GEORGE
TEL: +27 (0) 44 873 4923 **FAX:** +27 (0) 44 874 5953
EMAIL: info@sescc.net **WEBSITE:** www.sescc.net
ADDRESS: 102 Merriman Street, George 6530
PO BOX: 9087, George , 6530

CAPE TOWN
TEL: +27 (0) 21 554 5195 **FAX:** +27 (0) 86 575 2869
EMAIL: betsy@sescc.net **WEBSITE:** www.sescc.net
ADDRESS: Tableview, Cape Town, 7441
PO BOX: 443, Milnerton, 7435

FRESHWATER HABITAT IMPACT ASSESSMENT

for the

PROPOSED DEVELOPMENT OF THE REMAINDER OF ERF 562 AT KURLAND, PLETTENBERG BAY

PREPARED FOR: Theo Adams
Sonqua Consulting

PREPARED BY: Sharples Environmental Services cc
Contact Person: Debbie Fordham
Email: debbie@sescc.net

DATE: February 2020

DECLARATION OF INDEPENDENCE

I, Debbie Fordham, declare that I:

- Act as an independent specialist consultant, in this application, in the field of wetland ecology;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the amended EIA Regulations, 2014 (amended);
- Have, and will have, no vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the amended EIA Regulations, 2014; and
- Will provide the competent authority with access to all the information at my disposal regarding the application, whether such information is favourable to the applicant or not.

The following report has been prepared:

- As per the requirements of Section 32 (3) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) Environmental Impact Assessment Regulations 2017 as per Government Notice No. 326 Government Gazette, 7 April 2017.
- In accordance with Section 13: General Requirements for Environmental Assessment Practitioners (EAPs) and Specialists as well as per Appendix 6 of GNR 982 - Environmental Impact Assessment 2014 Regulations and the National Environmental Management Act, 1998.
- With consideration to Cape Nature's standard requirements for biodiversity assessments.
- In accordance with DEA&DP's Guideline on Involving biodiversity specialists in the EIA process.
- Independently of influence or prejudice by any parties.

PROJECT TEAM

The authors of this report are in agreeance with the 'Declaration of Independence'.

SPECIALIST	QUALIFICATIONS	ROLE	DETAILS
DEBBIE FORDHAM M.SC	M.Sc - Environmental Science BA (Hons) - Environmental Science BA - Environmental Science and Geography	Author & Reviewer	Debbie is a qualified aquatic ecologist and environmental scientist. Debbie holds a BA (Environmental Science and Geography), BA (Hons) and M.Sc in Environmental Science from Rhodes University. She was awarded her Master of Science degree, by thesis, in Wetland Science, entitled: The origin and evolution of the Tierkloof Wetland, a peatland dominated by *Prionium serratum* in the Western Cape. She has specialised in aquatic habitat assessment and has produced numerous aquatic habitat impact assessment reports. She is well established in her specialist field and has worked in various provinces within South Africa.
CONSULTANT	**QUALIFICATIONS**	**ROLE**	**DETAILS**
MARITA BURGER HONS	BSc (Hons) – Environmental Science	Lead Author	Marita is an environmental assessment practitioner. She holds a BSc in Environmental and Biological Sciences and a BSc Hons in Environmental Science. Her interests lie in GIS spatial analysis and mapping and the water use legislation under the National Water Act (1998). She has undertaken WULAs, GAs, and contributed to specialist reports.

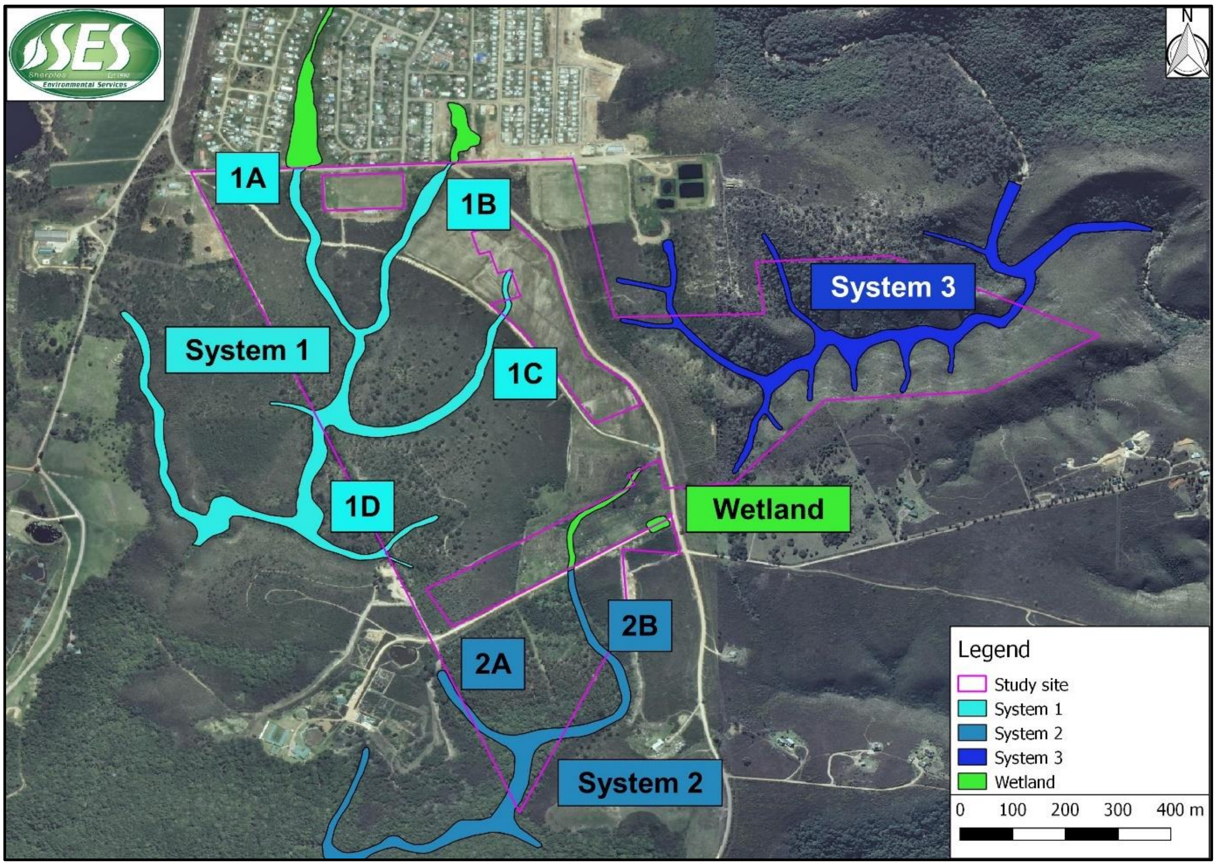
INDEMNITY AND COPYRIGHT

Report citation:
Sharples Environmental Services cc, 2020. Freshwater Habitat Impact Assessment for the proposed development of the Remainder of ERF 562 at Kurland, Plettenberg Bay.

EXECUTIVE SUMMARY

Sharples Environmental Services cc (SES) has been appointed by *Sonqua Consulting* on behalf of the Bitou Local Municipality, to conduct a Freshwater Specialist Impact Assessment for the proposed development of the Remainder of Erf 562 at Kurland, Plettenberg Bay. Development will largely be outside of riparian areas due to unfavourable topography, indicated in the proposed conceptual layout plan.

The initial desktop study did not identify any aquatic habitat of high conservation importance within the study area. However, three drainage systems were identified during site investigations and assessed further (see map below). The majority of riparian habitat falls within steeply sloped valleys that are not desirable for development but may be indirectly impacted, however, the aquatic habitat upslope with a gentler gradient will be directly impacted due to the closer proximity of infrastructure.



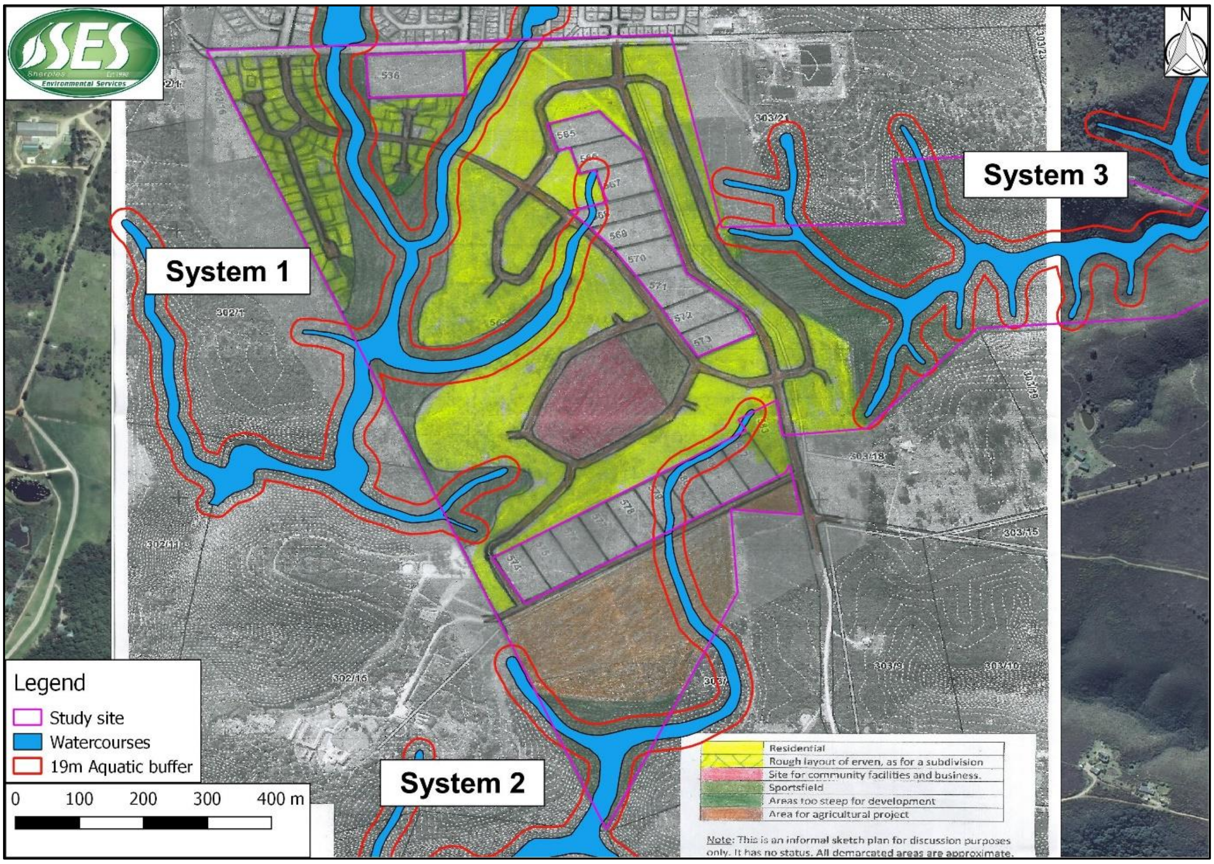
System 1 is a network of small, non-perennial drainage lines that flow through the developable area, before the valleys steepen, and will thus be directly impacted. The system is currently impacted by road crossings and various sources of pollution due to its proximity to the existing Kurland village. Detailed assessment determined that riparian habitat within System 1 is currently in a Poor condition (PES=D) and has a Low EIS.

System 2 is a network of non-perennial drainage lines but also contains wetland habitat in its upper reaches. The seasonal seep wetland is dominated by groundwater inputs and has a very diffuse flow pattern. It feeds a non-perennial stream downslope of the gravel road crossing. The watercourses are degraded due to historic agricultural and forestry activities that have altered the geomorphological characteristics, surface flow patterns and retention, and vegetation composition. The wetland obtained a 'C' PES score, indicating that the system is moderately modified from the perceived reference condition. The wetland was also determined to be of a Low-Moderate functional importance and of Low EIS. The non-perennial streams that comprise System 2 were determined to be of poor ecological state and of Low EIS, as in System 1.

System 3 is largely excluded from the development footprint due to the steep gradient of the valley sides surrounding the drainage lines. It is therefore unlikely to be significantly impacted by the proposed development. The system was determined to be in a moderately modified ecological state and of Low EIS.

The potential impacts development will have on the aquatic habitat were identified as freshwater habitat loss, sedimentation and erosion, water pollution, and flow modification. The impacts associated with the project are assessed as being of **Medium** significance. It can, however, be decreased to **Low** with the implementation of effective mitigation measures. The mitigation of impacts must focus on managing the runoff generated by the development and introducing it responsibly into the receiving environment.

In order to fully mitigate the impacts, a recommended 19 m buffer area from the boundary of the riparian habitat must be adopted and demarcated. The development is largely outside of the buffer zone due to the topography around drainage lines being unfavourable for development. However, there is a tributary of System 1 that is within the footprint proposed for development. This area is severely degraded and has limited ecological functioning, therefore the loss of this section will not result in high impacts.



19m buffer zone around aquatic habitat within the proposed development area.

The impacts are considered to be easily mitigated provided the mitigation measures and monitoring plan within this report are implemented and adhered to during the construction and operational phase of the project.

The project is deemed acceptable from an aquatic perspective due to no major loss of important aquatic habitat being anticipated following adoption of mitigation. The proposed activities will require authorisation in terms of the National Water Act (Act 36 of 1998) and it is therefore advised that a water use application be lodged with the Breede Gouritz Catchment Management Agency.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Sharples Environmental Services cc (SES) has been appointed by *Sonqua Consulting* on behalf of the Bitou Local Municipality, to conduct a Freshwater Specialist Impact Assessment for the proposed development of the Remainder of Erf 562 at Kurland, Plettenberg Bay.

1.1 Location

Kurland is a small township along the N2, in an agricultural area 15km northwest of Plettenberg Bay (Figure 1). The proposed development area is south of the existing township and will provide additional housing to the community.

Figure 1: Google Earth view of the location of the study site in relation to Plettenberg Bay

1.2 Background

An approximate layout of the development as it is currently proposed is given in Figure 2. This is an informal representation and was mainly done for the purpose of initial planning and risk assessment. The sketch shows the privately-owned erven/plots that are excluded from the proposed development, in the uncoloured areas. The green coloured areas indicate where development is restricted due to the steep topography. These steeper areas are also where most of the freshwater habitat is located. The developable areas are shown in yellow, red, a lighter shade of green and brown. Yellow indicates residential area. Red shows the site for community facilities and businesses. The adjacent light green area is proposed to be as sports fields. An agricultural project is proposed in the southern area and is indicated in brown. Some of the major roads are also shown on the layout.

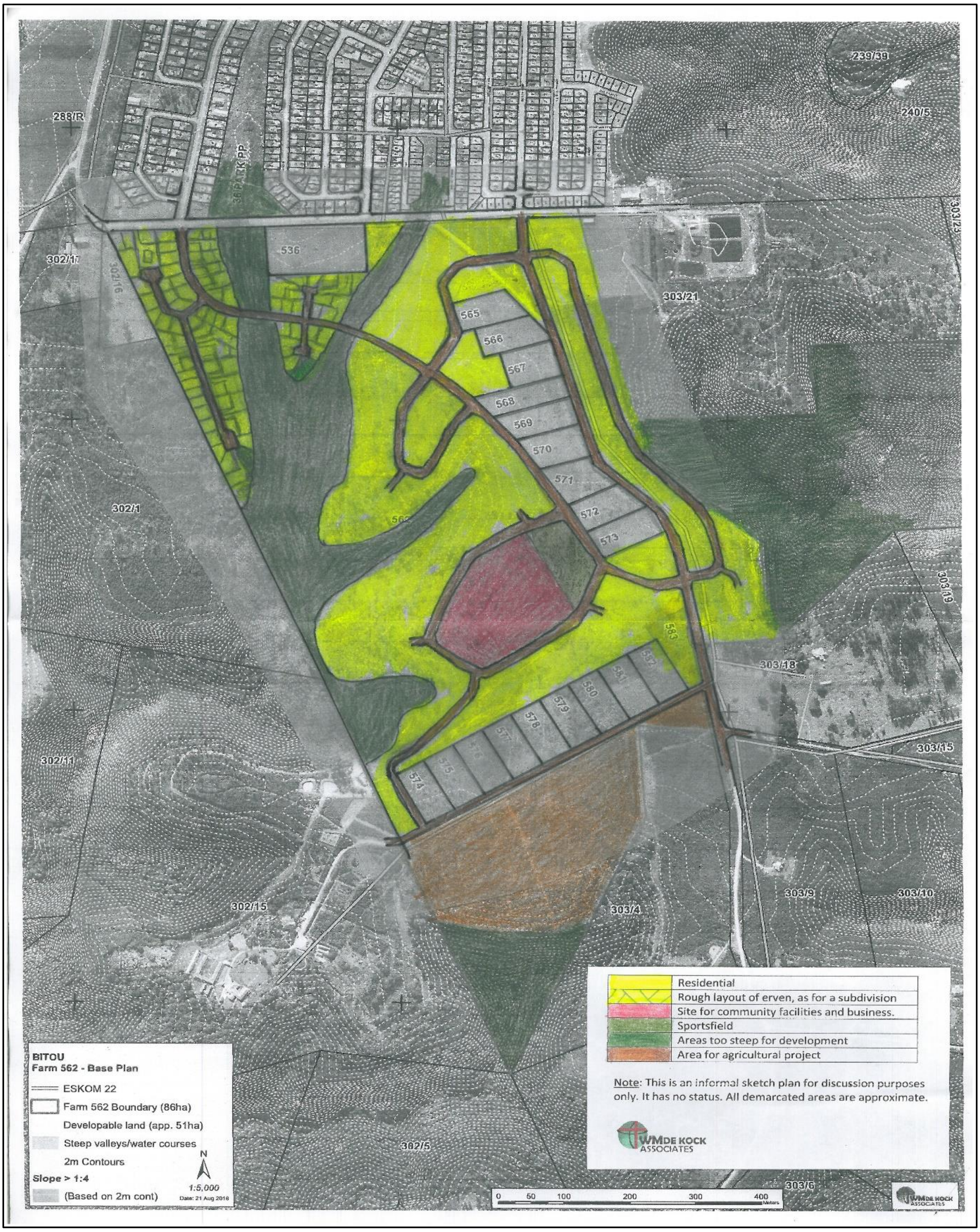


Figure 2: Proposed development of the study site.

According to the 2018 Bitou Local Municipality Spatial Development Framework (Bitou MSDF), the future expansion of Kurland will be towards the south and therefore on Erf 562. This expansion forms part of the Kurland UISP Phase 4 development which entails 270 units. In future however, the area could be developed to holding 500 residential units.

Erf 562 is one of the Strategic Development Areas identified in this MSDF (Figure 3) for the bulk of future residential development. In terms of the Bitou Municipality' housing backlog, 10% of the 4829 units are needed at Kurland. The proposed development will therefore aid significantly in providing houses for these people.

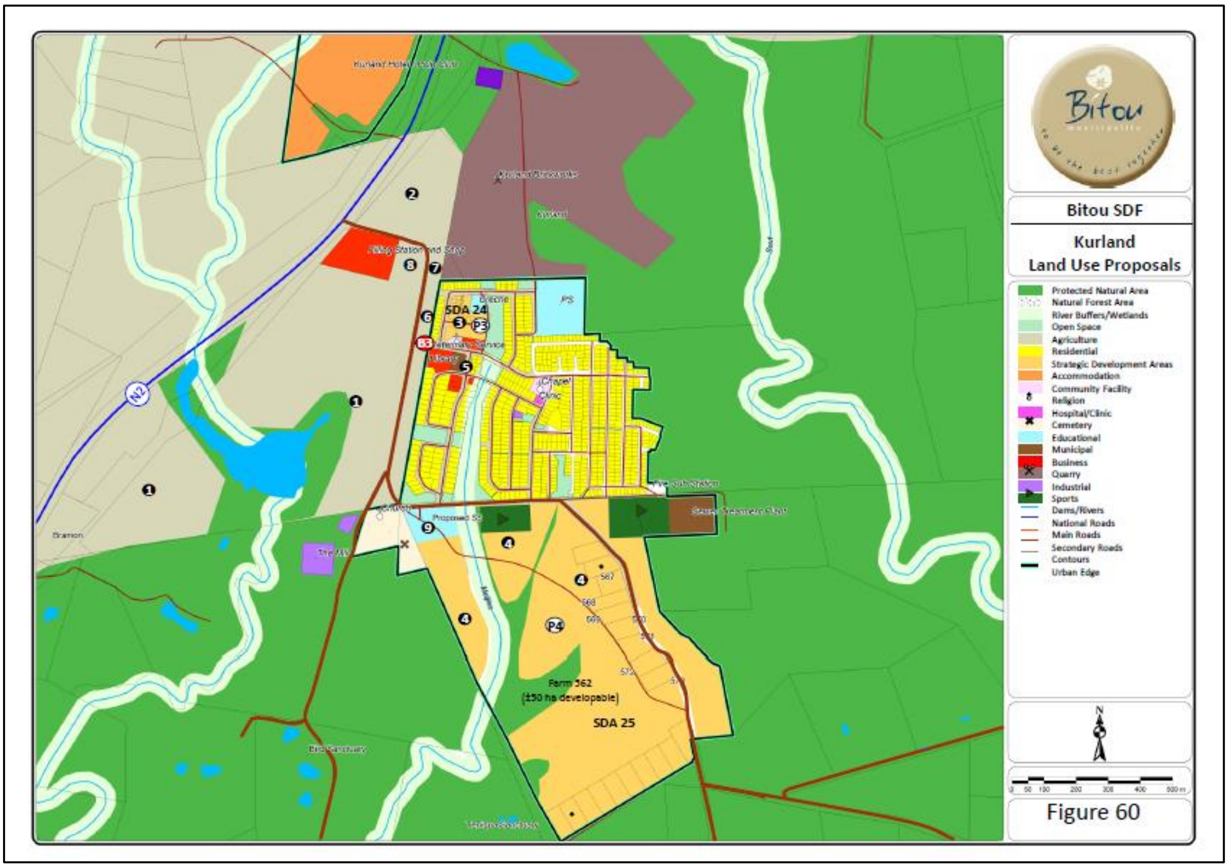


Figure 3: The Bitou SDF land use proposal for the Kurland areas indicating the site as a strategic development area.

No alternatives regarding this proposal have yet been provided by the client. However, the No-Go Alternative still applies and will be assessed as 'Trajectory of Change' within the study. The No-Go Alternative assumes that the development will not occur, and that the status quo of the site will continue. It is assumed during this scenario that the land owner will clear the alien invasive plants, as required by the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983), and apply Section 28 of the NEMA, "Duty of Care", that states that reasonable measures must be taken to prevent pollution or degradation from occurring, continuing or reoccurring.

1.3 Relevant Legislation

The protection of water resources is essential for sustainable development and therefore many policies and plans have been developed, and legislation promulgated, to protect these sensitive ecosystems. The proposed project must abide by the relevant legislative requirements. Table 1 below shows an outline of the environmental legislation relevant to the project.

Table 1: Relevant environmental legislation

Legislation	Relevance
South African Constitution 108 of 1996	The constitution includes the right to have the environment protected
National Environmental Management Act 107 of 1998	Outlines principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for coordinating environmental functions exercised by organs of state.
Environmental Impact Assessment (EIA) Regulations	The 2014 regulations have been promulgated in terms of Chapter 5 of NEMA and were amended on 7 April 2017 in Government Notice No. R. 326. In addition, listing notices (GN 324-327) lists activities which are subject to an environmental assessment.
The National Water Act 36 of 1998	Chapter 4 of the National Water Act addresses the use of water and stipulates the various types of licensed and unlicensed entitlements to the use of water. The water uses under Section 21 (NWA) that are associated with the proposed development are most likely section 21 (c) and (i). Also, according to the Department of Water and Sanitation (DWS), any structures within a 500-metre radius from the boundary of a wetland constitutes a Section 21(c) and (i) water use and as such requires a water use licence.
General Authorisations (GAs)	Any uses of water which do not meet the requirements of Schedule 1 or the GAs, require a license which should be obtained from the Department of Water and Sanitation (DWS). The project will require a Water Use Authorisation or General Authorisation in terms of Section 21 (c) and (i) of the National Water Act (NWA), Act 36 of 1998, as the development will impact watercourses. Government Notice R509 of 2016 was issued as a revision of the General Authorisations (No. 1191 of 1999) for section 21 (c) and (i) water uses (impeding or diverting flow or changing the bed, banks or characteristics of a watercourse) as defined under the NWA. Determining if a water use licence is required is associated with the risk of impacting on that watercourse. A low risk of impact could be authorised in terms of a General Authorisations (GA).
National Environmental Management: Biodiversity Act No. 10 of 2004	This is to provide for the management and conservation of South Africa's biodiversity through the protection of species and ecosystems; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources; and the establishment of a South African National Biodiversity Institute.
Conservation of Agricultural Resources Act 43 of 1967	To provide for control over the utilization of the natural agricultural resources of the Republic in order to promote the conservation of the soil, the water sources and the vegetation and the combating of weeds and invader plants; and for matters connected therewith.

1.4 Scope of Work

The Scope of Work in accordance with the specific Terms of Reference are described below:

Phase 1

- ✓ Contextualization of the study area in terms of important biophysical characteristics and the latest available aquatic conservation planning information (including but not limited to vegetation, CBAs, Threatened ecosystems, any Red data book information, NFEPA data, broader catchment drainage and protected areas).

- ✓ Desktop delineation and illustration of all watercourses within and surrounding the site utilising available site-specific data such as aerial photography, contour data and water resource data.
- ✓ A risk/screening assessment of the identified aquatic ecosystems (as well as within the surrounding NWA regulated area) to determine which ones will be impacted upon by the proposed development and therefore require groundtruthing and detailed assessment.

Phase 2

- ✓ Ground truthing, infield identification, delineation and mapping of any potentially affected aquatic ecosystems in terms of the Department of Water and Sanitation (DWAF 2008) *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas*.
- ✓ Classification of the identified aquatic ecosystems in accordance with the, '*National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa'* (Ollis *et al*. 2013) and *WET-Ecoservices* (Kotze *et al*. 2009).
- ✓ Description of the identified watercourses with photographic evidence.
- ✓ Conduct a Present Ecological State (PES), functional importance assessment and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland habitats, utilising the latest tools, such as:
  - → Level 1 WET-Health Version 2 tool (Macfarlane *et al*., 2009) – PES
  - → WET-Ecoservices (Kotze *et al*., 2009) and/or the Wetland EIS assessment tool of Rountree and Kotze (2013). - Functional assessment
- ✓ Conduct a Present Ecological State (PES) and Present Ecological Importance and Sensitivity (EIS) assessment of the delineated river/riparian habitats, utilising:
  - → Qualitative Index of Habitat Integrity (IHI) tool adapted from (Kleynhans, 1996) – PES
  - → DWAF (DWS) River EIS tool (Kleynhans, 1999) - EIS
- ✓ Indicate the Recommended Ecological Category (REC) of the impacted aquatic ecosystems.
- ✓ Identification, prediction and description of potential impacts on aquatic habitat during the construction and operational phases of the project.
- ✓ Identify direct, indirect, and cumulative impacts the proposed development will have on aquatic habitats and the significance of these impacts. Rate the significance of the impacts.
- ✓ Recommend actions that should be taken to avoid impacts on aquatic habitat, in alignment with the mitigation hierarchy, and any measures necessary to restore disturbed areas.
- ✓ The identification, description and assessment of opportunities/ constraints of the site.
- ✓ Determination of No Go and buffer zones.

- ✓ Identify legislation and permit requirements that are relevant to the development proposal from an aquatic perspective.

2 STUDY AREA

2.1 Drainage Setting

The study area of the proposed project is located within the DWS Quaternary Catchment K70A (Figure 4) and falls within the Breede Gouritz Water Management Area. The major rivers in the catchment are the Groot and Bobbejaan River. The catchment has a mean annual precipitation of 920 mm. Table 2 contains a summary of further biological characteristics.

Table 2: Biophysical characteristics of the area around the proposed project site

Biophysical categories	Biophysical characteristics	Source
Approx. Elevation (a.s.l.)	150 - 250 m	Google Earth™
Mean annual precipitation	920 mm	Schultz, 1998
Rainfall seasonality	All year	Surveyor General
Potential Evaporation	250 mm	Schultz, 1998
Quaternary catchment	K70A	Schultz, 1998
DWA Ecoregion	South Eastern Coastal Belt	DWA, 2005
Geology	Sandstone, shale and siltstone	Surveyor General

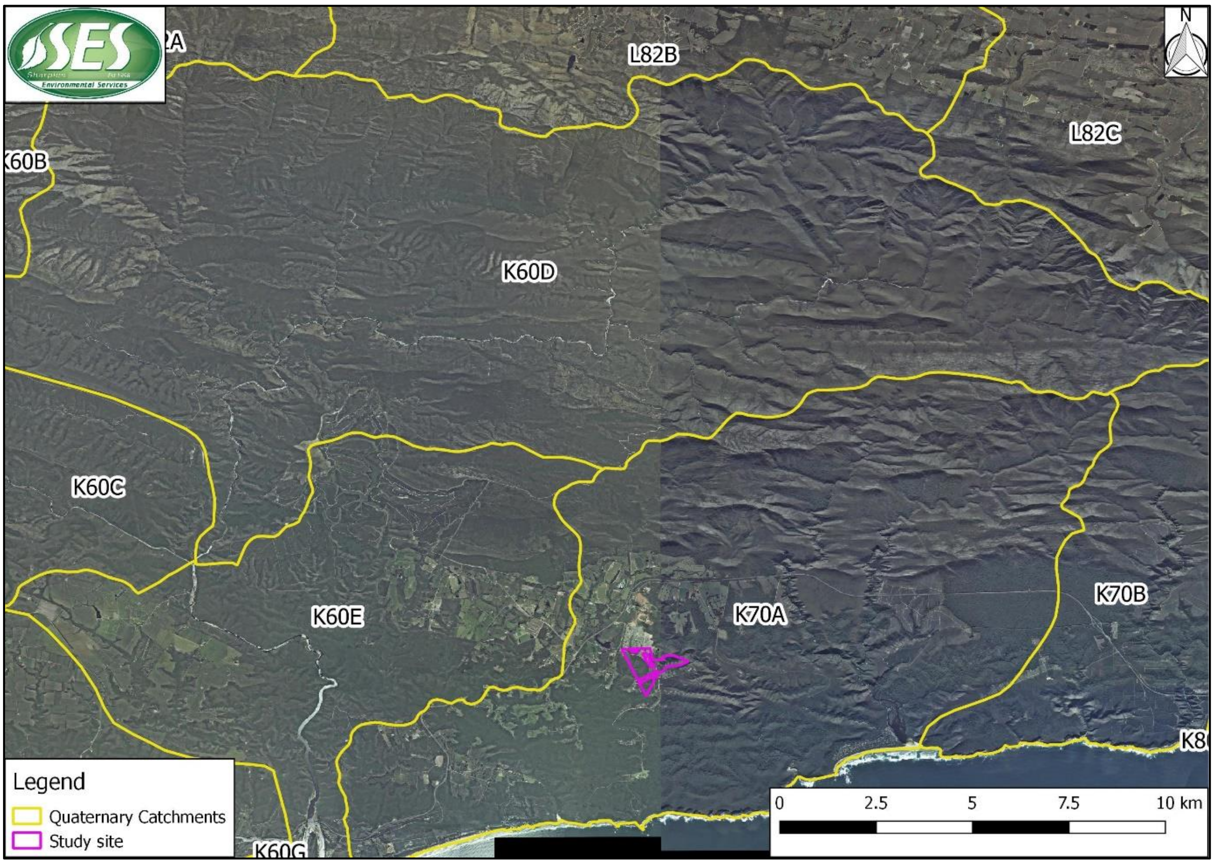


Figure 4: Map showing the study site within quaternary catchments K70A.

There are two watersheds within the property. Surface runoff is split east, southwest and south as can be seen in Figure 5. The developable area is largely drained in a southwest to west direction. The area that drains east is largely too steep for development. The drainage lines in the west of the property are also steep, but less so than in the east. The majority of the development is proposed to occur on the hilltop areas due to favourable topography.

The runoff that drains in a western and southern direction ends up in the Buffels River which merges with the Matjies River before reaching the ocean close to Keurboomstrand. The runoff draining east flows into the Sout River, shortly before it mouths into the ocean. All these rivers flow through protected areas.

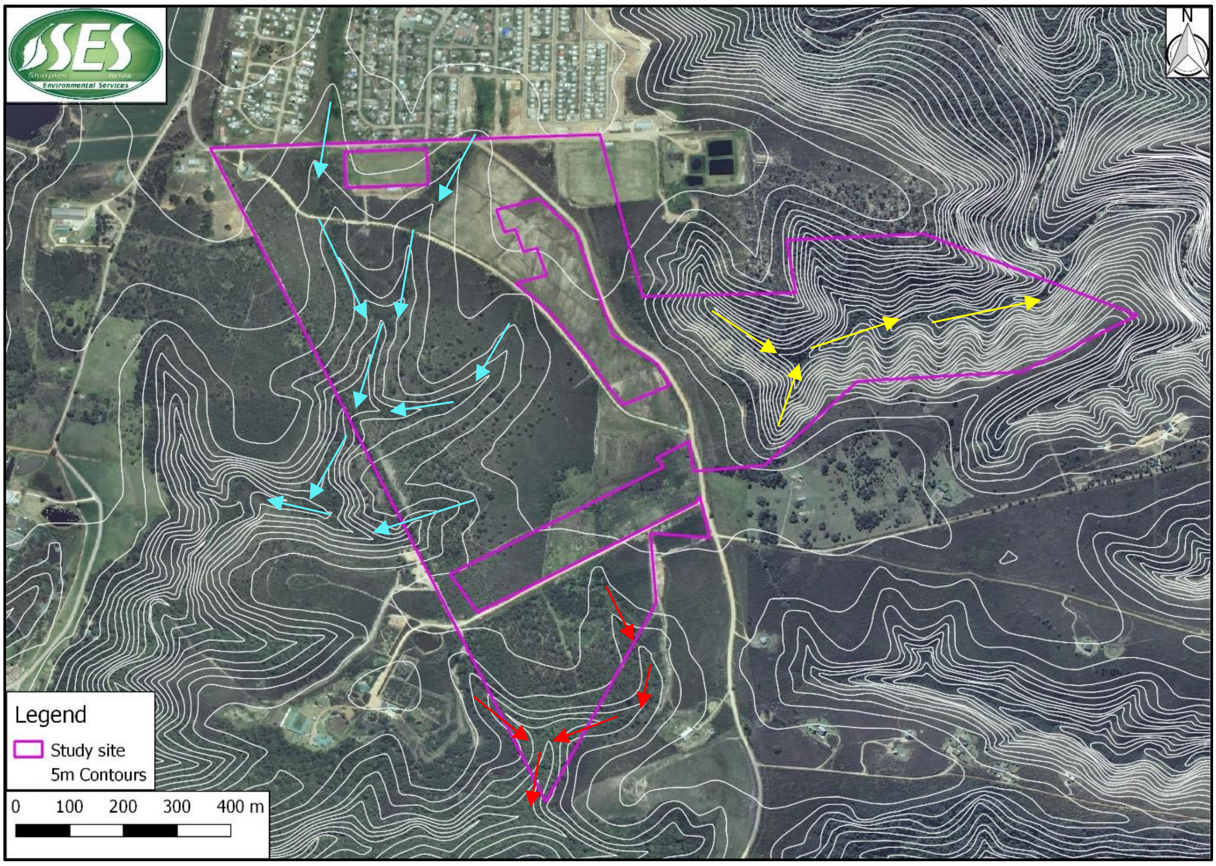


Figure 5: A contour map showing that the site drains in different directions. The arrows indicate the direction of drainage as follows: Yellow = east; Blue = west/southwest; Red = south.

The National Freshwater Ecosystem Priority Areas (NFEPA) map provides strategic spatial priorities for conserving South Africa's aquatic ecosystems and supporting sustainable use of water resources. FEPAs were identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries (Driver *et al.* 2011). No NFEPA wetlands occur on site. However, a Non-FEPA wetland was identified to the west of the site within the 500m regulated area (Figure 6). This wetland is a dam and artificial in nature. Furthermore, it is on the other side of the watershed and highly unlikely to be impacted by the proposed development activities.

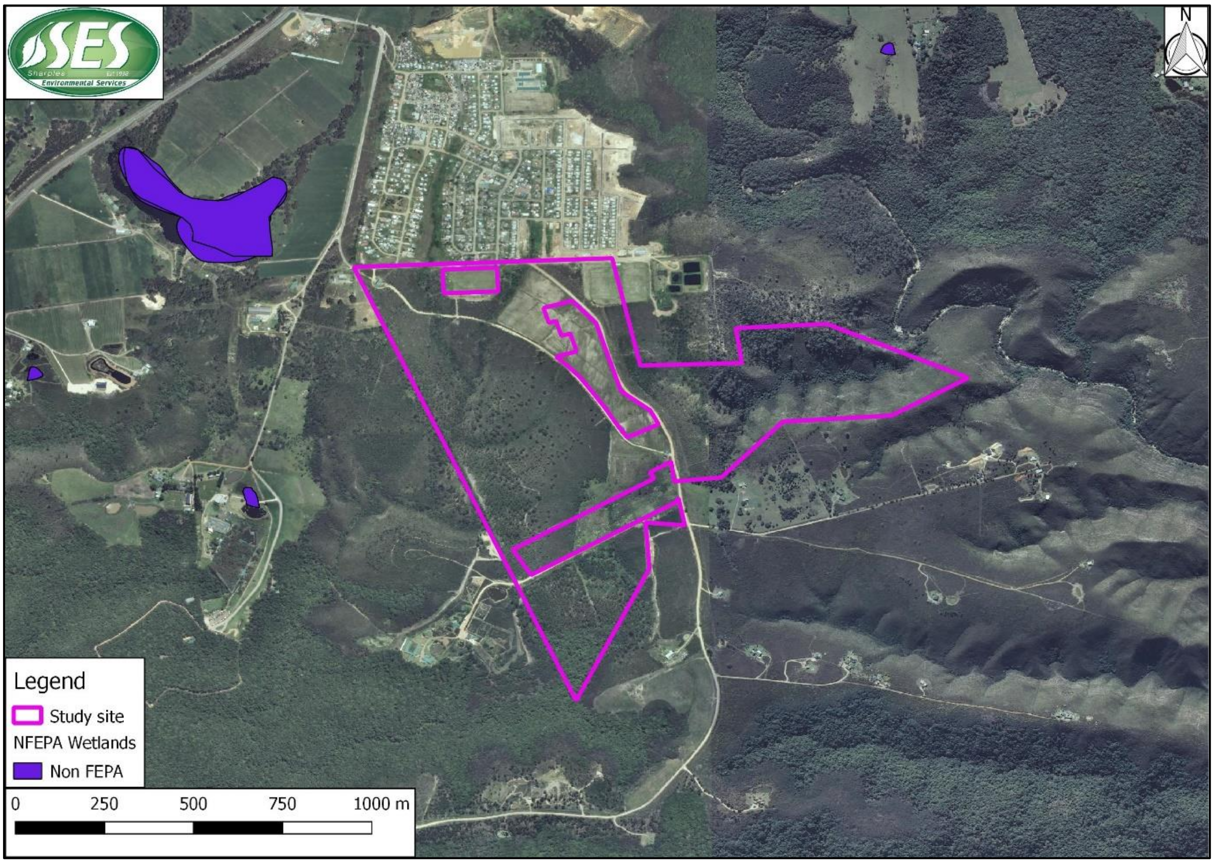


Figure 6: The map indicates wetlands identified by the National Freshwater Ecosystem Priority Area project. According to the project there are wetlands in the vicinity of the site, but they are not freshwater ecosystem priority areas.

The South African National Wetlands Map (NWM) provides information on the location, spatial extent and ecosystem types of estuarine and inland aquatic ecosystems (Van Deventer *et al.*, 2018). The latest version is the National Wetland Map 5, that was released in 2019. Figure 7 below shows the wetlands identified in relation to the study site. Both wetlands within the 500 m regulated area are classified as natural inland wetlands occurring within the Eastern Fynbos-Renosterveld Bioregion. The small wetland to the southeast is classified as a depression wetland and the larger wetland northwest of the site is classified as a seep wetland.

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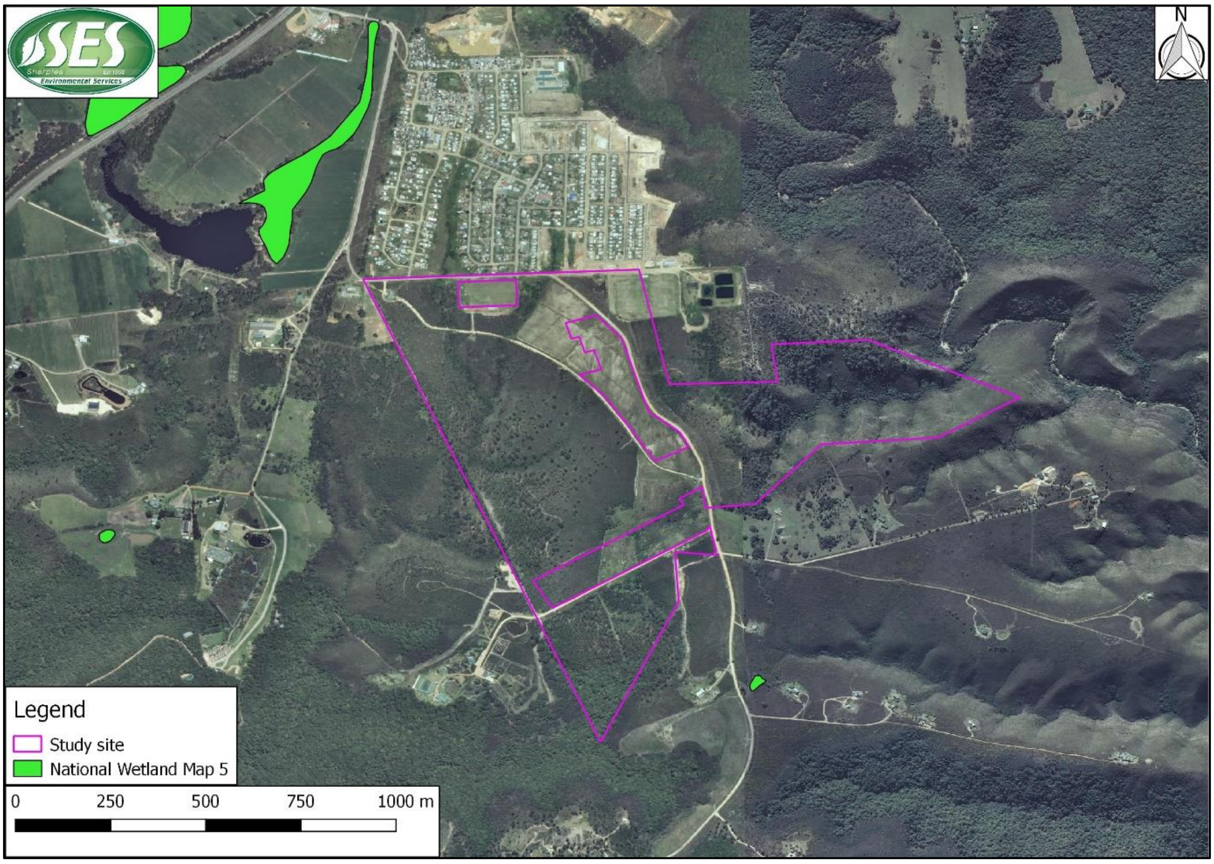

Figure 7: Wetlands within the 500 m regulated area identified by the National Wetland Map 5 (Van Deventer et al., 2018).

2.2 Vegetation

Mucina and Rutherford (2006) delineated vegetation units throughout Southern Africa and updated this data in 2012 and again in 2018. According to the most recent available vegetation mapping, the largest part of the site is comprised of Tsitsikamma Sandstone Fynbos (Figure 8). The southern portion of the property is mapped as Southern Afrotemperate Forest. A botanical survey (Berry, 2020) of the site was conducted, and the accuracy of this mapping will then be determined. Infestation of alien tree species, such as *Eucalyptus* and *Acacia mearnsii*, is however visible throughout the site. The ecosystems of the study site, and its immediate surrounding areas, are all classified as Least Threatened (Figure 9).

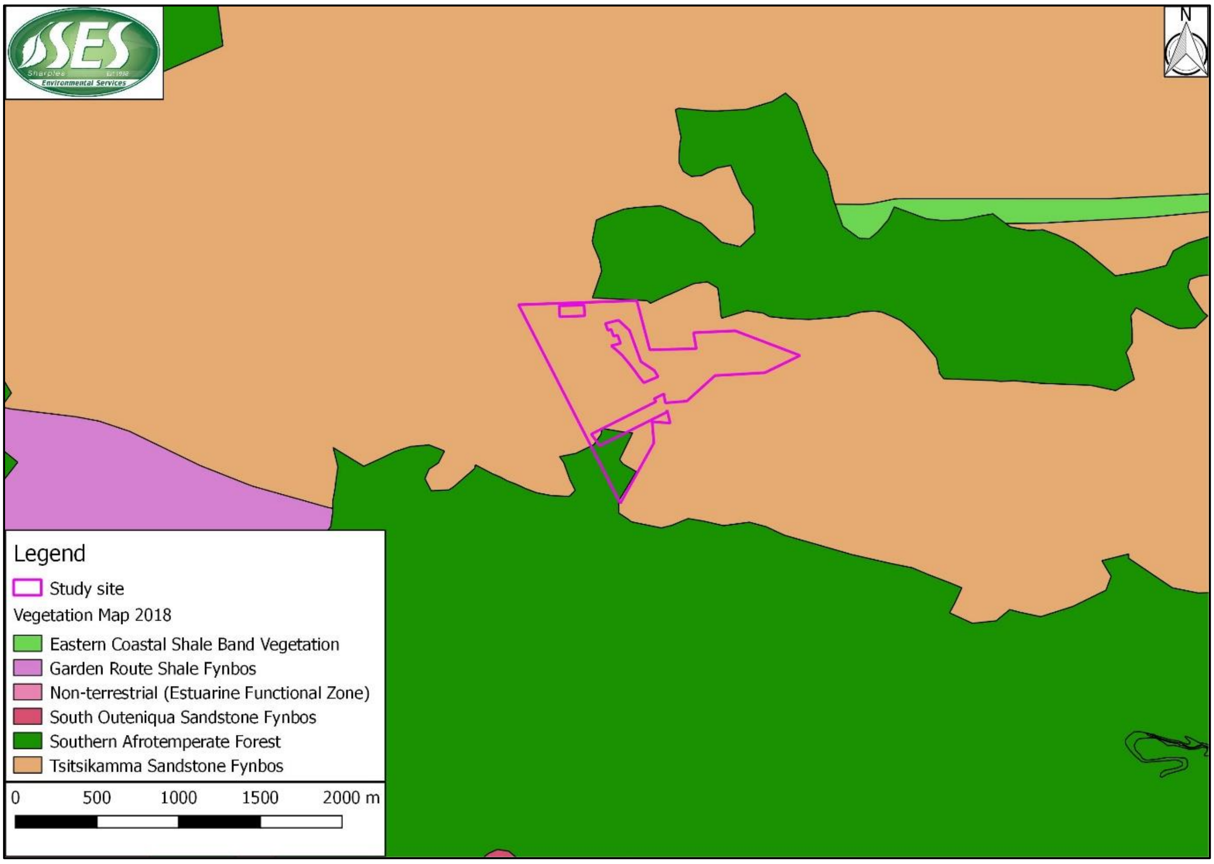

Figure 8: 2018 Vegetation Map showing the site is largely comprised of Tsitsikamma Sandstone Fynbos.

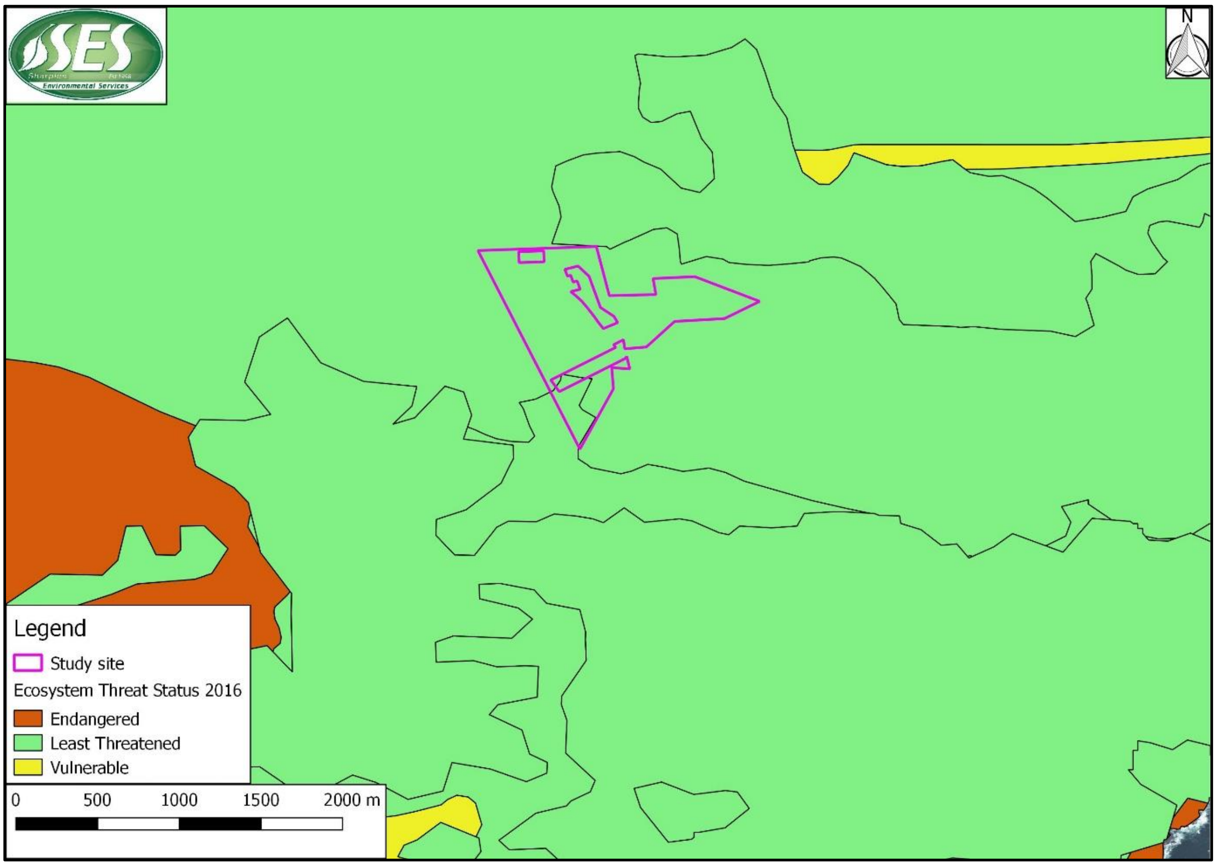

Figure 9: The Ecosystem Threat Status of areas in and around the study site.

2.3 Conservation Context

The Western Cape Biodiversity Spatial Plan (WCBSP) is recognized by both the Department of Environmental Affairs and South African National Biodiversity Institute. The primary purpose of a map of Critical Biodiversity Areas and Ecological Support Areas is to guide decision-making about where best to locate development. Critical Biodiversity Areas (CBA's) are required to meet biodiversity targets. These areas have high biodiversity and ecological value and therefore must be kept in a natural state without further loss of habitat or species. Low-impact, biodiversity sensitive land uses are the only land uses allowed in CBA's. Critically Endangered (CR) ecosystems, critical corridors for maintaining landscape connectivity and areas required to meet biodiversity pattern targets, are included in CBA's. The WCBSP made a distinction between areas likely to be in a natural condition (CBA1) and areas that could be degraded (CBA2). Ecological Support Areas (ESA's) are not essential for meeting biodiversity targets but are important as they support the functioning of CBA's and Protected Areas (PA's). ESA's support landscape connectivity, surrounds ecological infrastructure that provide ecosystem services, and strengthen resilience to climate change. These areas include Endangered vegetation; water source and recharge areas; and riparian habitat around rivers and wetlands. The WCBSP also made a distinction between ESA's in a functional condition (ESA1) and degraded areas in need of restoration (ESA2). Figure 10 shows that no aquatic CBAs are located within or near the study area. There are however portions of terrestrial and forest CBAs within the study area. The drainage lines in the property are classified as ESAs.

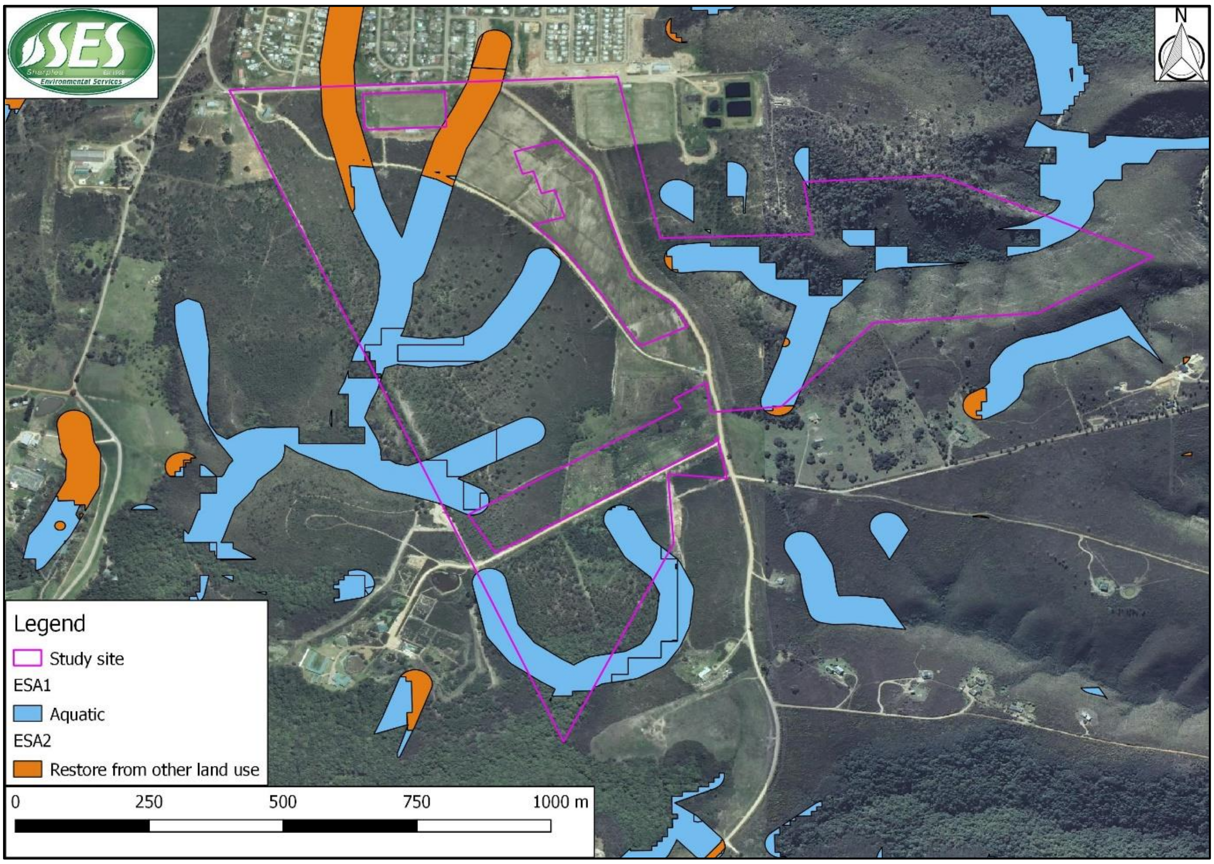

Figure 10: The study site in relation to aquatic features identified by the WCBSP (Pence 2017).

2.4 Existing impacts upon watercourses

Catchment and site-specific impacts are important for determining a baseline of the current status quo for the watercourses that will be impacted by any proposed developments. These characteristics are also important to note as they are used in assessing the various systems. Historical aerial photography shown in Figure 11 and 12, shows the landscape during the development of the existing Kurland township. The dominant land uses in the general area of the study site are agriculture and forestry. This has likely contributed to alien plant infestation throughout the study site.

Figure 11: Aerial imagery recorded in 1974.

Figure 12: Aerial imagery recorded in 1990.

Upstream of the proposed development, houses have encroached onto freshwater habitat, leaving only a narrow drain where a much broader wetland system used to be. This has altered runoff significantly. The runoff contains pollutants such as solid domestic waste that can bury aquatic habitat and hydrocarbons that deteriorate water quality. Runoff rates and volumes have been increased by the urban development. Furthermore, this disturbance has likely contributed to alien plant infestation within the drainage lines. Although these impacts occur upstream of the study site, the effect of altered runoff, confined flows and pollution deteriorate the health of the downstream system within the study site as well.

There are few formal structures in the proposed development area. However, the widespread solid domestic waste indicate that humans regularly occupy the undeveloped area. The existing urban development necessitated the construction of roads and culverts over watercourses. These culverts confine flows, cause erosion and destroy portions of aquatic habitat.

The presence of alien plant species throughout the study site is most likely due to the disturbance caused by historical forestry activities in the area. These plantations disturbed the area and introduced alien species, resulting in high density alien trees that outcompete natural vegetation. Plantations change sediment input into drainage lines, alter the stability of the slopes and reduce water inputs into the freshwater systems.

There is a wastewater treatment plant at the head of one of the northern tributaries that are part of the eastern drainage system in the study site. The system is therefore likely receiving treated effluent, and potentially untreated or poorly treated effluent, on a regular basis. It is also possible that this is a source of pollution into the system since many WWTW experience mechanical failures or power outages occasionally which leads to overflowing.

3 APPROACH AND METHODS

3.1 Desktop Assessment Methods

- The contextualization of the study area was undertaken in terms of important biophysical characteristics and the latest available aquatic conservation planning information in a Geographical Information System (GIS). It is imperative to develop an understanding of the regional drainage setting and longitudinal dynamics of the watercourse. The conservation planning information aids in the determination of importance and sensitivity, management objectives, and the significance of potential impacts.
- Following this, desktop delineation and illustration of all watercourses within the study area was undertaken utilising available site-specific data such as aerial photography, contour data and water resource data. Digitization and mapping were undertaken using QGIS 2.18 GIS software (Table 3).
- These results, as well as professional experience, allowed for the identification of specific watercourses that could potentially be impacted by the development and therefore required groundtruthing and detailed assessment. The following data sources listed within Table 2 assisted with the assessment.

Table 3: Utilised data and associated source relevant to the proposed project

Data	Source
Google Earth Pro™ Imagery	Google Earth Pro™
DWS Eco-regions (GIS data)	DWS (2005)
South African Vegetation Map (GIS Coverage)	Mucina & Rutherford (2018)
National Biodiversity Assessment Threatened Ecosystems (GIS Coverage)	SANBI (2011)
Geology	Surveyor General
Contours (elevation) - 5m intervals	Surveyor General
NFEPA river and wetland inventories (GIS Coverage)	CSIR (2011)
NEFPA river, wetland and estuarine FEPAs (GIS Coverage)	CSIR (2011)
Western Cape Biodiversity Framework 2017: Critical Biodiversity Areas of the Western Cape.	Pence (2017)
National Wetland Map 5	Van Deventer, et al. (2018)

3.2 Baseline Assessment Methods

- Infield site assessments were conducted on the 17th of July 2019 and the 22nd of August 2019 to confirm the location and extent of the systems identified as likely to be impacted by the proposed project. There are a number of factors which influence the level of impact, such as type of system, position of the system in relation to the project and position the system is located in the landscape. The identified aquatic ecosystems were classified in accordance with the, '*National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa'* (Ollis *et al*. 2013) and *WET-Ecoservices* (Kotze *et al*. 2009).

- Infield delineation was undertaken with a hand-held GPS, for mapping of any potentially affected aquatic ecosystems, in alignment with standard field-based procedures in terms of the Department of Water and Sanitation (DWAF 2008) *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas*. The delineation is based upon observations of the landscape setting, topography, vegetation and soil characteristics (using a hand-held soil auger for wetland soils).
- Determination of the Present Ecological State (PES), functional importance assessment and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland habitat.
  - ➢ The health/condition or Present Ecological State (PES) of the wetland was assessed using the Level 1 WET-Health assessment tool (Macfarlane *et al.* 2008), which is based on an understanding of both catchment and on-site impacts and the impact that these aspects have on system hydrology, geomorphology and the structure and composition of wetland vegetation.
  - ➢ Wetland benefits can be classified into goods/products (directly harvested from wetlands), functions/ services (performed by wetlands), and ecosystem scale attributes. The WET-Ecoservices tool (Kotze *et al*., 2009) is utilised to assess the goods and services that the individual wetlands under assessment provide, thereby aiding informed planning and decision-making. The tool provides guidelines for scoring the importance of a wetland in delivering each of 15 different ecosystem services (including flood attenuation, sediment trapping and provision of livestock grazing).
  - ➢ The Ecological Importance and Sensitivity (EIS) of freshwater habitats is an expression of the importance of the water resource for the maintenance of biological diversity and ecological functioning on local and wider scales; whilst Ecological Sensitivity (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007). There Wetland EIS Tool was utilised to determine EIS (Kleynhans, 1999).
- Determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) assessment of the delineated river/riparian habitats was undertaken utilising:
  - ➢ Qualitative Index of Habitat Integrity (IHI) tool adapted from (Kleynhans, 1996) – PES
  - ➢ DWAF (DWS) River EIS tool (Kleynhans, 1999) - EIS

- The PES and EIS results then allowed for the determination of management objectives for the potentially impacted aquatic ecosystems. hRefer to the Table below and Annexure 12 for a list and description of the tools utilised.

Table 4: Tools utilised for the assessment of water resources impacted upon by the proposed project.

METHOD/TOOL*	SOURCE	REFERENCE	APPENDIX (ANNEXURE)
Delineation of wetland and/or Riparian areas	*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas.*	(DWAF 2005)	12.1
Classification of wetlands and/ or other aquatic ecosystems	*National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa & WET-Ecoservices*	(Ollis *et al.*, 2013, Kotze *et al.*, 2009)	12.2
Present Ecological State (PES) Assessment (Wetland)	*WET-Health Assessment*	(McFarlane *et al.* 2009)	12.3
Functional Importance Assessment (Wetland)	*WET-Ecoservices Assessment*	(Kotze *et al.*, 2009)	12.4
Ecological Importance & Sensitivity (EIS) Assessment (wetland)	*DWAF Wetland EIS Tool*	(Duthie 1999)	12.5
Present Ecological State (PES) Assessment (River)	*Rapid IHI (Index of Habitat Integrity) tool developed Kleynhans (1996), Modified by DWAF*	(Ecoquat)	12.6
Ecological Importance & Sensitivity (EIS) Assessment (River)	*DWAF EIS tool developed by Kleynhans (1999)*	(Kleynhans, 1999)	12.7

3.3 Impact Assessment Methods

- The approach adopted is to identify and predict all potential direct and indirect impacts resulting from an activity from planning to rehabilitation. Thereafter, the impact significance is determined.
- Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). The degree of significance depends upon three dimensions: the measurable characteristics of the impact (e.g. intensity, extent and duration), the importance societies/communities place on the impact, and the likelihood / probability of the impact occurring. A methodology for assigning scores to the respective impacts is described in Annexure 12.
- Actions are thereafter recommended to prevent and mitigate the identified impacts on aquatic habitat, in alignment with the mitigation hierarchy, as well as any measures necessary to restore disturbed areas or ecological processes.

3.4 Opportunities and Constraint Analysis

- Regarding any proposed development on the property, a buffer area from the boundary of the aquatic habitat must be determined. The specific size of the buffer zone was determined by a tool developed by Macfarlane and Bredin (2016) called *Buffer zone guidelines for rivers, wetlands and estuaries*, site-based information and professional opinion. The final buffer requirement includes the implementation of practical management considerations/mitigation measures.
- Identify legislation and permit requirements that are relevant to the development proposal from an aquatic perspective.
- Present recommendations of the suitability of the site based on sensitivity analysis.

4 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations are relevant:

- The location of the proposed development was extrapolated from data provided by the client. No shapefiles with a more accurate layout have been provided as of yet. The layout has very limited detail which makes it difficult to accurately identify and assess impacts.
- No alternatives were provided for assessment as of yet.
- No stormwater plan was provided by the client as of yet.
- Civil engineering designs have not been undertaken. It is assumed that pipeline crossings will be along the proposed roadways and that no additional crossings will be required.
- Aquatic ecosystems vary both temporally and spatially. Once-off surveys such as this are therefore likely to miss certain ecological information due to seasonality, thus limiting accuracy and confidence.
- Infield soil and vegetation sampling was only undertaken within a specific focal area around the proposed development, while the remaining watercourses were delineated at a desktop level with limited accuracy.
- No detailed assessment of aquatic fauna/biota was undertaken.
- The vegetation information provided is based on observation not formal vegetation plots. As such species documented in this report should be considered as a list of dominant and/or indicator wetland/riparian species and only provide a very general indication of the composition of the riverine vegetation communities. Please see the Botanical Report (Berry, 2020) for more information.
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field survey and based on the assessor's working knowledge and experience with similar development projects. The degree of confidence is considered good.

- The study does not include flood line determination or offset calculations.
- No information regarding the proposed activities in the agricultural project area is available. It is assumed that cultivation or similar activities, will take place and that it will not occur within the watercourses of the area.
- The past land use disturbances to the soil profile and vegetation composition of this area, as well as the highly seasonal nature of the systems, decrease the accuracy of infield delineations.

5 RESULTS

Three drainage systems were identified on site (Figure 13). The Hydro-geomorphic units of each system were assessed together due to similar characteristics and impacts.

The northern most sections of System 1 are comprised of wetland habitat. These areas are within the existing Kurland township as can be seen in Figure 13. The wetlands are modified and degraded to a critical extent due to encroachment of housing infrastructure and various sources of pollution. However, since the new development will be downstream of the wetlands, it is not expected to impact on this degraded upslope part of the system. Therefore, it was not assessed further as part of System 1, and only noted due to it being within 500m of the development.

A small patch of wetland habitat is situated next to the road leading to Tenikwa Wildlife Rehabilitation and Awareness Centre. This wetland is likely artificial in nature and originated when the road and a berm to the south was constructed, which caused impoundment. This area is not currently included in the residential portion of the proposed development and will therefore not be impacted. The area could potentially be included in stormwater management by using it as a retention area which will assist in pollutant trapping and slowing runoff. This will depend on whether it is included in development in future. This artificial wetland area was not assessed further.

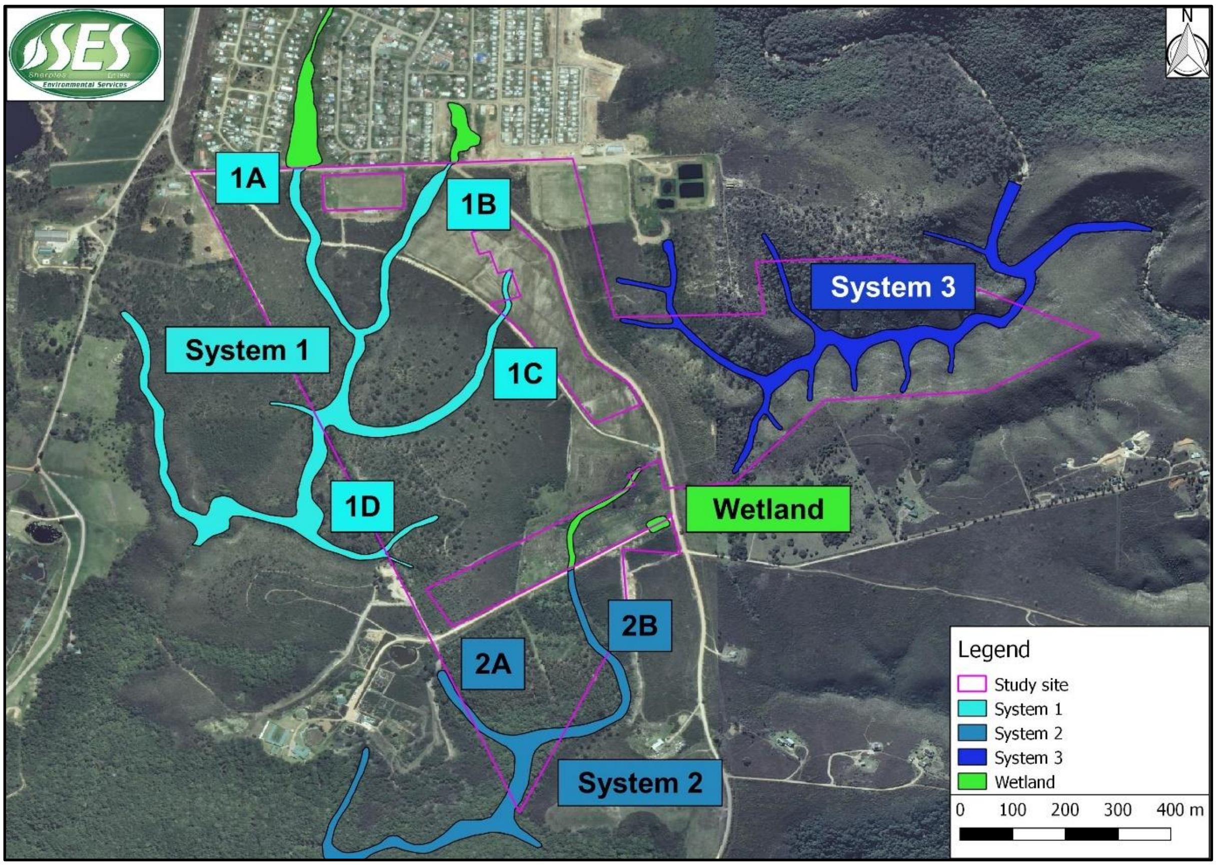

Figure 13: Delineation of freshwater habitat within the Remainder of Erf 562 and the existing Kurland township to the north of the study area.

5.1 System 1

5.1.1 Description

System 1 (Figure 13) is likely to be most impacted due to the topography of the areas surrounding these drainage lines being most favourable for development. The system has characteristics of a Transitional river system with average gradients of 2% - 4%. In the lower reaches of 1A and 1B, the gradient decreases and becomes more characteristic of an Upper foothills river. Transitional and Upper foothills systems both have moderately steep channels with limited floodplain development and reach types that include plane bed, pool-riffle and pool-rapid. The rivers are all non-perennial drainage lines that are up to three meters wide and has a sandy substrate. The system is incised below culverts which led to banks with a height of up to two meters.

The northern section of this system starts off as two drainage lines (Figure 14). They originate in the existing urban development, and merge within the area proposed to be developed. The western drainage line is referred to as 1A and the eastern as 1B. Drainage line 1C originates further east and joins the main system south of where 1A and 1B merge. Approximately in the middle of the property, two short drainage lines (1D) merge before joining the main system beyond the study area.

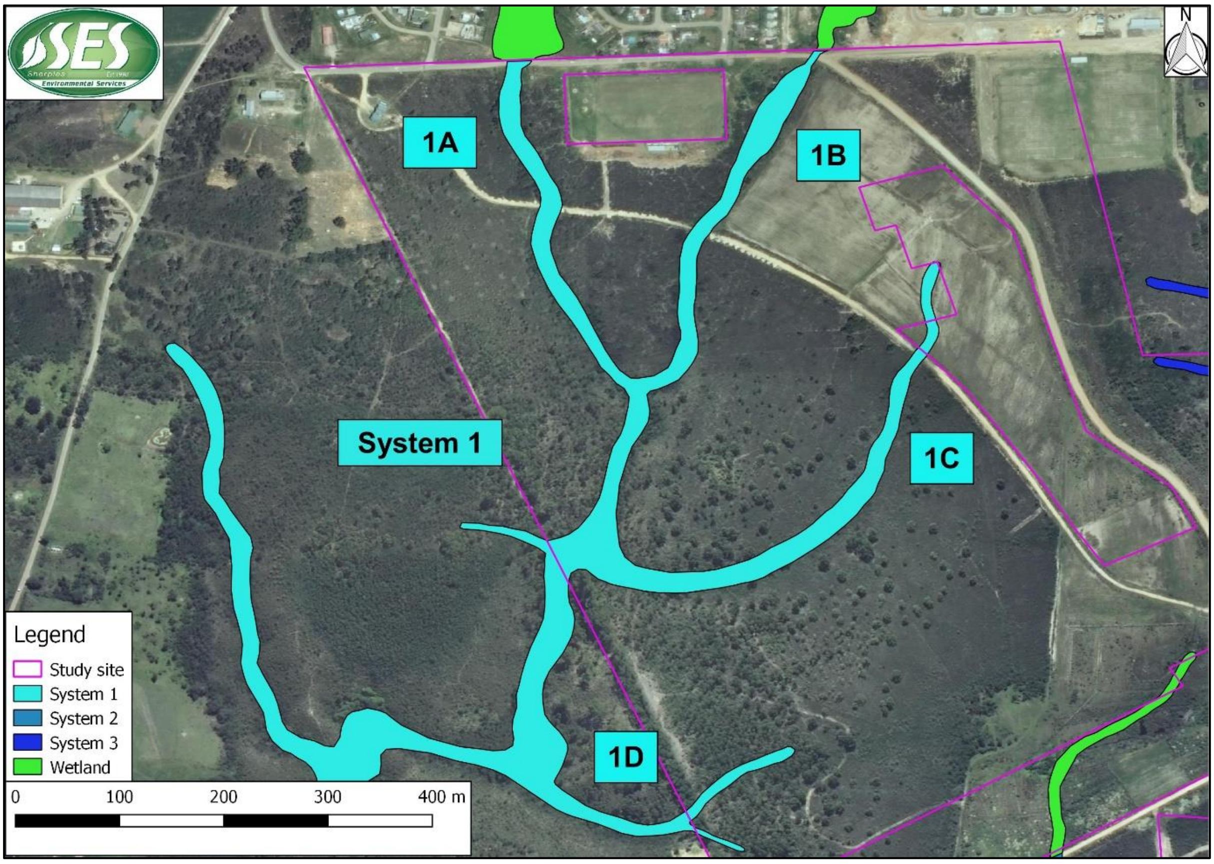

Figure 14: Map showing tributaries of System 1

The road below the existing Kurland township concentrates flow in drainage line 1A and 1B. This is visible at drainage line 1B due to instream excavations on the up and downstream side of the road crossing. The vegetation downstream of the road at drainage line 1A includes instream sedges. Alien vegetation, such as *Acacia sp.* and *Pinus sp*., are dominant downstream of the road at both 1A and 1B, which indicates that the system has been subject to disturbance.

Approximately 150 – 200 m downstream of the Kurland township, there is a two-track crossing drainage lines 1A and 1B (Figure 15C & D). In between the two drainage lines, below the township and above the two-track road, sports fields comprise most of the area.

The valley, where the two-track road crosses 1A, is deep with an incised channel. Regular human activity is evident from domestic waste and pathways heading in the direction of the sports fields. A box culvert enables vehicles to cross the drainage line. On the downstream side of the culvert, the road has eroded. The instream vegetation includes sedges, ferns and *Zantedeschia aethiopica* (Arum lily) that all contribute to a dense cover of the stream bed. Alien tree species such as *Pinus sp*. and *Acacia sp.* have established on the banks. The valley continues to deepen and steepen downstream of the two-track road. At the two-track crossing of 1B, the channel is also incised. Instream vegetation include sedges and ferns and similar alien tree species to those identified in 1A. Domestic waste is spread throughout the area and it appears that people are living within the thick vegetation.

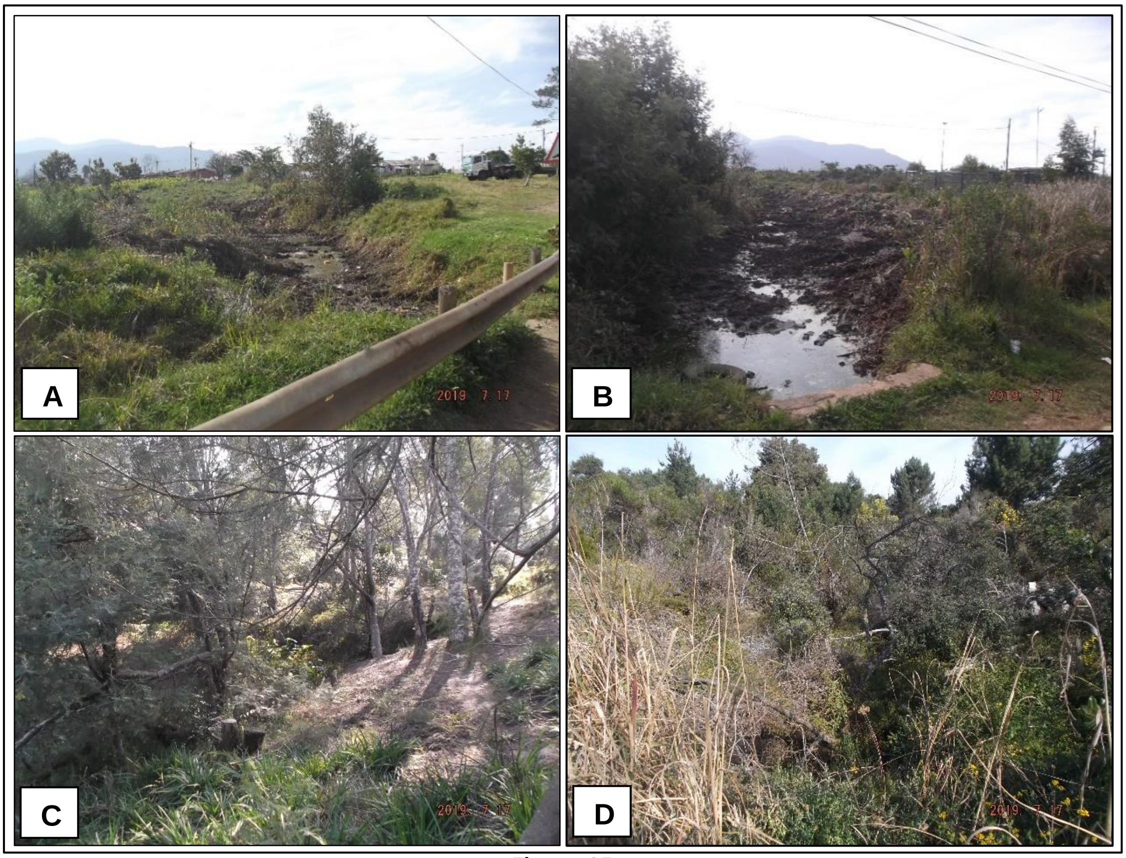

Figure 15
<u>Image A and C are of Drainage line 1A</u>. Image A shows excavated area, previously wetland, upstream of the study area. Image C shows the channel upstream of the box culvert at the two-track crossing.
<u>Image B and D are of Drainage line 1B</u>. Image B shows the excavations at the township upstream of the road. Image D was taken in the downstream direction of the two-track crossing and shows the thick vegetation instream as well as a less vegetated area on the western side of the valley.

Drainage line 1C also crosses the two-track road. At this crossing the road only dips slightly, and no deep channel has formed yet. The stream crossing is accommodated using a pipe and rocks that is placed underneath the road. This narrowed the natural width and flow of the stream. The vegetation is comprised of terrestrial Fynbos vegetation, such as *Erica* species as well as alien trees that include *Pinus sp*. and *Eucalyptus sp.* Drainage line 1D has largely been impacted by forestry in the past which led to the establishment of alien trees. It is a greater distance from the existing Kurland township and therefore anthropogenic impacts are less evident here.

5.1.2 Present Ecological State (PES)

The Present Ecological State (PES) refers to the health or integrity of river systems and includes both instream habitat as well as riparian habitat adjacent to the main channel. The rapid Index of Habitat Integrity (IHI) tool (Kleynhans, 1996) was used to determine river PES by comparing the current state of the in-stream and riparian habitats (with existing impacts) relative to the estimated reference state without anthropogenic impacts.

All the tributaries of System 1 were assessed as one. This was done due to the systems being connected and their characteristics and the impacts they are subject to, being similar. The system has been largely impacted by degradation of the wetland in the upper reaches of the system, north of the study site. Wetland habitat has been transformed by encroaching houses and increased runoff into the system from hardened surfaces, which decreased the wetlands ability to slow flows, prevent erosion and trap pollutants. The road crossings on the northern border of the study site and along the two-track road also degraded the stream by confining flows and causing erosion downstream of the culverts. The system is polluted by domestic and human waste and disturbed by the encroachment of alien plant species. The system obtained a PES score of 'D' which indicates that it is in a Poor condition (Table 5).

Table 5: Present Ecological State of System 1

Determinand	Score (0-5)	% intact	Rationale
Bed modification	3	50	The system is impacted by road crossings in various locations. The presence of culverts has confined flows and led to an eroded channel. Furthermore, in the upper reaches regular human activity is evident in and around the drainage lines, including pathways through the drainage lines.
Flow modification	3	50	Flow modification is mainly a result of the degradation of the wetlands above the proposed development area. Housing has encroached on these areas leading to degradation and increasing the runoff into the wetlands that cannot diffuse the flows as they would under natural conditions. The culverts and pipes have also led to confined flows downstream of road crossings. Alien vegetation impacts flow by reducing runoff into the system.
Inundation	0,5	90	Inundation is limited under natural conditions due to episodic stream flows. After rainfall, inundation on the upstream side of the culverts might occur for short periods of time but this is minimal. There are no dams or surface water within this system.
Bank condition	2,5	60	The banks have eroded and become increasingly incised in the upper reaches due to the road crossings confining flows. The banks are stable with no visible active erosion as most areas are well vegetated.
Riparian condition	3	50	The riparian area is stable and fairly well vegetated, especially further downstream. However, alien tree species do comprise some of the riparian vegetation that would have thicket vegetation under natural conditions.
Water quality modification	3	50	Due to the degraded state of the wetland above the study area, it is unable to effectively trap pollutants. The solid domestic waste found in and around drainage lines causes further water pollution. However, surface water availability is infrequent and dependent on rainfall events.
Average Score	**2,5**	58,3	
Ecological Category	**D**		**Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.**

5.1.3 Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity (EIS) of riparian areas is a representation of the importance of the aquatic resource for the maintenance of ecological functioning, and ability to recover from disturbance (Kleynhans & Louw, 2007). As a result of the nature of the system's stream (episodic flows, uniform types, etc.) it has limited EIS. The disturbances in the upper reaches of the system have resulted in degradation of the entire system. Therefore, the species/taxon richness is not expected to be significant at any scale. The stream is not identified as aquatic CBA or a FEPA system, and it is not within a conservation area. The system resultantly has a 'Low' EIS (Table 6). The system does however support the larger downstream system of the Buffels River that flows into the ocean near Keurboomstrand.

Table 6: Ecological Importance and Sensitivity Assessment of System 1

Determinants		Score (0-4)	Rationale
BIOTA (RIPARIAN & INSTREAM)	Rare & endangered (range: 4=very high - 0 = none)	0,5	No rare or threatened species were encountered on site. The tributaries have been significantly modified and little natural habitat remains.
	Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	1,5	As the system is located in the Fynbos biome, some populations will likely be unique on a local scale. However, limited intact habitat remains due to transformation of the riparian area.
	Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	1,0	The species associated with these riparian systems are likely very tolerant of increases and decreases in flow as the systems naturally flow episodically.
	Species/taxon richness (range: 4=very high - 1=low/marginal)	1,5	Few areas with natural vegetation remain that has not been altered by alien infestation to some extent, especially in the upper reaches. This leads to decreasing biodiversity.
RIPARIAN & INSTREAM HABITATS	Diversity of types (4=Very high - 1=marginal/low)	0,5	There is a low diversity in aquatic habitat types due to the drainage lines being topographically uniform with only intermittent flow.
	Refugia (4=Very high - 1=marginal/low)	1,0	The systems have a limited ability to provide refuge to biota during times of environmental stress. This is due to the degradation, limited diversity of habitat and intermittent flow.
	Sensitivity to flow changes (4=Very high - 1=marginal/low)	3,0	Due to intermittent flow occurring, any changes in flow will lead to altered habitat conditions.
	Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	1,0	These are streams with habitat types rarely sensitive to water quality change related to flow decreases or increases since they are used to intermittent flow.
	Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	0,5	The tributaries are not an important link in terms of connectivity for the survival of biota upstream and downstream. Due to the degraded state of the upper reaches it is unlikely to be an important migration route for biota.
	Importance of conservation & natural areas (range, 4=very high - 0=very low)	1	The tributaries are not in a natural/undisturbed area which is important for the conservation of ecological diversity on a provincial /regional scale. However, it is upstream of nature reserves which contributes to conservation efforts on a local scale.
MEDIAN OF DETERMINANTS		1,00	
ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORY (EIS)		**LOW, EC=D**	**One or a few elements sensitive to changes in water quality/hydrological regime**

5.1.4 Recommended Ecological Category

The recommended ecological category (REC) is used to inform future management objective for an aquatic ecosystem. The REC can be determined by using the PES (Present Ecological State) and EIS (Ecological Importance and Sensitivity) scores of the system. The management objective for this stream is to maintain the current health of the system.

5.2 System 2

System 2 drains the southern portion of the property (Figure 16). This area, mainly south of the road leading to Tenikwa Wildlife Rehabilitation and Awareness Centre, is dominated by *Eucalyptus* trees. The dominant presence of alien trees is likely due to historic forestry plantations in the area. The system is comprised of two drainage lines with the first (2A) shorter and running mostly along the western boundary of the property and the second (2B) to the eastern side, stretching further north into the property. The system has non-perennial streams with infrequent surface flows, sandy substrate and a steep gradient that is characteristic of a Transitional and Upper foothills river system. The channel is less impacted by roads and therefore less incised than System 1. The upper reaches of 2B has cryptic wetland habitat.

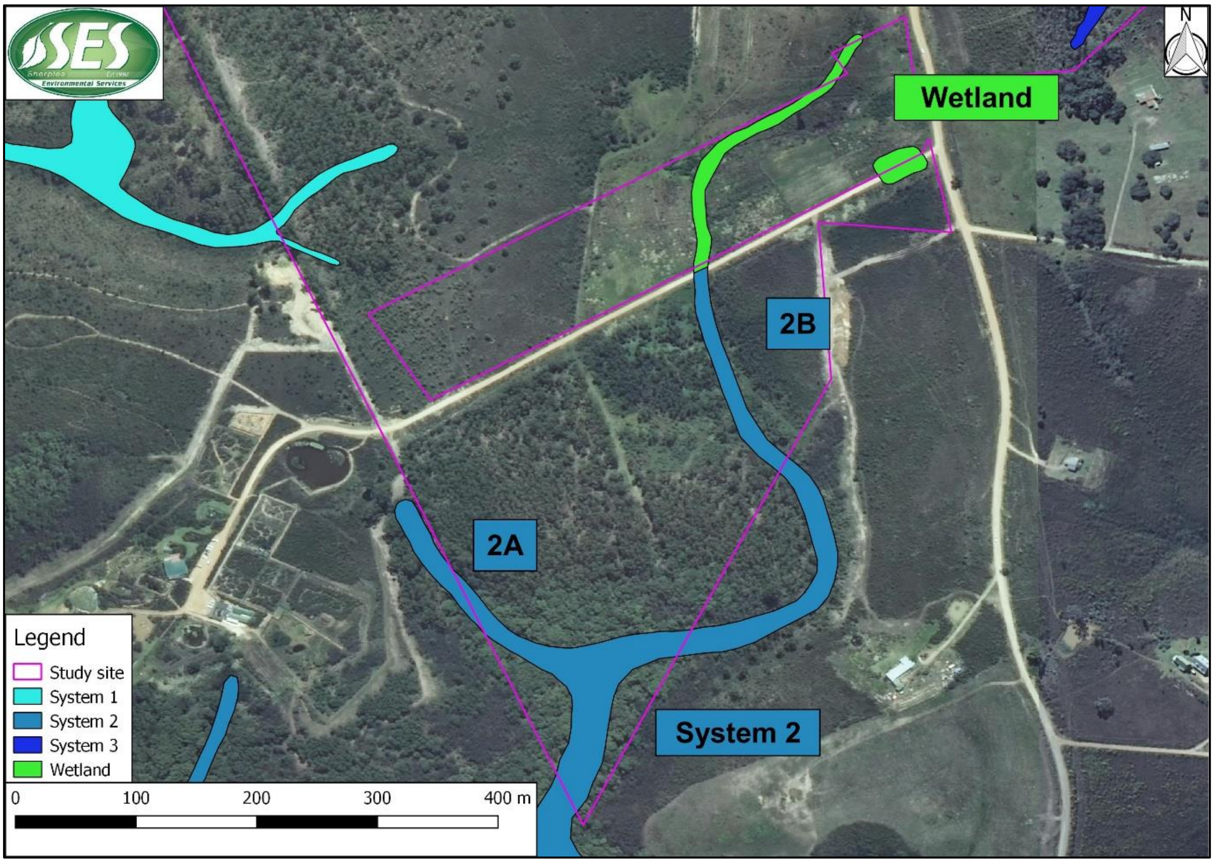

Figure 16: Map showing tributaries of System 2

The head of the 2A drainage line is in the Tenikwa area, from where it enters the *Eucalyptus* dominated southern section of the study site (Figure 17). Drainage line 2B originates on fairly flat topography, leading to the presence of wetland habitat. A valley starts to form approximately where the road and drainage line intersect. The road design does not accommodate a broad stream and it is likely that the resultant confined flows added to stream characteristics becoming more evident downstream of the road. The downstream area is densely vegetated with species such as *Acacia mearnsii* (Figure 18). The non-perennial stream section of 2B and the entire 2A is very similar to system 1 and therefore obtained the same PES and EIS scores. The wetland habitat in the upper reached of 2B (Figure 16) was assessed separately and is discussed below.

Figure 17: Drainage line 2A. The image shows the cleared area between the Tenikwa Wildlife Rehabilitation and Awareness Centre and the old plantation. The head of 2A is circled in red.

Figure 18: Photo showing drainage line 2B downstream of the road.

5.2.1 Wetland habitat

The portion of System 2 located on gentler topography above the road was classified as a seasonal seep wetland. The area gently slopes in a southwestern direction which leads to unidirectional flow downslope towards the road crossing and the downstream non-perennial drainage line into which the wetland feeds. Water inputs to the wetland likely include subsurface flow with diffuse overland flow occurring during and after rainfall events. Therefore, inundation only occurs periodically. The seep's connection to the stream has been impacted by the road crossing. However, confined flows are accommodated underneath the road.

It was challenging to delineate the wetland due to the habitat having cryptic and temporary features. Furthermore, the general area has been subject to agricultural activities and forestry in the past and this has transformed the geomorphological characteristics, surface flow patterns, retention capability and vegetation composition. However, the wetland is currently well vegetated largely with indigenous plant species. Vegetation such as *Kniphofia uvaria* (red hot poker), *Juncus sp.*, *Typha capensis*, *Cyperus sp.*, restios and many sedges grow within the wetland. At the road, where the transition of wetland to stream profile occurs, *Conyza sp.* and *Helichrysum cymosum* occur. Please see the botanical report for more information on the species occurring in the wetland area (Berry, 2020).

The largest part of the wetland falls within erven not currently included in the proposed development footprint. If these erven are incorporated in future, the wetland habitat needs to be avoided by adhering to the aquatic buffer.

5.2.2 Present Ecological State

The overall PES of the wetland was determined by assessing the PES scores for hydrology, geomorphology and vegetation. Hydrology achieved a 'C' category since it is largely intact, but inputs from the catchment is slightly reduced by alien tree species and historical agricultural that entailed artificial drainage of the area. The road downstream of the wetland has caused impedance of flow which has altered the hydrology of the system. The geomorphology component achieved an 'B' score due to there being limited active erosion and deposition. Vegetation PES is obtained a 'C' score due to grazing occurring in the wetland, alien vegetation encroachment and the presence of the road restricting the extent of wetland vegetation. Both the vegetation and soils are altered from natural conditions due to historical forestry and agricultural land uses. Although some characteristics have re-established, alien vegetation have encroached, and the vegetation is largely modified. The wetland has an overall 'C' PES score which means the system is moderately modified (Table 7).

Table 7: Results of the PES assessment

Result	Hydrology	Geomorphology	Vegetation	Overall PES	
Score	1.0	1.1	3.7	2.2	**Fair**
Category	C	B	C	**C**	

5.2.3 Functional Importance

Wetland benefits can be classified into goods/products (directly harvested from wetlands), functions/ services (performed by wetlands), and ecosystem scale attributes. The WET-EcoServices assessment highlights these benefits and the extent of each benefit for the wetlands. The assessment indicates that the wetland currently has a Low to Moderate functional importance (Figure 19). The functionality of the wetland is restricted by its cryptic nature, small size and historically altered condition. The wetland is most valuable in terms of services such as flood attenuation, erosion control and sediment trapping. It does not have any known cultural significance nor is it valuable in terms of tourism or education. The wetland supports natural resources to an extent since it supports livestock grazing and a drainage line which contributes to larger systems downstream.

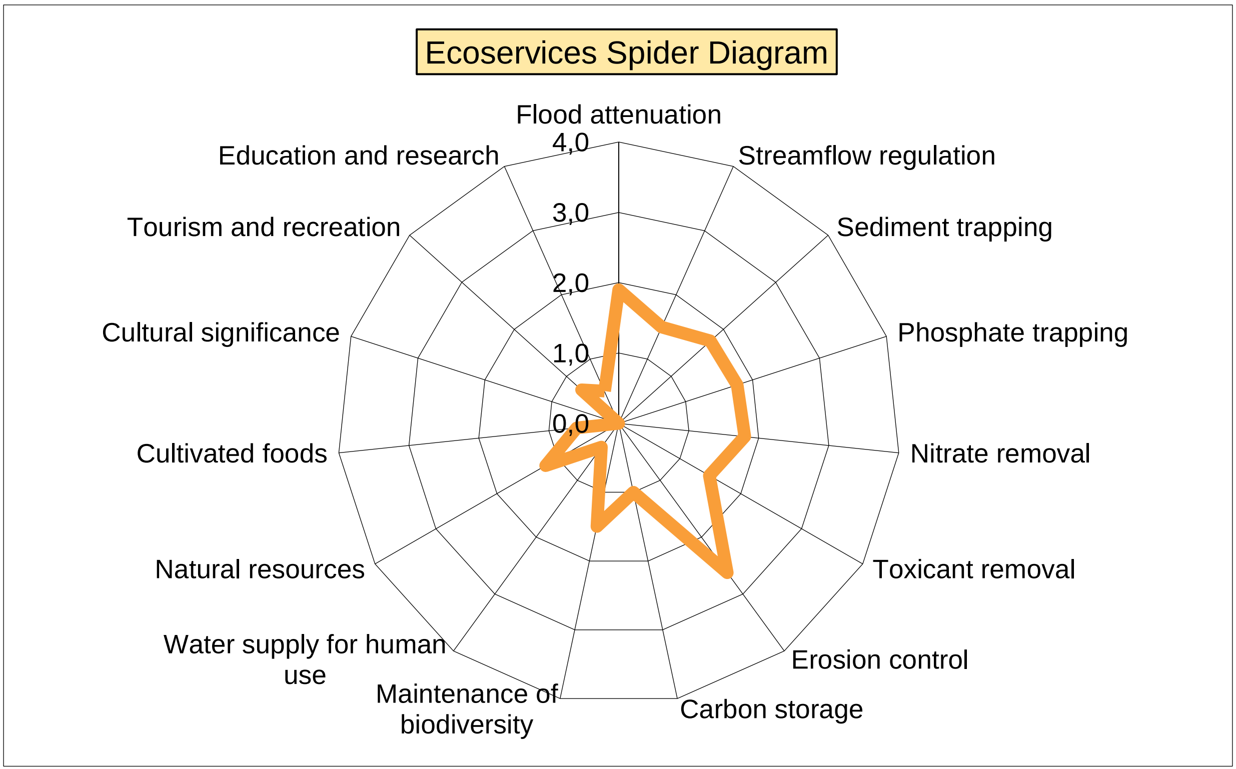

Figure 19: Functional importance results for the potentially impacted wetland

5.2.4 Ecological Importance and Sensitivity

The wetland obtained a 'Low' overall EIS score. The habitat has limited biodiversity and functional importance and it lacks major direct benefits to society, such as water for human use. The low score for biodiversity importance is due to the absence of rare species, the small size and low sensitivity of the wetland and it not being in an area that is protected. It does however provide some habitat for biodiversity. The wetland performs some functions by attenuating floods, trapping sediments and controlling erosion. The functions are however limited due to the wetland's small size and previous degradation by agricultural and forestry activities.

Table 8: Wetland EIS Assessment Results

SUMMARY	Seep Wetland	
	Score (out of 4)	**Rating**
BIODIVERSITY IMPORTANCE	1,00	Low
FUNCTIONAL/HYDROLOGICAL IMPORTANCE	1,38	Low
DIRECT BENEFITS TO SOCIETY	0,60	Low
Ecological Importance and Sensitivity (EIS)	**1,00**	**Low**

5.2.5 Recommended Ecological Category

The recommended ecological category for the wetland is to maintain it at a C PES score.

5.3 System 3

System 3 is located in the eastern portion of the study site. The upper reaches of the western tributaries of System 3 has a gradient of up to 12%, making it the steepest of the systems in the study area. This gradient is characteristic of Mountain headwater streams. These drainage lines, however, have sandy and clayey substrate and not bedrock predominantly. The first order tributaries receive intermittent flow under natural conditions. The tributary below the wastewater treatment plant (Figure 20) is likely receiving treated effluent and will therefore be more regularly inundated than the other tributaries. The system is also vulnerable to pollution in the event of mechanical failure at the WWTW. The valley sides are covered in alien *Eucalyptus* trees that likely extent into the riparian zone.

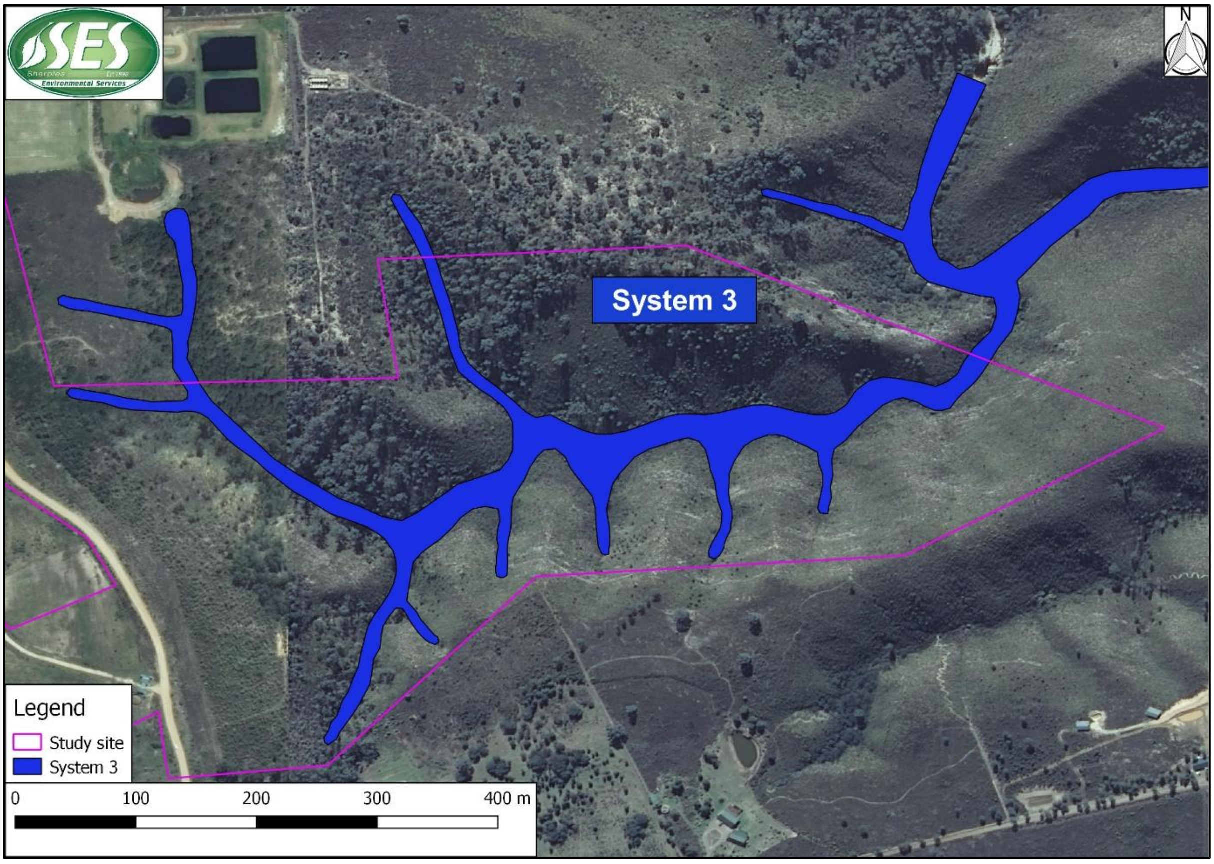

Figure 20: Map showing the extent of System 3 in the eastern portion of the study area.

Due to these steep gradients, the majority of the eastern section of the study site is excluded from development and therefore this system is less likely to be significantly impacted by the proposed development.

5.3.1 Present Ecological State

System 3 obtained a 'C' PES score indicating a Moderately modified system (Table 9). It has been less impacted than the drainage lines of System 1 and 2, due to it being more remote. However, there are various alien tree species surrounding the drainage lines that impact the runoff into the system. Furthermore, the Bitou Kurland Wastewater Plant, located just north of the system, is likely releasing treated effluent into one of the tributaries which could cause unnatural inundation and potentially lead to pollution in the event of mechanical failure.

Table 9: Present Ecological State of System 3

Determinant	Score (0-5)	% intact	Rationale
Bed modification	2	70	System 3 has been less impacted than System 1 with alien trees having the largest impact. Altered runoff may lead to erosion within the drainage lines which alters the bed.
Flow modification	1,5	80	Flow modification is mainly a result of the dominant presence of alien tree species around the drainage lines especially on the side of the development. Alien trees require more water than indigenous plants and therefore reduce runoff into the drainage lines. Releases from the

			WWTW likely cause more regular inundation in the affected drainage lines. There are no known other impeding structures or abstraction.
Inundation	0,5	90	Inundation is limited due to episodic stream flows. There are no known obstructions within the drainage lines that could cause unnatural inundation. Releases from the WWTW could however cause the affected drainage lines to be inundated more than under natural conditions.
Bank condition	2	70	The alien trees surrounding the drainage lines have likely contributed to the erosion of the banks which resulted in an incised channel. However, the steep topography would likely have caused it under natural conditions to a certain extent as well.
Riparian condition	2	70	The riparian area is stable and fairly well vegetated. However, alien tree species have encroached into the riparian habitat as a result of previous or current forestry activities.
Water quality modification	2,5	60	The most likely source of altered water quality will be releases from the WWTW into the drainage line. The tributaries are therefore not all impacted by this. Failure at the WWTW could compromise the water quality periodically.
Average Score	**1,8**	73,3	
Ecological Category	**C**		**Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.**

5.3.2 Ecological Importance and Sensitivity

The EIS assessment of System 3 obtained similar results to System 1 and 2. The EIS score for System 3 is also 'Low' since it has episodic flows and uniform habitat types (Table 10). The species/taxon richness is not expected to be significant on any scale – similar to System 1 and 2. This system has not been identified as aquatic CBA or FEPA and is not within a conservation area. The runoff from this system is however contributing to larger systems downstream.

Table 10: EIS Assessment results System 3

Determinants		Score (0-4)	Rationale
BIOTA (RIPARIAN & INSTREAM)	Rare & endangered (range: 4=very high - 0 = none)	0,5	No rare or threatened species were encountered on site.
	Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	1,0	Fynbos species: indigenous species occur but are limited in riparian area and outcompeted by alien tree species.
	Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	1,5	The species associated with these riparian systems are likely very tolerant of increases and decreases in flow as the systems are intermittently inundated. Certain parts of the system might be receiving more consistent flow due to releases from the WWTW.
	Species/taxon richness (range: 4=very high - 1=low/marginal)	1,5	Natural vegetation has been altered by the encroachment of alien vegetation into the riparian areas. Alien tree species outcompete natural vegetation.
RIPARIAN & INSTREA	Diversity of types (4=Very high - 1=marginal/low)	0,5	There is a low diversity in aquatic habitat types due to the drainage lines being topographically uniform with naturally intermittent flow.

	Refugia (4=Very high - 1=marginal/low)	1,0	The systems have a limited ability to provide refuge to biota during times of environmental stress. This is due to the limited diversity of habitat and intermittent flow.
	Sensitivity to flow changes (4=Very high - 1=marginal/low)	1,5	Habitat is not sensitive to flow changes since it is accustomed to episodic flows.
	Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	1,0	These are streams with habitat types rarely sensitive to water quality change related to flow decreases or increases since they are used to intermittent flow.
	Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	0,5	The tributaries not an important link in terms of connectivity for the survival of biota upstream and downstream.
	Importance of conservation & natural areas (range, 4=very high - 0=very low)	1	The tributaries are not in a natural/undisturbed area which is important for the conservation of ecological diversity on a provincial/regional scale. However, it is upstream of protected areas which contributes to conservation efforts.
MEDIAN OF DETERMINANTS		1,00	
ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORY (EIS)		**LOW, EC=D**	**One or a few elements sensitive to changes in water quality/hydrological regime.**

5.3.3 Recommended Ecological Category

The recommended ecological category for System 3 is to maintain the PES.

6 POTENTIAL IMPACTS

Aquatic ecosystems are particularly vulnerable to human activities and these activities can often result in irreversible damage or longer term, cumulative changes. The significance of an impact to the environment or ecosystem can only be assessed in terms of the change to ecosystem services, resources and biodiversity value associated with that system or component being assessed. The approach adopted is to identify and predict all potential direct and indirect impacts resulting from an activity from planning to rehabilitation. Thereafter, the impact significance is determined. Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). The degree of significance depends upon three dimensions: the measurable characteristics of the impact (e.g. intensity, extent and duration), the importance societies/communities place on the impact, and the likelihood / probability of the impact occurring.

Development will largely be outside of riparian areas due to unfavourable topography. Road crossings are proposed in the same location as the existing two track crossings and will therefore cause less disturbance than creating a new route. The proposed activities in the agricultural project area are not yet known and therefore the impacts associated with this part of the development is unclear.

The direct and indirect impacts associated with the project are grouped into four encapsulating impact categories where associated or interlinked impacts are grouped. Impacts have been separated into construction and operational phases of the project within these categories.

6.1 Disturbance/loss of aquatic vegetation and habitat

The disturbance or loss of aquatic vegetation and habitat refers to the direct physical destruction or disturbance of aquatic habitat caused by vegetation clearing, disturbance of riparian habitat, encroachment and colonisation of habitat by invasive alien plants.

6.1.1 Construction Phase

Indigenous aquatic vegetation within the stream catchments, and possibly within the riparian zone, will be removed and disturbed due to construction activities such as excavations and infilling, as well as machinery and workers on site. The movement of topsoil and incorrectly placed stockpiles could bury aquatic habitat. This will be a direct and immediate impact resulting in short to medium term vegetation loss. Due to construction, alien invasive species may encroach further into any disturbed areas and outcompete indigenous vegetation thereby reducing aquatic biodiversity.

6.1.2 Operational Phase

There is less direct risk to aquatic habitat during the operational phase as it will have been transformed already during construction. However, any remaining habitat is at threat due to the possibility of urban sprawl encroaching into aquatic habitat or increase pressure from livestock. The project may promote the establishment of disturbance-tolerant biota, including colonization by invasive alien species, weeds and pioneer plants if there is any ongoing disturbance near the riparian zone. Although this impact is initiated during the construction phase it is likely to persist into the operational phase. Additionally, the stormwater infrastructure of the housing and associated road network will increase and concentrate flows into the systems. This may lead to erosion in the systems.

6.2 Sedimentation and erosion

Sedimentation and erosion refer to the alteration in the physical characteristics of the river as a result of increased turbidity and sediment deposition, caused by soil erosion and earthworks that are associated with construction activities, as well as instability and collapse of unstable soils during project operation. These impacts can result in the deterioration of aquatic ecosystem integrity and a reduction/loss of habitat for aquatic dependent flora & fauna.

6.2.1 Construction Phase

Vegetation clearing and exposure of bare soils directly within and adjacent to the aquatic habitat during construction will decrease the soil binding capacity and cohesion of the upslope soils and thus increase the risk of erosion and sedimentation downslope. This may cause the burying of aquatic habitat. Ineffective site stormwater management, particularly in periods of high runoff, can lead to soil erosion from confined flows. Formation of rills and gullies from increased concentrated runoff might also occur. This increase in volume and velocity of runoff increases the particle carrying capacity of the water flowing over the surface. Soil compaction resulting in reduced infiltration and increased surface runoff together with the artificial creation of preferential flow paths due to construction activities, will result in increased quantities of flow entering the systems. The magnitude of this impact is increased by the steep topography adjacent to these drainage lines.

6.2.2 Operational Phase

Where soil erosion problems and bank stability concerns initiated during the construction phase are not timeously and adequately addressed, these can persist into the operational phase of the development project and continue to have a negative impact downstream. The increase in hardened surface by development, and the impact of road and pipe crossings will be considerable and, if not mitigated against, will result in further erosion. Surface runoff and velocities will be increased, and flows will be concentrated by stormwater infrastructure. Cultivation in the agricultural area may lead to increased sedimentation since large areas will be left unvegetated for periods of time. The steep slopes increase the magnitude of this impact.

6.3 Water Pollution

Water and/or soil pollution cause negative changes in the physical, chemical and biological characteristics of water resources (i.e. water quality). This can result in possible deterioration in aquatic ecosystem integrity and a reduction in, or loss of, species of conservation concern (i.e. rare, threatened/endangered species). Additionally, litter indirectly decreases the aesthetic value of the freshwater habitat.

6.3.1 Construction Phase

During construction there are a number of potential pollution inputs into the aquatic habitat (such as hydrocarbons and raw cement). These pollutants alter the water quality parameters such as turbidity, nutrient levels, chemical oxygen demand and pH. These alternations impact the species composition of the systems, especially species sensitive to minor changes in these parameters. Sudden drastic changes in water quality can also have chronic effects on aquatic biota in general and result in localised extinctions. Hydrocarbons including petrol/diesel and oils/grease/lubricants associated with construction activities (machinery, maintenance, storage, handling) may potentially enter the system by means of surface runoff or through dumping by construction workers. Raw cement may enter the systems through incorrect batching procedure and/or direct disposal. The incorrect positioning and maintenance of the portable chemical toilets and use of the surrounding environment as ablution facilities may result in sewage and chemicals entering the systems.

6.3.2 Operational Phase

Micro-litter such as cigarette butts may travel through certain stormwater grids and grids may not be regularly cleared. The increase in vehicles on the property due to the development increases the potential for pollutants to enter the systems. During maintenance of the development there could be water pollution impacts similar to those encountered in the construction phase. It is assumed that all wastewater will be disposed of via existing infrastructure and will not be treated on the property. It is likely that wastewater will be treated at the existing WWTW adjacent to the development, if there is capacity. The establishment of sewer pipes within and/or in close proximity to watercourse always poses a long-term threat to the water quality and ecological health of freshwater ecosystems due to the relatively high likelihood that surcharge events will occur at some point in the future. The agricultural area might be subject to fertiliser use which will lead to pollution from excess nutrients when runoff from these areas enter the aquatic habitat.

6.4 Flow Modification

The changes in the quantity, timing and distribution of water inputs and flows within the watercourses. Possible ecological consequences associated with this impact may include deterioration in freshwater ecosystem integrity, reduction/loss of habitat for aquatic dependent flora & fauna, and a reduction in the supply of ecosystem goods & services.

6.4.1 Construction Phase

Land clearing and earth works upslope of aquatic habitat will reduce infiltration rates and increase the surface runoff volume and velocity. Such changes in surface roughness and runoff rates may lead to some rill and gully erosion. Altered water inputs from upslope disturbances as well as modified water distribution and retention patterns will ultimately affect the hydrological integrity of water resources. This impact is likely to be magnified by the steep slopes around drainage lines.

6.4.2 Operational Phase

Hardened/artificial infrastructure will alter the natural processes of rainwater infiltration and surface runoff, promoting increased volumes and velocities of storm water runoff, which can be detrimental to the aquatic habitat receiving concentrated flows off of these areas. According to the SANRAL (2006), urbanisation typically increases the runoff rate by 20-50%, compared with natural conditions. Increased volumes and velocities of storm water draining from the area and discharging into the aquatic habitat will alter the natural ecology, increasing the risk of erosion and channel incision/scouring. Irrigation on the agricultural area may lead to altered and increased runoff when not managed properly.

7 IMPACT SIGNIFICANCE ASSESSMENT

The impact significance of the proposed development was determined for each potential impact of the project (Table 11). The impacts associated with the project are assessed as being of Medium significance. It can, however, largely be decreased to Low with the implementation of effective mitigation measures. The impacts are considered to be easily mitigated provided the mitigation measures and monitoring plan within this report are implemented and adhered to during the construction and operational phase of the project.

Table 11: Evaluation of potential impacts of the proposed development on aquatic habitat

	Impact	Mitigation	Extent	Duration	Magnitude	Probability	Significance	Reversibility	Mitigation Potential	Irreplaceable Resource Loss
Construction Phase	Loss and disturbance of aquatic vegetation & habitat	Without Mitigation	Local (2)	Medium (3)	Moderate (6)	Highly Likely (4)	**Medium (44)**	Irreversible	High	Yes
		With Mitigation	Site only (1)	Short (2)	Minor (2)	Probable (3)	**Low (15)**	Partly	Low	No
	Erosion & sedimentation	Without Mitigation	Regional (3)	Medium (3)	Moderate (6)	Definite (5)	**Medium (60)**	Partly	Medium	Yes
		With Mitigation	Local (2)	Short (2)	Low (4)	Probable (3)	**Low (24)**	Barely	Low	No
	Water Pollution	Without Mitigation	Local (2)	Short (2)	Moderate (6)	Probable (3)	**Medium (30)**	Partly	High	No
		With Mitigation	Site only (1)	Short (2)	Minor (2)	Improbable (2)	**Low (10)**	Barely	Low	No
	Flow modification	Without Mitigation	Regional (3)	Medium (3)	Moderate (6)	Highly Likely (4)	**Medium (48)**	Partly	Medium	No
		With Mitigation	Local (2)	Medium (3)	Low (4)	Probable (3)	**Low (27)**	Barely	Low	No

	Impact	Mitigation	Extent	Duration	Magnitude	Probability	Significance	Reversibility	Mitigation Potential	Irreplaceable Resource Loss
Operational Phase	Loss and disturbance of aquatic vegetation & habitat	Without Mitigation	Local (2)	Permanent (5)	Low (4)	Probable (3)	**Medium (33)**	Partly	Medium	No
		With Mitigation	Site only (1)	Permanent (5)	Minor (2)	Probable (3)	**Low (24)**	Barely	Low	No
	Erosion & sedimentation	Without Mitigation	Local (2)	Permanent (5)	Moderate (6)	Highly Likely (4)	**Medium (52)**	Partly	Medium	No
		With Mitigation	Site only (1)	Permanent (5)	Minor (2)	Probable (3)	**Low (24)**	Barely	Low	No
	Water Pollution	Without Mitigation	Local (2)	Permanent (5)	Low (4)	Probable (3)	**Medium (33)**	Partly	Medium	No
		With Mitigation	Site only (1)	Permanent (5)	Minor (2)	Improbable (2)	**Low (16)**	Barely	Low	No
	Flow modification	Without Mitigation	Local (2)	Permanent (5)	Moderate (6)	Highly Likely (4)	**Medium (52)**	Partly	Medium	No
		With Mitigation	Site only (1)	Permanent (5)	Low (4)	Probable (3)	**Medium (30)**	Barely	Low	No

8 CUMULATIVE IMPACTS

Cumulative impacts on the environment can result from broader, long term changes and not only as a result of a single activity or development. They are rather from the combined effects of many activities overtime. Rivers and wetlands are longitudinal systems where different reaches interact in a continuum along the length of the watercourse. This is vitally important to understand in the context of cumulative impacts from developments. Activities in the upper reaches influence the processes of the lower reaches and it must therefore be viewed as a whole.

The impacts associated with the development are found to be acceptable (after mitigation) when assessed on their own. Due to increasing development within the broader Plettenberg Bay area, the combination of development impacts becomes cumulatively significant. The drainage lines around Kurland are impacted more by agricultural and forestry activities than by housing developments. However, these land uses also cause altered runoff, water pollution and increased sedimentation and erosion in aquatic habitat. Land-use changes in catchments affect the timing and amount of runoff flow into watercourses, and land-use change within a watercourse affects the pattern of water flow through the them and its residence time.

The aquatic habitat downstream of the proposed development appear to be unimpacted as of yet. The large river systems that these systems contribute to cross through nature reserves and the Garden Route National Park. These systems are likely to be fairly resilient to deteriorating inputs and upstream pressures. However, it is still important to actively implement mitigation measures in order to ensure water in future.

The water resources of the entire country are threatened largely by the cumulative impacts of development rather than individual activities. The most effective and proactive solution is sustainable development planning with a broader spatial and temporal focus. It is imperative that a broader, strategic aquatic assessment be undertaken in relation to current and future development in this area. This would allow for the identification and protection of sensitive aquatic habitat on a catchment scale and aid sustainable development planning.

9 MITIGATION MEASURES

The mitigation of negative impacts on biodiversity and ecosystem goods and services is a legal requirement for authorisation purposes and must take on different forms depending on the significance of the impact and the specific area being affected. Mitigation requires the adoption of the precautionary principle and proactive planning that is enabled through a mitigation hierarchy. Its application is intended to strive to first avoid disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided altogether, to minimise, rehabilitate, and then finally offset any remaining significant residual negative impacts on biodiversity (DEA 2013).

The mitigation measures detailed within this report must be taken into consideration during financial planning of the construction phase of the development. This to ensure that sufficient funds are available to implement all the measures required to maintain the current PES score of the watercourses impacted upon.

Any potential risks must be managed and mitigated to ensure that no deterioration of the water resource takes place. Standard management measures should be implemented to ensure that any on-going activities do not result in a decline in water resource quality. Consideration should also be given to the rehabilitation of watercourses where feasible. Mitigation measures related to the impacts associated with the construction activities are intended to augment standard/generic mitigation measures included in the project-specific Environmental Management Programme (EMPr).

The monitoring of the development activities is essential to ensure the mitigation measures are implemented. Therefore, compliance with the mitigation recommendations must be audited by a suitably qualified independent Environmental Control Officer with an appropriately timed audit report. In the case where there is extensive damage to any aquatic system, where rehabilitation is required, a suitably qualified aquatic specialist must audit the site. Monitoring for non-compliance must be done on a daily basis by the contractors. Photographic records of all incidents and non-compliances must be retained. This is to ensure that the impacts on the aquatic habitat are adequately managed and mitigated against and the successful rehabilitation of any disturbed areas within any system occurs.

The mitigation of impacts must focus on managing the runoff generated by the development and introducing it responsibly into the receiving environment. The steep slopes surrounding the freshwater habitat make it especially vulnerable to increased velocity of runoff from the development.

Under the current proposal, there are various erven within the development that are privately owned and therefore not included as developable area. Some aquatic habitat, such as the System 2 wetland, is located within these erven. It must be noted that the same mitigation will apply to these aquatic features if the areas are incorporated into development in future. Avoiding the wetland habitat by adhering to the buffer is mandatory.

The following mitigation measures must be adhered to should development occur:

9.1 Design Phase: No-Go Zones

Aquatic buffer zones are designed to act as barriers between human activities and sensitive water resources in order to protect them from adverse negative impacts. Buffer zones associated with water resources have been shown to perform a wide range of functions and have therefore been adopted as a standard measure to protect water resources and associated biodiversity. An aquatic impact buffer zone is defined as a zone of vegetated land designed and managed so that sediment and pollutant transport carried from source areas via diffuse surface runoff is reduced to acceptable levels (Macfarlane and Bredin 2016). Typical threats to buffers in this area include:

- Access and use by local communities;
- Overgrazing and trampling by livestock;
- Transformation (e.g. new infrastructure); and
- Alien plant encroachment.

Regarding the proposed development, a buffer area from the boundary of the riparian habitat must be adopted and demarcated. The specific size of the buffer zone was determined by a tool developed by Macfarlane and Bredin (2016) called *Buffer zone guidelines for rivers, wetlands and estuaries*. A 19m aquatic buffer was determined using the tool (Figure 21). The buffer is measured from the edge of the delineated aquatic habitat which includes riparian vegetation. The width of the buffer is determined using a scientific tool that takes into account site specific attributes. The variables considered to determine the buffer include:

- Type of aquatic system;
- Management objectives of the system;
- Type of development proposed;
- Climatic factors such as rainfall intensity; and
- Buffer attributes such as the slope and soil permeability.

The development is largely outside of the buffer zone due to the topography around drainage lines being unfavourable for development. However, there is a tributary of System 1 that will be impacted by a road and housing development that is proposed over it. This area is severely degraded and has limited ecological functioning, therefore the loss of this section will not result in high impacts. It is recommended that all infrastructure be set back to outside of the aquatic buffer areas in the rest of the development. System 2 cuts through the proposed agricultural project area but it is not currently known what is proposed here. Therefore, there is a possibility to reduce the buffer in this area if the proposed agricultural practices are compatible with watercourse protection.

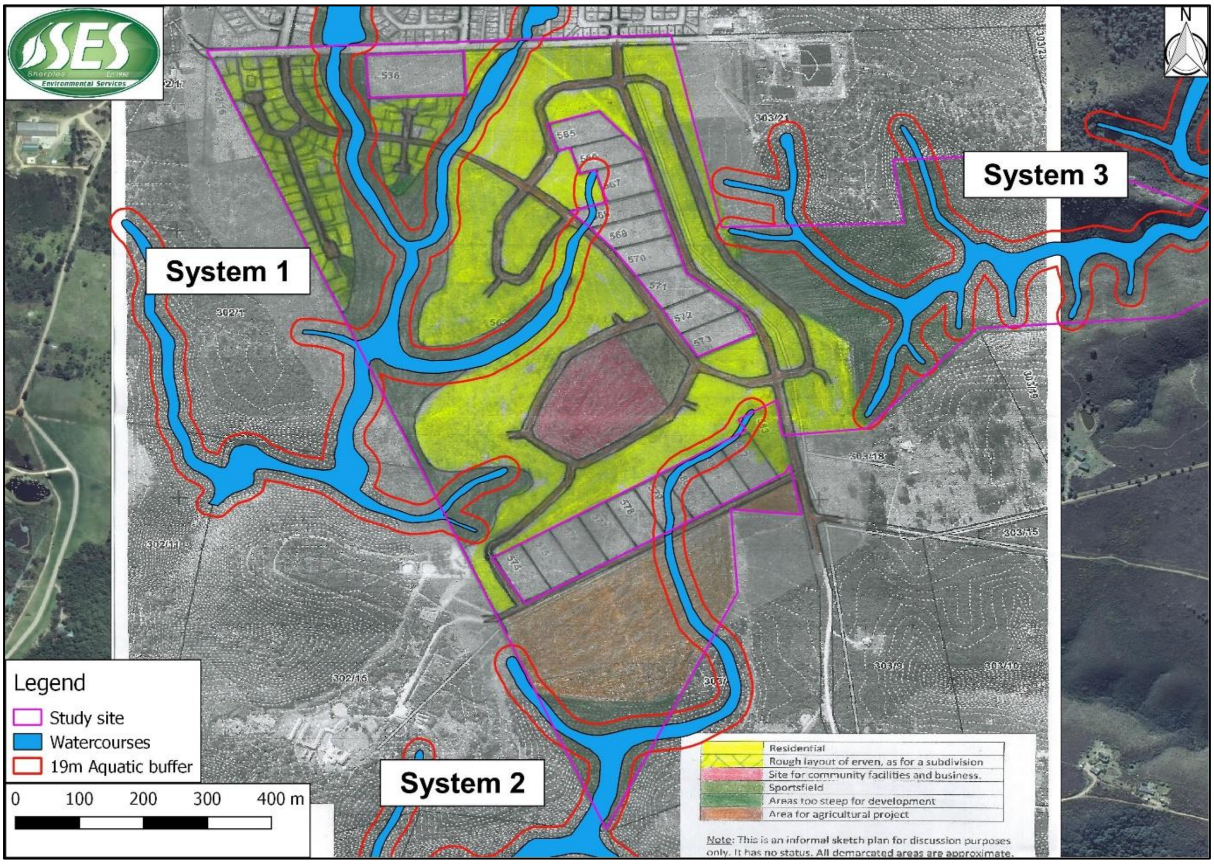

Figure 21: 19m buffer zone around aquatic habitat within the proposed development area.

9.2 Construction Phase

The mitigation of impacts should focus on managing the runoff generated by the development and introducing it responsibly into the receiving environment. The stormwater flows must enter the wetland areas in a diffuse flow pattern without pollutants. It must be noted that a formal stormwater management plan has not been undertaken. When developing a stormwater management plan for the site, it will be critical that due consideration is given to the collection and treatment of stormwater prior to discharge into the natural environment. It is therefore recommended that the stormwater management plan be developed with appropriate ecological input and be based on Sustainable Drainage Systems (SUDS).

Soft infrastructure must be considered where practical. For example, permeable surfaces can be done via permeable concrete block pavers (such as Amorflex), brick pavers, stone chip, and gravel and may contribute to slowing surface flows (especially if maintained). Stormwater managed by the development could be discharged into porous channels / swales ('infiltration channels or basins') running near parallel or parallel to contours within and along the edge of the development (Figure 22). This will provide for some filtration and removal of urban pollutants (e.g. oils and hydrocarbons), provide some attenuation by increasing the time runoff takes to reach low points, and reduce the energy of storm water flows within the stormwater system through increased roughness when compared with pipes and concrete V-drains.

Figure 22: Examples of soft infrastructure incorporated into the stormwater management design

Frequent stormwater outlets must be designed to prevent erosion at discharge points. All erosion protection measures (e.g. Reno-mattresses) must be established to reflect the natural slope of the surface and located at the natural ground level.

Stormwater exit points must include a best management practice approach to trap any additional suspended solids and pollutants originating from the proposed development. Also include the placement of stormwater grates (or similar). The use of grease traps/oil separators to prevent pollutants from entering the environment from stormwater is recommended. To ensure the efficiency of these, they must be regularly maintained. Key maintenance will include litter and sediment clearing and the servicing and maintenance of key collection points like catch pits, detention tanks etc. Such maintenance should be the responsibility of either the local municipality or, where possible, the relevant owners/estate associations, and budgeted for.

Stockpiles must not be located within the buffer zones around aquatic habitat. Erosion control measures including silt fences, low soil berms and/or shutter boards must be put in place around the stockpiles to limit sediment runoff from stockpiles. Alternatively, the exposed slopes must drain into small temporary stormwater and silt traps/ponds.

Regular inspections during the operational phase should also be undertaken to ensure that functions are not undermined by inappropriate activities.

Figure 23 and 24 show examples of measures that can be put in place to restrict erosion and sedimentation caused by construction activities.

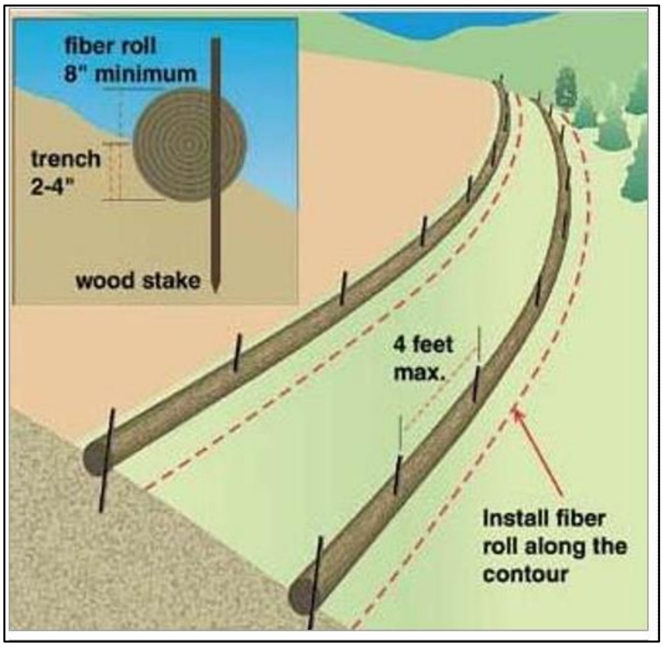

Figure 23: An example of a construction and/or rehabilitation methods to prevent erosion on the hillslope due to any soil disturbance and vegetation clearance

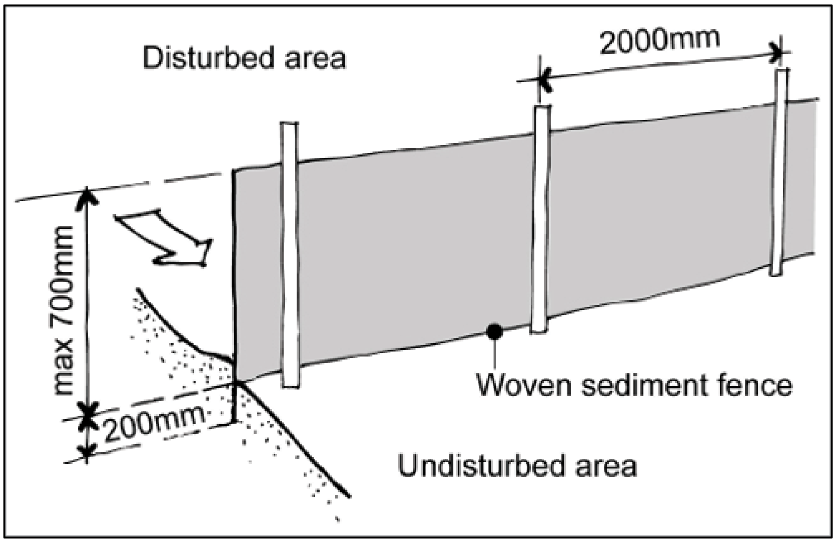

Figure 24: An example of a silt fence, which is a structure that could be put in place to restrict disturbance to the upslope area and it could potentially be used to delineate the buffer area.

9.3 Post-construction/ Rehabilitation Phase

Although it is recommended that no construction should be allowed to occur within or impact upon watercourses under the current proposal, there is always potential for accidental disturbance therefore guidelines for rehabilitation of aquatic habitats are provided. The aim of the rehabilitation is to ensure the necessary procedures are appropriately implemented in the natural environment that may be negatively affected by the development. The plan will promote the re-establishment of the ecological functioning of any area disturbed by construction activities. Also consult WET-

RehabEvaluate, WET-RehabMethods (Cowden and Kotze, 2009), and the river rehabilitation manual developed by Day *et al.* 2016, for further information.

Important guidelines for rehabilitation are:

- The area must be maintained through alien invasive plant species removal (which is the landowner's responsibility regardless of mitigation associated with this project) and the establishment of indigenous vegetation cover to filter run-off before it enters the freshwater habitat. Please see the Annexure for control options for likely alien invasive plants species.
- The solid domestic waste must be removed and disposed of offsite. All post-construction building material and waste must be cleared in accordance with the EMPr.
- Erosion features that have developed due to construction within the aquatic habitat due to the project are required to be stabilised. This may also include the need to deactivate any erosion headcuts/rills/gullies that may have developed.
- It is the contractor's responsibility to continuously monitor the area for newly established alien species during the contract and establishment period, which if present must be removed. Removal of these species shall be undertaken in a way which prevents any damage to the remaining indigenous species and inhibits the re-infestation of the cleaned areas.
- Alien/ invasive species shall not be stockpiled, they should be removed from site and dumped at an approved site.
- Any use of herbicides in removing alien plant species is required to be investigated by the ECO before use, for the necessity, type proposed to be used, effectiveness and impacts of the product on aquatic biota.
- A monitoring programme shall be in place, not only to ensure compliance with the EMPr throughout the construction phase, but also to monitor any post-construction environmental issues and impacts such as increased surface runoff. The monitoring should be regular and additional visits must be taken when there is potential risk to aquatic habitat.

9.4 Operational Phase

- The stormwater management infrastructure must be designed to ensure the runoff from the development is not highly concentrated before entering the buffer area. The volume and velocity of water must be reduced through discharging the surface flow at multiple locations surrounding the development, preventing erosion.
- Any evidence of erosion from this stormwater system must be rehabilitated and the volume/velocity of the water reduced through further structures and/or energy dissipaters. These structures must be incorporated within the layout area.

- The use and maintenance of grease traps/oil separators is recommended to prevent pollutants from entering the environment from stormwater.
- Appropriate wastewater infrastructure must be designed to prevent any such water from entering the surrounding environment.
- Maintenance of the aquatic habitat and buffer area must be implemented for it to remain effective. Apart from erosion control and alien invasive plant eradication, the encroachment of any further infrastructure or vehicles must be prevented.
- The local authority should prevent illegal dumping in this area by providing suitable waste disposal facilities where waste can be recycled and disposed of in a controlled manner.
- Engage with the community to explain the reasons why the buffer and the water resources are protected and what human activities are allowed. This could be targeted at learners to prevent the dumping of solid waste and other activities that threaten the watercourses and buffer zones.
- The community could be involved in the monitoring.
- Placement of signage near the boundary of the buffer zone should also be considered to help mark the boundary and educate the community about the purpose and value of protecting buffer zones. Information can include a description and visual of alien invasive plant species.

10 CONCLUSION

The assessment identified three watercourse systems within the proposed development area. There were also cryptic and artificial wetland habitat found on site. A 19m aquatic buffer was determined and overlaid onto the proposed development layout to determine where aquatic habitat will be impacted. The development will largely be outside of aquatic habitat due to the topography being unfavourable for development. The development will have a Medium impact significance on aquatic habitat. However, this can be largely reduced to a Low impact if mitigation is implemented.

The project is acceptable from an aquatic perspective due to no major loss of important aquatic habitat being anticipated following adoption of mitigation. The proposed activities will require authorisation in terms of the National Water Act (Act 36 of 1998) and it is therefore advised that a water use application be lodged with the Breede Gouritz Catchment Management Agency.

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12 ANNEXURE (METHODOLOGIES)

12.1 Wetland delineation and HGM type identification

Wetland delineation includes the confirmation of the occurrence of wetland and a determination of the outermost edge of the wetland. The outer boundary of wetlands was identified and delineated according to the Department of Water Affairs wetland delineation manual 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005a). Wetland indicators were used in the field delineation of the wetlands: position in landscape, vegetation and soil wetness (determined through soil sampling with a soil auger and the examining the degree of mottling).

Four specific wetland indicators were used in the detailed field delineation of wetlands, which include:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur.
- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation.
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

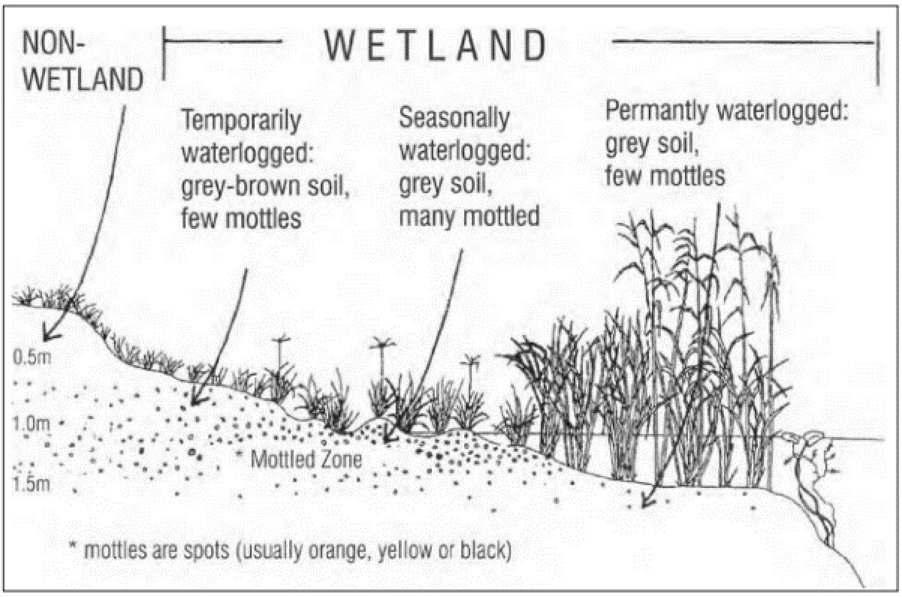

Figure A11.1a: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the middle to the edge of the wetland. Source: Donovan Kotze, University of KwaZulu-Natal.

According to the wetland definition used in the National Water Act, vegetation is the primary indicator, which must be present under normal circumstances. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role. The reason is that vegetation responds relatively quickly to changes in soil moisture regime or management and may be transformed; whereas the morphological indicators in the soil are far more permanent and will hold the signs of frequent saturation long after a wetland has been drained (perhaps for several centuries).

The permanent, seasonal and temporary wetness zones can be characterised to some extent by the soil wetness indicators that they display (Table A11.1a)

A11.1a: Soil Wetness Indicators in the various wetland zones

TEMPORARY ZONE	SEASONAL ZONE	PERMANENT ZONE
Minimal grey matrix (<10%)	Grey matrix (<10%)	Prominent grey matrix
Few high chroma mottles	Many low chroma mottles present	Few to no high chroma mottles
Short periods of saturation (less than three months per annum)	Significant periods of wetness (at least three months per annum)	Wetness all year round (possible sulphuric odour)

Table A11.1b: Relationship between wetness zones and vegetation types and classification of plants according to occurrence in wetlands

VEGETATION	TEMPORARY WETNESS ZONE	SEASONAL WETNESS ZONE	PERMANENT WETNESS ZONE
Herbaceous	Predominantly grass species; mixture of species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas	Hydrophilic sedges and grasses restricted to wetland areas	Dominated by: (1) emergent plants, including reeds (*Phragmites australis*), a mixture of sedges and bulrushes (Typha capensis), usually >1m tall; or (2) floating or submerged aquatic plants.
Woody	Mixture of woody species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas.	Hydrophilic woody species restricted to wetland areas	Hydrophilic woody species, which are restricted to wetland areas. Morphological adaptations to prolonged wetness (e.g. prop roots).
SYMBOL	**HYDRIC STATUS**	**DESCRIPTION/OCCURRENCE**	
Ow	Obligate wetland species	Almost always grow in wetlands (>90% occurrence)	
Fw/F+	Facultative wetland species	Usually grow in wetlands (67-99% occurrence) but occasionally found in non-wetland areas	
F	Facultative species	Equally likely to grow in wetlands (34-66% occurrence) and non-wetland areas	

Fd/F-	Facultative dryland species	Usually grow in non-wetland areas but sometimes grow in wetlands (1-34% occurrence)
D	Dryland species	Almost always grow in drylands

In order to identify the wetland types, using Kotze *et al.* (2009) and Ollie *et al*. (2013), a characterisation of hydrogeomorphic (HGM) types was conducted. These have been defined based on the geomorphic setting of the wetland in the landscape (e.g. hillslope or valley bottom, whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated), how water flows through the wetland (diffusely or channelled) and how water exits the wetland (Figure A11.1b).

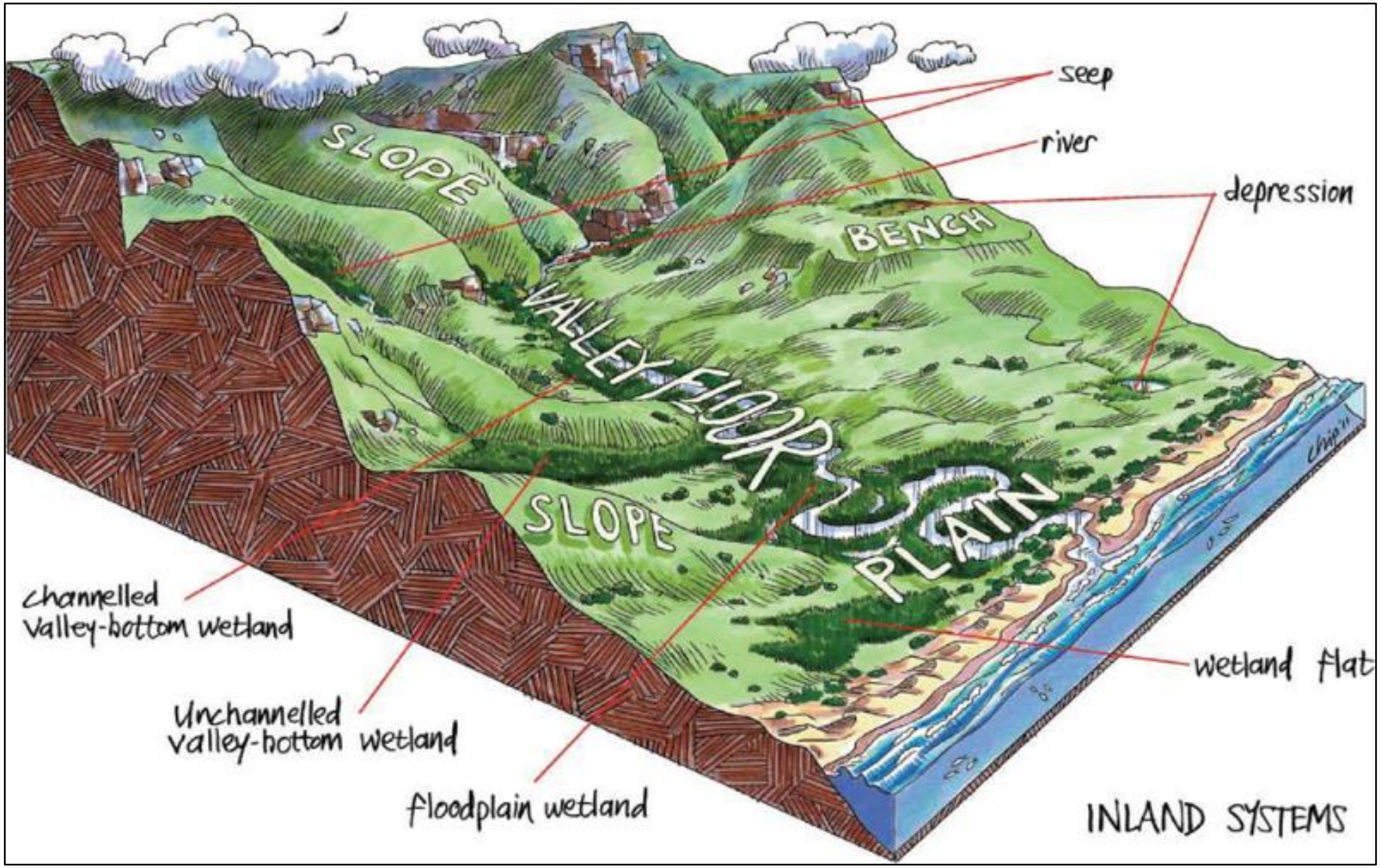

Figure A11.1b: Illustration of wetland types and their typical landscape setting (From Ollie <u>et al.</u> 2013)

12.2 Delineation of Riparian Areas

Riparian zones are described as "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 areas. Riparian zones can thus be distinguished from adjacent terrestrial areas through their association with the physical structure (banks) of the river or stream, as well as the distinctive structural and compositional vegetation zones between the riparian and upland terrestrial areas. Unlike wetland areas, riparian zones are usually not saturated for a long enough duration for redoxymorphic features to develop. Riparian zones instead develop in response to (and are adapted to) the physical disturbances caused by frequent overbank flooding from the associated river or stream channel.

Like wetlands, riparian areas can be identified using a set of indicators. The indicators for riparian areas are:

- **Landscape position**;
- **Alluvial soils** and recently deposited material;
- **Topography** associated with riparian areas; and
- **Vegetation** associated with riparian areas.

Landscape Position

A typical landscape can be divided into 5 main units, namely the:

- Crest (hilltop);
- Scarp (cliff);
- Midslope (often a convex slope);
- Footslope (often a concave slope); and
- Valley bottom.

Amongst these landscape units, riparian areas are only likely to develop on the valley bottom landscape units (i.e. adjacent to the river or stream channels; along the banks comprised of the sediment deposited by the channel). Alluvial soils are soils derived from material deposited by flowing water, especially in the valleys of large rivers. Riparian areas often, but not always, have alluvial soils. Whilst the presence of alluvial soils cannot always be used as a primary indicator to accurately delineate riparian areas, it can be used to confirm the topographical and vegetative indicators.

Quaternary **alluvial soil** deposits are often indicated on geological maps, and whilst the extent of these quaternary alluvial deposits usually far exceeds the extent of the contemporary riparian zone; such indicators are useful in identifying areas of the landscape where wider riparian zones may be expected to occur.

Topography and recently deposited material associated with riparian areas The National Water Act definition of riparian zones refers to the structure of the banks and likely presence of alluvium. A good indicator of the presence of riparian zones is the presence of alluvial deposited material adjacent to the active channel (such as benches and terraces), as well as the wider incised “macro-channels” which are typical of many of southern Africa’s eastern seaboard rivers. Recently deposited alluvial material outside of the main active channel banks can indicate a currently active flooding area; and thus the likely presence of wetlands. Vegetation associated with riparian areas unlike the delineation of wetland areas, where redoxymorphic features in the soil are the primary indicator, the identification of riparian areas relies heavily on vegetative indicators. Using vegetation, the outer boundary of a riparian area can be defined as the point where a distinctive change occurs: - in species composition relative to the adjacent terrestrial area; and - in the physical structure, such as vigour or robustness of growth forms of species similar to that of adjacent terrestrial areas. Growth form refers to the health, compactness, crowding, size, structure and/or numbers of individual plants.

As with the delineation approach for wetlands, the field delineation method for riparian areas focuses on two main indicators of riparian zones:

- **Vegetation Indicators**, and
- **Topography** of the banks of the river or stream.

Additional verification can be obtained by examining for any recently alluvial deposited material to indicate the extent of flooding and thus obtain at least a minimum riparian zone width. The following procedure should be used for delineation of riparian zones: A good rough indicator of the outer edge of the riparian areas is the edge of the macro channel bank. This is defined as the outer bank of a compound channel, and should not be confused with the active river or stream channel bank. The macro-channel is an incised feature, created by uplift of the subcontinent which caused many rivers to cut down to the underlying geology and creating a sort of “restrictive floodplain” within which one or more active channels flow. Floods seldom have any known influence outside of this incised feature. Within the macro-channel, flood benches may exist between the active channel and the top of the macro channel bank. These depositional features are often covered by alluvial deposits and may have riparian vegetation on them. Going (vertically) up the macro channel bank often represents a dramatic decrease in the frequency, duration and depth of flooding experienced, leading to a corresponding change in vegetation structure and composition.

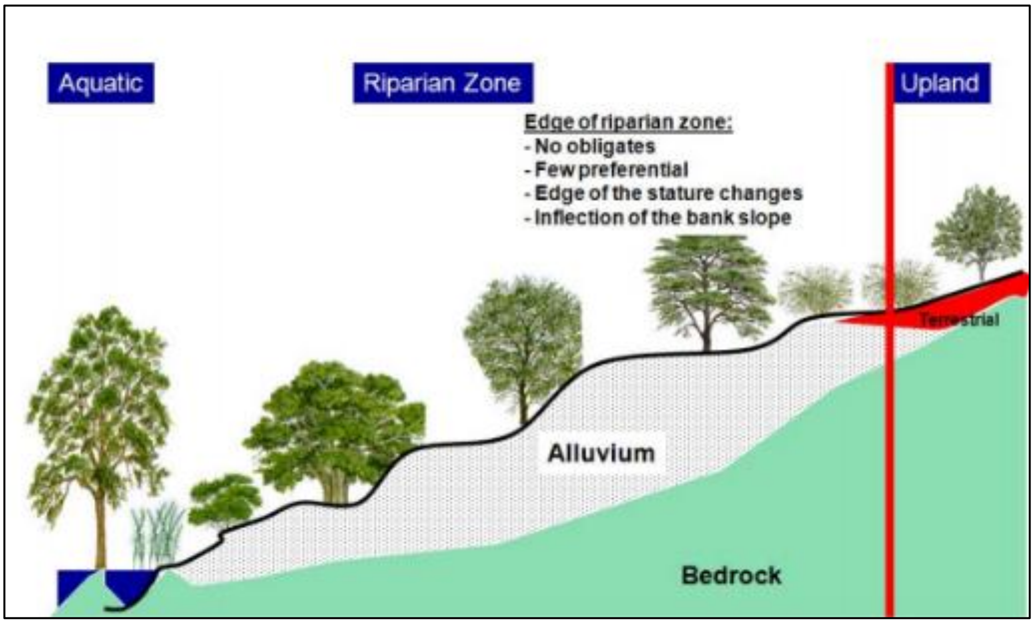

Figure A11.2a: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river. Note the coincidence of the inflection (in slope) on the bank with the change in vegetation structure and composition. The edge of the riparian zone coincides with an inflection point on the bank; where there are not obligates upslope; few preferential. The boundary also coincides with the outer edge of the stature differences (DWAF 2008).

12.3 Present Ecological State (PES) – Wetlands

WET-Health assists in assessing the health of wetlands using indicators based on geomorphology, hydrology and vegetation. For the purposes of rehabilitation planning and assessment, WET-Health helps users understand the condition of the wetland in order to determine whether it is beyond repair, whether it requires rehabilitation intervention, or whether, despite damage, it is perhaps healthy enough not to require intervention. It also helps diagnose the cause of wetland degradation so that rehabilitation workers can design appropriate interventions that treat both the symptoms and causes of degradation. WET-Health is tailored specifically for South African conditions and has wide application, including assessing the Present Ecological State of a wetland. There are two levels of complexity: Level 1 is used for assessment at a broad catchment level and Level 2 provides detail and confidence for individual wetlands based on field assessment of indicators of degradation (e.g. presence of alien plants). A basic tertiary education in agriculture and/or environmental sciences is required to use it effectively. Level 1 was utilised for the assessment.

WET-Health is a tool designed to assess the health or integrity of a wetland. Wetland health is defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition. This technique attempts to assess hydrological, geomorphological and vegetation health in three separate modules.

- **Hydrology** is defined in this context as the distribution and movement of water through a wetland and its soils. This module focuses on changes in water inputs as a result of changes in catchment activities and characteristics that affect water supply and its timing, as well as on modifications within the wetland that alter the water distribution and retention patterns within the wetland.
- **Geomorphology** is defined in this context as the distribution and retention patterns of sediment within the wetland. This module focuses on evaluating current geomorphic health through the presence of indicators of excessive sediment inputs and/or losses for clastic (minerogenic) and organic sediment (peat).
- **Vegetation** is defined in this context as the vegetation structural and compositional state. This module evaluates changes in vegetation composition and structure as a consequence of current and historic onsite transformation and/or disturbance.

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. The tool attempts to standardise the way that impacts are calculated and presented across each of the modules. This takes the form of assessing the spatial extent of impact of individual activities and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact (Table A11.2a).

Table A11.2a: Guideline for interpreting the magnitude of impacts on integrity (Macfarlane et al., 2008).

Impact Category	Description	Score
None	No discernible modification or the modification is such that it has no impact on this component of wetland integrity.	0 – 0.9
Small	Although identifiable, the impact of this modification on this component of wetland integrity is small.	1 – 1.9
Moderate	The impact of this modification on this component of wetland integrity is clearly identifiable, but limited.	2 – 3.9
Large	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a highly detrimental effect on this component of wetland integrity. Much of the wetland integrity has been lost but remaining integrity is still clearly identifiable.	6 – 7.9
Critical	The modification is so great that the ecosystem processes of this component of wetland integrity are almost totally destroyed, and 80% or more of the integrity has been lost.	8 – 10

Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions. Resultant health scores fall into one of six health categories (A-F) on a gradient from “unmodified/natural” (Category A) to “severe/complete deviation from natural” (Category F) as depicted in Table A11.2b, below. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic systems.

Table A11.2b. Health categories used by WET-Health for describing the integrity of wetlands (after Macfarlane et al., 2008).

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

An overall wetland health score was calculated by weighting the scores obtained for each module and combining them to give an overall combined score using the following formula:

Overall health rating = [(Hydrology*3) + (Geomorphology*2) + (Vegetation*2)] / 7

This overall score assists in providing an overall indication of wetland health/functionality which can in turn be used for recommending appropriate management measures.

12.4 Wetland Functional Importance (Goods and Services)

WET-EcoServices is used to assess the goods and services that individual wetlands provide, thereby aiding informed planning and decision making. It is designed for a class of wetlands known as palustrine wetlands (i.e. marshes, floodplains, vleis or seeps). The tool provides guidelines for scoring the importance of a wetland in delivering each of 15 different ecosystem services (including flood attenuation, sediment trapping and provision of livestock grazing). The first step is to characterise wetlands according to their hydro-geomorphic setting (e.g. floodplain). Ecosystem service delivery is then assessed either at Level 1, based on existing knowledge or at Level 2, based on a field assessment of key descriptors (e.g. flow pattern through the wetland).

The overall goal of WET-EcoServices is to assist decision makers, government officials, planners, consultants and educators in undertaking quick assessments of wetlands, specifically in order to reveal the ecosystem services that they supply. This allows for more informed planning and decision making. WET-EcoServices includes the assessment of several ecosystem services (listed in Table A11.4a) - that is, the benefits provided to people by the ecosystem.

Ecosystem services supplied by wetlands	Indirect benefits	Regulating and supporting benefits		Flood attenuation	The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream
				Streamflow regulation	Sustaining streamflow during low flow periods
			Water quality enhancement benefits	Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters
				Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters
				Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters
				Toxicant assimilation	Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters
				Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation.
				Carbon storage	The trapping of carbon by the wetland, principally as soil organic matter
	Direct benefits	**Biodiversity maintenance**[2]			Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity
		Provisioning benefits		Provision of water for human use	The provision of water extracted directly from the wetland for domestic, agriculture or other purposes
				Provision of harvestable resources	The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.
				Provision of cultivated foods	The provision of areas in the wetland favourable for the cultivation of foods
		Cultural benefits		Cultural heritage	Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants
				Tourism and recreation	Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife
				Education and research	Sites of value in the wetland for education or research

Table A11.4a: Ecosystem services assessed by WET-Ecoservices

The steps involved in applying WET-EcoServices can be summarised as follows.

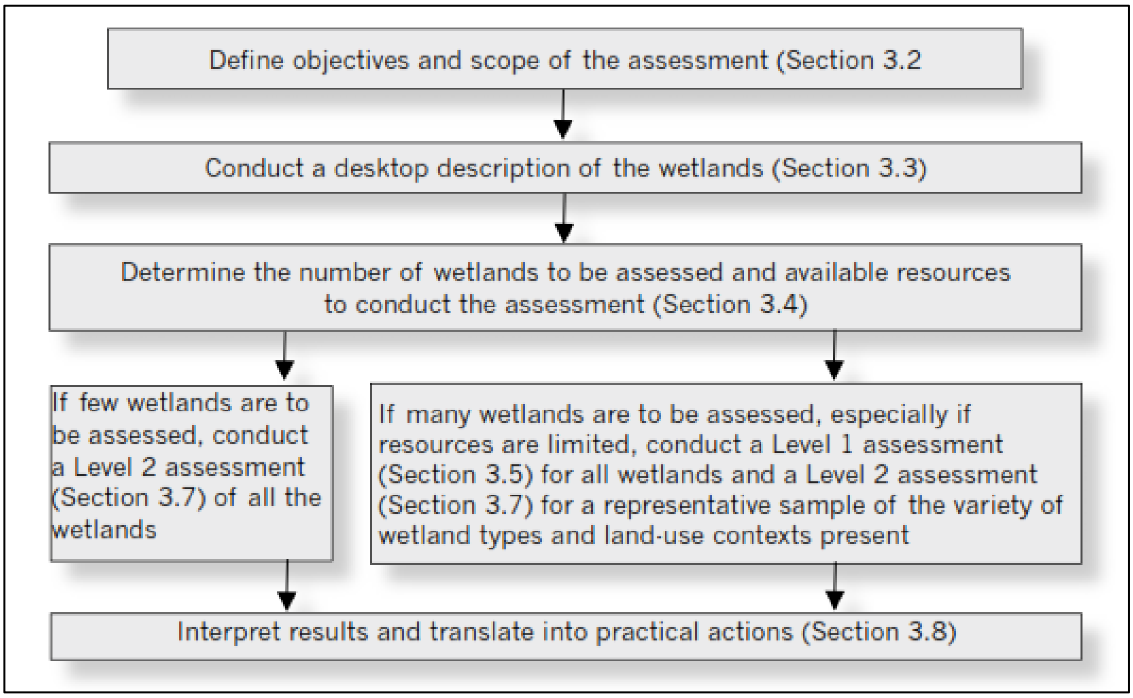

Figure A11.4a: Steps required for Wet-EcoServices. The sections referred to within this figure relate back to the Wetland Management Series: Wet-Ecoservices. WRC Report TT 339/08

12.5 Ecological Importance & Sensitivity (EIS) - Wetlands

The Ecological Importance and Sensitivity was determined by utilising a rapid scoring system. The system has been developed to provide a scoring approach for assessing the Ecological, Hydrological Functions; and Direct Human Benefits of importance and sensitivity of wetlands. These scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze et al (2008) on the assessment of wetland ecological goods and services from the WET-EcoServices tool (Rountree, 2010). An example of the scoring sheet is attached as Table A11.5a. The scores are then placed into a category of very low, low, moderate, high and very high as shown in Table 14.5b.

Table A11.5a: Example of scoring sheet for Ecological Importance and sensitivity

ECOLOGICAL IMPORTANCE AND SENSITIVITY:			
Ecological Importance	Score (0-4)	*Confidence (1-5)*	**Motivation for site**
Biodiversity support			
Presence of Red Data species			
Populations of unique species			
Migration/breeding/feeding sites			
Landscape scale			
Protection status of the wetland			
Protection status of the vegetation type			
Regional context of the ecological integrity			
Size and rarity of the wetland type/s present			
Diversity of habitat types			
Sensitivity of the wetland			
Sensitivity to changes in floods			
Sensitivity to changes in low flows/dry season			
Sensitivity to changes in water quality			
ECOLOGICAL IMPORTANCE & SENSITIVITY			
HYDROLOGICAL/FUNCTIONAL IMPORTANCE			
IMPORTANCE OF DIRECT HUMAN BENEFITS			
OVERALL IMPORTANCE			

Table A11.5b: Category of score for the Ecological Importance and Sensitivity

RATING	EXPLANATION
None, Rating = 0	Rarely sensitive to changes in water quality/hydrological regime
Low, Rating =1	One or a few elements sensitive to changes in water quality/hydrological regime
Moderate, Rating =2	Some elements sensitive to changes in water quality/hydrological regime
High, Rating =3	Many elements sensitive to changes in water quality/ hydrological regime
Very high, Rating =4	Very many elements sensitive to changes in water quality/ hydrological regime

12.6 Present Ecological State (PES) – Riparian

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

DWAF have developed a modified IHI, designed to accommodate the time constraints associated with desktop assessments or for instances where a rapid assessment of river conditions is required. The protocol does not distinguish between instream and riparian habitat and addresses six simple metrics to obtain an indication of Present Ecological State (PES). Each of the criteria are rated on a scale of 0 (close to natural) to 5 (critically modified) (Table A11.6a) according to the following metrics:

- Bed modification
- Flow modification
- Inundation
- Bank condition
- Riparian zone condition
- Water quality modification

This assessment was informed by (i) a site visit where potential impacts to each metric were assessed and evaluated and (ii) an understanding of the catchment feeding the river and landuses / activities that could have a detrimental impact on river ecosystems.

Table A11.6a: The rating scale for each of the various metrics in the assessment

RATING SCORE	IMPACT CLASS	DESCRIPTION
0	**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.*
0.5 - 1.0	**Low**	*The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.*
1.5 - 2.0	**Moderate**	*The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.*
2.5 - 3.0	**Large**	*The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.*
3.5 - 4.0	**Serious**	*The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.*
4.5 - 5.0	**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.*

The six metric ratings of the HGM under assessment are then averaged, resulting in one value. This value determines the Habitat Integrity PES category for the HGM (Table A11.6b).

Table A11.6b: The habitat integrity PES categories

HABITAT INTEGRITY PES CATEGORY	DESCRIPTION
A: Natural	Unmodified, natural.
B: Good	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C: Fair	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D: Poor	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E: Seriously modified	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F: Critically modified	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

12.7 Ecological Importance & Sensitivity – Riparian

The ecological importance of a wetland/river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Kleynhans & Louw, 2007; Resh et al., 1988; Milner, 1994). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity (Table A11.7a).

Table A11.7a: Components considered for the assessment of the ecological importance and sensitivity of a riparian system. An example of the scoring has also been provided.

Ecological Importance and Sensitivity assessment (Rivers)		
	Determinants	Score (0-4)
BIOTA (RIPARIAN & INSTREAM)	Rare & endangered (range: 4=very high - 0 = none)	0,5
	Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	0,0
	Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	0,5
	Species/taxon richness (range: 4=very high - 1=low/marginal)	1,5
RIPARIAN & INSTREAM HABITATS	Diversity of types (4=Very high - 1=marginal/low)	1,0
	Refugia (4=Very high - 1=marginal/low)	1,5
	Sensitivity to flow changes (4=Very high - 1=marginal/low)	1,0
	Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	1,0
	Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	1,0
	Importance of conservation & natural areas (range, 4=very high - 0=very low)	2
MEDIAN OF DETERMINANTS		1,00
ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORY (EIS)		LOW, EC=D

The scores assigned to the criteria in Table A11.7a were used to rate the overall EIS of each mapped unit according to Table A11.7b, below, which was based on the criteria used by DWS for river eco-classification (Kleynhans & Louw, 2007) and the WET-Health wetland integrity assessment method (Macfarlane et al., 2008).

Table A11.7b: The ratings associated with the assessment of the EIA for riparian areas

RATING	EXPLANATION
None, Rating = 0	Rarely sensitive to changes in water quality/hydrological regime
Low, Rating =1	One or a few elements sensitive to changes in water quality/hydrological regime
Moderate, Rating =2	Some elements sensitive to changes in water quality/hydrological regime
High, Rating =3	Many elements sensitive to changes in water quality/ hydrological regime
Very high, Rating =4	Very many elements sensitive to changes in water quality/ hydrological regime

12.8 Direct, Indirect and Cumulative Impacts Methodology

Direct, indirect and cumulative impacts should be assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high).
- The **duration**, wherein it will be indicated whether:
    - The lifetime of the impact will be of a very short duration (0-1 years) – assigned a score of 1.
    - The lifetime of the impact will be of short duration (2-5 years) – assigned a score of 2;
    - Medium term (5-15 years) – assigned a score of 3;
    - Long-term (> 15 years) – assigned a score of 4; or
    - Permanent – assigned a score of 5.

- The **magnitude**, quantified on a scale of 0-10, where:
    - 0 is small and will have no effect on the environment,
    - 2 is minor and will not result in an impact on processes,
    - 4 is low and will cause a slight impact on processes,
    - 6 is moderate and will result in processes continuing but in a modified way,
    - 8 is high (processes are altered to the extent that they temporarily cease), and
    - 10 is very high and results in complete destruction of patterns and permanent cessation of processes.

- The **probability** of occurrence, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1-5, where:
    - 1 is very improbable (probably will not happen),
    - 2 is improbable (some possibility, but low likelihood),
    - 3 is probable (distinct possibility),
    - 4 is highly likely (most likely) and;
    - 5 is definite (impact will occur regardless of any prevention measures).

- The **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high;

- The degree to which the impact can be reversed.
- The degree to which the impact may cause irreplaceable loss of resources; and
- The degree to which the impact can be mitigated.
- The significance is calculated by combining the criteria in the following formula, **S = (E+D+M) P**, where:
    - S = significance weighting
    - E = extent
    - D = duration
    - M = magnitude
    - P = probability

- The significance weightings for each potential impact are as follows:
    - <30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop the area),
    - 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
    - >60 points: High (i.e. where the impact must have an influence on the decision process to develop the area).

13 ANNEXURE: ALIEN INVASIVE PLANT CONTROL

Table showing control options for likely alien invasive plants species (Adapted from Day et al. 2016)

Acacia cyclops (Rooikrans)		**Manual:** Hand pulling or hoeing of seedlings or saplings. Grubbing, hoeing and digging out of immature stage up to 2 m. Felling and cutting of stump to the ground for larger mature trees. **Bio-Control:** Indigenous field mice eat the seeds. Rooikrans seed weevil. Flower galler (*Dasineura dielsi* Rubsaamen). Seed feeder (*Melanterius servulus*).
Acacia mearnsii *(Black Wattle)*		**Manual:** Hand pulling of seedlings or saplings <40 cm. Grubbing. Hoeing. Digging of immature trees up to 2 m. Felling used for large mature trees. Ringing, ring of 10 cm width in large plants. **Chemical:** Seedlings – Mamba, Garlon 4, Viroaxe. Tree stumps – Timbrel 3A. **Bio Control:** Stump fungus *(Cylindrobasidium laeve)* applied to freshly cut stumps. Seed weevil (*Melanterius maculates*).

Arundo donax (Spanish Reed)		**Manual:** Repeated removal. Cutting of stalks. However, cut stalks can re-root and manual methods generally unsustainable. **Chemical:** 3Apply MAMBA or Nexus GLYPHOSATE 360 Reg. NO L7113: Act /Wet no 36/ 1947. This is a broad spectrum herbicide so applicable in dense monospecific stands. Ideally use as foliar spray, just before winter (as this is the time that translocation in plant nutrients to the root-mass takes place in preparation for winter dormancy and toxin transfer to roots is most effective. If stands too dense for good foliar application, cut stems and then apply as foliar to resprouting material – but note that cut material may resprout and transfer to roots less effective as cutting stimulates stem growth. If mixed stands, use GLYPHOSATE 360, on cut stems, but note less effective.
Lantana camara		**Manual:** Hand pulling of seedlings or saplings. Grubbing or hoeing of small patches. Cutting is ineffective as plant coppices use of herbicides needed. Large infestation should be crushed or rolled with brush cutters then stumps treated with herbicides. **Chemical:** Seedlings/ saplings – Mamba/Kilo Touchdown / Access. Mature tree stumps – Chopper / Access/ Timbrel 3A. **Bio Control:** Flower galler (Aceria *lantanae* Cook). Leaf miner (*Calycomyza lantanae*). Leaf sucker (Falconia intermedia). Leaf feeder (*Hypena laceratalis* Walker). Leaf miner (*Octotoma scabripennis* Guerin-Meneville). Leaf miner (*Ophiomyia camarae* Spencer). Seed miner (*Ophiomyia lantanae*). Leaf & flower sucker (*Teleonemia scrupulosa* Stal). Leaf miner (*Uroplata girardi* Pic).

Pennisetum clandestinum (Kikuyu grass)		**Manual:** hand pull by roots; kikuyu often associated with raised fill / disturbed areas – removal will reduce invasion opportunities; Inclusion of hard paths on upland edge of river, buffer or wetland provides hard management edge from which to manage invasion and also reduces to some extent root spread **Chemical:** Spray with Roundup ® while grass is actively growing (not when dormant) and follow up spray any regrowth after 4 months.
Rubus spp (Bramble)		**Chemical:** Mamba max – most effective in autumn when downward sap movement.

Cirsium vulgare (Scottish Thistle)		**Manual:** hand pull
Hedychium gardnerianum (Kahili ginger lily)		**Manual:** hand pull