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 Residential Development of Portion 3 of the Farm Kraaibosch No. 195, George

PREPARED FOR: Groenkloof Ontwikkelings (Pty) Ltd
Contact Peron: Mr Niel Murray
Email: niel@groenkloof.net

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

DATE: 24 October 2019

EXECUTIVE SUMMARY

The proposed development of Kraaibosch No. 195 Portion 3 will form part of the expansion of George to welcome more people to the scenic Garden Route. Development increase pressure on the environment which, in this case, include aquatic habitat and therefore one of the most valuable resources – water.

Development of this property will impact on an ephemeral stream in the drainage line running down the middle of the property and a small instream dam near the top of the tributary. The tributary stream merges into the Swart River on the property boundary and therefore development will also influence this larger system to a certain extent. Neither the NFEPA nor the WCBSP data identifies the tributary as being of aquatic importance. The stream has been degraded by the impacts of agriculture and alien plant infestation and becomes an eroded gully towards the bottom of the valley. The catchment is mainly comprised of grazing pastures covered in grass species. Alien trees such as Pines and Black Wattle (*Acacia mearnsii*) cover the steep slopes. Both alien and indigenous flora comprise the riparian vegetation. According to the PES and EIS results the stream is in a fair condition and of low ecological importance. It is recommended that the system be maintained in its current state.

The potential impacts development will have on the tributary stream were identified as freshwater habitat loss, sedimentation and erosion, water pollution, and flow modification. The impacts of the development were determined to be of Medium significance but could, to a large degree, be decreased to Low if the necessary mitigation measures are implemented. The steep slopes require strict adherence to the No-Go buffer zone as they enhance the impacts of erosion and flow modification. Erosion and sedimentation pose the biggest risk to aquatic habitat and therefore all mitigation measures pertaining to this impact should be strictly adhered to. Flow modification cannot be restricted to having a low impact significance, even after mitigation. Monitoring of the site should take place to ensure the mitigation measures as set out in this report and those of the EMPr are followed.

The project is considered to be acceptable from an aquatic perspective. It is recommended that a water use licence in terms of Section 21(c) and (i) of the NWA (1998) be applied for due to the proposed activities triggering these water uses.

DECLARATION OF INDEPENDENCE

Independent Specialist Consultant

I, Debbie Fordham, declare that I:

- Act as an independent specialist consultant, in this application, in the field of wetland and riparian 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 Environmental Impact Assessment Regulations, 2014;
- 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 Environmental Impact Assessment 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	ROLE	QUALIFICATIONS	DETAILS
MARITA BURGER HONS	Author	BSc (Hons) – Environmental Science	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.
DEBBIE FORDHAM M.SC	Co-Author & Internal Reviewer	M.Sc - Environmental Science BA (Hons) - Environmental Science BA - Environmental Science and Geography	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.

INDEMNITY AND COPYRIGHT

Report citation:
Sharples Environmental Services cc, 2019. Freshwater Habitat Impact Assessment for the Proposed Residential Development on Portion 3 of Kraaibosch 195.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Sharples Environmental Services cc (SES) has been appointed to conduct a Freshwater Specialist Impact Assessment for the proposed residential development on Portion 3 of Farm Kraaibosch 195, in George (Figure 1). The property is situated within the urban edge, on the eastern side of George, and accessed off Glenwood Avenue. The property is bordered by the Swart River, downstream of the Garden Route Dam to the north. The Garden Route Dam is located mid-reach on the Kat River and provides water to George. The land use of the surrounding area, historically made up of small holdings and forestry plantations, is increasingly changing to residential development (such as Kraaibosch Estate and Groenkloof). Figure 2 shows the proposed layout plan for the development.

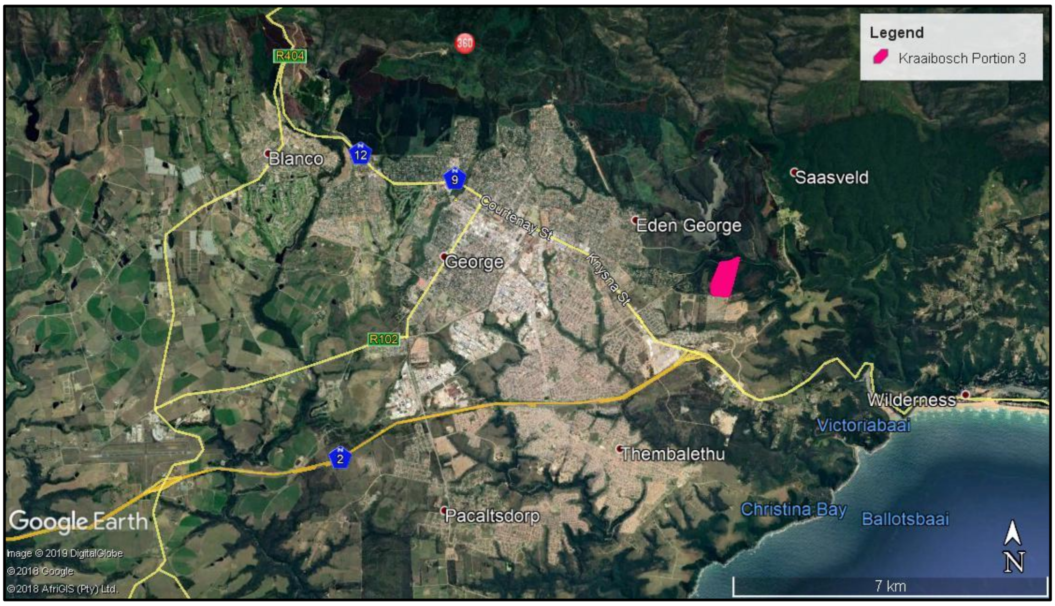

Figure 1: Location of the proposed development relative to George

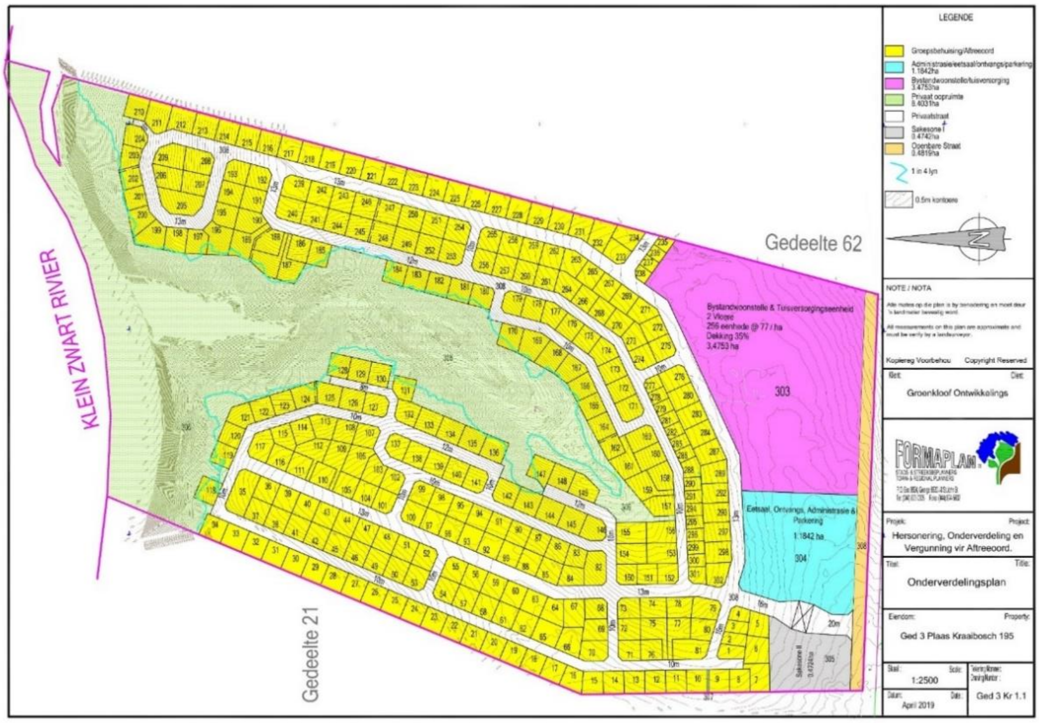

Figure 2: Proposed layout for the development of Portion 3 of the Farm Kraaibosch No. 195

1.1 Background

A Basic Assessment for development of the property was conducted in 2011. The proposed activity involved change in land use from Agricultural to Residential I, II (Group Housing) and Open Space with all the associated infrastructure normally required for such a project. An Environmental Authorisation (EA) was issued in the same year and approved the proposed development subject to certain conditions and excluding transformation to residential use of the portion of Erf 131 that falls below the 184 meter contour line. The EA was valid for a period of 5 years, therefore expiring in 2016.

In 2016 an amendment of the EA was applied for and granted. The amendment entailed two adjustments. Firstly, the holder of the EA needed to change from Adonai Shammah Trust to Groenkloof Ontwikkelings (Pty) Ltd since the latter had since bought the property and indicated that they would like the rights and obligations stipulated in the EA. The second adjustment was to extend the EA by 5 years in order to allow the new landowner time to plan and make the required changes to the layout and the Environmental Management Programme (EMPr). The amended EA is valid until 25 November 2021.

The EA discussed the biophysical component and states that development can only occur on slopes less steep than 1:4 and should be restricted to the flat areas above the valley. The 1:5 slope was determined as reference to serve as setback for the development footprint from the 1:4 slope. The 1:4 slope is indicated on the proposed layout (Figure 2) as a thin light blue line surrounding the watercourse/valley in the middle of the property.

1.2 Relevant Legislation

Both the NEMA EIA regulations and those of the NWA (see below) require a freshwater assessment to be undertaken as part of the development application. 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).
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). However, other water uses associated with the project may not allow for GA as sewage pipelines are excluded in the current available layout.
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.

1.3 Scope of Work

The Scope of Work in accordance with the specific Terms of Reference supplied by Sharples Environmental Services cc are described below:

Phase 1

- ✓ Contextualization of the study area in terms of important biophysical characteristics and the latest available aquatic conservation planning information.
- ✓ Desktop delineation and illustration of all watercourses within the study area utilising available site-specific data such as aerial photography, contour data and water resource data.
- ✓ A risk/screening assessment of these identified watercourses to determine which ones will be impacted upon by the proposed development areas.

Phase 2

- ✓ Ground truthing, infield identification, delineation and mapping of any 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:
  - → Level 1 WET-Health tool (Macfarlane *et al*., 2009) – PES
  - → WET-Ecoservices (Kotze *et al*., 2009) - 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 prevent impacts on aquatic habitat, in alignment with the mitigation hierarchy, and any measures necessary to restore disturbed areas or ecological processes.
- ✓ 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

George receives rainfall throughout the year, with the lowest amount in June and the highest amount in November. The average midday temperatures for the area range from 18.2°C in July to 27.6°C in February (Mucina and Rutherford, 2006). The area is characterised by gently undulating topography on the coastal plateau between the Outeniqua Mountains and the ocean. The geology is mainly granite and the soils on the majority of the site is highly erodible.

2.1 Drainage

The site is located within the DWS Quaternary Catchment K30C and falls within the Gouritz Water Management Area (Figure 3). The catchment drains towards the Indian Ocean in the south. The largest river in this catchment is the Kaaimans River with the Swart River being the main tributary. Both rivers have been mapped by the NFEPA project, but it is only the Kaaimans River that has received FEPA status, and both are classified as Moderately Modified (PES='C').

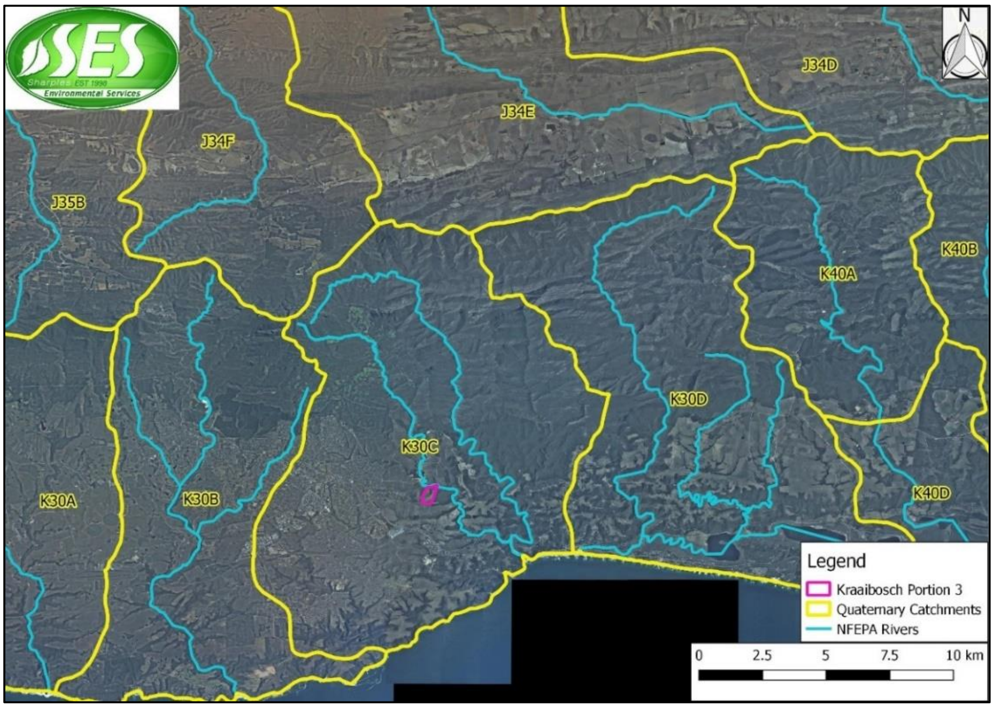

Figure 3: Map showing the Quaternary Catchments of the area in relation to the study site

2.2 NFEPA

The National Freshwater Ecosystem Priority Area project (NFEPA) aims to provide strategic spatial priority areas for conserving South Africa's aquatic ecosystems and supporting sustainable use of water resources. These priority areas are called Freshwater Ecosystem Priority Areas (FEPAs) and the main output of the NFEPA project was the creation of FEPA maps. 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). The NFEPA data does not identify any wetland or river ecosystems within the study area. The Swart River, flowing on the northern boundary of the property, was identified by NFEPA but not classified further (Figure 4).

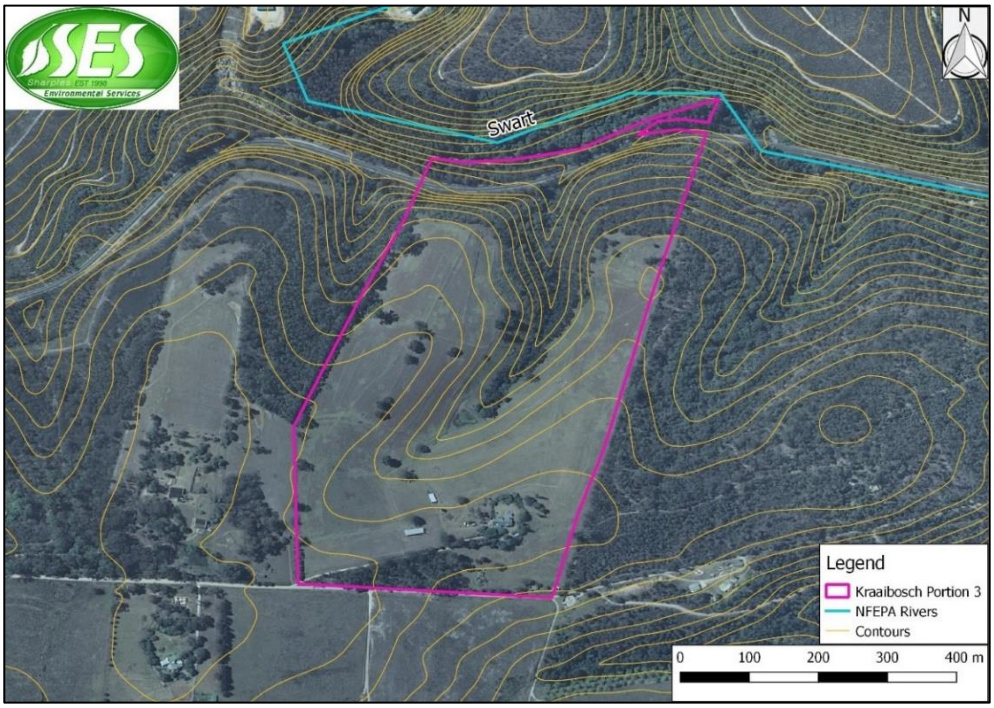

Figure 4: Map of NFEPA project identified aquatic areas in relation to the study area

2.3 Vegetation and Ecosystem threat status

The majority of the site is comprised of Garden Route Granite Fynbos with the remaining third classified as Garden Route Shale Fynbos (Figure 5) according to Mucina and Rutherford (2012). The latter area is classified as Critically Endangered (Figure 6) and was updated from being Endangered in 2014. The Garden Route Granite Fynbos area is classified as Endangered with the northern area, surrounding the Swart River, being Least Threatened. The threat status of the Endangered portion increased in 2016 from Vulnerable in 2014.

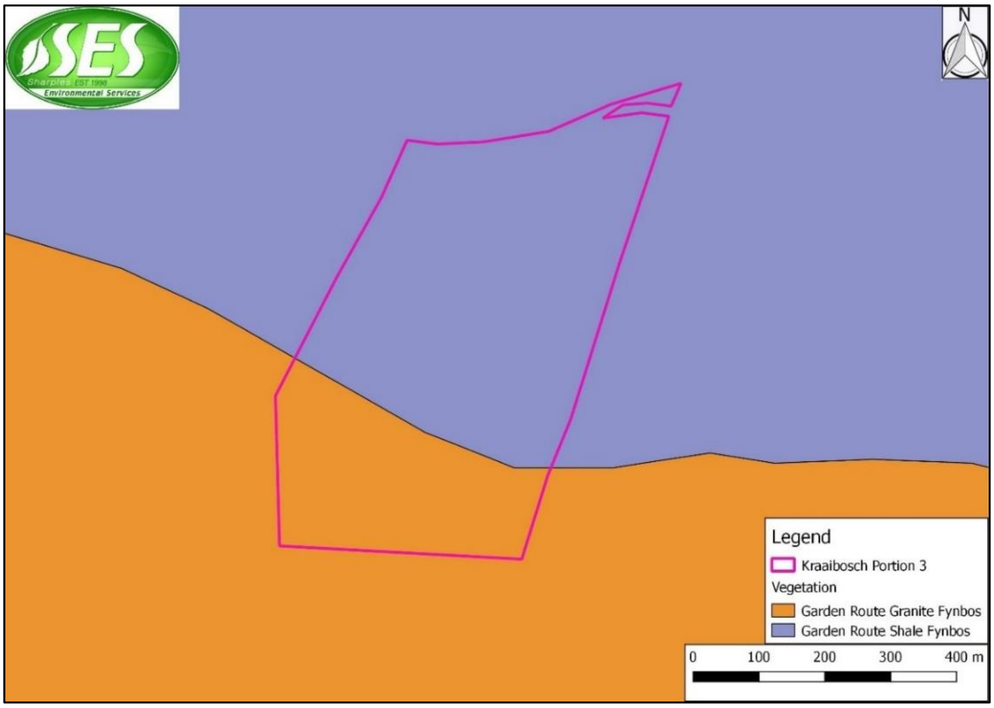

Figure 5: Vegetation map of the site according to Mucina and Rutherford (2012)

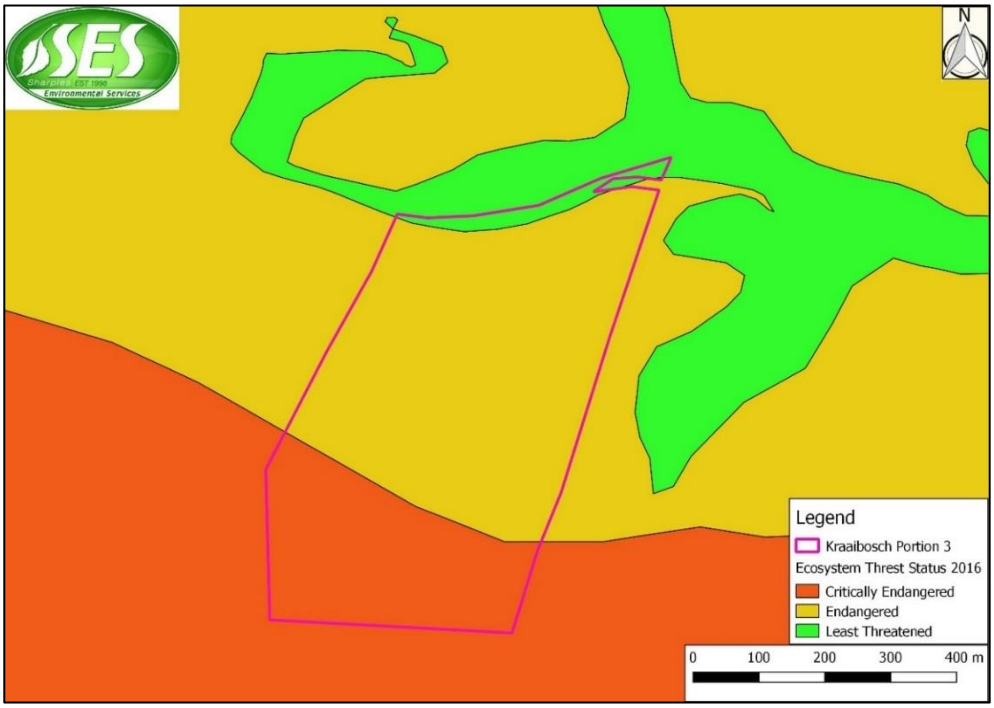

Figure 6: Ecosystem Threat Status of the study area

However, as confirmed in the botanical report of 2010, the majority of the property has been transformed to pastures for agricultural use and few indigenous species remain, leaving the area with low biodiversity. The alien grass species Kikuyu (*Pennisetum clandestinum*) and Paspalum (*Paspalum dilatum*) comprise most of the vegetation in the grazed areas (Vlok, 2010). Currently, horses graze the grass covered eastern portion of the property.

When the botanical report was published, the portion of the property surrounding the drainage line was covered in alien tree species dominated by *Acacia mearnsii* and *Pinus pinaster*. The fire event in October 2018 affected this property too and left most trees burned. The burnt trees were cut down, resulting in largely unvegetated slopes. During the 2019 site visit Black wattle (*Acacia mearnsii*) could be seen re-establishing on the slopes (Figure 7).

Figure 7: Emerging Black wattle (Acacia mearnsii) on the burnt slopes

2.4 Conservation status

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 (CBAs) 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 CBAs. Critically Endangered (CR) ecosystems, critical corridors for maintaining landscape connectivity and areas required to meet biodiversity pattern targets, are included in CBAs. 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 (ESAs) are not essential for meeting biodiversity targets but are important as they support the functioning of CBAs and Protected Areas (PAs). ESAs 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 ESAs in a functional condition (ESA1) and degraded areas in need of restoration (ESA2).

According to the WCBSP (Pence 2017), the proposed site is comprised of CBA1, CBA2, ESA1 and ESA2 habitats. The Swart River is classified as a CBA1 river. The area north of the Seven Passes Road (old Saasveld Road) is classified as Forest CBA1, with the small drainage area of the property mainly being terrestrial CBA1. The majority of the property is terrestrial ESA1. Therefore, most of the site is considered to be in natural or at least functional condition, however certain areas in need of restoration remain (Figure 8). The data does not indicate any strictly aquatic areas within the property. However, water resource protection is provided as a reason for classifying parts of the property as important biodiversity areas. Contours reveal a drainage area that forms a small tributary of the Swart River (Figure 4).

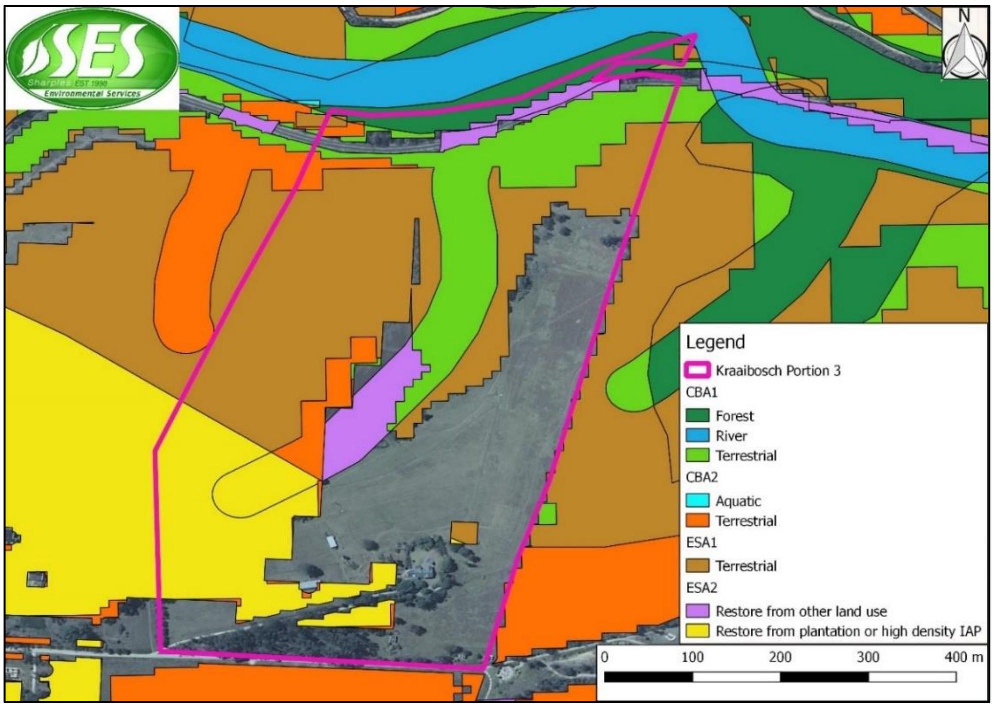

Figure 8: Map showing the CBAs and ESAs relative to the proposed site (Pence, 2017)

2.5 Existing impacts upon watercourses of the area

2.5.1 Urban Infrastructure and pollutants

Roads, pipelines, culverts and bridges create migration barriers to biota, resulting in reach to zone scale instream biological impacts. Localised scour around structures or flow impediments can result and alter the natural bank and channel, channel bank stability and floodplain processes. Additionally, flood protection measures and general infilling within the watercourses has modified the bed and bank characteristics. This has resulted in habitat loss and change to the watercourse and reduced aquatic species diversity. The road crossing concentrating diffuse flows into a small culvert can also inadvertently trigger gully formation. The encroachment of roads and housing onto floodplains can dramatically alter the flow rates, water quality and sediment regimes of watercourses. The Garden Route Dam, located a few 100 meters upstream of where this site's tributary joins the Swart River, significantly influences the state of the river through reduction in flow.

The greater the extent of hardened surfaces (e.g. roofs, parking lots etc.), the lower the infiltration of stormwater and therefore the greater the surface runoff and increase in flood peaks. A change in water distribution generally results in altered wetness regimes, which in turn affect the biophysical processes and the vegetation patterns. Urbanization of the catchment and its associated stormwater runoff is increasingly recognised as a threat to freshwater biodiversity not only because of the increased hydrological disturbance and habitat loss, but also because of an increased delivery of pollutants to streams. Recent development within the catchment include Groenkloof, which is just across the road from where this development is proposed. Stormwater runoff from urban surfaces may include nutrients, pollutants, raw sewage and other domestic waste. This waste can lead to eutrophication, excess plant growth causing changes to community dynamics, hypoxia (oxygen depletion) as well as inhibit the growth of bacteria that play an important role in removing nitrogen from water.

The Seven Passes Road is notorious for being used as a dumping spot for refuge bags. This adds to the pollution problem since the bags and/or its contents end up in the drainage lines and is washed downstream by the Swart River. Vehicles utilising this road add to pollution through hydrocarbon inputs. A few 100 meters upstream of the study site, the sewage pump station on the Garden Route Dam property inputs raw sewage into the Swart River.

2.5.2 Invasive alien plants

The infestation of alien invasive plants in the catchment and drainage lines of the area has altered the surface runoff and water inputs to watercourses. Within a river, these plants confine and block flows and smother indigenous vegetation from the periphery. On this property, the high density of alien species decreases water availability. Alien trees also fuel fires, increasing fire intensity and duration. This property's alien trees recently burned, leaving the ground bare and vulnerable to re-establishing alien species and erosion.

2.5.3 Forestry

Like alien invasive trees, the commercial forestry in the catchment (past and the present) has replaced natural habitat, altered surface water movement, and reduced flows. This land use has long-term impacts due to the disturbance of the soil profile which has likely led to the proliferation of Wattle Trees. Additionally, the periodic harvesting of the forestry trees exposes bare earth that potentially results in large sediment inputs into the drainage lines. All such land disturbances affect the processes and features of upstream reaches that influence those further downstream and/or eventually estuaries.

3 APPROACH AND METHODS

3.1 Desktop Assessment Methods

- The contextualization of each 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 2).
- 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 2: 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 (2006)
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)

3.2 Baseline Assessment Methods

- An infield site assessment was conducted on the 29th of April 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 and vegetation.
- 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. Refer to the Table below for a list and description of the tools utilised.

Table 3: Tools utilised for the assessment of water resources impacted upon by the proposed project.

METHOD/TOOL*	SOURCE	REFERENCE
Delineation of wetland and/or Riparian areas	*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas.*	(DWAF 2005)
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)
Present Ecological State (PES) Assessment (River)	*Rapid IHI (Index of Habitat Integrity) tool developed Kleynhans (1996), Modified by DWAF*	(Ecoquat)
Ecological Importance & Sensitivity (EIS) Assessment (River)	*DWAF EIS tool developed by Kleynhans (1999)*	(Kleynhans, 1999)

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 for the three alternatives 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 11.

- 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:

- No exact coordinates or spatial data was provided by the client to ensure accuracy of the buffer and aquatic habitat overlay on the layout. The overlay is therefore an approximate and should be verified with georeferenced layout data.
- The location of some proposed infrastructure, such as sewage pipes, are not included in the layout available when this report was compiled. It is therefore assumed that all infrastructure will be outside the watercourse.
- No stormwater management plans, surveyed contours, floodline data, alien tree clearing plans, engineering designs for road/pipe crossings or stormwater infrastructure outlets, construction method statements or proposed alternatives, have yet been provided.
- 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. The clearing of vegetation as a result of the recent fire in the area made delineation increasingly difficult.
- Infield soil and vegetation sampling was only undertaken within a specific focal area around the proposed development, while the remaining watercourse 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. The botanical report could be consulted for more detail on the general vegetation of the site; however, the reported study was done almost 10 years ago and vegetation has potentially been altered by the recent fire.

- 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.

5 RESULTS

Portion 3 of the Farm Kraaibosch 195 has a prominent drainage line running down the middle of the property in a northern direction (Figure 9). A small instream dam, covered in waterlilies (*Nymphaea sp.*), is located near the head of the drainage line (Figure 10B). Downstream of the dam the valley steepens significantly, as can be seen in Figure 10. The watercourse flows in a fairly straight north easterly direction, curves slightly west around a rock outcrop, flows through the Seven Passes Road culvert and merges with the Swart River at the northern boundary of the property. The stream has an ephemeral flow pattern which entails flows for very short periods of time after high rainfall. The riparian vegetation provides habitat for biota such as birds. No wetland habitat was found on site.

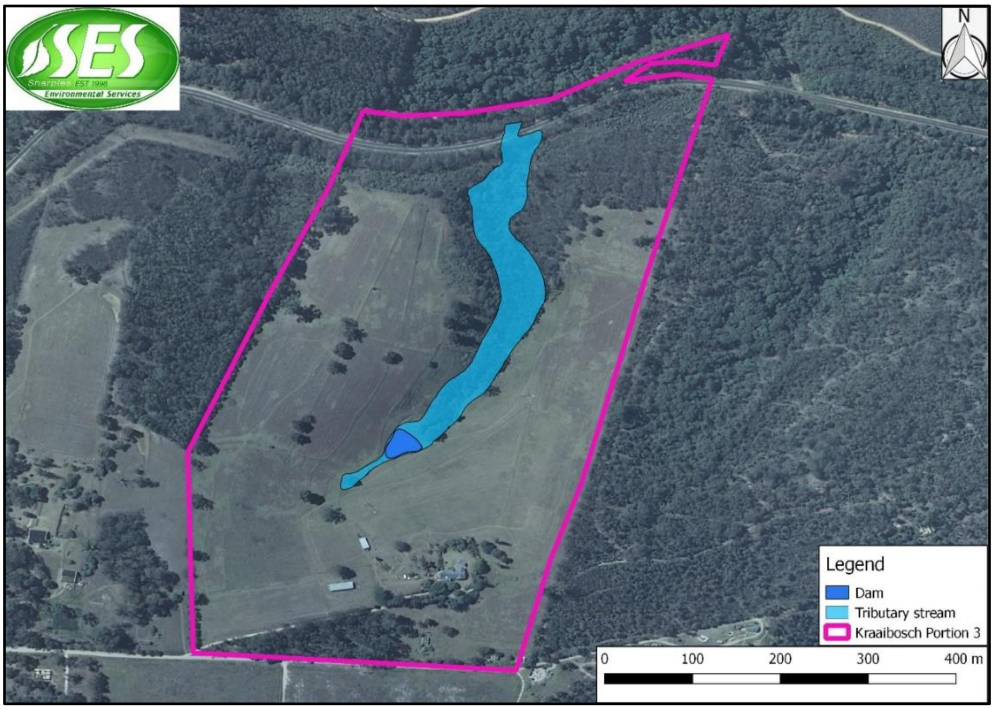

Figure 9: Delineation of aquatic habitat on Portion 3, Kraaibosch 195

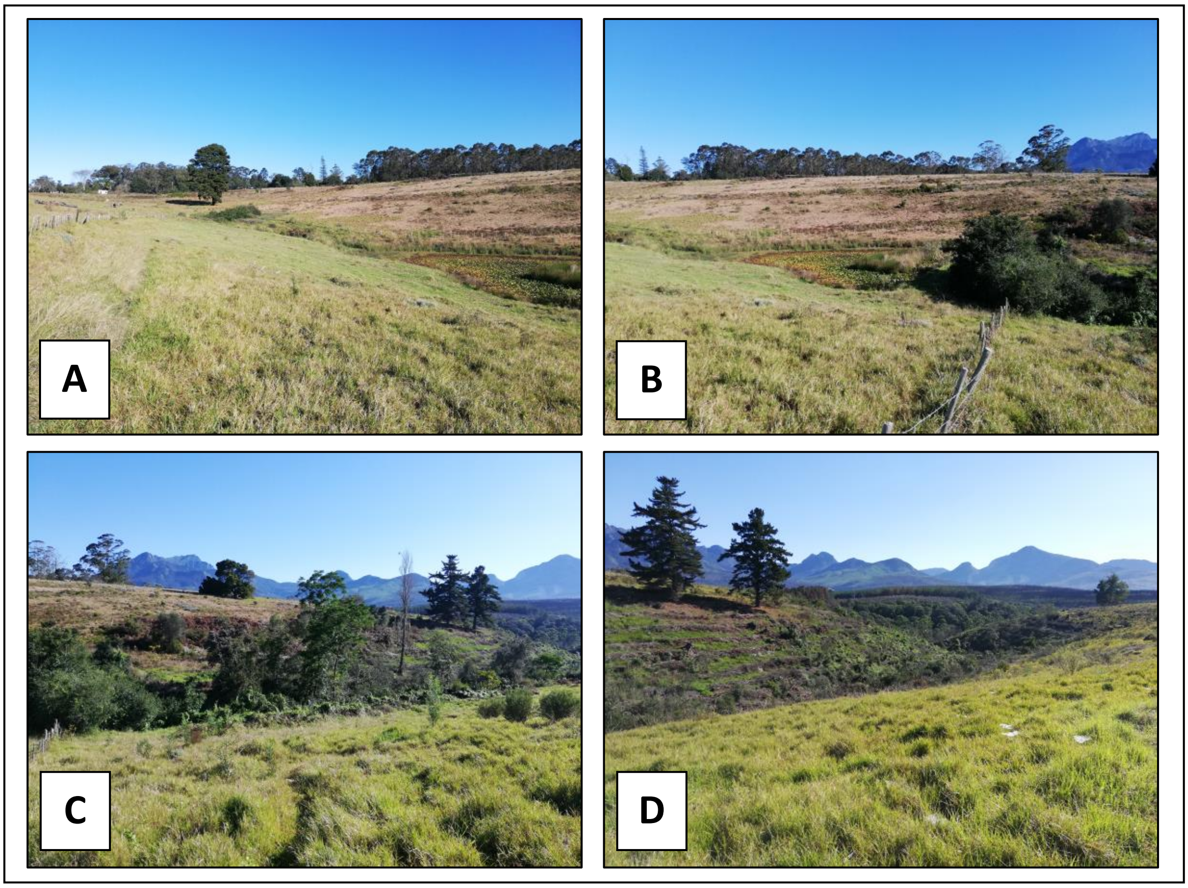

Figure 10: Overview of the drainage line from a point east of the dam. A & B show the area upstream of the dam and C & D show the area downstream.

5.1 Stream condition

The catchment is predominantly covered in grass species such as alien Kikuyu (*Pennisetum clandestinum*) and indigenous *Stenotaphrum secundatum*. The dense cover in these areas limit erosion rates but not as well as the natural indigenous vegetation would have. The north facing slopes, however, are much more sparsely vegetated as a result of the recent fire that left the vegetation burnt. These slopes are largely bare and vulnerable to erosion.

In the upper reach, the dam has caused headward erosion forming a narrow gully approximately half a meter deep. Terrestrial vegetation, such as native *Conyza scabrida* and *Paspalum urvillei*, invasive bracken fern (*Pteridium sp.*) and alien bugweed (*Solanum mauritianum*), are dominant in the area. The dam itself is covered in waterlily (*Nymphaeceae sp.*) with sedges such as *Cyperus sp*., *Juncus sp.* and *Typha capensis* reeds. Historically, before agriculture modified the habitat, it is likely that the freshwater habitat extended higher up, upslope of the dam.

Below the dam wall, a combination of alien and indigenous species occur along the banks of the stream. Alien vegetation dominates as a result of the level of disturbance in the surrounding area. Indigenous vegetation includes Camphor tree (*Cinnamomum camphora*), *Rhus chirindensis*, *Gymnosporia buxifolia* and Bracken fern (*Pteridium aquilinum*). Black wattle (*Acacia mearnsii*), Syringa tree (*Melia azedarach)*, Rooikrans (*Acacia cyclops*) and *Rubus cuneifolius* are some of the alien species present. The stream becomes an eroded gully as it progresses down slope towards the Swart River. The size of the gully is approximately 9 x 2 m in width. It increases in size as the valley deepens in the direction of the Swart River.

A small patch of indigenous forest remains as part of the riparian zone of the stream upslope of the Seven Passes road. It has species typical of Temperate Southern Montane forest and provides habitat for birds. This forest vegetation is likely to have covered the entire slope and only transitioned to Fynbos on top of the hill. Currently, most of the slope in this area is unvegetated, with only a few burnt, cut-down stumps of alien trees (presumably Black wattle and Pines) remaining. The alien species are re-establishing in the burnt area, but efforts to control this are evident.

5.2 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.

The alien invasive plant infestation and agricultural land-use have significantly modified the river system from the natural condition. In the upper reach, habitat has been transformed to pastures for livestock grazing and there is a dam impounding flows. This has resulted in an incised middle reach, that has a narrow and alien infested riparian zone. However, the water quality is not likely to substantially differ from the estimated reference condition (especially due to the non-perennial nature of the stream). In the lower reach, the burnt alien vegetation on the banks have been cleared but is re-establishing. Efforts to prevent this re-establishment are evident. It was determined that a loss and change of natural habitat and biota have occurred, resulting in a PES score of ‘C’. This indicates that the stream is in a fair condition (Table 4).

Table 4: Present Ecological State of the stream

Determinand	Score (0-5)	% intact	Rationale
Bed modification	2,5	60	The dam altered the size and shape of the bed in its immediate area. The drainage line upstream of the dam is eroded and the dam traps sediment, preventing it from being deposited further downstream. The clearing of vegetation after the recent fire caused more sediment to enter the system as some of the dead plant material and the exposed top soil has washed into the stream. Even though fire would have occurred naturally, alien vegetation altered the rate and spread of fire and necessitated the felling of trees. The road just before the confluence with the Swart River, has altered the stream through concentrating flows and clearing and infilling habitat.
Flow modification	2	70	Flow is altered by the dam and alien vegetation. The dam prevents low flows from the top to enter the system. Alien vegetation requires more water and therefore less water is available in the system. The culvert at the bottom of the drainage line concentrates flow before the stream reaches the Swart River. The area draining into the stream has been altered from natural Fynbos and Forest vegetation to grazing pastures with alien grass species and slopes with alien vegetation introduced by plantations in the area.
Inundation	1,5	80	The instream dam at the head of the system creates artificial inundation that influences vegetation cover directly upstream, however since the dam is in the upper reach it has limited influence in size. After heavy rainfall, inundation upstream of the Seven Passes Road might occur but will be limited due to the location of the culvert.
Bank condition	3	50	The banks are dominated by alien vegetation along the entire course of the stream and erosion has altered the banks. However, the banks are currently stable with limited erosion, even on the burnt slopes. The road crossing has altered the banks significantly.
Riparian condition	4	30	Alien vegetation dominates the majority of the riparian area. Most of the riparian area has been lost to agricultural development.
Water quality modification	1,5	80	The area surrounding the drainage line is covered by vegetation, although mostly alien. This and the presence of livestock has altered the quality of water entering the system. Even though the area has been altered from its natural state, very few pollutant sources are present, and the water quality is expected to be good.
Average Score	**2,4**	61,7	**Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.**
Ecological Category	**C**		

5.3 Ecological Importance and Sensitivity (EIS)

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 stream (episodic flows, uniform types, degraded etc.) it has limited EIS. The vast disturbances within the stream assessed have resulted in the dominance of disturbance tolerant species and thus the species/taxon richness is not expected to be significant at any scale. The topography and substrate of the channel is largely uniform. The stream is not classified as a FEPA river system, it is not within a conservation area and the current impacts have limited its contributions to ecological diversity.

Therefore, the ecological importance and sensitivity category of the stream was determined as being 'Low' (Table 5). It is small and limited natural habitat or diversity remains. However, it does support the important larger downstream systems of the Swart and Kaaimans Rivers and provides habitat for biota in the lower reaches to a moderate degree.

Table 5: Ecological Importance and Sensitivity Assessment

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	Few indigenous species occur and the area is dominated by alien vegetation.
	Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	0,5	Flows in the tributary are intermittent and therefore vegetation tolerant to altered flow occur.
	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.
RIPARIAN & INSTREAM HABITATS	Diversity of types (4=Very high - 1=marginal/low)	1	There is low diversity in aquatic habitat types due to the tributary being fairly short, small and steep and with only intermittent flows. The small dam at the top provides an alternative habitat.
	Refugia (4=Very high - 1=marginal/low)	1	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	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	The stream is mostly dry and therefore the habitat is tolerant of altered flow.
	Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	0,5	The stream is only a small, mostly dry tributary of the Swart River and therefore does not serve as a corridor for downstream biota.
	Importance of conservation & natural areas (range, 4=very high - 0=very low)	1	The stream does not fall within a conservation area.
MEDIAN OF DETERMINANTS		1	
ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORY (EIS)		**LOW, EC=D**	

5.4 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. However, it is the recommendation of the specialist that alien trees be managed, erosion halted, and indigenous riparian vegetation left to establish.

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. 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.

The effect of impacts on a tributary stream as small as the one in this property might seem insignificant. However, since aquatic systems form a network over a vast area it is important to consider cumulative impacts. George is expanding which increases urban pressure on aquatic systems. The Groenkloof Retirement Village and Kraaibosch Country Estate are some of the new developments in the vicinity of this property. New development around various tributaries in and around George is increasing urban pressure on aquatic systems. Urban pressure includes stormwater runoff containing various pollutants and altered flow rates of water entering the system. These impacts are, depending on severity, not restricted to the immediate aquatic habitat and may also cause degradation of downstream habitat.

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, encroachment and colonisation of habitat by invasive alien plants.

6.1.1 Construction Phase

The project will require the clearing of all vegetation in areas which topographically allow for development. Even though the current layout does not necessitate clearance of any aquatic habitat, it will be indirectly impacted by the excavations and vegetation clearing as this can lead to burying of vegetation downslope of the soil disturbance. However, there is little indigenous vegetation remaining due to dense alien invasive tree infestation and pastures covered by alien grass species, which would necessitate clearing by the landowner in any case.

6.1.2 Operational Phase

The project will promote the establishment of disturbance-tolerant biota, including colonization by invasive alien species, weeds and pioneer plants within the remaining habitat. Although this impact is initiated during the construction phase it is likely to persist into the operational phase. It is however unlikely that many sensitive species remain within the degraded areas. The stormwater infrastructure of the housing and associated road network will increase and concentrate flows. This may lead to erosion in the system that compromises remaining vegetated habitat. There is also the risk of certain garden plants establishing in riparian areas and outcompeting indigenous vegetation.

6.2 Sedimentation and erosion

Sedimentation and erosion refer to the alteration in the physical characteristics of rivers as a result of increased turbidity and sediment deposition, caused by soil erosion and earthworks that are associated with construction activities, as well as instability and collapse of unstable soils during project operation. 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 within and upslope of 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 and aquatic faunal fatalities. 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. These impacts are the biggest threat to the system since the steep slopes will enhance and increase the likelihood of the impact occurring. Furthermore, the construction will include extensive “cutting and filling” which increases the soils vulnerability to erosion.

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 on downstream water resources in and outside of the study area. The increase in hardened surface by the development will be considerable and, if not mitigated against, will result in further erosion/sedimentation. Surface runoff and velocities will increase, and flows might be concentrated by stormwater infrastructure. The steep slopes of the study area necessitate specific consideration of these impacts.

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). The result is only disturbance tolerant species remaining. The magnitude of water pollution related impacts is lessened by the drainage line only having episodic flows.

6.3.1 Construction Phase

During construction there are a number of potential pollution inputs into the aquatic systems (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 might 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

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 wastewater will not be treated on the property. However, should any onsite wastewater treatment infrastructure fail, and result in raw sewerage entering any watercourses, it may impact the water quality of the system. Water pollution could impact the downstream Swart and Kaaimans River, depending on whether the polluting activity coincides with sufficient rain to wash the pollutants down.

6.4 Flow Modification

Flow modification entails the changes in the quantity, timing and distribution of water inputs and flows within the watercourse. 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. Although the flow regime is naturally episodic and the habitat is therefore tolerant to altered flow, neither the construction nor operational conditions will be the same as natural conditions.

6.4.1 Construction Phase

Land clearing and earth works upslope of the watercourse 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 the stream.

6.4.2 Operational Phase

According to the SANRAL (2006), urbanisation typically increases the runoff rate by 20 - 50%, compared with natural conditions. Hardened/artificial infrastructure will alter the natural processes of rain water infiltration and surface runoff, promoting increased volumes and velocities of storm water runoff, which can be detrimental to the rivers receiving concentrated flows off of the area. Increased volumes and velocities of storm water draining from the development and discharging into down-slope aquatic habitat can alter the natural ecology of the system, increasing the risk of erosion and channel incision/scouring and backflooding. The stream is expected to get increased water inputs more regularly than under natural conditions.

7 IMPACT SIGNIFICANCE ASSESSMENT

The impact significance of the proposed development was determined for each potential impact of the project. Table 6 provide the impact assessment results grouped into construction phase and operational phase.

During the construction phase of the project the impacts are assessed as being Medium, but can be reduced to Low, after the implementation of mitigation measures. The mitigation should centre on the highest construction impact – erosion and sedimentation - by adhering to the buffer area and managing surface runoff appropriately. The after mitigation impacts only applies if absolutely no activity occurs within the buffer area.

The operational phase impacts associated with the project are assessed as being Medium; however, they may potentially be largely decreased to Low with the implementation of effective mitigation measures and the associated buffer area. The impact of Flow modification will, however, still be Medium even after mitigation. Operational mitigation must therefore focus upon managing stormwater flows effectively and preventing pollutants from entering the system especially considering the downstream water courses. The steep slopes in the deep valley is the main contributor to the higher impact significance associated with Flow modification.

The impacts are considered to be easily mitigated provided that mitigation measures, especially the buffer areas, and monitoring is implemented and adhered to during the construction and operational phases of the project. The impact significance associated with mitigation only applies if all mitigation measures are adhered to. Please refer to Chapter 8 for detailed mitigation measures.

No alternative layout has yet been provided. The No-Go alternative was however assessed as part of this report (Table 7). This alternative assumes that no development will occur and that the status quo of the site will persist. It is also assumed that the landowner will comply with legislated requirements by clearing alien vegetation, stopping further erosion and rehabilitating eroded areas in order to prevent any further degradation of the area. Legislation concerned here are the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) and Section 28 of the NEMA, which stipulates the "Duty of Care". A botanist should be appointed to advise on how to revegetate the areas affected by alien plant clearing. Measures should also be taken to prevent further erosion and rehabilitate existing eroded areas. This can be done by putting perpendicular structures in place to stop erosion below the dam. Figure 11 is an example of measures put in place to rehabilitate an eroded gully such as what occurs below the dam.

Figure 11: An example of rehabilitation, using various measures to stabilise and recontour a gully, that could be applied to the eroded gully below the dam.

Table 6: Evaluation of potential impacts of Kraaibosch Portion 3 residential development on freshwater 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)	Short (2)	Low (4)	Highly Likely (4)	**Medium (32)**	Partly	High	No
		With Mitigation	Site only (1)	Short (2)	Minor (2)	Improbable (2)	**Low (10)**	Barely	Low	No
	Erosion & sedimentation	Without Mitigation	Regional (3)	Short (2)	High (8)	Highly Likely (4)	**Medium (52)**	Partly	Medium	Yes
		With Mitigation	Site only (1)	Short (2)	Moderate (6)	Probable (3)	**Low (27)**	Barely	Low	No
	Water Pollution	Without Mitigation	Local (2)	Medium (3)	Moderate (6)	Probable (3)	**Medium (33)**	Partly	High	No
		With Mitigation	Site only (1)	Very short (1)	Minor (2)	Probable (3)	**Low (12)**	Barely	Low	No
	Flow modification	Without Mitigation	Local (2)	Short (2)	Moderate (6)	Highly Likely (4)	**Medium (40)**	Partly	Medium	No
		With Mitigation	Site only (1)	Short (2)	Minor (2)	Probable (3)	**Low (15)**	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)	Minor (2)	Probable (3)	**Low (27)**	Partly	High	No
		With Mitigation	Site only (1)	Permanent (5)	Small (0)	Very Improbable (1)	**Very Low (5)**	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)	Improbable (2)	**Low (16)**	Barely	Low	No
	Water Pollution	Without Mitigation	Regional (3)	Permanent (5)	Moderate (6)	Highly Likely (4)	**Medium (56)**	Partly	High	No
		With Mitigation	Local (2)	Permanent (5)	Minor (2)	Probable (3)	**Low (27)**	Barely	Low	No
	Flow modification	Without Mitigation	Local (2)	Permanent (5)	Moderate (6)	Highly Likely (4)	**Medium (52)**	Partly	Medium	No
		With Mitigation	Local (2)	Permanent (5)	Minor (2)	Probable (3)	**Medium (36)**	Barely	Low	No

Table 7: Evaluation of potential impacts on freshwater habitat if no development occurs on Portion 3 of Kraaibosch 195

	Impact	Mitigation	Extent	Duration	Magnitude	Probability	Significance	Reversibility	Mitigation Potential	Irreplaceable Resource Loss
No Go Alternative	Loss and disturbance of aquatic vegetation & habitat	Without Mitigation	Site only (1)	Short (2)	Minor (2)	Probable (3)	**Low (15)**	Partly	Medium	No
		With Mitigation	Site only (1)	Short (2)	Minor (2)	Improbable (2)	**Low (10)**	Barely	Low	No
	Erosion & sedimentation	Without Mitigation	Local (2)	Long-term (4)	Low (4)	Probable (3)	**Medium (30)**	Partly	High	No
		With Mitigation	Site only (1)	Short (2)	Low (4)	Improbable (2)	**Low (14)**	Barely	Low	No
	Water Pollution	Without Mitigation	Site only (1)	Short (2)	Low (4)	Improbable (2)	**Low (14)**	Barely	Medium	No
		With Mitigation	Site only (1)	Short (2)	Minor (2)	Improbable (2)	**Low (10)**	Barely	Low	No
	Flow modification	Without Mitigation	Local (2)	Medium (3)	Moderate (6)	Probable (3)	**Medium (33)**	Partly	Medium	No
		With Mitigation	Site only (1)	Short (2)	Minor (2)	Improbable (3)	**Low (15)**	Barely	Low	No

8 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/improve 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 next to the freshwater habitat make it especially vulnerable to increased velocity of runoff from the development. The following mitigation measures must be adhered to should development occur:

8.1 Design Phase and Buffer Area (No-Go Zone)

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).

A buffer area surrounding the freshwater habitat needs to be established, demarcated and strictly adhered to. The specific size of the buffer zone was informed by a tool developed by Macfarlane and Bredin (2016) called *Buffer zone guidelines for rivers, wetlands and estuaries*. A buffer of 22 m was determined using the tool and is indicated in Figure 12. Due to the topography of the site, most of the buffer area falls outside of the proposed development area. However, some of the properties on the eastern side of the drainage line and at the head of the watercourse, are encroaching into the aquatic habitat buffer. The layout should be amended to exclude the buffer area from all development activities. It is important to note that all infrastructure, such as for roads and stormwater attenuation, need to be constructed outside of the buffer to ensure that the buffer is adequate in protecting the aquatic habitat. The buffer must also be properly revegetated with indigenous vegetation, with the help of a botanist, prior to commencement of construction.

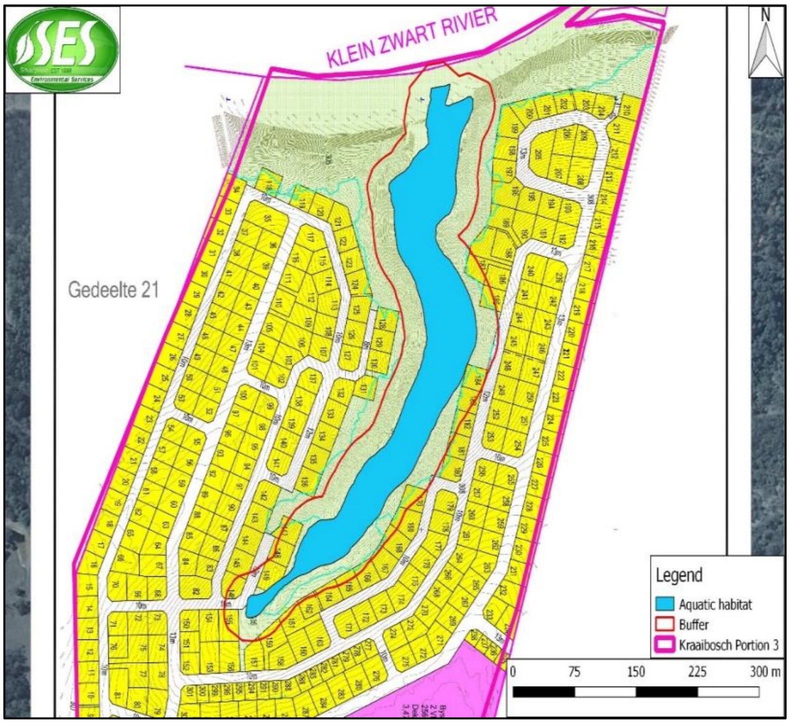

Figure 12: Buffer area surrounding the stream running through the centre of the property

The more ecologically important, intact vegetation is located near the bottom of the tributary, directly upslope of the road. The 1:4 setback line for development ensures an adequate buffer from this area. The open space above the natural vegetation forms part of the area left unvegetated as a result of the fire. This bare ground increases the risk of erosion occurring on the slopes and therefore these areas should be rehabilitated before construction to reduce sediment inputs. Figure 13 show an example of what could be implemented to stop erosion. All bare areas are also vulnerable to alien vegetation infestation and clearing will be the responsibility of the property owner. Taking this and the increased fire risk into account, it is recommended that the developer take the necessary measures to stabilize the slopes before construction. A botanist should be consulted to advise on how to revegetate the area with indigenous vegetation. Erosion within the drainage line/stream should also be rehabilitated with the help of an aquatic specialist.

Figure 13: An example of biodegradable netting, such as Bio Jute, for preventing erosion and rehabilitating areas of bare ground.

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. The gradient of the slopes should specifically be considered. It is therefore recommended that the stormwater management plan be developed with appropriate ecological input and be developed based on Sustainable Drainage Systems (SUDS).

8.2 Construction Phase

Preventing any construction, including workers and vehicles, from entering the buffer area is a key mitigation measure. The mitigation of impacts must focus on managing the runoff generated by the development and introducing it responsibly into the receiving environment. The stormwater flows must enter the aquatic areas in a diffuse flow pattern without pollutants. Removal of vegetation must only be when essential for the continuation of the project. Do not allow any disturbance to the adjoining natural vegetation cover or soils.

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 14). 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 14: Examples of soft infrastructure incorporated into the stormwater management design

Frequent stormwater outlets must be designed to prevent erosion at discharge points. On the steeper sections of the housing and road networks, it is recommended that the frequency of stormwater outlets is increased 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. Structures such as these must be located within the layout footprint and not encroach into the buffer areas.

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 budgeted for. Measures such as the placement of a grate at the road culvert inlet could potentially assist. The existing dam could be utilised as a retention pond for stormwater

Stockpiles must not be located within the buffer zone of the freshwater habitat. The furthest threshold must be adhered to. 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 construction phase should also be undertaken to ensure that functions are not undermined by inappropriate activities.

Figure 15 and 16 show examples of measures that can be put in place to restrict erosion and sedimentation caused by construction activities.

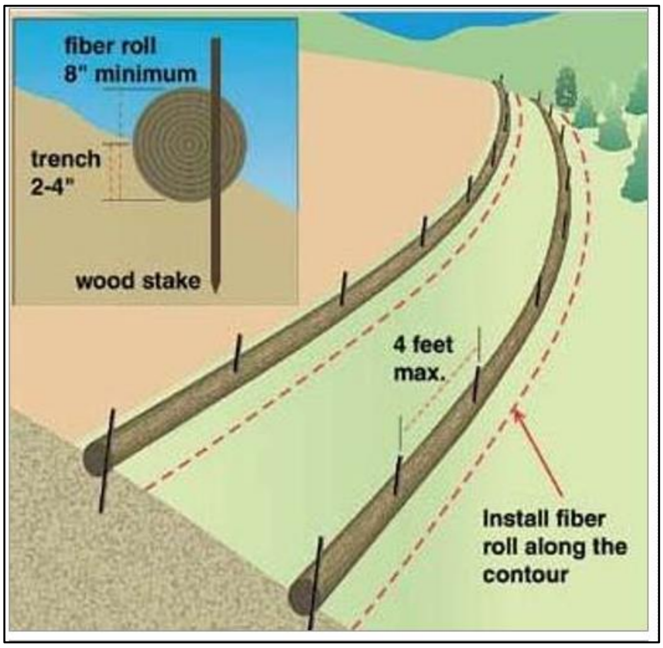

Figure 15: An example of a construction and/or rehabilitation methods to prevent erosion on the hillslope due to any soil disturbance and vegetation clearance

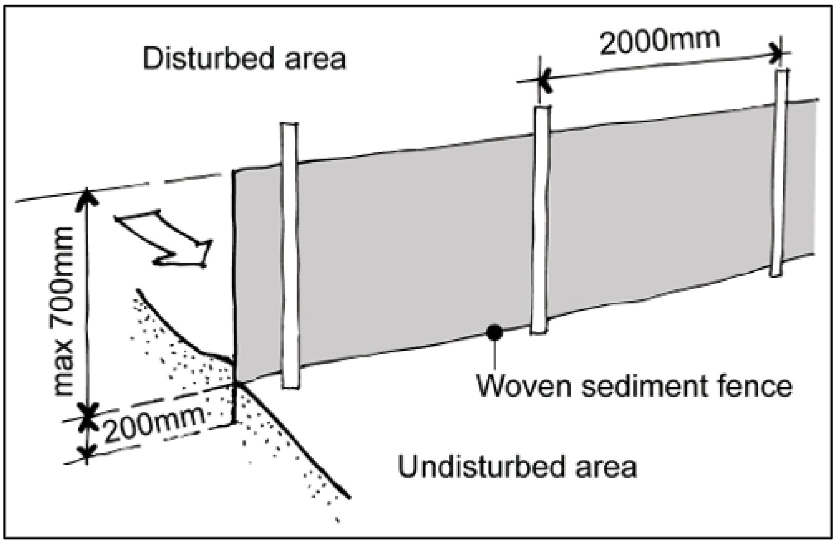

Figure 16: An example of a silt fence, which is a structure that could be put in place to restrict disturbance to the upslope area and it could potentially be used to delineate the buffer area.

8.3 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:

- A rehabilitation plan must be compiled with the assistance of a botanist to ensure that the buffer area is revegetated with indigenous plant species in the correct manner. 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 12 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.

- 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 freshwater habitat.

8.4 Operational Phase

- The stormwater management infrastructure must be designed to ensure the runoff from the development is not highly concentrated before entering the buffer and open space 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. <u>These structures must be incorporated within the layout area.</u>
- The use and maintenance of grease traps/oil separators to prevent pollutants from entering the environment from stormwater are recommended.
- Constructing water tanks to catch rain water runoff from the roof for irrigating purposes will reduce stormwater runoff and possible erosion associated therewith. The same system can be put in place at the communal buildings. The runoff can be used for watering open space.
- Appropriate wastewater infrastructure must be designed to prevent any such water from entering the surrounding environment.
- Maintenance of the 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.
- Engage with the community to explain the reasons why the buffer and the water resources are protected and what human activities are allowed. The Home Owners Association could be involved in the monitoring and Fynbos rehabilitation.
- 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 the sensitive habitats. Information can include a description and visual of alien invasive plant species as well as plant name signage for indigenous Fynbos species. Promoting a sense of

ownership from the residents of their open space area will benefit them as well as the environment.

- Walkways following the contours through fynbos vegetation or a bird hide near the indigenous forest for bird viewing and to take in the scenic landscape are potential uses in this specific project. Signage displaying birdlife supported by indigenous vegetation can be erected to stimulate interest in and use of the recreational space. These uses are unlikely to impact on the stream and would rather assist it by making it valuable to the residents in the immediate area. It promotes the use of the open space area that contains freshwater habitat for recreational activities and advocates the adoption of a buffer zone.

9 CONCLUSION

The proposed development of Kraaibosch No. 195 Portion 3 will form part of the expansion of George to welcome more people to the scenic Garden Route. Development increase pressure on the environment which, in this case, include aquatic habitat and therefore one of the most valuable resources – water.

Development of this property will impact on an ephemeral stream in the drainage line running down the middle of the property and a small instream dam near the top of the tributary. The tributary stream merges into the Swart River on the property boundary and therefore development will also influence this larger system to a certain extent. Neither the NFEPA nor the WCBSP data identifies the tributary as being of aquatic importance. The stream has been degraded by the impacts of agriculture and alien plant infestation and becomes an eroded gully towards the bottom of the valley. The catchment is mainly comprised of grazing pastures covered in grass species. Alien trees such as Pines and Black Wattle (*Acacia mearnsii*) cover the steep slopes. Both alien and indigenous flora comprise the riparian vegetation. According to the PES and EIS results the stream is in a fair condition and of low ecological importance.

The potential impacts development will have on the tributary stream were identified as freshwater habitat loss, sedimentation and erosion, water pollution, and flow modification. The impacts of the development were determined to be of Medium significance but could, to a large degree, be decreased to Low if the necessary mitigation measures are implemented. The steep slopes require strict adherence to the No-Go buffer zone as they enhance the impacts of erosion and flow modification. Erosion and sedimentation pose the biggest risk to aquatic habitat and therefore all mitigation measures pertaining to this impact should be strictly adhered to. Monitoring of the site should take place to ensure these mitigation measures as set out in this report and those of the EMPr are followed.

The project is considered to be acceptable from an aquatic perspective. It is recommended that a water use licence in terms of Section 21(c) and (i) of the NWA (1998) be applied for due to the proposed activities triggering these water uses.

10 REFERENCES

ARMITAGE, N., VICE, M., FISHER-JEFFES, L., WINTER, K., SPIEGEL, A., & DUNSTAN, J. 2013. Alternative Technology for Stormwater Management: *The South African Guidelines for Sustainable Drainage Systems.* Report to the Water Research Commission. Pretoria

BROMILOW, C. 2001. Problem Plants of South Africa: A Guide to the Identification and Control of more than 300 invasive plants and other weeds. Briza Publications, Pretoria.

COWDEN, C. & Kotze, D.C. 2009. WETRehabEvaluate: Guidelines for monitoring and evaluating wetland rehabilitation projects. WRC Report No TT 342/09, Water Research Commission, Pretoria.

CSIR (Council for Scientific and Industrial Research). 2010. National Aquatic Ecosystem Priority Areas (NFEPA). Council for Scientific and Industrial Research, Pretoria, South Africa.

DAY, L., ROWNTREE, M., & KING, H. 2016. The Development of a Comprehensive Manual for River Rehabilitation. WRC Report No TT 646/15. Water Research Commission, Pretoria.

DEPARTMENT OF ENVIRONMENTAL AFFAIRS, DEPARTMENT OF MINERAL RESOURCES, CHAMBER OF MINES, SOUTH AFRICAN MINING AND BIODIVERSITY FORUM, AND SOUTH AFRICAN NATIONAL BIODIVERSITY INSTITUTE. 2013. Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector. Pretoria.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, 1999a. Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems Version 1.0, Pretoria.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, 2005. A Practical Field Procedure for Identification and Delineation of Wetland and Riparian areas. Edition 1, September 2005. DWAF, Pretoria.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, 2007. Internal Guideline: Generic Water Use Authorisation Application Process

DEPARTMENT OF WATER AFFAIRS (DWA), 2014. Reserve Determination Studies for Surface Water, Groundwater, Estuaries and Wetlands in the Gouritz Water Management Area: *Desktop EcoClassification Report*. Prepared by Scherman Colloty & Associates. Report no. RDM/WMA16/00/CON/0213.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY. 2009. DWAF Training Manual: National Water Act Section 21(c) and (i) Water Uses. Version: November 2009.

DRIVER, A., NEL, J.L., SNADDON, K., MURRAY, K., ROUX, D.J., HILL, L., SWARTZ, E.R., MANUEL, J. & FUNKE, N. 2011. *Implementation Manual for Aquatic Ecosystem Priority Areas. Report to the Water Research Commission*. Pretoria

DWAF. 2008. Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas, prepared by M. Rountree, A. L. Batchelor, J. MacKenzie and D. Hoare. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa

KLEYNHANS, C.J. 1996. Index of Habitat Integrity (IHI).

KOTZE, D.C., MARNEWECK, G.C., BATCHELOR, A.L., LINDLEY, D.S. & COLLINS, N.B. 2009. WET-Ecoservices: A technique for rapidly assessing ecosystem services supplied by wetlands.

NAIMAN, R.J., & H. DECAMPS. 1997. The ecology of interfaces -- riparian zones. Annual Review of Ecology and Systematics 28:621-658

MACFARLANE, D.M. & BREDIN, I.P. 2016. Buffer zone guidelines for rivers, wetlands and estuaries. Part 2: Practical Guide. WRC Report No (tbc), Water Research Commission, Pretoria.

MACFARLANE, D.M., KOTZE, D.C., ELLERY, W.N., WALTERS, D., KOOPMAN, V., GOODMAN, P. & GOGE, C. 2008. WET-Health: A technique for rapidly assessing wetland health, Version 2.

MUCINA, L. & RUTHERFORD, M. C. (EDS) 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

LAWRENCE, D.P. 2007. Impact significance determination - Designing an approach. Environmental Impact Assessment Review 27: 730 - 754.

ROGERS KH. 1995. Riparian Wetlands. In: Wetlands of South Africa, Cowan GI (ed). Department of Environmental Affairs and Tourism: Pretoria.

TURPIE J; TALJAARD S; VAN NIEKERK L; ADAMS J; WOOLDRIDGE T; CYRUS D; CLARK B; & FORBES N. 2013. The Estuary Health Index: A standardised metric for use in estuary management and the determination of ecological water requirements. WRC Report No 1930/1/12.

VAN GINKEL, C.E., GLEN, R.P., GORDAN-GRAY, K.D., CILLIERS, C.J., MUASYA AND VAN DEVENTER, P.P., 2011. Easy identification of some South African Wetland Plants (Grasses, Resticios, Sedges, Rushes, Bulrushes, Eriocaulons and Yellow-eyed grasses). WRC Report No. TT 459/10.

VLOK, J. 2010. Specialist botanical report for the proposed development of the farm Kraaibosch (Farm 195/3, George). Regalis Environmental Services.

11 ANNEXURE (METHODOLOGIES)

11.1 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.

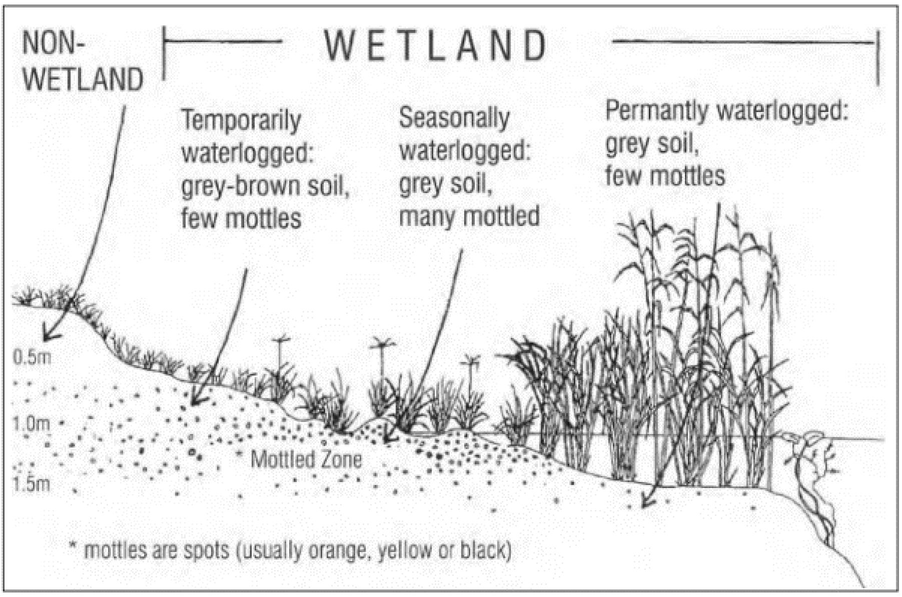

Figure A11.1a: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the middle to the edge of the wetland. Source: Donovan Kotze, University of KwaZulu-Natal.

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).

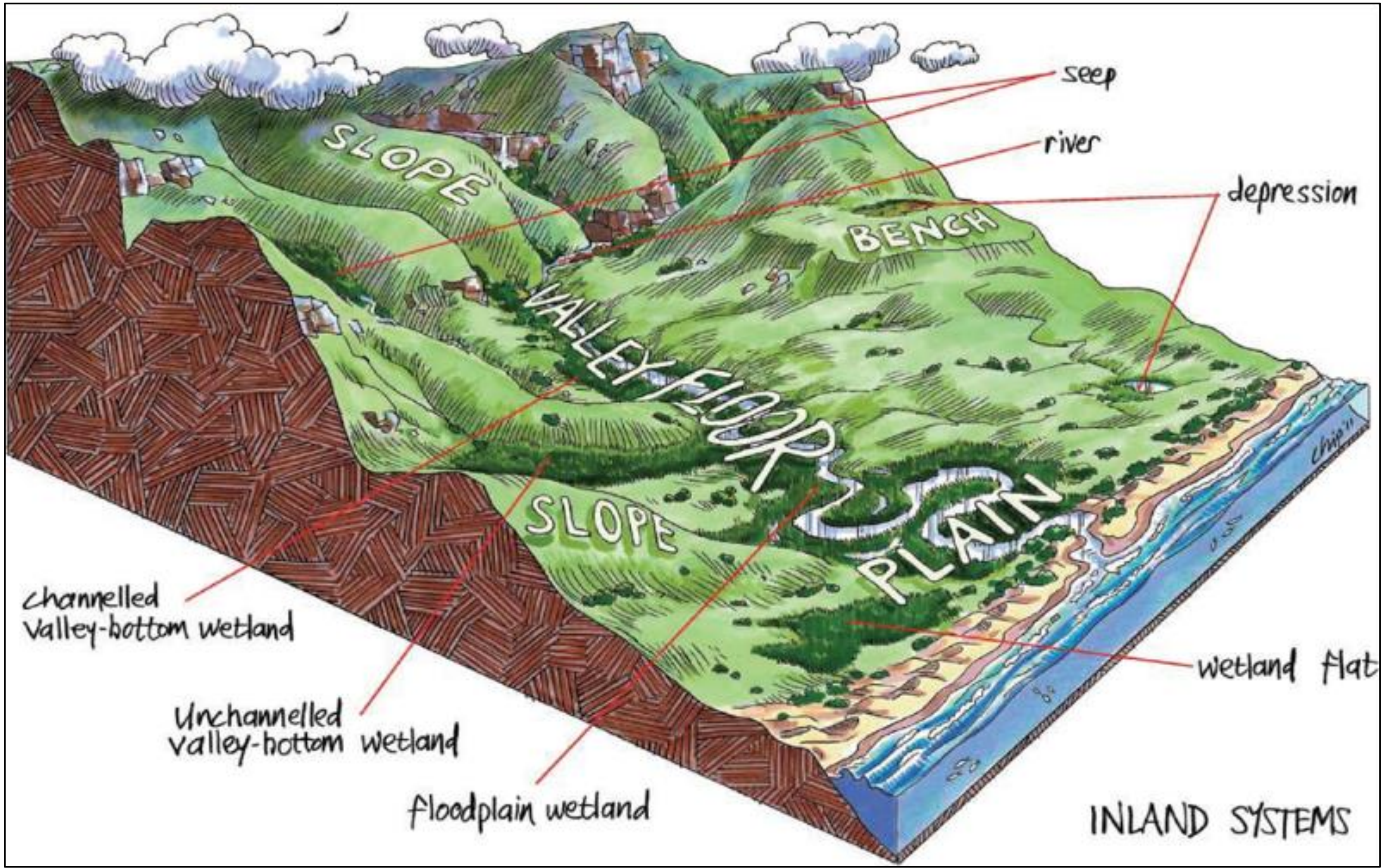

Figure A11.1b: Illustration of wetland types and their typical landscape setting (From Ollie et al. 2013)

11.2 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" i , Riparian zones can be 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.

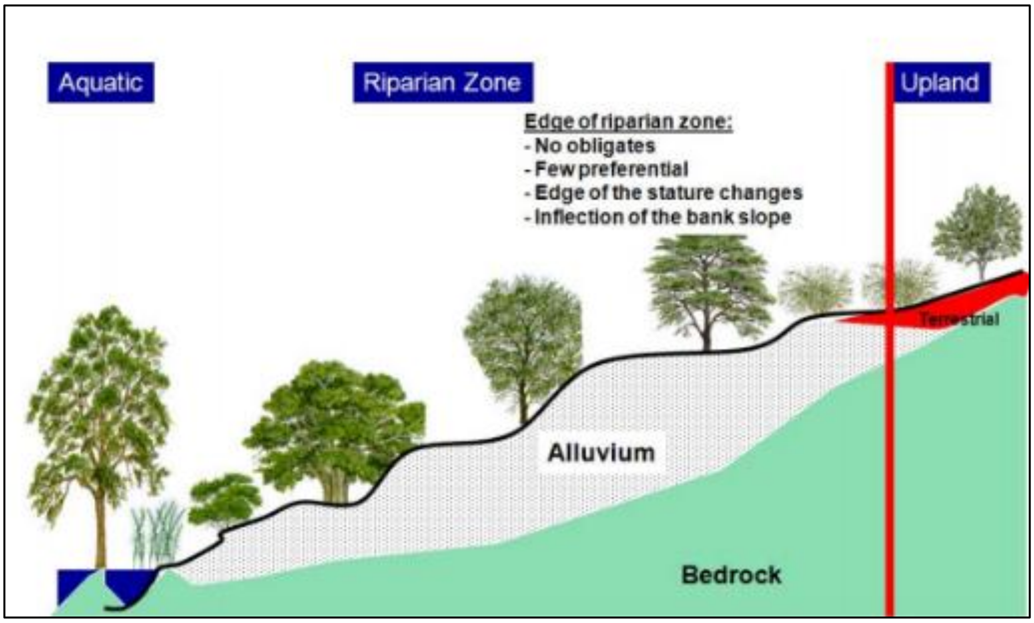

Figure A11.2a: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river. Note the coincidence of the inflection (in slope) on the bank with the change in vegetation structure and composition. The edge of the riparian zone coincides with an inflection point on the bank;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

11.3 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**
Moderat e	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.

11.4 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					
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.

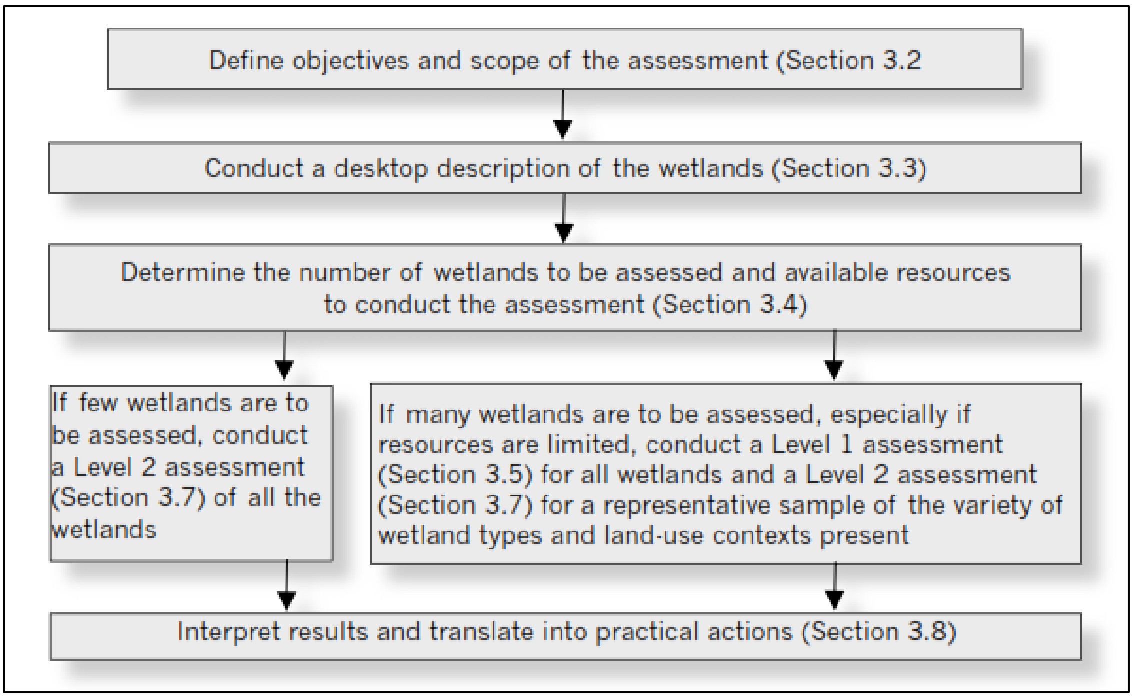

Figure A11.4a: Steps required for Wet-EcoServices. The sections referred to within this figure relate back to the Wetland Management Series: Wet-Ecoservices. WRC Report TT 339/08

11.5 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

11.6 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.

11.7 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

11.8 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).

12 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