WATERCOURSE & AQUATIC ASSESSMENT

FOR THE PROPOSED EXTENSION OF THE SDANGENI ACCESS ROAD, DR NKOSAZANA DLAMINI ZUMA LOCAL MUNICIPALITY, SISONKE DISTRICT MUNICIPALITY, KWAZULU-NATAL

Compiled by

Dr Bruce Scott-Shaw
NatureStamp (Pty) Ltd
Tel 078 399 9139
Email bruce@naturestamp.com

Compiled for

Amishka Mothilal
SLR Consulting
Tel 011 467 0945
Email amothilal@slrconsulting.com

DECEMBER 2020
DRAFT REPORT

Acronyms

CVB	Channeled Valley Bottom
DWS	Department of Water & Sanitation
DWAF	Department of Water Affairs & Forestry
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EIS	Ecological Importance & Sensitivity
EKZNW	Ezemvelo KwaZulu-Natal Wildlife
FEPA	Freshwater Ecosystem Priority Area
GIS	Geographical Information Systems
HGM	Hydro-Geomorphic
IAPs	Invasive Alien Plants
PES	Present Ecological State
NFEPA	National Freshwater Ecosystem Priority Areas

Table of Contents

Tables

Figures

Annexures

Specialist Details & Declaration

This report has been prepared in accordance with Section 13: General Requirements for Environmental Assessment Practitioners (EAPs) and Specialists as well as per Appendix 6 of GNR 327 Environmental Impact Assessment Regulations and the National Environmental Management Act (NEMA, No. 107 of 1998 as amended 2017). It has been prepared independently of influence or prejudice by any parties. A full declaration of independence has been provided in Annexure F. The details of Specialists are as follows –

Table 1 Details of Specialist

Specialist	Task	Qualification and accreditation	Client	Signature
Bruce Scott-Shaw NatureStamp	Fieldwork, Assessments & report	PhD, Hydrology	SLR Consulting	Date: 15/01/2021
Ross Goode	Fieldwork & Aquatic Assessment	Diploma	SLR Consulting	Date: 30/12/2020
Nick Davis Isikhungusethu Environmental Services	Design, GIS & Review	BSc, BSc Hon, MSc Hydrology	SLR Consulting	Date: 11/01/2021

Details of Authors:

Bruce is a hydrologist, whose focus is broadly on hydrological perspectives of land use management and climate change. He completed his MSc under Prof. Roland Schulze in the School of Bioresources Engineering and Environmental Hydrology (BEEH) at the University of KwaZulu-Natal, South Africa. Throughout his university career he mastered numerous models and tools relating to hydrology, soil science and GIS. Some of these include ACRU, SWAT, ArcMap, Idrisi, HEC-RAS, WRSM, SEBAL, MatLab and Loggernet. He has some basic programming skills on the Java and CR Basic platforms. Bruce completed his PhD at the Center for Water Resources Research (UKZN), which focused on rehabilitation of alien invaded riparian zones and catchments using indigenous trees. Bruce is currently affiliated to the University of KwaZulu-Natal where he is a post-doctoral student where he runs and calibrates hydrological and soil erosion models. Bruce has presented his research around the world, including the European Science Foundation (Amsterdam, 2010), COP17 (Durban, 2011), World Water Forum (Marseille, 2012), MatLab advanced modelling (Luxembourg, 2013), World Water Week (Singapore, 2014), Forests & Water, British Colombia, (Canada, 2015), World Forestry Congress (Durban, 2015), Society for Ecological Restoration (Brazil, 2017). Conservation Symposium (Howick, South Africa, 2018) and SWAT modelling in Siem Reap (Cambodia, 2019). As a consultant, Bruce is the director and principal hydrologist of NatureStamp (PTY) Ltd. In this capacity he undertakes flood studies, calculates hydrological flows, performs general hydrological modelling, stormwater design, dam designs, wetland assessments, water quality assessments, groundwater studies and soil surveys.

Details of Reviewer:

Nicholas Davis is a hydrologist whose focus is broadly on hydrological perspectives of land use management, climate change, estuarine and wetland systems. Throughout his studies and subsequent work at UKZN he has mastered several models and programs such as ACRU, HEC-RAS, ArcMap, QGIS, Indicators of Hydrologic Alteration software (IHA) and Idrisi. He has moderate VBA programming skills, basic UNIX and python programming skills.

1. INTRODUCTION

1.1 Project Background and Description of the Activity

SLR Consulting (South Africa) (Pty) (SLR) has been appointed by iX Engineers (Pty) Ltd, on behalf of the Nkosazana Dlamini Municipality, as the environmental service provider responsible for compiling an Application for Environmental Authorisation for the proposed extension of the Sdangeni Access Road. To inform this Application, SLR is undertaking a Basic Assessment process in terms of the Environmental Impact Assessment Regulations, 2014. Based on a preliminary screening, SLR have identified a potential risk to Ecology (including Wetlands) and Terrestrial Ecology and thus require the inputs of a specialist Ecologist. There are some watercourses traversing the proposed road extension footprint. The proposed road extension would be on a partially existing road track.

The assessment is conducted to determine the potential impacts that the road extension may have on the surrounding watercourses. These measurements will provide a pre-development baseline for comparisons with post-development assessments. The information contained in this report aims to contribute towards a water quality management plan. The MiniSASS assessment aims to address the following:

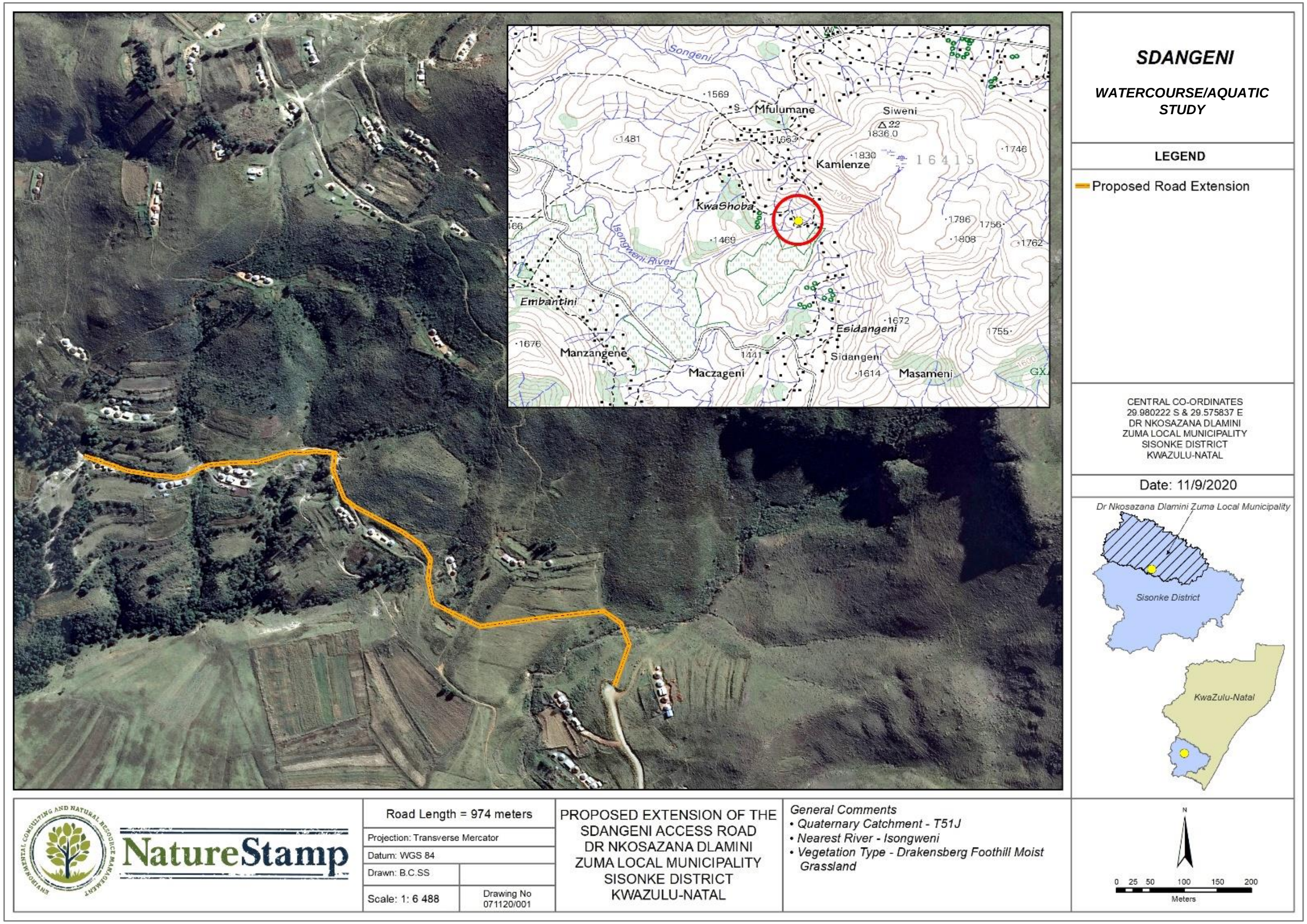
- Define the eco-status of the stream / river systems;
- Provide a biota specific water quality assessment;
- Provide an aquatic community integrity assessment;
- Define construction impacts on the systems;
- Provide an opinion on aquatic ecological health; and
- Provide a Water Quality Management Plan (WQMP) with proposed frequency and determinants for monitoring.

The proposed road extension will be located on the following property:

FARM DESCRIPTION	21-DIGIT SURVEYOR GENERAL (SG) CODE	Area (ha)
Remainder of Upper Umkomaas Location No. 1	N0FS00000001641500000	23 553.98

Uninformed and poorly planned infrastructural developments in the vicinity of water resources, such as sensitive surface and groundwater, can rapidly degrade these resources. Thus, pre-development (or in some cases post development) assessments are required to gain an understanding of the natural environment and guide the developmental process in order that site-specific mitigation measures can be put in place.

Figure 1 General setting of the road extension site



SDANGENI

WATERCOURSE/AQUATIC STUDY

LEGEND

🟧 Proposed Road Extension

CENTRAL CO-ORDINATES
29.980222 S & 29.575837 E
DR NKOSAZANA DLAMINI
ZUMA LOCAL MUNICIPALITY
SISONKE DISTRICT
KWAZULU-NATAL

Date: 11/9/2020

NatureStamp

ENVIRONMENTAL CONSULTING AND NATURAL RESOURCE MANAGEMENT

Road Length = 974 meters

Projection: Transverse Mercator

Datum: WGS 84

Drawn: B.C.SS

Scale: 1: 6 488

Drawing No
071120/001

PROPOSED EXTENSION OF THE
SDANGENI ACCESS ROAD
DR NKOSAZANA DLAMINI
ZUMA LOCAL MUNICIPALITY
SISONKE DISTRICT
KWAZULU-NATAL

General Comments

- *Quaternary Catchment - T51J*
- *Nearest River - Isongweni*
- *Vegetation Type - Drakensberg Foothill Moist Grassland*

Figure 2 ***Location of the proposed road extension***

1.2 Terms of reference

i. Watercourse/Aquatic Assessment

The condition/Present Ecological State (PES) of the delineated riverine and wetland areas present within 500 m of the proposed site; as well as the functional importance of any wetlands present within and near the development footprint would be assessed. This will involve:

a. an assessment of the delineated riverine areas by:
   i. determining the condition/PES of the riverine system using the rapid/qualitative Index of Habitat Integrity (IHI) tool (Kleynhans, 1996) for rivers (in-stream and riparian habitats assessed separately); and
   ii. determining the health/ecological importance & sensitivity (EIS) using the DWAF riverine EIS tool (Kleynhans, 1999).
b. an assessment of the delineated wetland areas by:
   i. determining the condition/ PES of the delineated wetlands using the Level 1 WET-Health tool (Macfarlane et al, 2009); and
   ii. determining the ecological importance & sensitivity (EIS) of the delineated wetlands using the Department of Water Affairs and Forestry (DWAF) wetland EIS tool (Duthie, 1999).
c. an impact assessment to investigate, evaluate and assess the impacts of the abovementioned activities on the environment.

ii. MiniSASS assessment to address the following:

- Define the eco-status of the stream / river systems;
- Provide a biota specific water quality assessment;
- Provide an aquatic community integrity assessment;
- Define construction impacts on the systems;
- Provide an opinion on aquatic ecological health; and
- Provide a Water Quality Management Plan (WQMP) with proposed frequency and determinants for monitoring.

iii. Impact Assessment/Risk Matrix and Management Plan / Mitigation Measures

General Authorization (GN 509, August 2016) applies to water use activities of section c) and i) of the NWA that have a low risk class as determined through the Risk Matrix, found in Appendix A of the GN. The impacts of the proposed development on the delineated watercourse areas would be identified, predicted and described. The significance of the proposed impacts would be rated according to nature, extent, magnitude, duration and probability. Measures would be recommended to mitigate impacts. Impacts and mitigation would be structured in a matrix that highlights overall risk as High, Medium, Low.

iv. Watercourse Management and Rehabilitation Plan, including Monitoring Programme

A Watercourse Management and Rehabilitation Plan would be developed to guide the construction and operational phases of the development. It would include a monitoring programme for surface water which established baseline water quality at the site. A series of actions for an audit plan would also be provided.

1.3 Classification System for Wetlands and Other Aquatic Systems

Differences in terminology can lead to confusion in the scientific and consulting fields. As such, terminology used in the context of this report needs to be defined. The National Water Act (No. 36 of 1998) defines a watercourse, wetland and riparian habitat as follows:

- A **watercourse** means - (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.
- A **wetland** means 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.
- A **riparian habitat** includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

Any features meeting these criteria within the development site were delineated and classified using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems hereafter referred to as the "Classification System" (Ollis *et. al*., 2013). A summary of Levels 1 to 4 of the classification system are discussed further below.

Inland wetland systems (non-coastal) are ecosystems that have no existing connection to the ocean which are inundated or saturated with water, either permanently or periodically (Ollis *et. al*., 2013). Inland wetland systems were divided into four levels by the Freshwater Consulting Group in 2009 and revised in 2013. Level 1 describes the connectivity of the system to the ocean, level 2 the regional setting (eco-region), level 3 the landscape setting, level 4A the hydro-geomorphic (HGM) type and level 4B the longitudinal zonation. Further information has been provided in Annexure B.
The level 3 classification has been divided into four landscape units. These are:

a) **Slope** – located on the side of a mountain, hill or valley that is steeper than lowland or upland floodplain zones.
b) **Valley Floor** – gently sloping lowest surface of a valley, excluding mountain headwater zones.
c) **Plain** – extensive area of low relief. Different from valley floors in that they do not lie between two side slopes, characteristic of lowland or upland floodplains.
d) **Bench** (hilltop/saddle/shelf) - an area of mostly level or nearly level high ground, including hilltops/crests, saddles and shelves/terraces/ledges.

Level 4 HGM types (which is commonly used to describe a specific wetland type) have been divided into 8 units. These are described as follows:

- **Channel** (river, including the banks) - an open conduit with clearly defined margins that (i) continuously or periodically contains flowing water. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow.
- **Channelled valley-bottom wetland** - a mostly flat valley-bottom wetland dissected by and typically elevated above a channel (see channel). Dominant water inputs to these areas are typically from the channel, either as surface flow resulting from overtopping of the channel bank/s or as interflow, or from adjacent valley-side slopes (as overland flow or interflow).
- **Un-channelled valley-bottom wetland** - a mostly flat valley-bottom wetland area without a major channel running through it, characterised by an absence of distinct channel banks and the prevalence of diffuse flows, even during and after high rainfall events.
- **Floodplain wetland** - the mostly flat or gently sloping wetland area adjacent to and formed by a Lowland or Upland Floodplain river, and subject to periodic inundation by overtopping of the channel bank.
- **Depression** - a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates. Dominant water sources are precipitation, ground water discharge, interflow and (diffuse or concentrated) overland flow.
- **Flat** - a near-level wetland area (i.e. with little or no relief) with little or no gradient, situated on a plain or a bench in terms of landscape setting. The primary source of water is precipitation.
- **Hillslope seep** - a wetland area located on (gentle to steep) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope.
- **Valley head seep** - a gently-sloping, typically concave wetland area located on a valley floor at the head of a drainage line, with water inputs mainly from subsurface flow.

2. ALLOWABLE ABSTRACTIONS AND LEGISLATION

Quaternary Catchment (QC) site: T51J (WMA 4 - Mvoti to Mzimkhulu). According to GN 538 (2016), the General Authorization (GA) limits for this QC are as follows–

- Abstraction of surface water: 80 000 m^3 / year @ 16 l/s from December to April.
- Storage of water: 80 000 m^3.
- Groundwater abstraction: 75 m^3/ha/year (allowed under GA).

These limits show that this catchment area is slightly water limited and restricted water use applies.

2. STUDY SITE

2.1 General Description

The site is located within Quaternary Catchment T51J; falling under the Mvoti to Mzimkhulu Water Management Area (WMA) and the uMgeni waterboard. The site is situated on the upper reach of the Ngwangwane river (Class C; Moderately Modified, WRC 2011) within the catchment area of the Mzimkhulu River.

Rainfall in the region occurs in the summer months (mostly December to February), with a mean annual precipitation of 909 mm (observed from rainfall station 0238293 W). The reference potential evaporation (ET_o) is approximately 1 545 mm (A-pan equivalent, after Schulze, 2011) and the mean annual actual evaporation is between 1400 – 1600 mm, which exceeds the annual rainfall. This suggests a high evaporative demand and a water limited system. Summers are warm to hot and winters are cool. The mean annual temperature is approximately 18.7 °C in summer and 8.7 °C in the winter months (Table 3). The underlying geology of the site is Tarkastad mudstone underlain by arenite of the Mesozoic Era. The soils overlain are sandy-clay-loam ranging from Hutton, Clovelly to Shortlands form in this particular area. Figure 3 shows photographs taken around the site indicating the prevalence of forestry in the area.

Table 2 Mean monthly rainfall and temperature observed at Sdangeni (derived from historical data)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Rainfall (mm)	141	131	117	44	17	4	6	13	33	74	104	129	**909**
Mean Temperature (°C)	18.7	18.5	17.2	14.2	11.4	8.7	9.3	11.3	13.9	15.0	16.4	17.9	**14.4**

Figure 3 The site along the proposed road area

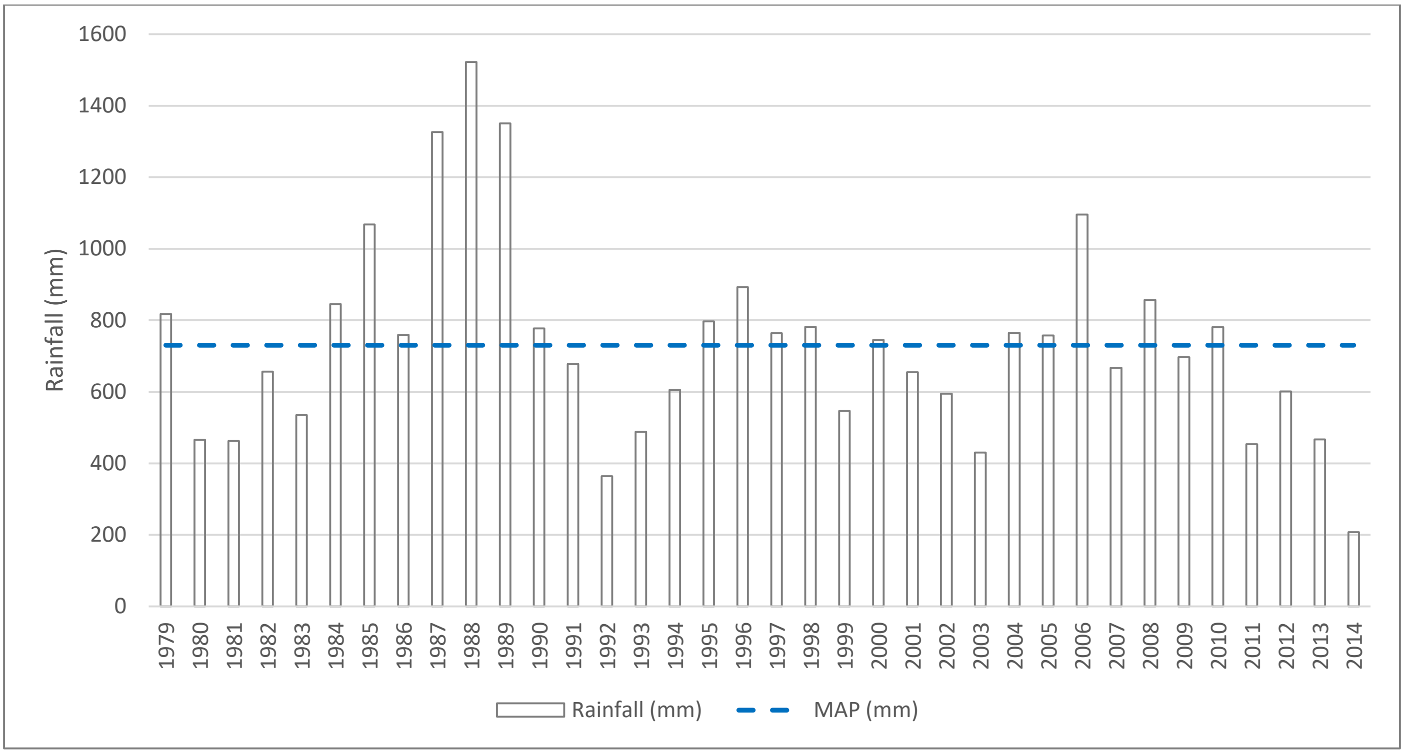


Figure 4 **Long-term rainfall near the site**

2.2 Legal Framework of the Study

The aim of this study is to assess the risk level of the road extension which is proposed to be constructed across drainage lines.

The proposed development triggers the following water use activities of Section 21, NWA–

c. impeding or diverting flow of water;
i. altering beds, banks, course or characteristics of a watercourse

Most of the road itself will not be impeding or diverting flow of water, nor altering bed, banks, course or characteristics of water - however, the developments such as the culvert crossing points and part of the road developments/upgrades are within the 'regulated area of a watercourse', which is described as (GN 509, August 2016) –

- The outer edge of the 1:100 year floodline and/or delineated riparian habitat whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam;
- In the absence of a determined 1:100 year floodline or riparian area, the area within 100m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or
- A 500m radius from the delineated boundary (extent) of the wetland or pan.

General Authorization (GN 509, August 2016) applies to water use activities of section c) and i) of the NWA that have a low risk class as determined through the Risk Matrix, found in Section 7. A Risk Assessment is hereby undertaken to determine the risk class of the road extension proposed for development within a wetland or watercourse. The Assessment is undertaken accordance with the methodology set out in Section 3.7. The pre-developed state was considered in this assessment.

3. METHODOLOGY

A detailed description of the methods has been provided. The regional context and desktop analysis were used as the point of departure. Subsequently, a site visit was undertaken to delineate any wetlands and riparian areas. These systems were then assessed to determine the potential impacts that have been caused. The assessment of these systems considered the following tools where relevant:

Table 3 Assessment approach and the recommended tools for rivers and wetlands

Aquatic Component	Method/Technique	Tool Utilized
Rivers	Delineation	*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005).*
	Classification	*National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis et al, 2014).*
	River condition/Present Ecological State (PES)	DWAF IHI (Index of Habitat Integrity) tool (Kleynhans, 1996) for rivers (riparian habitat only)
	River Ecological Importance & Sensitivity (EIS)	DWAF riverine EIS tool (Kleynhans, 1999)
Wetlands	Delineation	*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005).*
	Classification	*National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis et al, 2014).*
	Wetland condition/Present Ecological State (PES)	Level 1 WET-Health tool (Macfarlane *et al*., 2009)
	Wetland Functional/Ecosystem Services Assessment	Level 2 WET-EcoServices assessment tool (Kotze *et al*., 2009)
	Wetland Ecological Importance & Sensitivity (EIS)	DWAF wetland EIS tool (Duthie, 1999)

Table 4 Data type and source for the assessment

Data Type	Year	Source/Reference
Aerial Imagery	2016	Surveyor General
1:50 000 Topographical	2011	Surveyor General
5m Contour/12.5 m DEM	2010	Surveyor General/ALOS PALSAR
River Shapefile	2011	EKZNW
Land Cover	2014	EKZNW
Water Registration	2013	WARMS - DWS

*Data will be provided on request

3.1 Regional Context

3.1.1 National Freshwater Ecosystem Priority Areas (NFEPA) Project / Assessment

The 'National Freshwater Ecosystem Priority Areas' (NFEPA) project is a systematic biodiversity planning tool developed by the CSIR (2011) to identify freshwater areas considered the most important for biodiversity conservation. The key objectives of the NFEPA project are to ensure that all ecosystems and species are represented and that key ecological processes remain intact – achieving biodiversity targets within the smallest, most efficient area possible, with attention to connectivity over large areas (CSIR, 2011).

The conservation importance of the Sdangeni site was determined by consulting the relevant NFEPA layers (NFEPA WMA map, NFEPA wetlands and NFEPA rivers) in a geographical information system.

NFEPA was a three-year partnership project between South African National Biodiversity Institute (SANBI), CSIR, Water Research Commission (WRC), Department of Environmental Affairs (DEA), Department of Water Affairs

(DWA), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). NFEPA map products provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. These strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or FEPAs.

FEPAs were determined through a process of systematic biodiversity planning and were identified using a range of criteria for conserving ecosystems and associated biodiversity of rivers, wetlands and estuaries. FEPAs are often tributaries and wetlands that support hard-working large rivers, and are an essential part of an equitable and sustainable water resource strategy. FEPAs need to stay in a good condition to manage and conserve freshwater ecosystems, and to protect water resources for human use. The current and recommended condition for all river FEPAs is A or B ecological category. Wetland FEPAs that are currently in a condition lower than A or B should be rehabilitated to the best attainable ecological condition.

3.1.2 Terrain, Soils, Geology & Vegetation

Contour lines (5 meter) were used to calculate the slope of each of the banks. The soils and geology were obtained from GIS layers obtained from the Soil Science department at the University of KwaZulu-Natal (UKZN). Various vegetation databases were used to determine the likely or expected vegetation types (Mucina & Rutherford, 2006; Scott-Shaw & Escott, 2011). A number of recognized databases were utilized in achieving a comprehensive review, and allowing any regional or provincial conservation and biodiversity concerns to be highlighted. The Guideline for Biodiversity Impact Assessment (EKZNW, 2013) was followed where applicable. The following databases were interrogated:

- *Ezemvelo KZN wildlife (C-Plan & SEA Database)*

The C-Plan is a systematic conservation-planning package that consists of metadata within a shapefile, used by ArcGIS (or similar tool), which analyses biodiversity features and landscape units. C-Plan is used to identify a national reserve system that will satisfy specified conservation targets for biodiversity features (Lombard *et al*, 2003). These units or measurements are ideal for areas which have not been sampled. The C-Plan is an effective conservation tool when determining priority areas at a regional level and is being used throughout South Africa to identify areas of conservation value. Some of this information extends into the Eastern Cape.

The Strategic Environmental Assessment (SEA, 2000) Plan is a database of the modelled distribution of a selection of red data and endemic species that could, or are likely, to occur in an area.

- *Mucina and Rutherford's Vegetation Assessment*

The South African National Biodiversity Institute (SANBI) developed a database of vegetation types. This database provides information on groups of vegetation at a course scale. It is useful in determining the expected species, conservation status and management practices of an area. However, this database does not provide information on species of conservation concern. This database is used as a step towards grouping vegetation types identified on site.

3.2 Extent, Classification and Habitat Characteristics

The boundary of wetlands and riparian areas occurring on the site was identified and delineated according to the Department of Water Affairs wetland delineation manual '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas*' (Department of Water Affairs, 2005). Land cover data, contour data and the latest aerial imagery were examined in a thorough desktop analysis of the site. This provided important background information to the specialists' understanding of the broader context of the landscape (e.g. baseline vegetation, geology and climate). An on-site delineation was undertaken as described below.

3.2.1 Wetland Delineation

The following indicators stipulated in the national delineation guidelines were considered in the field. Not necessarily all of these indicators were used at each site. Mention was made in the results which of these indicators were used:

- **Terrain Unit Indicator** – this relates to the position within the landscape where a wetland may occur. A typical landscape can be divided into five main terrain units, namely the crest (hilltop), scarp (cliff), midslope (often a convex slope), footslope (often a concave slope), and valley bottom. As wetlands occur where there is a prolonged presence of water, the most common place one would expect to find wetlands is on the valley bottom (Rountree *et al,* 2008*)*.

- **Soil Form Indicator** – this identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.

- **Soil Wetness Indicator** - Prolonged saturation of soil results in the development of anaerobic conditions, which has a characteristic effect on soil morphology, causing two important redoximorphic features: mottling and gleying. The hue, value and chroma of soil samples obtained at varying depths can be visually interpreted with the aid of the Munsell Colour Chart and the interface between wetland and non-wetland zones determined.

- **Vegetation Indicator** – Plant species have varying tolerances to different moisture regimes. The presence, composition and distribution of specific hydrophytic plants within a system can be used as an indication of wetness and allow for inference of wetland characteristics.

The area was extensively traversed, auger sample points were taken as required and the exact location of sample points logged using a Garmin GPSMAP 64. At each sampling point the soils were sampled at depths of 0-10 cm and 40-50 cm below surface. The soil value, hue and matrix chroma were recorded for each sample according to the Munsell Soil Colour Chart, and the degree of mottling and/or presence of concretions were recorded. Although the site was severely transformed, any vegetation of interest was noted for the assessments. If the author was not able to identify any potentially important species, a leaf and bark sample was taken for analysis using a key guide.

3.2.2 Riparian Delineation

Riparian area/zone delineation is similar to wetland delineation in that indicators are used to define the edge of the system. It considers indicators such as topography, vegetation, alluvial soils, and deposition of material to mark the outer edge of the macro-channel and its associated vegetation. The Figure 5 shows the typical morphology of a river channel.

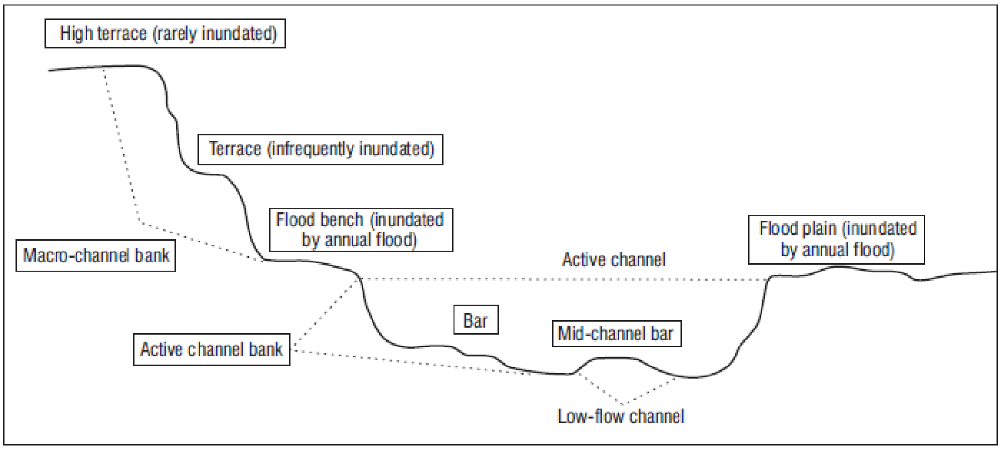


Figure 5 **Typical cross-section of a river showing channel morphology 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas – Edition 1' (Department of Water Affairs, 2005)**

A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas (DWAF, 2005) was used in the delineation of the riparian zone boundary. Delineated riparian zones were then classified using an HGM classification system based on the system proposed by Ollis *(*2013*)*. According to Cowan *et* al. (2005), riparian ecosystems are separated from other wetland ecosystems on the following three major features:

1. They have linear form as a consequence of their proximity to rivers and form a boundary between the terrestrial and aquatic ecosystems.

2. Energy and materials from the surrounding landscape converge and pass through riparian ecosystems. This amount is greater in terms of unit area than with any other system.
3. Riparian ecosystems are connected hydrologically to both upstream and downstream ecosystems (intermittently).

An example of the soil sampling approach is provided in Figure 6.

Figure 6 **Soil sampling undertaken at the site**

3.3 Present Ecological State (PES) Assessment for Riparian Areas

3.3.1 Present Ecological State (adapted from WET-Health, Macfarlane *et al*., 2008)

A WET-Health (Macfarlane *et al*., 2009) Level 1 Rapid Appraisal was used to assess the eco-physical health of any wetlands in the study area. Focusing on geomorphology, hydrology and vegetation, the tool examines the impacts and indicators of change within the system and its catchment by determining the deviation (in terms of structure and function) from the natural reference condition. The outcomes of the appraisal place importance on issues that should be addressed through rehabilitation, mitigation and/or prevention measures. A standardized scoring system allows for consistencies between different systems and reduces user subjectivity.

Scores are allocated according to the magnitude and extent of impact. These scores are integrated to produce an overall score for Present Ecological State (PES) of the system – *namely, natural, largely natural, moderately modified, largely modified, extensively modified,* and *critically modified.*

3.3.2 Index of Habitat Integrity (IHI)

The ecological integrity of a river is defined as its ability to support and maintain a balanced, integrated composition of physico-chemical and habitat characteristics, as well as biotic components on a temporal and spatial scale that are comparable to the natural characteristics of ecosystems of the region (Kemper, 1999). The observed or deduced condition of these criteria as compared to what it could have been under unperturbed conditions is surmised to indicate a change in the habitat integrity. The methodology is based on the qualitative assessment of a number of pre-weighted criteria which indicate the integrity of the in-stream and riparian habitats available for use by riverine biota. Tables 5, 6 & 7 provide the list of criteria and their scores, the impact category and the final scores for the IHI assessment that were used in the calculations.

Table 5 Criteria used in the assessment of the habitat integrity

Criterion	Relevance
Water abstraction	Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
Flow modification	Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
Bed modification	Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment (Gordon *et al*., 1993). Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation (Hilden & Rapport, 1993) is also included.
Channel modification	May be the result of a change in flow, which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included.
Water quality modification	Originates from point and diffuse point sources. Measured directly or 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 aquatic fauna	The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance.
Solid waste disposal	A direct anthropogenic impact which may alter habitat structurally. Also a general indication of the misuse and mismanagement of the river.
Indigenous vegetation removal	Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river (Gordon *et al*., 1992). Refers to physical removal for farming, firewood and overgrazing.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous organic matter input will also be changed. Riparian zone habitat diversity is also reduced.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

Table 6 Impact classes and their associated scores

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

Table 7 Description of the IHI categories

Category	Description	Score (% of total)
A	Unmodified, natural.	100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-99
C	Moderately modified. A 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 have occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions are extensive.	20-39
F	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0-19

3.4 Ecological Importance & Sensitivity (EIS) Assessment (Riparian)

The Ecological Importance and Sensitivity (EIS) of riparian areas is an expression of the importance of the aquatic resource for the maintenance of biological diversity and ecological functioning on a local scale to a broader scale; 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). In this study a qualitative assessment was applied and was partially informed by the present state assessment. This assessment followed the DWA river eco-classification criteria (Module A, Kleynhans & Louw, 2007). The classification provides insights into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition (Kleynhans & Louw, 2007). This further provides the information needed to derive desirable and attainable future ecological objectives for the river (Kleynhans & Louw, 2007).

Table 8 List of the EIS categories used in the assessment tool (Kleynhans & Louw, 2007)

Ecological Importance and Sensitivity Categories	General Description
Very high	Quaternaries/delineations that are considered to be unique on a national or even international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use.
High	Quaternaries/delineations that are considered to be unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases, may have a substantial capacity for use.
Moderate	Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually not very sensitive to flow modifications and often have a substantial capacity for use.
Low/marginal	Quaternaries/delineations that are not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have a substantial capacity for use.

Table 9 Rating scheme used for the assessment of riparian EIS (Kleynhans & Louw, 2007)

Score	Channel Type	Conservation Context			Vegetation and Habitat Integrity	Connectivity	Threat Status of Vegetation Type
0	Ephemeral Stream	Non-FEPA river	No status	None/Excluded	No natural remaining	None	No Status
1	Stream – non-perennial flow		Upstream management area	Available	Very poor	Very low	Least Threatened
2	Stream – perennial flow		Rehab FEPA		Poor	Low	Vulnerable
3	Minor river – non-perennial flow		Fish Corridor	Earmarked for conservation	Moderately modified	Moderate	Near Threatened
4	Minor river – perennial flow		Fish Support Area		Largely natural	High	Endangered
5	Major river – perennial flow	FEPA river	River FEPA	Protected	Unmodified/natural habitat	Very High	Critically Endangered

3.5 MiniSASS Assessment

The MiniSASS assessment was undertaken at HGM unit 3 and 5. The site survey included a qualitative assessment of aquatic macro-invertebrates based on the MiniSASS survey method and an assessment of instream and riparian habitat. All available hydraulic biotopes (stones-in-current, stones-out-of-current; gravel, sand and mud; aquatic vegetation, marginal vegetation) were sampled using a 30x30cm net with 1mm mesh size. The sampling areas were specifically selected to accurately represent all three biotopes, as well as to include diversity between flow velocities, sun exposure, types of riffles / rapids and sandy / rocky stream beds.

The key principle of the MiniSASS method is the ranking system for aquatic macro-invertebrates, which are scored from 1-17 in terms of their sensitivity to water quality levels, with a score of 17 being the most sensitive to poor water quality. The MiniSASS score is determined by dividing the total score by the number of taxa groups found, and then interpreted depending on whether the stream is categorised as a sandy or rocky type, to give the ecological condition. The stream was sampled over a total distance of 20m. The nearest residential properties are located within 50 m of the watercourse. Small amounts of pollution could be seen within the stream bed and along the banks.

3.6 Impact Assessment

The aim of the impact assessment is to identify the impacts that the current activity, as well as the remaining construction and operational phase of the development will have on the receiving environment. If avoidance is not possible, mitigation is required in the form of practical actions (Ramsar Convention, 2008). Mitigation actions can be grouped into the following:

i. **Pre-construction:** This may take the form of changes in the scale of the development (e.g. reduce the size of the development), location of development (e.g. find an alternative area with less impact), and design (e.g. change the structural design to accommodate flows and continuity).
ii. **Construction:** This may take the form of a process change (e.g. changes in construction methods), siting (e.g. locality to sensitive areas), sequencing and phasing (e.g. construction during seasonal periods).
iii. **Operational:** This may take the form of changes in post management (e.g. change management to match unpredicted impacts), monitoring (e.g. frequent checks by an ECO), rehabilitation (e.g. if mitigation actions are not effective).

An assessment of the potential impacts of the El Dorado dam activities was guided by the EKZNW handbook for biodiversity impact assessments (2011). As it is an existing impact, a pre- and post-rehabilitation assessment was undertaken.

It must be noted that am **impact assessment was undertaken** to identify pre-development and post-development impacts.

3.7 Risk Assessment

The risk assessment matrix assesses the likely impact the proposed development and associated infrastructure/activities may have on the wetland/watercourse. Only Low Risk Activities located within the regulated area of the watercourse will qualify for a GA according to this Notice. Medium and High risk activities will require a Section 21 (c) and (i) water use licence.

The criteria, calculations and ranking considered are as follows:

Severity
How severe does the aspects impact on resource quality (flow regime, water quality, geomorphology, biota, habitat?

Insignificant / non -harmful	**1**
Small / potentially harmful	**2**
Significant / slightly harmful	**3**
Great/ harmful	**4**
Disastrous / extremely harmful and /or wetland(s) involved	**5**
Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland. The score of 5 is only compulsory for the significance rating.	

Spatial scale
How big is the area that the aspect is impacting on?

Area specific (at impact site)	**1**
Whole site (entire surface right)	**2**
Regional / neighbouring areas (downstream within quaternary catchment)	**3**
National (impacting beyond secondary catchment or provinces)	**4**
Global (impacting beyond SA boundary)	**5**

Duration
How long does the aspect impact on the environment and resource quality?

One day to one month, PES, EIS and /or REC not impacted	**1**
One month to one year, PES, EIS and /or REC impacted but no change in status	**2**
One year to 10 years, PES, EIS and /or REC impacted to a lower status but can be improved over this period through mitigation	**3**
Life of the activity, PES, EIS and /or REC permanently lowered	**4**
More than life of the organisation /facility, PES and EIS scores, a E or F	**5**
PES and EIS (sensitivity) must be considered.	

Frequency of the Activity
How often do you do the specific activity?

Annually or less	**1**
6 monthly	**2**
Monthly	**3**
Weekly	**4**
Daily	**5**

Frequency of the incident/impact
How often does the activity impact on the environment?

Almost never / almost impossible / >20%	**1**
Very seldom / highly unlikely / >40%	**2**
Infrequent / unlikely / seldom / >60%	**3**
Often / regularly/ likely / possible / >80%	**4**
Daily / highly likely / definitely / >100%	**5**

Legal Issues
How is the activity governed by legislation?

No legislation	**1**
Fully covered by legislation (wetlands are legally governed)	**5**
Located within the regulated areas	

Detection
How quickly/easily can the impacts/risks of the activity be observed on the resource quality, people and property?

Immediately	**1**
Without much effort	**2**
Need some effort	**3**
Remote and difficult to observe	**4**
Covered	**5**

3.7.1 Rating classes

Rating	Class	Management Description
1-55	**(L) Low Risk**	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands are excluded.
56-169	**(M) Moderate Risk**	Risk and impact on watercourses are notable and require mitigation measures on a higher level, which costs more and requires specialist input. Wetlands may be excluded.
170-300	**(H) High Risk**	Always involves wetlands. Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.

3.7.2 Calculations

Consequence = Severity + Spatial Scale + Duration
Likelihood = Frequency of Activity + Frequency of Incident + Legal Issues + Detection
Significance \ Risk = Consequence x Likelihood

4. LIMITATIONS AND ASSUMPTIONS

In order to apply generalized and often rigid scientific methods or techniques to natural, dynamic environments, a number of assumptions are made. Furthermore, a number of limitations exist when assessing such complex ecological systems. The following constraints may have affected this assessment –

- A Garmin GPSMAP 64 was used in the mapping of waypoints on-site. The accuracy of the GPS is affected by the availability of corresponding satellites and accuracy ranges from 1 to 3 m after post-processing corrections have been applied.

- A Munsell Soil Colour Chart was used to assess soil morphology. This tool requires that a dry sample of soil be assessed. However, due to in-field time constraints, slightly wet soil samples were assessed. Wet samples would have consistently lower values than dry soils; and this is taken into consideration.

- Although the vegetation was taken into account, protected and threatened species, such as bulbs that have not emerged, may not have been identified. Due to the development extending into sensitive areas (such as buffer areas and the actual watercourse), a vegetation survey was undertaken in a separate study.

- The soils were very uniform, as such it was difficult to determine the difference between temporary and dry-land wetland/riparian areas.

- The sampling was undertaken after a severe drought. Given these circumstances, extra caution was taken to ensure that watercourse features were not overlooked. Furthermore, the water quality sampling may differ from median year samples as parameters may be concentrated in such conditions (reduced flow).

5. RESULTS AND DISCUSSION

5.1 Regional Context

5.1.1 NFEPA assessment

In accordance with the NFEPA guidelines, the drainage line (and its associated riparian areas) that the proposed road upgrade crosses, have not been classified as a FEPA system, which indicates that this system is not a national freshwater conservation priority.

FEPA wetlands were not identified within 500m of the study site. The nearest is a natural flat/bench wetland approximately 940 meters from the road. The layer codes for River FEPAs and associated sub-quaternary catchments, Fish Support Areas and associated sub-quaternary catchments and Upstream Management Areas.

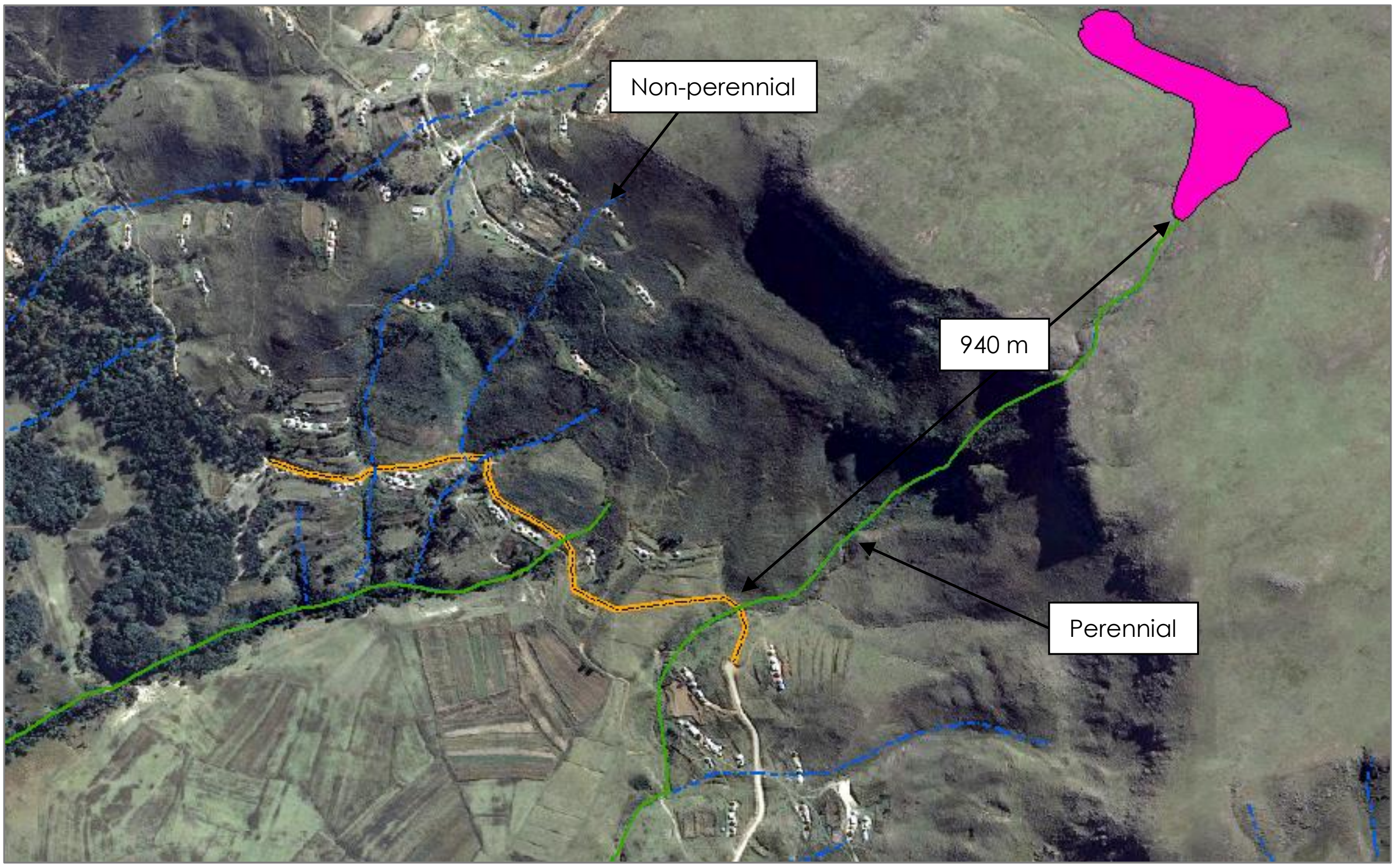


Figure 7 NFEPA wetlands (pink) within proximity to the Sdangeni road upgrade

5.1.2 Vegetation

This site is dominated by Drakensberg Foothill Moist Grassland (Gs 10, Mucina and Rutherford, 2006). This occurs within the sub-escarpment grassland biome. The desktop analysis revealed that the area is a least threatened area, poorly protected, with the potential for some flagged fauna and flora (e.g. red data species and endangered wildlife) being found from the C-plan, SEA and MINSET databases. However, this does not necessarily mean that rare or endangered species will occur in the area of interest. The vegetation type has 82.1 % remaining and is hardly protected. The following information was collected for the vegetation unit Gs 10 (Mucina & Rutherford, 2006; Scott-Shaw & Escott, 2011). The characteristics of this grassland are described as:

- **Distribution:** KwaZulu-Natal and Eastern Cape Provinces: Broad arc of Drakensberg piedmonts covering the surrounds of Bergville in the north, Nottingham Road, Impendle, Bulwer in the east, and Kokstad, Mount Currie, Underberg (KZN) and the surrounds of Mt Fletcher, Ugie, Maclear and Elliot (Eastern Cape) in the southwest.

- **Altitude:** 880– 1 860 m.

- **Vegetation and Landscape features:** Moderately rolling and mountainous, much incised by river gorges of drier vegetation types and by forest, and covered in forb-rich grassland dominated by short bunch grasses including *Themeda triandra* and *Tristachya leucothrix*.

5.1.3 Historical analysis

The historical analysis is useful to assist in determining the natural state of a site and what transformation it has gone through. There is a partially existing road throughout the extent of the proposed road upgrade. As a watercourse study was not undertaken before the existing roads and settlements were built, it is difficult to determine where a watercourse may have previously existed without the use of historical imagery. Additionally, the discharge and diversions due to the settlement and roads has altered the hydrological state of the site.

The site as observed through a series of historical images (Figure 8), shows the following:

- The surrounding site was previously cultivated as far back as 1977;
- There were clear drainage lines at this point in time;
- There was no additional (lost) wetlands present prior to the current state;
- There has been a slight increase in settlements and roads;
- There is a clear recent invasion/planting of *Acacia mearnsii* (Black Wattle) in recent years that are poorly managed.

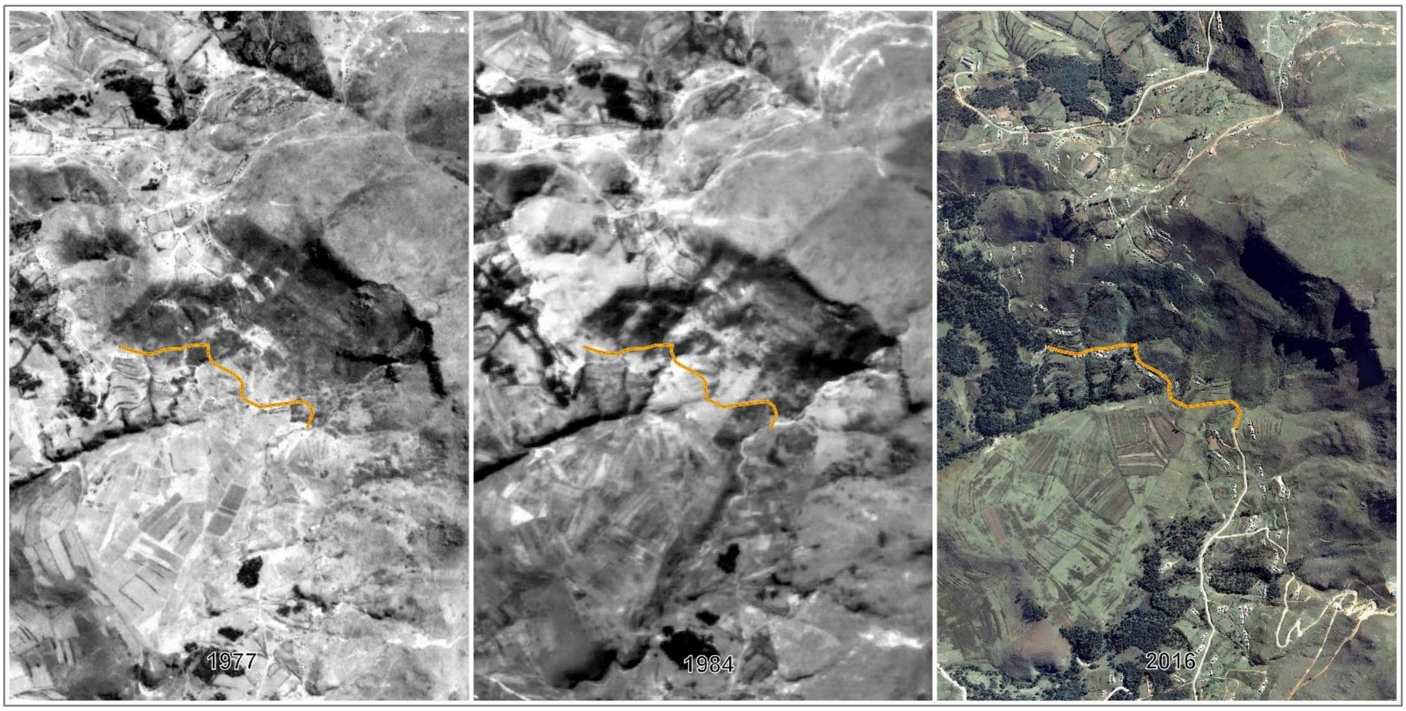


Figure 8 Historical imagery of the road upgrade site from 1977 to present

5.1.4 Site Terrain

The site is generally very steep. (Figure 9). However, the proposed road follows the contour line so the change in height is low. However, due to the steep slopes above and below the road, this site is at a high risk of erosion.

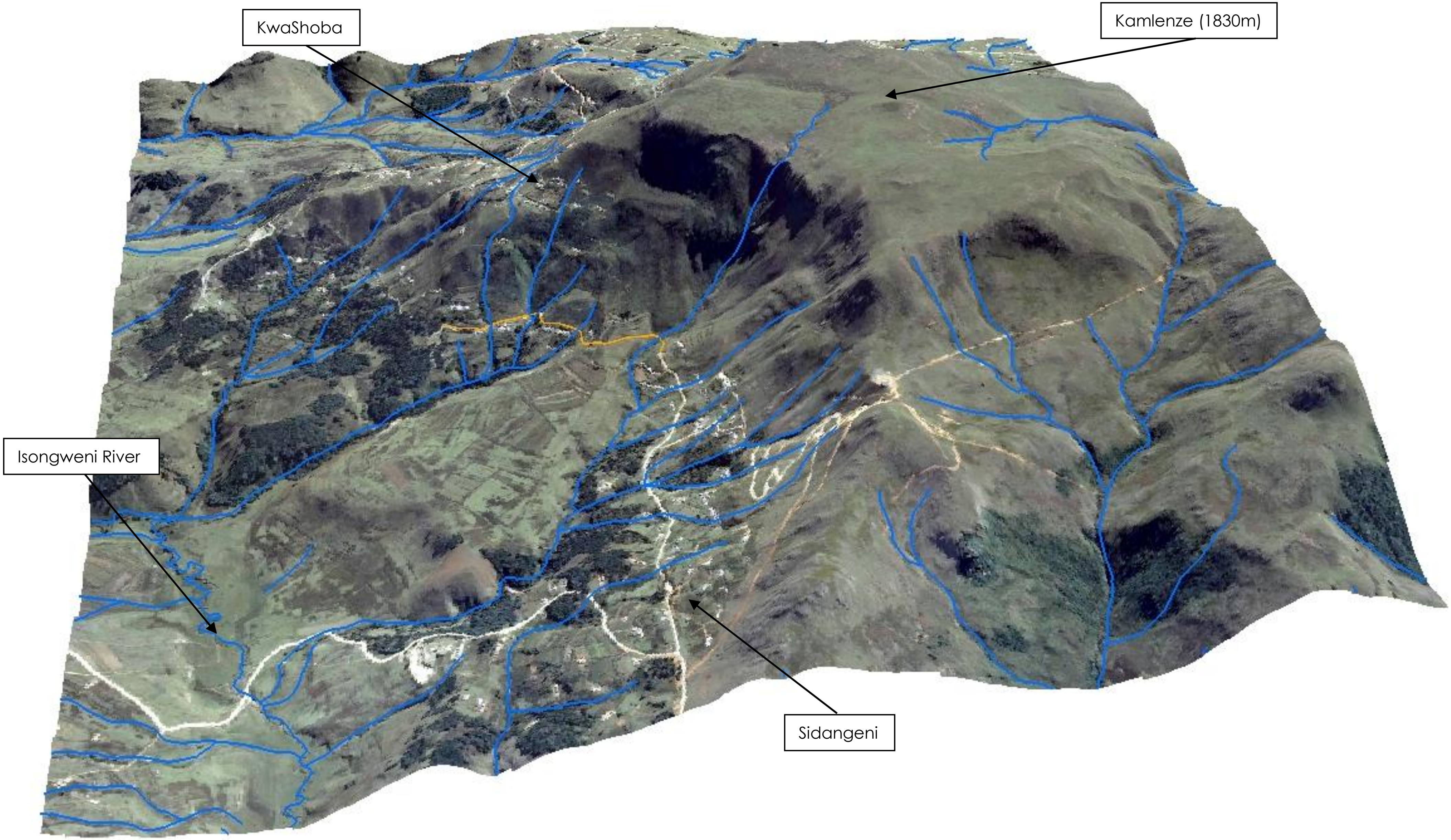


Figure 9 Terrain model of the proposed Sdangeni road upgrade

5.2 Extent, Classification and Habitat Characteristics

The current land cover was obtained from various databases and the site visit. The site is surrounded by low density settlements and gravel roads. Grassland areas exist around the site. Some patches of alien invaders were noted. The footprint of the road upgrade is on partially pre-existing road/foot path areas.

The dominant species in the riparian areas were mostly indigenous sedge with *Haleria lucida, Buddleja auriculata and Leucosidea sericea* being prevalent in patches along the drainage line. Severe erosion was observed on site, the site is at risk of future erosion due to the slope and recently transformed state. This ecosystem may hold some key species. The existing watercourse has been impacted upon by the settlement and changes in the hydrological regime have occurred.

The site consists of some areas of hydrological interest and these areas have been tabulated (Table 10) and described in detail. The HGM units are further illustrated in Figure 11. Wetlands/riparian areas that the road extension may impact upon were assessed for wetland health and functionality. The wetlands/riparian areas have been delineated to show no go areas and were used initially to check the connectivity of the systems and potential impacts from the development.

Figure 10 **Typical vegetation around the site**

The following wetland/riparian systems were identified

- HGM 1: Drainage line (non-perennial tributary of the Isongweni system)
- HGM 2: Drainage line (non-perennial tributary of the Isongweni system)
- HGM 3: Drainage line (perennial tributary of the Isongweni system)
- HGM 4: Drainage line (non-perennial tributary of the Isongweni system)
- HGM 5: Drainage line (perennial tributary of the Isongweni system)

Two downstream wetlands were identified and delineated as additional “no-go” areas. The majority of the soils identified adjacent to the watercourse were sandy clay soils (Alluvium - yellowish-brown sandy clay). The drainage lines were rocky with limited soil. No hydric soil characteristics were found outside of the wetland/riparian areas. The hydric soils, identified by gleyed or mottled characteristics, were found at a depth of 10-30 cm along the modified edges of the visibly clear riparian areas.

Table 10 Description of HGM units

Feature	Wetland/Riparian/Artificial	Description & Vegetation	Soil Characteristics	On-site images
Drainage Line (HGM 1)	Riparian (non-perennial)	Banks of the Isongweni tributary. Dominated by small indigenous woody species. Evidence of erosion along crossing areas.	Main channel: Gray (Gleyed) Depth sampled: 0-0.2m Yellow-brown a-pedal soils Very little topsoil remaining	
Drainage Line (HGM 2)	Riparian (non-perennial)	Banks of the Isongweni tributary. Dominated by small indigenous woody and grass species. Slight evidence of erosion along crossing areas.	Mottle % - 2-5% Hue – 7.5YR Value – 5 Chroma – 1 (Dark Gray) Depth sampled: 0-0.2m Organic matter content in the upper layer	
Drainage Line (HGM 3)	Riparian (perennial)	Banks of the Isongweni tributary. Dominated by larger indigenous woody species. Evidence of erosion along crossing area edges.	Main channel: Rocky, unable to sample soil. Continual flow and aquatic life present	
Drainage Line (HGM 4)	Riparian (non-perennial)	Banks of the Isongweni tributary. Dominated by small indigenous woody species. Evidence of erosion along crossing areas.	Main channel: Gray (Gleyed) Depth sampled: 0-0.2m Yellow-brown a-pedal soils Very little topsoil remaining	
Drainage Line (HGM 5)	Riparian (perennial)	Banks of the Isongweni tributary. Dominated by small forb and grass species. This channel is in pristine condition.	Main channel: Rocky, unable to sample soil. Continual flow and aquatic life present	

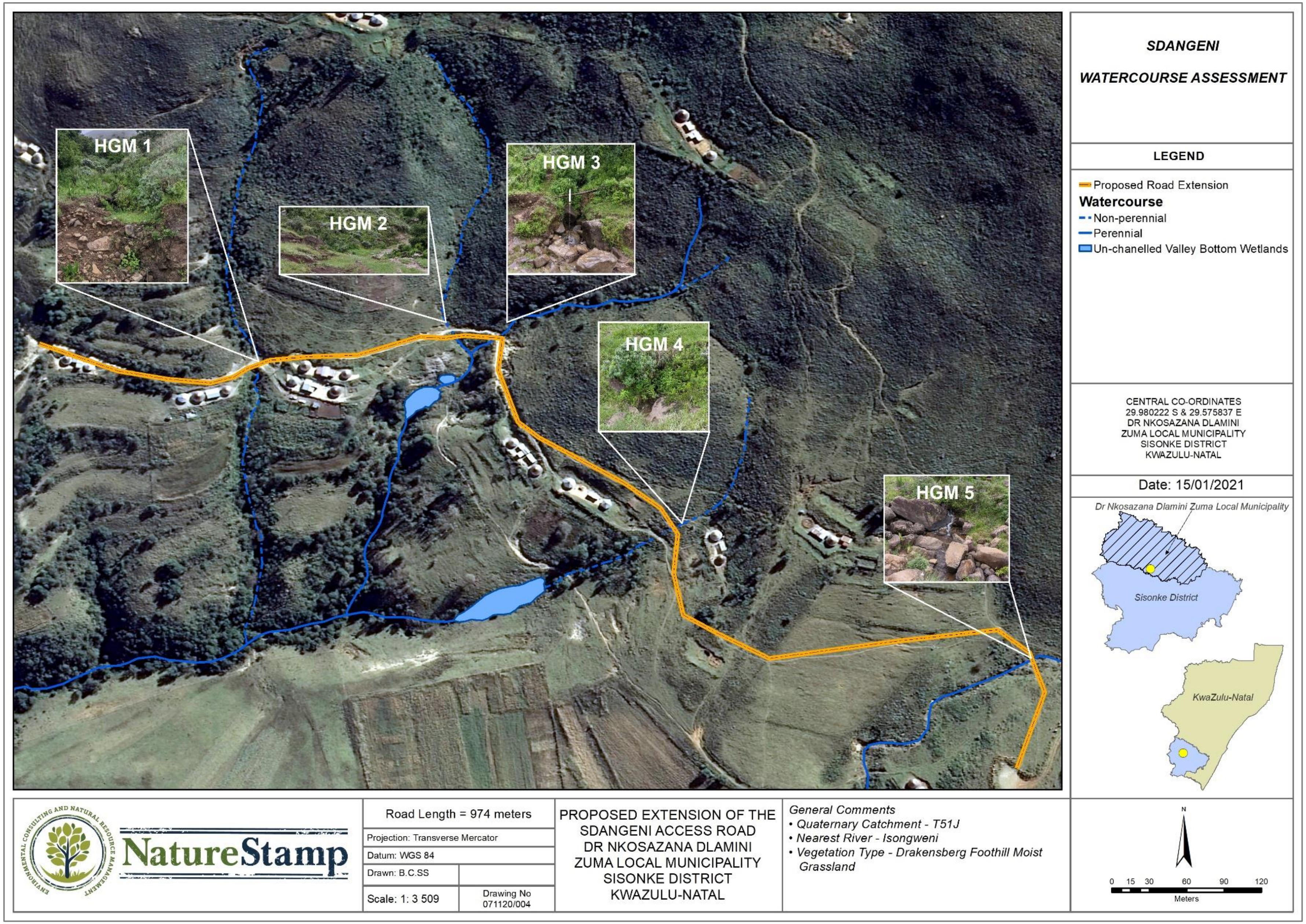


Figure 11 HGM units identified along the proposed Sdangeni road extension

5.3 Present Ecological State (PES)

5.3.1 Index of Habitat Integrity for riparian areas

The Index of Habitat Integrity tool (Kleynhans, 1996) was used to determine the integrity of the streams and their associated riparian habitats linked to the Isongweni system. HGM units 1, 2 and 4, which are non-perennial systems were grouped together. In similar vein, HGM units 3 and 5, which are perennial systems sharing very similar habitats were assessed together. The pre-development state was determined by assessments of the immediate surrounding areas. The results for the **pre-development state HGM units 1,2 and 4 show a PES category of C** (75.08, Table 11): "*Moderately modified.* A slight loss and change of natural habitat and biota have occurred due to the surrounding plantations but the basic ecosystem functions are still predominantly unchanged." The riparian areas have been disturbed by footpaths and erosion is visible along the channel edges.

The results for the **pre-development state of HGM units 3 and 5 show a PES category of B** (80.84, Table 12): "Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged." Some abstractions points (pipes and storage tanks) were observed although in small volumes. Erosion was present near these channels but the stream were in generally good condition.

Table 11 Pre-development PES score using the Index of Habitat Integrity tool (Kleynhans, 1999) for the Isongweni non-perennial tributarys

Riparian Zone					
Criterion	**Score**	**Weighting**	**Actual**	**Potential**	
Indigenous vegetation removal	3	13	39	325	
Exotic vegetation encroachment	4	12	48	300	
Bank Erosion	21	14	294	350	
Channel modification	6	12	72	300	
Water abstraction	2	13	26	325	
Inundation	2	11	22	275	
Flow modification	8	12	96	300	
Water quality	2	13	26	325	
Totals			**623**	**2500**	**24.92**
Category					**75.08**

Table 12 Post-development PES score using the Index of Habitat Integrity tool (Kleynhans, 1999) for the Isongweni perennial tributarys

Riparian Zone					
Criterion	**Score**	**Weighting**	**Actual**	**Potential**	
Indigenous vegetation removal	2	13	26	325	
Exotic vegetation encroachment	4	12	48	300	
Bank Erosion	14	14	196	350	
Channel modification	4	12	48	300	
Water abstraction	6	13	78	325	
Inundation	2	11	22	275	
Flow modification	4	12	48	300	
Water quality	1	13	13	325	
Totals			**479**	**2500**	**19.16**
Category					**80.84**

5.3.2 WET-Health (Macfarlane et al., 2008) of wetlands

A WET-Health assessment was undertaken for the wetlands found within and near to the proposed road upgrade. Wetlands that are part of the same system but have split due to developments were grouped together in the health assessments.

- *Hydrology*

The Un-channelled Valley Bottom (UVB) wetlands on site are largely natural. There was little to no variation in soil form, terrain and the vegetation surrounding the wetlands and the riparian areas apart from an increase in sedge species. The present hydrological state of the UVB wetlands was given a score of B, indicating that the modifications on the hydrological integrity are small. The MAP: PET ratio indicates that the wetlands are not dependant on direct precipitation falling onto the wetland, depending on flow from upstream to a greater extent, making these wetlands more vulnerable to reduced flows.

The key factors influencing hydrological impacts on the wetland is the encroachment by humans and high water using vegetation in the wetland catchment. These are streamflow reduction activities that are decreasing water flow into the system. Natural water distribution and retention patterns are altered as a result of impeding structures above the wetlands, such as the roads and plots for houses that have resulted in hardened surfaces and therefore greater runoff as the surface roughness is altered. Additional contributions of grey water are noted but minimal.

Table 13 The hydrology module for the Sdangeni Road UVB wetland

Hydrology module	Channelled Valley Bottom
Extent of the wetland (ha)	0.14
MAP:PET	0.4 – 0.49
Vulnerability factor	0,9
Combined score for increased and decreased flows	1
Intensity of impact of factors potentially altering flow patterns	1.3 – small
Magnitude of impact of canalisation and stream modification	1.4
Magnitude of impact of impeding features	2
Magnitude of impact of altered surface roughness	1.2
Impact of direct water losses	0.1
Magnitude of impact of recent deposition, infilling or excavation	0
Combined magnitude of impact of on-site activities	2 – Low
Combined magnitude score as a result of impacts on hydrological functioning	4.7
Overall hydrological health	Although identifiable, the impact of the modifications on the hydrological integrity are small.
Present hydrological state of the HGM unit	**B**
Trajectory of change of wetland hydrology	(→)

- *Vegetation*

The present state of wetland vegetation of the wetland been given a class B as the vegetation composition is mostly natural. There is some impact from the nearby roads and houses that has resulted in the reduction of characteristic indigenous wetland species and human disturbances have resulted in an alteration of introduced; alien and or increased ruderal species. Additionally, the exclusion of fire has led to an increase in woody vegetation.

Table 14 Vegetation module for the Sdangeni Road UVB wetland

Vegetation module	Channelled Valley Bottom
Extent of the HGM unit (ha)	0.14
Identify and estimate the extent of each disturbance class	Low
Magnitude of impact score	2.6
Present vegetation state	B
Trajectory of change to wetland vegetation	(→)
Overall vegetation health	A very minor change to vegetation composition is evident at the site
Alien vegetation present (%)	3

- *Geomorphology*

The overall geomorphological health of the valley bottom wetlands was classified as B, which is largely natural. This was due to existing deposition and historical changes from farming practices. The trajectory of change, if the impacts do not continue, is likely to remain stable (→).

Table 15 Geomorphology module for the Sdangeni Road UVB wetland

Geomorphology module	**Channelled Valley Bottom**
Extent of the HGM unit (ha)	0.14
Impacts of channel straightening	0.4
Extent of impact of infilling	18
Impacts of changes in runoff characteristics	0.5
Impacts of erosion	0.1
Impacts of deposition	0.5
Present geomorphic state	**B**
Trajectory of change of geomorphic state	(→)
Overall geomorphological health	**Largely natural with few modifications. A slight change in geomorphic processes is discernible but the system remains largely intact**

- *Overall Health*

The overall health based on the **combined impact score is B (largely natural)**. A slight change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact. The primary impact upon this system is increases in sedimentation, erosion and invasive alien plants, enhanced by the proposed development.

As a result of the proposed developments there will likely be a slight change in the quality of the water. The goal is to maintain the state but still address the changes identified below:

- Ensure no change in water quality of these systems;
- Manage soil loss and sediments from the development area;
- Ensure no invasive alien plants establish; and
- Ensure preservation of the wetlands by applying a suitable buffer.

5.4 Ecological Importance & Sensitivity Assessment

An EIS category was determined for the three non-perennial and two perennial tributaries of the Isongweni system. The category of these systems and the linked downstream wetlands (Table 16 and Table 17) was calculated to be Moderate: 'Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These streams (in terms of biota and habitat) are usually not very sensitive to flow modifications and often have a substantial capacity for use.'

Table 16 EIS category scoring summary for the Isongweni non-perennial tributary

Component	Score (0-5)	Comments/description
Channel Type	1	Stream – non-perennial flow
Conservation Context	0	No status
Vegetation and Habitat Integrity	4	Largely natural
Connectivity	4	High
Threat Status of Vegetation Type	1	Least Threatened
EIS Rating	**2.0**	**Moderate**

Table 17 EIS category scoring summary for the Isongweni perennial tributary

Component	Score (0-5)	Comments/description
Channel Type	2	Stream – perennial flow
Conservation Context	0	No status
Vegetation and Habitat Integrity	4	Largely natural
Connectivity	5	Very High
Threat Status of Vegetation Type	1	Least Threatened
EIS Rating	**2.4**	**Moderate**

Considering the PES and EIS scores, the recommended management objective for the Sdangeni road extension would be to maintain the present integrity and ecosystem functioning of the system and ensure **no flow modifications and water quality impacts.**

5.5 MiniSASS Assessment

The sampling sites were located adjacent to gravel road, which is situated within low income rural area. The site was largely natural with very few observations of organic waste material / pollution on site and is currently not imposing noticeable impacts on the aquatic macro-invertebrates inhabiting the watercourse. The natural state of the watercourses is further evident with the watercourses being used for potable water, which is supported by the results of the MiniSASS assessment. Figure 12 provides an example of a typical MiniSASS sample, which was collected from all available biotopes from the stream on site. An example of the scores expected for each ecological condition, depending on the type of stream or river, is provided in Table 16. This table is used for interpreting MiniSASS data to determine the natural / modified state of the assessed watercourse in terms of their ecological health category.

Figure 12 Sample container used to assist in identifying invertebrates

5.5.1 Aquatic Findings

A total of 4 different groups of taxa were collected from the watercourse and including worms, dragonflies, bugs/beetles and true flies (see Annexure E). The total score and MiniSASS (Average) score is 49 and 8.1 respectively. According to the interpretation table below, this is above 7.2 (rocky type) and therefore falls within the "Natural Condition" ecological category, which is described as being unchhanged.

Table 18 Ecological categories for interpreting MiniSASS data

Ecological Category (Condition)	**River Category**	
	Sandy Type	**Rocky Type**
Natural Condition (Unchanged / untouched – Blue)	> 6.9	> 7.2
Good Condition (Few modifications – Green)	5.9 – 6.8	6.2 – 7.1
Fair Condition (Some modifications – Orange)	5.4 – 5.8	5.7 – 6.1
Poor Condition (Lots of modifications – Red)	4.8 – 5.3	5.3 – 5.6
Very Poor Condition (Critically modified – Purple)	< 4.8	< 5.3

5.5.2 Potential Aquatic Impacts

The following impacts are likely to take place on the watercourse as a result of the proposed development:

- Watercourse pollution in the form of organic and inorganic contamination. For example, construction materials such as oil & grease, steel, cement, rubble, etc. may be released or spilled into the tributary due to poor construction practices and carelessness / negligence for the surrounding environment. Furthermore, if appropriate ablution facilities are not provided during the construction phase, this may result in the watercourses collecting organic effluent as runoff from the surrounding catchment.
- An increase in sand or rubble could potentially lead to increased sediment load within the watercourses and negatively affect the aquatic environment as well as the macro-organisms residing within them.
- Inorganic chemicals such as cement or petrochemicals from construction vehicles can have highly detrimental effects on aquatic habitats and greatly reduce the biological diversity of macro-invertebrates inhabiting the watercourses.
- A loss of macro-invertebrates can cause negative knock on effects for larger stream dwelling organisms such as frogs, fish and birds due to the reduced food supply, which would then reduce the overall intactness of the ecosystem.
- Due to disturbances, an increase in invasive alien plants is likely to occur which will result in a loss of habitat for terrestrial and aquatic organisms.

5.5.3 Water Quality Management Plan

Considering the likely development related impacts, the following conditions are proposed as a Water Quality Management Plan (WQMP):

1. Construction materials should be stored and maintained away from the watercourse (30 m away from the watercourse). This would assist to prevent substances such as sand, cement, steel, bricks or rubble from being washed into the watercourse.
2. Any demolition or removal of existing materials must be done with careful consideration for the surrounding / adjacent watercourses. This is to avoid spilling substances such as rubble and concrete into the watercourse, which would then be washed downstream.
3. Any existing material that is removed from the project area must not be placed within 30 m from a watercourse and should be removed from the site area within 52 hours (3 days).
4. Construction vehicles should not be parked within 30 m of a watercourse, unless specifically needed at that point in time for construction activities taking place around the watercourse.
5. Appropriate ablution facilities as well as abundant supplies of waste collection bins must be provided for construction workers on site. This will prevent the watercourse from becoming degraded and contaminated with both organic effluent and inorganic litter / rubbish.
6. Any concrete mixing taking place on site must be conducted on impermeable plastic sheets to prevent cement from entering the watercourse through seepage or accidental spillage. Alternatively, cement mixing can take place within the footprint where permanent concreting will occur.
7. Follow up watercourse assessments must be undertaken during the construction phase as well as the operational phase to ensure that the watercourses within the project area are not being polluted as a result of the proposed development activities.
8. A MiniSASS follow up assessment should take place on site between the closure of the construction phase and the initiation of the operational phase, as well as bi-annually for the first year of operation.

Taking into account the listed potential impacts as well as the mitigation measures proposed for the WQMP, it is the opinion of the specialist that the proposed development should be approved. There are no fatal flaws, major concerns or significant impacts associated with the proposed development project. This is largely due to the fact that the majority of the surrounding areas, as well as the proposed development area, have already been disturbed and currently need intervention for erosion control. Although the watercourse is near pristine, there is unlikely to be any significant impacts or further degradation as a result of the proposed development. However, it is imperative that the conditions of the WQMP are incorporated into the Environmental Management Programme and Environmental Authorization (should it be granted) in order to ensure the adequate protection of watercourse on site.

6. POTENTIAL IMPACT PREDICTIONS AND DESCRIPTIONS

The site is in a visibly modified condition due to erosion concerns. The primary surrounding impacts are settlement encroachment and erosion. However, the riparian and wetlands systems are still intact and the households are situated away from these systems. The site was historically partially cultivated for many years. However, the wetland on site is performing much need services to the downstream area and provide a habitat for important species.

The road upgrade site has a small catchment area on an unnamed tributary of the Isongweni system.

Figure 13 Erosion present along the proposed road extension

6.1 Present Impacts

Within the Sdangeni development footprint, the existing impacts on the watercourses and respective catchment areas include -

- The presence of water demanding plantation species that have replaced grassland;
- Subsistence farming within watercourse systems (small scale);
- Invasive alien plant invasion in disturbed areas (particularly along servitudes and road edges);
- The clearance of natural habitat for settlements and pathways between houses;
- Concentrated flow paths from drain outlets/dongas along the roads
- Historical modification of watercourse systems for agriculture; and
- Erosion and sedimentation.

In the broader WMA, similar impacts are present as noted for the Sdangeni site. Additional existing impacts on the watercourses and respective catchment areas include -

- Infrastructure development within wetland systems (wetland encroachment) or river banks – leading to a direct loss of wetland systems and decrease in provision of ecosystem services;
- Cattle grazing in wetlands and the riparian edge – potential for a change in vegetation species composition to occur, soil erosion (cattle path erosion is prevalent in the area) and water pollution;
- Canalisation of streams and rivers – leading to change in the hydrological regime;
- Informal and formal watercourse crossings – leading to the change in hydrological regime;
- Litter and solid waste disposal – direct water pollution; and
- Poor or absent sanitation – direct water pollution.

In addition to these impacts, there is a high risk of flood damage (infrastructure, cattle, crops and livelihood) to the community living within the flood line. With the draining of the wetland systems, there is also a likelihood that soil sediment levels would increase resulting in a loss of yield.

6.2 Potential Impacts During Construction

Some impacts are likely during operation. These include -

Table 19 Impact Drivers and Description – Construction Phase

ACTIVITY / DRIVER OF IMPACT	IMPACT	DESCRIPTION OF HOW IMPACT OCCURS
Infilling of rubble within the wetland edge	**Enhanced erosion potential**	As a result of subsequent changes in the hydrological partitions and slight modifications to the slope and soil characteristics (changes to vegetation cover, root content and infiltration rates). This is further described – The increase in slope and bank construction has enhanced erosion potential (greater energy for sediment wash). The reduction in vegetation cover results in open bare soil therefore reducing the surface roughness and increasing the erosive potential to the elements (wind and rain). Sheet wash, rill and gully erosion is likely and may lead to the collapse or slumping of wetland/stream bank areas that would bury marginal wetland habitat. An increase in compaction of the soils along the edge of the plot where heavy machinery traverses has led to an increase in the runoff.
	Decrease in water quality	As a result of contaminants from heavy machinery (oil, fuel) infiltrating / washed into the system as well as sediments from the infilling area.
	Spread of alien invasives	As these plants colonise stockpiles and spoil sites / spoil sites given their easily dispersed seed.
	Continued alteration of flow pattern	A result of concentrated flow from impervious surfaces and storm water channels. A general change in flow regimes (straightening of channel).
High activity of heavy machinery and construction staff to move rubble on-site	**Air pollution affecting wetland fauna**	As a result of excessive air emissions from heavy machinery and generators.
	Noise and disturbance affecting wetland fauna	As a result of excessive air emissions from heavy machinery and generators.
	Decrease in water quality **(impact to aquatic flora and fauna; and water supply)**	As a result of potential leaks of fuel, grease and oil from the heavy machinery. Wash related to the above-mentioned changes during rainfall events will lead to the movement of these substances into the soil and the watercourse systems. As a result of improper storage and handling of hazardous chemicals such as fuel and oil as well as chemicals relating to staff ablution facilities. As a result of any spills, such as concrete, during construction.

6.3 Potential Impacts During Operation

The majority of the impacts will be during construction. However, some impacts are likely during operation. These include -

- **Increase in population:** a likely increase in vehicles using this route due to the improved infrastructure. This may lead to more people moving to the area (more households) and a greater intensity of the present impacts;
- **Increase in pollution:** an increase in pollution from the road surfaces including petro-chemicals and human rubbish. An increase of visitors and vendors during operation may lead to further pollution;
- **Increase in surface runoff:** Increase in impervious surfaces which may promote erosion and flash floods; and
- **Increase in overall edge effects on wetland:** heightened activity in the area
- **Continued alteration of flow pattern:** as a result of concentration of flow through culverts

Table 20 Impact Drivers and Description – Operation Phase

ACTIVITY / DRIVER OF IMPACT	IMPACT	DESCRIPTION OF HOW IMPACT OCCURS
Disturbance of the linear flow channel	**Potential for leaks and contamination of watercourses**	A change in the flow regime due to the construction of culverts associated with the road. This may alter the watercourse bed and flow regimes.
Stormwater runoff along the hardened surfaces of the road upgrades	**Soil wash/Erosion**	Disturbance of the soil profile and vegetative cover may prompt a change in flow path, with surface runoff running in rills along the concrete edges.
Foundations and obstructions	**Change in subsurface water movement**	The development of the road deeper than the upper soil profile may cause sub-surface water movement to be diverted and potentially concentrated resulting in inundation areas.
Greater human/vehicle movement through the site	**Increase in pollution**	An increase of visitors and vendors during operation may lead to further pollution such as plastics, cans and glass.

6.4 Impacts associated with Climate Change Projections

The following potential impacts may arise as a result of climatic changes in the future, which would possibly effect the Sdangeni watercourses and surrounding environment:

- Increase in extreme weather events such as powerful rain/thunderstorms, strong winds, intense heat waves, severe coldness and increased lightning strikes.
- The risk of contamination of watercourses would increase due to significantly greater volumes of runoff, which may lead to disease outbreaks and human health problems.
- The changing environmental conditions could potentially increase the invasion of alien plants species within and surrounding watercourses due to newly suitable temperature and weather conditions.
- Alien vegetation uses more water than indigenous vegetation, therefore reducing natural water supplies / choking natural watercourses. Alien plants have the ability to overpower indigenous vegetation and becoming overgrown within rivers and streams.

7. RISK ASSESSMENT

A risk assessment, as outlined in the methodology, was undertaken at the proposed road upgrade site. Information from spatial datasets, as well as the site visit was used to populate the risk matrix (Table 21). A risk matrix of proposed activities was undertaken.

The results indicate that the activities will have a low risk with the impact on flow regimes being notable but still low. This low risk is due to the site being within a small catchment, the slightly modified pre-existing state of the site and the best practice management adopted on site. However, there is still a risk associated with surface water. This is particularly relevant given the proximity of the site and the water shortage in the province. The activities associated with the road extension need to be addressed through a monitoring plan to ensure the risks are mitigated.

This risk assessment assumes that stormwater management and erosion control is appropriately applied. The risk associated with the site are low only because of the conditions stated in this report. **Should these not be adhered to, the risk would be moderate**.

The following tables gives the overall risk score, according to the Risk Matrix, for the construction and operation of the road within mitigation measures adopted.

Table 21 Risk matrix assessment for the impacts identified for the construction and operation of the activities

	Activity	Aspect	Severity	Consequence	Likelihood	Significance	Risk Rating
HGM Units 1 – 5 (Drainage Lines)							
CONSTRUCTION	Development within a watercourse	Creating a road platform using machinery (earthworks) leading to sedimentation	1.5	4.5	11	49.5	**L**
		Use of effluent septic tank and soakaway for workers leading to potential contamination	1.75	3.75	11	41.25	**L**
		Increased activity of workers and machinery on-site (noise, dust, traffic disturbance)	1.75	4.75	11	52.25	**L**
		Storage of petro-chemicals on site	2.25	5.25	10	52.5	**L**
OPERATION	Development within a watercourse	Increase in settlements (more households)	2.25	7.25	7	49	**L**
		Increased storm water on site leading to soil wash	1.75	6.75	7	47.25	**L**
		Change is sub-surface water movement	1.5	5.5	6	33	**L**
		General increase is pollution (noise and litter)	1.75	6.75	6	40.5	**L**
Un-channeled Valley Bottom							
CONSTRUCTION	Development within a watercourse	Creating a road platform using machinery (earthworks) leading to sedimentation	2.25	5.25	7	36.75	**L**
		Use of effluent septic tank and soakaway for workers leading to potential contamination	3.5	3.5	7	24.5	**L**
		Increased activity of workers and machinery on-site (noise, dust, traffic disturbance)	5	5	7	35	**L**
		Storage of petro-chemicals on site	4	4	6	24	**L**
OPERATION	Development within a watercourse	Increase in settlements (more households)	5	5	6	30	**L**
		Increased storm water on site leading to soil wash	5	5	7	35	**L**
		General increase is pollution (noise and litter)	7	7	6	42	**L**

8. PROPOSED INTERVENTION MEASURES & SURFACE WATER MONITORING PROGRAMME

8.1 Objectives of rehabilitation

The overarching intent of wetland rehabilitation is to ensure the services, attributes and functions of the wetland are conserved. Wetland rehabilitation efforts must work with natural processes at all times and consideration must be given to the fact that rehabilitation is a *process* and not an endpoint. Continued follow-up and ongoing care is required to ensure the desired outcome is achieved and maintained.

The rehabilitation objectives to ensure that wetlands/watercourses around the road extension area are preserved are as follows –

i. Restore hydrology of the drainage line crossing points;
ii. Restore indigenous wetland vegetation (species recommendations available in the vegetation report);
iii. Secure the road edges from future erosion; and
iv. Prevent further degradation to the wetland.

The objectives are required to offset the impact created as a result of the road construction.

8.2 Actions to meet objectives

Following a site-based assessment, it is the opinion of the specialist that a site-specific 15 m buffer from crossing points be used as the area to focus rehabilitation activities on.

Table 22 Rehabilitation actions

Objective	Action	Result	Timing
Restore hydrology of the drainage lines	The material found within 15m of the crossing point should be removed and vegetated manually.	Restore surface flows into the drainage lines. Prevent compaction of the system.	With immediate effect.
	Stormwater should be appropriately managed from the road surfaces, attenuation encouraged with numerous discharge points and infiltration encouraged.	Encourage slow, dissipated flows towards the stream/wetland. A Stormwater Management Plan must be developed which accounts for this. A vegetation list (NatureStamp, 2021) provides a list of recommended indigenous species for the proposed rehabilitation.	Planted in spring or summer months.
Restore indigenous wetland vegetation	Remove alien plants from the stream/wetland, through either manual or chemical control.	Improve biodiversity	During winter months
	Plant this zone and the buffer with indigenous veld mix.	Restore integrity of the wetland buffer. Increase surface roughness to slow down surface flows entering the riparian areas/wetlands.	Planted in spring or summer months to ensure plant survival, after material has been removed.
	Where practical, plant obligate wetland species within permanent wetland zones. The wetland species would include: *Cyperus, Juncus, Kniphofia and Phragmites.*	Encourage dense stands of robust wetland vegetation to assist in water purification. Combat alien plant invasion.	With immediate effect, preferably in the summer months.
Prevent further degradation to the drainage lines	Apply a road reserve buffer wherein no further development should take place without prior Environmental Authorization	Allow dissipated flow into natural systems.	With immediate effect.

8.3 Ongoing monitoring

- Erosion Control – During and after the rehabilitation process, some erosion may take place while the system stabilizes. However as the vegetation establishes, erosion should halt all together. Erosion should be monitored by visual inspection Fixed point photography can be used to observe progress of problem zones.

- Soil Compaction – After removing the infill material, all areas must be scarified to loosen compacted areas. Should pooling be seen after rainfall, it will indicate that such areas may require further 'loosening'.

- Water flow – The rehabilitated crossing points should maintain their natural flow path, with high surface roughness (plugs / vegetation). This can be monitored by visual inspection and fixed point photography used to observe progress of problem zones.

- Vegetation – In order to ascertain whether indigenous greening objectives are being achieved, the establishment of planted indigenous material should be evident, with plant vigour being seen to increase particularly on riparian/wetland edges. Alien vegetation on the site should be notably low. Site investigations and fixed point photography would allow for inspection of progress.

8.4 Final monitoring

In order to assess the success of rehabilitation, a further assessment of PES is recommended after a period of one year.

There is potential through this development to address the severe erosion concerns that exist on the site. Additionally, if this is not addressed, the structural integrity of the road may be diminished.

It is recommended that the contractor stabilize banks where erosion has already occurred.

9. CONCLUSION

The developers of the proposed Sdangeni road extension must note that watercourses are protected by nine Acts and two Ordinances in KwaZulu-Natal[1], which verifies that both national and provincial authorities recognise these systems as highly valuable multiple-use resources and are committed to their conservation. The work undertaken for this report indicates that watercourse systems/wetlands were identified within the extension area, as detailed in Section 5.2. However, this is a partially existing road/footpath site. The greater area contains some wetlands, which have been assessed in this study. These drainage lines are in near pristine condition and need to be conserved.

No watercourse system was identified as a FEPA system but should still be given extra protection to mitigate the impacts identified. The developments proposed for the site will have some impact on these surrounding watercourses. However, with mitigation measures, the overall change will be low. The primary concern will be the construction phase of the road (spoil/rubble/chemical waste). The recommendations for the development are to implement adequate stormwater runoff attenuation structures and rehabilitate the sites around the crossing. Concentrated flow release points should dissipate and regulate flow off the surfaces towards the natural drainage lines, via a number of discharge points. At all times, disturbance to wetland areas should be avoided.

This proposed road extension presents an opportunity to address the existing erosion along this cattle/footpath route. Should this not be addressed, the longevity of the proposed road extension will be at risk.

---

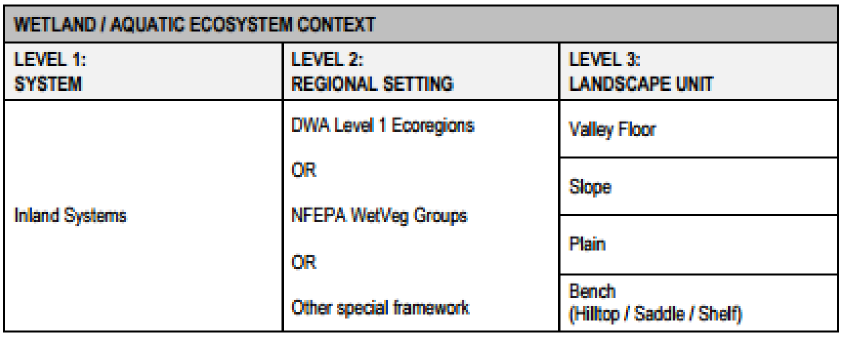
[1] The Lake Areas Development Act, Act No. 39 of 1975; The National Water Act, Act No. 36 of 1998; The Mountain Catchment Areas Act, Act No. 63 of 1976; The Environmental Conservation Act, Act No. 73 of 1976; The National Environmental Management Act, Act No. 107 of 1998; The Conservation of Agricultural Resources Act, Act No. 43 of 1983; The Town Planning Ordinance 27 of 1949; The Physical Planning Act, Act No. 88 of 1967; The Forest Act, Act No. 84 of 1998; The Natal Nature Conservation Ordinance No. 15 of 1974; The KwaZulu Nature Conservation Act, Act No. 8 of 1975

10. REFERENCES

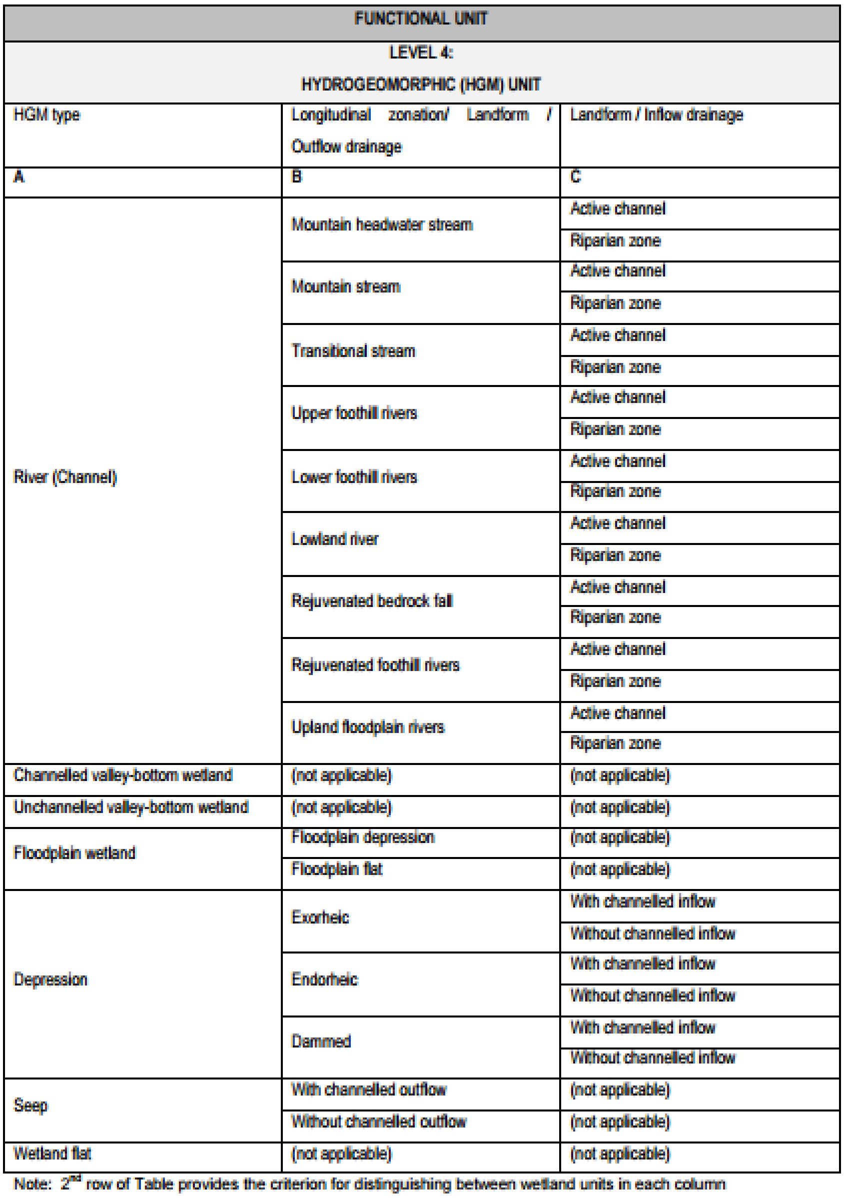
1. BEGG, G.W. (1978) The estuaries of Natal. Natal Town and Regional Planning Report No. 41. Pietermaritzburg, South Africa.
2. BOK A, Kotze P, Heath R & Rossouw J 2007. Guidelines for the Planning, Design and Operation of Fishways in South Africa. WRC Report No. TT287/07. Water Research Commission, Pretoria.
3. BRAACK, A.M. (Mondi Wetlands Programme) D. Walters (Mondi Wetlands Programme) D.C. Kotze (University of Natal) (undated). *Practical Wetland Management.*
4. COWLING, R.M, Pressey, R.L, Rouget, M. & Lombard, A.T. (2003). *A conservation plan for a global biodiversity hotspot - the Cape Floristic Region, South Africa. Biological Conservation 112, 191-216.*
5. CSIR (Council for Scientific and Industrial Research). 2010. National Freshwater Ecosystem Priority Areas (NFEPA). Council for Scientific and Industrial Research, Pretoria, South Africa.
6. DALLAS HF 2007. River Health Programme: South African Scoring System (SASS) data interpretation guidelines. The River Health Programme, Department of Water Affairs & Forestry, Water Research Commission and Department of Environmental Affairs and Tourism
7. http://www.dwa.gov.za/iwqs/rhp/methods/SASS%20Interpretation%20Guidelines.pdf
8. DICKENS CWS & GRAHAM PM, 2002. The South African Scoring System (SASS) Version 5 Rapid Bioassessment for Rivers. African Journal of Aquatic Science 27: 1–10
9. DWA (2010) Department of Water Affairs, Hydrological Information System. http://www.gov.za/Hydrology/ (Accessed 15 July 2010).
10. Department of Water Affairs and Forestry, South Africa. (2007) DWAF report No. N/0000/00/WEI/0407. Manual for the assessment of a Wetland Index of Habitat Integrity for South African floodplain and channelled valley bottom wetland types by M. Rountree (ed); C.P. Todd, C. J. Kleynhans, A. L. Batchelor, M. D. Louw, D. Kotze, D. Walters, S. Schroeder, P. Illgner, M. Uys. and G.C. Marneweck.
11. DWA (2008). Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas (DRAFT), prepared by M. Rountree, A. L. Batchelor, J. MacKenzie and D. Hoare. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.
12. DWA (2005). A practical field procedure for identification and delineation of wetlands and riparian areas, Pretoria, South Africa.
13. *EKZNW* (2009) *Ezemvelo* KZN Wildlife Biodiversity database. P.O. Box 13053, Cascades, 3203, South Africa.
14. http://www.dwaf.gov.za/iwqs/gis_data/RHPdata.htm
15. KLEYNHANS, C.J., THIRION, C. & MOOLMAN, J. (2005) A level I river ecoregion classification system for South Africa, Lesotho and Swaziland. Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria.
16. KLEYNHANS, C.J. (1996). A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhu River. Journal of Aquatic Ecosystem Health 5: 41 - 54.
17. KEMPER, N. 1999: Intermediate habitat integrity assessment for use in the rapid and intermediate assessments. IWR Environmental
18. MACFARLANE, D.M., BREDIN, I.P., ADAMS, J.B., ZUNGU, M.M., BATE, G.C. and DICKENS, C.W.S. 2014. Preliminary guideline for the determination of buffer zones for rivers, wetlands and estuaries. Final Consolidated Report. WRC Report No TT 610/14, Water Research Commission, Pretoria.
19. MOOLMAN, J. (2006) Slope classification of southern African Rivers.
20. MUCINA, L. and RUTHERFORD C (2006). The Vegetation of South Africa, Lesotho and Swaziland. SANBI.
21. Ramsar Convention, 2008
22. SANBI 2009. Further Development of a proposed National Wetland Classification System for South Africa.
23. SCHULZE, RE. (2011) Atlas of Climate Change and the South African Agricultural Sector: A 2010 Perspective. Department of Agriculture, Forestry and Fisheries, Pretoria, RSA. pp 387.
24. SCOTT-SHAW, C.R and ESCOTT, B.J. (Eds) (2011) KwaZulu-Natal Provincial Pre-Transformation Vegetation Type Map – 2011. Unpublished GIS Coverage [kznveg05v2_1_11_wll.zip], Biodiversity Conservation Planning Division, Ezemvelo KZN Wildlife, P. O. Box 13053, Cascades, Pietermaritzburg, 3202.

25. WHITFIELD A.K. (1992) A characterisation of southern African estuarine systems. South African Journal of Aquatic Science 18: 89-103
26. WRC (2008). WET-Eco-Services A technique for rapidly assessing ecosystem services supplied by wetlands, prepared by D. Kotze, G. Marneweck, A. Batchelor, D. Lindley and N. Collins, Pretoria, South Africa.
27. WRC (2008). WET-Health A technique for rapidly assessing wetland health, prepared by DM. Macfarlane, DC. Kotze, WN. Ellery, D. Walters, V. Koopman, P. Goodman and C. Goge, Pretoria, South Africa.
28. WRC, Driver, A, Nel, JL, Snaddon, K, Murray, K, Roux, KJ, Hill, L, Swartz, ER, Manuel, J, Funke, N (2011) Implementation Manual for Freshwater Ecosystem Priority Areas, SANBI.

ANNEXURE A Classification structure for inland systems up to Level 4



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



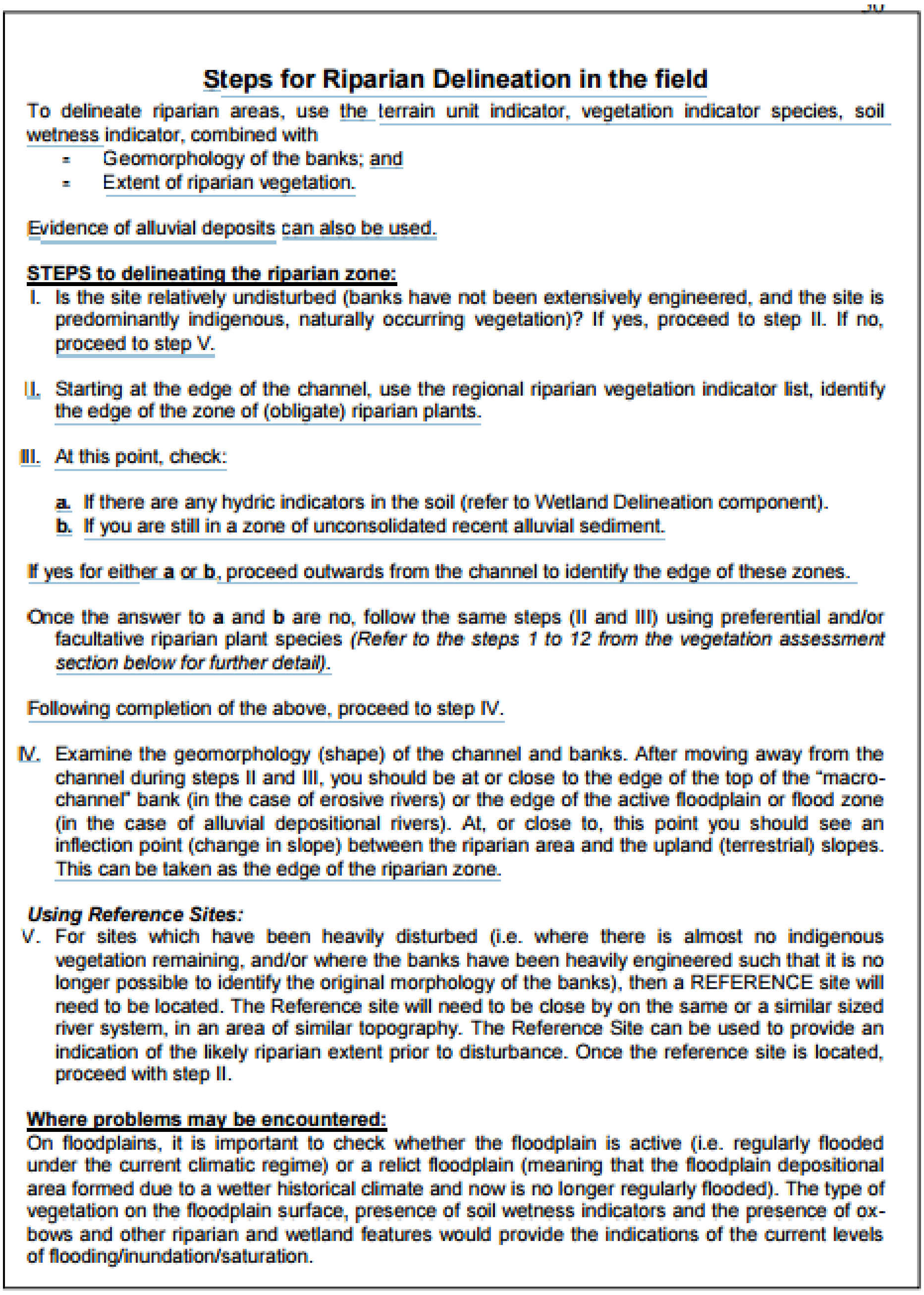
FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River (Channel)	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional stream	Active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

Note: 2nd row of Table provides the criterion for distinguishing between wetland units in each column

ANNEXURE B Wetland and soil classification field datasheet example

Sampling Sheet Summary	
Wetland	Sdangeni
Area (ha)	<5
Indicator	Soil and vegetation
Connectivity (level 1)	Inland
Eco region (level 2)	South Eastern Uplands
Landscape setting (level 3)	Riparian system
HGM Type (level 4A)	Endhoreic
Longitudinal zonation (level 4B)	With channel
Hydrological regime	Frequent Inundation
Soil characteristics	Hue – Gley 2 to 5YR Value – 4 Chroma – 2 (Dark Reddish Gray) Depth sampled: 0-0.5m
Comment	No change in soil characteristics

ANNEXURE C Steps for Riparian Delineation



Steps for Riparian Delineation in the field

To delineate riparian areas, use the terrain unit indicator, vegetation indicator species, soil wetness indicator, combined with

- Geomorphology of the banks; and
- Extent of riparian vegetation.

Evidence of alluvial deposits can also be used.

STEPS to delineating the riparian zone:

I. Is the site relatively undisturbed (banks have not been extensively engineered, and the site is predominantly indigenous, naturally occurring vegetation)? If yes, proceed to step II. If no, proceed to step V.

II. Starting at the edge of the channel, use the regional riparian vegetation indicator list, identify the edge of the zone of (obligate) riparian plants.

III. At this point, check:

a. If there are any hydric indicators in the soil (refer to Wetland Delineation component).
b. If you are still in a zone of unconsolidated recent alluvial sediment.

If yes for either **a** or **b**, proceed outwards from the channel to identify the edge of these zones.

Once the answer to **a** and **b** are no, follow the same steps (II and III) using preferential and/or facultative riparian plant species *(Refer to the steps 1 to 12 from the vegetation assessment section below for further detail)*.

Following completion of the above, proceed to step IV.

IV. Examine the geomorphology (shape) of the channel and banks. After moving away from the channel during steps II and III, you should be at or close to the edge of the top of the "macro-channel" bank (in the case of erosive rivers) or the edge of the active floodplain or flood zone (in the case of alluvial depositional rivers). At, or close to, this point you should see an inflection point (change in slope) between the riparian area and the upland (terrestrial) slopes. This can be taken as the edge of the riparian zone.

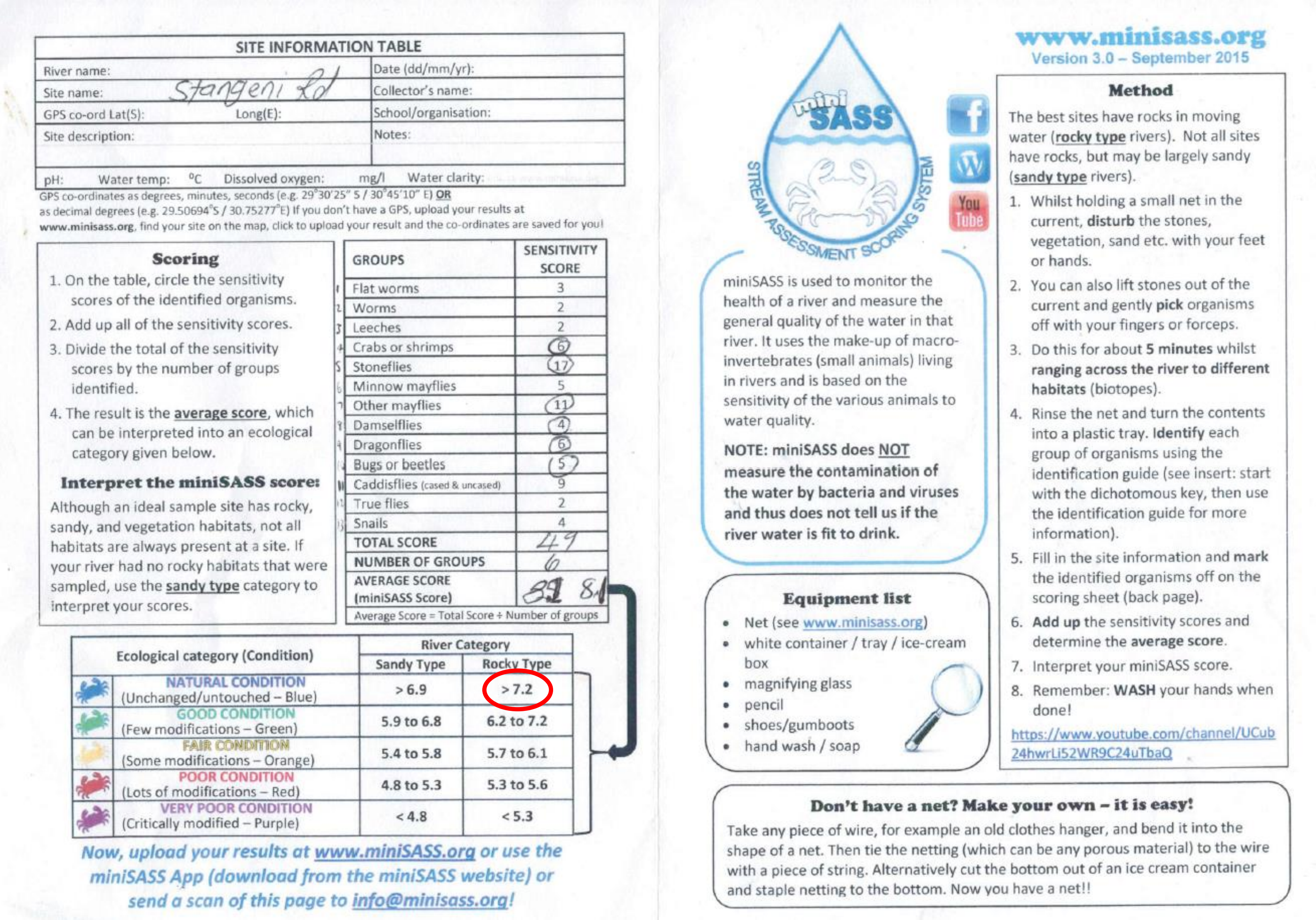
Using Reference Sites:

V. For sites which have been heavily disturbed (i.e. where there is almost no indigenous vegetation remaining, and/or where the banks have been heavily engineered such that it is no longer possible to identify the original morphology of the banks), then a REFERENCE site will need to be located. The Reference site will need to be close by on the same or a similar sized river system, in an area of similar topography. The Reference Site can be used to provide an indication of the likely riparian extent prior to disturbance. Once the reference site is located, proceed with step II.

Where problems may be encountered:

On floodplains, it is important to check whether the floodplain is active (i.e. regularly flooded under the current climatic regime) or a relict floodplain (meaning that the floodplain depositional area formed due to a wetter historical climate and now is no longer regularly flooded). The type of vegetation on the floodplain surface, presence of soil wetness indicators and the presence of ox-bows and other riparian and wetland features would provide the indications of the current levels of flooding/inundation/saturation.

ANNEXURE D MiniSASS Assessment Score Sheet



SITE INFORMATION TABLE

River name:

Site name: Stangeni Rd

GPS co-ord Lat(S): Long(E):

Site description:

Date (dd/mm/yr):

Collector's name:

School/organisation:

Notes:

pH: Water temp: °C Dissolved oxygen: mg/l Water clarity:

GPS co-ordinates as degrees, minutes, seconds (e.g. 29°30'25" S / 30°45'10" E) **OR** as decimal degrees (e.g. 29.50694°S / 30.75277°E) If you don't have a GPS, upload your results at **www.minisass.org**, find your site on the map, click to upload your result and the co-ordinates are saved for you!

Scoring

1. On the table, circle the sensitivity scores of the identified organisms.
2. Add up all of the sensitivity scores.
3. Divide the total of the sensitivity scores by the number of groups identified.
4. The result is the **average score**, which can be interpreted into an ecological category given below.

Interpret the miniSASS score:

Although an ideal sample site has rocky, sandy, and vegetation habitats, not all habitats are always present at a site. If your river had no rocky habitats that were sampled, use the **sandy type** category to interpret your scores.

	GROUPS	SENSITIVITY SCORE
1	Flat worms	3
2	Worms	2
3	Leeches	2
4	Crabs or shrimps	[✓ 6]
5	Stoneflies	[✓ 17]
6	Minnow mayflies	5
7	Other mayflies	[✓ 11]
8	Damselflies	[✓ 4]
9	Dragonflies	[✓ 6]
10	Bugs or beetles	[✓ 5]
11	Caddisflies (cased & uncased)	9
12	True flies	2
13	Snails	4
	TOTAL SCORE	49
	NUMBER OF GROUPS	6
	AVERAGE SCORE (miniSASS Score)	~~8.1~~ 8.1
	Average Score = Total Score ÷ Number of groups	

Ecological category (Condition)	River Category	
	Sandy Type	Rocky Type
NATURAL CONDITION (Unchanged/untouched – Blue)	> 6.9	[✓ > 7.2]
GOOD CONDITION (Few modifications – Green)	5.9 to 6.8	6.2 to 7.2
FAIR CONDITION (Some modifications – Orange)	5.4 to 5.8	5.7 to 6.1
POOR CONDITION (Lots of modifications – Red)	4.8 to 5.3	5.3 to 5.6
VERY POOR CONDITION (Critically modified – Purple)	< 4.8	< 5.3

Now, upload your results at www.miniSASS.org or use the miniSASS App (download from the miniSASS website) or send a scan of this page to info@minisass.org!

miniSASS STREAM ASSESSMENT SCORING SYSTEM

miniSASS is used to monitor the health of a river and measure the general quality of the water in that river. It uses the make-up of macro-invertebrates (small animals) living in rivers and is based on the sensitivity of the various animals to water quality.

NOTE: miniSASS does NOT measure the contamination of the water by bacteria and viruses and thus does not tell us if the river water is fit to drink.

Equipment list

- Net (see www.minisass.org)
- white container / tray / ice-cream box
- magnifying glass
- pencil
- shoes/gumboots
- hand wash / soap

www.minisass.org
Version 3.0 – September 2015

Method

The best sites have rocks in moving water (**rocky type** rivers). Not all sites have rocks, but may be largely sandy (**sandy type** rivers).

1. Whilst holding a small net in the current, **disturb** the stones, vegetation, sand etc. with your feet or hands.
2. You can also lift stones out of the current and gently **pick** organisms off with your fingers or forceps.
3. Do this for about **5 minutes** whilst **ranging across the river to different habitats** (biotopes).
4. Rinse the net and turn the contents into a plastic tray. **Identify** each group of organisms using the identification guide (see insert: start with the dichotomous key, then use the identification guide for more information).
5. Fill in the site information and **mark** the identified organisms off on the scoring sheet (back page).
6. **Add up** the sensitivity scores and determine the **average score**.
7. Interpret your miniSASS score.
8. Remember: **WASH** your hands when done!

https://www.youtube.com/channel/UCub24hwrLi52WR9C24uTbaQ

Don't have a net? Make your own – it is easy!

Take any piece of wire, for example an old clothes hanger, and bend it into the shape of a net. Then tie the netting (which can be any porous material) to the wire with a piece of string. Alternatively cut the bottom out of an ice cream container and staple netting to the bottom. Now you have a net!!

ANNEXURE E Wetland vegetation mix

grass seed mix

WETLAND

Contents:

1. ORGANIC FERTILIZER
It provides nutrients to the soil
It improves soil structure
It retains moisture

2. ZEOLITE
Zeolite is a soil conditioner
It retains nutrients in sandy soil
It retains moisture
It reduces nutrient loss
It removes heavy metals from soil

3. ORGANIC MATERIAL

4. GRASS SPECIES
Contents may vary

Andropogon eucomus
Aristida junciformis
Chloris gayana
Cynodon dactylon
Diandrochloa namaquensis
Digitaria eriantha
Eragrostis capensis
Eragrostis gummiflua
Imperata cylindrica
Ischaemum fasciculatum
Panicum coloratum
Schizachyrium sanguineum
Setaria incrassata
Sporobolus africanus
Sporobolus fimbriatus

SOWING INSTRUCTIONS

- Scarify to loosen soil by raking.
- Sow half of the seed with first application. Sow the rest as a second application to ensure proper coverage.
- Cover seed lightly by raking.
- Water gently or alternatively utilize as dryland seed mix.

Application

100g / 25 m2 (5m x 5m) ☐
500g / 125 m2 (11m x 11m) ☐
1kg / 250 m2 (16m x 16 m) ☐
5 kg / 1250 m2 (35m x 35m) ☐

WARNING
Selected seed treated.
Do not use seed for:
food, feed or consumption.

Diverse Ecological Solutions (Pty) Ltd
Office Tel: +27 (0) 12 545 4069
Cell: +27 (0) 82 888 8643 Email: barend@ecologicalsolutions.info
Cell: +27 (0) 83 293 0229 Email: ivan@ecologicalsolutions.info

emulating nature ... protecting biodiversity