vegetation;
- Spills from motor vehicles must be cleaned up and treated immediately; and
- All staff motor vehicles should be regularly inspected for leaks, and re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Runoff from road surfaces contaminating wetland / riparian areas; • Erosion and sedimentation of wetland / riparian habitat due to altered runoff patterns.							

Loss of wetland / riparian ecoservices

Essential mitigation:

- Regular maintenance of all roads, with specific mention of wetland / riparian crossings, must take place in order to minimise the risk of further degradation to wetland / riparian habitat;
- Regularly inspect wetland and riparian crossings for sedimentation and incision;
- Monitor wetland crossings for proliferation of alien vegetation;
- Spills from motor vehicles must be cleaned up and treated immediately; and
- All staff motor vehicles should be regularly inspected for leaks, and re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Inability to support biodiversity as a result of changes to water quality, increased sedimentation and alteration of natural hydrological regimes; • Alteration of natural hydrological regime, impacting on flood attenuation and streamflow regulation capabilities							

Impact on wetland / riparian hydrology and sediment budget

Essential mitigation:

- Regular maintenance of all roads, with specific mention of wetland / riparian crossings, must take place in order to minimise the risk of further degradation to wetland / riparian habitat;
- Regularly inspect wetland and riparian crossings for sedimentation and incision; and
- Monitor wetland crossings for proliferation of alien vegetation.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Erosion and increased sedimentation leading to altered geomorphology and smothering of wetland biota							

9.3 IMPACT STATEMENT FOR IRRIGATION AREAS

The irrigation fields were briefly assessed and selected areas were investigated as examples of the condition of these areas. The proposed agricultural fields are located within old farming lands, historically used since they have the highest agricultural potential and yield the highest harvests. No wetland features were identified in these areas during the field assessments. Furthermore, the fields have been uniformly heavily disturbed due to prior farming activities, and as such provide very limited habitat to faunal or floral species within the area and region, and the decommissioning of these areas as irrigated croplands is considered an insignificant impact to the regional wetland ecology.

9.4 POST CONSTRUCTION MAINTENANCE

Upon completion of this assessment, the following recommendations have been made:

- Regularly monitor and maintain the state of the gabions in order to ensure the stability of the gabion structures and prevent bank failure.
- Inspections should be repeated at least bi-annually and maintenance work should be completed as soon as damage is observed. The wall should be additionally inspected after severe weather or flood occurrences.
- If there has been a failure of one or more mesh wires, the area must be patched.
- The gabion structures should be inspected for excessive localised bulging and settlement.
- Where settlements have occurred, the cause should be investigated. In severe cases, the affected area should be taken down and reconstructed, reinstating the foundation. Where settlements are minor, these should be monitored on a six monthly basis to determine if it is an initial settlement problem or a long-term problem. Initial settlements generally stabilise and do not cause further problems. Long-term settlements must be investigated as to the cause and remedial action taken.
- Excessive localised bulging of gabions should be repaired by opening, emptying and repacking the affected units.

10 IMPACT ASSESSMENT FOR THE NO PROJECT ALTERNATIVE

This Chapter presents the findings of the environmental impact assessment for the no-project alternative.

From a wetland and riparian ecology perspective, should the project not proceed, no significant impacts on wetland or riparian habitat, ecological functioning, hydrology or sediment balance are anticipated. The construction of the Ntabelanga and Lalini Dams are expected to result in significant permanent losses of wetland and riparian habitat, subsequently resulting in the loss of ecological functioning and alterations to the hydrology and sediment balance of these habitats. Furthermore, altered instream flows due to the periodic release of water from the dams would impact on riparian vegetation and aquatic organisms, although this can be mitigated by adhering to the stipulated EWRs for each dam.

Nevertheless, it is expected that should the status quo remain within the study area, these habitats will still undergo alterations as a result of the continued impacts of anthropogenic activities such as vegetation clearing, sediment winning, crop cultivation within wetland habitats, etc. Additionally, due to the extensive erosion within the study area and the catchment, sediment inputs to wetland and riparian habitats are anticipated, thus potentially altering flow patterns within wetlands and riparian zones, as well as smothering vegetation and aquatic macro-invertebrates.

11 MITIGATION HIERARCHY AND OFFSET DISCUSSION

'Mitigation' is a broad term that covers all components of the 'mitigation hierarchy' defined hereunder. It involves selecting and implementing measures – amongst others – to conserve biodiversity and to protect, the users of biodiversity and other affected stakeholders from potentially adverse impacts as a result of development. The aim is to prevent adverse impacts from occurring or, where this is unavoidable, to limit their significance to an acceptable level. Offsetting of impacts is considered to be the last option in the mitigation hierarchy for any project.

The mitigation hierarchy in general consists of the following in order of which impacts should be mitigated (DEA *at al.* 2013):

1. **Avoid/prevent impact:** can be done through utilising alternative sites, technology and scale of projects to prevent impacts. In some cases if impacts are expected to be too high the "no project" option should also be considered, especially where it is expected that the lower levels of mitigation will not be adequate to limit environmental damage and eco-service provision to suitable levels;
2. **Minimise impact:** can be done through utilisation of alternatives that will ensure that impacts on biodiversity and ecoservices provision are reduced. Impact minimisation is considered an essential part of any development project;
3. **Rehabilitate impact** is applicable to areas where impact avoidance and minimisation are unavoidable where an attempt to re-instate impacted areas and return them to conditions which are ecologically similar to the pre-project condition or an agreed post project land use, for example arable land. Rehabilitation often only restores ecological function to some degree to avoid ongoing negative impacts and to minimise aesthetic damage to the setting of a project.
4. **Offset impact:** refers to compensating for latent or unavoidable negative impacts on biodiversity. Offsetting should take place to address any impacts deemed to be unacceptable which cannot be mitigated through the other mechanisms in the mitigation hierarchy. The objective of biodiversity offsets should be to ensure no net loss of biodiversity. Biodiversity offsets can be considered to be a last resort to compensate for residual negative impacts on biodiversity.

Following the assessment of the resources within the study area, impacts associated with the project, with specific mention of the construction of the Ntabelanga and Lalini Dams and their associated infrastructure, are deemed high largely due to the impact assessment method. Nevertheless, the impacts are considered acceptable when taking into account the socio-economic value of the dams compared to the residual impacts on wetland biodiversity. Whilst the riparian and wetland habitats within the study area are considered to be ecologically important and sensitive on a localised and provincial scale, these habitats have already undergone varying degrees of transformation due to ongoing anthropogenic activities within the area, thus the integrity and overall value of these riparian and wetlands areas has been compromised to some extent. Residual impacts such as crane conservation within wetland habitat are deemed unlikely to be mitigated by offsetting the riparian and wetland habitats thus limiting the significance of an offset programme. Nevertheless, although it is the opinion of the specialists that a formal offset is not required, conservation initiatives could potentially contribute to the overall success and value of the project. The mitigation hierarchy as defined above should therefore be implemented accordingly in order to minimise the significance of the impact of the proposed development to ensure that regional conservation targets and objectives are met while still ensuring sustainable development.

12 CONSULTATION PROCESS

12.1 CONSULATION PROCESS FOLLOWED

PUBLIC PARTICIPATION

Engagement with Interested and Affected Parties (I&APs) forms an integral component of the EIA process. I&APs have an opportunity at various stages throughout the EIA process to gain more knowledge about the proposed project, to provide input into the process and to verify that their issues and concerns have been addressed.

The proposed project was announced in April 2014 to elicit comment from and register I&APs from as broad a spectrum of public as possible. The announcement was done by the following means:

- The distribution of Background Information Documents (BIDs) in English and IsiXhosa;
- Placement of site notices in the project area and Municipal offices (Tsolo and Qumbu);
- Placement of advertisements in one regional (The Herald) and two local (Daily Dispatch and the Mthatha Fever) newspapers; and
- Publication of all available information on the DWS web site (www.dwa.gov.za/mzimvubu).

The Draft Scoping Report (DSR) was made available for a 30 day public comment period in May 2014. All documents were uploaded to the web, notification letters were sent out, the summary of the DSR was translated into isiXhosa, distributed to all registered stakeholders and hardcopies of the full report and translated summary report were available at public places. Additionally, three public meetings were held in the affected areas, Siqhungqwini, Tsolo and Lalini respectively. An Authorities Forum Meeting with all relevant authorities was held in the Eastern Cape on the 28 May 2014. This was to assist the authorities with commenting on the relevant documentation.

Comments received from stakeholders were captured in the Issues and Response Report (IRR) which formed part of the Final Scoping Report (FSR). The FSR was made available to the public for a 21 day comment period on 13 June 2014 and was submitted to the Department of Environmental Affairs (DEA). Comments received during the Final Scoping public comment period were compiled and an updated IRR was submitted to DEA on 8 July 204 and uploaded to the website. The FSR was accepted by DEA with certain conditions on 15 July 2014. Following this, a newsletter was compiled and translated to isiXhosa, explaining everything that has happened to date as well as what is to come. Both the English and isiXhosa versions were electronically distributed to all registered stakeholders and hardcopies were distributed by the local facilitators in the affected areas.

The Draft Environmental Impact Assessment Report (DEIR), its summary (translated into isiXhosa), the various specialist studies, the Environmental Management Programmes (one for the construction and operation of the project, and one for the borrow areas and quarries) as well as the Water Use Licence Application will be made available for a period of thirty (30 days) for stakeholders to comment. Hardcopies will be made available at the same venues as the DSR and all documents will be uploaded to the website. The availability of these documents as well as the announcement of the upcoming public meetings in Siqhungqwini, Tsolo and Lalini will be advertised on the Eastern Cape SABC radio station, Umhlobo Wenene FM, which has a listenership of over 4 million people. Another Authorities Forum Meeting is scheduled for October 2014.

Stakeholder comments will be taken into consideration with the preparation of the final documents. The availability of the final documents will be announced prior to submission to the decision-making authority. Once a decision has been made by the DEA, all stakeholders will again be notified.

The Issue and Response Report (Final Version 1) as submitted to the Department of Environmental Affairs with the Final Scoping Report did not contain matters pertaining to wetlands, as no applicable comments were received during the process.

12.2 SUMMARY OF COMMENTS RECEIVED

No comments pertaining to the impact of the proposed development on wetland resources were received.

13 OTHER INFORMATION REQUESTED BY THE AUTHORITY

DEA requested that the impacts of the proposed facility on water courses and water resources in the area be assessed in the EIA phase. The impact on wetlands is assessed in this report.

14 IMPACT STATEMENT

Table 37 summarises the perceived impacts before and after the implementation of mitigation measures. The Ntabelanga and Lalini Dams will have the greatest impact on wetland and riparian habitat, as wetland habitat will be permanently lost during the first filling.

Table 37: Summary of impacts of the construction and operations of the two dams and their associated infrastructure on wetland and riparian ecology.

Impact	Construction and First Filling		Operational Phase	
Mitigation Status	**Unmitigated**	**Mitigated**	**Unmitigated**	**Mitigated**
Roads and pipelines: impact on habitat	Low	Very Low	Low	Very Low
Roads and pipelines: impact on ecoservices	Low	Very Low	Low	Very Low
Roads and pipelines: impact on hydrology and sediment balance	Low	Very Low	Low	Very Low
Electricity generation and distribution: impact on habitat	Low	Very Low	Medium Low	Very Low
Electricity generation and distribution: impact on ecoservices	Low	Very Low	Medium Low	Very Low
Electricity generation and distribution: impact on hydrology and sediment balance	Low	Very Low	Medium Low	Very Low
Ntabelanga and Lalini Dams: impact on habitat	High	High	Medium High	Medium High
Ntabelanga and Lalini Dams: impact on ecoservices	High	High	Medium High	Medium High
Ntabelanga and Lalini Dams: impact on hydrology and sediment balance	High	High	Medium High	Medium High

14.1 NTABELANGA DAM

Construction of the Ntabelanga Dam entails the construction of the dam wall, associated infrastructure such as the camp sites, quarries and borrow pits, accommodation for operational staff and the first filling of the dam.

Construction of the dam wall not only necessitates the removal of riparian vegetation, but also requires the movement of construction vehicles in the vicinity of or through wetland features (existing roads, earmarked for upgrades, currently traverse several wetland features). The first filling of the dam will result in the permanent loss of wetland habitat; due to the nature of the development, this cannot be avoided. It is therefore imperative that measures are taken in order to minimise the impact on those portions of the affected wetland features which will not be inundated with special mention of areas downstream of the proposed dam. Due to the extensive loss of drainage lines, channelled valley bottom wetland features and riparian habitat during the first filling of the dam, the perceived impacts of the dam during the construction phase are considered to be high. However, taking into account that permanent habitat loss will already have occurred, the perceived impacts of the dam during its operational phase are deemed to be medium high.

14.2 LALINI DAM

It is anticipated that the impacts on wetland and riparian habitat as a result of the construction and first filling of the Lalini Dam will be similar in nature to the impacts of the construction of the Ntabelanga Dam, i.e. loss of vegetation, sedimentation of features and permanent loss of habitat due to inundation. Due to the permanent loss of drainage lines, channelled valley bottom wetlands and riparian habitat, as with the Ntabelanga Dam, the perceived impacts of the Lalini Dam on these features is deemed to be high. Impacts during the operational phase are considered to be medium high, due to the extent and intensity of the impacts during the construction and first filling of the dam.

Three capacities are under consideration for Lalini Dam. The second alternative, i.e. a Full Supply Level of 752.42mamsl, will result in the lowest direct loss of wetland habitat, and is thus considered to be the most viable option in terms of wetland conservation.

14.3 PRIMARY, SECONDARY AND IRRIGATION PIPELINES

It was evident during the site assessment that existing pipelines are laid in close proximity to existing roads, and it is therefore highly recommended that new pipelines are laid along these routes as far as possible. Whilst it is acknowledged that it may not be feasible in all areas to avoid wetland / riparian habitat, careful planning should take place to avoid the laying of pipelines within or traversing wetland / riparian features wherever possible, with specific mention of drainage lines, channelled valley bottom wetlands or riparian zones. Where it is essential that pipelines cross wetland / riparian habitat, no support structures should be constructed within the active channels and must be placed outside of wetland / riparian habitat. In addition wherever possible this infrastructure should cross wetlands at right angles to minimise the footprint in wetland areas. The impacts associated with the installation and operation of the pipelines is nevertheless considered to be very low should suitable mitigation take place.

14.4 ROAD UPGRADES AND CONSTRUCTION OF NEW ROADS

Existing roads are deemed to have already impacted on wetland and riparian habitat to some degree, altering flow patterns, sediment balance, vegetation communities in the vicinity of wetland crossings, and introducing additional water inputs to the wetlands as a result of runoff. Therefore, the proposed upgrades to the existing roads are deemed to have a marginally lower level of impacts than the construction of new roads. It is highly recommended that access roads to both construction sites be planned along existing roads wherever possible in order to minimise further impacts on wetland or riparian habitat. Should it not be feasible to do this, new roads should be planned in areas of lowered sensitivity and should preferably not traverse drainage lines, channelled valley bottom wetlands or riparian habitat. It is however acknowledged that in some instances, it will be necessary for roads to cross wetland / riparian habitat. Where this is necessary, the crossing designs of bridges must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels. In addition wherever possible this infrastructure should cross wetlands at right angle to minimise the footprint in wetland areas.

14.5 POWER GENERATION WITH HYDROTUNNELS AND POWER LINE ALTERNATIVES

The construction of power lines is considered to be a moderately low risk activity in terms of wetland and riparian habitat conservation. The primary concern associated with this activity is the release of water in the generation tunnels, as the fluctuating water levels in the riparian zone particularly could potentially alter the floral species composition and community structure, thus altering the riparian habitat, influencing the ability of the riparian zone to support biodiversity. All three routing options of the hydrotunnels under consideration have equal potential to impact on the riparian zone in this manner. As the tunnels will be predominantly below ground, it is considered unlikely that wetland habitat will be impacted significantly by these tunnels.

The placement of support towers for the power lines is also of concern. Care should be taken to ensure that these structures are not placed within wetland or riparian habitat, or within their respective buffer zones. As with the construction of the pipelines, should it be necessary to place support towers within wetland habitat, it is highly recommended that these structures be placed outside of the active channels (in the case of the drainage lines or channelled valley bottom wetland features), in order to minimise the impacts on the hydrology of these systems.

14.6 KEY MITIGATION MEASURES

The essential mitigation measures referred to in Section 6: General Management and Good Housekeeping Practices must be adhered to, in addition to the key mitigation measures presented in Sections 7 to 9. These key mitigation measures are:

- Areas of increased sensitivity as shown in the sensitivity and buffer zone maps developed (**Figures 22-23 and 30-31**) should ideally be avoided in terms of the placement of infrastructure in order to minimise the footprints within wetland features. However, it is acknowledged that due to the scale of this project and the mountainous terrain within which much of the infrastructure is planned, it will not always be possible to completely avoid all wetland or riparian habitat. In such instances, mitigation measures to limit the impacts (such as ensuring the design of crossings allows for the retention of wetland soil conditions as discussed in Section 9 of this report) must be implemented;
- Quarries and borrow pits should ideally be placed within the dam footprints in order to preserve wetland and riparian habitat outside of the dam footprints, and to reduce sedimentation of the riparian resources. According to the EAP this has been achieved;
- Minimise the construction footprints and implement strict controls of edge effects;
- Erosion management and sediment controls such as the use of gabions or reno mattresses, revegetation of profiled slopes, erosion berms, drift fences with hessian and silt traps must be strictly implemented from the outset of construction activities;
- It is critical that an alien vegetation control programme is implemented, as encroachment of alien vegetation is already apparent in the study area and is expected to increase as a result of the disturbances resulting during the construction process. Rehabilitation of disturbed areas, utilising indigenous wetland vegetation species, will assist in retaining essential wetland ecological services, particularly flood attenuation, sediment trapping and erosion control, and assimilation of nutrients and toxicants, thus reducing the impacts of construction related activities;
- Implement measures such as sediment control, and prevention of pollution (solid wastes, oil spills, discharge of sewage) to minimise impacts on the water quality of nearby adjacent rivers;

- Support structures for pipelines must be placed outside of riparian features, channelled valley bottom wetlands and drainage lines. Should it be essential to place such support structures within these features, the designs of such structures must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels. In order to achieve this all crossings of wetlands should take place at right angles wherever possible;
- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- During operations and maintenance of infrastructure, vehicles must remain on designated roads and not be permitted to drive through sensitive wetland / riparian habitat, particularly on the edges of the dams where loss of wetland habitat and therefore ability of the wetlands to provide ecological services, is already compromised.
- Maintenance personnel must ensure that any tools and/or waste products resulting from maintenance activities are removed from the site following completion of maintenance.
- Wherever possible, it is preferable that existing roads be upgraded, rather than constructing new roads, in order to minimise the impact of construction on wetland / riparian habitat;
- Where it is necessary to traverse features such as drainage lines, channelled valley bottom wetlands and riparian habitat, the crossing designs of bridges must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels. In order to achieve this all crossings of wetlands should take place at right angles wherever possible;
- If it is absolutely unavoidable that wetland / riparian habitat is affected during the construction of new roads, especially during bridge or culvert construction, disturbance to any wetland crossings must be minimised and suitably rehabilitated. The design of such culverts / bridges should allow for wetland soil conditions to be maintained both upstream and downstream of the crossing to such a degree that wetland vegetation community structures upstream and downstream of the crossing are maintained. In this regard, special mention is made of:
  - The design of such culverts and/or bridges should ensure that the permanent wetland zone should have inundated soil conditions throughout the year extending to the soil surface;
  - The design of such culverts and/or bridges should ensure that the seasonal wetland zone should have water-logged soils within 500mm of the soil surface during the summer rainfall period;
  - Temporary wetland zone areas should have waterlogged soil conditions occurring to within 300m of the land surface during the summer rainfall period;
- Ensure that no incision and canalisation of the wetland system takes place as a result of the construction of the culverts;
- It must be ensured that flow connectivity along the wetland features is maintained;
- Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles;
- Monitor all systems for incision and sedimentation;

- As much vegetation growth as possible should be promoted within the wetland areas in order to protect soils. In this regard, special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting (where applicable) are to be implemented;
- Regular maintenance of all roads, with specific mention of wetland / riparian crossings, must take place in order to minimise the risk of further degradation to wetland / riparian habitat.

15 CONCLUSION AND RECOMMENDATIONS

The riparian habitat of the Tsitsa River and its tributaries, including the Inxu River, have undergone moderate levels of transformation as a result of anthropogenic activities, such as as grazing of cattle, harvesting of thatching grass and firewood, and sand winning. Despite these disturbances however, these systems are deemed to provide moderately high levels of functionality and ecological and socio-cultural services. The assessment of these riparian features indicated that they all fall within a PES Category C (moderately modified; loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged). Due to the presence of suitable breeding and foraging habitat for a number of faunal species of conservation concern, the high level of integrity of the river and levels of ecological service provision, the Tsitsa River and the tributaries assessed are deemed to be in an EIS Category B, indicating that they are considered ecologically important and sensitive on a regional, and potentially provincial scale.

In terms of wetland features, four basic HGM units were identified within the study area, namely channelled valley bottom, hillslope seeps, depressions and drainage lines. Of these, the channelled valley bottom wetland features are considered to hold the greatest value, as they obtained scores indicating moderately high levels of ecological and socio-cultural service provision and functionality, and were found to be in a PES Category C and EIS Category B. Whilst the drainage lines received similar scores to the hillslope seep and depression wetlands and were thus placed in the same PES Category (C) they are deemed to have moderately higher ecological importance and sensitivity than the other two HGM units, and were placed in an EIS Category B.

The construction of the Ntabelanga and Lalini Dams pose a significant threat to the conservation of wetland and riparian resources in the study area. The anticipated cumulative loss of riparian and wetland habitat arising from the construction and first filling of the dams is estimated to be 1034.30 hectares; overall this is deemed to be a relatively insignificant fraction of the wetland resources within the Mzimvubu subWMA. The loss of wetland habitat will result in the loss of the associated ecoservices such as flood attenuation and sediment trapping. Additionally, populations of wetland-dependent faunal and floral species may be lost or reduced as a result of the loss of wetland habitat. Whilst the proposed dams have the potential to provide foraging habitat to certain faunal species, particularly avifauna, and certain obligate and facultative floral species may grow around the edge of the dams, the structure and function of this newly established littoral zone will not significantly compensate for the loss of wetland and riparian resources that will occur as a result of first flooding.

The construction of associated infrastructure, such as pipelines, power lines and roads, is anticipated to have a relatively low impact on the ecology of wetland and riparian habitat, provided the mitigation measures set out in this report are implemented.

Upon completion of this wetland assessment, it is the opinion of the specialist that, from a wetland ecological point of view, the proposed development be considered favourably, provided that the essential impact mitigation measures as set out in Sections 6 to 9 of this report are adhered to and with special mention of the strict adherence to the EWR's to ensure that impacts are limited to the FSL of the dams and that impacts of downstream areas are limited.

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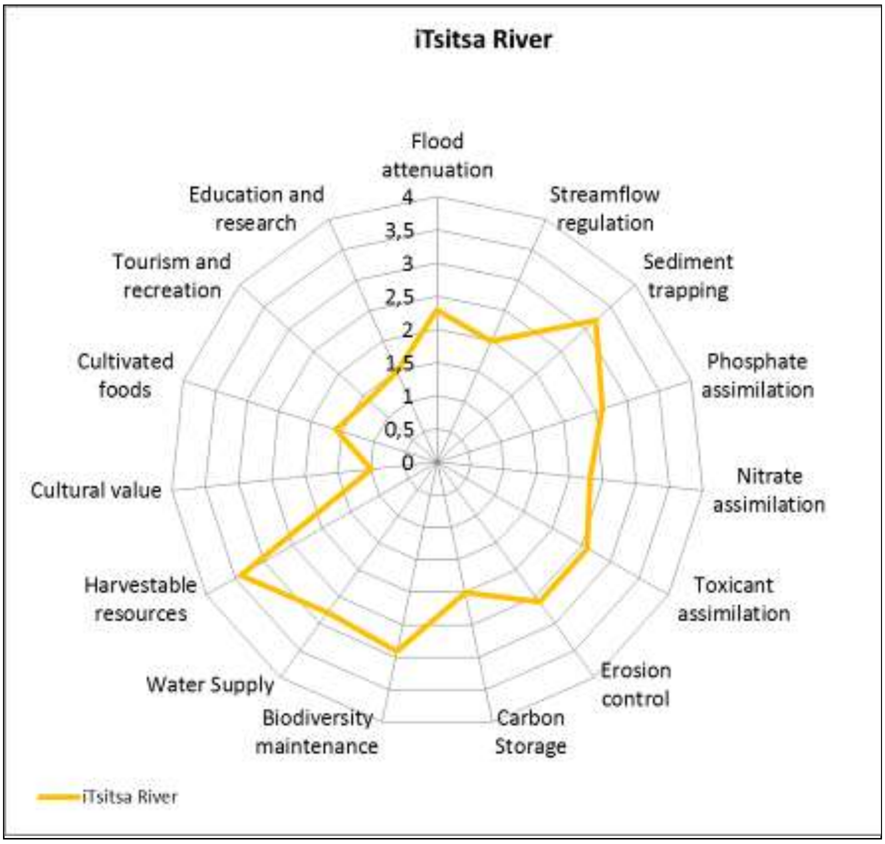
APPENDIX A
PRESENTATION OF WETLAND FUNCTION ASSESSMENT RESULTS

Results of the WET-Ecoservices assessment applied to the Tsitsa River.

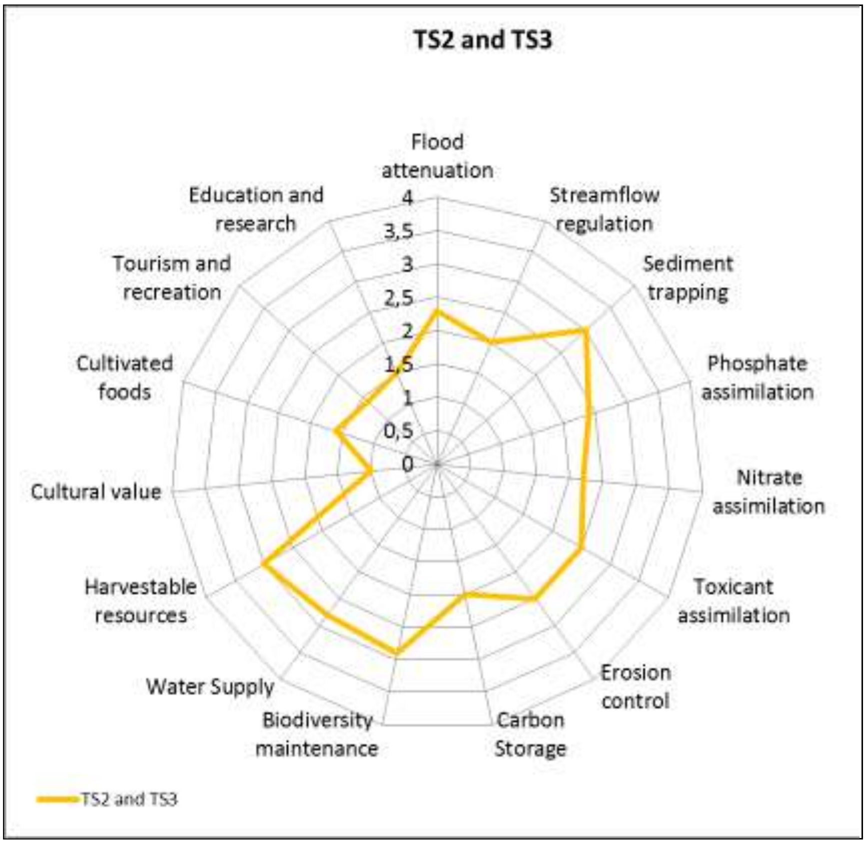
Ecosystem service	Tsitsa River
Flood attenuation	2,3
Streamflow regulation	2
Sediment trapping	3,2
Phosphate assimilation	2,6
Nitrate assimilation	2,3
Toxicant assimilation	2,6
Erosion control	2,6
Carbon Storage	2
Biodiversity maintenance	2,9
Water Supply	2,8
Harvestable resources	3,4
Cultural value	1
Cultivated foods	1,6
Tourism and recreation	1,4
Education and research	1,5
SUM	**34,2**
Average score	**2,3**



Radar plot of wetland services provided by the Tsitsa River.

Results of the WET-Ecoservices assessment applied to riparian zones of the unnamed tributaries of the Tsitsa River (TS2 and TS3).

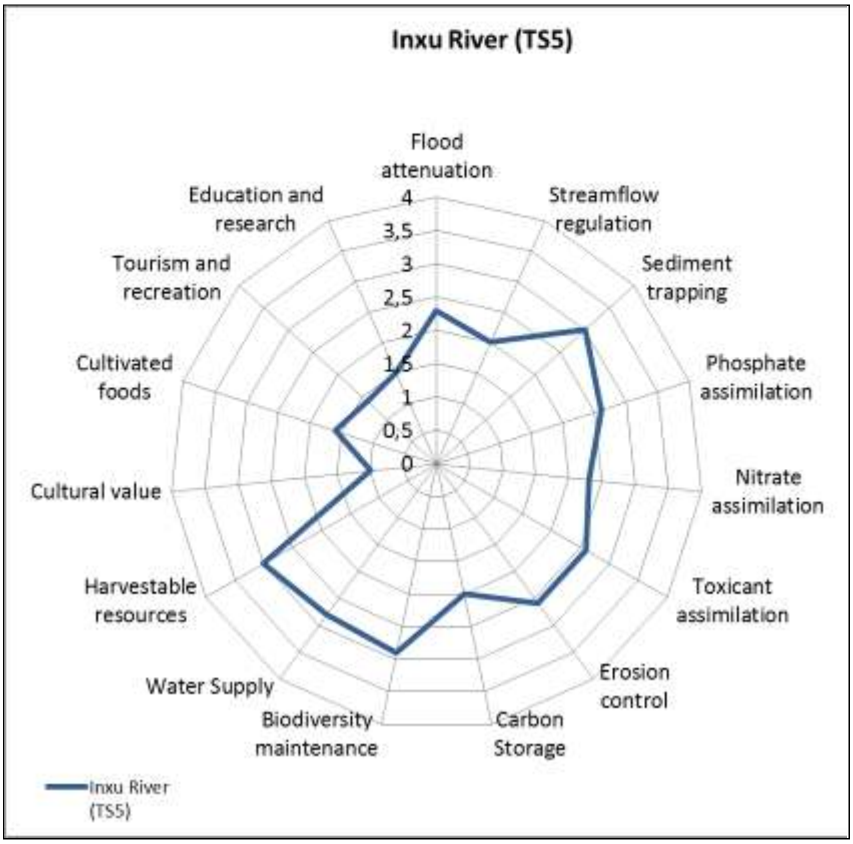
Ecosystem service	TS2 and TS3
Flood attenuation	2,3
Streamflow regulation	2
Sediment trapping	3
Phosphate assimilation	2,4
Nitrate assimilation	2,2
Toxicant assimilation	2,5
Erosion control	2,5
Carbon Storage	2
Biodiversity maintenance	2,9
Water Supply	2,8
Harvestable resources	3
Cultural value	1
Cultivated foods	1,6
Tourism and recreation	1,4
Education and research	1,5
SUM	**33,1**
Average score	**2,2**



Radar plot of wetland services provided by the riparian zones of the unnamed tributaries of the Tsitsa River (TS2 and TS3).

Results of the WET-Ecoservices assessment applied to riparian zone of the Inxu River (TS5)

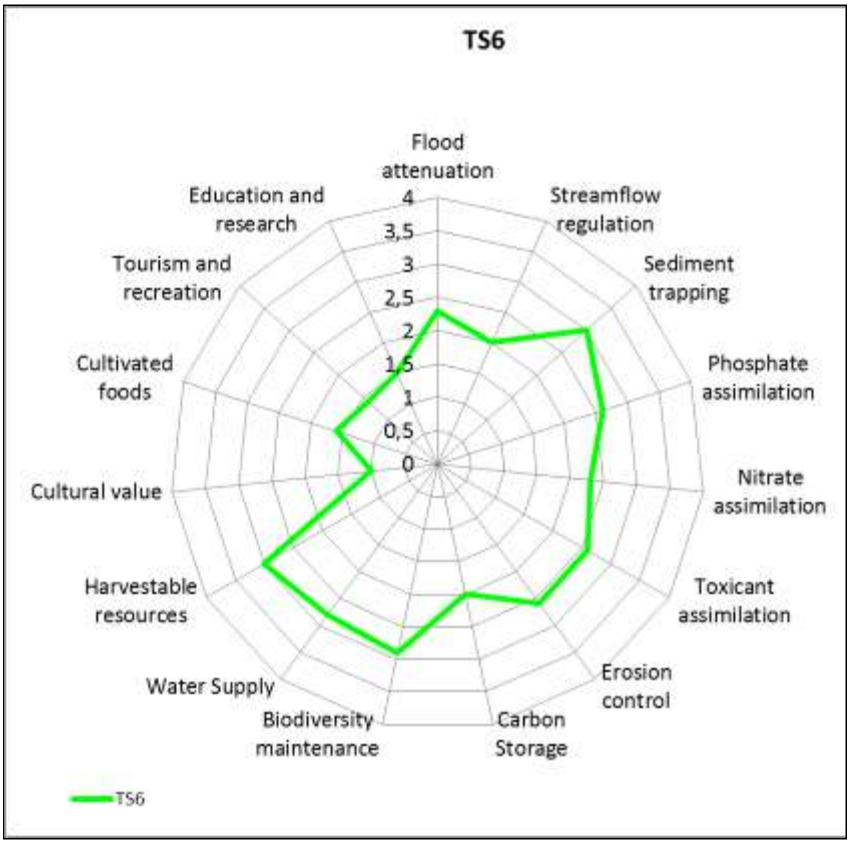
Ecosystem service	Inxu River (TS5)
Flood attenuation	2,3
Streamflow regulation	2
Sediment trapping	3
Phosphate assimilation	2,6
Nitrate assimilation	2,3
Toxicant assimilation	2,6
Erosion control	2,6
Carbon Storage	2
Biodiversity maintenance	2,9
Water Supply	2,8
Harvestable resources	3
Cultural value	1
Cultivated foods	1,6
Tourism and recreation	1,4
Education and research	1,5
SUM	**33,6**
Average score	**2,2**



Radar plot of wetland services provided by the Inxu River (TS5)

Results of the WET-Ecoservices assessment applied to riparian zone of the unnamed tributary of the Tsitsa River (TS6)

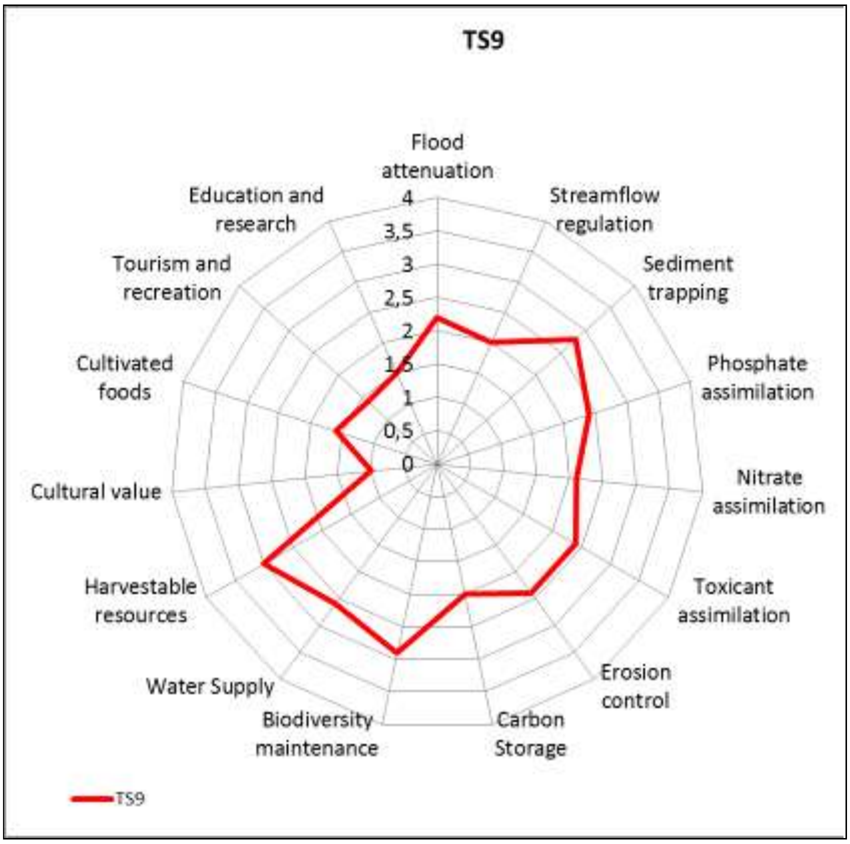
Ecosystem service	TS6
Flood attenuation	2,3
Streamflow regulation	2
Sediment trapping	3
Phosphate assimilation	2,6
Nitrate assimilation	2,3
Toxicant assimilation	2,6
Erosion control	2,6
Carbon Storage	2
Biodiversity maintenance	2,9
Water Supply	2,8
Harvestable resources	3
Cultural value	1
Cultivated foods	1,6
Tourism and recreation	1,4
Education and research	1,5
SUM	**33,6**
Average score	**2,2**



Radar plot of wetland services provided by the riparian zones of the unnamed tributaries of the Tsitsa River (TS6).

Results of the WET-Ecoservices assessment applied to riparian zone of the unnamed tributary of the Tsitsa River (TS9)

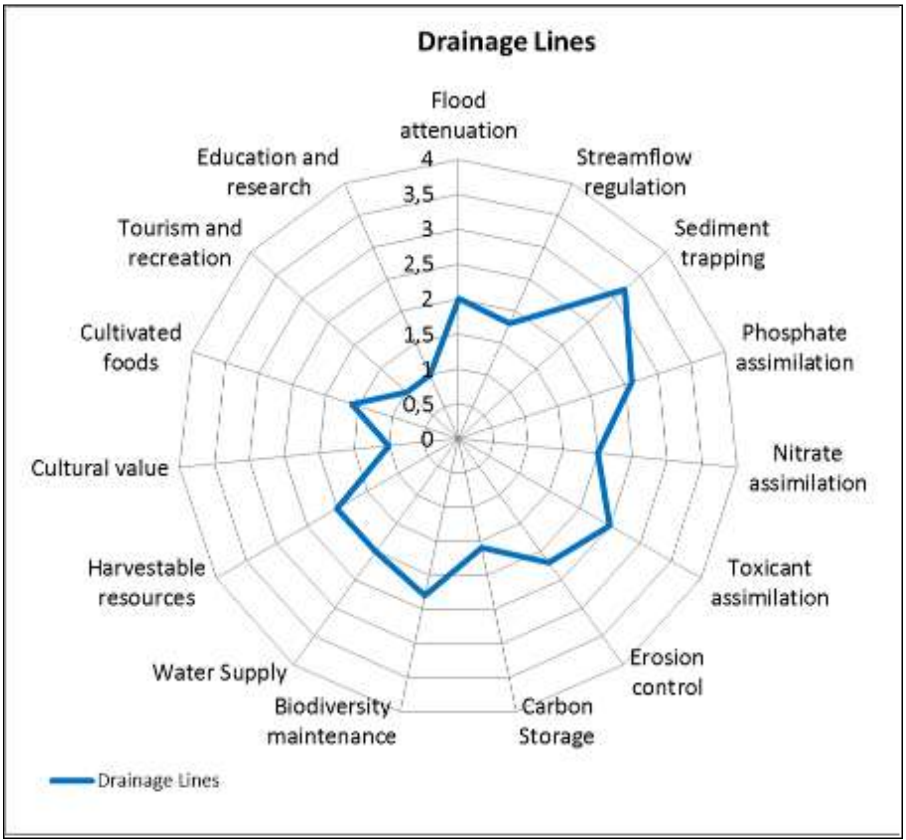
Ecosystem service	TS9
Flood attenuation	2,2
Streamflow regulation	2
Sediment trapping	2,8
Phosphate assimilation	2,4
Nitrate assimilation	2,1
Toxicant assimilation	2,4
Erosion control	2,4
Carbon Storage	2
Biodiversity maintenance	2,9
Water Supply	2,6
Harvestable resources	3
Cultural value	1
Cultivated foods	1,6
Tourism and recreation	1,4
Education and research	1,5
SUM	**32,3**
Average score	**2,2**



Radar plot of wetland services provided by the riparian zones of the unnamed tributaries of the Tsitsa River (TS9).

Results of the WET-Ecoservices assessment applied to the drainage line features.

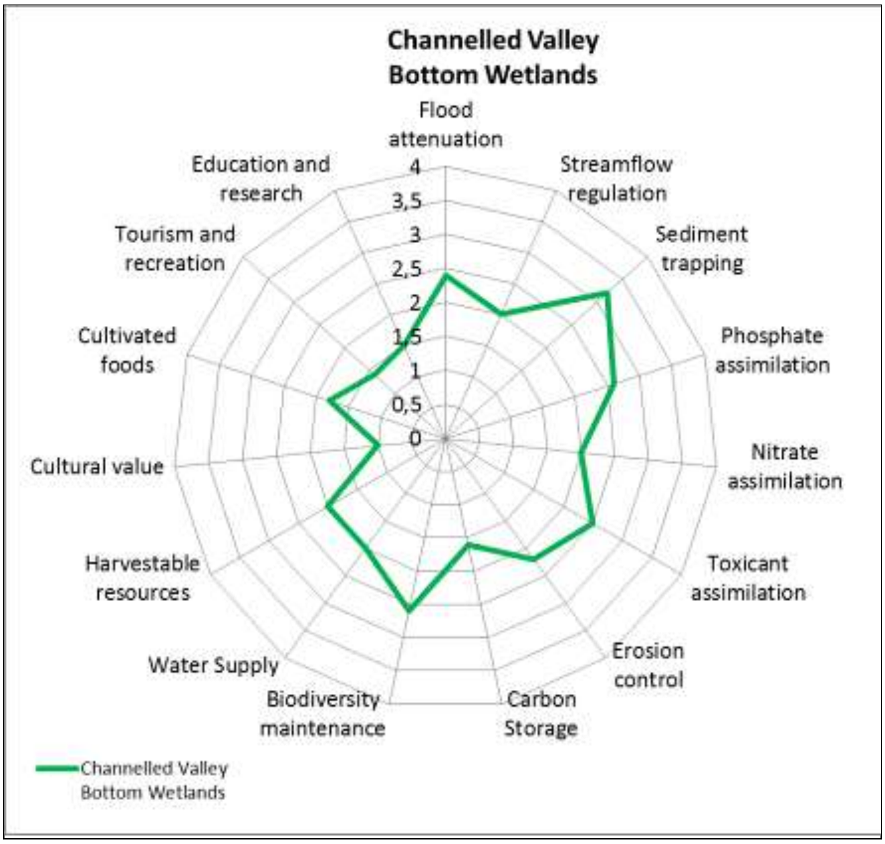
Ecosystem service	Drainage Lines
Flood attenuation	2
Streamflow regulation	1,8
Sediment trapping	3,2
Phosphate assimilation	2,6
Nitrate assimilation	2
Toxicant assimilation	2,5
Erosion control	2,2
Carbon Storage	1,6
Biodiversity maintenance	2,3
Water Supply	2
Harvestable resources	2
Cultural value	1
Cultivated foods	1,6
Tourism and recreation	1
Education and research	1
SUM	**28,8**
Average score	**1,9**



Radar plot of wetland services provided by the drainage line features.

Results of the WET-Ecoservices assessment applied to the channelled valley bottom wetland features.

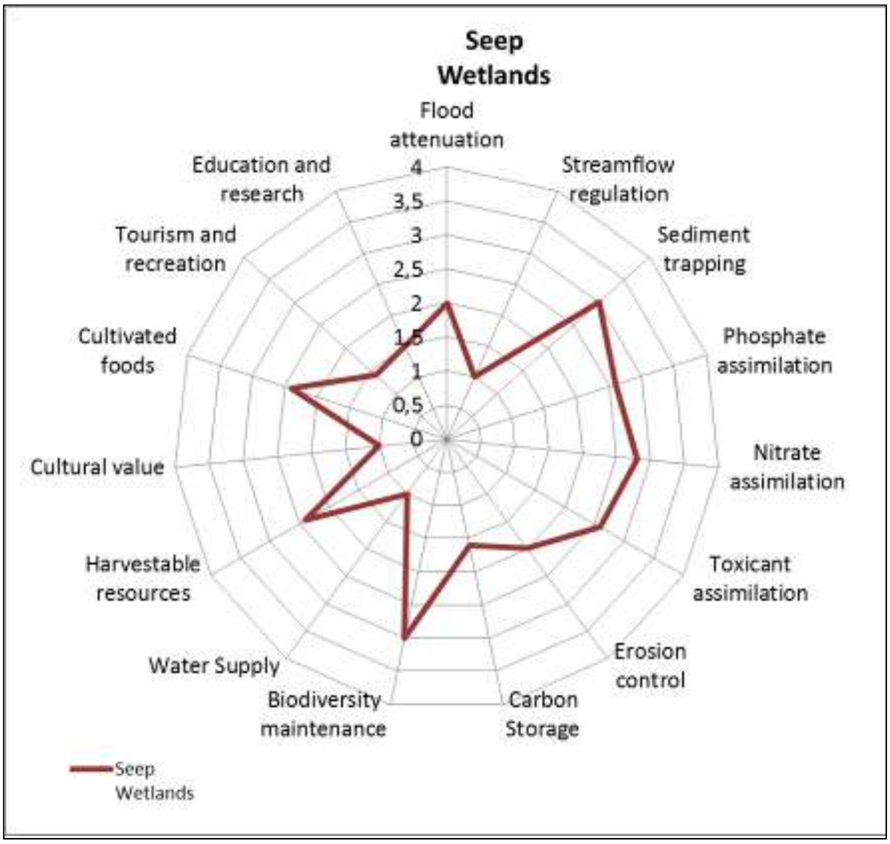
Ecosystem service	Channelled Valley Bottom Wetlands
Flood attenuation	2,4
Streamflow regulation	2
Sediment trapping	3,2
Phosphate assimilation	2,6
Nitrate assimilation	2
Toxicant assimilation	2,5
Erosion control	2,2
Carbon Storage	1,6
Biodiversity maintenance	2,6
Water Supply	2
Harvestable resources	2
Cultural value	1
Cultivated foods	1,8
Tourism and recreation	1,4
Education and research	1,5
SUM	**30,8**
Average score	**2,1**



Radar plot of wetland services provided by the channelled valley bottom wetland features.

Results of the WET-Ecoservices assessment applied to the seep wetland features.

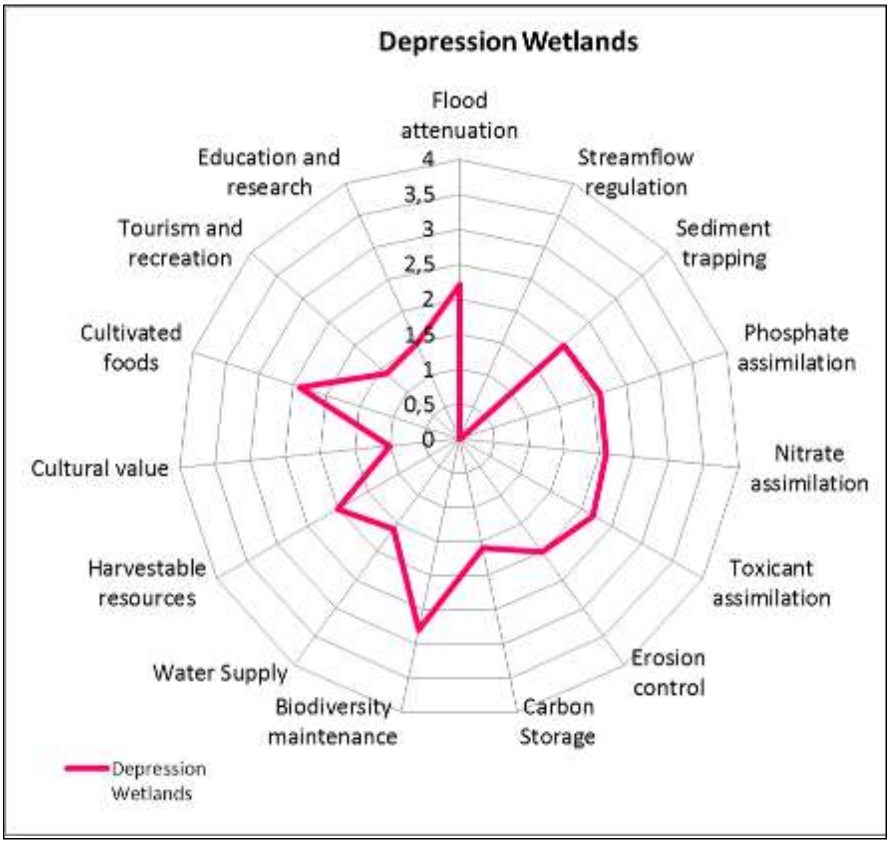
Ecosystem service	Seep Wetlands
Flood attenuation	2
Streamflow regulation	1
Sediment trapping	3
Phosphate assimilation	2,6
Nitrate assimilation	2,8
Toxicant assimilation	2,6
Erosion control	2
Carbon Storage	1,6
Biodiversity maintenance	3
Water Supply	1
Harvestable resources	2,4
Cultural value	1
Cultivated foods	2,4
Tourism and recreation	1,4
Education and research	1,5
SUM	**30,3**
Average score	**2,0**



Radar plot of wetland services provided by the seep wetland features.

Results of the WET-Ecoservices assessment applied to the depression wetland features.

Ecosystem service	Depression Wetlands
Flood attenuation	2,2
Streamflow regulation	0
Sediment trapping	2
Phosphate assimilation	2,1
Nitrate assimilation	2,1
Toxicant assimilation	2,2
Erosion control	2
Carbon Storage	1,6
Biodiversity maintenance	2,8
Water Supply	1,6
Harvestable resources	2
Cultural value	1
Cultivated foods	2,4
Tourism and recreation	1,4
Education and research	1,5
SUM	**26,9**
Average score	**1,8**



Radar plot of wetland services provided by the depression wetland features.

APPENDIX B
PRESENTATION OF WET-IHI ASSESSMENT RESULTS FOR THE RIPARIAN SYSTEMS

Summary of results of the WET-IHI assessment applied to the Tsitsa River.

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**1,4**		
Hydrology	1	100	1,0	*3,0*	**B/C**
Geomorphology	2	80	2,1	*3,8*	**C/D**
Water Quality	3	30	0,8	*2,0*	**B**
WETLAND LANDUSE ACTIVITIES:		**80**	**0,9**	***3,6***	
Vegetation Alteration Score	1	100	0,9	*3,6*	**B/C**
OVERALL SCORE:			**1,2**	***Confidence Rating***	
	PES %		**76,7**		
	PES Category:		**C**	***1,6***	

Summary of results of the WET-IHI assessment applied to the unnamed tributaries of the Tsitsa River (TS2 and TS3).

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**1,7**		
Hydrology	1	100	1,1	*3,0*	**B/C**
Geomorphology	2	80	2,8	*3,8*	**D**
Water Quality	3	30	1,0	*2,0*	**B/C**
WETLAND LANDUSE ACTIVITIES:		**80**	**0,9**	***3,7***	
Vegetation Alteration Score	1	100	0,9	*3,7*	**B**
OVERALL SCORE:			**1,3**	***Confidence Rating***	
	PES %		**73,3**		
	PES Category:		**C**	***1,6***	

Summary of results of the WET-IHI assessment applied to the Inxu River (TS5).

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**1,4**		
Hydrology	1	100	1,1	*3,0*	**C**
Geomorphology	2	80	2,0	*3,8*	**C/D**
Water Quality	3	30	1,0	*2,0*	**B/C**
WETLAND LANDUSE ACTIVITIES:		**80**	**0,9**	***3,8***	
Vegetation Alteration Score	1	100	0,9	*3,8*	**B/C**
OVERALL SCORE:			**1,2**	***Confidence Rating***	
	PES %		**75,9**		
	PES Category:		**C**	***1,7***	

Summary of results of the WET-IHI assessment applied to the unnamed tributary of the Tsitsa River (TS6).

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**1,4**		
Hydrology	1	100	1,1	*3,0*	**B/C**
Geomorphology	2	80	2,0	*3,8*	**C/D**
Water Quality	3	30	1,0	*2,0*	**B/C**
WETLAND LANDUSE ACTIVITIES:		**80**	**0,9**	***3,8***	
Vegetation Alteration Score	1	100	0,9	*3,8*	**B/C**
OVERALL SCORE:			**1,2**	***Confidence Rating***	
	PES %		**76,2**		
	PES Category:		**C**	***1,7***	

Summary of results of the WET-IHI assessment applied to the unnamed tributary of the Tsitsa River (TS9).

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**1,3**		
Hydrology	1	100	0,9	*3,1*	**B/C**
Geomorphology	2	80	2,0	*3,8*	**C/D**
Water Quality	3	30	0,9	*2,0*	**B**
WETLAND LANDUSE ACTIVITIES:		**80**	**1,0**	***3,9***	
Vegetation Alteration Score	1	100	1,0	*3,9*	**B/C**
OVERALL SCORE:			**1,2**	***Confidence Rating***	
	PES %		**76,7**		
	PES Category:		**C**	***1,7***	