PROPOSED NTATSHANA ROAD & ASSOCIATED BRIDGE INFRASTRUCTURE DEVELOPMENT PROJECT, UMZUMBE LOCAL MUNICIPALITY, KWAZULU-NATAL

Freshwater Aquatic Habitat Impact Assessment Report

Version 1.0

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SPECIALIST ASSESSMENT REPORT DETAILS AND DECLARATION OF INDEPENDENCE

This is to certify that the following wetland delineation report has been prepared has been prepared independently of any influence or prejudice as may be specified by the Department of Agriculture and Environmental Affairs (DAEA).

Document Title:	*Specialist Freshwater Aquatic Habitat Impact Assessment Report for the proposed Ntatshana Road and Associated Bridge Infrastructure, Umzumbe Local Municipality, KZN.*
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EXECUTIVE SUMMARY

The Umzumbe Local Municipality is proposing to establish the Ntatshana Road which will serve to link two local community areas, Maqhikizana and Mthwalume located on either side of the Mtwalume River within the Umzumbe Local Municipality, KwaZulu-Natal. This report sets out the findings of a **Specialist Freshwater Aquatic Habitat Assessment**, including wetlands and river/stream ecosystems and riparian habitat, associated with the proposed **Ntatshana Road and bridge development** project. The main findings of this specialist report have been summarized below as follows:

The proposed road and bridge development has two route alignment route options, with option 1 which crosses the Mtwalume River further to the south of option 2 being the Municipality's preferred option. The specialist aquatic assessment report served to identify and assess aquatic ecosystems, including wetlands and rivers, associated with both route alignment options in order to inform the Environmental Assessment and Water Use Licensing processes for the development project.

Following a desktop mapping and preliminary risk assessment of water resources within 500m of the proposed development site, an onsite delineation of potentially affected water resources was conducted. **This was restricted to rivers, streams and associated riparian areas only, with wetland areas unlikely to be affected by the development proposal.** Soil and vegetation sampling in conjunction with topographical features enabled the field identification and delineation of three aquatic ecosystems and associated habitats in the vicinity of the proposed development that are likely to be impacted by the project, including:

- **Relatively large perennial Mtwalume River (R02).** The assessment of ecological integrity found the river reaches assessed to be **Largely Natural ("B" PES category)**, reflected by good instream water quality, a rating of largely natural for macro-invertebrate sampling and analysis (SASS5) and instream/riparian habitat integrity was also regarded as largely intact (~88% intact). The river was regarded as being of **Moderate Ecological Importance and Sensitivity (EIS).** According to the desktop fish presence database compiled by the Department of Water and Sanitation (DWS, 2014) for major rivers, the Mtwalume River potentially harbours six migratory species, with only the Mozambique Tilapia/Blue Kurper being considered Near Threatened whilst the rest of the species are either of Least Concern or not classified. The implication in this case is that the long-term modification of the ecological processes and on-site habitat for the Mtwalume River reach assessed will be considered undesirable and unacceptable.
- **A smaller seasonally intermittent to weakly perennial stream channel and tributary of the Mtwalume River (R03).** This system was assessed as being **Moderately Modified ("C" PES category),** reflected by a modified instream and riparian habitat, and **EIS was rated as being relatively Low.**
- **An ephemeral/dry drainage line/channel (E02).** The small degraded channel was found to be **largely modified/poor ecological condition** and of a **Low EIS**.

Future management of these freshwater ecosystems should be informed by recommended management objectives for the water resource which, in the absence of classification, is generally based on the current status of the water resource or PES and the EIS for the resources (DWAF, 2007). The recommended management objective (based on a combined PES and EIS rating) should be to ***maintain the current status quo of aquatic ecosystems without any further loss of integrity/functioning (PES/EIS).*** This is also supported by Ezemvelo KZN Wildlife (EKZNW) whose guiding principle with regards to biodiversity conservation and sustainable development is one of ***no net loss of biodiversity and ecosystem processes.***

According to NEMA (National Environmental Management Act), sensitive, vulnerable, highly dynamic or stressed ecosystems, such as rivers and wetlands, require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure. The identified potential direct and indirect negative impacts of the proposed development on the local freshwater environment can be divided into the following four (4) impact categories:

1. **Habitat/vegetation destruction and modification impacts;**
2. **Flow modification/Hydrological impacts;**
3. **Erosion and sedimentation impacts; and**
4. **Water pollution impacts**.

The most significant impacts are likely to be associated with the **potential destruction of instream and riparian habitat during construction, the risk of modifying natural/pre-development flow characteristics at river/stream crossings** as well as **erosion/sedimentation risks which are likely to be problematic for both construction and operational phases** of the project.

Most aquatic ecological impacts can probably be quite effectively mitigated on-site by avoiding sensitive wetland/riverine areas and supplemented by the application of on-site practical mitigation measures and management principles to control erosion, sedimentation and pollution impacts and risks. With this mitigation in place, **impacts on aquatic ecosystem integrity and functioning can be potentially mitigated and reduced from a moderate significance level to a sufficiently low to insignificant level.** Impact mitigation and management would be best achieved by incorporating the recommended management & mitigation measures into an **Environmental Management Programme (EMPr)** for the site with appropriate **monitoring recommendations** also included. Freshwater habitat **Rehabilitation Guidelines** for degraded aquatic habitats disturbed during construction have also been included in the report, together with recommendations for ecological monitoring during both road construction and post-construction/operational phases of the development project.

Of the two alternative route options provided for assessment, **alternative route 2 was assessed as having more engineering constraints (steep slope, narrow mountain ridge, etc.) which translate to higher environmental risks** in terms of potential bank/slope **instability and sediment/erosion impacts. Route** option 1 is therefore considered the preferred route alignment by the specialists on condition that the proposed mitigation and management recommendations, rehabilitation requirements and monitor protocols outlined in this specialist report are strictly adhered to.

Other requirements include the need for a **Water Use License** (WUL) according to Section 21 of the National Water Act No. 36 of 1998: Section 21 (c): impeding or diverting the flow of water in a watercourse and Section 21 (i): altering the bed, banks, course or characteristics of a watercourse were identified as being triggered by the proposed development and therefore require a WULA. A third water use (Section 21 (a): taking water from a water resource) could potentially be triggered if water for construction purposes is to be abstracted from the Mtwalume River. No protected/threatened species of flora/fauna were observed at the site (and these are unlikely to potentially occur in such a degraded environment), and therefore there is no immediate need for relevant permits to remove/relocate any aquatic species.

It is further recommended that Section 8 of this report which deals with 'Impacts Mitigation/Management' be referenced in the Environmental Authorisation (EA) for this project as a specific condition of the EA and Water Use License.

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DEFINITION OF TERMS

Acute Effect Value (AEV) for aquatic ecosystems	The Acute Effect Value (AEV) is defined as that concentration or level of a constituent above which there is expected to be a significant probability of acute toxic effects to up to 5 % of the species in the aquatic community. If such acute effects persist for even a short while, or occur at too high a frequency, they can quickly cause the death and disappearance of sensitive species or communities from aquatic ecosystems. This can have considerable negative consequences for the health of aquatic ecosystems, even over a short period (DWAF 1996a).
Biodiversity	The wide variety of plant and animal species occurring in their natural environment (habitats). The term encompasses different ecosystems, landscapes, communities, populations and genes as well as the ecological and evolutionary processes that allow these elements of biodiversity to persist over time.
Chronic Effect Value (CEV) for aquatic ecosystems	The Chronic Effect Value (CEV) is defined as that concentration or level of a constituent at which there is expected to be a significant probability of measurable chronic effects to up to 5 % of the species in the aquatic community. If such chronic effects persist for some time and/or occur frequently, they can lead to the eventual death of individuals and disappearance of sensitive species from aquatic ecosystems. This can have considerable negative consequences for the health of aquatic ecosystems, since all components of aquatic ecosystems are interdependent (DWAF 1996a).
Catchment	A catchment is an area where water is collected by the natural landscape. In a catchment, all rain and run-off water eventually flows to a river, wetland, lake or ocean, or into the groundwater system.
Conservation	The safeguarding of biodiversity and its processes (often referred to as Biodiversity Conservation).
Delineation	Refers to the technique of establishing the boundary of a resource such as a wetland or riparian area.
Ecosystem	An ecosystem is essentially a working natural system, maintained by internal ecological processes, relationships and interactions between the biotic (plants & animals) and the non-living or abiotic environment (e.g. soil, atmosphere). Ecosystems can operate at different scales, from very small (e.g. a small wetland pan) to large landscapes (e.g. an entire water catchment area).
Ecosystem Goods and Services	The goods and benefits people obtain from natural ecosystems. Various different types of ecosystems provide a range of ecosystem goods and services. Aquatic ecosystems such as rivers and wetlands provide goods such as forage for livestock grazing or sedges for craft production and services such as pollutant trapping and flood attenuation. They also provide habitat for a range of aquatic biota.
Erosion (gulley)	Erosion is the process by which soil and rock are removed from the Earth's surface by natural processes such as wind or water flow, and then transported and deposited in other locations. While erosion is a natural process, human activities have dramatically increased the rate at which erosion is occurring globally. Erosion gullies are erosive channels formed by the action of concentrated surface runoff.
Ezemvelo KZN Wildlife	Ezemvelo KwaZulu-Natal Wildlife, the local conservation authority for the Province of KwaZulu-Natal.
Endemic	Refers to a plant, animal species or a specific vegetation type which is naturally restricted to a particular defined region (not to be confused with indigenous). A species of animal may, for example, be endemic to South Africa in which case it occurs naturally anywhere in the country, or endemic only to a specific geographical area within the country, which means it is restricted to this area and grows naturally nowhere else in the country.
Function/functioning/ functional	Used here to describe natural systems working or operating in a healthy way, opposed to dysfunctional, which means working poorly or in an unhealthy way.
Habitat	The general features of an area inhabited by animal or plant which are essential to its survival (i.e. the natural "home" of a plant or animal species).
Hydric status	A classification of plants according to occurrence in wetlands and can be useful in determining whether the habitat at a site is wetland/riparian based on the hydric status of dominant species occurring.
Indigenous	Naturally occurring or "native" to a broad area, such as South Africa in this context.
Intact	Used here to describe natural environment that is not badly damaged, and is still operating healthily.
Invasive alien plants	Alien invasive species (IAPs) means any non-indigenous plant or animal species whose establishment and spread outside of its natural range threatens natural ecosystems, habitats or other species or has the potential to threaten ecosystems, habitats or other species.
Mitigate/Mitigation	Mitigating impacts refers to reactive practical actions that minimize or reduce in situ impacts. Examples of mitigation include "changes to the scale, design, location, siting,

	process, sequencing, phasing, and management and/or monitoring of the proposed activity, as well as restoration or rehabilitation of sites". Mitigation actions can take place anywhere, as long as their effect is to reduce the effect on the site where change in ecological character is likely, or the values of the site are affected by those changes (Ramsar Convention, 2012).
Riparian habitat / Riparian area / Riparian zone	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 (National Water Act).
Risk	A prediction of the likelihood and impact of an outcome; usually referring to the likelihood of a variation from the intended outcome.
Soil Mottles/ Mottling	Soil mottling is a feature of hydromorphic (wet) soils and common to wetland areas. Mottles refer to secondary soil colours not associated with soil compositional properties that usually develop when soils are frequently wet for long periods of time. In water-logged soils, anaerobic (oxygen deficient) conditions generally causes redoximorphic soil features such as red mottles to develop. Lithochromic mottles on the other hand are a type of mottling associated with variations of colour due to weathering of parent materials.
Systematic conservation plan	An approach to conservation that prioritises actions by setting quantitative targets for biodiversity features such as broad habitat units or vegetation types. It is premised on conserving a representative sample of biodiversity pattern, including species and habitats (the principle of representation), as well as the ecological and evolutionary processes that maintain biodiversity over time (the principle of persistence).
Target Water Quality Range (TWQR) for aquatic ecosystems	The Target Water Quality Range (TWQR) is the range of concentrations or levels within which no measurable adverse effects are expected on the health of aquatic ecosystems, and should therefore ensure their protection (DWAF 1996a).
Target Water Quality Range (TWQR) for domestic use	Fitness of water to be used for domestic purposes, primarily for human consumption but also for bathing and other household uses. The guidelines are applicable to any water that is used for domestic purposes, irrespective of its source (municipal supply, borehole, river, etc.) or whether or not it has been treated (DWAF 1996b).
Threatened ecosystem	In the context of this document, refers to Critically Endangered, Endangered and Vulnerable ecosystems.
Threat Status	Threat status (of a species or community type) is a simple but highly integrated indicator of vulnerability. It contains information about past loss (of numbers and / or habitat), the number and intensity of threats, and current prospects as indicated by recent population growth or decline. Any one of these metrics could be used to measure vulnerability. One much used example of a threat status classification system is the IUCN Red List of Threatened Species (BBOP, 2009).
Transformation (habitat loss)	Refers to the destruction and clearing an area of its indigenous vegetation, resulting in loss of natural habitat. In many instances, this can and has led to the partial or complete breakdown of natural ecological processes.
Water course	Means a river or spring; a natural channel in which water flows regularly or intermittently: a wetland, lake or dam into which, or from which, water flows: und any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks (National Water Act, 1998).
Wetland	Refers to 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 (National Water Act, 1998).
Wetland Vegetation Group	Broad wetland vegetation groupings reflect differences in regional context such as geology, soils and climate, which in turn affect the ecological characteristics and functionality of wetlands.

ABBREVIATIONS/ACRONYMS USED

CBA	Critical Biodiversity Area
CR	Critically Endangered (threat status)
DEA	Department of Environmental Affairs (formerly DEAT)
DOT	Department of Transport
DWS	Department of Water and Sanitation (formerly DWA/F)
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment: EIA regulations promulgated under section 24(5) of NEMA and published in Government Notice R.543 in Government Gazette 33306 of 18 June 2010
EI	Ecological Infrastructure
EIS	Ecological Importance and Sensitivity
EKZNW	Ezemvelo KwaZulu-Natal Wildlife: as defined in Act 9 of 1997 as KZN Nature Conservation Service
EMPr	Environmental Management Programme
EN	Endangered (threat status)
ESA	Ecological Support Area
FEPA	Freshwater Ecosystem Priority Area
FW	Facultative wetland species - usually grow in wetlands (67-99% occurrence) but occasionally found in non-wetland areas
GIS	Geographical Information Systems
GPS	Global Positioning System
HGM	Hydro-Geomorphic (unit)
IAPs	Invasive Alien Plants
IHI	Index of Habitat Integrity
LT	Least Threatened (threat status)
NEMA	National Environmental Management Act No.107 of 1998
NEM:BA	National Environmental Management: Biodiversity Act No.10 of 2004
NFEPA	National Freshwater Ecosystem Priority Areas, identified to meet national freshwater conservation targets (CSIR, 2011)
NT	Near Threatened (threat status)
NWA	National Water Act No.36 of 1998
Ow	Obligate wetland species
PES	Present Ecological State, referring to the current state or condition of an environmental resource in terms of its characteristics and reflecting change from its reference condition.
SANBI	South African National Biodiversity Institute
TWQR	Target Water Quality Range
VU	Vulnerable (threat status)

1 INTRODUCTION

1.1 Project Background and Locality

Eco-Pulse Environmental Consulting Services (Eco-Pulse) was appointed by Royal Haskoning DHV (RHDHV) to undertake a Freshwater Aquatic Habitat Impact Assessment for the proposed development of 'Ntatshana Road' and associated bridge infrastructure for river crossings. The assessment included both wetlands and instream and riparian habitats associated with rivers and streams in the project area. The study area is located across two local community areas; Maqhikizana and Mthwalume within the Umzumbe Local Municipality, Ugu District, KwaZulu-Natal. The location of the two road route alignments is shown below in Figure 1 (Route 1 is the preferred route alignment represented by the 'Red' line, with Route 2 being the alternative route alignment represented by the 'Blue' line on the map).

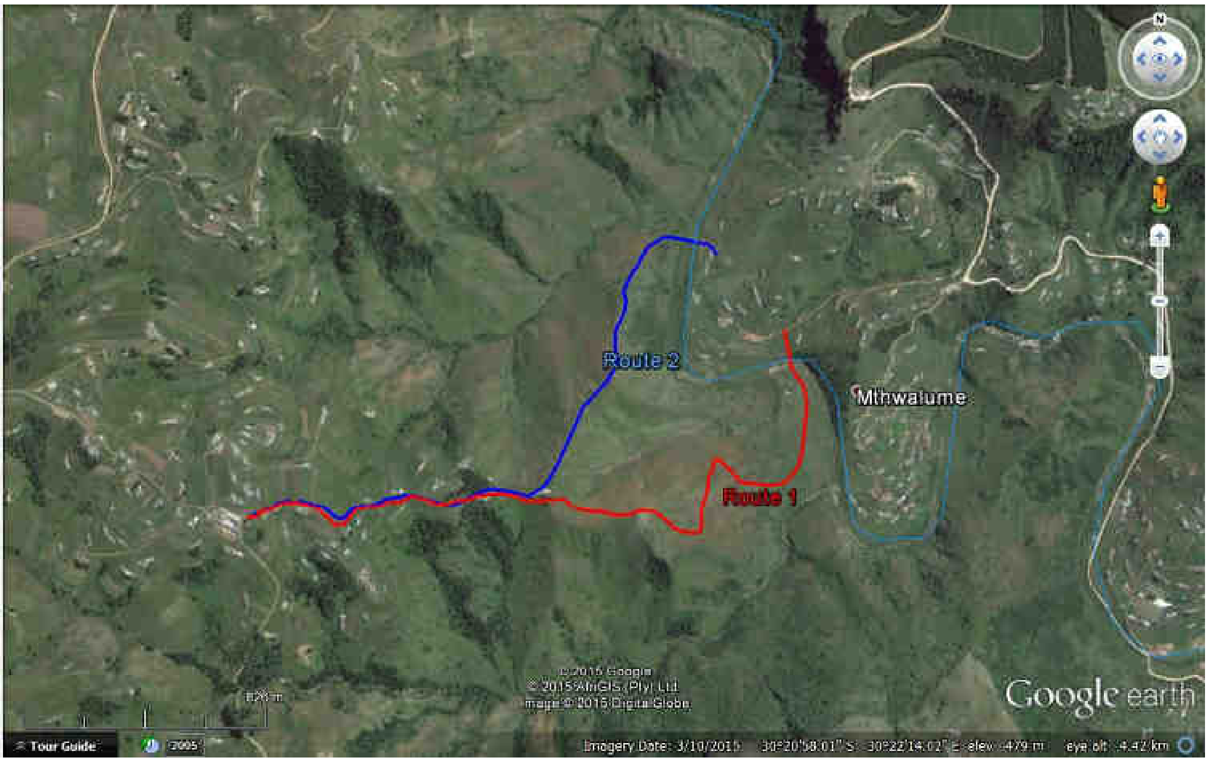


Figure 1 Map showing the two road route alignment options assessed relative to the Mtwalume River (Route 1 is the preferred route alignment represented by the 'Red' line, with Route 2 being the alternative route alignment represented by the 'Blue' line on the map).

1.2 Project Description

The Umzumbe Local Municipality is proposing to develop a ~2.2km long and 5m wide access road between District Roads D1050 and D20. The road will cross the Mtwalume River by means of a proposed low level bridge spanning roughly 50m across the river. The bridge will have 5 spans measuring 10m each and four (4) piers, two of which will be placed within the active channel of the Mtwalume River, with the remaining two piers to be located on the upper banks outside of the active channel. It is planned to have the bridge suspended approximately 6m above the lowest point of the river bed. The sections of the road approaching the river will be slightly raised above ground level and held back by two (2) abutments on each river bank. The bridge plan and details for the preferred route alignment (Route option 1 in Figure 1) have been provided in Figure 2, below. Details for the alternative route (option 2) were not provided to the aquatic specialists from Eco-Pulse as these were not available at the time of the assessment.

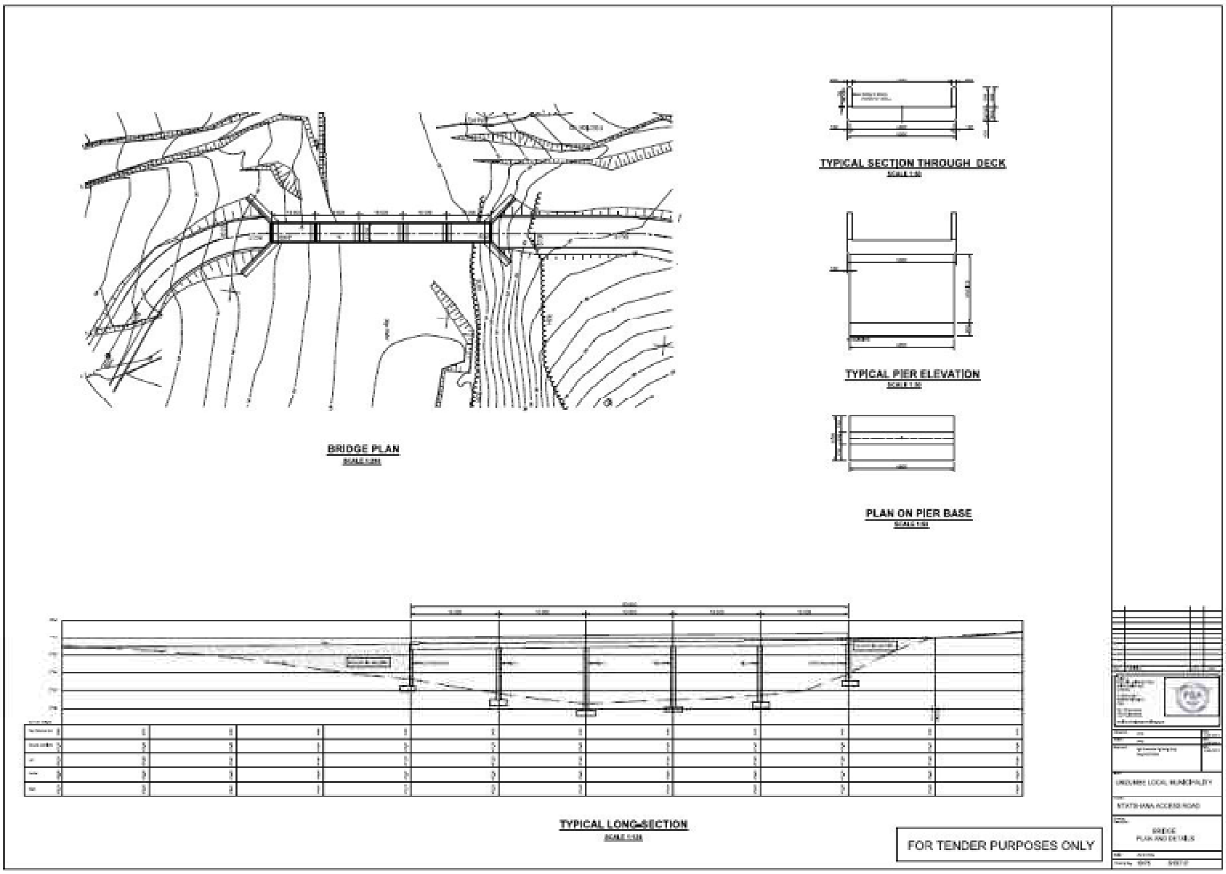


Figure 2 Design drawing showing the proposed bridge structure planned for the preferred route alignment option 1 crossing the Mtwalume River.

1.3 Scope of Work

The scope of work associated with the freshwater aquatic habitat impact assessment was as follows:

- Contextualization of the study area in terms of important biophysical characteristics and aquatic conservation planning information available at the time of the study.
- Desktop delineation and mapping of all watercourses (including wetland and riparian habitat) within a 500m radius of the two road route alignment options using available imagery, contour information and spatial datasets in a Geographical Information System (GIS).
- Desktop classification of watercourses identified in terms of riverine and wetland types.
- Undertaking a rapid aquatic screening and risk assessment to determine which of the desktop delineated/mapped watercourses is likely to be measurably affected by the proposed development activity and are likely to trigger Section 21 c or i water use. *This will flag watercourses for further focal assessment whilst identifying areas that will not be affected by*

the project and will therefore not require further assessment (i.e. wetlands/rivers within adjacent catchments or upstream/significantly downstream of the predicted impact zone).

- Detailed infield delineation of river/stream channels, riparian habitat and wetland habitat within 32m of the proposed road and 100m downstream of watercourse crossings and/or at risk of being adversely impacted by the proposed development (i.e. those flagged during the desktop screening/risk assessment), according to the approach and methods contained in the manual '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas*' (DWAF, 2005).
- Classification of the delineated riverine and wetland areas using the latest *National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa* (Ollis *et al.*, 2013).
- Description of the biophysical characteristics of the delineated freshwater habitats based on onsite observations and sampling – hydrology, soils, vegetation, etc.
- Functional assessment of freshwater aquatic ecosystems and associated habitats based on field investigations, involving:
  - For riparian areas, river integrity will be assessed using the rapid Index of Habitat Integrity, IHI) assessment method (adapted from Kleynhans, 1996); and
  - Assessment of the Ecological Importance and Sensitivity (EIS) of the delineated instream and riparian habitats using the rapid DWAF EIS tool (1999).
- Undertake water quality (chemistry) sampling and laboratory analysis to inform in-stream habitat condition and the effect of surrounding land use pressures for the main crossing over the Mtwalume River.
- Undertaking aquatic macro-invertebrate sampling and analysis for the Mtwalume River, using the South African Scoring System 5 (SASS 5) tool (Graham & Dickens, 2002).
- Identification, description and assessment of the scope, scale and significance of potential aquatic ecological impacts for the construction & operational phases and related activities associated with the proposed road infrastructure development on the delineated freshwater habitats/ecosystems. *Note that the predicted change in the state and level of ecosystem services provided by the delineated freshwater habitats will qualitatively described based on professional opinion (and not using formal post-development assessment tools).*
- Provision of recommendations for mitigating and managing the ecological impacts identified, including practical guidelines for rehabilitation of disturbed areas and an ecological monitoring protocol.
- Outline any necessary/relevant environmental licensing/permitting requirements triggered by the development, including the need for a Water Use License in terms of Section 21 of the NWA.
- Reporting: compilation and electronic submission of a single *Specialist Aquatic Assessment Report*.

1.4 The Importance of Freshwater Resources and their Conservation

Water affects every activity and aspiration of human society and sustains all ecosystems. "Freshwater ecosystems" refer to all inland water bodies whether fresh or saline, including rivers, lakes, wetlands, sub-surface waters and estuaries (Driver *et al*., 2011). South Africa's freshwater ecosystems are diverse, ranging from sub-tropical in the north-eastern part of the country, to semi-arid and arid in the interior, to the cool and temperate rivers of the fynbos. Wetlands and rivers form a fascinating and essential part of our natural heritage, and are often referred to as the "kidneys" and "arteries" of our living landscapes and this is particularly true in semi-arid countries such as South Africa (Nel *et al*., 2013). Rivers and their associated riparian zones are vital for supplying freshwater (South Africa's most scare natural resource) and are important in providing additional biophysical, social, cultural, economic and aesthetic services (Nel *et al*., 2013). The health of our rivers and wetlands is measured by the diversity and health of the species we share these resources with. Healthy river ecosystems can increase resilience to the impacts of climate change, by allowing ecosystems and species to adapt as naturally as possible to the changes and by buffering human settlements and activities from the impacts of extreme weather events (Nel *et al*., 2013). Freshwater ecosystems are likely to be particularly hard hit by rising temperatures and shifting rainfall patterns, and yet healthy, intact freshwater ecosystems are vital for maintaining resilience to climate change and mitigating its impact on human wellbeing by helping to maintain a consistent supply of water and for reducing flood risk and mitigating the impact of flash floods. We therefore need to be mindful of the fact that without the integrity of our natural river systems, there will be no sustained long-term economic growth or life (DEA *et al.,* 2013).

Freshwater ecosystems, including rivers and wetlands, are also particularly vulnerable to anthropogenic or human activities, which can often lead to irreversible damage or longer term, gradual/cumulative changes to freshwater resources and associated aquatic ecosystems. Since channelled systems such as rivers, streams and drainage lines are generally located at the lowest point in the landscape; they are often the "receivers" of wastes, sediment and pollutants transported via surface water runoff as well as subsurface water movement (Driver *et al*., 2011). This combined with the strong connectivity of freshwater ecosystems, means that they are highly susceptible to upstream, downstream and upland impacts, including changes to water quality and quantity as well as changes to aquatic habitat & biota (Driver *et al*., 2011). South Africa's freshwater ecosystems have been mapped and classified into National Freshwater Ecosystem Priority Areas (NFEPAs). This work shows that 60% of our river ecosystems are threatened and 23% are critically endangered. The situation for wetlands is even worse: 65% of our wetland types are threatened, and 48% are critically endangered (Driver *et al*., 2011*)*. South Africa's freshwater fauna also display high levels of threat: at least one third of freshwater fish indigenous to South Africa are reported as threatened, and a recent southern African study on the conservation status of major freshwater-dependent taxonomic groups (fishes, molluscs, dragonflies, crabs and vascular plants) reported far higher levels of threat in South Africa than in the rest of the region (Darwall *et al*., 2009). Clearly, urgent attention is required to ensure that representative natural examples of the different ecosystems that make up the natural heritage of this country for current and future generations to come. The degradation of South African rivers and wetlands s is a concern now recognized by Government as requiring urgent action and the protection of freshwater resources, including rivers and wetlands, is considered fundamental to the sustainable management of South Africa's water resources in the context of the reconstruction and development of the country.

1.5 Relevant Environmental Legislation

In response to the importance of freshwater aquatic resources, protection of wetlands and rivers has been campaigned at national and international levels. This has led to the development of various policies and promulgation of a range of legislation to help protect these sensitive and important ecosystems. The following relevant environmental legislation pertains to the protection and use of aquatic ecosystems (i.e. wetlands and rivers) in South Africa (Table 1, below):

Table 1. Relevant environmental legislation pertains to the protection and use of aquatic ecosystems (i.e. wetlands and rivers) in South Africa.

South African Constitution 108 of 1996	This includes the right to have the environment protected through legislative or other means.
National Environmental Management Act 107 of 1998	This is a fundamentally important piece of legislation and effectively promotes sustainable development and entrenches principles such as the 'precautionary approach', 'polluter pays', and requires responsibility for impacts to be taken throughout the life cycle of a project.
Environmental Impact Assessment (EIA) Regulations	New regulations have been promulgated in terms of Chapter 5 of NEMA and were published on 4 December 2014 in Government Notice No. R. 32828. In addition, listing notices (GN 983-985) lists activities which are subject to an environmental assessment.
The National Water Act 36 of 1998	This Act imposes 'duty of care' on all landowners, to ensure that water resources are not polluted. The following Clause in terms of the National Water Act is applicable in this case: **19 (1**) "*An owner of land, a person in control of land or a person who occupies or uses the land on which (a) any activity or process is or was performed or undertaken; which causes, has caused or likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring*" Chapter 4 of the National Water Act is of particular relevance to wetlands and addresses the use of water and stipulates the various types of licensed and unlicensed entitlements to the use water. Water use is defined very broadly in the Act and effectively requires that any activities with a potential impact on wetlands (within a distance of 500m upstream or downstream of a wetland) be authorized.
General Authorisations (GAs)	These have been promulgated under the National Water Act and were published under GNR 398 of 26 March 2004. Any uses of water which do not meet the requirements of Schedule 1 or the GAs, require a license which should be obtained from the Department of Water and Sanitation (DWS).
National Environmental Management: Biodiversity Act No. 10 of 2004	The intention of this Act is to protect species and ecosystems and promote the sustainable use of indigenous biological resources. It addresses aspects such as protection of threatened ecosystems and imposes a duty of care relating to listed invasive alien plants.
Conservation of Agricultural Resources Act 43 of 1967	The intention of this Act is to control the over-utilization of South Africa's natural agricultural resources, and to promote the conservation of soil and water resources and natural vegetation. This includes wetland systems and requires authorizations to be obtained for a range of impacts associated with cultivation of wetland areas.

Other pieces of legislation that may also be of some relevance include:

- The National Forests Act No. 84 of 1998;
- The Natural Heritage Resources Act No. 25 of 1999;
- The National Environmental Management: Protected Areas Act No. 57 of 2003;
- Minerals and Petroleum Resources Development Act No. 28 of 2002;
- Nature and Environmental Conservation Ordinance No. 19 of 1974; and
- The Mountain Catchments Areas Act No. 62 of 1970.

Any developments with a potential impact to the environment therefore typically need to be assessed to ensure that impacts are adequately minimized. Authorizations may also be required before planned activities can commence.

2 APPROACH AND METHODS

2.1 Approach to the Assessment

The following approach to the aquatic assessment was taken:

1. **Desktop risk screening assessment** in a Geographical Information System (GIS) using available imagery and datasets for the Province to identify and screen freshwater resources within a 500m radius (DWS regulated area) of the development to inform further assessment.
2. **Field delineation and site assessment** of wetland/riparian habitat condition and functioning, including:
    a. The extent of wetland/riparian habitat (wetland/riparian field delineation);
    b. Condition of ecosystems/habitat;
    c. Water quality (chemistry) sampling & analysis;
    d. SASS sampling and analysis (aquatic invertebrates);
    e. Ecological importance & Sensitivity of wetlands/rivers;
    f. Vegetation type and ecosystem status;
    g. Vegetation composition and structure;
    h. Occurrence of threatened species of fauna/flora;
    i. Species/features of special concern;
    j. Sensitivity of features; and
    k. Importance of spatial components of ecological processes (e.g. ecological corridors).
3. **Identification and description of impacts to water resources, impact significance assessment.**
4. **Recommendation of impact management/mitigation measures** to deal with anticipated ecological impacts, including planning and design recommendations and aquatic rehabilitation and monitoring requirements.
5. **Recommendations regarding Environmental Licensing/Permitting requirements.**

2.2 Data Sources Consulted

The following data sources and GIS spatial information provided listed in Table 2 (below) was consulted to inform the specialist assessment. The data type, relevance to the project and source of the information has been provided.

Table 2. Data sources and GIS information consulted to inform the aquatic assessment.

DATA/COVERAGE TYPE	RELEVANCE	SOURCE
Biophysical Context		
2009 Colour aerial photography	*Desktop mapping of drainage network*	QGIS On-line
Latest Google Earth ™ imagery	*To supplement available aerial photography where needed*	Google Earth™ On-line
5m Elevation Contours (GIS Coverage)	*Desktop mapping of drainage network*	KZN relief line dataset
DWA Eco-regions (GIS Coverage)	*Classification of local Ecoregions*	DWA (2005)
KZN Geology (GIS Coverage)	*Assessment of underlying geology controlling soil formation and aspects of wetland/river geomorphology*	SA Geology dataset
Geomorphological Provinces of South Africa	*Understand regional geomorphology controlling the physical environment*	Partridge *et al.* (2010)
South African Vegetation Map (GIS Coverage)	*Classify vegetation types and determination of reference primary vegetation*	Mucina & Rutherford (2006)
KwaZulu-Natal Vegetation Map (GIS Coverage)	*Classify vegetation types and determination of reference primary vegetation*	EKZNW (2011)
NFEPA: NFEPA river and wetland inventories (GIS Coverage)	*Highlight potential onsite and local rivers and wetlands*	CSIR (2011)
KZN Rivers (GIS Coverage)	*Highlight potential onsite and local rivers and wetlands and map local drainage network*	SA Rivers dataset
Conservation Context		
NFEPA: River, wetland and estuarine FEPAs (GIS Coverage)	*Shows location of national aquatic ecosystems conservation priorities*	CSIR (2011)
KwaZulu-Natal Vegetation Map (GIS Coverage)	*Determination of provincial threat status of local vegetation types*	EKZNW (2011)
Freshwater Systematic Conservation Plan for KZN (GIS Coverage)	*Location and extent of conservation planning units*	EKZNW (2007)
Strategic Water Source Areas (GIS Coverage)	*Location and extent of strategic water source areas*	(Nel *et al.*, 2013)

2.3 Methods Used

Table 3 below summarises the methods that were used as part of the specialist aquatic assessment. For additional details on the individual assessment methods applied in this study, refer to **Annexure A** at the back of this report.

Table 3. Summary of methods used in the assessment of freshwater habitats.

METHOD/TECHNIQUE	REFERENCE FOR METHODS/TOOLS USED	ANNEXURE
Wetland/riparian area delineation	➢ A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005)	**A1**
Classification of water resources (rivers & wetlands)	➢ National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al.*, 2013) ➢ Classification system for channelled watercourses	**A2**

METHOD/TECHNIQUE		REFERENCE FOR METHODS/TOOLS USED	ANNEXURE
		(Eco-Pulse, 2013)	
Assessment of conservation context of aquatic resources		➢ National Freshwater Ecosystem Priority Areas or NFEPA Project (CSIR, 2011) ➢ Aquatic Systematic Conservation Plan (CPLAN) for the Province (EKZNW, 2007)	-
River Baseline Ecological Condition & Functioning	**River condition/Present Ecological State (PES)**	➢ Revised IHI (Index of Habitat Integrity) tool adapted from Kleynhans, 1996.	**A3**
	River Ecological Importance & Sensitivity (EIS)	➢ Rapid DWAF EIS tool (Kleynhans, 1999).	**A4**
	Macro-invertebrates	➢ South African Scoring System or SASS5 method (Dickens & Graham, 2002)	**A5**
	Physico-chemical water quality	➢ Water sampling and laboratory analyses for selected determinands.	**A6**
Impact Significance Assessment		➢ Impact assessment method (Eco-Pulse, 2015)	**A7**

2.4 Assumptions and Limitations

The following limitations and assumptions apply to this assessment:

- This report deals exclusively with a defined area and the extent and nature of wetlands/aquatic ecosystems in that area.
- Not all wetlands within the 500m DWS regulated area were assessed/delineated in the field. Focal areas at risk of being impacted or triggering Section 21 c and i water use were flagged during the desktop risk/screening exercise to be assessed in detail in the field. Thus, finer habitat type details of the systems not formally assessed were not acquired.
- The delineation of the outer boundary of riparian areas is based on a number of indicators, including topography (macro-channel features), the presence of alluvial deposition and vegetation indicators. The boundaries mapped in this specialist report therefore represent the approximate boundary of riparian habitat as evaluated by an assessor familiar and well-practiced in the delineation technique.
- It is important to note that the delineation of some wetland and riparian areas was made difficult by the following:
    - Infilling of wetland and riparian areas due to land use and infrastructure; and
    - Replacement of indigenous vegetation by invasive alien plants in many areas.
- Mapped boundaries are based largely on the GPS locations of soil sampling points. GPS accuracy will therefore affect the accuracy rating of mapped sampling points and therefore wetland/riparian boundaries. Soil sampling points were recorded using a Garmin Oregon™ Global Positioning System (GPS) with an accuracy of 3-5m.
- Infield soil and vegetation sampling was only undertaken within a specific focal area in the vicinity of the proposed development, while the remaining water resource/HGM units were delineated at a desktop level with limited accuracy.
- While disturbance and transformation of aquatic habitats can lead to shifts in the type and extent of aquatic ecosystems, it is important to note that the current extent and classification is reported on here.

- The Ecological Importance and Sensitivity Analysis did not specifically address the finer-scale biological aspects of the rivers such as fauna (amphibians and invertebrates) occurring. No detailed assessment of aquatic fauna/biota was undertaken. Fauna documented in this report are based on site observations during site visits and are therefore not intended to reflect the overall faunal composition of the habitats assessed.
- The field assessment was undertaken in late winter (August 2015) and therefore does not cover the seasonal variation in conditions likely to occur at the site (although the effects of seasonality were estimated where possible). The need for seasonal studies or nocturnal surveys should be applied on case-by-case basis and not a single blanket approach (i.e. where preliminary studies reveal the potential presence of Red data species that maybe seasonally present or can only be identified during nocturnal studies).
- All field assessments were limited to day-time assessments.
- Sampling by its nature, means that generally not all aspects of ecosystems can be assessed and identified.
- With ecology being dynamic and complex, there is the likelihood that some aspects (some of which may be important) may have been overlooked.
- The vegetation information provided is based on observation not formal vegetation plots. As such species documented in this report should be considered as a list of dominant and/or indicator wetland/riparian species and only provide a very general indication of the composition of the wetland/riverine vegetation communities.
- Additional information used to inform the assessment was limited to data and GIS coverage's available for the Province at the time of the assessment.
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field survey and based on the assessor's working knowledge and experience with similar development projects.
- Evaluation of the significance of impacts with mitigation takes into account mitigation measures provided in this report and standard mitigation measures included in the Environmental Management Programme (EMPr).
- Post-development PES and EIS assessments were not undertaken. The predicted change in the state and level of ecosystem services provided by the delineated freshwater habitats was qualitatively described based on professional opinion.
- Water quality results are based on once off grab samples and don't take into account seasonal and temporal variability.

3 BACKGROUND TO THE STUDY AREA

3.1 Regional / Local Biophysical Setting

The proposed Ntatshana Road is planned to be cross the Mtwalume River at the location shown in Figure 3, below. The Mtwalume River is a relatively large perennial river that flows in a south-easterly direction and ultimately discharges into the South Indian Ocean. The study area is located within the middle reaches of the river system and catchment, with the DWS quaternary catchment being U80E, which falls within uMvoti-Mzimkhulu WMA (Water Management Area). The drainage setting within a 500m radius of the two alternative route options assessed (i.e. the 500m DWS regulated area for water use) is characterised by gorges and confined valleys with steep slopes, with numerous ephemeral/intermittent drainage lines occurring on the steep slopes in the area (see Figure 4 over the page). The road is planned to be located on a ridgeline (catchment divide separating the valley to the south and north in Figure 4) and will extend onto the valley floor to the west where it will cross the Mtwalume River by means of a suspended low-level bridge. Route option 1 ('Purple' line in Figure 4) will also cross a small ephemeral drainage line at numerous points prior to crossing the Mtwalume River main channel.

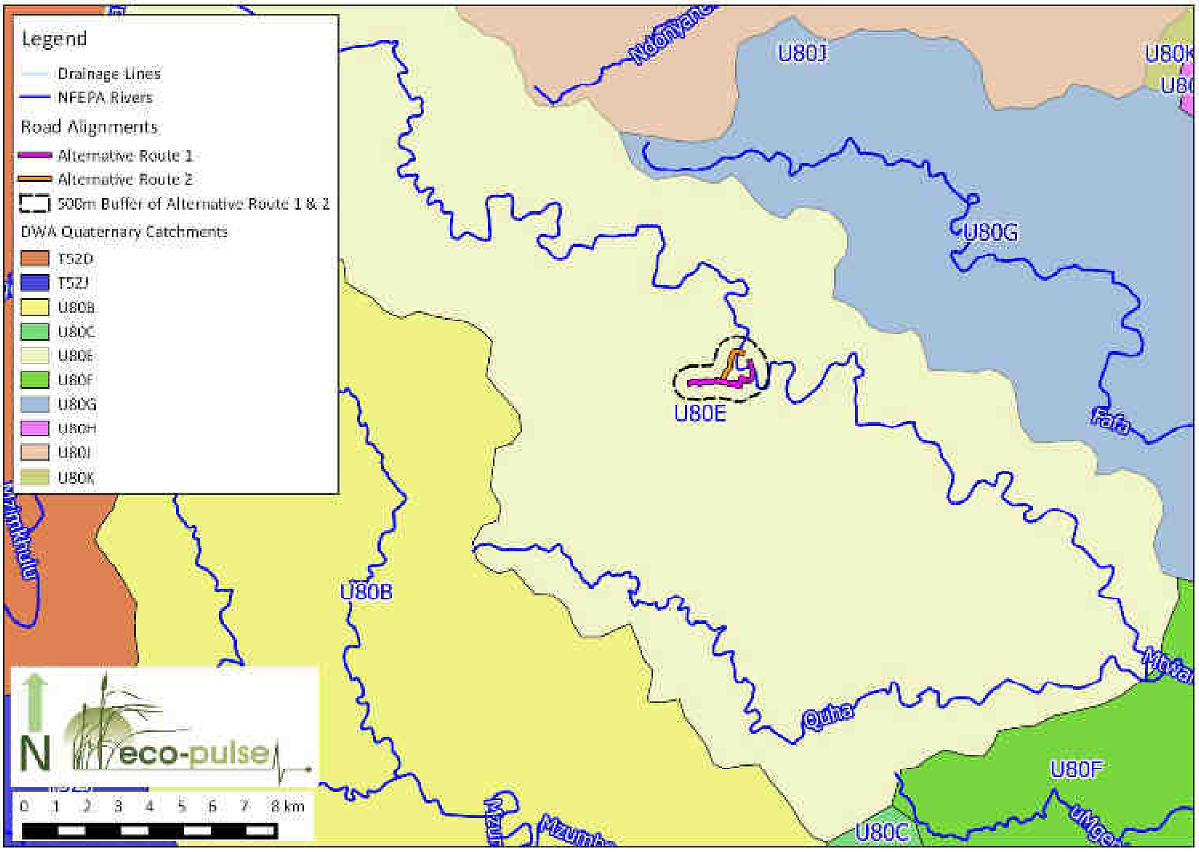


Figure 3 Map showing the planned road development rute alignment relative to the Mtwalume River, within the middle-reaches of DWA Quaternary Catchment U80E.

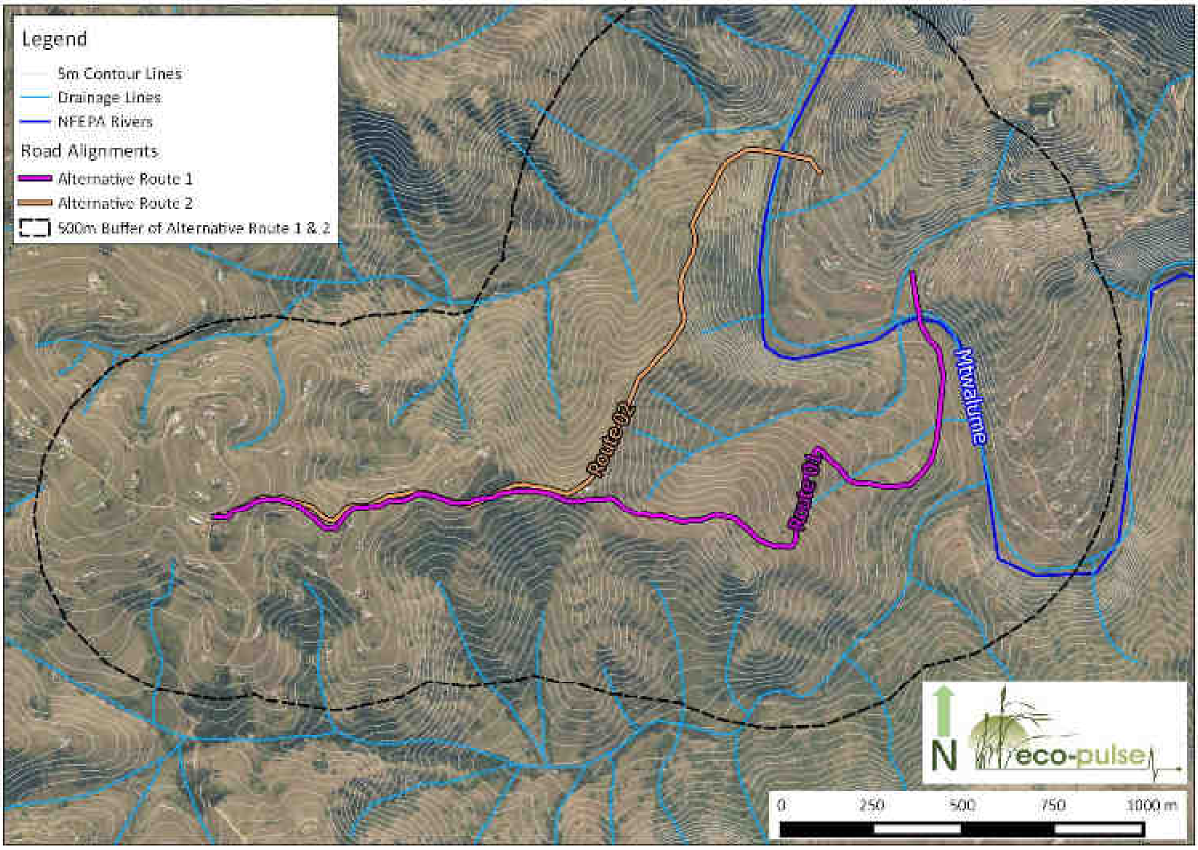


Figure 4 Local drainage setting showing the the two route alignment options relative to the local drainage setting *(Route 1 is the preferred route alignment represented by the 'Purple' line, with Route 2 being the alternative route alignment represented by the 'Orange' line on the map).*

The key biophysical setting details of the study area and surrounds are summarised in Table 4, below.

Table 4. Key biophysical setting details of the study area.

Biophysical Aspects	Desktop Biophysical Details	Source
Elevation a.m.s.l	780-480m	Google Earth ™
Mean annual precipitation (MAP)	830.2mm	Schulze, 1997
Rainfall seasonality	Early, Mid Summer	DWAF, 2007
Mean annual temperature	20 - 22 °C	DWAF, 2007
Potential Evaporation (mm) Mean Annual A-pan Equivalent	1544.6mm	Schulze, 1997
Median Annual Simulated Runoff (mm)	157.5mm	Schulze, 1997
Geomorphic Province	Southeastern Coastal Hinterland	Partridge et al., 2010
Geology	Gneiss	SA Geology dataset
Water management area	Mvoti to uMzimkhulu	DWA
Quaternary catchment	U80E	DWA
Main collecting river(s) in the catchment	Mthwalume River	CSIR, 2011
Geomorphic zone of the reach assessed	Upper foothills	CSIR, 2011
DWA Ecoregion	17.01 (North-Eastern Coastal Belt)	DWA, 2005
National vegetation type	Ngongoni Veld (SVs4) & KwaZulu-Natal Coastal Belt (CB3)	Mucina & Rutherford, 2006

Biophysical Aspects	Desktop Biophysical Details	Source
Provincial vegetation types	Moist Coast Hinterland Grassland (DS 20) Dry Coast Hinterland Grassland (GS 19)	EKZNW, 2010
Wetland vegetation group	Sub-Escarpment Savanna & Indian Ocean Coastal Belt Group 2	CSIR, 2011

3.2 Conservation Context

Understanding the conservation context and importance of the study area and surrounds is important to inform decision making regarding the management of the aquatic resources in the area. In this regard, national, provincial and regional conservation planning information is available and was used to obtain an overview of the study site. Key conservation context details of the project site and surrounds have been summarised in Table 5, below.

Table 5. Key conservation context details for the study area.

NATIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset	**Relevant Conservation Feature**	**Location in Relation to Project Site**	**Conservation Planning Status**
National Threatened Ecosystems (SANBI & DEA, 2011) – remaining extent	Vegetation type: Ngongoni Veld	Site	**Vulnerable**
National Vegetation Map (Mucina & Rutherford, 2006)	Ngongoni Veld (SVs4) / KwaZulu-Natal Coastal Belt (CB 3)	Intact terrestrial vegetation	**Vulnerable / Endangered**
The National Freshwater Ecosystem Priority Area (NFEPA) Assessment (CSIR, 2011)	Mtwalume River and catchment area	River/catchment/ wetlands	**FEPA river and catchment** **Indian Ocean Coastal Belt Group 2 (Wetland Vegetation Group): Critically Endangered wetland vegetation type**
PROVINCIAL AND REGIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset	**Relevant Conservation Feature**	**Location in Relation to Project Site**	**Conservation Planning Status**
KZN Vegetation Map (EKZNW, 2012)	Dry Coast Hinterland Grassland (GS 19)	Intact terrestrial vegetation	**Vulnerable**
KZN Aquatic Conservation Plan (EKZNW, 2007)	Freshwater Planning Unit No. 3867	General study area	Available (no status)
KZN Terrestrial Conservation Plan (EKZNW, 2010)	Biodiversity Priority Areas	General study area	**Biodiversity Priority Area 1 and 2**
Ugu District Biodiversity Sector Plan or BSP (EKZNW, 2013)	Ecological Support Areas (ESAs) and Ecological Infrastructure (EI)	Rivers and drainage lines (see Figure 6)	**Ecosystem functionality needs to be maintained in these areas**

Conservation concerns and features of particular importance to the study area are summarised below as follows:

3.2.1 *NFEPA (National Freshwater Ecosystem Priority Areas)*

The National Freshwater Ecosystem Priority Area (NFEPA) project (Nel et al., 2011), is the first formally adopted national freshwater conservation plan that provides strategic spatial priorities for conserving the country's freshwater ecosystems and supporting the sustainable use of water resources that includes rivers, wetlands and estuaries. FEPA maps show various different categories, each with different management implications. The categories include river FEPAs and associated sub-quaternary catchments, wetland FEPAs, wetland clusters, Fish Support Areas (FSAs) and associated sub-quaternary catchments, fish sanctuaries, phase 2 FEPAs and associated sub-quaternary catchments, and Upstream Management Areas (UMAs). Categories relevant to this study include river FEPAs and associated catchments. The Mtwalume River is recognised nationally as an important river FEPA (Freshwater Ecosystem Priority Area) and should be managed in such a way as to protect the current state and functioning of the river system. The entire river catchment is also considered a FEPA (see Figure 5, over the page). In terms of the conservation threat status of wetland vegetation, intact wetlands within the Sub-Escapement Savanna wetland vegetation type are classified as Endangered and wetlands within the Indian Ocean Coastal Belt Group 2 wetland vegetation type are classified as Critically Endangered (CSIR, 2011). While there are no identified wetlands FEPAs for the study site, the downstream estuary is considered of high conservation importance. Land-use/development implications in terms of the FEPA status of rivers, wetlands and their associated catchment areas include the following:

- River and wetland FEPAs need to be maintained in a good condition in order to achieve biodiversity goals and protect water resources from human use;
- In the absence of a national protocol, a generic 100m buffer should be established around wetland/river FEPAs; and
- The surrounding land and smaller stream network needs to be managed in a way that maintains the good condition of the river reach.

3.2.2 *KZN Vegetation Map*

Intact terrestrial vegetation (Ngongoni Veld/grassland in the western study area, shown in Figure 6 (over page) is classified as Vulnerable and KwaZulu-Natal Coastal Belt vegetation type is considered Critically Endangered.

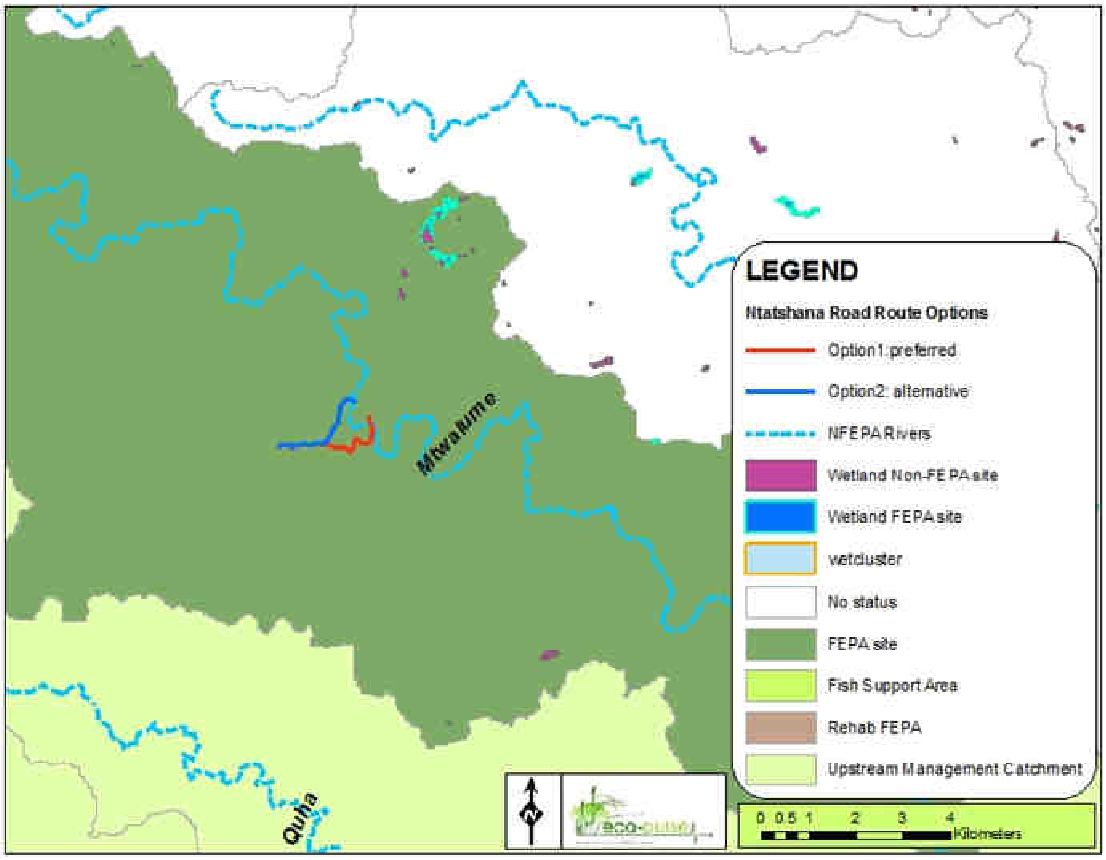


Figure 5 Local drainage setting and location of river and wetland FEPAs associated with the Mtwalume River catchment in the area of study.

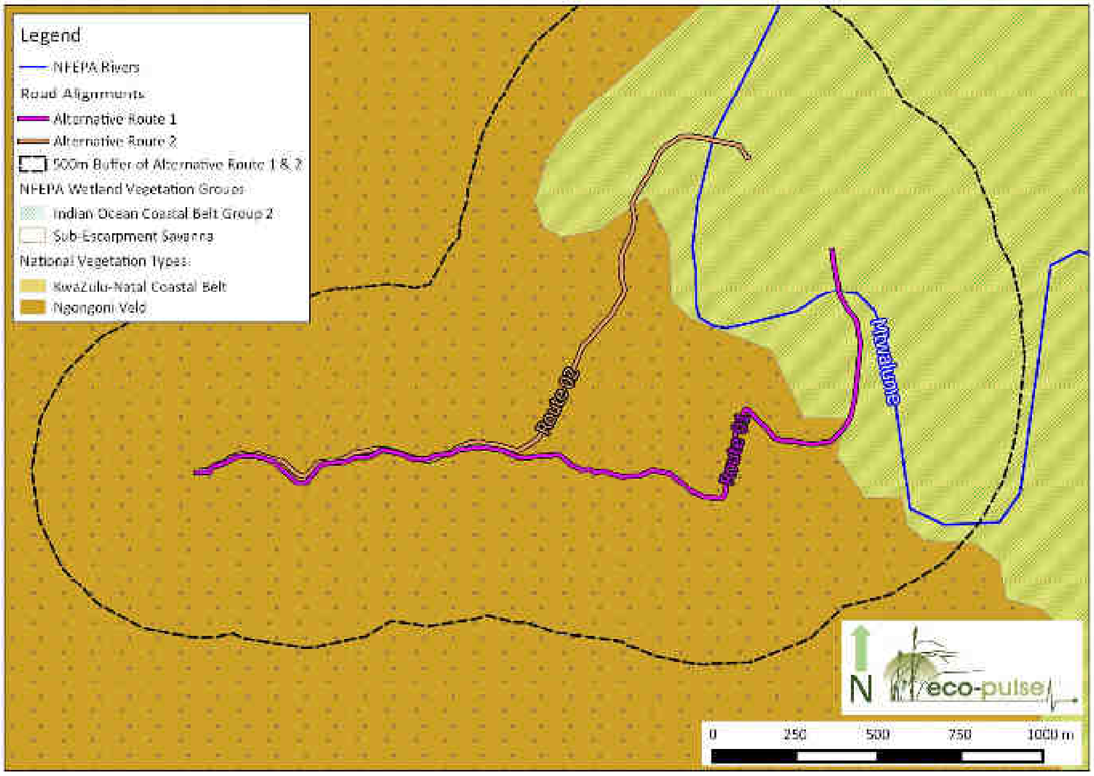


Figure 6 Vegetation Type Map showing both wetland and terrestrial vegetation types within the study area.

3.2.3 *Terrestrial Systematic Conservation Plan (CPLAN)*

The study area and catchment of the Mtwalume River is regarded as "Available" in terms of the KZN Freshwater Systematic Conservation Plan: this means the study area and its surrounding have not been prioritised at a provincial level for freshwater conservation or for meeting Provincial Biodiversity Conservation targets. In terms of the outputs of the Provincial Terrestrial Systematic Conservation Plan (CPLAN), however, the GIS coverage obtained from EKZNW (2010) reveals sections of the study area that have been classified as Biodiversity priority Areas (BPA 1 areas shown shaded in "Red" in Figure 7, with BPA3 areas shaded in "Yellow"). Biodiversity Priority Areas (BPAs) refer to natural areas that are viewed as necessary to ensure protection of biodiversity, environmental sustainability, and human well-being. The importance of the biodiversity features in Biodiversity Priority Areas and the associated ecosystem services is sufficiently high that, if their existence and condition are confirmed, the likelihood of a fatal flaw for new development projects is high (i.e. development projects are likely to be significantly constrained or may not receive necessary environmental authorisations). The relevant modelled planning units have identified the potential presence of the following terrestrial biodiversity features responsible for the mapped areas shown in Figure 7 (below) being classified as BPAs:

- *KwaZulu-Natal Sandstone Sourveld (Critically Endangered)*
- *Moist Ngongoni Veld (Vulnerable)*
- *South Coast Bushland*
- *Helichrysum woodii*
- *Gulella separata*
- *Euonyma lymneaeformis*
- *Odontomelus eshowe*
- *Doratogonus infragilis*
- *Ceropegia rudatisii*
- *Cochlitoma semigranosa.*

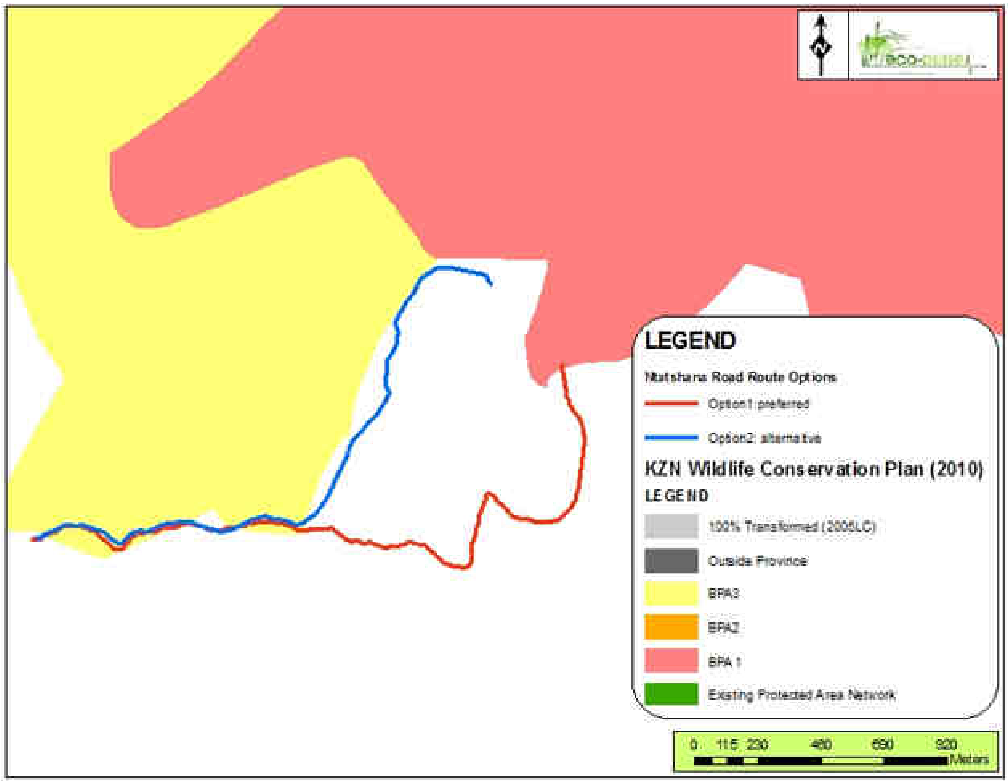


Figure 7 Map showing the location of the study site in relation to Biodiversity Priority Areas (BPA1 areas shown shaded in "Red", BPA3 areas shaded in "Yellow") identified in the Terrestrial Systematic Conservation Plan for KZN (Ezemvelo KZN Wildlife, 2010).

3.2.4 *Ugu District BSP (Biodiversity Sector Plan)*

The Biodiversity Sector Plan (BSP) for the Ugu District Municipality (EKZNW, 2013) was interrogated in terms of the location, extent and relevance of local conservation priorities identified for the project site and immediate surrounding areas. The BSP is intended to assist and guide land use planners and managers within the Ugu District and its respective local municipalities, to account for biodiversity conservation priorities in all land use planning and management decisions, thereby promoting sustainable development and the protection of biodiversity, and in turn the protection of ecological infrastructure and associated ecosystem services. Important local biodiversity conservation priorities are shown mapped in Figure 8, below.

- **Terrestrial Critical Biodiversity Areas or CBAs** associated with undisturbed grassland on steep slopes within the valley to the north of the road alignment and north-east across the Mtwalume River (shown shaded in "Red" in Figure 8). *CBAs represent natural or near-natural landscapes that are considered critical for meeting biodiversity targets and thresholds, and which safeguard areas thus ensuring the persistence of viable populations of species, and the functionality of ecosystems and ecological infrastructure. CBAs should be maintained in a natural state with limited to no biodiversity loss.*
- **Aquatic Ecological Support Areas or ESAs** associated with the Mtwalume River and associated tributary streams/drainagre lines (shown shaded in "Yellow" in Figure 8). *ESAs represent functional but not necessarily entirely natural landscapes that are largely required to ensure the persistence and maintenance of biodiversity patterns and ecological processes within the critical biodiversity areas. Ecosystem functionality needs to be maintained in these areas, allowing for some loss of biodiversity but without degrading Present Ecological State (PES) category.*
- **Ecological Infrastructure or EI** associated mainly with the smaller drainage network in the study area and key ecological linkages/corridors (shown outlined in "Green" in Figure 8). *Ecological Infrastructure (EI) includes functional features, habitats or landscapes that provide important ecological goods and services to society (ie. water security, disaster relief, preventing soil loss and in maintaining or improving key services such as clean water for domestic and recreational use). Whilst Ecosystem Goods and Services can be derived from non-natural land-use practices, only naturally-derived EI is reflected in this context.*

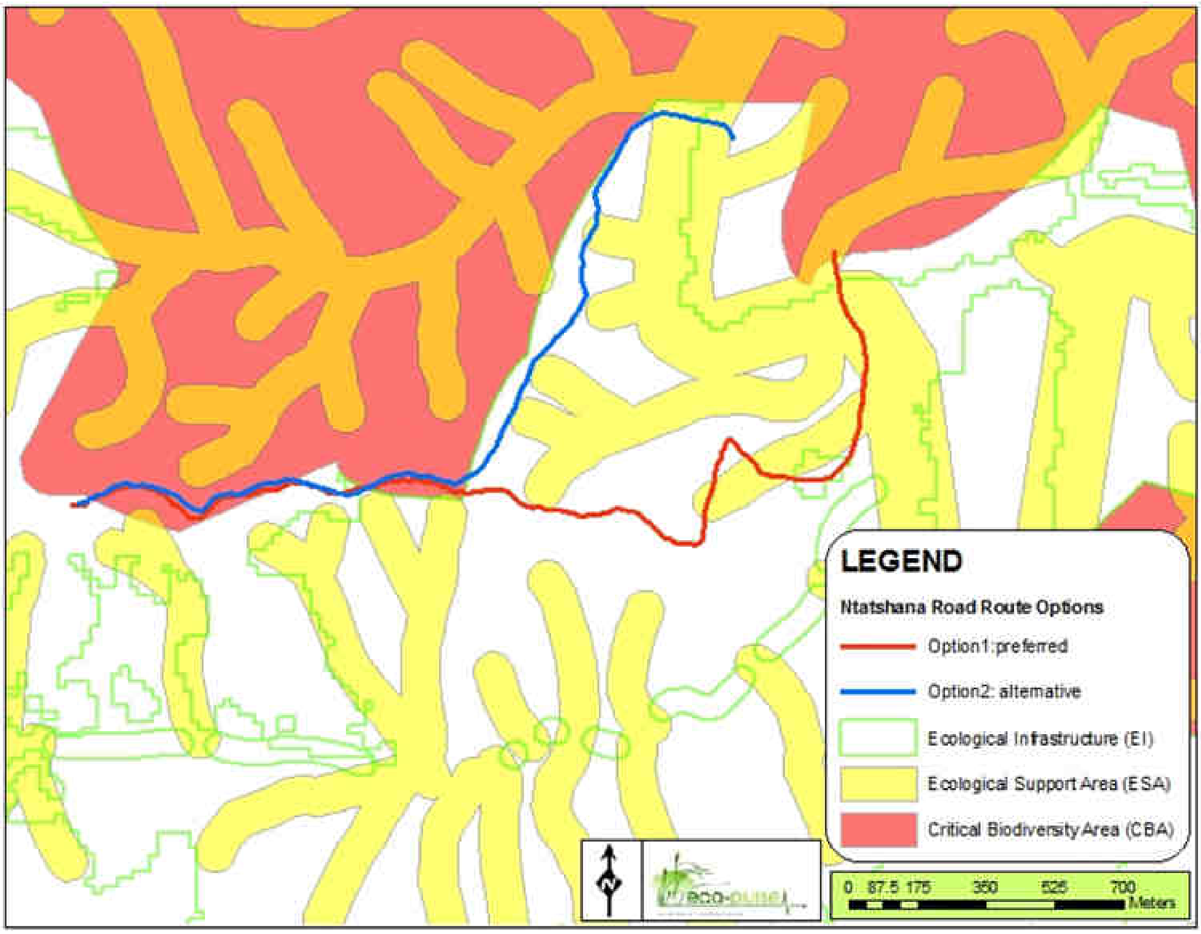


Figure 8 Map showing the location and extent of CBAs, ESAs and EI highlighted in the Ugu Biodiversity Sector Plan (EKZNW, 2013).

4 AQUATIC SCREENING/RISK ASSESSMENT

An initial freshwater/aquatic resource risk screening exercise was undertaken to determine the risk of water resources being impacted by the proposed development or triggering environmental/water use licensing requirements in terms of the NEMA (National Environmental Management Act) and NWA (National Water Act). This involved identifying and delineating all water resources (including wetland sand rivers) at a desktop level within the 500m regulated area specified by DWS (i.e. within a 500m radius of the proposed road development), to determine which wetlands are at risk of impact and which are low risk systems based on their proximity to the development and position in the landscape. The results of the risk assessment were used to determine which water resources required further detailed assessed in order to determine the extent of adverse impact and inform the mitigation of such impacts.

Wetlands and riverine ecosystems/habitat within the 500m regulated area are shown mapped in Figure 9 (with rationale for risk rating in Table 7) and have been screened and risk rated according to the risk categories in Table 6, below. ***The results suggest that aquatic resource units R02, R03 and E02 are at a moderate-high risk of being negatively affected by the development and will require further assessment to inform the assessment of impacts and recommendations for mitigating/managing ecological impacts. The remaining resources were rated as low risk and unlikely to incur negative impacts related to the development and also unlikely to trigger the requirements for a WULA in terms of Section 21 c and i water use. For this reason, these resource units were not subject to further assessment.***

Table 6. Risk rating table used to rate degradation risk to water resource units.

RISK RATING	CRITERIA/RATIONALE
High	These resources are likely to require impact assessment and/or a Water Use License in terms of Section 21 c & i of the National Water Act for the following reasons: • Resources are located within or in close proximity to the development footprint/impact zone and there is therefore a high/definite probability of direct and/or indirect ecological impacts to the aquatic resource occurring that are likely to modify the structure, functioning and characteristics of the watercourse. • There is a high risk of a potential large modification/reduction in the current level of aquatic ecosystem services provided by wetlands/rivers and/or complete loss of services.
Moderate	Whilst is regarded as moderate, these resources may require impact assessment and a Water Use License in terms of Section 21 c & i of the National Water Act for the following reasons: • Resources are located immediately upstream or within a short distance downstream of the development impact zone or within a range at which they are likely to incur more indirect impacts associated with the development (such as water pollution, sedimentation, scouring and altered hydrology).
Low	These resources are regarded as low risk and are unlikely to require impact assessment or Water Use License in terms of Section 21 c & i of the National Water Act for the following reasons: • Resources are located within another adjacent sub-catchment and will not be impacted by the development project in any way, shape or form. • Resources are located a significant distance upstream of the impact footprint and are highly unlikely to be impacted by the development project. • Resources are located in a position in the landscape relative to the development such that they do not trigger requirements for Environmental Assessment according to the NEMA: EIA

RISK RATING	CRITERIA/RATIONALE
	regulations. • Resources are located downstream of the identified impacted area but well beyond the range at which they are likely to incur impacts associated with the development (such as water pollution, sedimentation, scouring and altered hydrology). • Low to no ecosystem modification/degradation is anticipated as a result of secondary or indirect impacts.

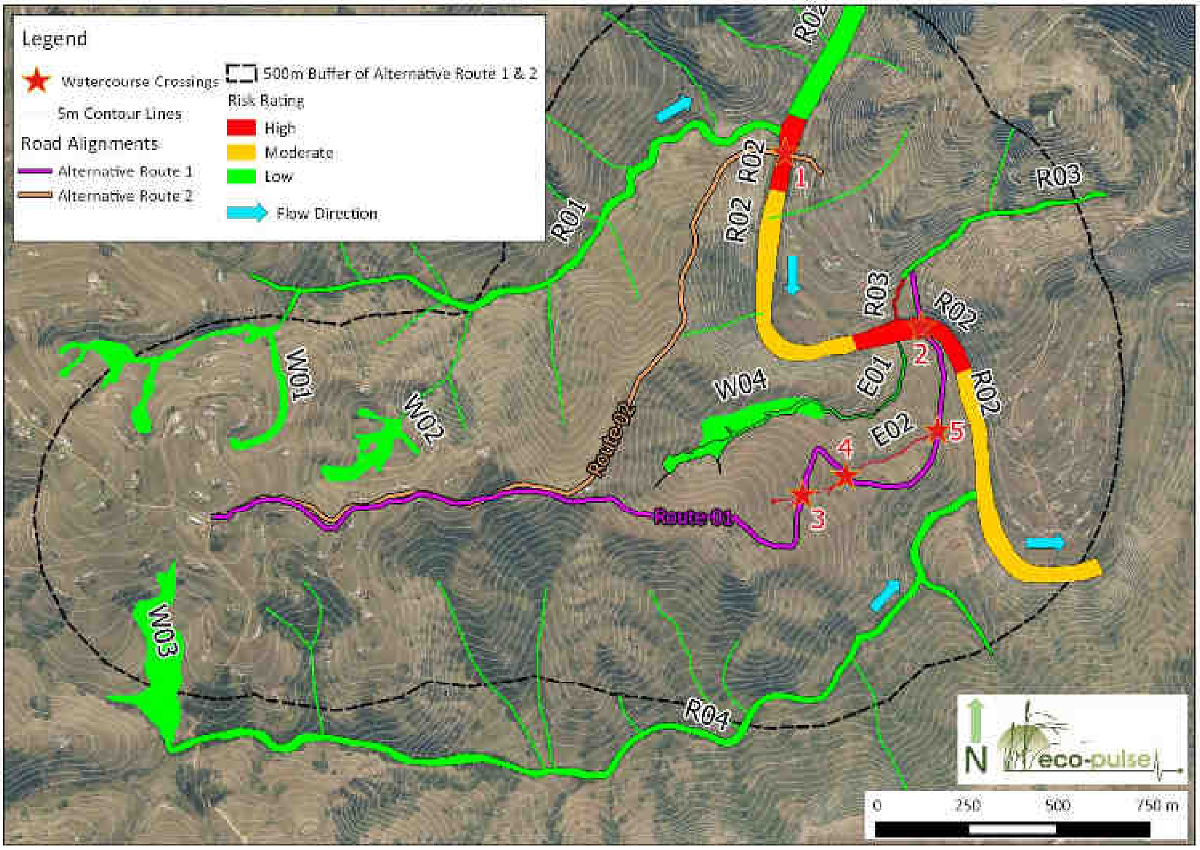


Figure 9 Map showing the outputs of the desktop aquatic risk assessment/screening undertaken for the Ntatshana Road development project. The map shows the location of the proposed road route alignment options ("Purple" and "orange" lines), with a 500m radius (DWS regulated area - "Black" dashed circle) from the development; and aquatic resources with impact risk rated (areas shaded in "Red" – High Risk, "Orange" – Moderate Risk and "Green" – Low Risk). Identified watercourse crossings by the proposed road are indicated as numbered "Red" stars (crossings 1-5).

Table 7. Summary of risk ratings for desktop delineated/mapped water resource units within a 500m radius of the proposed Ntatshana Road development route options 1 and 2.

Water Resource Unit	HGM Type	Risk rating	Rationale	Triggers need for a WULA or further impact assessment?
W01	Hillslope seep	Low	This wetland unit falls within a different sub-catchment/micro-catchment and is therefore highly unlikely to be impacted by the proposed road development.	No
W02	Hillslope seep	Low	Wetland W02 is located a distance downstream of the road in the adjacent catchment area to the north and is associated with a low risk of being adversely impacted/having the characteristics of the wetland	No

Water Resource Unit	HGM Type	Risk rating	Rationale	Triggers need for a WULA or further impact assessment?
			altered due to the presence of an intact grassland buffer zone of width >80m. This buffer is likely to adequately protect the downstream resource from sedimentation and hydrological impacts, hence the low risk rating for this system.	
W03	Hillslope seep	Low	*As per W01.*	No
W04	Footslope seep	Low	Wetland W02 is located a distance downstream of the road and is associated with a low risk of being adversely impacted/having the characteristics of the wetland altered due to the presence of an intact grassland buffer zone of width >300m between the road and wetland. This buffer is likely to adequately protect the downstream resource from sedimentation and hydrological impacts, hence the low risk rating for this system.	No
R01	Small Perennial River	Low	Riparian unit R01 is a tributary of the Mtwalume River and its confluence with the Mtwalume River occurs just upstream of the crossing point of alternative route 2. The development is unlikely to affect this unit.	No
R02	Large Perennial River	High	The Mtwalume River stands to be directly affected by the proposed road/bridge infrastructure development which will cross a section of the river. There physical disturbance of the site (excavation, vegetation clearing, infilling, temporary flow modification, physical disturbance by construction vehicles, etc.). Areas just below the direct impact zone are likely to be moderately impacted by secondary impacts such as sedimentation and water quality impacts. As such the risk is considered moderate in these areas. Potential river crossings include crossings 1 and 2 (see Figure 9).	Yes
R03	Seasonal Stream	High	The lower section of riparian zone R03 which is situated along the proposed alternative 1 road infrastructure (preferred) is likely to be significantly impacted by the proposed road development, hence the high risk rating associated with the stream reach. The section upstream of the proposed development area is however at low risk.	Yes
R04	Small Perennial River	Low	Riparian unit R04 is situated well outside the impact zone and is a significant distance downstream to be well-buffered by intact terrestrial grassland/bush land habitat. The large, intact buffer is likely to adequately protect the downstream resource from sedimentation and hydrological impacts, hence the low risk rating for this system.	No
E01	Small Intermittent Stream/ Gulley	Low	Ephemeral stream E01 is considered at low risk of being impacted negatively by the development due to its location well-outside the direct impact zone. A large (+/- 200m), intact grassed terrestrial buffer zone between the drainage line and the road development is likely to provide more than adequate protection to the downstream resource from indirect impacts such as sedimentation and hydrological impacts, hence the low risk rating for this system.	No
E02	Small Intermittent Stream/ Gulley	High	The proposed road is planned to cross this ephemeral channel about 3 times (potential channel crossings include crossings 3, 4 and 5 in Figure 9) thus putting this channel at	Yes

Water Resource Unit	HGM Type	Risk rating	Rationale	Triggers need for a WULA or further impact assessment?
			high risk of degradation and modification related to construction activities. The channel is likely to be excavated, infilled and adversely impacted by stormwater management.	
Other small drainage lines (not labelled)	Small Intermittent Streams	Low	The remaining unnamed drainage lines are all considered at low risk of being impacted negatively by the development due to their location downstream and well-outside the direct impact zone. Large intact grassed terrestrial buffer zones between the drainage lines and the road development are likely to provide more than adequate protection to the downstream resources from indirect impacts such as sedimentation and hydrological impacts, hence the low risk rating for these systems.	No

5 BASELINE AQUATIC ASSESSMENT FINDINGS

This section of the report deals with the findings of the wetland/riparian areas delineation and baseline condition and functional assessment undertaken for the freshwater aquatic resources (wetland and rivers/streams) flagged/identified as requiring further assessment to inform the Environmental Assessment and Water Use Licensing requirements for the pedestrian bridge development project (*as detailed in the aquatic ecosystem risk/screening assessment in Section 4 of this report*). All aquatic ecosystems were investigated in the field over a period of two days in August 2015.

5.1 Location, extent, classification and description of Aquatic Resources and Habitat Types that stand to be affected by the development

Freshwater aquatic resources and associated habitat flagged in the screening/risk assessment as requiring further assessment (high risk of impact) to inform the Environmental Authorisation and Water Use License processes (see Section 4 of this report) included:

- **R02:** *Mtwalume River main channel and riparian habitat located in the eastern study area and associated with road development route options 1 and 2*.
- **R03:** *tributary stream channel to the Mtwalume River located in the north-eastern study area and associated with road development route options 1 only*.
- **E02:** *small ephemeral drainage line located in the south-eastern study area - associated with road development route options 1 only.*

These water resource units (rivers, streams and riparian habitats) are shown mapped in Figure 10 (below) and were the subject of further detailed field delineation and assessment to inform the Environmental Authorisation and Water Use License processes (i.e. to inform the assessment of potential impacts and recommendation of impact mitigation/management measures, ecological monitoring requirements and water use licensing requirements). Note that water resources flagged as requiring further infield verification, delineation and assessment were limited to rivers, streams and associated riparian habitat. Wetland systems and habitat were not flagged as requiring further assessment and have therefore not been dealt with under this section of the report.

Note that despite the previous preliminary ecological habitat assessment undertaken by Cook (2013) having mapped relatively extensive hillslope seepage wetlands in the catchment area of the Mtwalume River within the steep valley to the immediate east of where the two route options split, extensive soil and vegetation sampling in this area revealed only a small seepage wetland (wetland W04 in Figure 10, over-page) at the footslope of the steep valley and associated with floor of erosion gulley E01. The soils associated with the steep slopes of this valley were found to be dry, medium to dark brown loam with high matrix chroma and lacking any signs of mottling that would indicate the presence of wetland/hydric soils. Vegetation in this area was also dominated by terrestrial grasses and species of Aloes that would be intolerant of the saturated soils/conditions associated with wetland habitats. Furthermore, no wetland habitat was found to occur in the small valley associated with eroded channel E02 which will be traversed by road alignment option 1, as per Figure 10 below. Further details of the soil sampling to inform the delineation undertaken within the valley of ephemeral channels E01 and E02 has been included as **Annexure D** of this report, including a map of soil sampling points and photographic record of sample sites.

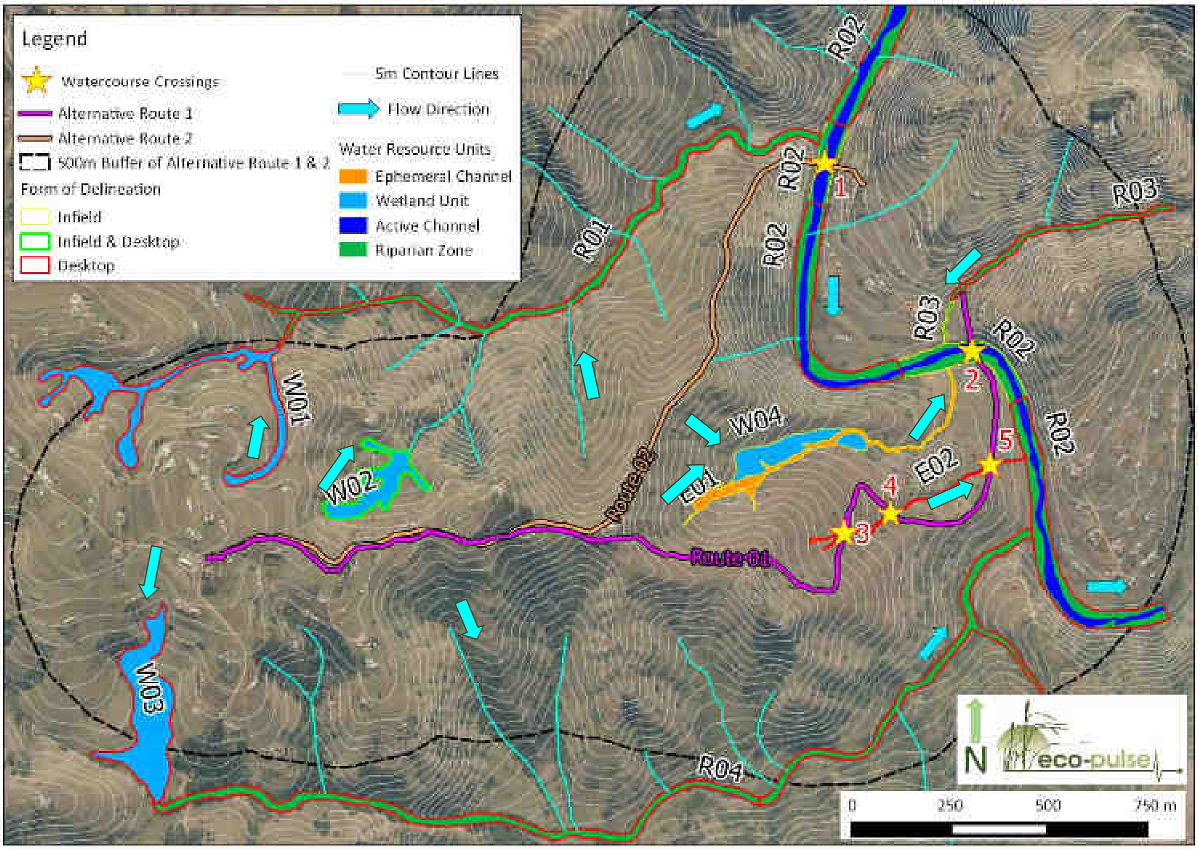


Figure 10 Water resource units within a 500m radius of the road route options 1 and 2, showing **R02** (main Mtwalume River), **RO3** (stream channel) and **E02** (small ephemeral drainage line) which were subject to further field delineation and detailed assessment. Identified watercourse crossings by the proposed road are indicated as numbered "Yellow" stars (crossings 1-5).

As indicated in Figure 10 (above), alternative route 1 (preferred road route alignment) will have four watercourse crossings (crossings 2, 3, 4 and 5) whilst alternative route option 2 will have only one water course crossing (crossing 1). GPS coordinates of the potential watercourse crossings are also presented in Table 8, below.

Table 8. GPS coordinates of potential water course crossings associated with the Ntatshana Road options 1 and 2.

Crossing Number (see Figure 10)	**Affected Water Resource Unit**	**HGM Type**	**GPS Coordinates**
1	R02 (Mtwalume River)	River	30°20'48.60"S | 30°21'5.52"E
2	R02 (Mtwalume River)	River	30°21'4.17"S | 30°21'19.60"E
3	E02 (Tributary of the Mtwalume River)	Stream	30°21'19.18"S | 30°21'7.34"E
4	E02 (Tributary of the Mtwalume	Stream	30°21'17.54"S | 30°21'11.79"E

Crossing Number (see Figure 10)	Affected Water Resource Unit	HGM Type	GPS Coordinates
	River)		
5	E02 (Tributary of the Mtwalume River)	Stream	30°21'13.49"S | 30°21'21.29"E

A summary of the basic biophysical details of water resource units R02, R03 and E02 assessed is provided in Table 9, below.

Table 9. Summary of basic biophysical details of riverine/stream units R02, R03 and E02.

Attributes	**R02:** Mtwalume River	**R03:** tributary stream of the Mtwalume River	**EO2:** ephemeral drainage line
GPS Coordinates	30°21'4.89"S | 30°21'15.11"E	30°21'0.67"S | 30°21'17.35"E	30°21'17.88"S | 30°21'11.18"E
Type	River	Stream	Intermittent/ephemeral drainage line
Longitudinal zonation	Transitional	Mountain stream	Mountain headwater stream
Landform	Active channel & vegetated riparian zone	Active channel & vegetated riparian zone	Eroded channel, riparian vegetation absent
Dominant water input	Overland flow and inputs from tributaries	Overland flow & subsurface seepage from catchment	Overland flow, lateral seepage from supporting catchment
Flow regime	Perennial	Weakly Perennial/Seasonal	Intermittent/Ephemeral (flow only storm events)
Catchment size	Large (ca. 18, 116 ha)	Small (ca. 76 ha)	Very small (ca. 13ha)
Primary land use in catchment	Untransformed grassland, degraded/overgrazed veld, forestry plantations, scattered rural human settlement, subsistence cultivation, alien vegetation	Transformed and degraded grassland	Largely untransformed grassland
Channel morphology /dimensions	20-30m wide x 1-3m deep	1-3m wide x 0.5-1m deep	0.5m wide x 0.5m deep
Substrate	Mineral soil - alluvium	Mineral soil - alluvium	Mineral soil - bedrock
Biotopes present	Marginal vegetation out of current, marginal vegetation in current, aquatic vegetation, gravel-sand-mud.	Marginal vegetation out of current, marginal vegetation in current, gravel-sand-mud.	N/A (absent)
Reach slope	0.5-1%	3-5%	20-30%
Length of river reach assessed	~1.5km	~140m	~600m
Area of riparian zone assessed	Roughly 6ha	<1ha	N/A (riparian vegetation absent)
Onsite impacts	• Increased alien vegetation infestation and bush encroachment; • Physical disturbance of vegetation and soil linked with access roads/tracks; • Trampling and overgrazing of	• Increased alien vegetation infestation and bush encroachment; • Physical disturbance of vegetation on the left bank associated with the construction of a new maintenance road; and • Infilling of the riparian zone and active channel.	• Increased alien vegetation infestation and bush encroachment; • Physical disturbance of vegetation and soils linked with access roads/tracks; and • Trampling and overgrazing of vegetation by livestock.

Attributes	**R02:** Mtwalume River	**R03:** tributary stream of the Mtwalume River	**EO2:** ephemeral drainage line
	vegetation by livestock; • Sediment deposition within the riparian zone immediately above alternative route 1; and • Limited water abstraction for domestic purposes.		

5.1.1 *Mtwalume River (R02) description*

The Mtwalume River reach assessed is located in the eastern study area and associated with road development route options 1 and 2. The river was sampled at two locations pertaining to the two route alignment options crossings of the river channel. The river is a relatively large perennial system dominated by a single, sinuous, mixed alluvial-bedrock channel with numerous depositional features in the form of cobble, boulder and gravel bars and riffles. The channel is varies from 20-40m width in places and ranges in depth from 1 – 3m. The river is currently in a relatively good ecological condition due to the largely natural state of the river catchment (with limited agricultural and human settlement impacts), with limited onsite anthropogenic impacts apart from colonisation of disturbed riparian habitat by alien plants and weeds.

The Mtwalume River reach assessed comprised of two distinct vegetation community types: (i) **short degraded grassland** and (ii) **dense wooded alien thicket**. The degraded grassland habitat occurred from the edge of the active channel and extended upslope and transitioned towards the adjacent terrestrial grassland vegetation. Marginal vegetation was found to be dominated primarily by short sedges such as *Cyperus esculentus* whilst the non-marginal community comprised indigenous grasses, sedges and reeds, the dominant species being *Aristida junciformis, Cyperus esculentus, Cyperus latifolius, Phragmites australis, Eleocharis acutangula, Miscanthus junceus* and *Sporobolus pyramidalis*. Common indigenous herbaceous vegetation was found to include *Ludwigia octovalis, Thelypteris palustris, Hypochaeris radicata* and *Leonotis sp., together* with a number of exotic herbs such as *Centella asiatica, Bidens pilosa, Ageratum conyzoides, Ricinus communis, Solanum incanum, Tagetes minuta* and *Verbena bonariensis*. Woody vegetation within the riparian zone was found to be limited to *Ficus sur* saplings, *Phragmites australis reeds* and *Miscanthus junceus* grass tussocks, along with a number of exotic shrubs and trees including: *Lantana camara, Senna didymobotrya, Psidium guajava, Rubus cuneifolius* and *Caesalpinia decapetala*.

A selection of digital photographs taken for the Mtwalume River (R02) at the two potential crossing sites has been provided below:

R02: Mtwalume River (crossing point for alternative option - route 2)

Photo 1: Downstream view of the right bank of the Mtwalume River crossing for road development route option 2. Trampled *Cyperus latifolius* sedge habitat can be seen in the foreground with woody alien vegetation in the background.

Photo 2: Upstream view of the active channel of the Mtwalume River (mixed bedrock-alluvial system). On the left hand (left bank) one can see a dense alien thicket.

Photo 3: Downstream view of the active Mtwalume iver channel with vegetated island and bank attached bars.

Photo 4: View downstream of the proposed crossing point for route option 2. On the right bank is a dense vegetated alien thicket.

R02: Mtwalume River (crossing point for preferred option- route 1)

Photo 5: View looking upstream taken avove the proposed crossing point for route option 1 (preferred road aligment).

Photo 6: View of the crossing point for the preferred route (option 1) taken from the right bank to the south of the crosising. The crossing point has been recently disturbed upstream by heavy construction vehicles involved with maintaining an access road.

Photo 7: View of the crossing point for option , taken from the left bank (northern side), showing a recently graded dirt acces road.

Photo 8: View looking upstream at a point below the proposed Mtwalume River crossing point, showing the active channel heavily confined on the right hand side by a steep bank/scarp face.

5.1.2 *Tributary stream of the Mtwalume River (R03) description*

R03 is a small tributary stream that adjoins and discharges into the Mtwalume River from the north east and is associated with road development route option 1 only. The stream is small in size (1-3m wide, up to 1m depth) and dominated by a single mixed alluvial-bedrock channel lacking depositional features, with a narrow riparian zone dominated by exotic plants (dense alien thicket). The river is currently in a fair ecological condition due to the modified state of the small, steep upstream catchment supporting this river that is characterised by rural settlement and subsistence farming, with exposed soils and dirt tracks. Onsite anthropogenic impacts include vegetation removal and infilling and heavy infestation by alien plants and weeds.

The smaller tributary stream was characterised by one vegetation community type, namely **dense woody alien thicket**. This community had been degraded and was found to be dominated by alien vegetation due to woody alien invader encroachment into the disturbed riparian habitat. Indigenous species abundance and richness was generally considered low for this system. Exotic shrubs have typically formed an impenetrable alien thicket, with the main exotic species being *Lantana camara, Listea glutinosa, Caesalpinia decapetala, Senna didymobotrya, Psidium guava, Rubus cuneifolius,* with some scattered indigenous species comprising the riparian vegetation, including: *Syzigium cordatum, Cussonia spicata, Ficus sur, Setaria sphacelata, Phragmites australis, Aristida junciformis* and *Miscanthus junceus.* Marginal vegetation within the active channel was limited to a few indigenous grass, sedge and reed species, the dominant ones being *Aristida junciformis, Phragmites australis, Cyperus latifolius* and *Miscanthus junceus.*

A selection of digital photographs taken for the tributary stream (R03) has been provided below:

R03: Tributary stream of the Mtwalume River

Photo 9: Riparian vegetation clearing and infilling of the tributary stream channel R03 associated with the construction of a new access road.

Photo 10: Riparian vegetation clearing and infilling.

Photo 11: Newly constructed access road adjacent riparian zone of stream channel R03 with dense alien thicket.

Photo 12: Another view of the newly constructed access road running along the edge of riparian zone R03.

5.1.3 *Small ephemeral drainage channel (E02) description*

E02 is considered to be a narrow, ephemeral (intermittent) drainage line/channel that is thought to experience flow only after significant rainfall events (storm flow). It is a tributary of the Mtwalume River that adjoins the main from the south-west and is associated with road development route option 1 only. The channel is degraded/heavily eroded and small in size (<0.5m) and dominated by a single straight channel that resembles an erosion gulley/donga in places. The drainage line is currently considered to be in a poor ecological condition due to the effects of onsite erosion and catchment degradation.

The vegetation community along ephemeral drainage line E02 can be best described as **wooded grassland or grassland with bushclumps.** *Aristida junciformis* was the dominant characteristic species throughout the full length of the drainage channel whilst *Aloe marlothii* was particularly abundant in the upper reaches of the drainage line. Arborescent species encroaching on the lower section of the grassland included a number of exotic shrubs such as *Plectranthus comosus, Senna didymobotrya, Lantana camara, Rubus cuneifolius, Psidium guava,* with scattered indigenous *Syzigium cordatum* trees interspersed.

A selection of digital photographs taken for ephemeral channel (E02) has been provided below:

E02: Ephemeral drainage line

Photo 13: View looking downstream over the upper reaches of the catchment feeding the ephemeral channel E02.

Photo 14: View looking downslope over the middle sections of the steep, ephemeral drainage line/stream channel.

Photo 15: View of the lower reach of the drainage line where gulley erosion is notably significant.

Photo 16: View upslope above the emphemeral drainage line. In the background are woody species encroaching into the adjacent terrestrial grassland.

5.2 Ecological Assessment Results: River/stream PES & EIS

5.2.1 *Desktop PES, EIS & Fish Species Information (DWS, 2014)*

Desktop PES/EIS information was obtained for the region and was based on an assessment undertaken by the Department of Water and Sanitation (DWS, 2014) for major rivers in the country. Based on this dataset, the Mtwalume River reach potentially affected by the proposed road development is considered Moderately Modified ('C' PES category) and of High Ecological Importance & Sensitivity ("B" ecological category). Table 10 (below) summarises the main outputs of the desktop assessment of the PES and EIS for the Mtwalume River and was used as an initial basis to inform the detailed field assessment of river PES/EIS.

Table 10. Summary of desktop PES/EIS assessment outputs for the Mtwalume River (DWS, 2014).

General	SQ reach	U80E-05028
	SQ reach name	Mtwalume
	SQ reach length	74.64 km
	SQ reach assessed by experts	Yes
Ecological Importance (EI) & Ecological Sensitivity (ES)	EI class	High
	ES class	High
	ECOLOGICAL CATEGORY (EI & ES)	**B: HIGH**
Present Ecological State (PES)	Instream habitat continuity modification	Moderate
	Riparian/wetland continuity modification	Moderate

	Potential instream habitat modification	Moderate
	Potential riparian/wetland habitat modification	Moderate
	Potential flow modification	Moderate
	Potential physico-chemical modification	Small
	PES CATEGORY	**C: Moderately Modified**

Of the six migratory species are modelled to be present in the Mtwalume River, only one species, **Mozambique Tilapia/Blue Kurper (***Oreochromis mossambicus*), has a conservation/threat status of **Near Threatened**. Table 11 summarises the threat status and migratory requirements of each of the six species modelled as likely to be present in the Mtwalume River.

Table 11. Summary of desktop modelled fish potential occurrence (DWS, 2014) and migratory requirements according to (Kleynhans, 2008).

Species Scientific Name	Threat status	Migration Score	Migration Comment
African Longfin Eel *Anguilla mossambica*	Least Concern	5 -Species with requirement for catchment scale migrations	Up to watershed, >100km
KwaZulu-Natal Yellowfish *Barbus natalensis*	Not Classified	3 - Species with requirement for movement between reaches / fish habitat segments	20-100
Redtail Barb *Barbus gurneyi*	Least Concern	1 – Species with requirement for movement within the reach/fish habitat segments	<10km
African Sharptooth Catfish *Clarias gariepinus*	Least Concern	3 - Species with requirement for movement between reaches / fish habitat segments	Long distances
Mozambique Tilapia/Blue Kurper *Oreochromis mossambicus*	**Near Threatened**	3 - Species with requirement for movement between reaches / fish habitat segments	0-20km
Banded Tilapia *Tilapia sparrmanii*	Least Concern	3 - Species with requirement for movement between reaches / fish habitat segments	8km reported

5.2.2 *Water quality (chemistry) analysis*

The term 'water quality' is used to describe the microbiological, physical and chemical properties of water resources as defined by the National Water Act (Act No. 36 of 1998) that determine its fitness for a specific use, (in this case, sustenance of aquatic biota) determined by substances which are either dissolved or suspended in the water (DWAF, 2001). In this context, water quality therefore refers to its fitness for maintaining the health of aquatic ecosystems and water quality variables potentially affecting aquatic ecosystems may be physical (turbidity, suspended solids, temperature) or chemical in nature (non-toxic: pH, Total Dissolved Solids, salinity, conductivity, individual ions, nutrients, organic enrichment and dissolved oxygen: and toxic: biocides and trace elements).

Two water samples were taken from the Mtwalume River; one directly downstream of the crossing point of the preferred route alignment option 1 (Sample 1) and another directly downstream of the crossing point of alternative route 2 (Sample 2). Five determinands were sampled and analysed on-site using a YSI Pro Series handheld water quality meter (included temperature, dissolved oxygen, total dissolved solids and pH) with 'water clarity' assessed using a manual water clarity tube. The other five determinands were sent to a SANAS accredited laboratory for analysis (included ammonia, *E. coli*, orthophosphates, nitrite/nitrate and suspended solids).

The results of the water quality analysis indicate that most determinands at both sample sites are well within the Target Water Quality Range (TWQR) for aquatic ecosystems (as defined by DWAF, 1996) and the results are shown in Table 12, below. PH was found to be neutral, whilst the levels of nitrate and phosphate were found to be low. Dissolved and suspended solids levels are characteristic of coastal river systems, whilst the slightly elevated bacterial levels (*E.coli)* are likely linked to human/animal waste from the catchment. The only exception was the Ammonia level for Sample 1 (highlighted in orange in Table 12, below) which was found to be slightly elevated close to the Chronic Effect Value (CEV) for this nutrient. This elevation in ammonia concentrations is likely attributed to animal waste inputs associated with livestock using instream and riparian areas directly upstream of either sampling locations or the use of detergents for the washing of clothing by local community members. Based on the once-off grab samples, the overall water quality for the Mtwalume River at the time of the sampling can be considered to be largely good.

Table 12. Summary results of water sample analysis taken from the Mtwalume River (R02) in August 2015.

Determinand	Units	TWQR (Aquatic ecosystems)	Chronic Effect Value (CEV)	Acute Effect Value (AEV)	Domestic TWQR	Mtwalume River	
						Sample 1: downstream crossing	**Sample 2:** upstream crossing
Clarity	cm	N/A	N/A	N/A	N/A	100	100
Ammonia	mg N/l	> 0.007	0.015	0.1	0 - 1	0.12	<0.08
Dissolved Oxygen	% saturation	80% - 120% saturation	> 60%	> 40%	NA	106.7	109.4
E. coli	colonies per 100ml	130 (full contact)	Not available	Not available	0	48	60
Nitrate/Nitrite	mg N/l	Not vary 15% of background unimpacted conditions, <0.5 will limit eutrophication	2.5 - 10 (Eutrophic)	>10 Hypertrophic	0 - 6	0.32	0.30
Orthophosphate	mg P/l	Not vary 15% of background unimpacted conditions, <0.005 will limit eutrophication	0.025 - 0.25 (Eutrophic)	>0.25 (Hypertrophic)	Not available	0.015	0.004
pH	pH units	Not vary >0.5 or 5% of background	Not available	Not available	6.0 - 9.0	7.86	7.98
Suspended solids at 105°C	Mg/l	Not increase <15% of background and >100mg/l for all aquatic ecosystems	NA	NA	NA	<10	<10
Total Dissolved Solids	Mg/L	N/A	N/A	N/A	N/A	78.3	76.01
Temperature	°C	Not vary >2°C or 10% of background	NA	NA	NA	14.7	15.6

5.2.3 Aquatic macro-invertebrates sampling and analysis results (SASS5)

The South African Scoring System or SASS 5 (Dickens & Graham, 2002) was used to quantify the current composition and structure of aquatic invertebrate communities within the Mtwalume River. SASS provides a useful indication of localised conditions in a river over the short term as invertebrate organisms (e.g. insect larvae, snails, crabs, worms) generally require specific aquatic habitat types and water quality conditions for at least part of their life cycle and are relatively short-lived and remain in one area during their aquatic life phase. Note that SASS sampling was undertaken only for the larger Mtwalume River based on the suitability of available in-stream habitat for the application of the technique and was not undertaken for the smaller tributaries due to lack of suitable habitat at these sites for the purposes of this assessment.

Table 13 (below) summarises the SASS5 results for the two sampling sites on the Mtwalume River. Two sites were sampled along the Mtwalume River using the SASS5 technique; one directly downstream of the crossing point of preferred route 1 (Site 1) and another directly downstream of the crossing point of alternative route 2 (Site 2). In-stream biotope availability and diversity and was generally good overall, although site 2 had marginally lower biotope diversity/quality. According the South Africa Scoring System (SASS) Data Interpretation Guidelines (Dallas, 2007) for the North Eastern Coastal Belt – Upper biological band, the Mtwalume River system at both crossing sites assessed can be classified as **Largely Natural ("B" PES category).** These results coincide with the good water quality conditions prevailing within the Mtwalume River, as indicated in Section 5.2.2, above. The high SASS5 scores drive the determination of the current ecological category as largely natural, whereas the Average Score per Taxa (ASPT) is somewhat lower. This indicates that while taxonomic richness is high across both sites, the average sensitivity of taxa (as indicated by the ASPT) is considered moderate overall. The ASTP for site 1 was however notably higher than that of site 2 indicating the higher occurrence of sensitive taxa at site 1. While the occurrence of instream biota (such as macro-invertebrates) will vary seasonally, results do provide useful insight into longer term health or integrity within the instream environments.

Table 13. Results from the SASS5 sampling and analysis for the Mtwalume River.

	Results	Riparian Zone R02 (Mtwalume River)	
		Site 1	Site2
In-stream biotope rating (0-5)	Stones In Current (SIC)	4	3
	Stones Out Of Current (SOOC)	3	3
	Bedrock	3	3
	Aquatic Vegetation	2	2
	Marginal Vegetation In Current	4	4
	Marginal Vegetation Out Of Current	3	3
	Gravel	5	4
	Sand	5	5
	Mud	3	3
	Biotope Score (%)	**71**	**67**
	SASS Score	**176**	**162**
	No. of Taxa	**27**	**28**
	ASPT	**6.5**	**5.8**

	Results	Riparian Zone R02 (Mtwalume River)	
		Site 1	Site2
	Ecological Category (PES)	B: Largely Natural	B: Largely Natural

5.2.4 *Present Ecological State (PES) of Aquatic Habitats*

The Present Ecological State (PES) refers to the health or integrity of a river system, and includes both in-stream habitat as well as riparian habitat adjacent to the main channel. Habitat is considered one of the most important factors that determine the health of river ecosystems since the availability and diversity of habitats (in-stream and riparian areas) are important determinants of the biota that are present in a river system (Kleynhans 1996). The 'habitat integrity' of a river refers to the "maintenance of a balanced composition of physic-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region" (Kleynhans, 1996). It is seen as a surrogate for the assessment of biological responses to driver changes.

The IHI (Index of Habitat Integrity)1996, version 2 (Kleynhans, 2012) was used to assess habitat integrity and is based on an interpretation of the deviation from the reference condition for the river reach assessed and is approached from both an instream and riparian zone perspective. Specification of the reference state is followed by an impact-based approach, whereby the extent and intensity of anthropogenic impacts are interrogated to interpret the level of modification to the primary drivers of river health, namely hydrology, vegetation and physico-chemical conditions. Naturally, the severity of impacts on habitat integrity will vary according to the natural characteristics of different rivers, with particular river types being inherently more sensitive to certain types of impacts than others.

A summary of the results of the IHI assessment for the two river reaches (for the Mtwalume River R02 and tributary stream R03) assessed as part of this study is presented below in Table 14 and Figure 11, with further detailed results in **Annexure C**. Catchment land use impacts on flow regime and water quality currently has a small effect on both instream and riparian habitat integrity, with the major impacts being onsite in the form of vegetation removal and alien plant infestations. These impacts were found to be far more pronounced for the tributary stream (R03) than for the larger Mtwalume main channel (R02). As such, the combined ecological rating for habitat (instream and riparian) associated with the **Mtwalume River (site R02) was rated as being in a good condition or largely natural ('B" PES category),** whilst the **tributary stream (R03) was regarded as being moderately modified ('C" PES category)**.

*The present ecological state of habitat associated with the ephemeral drainage line (E02) was not assessed using the IHI method, however, based on specialist opinion, this system can be regarded as being of a **poor condition or largely modified ("D/E" PES category)**.*

Table 14. Summary of the Index of Habitat Integrity (IHI) results for the Mtwalume River (R02) and its tributary stream (R03).

HGM	Zone	IHI Score & IHI Class	Description	Weighted overall Score
R02 Mtwalume River	Instream	87.5% B	The instream habitat of the reach of the Mtwalume River assessed can be regarded as largely natural with few modifications. A large number of small agricultural dams located in the upper third of the rivers catchment have slightly altered flow regimes through impounding and regulation of flows, with a small reduction in stream flows and floodpeaks due to forestry in the catchment. Reduced floodpeaks and flows are likely to be counteracted by the effects of reduced ground cover and poor veld condition in areas that have been overgrazed, cultivated or transformed for rural settlement development and dirt roads. The presence of cultivated sugarcane lands under irrigation indicates possible abstraction of water from the dams/river which will have some effect in reducing flows. Water quality is also considered to be good for the instream environment. Cumulatively the abovementioned impacts have had only a minor impact such that the ecosystem remains largely unchanged.	87.7% B
	Riparian	88.0% B	The riparian habitat of the Mtwalume River reach assessed was also considered to be largely natural with few modifications evident. The primarily impact is that of alien vegetation infestations on the flood benches and terraces of the Mtwalume River, with dense alien thicket in places. Furthermore vegetation trampling and overgrazing by livestock has decreased the effectiveness of the terrestrial buffer, leaving the riparian habitat more vulnerable to edge impacts. Alteration of flow regimes and seasonal inundation levels through abstraction and damming of flows is likely to affect low flows to the greatest degree for this system. Cumulatively the abovementioned impacts have had only a minor impact on riparian habitat integrity such that the ecosystem remains largely unchanged.	
R03 Tributary of the Mtwalume River	Instream	74.7% C	The instream habitat of the tributary of the Mtwalume River was assessed as being moderately modified. Impacts to the instream habitat are linked with the current road development/maintenance being undertaken on the left bank of the stream (R03). Sections of the left bank have been infilled and fill material pushed into the stream. As a result instream habitat type, abundance and size have been negatively impacted. Minor impacts include solid waste recorded in stream, altered chemical properties of water as a result of anthropogenic and livestock impacts and limited water abstraction by locals.	73.5% C
	Riparian	71.7% C	The riparian habitat has also been moderately modified primarily by construction related impacts. The left bank of the stream has been stripped of vegetation which offered habitat to fauna. A high abundance of woody alien vegetation was recorded within the stream channel and on the right bank of the stream resulting in impenetrable thickets for fauna.	

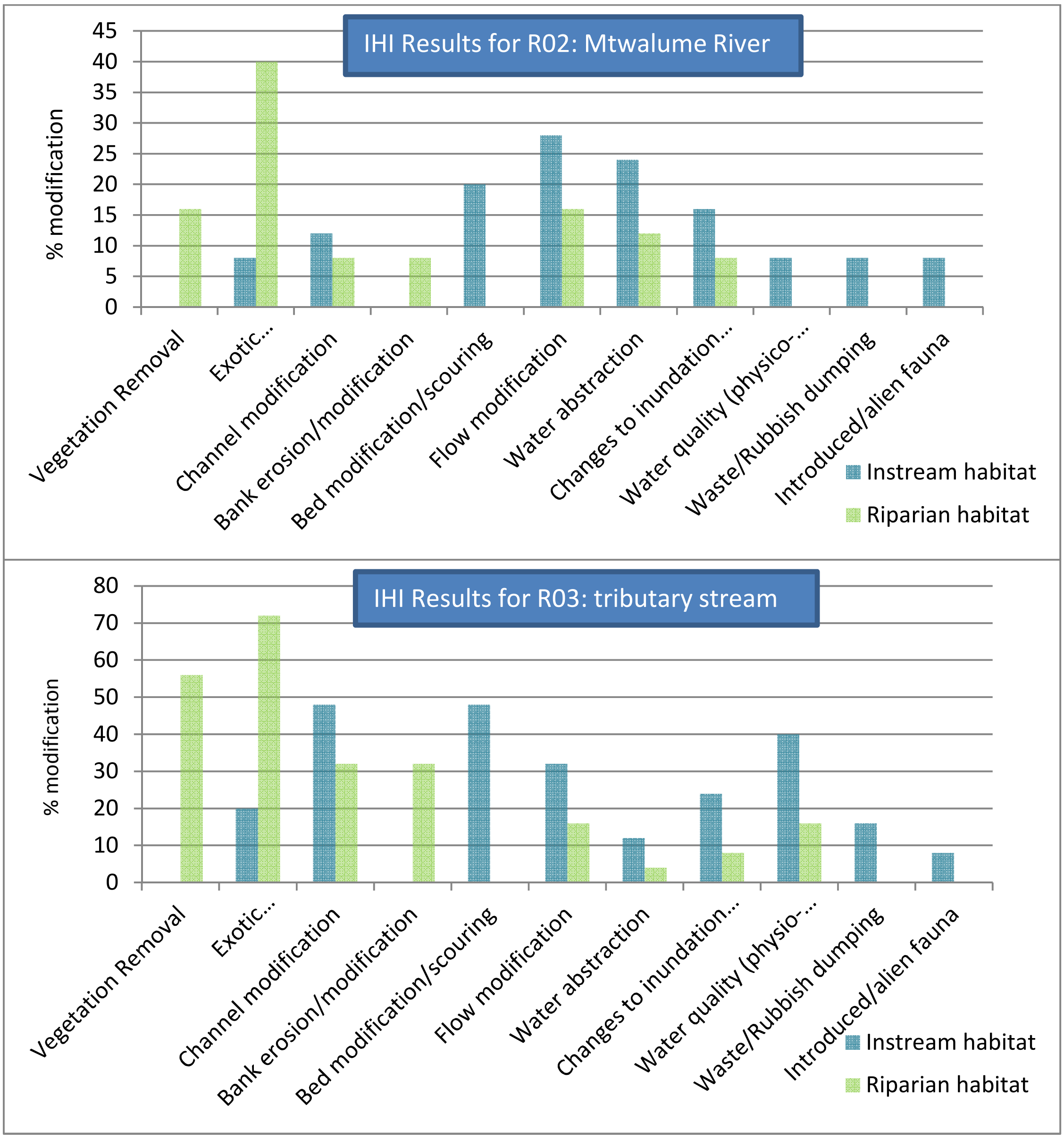


Figure 11 Bar graphs comparing the results of the Index of Habitat Integrity (IHI) assessment, indicating and comparing the estimated level of habitat modification for the Mtwalume River (R02) and tributary stream (R03).

Note that individual IHI assessment Excel ™ spreadsheets can be made available by Eco-Pulse upon request.

5.2.5 *Ecological Importance & Sensitivity (EIS) of Aquatic Resources*

The Ecological Importance and Sensitivity (EIS) of riparian areas is an expression of the importance of the aquatic resource for the maintenance of biological diversity and ecological functioning on local and wider scales; whilst Ecological Sensitivity (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007).

For the purposes of this assessment, river EIS was based on rating the importance and sensitivity of riparian & in-stream biota (including fauna & flora) and habitat, using both desktop and on-site indicators. The **Mtwalume River reach assessed (R02) was regarded as being of Moderate Ecological Importance & Sensitivity (EIS)** and this is attributed to the potential presence of migratory fish species that are sensitive to environmental impacts and a moderately high diversity of riverine habitats and biotopes that support aquatic biota, combined with the relatively high conservation importance of the Mtwalume River (FEPA river and catchment, and an Ecological Support Area). **The smaller tributary stream of Mtwalume River (i.e. R03) was assessed as being of relatively Low EIS** and this is due to the weakly perennial to seasonally intermittent nature of flows experienced by the stream which limits the capacity to support biota, with low habitat diversity and quality due to alien vegetation infestation and other direct/indirect anthropogenic impacts. A breakdown of the EIS scores and ratings for riparian zone R02 and R03 have been provided in Tables 15 and 16, below.

The EIS of ephemeral drainage line (E02) was not formally rated using the DWAF EIS tool. However, based on specialist opinion, the lack of suitable habitat for red-data/endemic species, poor quality and limited availability of habitat, limited ecological/conservation importance in the landscape and limited sensitivity to impacts (already degraded state); ***E02 can be regarded as being of generally Low Ecological Importance with limited sensitivity to external impacts.***

Table 15. Summary of the EIS assessment for the riparian zone R02 (main Mtwalume River).

DETERMINANTS	Score (0-4)	Rating	Rationale/Comments
AQUATIC BIOTA			
Rare & Endangered Species	2.0	Moderate	The Blue kurper *Oreochromis mossambicus* is a Near Threatened fish modelled to inhabit the Mtwalume River. No rare/threatened biota was observed during field sampling.
Unique Species (endemic, isolated, etc.)	2.0	Moderate	The Redtail Barb (*Barbus natalensis*) is a fish endemic to South Africa modelled to occur within the reach. No endemic fish species were observed during the site investigations for the river reach assessed.
Intolerant Biota (flow and water quality)	2.5	Moderate	Flows and water quality allow for a permanent, moderately high diversity of habitats that are available to support aquatic biota. The system may also be used by biota from downstream rivers for refugia, breeding and feeding habitat. While flows are perennial, the river is not a particularly large system and is likely to experience periods of low flow, especially during the dry season. This increases the sensitivity of the system in terms of fish and macro-invertebrates sensitivity to flow and water quality impacts which are not as easily buffered as with systems experiencing regular flashy or high flows.
Species/taxon richness	2.0	Moderate	Whilst no formal assessment of species/taxon richness was undertaken it is assumed that species/taxon richness is moderate based on limited impacts to water quality and habitat.
HABITAT (INSTREAM & RIPARIAN)			
Diversity of habitat types	3.0	**High**	The Mtwalume River has a fairly diverse array of biotopes including pools, riffles, rapids, runs, in current and out of current marginal vegetation, limited bedrock bed and GSM (gravel, sand and mud). Riparian habitats are somewhat limited to only short herbaceous vegetation and alien-infested overhanging woody vegetation. Historical and recent clearing of vegetation from the riparian zone was also apparent.

DETERMINANTS	Score (0-4)	Rating	Rationale/Comments
Refugia for biota	2.5	Moderate	During environmental stress periods, this perennial river is likely to provide refugia to biota in the form of pools, riffles, bars and in current and out of current marginal vegetation. Riparian habitat is somewhat degraded/less extensive than anticipated under baseline/reference conditions and therefore not considered as important as refugia for sensitive species.
Sensitivity of the resource to changes in flow	1.33	Very Low	Changes in flows are likely to have a limited impact on the quality of habitats provided by the river because the river is characterised by riffles and runs controlled by medium to large rock in the river. The Mtwalume River is therefore considered to be of moderately low sensitivity to flow-related impacts.
Sensitivity of the resource to changes in water quality	1.50	Very Low	Water quality within the river is considered fairly good (reasonably low bacteria/nutrient levels) and present habitats can therefore be considered moderately sensitive to changes in water quality. The river however has a high assimilative capacity for water quality changes which decreases the overall level of sensitivity to changes in water quality.
Importance as a migration route/wildlife corridor	2.5	Moderate	The 6 aquatic fauna modelled to inhabit the Mtwalume River generally migrate between reaches (i.e. 5-100km) with the exception of the African Longfin eel *(Anguilla mossambica)* which migrates at a catchment scale (up to 100km). Given this information the river is considered of importance as a migration route/wildlife corridor.
Conservation importance of the resource	3	**High**	From an aquatic conservation perspective the river reach assessed is considered to be of moderately high conservation value. This is supported by the NFEPA dataset (FEP river and catchment area) and the Biodiversity Sector Plan for Ugu Municipality which recognises rivers and their buffer zones in the study area as Ecological Support Areas (ESA).
MEDIAN OF DETERMINANTS	**2.3 / 4**		
EIS	**Moderate, EC=C**		*Features that are considered to be ecologically important and sensitive at a local scale. The functioning and/or biodiversity of these features is not usually sensitive to anthropogenic disturbances. They typically play a small role in providing ecological services at the local scale.*

Table 16. Summary of the EIS assessment for the riparian zone R03 (tributary stream of the Mtwalume River).

DETERMINANTS	Score (0-4)	Rating	Rationale/Comments
AQUATIC BIOTA			
Rare & Endangered Species	0.5	Very Low	No rare and endangered species are modelled to exist within the stream reach assessed. No rare/threatened biota was observed during field sampling.
Unique Species (endemic, isolated, etc.)	1	Very Low	Whilst no unique species were encountered during field investigations, it is though that some unique species may utilise this habitat.
Intolerant Biota (flow and water quality)	0.5	Very Low	Due to the weakly seasonal flows of the stream, it is unlikely that intolerant biota to flow and flow related water quality are present. Such species are likely to have migrated to the downstream perennial Mtwalume River.
Species/taxon richness	0.5	Very Low	Whilst a formal species/taxon richness was not undertaken it is assumed that the species richness is low due to seasonally intermittent flows being a limiting factor for this system.
HABITAT (INSTREAM & RIPARIAN)			
Diversity of habitat types	1	Very Low	The diversity of habitat types is considered to be low due to the limited size of the stream and narrow riparian zone which appeared infested with alien plants.

DETERMINANTS	Score (0-4)	Rating	Rationale/Comments
Refugia for biota	1	Very Low	Due to the limited habitat diversity and weakly perennial flows, the stream probably provides only marginal refugia to biota during periods of environmental stress.
Sensitivity of the resource to changes in flow	2.25	Moderate	The small stream size and seasonally intermittent nature of flows makes this system moderately vulnerable to changes in flow volumes and timing.
Sensitivity of the resource to changes in water quality	2.27	Moderate	The small size of the stream and seasonally intermittent nature of flows limits the assimilative capacity of the system; leaving the stream moderately sensitive to water quality impacts.
Importance as a migration route/wildlife corridor	*1*	Very Low	The weakly perennial nature of flows, small catchment size, low diversity of habitat, reduced riparian zone width and presence of restrictive barriers and proximity of local residences reduces the importance of this system as a potential migration route or wildlife corridor.
Conservation importance of the resource	2	Moderate	From an aquatic conservation perspective the river reach assessed is considered to be of moderate conservation value. Whilst not recognised as a FEPA river, the system does support the downstream Mtwalume River which is a FEPA. This is further supported by the Biodiversity Sector Plan for Ugu Municipality which recognises the river system and buffer zone as an important Ecological Support Area (ESA).
MEDIAN OF DETERMINANTS	**1.0 / 4**		
EIS	**Low, EC=F**		*Features regarded as somewhat ecologically important and sensitive at a local scale. The functioning and/or biodiversity features have a low-medium sensitivity to anthropogenic disturbances. They typically play a very small role in providing ecological services at the local scale.*

Note that individual EIS assessment Excel ™ spreadsheets can be made available by Eco-Pulse upon request.

6 AQUATIC RESOURCE MANAGEMENT PRINCIPLES AND OBJECTIVES

The future management of the freshwater ecosystems identified for the project area should be informed by recommended management objectives for the water resource which, in the absence of classification, is generally based on the current ecological state or PES (Present Ecological State) and the EIS (Ecological Importance and Sensitivity) of water resources (DWAF, 2007 – see Table 17, below).

Table 17. Management measures for water resources.

			EIS			
			Very high	**High**	**Moderate**	**Low**
PES	**A**	**PristineNatural**	A Maintain	A Maintain	A Maintain	A Maintain
	B	**Largely Natural**	A Improve	A/B Improve	**B Maintain**	B Maintain
	C	**Good - Fair**	B Improve	B/C Improve	C Maintain	**C Maintain**
	D	**Poor**	C Improve	C/D Improve	D Maintain	**D Maintain**
	E/F	**Very Poor**	D Improve	E/F Improve	E/F Maintain	E/F Maintain

This suggests that the recommended management objective for the Mtwalume River (R02) and tributary stream (R03) should be at a minimum to ***'maintain the current status quo of aquatic ecosystems without any further loss of integrity (PES) or functioning (EIS)'*** (Table 18, below). **Given the nature of the proposed development (low anticipated residual impact) it is considered acceptable to maintain the current status quo without any further loss of integrity.**

Table 18. Recommended management objectives for the Mtwalume River (R02), tributary stream (R03) and ephemeral channel (E02) based on their individual PES and EIS ratings.

HGM	**PES**	**EIS**	**Recommended Management Objective**
R02	B: Largely Natural	Moderate	*Maintain PES/EIS*
R03	C: Fair	Low	*Maintain PES/EIS*
E02	D/E: Poor	Low	*Maintain PES/EIS*

This is also supported by Ezemvelo KZN Wildlife (EKZNW) in their guideline document: Guidelines for Biodiversity Impact Assessment (EKZNW, 2013). According to the document, the guiding principle with regards to biodiversity conservation and sustainable development adopted by EKZNW is one of ***no net loss of biodiversity and ecosystem processes.*** To achieve this principle, a proactive approach to planning and biodiversity conservation must be adopted to ensure:

- The early identification and evaluation of potential biodiversity impacts that may constitute 'fatal flaws', or significant biodiversity related/management issues;
- The early identification and evaluation of conceptual alternatives which could prevent, avoid or reduce significant impacts on biodiversity, or enhance or secure opportunities for biodiversity conservation; and

- The appropriate design of mitigation through the mitigation hierarchy which should strive first avoid disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided altogether, to minimise, rehabilitate, and then finally offset any remaining residual negative impacts on biodiversity.

7 AQUATIC ECOLOGICAL IMPACT ASSESSMENT

7.1 Identification and Description of Potential Ecological Impacts

Freshwater ecosystems, including wetlands & rivers, are particularly vulnerable to human activities and these activities can often lead to irreversible damage or longer term, gradual/cumulative changes to these ecosystems. When making inferences on the impact of development activities on aquatic ecosystems it is important to understand that these impacts speak specifically to their effect on the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) or functional importance/value of aquatic ecosystems. All of these are linked to the physical components and processes of aquatic ecosystems, including hydrology, geomorphology and vegetation as well as the biota that inhabit these ecosystems. Anthropogenic activities can generally impact either directly (e.g. physical change to habitat) or indirectly (e.g. changes to water quantity & quality). Figure 12 (below) shows how impacts to aquatic ecosystems such as habitat loss, flow modification and pollution can have a number of negative ecological consequences for the receiving aquatic environment, ranging from loss of sensitive species to reduced ecosystem goods & services provision.

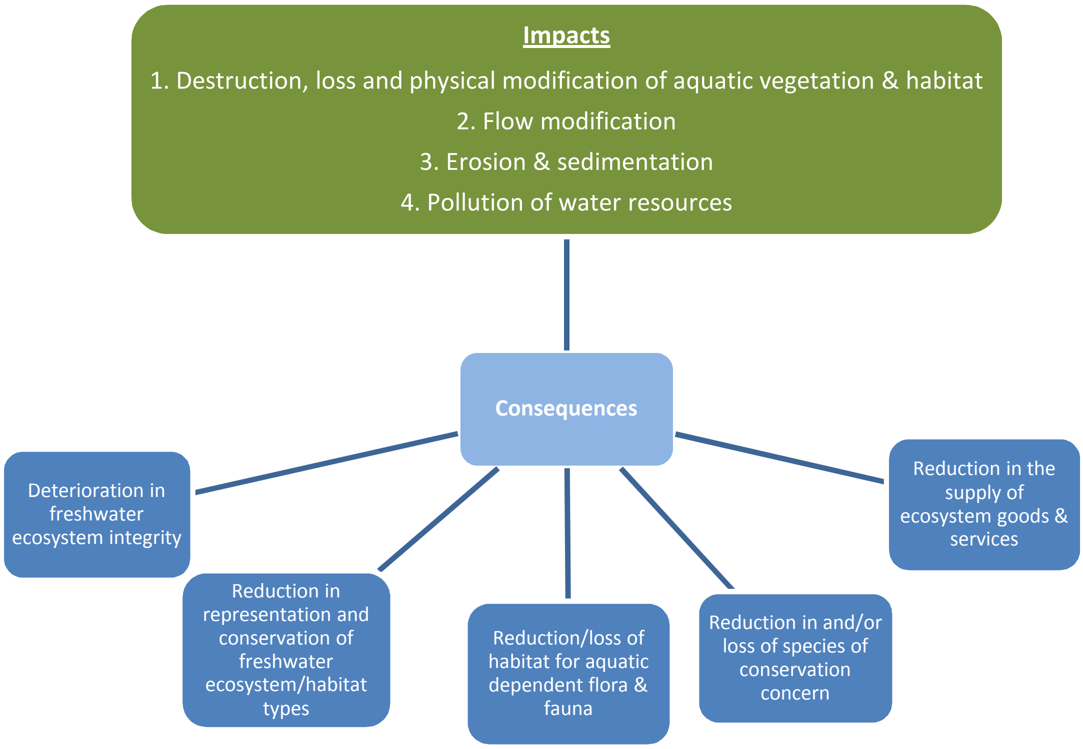


Figure 12 Diagram showing the range of typical negative ecological consequences for aquatic resources as a result of direct and indirect anthropogenic impacts.

Aquatic ecological impacts associated specifically with the proposed road and bridge construction project are discussed below. Potential impacts have been split into (i) **Construction Phase Impacts** which will occur during the construction phase and (ii) **Operational Phase Impacts** which will occur during the operational phase. While an attempt has been made to separate impacts into categories, there is inevitably some degree of overlap due to the inherent interrelatedness of aquatic ecological impacts.

A noteworthy limitation to the assessment of impacts is that engineering drawings and layouts for alternative route alignment option 2 were requested but not made available to the aquatic specialists from Eco-Pulse at the time of compiling this report. Therefore, impacts discussed for route option 2 are to the best judgement of the authors based on experience with road/bridge development scenarios for similar river systems in KZN.

IMPACT 1: Destruction, loss and physical modification of aquatic vegetation & habitat for biota

This refers to the direct physical destruction or disturbance of aquatic habitat caused by vegetation clearing, disturbance of wetland/riparian habitat, encroachment/colonisation of habitat by invasive alien plants and alteration of river and wetland geomorphological profiles (including stream beds and banks). Possible ecological consequences associated with this impact may include:

- *Reduction in representation and conservation of freshwater ecosystem/habitat types;*
- *Reduction in the supply of ecosystem goods & services;*
- *Reduction/loss of habitat for aquatic dependent flora & fauna; and*
- *Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species).*

Construction Phase:

Freshwater riverine vegetation and habitat can be impacted directly through the complete removal or partial disturbance of existing indigenous vegetation during road construction (stripping of vegetation and infilling), leading to the deterioration in the ecological condition of aquatic vegetation and availability of habitat supporting aquatic biota. This is associated with the construction footprint being located within or across a watercourse and by machinery and workers accessing the site. In many cases, clearing and disturbance is not only limited to the construction zone and may include areas used by machinery and workers to access the site and to construct temporary drainage, storm water and erosion control measures. The result is either the complete loss or the disturbance and partial loss of indigenous vegetation communities and habitat in the broader area. Likely secondary consequences of such direct physical disturbance impacts include a reduction in channel bank stability, exposed bank erosion and in-stream and riparian habitat sedimentation down slope and downstream. Also, in general, with increased human presence associated with construction projects, increased pressure on natural resources may result through the hunting/poaching/trapping of fauna as well as the harvesting of indigenous plants for various uses. Noise and dust caused by human activities can also affect the use of adjoining habitat by various species. This impact is likely to be most significant for intact, species diverse riverine ecosystems, particularly those that may potentially harbour sensitive or rare/threatened species of flora & fauna. **The construction of the road-bridge crossing over the main Mtwalume River will result in the trampling and destruction of riparian vegetation growing on the river banks and adjacent river floodplain. Excavations for the bridge piers will require complete and permanent removal of vegetation within the riparian area. Movement of construction vehicles within the construction site will also result in trampling of vegetation within the riparian zone and could extend beyond the immediate bridge footprint for access purposes. The overall magnitude of this impact is negated by the fact that the riparian zone width is relatively narrow and contains a moderate level of alien invasive plant species with limited biodiversity value.**

Operation Phase:

Road development across rivers and in the vicinity of watercourses is likely to introduce unnatural disturbance to the aquatic ecosystems and habitat and generally promotes the establishment of disturbance-tolerant species, including colonization by Invasive Alien Plants (IAPs), weeds and pioneer plant species, particular where there is an existing seed source for these plants nearby. Although this impact is initiated during the construction phase of the project, it is likely to persist well into the operation phase. IAPs can have far-reaching detrimental effects on native biota and has been widely accepted as being a leading cause of biodiversity loss in South Africa. They typically have rapid reproductive turnover and are able to outcompete native species for environmental resources, alter soil stability, promote erosion, change litter accumulation and soil properties and promote of suppress fire. In addition, certain alien plants exacerbate soil erosion whilst others contribute to a reduction in stream flows thereby potentially increasing sediment inputs and altering natural hydrology of receiving watercourses. **The significance of this impact is likely to be highest for the Mtwalume River crossing for route option 1 (lower/southern road route) than for the upper crossing for road alignment 2 (northern crossing) due to this river rec being more intact with a comparatively lower abundance of IAPs and weed species). Poorly rehabilitated areas during the construction phase are also likely to contribute to the erosion of the river banks and degradation of the riparian habitats at crossing points.**

IMPACT 2: Flow modification/Hydrological impacts

This refers to any alterations in the quantity, timing and distribution of water inputs and flows within a watercourse, such as a wetland or river/stream. Possible ecological consequences associated with this impact may include:

- *Deterioration in freshwater ecosystem integrity;*
- *Reduction/loss of habitat for aquatic dependent flora & fauna; and*
- *Reduction in the supply of ecosystem goods & services.*

Construction Phase:

Construction activities associated with bulk earthworks (such as excavations, reshaping, back-filling and compaction) can also alter natural patterns of surface runoff reaching water resources down slope/downstream. Infilling, compaction and rutting of soils caused by construction may also alter the patterns of diffuse surface and sub-surface flows by altering micro-topography and the permeability of soil profiles. Changes in flow patterns reaching aquatic ecosystems does not only affect hydrological functionality and thus ecosystem integrity, but can also lead to erosion and sedimentation though increased runoff velocities (linked to artificial concentrated flow paths created during construction). Furthermore, should temporary damming and abstraction of water take place at river/stream crossings, a short-term reduction in flows to downstream aquatic habitat/ecosystems may also result. Temporary obstructions/impoundments may also alter the sediment balance by retaining sediment and resulting in increased erosive power of the sediment-starved water affecting areas downstream of impoundments. Temporary f**low modification during construction is anticipated due to the potential need for flow diversions to create a "dry" working area when working within perennial river systems such as the Mtwalume. Whilst this impact may be temporary, impact significance can be potentially high depending on the method of diversion/impoundment of flows. Flow diversion can also lead to concentrated flows which have the potential to alter the base of the river section where the diversion will occur and eroded adjacent river banks. If this is not adequately addressed post-construction through stream rehabilitation, the natural flow and distribution patterns of flows may be artificially altered. Furthermore, temporary bypass/access roads across the river can also affect flow patterns and velocities to some extent.**

Operation Phase:

Hardened/artificial infrastructure such as roads will generally alter the natural processes of rain water infiltration and surface runoff, promoting increased volumes and velocities of storm water runoff which can be detrimental to water resources receiving concentrated flows off of these areas. **Increased volumes and velocities of storm water draining from the road and discharging into downstream rivers/streams/wetlands can alter the natural ecology of a wetland/river system, also increasing the risk of erosion and channel incision/scouring. Furthermore, where bridge piers are built within the riparian zone they have the potential to alter the natural flow characteristics of high flows in particular, affecting natural channel morphology through the alteration of natural flows and sediment dynamics. Bridge crossings can also alter natural base-levels of rivers/streams if incorrectly designed/constructed, leading to altered erosion regime which can lead to increased scouring of the channel and incision/erosion impacts, also leading to the potential modification of instream and riparian habitats.**

IMPACT 3: Erosion & sedimentation

This refers to the alteration in the physical characteristics of wetlands and rivers as a result of increased turbidity and sediment deposition, caused by soil erosion and earthworks that are associated with construction activities, as well as instability and collapse of unstable soils during project operation. Possible ecological consequences associated with this impact may include:

- *Deterioration in freshwater ecosystem integrity; and*
- *Reduction/loss of habitat for aquatic dependent flora & fauna.*

Construction Phase:

Vegetation clearing and denuded soils within and upslope of the stream/river habitats during construction will increase the risk of erosion and sedimentation of downstream habitats. If runoff and erosion control measures are not effectively implemented by the contractors, erosion rills and gullies may form along the cleared and exposed slopes upslope within the construction footprint and lead to increased rates of erosion and sedimentation within the riparian and in-stream habitat in the vicinity of the construction zone. These impacts will be more pronounced during rainfall events and/windy conditions, and especially where steep slopes/gradients are encountered. Such impacts during low flows will likely result in increased sediment loads, increased bed sedimentation and increased water turbidity that will likely contribute to decreased local water quality and degradation in local aquatic habitat integrity. If construction is undertaken in a poor manner with little consideration of minimising erosion and sedimentation impacts, there could be significant impacts in and around the construction zone that will contribute to deterioration in local in-stream, riparian and wetland habitat, both onsite and downstream. Some of the key biological effects related to the elevated levels of deposition and suspended sediment within the water column of rivers/wetlands may include:

- Habitat alteration downstream of crossing points due to increased sediment deposition;
- The creation of low light conditions reducing photosynthetic activity and the visual abilities of foraging aquatic biota;
- Increased downstream drift by benthic invertebrates causing localised reductions in population densities; and
- Reduced density and diversity in benthic invertebrate and fish communities as a result of reduced water quality (suspended solids impacting intolerance taxa), habitat degradation caused by smothering of aquatic habitat, changes in streambed and biotope composition (i.e. reduced habitat suitability through the destruction of habitat).

Erosion and sedimentation is likely to be a key construction-related impact experienced during bulk earthworks, excavations and backfilling required to implement the new road/bridge infrastructure. This is likely to be most significant for smaller streams which have limited buffering capacity for sediment-related impacts and areas where steep slopes are encountered.

Operation Phase:

Where soil erosion problems and bank stability concerns initiated during the construction phase are not timeously and adequately addressed through on-site rehabilitation post-construction, these can persist into the operational phase of the project and continue to have a negative impact on adjacent/downstream water resources for an extended period of time. The consequences of erosion & sedimentation are highlighted above under the Construction Phase impact description. **Flow related impacts at bridge crossings (dealt with under Impact 2, above) have the potential to increase the erosive capacity of the river system and can lead to bank instability and collapse and channel bed scouring. The proposed road infrastructure is also likely to increase the risk of erosion particularly on the steep slopes approaching the Mtwalume River. Water draining off the new road surfaces and drains at potentially high velocities will have the capacity to erode soils and deliver sediment to the downstream river system. The significance of erosion and sedimentation is likely to be high given the steep slopes in the project area and the presence of generally shallow topsoils and erodible duplex soils.**

IMPACT 4: Pollution of water resources

This refers to the alteration or deterioration in the physical, chemical and biological characteristics of water resources (i.e. water quality) such as wetlands & rivers as a result of water/soil pollution. The term 'water quality' must be viewed in terms of the fitness or suitability of water for a specific use (DWAF, 2001). In the context of this impact assessment, water quality refers to its fitness for maintaining the health aquatic ecosystems. *Possible ecological consequences associated with this impact may include:*

- *Deterioration in freshwater ecosystem integrity; and*
- *Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species).*

Construction Phase:

Potential construction phase contaminants and their relevant source may include:

- **Hydrocarbons** – leakages from petrol/diesel stores and machinery/vehicles, spillages from poor dispensing practices;
- **Oils and grease** - leakages from oil/grease stores and machinery/vehicles, spillages from poor handling and disposal practices;
- **Cement** - spillages from poor mixing and disposal practices;
- **Bitumen** - spillages from poor application, handling and disposal practices;
- **Sewage** – leakages from and/or poor servicing of chemical toilets and/or informal use of surrounding bush by workers; and
- **Sediment** – suspension of fine soil particles as a result of soil disturbance and altered flow patterns (covered

above).

These contaminants may enter the downstream channel and water column of watercourses during construction activities and have the capacity to negatively affect the in-stream aquatic habitat and species (especially where there are sensitive or intolerant species of flora and fauna in the receiving aquatic environment). Where significant changes in water quality occur, this will ultimately result in a shift in aquatic species composition, favouring more tolerant species and potentially resulting in the localised reduction of sensitive species. Sudden drastic changes in water quality can also have chronic effects on aquatic biota in general, leading to localised extinctions. Measurable negative water quality impacts are of significance within the study due to the relatively good quality of water within the rivers/streams in the study area. **Considering that migratory fish species (*Barbus spp. and Anguilla mossambica*) have been modelled to inhabit the Mtwalume River and which are sensitive or intolerant to water quality changes, the significance of this impact may be potentially high.**

Operation Phase:

Pollution sources from development projects in their operational-phase can vary greatly. **Since the road infrastructure will be permeable and limited traffic will utilise the road and bridge, the impact on water quality is likely to be negligible. By nature, the proposed road may increase the likelihood of the disposal of solid waste and other waste materials directly into the river by pedestrians, which could contribute to the degradation in water quality and in-stream habitats.**

7.2 Impact Significance Assessment

Impact significance is defined broadly as a measure of the '*desirability, importance and acceptability of an impact to society*' (Lawrence, 2007). The degree of significance depends upon two dimensions: the measurable characteristics of the impact (e.g. intensity, extent, duration) and the importance societies/communities place on the impact. Put another way, impact significance is the product of the value or importance of the resources, systems and/or components that will be impacted and the intensity or magnitude (degree and extent of change) of the impact on those resources, systems and/or components.

An attempt has been made to quantify the relative significance of the range of potential negative impacts identified in section 7.1, with a summary of the results of the impact significance assessment provided in Table 19, below. The significance of the identified potential impacts of the proposed development on freshwater ecosystems was assessed for the following realistically possible scenarios:

i. **Realistic "poor mitigation" scenario** – this is a realistic worst case scenario involving the poor implementation of construction mitigation, bare minimum incorporation of recommended design mitigation, poor operational maintenance, and poor onsite rehabilitation.

ii. **Realistic "good mitigation" scenario** – this is a realistic best case scenario involving the effective implementation of construction mitigation, incorporation of the majority of design mitigation, good operational maintenance and successful rehabilitation. Please note that this realistic scenario does not assume that unrealistic mitigation measures will be implemented and/or measures known to have poor implementation success (>90% of the time) will be effectively implemented.

For further information on the impact assessment method the reader is referred to ***Annexure A7****, with further results of the assessment contained in* ***Annexure B*** *at the back of this report.*

A. Construction Phase Impact Significance:

With poor mitigation, impacts will likely be of moderate impact significance, with the destruction, loss and physical modification of aquatic vegetation/habitat, temporary flow modification and erosion/sedimentation risks being the most significant. This is likely to be driven by disturbance/loss of riparian habitats, poor management for flows in the river, soil erosion and increased siltation and water turbidity. Hydrological impacts during the construction phase are likely to remain low (limited duration and will be particularly low if work is undertaken during the dry season) and water pollution impacts are likely to be low. With the effective and strict adherence to the mitigation measures provided in this report (i.e. good mitigation), the significance of all impacts can be reduced to moderately-low to low significance.

B. Operational Phase Impact Significance:

Under a poor mitigation scenario, impacts will likely range between a moderate and low impact significance. The most significant impacts to aquatic ecosystems and habitat during operation are likely to include flow modification linked to water runoff from road surfaces and alteration of the natural flow regime/dynamics as a result of river crossing infrastructure. Pollution of water resources on the other hand is expected to be low due to limited traffic expected to be utilising the road infrastructure. With the effective and strict adherence to the mitigation measures provided in this report (i.e. good mitigation), the significance of all operational impacts can be reduced to moderately-low to low significance levels. This should be sufficiently low to protect the aquatic environment from further deterioration, however, due to the steep slopes and erodible nature of the soils in the study area, erosion and sedimentation risks will require careful management to reduce the scale and intensity of these impact on the aquatic resources in the study area.

Table 19. Assessment of the significance of potential construction & operational aquatic ecological impacts associated with the proposed Ntatshana road and bridge development project.

IMPACT		Construction Phase			Operational Phase	
		Poor mitigation	Good mitigation		Poor mitigation	Good mitigation
1	**Destruction, loss and physical modification of aquatic vegetation & habitat**	**Moderate**	**Moderately Low**		**Moderate**	**Moderately Low**
2	**Flow modification/Hydrological impacts**	**Moderate**	**Moderately Low**		**Moderate**	**Moderately Low**
3	**Erosion & sedimentation**	**Moderate**	**Moderately Low**		**Moderate**	**Moderately Low**
4	**Pollution of water resources**	**Moderately Low**	**Low**		**Low**	**Low**

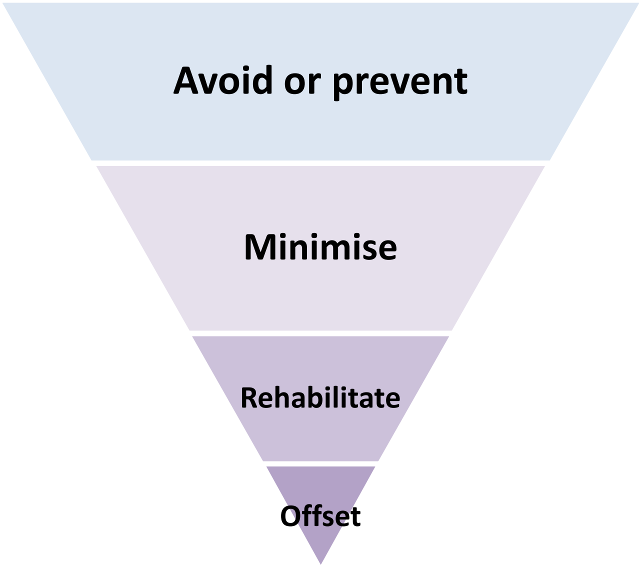
Note that individual impact significance assessment Excel ™ spreadsheets can be made available by Eco-Pulse upon request.

8 IMPACT MITIGATION & MANAGEMENT

According to the National Environmental Management Act No. 107 of 1998 (NEMA), sensitive, vulnerable, highly dynamic or stressed ecosystems, such as wetlands, rivers and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure. NEMA also requires "*a risk-averse and cautious approach which takes into account the limits of current knowledge about the consequences of decisions and actions*". The 'precautionary principle' therefore applies and cost-effective measures must be implemented to pro-actively prevent degradation of the region's water resources and the social systems that depend on it. ***Ultimately, the risk of water resource degradation and biodiversity reduction/loss must drive sustainability in road development design.***

The protection of water resources (wetlands & rivers/streams) begins with the avoidance of adverse impacts and where such avoidance is not feasible; to apply appropriate mitigation in the form of reactive practical actions that minimizes or reduces in situ impacts. Driver *et al.* (2011) recommend that the management of freshwater ecosystems should aim to prevent the occurrence of large-scale damaging events as well as repeated, chronic, persistent, subtle events which can in the long-term be far more damaging (e.g. as a result of sedimentation and pollution). 'Impact Mitigation' is a broad term that covers all components involved in selecting and implementing measures to conserve biodiversity and prevent significant adverse impacts as a result of potentially harmful activities to natural ecosystems. The mitigation of negative impacts on aquatic resources is a legal requirement for authorisation purposes and must take on different forms depending on the significance of impacts and the particulars of the target area being affected. This generally follows some form of 'mitigation hierarchy' (see Figure 13, below) which aims firstly at avoiding disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided, to minimise, rehabilitate, and then finally offset any remaining significant residual impacts.

The mitigation hierarchy is inherently proactive, requiring the on-going and iterative consideration of alternatives in terms of project location, siting, scale, layout, technology and phasing until the proposed development can best be accommodated without incurring significant negative impacts to the receiving environment. In cases where the receiving environment cannot support the development or where the project will destroy the natural resources on which local communities are wholly dependent for their livelihoods or eradicate unique biodiversity; the development may not be feasible and the developer knows of these risks, and can plan to avoid them, the better. In the case of particularly sensitive ecosystems, where ecological impacts can be severe, the guiding principle should generally be "*anticipate and prevent*" rather than "*assess and repair*".



*Refers to considering options in project location, sitting, scale, layout, technology and phasing **to avoid impacts** on biodiversity, associated ecosystem services, and people. This is the best option, but is not always possible. Where environmental and social factors give rise to unacceptable negative impacts mining should not take place. In such cases it is unlikely to be possible or appropriate to rely on the latter steps in the mitigation.*

*Refers to considering alternatives in the project location, siting, scale, layout, technology and phasing that would **minimise impacts** on biodiversity and ecosystem services. In cases where there are environmental and social constraints every effort should be made to minimise impacts.*

*Refers to **rehabilitation** of areas where impacts are unavoidable and measures are provided to return impacted areas to near-natural state or an agreed land use after mine closure. Although rehabilitation may fall short of replicating the diversity and complexity of a natural system.*

*Refers to measures over and above rehabilitation to compensate for the residual negative effects on biodiversity, after every effort has been made to minimise and then rehabilitate impacts. **Biodiversity offsets** can provide a mechanism to compensate for significant residual impacts on biodiversity.*

Figure 13 Diagram illustrating the 'mitigation hierarchy' (after DEA *et al*., 2013).

In dealing with significant impacts to aquatic resources during both the construction and operation phases of the road infrastructure, mitigation would be best achieved through the incorporation of the mitigation measures recommended in this section of the specialist aquatic report into an Environmental Management Programme (EMPr) for the project. The following guidelines for EMPr implementation should be considered:

- This EMPr should define the responsibilities, budgets and necessary training required for implementing the recommendations made in this report. This will need to include impact management and the provision for regular auditing to verify environmental compliance.
- A document handling system must be established to ensure availability of all documents required for the effective functioning of the EMPr. Supplementary EMPr documentation should include: Incident reports; Training records; Site inspection reports; Monitoring reports; Auditing reports; and Complaints received.
- The Contractor will need to develop an internal reporting structure to monitor compliance with the commitments given in the EMPr as construction progresses.
- The EMPr should be enforced and monitored for compliance by a suitably qualified/trained ECO (Environmental Control Officer) with any additional supporting EO's (Environmental Officers) having the required competency skills and experience to ensure that environmental mitigation measures are being implemented and appropriate action is taken where potentially adverse environmental impacts are highlighted through monitoring and surveillance.
- The ECO will need to be responsible for conducting regular site-inspections of the construction, rehabilitation and operation processes, reporting back to the relevant environmental authorities with findings of these investigations.
- All incidents must be investigated in association with the ECO. The cause should be highlighted and training should be provided to the workers to prevent a recurrence of similar incidents. Incidents must be handled appropriately and a record kept of all incidents. Photos should be

taken of the incident and a comprehensive record must be kept of the incident and the corrective and preventative actions taken.

- The ECO will also need to prepare a training programme to educate machine operators about the sensitivity of constructing within aquatic environments associated with wetlands/rivers and also be responsible for preparing a monitoring programme to evaluate construction compliance with the conditions of the EMPr.

Mitigation measures specific to the potential aquatic impacts identified and discussed in Section 7 of this report have been provided below and include:

- **Pre-construction planning and design recommendations** (section 8.1);
- **Construction phase impact mitigation guidelines** (section 8.2);
- **Post-construction Freshwater rehabilitation guidelines** (section 8.3);
- **Operational-phase impact mitigation guidelines** (section 8.4); and
- **Monitoring recommendations** (section 8.5).

8.1 Pre-construction Planning and Design Recommendations

In line with the overarching principles of the mitigation hierarchy of 'avoid, minimise, remediate and offset', it is recommended that potential impacts to aquatic ecosystems be avoided and minimised as far as possible through implementation of the following project planning and design environmental guidelines which need to be considered prior to construction/implementation of the project:

A. Bridge Design Recommendations

The following alignment measures should be incorporated into the design of the proposed bridge:

- The proposed bridge structure across the Mtwalume main river channel (based on the layout plans/engineering designs made available to Eco-Pulse) is generally considered acceptable as the structure is located so as to confine impacts to a zone that is already largely affected by a maintenance access dirt road and the crossing appears perpendicular to the direction/orientation of flow. It is recommended however that the number of support piers to be located within the active river channel (wetted zone) be limited in number as far as possible.
- The design of the bridge infrastructure will need to seek a balance of economic, technical and safety requirements whilst also ensuring that risks and impacts to the riverine environment are minimised as far as possible. Importantly, bridge infrastructure will need to be designed to be appropriately protected and robust enough to withstand a significant flood event.
- The number and width of pillars, vertical columns and buttresses placed within the river channel and floodplain should be minimised and all precautions should be taken to avoid excessive disturbance of the channel banks and reduce the risk of erosion/increased sedimentation.
- Bridges must span the entire width of the river/stream channel wherever possible.

- Where crossings are sufficiently narrow (i.e. narrow stream such as R03), bridge piers are not advocated within the instream channel and all bridges should span the width of the channel or box/piped culverts are to be used.
- All culverts placed within rivers/streams should be designed and installed such that their invert levels matches the natural river bed levels occurring within the watercourse (river/stream) prior to construction (i.e. the base of the new river/stream causeway must match the current/pre-construction upstream base level of the rivers/streams so as to avoid modifications to the natural flow and base-level as far as possible).
- The extent of infilling within the river instream habitat must be minimised as far as possible.
- Structures must not degrade water quality, cause erosion, sedimentation or instability in the watercourse, significantly alter the physical structure of the watercourse, induce flooding of adjacent areas or be structurally unstable.
- Bridge and culvert structures must be designed to adequately allow for the natural movement of water from the upstream to the downstream sides of the structure without inhibiting the natural movement of water and may not result in changes to flow volumes and velocities, or create artificially inundated areas but allow for the free-flow movement of water.
- Bridge piers and associated works, should be designed in such a way so that they don't alter the extent of the natural floodlines for the watercourse.
- Appropriate measures to dissipate flow velocity below structures must be considered and designed for pre-construction.
- Structures that cater for through flows (e.g. box/pipe culverts) should not only allow for the maximum volume of flows but should distribute flows naturally so not to concentrate flows downstream, which could induce erosion/scouring.
- Stormwater and any runoff generated by the hard surfaces should be discharged into energy dissipation structures prior to being discharged back into the natural water courses (such as retention ponds or areas with rock rip-rap grassed with indigenous vegetation to encourage the trapping of silt and attenuation of flows).
- Structures must be designed so as not to significantly restrict the movement of aquatic biota (such as migratory fish species) along rivers and streams.
- Design and construct any necessary erosion protection works where the bridge infrastructure intersects the channel banks of the Mtwalume River in order to prevent scouring or outer-bank erosion. Protection works to be considered include gabions, reno mattresses or other stabilising structures to armour them.
- Limit the physical footprint of the road and verges that would require clearing to a minimum.

B. Access Routes and 'No Go' Area Recommendations

With regards to accessing the sites and avoiding sensitive areas, the following is recommended:

- Access must be confined to the existing dirt access road leading to the Mtwalume River only.
- Delineated riparian and instream habitats outside of the construction zone are considered sensitive "No-Go" areas and access/activities are to be strictly prohibited in these areas.
- A maximum construction working servitude width of 10m should be allowed on either side of the bridge. The 10m servitude includes the temporary bypass road required for access.

- Where temporary access roads/footpaths may be required, the following needs to be considered:
  - Access routes/paths through intact indigenous riverine vegetation must be preapproved and signed off by the ECO prior to construction commencing and must take into account the sensitivity of the vegetation occurring at the site.
  - Preferably utilise existing access paths or access through disturbed/invaded vegetation before considering the clearing of vegetation.
  - Temporary access routes must avoid the mapped/delineated riparian areas and wetlands as far as possible and should not be located within 20m of these watercourses where practically possible. The mapped wetland and streams in this specialist report are generally considered 'No Go' areas outside of preapproved river crossings.
  - Temporary access roads must not be aligned perpendicular to steep slopes for long stretches where possible in order to avoid the road acting as a preferential flow path for water runoff.
  - Access roads must be one-way, limited to 3m width and adequate turning areas outside of the riparian areas may need to be identified and demarcated in conjunction with the ECO.
- Site camp and equipment lay-down areas are not to be located within delineated riparian areas or wetlands and should rather be located within disturbed terrestrial grassland areas. These areas will need to be preapproved by the ECO before commencing with construction.

C. Contractor induction and staff environmental awareness/training

- Training needs must be identified prior to commencement of the project, based on the available and existing capacity of site and project personnel.
- Staff environmental induction must take place prior to construction commencing and any sub-contractors utilised must be inducted before starting work onsite. All contractor employees must receive basic environmental awareness training and shall be educated on the requirements of the EMPr. The environmental induction training is the responsibility of the project manager and the contractor and should be undertaken by the EO or a suitably qualified person. The Environmental Control Officer (ECO) must oversee and monitor the induction training to ensure that the training is sufficient and that adequate training is provided prior to construction commencing.
- All staff involved in work within freshwater (river/stream) habitats must receive specific inductions related to the detailed methods statements compiled for working in these areas.
- All managers, contractors, labourers and personnel involved during the project are to be familiarized with the method statement.
- It is vital that all personnel are adequately trained to perform their designated tasks to the accepted standards.
- The ECO must monitor the compliance of the Contractors and instruct the Contractors where necessary. The ECO may request that the Project Manager suspend part or all the works if the Contractors repeatedly cause damage to the environment. The suspension should be

enforced until such time as the offending actions, procedure or equipment is corrected and the environmental damage repaired.

- A copy of the method statement will need to be made available at the construction site offices/site camp at all times.

8.2 Construction-Phase Impact Mitigation Guidelines

The following project-specific mitigation measures are recommended during the construction phase of the project:

A. Finalisation of Method Statements for working in sensitive areas

A method statement for working within the riverine/stream habitats (where this has been identified) must be compiled by the ECO in line with the mitigation measures proposed below and in conjunction with the appointed contractor in order to confirm all methods of watercourse encroachment and the most practical and effective steps to minimise the impacts to instream and riparian aquatic habitat.

B. Phasing and timing of construction works

It is highly recommended that construction take place during the dry/winter months (May-September) to reduce erosion and sedimentation risks associated with high summer rainfall in this region. Construction within/across watercourses will also be less problematic during periods of low flow for perennial river systems such as the Mtwalume River.

C. Site Setup and establishment

i. <u>Defining the construction servitude/working area:</u>

- The construction servitude/working area will likely comprise the following:
    - Construction footprint and working area.
    - Temporary access roads (and vehicle turning area).
    - Soil stockpile area.
    - Equipment laydown and storage area.
- The active channel of the Mtwalume River is strictly a sensitive 'NO GO' area and should under no circumstance be accessed or crossed by any vehicle or machinery (except at the proposed river crossing site).
- Manage access at the approach and departure points to river channels to prevent vehicles crossing these areas upstream or downstream of designated construction areas.
- No equipment laydown or storage areas must be located within 50m of any watercourse and/or within the 1:100 year floodline of a river/stream.
- No soil stockpile areas must be located within 20m of any watercourse.

ii. <u>Demarcations and No-go Areas:</u>

- The outer edge of the construction servitude/working area (as defined above) must be clearly demarcated for the entire construction phase using an orange hazard/bonnox fencing where practical/appropriate.

- Once temporary access routes have been agreed to by the ECO, the outer edge of the access route must be staked out by the contractor using brightly coloured stakes prior to the access route being used by machinery.
- All demarcation work must be signed off by the ECO before any work commences.
- Any contractors found working inside the 'No-Go' areas should be fined as per a fining schedule/system setup for the project.

D. Accidental Incursions into Sensitive/No-Go Areas

- Should any wetland and riparian areas outside of the construction corridor be disturbed during the construction phase, these areas must be rehabilitated immediately. All disturbed areas must be prepared and then re-vegetated to the satisfaction of the ECO as per the relevant re-vegetation/re-planting plan.
- Where river/stream channels have been disturbed, the channels should be re-graded, stabilised using erosion control measures and re-vegetated as per the relevant re-vegetation/re-planting plan.

E. Water Abstraction and use

The following guidelines pertain to the abstraction and general use of water from wetlands/rivers:

- No water is to be abstracted from wetlands for use in construction activities without prior approval by the Department of Water and Sanitation (DWS), subject to acquiring a relevant Water Use License in terms of Section 21 (a) of the National Water Act for taking water from a water resource.
- Abstraction points should be carefully selected to minimize impacts to sensitive water courses. To this effect, large perennial rivers should be selected for water abstraction purposes rather than abstracting from small streams that are more sensitive to reductions in water volume.
- The Contractor shall only be allowed to draw water from the source/s designated by the ECO.
- Excavating trenches or pits within wetlands or rivers for the purpose of intercepting groundwater or diffuse surface flows to facilitate water abstraction is not to be permitted.
- Water abstraction is to be by suction pumps connected to water carts only. Water carts are to utilise existing access roads to abstraction points and are not to encroach into "no-go" and sensitive areas. Water carts are not to enter directly into wetland or the in-stream areas of river channels.
- Care is to be taken not to disturb the channel bed of watercourses during abstraction of water using suction pumps.
- Locate the suction pump inlet at a sufficient height above the channel bed/floor where bed-load sediments accumulate.
- Where necessary, install a suitable sediment filter/screen in front of the suction pump inlet to remove undesirable sediments, particles and debris from entering the pump.
- Employees are not to make use of any natural water sources (e.g. rivers/wetlands) for the purposes of swimming, bathing or washing of equipment, machinery or clothes.
- Drinking water is to be provided to all employees and labourers are to be discouraged from drinking directly from wetlands/rivers on site. Suitable domestic water supply to be sourced for

human consumption by workers onsite (to comply with DWS specifications for drinking water). Water for human consumption should be available at the site offices and at other convenient locations on site where work occurs.

F. Soil Management (Stockpile areas)

- No soil stockpile areas must be located within 50m of any watercourse (includes delineated riparian areas or rivers/streams and wetlands).
- Erosion/sediment control measures such as silt fences, low soil berms or wooden shutter boards must be placed around soil/material stockpiles to limit sediment runoff from stockpiles.
- Subsoil and topsoil is to be stockpiled separately. Stockpiled soil must be replaced in the reverse order as to which it was removed (subsoil first followed by topsoil).
- Stockpiles of construction materials must be clearly separated from soil stockpiles in order to limit any contamination of soils.
- The stockpiles may only be placed within demarcated stockpile areas, which must fall within the demarcated construction area. The contractor shall, where possible, avoid stockpiling materials in vegetated areas that will not be cleared.
- Stockpiled soils are to be kept free of weeds and are not to be compacted. The stockpiled soil must be kept moist using some form of spray irrigation on a regular basis as appropriate and according to weather conditions.
- The slope and height of stockpiles must be limited to 2m and are not be sloped more than 1:2 to avoid collapse.
- Spoil material must be hauled to a designated spoil site. No spoil material must be pushed down slope or discarded on site.

G. Flow and erosion/sedimentation control measures

Storm water and erosion control measures must be implemented during the construction phase to ensure that erosion and sedimentation impacts to the rivers/streams including in-stream habitats are minimised and avoided. In this regard, the following measures should be implemented:

- Vegetation/soil clearing activities must only be undertaken during agreed working times and permitted weather conditions. If heavy rains are expected, clearing activities should be put on hold. In this regard, the contractor must be aware of weather forecasts.
- Construction activities should be scheduled to minimise the duration of exposure to bare soils on site, especially on steep slopes.
- Run-off generated from cleared and disturbed areas such as access roads and slopes that drain into rivers, streams or wetlands must be controlled using erosion control and sediment trapping measures. These control measures must be established at regular intervals perpendicular to the slope to break surface flow energy and reduce erosion as well as trap sediment.
- Sediment barriers (e.g. silt fences, sandbags, hay bales, earthen filter berms or retaining walls) must be established to protect downstream watercourses from erosion and sedimentation impacts from upslope. Sediment barriers should be regularly maintained and cleared so as to ensure effective drainage.

- Berms, sandbags and/or silt fences employed must be maintained and monitored for the duration of the construction phase and repaired immediately when damaged. The berms, sandbags and silt fences must only be removed once vegetation cover has successfully re-colonised the disturbed areas post-rehabilitation.
- Any dewatering is to be done so in such a manner that water does not result in concentrated flow down slope that could cause soil erosion.
- Ensure that any trenches or excavations are closed and compacted immediately after construction is completed.
- All river/stream channel embankments at crossings must be rehabilitated to ensure both longitudinal and cross sectional stability against summer floods. Depending on the circumstances, this may necessitate stabilizing structures such as gabions or reno mattresses as well as careful attention to vegetation rehabilitation.
- After every rainfall event, the contractor must check the site for erosion damage and rehabilitate this damage immediately. Erosion rills and gullies must be filled-in with appropriate material and silt fences or fascine work must be established along the gulley for additional protection until grass has re-colonised the rehabilitated area.

Note that it will be important to ensure that all of the above-listed mitigation measures are costed for in the construction phase financial planning and budget so that the contractor and/or developer cannot give financial budget constraints as reasons for non-compliance. Proof of financial provision of these mitigation measures must be submitted to the ECO prior to construction commencing.

H. Pollution prevention measures

The following measures should be implemented in conjunction with any generic pollution prevention measures provided in the Construction Environmental Management Programme (EMPr):

- The proper storage and handling of hazardous substances (e.g. fuel, oil, cement, bitumen, paint, etc.) needs to be administered. Storage containers must be regularly inspected so as to prevent leaks.
- Hazardous storage and refueling areas must be bunded prior to their use on site during the construction period following the appropriate SANS codes.
- The bund wall should be high enough to contain at least 110% of any stored volume.
- The surface of the bunded surface should be graded to the centre so that spillage may be collected and satisfactorily disposed of.
- Mixing and/or decanting of all chemicals and hazardous substances must take place on a tray, shutter boards or on an impermeable surface and must be protected from the ingress and egress of stormwater.
- Cement/concrete batching is to be located in an area of low environmental sensitivity away from water courses and pre-approved by the ECO. No batching activities shall occur on unprotected ground. Adequate surface protection will be required.
- Drip trays should be utilised at all dispensing areas.
- No refueling, servicing nor chemical storage should occur within 50m of the delineated wetland/aquatic/stream habitat or within the 100-year flood line, whichever is applicable.

- Vehicle maintenance should not take place on site unless a specific bunded area is constructed for such a purpose.
- Ensure that transport, storage, handling and disposal of hazardous substances is adequately controlled and managed. Correct emergency procedures and cleaning up operations should be implemented in the event of accidental spillage.
- If a water pump is required, the water pump must operate inside or on top of a drip tray to prevent any spillage of fuel and limit the risk of soil/water contamination. The drip tray will need to be lined with absorbent pads and checked daily while in use.
- All equipment to be used within the sensitive working areas (within the channel) must be checked daily for oil and diesel leaks before gaining access to these working areas.
- An emergency spill response procedure must be formulated and staff is to be trained in spill response. All necessary equipment for dealing with spills of fuels/chemicals must be available at the site. Spills must be cleaned up immediately and contaminated soil/material disposed of appropriately at a registered site.
- 44-gallon drums must be kept on site to collect contaminated soil. These should be disposed of at a registered hazardous waste site.
- Sanitation - portable toilets (1 toilet per 10 users) to be provided where construction is occurring. Workers need to be encouraged to use these facilities and not the natural environment. Toilets must not be located within the 1:100yr flood line of a watercourse or closer than 50m or from any natural water bodies including rivers, streams, riparian areas and wetlands. Waste from chemical toilets must be disposed of regularly (at least once a week) and in a responsible manner by a registered waste contractor. Toilet facilities must be serviced weekly and in a responsible manner by a registered waste contractor to prevent pollution and improper hygiene conditions.
- Contaminated water containing fuel, oil or other hazardous substances must never be released into the environment. It must be disposed of at a registered hazardous landfill site.

I. Solid waste pollution control

- Eating areas must not be located within 20m of the wetland/stream/riparian habitats.
- Provide adequate rubbish bins and waste disposal facilities on-site and educate/encourage workers not to litter or dispose of solid waste in the natural environment but to use available facilities for waste disposal.
- Clear and completely remove from site all general waste, constructional plant, equipment, surplus rock and other foreign materials once construction has been completed.
- Recycling/re-use of waste is to be encouraged.
- Litter generated by the construction crew must be collected in rubbish bins and disposed of weekly at registered sites by a registered waste management company.
- No litter, refuse, wastes, rubbish, rubble, debris and builders wastes generated on the premises be placed, dumped or deposited on adjacent/surrounding properties during or after the construction period, but disposed of at an approved dumping site. The construction site must be kept clean and tidy and free from rubbish.

J. Wildlife Management

- No wild animal may under any circumstance be hunted, snared, captured, injured, killed, harmed in any way or removed from the site. This includes animals perceived to be vermin (such as snakes, rats, mice, etc).
- Any fauna that are found within the construction zone must be moved to the closest point of natural or semi-natural vegetation outside the construction corridor.
- The handling and relocation of any animal perceived to be dangerous/venomous/poisonous must be undertaken by a suitably trained individual.

K. Fire management:

- No open fires to be permitted on construction sites. Fires may only be made within the construction camp and only in areas and for purposes approved by the ECO.
- Fire prevention facilities must be present at all hazardous storage facilities.
- Ensure adequate fire-fighting equipment is available and train workers on how to use it.
- Ensure that all workers on site know the proper procedure in case of a fire occurring on site.
- Smoking must not be permitted in areas considered to be a fire hazard.
- Ensure that no refuse wastes are burnt on the site or on surrounding premises.

L. Alien plant control:

- All alien invasive vegetation that has colonised the construction site must be removed, preferably by uprooting. The contactor should consult the ECO regarding the method of removal.
- All bare surfaces across the construction site must be checked for alien invasive plants at the end of every month and alien pants removed by hand pulling/uprooting and adequately disposed.
- Herbicides should be utilised where hand pulling/uprooting is not possible. ONLY herbicides which have been certified safe for use in wetlands/aquatic environments by an independent testing authority may be considered. The ECO must be consulted in this regard.
- The ECO should assess the need / desirability for further monitoring and control after the first 12 months and include any recommendations for further action to the relevant environmental authority (EDTEA).

M. Measures for Working within and around Rivers & Streams

i. <u>Working servitude and construction area demarcation:</u>

- The working servitude must be demarcated on both sides using orange hazard netting prior to construction commencing.
- The demarcation work must be signed off by the Environmental Control Officer (ECO) before any work commences.
- All freshwater habitats outside of the demarcated construction area must be considered 'No-Go' areas for the duration of the construction phase. Any contractors found working inside the no-go areas should be fined as per fining schedule/system setup for the project.

- The location of topsoil and subsoil stockpile areas, dewatering filtration areas and equipment lay down areas must be agreed to and demarcated to the satisfaction of the ECO prior to the clearing.
- Construction materials must only be brought to the equipment laydown area 3 days prior to use and must not be kept for more than 2 weeks. Timing of delivery is critical.

ii. Working servitude clearing:

- Before any work commences, sediment control/silt capture measures (e.g. bidim/silt curtains) must be installed downstream of the working areas. A minimum of 3 rows of silt fences/curtains shall be installed across the river/stream channel (where practically possible/appropriate). The ECO must be present during the location of sites and installation of the silt curtains.
- Avoid accessing the construction site from eroded or slumping river banks prone to collapse.
- When crossing rivers and streams, work from the edge of the watercourse where practically possible to avoid direct impacts to in-stream habitat.
- No physical damage should be done to any aspects of the channel and banks of watercourses other than those necessary to complete the works as specified. Channel bed and bank materials are not to be removed from the watercourse or used for construction purposes. Bed material disturbed during construction should be stockpiled for use in rehabilitation.
- Excavated rock and sediments from the construction zone, and including any foreign materials, should not be placed within the channel in order to reduce the possibility of material being washed downstream. Excavated material shall be placed on top of the upper macro-channel banks outside of the riparian zone only.
- Prior to the stripping, infilling, excavation and re-shaping of the aquatic habitat within the development footprint/corridor, a search and rescue of indigenous flora and fauna must be undertaken by a qualified botanist and zoologist respectively prior to habitat destruction.
- Thereafter, any topsoil and vegetation from areas to be excavated should be stripped and stored at the designated soil stockpile area outside of the wetland/aquatic zone for use later in rehabilitation.

iii. Temporary River/Flow Diversions:

- Where construction is to take place within a watercourse (river/wetland), temporary diversions may need to be put in place to temporarily divert water away from activities and ensure a dry work area.
- To reduce the requirements to divert water from the construction working area within or adjacent to a watercourse, all construction activities within wet areas should ideally take place in the dry season/winter (May to September of any given year) where this is possible (depending on project timeframes).
- Perennial river systems (such as the Mtwalume River) will likely require temporary flow diversion during bridge construction, depending on the method of construction.
- Construction in the waterway should progress as quickly as practical to reduce the risk of exceeding the temporary diversion capacity.

- Diversions shall be temporary in nature and no permanent walls, berms or dams may be installed within a watercourse.
- Only one diversion is to be made at a time for each watercourse affected.
- Under no circumstance shall a new channel or drainage canals be excavated to divert water away from construction activities;
- Re-directed flow must not be channelled towards stream/river banks which could cause bank erosion.
- Sandbags used in any diversion or for any other activity within a watercourse (rivers & wetlands) must be in a good condition, so that they do not burst and empty sediment into the watercourse;
- Upon completion of the construction at the site, the diversions shall be removed to restore natural flow patterns, and the channel/wetland rehabilitated/restored to their original configurations as soon as practically possible.
- Options for temporary flow diversion when working within channels may include:
    - o diversion of the entire watercourse through use of a bypass large diameter pipe;
    - o the installation of removable coffer dams; and
    - o use of removal sandbags.
    - o Figure 14 (below) serves as a guide to support decisions around the use of coffer dams versus temporary barriers, etc.
- Once the correct approach has been adopted for the type of construction, it will be important to undertake the desired approach according to the best practise methods, as described in Table 20, below.

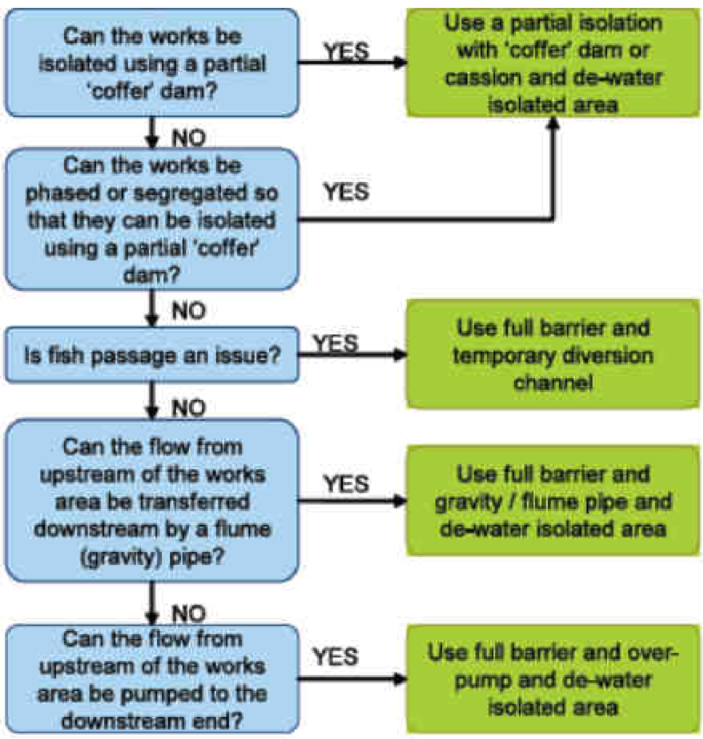
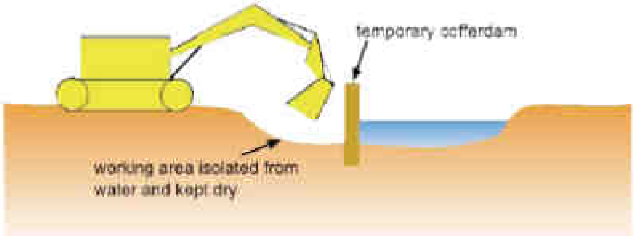
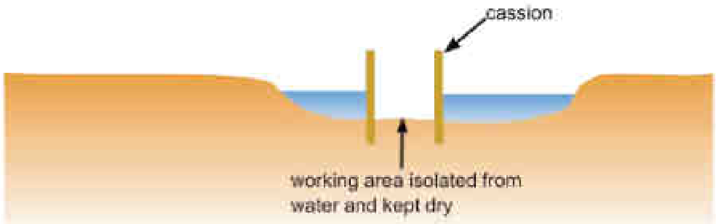
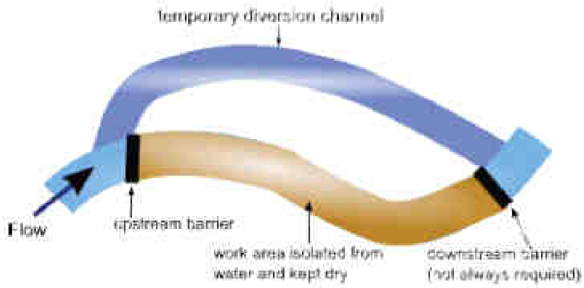
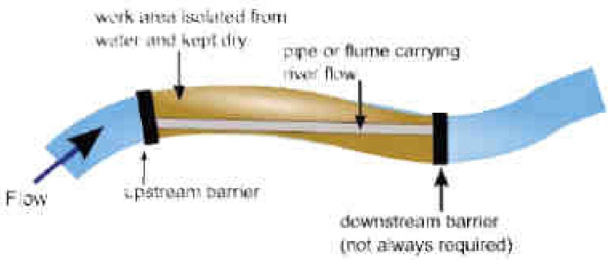
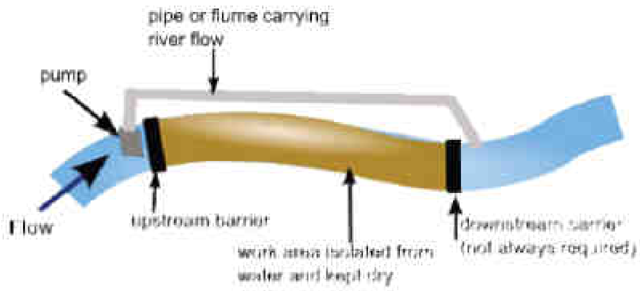
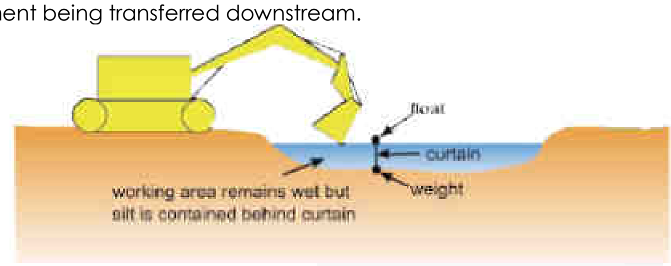


Figure 14 Decision support system for using cofferdams (after SEPA, 2009)

Table 20. Best practise methods for partial and full isolation (after SEPA, 2009).

Method/Approach	Description
Partial isolation	Partial area of the channel is isolated and kept dry with the use of barriers (often referred to as a cofferdam) and flow is allowed to continue in the remainder of the channel. Barriers used to isolate part of the channel can be made of a number of different materials. 
Partial isolation using a Caisson	Provides isolation of the channel similar to cofferdams. They are essentially large boxes or cylinders (usually pre-cast concrete and steel) which are open at the top and bottom and are lowered into the water to isolate an area of bed. 
Full isolation Temporary diversion channel	A whole section of the channel is isolated and kept dry, and the water is transferred downstream of the works area by excavating a temporary open channel. 
Full isolation gravity/flume pipe	A whole section of the channel is isolated using barriers that span the full width of the river. This keeps a stretch of the river dry and the water is transferred downstream of the works area through gravity fed flumes/pipes. The flume(s) is normally placed on the bed of the watercourse through the works area and outfalls at the downstream barrier, if present, or far enough downstream to prevent the water backing up into the work area. 
Full isolation over pumping / siphon	A whole section of the channel is isolated using barriers that span the full width of the river. This keeps a stretch of the river dry and the water is transferred downstream of the works area by mechanical assistance (pumping or siphon). The pump and associated pipe work need not be located in the isolated area.

Method/Approach	Description
	
Isolation with silt curtain	In this case the works area still remains wet and a silt curtain is placed around the works area to minimise sediment being transferred downstream. 

N. General rehabilitation (during construction)

- New embankments within and upstream of streams must be appropriately compacted, stabilised and revegetated to prevent bank instability/erosion from occurring.
- Immediately after construction, disturbed areas must be re-vegetated using rescued plant sods and supplemented with transplants from adjoining like habitats if required. Alternatively, re-seeding via broadcasting using an indigenous seed mix reflecting the general species composition of the area should also be used where necessary.
- A biodegradable geofabric mat or 'vegetation blanket' must be utilized to protect the topsoil on steep slopes from water and wind erosion during re-vegetation. Alternatively, the plants can be secured using a coarse mesh (steel wire or plastic). The mesh or mat is placed over the vegetation securing it until it can fully establish. The plants must be able to grow unhindered through the mesh or matting. Mats can be staked down.
- Alien and weedy vegetation that colonize the disturbed areas must be removed and eradicated.
- The soils must be adequately prepared prior to planting by a contractor with experience in re-vegetation and under no circumstances must fertiliser be applied.
- Once the initial transplants / plugs are planted, the contractor to conduct weekly site visits to monitor re-establishment and remove alien plants (in accordance with the latest revised NEM:BA requirements) and address any re-vegetation concerns until re-vegetation is considered successful (i.e. >90% indigenous cover). Thereafter, the rehabilitation must be signed off by the ECO.

8.3 Post-Construction Aquatic Habitat Rehabilitation Guidelines

Aquatic habitat (instream and riparian habitat) associated with rivers and streams that is intentionally (planned) or unintentionally (accidently) disturbed during the construction phase, will need to be appropriately rehabilitated as soon as construction has been completed. This section provides guidelines on rehabilitating the riverine habitats where deemed necessary. Rehabilitation refers to all disturbed areas affected by construction activities. The key objectives of rehabilitation in this context are as follows:

- Stabilise erodible soils/material.
- Ensure continued hydrological functioning.
- Ensure all disturbed areas are well vegetated.
- Ensure alien plant do not colonise the disturbed areas.

Rehabilitation will aid the recovery of the ecosystems and can be seen as critical in preventing further impacts to these systems including those associated with alien plant infestations, soil erosion and sedimentation. The rehabilitation guidelines below have been recommended for the project. A basic framework for monitoring rehabilitation outcomes has also been provided in Table 21.

Rehabilitation of disturbed riverine areas:

- A trained rehabilitation expert should be contracted to oversee the rehabilitation of disturbed riverine and adjacent areas.
- For bridge crossings, once the base is cast and the piers are constructed, the excavated riparian zone must be backfilled with boulders, subsoil and topsoils in the proper order that they were excavated.
- All foreign material (e.g. sand bags, rock fill, imported soils, aggregate, geofabric, waste products, etc.) must be removed from the watercourse, taking care not to remove natural sediment/rock from the river/stream bed or banks. Minimise additional disturbance by limiting the use of heavy vehicles and personnel during clean-up operations.
- The channel bed must be reinstated as close to its original condition as possible.
- Any erosion features immediately upslope and/or within the freshwater habitat that is created during the construction phase needs to be stabilised. This may also include the need to deactivate any erosion headcuts/rills/gullies that may have developed. Compacted soil infill, rock plugs, gabions or any other suitable measures can be used for this purpose.
- Once re-graded, the soils within the riparian zone (river banks and beyond) must be adequately ripped/loosened where compacted in order to promote re-vegetation, as informed by the ECO, and topsoil must be re-distributed across the banks in parallel to implementation of bank stabilisation and erosion protection. Care shall be taken not to mix the topsoil with the subsoil during re-shaping operations.
- If there is not enough topsoil to cover over the entire construction corridor, additional topsoil must be sourced from a geologically comparable area.
- River banks at risk of erosion must be reinforced with gabion retaining walls where necessary. Temporary measures to prevent soil loss on the banks must be implemented and may include rows of sand bags/silt fences at the break in slope.
- Immediately after the topsoil is reinstated and the riparian areas stabilised, the disturbed areas must be re-vegetated using the rescued plants from the area cleared and supplemented with

transplants from adjoining habitats of similar plant composition. The plant plugs should be planted at a medium to high density with appropriate plant spacing as per the tree/plant species type.

- For areas being re-seeded via broadcasting, the soil needs to be prepared to optimise germination. Such preparation is undertaken by hand hoeing. The soil in the seedbed should be loosened but firmed to facilitate good contact between the seeds and the soil.
- On steep slopes or within specific high energy environments, a biodegradable geofabric (or vegetation blanket) must be utilized to protect the topsoil from water and wind erosion when planting the plugs. Alternatively, the plants can be secured using a biodegradable soil server. The plants must be able to grow unhindered through the matting.
- Rapidly germinating indigenous species (e.g. fast growing, deep rooting, rhizomatous, stoloniferous) known to bind soils in terrestrial, riparian and/or wetland areas must be utilised where there is a strong motivation for stabilisation over reinstating similar plant communities to that being disturbed.
- When sourcing plants from nurseries, it is important to consider the genetic origin of the plants. It is considered best to use small regional nurseries that breed plants from the region, instead of large commercial nurseries that are likely to obtain stock from large regional suppliers.
- Although it would be advantageous to plant at the onset of the wet season (early spring – August to October), such timing would coincide with peak flow events that pose a higher risk to re-vegetation failure. Therefore, carefully planning is required to maximise the success of re-vegetation and avoiding peak flow events. Thus, it is likely that some watering will be required. The timing of the construction phase should aim to meet this requirement.
- Do not use fertilizer, lime, or mulch unless absolutely required.
- Where re-vegetation on its own is not sufficient to stabilize the banks (as determined by a rehabilitation specialist), 'soft' stabilization (bioengineering applications) (e.g. fascine work, brush mattresses etc.) interventions should be installed where necessary and applicable (to be determined in the detailed rehabilitation plan). As a principle, 'soft' stabilisation interventions should be favoured over 'hard' interventions wherever possible to ensure that the channel retains some dynamism and habitat. The following soft interventions (in addition to re-vegetation) should be investigated (Russell, 2009):
    - Fibre mats / blankets/ mattresses / nets.
    - Fibre rolls.
    - Fibre bags.
    - Brush or vegetation mattresses (mats).
    - Terracing.
    - Live or inert fascines.
    - Live staking.
- It is important to note that bioengineering interventions are vulnerable to failure immediately following construction should a drought or large flood take place. Thus, the timing of construction to avoid peak flow conditions is very important to the rehabilitation success. This will, however, result in the need to irrigate the re-vegetated area to aid establishment. If using fibre mats, avoid 3D 'tangle' type mats and fibre mats with a scrim section for ecological reasons.

- Temporary erosion protection measures must only be removed once good vegetation cover has established.
- Once the initial transplants / plugs are planted, the landscaper must conduct weekly site visits to remove alien plants (in accordance with the latest revised NEM:BA requirements) and address any re-vegetation concerns until re-vegetation is considered successful (i.e. >80% indigenous cover). Alien and weedy vegetation that colonize the rehabilitation areas must be removed and eradicated immediately via hand pulling and should be adequately disposed of. Care must be taken, however, of not clearing all weeds indiscriminately as the weeds may be performing a useful soil covering and binding function.
- A basic framework for rehabilitation monitoring is provided in Table 21 (below), however, please note that more regular maintenance is required by the implementing contractor until such a time that re-vegetation is successful.
- Recovery of disturbed areas should be assessed for the first 6 months. Any areas that are not progressing satisfactorily must be identified and action must be taken to actively re-vegetate these areas. If natural recovery is progressing well, no further intervention may be required.
- The ECO should assess the need / desirability for further monitoring and control after the first 12 months and include any recommendations for further action to the relevant environmental authority (EDTEA).
- The use of herbicides in IAP control will require an investigation into the necessity, type to be used, effectiveness and impacts of the agent on aquatic biota.
- Thereafter, the rehabilitation must be signed off by the ECO.

Table 21. A basic framework for rehabilitation monitoring.

Phasing	Frequency	Assessment	Duration
Pre-Construction Phase	Before construction commences	Baseline fixed-point photography of freshwater habitat to be cleared	Before construction commences
Remediation Phase	Bi-monthly (every 2 weeks) site visit and monthly report	Compliance with rehabilitation plan and method statements, intervention/bank stability, success of re-vegetation, alien/weed encroachment	±3 months
Recovery phase (after successful re-vegetation)	Bi-annual site visit and ad-hoc site visits following large storm events	Intervention stability / bank stability, success of re-vegetation, alien/weed encroachment	±12 months

8.4 Operation-Phase Impact Mitigation Guidelines

A. Impacts to aquatic habitat caused by alien/exotic vegetation

It is the responsibility of the developer/applicant to eradicate and control alien invasive plants that invade all areas disturbed by the construction and operation of the proposed road infrastructure.. In terms of Section 75 of NEMBA, the following applies to the control & eradication of invasive species:

- The control and eradication of a listed invasive species must be carried out by means of methods that are appropriate for the species concerned and the environment in which it occurs;

- Any action taken to control and eradicate a listed invasive species must be executed with caution and in a manner that may cause the least possible harm to biodiversity and damage to the environment; and
- The methods employed to control and eradicate a listed invasive species must also be directed at the offspring, propagating material and re-growth of such invasive species in order to prevent such species from producing offspring, forming seed, regenerating or re-establishing itself in any manner.
- It is recommended that bi-annual annual alien plant clearing be undertaken by the applicant for the first year post-rehabilitation. Thereafter, alien plant clearing should be undertaken annually until such a time that further risks of alien invasion resulting from disturbance factors are considered negligible.

B. Erosion and sedimentation impacts

- Stormwater drainage must be designed such that it discharges water into the nearby veld at short intervals of 10m to break the energy of water.
- The river banks adjoining bridge crossings/causeways must be reinforced with gabion basket retaining walls.
- The side drains must discharge their water into gabion-basket-wing walls of the culvert. This will eliminate erosion of the river banks.
- Any approaching road side drains must be grassed with indigenous runner grasses in order to help curb erosion.

8.5 Monitoring Recommendations

Monitoring is required in order to ensure that wetlands and streams associated with the proposed development are maintained in their current ecological state or improved but incurring no net loss to functionality as a result of the project. It is recommended that a Monitoring Programme be developed and implemented in accordance with the following guidelines:

A. Responsibilities for monitoring:

Compliance monitoring will be the responsibility of a suitably qualified/trained ECO (Environmental Control Officer) with any additional supporting EO's (Environmental Officers) having the required competency skills and experience to ensure that monitoring is undertaken effectively and appropriately.

B. Construction monitoring objectives:

Key monitoring objectives during the construction-phase should include:

- Ensuring that management and mitigation measure are adequately implemented to limit the potential impact on aquatic resources; and
- Ensuring that disturbed areas have been adequately to stabilise and rehabilitated to minimise residual impacts to affected resources.

C. Record keeping:

The ECO shall keep a record of activities occurring on site, including but not limited to:

- Meetings attended;
- Method Statements received, accepted and approved;
- Issues arising on site and cases of non-compliance with the EMPr;
- Corrective actions taken to solve problems that arise;
- Penalties/fines issued; and
- Complaints from interested and affected parties.

D. Construction phase monitoring requirements (ECO):

During construction: This involves the monitoring of construction related impacts as identified in this report. Regular monitoring of the construction activities is critical to ensure that any problems with are picked up in a timeous manner. In this regard, the following potential concerns should be taken into consideration:

- Destruction of habitat outside the construction servitude including 'No Go' areas;
- Erosion of the bed and banks of rivers/streams;
- Signs of intense or excessive erosion (gullies, rills, scouring and headcuts) and/or sedimentation within, along the edge and/or immediately downstream of the construction zone.
- Erosion of disturbed soils and soil stockpiles by surface wash processes;
- Sedimentation of aquatic habitats downstream of work areas (resulting from stockpiled earth);
- Altering the hydrology and through flows to downstream habitat during construction across rivers/streams;
- Pollution of water resources (with a particular focus on water turbidity and hazardous substances such as fuels, oils and cement products);
- Poorly maintained and damaged erosion control measures e.g. sand bags, silt fences and silt curtains; and
- Evidence of unsafe working conditions (e.g. working during high flows).

These risks can be monitored visually on-site by the ECO (together with construction staff) with relative ease and should be reported on regularly during the construction process. Any concerns noted should be prioritised for immediate corrective action and implemented as soon as possible.

Directly after construction (rehabilitation effectiveness): This involves monitoring the effectiveness of rehabilitation activities. The ECO and construction staff would need to perform routine checks of rehabilitation effectiveness with the initial focus on stabilising and vegetating disturbed soils and the restoration of natural topography. This can also be achieved through basic visual inspections documenting inadequacies in the rehabilitation outcomes for remediation. Once complete it is recommended that an independent aquatic specialist is consulted to ensure the success of rehabilitation and to identify shortcomings that will need to be addressed.

Operation phase monitoring requirements:

This involves annual monitoring of water resources (rivers/streams) affected by the development in order to ensure that operational impacts identified for each watercourse crossing are being effectively managed. This can also be achieved through basic visual inspections by the ECO and support staff, documenting issues such as:

- Alien Invasive Plant invasion;
- Erosion headcuts;
- Scouring and deposition associated with storm water runoff;
- Channel incision downstream of development;
- Blockage of culverts/pipes;
- Scouring around infrastructure at river/stream crossings; and
- Channel bank erosion and collapse (bank instability concerns).

9 LICENSE & PERMIT REQUIREMENTS

9.1 Water Use Licensing Requirements

Section 21 of the National Water Act (No 36 of 1998) lists certain activities for which water use must be licensed, unless its use is excluded. There are several reasons why water users are required to register and license their water use with the Department of Water and Sanitation (DWS), the most important being: to manage and control water resources for planning and development; to protect water resources against over-use, damage and impacts; and to ensure fair allocation of water among users.

Depending on the nature of the development and water use, Section 21 (a), (c) and (i) water uses described in Table 22 (below) could potentially be triggered by the development (and associated activities) and would then require a Water Use License (WUL) from the DWS. General Authorizations (GAs) do not apply to the use of water within a 500m radius from the boundary of a wetland. The potential for the road development project to trigger these water uses has been investigated by considering the proximity of the activity to the watercourses assessed in the specialist report and the risk of any related activities resulting in impacts to the resource quality of the water course, as specified under Chapter 4, Section 21 of the National Water Act No. 36 of 1998.

Given that planned development activities will take place within 500m of a watercourse (wetlands, rivers and stream channels), the following documents (amongst others) will be needed for a Water Use License Application (WULA), as required by the DWS:

- Water resources delineation supplied together with and assessment of PES and EIS (i.e. this report).
- Application forms for Section 21 (a), (c) and (i) use, where relevant. Note that the current Section 21 (c) and (i) General Authorizations (GAs) do not apply to the use of water within a 500m radius from the boundary of a wetland. Should construction within these boundaries be considered, licensing and not registration will have to take place.

- Supporting documentation in terms of the activity and applicant.

Table 22. Water Uses applicable to the proposed development.

NWA Section 21 Water Use	Description (DWAF, 2009)	Water Use Triggered	Relevance to the site
21 (a): *Taking water from a watercourse*	Abstraction of water from a water resource.	**Possible**	Abstraction of water for construction/re-vegetation purposes may fall under General Authorisation depending on quantity abstracted. No details on potential abstraction were provided and as such the potential use is unconfirmed.
21(c): Impeding or diverting the flow of water in a watercourse	This water use includes the temporary or permanent obstruction or hindrance to the flow of water into watercourse by structures built either fully or partially in or across a watercourse; or a temporary or permanent structure causing the flow of water to be re-routed in a watercourse for any purpose.	**Yes**	This water use is generally a standard requirement for any development within 500m of any wetland or within the 1:100 year floodline of a watercourse. Construction within rivers/streams at road crossings will trigger this water-use.
21(i): Altering the bed, banks, course or characteristics of a water course	This water use relates to any change affecting the resource quality of the watercourse (the area within the riparian habitat or 1:100 year floodline, whichever is the greatest).	**Yes**	This water use is generally a standard requirement for any development within 500m of any wetland or within the 1:100 year floodline of a watercourse. Construction within rivers/streams at all road crossings will trigger this water-use.

General Authorization No. 542 (as published in the Government Gazette No. 32212, dated 15 May 2009) replaces the need for a water user to apply for a license for water use in terms of Section 21 (c) and 21 (i) of the National Water Act, provided that the use is within the conditions set out in the General Authorisation (GA). The proposed road project is excluded in terms of section 6 as the GA does not apply to any water use within a 500m radius from the boundary of any watercourse (river or wetland).

9.2 Permits to remove/destroy indigenous plant species

No protected or threatened species requiring permits have been identified for the aquatic ecosystems (rivers, streams and riparian habitats) assessed as part of this study.

10 CONCLUSION

The proposed Ntatshana Road and bridge development project is designed to serve as a link between two local community areas, Maqhikizana and Mthwalume located on either side of the Mtwalume River within the Umzumbe Local Municipality, KwaZulu-Natal. The Specialist Freshwater Habitat Assessment undertaken by Eco-Pulse Consulting in August 2015 identified three aquatic resources (rivers and streams) in the vicinity of the proposed development that are likely to be impacted by the project, including:

- The main perennial Mtwalume River (R02). The assessment of ecological integrity found the river reaches assessed to be Largely Natural ("B" PES category), reflected by good instream water quality, a rating of largely natural for macro-invertebrate sampling and analysis (SASS5) and instream/riparian habitat integrity was also regarded as largely intact (~88% intact). The river was regarded as being of Moderate Ecological Importance and Sensitivity (EIS). According to the desktop fish presence database compiled by the Department of Water and Sanitation (DWS, 2014) for major rivers, the Mtwalume River potentially harbours six migratory species, with only the Mozambique Tilapia/Blue Kurper being considered Near Threatened whilst the rest of the species are either of Least Concern or not classified. The implication in this case is that the long-term modification of the ecological processes and on-site habitat for the Mtwalume River reach assessed will be considered undesirable and unacceptable.
- A smaller seasonally intermittent stream channel and tributary of the Mtwalume River (R03). This system was assessed as being Moderately Modified ("C" PES category), reflected by a modified instream and riparian habitat, and EIS was rated as being relatively Low.
- An ephemeral/dry drainage line/channel (E02). The small degraded channel was found to be largely modified/poor ecological condition and of a Low EIS.

The most significant impacts to these aquatic resources are likely to be associated with the potential destruction of instream and riparian habitat during construction, the risk of altering natural flow characteristics at river/stream crossings as well as erosion/sedimentation risks which are likely to be problematic for both construction and operational phases of the project. Future management of the freshwater ecosystems should be to *maintain the current status quo of aquatic ecosystems without any further loss of integrity/functioning (PES/EIS)*. In order to achieve this objective, recommendations have been made regarding the design of the project and infrastructure as well as the provision of practical mitigation measures and impact management consideration to deal with anticipated construction phase and operational risks. Most aquatic ecological impacts can probably be avoided by limiting works/activities within sensitive wetland/riverine areas and supplemented by the application of on-site practical mitigation measures and management principles to control erosion, sedimentation and pollution impacts and risks. With this mitigation in place, impacts on aquatic ecosystem integrity and functioning can be potentially reduced from a moderate significance level to a sufficiently low level. This would be best achieved by incorporating the recommended management & mitigation measures into an Environmental Management Programme (EMPr) for the site, together with appropriate rehabilitation guidelines and ecological monitoring recommendations.

Of the two alternative route options provided for assessment, alternative route 2 was assessed as having more engineering constraints (steep slope, narrow mountain ridge, etc.) which translate to higher environmental risks in terms of potential bank/slope instability and sediment/erosion impacts. Route option 1 is therefore considered the preferred route alignment by the specialists on condition that the proposed mitigation and management recommendations, rehabilitation requirements and monitor protocols outlined in this specialist report are strictly adhered to. It is therefore recommended that recommended mitigation measures provided in Section 7 of this report be referenced as specific conditions of the Environmental Authorisation (EA) and/or Water Use Licence (WUL) for this project.

Other requirements include the need for a Water Use License according to Section 21 of the National Water Act No. 36 of 1998. No protected/threatened species of flora/fauna were observed and there is no immediate need for relevant permits to remove/relocate any aquatic species.

It must also be noted that during the initial field visit conducted on the 4th August 2015 it was noted that sections of road which appeared to be aligned with proposed alternative route 1 were under construction/maintenance. Of particular concern was the large quantities of spoil material (soil) pushed down slope along the length of the road, a 2m deep cut had been made along one of the valley slopes, clearing of a new access road within 32m of a watercourse (i.e. Mtwalume River and tributary stream channels) and infilling of riparian zone R02 (tributary of the Mtwalume River). Whilst a response to our enquiry from RHDHV suggested that the activities are part of routine road maintenance operations it is recommended that further investigation be undertaken to confirm that the activities do not trigger any Listed Activities in terms of the 2014 EIA Regulations, a Water Use Licence in terms of the National Water Act and are not related to the construction of the Ntatshana road route option 1.

Should you have any queries regarding the findings and recommendations in this Specialist Freshwater Aquatic Assessment report, please contact Eco-Pulse Consulting.

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12 ANNEXURES

ANNEXURE A: Detailed Assessment Methods

A1 Wetland/Riparian delineation

- **Wetland delineation**

The outer boundary of wetlands was identified and delineated according to the Department of Water Affairs wetland delineation manual '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (*DWAF, 2005). Three specific wetland indicators were used in the detailed field delineation of wetlands, which include:

- **Terrain unit indicator**

A practical index used for identifying those parts of the landscape where wetlands are likely to occur based on the general topography of the area.

- **Wetland vegetation indicator**

Vegetation in an untransformed state is a useful guide in finding the boundary of a wetland as plant communities generally undergo distinct changes in species composition as one proceeds along the wetness gradient from the centre of a wetland towards adjacent terrestrial areas. An example of criteria used to classify wetland vegetation and inform the delineation of wetland zones is provided in Table 23. A hydric status was allocated for each plant species sampled based on the field experience of the assessor and using available literature, including:

- *A practical field procedure for the identification and delineation of wetlands and riparian areas (DWAF, 2005);*
- *Easy identification of some South African Wetland Plants: Grasses, Resticios, Sedges, Rushes, Bulrushes, Eriocaulons and Yellow-eyed grasses (Van Ginkel et al., 2011);*
- *Guide to grasses of Southern Africa (Van Oudtshoorn, 2006);*
- *Field Guide to Trees of Southern Africa (Van Wyk & Van Wyk, 2007);*
- *Pooley, E., 2005. A field guide to Wildflowers of KZN and the Eastern Region (Pooley, 2005); and*
- *Problem Plants and Alien Weeds of South Africa (Bromilow, 2010).*

Table 23. Criteria used to inform the delineation of wetland habitat based on wetland vegetation (adapted from Macfarlane *et al.*, 2008 and DWAF, 2005).

Vegetation	Temporary wetness zone	Seasonal wetness zone	Permanent wetness zone
Herbaceous	Mixture of non-wetland species and hydrophilic plant species restricted to wetland areas	Hydrophilic sedges and grasses restricted to wetland areas	Emergent plants including reeds and bulrushes; floating or submerged aquatic plants

Vegetation	Temporary wetness zone	Seasonal wetness zone	Permanent wetness zone
Woody	Mixture of non-wetland and hydrophilic species restricted to wetland areas	Hydrophilic woody species restricted to wetland areas	Hydrophilic woody species restricted to wetland areas with morphological adaptations to prolonged wetness (e.g.: prop roots)
SYMBOL	**HYDRIC STATUS**	**DESCRIPTION/OCCURRENCE**	
Ow	Obligate wetland species	Almost always grow in wetlands (>90% occurrence)	
Fw/F+	Facultative wetland species	Usually grow in wetlands (67-99% occurrence) but occasionally found in non-wetland areas	
F	Facultative species	Equally likely to grow in wetlands (34-66% occurrence) and non-wetland areas	
Fd/F-	Facultative dryland species	Usually grow in non-wetland areas but sometimes grow in wetlands (1-34% occurrence)	
D	Dryland species	Almost always grow in drylands	

- **Soil wetness indicator**

According to the wetland definition used in the National Water Act (NWA, 1998), vegetation is the primary indicator which must be present under normal circumstances. However, in practice the soil wetness indicator (informed by investigating the top 50cm of wetland topsoil) tends to be the most important, and the other three indicators are used to refine the assessment. The reason for this is that vegetation responds relatively quickly to changes in soil moisture and may be transformed by local impacts; whereas the soil morphological indicators are far more permanent and will retain the signs of frequent saturation (wetland conditions) long after a wetland has been transformed/drained (DWAF, 2005). Thus the on-site assessment of wetland indicators focused largely on using soil wetness indicators, determined through soil sampling with a soil auger, with vegetation and topography being a secondary indicator. A Munsell Soil Colour Chart was used to ascertain soil colour values including hue, colour value and matrix chroma as well as degree of mottling in order to inform the identification of wetland (hydric) soils. Soil sampling points were recorded using a GPS (Global Positioning System) and captured using Geographical Information Systems (GIS) for further processing. An example of soil criteria used to assess the presence of wetland soils is provided below in Table 24 while Figure 15 provides a conceptual overview of soil and vegetation characteristics across the different wetness zones.

Table 24. Soil criteria used to inform wetland delineation using soil wetness as an indicator (after DWAF, 2005).

Soil depth	Temporary wetness zone	Seasonal wetness zone	Permanent wetness zone
0 – 10cm	**Matrix chroma**: 1- 3 (Grey matrix <10%) **Mottles**: Few/None high chroma mottles **Organic Matter**: Low **Sulphidic**: No	**Matrix chroma**: 0- 2 (Grey matrix >10%) **Mottles**: Many low chroma mottles **Organic Matter**: Medium **Sulphidic**: Seldom	**Matrix chroma**: 0- 1 (Prominent grey matrix) **Mottles**: Few/None high chroma mottles **Organic Matter**: High **Sulphidic**: Often
30 – 50cm	**Matrix chroma**: 0 – 2 **Mottles**: Few/Many	As Above	As Above

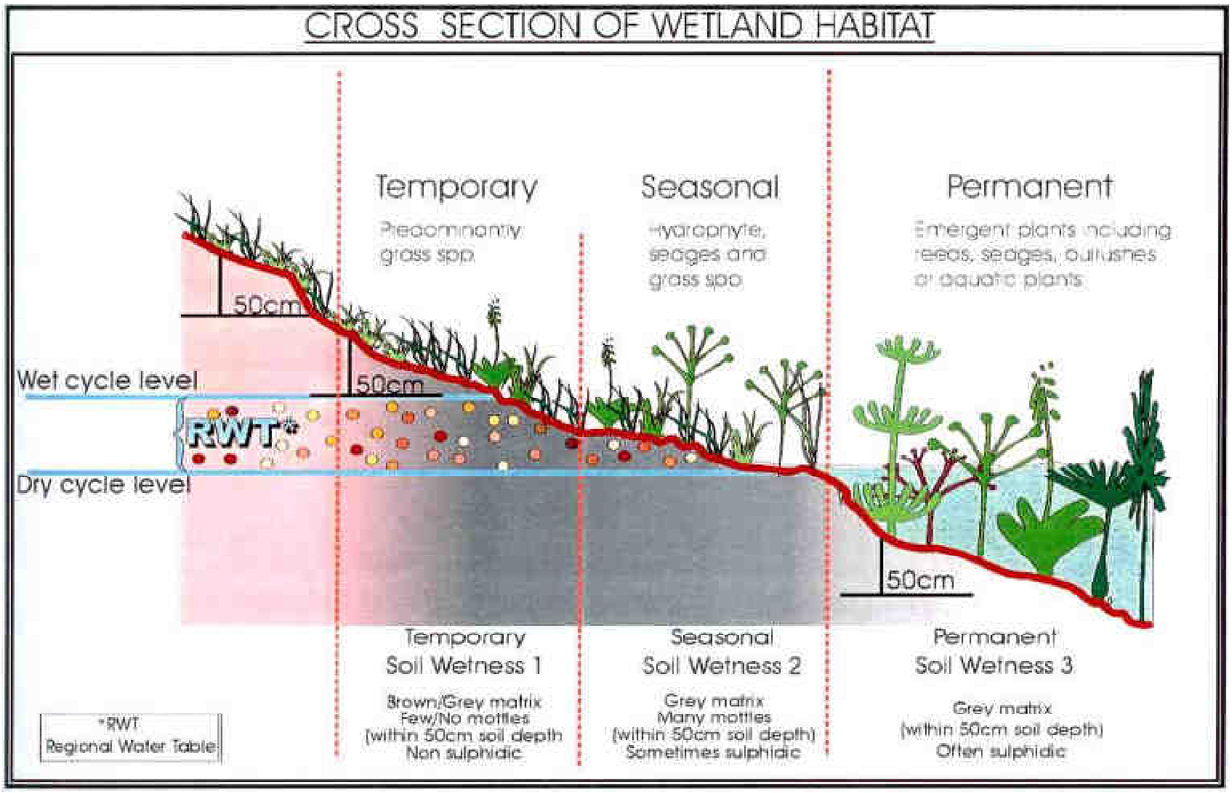


Figure 15 Diagram representing the different zones of wetness found within a wetland (DWAF, 2005).

- <u>**Delineation of riparian areas**</u>

The location of drainage features and boundary of any riparian areas (also known as the riparian zone) was delineated according to the methods in the Department of Water Affairs wetland delineation manual '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas*' (DWAF, 2005). Like wetlands, riparian areas have their own unique set of indicators required in order to delineate these features. In the absence of typical wetland features, riparian area indicators were used instead to identify and delineate the edge of riparian areas, in accordance with the DWAF delineation manual, which included:

- **Alluvial soils and deposited material**: this includes relatively recently deposited sand, mud, etc. deposited by flowing water that can be used to confirm the topographical and vegetation indicators.
- **Channel morphology/topography associated with the watercourse**: the outer edge of the macro-channel bank associated with a river/stream provides a rough indication of the outer edge of a riparian area.
- **Vegetation composition & structure**: unlike the delineation of wetland areas where hydromorphic soils are the primary indicator, the delineation of riparian areas relies primarily on vegetation indicators. Using vegetation, the outer boundary of a riparian area must be adjacent to a watercourse and can be defined as the zone where a distinctive change occurs with respects to:

- o Species composition relative to adjacent terrestrial areas; and
- o Changes in the physical structure such as vigour or robustness of growth forms of species similar to that of adjacent terrestrial areas (growth from refers to the health, compactness, crowding, size, structure and numbers of individual plants).

Note that the sole reliance on one indicator can be misleading (e.g. many species of plants can successfully grow both in and out of wet areas) and a combination of all three indicators should therefore be used to provide for a logical, defensible (higher level of confidence) and technical basis for riparian area delineation

A2 Classification of wetlands and rivers

For the purposes of this study, wetlands were classified according to HGM (hydro geomorphic) type (Level 4A classification level) using the National Wetland Classification System which was developed for the South African National Biodiversity Institute (Ollis *et al.*, 20013) as outlined in Table 25, below.

Table 25. Wetland classification (after Ollis *et al.*, 2013).

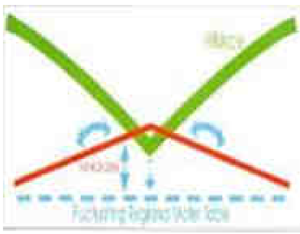
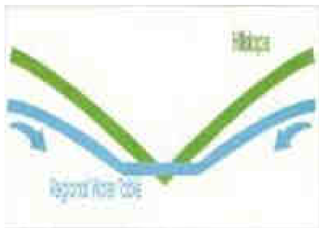
LEVEL 3	LEVEL 4A	
Landscape Setting	**HGM Type**	**Description**
SLOPE	Channel (river)	*Areas of channelled flow including rivers and streams where water is largely confined to a main channel during low flows. Flood waters may over top the banks of the channel and spread onto an adjacent floodplain*
	Hillslope seep	*Wetlands on slopes formed mainly by the discharge of sub-surface water.*
VALLEY FLOOR	Channel (river)	*River channels in a valley floor setting.*
	Channelled valley-bottom wetland	*Valley floors with one or more well-defined stream channels, but lacking characteristic floodplain features.*
	Unchannelled valley-bottom wetland	*Valley floors with no clearly defined stream channel.*
	Floodplain wetland	*Valley floors with a well-defined stream channel, gently sloped and characterised by floodplain features such as oxbows and natural levees.*
	Depression	*Basin-shaped areas that allow for the accumulation of surface water, an outlet may be absent (e.g. pans).*
	Valleyhead seep	*Seeps located at the head of a valley, often the source of streams.*
PLAIN	Channel (river)	*River channels in a plain landscape setting.*
	Floodplain wetland	*Floodplain wetlands as above but in a plain landscape setting.*
	Unchannelled valley-bottom wetland	*Unchannelled valley bottom type wetlands as above but in a plain landscape setting.*
	Depression	*Depression type wetlands as above but in a plain landscape setting.*
	Flat	*Extensive areas characterised by level, gently undulating or uniformly sloping land with a very gentle gradient.*
BENCH (HILLTOP / SADDLE / SHELF)	Depression	*Depression wetlands located on a bench.*
	Flat	*Flat wetlands located on a bench.*

River/stream channels within the project areas were mapped in GIS using a combination of digital satellite imagery in conjunction with GPS points and data captured in the field. The classification of channels was based on the size of channels (Table 26) and the nature of flows through the channel (Table 27).

Table 26. Classification of channels according to channel size.

CHANNEL WIDTH	RESOURCE DESCRIPTION
>10 m	**Major Rivers**
2 – 10 m	**Rivers**
<2 m	**Streams**

Table 27. Classification of channels according to nature of flows.

	CHANNEL SECTION (CLASS)		
	"A" type	**"B" type**	**"C" type**
	Ephemeral systems	**Weakly ephemeral to seasonal systems**	**Perennial systems**
DESCRIPTION	A water-course that has no riparian habitat and no soil hydromorphy (ie. strongly ephemeral systems). Signs of wetness rarely persist in the soil profile	A water-course with riparian vegetation/habitat and intermittent base flow (ie. weakly ephemeral to non-perennial/seasonal systems). These channels show signs of wetness indicating the presence of water for significant periods of time.	A water-course with permanent-type riparian vegetation/habitat, permanent base flow and permanent inundation (ie. perennial systems).
HYDROLOGY	A-section channels are situated well above the zone of saturation (no direct contact between surface water system and ground water system) and hence do not carry base-flows . They do however carry storm water runoff following intense rainfall events (ephemeral), but this is generally short-lived.	Channel bed situated within the zone of the seasonally fluctuating regional water table (ie. intermittent base flow depending on water table). Periods of no flow may be experienced during dry periods, with residual pools often remaining within the channel.	Water course is situated within the zone of the permanent saturation, meaning flow is all year round except in the case of extreme drought.
TOPOGRAPHICAL POSITION	Valley head (upper reaches of catchments). Channel type also linked to steep slopes which are responsible for water leaving the system rapidly.	Mid-section of valley (middle reaches of catchments).	Valley bottom areas (middle to lower reaches of catchments).
DIAGRAM			

PHOTO			

A3 Riverine Present Ecological State – Index of Habitat Integrity (IHI)

Habitat is one of the most important factors that determine the health of river ecosystems since the availability and diversity of habitats (in-stream and riparian areas) are important determinants of the biota that are present in a river system (Kleynhans, 1996). The 'habitat integrity' of a river refers to the "*maintenance of a balanced composition of physic-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region*" (Kleynhans, 1996). It is seen as a surrogate for the assessment of biological responses to driver changes.

The IHI (Index of Habitat Integrity)1996, version 2 (Kleynhans, 2012) was used to assess habitat integrity and is based on an interpretation of the deviation from the reference condition for the river reach assessed and is approached from both an instream and riparian zone perspective. Specification of the reference state is followed by an impact-based approach, whereby the extent and intensity of anthropogenic impacts are interrogated to interpret the level of modification to the primary drivers of river health, namely hydrology, geomorphology and physic-chemical conditions. Naturally, the severity of impacts on habitat integrity will vary according to the natural characteristics of different rivers, with particular river types being inherently more sensitive to certain types of impacts than others. The IHI assessment involved the assessment and rating of a range of criteria for instream and riparian habitat (see Box 1, below) scored individually (using an impact magnitude rating scale from 0-25) using Table 28 as a guide. This assessment is informed by a site visit to a specific section of the river but is refined based on a desktop review of reach and catchment-scale impacts based on available aerial photography and land cover information.

Table 28. Rating table used to assess impacts to river systems.

Impact Class	Description	Score
A: Natural	No discernible impact, or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.	0
B: Good	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability is also very small.	1-5
C: Fair	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability is also limited.	6-10
D: Poor	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.	11-15
E: Seriously modified	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area is affected. Only small areas are not influenced.	16-20

Impact Class	Description	Score
F: Critically modified	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21-25

Box 1. *Criteria assessed in the Index of Habitat Integrity* (after Kleynhans, 1996).

- ***Water abstraction:*** Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
- ***Flow modification*:** Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
- ***Inundation*:** Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments (Gordon *et al.*, 1992).
- ***Bed modification:*** This has a direct bearing on the amount and availability of substrate characteristics of available habitats. Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment. Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation is also included.
- ***Bank erosion*:** Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.
- ***Channel modification:*** May be the result of a change in flow which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included. Any densification of woody exotic species would lead to channel shape change through increased sediment deposits. This has serious implications for more extensive bank over-topping during flood events with increased scouring along outer edges of the Dry Bank. It is the extremes, i.e. drought or very wet events, which are particularly crucial sensitive periods to be considered.
- ***Water quality:*** Originates from point and diffuse point sources. Measured directly or agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
- ***Inundation:*** Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments (Gordon *et al.*, 1992).
- ***Exotic macrophytes:*** Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
- ***Exotic fauna***: The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance.
- ***Solid waste disposal***: A direct anthropogenic impact which may alter habitat structurally. Also a general indication of the misuse and mismanagement of the river.
- ***Vegetation removal:*** Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river. Refers to physical removal for farming, firewood and overgrazing. Includes both exotic and indigenous vegetation.
- ***Exotic vegetation:*** Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone.
- ***Connectivity:*** Relates to changes that influence the movement of aquatic biota, both laterally onto adjacent floodplain areas and longitudinal movement upstream and downstream. These modifications can affect the life-history stage requirements and recolonization options for instream biota.

A4 Riverine Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) of riparian areas is an expression of the importance of the aquatic resource for the maintenance of biological diversity and ecological functioning on local and wider scales; whilst Ecological Sensitivity (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007). For the purposes of this assessment, the EIS assessment for riparian areas was based on rating the following criteria using the scheme in Table 29:

- **Riparian & in-stream biota**: referring to the presence and status of biota (*including fauna & flora).* This includes aspects of species richness/diversity, the presence of rare/endangered species, unique species/endemics, species that are sensitive to changes in flows/water quality.

- **Riparian & in-stream habitat:** including the diversity of habitat types within the in-stream and riparian zones, the sensitivity of habitats to changes in flow/water quality and the importance of riparian areas as migration routes/ecological corridors as well as the conservation importance of areas.

Table 29. Rating scheme used to rate EIS for riparian areas.

CRITERIA	RATING SCORE				
	0	1	2	3	4
Presence of rare/endangered species Presence of unique/endemic species Presence of species considered intolerant/sensitive to changes in flows/water quality	None	Low	Moderate	High	Very High
Diversity of habitat types Presence of refugia/Refuge value of habitat types Habitat sensitivity to changes in flow Habitat sensitivity to changes in water quality Importance in terms of migration routes/ecological corridors	Very Low	Low	Moderate	High	Very High
Conservation importance	None	Low (Local level)	Moderate (Provincial level)	High (National level)	Very High (National/ International level)

The scores assigned to the criteria in Table 29 were used to rate the overall EIS of each mapped unit according to Table 30, below, which was based on the criteria used by DWS for river eco-classification (Kleynhans & Louw, 2007) and the WET-Health wetland integrity assessment method (Macfarlane *et al.*, 2008).

Table 30. EIS classes used to inform the assessment (after Kleynhans & Louw, 2007).

EIS Score	EIS Rating	General Description
0	None/ Negligible	Features that are highly transformed and have no ecological importance at any scale. Such features have a very low sensitivity to anthropogenic disturbances.
1	Very Low	Features are not ecologically important and sensitive at any scale. The biodiversity of these areas is typically ubiquitous with low sensitivity to anthropogenic disturbances and play an insignificant role in providing ecological services.
2	Low	Features regarded as somewhat ecologically important and sensitive at a local scale. The functioning and/or biodiversity features have a low-medium sensitivity to anthropogenic disturbances. They typically play a very small role in providing ecological services at the local scale.
3	Medium	Features that are considered to be ecologically important and sensitive at a local scale. The functioning and/or biodiversity of these features is not usually sensitive to anthropogenic disturbances. They typically play a small role in providing ecological services at the local scale.
4	High	Features that are considered to be ecologically important and sensitive at a regional scale. The functioning and/or biodiversity of these features are typically moderately sensitive to anthropogenic disturbances. They typically play an important role in providing ecological services at the local scale.
5	Very High	Features that are considered ecologically important and sensitive on a national or even international level. The functioning and/or biodiversity of these features are usually very sensitive to anthropogenic disturbances. This includes areas that play a major role in providing goods and services at a local or regional level.

A5 Macro-invertebrate sampling and analysis (SASS5)

The composition and structure of aquatic invertebrate communities provides a useful indication of the ecological condition of rivers. A variety of invertebrate organisms (e.g. insect larvae, snails, crabs, worms) require specific aquatic habitat types and water quality conditions for at least part of their life cycle. As most invertebrates are relatively short-lived and remain in one area during their aquatic life phase, they are particularly good indicators of localised conditions in a river over the short term (months). The South African Scoring System or SASS 5 (Dickens & Graham, 2002) is a rapid bio-assessment method for determining the health or condition of rivers based on sampling aquatic macroinvertebrate communities. It can be applied to river health and water quality monitoring (Dickens and Graham, 2002) and to gauge the ecological state of aquatic ecosystems (Thirion, 2007). This technique has been accredited to ISO17025 standards and forms part of one of the DWS river ecoclassification models for EcoStatus determination. The SASS is a relatively simple index that is based on the families of aquatic invertebrates present at the site. Generally depending on the occurrence of different aquatic taxa, which have different pollution tolerance ratings, each bio-indicator assessment provides an indication of the state of health of the river. The scores range on a scale from 1 to 15, with 1 assigned to taxa tolerant of poor or variable water quality and 15 assigned to taxa that are intolerant to poor or fluctuating water quality. Generally the higher the index (e.g. SASS score or ASPT) the better the health, or condition, of a river. Interpretation of the results obtained was done using the Ecological Categories or "Biological Bands" of Dallas (2007). The bands are region-specific aggregations of SASS score and ASPT Values into categories which indicate the condition or health of a reference site in that region. Higher SASS and ASPT values place the site into categories of better condition or health. The descriptions of the various bands are shown in Table 31, below.

Note that SASS sampling was undertaken for the Mtwalume River based on the suitability of available in-stream habitat for the application of the technique. SASS was not undertaken for the smaller tributaries due to lack of suitable habitat for the purposes of this assessment.

Table 31. Biological bands or ecological categories used to define stream condition (Dallas, 2007).

Biological Band / Ecological Category	Ecological Category Name	Description
A	Natural	No or negligible modification of in-stream and riparian habitats and biota.
B	Good	Ecosystems essentially in good state; biodiversity largely intact
C	Fair	A few sensitive species may be lost; lower abundances of biological populations may occur.
D	Poor	Habitat diversity and availability have declined; mostly only tolerant species present; species present are often diseased; population dynamics have been disrupted (e.g. biota can no longer breed or alien species have invaded the ecosystem).
E	Seriously modified	Loss of habitat availability and high levels of pollution, result in few families being present due to the loss on most intolerant forms.

A6 Physico-chemical water quality sampling and analysis

In situ physic-chemical water quality variables were measured and recorded at elected sites using a YSI Pro Series hand-held meter in addition to water samples which were collected analysis at a SANAS accredited laboratory, where necessary. These parameters were sampled to provide prevailing physico-chemical water quality, as well as to provide ancillary data to interpret SASS analyses. Water quality results were compared to the Target Water Quality Range (TWQR) for aquatic ecosystems as set out by DWAF (1996). Table 32 below provides descriptions of the various TWQR effects on aquatic biota.

Table 32. Descriptions of Target Water Quality Range (TWQR) for aquatic ecosystems (DWAF, 1996).

Category	Description and effect
Target Water Quality Range (TWQR) for aquatic ecosystems	The Target Water Quality Range (TWQR) is the range of concentrations or levels within which no measurable adverse effects are expected on the health of aquatic ecosystems, and should therefore ensure their protection.
Chronic Effect Value (CEV) for aquatic ecosystems	The Chronic Effect Value (CEV) is defined as that concentration or level of a constituent at which there is expected to be a significant probability of measurable chronic effects to up to 5 % of the species in the aquatic community. If such chronic effects persist for some time and/or occur frequently, they can lead to the eventual death of individuals and disappearance of sensitive species from aquatic ecosystems. This can have considerable negative consequences for the health of aquatic ecosystems, since all components of aquatic ecosystems are interdependent.
Acute Effect Value (AEV) for aquatic ecosystems	The Acute Effect Value (AEV) is defined as that concentration or level of a constituent above which there is expected to be a significant probability of acute toxic effects to up to 5 % of the species in the aquatic community. If such acute effects persist for even a short while, or occur at too high a frequency, they can quickly cause the death and disappearance of sensitive species or communities from aquatic ecosystems. This can have considerable negative consequences for the health of aquatic ecosystems, even over a short period.

A7 Impact significance assessment

Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). The degree of significance depends upon three dimensions: the measurable characteristics of the impact (e.g. intensity, extent and duration), the importance societies/communities place on the impact (or resource being affected), and the likelihood / probability of the impact occurring. In light of this understanding, significance can only be assessed if one knows the importance or value of the environmental change/impact. Thus, end point or eventual impacts that can be valued like impacts to water resources, ecosystem services and biodiversity conservation can only be assessed in terms of significance and are referred to as ultimate consequences of an activity or a suite of impacts. Put another way, the significance of an impact to the environment or ecosystem can only be assessed in terms of the change to ecosystem services, resources and biodiversity value associated with that system or component being assessed.

For the purposes of this assessment, the assessment of potential impacts was undertaken using an "Impact Assessment Methodology for EIAs" adopted by Eco-Pulse (2015). This assessment was informed by baseline aquatic information contained in this report relating to the sensitivity of habitats and potential occurrence of protected species as well as information on the proposed development provided by the client and experience in similar projects in South Africa. The approach adopted is to identify and predict all potential primary and secondary/indirect impacts resulting from an activity from origin (e.g. catchment land hardening) to end point (e.g. loss of ecosystem services as a result of erosion). Thereafter, the approach is to rate intensity as the realistic worst case consequence (end-point / ultimate) of an activity (according to Table 33 below) and then assess the likelihood of this consequence occurring as well as the extent and duration of the impact.

Impact significance = (impact intensity + impact extent + impact duration) x impact likelihood.

This formula is based on the basic risk formula: **Risk = consequence x probability**

Table 33. Criteria and numerical values for rating environmental impacts.

Score	Rating	Description
Intensity (I) – defines the magnitude and importance of the impact		
16	**High**	Loss of human life. Deterioration in human health. High impacts to water resources: · Critical / severe local scale (or larger) ecosystem modification/degradation and/or collapse. · Critical / severe local scale (or larger) modification (reduction in level) of ecosystem services and/or loss of ecosystem services. Critical / severe ecosystem impact description: Impact affects the continued viability of the systems/components and the quality, use, integrity and functionality of the systems/components permanently ceases and are irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible, rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation. · Extinction of habitat type or serious impact to future viability of a critically endangered habitat type. · Extinction of species or serious impact to survival of critically endangered species.
8	**Moderately-High**	· Loss of livelihoods. · Individual economic loss. Moderately-high impacts to water resources: · Large local scale (or larger) ecosystem modification/degradation and/or collapse. · Large local scale (or larger) modification (reduction in level) of ecosystem services and/or loss of ecosystem services. Large ecosystem impact description: Impact affects the continued viability of the systems/components and the quality, use, integrity and functionality of the systems/components are severely impaired and may temporarily cease. High costs of rehabilitation and remediation, but possible. · Measurable reduction in extent of endangered and critically endangered habitat types. · Measurable reduction in endangered and critically endangered floral and faunal populations.

Score	Rating	Description
4	**Moderate**	Moderate impacts to water resources: · Moderate local scale (or larger) ecosystem modification/degradation and/or collapse. · Moderate local scale (or larger) modification (reduction in level) of ecosystem services and/or loss of ecosystem services. Moderate ecosystem impact description: Impact alters the quality, use and integrity of the systems/components but the systems/ components still continue to function but in a moderately modified way (integrity and functionality impaired but major key processes/drivers somewhat intact / maintained). · Measurable reduction in vulnerable habitat types. · Measurable reduction in non-threatened habitat types resulting in an up-listing to threatened status. · Measurable reduction in near-threatened and vulnerable floral and faunal populations. · Measurable reduction in non-threatened floral and faunal populations resulting in an up-listing to threatened status.
2	**Moderately-Low**	Moderately-low impacts to water resources: · Small but measurable local scale (or larger) ecosystem modification / degradation. · Small but measurable local scale (or larger) modification (reduction in level) of ecosystem services and/or loss of ecosystem services. Small ecosystem impact description: Impact alters the quality, use and integrity of the systems/components but the systems/ components still continue to function, although in a slightly modified way. Integrity, function and major key processes/drivers are slightly altered but are still intact / maintained. · Reduction in non-threatened endangered habitat types with no up-listing to threatened status. · Reduction in non-threatened floral and faunal populations with no up-listing to threatened status.
1	**Low**	Negative change to onsite characteristics but with no impact on: · Human life · Human health · Local water resources, local ecosystem services and/or key ecosystem controlling variables · Threatened habitat conservation/representation · Threatened species survival
Extent (E) – relates to the extent of the Impact Intensity		
5	**Global**	The scale/extent of the impact is global/worldwide.
4	**National**	The scale/extent of the impact is applicable to the Republic of South Africa
3	**Regional**	Impact footprint includes the greater surrounding area within which the site is located (e.g. between 20-200km radius of the site).
2	**Local**	Impact footprint extends beyond the cadastral boundary of the site to include the areas adjacent and immediately surrounding the site (e.g. between a 0-20km radius of the site).
1	**Site**	Impact footprint remains within the cadastral boundary of the site.
Duration (D) – relates to the duration of the Impact Intensity		
5	**Permanent**	The impact will continue indefinitely and is irreversible.
4	**Long-term**	The impact and its effects will continue for a period in excess of 30 years. However, the impact is reversible with relevant and applicable mitigation and management actions.
3	**Medium-term**	The impact and its effects will last for 10-30 years. The impact is reversible with relevant and applicable mitigation and management actions.
2	**Medium-short**	The impact and its effects will continue or last for the period of a relatively long construction period and/or a limited recovery time after this construction period, thereafter it will be entirely negated (3 – 10 years). The impact is fully reversible.
1	**Short-term**	The impact and its effects will only last for as long as the construction period and will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 3 years). The impact is fully reversible.
Probability (P) – relates to the likelihood of the Impact Intensity		
1	**Definite**	More than 75% chance of occurrence. The impact is known to occur regularly under similar conditions and settings.
0.75	**Highly Probable**	The impact has a 41-75% chance of occurring and thus is likely to occur. The impact is known to occur sporadically in similar conditions and settings.

Score	Rating	Description
0.5	**Possible**	The impact has a 10-40% chance of occurring. This impact may/could occur and is known to occur in low frequencies under the similar conditions and settings.
0.2	**Unlikely**	The possibility of the impact occurring is low with less than 10% chance of occurring. The impact has not been known to occur under similar conditions and settings.
0.1	**Improbable**	The possibility of the impact occurring is negligible and only under exceptional circumstances.

Table 34. Impact significance categories and definitions.

Impact Significance	Impact Significance Score Range	Definition
High	**18 - 26**	Unacceptable and fatally flawed. Impact should be avoided and limited opportunity for offset/compensatory mitigation. The proposed activity should only be approved under special circumstances.
Moderately High	**13 – 17.9**	Generally unacceptable unless offset/compensated for by positive gains in other aspects of the environment that are of critically high importance (i.e. national or international importance only). Strict conditions and high levels of compliance and enforcement are required. The potential impact will affect a decision regarding the proposed activity require that the need and desirability for the project be clearly substantiated to justify the associated ecological risks.
Moderate	**8 – 12.9**	Impact has potential to be significant but is acceptable provided that there are strict conditions and high levels of compliance and enforcement. If there is reasonable doubt as to the successful implementation of the strict mitigation measures, the impact should be considered unacceptable. The potential impact should influence the decision regarding the proposed activity and requires a clear and substantiated need and desirability for the project to justify the risks.
Moderately Low	**5 – 7.9**	Acceptable with moderately-low to moderate risks provided that specific/generic mitigation applied and routine inspections undertaken. The potential impact may not have any meaningful influence on the decision regarding the proposed activity.
Low	**0 – 4.9**	The potential impact is very small or insignificant and should not have any meaningful influence on the decision regarding the proposed activity. Basic duty of care must be ensured.

A confidence rating was also given to the impacts rated in accordance with Table 35, below:

Table 35. Confidence ratings used when assigning impact significance ratings.

Level of confidence	Contributing factors affecting confidence
Low	A low confidence level is attributed to a low-moderate level of available project information and somewhat limited data and/or understanding of the receiving environment.
Medium	The confidence level is medium, being based on specialist understanding and previous experience of the likelihood of impacts in the context of the development project with a relatively large amount of available project information and data related to the receiving environment.
High	The confidence level is high, being based on quantifiable information gathered in the field.

ANNEXURE B: Impact significance assessment results for construction and operation ecological impacts

Construction Phase Impact Significance Assessment								
IMPACT SIGNIFICANCE: Un-Mitigated								
No.	**IMPACT**	**Status**	**Extent**	**Intensity**	**Duration**	**Probability**	**Significance**	**Confidence**
1	**Destruction, loss and physical modification of aquatic vegetation & habitat**	Negative	Local	Moderately-High	Permanent	Highly Probable	**Moderate**	Medium
2	**Flow modification**	Negative	Local	Moderately-High	Short term	Highly Probable	**Moderate**	Low
3	**Erosion & sedimentation**	Negative	Local	Moderately-High	Long term	Highly Probable	**Moderate**	Medium
4	**Pollution of water resources**	Negative	Local	Moderately-High	Medium term	Possible	**Moderately Low**	Low
IMPACT SIGNIFICANCE: With Mitigation								
No.	**IMPACT**	**Status**	**Extent**	**Intensity**	**Duration**	**Probability**	**Significance**	**Confidence**
1	**Destruction, loss and physical modification of aquatic vegetation & habitat**	Negative	Site	Moderate	Permanent	Highly Probable	**Moderately Low**	Medium
2	**Flow modification**	Negative	Local	Moderate	Short term	Highly Probable	**Moderately Low**	Low
3	**Erosion & sedimentation**	Negative	Site	Moderately-High	Short term	Possible	**Moderately Low**	Medium
4	**Pollution of water resources**	Negative	Site	Moderate	Short term	Unlikely	**Low**	Low

Operation Phase Impact Significance Assessment								
IMPACT SIGNIFICANCE: Un-Mitigated								
No.	**IMPACT**	**Status**	**Extent**	**Intensity**	**Duration**	**Probability**	**Significance**	**Confidence**
1	**Destruction, loss and physical modification of aquatic vegetation & habitat**	Negative	Local	Moderately-High	Long term	Highly Probable	**Moderate**	Medium
2	**Flow modification**	Negative	Local	Moderately-High	Long term	Highly Probable	**Moderate**	Low
3	**Erosion & sedimentation**	Negative	Local	Moderately-High	Long term	Highly Probable	**Moderate**	Medium
4	**Pollution of water resources**	Negative	Local	Moderately-Low	Long term	Possible	**Low**	Low
IMPACT SIGNIFICANCE: With Mitigation								
No.	**IMPACT**	**Status**	**Extent**	**Intensity**	**Duration**	**Probability**	**Significance**	**Confidence**
1	**Destruction, loss and physical modification of aquatic vegetation & habitat**	Negative	Site	Moderately-High	Medium term	Possible	**Moderately Low**	Medium
2	**Flow modification**	Negative	Local	Moderately-High	Long term	Possible	**Moderately Low**	Low
3	**Erosion & sedimentation**	Negative	Site	Moderately-High	Long term	Possible	**Moderately Low**	Medium
4	**Pollution of water resources**	Negative	Local	Moderately-Low	Long term	Possible	**Low**	Low

ANNEXURE C1: Results of the IHI assessment for R02: Mtwalume River

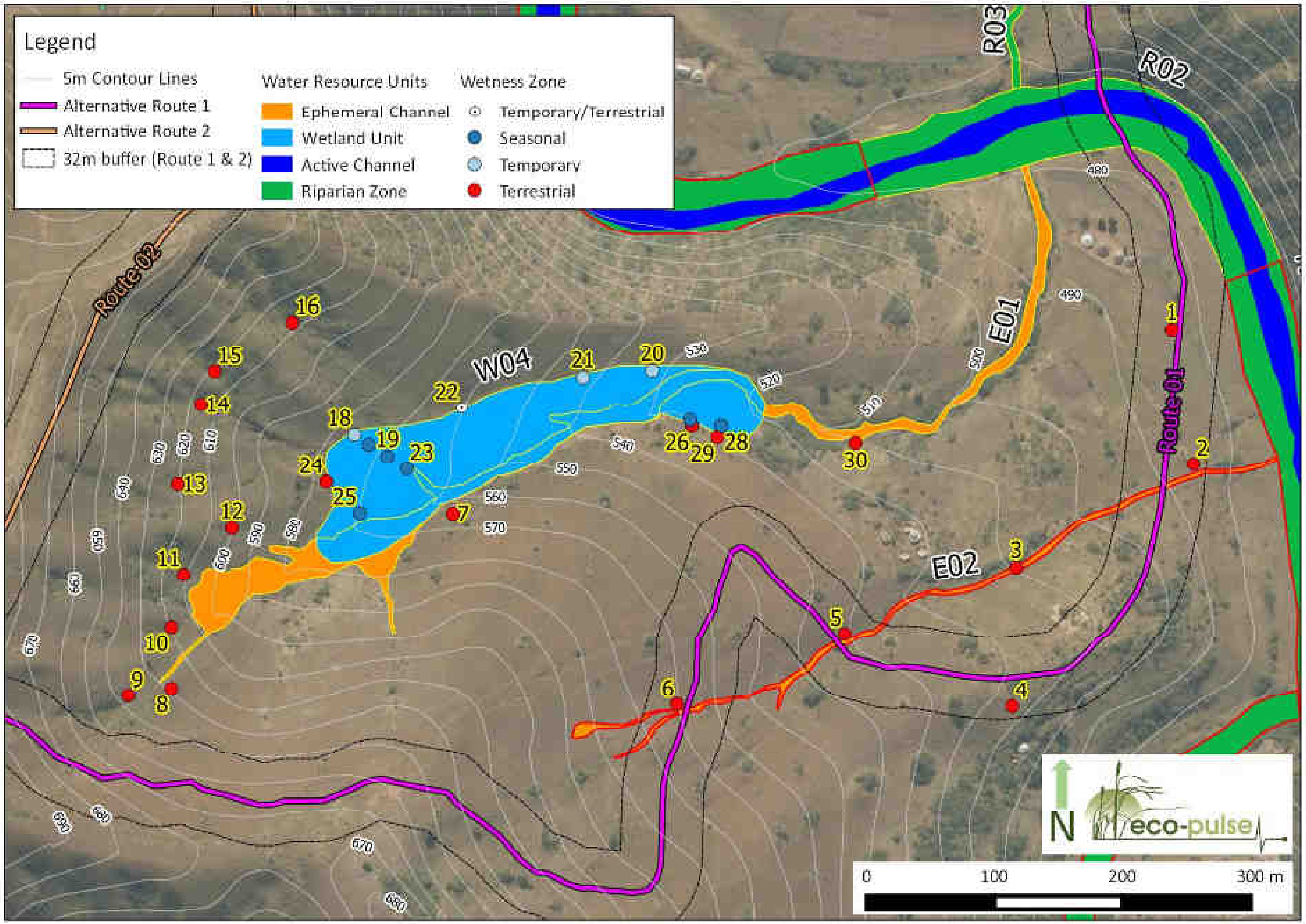
River IHI (Kleynhans, 1996)				
Project Name	*Ntatshana Road & Bridge*			
Assessor(s)	*BM, RvD, ATL*			
Date	*2015/08/17*			
General Descriptors				
River Reach ID	**R02**			
Channel Type	Large River			
River Sinuosity	Sinuous			
Perenniality	Perennial			
Bed Type	Mixed bedrock-alluvial			
CRITERIA	***Instream Score (0-25)***	***Instream Impact Rating***	***Riparian Score (0-25)***	***Riparian Impact Rating***
VEGETATION CONDITION				
Vegetation Removal	*N/A*	*N/A*	4	Very Low
Exotic Vegetation/Introduced macrophytes	2	Very Low	10	Low
Score	*2.0*	Very Low	*7.0*	Low
GEOMORPHIC/STRUCTURAL INTACTNESS				
Channel modification	3	Very Low	2	Very Low
Bank erosion/modification	*N/A*	*N/A*	2	Very Low
Bed modification/scouring	*5*	Very Low	*N/A*	*N/A*
Score	*4.0*	Very Low	*2.0*	Very Low
HYDROLOGICAL MODIFICATION				
Flow modification	*7*	Low	4	Very Low
Water abstraction	*6*	Low	3	Very Low
Changes to inundation period/level of inundation	*4*	Very Low	2	Very Low
Score	*5.7*	Low	*3.0*	Very Low
WATER COLUMN MODIFICATION				
Water quality (physico-chem alteration)	*2*	Very Low	0	None
Waste/Rubbish dumping	*2*	Very Low	0	None
Score	*2.0*	Very Low	*0.0*	None
IMPACTS TO AQUATIC BIOTA				
Introduced/alien fauna	*2*	Very Low	*N/A*	*N/A*
Score	*2.0*	Very Low	*N/A*	*N/A*
	PES	PES (%)	Ecological Category	
Overall Instream Habitat PES	*3.1*	*87.5*	*B: Good*	
Overall Riparian Habitat PES	*3.0*	*88.0*	*B: Good*	
Overall River PES	**3.1**	**87.7**	*B: Good*	

ANNEXURE C2: Results of the IHI assessment for R04: tributary stream

River IHI (Kleynhans, 1996)				
Project Name	*Ntatshana Road & Bridge*			
Assessor(s)	*BM, RvD, ATL*			
Date	*2015/08/17*			
General Descriptors				
River Reach ID	**R03**			
Channel Type	Stream			
River Sinuosity	Straight			
Perenniality	Perennial			
Bed Type	Mixed bedrock-alluvial			
CRITERIA	***Instream Score (0-25)***	***Instream Impact Rating***	***Riparian Score (0-25)***	***Riparian Impact Rating***
VEGETATION CONDITION				
Vegetation Removal	*N/A*	*N/A*	14	Moderate
Exotic Vegetation/Introduced macrophytes	5	Very Low	18	High
Score	*5.0*	Very Low	*16.0*	High
GEOMORPHIC/STRUCTURAL INTACTNESS				
Channel modification	12	Moderate	8	Low
Bank erosion/modification	*N/A*	*N/A*	8	Low
Bed modification/scouring	*12*	Moderate	*N/A*	*N/A*
Score	*12.0*	Moderate	*8.0*	Low
HYDROLOGICAL MODIFICATION				
Flow modification	*8*	Low	4	Very Low
Water abstraction	*3*	Very Low	1	Very Low
Changes to inundation period/level of inundation	*6*	Low	2	Very Low
Score	*5.7*	Low	*2.3*	Very Low
WATER COLUMN MODIFICATION				
Water quality (physio-chem alteration)	*10*	Low	4	Very Low
Waste/Rubbish dumping	*4*	Very Low	0	None
Score	*7.0*	Low	*2.0*	Very Low
IMPACTS TO AQUATIC BIOTA				
Introduced/alien fauna	*2*	Very Low	*N/A*	*N/A*
Score	*2.0*	Very Low	*N/A*	*N/A*
	PES	PES (%)	Ecological Category	
Overall Instream Habitat PES	*6.3*	*74.7*	*C: Fair*	
Overall Riparian Habitat PES	*7.1*	*71.7*	*C: Fair*	
Overall River PES	**6.6**	**73.5**	*C: Fair*	

ANNEXURE D: Results of the wetland delineation and soil sampling within the valley associated with E01 and E02

D1: Map showing delineated wetland habitat/features and the location of soil sampling points.



D2: Record of soil samples for the sample sites shown on the map in D1.

Soil Sample Point	Soil Type	HUE/VALUE/ CHROMA	Soil Description	Sample at depth 0-20cm	Sample at depth 20-50cm	Soil Core
1	Terrestrial (non-wetland)	7.5YR 3/2	Dry, brown, sandy loam with no signs of mottling			
2	Terrestrial (non-wetland)	7.5YR 3/3	Dry, brown, Sandy loam with high soil matrix chroma value and no signs of mottling			

Soil Sample Point	Soil Type	HUE/VALUE/ CHROMA	Soil Description	Sample at depth 0-20cm	Sample at depth 20-50cm	Soil Core
3	Terrestrial (non-wetland)	7.5YR 3/3	Dry, brown, Sandy loam with high soil matrix chroma value and no signs of mottling			
4	Terrestrial (non-wetland)	7.5YR 3/4	Dry, Brown, Loam with high soil matrix chroma value and no signs of mottling		Shallow bedrock encountered at 20cm	

Soil Sample Point	Soil Type	HUE/VALUE/ CHROMA	Soil Description	Sample at depth 0-20cm	Sample at depth 20-50cm	Soil Core
5	Terrestrial (non-wetland)	7.5YR 4/4	Dry, Brown, Loam with high soil matrix chroma value and no signs of mottling			
6	Terrestrial (non-wetland)	7.5YR 4/6	Dry, Brown, Loam with high soil matrix chroma value and no signs of mottling		N/A	N/A

Soil Sample Point	Soil Type	HUE/VALUE/ CHROMA	Soil Description	Sample at depth 0-20cm	Sample at depth 20-50cm	Soil Core
7	Terrestrial (non-wetland)	7.5YR 4/4	Dry, Brown, Sandy loam with high soil matrix chroma value and no signs of mottling			
8	Terrestrial (non-wetland)	10YR 3/3	Dry, Dark Brown, Loam with no signs of mottling			

Soil Sample Point	Soil Type	HUE/VALUE/ CHROMA	Soil Description	Sample at depth 0-20cm	Sample at depth 20-50cm	Soil Core
9	Terrestrial (non-wetland)	10YR 4/3	Dry, Dark Brown, loam with no signs of mottling		N/A	
10	Terrestrial (non-wetland)	10YR 3/3	Dry, Dark brown, loam with no signs of mottling			

Soil Sample Point	Soil Type	HUE/VALUE/ CHROMA	Soil Description	Sample at depth 0-20cm	Sample at depth 20-50cm	Soil Core
11	Terrestrial (non-wetland)	10YR 3/3	Dry, Dark brown, Sandy clay loam with no signs of mottling			N/A
12	Terrestrial (non-wetland)	10YR 2/1	Dry, Very Dark Brown, Sandy clay loam with no signs of mottling		N/A	

Soil Sample Point	Soil Type	HUE/VALUE/ CHROMA	Soil Description	Sample at depth 0-20cm	Sample at depth 20-50cm	Soil Core
13	Terrestrial (non-wetland)	10YR 2/1	Dry, Black, Sandy clay with no signs of mottling		N/A	
14	Terrestrial (non-wetland)	10YR 3/2	Dry, Dark brown, Loam with no signs of mottling		N/A	

Soil Sample Point	Soil Type	HUE/VALUE/ CHROMA	Soil Description	Sample at depth 0-20cm	Sample at depth 20-50cm	Soil Core
15	Terrestrial (non-wetland)	10YR 3/2	Dry, Dark brown, loam with no signs of mottling		N/A	
16	Terrestrial (non-wetland)	10YR 3/2	Dry, Dark Brown, Sandy loam with no signs of mottling			

Soil Sample Point	Soil Type	HUE/VALUE/ CHROMA	Soil Description	Sample at depth 0-20cm	Sample at depth 20-50cm	Soil Core
17	Seasonal wetland	10YR 4/1	Moist, Dark Gray, Clay loam with a high abundance of mottles			N/A
18	Temporary wetland	10YR 4/1	Moist, Dark Gray, Clay loam with few orange mottles			
19	Seasonal wetland	10YR 3/1	Moist, Very Dark Gray, Clay with many mottles		N/A	N/A

Soil Sample Point	Soil Type	HUE/VALUE/ CHROMA	Soil Description	Sample at depth 0-20cm	Sample at depth 20-50cm	Soil Core
20	Temporary wetland	10YR 4/2	Moist, Dark Grayish Brown, Clay loam with few yellow mottles		N/A	N/A
21	Temporary wetland	10YR 3/1	Moist, Dark Gray, Clay loam with few mottles		N/A	N/A
22	Marginal wetland	10YR 3/1	Dry, Dark Gray, Clay loam with very faint mottles			

Soil Sample Point	Soil Type	HUE/VALUE/ CHROMA	Soil Description	Sample at depth 0-20cm	Sample at depth 20-50cm	Soil Core
23	Seasonal wetland	10YR 4/1	Moist, Dark Gray, Clay with orange mottles		N/A	N/A
24	Terrestrial (non-wetland)	10YR 4/3	Dry, Dark Brown, Loam with no signs of mottling		N/A	N/A
25	Seasonal wetland	10YR 4/1	Moist, Dark Gray Brown, Clay with yellow mottles	N/A		N/A

Soil Sample Point	Soil Type	HUE/VALUE/ CHROMA	Soil Description	Sample at depth 0-20cm	Sample at depth 20-50cm	Soil Core
26	Terrestrial (non-wetland)	10YR 4/3	Dry Dark Brown, Loam with no signs of mottling		N/A	N/A
27	Seasonal wetland	10YR 4/2 10YR 3/1	Moist, Dark Grayish Brown – Very Dark Gray, Sandy clay with orange mottles		N/A	N/A
28	Seasonal wetland	10YR 3/1	Wet, Black, Clay with a high abundance of mottles		N/A	N/A

Soil Sample Point	Soil Type	HUE/VALUE/ CHROMA	Soil Description	Sample at depth 0-20cm	Sample at depth 20-50cm	Soil Core
29	Terrestrial (non-wetland)	10YR 3/4	Dry, Brown, Loam with high soil matrix chroma value and no signs of mottling		N/A	N/A
30	Terrestrial (non-wetland)	10YR 4/3	Moist, Brown, Clay with high soil matrix chroma value and no signs of mottling	N/A		N/A