‘Kingsburgh Residential Estate’
Portions of Erven 2954, 2955 & 2957
eThekwini Municipality, KwaZulu-Natal

Aquatic Assessment Report

Version 1.0

Rev. 0

Date: 20th July 2018

Eco-Pulse Environmental Consulting Services

Report No: EP377-01

Prepared for: **Dan's Spares cc**

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Contact: **C.J. Dannhauser**

Prepared by: **Eco-Pulse Environmental Consulting Services cc**

26 Mallory Road, Hilton, 3245, South Africa

Contact person: **Mr. Adam Teixeira-Leite**

Wetland & Aquatic Ecologist (*Pr.Sci.Nat*.)

Cell: 082 310 6769

E-mail: ateixeira@eco-pulse.co.za

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SPECIALIST ASSESSMENT REPORT DETAILS AND DECLARATION OF INDEPENDENCE

This is to certify that the following report has been prepared as per the requirements of Section 32 (3) of the NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (Act No. 107 OF 1998) ENVIRONMENTAL IMPACT ASSESSMENT REGULATIONS 2014 as per Government Notice No. 38282 GOVERNMENT GAZETTE, 4 DECEMBER 2014 (as amended) as well as the requirements of the Department of Water & Sanitation for Water Use Licensing and wetland/aquatic assessment, as outlined in the 'Regulations Regarding the Procedural Requirements for Water Use License Applications and Appeals' contained in the Government Gazette No. 40713 of 24 March 2017.

Document Title:	Kingsburgh Residential Estate: ***Aquatic Assessment Report***
Report No.	EP377-01
Version	1.0
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Date:	20th July 2018
Report prepared by:	**Mr Shaun McNamara** (M.Sc Geography)
Internally Reviewed & signed off by:	**Mr Adam Teixeira-Leite** (BSc. Hons. Environmental Science) Professional Natural Scientist (*Pr. Sci. Nat.*) (Ecological Science) Senior Scientist/ Wetland and Aquatic Ecologist
Client:	Dan's Spares cc

I, **Shaun McNamara**, hereby declare that this report has been prepared independently of any influence or prejudice as may be specified by the Department of Environmental Affairs and Department of Water & Sanitation.

Signed: ______________________ Date: 20th July 2018

DETAILS OF PROJECT TEAM

The relevant experience of specialist team members from Eco-Pulse Consulting involved in the assessment and compilation of this report are briefly summarized below. *Curriculum Vitae's* of the specialist team are available on request.

Specialist	Role	Details
Adam Teixeira-Leite *Pr.Sci.Nat.* Senior Scientist & Ecologist	Project leader, Internal review	Adam is a Senior Environmental Scientist at Eco-Pulse with a BSc. Honours degree in *Environmental Science: Earth Sciences*, research Msc (Water & Environmental Management): *in prep.* He is a registered Professional Natural Scientist (Pr. Sci. Nat.) with 10 years' experience, having worked extensively on numerous specialist ecological assessment projects, both for wetland/aquatic and terrestrial (grasslands and forests) habitats and ecosystems in KZN, the Free State, Gauteng, Eastern Cape, Western Cape and Lesotho. He is also experienced in undertaking alien plant surveys and developing ecological rehabilitation and management plans and programmes.
Ross van Deventer Environmental Scientist	Fieldwork	Ross van Deventer has an MSc (Environmental Science) with training in integrated environmental management along with specialist training in the field of water resource management and aquatic science. His MSc research focused on water quality and ecological integrity of stream networks in the upper uMngeni catchment in response to catchment land use impacts. His specialised training is further complemented by experience gained at Eco-Pulse Environmental Consulting Services in a number of wetland and riparian assessments. This includes wetland and riparian delineation, Present Ecological State and Ecological Importance and Sensitivity assessments. He is competent in the application of current best practise guidelines and assessments tools and is accredited in the application of the SASS5 bio-monitoring technique.
Shaun McNamara Junior Environmental Scientist	Fieldwork & Lead Author	Shaun is an intern at Eco-Pulse with an Honours degree in Environmental Water Management, with a strong focus on integrated catchment management and wetland ecology. He also holds a MSc (Research Masters) in Geography with his dissertation focusing on fluvial geomorphology and processes of wetland formation and evolution. Shaun has experience in the collection and analysis of data relating to geomorphology and wetland assessments.

EXECUTIVE SUMMARY

Dan's Spares cc (the 'Applicant') intends to establish a residential development on portions of ERF 2954, ERF 2955 and ERF 2957, Kingsburgh, eThekwini Municipality, KwaZulu-Natal. This report sets out the findings of the Specialist Aquatic Assessment undertaken by Eco-Pulse in June/July 2018 as part of the requirements for environmental authorization and water use licensing for this development project. The main findings of this report have been summarized below as follows:

Catchment Context:

i. The area of study is located within the **Pongola-Mtamvuna WMA** (Water Management Area) and within DWS **Quaternary catchment U70F**. A seasonal stream runs through the middle of the property in a southerly direction where it meets and discharges into the **Little Manzimtoti River** Borders the property boundary to the South. The Little Manzimtoti Estuary is approximately 0.5km downstream of the property. Two ephemeral streams drain the eastern portion of the property.

Baseline Wetland PES & EIS:

ii. Several watercourses were identified within the DWS regulated area for water use consideration (i.e. 500m radius of the development property). These watercourses were assessed and screened in terms of their potential risk of being impacted by the proposed development. The results of this screening process highlighted **one (1) seasonal mountain stream** and **two (2) ephemeral mountain streams** that were rated as being risk of being potentially impacted by the development.

iii. The findings of the baseline aquatic assessment showed that, owing to a range of existing impacts, all three stream units (R01, R02 and R03) were in a **'largely modified' ('D' PES class)** state with a **'Moderately-Low' to 'Low' EIS** rating.

iv. IMPORTANTLY, NO WETLANDS WERE IDENTIFIED WITHIN 500M OF THE DEVELOPMENT AT RISK OF BEING POTENTIALLY IMPACTED BY THE DEVELOPMENT PROJECT.

Resource Management Objectives & Recommendations:

v. Future management of the riverine ecosystems associated with the development should be informed by the recommended management objectives for the water resource. In the absence of the classification, water resource management objectives are generally based on the current state 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.***

Aquatic Impacts & Risk Management:

vi. 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 most significant impacts linked with the project are likely to be associated with the **(i) risk of increased sediment inputs and turbidity during construction, (ii) the risk of modifying natural/pre-development flow characteristics with the development of hardened surfaces and (iii) possible leakages/spills from wastewater pipelines during the operation of the development.** Under **a 'good' management scenario** (i.e. taking into consideration the impact mitigation recommendations made by Eco-Pulse and contained in the specialist aquatic assessment report), the **significance of impacts is expected to be reduced to relatively 'low' environmentally 'acceptable' levels.**

vii. Most aquatic ecological impacts can be effectively mitigated on-site by:

1. **Ensuring that direct impacts to streams are avoided wherever possible** through ecologically sound and sustainable development layout planning that takes into account the location and sensitivity of the remaining ecological infrastructure at the site and through implementing relevant aquatic buffer zones (15m width prescribed);
2. **Employing creative design principles and ecologically sensitive methods** in infrastructure design and layouts to minimise the risk of indirect impacts;
3. **Ensuring that storm water management design and implementation takes into account the requirements of the environment**, including wetlands and rivers; and
4. Taking necessary efforts aimed at **minimising/reducing potential wastewater inputs into streams.**

Avoiding sensitive riparian areas and applying appropriate buffer zones and restricting activities within this zone (15m buffer zone recommended), supplemented by the application of on-site practical mitigation measures and management principles to control erosion, sedimentation and water pollution impacts and risks will be necessary to reduce the significance of impacts and ensure the sustainable management of the water resources and ecological infrastructure on the property (and downstream). Water resource management and mitigation is dealt with in detail under Chapter 6 of this report.

Water Use Licensing Requirements:

viii. The proposed **development requires a Water Use License (WUL) in terms of Chapter 4 and Section 21 (c) and (i)** of the National Water Act No. 36 of 1998 and this must be secured prior to the commencement of construction. Key activities that constitute a 'non-consumptive' water use in terms of Section 21 (c) and (i) include:

- Construction of wastewater (sewer) pipelines across watercourses; and
- Storm water runoff management from the operation of the development.

There are no consumptive water uses identified (no abstraction or storage of water), hence Section 21 (a) and (b) water uses do not apply. Since wastewater will be managed by tying in to an existing wastewater pipeline to the regional/municipal WWTW (Waste Water Treatment Works) for treatment and disposal offsite, Section 21 (g) water use also does not apply to the project.

Given that wastewater pipelines are to be constructed and installed as part of this project (with crossings of river R01 planned), this development does not meet the DWS conditions for a General Authorisation for 21 (c) and (i) water uses under this scenario and **a full WULA will therefore be required.**

Conclusion:

ix. Based on the impact significance assessment undertaken by Eco-Pulse, **there are no potential 'fatal flaws'** associated with the proposed development project from an aquatic ecosystems perspective and **the proposed development is generally considered acceptable,** granted that the impact mitigation and management measures (provided in Chapter 6) are applied to best-practice standards and in accordance with the recommendations made by the aquatic ecologists from Eco-Pulse. A water use license for Section 21 (c) & (i) water uses associated with the management of storm water runoff and for the sewer pipeline crossings of river R01 will be required prior to construction commencing. A Water Use License Application (WULA) process must therefore be undertaken.

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DEFINITION OF TERMS

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.
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).
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 Type	This is a combination between wetland vegetation group and Level 4 of the National Wetland Classification System, which describes the Landform of the wetland.
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)
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)
HOA	Home Owners Association
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)
Ow	Obligate wetland species
NWA	National Water Act No.36 of 1998
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
VU	Vulnerable (threat status)

1 BACKGROUND & INTRODUCTION

1.1 Project Background & Locality

Dan's Spares cc (the 'Applicant') intends to establish a residential development on portions of ERF 2954, ERF 2955 and ERF 2957, Kingsburgh, eThekwini Municipality, KwaZulu-Natal. The proposed development will occupy 3 'nodes' within a greater property boundary (Figure 1). The nodes are located on elevated ridge lines and are separated from each other by steep and densely vegetated valleys. Each node is set to include numerous residential units and other ancillary/associated residential infrastructure and services. A portion of the development property borders the Doon Heights Primary School to its east. The Kingsburgh Wastewater Treatment Works (WWTW) facility is located south of the property on the southern side of the Little Manzimtoti River. East of the property is the Shulton Park suburb of the town of Kingsburgh. The property is approximately 1.2 km west of the N2 Highway and 1.8 km inland from the Indian Ocean.

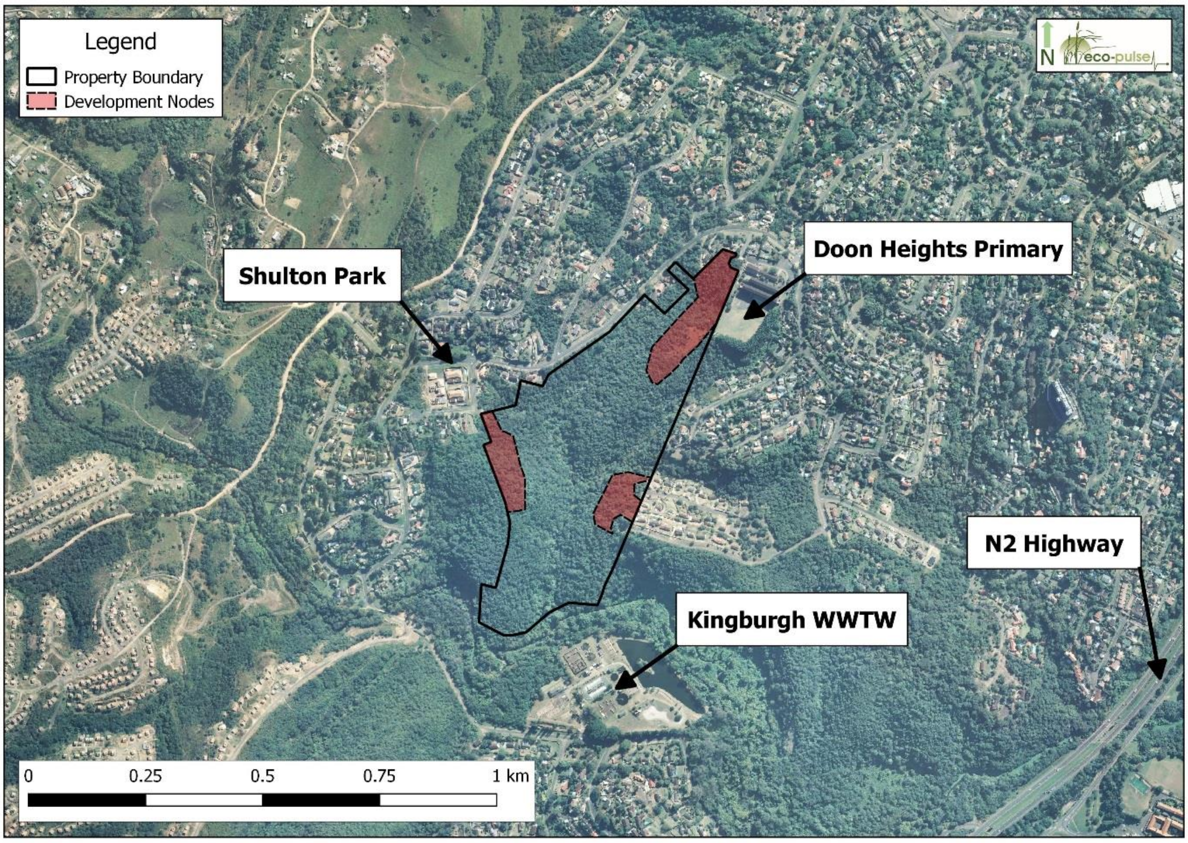

Figure 1 Map showing the location and extent of the property boundary (outlined in 'black' and development nodes (shaded in 'red') relative to Kingsburgh WWTW, the N2 Highway, Doon Heights Primary School and the Shulton Park suburb of Kingsburgh town Estuary.

1.2 Scope of Work

The specialist Freshwater (Aquatic) Habitat Impact Assessment was undertaken as per the following scope of work:

1. Contextualization of the study area in terms of important biophysical characteristics and aquatic conservation planning using available spatial datasets and conservation plans.
2. Desktop identification, delineation/mapping and 'impact/risk likelihood screening assessment' of all watercourses (includes rivers, riparian areas and wetlands) within the DWS 'regulated area' (i.e. within a 500m radius of the proposed development activities).
3. Delineation of all watercourses occurring within the study area according to the methods contained in the manual '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas'* (DWAF, 2005).
4. Classification of delineated wetlands/rivers using the latest National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al.,* 2013).
5. Application of the DWS "Risk Assessment Matrix" for watercourses likely to be impacted by the development, as detailed in the General Authorisation in terms of Section 39 of the National Water Act No. 36 of 1998 for Water Uses as defined in Section 21 (C) and/or Section 21 (I), as contained in Government Gazette No. 40229, 26 August 2016 and contained within the DWS document titled 'Section 21(c) and (i) Risk-based assessment and authorization, October 2014, Edition 2'.
6. Present Ecological State (PES) and ecological/functional importance and sensitivity (EIS) assessment for water resources (wetlands and rivers) deemed to be measurably impacted (based on the desktop impact/risk screening assessment and field investigations), as outlined below:
    a. Rapid riparian vegetation and habitat survey.
    b. Qualitative Index of Habitat Integrity (QIHI) assessment (Kleynhans, 1996) to establish the Present Ecological State (PES) of rivers/streams.
    c. Assessment of the present Ecological Importance and Sensitivity (EIS) of the delineated wetland and river units using the DWAF EIS tools (Duthie, 1999 and Kleynhans, 1999, respectively).
7. Identification and description of the direct and indirect aquatic ecological impacts of the construction and operation phases of the proposed development.
8. Recommendations for impact mitigation in line with the 'mitigation hierarchy', which seeks first to avoid impacts, then minimize potential impacts and finally rehabilitate or offset to compensate for residual impacts to wetlands/rivers. This included:
    a. Provision of suitable aquatic buffer zones in accordance with the latest National Aquatic Buffer Zone Guidelines (Macfarlane & Bredin, 2016).
    b. Key storm water management recommendations.

   c. Best practice sewer and water pipeline alignment measures.
   d. Provision of ecological monitoring recommendations.
9. Identification and reporting on any permit/licensing requirements that may be relevant to the site (for example protected plant permits/water use license requirements).
10. Description of assumptions made and any uncertainties or gaps in knowledge.
11. Reporting: Compilation of a single Specialist Freshwater (Aquatic) Habitat Impact Assessment Report including all relevant maps and supporting information.

1.3 Key Definitions and Concepts

Under Section 1(1)(xxiv) of the National Water Act No. 36 of 1998 (NWA), a 'watercourse' is defined as:

a) a **river** or **spring**;
b) a **natural channel** in which water flows regularly or intermittently;
c) a **wetland, lake or dam** into which, or from which, water flows; and
d) 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.

This assessment focuses on the assessment of all natural watercourses and their associated habitats / ecosystems likely to be measurably affected by the proposed development, focussing specifically on wetlands, streams and rivers. For the purposes of this assessment, wetlands, streams and rivers are defined as follows:

- **Wetlands** are areas that have water on the surface or within the root zone for extended periods throughout the year such that anaerobic soil conditions develop which favour the growth and regeneration of hydrophytic vegetation (plants which are adapted to saturated and anaerobic soil conditions). In terms of Section 1 of the NWA, wetlands are legally defined as: (1) "…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."
- **Rivers and streams** are natural channels that are permanent, seasonal or temporary conduits of freshwater. In terms of ecological habitats, rivers and streams comprise in-stream aquatic habitat and riparian habitat. Generally, riparian zones mark the outer edge of stream and river systems. Streams and rivers are differentiated in terms of channel dimensions and generally fall within the broad category of rivers / riverine ecosystems in this report.
- **Instream habitat** is the aquatic habitat (or alluvial in the case of intermittent / ephemeral watercourses) within the active channel that includes the water column, river bed and the inundated active channel margins, and associated vegetation. In terms of Section 1 of the NWA, instream habitat is legally defined as habitat that includes "…the physical structure of a watercourse and the associated vegetation in relation to the bed of the watercourse."

- A **riparian zone** is a habitat, comprising bare soil, rock and/or vegetation that is: (i) associated with a watercourse; (ii) commonly characterised by alluvial soils; and (iii) inundated or flooded to an extent and with a frequency sufficient to support vegetation species with a composition and physical structure distinct from those of adjacent land areas (DWAF, 2005a). In terms of Section 1 of the NWA, riparian habitat is legally defined as: 'habitat that "…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."

1.4 Conservation and Functional Importance of Aquatic Ecosystems

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*)*. Recent studies reveal that less than one third of South Africa's main rivers are considered to be in an ecologically 'natural' state, with the principal threat to freshwater systems being human activities, including river regulation, followed by catchment transformation (Rivers-Moore & Goodman, 2009). 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 Overview of Relevant Environmental Legislation

The link between ecological integrity of freshwater resources and their continued provision of valuable ecosystem goods and services to burgeoning populations is well-recognised, both globally and nationally (Rivers-Moore *et al.,* 2007). In response to the importance of freshwater aquatic resources, protection of wetlands and rivers has been campaigned at national and international levels. A strong legislative framework which backs up South Africa's obligations to numerous international conservation agreements creates the necessary enabling legal framework for the protection of freshwater resources in the country. Relevant environmental legislation pertaining to the protection and use of aquatic ecosystems (i.e. wetlands and rivers) in South Africa has been included in Table 1 below.

Table 1. Description of relevant environmental legislation.

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 Licenced and un-licenced 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 Licence 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 to wetlands/rivers 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.

2 APPROACH & METHODS

2.1 General Approach

The general approach to the freshwater aquatic baseline assessment was based on the proposed framework for wetland assessment proposed in the Water Research Commission's (WRC) report titled: '*Development of a decision-support framework for wetland assessment in South Africa and a Decision-Support Protocol for the rapid assessment of wetland ecological condition*' (Ollis *et al*., 2014). This is shown graphically below in Figure 2.

Note that the aquatic assessment report has also been developed in line with the National Environmental Management Act No. 107 of 1998 and the requirements of the Department of Water & Sanitation (DWS) for Water Use Licensing, as outlined in the 'Regulations Regarding the Procedural Requirements for Water Use License Applications and Appeals' contained in the Government Gazette No. 40713 of 24 March 2017.

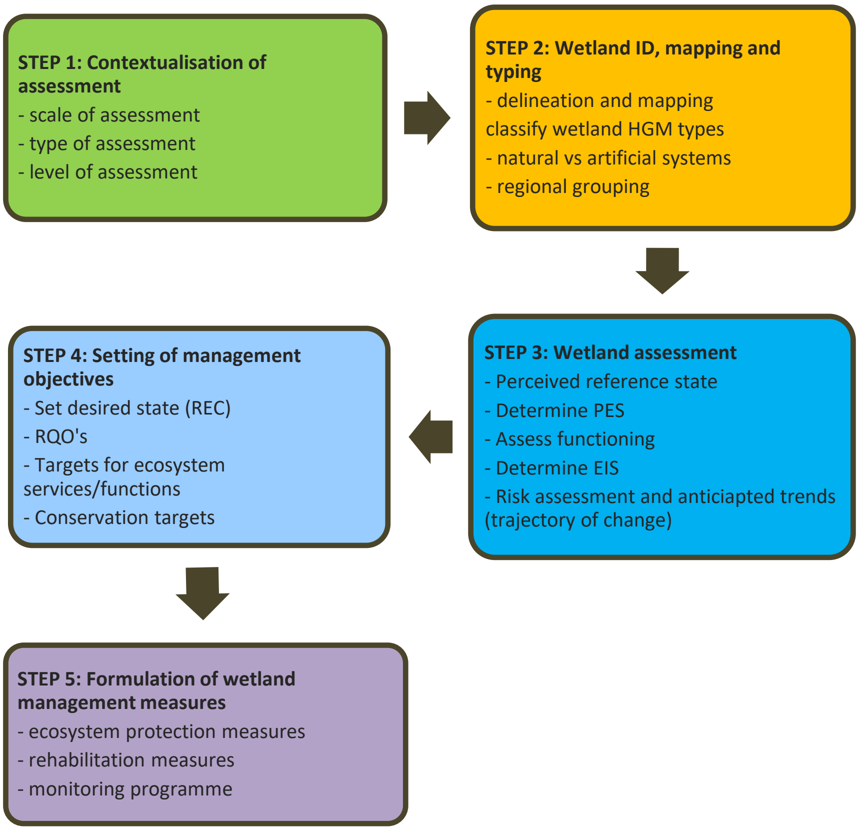

Figure 2 Proposed decision-support framework for wetland assessment in SA (after Ollis et al., 2014).

2.2 Methods Used

2.2.1 Desktop Review of Freshwater Ecosystem Context

As freshwater ecosystems are linear features that are often connected over regional scales, it is of vital importance to contextualise the freshwater ecosystems in the study area in terms of local and regional biophysical and drainage settings, as well as in terms of conservation and water resource management planning. Such an understanding will assist in the assessment of the importance and sensitivity of the onsite freshwater ecosystems, the setting of management objectives and the assessment of the significance of anticipated impacts.

A. Review of Biophysical & Conservation Context

The following (Table 2) desktop biophysical and conservation planning data sources and GIS spatial information were consulted to inform the assessment:

Table 2. Data sources and GIS information consulted to inform the Aquatic Assessment.

Data/Coverage Type	Relevance	Source
	Biophysical Context	
Quaternary catchment MAP, MAT, MAR and PET	*Determination of climatic factors that drive freshwater hydrology.*	Schulze, 1998
eThekwini Geology (GIS Coverage)	*Understand regional geology*	eThekwini Municipality
Geomorphic provinces of South Africa, Lesotho and Swaziland	*Understand regional geomorphology controlling the physical environment*	Partridge *et al.*, 2010
DWA Eco-regions (GIS Coverage)	*Understand the regional biophysical context in which water resources within the study area occur*	DWA (2005)
South African Vegetation Map (GIS Coverage)	*Classify vegetation types and determination of reference vegetation and its national threat status*	Mucina & Rutherford (2006)
KwaZulu-Natal Vegetation Map (GIS Coverage)	*Classify vegetation types and determination of reference vegetation and its provincial threat status*	Scott-Shaw and Escott (2011)
	Conservation Context	
National Freshwater Ecosystem Priority Areas (NFEPA) (GIS Coverage)	*Shows location of national aquatic ecosystems conservation priorities*	CSIR (2011)
National Biodiversity Assessment - Threatened Ecosystems (GIS Coverage)	*Freshwater ecosystem / vegetation type threat status*	SANBI (2011)
KwaZulu-Natal Provincial Pre-Transformation Vegetation Type Map (GIS Coverage)	*Classify vegetation types and determination of reference primary vegetation and its provincial threat status*	Scott-Shaw and Escott (2011)
KZN Terrestrial Systematic Conservation Plan MINSET (GIS Coverage)	*Provincial conservation planning importance.*	EKZNW (2011)
KZN Terrestrial Systematic Conservation Assessment (GIS Coverage)	*Provincial conservation planning importance.*	EKZNW (2016)
KZN Aquatic Systematic Conservation Plan (GIS Coverage)	*Provincial conservation planning importance.*	EKZNW (2007)
Durban Metropolitan Open Space System (D'MOSS) (GIS Coverage)	*Location and extent of open space systems and ecological corridors*	EThekwini Municipality (2011)
Durban Systematic Conservation Plan (GIS Coverage)	*Municipal conservation planning importance.*	Maclean *et al.* (2015)

B. Review of Available Studies & Freshwater Management Frameworks/ Guidelines

In addition to these conservation planning datasets, available wetland, river and estuarine studies were reviewed and summarised to provide an understanding of existing knowledge of the receiving aquatic environment. This included the following studies:

- *Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa (DWS, 2014).*
- *Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area (DWS, 2015).*
- *National Biodiversity Assessment 2011: National Estuary Biodiversity Plan for South Africa (Turpie et al., 2012).*
- *Estuaries of Durban, KwaZulu-Natal, South Africa. Report for the Environmental Management Department, eThekwini Municipality (Forbes and Demetriades, 2008).*

2.2.2 *Desktop Mapping*

Desktop delineations of all the watercourses within 500m of the proposed development was undertaken using available river datasets, 2m contour lines and colour aerial photography (eThekwini Municipality, 2015) supplemented by Google Earth™ imagery (where more up to date or historic imagery was needed). Digitization and mapping was undertaken using QGIS 2.18 GIS software. All of the mapped watercourses were then broadly subdivided into distinct resource units (i.e. classified as either riverine or wetland systems / habitat). This was undertaken based on topographic setting, aerial photographic analysis and professional experience in working in the region.

2.2.3 'Impact Potential' Screening Assessment

Following the desktop identification and mapping exercise, watercourses were assigned preliminary 'likelihood of impact' ratings based on the likelihood that activities associated with the proposed development will result in measurable direct or indirect changes to the mapped watercourse units within 500m of the proposed development. The 'impact potential' ratings were refined following the completion of the field work. Each watercourse unit was ascribed a qualitative 'impact potential' rating according to the ratings and descriptions provided in Table 3, below.

Table 3. Qualitative 'likelihood of impact' ratings and descriptions.

Likelihood of Impact Rating	Description of Rating Guidelines
High	These resources are likely to 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 located **within the footprint** of the proposed development activity and will definitely be impacted by the project; and/or • resources located **within 15m upstream and/or upslope** of the proposed development activity and trigger requirements for Environmental Authorisation according to the NEMA: EIA regulations; and/or • resources located **within 15m or downslope** of the development and trigger requirements for Environmental Authorisation according to the NEMA: EIA regulations; and/or • resources located downstream within the following parameters: o **within 15m downstream** of a low risk development; o **within 50m downstream** of a moderate risk development; and/or o **within 100m downstream** of a high risk development e.g. mining large industrial land uses.
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 located **within 32m but greater than 15m upstream, upslope or downslope** of the proposed development; and/or • resources located within a range at which they are likely to incur indirect impacts associated with the development (such as water pollution, sedimentation and erosion) based on development land use intensity and development area. This is generally resources located downstream within the following parameters: o **within 32m downstream** of a low risk development; o **within 100m downstream** of a moderate risk development; and/or o **within 500m downstream** of a high risk development (note that the extent of the affected area downstream could be greater than 500m for high risk

Likelihood of Impact Rating	Description of Rating Guidelines
	developments or developments that have extensive water quality and flow impacts e.g. dams / abstraction and treatment plants);
Low	These resources 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 located a distance upstream, upslope or downslope (>32m) of the proposed development and which are unlikely to be impacted by the development project; and/or • resources located downstream but well beyond the range at which they are likely to incur impacts associated with the development (such as water pollution, sedimentation and erosion). This is generally resources located downstream within the following parameters: ○ **greater than 32m downstream** of a low risk development; ○ **greater than 100m downstream** of a moderate risk development; and/or ○ **greater than 500m downstream** of a high risk development (note that the extent of the affected area downstream could be greater than 500m for high risk developments or developments that have extensive water quality and flow impacts e.g. dams / abstraction and treatment plants);
Very Low	These resources will not require impact assessment or a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: • resources located within another adjacent sub-catchment and which will not be impacted by the development in any way, shape or form.

2.2.4 Baseline Aquatic Assessment

The methods of data collection, analysis and assessment employed as part of the baseline freshwater habitat assessment are briefly discussed in this section. The assessments undertaken as part of this study are listed in Table 4 below along with the relevant published guidelines and assessment tools/methods/protocols utilised. A more comprehensive description of the methods listed below is included in **Annexure A**.

Table 4. Summary of methods used in the assessment of delineated water resource units.

Method/Technique		Reference for Methods/Tools Used	Annexure
Rivers	**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)*	**A2**
	River condition/PES	• *IHI (Index of Habitat Integrity) tool (Kleynhans, 1996)*	**A3**
	River Ecological Importance & Sensitivity (EIS)	• *Rapid DWAF EIS tool (Kleynhans, 1999).*	**A4**

2.2.5 *Impact Assessment*

While details of specific impacts will vary according to the site and development activity, aquatic/freshwater ecosystem impacts can typically be grouped into the following three (3) categories based on distinct impact-causing activities, ecosystem components and impact pathways:

A. **Direct habitat loss and modification impacts** – This impact type refers to the direct physical destruction and/or disturbance of freshwater habitat by human activities like vegetation / habitat clearing (stripping / grubbing), surface reshaping / alteration, earthworks (i.e. excavation and infilling) and flooding. This impact also includes the resultant impacts to ecosystem condition and ecosystem services but does not include the indirect hydrological, geomorphological and ecological impacts of such activities like flow modification, erosion and sedimentation and associated downstream habitat degradation.

B. **Indirect flow modification, erosion and/or sedimentation impacts** – This impact type refers to all of the indirect impacts resulting from and associated with human activities that alter wetland/river hydrological and geomorphological (erosion and sedimentation) processes and structures like: (i) direct physical habitat modification; (ii) catchment and buffer zone land cover modification and transformation (e.g. vegetation clearing, surface hardening, stormwater management and cultivation); and (iii) flow regulation, abstraction and controlled discharges. This impact also includes the resultant impacts to ecosystem condition and ecosystem services.

C. **Water pollution impacts** – This impact refers to the alteration or deterioration in the physical, chemical and biological characteristics of water within watercourses and the associated ecological impacts. In the context of this impact assessment, water quality refers to its fitness for maintaining the health of aquatic ecosystems and for current uses, domestic and agricultural.

The significance of each impact type in terms of the above listed impact characteristics was assessed in terms of the ultimate impact consequences or end-points (i.e. impacts to resources of known societal value) in line with the National Wetland Offset Guidelines (SANBI & DWS, 2014), namely:

(i) **Impacts to water resource supply and quality**: This addresses impacts to the quantity and quality of water provided by water resources. Such impacts may be the result of more direct impacts like abstraction, regulation and/or return discharges, and/or the result of freshwater ecosystem loss or degradation that affects the ability of watercourses to provide supporting regulating and supporting services.

(ii) **Impacts to ecosystem and habitat conservation (ecosystem biodiversity):** This deals specifically with impacts to quality and condition of habitat and the ability to meet conservation targets for freshwater ecosystems. This therefore accounts for the loss or change in freshwater habitat, which is particularly important for highly threatened ecosystem types.

(iii) **Impacts to species of conservation concern (species biodiversity)**: This addresses impacts on freshwater biota, with a particular emphasis on species or populations of conservation concern and the ability to meet species conservation targets.

(iv) **Impacts to local communities**: This deals with impacts to local communities reliant on freshwater ecosystem goods and services, specifically impacts to provisioning (e.g. water supply & cultivated foods) and cultural services (e.g. cultural significance or recreational values) of direct value to local users and consequences for human health, safety and livelihood support.

The approach to impact conceptualisation is depicted by the diagram in Figure 3, below.

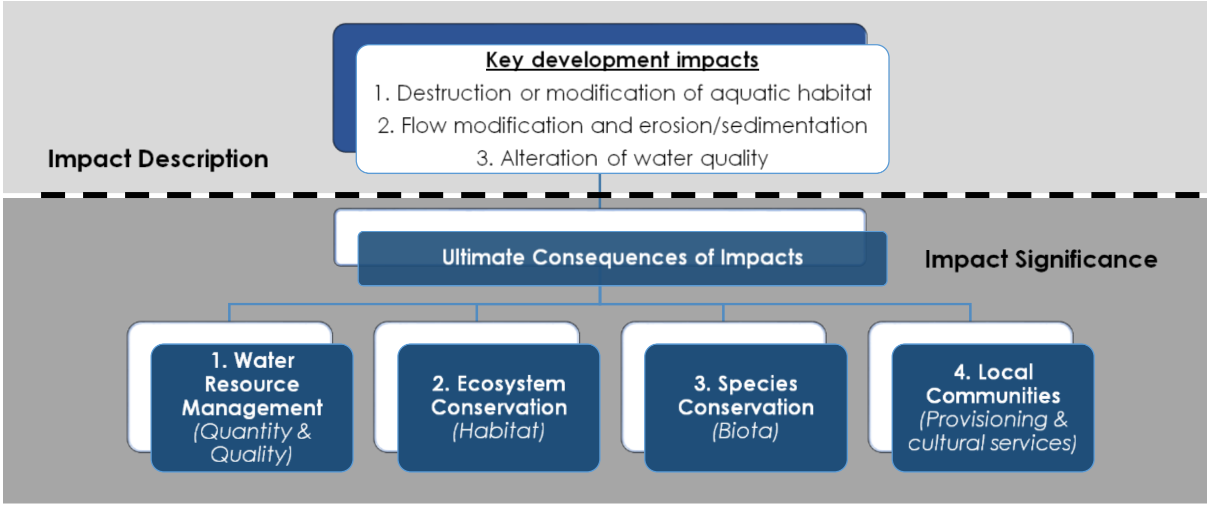

Figure 3 Diagram illustrating how the impact assessment framework is conceptualized.

The impact assessment was undertaken for the following mitigation scenarios only:

- **Realistic Poor Mitigation Scenario**: This scenario involves the implementation of the development plan and designs that are current proposed with the associated implementation of standard construction and operational phase mitigation measures. In terms of implementation success, this scenario assumes a realistic / likely poor implementation scenario based on the author's experience with such developments. It is important to note that it is our experience in similar development settings that contractor compliance with construction Environmental Management Programmes (EMPr) is poor and that operational maintenance is poor.
- **Realistic Good Mitigation Scenario**: This scenario involves the implementation of the development plan and designs that are current proposed with the associated implementation of the construction and operational phase mitigation measure recommended by the author. In terms of implementation success, this scenario assumes a realistic best-case scenario for implementation based on the author's experience with such developments.

2.2.6 DWS Aquatic Risk Assessment

Government Notice 509 of 2016 published in terms of Section 39 of the NWA sets out the terms and conditions for the General Authorisation of Section 21(c[1]) and 21(i[2]) water uses, key among which is that only developments posing a 'Low Risk' to watercourses can apply for a GA. Note that the GA does not apply to the following activities:

[1] 21(c): Impeding or diverting the flow of water in a watercourse

[2] 21(i): Altering the bed, banks, course or characteristics of a watercourse

- Water use for the rehabilitation of a wetland/river as contemplated in GA 1198 contained in GG 32805 (18 December 2009).
- Use of water within the 'regulated area'[3] of a watercourse where the Risk Class is **Medium or High.**
- Where any other water use as defined in Section 21 of the NWA must be applied for.
- Where storage of water results from Section 21 (c) and/or (i) water use.
- Any water use associated with the construction, installation or maintenance of any sewerage pipeline, pipelines carrying hazardous materials and to raw water and wastewater treatment works.

To this end, the DWS have developed a Risk Assessment Matrix/Tool to assess water risks associated with development activities. The DWS Risk Matrix/Assessment Tool (based on the DWS 2015 publication: 'Section 21 c and I water use Risk Assessment Protocol') was applied to the proposed project. The tool uses the following approach to calculating risk:

RISK = CONSEQUENCE X LIKELIHOOD Whereby: CONSEQUENCE = SEVERITY + SPATIAL SCALE + DURATION And LIKELIHOOD = FREQUENCY OF ACTIVITY + FREQUENCY OF IMPACT + LEGAL ISSUES + DETECTION

The key risk stressors[4] associated with each of the three impact groups / types considered were:

1. **Direct habitat loss and modification impacts** – Physical disturbance.
2. **Indirect flow modification, erosion and/or sedimentation impacts** – Erosive surface runoff, sediment and increased and/or reduced water inputs.
3. **Water pollution impacts** – Chemical, organic and biological pollutants.

For each of the above stressors, risk was assessed qualitatively using the DWS risk matrix tool. It is important to note that the risk matrix/assessment tool also makes provision for the downgrading of risk to low in borderline moderate/low cases subject to independent specialist motivation granted that (i) the initial risk score is within twenty five (25) risk points of the 'Low' class and that mitigation measures are provided to support the reduction of risk. The tool was applied to the project for the highest risk activities and watercourses to inform WUL requirements for the proposed development.

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[3] The 'regulated area' of a watercourse; for Section 21 (c) or (i) of the Act refers to:

i. *The outer edge of the 1:100 yr flood line and/or delineated riparian habitat, whichever is greatest, as measured from the centre of the watercourse of a river, spring, natural channel, lake or dam.*
ii. *In the absence of a determined 1:100 yr flood line or riparian area, refers to the area within 100m from the edge of a watercourse (where the edge is the first identifiable annual bank fill flood bench).*
iii. *A 500m radius from the delineated boundary of any wetland or pan.*

2.3 Assumptions, Limitations & Information Gaps

The following limitations and assumptions apply to the assessment:

2.3.1 General Assumptions & Limitations

- This report deals exclusively with a defined area and the extent and nature of freshwater/aquatic habitat and ecosystems in that area.
- 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.
- All field assessments were limited to day-time assessments.

2.3.2 Sampling Limitations & Assumptions

- With ecology being dynamic and complex, there is the likelihood that some aspects (some of which may be important) may have been overlooked.
- While disturbance and transformation of habitats can lead to shifts in the type and extent of freshwater ecosystems, it is important to note that the current extent and classification is reported on here.
- Sampling by its nature, means that generally not all aspects of ecosystems can be assessed and identified.
- All vegetation information recorded was based on the onsite observations of the author and no formal vegetation sampling was undertaken. Furthermore, the vegetation information provided only gives an indication of the dominant and/or indicator riparian species and only provides a general indication of the composition of the vegetation communities. Thus, the vegetation information provided has limitations for true botanical applications i.e. accurate and detailed species lists and rare / Red Data species identification.
- Not all watercourses within the 500m DWS regulated area were assessed/delineated in the field. Focal areas at risk of being impacted or triggering Section 21 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.
- Inferences made about the ecological integrity/health of the watercourses assessed was based on selected variables sampled on selected occasions at selected geographic locations. This limits the degree to which this information can be extrapolated spatially and temporally (i.e. over seasons). Watercourses by nature can be highly variable ecosystems and can display fine and large scales changes in the structure, composition and quality of the habitat over periods of time.
- No formal faunal survey was undertaken.

2.3.3 'Seasonality' of the Assessment

- A single site visit was undertaken in June 2018. This does not cover seasonal variability in flows and riverine vegetation.

- The location of the study area within the coastal zone of KZN (largely subtropical climate) means that climate has less of an effect on aquatic ecosystems and vegetation characteristics than typical Highveld inland systems which are exposed to more extreme variations in temperatures between seasons. Thus, vegetation response is limited and species structure and composition tend to remain the same or very similar between seasons.
- The purposes of field investigations were to gather information about the condition and sensitivity of watercourses onsite. Seasonality was not seen as a limiting factor in the collection of this information.

2.3.4 Baseline Ecological Assessment

- The PES and EIS assessments undertaken are largely qualitative assessment tools and thus the results are open to professional opinion and interpretation. We have made an effort to substantiate all claims where applicable and necessary.
- The EIS assessment did not specifically address the finer-scale biological aspects of the rivers such as occurrence of fauna (amphibians and invertebrates).
- Where necessary expert knowledge and insight was used to override prescriptive tools which may not capture subtleties that exist in the natural environment.

2.3.5 Assumptions with Respect to the Assessment of Impacts

- 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 projects.
- Evaluation of the significance of impacts with mitigation takes into account mitigation measures and best management practice, as provided in this report.

2.3.6 Assumptions with Respect to the Assessment of Risk

Risks were assessed based on the DWS Risk Assessment Matrix. The following assumptions apply to the application of the DWS risk matrix tool in the context of project in question:

- All risk ratings generated by the DWS risk matrix are conditional on the effective implementation of the specialist mitigation measures provided in this report.
- For the severity ratings, impacts to watercourses were assessed on their merits rather than automatically scoring impacts to watercourses as 'disastrous' as guided in the DWS risk matrix.
- The severity assessment for changes in flow regime and physico-chemical impacts were interpreted in terms of the changes to the local freshwater ecosystem represented by the potentially affected reaches.
- For the scoring of impact duration, the predicted change in PES was also considered which could override the actual duration of the impact where applicable e.g. if the impact duration was long term (typically a score of 4 out of 5) but the predicted change in PES is negligible, the impact duration was down-rated to a score of 2 in line with the duration criteria descriptions in the risk matrix tool.

3 DESKTOP ASSESSMENT FINDINGS

Understanding the biophysical and conservation context of the study area and surrounding landscape is important as it informs decision making regarding the significance of the area to be affected. In this regard, national, provincial and regional biophysical and conservation datasets were screened, the results of which are presented in the sections that follow.

3.1 Biophysical Context

3.1.1 Climatic Setting

On average the town of Amanzimtoti, which is 5 km north of Kingsburgh, receives approximately 783mm of rain per year. Most of this rainfall occurs during the mid-summer period. The lowest average rainfall occurs in June and July (16mm) while the highest occurs in January (109mm). The average mid-day temperatures for Amanzimtoti ranges from 22°C in July to 27°C in February (Figure 4). Source: http://www.saexplorer.co.za/south-africa/climate/amanzimtoti_climate.asp

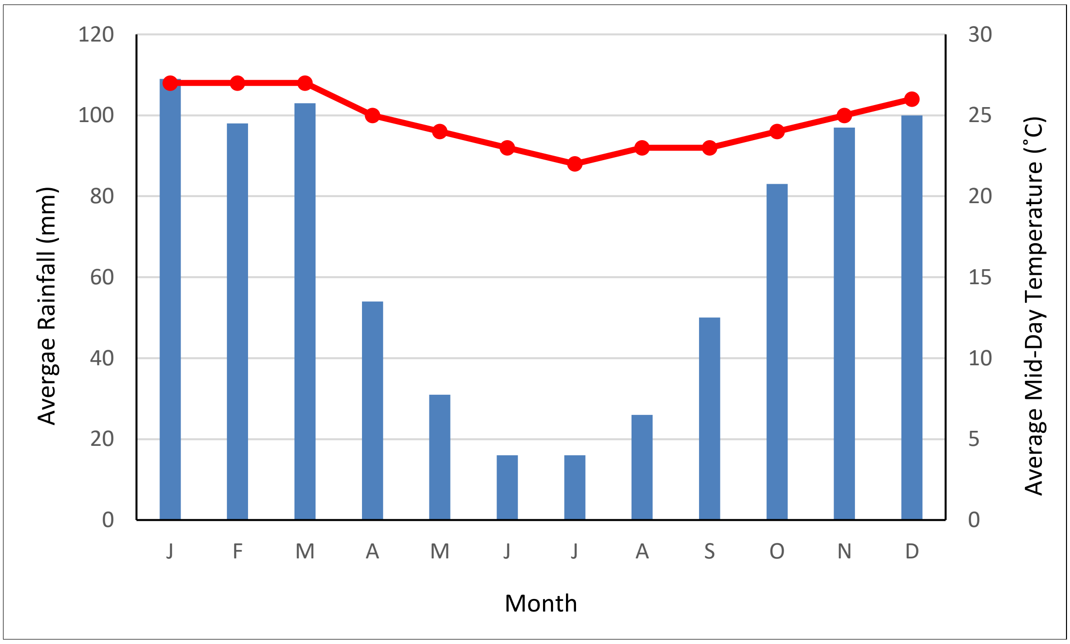

Figure 4 Climatograph for Amanzimtoti, near Kingsburgh. Data Source: (http://www.saexplorer.co.za/south-africa/climate/amanzimtoti_climate.asp)

3.1.2 Drainage Setting & Topography

The study area is located within DWS Quaternary Catchment **U70F**, near its divide with Quaternary Catchment U70D (Figure 5), in the Pongola - Mtamvuna Water Management Area (WMA). A seasonal stream runs through the middle of the property in a southerly direction where it meets and discharges into the **Little Manzimtoti River** Borders the property boundary to the South. The Little Manzimtoti Estuary is approximately 0.5km downstream of the property. Two ephemeral streams drain the eastern portion of the property. These watercourses converge with the seasonal stream near the centre of the property (Figure 5).

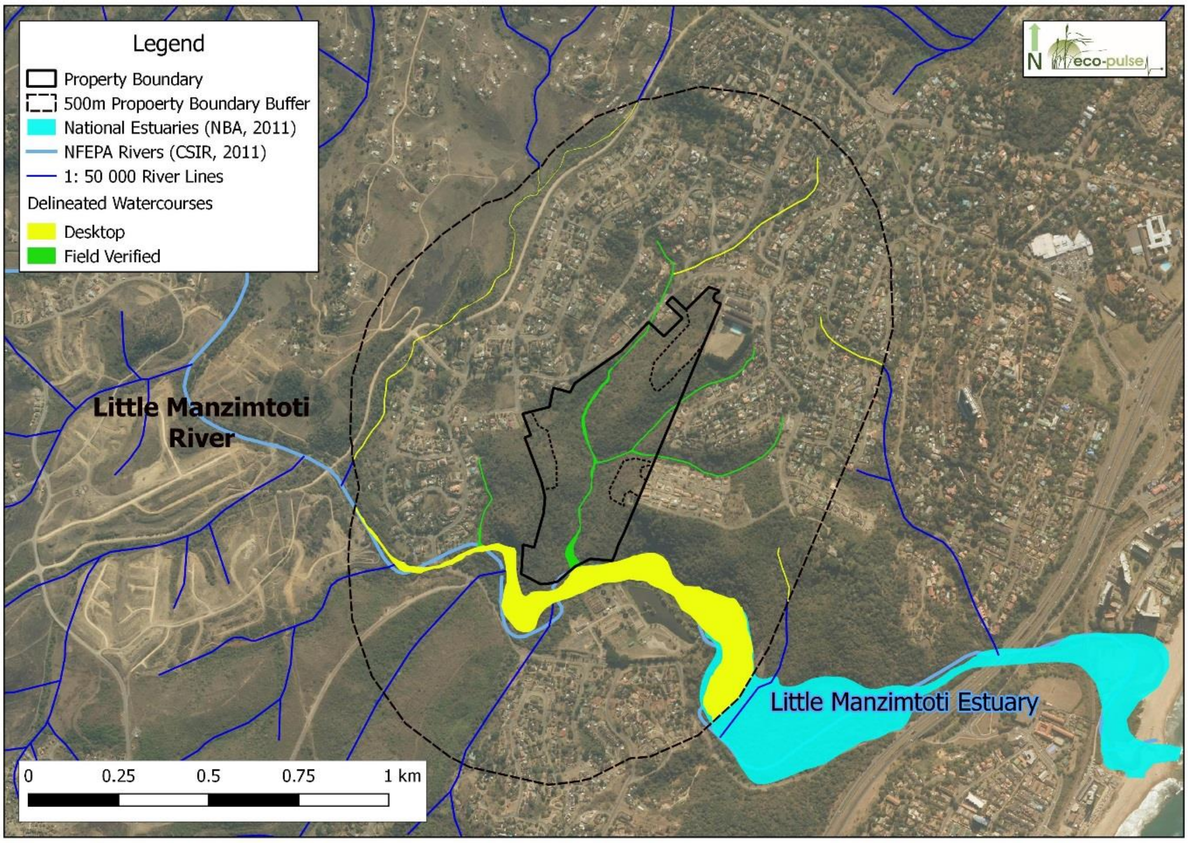

Figure 5 Map showing the local drainage network of the study area.

3.1.3 Geology & Soils

According to the geomorphic provinces of South Africa, Lesotho and Swaziland (Partridge *et al.,* 2010), the study area occurs within the South-Eastern Coastal Hinterland. This geomorphic province stretches from the Great Kei River in the Eastern Cape through to northern Swaziland. It is predominantly underlain by Karoo rocks (Ecca and Dwyka Groups in the north and Beaufort Group further south), whilst the hills in the area are capped by arenite (sandstone).

According to the Council for geoscience (2008) 1:1000 000 geological map of South Africa and the KZN Geology Map, the study area is underlain by Natal Group Sandstone characterised by Diamicite with varved shale, mudstone and fluvioglacial gravel.

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 aquatic ecosystems, habitats and associated biodiversity in the area. In this regard, national, provincial and regional conservation planning information available was used to obtain an overview of the study site. Key aquatic conservation context details of the project site and surrounds have been summarised in Table 5, below.

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

NATIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset	**Relevant Conservation Feature**	**Conservation Planning Status**	**Location in Relation to Project Site**
National Freshwater Ecosystem Priority Areas (NFEPA) (CSIR, 2011)	Wetlands	Non-FEPA Wetlands (estuary)	Downstream of the development site
	Rivers	Non-FEPA Rivers	
PROVINCIAL AND REGIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset	**Relevant Conservation Feature**	**Conservation Planning Status**	**Location in Relation to Project Site**
KZN Aquatic Conservation Plan (EKZNW, 2007)	Catchment area	'Available'	Site and Catchment

3.2.1 *Reference Vegetation Types & Threat Status*

According to the National Vegetation Map (Mucina & Rutherford, 2006) the reference[5] vegetation type for the study area is 'KwaZulu-Natal Coastal Belt' (CB 3), which is classified as 'Endangered' at a National-level according to the National Biodiversity Assessment (SANBI, 2011).

According to the Provincial Vegetation Types for KwaZulu-Natal (Scott-Shaw & Escott, 2011), the entire study is similarly classified as 'KwaZulu-Natal Coastal Belt Grassland' (CB 3) and is considered 'Critically Endangered' at a Provincial conservation planning level. Importantly, vegetation within the study area has been largely transformed by urban encroachment and the introduction of alien invasive species. Therefore the study area is no longer considered representative of the natural coastal grassland that would have formerly characterised the area prior to human development.

3.2.2 *Conservation Planning Context*

A. National Freshwater Ecosystem Priority Area (NFEPA) Assessment (CSIR 2011)

The National Freshwater Ecosystem Priority Areas (NFEPA) project 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, which includes rivers, wetlands and estuaries. The importance of water resources in meeting national freshwater conservation targets is provided in the National Freshwater Ecosystems Priority Areas (NFEPA) outputs and coverage's (CSIR, 2011). According to the NFEPA project spatial outputs:

- The Little Manzimtoti River is not considered a river FEPA due to the poor condition of the river and poor water quality;

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[5] It is important to note that these are broad reference vegetation types and it cannot be assumed that current and/or remaining vegetation communities or ecosystem types represent these reference types. These broad types do not account for habitat loss, modification or degradation.

- The Little Manzimtoti Estuary has not been identified as wetland FEPA;

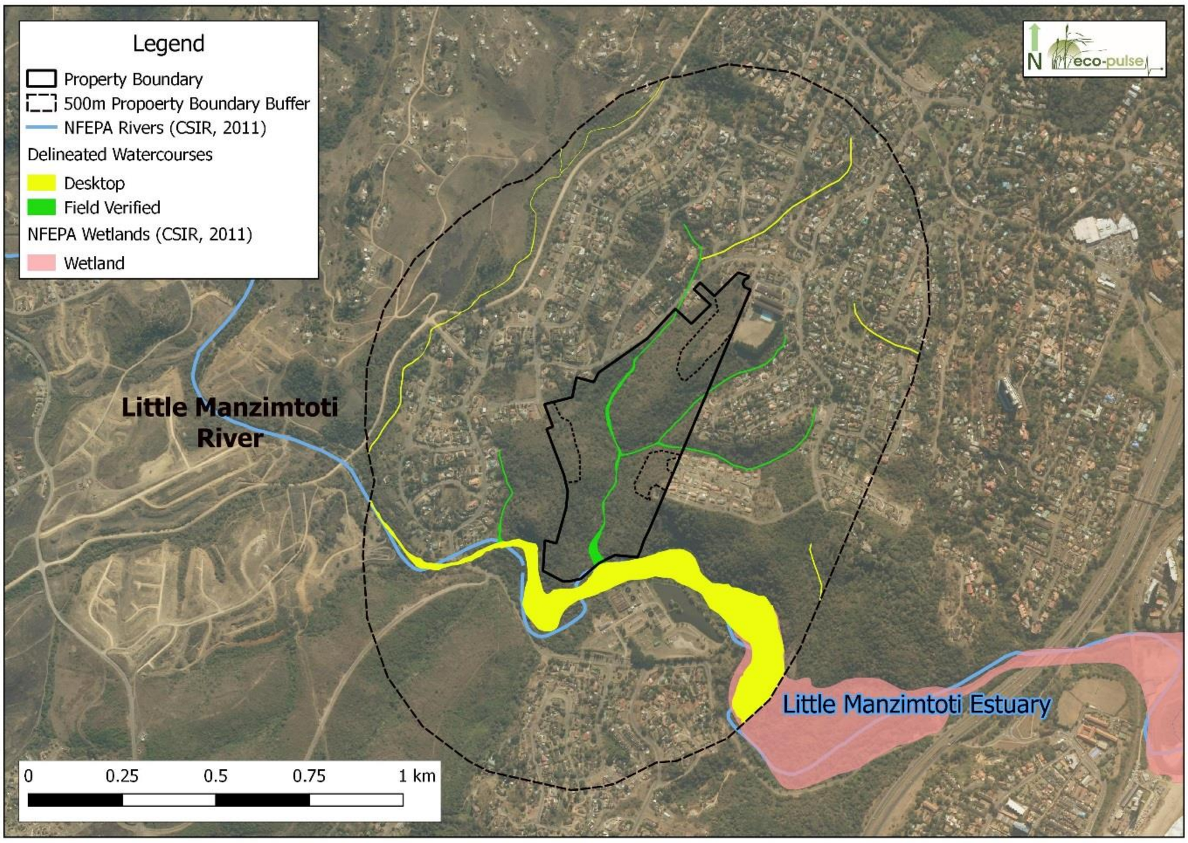


Figure 6 Map showing location and extent of wetlands and rivers identified by the NFEPA project (CSIR, 2011) in relation to the focal area of study.

B. KwaZulu-Natal Freshwater Systematic Conservation Plan (FSCP) (EKZNW 2007)

According to the KwaZulu-Natal FSCP (EKZNW 2007), the area has been classified as 'Available'. This conservation status implies that at this time the planning unit has NOT been earmarked for conservation, but is available to meet provincial conservation targets should earmarked catchments become 'unavailable'.

C. Durban Metropolitan Open Space System (D'MOSS)

The eThekwini Municipality has a long history of open space planning, dating back to the early 1980's. At a municipal level, there are a number of biodiversity/conservation planning datasets and documents that have been produced by eThekwini Municipality's Environmental Division, one being the municipal conservation plan produced by the City which is linked to the Durban Metropolitan Open Space System (D'MOSS).

D'MOSS is essentially a system made up of a series of interconnected open spaces that incorporate areas of high biodiversity value and other supporting elements, delivering a range of ecosystem goods and services including water supply, food, raw materials, soil formation processes, nutrient cycling, erosion control, flood attenuation and climate change mitigation (i.e. carbon storage capacity). The ecosystem goods and services provided free of charge by D'MOSS were conservatively valued in 2017 to be in the order of at least R4.2 billion per annum, excluding the value that open space contributes to tourism. Without these free services, the municipality would require an unaffordable increase to its budget to provide these services, especially in rural areas where communities rely heavily on the natural environment for daily needs. D'MOSS is mapped by the Biodiversity Planning Branch of the EPCPD (Environmental Planning and Climate Protection Department) of eThekwini Municpality using the Systemmatic Conservation Planning approach which is recognsided at both the National and Provincial levels. The mapped coverage is incorporated into the city's Integrated Development Plan (IDP), associated Strategic Development Framework (SDF) and the regional Spatial Development Plans (SDP). Source of information on D'MOSS: http://www.durban.gov.za

Areas within and surrounding the property boundary has been highlighted by the D'MOSS coverage. The majority of the property is however considered to be in a 'Degraded' state (Figure 7). A portion of the property, near its southern boundary, is considered to be 'Good' condition according to the D'MOSS spatial coverage.

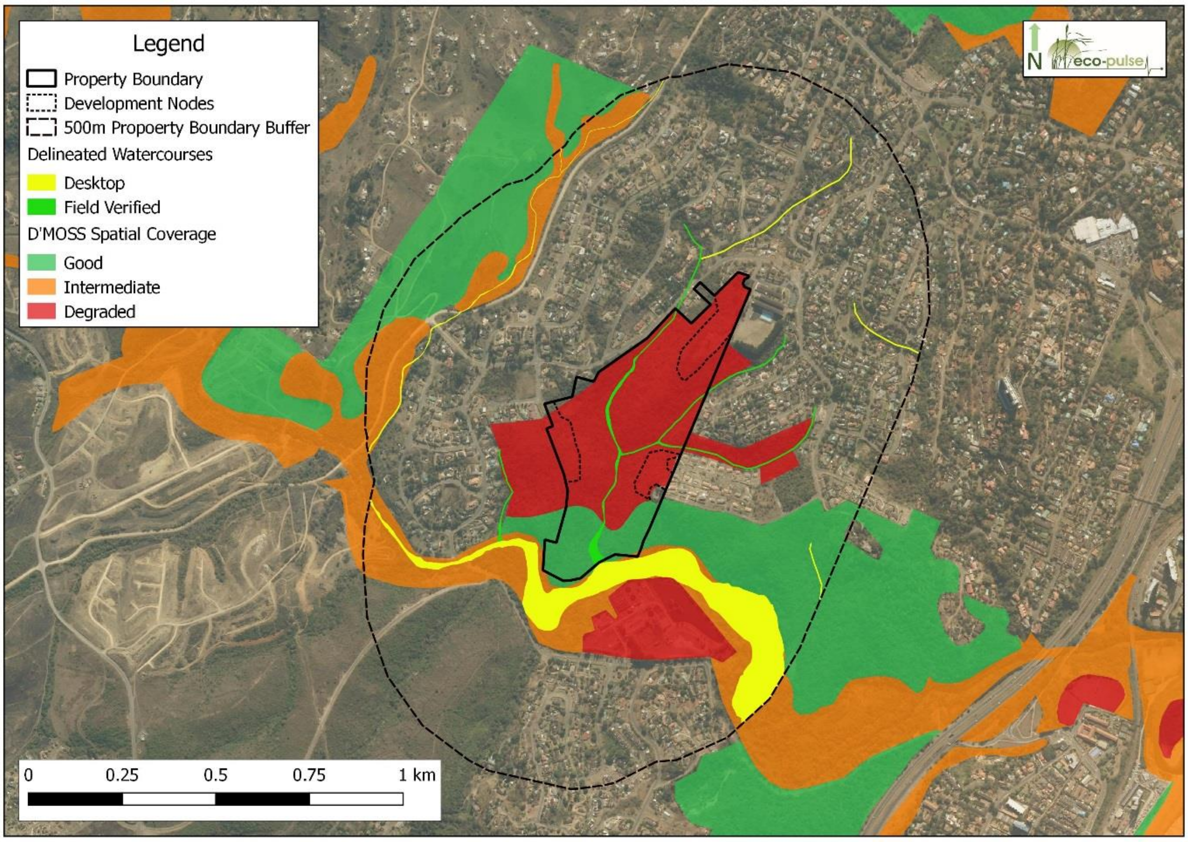


Figure 7 Map showing the location and extent of D'MOSS areas in relation to the study site.

D. Durban's Systematic Conservation Assessment (Maclean *et al.*, 2015)

The eThekwini's Systematic Conservation Assessment or SCA (Maclean *et al*, 2015) identifies local conservation priorities in the form of CBAs (Critical Biodiversity Areas) and ESAs (Ecological Support Areas). These areas are considered important in meeting municipal biodiversity conservation targets and maintaining ecological functioning within untransformed terrestrial and freshwater ecosystems. According to the SCA spatial coverage the full extent of the property boundary is marked as a CBA (Figure 8, below).

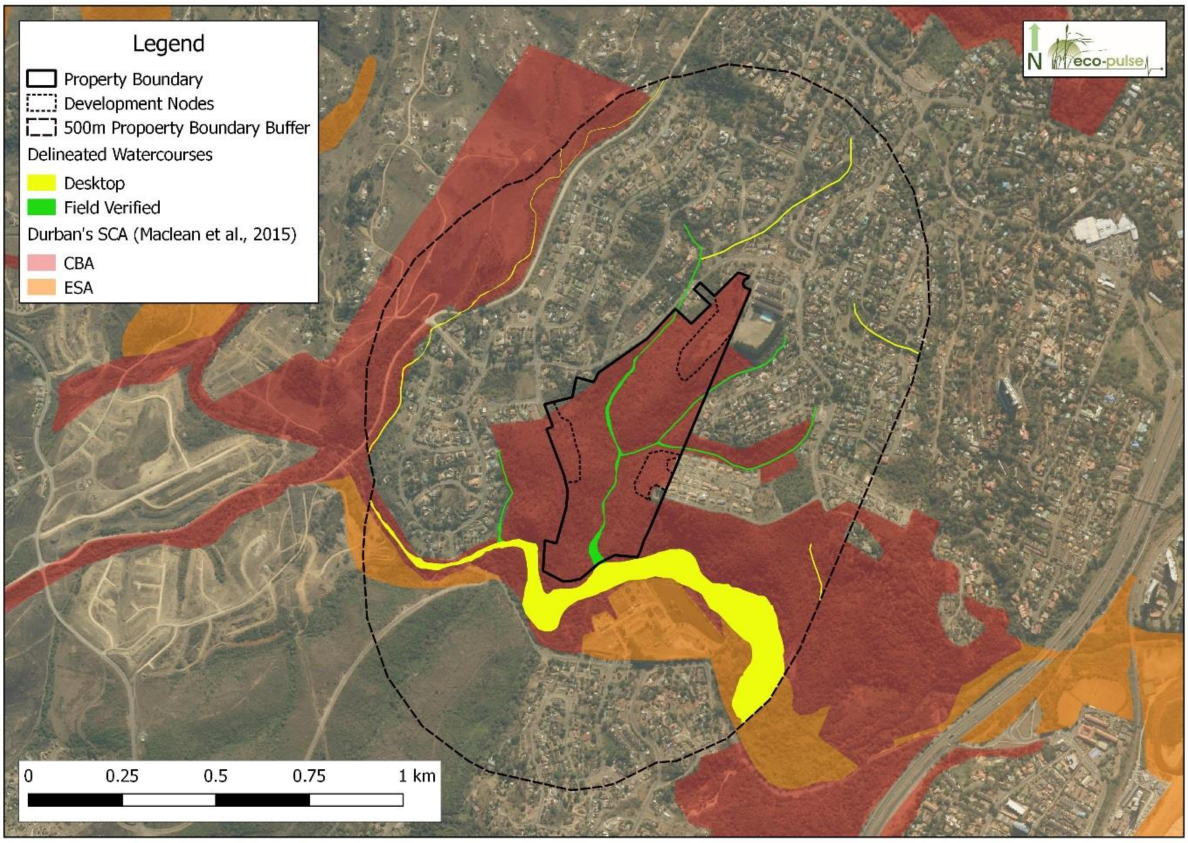


Figure 8 Map showing the location and extent of local conservation priorities according to Durban's Systematic Conservation Assessment (Maclean *et al*., 2015), in relation to the study site.

3.3 Summary of Existing Studies & Available Information

3.3.1 Available Information on the Little Manzimtoti River

In 2015 DWS undertook a process of classifying the water resources and determining comprehensive reserve and resource quality objectives in the Pongola - Umzimkulu Water Management Area. According to information presented as part of this study the lower Little Manzimtoti River (U70F-04893) is in 'fair' condition ('C' PES Category). The main impacts on the ecological state of the river are considered to be urban runoff affecting the systems water quality and the occurrence of flow reducing activities along the course of the river. These impacts are a result of the dominance of urban areas within the catchment of the lower Little Manzimtoti River. The recommended ecological category (REC) of the Little Manzimtoti River is a 'C'. Table 6, below summarises the relevant information from the 2015 DWS study.

Table 6. Summary of the desktop PES and EIS information for the Little aManzimtoti River (DWS, 2015).

Quaternary Catchment	River Name	Reach length	Assessed by experts	PES (present ecological state)	REC (recommended ecological category)
U70F - 04893	Little Manzimtoti	16.51km	Yes	C: Fair	C

3.3.2 Available Information on the Little Manzimtoti Estuary

According to the 2008 technical report by Forbes and Demetriades on the 'Estuaries of Durban', the Little Manzimtoti Estuary (referred to as the the aManzimtoti Estuary in this report) is classified as a temporarily open estuary system. The system is considered 'highly degraded' with the main impacts being related to infilling, road construction, river diversion and high levels of nutrients in the system (eutrophication) from excessive sewage inputs (Forbes and Demetriades, 2008). The system has been extensively invaded by a variety of floating and terrestrial alien vegetation species and the southern floodplain of the system has been completely cleared to create sports fields (Begg (1987). The benthic macro invertebrate community encountered in the estuary was considered the worst of all surveyed estuarine systems (Forbes and Demetriades, 2008)

According to the National Biodiversity Assessment: National Estuary Biodiversity Plan for South Africa (Turpie *et al.,* 2012), the Litte Manzimtoti Estuary is in 'Poor' ('D' PES Category) condition. The recommended ecological category for the system is to maintain its present ecological health ('D: Poor'). Table 7 below summarises the results from the assessment by Turpie *et al.,* (2012).

Table 7. Summary of information for the Little aManzimtoti River Estuary (Turpie *et al.,* 2012).

Estuary	PES	Priority set for National and/or CAPE	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of REC
Little Manzimtoti	D: 'Poor'	N/A	N/A	N/A	D: 'Poor'

According to DWS (2015), the Little Manzimtoti Estuary is 'Seriously Modified' ('E' PES Category). Its recommended ecological category (REC) is D: 'Poor' PES Category. The interventions required to achieve this REC, according to DWS (2015) are summarised in Table 8, below.

Table 8. Little aManzimtoti River Estuary PES, REC and suggested interventions (DWS, 2015).

Estuary	PES	REC	Interventions required to achieve the REC
Little Manzimtoti	E: 'Seriously Modified'	D: 'Poor'	• Protect base flows to estuary to maintain mouth state and salinity profile. • Improve water quality. • Partial restoration of estuarine riparian habitat.

3.4 Desktop Mapping & Screening

All watercourses occurring within a 500m radius of the proposed development [i.e. within the DWS regulated area for Section 21 (c) and/or (i) water uses] were mapped at a desktop level and classified in terms of their Hydro Geomorphic (HGM) type in accordance with the national wetland/river classification define by Ollis *et al.* (2013). This was done using a GIS (Geographical Information Systems) software through analysis of available aerial images (Google Earth™ and historic aerial photography), elevation contours and existing wetland and river coverage's for the region.

An initial desktop screening of 'impact potential' for identified watercourse units within a 500m radius of the development was also undertaken in GIS and then verified in the field. The main risks likely to be associated with the construction and operation of the proposed development include:

1. **Direct physical loss and/or modification** of watercourses within the development site, both planned and accidental;
2. **Direct physical alteration of flow characteristics** of watercourses within the development site and associated **erosion and sedimentation impacts**;
3. **Alteration of catchment surface water processes / hydrological inputs** and associated **erosion and sedimentation impacts**; and
4. **Surface runoff contamination** and local watercourse **water quality deterioration**.

Based on the above-mentioned risks multiple watercourses were regarded as being "moderate" or "high" in terms of the probability of incurring construction and operation related impacts (shown respectively shaded in 'orange' and 'red' on the map in Figure 9). Although these watercourses are located more than 15m away from the proposed development, they could potentially incur secondary impacts associated with storm water and wastewater discharge. These watercourses required further assessment and a water use licence application in terms of the requirements of Chapter 4 and Section 21 of the National Water Act No. 36 of 1998.

All other watercourse units identified within a 500m radius of the development site (i.e. within the DWS regulated area for Section 21 C & I water uses') were regarded as being 'unlikely' to incur any impacts that could alter their characteristics and therefore did not require further assessment.

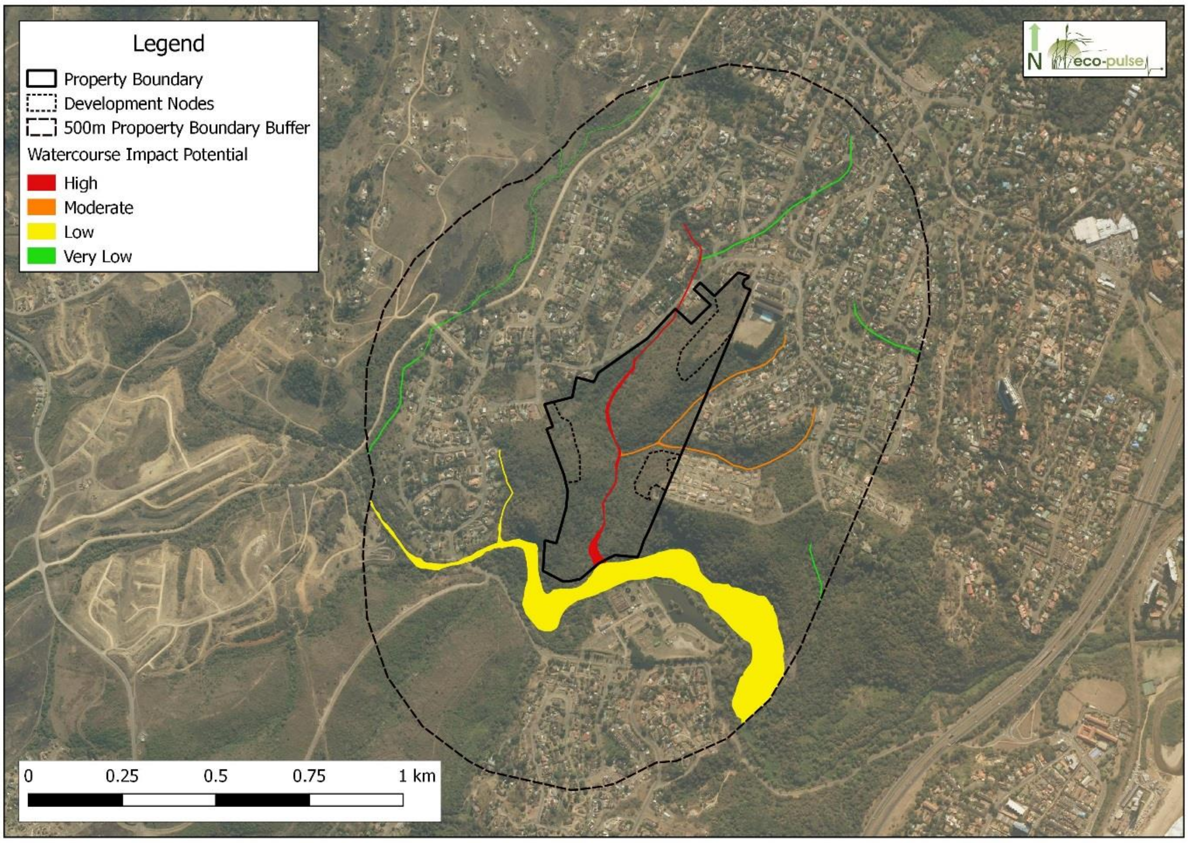


Figure 9 Map showing the desktop 'watercourse impact potential' screening outputs for all watercourses within 500m of the development proposed.

4 AQUATIC BASELINE ASSESSMENT

4.1 Baseline Aquatic Habitat Assessment

4.1.1 Riparian Zone Delineation and Classification

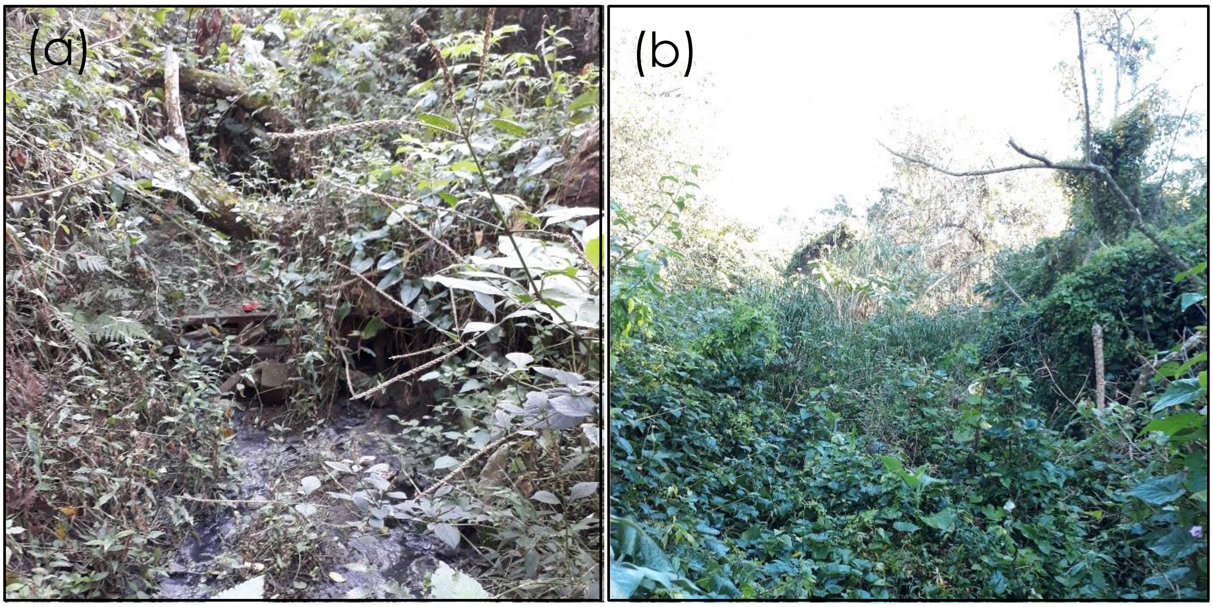
The delineation of the 'riparian zone' or extent of 'riparian habitat' associated with the tributary rivers adjacent to and downstream of the site of the planned development was undertaken in accordance methods in the Department of Water Affairs wetland/riparian habitat delineation manual '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (*DWAF, 2005*).* This involved an analysis of local topography to identify the outer macro-channel bank of the stream/river, vegetation sapling to identify typical riparian vs terrestrial species and soil sampling to assess alluvial material deposited by the stream. Rivers/streams were classified according to perennially of flows.

This exercise confirmed the presence of **one (1) seasonal mountain stream** and **two (2) ephemeral mountain streams** that were rated as having a potentially 'moderate' or 'high' risk of being impacted by the development (Figure 10). Each of these streams were small watercourses with narrow areas of riparian habitat. Given their potential to be impacted by the construction and/or operation of the proposed development these three (3) streams formed the focus of the detailed baseline (PES/EIS) assessment. Detailed descriptions of each stream unit, including type, habitat/vegetation characteristics and notable existing impacts has been provided in Table 9.

NO WETLANDS were identified within or surrounding the property of the proposed development.

A selection of digital photographs of the assessed riverine habitats is presented below:

Photographs of seasonal river R01. Photograph (a) is taken upstream of surcharging wastewater manholes while (b) is taken downstream of surcharging wastewater manholes.



(a) Upstream facing photograph of ephemeral stream R02 and (b) downstream facing photograph of R03.

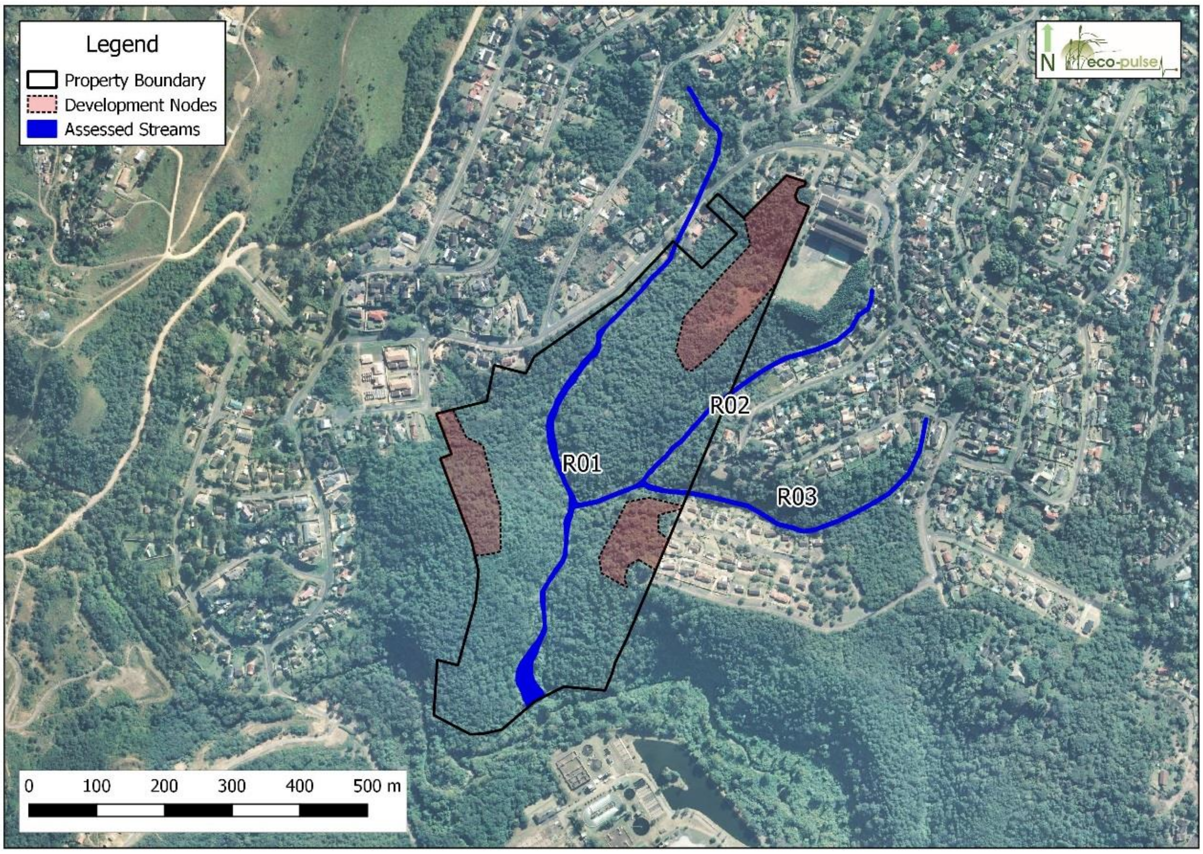


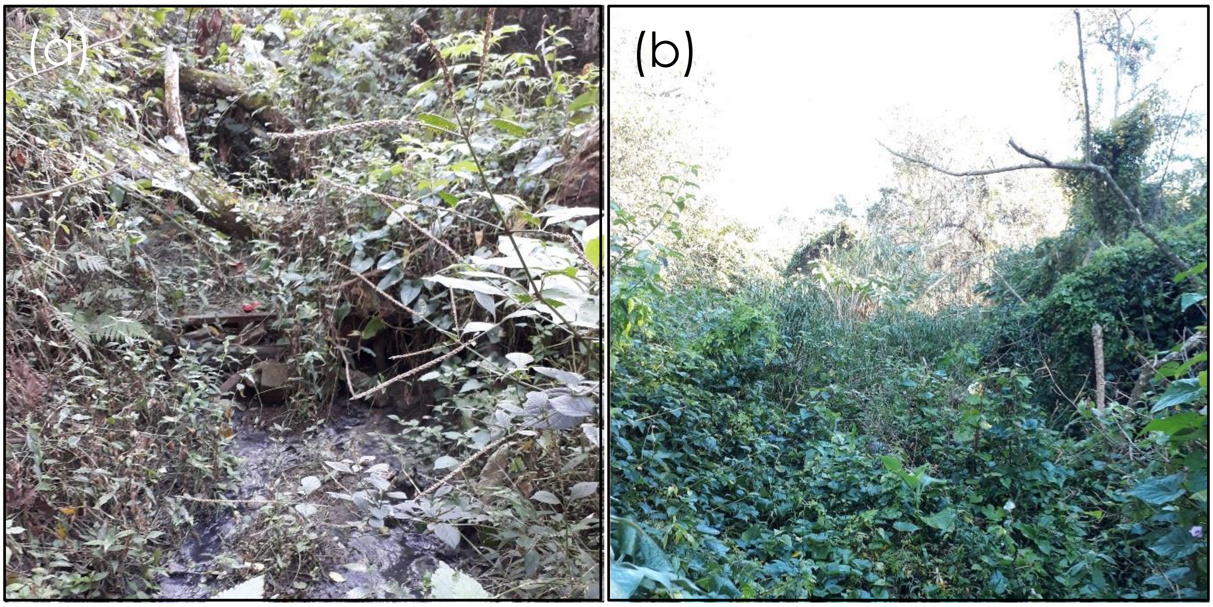
Figure 10 Map showing watercourses (rivers/streams with riparian habitat delineated) identified as being at particular risk of being impacted by the proposed development.

Table 9. Summarised description of watercourses sampled.

Unit ID	Classification	Flow Type	General Description	*Broad Vegetation Communities*	Existing Impacts
R01	Mountain Stream	Seasonal flow	Steep-gradient. Mostly flowing over bedrock. Alternating bedrock runs, riffles and pools along the length of the stream	**Instream vegetation**: • Dense *Coix lacryma-jobi* and *Cyperus dives* clumps at certain localities. *Canna indica* and *Commelina benghalensis* also abundant. **Riparian vegetation**: • Dense tree community dominated by *Schinus terebinthifolius,* and *Melia azedarach. Phoenix reclinata and Ficus sur* were sub-dominant tree species. • Abundant Invasive Alien Plant (IAPs): mainly *Achyranthes aspera, Chromolaena odorata and Solanum mauritianum. Canna indica and Lantana camara* also present.	• IAP infestation • Bed scour and bank erosion • Sewage inputs from surcharging manholes adjacent to the river/stream channel
R02	Mountain Stream	Ephemeral flow	Steep-gradient. Mostly flowing over bedrock. Alternating bedrock runs, riffles and pools along the length of the stream	**Instream vegetation**: • Dense *Coix lacryma-jobi* and *Cyperus dives* clumps at certain localities. *Canna indica benghalensis* also abundant. **Riparian vegetation**: • Dense alien tree community dominated by *Schinus terebinthifolius,* and *Melia azedarach. Phoenix reclinata and Ficus sur* were a sub-dominant tree species. • Abundant Invasive Alien Plant (IAPs): mainly *Achyranthes aspera, Chromolaena odorata and Rubus cuneifolius. Tithonia diversifolia, Ipomoea cairica and Lantana camara* also present.	• IAP infestation. • Bed scour and bank erosion • Sewage inputs from surcharging manholes adjacent to the stream channel
R03	Mountain Stream	Ephemeral flow	Steep-gradient stream with a bedrock channel that is now entirely overgrown with IAPs.	**Instream vegetation**: • *Dense stands of Cyperus dives and Cyperus textilis. Canna indica, Setaria megaphylla, Rubus cuneifolius and Achyranthes aspera* have encroached into the channel. **Riparian vegetation**: • *Largely dominated by Achyranthes aspera and Rubus cuneifolius.* • *Melia azedarach, Tithonia diversifolia, Lantana camara and Solanum mauritianum* were sub-dominant species.	• IAP infestation • Limited bed scour and bank erosion

A selection of digital photographs of assessed riverine habitats is presented below:

Upstream (a) and downstream (b) facing photographs of R01. Photograph (a) is taken upstream of surcharging wastewater manholes while (b) is taken downstream of surcharging wastewater manholes.



Upstream facing photograph of R02 (a) and downstream facing photograph of R03 (b)

4.1.2 River/Stream PES Assessment (IHI)

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 Present Ecological State (PES) refers to the health or integrity of a river system, and includes both instream 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). Habitat integrity for instream and riparian habitats was assessed separately based on the following indicators of habitat integrity:

1. Water abstraction
2. Flow modification
3. Inundation
4. Bed modification
5. Bank erosion
6. Channel modification
7. Water quality
8. Solid waste disposal
9. Vegetation removal
10. Exotic vegetation
11. Connectivity

The results of the river IHI assessment (Table 10) indicate that both the instream and riparian habitats of river unit R01 and R03 were in 'Poor' ('D' PES) condition. The instream habitat of river unit R02 was in a 'Poor' ('D' PES) condition, whilst the riparian habitat was 'Fair' ('C' PES) with the overall PES of all three (3) assessed streams being 'Poor' or 'Largely Modified', as reflected by a 'D' PES Category.

Table 10. Summary of the PES assessment for river R01.

TYPE	Instream Habitat PES	Riparian Habitat PES	Overall PES	PES Description
R01 *'Seasonal Mountain Stream'*	D PES: 'Poor'	D PES: 'Poor'	**D PES: 'Poor'**	• Both the riparian and instream habitat has been severely impacted by dense alien plant infestations which has replaced much of the indigenous instream and riparian vegetation. • Increased runoff (timing and quantity of flows) is associated with this river's largely urban catchment, which has caused bed scour and bank erosion along much of the stream course. • Multiple surcharging sewage manholes exist along the course of this unit. This is having a critical effect on the water quality of the stream.
R02 *'Ephemeral Mountain Stream'*	D PES: 'Poor'	C PES: 'Fair'	**D PES: 'Poor'**	• Both the riparian and instream habitat has been severely impacted by dense alien plant infestations which has replaced much of the indigenous instream and riparian vegetation. • Increased runoff (timing and quantity of flows) is associated with this river's largely urban catchment, which has caused bed scour and bank erosion along much of the stream course. • Multiple surcharging sewage manholes exist along the course of this unit. Sewage inputs from surcharging manholes is maintaining flow in this unit during dry/low flow conditions, and is having a critical effect on the water quality of the stream.
R03 *'Ephemeral Mountain Stream'*	D PES: 'Poor'	D PES: 'Poor'	**D PES: 'Poor'**	• Both the riparian and instream habitat has been severely impacted by dense alien plant infestations which has replaced much of the indigenous

TYPE	Instream Habitat PES	Riparian Habitat PES	Overall PES	PES Description
				instream and riparian vegetation. • Informally dumped rubbish (garden and household refuse) were common along the course of this unit. • Although limited compared to R01 and R02, bed scour was evident along the length of this stream unit,

Note that the river IHI assessment Excel ™ spreadsheet can be made available by Eco-Pulse upon request.

Photographs of significant existing impacts affecting the PES of the streams are presented below:

Photographs of surcharging sewage manholes discharging waste into R01 (a & d), an exposed wastewater pipeline adjacent to R01 (b) and accumulated sewage within the channel of R01 (c).

(a) Photograph showing of erosion along a storm water outfall that drains Longacre's Drive, which runs parallel to R01 with severe bank erosion and (b) Similar erosion features were noted at multiple locations along the course of stream R02.

4.1.3 Ecological Importance & Sensitivity (EIS) of Rivers/Streams

The Ecological Importance 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 (Table 11). A breakdown of key EIS determinants is provided below:

- Within a landscape that has been greatly modified, the stream network and associated dense riparian habitat of river R01 was considered moderately important wildlife migration corridors;
- R01 has a high diversity of instream habitat types due to the alternating bedrock runs, pools and riffles along its course.
- None of the stream are likely to harbour rare or endangered species due to the poor ecological state of instream and riparian habitat and poor water quality.
- The assessed streams are unlikely to offer refugia for biota and are unlikely to host unique and intolerant aquatic biota due to prevailing seasonal and ephemeral flow conditions
- The stream units are likely to be moderately sensitive to flow related changes in water quality due to prevailing seasonal and ephemeral flow conditions

Table 11. Summary of the EIS assessment for streams R01, R02 and R03

	EIS Determinant	EIS Rating: R01	EIS Rating: R02	EIS Rating: R03
Riparian & Instream Biota	Rare & endangered species	Very Low	None	None
	Unique species (endemic, isolated, etc.)	None	None	None
	Intolerant species sensitive to flow/water quality modifications	Very Low	Very Low	None
	Species/taxon richness	Low	Very Low	Very Low
Riparian & Instream Habitat	Diversity of habitat types	Moderate	Low	Very Low
	Refugia for biota	Low	Very Low	Very Low
	Sensitivity to flow changes	Moderate	Low	Very Low
	Sensitivity to flow related water quality changes	Moderate	Moderate	Low
	Migration route/corridor (instream & riparian)	Moderate	Low	Low
	Importance of conservation & natural areas	Moderately-Low	Low	Low
EIS Category		**Moderately-Low**	**Low**	**Very Low**

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

4.2 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 12, below).

Table 12. Management measures for water resources.

			EIS			
			Very high	**High**	**Moderate**	**Low**
PES	**A**	**Pristine/Natural**	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

The recommended management objective for all watercourses assessed 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 13, below).

Table 13. Summary of the assessment of the Resources Management Objectives based on PES and EIS ratings.

Watercourse	Type	PES	EIS	RMO
R01	Seasonal Stream	D: Poor	Moderately- Low	*Maintain PES/EIS*
R02	Ephemeral Stream	D: Poor	Low	
R03	Ephemeral Stream	D: Poor	Very Low	

This is further 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 ecological 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 aquatic biodiversity, or enhance or secure opportunities for ecosystem 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.

5 ECOLOGICAL IMPACT DESCRIPTION & ASSESSMENT

Aquatic ecological impacts have been identified and assessed in Chapter 5 of this report in order to inform and provide for the appropriate mitigation and management of impacts (Chapter 6) associated with the proposed development project in an effort to meet the management objectives defined for the water resources on the property and downstream (see Section 4.2).

This Chapter of the report deals with the identification, description and significance assessment of the potential construction and operational impacts and risks posed to onsite and downstream watercourses by the proposed residential development.

5.1 Proposed Development Context

The planned development is to be located outside of the delineated riparian habitat of the seasonal and ephemeral streams downstream of the three development notes/sites. Planned infrastructure will include:

- Hardened surfaces associated with the residential development;
- Parking and road infrastructure;
- Storm water management infrastructure comprising outfalls to the downstream environment; and
- Waste water pipeline to traverse stream channels (pipe network) to connect to the waterborne sewage pipeline conveying wastewater to the Amanzimtoti Regional WWTW (Waste Water Treatment Works) located downstream.

5.2 Ecological Impact Descriptions & Assessment

Freshwater ecosystems, including wetlands and 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. Threats to freshwater biodiversity include processes and activities which reduce system persistence, and alter community diversity and patterns, including reduced genetic diversity (Rivers-Moore *et al.,* 2007).

When making inferences on the potential impacts or risks that development activities place on ecosystems, it is important to understand that these impacts speak specifically to their effect on the ecological condition and/or functional importance/value of these ecosystems. Generally, impacts can be grouped into the following broad categories:

A. **Direct impacts**: are those impacts directly linked to the project (e.g. clearing of land, destruction of vegetation and habitat).

B. **Indirect impacts**: are those impacts resulting from the project that may occur beyond or downslope/downstream of the boundaries of the project site and/or after the project activity has ceased (e.g. migration of pollutants from construction sites).

Impacts to watercourses were identified and described based on an understanding of the receiving aquatic environment, associated sensitivities and the location and extent of the proposed infrastructure. *Note that while an attempt has been made to separate impacts into categories, there is inevitably some degree of overlap due to the inherent interrelatedness of many ecological impacts.*

Impact 1: Physical Destruction and/or Modification Impacts

This impact refers to the physical destruction or disturbance of riverine (instream and riparian) habitat caused by vegetation clearing, excavation and/or infilling during the construction of infrastructure associated with the proposed development, as well as associated with unintended indirect/secondary disturbances that are likely to persist during the operational phase of the infrastructure.

A. Construction Phase Impacts:

Riparian vegetation and habitat can be impacted directly through the complete removal or partial disturbance of existing indigenous vegetation during construction (stripping of vegetation and infilling), leading to the deterioration in the ecological condition of the riparian habitat and stream ecosystem.

Due to the development being planned outside of the delineated riparian habitat, there is unlikely to be any direct loss of vegetation and habitat associated with the three residential development nodes.
In order to provide sanitation services to the development, a gravity pipeline is proposed to provide for the reticulation of domestic wastewater down the valley towards the regional Kingsburgh WWTW located downstream. This will require a pipeline crossing over the seasonal stream R01 at two locations to tie into the existing municipal wastewater pipeline (shown below in Figure 11). Whilst instream riverine habitat is unlikely to be disturbed where pipes are suspended across the channel (pipe bridge), the riparian habitat at each crossing is likely to be disturbed. Due to the riparian habitat of R01 being in a 'poor' condition (D PES) and dominated by Alien Plant species, the magnitude of the habitat disturbance is likely to be relatively moderate, with impact significance likely to be 'moderately-low' under a 'good' mitigation scenario taking into account the mitigation measures proposed under Chapter 6 of this report.

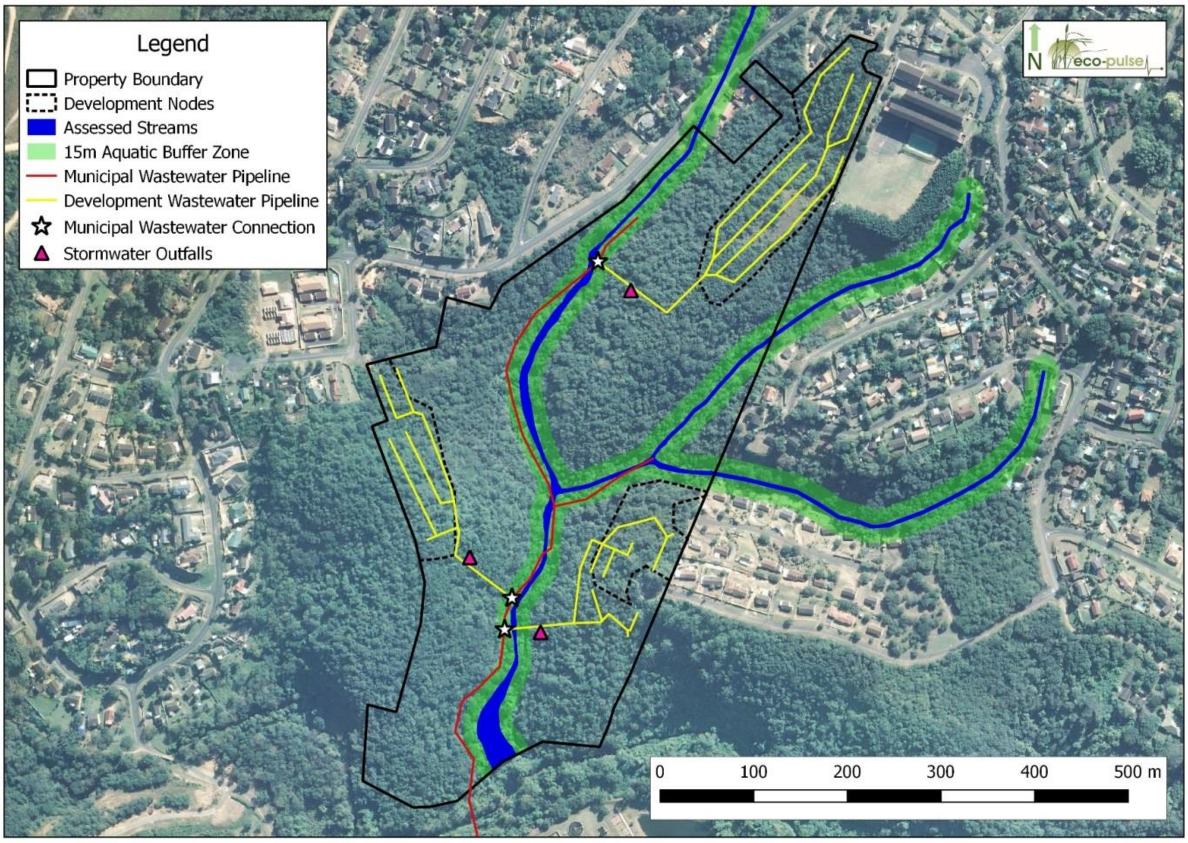


Figure 11 Map showing watercourses (rivers/streams with riparian habitat delineated) with the proposed municipal wastewater connections and sewer pipeline shown ('yellow' lines on the map).

B. Operational Phase Impacts:

During operation, there is unlikely to be any direct or indirect impacts to watercourses which are located outside of the development footprint. Whilst the presence of a number of Invasive Alien Plant (IAP) species and undesirable weeds identified on the property creates a risk of alien plant and weed communities expanding and further colonising riparian areas if left unmanaged or poorly managed (particularly at wastewater pipeline crossing sites), the existing high IAP levels currently affecting the riparian habitat means that any further colonisation by IAPs is unlikely to be of great significance for the already degraded riverine habitat.

The anticipated significance of operational phase destruction and/or modification impacts is likely to be moderately-low (negative) for a poorly managed scenario, and of low (negative) significance where 'good' mitigation is involved (*in accordance with best practice impact mitigation and management measures recommended as per Chapter 6 of this report*).

Impact Description	Mitigation Level	Impact Significance	
		Construction Phase	Operational Phase
1 Destruction and modification of freshwater habitat	'Poor' / 'Standard' Mitigation	Moderately-Low (negative)	Moderately-Low (negative)
	'Good' Mitigation	Low (negative)	Low (negative)

Impact 2: Flow Modification and Erosion/Sedimentation Impacts

This impact relates to the potential for modification of hydrological drivers (volumes, velocities pattern and timing of flow received and distributed though the rivers), including the resultant change in fluvio-geomorphological processes (i.e. such as rates of erosion and deposition of sediment).

A. Construction Phase Impacts:

During construction, there is a risk of vegetation stripping and bulk earthworks occurring adjacent and upstream of rivers/streams, resulting in increased surface runoff volumes and velocities, which can lead to soil erosion and entrain sediment, transporting and discharging this downstream. The effect of enhanced/unnatural sediment deposition on instream habitats is well-documented, and can lead to habitat destruction, blanketing of vegetation and temporary disturbance of the natural aquatic breeding and refugia. Intolerant species of aquatic biota (fauna and flora) would be most at risk; however these species are unlikely to be present within the streams downstream of the development planned due to the current high levels of modification of instream and riparian habitat. Impact significance is likely to be Moderately-Low under a 'poor' or 'standard' mitigation scenario but can easily be reduced to a 'Low' level through adequate on-site mitigation and controls during construction.

B. Operational Phase Impacts:

During operation, it is expected that there will be increased water inputs to the adjacent stream from associated with an increase in hardened surfaces associated with built infrastructure development, leading to the reduced infiltration capacity of the ground and increased runoff volumes and rates.

The development of hardened surfaces within a river/stream catchment is recognized as having the potential to either increase or decrease the flows that reach downstream aquatic systems such as wetlands, rivers and streams. Greater volumes of water are generated more quickly while smaller and longer-duration flows that would occur under less developed conditions are reduced or perhaps eliminated. Research has shown that collecting storm water through modern storm drains, culverts, and catchments results in the rapid transport of large volumes of storm water runoff into rivers, lakes, and wetlands at much faster rates and higher volumes than under predevelopment conditions (Sheldon *et al.*, 2003). The amount of impervious surface within a contributing basin is a key influence on hydrologic patterns, and even small changes in watershed conditions have measurable influences on the flows and volumes of water in the system. Increased imperviousness (more hardened or impermeable surfaces) will experience an increase in the magnitude of runoff volume from a given storm event. The "typical" event occurs far more frequently. For example, the peak flows created from a two-year storm event, after urbanization, will occur far more frequently than every two years. Small storm events that did not create measurable peak discharges in natural vegetation conditions create measurable peak runoff flows in urbanized conditions, because the removal of the vegetation makes the same size storm event result in far greater volumes of water reaching aquatic resources such as wetlands and streams. Larger flows with more erosive force may occur in urbanized basins with much greater frequency, for example increasing from once or twice per decade to several times per year.

Ultimately, the consequences of the interplay between rates, volumes, and durations of flows are complex and research on the impacts of urbanization on storm water and watershed processes indicates that catchment hardening results in several disturbances that can impact wetlands and rivers, including:

- Increased erosion;
- Sediment movement and deposition;
- Burying of vegetation;
- Increased depths of inundation;
- Water level fluctuations;
- Down-cutting or incising of natural channels (which can remove riparian vegetation from the floodplain);
- Changes in the seasonal extent and duration of saturation and inundation; and
- Unstable substrates.

While the impacts discussed above are all possible and can be considered of 'Moderate' impact significance under a 'poor' or 'standard' mitigation scenario, the likelihood of flow and flow-related erosion and sedimentation risks can be reduced through careful planning, environmental design considerations and the implementation of site-specific construction phase mitigation measures, *as per the recommendations made in Chapter 6 of this aquatic report*, reducing impact significance to a potentially 'Low' level.

Impact Description	Mitigation Level	Impact Significance	
		Construction Phase	Operational Phase
2 Flow modification and erosion / sedimentation	'Poor' / 'Standard' Mitigation	Moderate (negative)	Moderate (negative)
	'Good' Mitigation	Low (negative)	Low (negative)

Impact 3: Water Quality Impacts

This impact refers to the modification of the microbiological, physical and chemical properties of water that determine its fitness for a specific use, determined by substances which are either dissolved or suspended in the water. Pollution of water resources is a human-induced impact and defined by the National Water Act No. 36 of 1998 as the direct or indirect alteration of the physical, chemical or biological properties of a water resource so as to make it:

a) Less fit for any beneficial purpose for which it may reasonably be expected to be used;

b) Harmful or potentially harmful –

- *to the welfare, health or safety of human beings;*
- *to any aquatic or non-aquatic organisms;*
- *to the resource quality; or*
- *to property.*

A. <u>Construction Phase Impacts:</u>

In the context of the planned development and the receiving riverine environments, water quality refers to its fitness for maintaining the health of aquatic ecosystems, namely streams. Key sources of contaminants during the construction phase of the development project that could alter water quality 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.
- Sewage – leakages from and/or poor servicing of chemical toilets and/or informal use of surrounding bush by workers.
- Suspended solids – suspension of fine soil particles as a result of soil disturbance and altered flow patterns.

Mismanagement of the above contaminants and soil stockpiles could potentially result in the pollution of the adjacent watercourse. Although water pollution impacts can potentially be experienced during the construction phase of the project, the quantity of pollutants is likely to be quite limited. Also, given the current degraded state of the watercourses downstream (poor PES) which is presently already polluted with various contaminants (including bacteria and pathogens from untreated wastewater leakages from surcharging manholes), further water quality impacts are likely to be moderated by the poor PES and moderately-low to low importance/sensitivity of the receiving water resources.

B. <u>Operational Phase Impacts:</u>

Pollution sources from developments in their operational-phase can vary greatly. Potential operational phase contaminants and their relevant sources may include:

- **Suspended solids –** associated with runoff from hardened surfaces and bare soils leading to soil erosion and sedimentation.
- **Sewage –** associated with leaks, infrastructure failure and/or storm water ingress into sewer manholes leading to the surcharge of contaminated water.
- **Hydrocarbons, oils and grease** – run-off from parking lots and roads.
- **Toxicants** – run-off containing detergents and other toxic substances used by residents.

These contaminants, which may enter downstream and adjacent watercourses, have the capacity to negatively affect the in-stream aquatic habitat and species. 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.

The key water quality risk associated with the operational development relates to possible wastewater pipeline failure or leakage to the environment, which is likely to be of 'moderate' impact significance. Although such events are likely to be infrequent, short-lived and addressed through management and maintenance actions in a timeous manner, failed and leaking wastewater infrastructure (pipelines conveying untreated effluent to tie in with the Kingsburgh WWTW) pose a significant risk to watercourse quality. Existing surcharging municipal sewer manholes are already a concern for the river valley assessed. It is therefore strongly advised that the current wastewater infrastructure issues be reported to and dealt with by the local municipality (eThekwini Water & Sanitation) prior to this proposed development connecting to existing municipal infrastructure in order to avoid cumulative water quality impacts.

Impact Description	Mitigation Level	Impact Significance	
		Construction Phase	Operational Phase
3 Water quality impacts	'Poor' / 'Standard' Mitigation	Moderately-Low (negative)	Moderate (negative)
	'Good' Mitigation	Low (negative)	Moderately-Low (negative)

5.3 Impact Significance Statement

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 qualitatively quantify the relative significance of the ultimate negative consequences associated with the range of negative impacts potentially associated with the planned development. The significance of identified impacts on freshwater ecosystems was assessed for the following realistically possible scenarios:

i. **Realistic "standard / 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 / best practical 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.

Table 14 below provides an overview of the impact ratings presented per impact category. Due to the development footprint being located outside of the delineated watercourse and riparian habitat, direct impacts are unlikely to occur except for where planned sewer pipelines are to cross watercourses. Key indirect impacts are associated with possible storm water run-off and water contamination impacts during the construction and operational phases of the development. With appropriate and timeously applied impact mitigation and management (*according to the recommendations provided in Chapter 6 of this specialist aquatic report*), key indirect/secondary impacts associated with the management of storm water are likely to be easily manageable and potentially of 'low' to 'moderately-low' impact significance overall.

Table 14. Summary of construction and operation phase aquatic impact significance ratings.

Impact Description	Mitigation Level	Impact Significance	
		Construction Phase	Operational Phase
1 Destruction and modification of freshwater habitat	'Poor' / 'Standard' Mitigation	Moderately-Low (-)	Moderately-Low (-)
	'Good' Mitigation	Low (-)	Low (-)
2 Flow modification and erosion / sedimentation	'Poor' / 'Standard' Mitigation	Moderate (-)	Moderate (-)
	'Good' Mitigation	Low (-)	Low (-)
3 Water quality impacts	'Poor' / 'Standard' Mitigation	Moderately-Low (-)	Moderate (-)
	'Good' Mitigation	Low (-)	Moderately-Low (-)

6 ECOLOGICAL IMPACT MITIGATION

6.1 Introduction

A strong legislative framework which backs up South Africa's obligations to numerous international conservation agreements creates the necessary enabling legal framework for the protection and management of freshwater resources in the country. Given the value of wetlands and other aquatic ecosystems (such as rivers and estuaries) and the fact that humans depend on aquatic resources, it is against the law to deliberately damage wetlands and rivers. The law therefore places, directly and indirectly, the responsibility on landowners and other responsible parties, to manage and restore wetlands/rivers where relevant.

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 development design.***

Of particular importance is the requirement of 'duty of care' with regards to environmental remediation stipulated in Section 28 of NEMA (National Environmental Management Act No.107 of 1998):

> **Duty of care and remediation of environmental damage**: "(1) *Every person who causes has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot be reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.*"

6.2 Approach to Impact Mitigation: *'The Mitigation Hierarchy'*

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 12, 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.

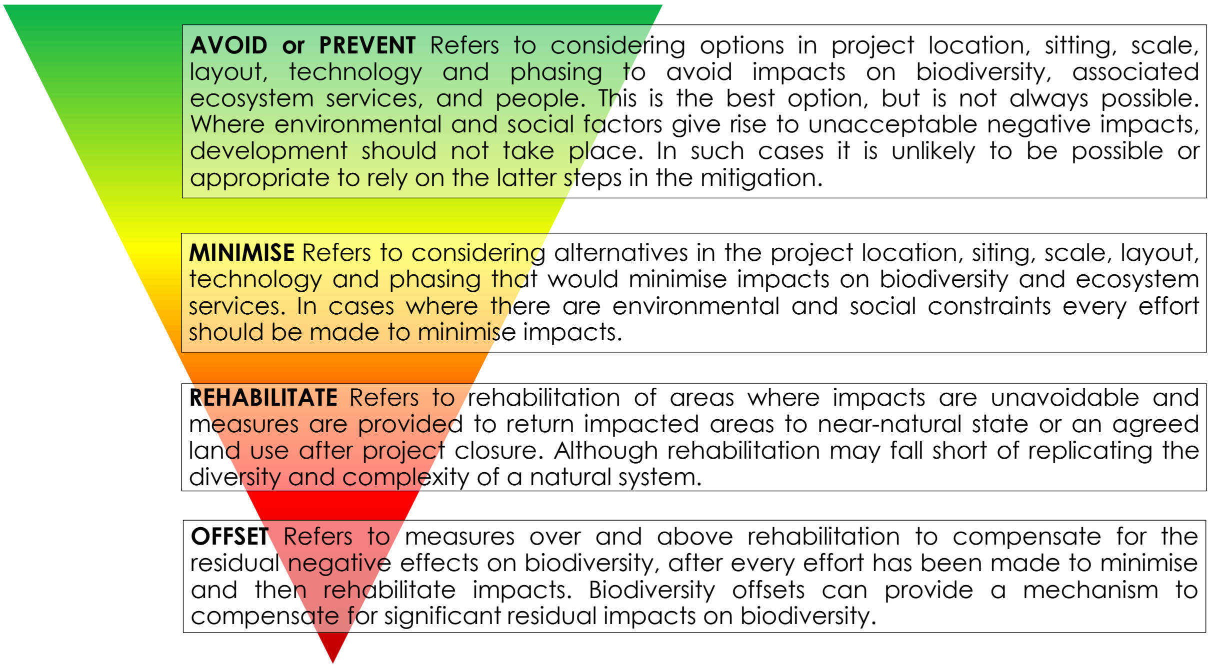


Figure 12 Diagram illustrating the 'mitigation hierarchy' (after DEA *et al*., 2013).

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*". This principle is also in line with the recommended management objective for the project and receiving aquatic environment, that being to '*maintain the current status quo of aquatic ecosystems without any further loss of integrity (PES) or functioning*'.

A stepped approach has therefore been followed in trying to minimize impacts, which includes:

i. **Firstly, attempting to avoid/prevent impacts through appropriate project design and location:** *Development set-backs / buffer zones recommended*

ii. **Secondly, employing mitigation measures aimed at minimizing the likelihood and intensity of potential risks/impacts**: *Provision of construction and operation phase management and mitigation measures to avoid any unnecessary direct or indirect impacts to watercourses.*

iii. **Thirdly, addressing residual impacts to areas adjacent to the development site which may be impacted:** *riparian rehabilitation guidelines applicable to pipeline crossings of watercourse R01.*

iv. **Lastly, compensating for any remaining/residual impacts associated with permanent habitat transformation:** *not applicable (no residual impact or 'significant' loss of habitat or ecosystem functioning anticipated where fully mitigated).*

6.3 Implementation of Mitigation Measures

In terms of Section 2 and Section 28 of NEMA (National Environmental Management Act, 1998), the land owner is responsible for any environmental damage, pollution or ecological degradation caused by their activities "inside and outside the boundaries of the area to which such right, permit or permission relates". In dealing with the range of potential ecological impacts to natural ecosystems and biodiversity highlighted in this report, this would be best achieved through the incorporation of the management & mitigation measures (recommended in this report) into the Construction **Environmental Management Programme (EMPr**) for the development project. The EMPr should be separated into construction & operational phase.

The EMPr should define the responsibilities, budgets and necessary training required for implementing the recommendations made in this report. This will need to include appropriate monitoring as well as impact management and the provision for regular auditing to verify environmental compliance. 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 process and activities and reporting back to the relevant environmental authorities with findings of these investigations. The ECO will also need to be responsible for preparing a monitoring programme to evaluate construction compliance with the conditions of the EMPr.

6.4 Development Planning: Environmental Guidelines and Principles

At the forefront of mitigating impacts to the rivers and streams adjacent to the development site (and downstream) should be the incorporation of ecological and environmental sustainability concepts into the design of the development project, with a central focus on the following:

1. Ensuring that direct impacts to watercourses are avoided wherever possible through ecologically sound and sustainable development layout planning that takes into account the location and sensitivity of the remaining ecological infrastructure at the site;
2. Employing creative design principles and ecologically sensitive methods in infrastructure design and layouts to minimise the risk of indirect impacts;
3. Ensuring that storm water management design and implementation takes into account the requirements of the environment, including rivers/streams; and
4. Taking necessary efforts aimed at minimising/reducing potential waste streams.

6.4.1 Aquatic Buffer Zones

'Buffer zones' (also termed "development set-backs") are essentially strips of vegetated undeveloped land typically designed to act as a protective barrier between human activities and sensitive habitats such as wetlands, rivers and forests. Research shows that buffer zones are useful at performing a wide range of functions such as sediment trapping and nutrient retention, and in doing so, play an important role in protecting water resources from the adverse impacts that are typically associated with various land-uses and development. Although there are no legislative requirements regarding the establishment of buffers around water resources in the South African legislation, the application of buffers is aligned with the principles of the National Water Act (1998), which is to provide for the sustaining of water quality and preserving natural aquatic habitats and ecosystem functions.

Based on the nature of the proposed development and the receiving aquatic environment's susceptibility to water quality and storm water run-off impacts, buffer zones (or 'development setbacks') are proposed as a means of minimizing potential environmental impacts and reducing the risk of aquatic habitat degradation in the long term.

According to the draft Guidelines for Biodiversity Impact Assessment in KZN (EKZNW, 2011), a standard buffer width of 30m from the outer edge of the delineated wetlands and the riparian zone of rivers in the Province of KZN, often irrespective of site conditions and development/land use type. The guideline document goes on to recommend that the determination of ecological buffers should rather be based on a number of site-specific factors. A national protocol for buffer determination around rivers, wetlands and estuaries has recently been developed (Macfarlane & Bredin, 2016) and represents emerging best-practice in aquatic buffer zone determination.

The buffer model by Macfarlane & Bredin (2016) produces an output based on potential risks associated with the proposed development type, in conjunction with the sensitivity of aquatic resources (i.e. wetlands and rivers). Potential risk to rivers in terms of a range of criteria (see Table 15, below) are estimated by the model and used to allocate suitable buffers based on the generic risk levels associated with the proposed development type. According to the Preliminary Guideline for the Determination of Buffer Zones (Macfarlane & Bredin, 2016), buffer zone requirements are only advocated where scientific studies have shown that they can be effective mitigation measures. Table 15 below highlights situations where the implementation of suitable aquatic buffer zones can have a potentially positive mitigating effect and should be considered in impact mitigation (e.g. water quality and sediment impacts). Table 15 also highlights situations where buffers are not particularly well suited at mitigating impacts/risks, such that other forms of mitigation should be identified/considered (e.g. water quantity impacts, including stream flow reduction activities).

Table 15. Preliminary desktop-level threats used in the aquatic buffer assessment (after Macfarlane & Bredin, 2016).

Threat Type	Preliminary Threat Ratings		Approach for Addressing Threats
	Construction Phase	Operation Phase	
1. Alteration to flow volumes	Very Low	Moderate	• Source directed controls • Restricting surface flow requirement (SFR) activities
2. Alteration of patterns of flows (increased flood peaks)	Very Low	Moderate	• Control of water inputs
3. Increase in sediment inputs & turbidity	High	Low	• **Buffer zones** • Other suitable on-site BMPs
4. Increased nutrient inputs	Very Low	Low	
5. Inputs of toxic organic contaminants	Very Low	Low	
6. Inputs of toxic heavy metal contaminants	Low	Low	
7. Alteration of acidity (pH)	Very Low	Very Low	• On-site BMPs and other measures
8. Increased inputs of salts (salinization)	N/A	Very Low	
9. Change (elevation) of water temperature	Very Low	Very Low	
10. Pathogen inputs (i.e. disease-causing organisms)	Low	Low	• **Buffer zones** • Other suitable on-site BMPs

The buffer tool was applied for each stream on the property. A summary of the buffer assessment, including key assumptions and considered criteria, is provided below:

- The "Residential" land use / development type was used for this assessment;
- The model considers site specific information and sensitivities of the water resource to the identified development threats. This includes additional information regarding the characteristics of the site which relate to the watercourse HGM type, channel width, system hydrology, soils characteristics, geology and geomorphology, topography (slope), runoff characteristics, erosion vulnerability, inherent nutrient levels in the landscape, level of domestic use of water resources and vegetation characteristics;
- Buffers were informed by the Present Ecological State (PES) and Ecological Importance & Sensitivity (EIS) of the river unit;
- The key construction phase risk linked with the proposed development type is increased sediment inputs and turbidity;
- Key operation phase risks linked with the proposed development type are increased flood peaks and alterations to flow volumes;

- Buffers may be most effective at reducing pollutants in diffuse surface flow but are far less effective at addressing point-source pollution or concentrated flows and their role in mitigating pollution impacts associated with ground-water (subsurface flow) is not well documented;
- While buffer zones are known to work well at trapping sediments and nutrients, the potential to reduce impacts such as point source pollution and sedimentation is strongly dependent on the site-specific characteristics of the buffer (such as vegetation cover, slope of the buffer, etc.);
- For impacts involving the concentration of surface flow (e.g. storm water discharge, etc.) buffers have a limited capacity to function at attenuating flows and trapping sediment/nutrients/pollutants;
- In order to maximise their effectiveness, buffer zones will need to be established and maintained with indigenous vegetation cover (without erosion features/concentrated flow paths) as open space natural grassland areas with appropriate alien plant control and/or slashing to maintain grass cover; and
- The proposed aquatic buffer zone widths do not specifically take into account biodiversity concerns related to fauna/flora, etc.

Based on the threats posed by the potential Industry Development scenario for the site, the buffer model calculated appropriate buffer widths under two scenarios:

1. Without specific Mitigation; and
2. With specific Impact/Risk Mitigation

Without specific impact/risk mitigation a buffer of 34m was recommended for the streams on the property. With specific mitigation (focusing on the management of potential pollutants/contaminants and the management of storm water runoff to predevelopment conditions) the model suggests that the buffers may be **reduced to 15m** (see Table 16, below). The **final buffer width for each of the assessed streams is 15m** (measured horizontally from the edge of the delineated watercourse or channel bank). This buffer width is deemed appropriate for the proposed development based on the assumption that site-specific mitigation concerns and measures will be recommended and implemented during the construction and operational phases of this development. Table 16, below summarises the buffer model outputs. The recommended buffers are shown spatially on the map in Figure 13.

Table 16. Summary of buffer recommendations for the proposed development project.

Watercourses	Project Phase	Recommended Aquatic Buffer Width	
		Without specific impact/risk mitigation	With specific impact/risk mitigation
R01, R02, R03	Construction	34m	15m
	Operation	15m	15m
	Final Buffer Width	**34m**	**15m**

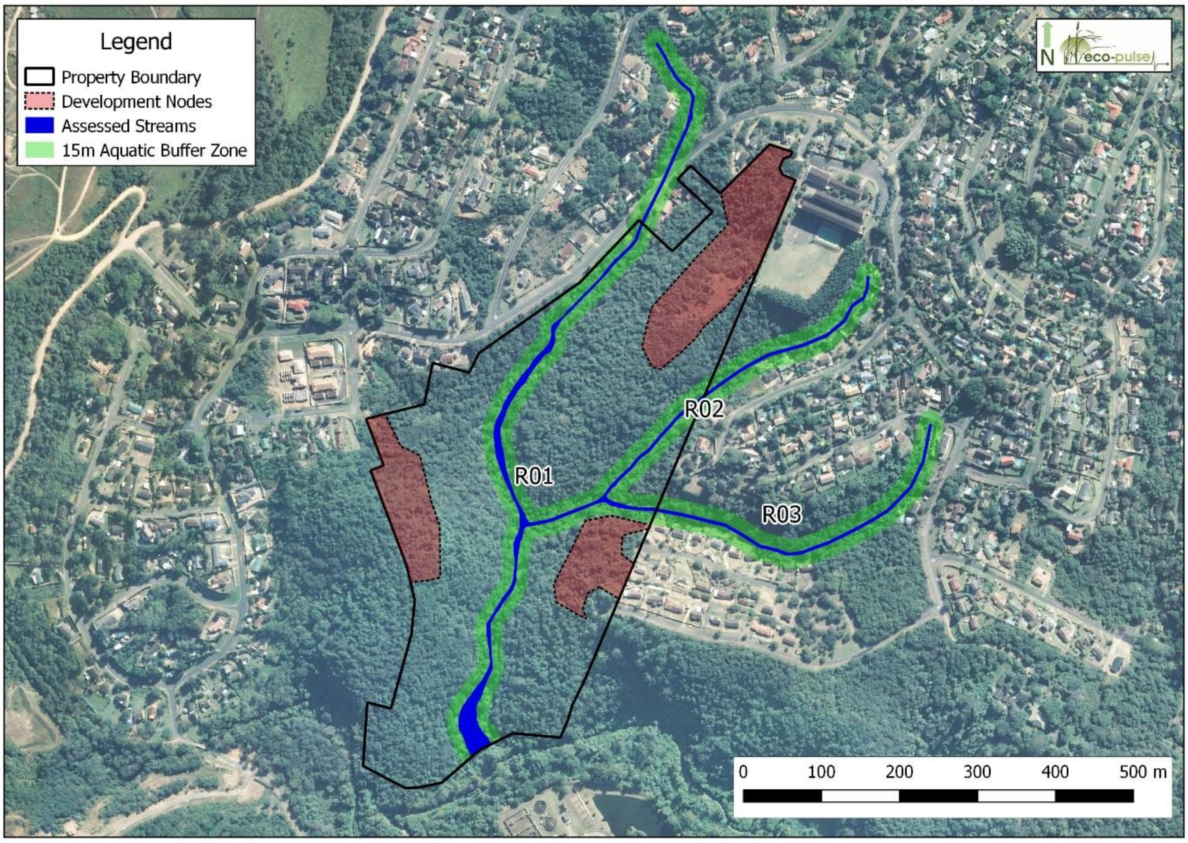


Figure 13 Map showing the recommended 15m aquatic buffer zone.

6.4.2 Storm Water Management

The management of storm water prior to discharge and the manner in which water is released into the natural environment will be critical in managing and protecting downstream aquatic resources from degradation and to allow for the continued capacity of these natural areas to receive and absorb/transmit storm water from the site. This is in light of the risk of altered flow volumes and velocities in the post-development (operational phase) context of the site and the risk of further erosion and sedimentation of adjacent / downstream rivers as a result.

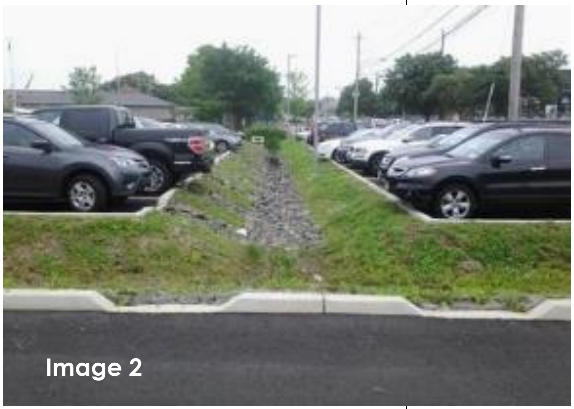
An appropriate storm water management plan must be designed for the development project in line with best practice. Storm water management at the site is likely to be handled by some form of generic storm water management system that allows for the satisfactory drainage of accumulated surface water from roofed and hardened surfaces to approved points of disposal and that adequately attenuates flows before discharging into the natural drainage network. A range of recommendations and guidelines for managing storm water runoff from the perspective of protecting rivers on the property (and downstream) have been compiled by the specialists from Eco-Pulse Consulting involved in undertaking the aquatic assessment and are based on recommendations made for similar development projects. It is recommended that these guidelines/recommendations for managing storm water be considered by the developer/project engineers and used to inform the development of the storm water management plan and system for the project.

The guidelines and recommendations for storm water management (Table 17) apply to the development project and need to be considered when designing and developing a storm water management plan and system for the property.

Table 17. Storm water management recommendations.

Item	Recommendations
Grading of the site	• To avoid the formation of preferential storm water flow paths and associated point source erosion/ scouring the entire site must be graded/ sloped to encourage shallow diffuse sheet flow towards storm water collection and conveyance systems.
Source controls & Rainwater harvesting	• Storm water should be harvested onsite from roofed surfaces thus reducing the quantity (volume) of water received by downstream water resources as surface flow. This water is to be used onsite for non-potable applications or made available for irrigation of agricultural fields or other non-potable uses. • It will be critically important to maximise runoff infiltration within footprint and within the aquatic buffer zone. Recommended infiltration structures include underground storage tanks, bio-retention areas and unlined detention basins, infiltration basins, and grassed swales. • The use of hardened surfaces on the property should be kept to a minimum as far as possible to encourage infiltration and reduce runoff capacity. Car parks for example could be gravel or another semi-permeable material (permeable paving, porous bricks/blocks) rather than impermeable asphalt or concrete.
Attenuation	• Ideally, all storm water runoff generated by the proposed development during all design storm events should be attenuated within the development footprint to pre-development levels prior to discharge to the freshwater environment. • All storm water management infrastructure/ systems including collection, detention, attenuation, conveyance and outlet structures must be located outside of delineated watercourses and their respective buffer zones with some allowance for outlet protection/ armouring within buffers where this is not practically feasible.
Local controls and storm water conveyance	• The location and design of road drainage and discharge points shall be done in a manner that minimises peak discharge to downstream aquatic resources by considering the following: i. Decreasing volume of water reaching watercourses as surface flow by encouraging infiltration; and ii. Decreasing velocity of flows entering aquatic resources (either through structural or vegetative means). • Use a combination of open, grass-lined channels/swales and stone-filled infiltration ditches rather than simply relying on underground piped systems or concrete V-drains. This will encourage infiltration across the site, provide for the filtration and removal of pollutants and provide for some degree of flow attenuation by reducing the energy and velocity of storm water flows through increased roughness when compared with pipes and concrete V-drains • For parking lots and driveways - garden beds (landscaped areas) and storm water conveyance channels, the use of concave open-lined swales or bio-retention areas should be used to receive and convey storm water. For these areas no curbs or spaced curbs are recommended so water can move freely from hardened surfaces into the swales or bio-retention areas. • Equally, if flower/plant beds are to be established adjacent to paved surfaces, then these should be designed to receive storm water from hardened surfaces and should be planted with robust indigenous species that to contribute to storm water management objectives. • Road runoff will need to be managed through use of grassed swales or grassed drainage trenches running parallel along the road on the downslope side of the access road. Grassed swales/drainage ditches/trenches will intercept runoff and promote storm water infiltration thus reducing surface runoff volumes and velocities downslope. Alternatively, numerous metre drains can be constructed to dissipate water in small quantities and low velocities. • Bio-retention methods do not only address flow volume and velocity issues but are an effective means of removing suspended solids, heavy metals, hydrocarbons, organic compounds, and dissolved nutrients from storm water. Images 1 and 2, below, provide a visual example of the type of bio-retention swales being recommended[6].

[6] Note that Images 1 to 4 are for visual aid and descriptive purposes only. They should be considered conceptual in nature and do not promote any particular product, company or brand.

Item	Recommendations
	 Source: https://za.pinterest.com/pin/419186677789410327/  Source: http://www.dec.ny.gov/lands/100871.html
Storm water outlets	Storm water discharge outlets are to be used to ensure that the erosive energy of surface run-off is dissipated and sediment suspended in the run-off is trapped before entering aquatic ecosystems. With regards to these outlets, the following environmentally responsible storm water discharge/outlet design considerations should be considered: • A series of smaller storm water outlets is recommended over a few large outlets. The storm water outlets must be constructed at regular intervals to spread out surface flow and avoid flow concentration. • All outlets must be designed to dissipate the energy of outgoing flows to reduce point source scouring and erosion risks. In this regard, adequately sized concrete stilling basins/sumps must be installed at all outlets and flow from these stilling basins must fall onto suitably designed gabion reno-mattresses with wing walls. The reno-mattresses must extend an appropriate distance downslope to ensure that erosion risks are minimised. • Appropriate amouring (e.g. reno-mattresses or rock packs) downstream/downslope of discharge points is essential to avoid scouring and sedimentation. This applies to discharge points in terrestrial and aquatic ecosystems and is of particular importance due to the sandy erodible nature of the soils in the study area. • The outlet reno-mattresses must be established to reflect the natural slope of the surface it is constructed on and are to be located at the natural ground-level. • The outlets and associated outlet protection structures should be aligned parallel to contours wherever possible to reduce the gradient of outflows and remain outside of rivers/streams and their buffer zones where possible.
Inlet protection	• Measures to capture solid waste and debris entrained in storm water entering the storm water management system (inlet protection devices) will be incorporated into the design of the system and could include the use of either curb inlet/inlet drain grates and/or debris baskets/bags.
Management of 'dirty water'	• The recycling/reuse of dirty water is promoted; alternatively this water will need to be directed into the sewer system.

It will be important for all storm water management (including conveying of storm water and attenuation structures/facilities) be undertaken on the site of the development and that this be **located outside of the delineated riparian areas and 15m buffer zone.** This is in line with best practice and is also aligned with the requirements of the Department of Water & Sanitation.

It is also important to note that storm water infrastructure will likely require regular on-going **maintenance** in the form of silt, debris/litter clearing in order to ensure their optimal functioning. They will therefore be designed to cater for regular maintenance.

6.4.3 Wastewater Management

It is understood that domestic wastewater (sewage) will be managed by tying into the existing waterborne sewage pipeline network servicing the Kingsburgh region, which wastewater to the regional Amanzimtoti WWTW (Waste Water Treatment Works) for treatment and disposal. In order to convey waste water to the municipal connection, a series of gravity pipelines will be required, which will necessitate the crossing of the seasonal stream R01 at two locations. It is recommended that a **pipe-bridge type structure** be constructed to suspend the pipeline over the bedrock channel, to avoid impacts to the instream environment. The following pipeline crossing design guidelines apply:

- The pipeline should be designed in such a way so as to take into account future channel dynamics.
- Where practically possible river crossings are to follow pipe bridges over the river and not cross the channel. The pipe bridges will need to be designed such that pipes are suspended sufficiently high above the channel bed and above the high water mark so as not to interfere with natural flow regimes and such that pipes do not act as traps for debris and sediment transported through the channel.
- Piers are to be places on either side of the channel and not to be placed within the channel bed. Piers should be placed a sufficient distance up the bank (preferably on the top of the upper bank) and not below the water mark/bank full level.
- Necessary erosion protection works must be constructed where the pipeline intersects the macro-channel banks of the 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.

There is therefore no need to consider an onsite package type treatment plant or septic tanks. As no wastewater will be treated or disposed of on site, no further recommendations are provided. However, if and where septic tanks are to be considered, the option of installing conservancy tanks as a feasible alternative option should first be considered.

6.5 Construction Phase: Practical Onsite Mitigation Measures

A number of practical measures and onsite controls are also recommended to prevent or limit the impact of the proposed development project during the **construction phase**. These should be included in the Environmental Management Programme (EMPr) for the development project where not already covered by the EMPr.

Impact mitigation measures and recommendations have been compiled based on specialist knowledge and experience in similar waste water pipeline projects as well as a range of literature including:

- FERC (US Federal Energy Regulatory Commission), 2002. Wetland and Waterbody construction and mitigation procedures.

- DWAF (Department of Water Affairs and Forestry) 2005b. Environmental Best Practice Specifications: Operation. Integrated Environmental Management Sub-Series No. IEMS 1.6. Third Edition. DWAF, Pretoria.
- DWAF (Department of Water Affairs and Forestry) 2005c. Environmental Best Practice Specifications: Operation. Integrated Environmental Management Sub-Series No. IEMS 1.6. Third Edition. DWAF, Pretoria.
- CSIR, 2003. Guidelines for human settlement planning and design. Chapter 10: Sanitation. Revised August 2003.

The following mitigation measures must be implemented in conjunction with any generic measures provided in the Environmental Management Programme (EMPr):

A. Defining and Management of No-Go Areas

- The edges of the construction servitude / development zone within the vicinity of the stream / riparian habitat and 15m buffer zone must be clearly staked-out by a surveyor and demarcated using highly visible material (e.g. danger tape) prior to construction commencing.
- The demarcation work must be signed off by the Environmental Control Officer (ECO) before any work commences.
- Demarcations are to remain until construction and rehabilitation is complete.
- All areas outside of this demarcated working servitude must be considered no-go areas for the entire construction phase.
- No equipment laydown or storage areas must be located within delineated riparian areas or the recommended 15m aquatic buffer zone.
- Access to and from the development area should be either via existing roads or within the construction servitude.
- Any contractor found working within No-Go areas must be fined as per fining schedule/system setup for the project.
- All disturbed areas beyond the construction site that are intentionally or accidentally disturbed during the construction phase must be rehabilitated immediately to the satisfaction of the ECO. All disturbed areas must be prepared and then re-vegetated to the satisfaction of the ECO as per the relevant rehabilitation plan.

B. Specific Measures for Working within or Directly Upslope of Rivers

- No clearing of indigenous vegetation outside of the defined working servitudes is permitted for any reason (i.e. for fire wood or medicinal use).
- Any direct modification of river habitat for the installation of culverts and road drainage must be limited to the construction servitude. For roads this should be limited to the road footprint.
- Before any work commences, sediment control/silt capture measures (e.g. bidim/silt curtains) must be installed downstream/downslope of the active working areas. Quantities of silt

fences/curtains shall be decided on site with the engineer, contractor and ECO. The ECO should be present during the location and installation of the silt curtains.

- Silt fences/curtains must be regularly checked and maintained (de-silted to ensure continued capacity to trap silt), and repaired where necessary. When de-silting takes place silt must not be returned to the watercourse.
- Any topsoil removed from watercourses must be stockpiled separately from subsoil material and be stored appropriately for use in rehabilitation activities.
- If necessary, indigenous riparian vegetation must be must be carefully removed and stored in an appropriate facility for rehabilitation purposes.
- Movement of construction vehicles across rivers must be minimised as much as possible.
- Excavated rock and sediments from the construction zone, and including any foreign materials, should not be placed within the delineated rivers and riparian areas in order to reduce the possibility of material being washed downstream.
- 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.
- Any topsoil and vegetation from areas to be excavated should be stripped and stored at the designated soil stockpile area outside of the aquatic zone for use later in rehabilitation.
- Disturbed channel bed material should be stockpiled for use in rehabilitation.
- Soil and other material required for construction purposes must not be derived from any river.
- Any indigenous vegetation suitable for rehabilitation should be stored appropriately for later use.
- Where possible, vegetation should be cut to ground level rather than removing completely so as to assist with binding/stabilising the soil during land-clearing operations.
- The ECO will need to mark any indigenous riparian trees or sensitive plant species adjacent to the construction servitude that are not to be damaged during construction.
- No persons may remove, damage, deface, paint or disturb of any flora (plants) outside of the demarcated construction areas, unless specifically authorised by the ECO in consultation with the resident engineer.
- All cleared and trimmed vegetation shall be removed from the watercourse upon completion of clearing in order to prevent the risk of flooding/snagging.

C. Wildlife & Natural Resources Management

- At the start of the project, the contractor must undertake environmental awareness training for all employees. This should include basic environmental training based on the requirements of the EMPr, including training on avoiding and conserving local wildlife. Education of workers/employees onsite on not to harm wildlife unnecessarily will assist in mitigating this impact

- 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.).
- The handling and relocation of any animal perceived to be dangerous/venomous/poisonous must be undertaken by a suitably trained individual.
- Any fauna that is found within the construction zone must be moved to the closest point of natural habitat outside the construction area.
- All vehicles accessing the site should adhere to a low speed limit to avoid running over susceptible species such as reptiles (snakes and lizards).

D. Soil Management (Stockpile Areas)

- The topsoil layer must be stripped from the construction footprint and stockpiled separately from overburden (subsoil and rocky material). The thickness of the topsoil for harvesting must be obtaining from the geotechnical report and if not defined in the report, the top 30cm must be harvested.
- Topsoil is to be handled twice only – once during stripping and stockpiling, and once during replacement and levelling.
- All stockpile areas must ideally be established on disturbed flat ground or within the proposed development area.
- Stripped topsoil should be reinstated in areas from which they are stripped. A stockpile register may help in this regard.
- Where the risk of erosion of the soil stockpiles is high, erosion/sediment control measures such as silt fences, concrete blocks and/or sand bags must be placed around soil/material stockpiles to limit sediment runoff from stockpiles.
- Stockpiled soil is to be kept free of weeds and not to be compacted.
- The slope and height of stockpiles must be limited to 2m to avoid soil compaction and destruction of soil microbes.
- Spoil material must be hauled to a designated spoil site. No spoil material must be discarded on site.

E. Erosion Control Measures

Storm water and erosion control measures must be implemented during the construction phase to ensure that erosion is avoided or minimised. In this regard, the following measures should be implemented:

- Wherever possible, existing vegetation cover on the development site should be maintained during the construction phase. The unnecessary removal of groundcover from slopes must be prevented, especially on steep slopes which will not be developed.
- Vegetation clearing and soil stripping 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.

- Any vegetation clearing should be done immediately before construction activities to avoid prolonged exposure of the soil to weather elements.
- All bare slopes and surfaces to be exposed to the elements during clearing and earthworks must be protected against erosion using rows of silt fences, sandbags, hay bales and/or earthen berms spaced along contours at regular intervals. The spacing interval must be smaller for steeper slopes and if required the ECO should advise in this regard.
- All temporary erosion and sediment control measures must be monitored for the duration of the construction phase and repaired immediately when damaged. All temporary erosion and sediment control structures must only be removed once vegetation cover has successfully recolonised the affected areas.
- 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 vegetation has re-colonised the rehabilitated area.

F. Pollution Prevention Measures

The following pollution prevention measures must be implemented at the site:

- The proper storage, handling and disposal of hazardous substances (e.g. fuel, oil, cement, etc.) must be undertaken.
- All hazardous substances must be stored in appropriate containment structures free from the ingress and egress of storm water runoff.
- Hazardous storage and re-fuelling areas must be bunded prior to their use on site during the construction period. The bund wall should be high enough to contain at least 110% of any stored volume.
- 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 storm water.
- Cement/concrete batching is to be located in an area to be hardened and must first be approved by the ECO. No batching activities shall occur directly on the ground.
- Provide drip-trays beneath standing machinery/plant that are prone to leaks.
- No refuelling, servicing nor chemical storage should occur outside the established construction camp.
- Vehicle maintenance should not take place on site unless a specific bunded area is constructed for such a purpose.
- Spillages of fuels, oils and other potentially harmful chemicals should be cleaned up immediately and contaminants properly disposed of using appropriate spill kits. Any contaminated soil from the construction site must be removed and rehabilitated accordingly or disposed appropriately.

- 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.
- 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 within the buffer of any natural watercourses. 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.

G. Management of Solid Waste

- Provide adequate rubbish bins and waste disposal facilities on-site and at the contractors site camp.
- Litter bins must be equipped with a closing mechanism to prevent their contents from blowing out or wild animals from accessing the contents.
- Clear and completely remove from site all general waste, constructional plant, equipment, surplus rock and other foreign materials once construction has been completed.
- The construction site must be kept clean and tidy and free from rubbish.
- Recycling/re-use of waste is to be encouraged.
- No solid waste may be burned on site.

H. Invasive Alien Plant (IAP) Control

- Equipment used on site must be seed free and vehicles must be properly washed before moving onto site.
- All invasive alien plants that colonise the construction site must be removed immediately on detection, preferably by uprooting. The contactor should consult the ECO regarding the method of removal if uprooting is unfeasible (e.g. mechanical and/or herbicide methods).
- All bare surfaces across the construction site must be checked for IAPs every two weeks and if recorded, IAPs must be removed by hand pulling/uprooting and burned in a controlled environment.
- Herbicides should be utilised where hand pulling/uprooting is not possible.

I. Water Abstraction and Use

- No water is to be abstracted from any river on the site or downstream 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.
- Employees are not to make use of any natural water sources (e.g. wetlands or rivers) 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 or rivers on site.

J. Fire Management

- No open fires to be permitted outside of designated areas. 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.

6.6 Operational Impact Mitigation Recommendations

A number of aquatic ecosystem management and mitigation measures are recommended to address the operational impacts of the project and it is recommended that these be included in an operational EMPr for the operational development project and related activities:

A. Access Control

Access to rivers/streams should be controlled / restricted to promote the preservation of these sensitive environments.

B. Maintenance of Storm Water Infrastructure

Importantly, the storm water management system and related infrastructure is likely to require regular on-going maintenance in the form of silt, debris/litter clearing in order to ensure the optimal functioning of such systems. Storm water management systems will therefore be designed with longevity in mind and in order to require little maintenance by catering for silting, etc.

C. Landscaping Recommendations

It is recommended that landscaping promote the use of indigenous species common to the region and that as much natural ground cover is established (naturally) on the site to help with binding soils and encouraging water infiltration, thus reducing overland flows and the pressure on storm water management infrastructure.

D. Waste Minimisation, Reuse and Recycling

A culture of "conserve, reduce, reuse & recycle" should be promoted with regards to the use and disposal of products to minimise resource consumption and reduce the amount of potential waste. Project design can also promote the conservation and efficient utilisation of water, implement rainwater harvesting measures, the recycling / re-use through grey water systems and using water efficient fittings.

E. Rules and Regulations for Future Land Owners

It is recommended that all future tenants should be provided with a set of rules and obligations regarding the correct use of any toilets, drains, sinks, etc. Biodegradable detergents and cleaning materials should be promoted where the storm water runoff from the development site could be contaminated by such products, for example.

F. IAP (Invasive Alien Plant) Control

In line with the requirements of Section 2(2) and Section 3 (2) the National Environmental Management: Biodiversity Act (NEM:BA), which obligates the landowner/developer to control IAPs on his property, all IAPs within the property must be controlled on an on-going basis. The need for this exercise will need to be reviewed based on the presence of IAPs during the operational phase and the ECO will advise accordingly.

6.7 Monitoring Recommendations

6.7.1 Introduction

Monitoring is required in order to ensure that rivers/streams associated with the proposed development are maintained in their current ecological state or improved but incurring <u>no net loss</u> to habitat condition and functionality as a result of the project.

6.7.2 Approach to Monitoring

It is recommended that a suitable and appropriate **Aquatic BioMonitoring Plan** 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 rivers; and
- Ensuring that disturbed riparian 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:

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 zone including 'No Go' areas;
- Destruction of conservation important/protected plants and trees;
- Erosion of channels;
- 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, road batters and soil stockpiles by surface wash processes;
- Sedimentation of habitat downstream of work areas;
- Altering the hydrology and through flows to downstream rivers during construction;
- Pollution of watercourses (with a particular focus on 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).

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, as per the Conceptual Aquatic Habitat Rehabilitation Plan (to be developed as part of the WULA for the project).

E. Operation phase monitoring requirements:

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

- Invasive Alien Plant infestation;
- Scouring and deposition associated with storm water runoff;

- Development of erosion 'headcuts';
- Channel incision downstream of development;
- Blockage/siltation of culverts/pipes/side drains;
- Scouring around infrastructure at river/stream crossings; and
- Erosion or instability of road embankments.

Surface water quality will be monitored at strategic points in the landscape and the results will be used to inform further management actions, remedial measures and/or the revision of mitigation strategies aimed at protecting the watercourse on the property and downstream from water quality impacts associated with the development. This monitoring plan should be referred to for all aspects of surface water quality monitoring and biomonitoring at the site. Note that due to the absence of suitable instream/channelled riverine associated with perennial rivers and flow, river health indicators and techniques (such as the SASS 5 macro-inveterate sampling method) are not recommended for aquatic biomonitoring. Instead simple surface water quality sampling and analysis and 'basic river habitat integrity monitoring' (using the Index of Habitat Integrity or IHI method for example) should be used to monitor any changes to aquatic habitat condition.

Note that operational monitoring of storm water and wastewater management infrastructure is to occur as per best-practice and in line with the engineers specifications. It will be critical that any leakages or failures leading to the release of untreated effluent be identified and rectified through regular site inspections by trained individuals.

6.8 Rehabilitation Strategy & Guidelines

Rehabilitation refers to the process of reinstating the natural hydrological, geomorphological and ecological processes of a degraded riverine/wetland habitat system with the aim of recovering system integrity and ecosystem service delivery (Russell, 2009). Wetland rehabilitation also refers to the halting and decline in integrity (stabilisation) of an ecological system that is in the process of degrading with the aim of maintaining system integrity and ecosystem service delivery (Russell, 2009). The rehabilitation process essentially involves the following tasks:

- Identification of causes of system degradation.
- Identification of practical and feasible rehabilitation objectives/goals.
- Identification of rehabilitation interventions to achieve the objectives/goals.
- Location and design of rehabilitation structures.
- Compilation of intervention plans and programmes e.g. re-vegetation plans.
- Compilation of intervention implementation management plans.
- Compilation of monitoring programme.

The need for an aquatic rehabilitation plan has been identified of being of relevance to the project due to the potential for wastewater pipeline construction across wetland leading to vegetation and habitat destruction. A conceptual level aquatic habitat rehabilitation plan will need to be developed for the project and to accompany any application for a Water Use License for the project. The overall aim of the rehabilitation should be to stabilise any unstable soils or erosion at the pipeline-river crossing site and revegetate the area disturbed in order to create a 'self/sustaining' riparian community over time. Owing to the vital role of vegetation in aquatic ecosystem health and functioning, the re-establishment of natural or semi-natural vegetation is widely recognized as an important component of any river rehabilitation programme or plan. The following guidelines will need to be considered when compiling the rehabilitation plan:

- The purpose and objectives of the plan must be clearly defined;
- Target areas for river rehabilitation mist be clearly identified and described;
- Key concepts and principles to be defined;
- Legal context to be described;
- Roles and responsibilities to be defined clearly;
- Timing of rehabilitation;
- Methods of site preparation, alien plant control and revegetation to be defined;
- Post-rehabilitation monitoring to be considered; and
- Methods of rehabilitation to be as per the diagram in Figure 14, below.

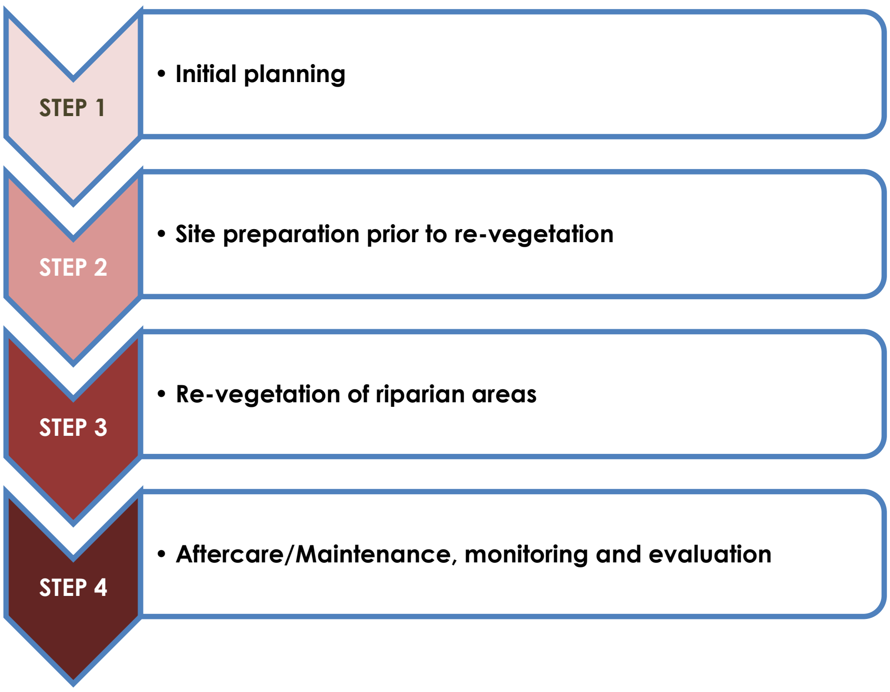


Figure 14 Steps involved in the rehabilitation of aquatic ecosystems.

7 WATER USE LICENSING REQUIREMENTS

7.1 Applicable Water Use Activities

Chapter 4 and Section 21 of the National Water Act (No. 36 of 1998) lists certain activities for which water uses must be licensed, unless its use is excluded. There are several reasons why water users are required to register and license their water uses with the Department of Water & Sanitation (DWS). The most important reasons being: (i) to manage and control water resources for planning and development; (ii) to protect water resources against over-use, damage and impacts and (iii) to ensure fair allocation of water among users. The water uses described in Table 18 (below) have been identified as being associated with the proposed development.

Only Section 21 (i) water use (described in Table 18, below and identified on the map in Figure 15) could be associated with the development and management of storm water runoff and construction of wastewater pipelines across river R01.

There is no abstraction or storage of water planned for the site, hence Section 21 (a) and (b) water uses do not apply. Since wastewater will be managed by tying in to an existing wastewater pipeline to the regional/municipal WWTW (Waste Water Treatment Works) for treatment and disposal offsite, Section 21 (g) water use also does not apply to the project.

Table 18. Water Uses applicable to the proposed residential development at Kingsburgh.

NWA Section 21 Water Use	**Description** (DWAF, 2009)	Development activities constituting the water use
Section 21 (i): *Altering the bed, banks, course or characteristics of a watercourse*	*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).*	• Storm water runoff from development (hardened surfaces such as buildings and roads) with the potential for erosion/siltation during construction & operation. • Sewer pipelines crossing watercourses via pipe bridges.

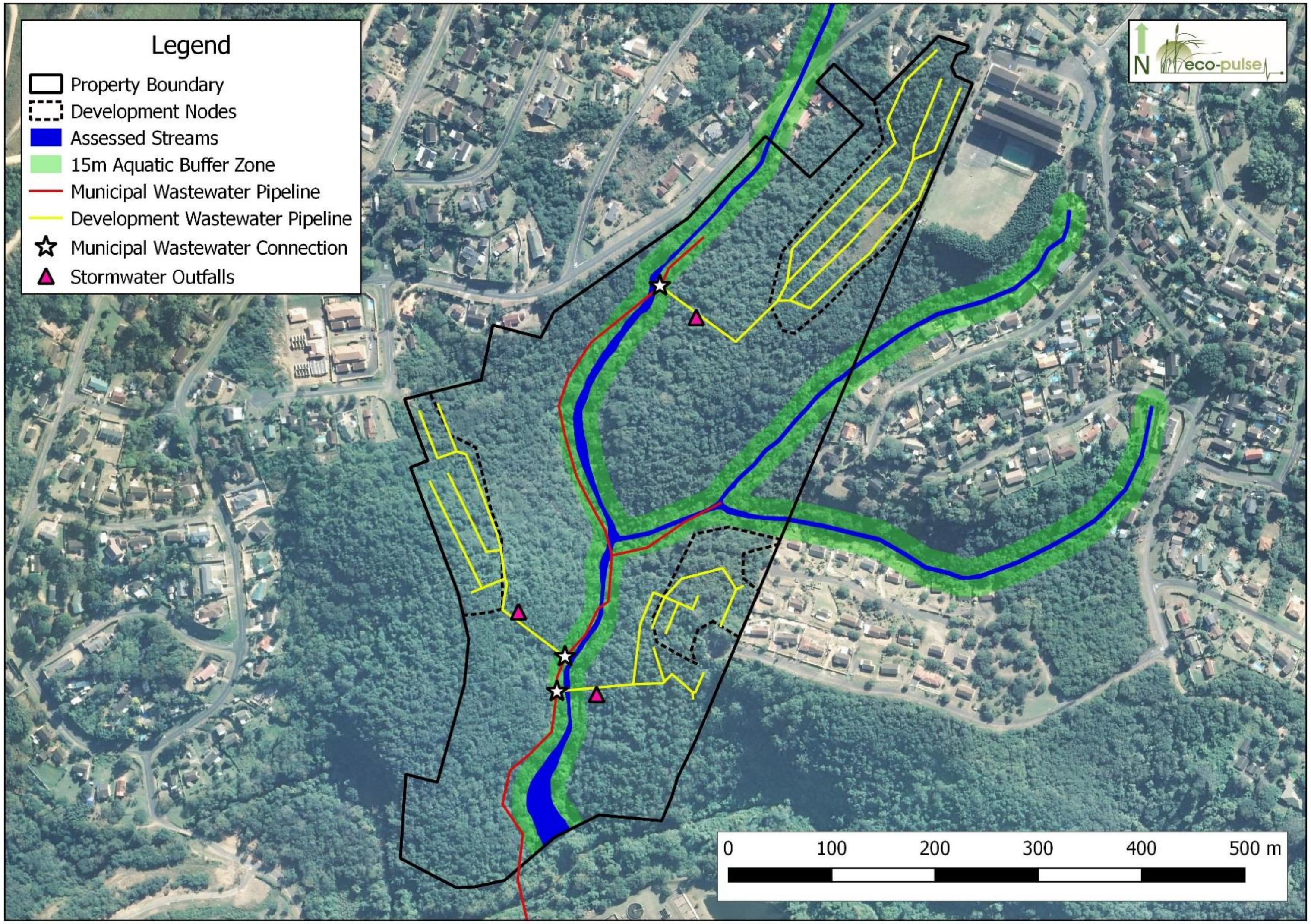


Figure 15 Water Uses Map: showing the location of applicable water uses (Section 21 i).

7.2 Aquatic Risk Assessment

Water resource screening and risk rating is largely a requirement for all potential water uses as contemplated in the National Water Act No. 36 of 1998 (NWA). Risk can be defined broadly as '*a prediction of the likelihood or probability and impact of an outcome as a result of external or internal vulnerabilities operating on a system and which may be possible to avoid through pre-emptive action*'.

The recent General Authorisation (GA) in terms of Section 39 of the National Water Act No. 36 of 1998 for Water Uses as defined in Section 21 (c) and/or Section 21 (i), (as contained in Government Gazette No. 40229, 26 August 2016) replaces the need for a water user to apply for a license in terms of the National Water Act No. 36 of 1998, '*provided that the water use is within the limits and conditions of the GA*'. Note that the GA does not apply to:

1. Water use for the rehabilitation of a wetland as contemplated in GA 1198 contained in GG 32805 (18 December 2009).
2. Use of water within the 'regulated area'[7] of a watercourse where the Risk Class is **Medium or High.**
3. Where any other water use as defined in Section 21 of the NWA must be applied for.
4. Where storage of water results from Section 21 (c) and/or (i) water use.
5. Any water use associated with the construction, installation or maintenance of any sewage pipeline, pipelines carrying hazardous materials and/or raw water (wastewater) to a wastewater treatment works facility

7.2.1 Identification & Description of Typical Risks

The DWS has developed a Risk Assessment Matrix/Tool to assess the risk to watercourses associated with typical development activities. The DWS Risk Matrix/Assessment Tool was applied to the proposed development with emphasis on Section 21 (c) and (i) water uses.

The Risk Assessment Matrix/Tool considers the risks posed to watercourses posed by various activities and for different phases of a development (i.e. Construction and Operation in this case). Activities typically give rise to different environmental stressors (or aspects) which manifest in impacts to the receiving aquatic environment and ecosystems. The tool rates the anticipated severity of impacts on the four key drivers of aquatic ecosystem persistence, health and functioning, that being:

1. **Flow Regime**

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[7] The 'regulated area' of a watercourse; for Section 21 (c) or (i) of the Act refers to:

iv. The outer edge of the 1:100 year flood line and/or delineated riparian habitat, whichever is greatest, as measured from the centre of the watercourse of a river, spring, natural channel, lake or dam.

v. In the absence of a determined 1:100 year flood line or riparian area, refers to the area within 100m from the edge of a watercourse (where the edge is the first identifiable annual bank fill flood bench).

vi. A 500m radius from the delineated boundary of any wetland or pan.

2. **Water Quality**
3. **Habitat & Vegetation**
4. **Aquatic Biota**

Possible activities, aspects (or stressors) and potential ecological risks associated with the planned residential estate development, that could potentially manifest in impacts to the four drivers of river condition/functioning as defined by the DWS, are included in the sections that follow.

Construction Phase Activities, Aspects (stressors) & Risks:

Activities, stressors and ecological risks likely to be associated with the construction phase of the development are likely to include:

1. Site clearing (vegetation stripping).
2. Earth works, land preparation (site grading and platforming) and construction of infrastructure (roads, housing, wastewater pipelines, storm water infrastructure etc.).
3. Alteration of soil profiles and associated flow patterns with a resultant increase in sediment delivered to watercourses (sedimentation and increased turbidity).
4. Use of machinery and other sources of hazardous pollutants within and adjacent to watercourses (i.e. in order to undertake Activity 1 & 2 above).
5. Potential water pollution and associated biotic impacts from hazardous substances such as oils, grease, hydrocarbons and volatile organic compounds

Operational Phase Activities, Aspects (stressors) & Risks:

Operationally, the main activities and stressors would probably relate to:

1. Increased storm water run-off volumes and velocities from storm water management systems.
   Increased floodpeaks received by watercourses and associated erosion and sedimentation impacts.
2. Contaminated urban run-off containing heavy metal, hydrocarbons, solids and organic compounds (from roads, parking lots and other hardened surfaces.
   Low intensity water pollution and associated water resource management and biotic impacts.
3. Possible leakages/ spills from broken sewage pipelines. Possible water pollution and associated water resource management and biotic impacts.

7.2.2 Quantifying ecological risks

For the purposes of this aquatic risk assessment, the DWS "Risk Assessment Matrix" approach, as detailed in the latest General Authorisation in terms of Section 39 of the National Water Act, was applied at a project level in order to identify whether the project will fall within the realm of a GA or whether a full WULA will likely be required, and also to dictate what level of risk/impact mitigation will be required for the construction and operational phases of the project to reduce risk to manageable and environmentally acceptable levels.

The results indicate that the risks posed by the construction and operation of the development to watercourses will be '**moderate'** overall in a standard mitigation scenario. This risk rating is driven by possible water pollution and associated water resource management and biotic impacts linked with accidental leakages/spills from wastewater pipeline infrastructure, and by potential storm water run-off and related erosion impacts. With the addition of mitigation measures contained in section 6 of this specialist aquatic assessment report, most risk ratings can be reduced to low levels overall. However, given that wastewater pipelines are to be constructed and installed as part of this project, this development does not meet the DWS conditions for a General Authorisation for 21 (c) and (i) water uses under this scenario. A full WUL will therefore be required. Table 19 provides a summary of the risk assessment with the full risk assessment table provided in **Annexure B.**

Table 19. Summary of the DWS Risk Matrix/Tool assessment results applied to the Kingsburgh Residential Estate Development Project.

Phase(s)	Activity	Aspect	Impact	Significance	Risk Rating	Revised Risk Rating for Borderline LOW / MODERATE Ratings	PES & EIS of Affected Watercourse	Impact/Risk Mitigation Proposed
Construction	Clearing, site grading/ platforming land preparations and construction of all infrastructure including buildings and associated service infrastructure.	1. Site clearing (vegetation stripping).	Potential physical destruction of freshwater habitat (bed and banks) and protected plant species.	42.5	Low	Low	Streams R01, R02 & R03:' D' PES & 'Low' EIS	• All development (with the exception of some roads and services pipelines) to be located outside of the 15m buffer setback (see Section 6.1.1). Apart from road and pipeline crossings of buffers and watercourses, no development is permitted in this buffer zone. • No clearing of indigenous vegetation outside of the defined working servitudes to be permitted for any reason. • Indigenous riparian vegetation removed from the road footprint and suitable for rehabilitation activities must be carefully removed and stored in an appropriate facility for rehabilitation purposes. • Minimise disturbance when working within watercourses (i. e. no development outside of the demarcated construction servitude) • Rehabilitate disturbed river habitat immediately after construction. Apply other specific measures for working within watercourses (see Section 6).
		2. Earth works, land preparation (site grading and platforming) and construction of infrastructure (roads, housing, pipelines, storm water infrastructure etc.).	Alteration of soil profiles and associated flow patterns with a resultant increase in sediment delivered to watercourses (sedimentation and increased turbidity).	71.5	Moderate	Low		• All development (with the exception of some roads and services pipelines) to be located outside of the 15m buffer setback (see Section 6.1.1). Apart from road and pipeline crossings of buffers and watercourses, no development is permitted in this buffer zone. • Minimise disturbance when working within watercourses (i. e. no development outside of the demarcated construction servitude) • 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. • Any topsoil removed from watercourses must be stockpiled separately from subsoil material and be stored appropriately for use in rehabilitation activities. • Rehabilitate disturbed river habitat immediately after construction as per the recommendations contained in the Aquatic Rehabilitation Plan (contained in Appendix A. Apply other specific measures for working within watercourses (see Section 6).

Phase(s)	Activity	Aspect	Impact	Significance	Risk Rating	Revised Risk Rating for Borderline LOW / MODERATE Ratings	PES & EIS of Affected Watercourse	Impact/Risk Mitigation Proposed
		3. Use of machinery and other sources of hazardous pollutants within and adjacent to watercourses (i.e. in order to undertake Activity 1 & 2 above).	Potential water pollution and associated biotic impacts from hazardous substances such as oils, grease, hydrocarbons and volatile organic compounds.	55.0	Low	Low		• No equipment laydown or storage areas must be located within the recommended 15m buffer of watercourses. • All necessary equipment for dealing with spills of fuels/chemicals must be available at the site. • Movement of construction vehicles across rivers must be minimised as much as possible. • No vehicle/machinery refuelling or servicing should occur within the buffer of the delineated watercourses. • No vehicles transporting concrete or any hazardous product may be washed on site. • Employees are not to make use of any natural water sources (e.g. rivers) for the purposes of washing equipment, vehicles or machinery. Apply other specific measures for working within watercourses (Section 6).
Operational	Development operation including petrol filling station, management of stormwater and greywater and wastewater reticulation.	1. Increased storm water run-off volumes and velocities from storm water management systems.	Increased floodpeaks and associated erosion and possible sedimentation impacts.	71.5	Moderate	Low	Streams R01, R02 & R03:' D' PES & 'Low' EIS	• All storm water management infrastructure/ systems including collection, detention, attenuation, conveyance and outlet structures must be located outside of delineated watercourses and their respective 15m buffer zones with some allowance for outlet protection/ armouring within buffers where this is not practically feasible. • Adequately designed storm water conveyance infrastructure and discharge outlets are to be used to ensure that the erosive energy of surface run-off is dissipated and sediment suspended in the run-off is trapped before entering aquatic ecosystems. Design of this infrastructure should take into consideration the design recommendations mentioned in Section 6.1.2 of this report. Along with the above mentioned mitigations, a storm water management plan should be compiled for this development. This should take into account all specific measures for relating to storm water management mentioned Section 6 of this report.

Phase(s)	Activity	Aspect	Impact	Significance	Risk Rating	Revised Risk Rating for Borderline LOW / MODERATE Ratings	PES & EIS of Affected Watercourse	Impact/Risk Mitigation Proposed
		2. Contaminated urban run-off containing heavy metal, hydrocarbons, solids and organic compounds (from roads, parking lots and other hardened surfaces.	Potential water pollution and associated water resource management and biotic impacts.	51	Low	Low		• Measures to capture solid waste and debris entrained in storm water entering the storm water management system (inlet protection devices) must be incorporated into the design of the system • Storm water conveyance through bio-retention methods should be used where possible as these are an effective means of removing suspended solids, heavy metals, hydrocarbons, organic compounds, and dissolved nutrients from storm water. • Storm water management systems will be designed with longevity in mind and in order to require little maintenance by catering for silting, etc. Along with the above mentioned mitigations, a storm water management plan should be compiled for this development. This should take into account all specific measures for relating to storm water management mentioned Section 6 of this report.
		3. Possible leakages/ spills from waste water pipelines.	Possible water pollution and associated water resource management and biotic impacts.	117	Moderate	Moderate		• Regularly inspect and maintain sewage infrastructure. • Place signage containing contact details of maintenance staff and key personal responsible for managing sewage infrastructure. Civilians must be encouraged to report on any sewage issues. Attend to leakages and compromised infrastructure immediately by applying the measures contained in the Aquatic Contingency Plan that should be for the development project

8 CONCLUSION

The planned establishment of a residential development in the suburb of Kingsburgh, eThekwini Municipality (KwaZulu-Natal) is likely to negatively impact on three small coastal streams/rivers, one of which is a seasonal river and tributary of the Little Manzimtoti River, the other two being smaller ephemeral bedrock streams. All three rivers/streams were found to be in a 'poor' ecological condition ('D' PES) and of 'Moderately-Low' to 'Low' EIS based on the aquatic assessment undertaken by Eco-Pulse in June 2018. Future management of the freshwater (streams) ecosystems associated with the development site should be to *maintain the current status quo of aquatic ecosystems without any further loss of integrity/functioning (PES/EIS).*

The most significant impacts linked with the project are likely to be associated with the (i) risk of increased sediment inputs and turbidity during construction, (ii) the risk of modifying natural/pre-development flow characteristics with the development of hardened surfaces and (iii) possible leakages/spills from waste water pipelines during the operation of the development. These impacts are expected to generally be of 'moderate' to 'moderately-low' impact significance under a poor management scenario, with the significance of impacts expected to be reduced to 'low' and environmentally 'acceptable' levels with best practice or 'good' mitigation. The proposed development is therefore generally considered acceptable from an aquatic ecological perspective based on the condition that the proposed mitigation and management recommendations (i.e. impact mitigation recommendations provided in Chapter 6 of this report) are applied timeously and to best-practice standards.

The proposed development requires a Water Use License (WUL) in terms of Chapter 4 and Section 21 (c) and (i) of the National Water Act No. 36 of 1998 and this must be secured prior to the commencement of construction. Given that wastewater pipelines are to be constructed and installed as part of this project (with crossings of river R01 planned), this development does not meet the DWS conditions for a General Authorisation for 21 (c) and (i) water uses under this scenario and a full WULA will therefore be required.

Should you have any queries regarding the findings and recommendations in this Specialist Aquatic Habitat Impact Assessment Report, please contact Eco-Pulse Environmental Consulting Services directly.

Yours sincerely

Adam Teixeira-Leite *Pr.Sci.Nat.*

Senior Scientist & Wetland Ecologist

Email: ateixeira@eco-pulse.co.za

Cell: 082 310 6769

Shaun McNamara *MSc.*

Junior Environmental Scientist

Email: smcnamara@eco-pulse.co.za

Cell: 084 596 6078

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10 ANNEXURES

ANNEXURE A: Detailed Assessment Methods.

A1 Delineation of Riparian Areas

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). According to the manual, this involves marking the outer edge of the macro-channel bank and associated vegetation. Like wetlands, riparian areas have their own unique set of indicators required in order to delineate these features. Delineation of riparian areas generally requires that the following be taken into account:

- **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**: this is the primary indicator of a riparian area, whereby the edge of the riparian zone is defined as the zone where a distinctive change in species composition and physical structure occurs between those of surrounding/adjacent terrestrial areas. In this case a combination of aerial photography analysis and on-site field information (pertaining to the vegetation health, compactness, crowding, size, structure and numbers of individual plants) was used to differentiate between riparian and terrestrial vegetation.
- **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.

Since NO WETLANDS were associated with the study area, only riparian areas were subject to delineation.

A2 Classification of Rivers

For the purposes of this study, riverine ecosystems were classified according to HGM (hydro geomorphic) type (to Level 4b classification level) using the National Wetland Classification System developed for the South African National Biodiversity Institute (Ollis *et al.*, 2013) as outlined in Table 22, below. Initially the systems requires the classification of the landform in which the wetland or river occurs (Level 3 classification) according to the following four (4) groups:

- Valley floor: the base of a valley, situated be- tween two distinct valley side-slopes, where alluvial or fluvial processes typically dominate
- Slope: an inclined stretch of ground typically located on the side of a mountain, hill or valley, not forming part of a valley floor. Includes scarp slopes, mid-slopes and foot-slopes.

- Plain: an extensive area of low relief. These areas are generally characterised by relatively level, gently undulating or uniformly sloping land with a very gentle gradient that is not located within a valley. Gradient is typically less than 0.01 or 1:100.
- Bench: a relatively discrete area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops, saddles and shelves. Benches are significantly less extensive than plains, typically being less than 50 ha in area. Benches include hilltops, saddles and shelfs.

Figure 16 below provides a basic schematic showing the four (4) landforms used to classify wetlands and river at level three (Ollis *et al*., 2013). Table 20 that follows summarises the level 4 criteria used to classify wetlands and river to level 4b, the level which was applied to the study. It is important to note that level 4 HGM types may occur within two or more level three landforms (i.e. level 4 HGM type is not dependant on the level three classification).

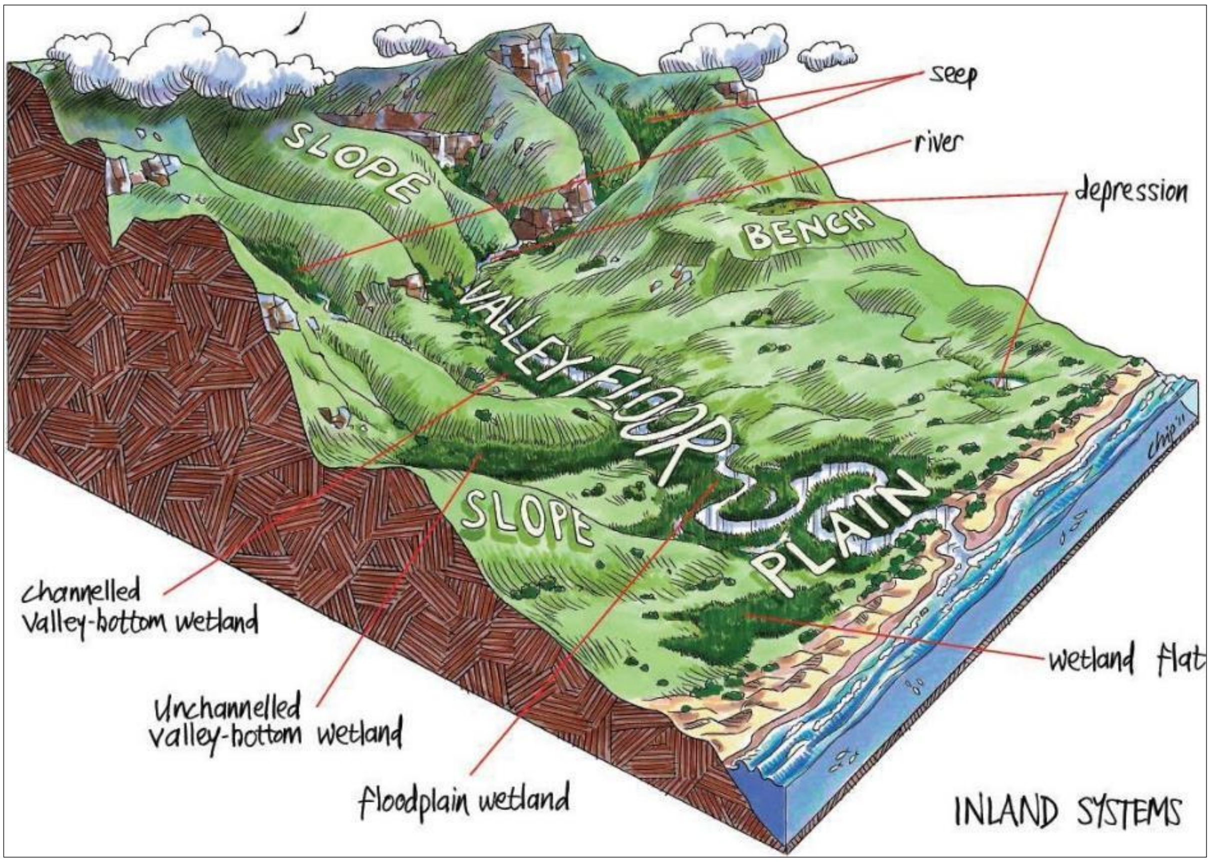


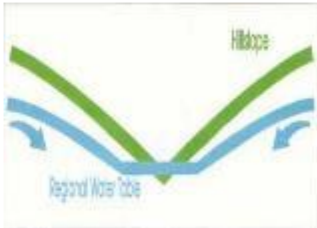
Figure 16 Illustration of the seven primary HGM Units and their typical landscape settings (Source: Ollis *et al*., 2013)

Table 20. Level 4 wetland and river classification (after Ollis *et al*., 2013).

HGM type (Level 4a)	Longitudinal zonation/Landform/ Outflow drainage (Level 4b)	Description
Rivers	**Mountain headwater stream** >0.1	A very steep-gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order. Reach types include bedrock fall and cascades.
	Mountain stream 0.040–0.099	Steep-gradient stream dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach types include cascades, bedrock fall, step-pool, plane bed. Approximate equal distribution of 'vertical' and 'horizontal' flow components.
	Transitional 0.020–0.039	Moderately steep stream dominated by bedrock or boulders. Reach types include plane bed, pool-rapid or pool-riffle. Confined or semi-confined valley floor with limited floodplain development.
	Upper foothills 0.005–0.019	Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plane bed, pool-riffle or pool-rapid reach types. Length of pools and riffles/ rapids similar. Narrow floodplain of sand, gravel or cobble often present.
	Lower foothills 0.001–0.005	Lower gradient, mixed-bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock-controlled. Reach types typically include pool-riffle or pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Floodplain often present.
	Lowland river 0.0001–0.0010	Low-gradient, alluvial sand-bed channel, typically regime reach type. Often confined, but fully developed meandering pattern within a distinct floodplain develops in unconfined reaches where there is an increase in silt content in bed or banks.
	Rejuvenated bedrock fall/cascades >0.02	Moderate to steep gradient, often confined channel (gorge) resulting from uplift in the middle to lower reaches of the long profile, limited lateral development of alluvial features, reach types include bedrock fall, cascades and pool-rapid.
	Rejuvenated foothills 0.001–0.020	Steepened section within middle reaches of the river caused by uplift, often within or downstream of gorge; characteristics similar to foothills (gravel/ cobble-bed rivers with pool-riffle/pool-rapid morphology) but of a higher order. A compound channel is often present with an active channel contained within a macro-channel activated only during infrequent flood events. A floodplain may be present between the active and macro-channel.
	Upland floodplain <0.005	An upland low-gradient channel, often associated with uplifted plateau areas as occur beneath the eastern escarpment.

The classification of channels was further defined based on the based nature of flows through the channel (Table 21). The delineated river and stream units were classified in terms of four (4) attributes in line with the approach adopted for the Eco-Classification namely perenniality, longitudinal zonation, channel width and channel material. This classification was based on observations of channel width, bank and bed materials and observable flow during field work at sampling / observation points.

Table 21. 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			

A3 River Present Ecological State Assessment (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 0-10) using Table 22 as a guide. This assessment is informed by a site visit to a specific section or reach 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 22. Rating table used to assess impacts to riverine habitat.

Impact Class	Description	Score
A	Unmodified, natural.	90 – 100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80 – 89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60 – 79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 – 39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0 – 19

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 River Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) of riverine 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 23.

Table 23. 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 25 were used to rate the overall EIS of each mapped unit according to Table 26 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 24. 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.

ANNEXURE B: DWS Aquatic Risk Matrix Assessment Results

RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I Water Use Risk Assessment Protocol)

Project Name: Kingsburgh Residential Estate

Date: 05 July 2018

Name of Assessor(s): Mr. Adam Teixeira-Leite *(Pr.Sci.Nat.)* **SACNASP Registration No.** 400332/13

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE.

Phase(s)	Activity	Aspect	Impact	Flow Regime	Physico & chemical (water Quality)	Habitat (Geomogh & Vegetation)	Biota	Severity	Spatial Scale	Duration	Consequence	Frequency of Activity	Freqguency of Impact	Legal Issues	Detetion	Likelihood	Significance	Risk Rating	Revised Risk Rating	Borderline LOW / MODERATE Rating Classes	PES & EIS of Affected Watercourse
Construction	Clearing, site grading/ platforming land preparations and construction of all infrastructure including buildings and associated service infrastructure.	1. Site clearing (vegetation stripping).	Potential physical destruction of freshwater habitat (bed and banks) and protected plant species.	1	1	2	1	1.25	1	2	4.25	1	3	5	1	10	42.5	Low	42.5	Low	Streams R01, R02, and R03:' D' PES & 'Low' EIS
		2. Earth works, land preparation (site grading and platforming) and construction of infrastructure (roads, housing, pipelines, storm water infrastructure etc.).	Alteration of soil profiles and associated flow patterns with a resultant increase in sediment delivered to watercourses (sedimentation and increased turbidity).	2	3	3	2	2.5	2	2	6.5	1	4	5	1	11	71.5	Moderate	46.5	Low	

Phase(s)	Activity	Aspect	Impact	Flow Regime	Physico & chemical (water Quality)	Habitat (Geomogh & Vegetation)	Biota	Severity	Spatial Scale	Duration	Consequence	Frequency of Activity	Fregquency of Impact	Legal Issues	Detetion	Likelihood	Significance	Risk Rating	Revised Risk Rating	Borderline LOW / MODERATE Rating Classes	PES & EIS of Affected Watercourse
		3. Use of machinery and other sources of hazardous pollutants within and adjacent to watercourses (i.e. in order to undertake Activity 1 & 2 above).	Potential water pollution and associated biotic impacts from hazardous substances such as oils, grease, hydrocarbons and volatile organic compounds.	1	2	1	2	1.5	2	2	5.5	1	2	5	2	10	55	Low	55	Low	
Operational	Development operation including management of storm water and greywater and wastewater reticulation.	1. Increased storm water run-off volumes and velocities from storm water management systems.	Increased floodpeaks and associated erosion and possible sedimentation impacts.	2	1	2	1	1.5	2	2	5.5	2	3	5	3	13	71.5	Moderate	46.5	Low	Streams R01, R02, and R03:' D' PES & 'Low' EIS
		2. Contaminated urban run-off containing heavy metal, hydrocarbons, solids and organic compounds (from roads, parking lots and other hardened surfaces.	Potential water pollution and associated water resource management and biotic impacts.	1	2	1	1	1.25	2	1	4.25	2	2	5	3	12	51	Low	51	Low	

Phase(s)	Activity	Aspect	Impact	Flow Regime	Physico & chemical (water Quality)	Habitat (Geomogh & Vegetation)	Biota	Severity	Spatial Scale	Duration	Consequence	Frequency of Activity	Fregquency of Impact	Legal Issues	Detetion	Likelihood	Significance	Risk Rating	Revised Risk Rating	Borderline LOW / MODERATE Rating Classes	PES & EIS of Affected Watercourse
		3. Possible leakages/ spills from wastewater pipelines.	Possible water pollution and associated water resource management and biotic impacts.	2	4	2	4	3	3	3	9	4	1	5	3	13	117	Moderate	92	Moderate	