Upstream Consulting

Aquatic specialist services

- Cell: 072 444 8243
- Email: debbie@upstreamconsulting.co.za
- Address: 25 Blommekloof Street, George, 6530

www.upstreamconsulting.co.za

AQUATIC BIODIVERSITY IMPACT ASSESSMENT

for the proposed

DEVELOPMENT OF A RESIDENTIAL ESTATE ON REMAINDER OF PORTION 21 OF FARM 195 (PIETER KOEN TRUST), GEORGE

DATE: 15 August 2023
Version 2

PREPARED FOR:

Sharples Environmental Services cc
102 Merriman Street
George
6529

PREPARED BY:

Debbie Fordham
Upstream Consulting
25 Blommekloof St, George, 6529
debbie@upstreamconsulting.co.za

Executive Summary

A residential development is proposed on the Remainder of Portion 21 of Farm 195, within the urban edge of George. The site falls within an area identified as having "Very High" aquatic sensitivity by the National Web based Environmental Screening Tool and therefore required an aquatic biodiversity impact assessment to inform the environmental authorisation process.

The site is located within the DWS Quaternary Catchment K30C and falls within the Coastal Gouritz Water Management Area. It is located within the Outeniqua Strategic Water Source Area for Surface Water. 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. There is a drainage line on the property which flows into the Swart River to the north. There are no aquatic CBA or ESA habitats within the development site. However, the Swart River is classified as CBA1 river habitat and must be conserved.

Seven watercourses, and a number of dams, were identified and mapped within a 500m radius of the proposed development. For reference purposes, the identified HGM units were named:

HGM1 – tributary stream
HGM2 – seep wetland
HGM3 – tributary stream
HGM4 – tributary stream
HGM5 – seep wetland
HGM6 – Swart River
HGM7 – Klein Swart River

HGM1 and HGM2, as well as three small dams, are located within the property boundary and will be directly impacted by development. The other watercourses, excepting HGM5, may be indirectly impacted due to changes in surface runoff from development upslope.

Site assessment determined that the non-perennial tributary streams are in a Largely Modified ecological state. The catchment has been subjected to land transformation for agriculture. The disturbances have resulted in habitat loss, altered channel morphology, and the proliferation of alien invasive plant species within the riparian area. The EIS of these ephemeral streams was determined to be Low. No endemic or conservation worthy aquatic species (Listed or Protected) were observed. However, it is recommended that the HGM1 stream be improved through further/ continued alien plant removal and the adoption of a 30m aquatic buffer zone.

It is recommended that the dam nearest to Glenwood Avenue is retained as an aquatic feature, but the contour dams do not need to be conserved. The HGM2 seep wetland, which originates alongside the road on the southern boundary, is in a Severely Modified condition (falling within the E category for PES assessment). Development downstream of the road has resulted in complete loss of wetland habitat in the lower reaches. However, the remaining wetland habitat of HGM2 on the property should be retained, to regulate stormwater runoff from the

development. A 12m buffer from the wetland edge is recommended. There should be no hard surfaces within the buffer areas, but they can be used as mixed-use open space for low impact activities, such as walking trails and picnic sites.

The direct and indirect impacts associated with the project were grouped into four encapsulating impact categories and assessed as:

- Impact 1: Increased surface water runoff and stormwater flow patterns on form and function during the construction and into the operational phase, i.e. changes to the hydrological regime
- Impact 2: Changes to hydrological regime that could also lead to sedimentation and erosion, which could also occur in the operational phase
- Impact 3: Potential impact on localised surface water quality
- Impact 4: Cumulative impacts on the aquatic resources of the area, such as the Swart River downstream

The impact significance upon aquatic biodiversity for the preferred project layout was determined as Low, after mitigation. The HGM1 stream is in a largely modified condition and the project activities, after mitigation, will not cause further deterioration of any water resources. A stormwater management plan (incorporating SUDS concepts) should be compiled to prevent further erosion within the watercourses, as well as prevent contaminated water from entering the surrounding environment. Positive impacts could be achieved through rehabilitation and long-term management of the riparian areas and buffer zones. There are no impacts associated with the No Go Alternative, but this assumes that sufficient resources will be allocated to manage the land and halt existing impacts (such as alien plant infestation and erosion). Provided stormwater is appropriately managed, the project should not impact upon the desktop mapped Strategic Water Source Area. There is currently no legislation directly related to SWSAs but by adhering to the NWA legislation the SWSA will not be compromised.

There are no fatal flaws associated with the project, provided all the mitigation measures are adopted. The mitigation of impacts must focus on preventing water pollution, maintaining aquatic habitat integrity, and managing the runoff generated by the development and introducing it responsibly into the receiving environment.

Specialist Assessment Protocol Index

Report reference to Table 1 - Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Aquatic Biodiversity

2. Aquatic Biodiversity Specialist Assessment	
2.1. The assessment must be prepared by a specialist registered with the South African Council for Natural Scientific Professionals (SACNASP), with expertise in the field of aquatic sciences.	Debbie Fordham SACNASP Registration number 119102 (Ecology)
2.2. The assessment must be undertaken on the preferred site and within the proposed development footprint.	Section 1- Introduction 1.1 –Location & 1.2 – Project description
2.3. The assessment must provide a baseline description of the site which includes, as a minimum, the following aspects:	
2.3.1. a description of the aquatic biodiversity and ecosystems on the site, including;	Section 6 – Affected Environment Section 7 - Results
(a) aquatic ecosystem types; and (b) presence of aquatic species, and composition of aquatic species communities, their habitat, distribution and movement patterns;	Section 6.1 – The Drainage Network Section 7.1 – Identified habitat
2.3.2. the threat status of the ecosystem and species as identified by the screening tool;	Very High 1.4 -Screening tool results Section 6.5 – Conservation context Section 6.4 - SAIIAE
2.3.3. an indication of the national and provincial priority status of the aquatic ecosystem, including a description of the criteria for the given status (i.e. if the site includes a wetland or a river freshwater ecosystem priority area or sub catchment, a strategic water source area, a priority estuary, whether or not they are free-flowing rivers, wetland clusters, a critical biodiversity or ecologically sensitivity area); and	Section 6 – Affected Environment CBA 1 River
2.3.4. a description of the ecological importance and sensitivity of the aquatic ecosystem including:	Section 7. Delineated aquatic habitat Section 6 & 7 – Affected Environment & Results
(a) the description (spatially, if possible) of the ecosystem processes that operate in relation to the aquatic ecosystems on and immediately adjacent to the site (e.g. movement of surface and subsurface water, recharge, discharge, sediment transport, etc.); and (b) the historic ecological condition (reference) as well as present ecological state of rivers (in-stream, riparian and floodplain	Section 6.1 – Drainage network Section 7.1 – Identified aquatic habitat Section 6.7 –Historic land use

habitat), wetlands and/or estuaries in terms of possible changes to the channel and flow regime (surface and groundwater).	
2.4. The assessment must identify alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification and which were not considered appropriate.	Section 7 – Results
2.5. Related to impacts, a detailed assessment of the potential impacts of the proposed development on the following aspects must be undertaken to answer the following questions:	
2.5.1. is the proposed development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?	Refer to Section 9 – Impact assessment and tables
2.5.2. is the proposed development consistent with maintaining the resource quality objectives for the aquatic ecosystems present?	
2.5.3. how will the proposed development impact on fixed and dynamic ecological processes that operate within or across the site? This must include:	Section 8 – Identified Impacts
(a) impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes (e.g. suppression of floods, loss of flood attenuation capacity, unseasonal flooding or destruction of floodplain processes); (b) will the proposed development change the sediment regime of the aquatic ecosystem and its sub-catchment (e.g. sand movement, meandering river mouth or estuary, flooding or sedimentation patterns); (c) what will the extent of the modification in relation to the overall aquatic ecosystem be (e.g. at the source, upstream or downstream portion, in the temporary / seasonal / permanent zone of a wetland, in the riparian zone or within the channel of a watercourse, etc.); and (d) to what extent will the risks associated with water uses and related activities change;	Section 8.2 –Flow pattern changes 8.3 - Erosion and Sedimentation Section 8.1 – Loss of riparian habitat Section 8.4 Water Quality impacts
2.5.4. how will the proposed development impact on the functioning of the aquatic feature? This must include:	Section 9 – Impact Significance Assessment
(a) base flows (e.g. too little or too much water in terms of characteristics and requirements of the system); (b) quantity of water including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over-abstraction or instream or off-stream impoundment of a wetland or river); (c) change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an unchannelled valley-bottom wetland to a channelled valley-bottom wetland); (d) quality of water (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication); (e) fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal); and	Refer to Section 9 – Impact assessment and tables Section 8 – Identified Impacts Section 9 Impact Assessment

(f) the loss or degradation of all or part of any unique or important features associated with or within the aquatic ecosystem (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soils, etc.);	
2.5.5. how will the proposed development impact on key ecosystems regulating and supporting services especially:	Low Impact (after mitigation) Section 9 – Impact Significance Assessment
(a) flood attenuation; (b) streamflow regulation; (c) sediment trapping; (d) phosphate assimilation; (e) nitrate assimilation; (f) toxicant assimilation; (g) erosion control; and (h) carbon storage?	Section 8 – discussion of identified impacts
2.5.6. how will the proposed development impact community composition (numbers and density of species) and integrity (condition, viability, predator-prey ratios, dispersal rates, etc.) of the faunal and vegetation communities inhabiting the site?	Section 8 and Impact Table of Section 9
2.6. In addition to the above, where applicable, impacts to the frequency of estuary mouth closure should be considered, in relation to: (a) size of the estuary; (b) availability of sediment; (c) wave action in the mouth; (d) protection of the mouth; (e) beach slope; (f) volume of mean annual runoff; and (g) extent of saline intrusion (especially relevant to permanently open systems).	Section 7.1.1 – Swart River
2.7. The findings of the specialist assessment must be written up in an Aquatic Biodiversity Specialist Assessment Report that contains, as a minimum, the following information:	
2.7.1. contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae;	Appendix 2 – Specialist curriculum vitae
2.7.2. a signed statement of independence by the specialist;	Below Declaration of Independence –Page vi
2.7.3. a statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	4.2 – Site assessment Section 4 – Approach and methodology Section 5 - Assumptions
2.7.4. the methodology used to undertake the site inspection and the specialist assessment, including equipment and modelling used, where relevant;	Section 4 – Approach and methodology

Declaration of Independence

SPECIALIST REPORT DETAILS

This report has been prepared as per the requirements of the Environmental Impact Assessment Regulations and the National Environmental Management Act (Act 107 of 1998), any subsequent amendments and any relevant National and / or Provincial Policies related to biodiversity assessments. This also includes the minim requirements as stipulated in the National Water Act (Act 36 of 1998), as amended in Water Use Licence Application and Appeals Regulations, 2017 Government Notice R267 in Government Gazette 40713 dated 24 March 2017, which includes the minimum requirements for an Aquatic Biodiversity Report.

Report prepared by: Debbie Fordham (Ecology 119102)

Expertise / Field of Study: Internationally certified Professional Wetland Scientist and registered SACNASP ecologist, with 10 years of working experience, specialising in aquatic ecology. Debbie holds a M.Sc. degree in Environmental Science from Rhodes University, by thesis, entitled: The geomorphic origin and evolution of the Tierkloof Wetland, a peatland dominated by *Prionium serratum* in the Western Cape. She is a member of scientific organisations such as the Society of Wetland Scientists (SWS), the South African Wetland Society (SAWS), and the Southern African Association of Geomorphologists (SAAG).

I, **Debbie Fordham** declare that this report has been prepared independently of any influence or prejudice as may be specified by the National Department of Environmental Affairs Fisheries and Forestry and or Department of Water and Sanitation.

Signed:… .... Date:…15 August 2023………

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1 INTRODUCTION

Debbie Fordham of Upstream Consulting has been appointed by Sharples Environmental Services cc, to undertake an aquatic biodiversity impact assessment for the proposed residential development on the Remainder of Portion 21 of Farm 195, in George. The site falls within an area identified as having "Very High" aquatic sensitivity by the National Web based Environmental Screening Tool due to its location within a Strategic Water Source Area for Surface Water. The proposal therefore requires an aquatic specialist study to inform the NEMA environmental authorisation process.

1.1 LOCATION

The Remainder of Portion 21 of Farm 195 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. (Figure 1). The land use of the surrounding area, historically made up of small holdings and forestry plantations, is increasingly changing to residential developments (such as Kraaibosch Estate and Groenkloof Estate on the opposite side of Glenwood Avenue).

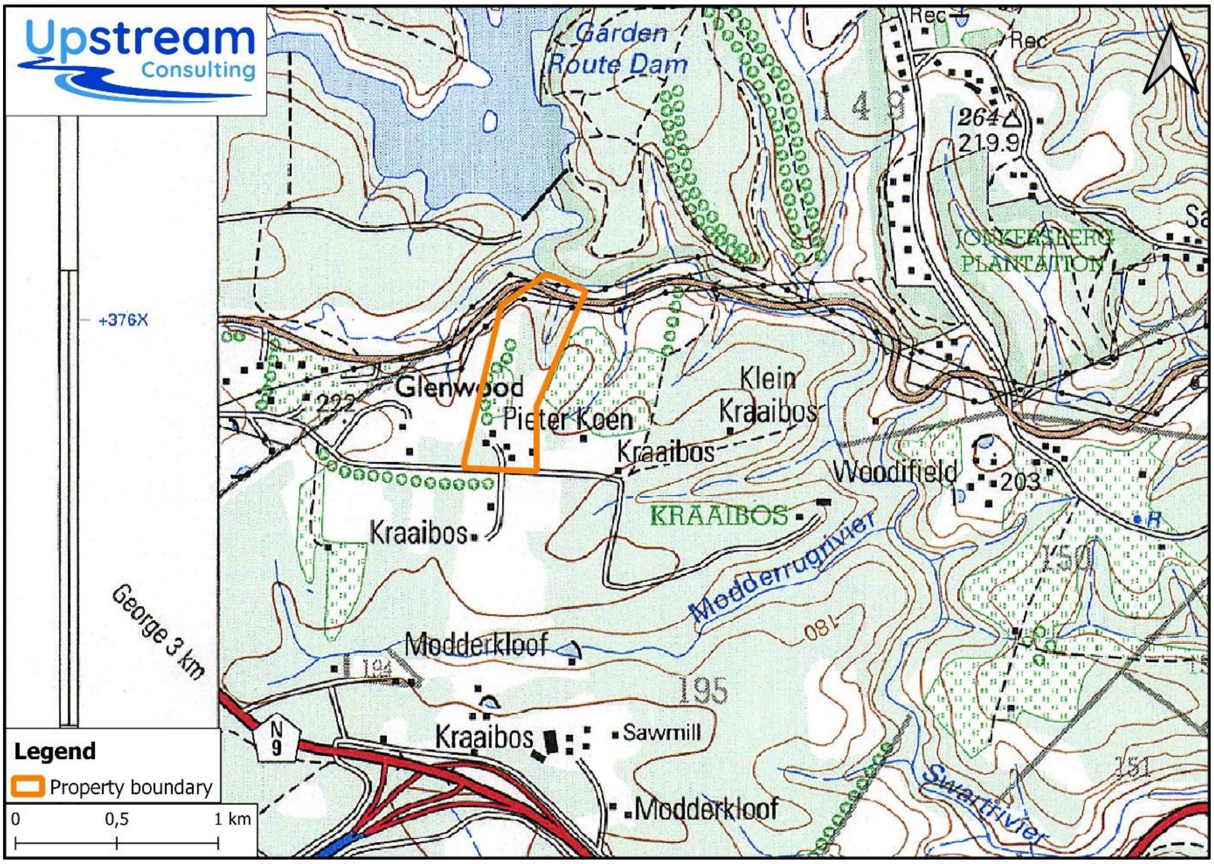

Figure 1: The location of the Remainder of Portion 21 of Farm 195

1.2 Project Description

The property is 23.30 ha in extent and 17 ha are available for housing. A conceptual layout plan, dated 2022, was provided for aquatic assessment in January 2023 and a site sensitivity assessment was undertaken. A report was compiled which recommended that a 30m river buffer zone and stormwater management measures should be included in the layout plan to prevent further erosion within the watercourses, as well as prevent contaminated water from entering the surrounding environment. Following the initial report, and an on-site project meeting, the aquatic specialist input was then taken forward and considered within the formal EA process.

In August 2023, an amended development layout plan was provided for further aquatic biodiversity impact assessment. The latest development layout, dated 2023, shows the recommended river buffer zone and the proposed stormwater management measures. Additional information has also since become available for inclusion in the aquatic impact assessment, such as the location of water and sewage infrastructure.

Therefore, two alternative project layouts have been assessed for their impact upon aquatic biodiversity, namely Alternative A (the latest site layout plan) and Alternative B (the 2022 site layout plan).

1.2.1 Alternative A

Alternative A is the preferred project alternative presented for environmental authorisation. The recommended mitigation measures of the initial aquatic specialist report (including buffer and no-go area shapefiles) have been applied in this site layout alternative.

Refer to Figure 2 for the latest site layout plan, assessed as Alternative A (SDK Architects, 2023), showing the following estate components:

A. 128 Single Residential II Zoning – 3 Storey Apartments
B. Business Zone III with neighbourhood shop and flats above
C. Historic Precinct (Clubhouse, Restaurant, Gym)
D. 36 High density group housing (cottages)
E. 64 Group housing
F. 79 Single residential erven

Total opportunities = 307

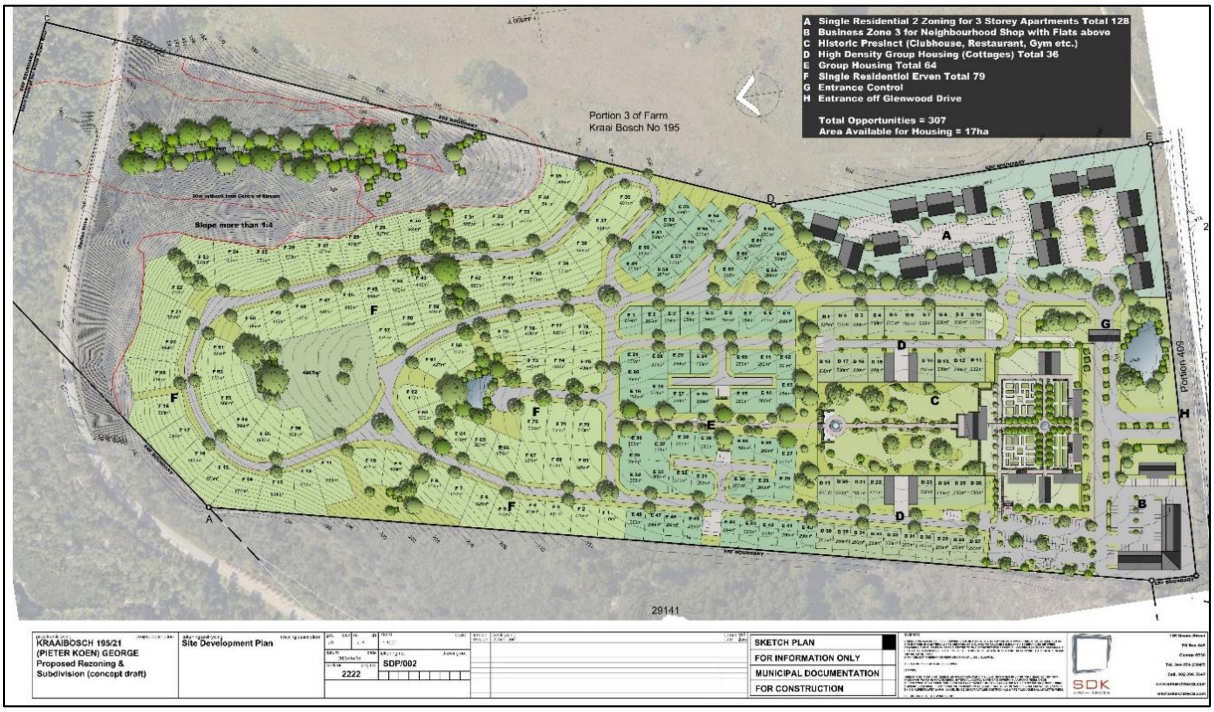

Figure 2: Conceptual layout of Alternative A for the proposed development (SDK Architects, 2023)

1.2.2 Alternative B

Alternative B is the conceptual development layout plan provided for initial assessment (SDK Architects, 2022).

The Alternative B estate plan comprises of the following:

A. 128 Single Residential II Zoning – 3 Storey Apartments
B. Business Zone III with neighbourhood shop and flats above
C. Historic Precinct (Clubhouse, Restaurant, Gym)
D. 40 High density group housing (cottages)
E. 47 Group housing
F. 101 Single residential erven

Total opportunities = 316

Figure 3 is a conceptual layout of Alternative B.

Figure 3: Conceptual layout of Alternative B for the proposed development (SDK Architects, 2022)

1.2.3 Civil Design information

The relevant information below is taken from the layouts and design reports provided:

1.2.3.1 Water

George Municipality have confirmed that they will have sufficient supply of treated potable water to provide this proposed development with an on-site connection. It is my understanding of the information and drawings provided that a water pipeline is proposed to cross the watercourse.

1.2.3.2 Sewage disposal

The sewage master plan of the Local Authority does allow for this development in terms of bulk disposal and treatment of the sewage outfall. The Local Authority has confirmed the availability of this service. The estimated sewerage effluent quantity produced for the development and based on the water demand will be 135,57 kl/day. This equates to a peak flow of 4,87 l/s. The developer will be responsible to deliver sewage by gravity or by pumping to an existing outfall sewer which is in close proximity to the proposed development (to the west and east of the site). Two temporary pumpstations will be required to pump effluent from the east to the west side of the Development. These temporary measures will be constructed and maintained by the developer. Once the developments to the east have been implemented the temporary measures will be substituted by connecting the pump stations to the gravity system to the east.

It is my understanding that a sewage pipeline is proposed to be buried through the riparian area of the watercourse, and that the temporary measures include the construction of a pumpstation, located within 100m of the watercourse.

1.2.3.3 Stormwater Disposal and Management Plan

According to the civil report and drawings, the following is relevant: Stormwater infrastructure is envisaged to be provided by the developer – see drawing G5215BA-CE-102-A, G5215BA-CE-110-A and G5215BA-CE-111-A. All necessary precautions will be taken to prevent erosion.

1.2.3.3.1 Design Philosophy

Stormwater management will be according to recommendations contained in the Red Book i.e., Guidelines for Human Settlement Planning and Design as compiled by the CSIR. The principals of SuDS will further be considered to minimise the amount and impact of stormwater leaving the site. A dual drainage system will be adopted. Source control of the minor flood with 1:5 year or less recurrence intervals will be provided by the utilisation of roof water collection rainwater tanks to collect runoff from roofs for later use in irrigation of gardens etc. Local control will be facilitated by the use of catchment structures and will, where possible, be constructed per erf pockets as required. This will to some extent facilitate infiltration of water at source. The major flood with 1:50 year recurrence interval will be carried in the streets and the formal system (as per Guidelines) and only where the above minor system's capacity is exceeded, then in overland open or piped channels to the natural watercourses. During the detail design phase, storm runoff from catchment areas will be calculated and catchpit inlets will be positioned and sized to match runoff volumes. The capacity of road kerbs will also be checked against major runoff volumes. Stormwater servitudes will be provided between erven where necessary to accommodate overland open channels with sufficient capacity to carry major storm runoff from the edge of the road to the nearest natural watercourse.

1.2.3.3.2 Specific Considerations

Runoff from the land will increase because of the development, but this will be accommodated in the design of the minor and major stormwater system. The increased runoff will not affect any existing or proposed properties, since all properties are well above the 1:100 year flood lines for the major natural watercourse (Swart River).

1.2.3.3.3 Increased overland flow velocities

Various measures will be incorporated to mitigate increased flow velocities like:

• Energy dissipaters and stilling basins at stormwater pipe outlets. Reno mattress aprons with stilling basins where appropriate will be provided at all culvert outlets. Large rocks will be effective as energy dissipaters and will contribute to the landscaping.

• Lining of open channels with grass (swales) and or stone pitching where required.

• Utilisation of invader tree logs to act as flow speed calming structures placed across flow paths and anchored properly.

• Utilisation of Gabion type structures to act as flow speed calming elements placed across flow paths and anchored properly.

1.2.3.3.4 Quality of water

Long term contamination of stormwater run-off is not a concern as the development consists mostly of commercial and housing development. In line with the SuDS principals pipe culvert outlets will be provided with Gabion and Reno mattress structures to facilitate slowing of minor storm flows and to provide infiltration areas to augment subsurface flow. Possible pollutants will be trapped in these structures and can be cleaned out as part of a regular maintenance schedule. The site is most vulnerable during the construction phase, and it will be necessary to utilize silt screens and onion bags to trap silt before the run-off joins the natural watercourses. Once vegetation in all the disturbed areas of the development is well established and ground surfaces have consolidated, no further measures will be required. These measures will be the subject of the Environmental Management Plan (EMP) which will be issued to the contractor at construction stage. The Environmental Control Officer (ECO) will be responsible for enforcing the EMP.

1.2.3.3.5 Protection of slopes that occur on the property

Natural slopes that have been disturbed and where sheet flow occurs will be landscaped and revegetated. Where flow is concentrated, measures will be incorporated as proposed above. Where stormwater is channelled towards the river and tributary streams, outlets have been spaced at intervals along the stream edge to avoid concentration of large flows. Stormwater will thus be fed into the streams and river system along a wide front allowing dissipated flow and seepage to all areas.

1.2.3.4 Watercourse/River Crossings

It is not anticipated at this stage to have any road river crossings constructed.

1.2.3.4.1 Preliminary High level Flow Estimation

The figures provided below should be considered as estimated quantities only. Flow estimation has been done according to the Rational Method for the 1:5 years return period nl. stormwater accommodated in the underground piped system and stormwater accommodated as overland sheet flow per the existing topography. Flow is indicated for the east side contributing to the existing stream as follows.
Pre-development flows: - 202,63 l/s
Post-development flows: - 399,18 l/s
As can be seen the expected increase in flow is 196,55 l/s.

1.3 SCREENING TOOL RESULTS

The National Web based Environmental Screening Tool was utilised for this proposal in terms of the Environmental Impact Assessment (EIA) Regulations 2014, as amended, to screen the proposed site for any environmental sensitivity. The Screening Tool identifies related exclusions and/ or specific requirements including specialist studies applicable to the proposed site. The Screening Tool allows for the generating of a Screening Report referred to in Regulation 16 (1) (v) of the Environmental Impact Assessment Regulations 2014, as amended whereby a Screening Report is required to accompany any application for Environmental Authorisation. Requirements for the assessment and reporting of impacts of development on aquatic biodiversity are set out in the 'Protocol for the assessment and reporting of environmental impacts on aquatic biodiversity published in Government Notice No. 648, Government Gazette 45421, on the 10 of May 2020.

According to the Screening Report, the site has areas of "Very High" aquatic sensitivity and requires the assessment and reporting of impacts on Aquatic Biodiversity (Figure 4). The site verification assessment was undertaken and is attached as a Site Verification Report in Appendix 3. The Very High aquatic biodiversity sensitivity rating for parts of the site was confirmed. Therefore, the Aquatic Biodiversity Impact Assessment report was required and has been compiled in accordance with the latest NEMA Minimum Requirements and Protocol for Specialist Aquatic Biodiversity Impact Assessment (10 May 2020).

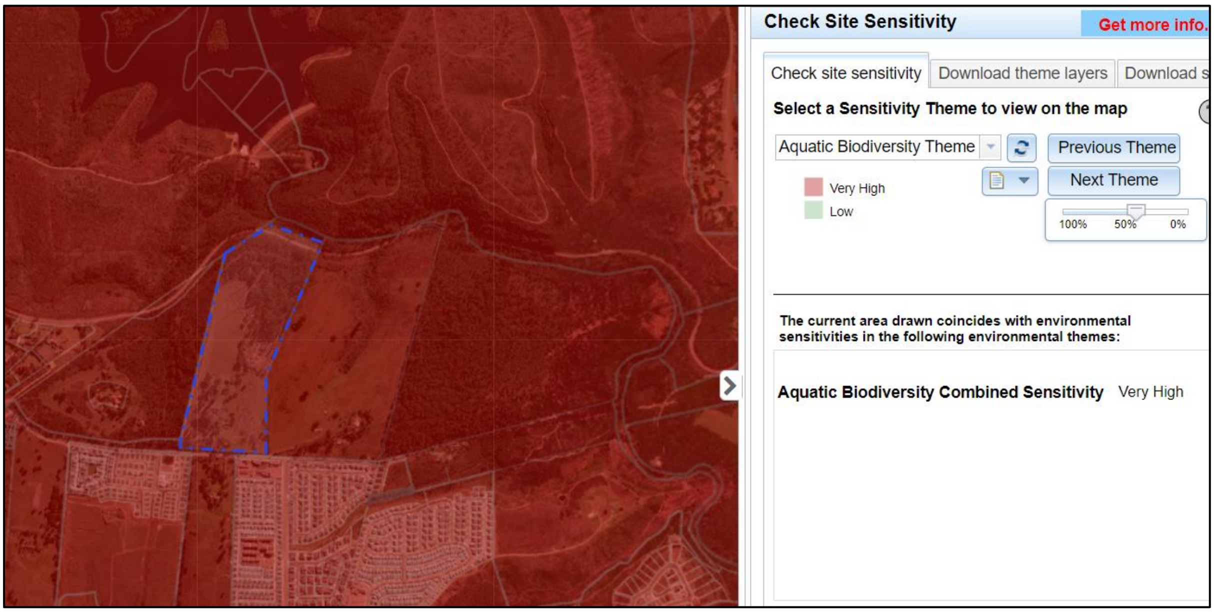

Figure 4: Aquatic biodiversity sensitivity map of the study area from the DFFE Screening Tool

2 RELEVANT LEGISLATION

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

Table 1: Relevant environmental legislation

Legislation	Relevance
South African Constitution 108 of 1996	The constitution includes the right to have the environment protected
National Environmental Management Act 107 of 1998	Outlines principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for coordinating environmental functions exercised by organs of state. Chapter 1(4r) states that

	sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure. Section 24 of NEMA requires that the potential impact on the environment, socio-economic conditions and cultural heritage of activities that require authorisation, must be investigated and assessed prior to implementation, and reported to the authority.
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	The proposed project requires water use authorisation in terms of Chapter 4 and Section 21 of the National Water Act No. 36 of 1998, and this must be secured prior to the commencement of activities. 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.
Conservation of Agricultural Resources Act (Act 43 of 1983)	The Conservation of Agricultural Resources Act (CARA) is to provide for the conservation of the natural agricultural resources by the maintenance of production potential of land, by the combating and prevention of erosion and weakening or destruction of the water sources, and by the protection of the vegetation and the combating of weeds and invader plants.
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.

3 TERMS OF REFERENCE

- Contextualization of the study area in terms of important biophysical characteristics and the latest available aquatic conservation planning information (including but not limited to the South African Inventory of Inland Aquatic Ecosystems (SAIIAE), vegetation, CBAs, Threatened ecosystems, any Red data book information, NFEPA data, broader catchment drainage and protected areas).
- Desktop delineation and illustration of all watercourses within and surrounding the study area utilising available site-specific data such as aerial photography, contour data and water resource data.
- Prepare a map demarcating the respective watercourses or wetland/s, within the study area. This will demonstrate, from a holistic point of view the connectivity between the site and

the surrounding regions, i.e. the hydrological zone of influence while classifying the hydrogeomorphic type of the respective water courses / wetlands in relation to present land-use and their current state. The maps depicting demarcated waterbodies will be delineated to a scale of 1:10 000, following the methodology described by the DWS.

- A risk/screening assessment of the identified aquatic ecosystems to determine which ones will be impacted upon and therefore require ground truthing and detailed assessment.
- Ground truthing, identification, delineation and mapping of the 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).
- Conduct a Present Ecological State (PES), functional importance assessment and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland and riparian habitats.
- Identification, prediction and description of potential impacts on aquatic habitat during the construction and operational phases of the project. Impacts are described in terms of their extent, intensity, and duration. The other aspects that must be included in the evaluation are probability, reversibility, irreplaceability, mitigation potential, and confidence in the evaluation.
- All direct, indirect, and cumulative impacts for each alternative will be rated with and without mitigation to determine the significance of the impacts.
- Recommend actions that should be taken to avoid impacts on aquatic habitat, in alignment with the mitigation hierarchy, and any measures necessary to restore disturbed areas or ecological processes.
- Rehabilitation guidelines for disturbed areas associated with the proposed project and monitoring.

4 APPROACH AND METHODS

This study followed the approaches of several national guidelines with regards to wetland/ riparian assessment. See Appendix 1. The following approach to the aquatic habitat assessment is undertaken:

4.1 DESKTOP ASSESSMENT METHODS

The contextualization of the study area was undertaken in terms of important biophysical characteristics and the latest available aquatic conservation planning information (i.e. existing data for coastal management lines, NFEPA identified rivers and wetlands, critical biodiversity areas (WBSP 2017), estuaries, vegetation units, ecosystem threat status, catchment boundaries, geology, land uses, etc.) in a Geographical Information System (GIS). A South African Inventory of Inland Aquatic Ecosystems (SAIIAE) was established during the National

Biodiversity Assessment of 2018 (Van Deventer *et al.* 2018). The SAIIAE offers a collection of data layers pertaining to ecosystem types and pressures for both rivers and inland wetlands. National Wetland Map 5 includes inland wetlands and estuaries, associated with river line data and many other data sets within the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) 2018. It is imperative to develop an understanding of the regional drainage setting and longitudinal dynamics of the watercourses and the coastal dynamic. The conservation planning information aids in the determination of the level 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 3.28 GIS software. These results, as well as professional experience, allowed for the identification of sensitive habitat that could potentially be impacted by the project and therefore required ground truthing and detailed assessment.

4.2 Baseline Assessment Methods

A site assessment was conducted on the 30th of January 2023 to confirm desktop findings, gather additional information, and define the boundaries of the aquatic habitat. General observations were made with regards to the vegetation, fauna and current impacts. 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 (Figure 5), for mapping of any potentially affected aquatic ecosystems, in alignment with standard field-based procedures in terms of the Department of Water and Sanitation (DWAF 2008) *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas*. The delineation is based upon observations of the landscape setting, topography, vegetation and soil characteristics (using a hand held soil auger for wetland soils).

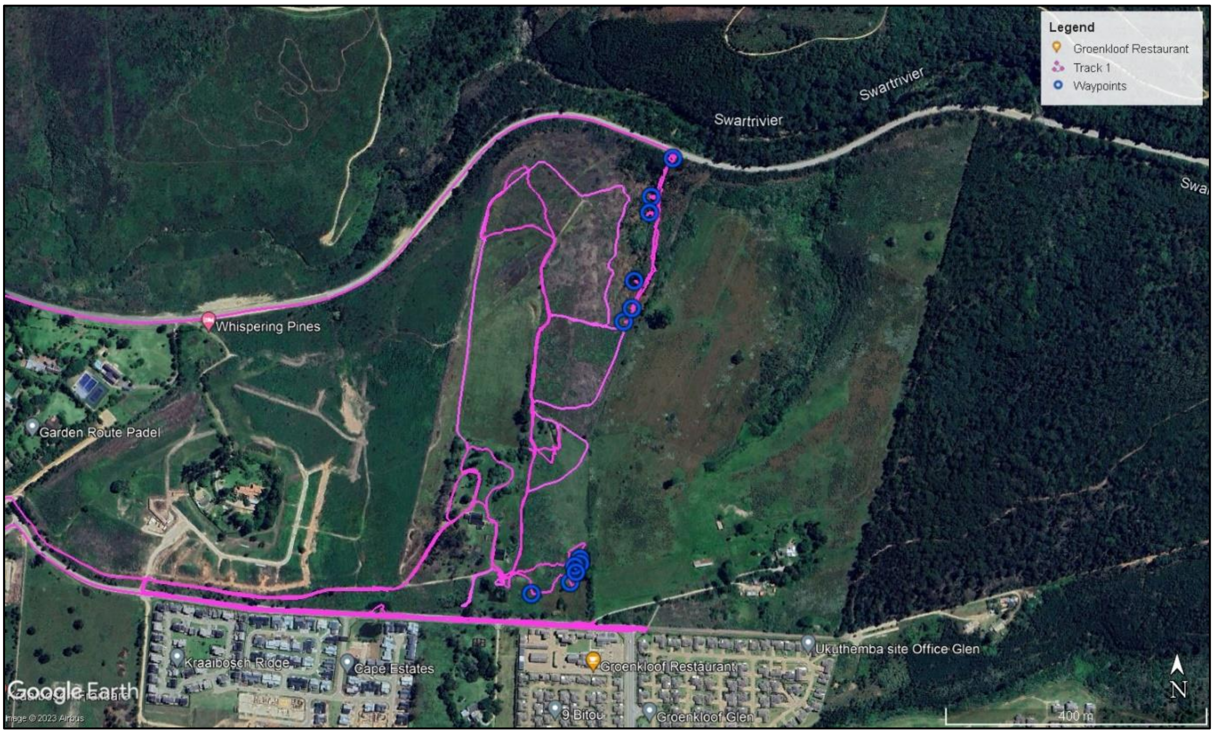

Figure 5: Map showing the GPS tracks associated with the site assessment

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

Determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland habitat was undertaken utilising:

- The health/condition or Present Ecological State (PES) of the wetland was assessed using the Level 2 WET-Health assessment tool Version 2 (Macfarlane et al. 2020), which is based on an understanding of both catchment and on-site impacts and the impact that these aspects have on system hydrology, geomorphology and the structure and composition of wetland vegetation.
- The WET-Ecoservices tool (Kotze et al., 2020) is utilised to assess the goods and services that the individual wetlands under assessment provide, thereby aiding informed planning and decision-making. Wetland benefits can be classified into goods/products (directly harvested from wetlands), functions/ services (performed by wetlands), and ecosystem scale attributes. 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).

4.3 Impact Assessment Methods

The approach adopted is to identify and predict all potential direct and indirect impacts resulting from an activity from planning to rehabilitation. Thereafter, the impact significance is determined. Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). The degree of significance depends upon three dimensions: the measurable characteristics of the impact (e.g. intensity, extent and duration), the importance societies/communities place on the impact, and the likelihood / probability of the impact occurring. Unknown parameters are given the highest score as significance scoring follows the Precautionary Principle. A methodology for assigning scores to the respective impacts is described in Appendix 1.

Cumulative impacts affect the significance ranking of an impact because the impact is taken in consideration of both onsite and offsite sources. For example, pollution making its way into a river from a development may be within acceptable national standards. Activities in the surrounding area may also create pollution which does not exceed these standards. However, if both onsite and offsite pollution activities take place simultaneously, the total pollution level may exceed the standards. For this reason, it is important to consider impacts in terms of their cumulative nature.

4.4 Mitigation and Monitoring

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. No-Go Areas will be determined, and any necessary monitoring protocol will be developed.

5 ASSUMPTIONS AND LIMITATIONS

- Aquatic ecosystems vary both temporally and spatially. Once-off surveys such as this can miss certain ecological information due to seasonality, thus limiting accuracy and confidence.
- The locations of the proposed activities were extrapolated from pdf. layouts provided by the client.
- While disturbance and transformation of habitats can lead to shifts in the type and extent of aquatic ecosystems, it is important to note that the current extent and classification is reported on here.
- All soil/vegetation/terrain sampling points were recorded using a Garmin Montana Global Positioning System (GPS) and captured using Geographical Information Systems (GIS) for further processing.

- Infield soil and vegetation sampling was only undertaken within a specific focal area around the proposed activities, while the remaining watercourses were delineated at a desktop level with limited accuracy.
- No detailed assessment of aquatic fauna/biota (e.g. fish, invertebrates, microphytes, etc.) was undertaken, and not deemed necessary.
- 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. Refer to the terrestrial specialist reports for further details on site vegetation.
- The scope of work did not include water quality sampling and the water quality characteristics were inferred from the biophysical characteristics of the area and catchment land uses.
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field survey and based on the assessor's working knowledge and experience with similar projects. The degree of confidence is considered high.

6 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The desktop/ screening study was informed by the available datasets relevant to water resources, as well as historic and the latest aerial imagery, to develop an understanding of the fluvial processes of the study area. A significant amount of the latest spatial data has been provided through the products of the 2018 National Biodiversity Assessment (NBA). The NBA is the primary tool for monitoring and reporting on the state of biodiversity in South Africa. It is used to inform policies, strategies and actions in a range of sectors for managing and conserving biodiversity more effectively. The desktop study was followed by the detailed site assessment. The general biophysical characteristics of the study area are described below.

6.1 BIOPHYSICAL CHARACTERISTICS

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 comprises mainly of phyllite and quartzite strata of the Kaaimans Group, with quartzitic sandstones of the Table Mountain Group (Cape Supergroup), as well as gneissic granite and granodiorite from George Batholith (Cape Granite), which are highly erodible (Figure 6).

According to Mucina and Rutherford (2012), the vegetation is sensitive in nature; mapped as Garden Route Shale Fynbos in the northern portion, and Garden Route Granite Fynbos covering the southern portion of the site (Figure 7). In the 2016 list of Threatened Ecosystems of the Western Cape (WCBSP), these vegetation units were classified as Endangered and Critically Endangered, respectively. However, in the latest National Biodiversity Assessment (2018) the Ecosystem Threat Status of Garden Route Shale Fynbos has been reduced to Vulnerable. Land transformation for agriculture and development, as well as alien tree infestation in this area, have replaced much of the natural vegetation.

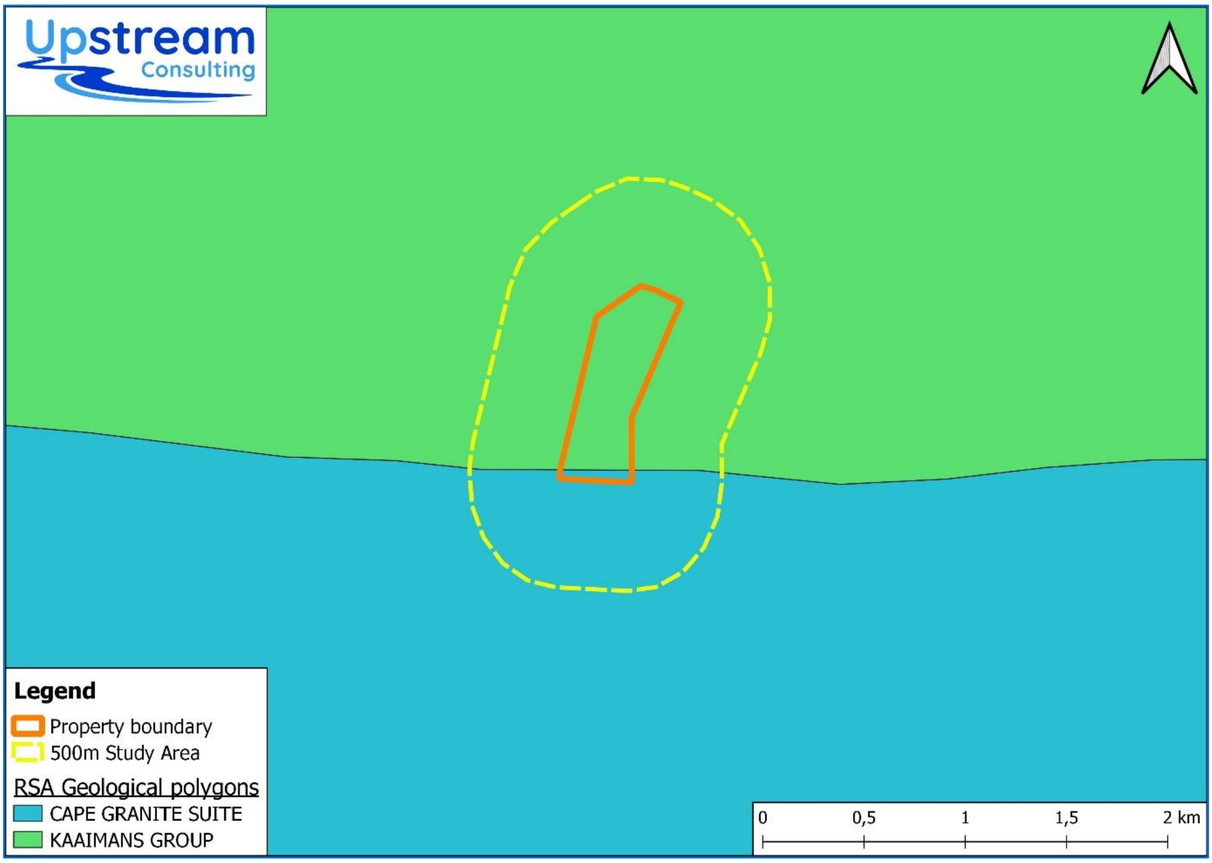

Figure 6: 1: 1 000 000 SA Geological Map of the study area

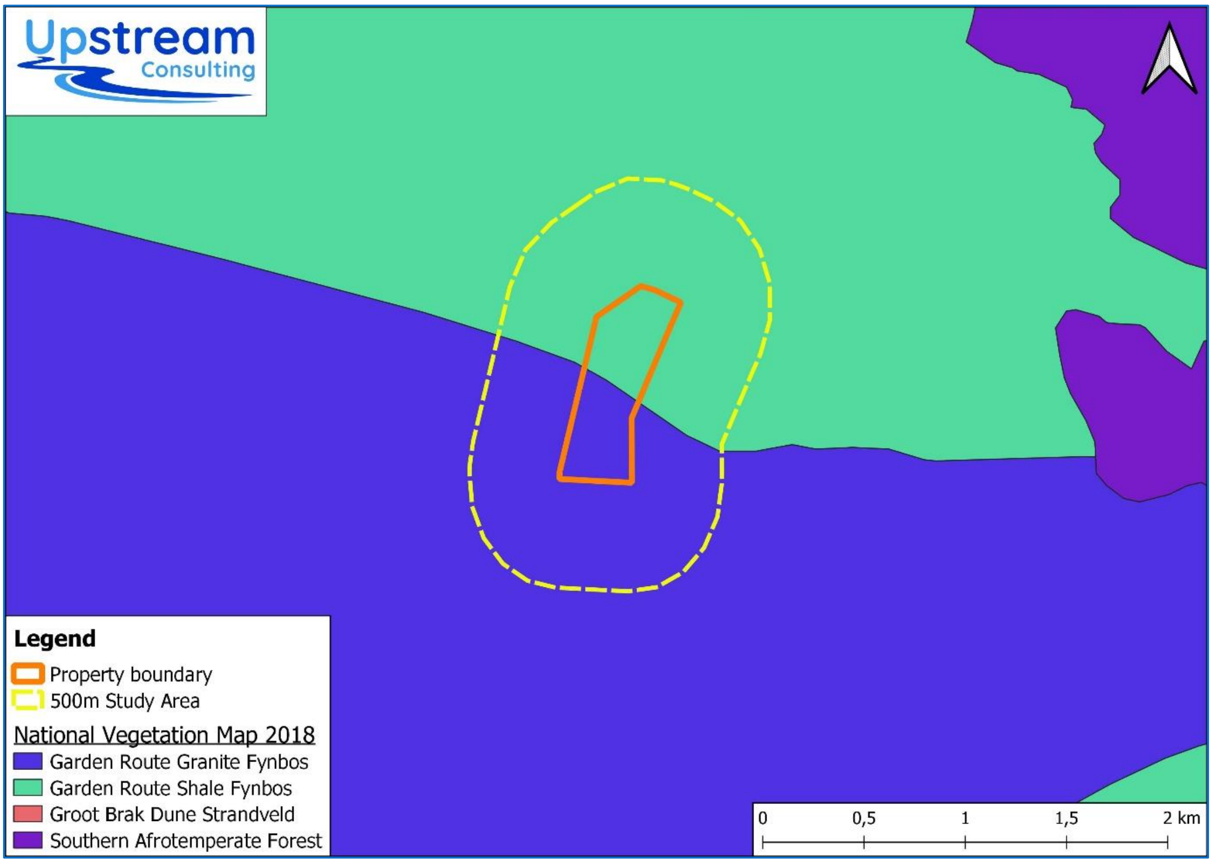

Figure 7: South African Vegetation Map 2018

6.2 DRAINAGE NETWORK

The site falls within the Southern Coastal Belt Ecoregion which is described by Kleynhans *et al.* (2005) as an area of hills and mountains with moderate to high relief and surrounding plains varying in altitude from sea level to 700 MASL.

The site is located within the DWS Quaternary Catchment K30C and falls within the Coastal Gouritz Water Management Area (Figure 8). 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').

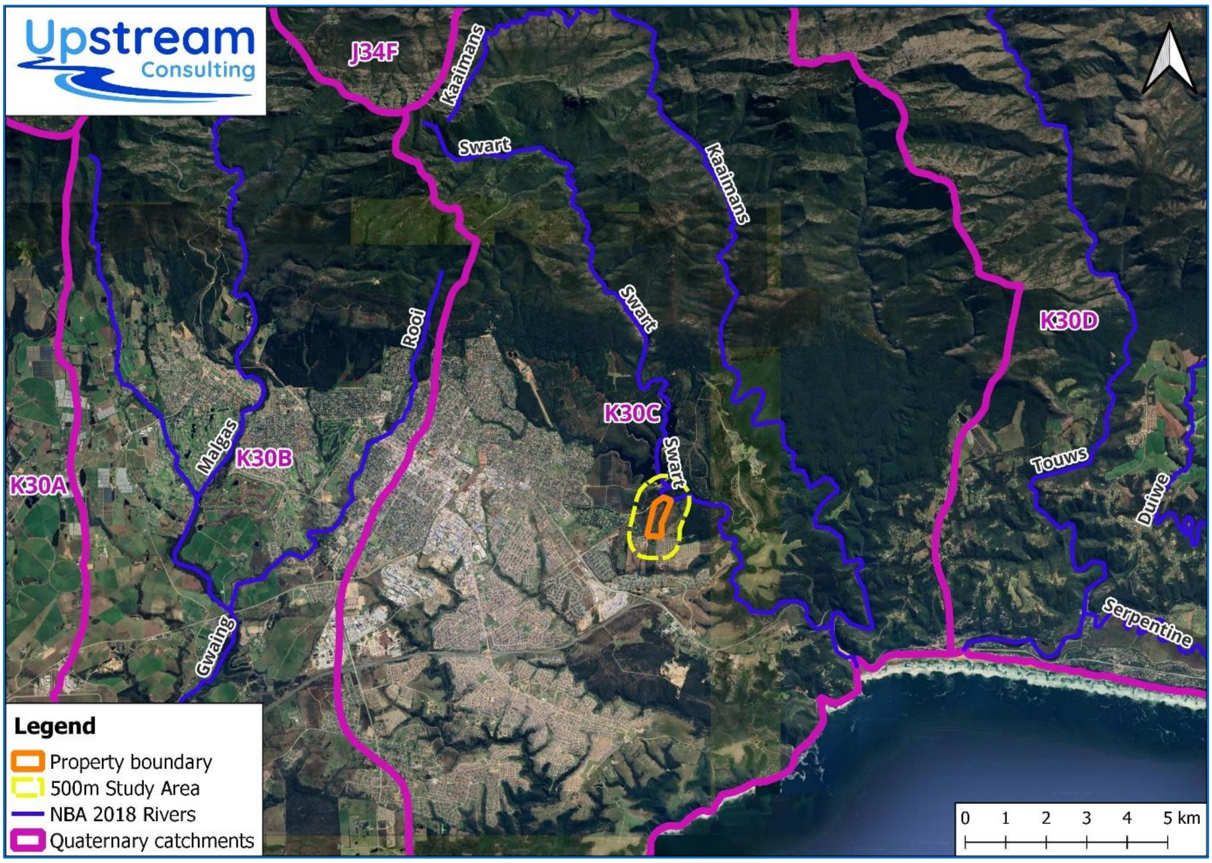

Figure 8: Map of the property in relation to the major rivers of quaternary catchment K30C

6.3 South African Inventory of Inland Aquatic Ecosystems

A South African Inventory of Inland Aquatic Ecosystems (SAIIAE) was established during the 2018 National Biodiversity Assessment (Van Deventer *et al.* 2018). The SAIIAE offers a collection of data layers pertaining to ecosystem types and pressures for both rivers and inland wetlands. The National Wetland Map 5 (NWM5) includes inland wetlands and estuaries, associated with river line data and many other data sets. The NWM5 shows no natural wetland ecosystems identified within the study area. The dataset does however identify the Garden Route Dam and a few farm dams as artificial wetland habitat (Figure 9).

The NBA 2018 Rivers Map is a GIS layer which summarises the river condition, river ecosystem types, flagship and free-flowing river information (Van Deventer *et al.* 2019). The river lines data set is associated with the National Wetland Map 5 (NWM5) issued with the SAIIAE. The GIS layer of origin is the 1:500 000 rivers data layer that DWAF coded for geomorphological zonations, with added data from the Chief Directorate Surveys and Mapping's (CDSM) 1:50 000 rivers GIS layer, and information generated during the NFEPA project in 2011. The NBA 2018 Rivers data only identifies the perennial Swart River flowing north of the property (Figure 9). The PES is within the 'D' category meaning that the Swart River has been largely modified in this reach. This can largely be attributed to the dam. The ecosystem threat status is classified as Least Threatened. The non-perennial systems depicted in Figure 9 are from the 1:500000 cadastral rivers data. This shows a drainage line in the northern half of the property; a non-perennial tributary of the Swart River.

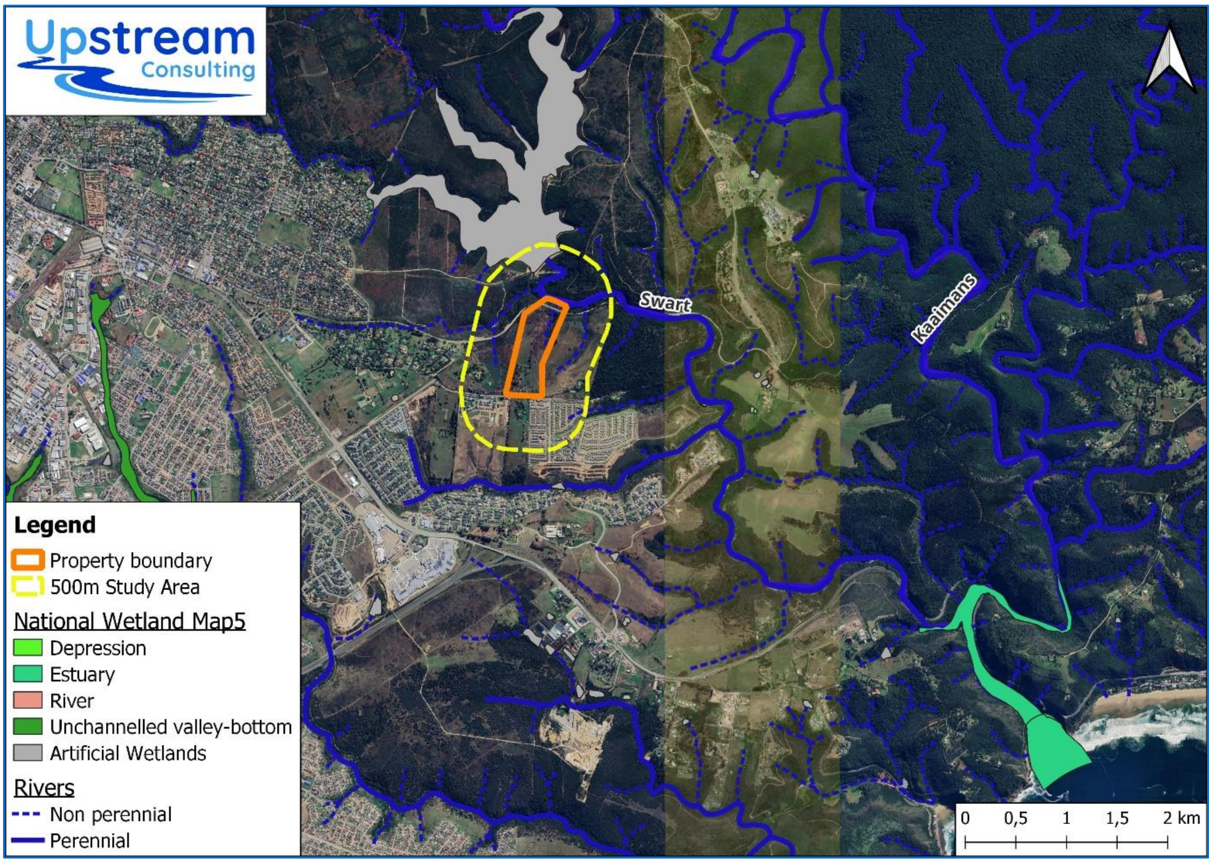

Figure 9: The project site in relation to the national river and wetland inventories (CSIR, 2018)

6.4 Strategic Water Source Areas

The study area is located within the Outeniqua Strategic Water Source Area for Surface Water (Figure 10). The mountainous area north of the site is mapped as the George and Outeniqua Strategic Water Source Area for Groundwater.

A Strategic Water Source Areas (SWSA) is where the water that is supplied is considered to be of national importance for water security. Surface water SWSAs are found in areas with high rainfall and produce most of the runoff. Groundwater SWSAs have high groundwater recharge and are located where the groundwater forms a nationally important resource. There are 22 national-level SWSAs for surface water (SWSA-sw) and 37 for groundwater (SWSA-gw). The SWSA-sw in South Africa, Lesotho and Swaziland occupy 10% of the land area and generate 50% of the mean annual runoff. They support at least 60% of the population, 70% of the national economic activity, and provide about 70% of the water used for irrigation. The SWSA-gw cover 9% of the area of South Africa, account for 15% of the recharge, 46% of the groundwater used by agriculture and 47% of the groundwater used by industry.

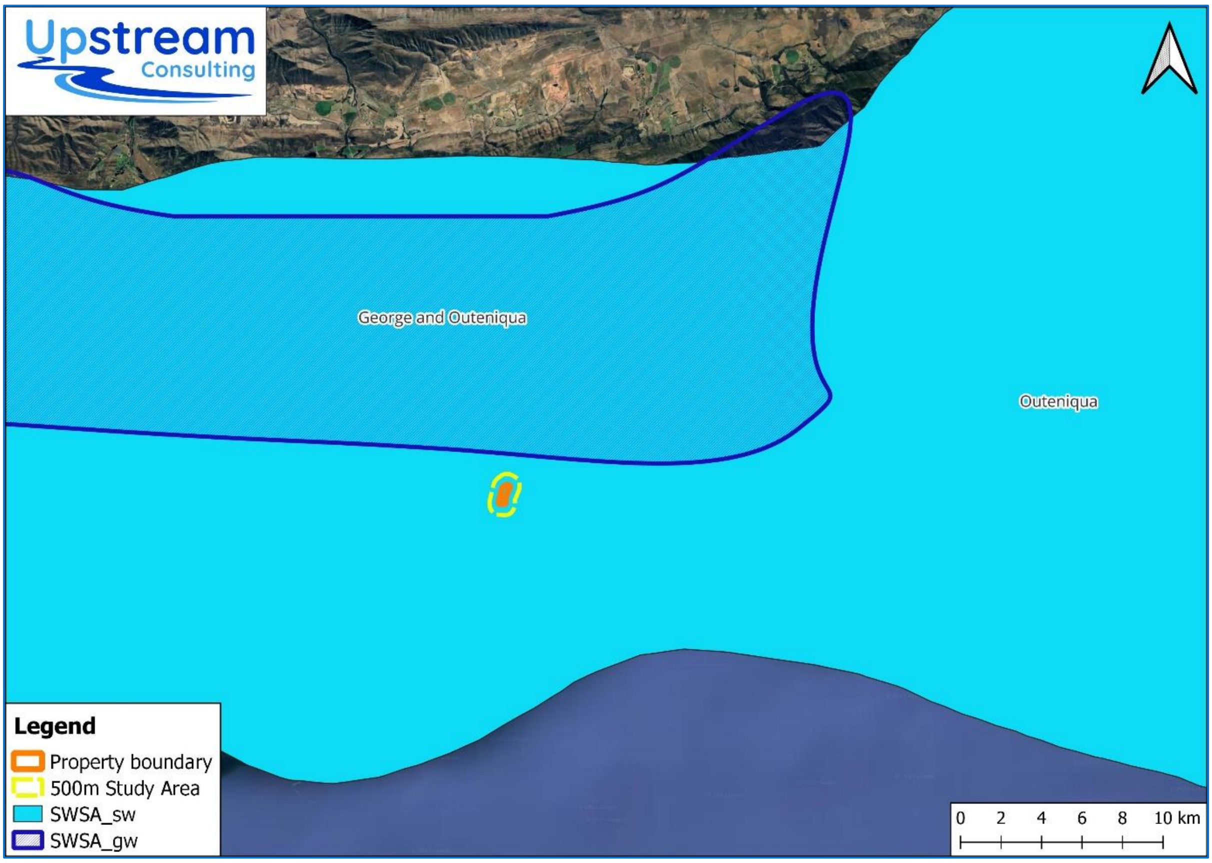

Figure 10: The project site in relation to SWSAs for surface water and groundwater

6.5 Conservation context

The Western Cape Biodiversity Spatial Plan (WCBSP) identifies biodiversity priority areas, CBAs and Ecological Support Areas (ESAs), which, together with Protected Areas, are important for the persistence of a viable representative sample of all ecosystem types and species, as well as the long-term ecological functioning of the landscape as a whole. The primary purpose of a map of Critical Biodiversity Areas and Ecological Support Areas is to guide decision-making about where best to locate development. Critical Biodiversity Areas (CBA's) are required to meet biodiversity targets. According to the WCBSP, these areas have high biodiversity and ecological value and therefore must be kept in a natural state without further loss of habitat or species.

Figure 11 shows that there are no aquatic CBA or ESA habitats within the development site. However, the Swart River in the north is classified as CBA1 river habitat and is thus a biodiversity priority area for conservation. No endemic or conservation worthy aquatic species (Listed or Protected) were observed within the site. Due to either the ephemeral flow, and/or the highly modified condition of the area, it is likely that any aquatic species are disturbance-tolerant species with a low level of biodiversity.

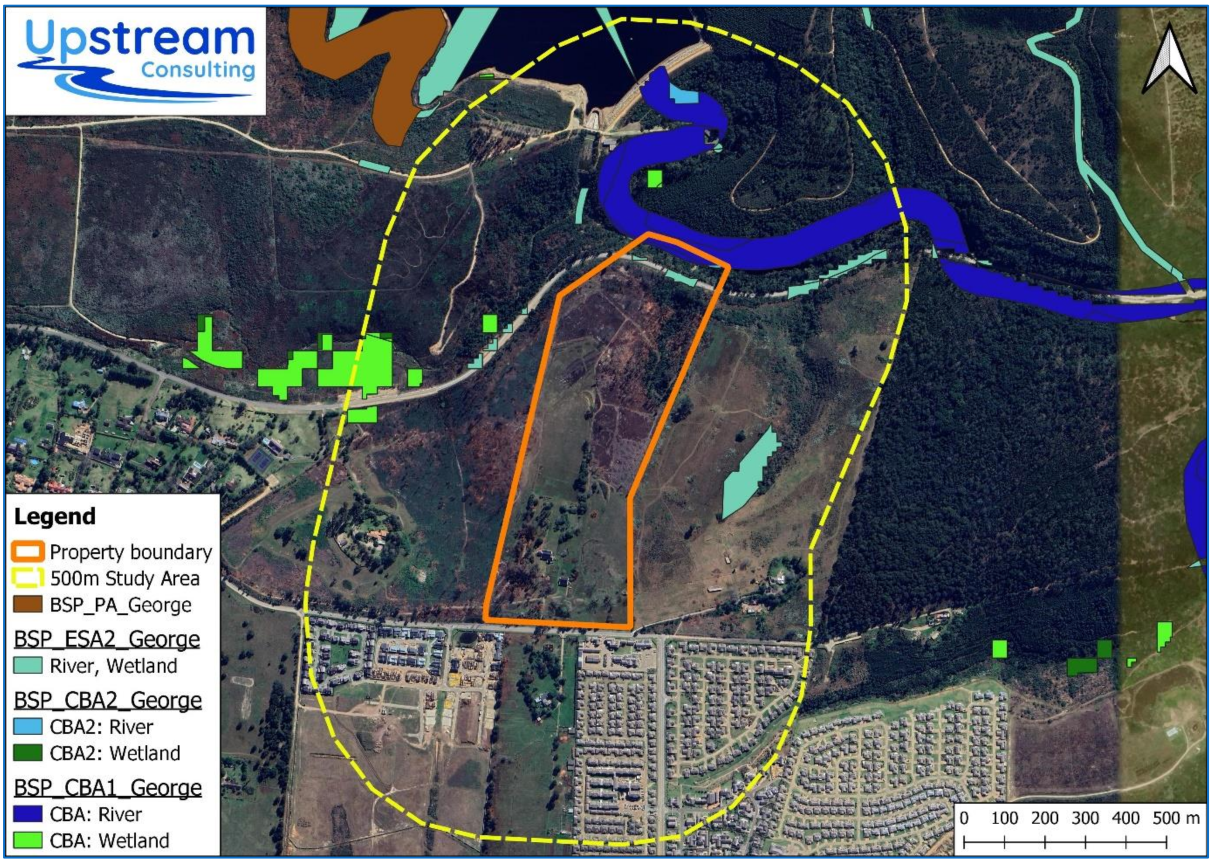

Figure 11: Map of the site in relation to aquatic priority areas identified in the WCBSP (2017)

6.6 HISTORIC CONTEXT

Historic aerial photography from 1957 shows that the site has been used as pasture for many years and remains undeveloped (Figure 12). The impacts upon the environment include the transformation of natural vegetation on the hilltops to grazing pastures and the presence of small livestock dams. The steeper drainage lines have not been cleared but it is likely that alien invasive tree species will have begun establishing in the area.

Figure 12: Historical aerial photography of the area in 1957

7 RESULTS

The aquatic habitats within a 500 metre radius of the proposed development were identified and mapped on a desktop level utilising available data. In order to identify the wetland/river types, using Kotze *et al.* (2009) and Ollis *et al.* (2013), a characterisation of hydrogeomorphic (HGM) types was conducted. Following the desktop findings, the infield site assessment (conducted on the 30th of January 2023) confirmed the location and extent of these systems. Subsequent screening provided an indication of which of these systems may potentially be impacted upon by the project. The findings are detailed in this section below.

7.1 DELINEATION AND CLASSIFICATION

Following the contextualisation of the study area with the available desktop data, a site visit was conducted to groundtruth the findings and delineate the aquatic habitat and map it within the 500m radius of the development area. The additional information collected in the field allowed for the development of an improved baseline aquatic habitat delineation map (Figure 13).

Seven watercourses, and a number of dams, were identified and mapped within a 500m radius of the proposed development. In order to identify the wetland types, using Kotze et al. (2009) and Ollis *et al.* (2013), a characterisation of hydrogeomorphic (HGM) types was conducted. For reference purposes, the identified HGM units were named as follows:

HGM1 – tributary stream
HGM2 – seep wetland
HGM3 – tributary stream
HGM4 – tributary stream
HGM5 – seep wetland
HGM6 – Swart River
HGM7 – Klein Swart River

Figure 13 shows the above-listed watercourses in relation to the development and 500m radius study area.

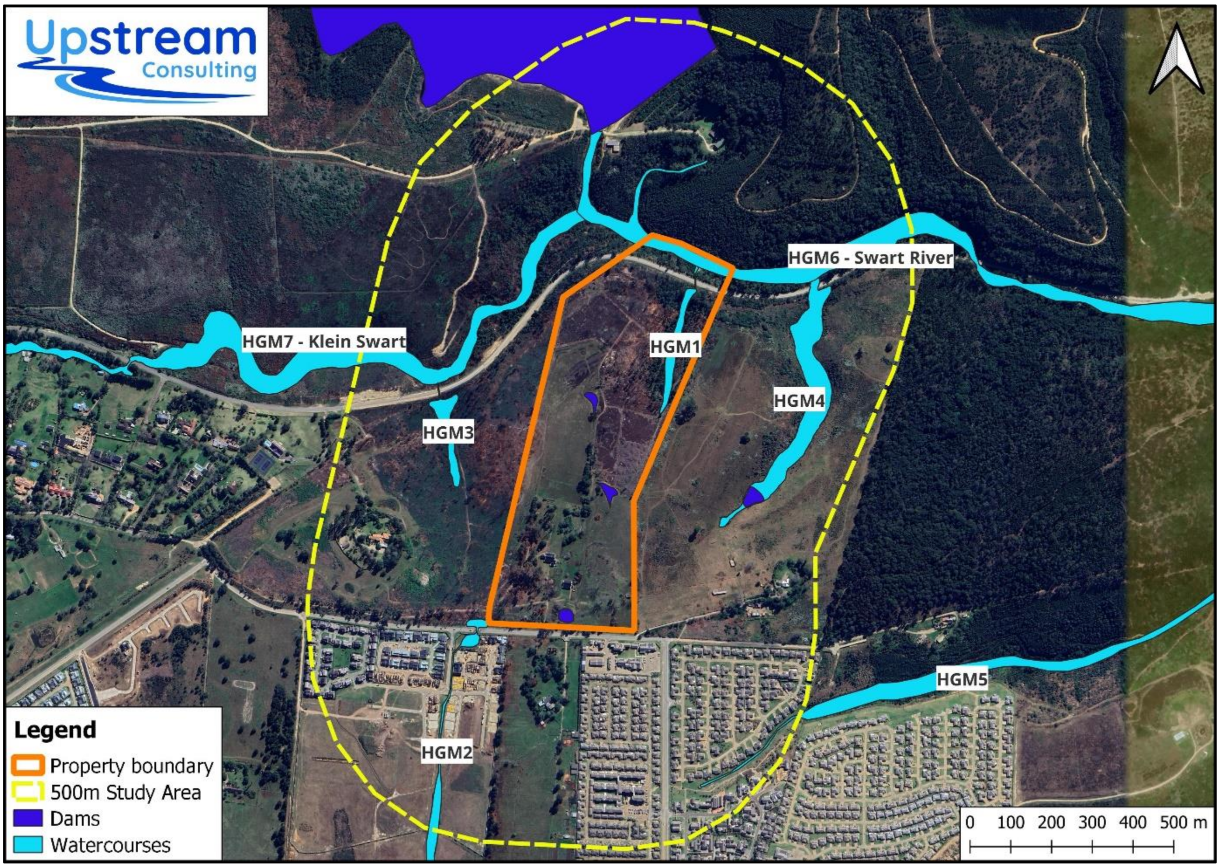

Figure 13: Map of the delineated aquatic habitat

7.2 SCREENING

Subsequent screening provided an indication of which of these systems may potentially be impacted upon by the project and required further assessment. 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. Due to the topography of the proposed site, and its location upon a hilltop, surface runoff will flow in all directions. with varying volumes, entering four different drainage areas.

The majority of the runoff is directed towards the HGM1 non-perennial stream within the property. However, there are development areas sloping towards HGM2 (south), HGM3 (west), and HGM4 (east). As HGM1 is a tributary of the Swart River (HGM6), the hydrological changes from the development may also impact upon the Swart River. HGM3 is a tributary drainage to the Klein Swart River (HGM7) which in turn also enters the Swart River. Therefore, all the identified watercourses, excepting HGM5 which does not receive runoff from the site, may potentially be impacted by the development (Figure 14).

Instream dams are assessed as part of the HGM unit within which they are situated. The Garden Route Dam is an instream impoundment on the Swart River, but it will not be impacted upon by the project. Only the downstream reach of the Swart River could potentially be indirectly impacted upon. There is also a small instream dam on the HGM4 system which may be indirectly impacted by the development. The other dams are located within the property and will be impacted upon (Figure 14); however, these systems are largely artificial in nature and are not connected to the broader drainage network.

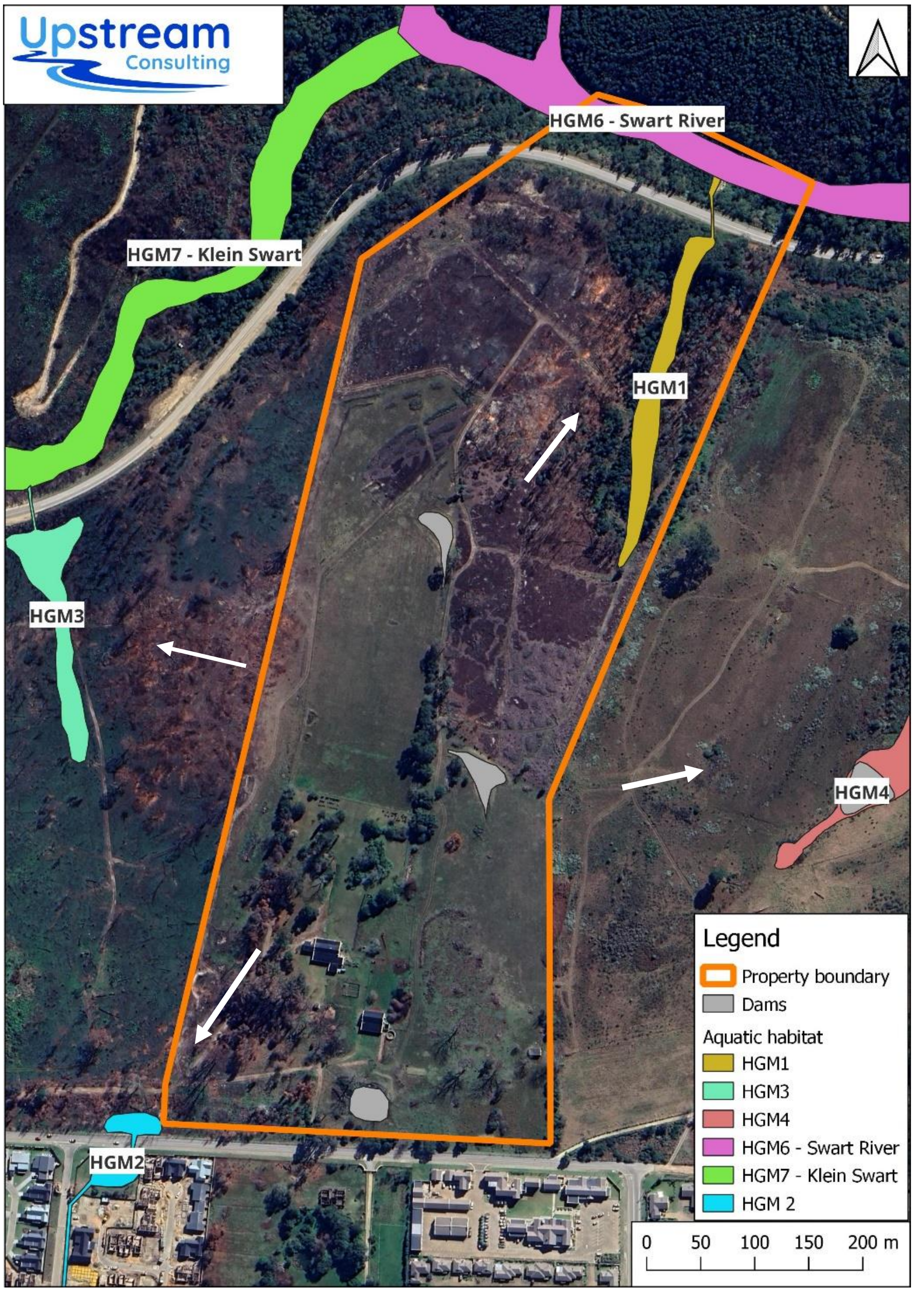

Figure 14: Map of the potentially affected HGM units and dams

7.3 DESCRIPTION OF AFFECTED AQUATIC HABITAT

The HGM1 watercourse is an ephemeral stream which flows uniformly from the development site, through a road culvert, and into the Swart River to the north (Figure 15). The lower reach flows steeply through remaining forest reach (top photograph). There are tall alien invasive trees (such as *Eucalyptus grandis* and *Acacia melanoxylon*) established within the indigenous canopy. The culvert is damaged and there is erosion at the outlet on the banks of the Swart River. There is illegal dumping into the channel taking place at the inlet alongside the road.

Upstream of the road there has been large-scale alien tree clearing, largely of the Eucalyptus species. As a result, there are areas of bare ground, eroded pathways into the drainage line, and felled tree trunks covering the channel. The channel is slightly incised (approximately 1m) until mid-reach when the longitudinal gradient lessens, and the natural U-valley shape is clear. At the time of the site visit, there were shallow pools of water in the typically dry channel, following heavy rains on the previous day (Middle photograph in Figure 15). Although a significant number of alien trees have been felled, many more remain, as well as other invasive species such as *Solanum mauritianum* and Bambusa sp. in the riparian area.

In the upper reach the channel is broader and shallow. There is some indigenous fynbos vegetation evident, but it is clear from the clearing activities that this area was heavily infested with alien plants. Currently there are large areas of bare ground, disturbed soil, and tracks from clearing the trees (bottom photograph in Figure 15). The Present Ecological State (PES) or integrity of the stream HGM1 was determined as being Largely Modified.

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 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. It is not classified as a priority river system; it is not within a conservation area, and the current impacts have limited its contributions to ecological diversity. However, it does support the important larger downstream systems of the Swart and Kaaimans Rivers and provides habitat for biota in the lower reaches, if only to a moderate degree. The overall EIS category of the stream was determined as being ‘Low’.

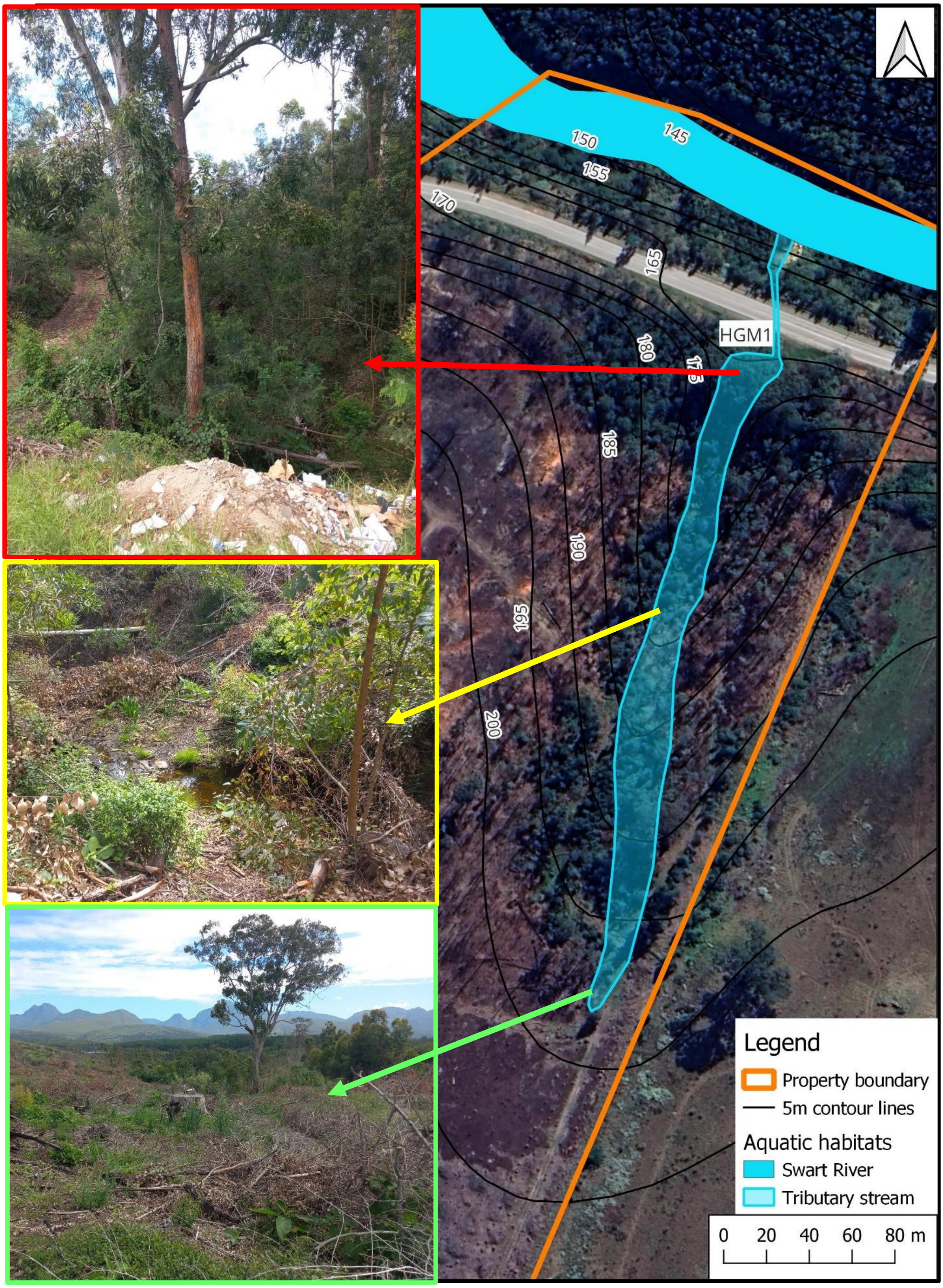

Figure 15: Map and photographs of the non-perennial tributary stream (HGM1) to the Swart River

HGM2 is a critically modified seep wetland which originates on the southern property boundary, alongside the road (PES = E). Under natural conditions, the seep would flow in a diffuse manner towards the south and be vegetated with short sedges and fynbos plants. However, the Glenwood Avenue Road has been constructed through the head of the wetland, resulting in impoundment of water upslope of the road in a depression, prior to a culvert directing confined flow below the road into the neighbouring development. The depression is more permanently inundated than the reference state and contains Juncus species and reeds such as *Typha capensis*. The lower reaches have been completely lost to development and the seep no longer functions in a natural manner. The remaining wetland should be retained to regulate stormwater flows from the site, but overall, the seep has Very Low ecological importance and sensitivity (EIS).

HGM3 and HGM4 are both very similar ephemeral tributary streams to the HGM1 system on the property. They have been subjected to the same land use and cover changes over time. Additionally, both of these catchments are either under development or authorised for development similar to that of HGM1. These systems are at risk of receiving increased stormwater runoff and pollutants from urban development.

7.4 AQUATIC BUFFER ZONES

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). 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.

Currently there are no formalised riverine or wetland buffer distances provided by the provincial authorities and as such the buffer model as described Macfarlane & Bredin (2017) for wetlands and rivers was used. These buffer models are based on the condition of the waterbody, the state of the remainder of the site, coupled to the type of activity, as well as the proposed alteration of hydrological flows. Based then on the information known for the site, a 30m river buffer is recommended from the edge of the riparian habitat of HGM1, and a 12m buffer from the wetland edge of the HGM2 seep. It is recommended that the dam nearest to Glenwood Avenue is retained as an aquatic feature, but the contour dams do not need to be conserved in any way.

8 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. Therefore, the potential impacts assessed, which are indirect in nature, include:

- Impact 1: disturbance to aquatic habitat and biota during construction
- Impact 2: Increased surface water runoff and stormwater flow patterns on form and function during the construction and into the operational phase, i.e. changes to the hydrological regime
- Impact 3: Changes to hydrological regime that could also lead to sedimentation and erosion, which could also occur in the operational phase
- Impact 4: Potential impact on localised surface water quality
- Impact 5: Cumulative impacts on the aquatic resources of the area, such as the Swart River downstream

There are no impacts associated with the No Go Alternative. Adherence to a buffer area, and a stormwater management plan with SUDS, will protect aquatic habitat from the majority of potential impacts detailed below.

8.1 AQUATIC HABITAT DISTURBANCE

The disturbance or loss of aquatic vegetation and habitat refers to the direct physical destruction or disturbance of aquatic habitat caused by earthworks, vegetation clearing, and encroachment and colonisation of habitat by invasive alien plants. During construction the pipeline installation within the watercourse will necessitate the clearance of vegetation along the route, and earthworks on the riverbanks. Invasive alien plants will colonise any disturbed areas which are not rehabilitated and out-compete indigenous vegetation. Without mitigation, the impact can result in further deterioration in freshwater ecosystem integrity, and a reduction in the supply of ecosystem services.

8.2 HYDROLOGICAL CHANGES

The project can potentially result in changes in the quantity, timing and distribution of water inputs and flows within the downslope watercourses. Hardened/artificial infrastructure will alter the natural processes of rainwater infiltration and surface runoff, promoting increased volumes and velocities of storm water runoff, which can be detrimental to the rivers receiving concentrated flows from the area. According to the SANRAL (2006), urbanisation typically increases the runoff rate by 20 -50%, compared with natural conditions. Increased volumes and velocities of storm water draining from the development and discharging into down-slope watercourses can alter the natural ecology of the systems, increasing the risk of erosion and channel incision/scouring. Stormwater management during operation will be critical in ensuring that runoff characteristics mimic the natural scenario and do not lead to increased floodpeaks and flow velocities which could lead to increased erosion and sedimentation risks that could potentially affect the downstream system.

8.3 EROSION AND SEDIMENTATION

During construction, the project will require a large area of vegetation on the property to be cleared resulting in soil disturbance and cover changes in the catchment. Vegetation clearing and exposure of bare soils 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. 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. This increase in volume and velocity of runoff increases the particle carrying capacity of the water flowing over the surface. 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 the study area.

The construction activities associated with burying the sewage and water pipelines through the watercourse can result in sedimentation downstream if not mitigated against. During operation, if the pipeline crossing is not stabilised and rehabilitated, a change in channel morphology can cause erosion directly downslope of the structure.

During the operational phase, the increase in hardened surface by the development can result in further erosion/sedimentation in the watercourses downslope. Surface runoff and velocities will be increased, and flows may be concentrated by stormwater infrastructure. The project may also 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. Erosion must be controlled at stormwater outlet structures.

8.4 WATER QUALITY

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. Hydrocarbons including petrol/diesel and oils/grease/lubricants associated with construction activities (machinery, maintenance, storage, handling) may potentially enter the nearby watercourse by means of surface runoff or through dumping by construction workers.

In the operational phase, stormwater runoff from developed surfaces may include nutrients, pollutants, raw sewage, and other domestic waste. The establishment of sewage infrastructure in close proximity to watercourses always poses a long-term threat to the water quality and ecological health of aquatic ecosystems due to the relatively high likelihood that surcharge events will occur at some point in the future. A complete shift in the structure and composition of aquatic biotic communities is the result, as well as a general degradation in water resource quality that could have negative impacts to human users. Over the lifetime of the development, surcharge events and/or pipe leakages will likely occur and as a result some pollution as a result of sewage infrastructure is probable. Mitigation measures must be put in place to reduce the intensity of pollution events and ultimately reduce pollutant loads. If contaminated stormwater runoff or sewage enters the Swart River, it 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. Additionally, if not prevented, litter, and contaminants, including sand, silt, and dirt particles, will enter storm water runoff and can pollute the downslope watercourses. Micro-litter such as cigarette butts may travel through certain stormwater grids and grids may not be regularly cleared.

8.5 CUMULATIVE IMPACTS

Cumulative impacts on the environment can result from broader, long-term changes and not only as a result of a single activity. They are rather from the combined effects of many activities overtime. In relation to an activity, cumulative impact means *"the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may be significant when added to the existing and reasonably foreseeable impacts eventuating from similar or diverse activities"* (NEMA EIA Reg GN R982 of 2014).

Rivers are longitudinal systems where different reaches interact in a continuum along the length of the river. Activities in the upper reaches influence the processes of the lower reaches and it must therefore be viewed as a whole. Watercourses are set apart from many other ecosystem types by the degree to which they integrate with and are influenced by the surrounding landscape, or catchment. The physical, chemical and biological characteristics of any river are determined almost entirely by the nature of its catchment and the activities, human and natural, that take place in it (Davies and Day 1998). Widespread land use conversion at a catchment scale can dramatically alter the flow rates, water quality and sediment regimes of watercourses.

The properties on the southern side of Glenwood Avenue are largely already developed into residential estates, such as that which is proposed. The undeveloped farms surrounding the area, as well as the Garden Route Dam property to the north, are all earmarked for similar urban development. Cumulatively the impact of these residential estates upon surface water has been significant. However, these properties are all within the urban edge and each development is responsible for managing stormwater runoff appropriately. Since all the surrounding properties are developed or authorised for development, the location of this development is logical and must be viewed within a strategic context. The cumulative impact of the project upon aquatic biodiversity is of medium significance but following mitigation it can be decreased to acceptable levels. Adherence to a buffer area will protect aquatic habitat from the majority of potential impacts.

After mitigation is applied to manage stormwater appropriately, the project is not expected to have residual impacts upon the environment. It should not impact upon the desktop mapped Strategic Water Source Area. The development will not reduce the number of benefits gained by society from the water source area. The development will need to comply with all regulations of the National Water Act (Act 36 of 1998), including the protection of downstream users, and minimise any potential ecological impacts upon water resources. There is currently no legislation directly related to SWSAs but by adhering to the NWA legislation the SWSA will not be compromised. After mitigation and the rehabilitation of the riparian zone, the project will not reduce the ecological resilience of the river to future climate changes.

9 IMPACT ASSESSMENT

The impact significance of the proposed project, as well as the alternatives, was determined for each potential impact, direct and indirect for each phase. Refer to impact tables in Section 9.1 and 9.2 below, as well as impact assessment methodology in Appendix 2.

It was determined that, after mitigation, the overall impacts associated with the latest project layout (Alternative A) are of Low negative significance to aquatic biodiversity, while Alternative B (which encroaches into the buffer zone) will have Medium to Low impact significance. Therefore, Alternative A is the preferred development proposal from an aquatic perspective, but there are no high impacts associated with either proposal. The No-Go Alternative was determined to have no new impacts upon aquatic biodiversity.

The most significant potential impact is sedimentation of the river from unconsolidated soils being transported via surface runoff, as well as erosion during the operational phase from stormwater runoff, and the pipeline crossings. The HGM1 stream is in a largely modified condition and the project activities, after mitigation, will not cause further deterioration of any water resources. A stormwater management plan should be compiled to prevent further erosion and sedimentation within the watercourses, as well as prevent contaminated water from entering the surrounding environment. The impacts can be decreased to acceptable levels provided that mitigation measures, especially the buffer areas, are implemented and adhered to during the construction and operational phase of the project. Buffer areas, applied in conjunction with other measures, can be very effective measures to mitigate impacts from development upon aquatic habitat. Refer to Section 10 for recommended mitigation measures.

There is potential for enhancing the value of the development through incorporating rehabilitation of the riparian and buffer area. Once rehabilitated, the buffer can be used for low impact open space activities, such as short walking trails and bird viewing. The No Go Alternative has no impacts associated with it but assumes that sufficient resources will be allocated to manage the land and halt existing impacts (such as alien plant infestation and erosion).

9.1 Alternative A Impact Tables

Alternative A is shown in the latest site development layout plan (SDK Architects, 2023). As opposed to the initial proposal (Alternative B), this layout has set-back hard infrastructure from the recommended buffer area and included stormwater management measures into the design. Therefore, the potential impacts for both layouts are the same, but Alternative A has a lower risk of impacting aquatic biodiversity and is the preferred development proposal. Refer to Tables 2 to 6 for the results of impact assessment which show that after mitigation, Alternative A was determined to have Low impact significance.

Table 2: Impact assessment summary for Impact 1 – Disturbance of aquatic habitat biota

Impact Phase: Construction phase					
Nature of the impact: The disturbance or loss of aquatic vegetation and habitat refers to the direct physical destruction or disturbance which can result in further deterioration in freshwater ecosystem integrity, and a reduction in the supply of ecosystem services.					
Description of Impact: Construction of pipeline through watercourse, **c**learance of vegetation, earthworks on the riverbanks, and further invasive alien plant infestation.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Mitigation	Site	Medium term	Recoverable	Moderate	Highly probable
Score	1	3	3	3	4
With Mitigation	Site	Immediate	Reversible	Low	Low probability
Score	1	1	1	2	2

Significance Calculation	Without Mitigation	With Mitigation
S=(E+D+R+M)*P	Medium Impact (40)	Low Impact (10)

Table 3: Impact assessment summary for Impact 2 – Changes to the hydrological regime

Impact Phase: Construction and Operation					
Nature of the impact: Possible increase in surface water runoff/ patterns on form and function during the construction and into the operational phase, i.e. changes to the hydrological regime					
Description of Impact: Any increase in hard surface areas and changes to the microtopography of the site, as a result of the development, will increase concentrated surface water runoff toward the streams and Swart River. Poor stormwater management could result in localised changes to flows (volume) that would result in form and function changes within aquatic habitat. The impact can result in further deterioration in freshwater ecosystem integrity, and a reduction in the supply of ecosystem services.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Mitigation	Local	Permanent	Recoverable	Moderate	Probable
Score	2	5	3	3	3
With Mitigation	Site	Permanent	Recoverable	Low	Low Probability
Score	1	5	3	2	2
Significance Calculation	**Without Mitigation**			**With Mitigation**	
S=(E+D+R+M)*P	Medium Impact (39)			Low Impact (22)	

Table 4: Impact assessment summary for Impact 3 – Sedimentation and erosion

Impact Phase: Construction and Operation					
Nature of the impact: Changes to hydrological regimes that could also lead to sedimentation and erosion, that could also occur in the operational phase					
Description of Impact: Construction of pipeline through watercourse and concentrated stormwater flow paths and altered flow patterns causing increased erosion within the stream and sedimentation in the Swart River as the disturbed soils are carried by unmanaged surface runoff down slope. These impacts can result in the deterioration of aquatic ecosystem integrity and a reduction/loss of habitat for flora & fauna.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Mitigation	Regional	Permanent	Recoverable	Moderate	Highly probable

Score	3	5	3	3	4
With Mitigation	Site	Long term	Reversible	Low	Probable
Score	1	4	1	2	3
Significance Calculation	**Without Mitigation**			**With Mitigation**	
S=(E+D+R+M)*P	Medium Impact (56)			Low Impact (24)	

Table 5: Impact assessment summary for Impact 4 –Changes to surface water quality

Impact Phase: Construction and Operation					
Nature of the impact: Potential impact on localised surface water quality (indirect)					
Description of Impact: During all phases of the project there is potential for surface runoff to be contaminated and enter the watercourses, especially during flood events. During construction, earthworks will expose and mobilise earth materials, and a number of materials as well as chemicals will be imported and used on site and may end up in the surface water, including soaps, oils, grease and fuels, human wastes, cementitious wastes, paints and solvents, etc. In the operational phase, hydrocarbons and chemicals could potentially enter the watercourses. If not prevented, litter, and contaminants, including sand, silt, and dirt particles, will enter storm water runoff and pollute the watercourse. Micro-litter such as cigarette butts may travel through certain stormwater grids and grids may not be regularly cleared. This can result in possible deterioration in aquatic ecosystem integrity and species diversity.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Mitigation	Regional	Long Term	Recoverable	Moderate	Probable
Score	3	3	3	3	3
With Mitigation	Site	Medium Term	Reversible	Low	Improbable
Score	1	2	1	2	1
Significance Calculation	**Without Mitigation**			**With Mitigation**	
S=(E+D+R+M)*P	Medium Impact (36)			Low Impact (6)	

Table 6: Cumulative impact assessment for aquatic biodiversity

Cumulative Impact: Cumulative impacts on the aquatic resources of the area
Description of Cumulative Impact: Increased urban development is changing the hydrology of the catchment. However, this development in the context of the surrounding developments, is unlikely to change the overall outcome. Rehabilitation of the drainage areas as part of the development open space system could improve riparian habitats that are currently unmanaged and degraded. The mitigation proposed will ensure that the form and or function of downstream areas remain intact.

Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Enhancement	Regional	Permanent	Recoverable	Moderate	Probable
Score	3	5	3	3	3
With Enhancement	Local	Long Term	Reversible	Low	Improbable
Score	2	4	1	2	1
Significance Calculation	**Without Enhancement**			**With Enhancement**	
S=(E+D+R+M)*P	Medium Impact (42)			Low Impact (9)	

9.2 ALTERNATIVE B IMPACT TABLES

The Alternative B layout will have a slightly higher impact upon aquatic biodiversity and does not include a buffer zone. Refer to Tables 7 to 11 below.

Table 7: Alternative B assessment summary for Impact 1 – Disturbance of aquatic habitat

Impact Phase: Construction phase					
Nature of the impact: The disturbance or loss of aquatic vegetation and habitat refers to the direct physical destruction or disturbance which can result in further deterioration in freshwater ecosystem integrity, and a reduction in the supply of ecosystem services.					
Description of Impact: Construction of pipeline through watercourse, **c**learance of vegetation, earthworks on the riverbanks, and further invasive alien plant infestation.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Mitigation	Local	Medium term	Recoverable	Moderate	Highly probable
Score	2	3	3	3	4
With Mitigation	Site	Short term	Reversible	Low	Probable
Score	1	2	1	2	3
Significance Calculation	**Without Mitigation**			**With Mitigation**	
S=(E+D+R+M)*P	Medium Impact (44)			Low Impact (18)	

Table 8: Alternative B assessment summary for Impact 2 – Changes to hydrology

Impact Phase: Construction and Operation

Nature of the impact: Possible increase in surface water runoff/ patterns on form and function during the construction and into the operational phase, i.e. changes to the hydrological regime					
Description of Impact: Any increase in hard surface areas and changes to the microtopography of the site, as a result of the development, will increase concentrated surface water runoff toward the streams and Swart River. Poor stormwater management could result in localised changes to flows (volume) that would result in form and function changes within aquatic habitat. The impact can result in further deterioration in freshwater ecosystem integrity, and a reduction in the supply of ecosystem services.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Mitigation	Local	Permanent	Irreversible	Moderate	Highly probable
Score	2	5	5	3	4
With Mitigation	Site	Permanent	Recoverable	Low	Probable
Score	1	5	3	2	3
Significance Calculation	**Without Mitigation**		**With Mitigation**		
S=(E+D+R+M)*P	Medium to High Impact (60)		Medium Impact (33)		

Table 9: Alternative B assessment summary for Impact 3 – Sedimentation and erosion

Impact Phase: Construction and Operation					
Nature of the impact: Changes to hydrological regimes that could also lead to sedimentation and erosion, that could also occur in the operational phase					
Description of Impact: Construction of pipeline through watercourse and concentrated stormwater flow paths and altered flow patterns causing increased erosion within the stream and sedimentation in the Swart River as the disturbed soils are carried by unmanaged surface runoff down slope. These impacts can result in the deterioration of aquatic ecosystem integrity and a reduction/loss of habitat for flora & fauna.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Mitigation	Regional	Permanent	Recoverable	High	Highly probable
Score	3	5	3	4	4
With Mitigation	Local	Long term	Reversible	Moderate	Probable
Score	2	4	1	3	3
Significance Calculation	**Without Mitigation**		**With Mitigation**		
S=(E+D+R+M)*P	Medium -High Impact (60)		Medium Impact (30)		

Table 10: Alternative B assessment summary for Impact 4 –Changes to surface water quality

Impact Phase: Construction and Operation					
Nature of the impact: Potential impact on localised surface water quality (indirect)					
Description of Impact: During all phases of the project there is potential for surface runoff to be contaminated and enter the watercourses, especially during flood events. During construction, earthworks will expose and mobilise earth materials, and a number of materials as well as chemicals will be imported and used on site and may end up in the surface water, including soaps, oils, grease and fuels, human wastes, cementitious wastes, paints and solvents, etc. In the operational phase, hydrocarbons and chemicals could potentially enter the watercourses. If not prevented, litter, and contaminants, including sand, silt, and dirt particles, will enter storm water runoff and pollute the watercourse. Micro-litter such as cigarette butts may travel through certain stormwater grids and grids may not be regularly cleared. This can result in possible deterioration in aquatic ecosystem integrity and species diversity.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Mitigation	Regional	Long Term	Recoverable	Moderate	Highly probable
Score	3	4	3	3	4
With Mitigation	Local	Medium Term	Reversible	Low	Probable
Score	2	3	1	2	3
Significance Calculation	**Without Mitigation**			**With Mitigation**	
S=(E+D+R+M)*P	Medium Impact (52)			Low Impact (24)	

Table 11: Cumulative impact assessment for aquatic biodiversity

Cumulative Impact: Cumulative impacts on the aquatic resources of the area					
Description of Cumulative Impact: Increased urban development is changing the hydrology of the catchment. However, this development in the context of the surrounding developments, is unlikely to change the overall outcome. Rehabilitation of the drainage areas as part of the development open space system could improve riparian habitats that are currently unmanaged and degraded. The mitigation proposed will ensure that the form and or function of downstream areas remain intact.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Enhancement	Regional	Permanent	Irreversible	Moderate	Probable
Score	3	5	5	3	3

With Enhancement	Local	Long Term	Recoverable	Low	Low probability
Score	2	4	3	2	2
Significance Calculation	**Without Enhancement**			**With Enhancement**	
S=(E+D+R+M)*P	Medium Impact (48)			Low Impact (22)	

10 MITIGATION

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). Any potential risks must be managed and mitigated to ensure that no deterioration to 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.

Mitigation measures related to the impacts associated with the activities are intended to augment standard/generic mitigation measures included in the project-specific Environmental Management Programme (EMP). The monitoring of the 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. Monitoring should focus on adherence to the aquatic buffer zone (No-Go area) and sediment control.

10.1 WATER POLLUTION MITIGATION

- A stormwater management plan and report must be developed for the site.
- Reasonable measures must be taken to provide back-up for mechanical, electrical, operational or process failure and malfunction at pump stations. At a minimum there should be an alarm system to warn of an electrical failure and sufficient standby equipment to provide for reasonable assurance that the infrastructure can be fully functional within at least 24 hours. Emergency power shall be provided that will prevent overflows from occurring during any power outage. Installing permanent generators at each station is strongly advised.
- Pump stations will need to be placed within a suitably lined, impermeable concrete bunded area with the capacity to hold untreated waste water in an emergency and

provide for sufficient time for maintenance staff to address any faults/ problems. This is to limit the risk of untreated sewage overflowing in the event of any leakage or accidental spillage at the pump station.

- The Department of Water regional office should be notified, as soon as possible, of any significant chemical spill or leakage to the environment where there is the potential to contaminate surface water or groundwater.
- 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.
- Inlet protection measures to capture solid waste and debris entrained in storm water entering the storm water management system (inlet protection devices) will be incorporated into the design of the system and could include the use of either curb inlet/inlet drain grates and/or debris baskets/bags.
- It is also important to note that storm water infrastructure will likely require regular on-going maintenance in the form of silt, debris/litter clearing in order to ensure their optimal functioning.

10.2 Sedimentation and Erosion Mitigation

- A stormwater management plan must be developed in the preconstruction phase, detailing the stormwater structures and management interventions that must be installed to manage the increase of surface water flows directly into any natural systems. The stormwater management infrastructure must be designed to ensure the runoff from the development is not contaminated before entering the surrounding area. The volume and velocity of water must be reduced through discharging the surface flow at multiple locations surrounding the development. Effective stormwater management must include effective stabilisation of exposed soil.
- Sedimentation must be minimised with appropriate measures. Any construction causing bare slopes and surfaces to be exposed to the elements must include measures to protect against erosion using covers, silt fences, sandbags, earthen berms etc.
- All stockpiles must be protected and located in flat areas where run-off will be minimised and sediment recoverable.
- Construction must have contingency plans for high rainfall events during construction. Even in the operational phase, measures to contain impacts caused during high rainfall events must be planned for and available for use.
- 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 aquatic habitat.

- Stormwater infrastructure must be inspected at least once every year (before the onset of rains) to ensure that it is working efficiently. 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.
- Construction of the pipeline should preferably be done during the drier months when the water quality impacts from the construction activities may impact on the downslope watercourses. Measures to contain impacts caused during high rainfall events (such as substantial sedimentation and/or erosion) must be planned for and available for use.
- Before any work commences, sediment control/silt capture measures (e.g. bidim/silt curtains) must be installed downstream/downslope of the active working areas. Silt fences/curtains must be regularly checked and maintained (de-silted to ensure continued capacity to trap silt) and repaired where necessary. When de-silting takes place the silt must not be returned to the watercourse.

10.3 MITIGATION OF HYDROLOGICAL CHANGES

- Avoid multiple watercourse crossings and align pipeline crossings as close to each other as possible.
- Crossings must be constructed perpendicular to the natural direction of flow.
- Pipelines across watercourses should be buried at a sufficient depth below ground level such that the pipelines do not interfere with surface water movement or create obstructions where flows can cause erosion to initiate.
- A stormwater management plan must be developed in the preconstruction phase, detailing the stormwater structures and management interventions that must be installed to manage the changes to surface water flows.
- When developing a stormwater management plan for the site, it will be critical that due consideration is given to the collection and treatment of stormwater prior to discharge into the natural environment. It is therefore recommended that the stormwater management plan be developed with appropriate ecological input and be developed based on Sustainable Drainage Systems (SUDS). The SUDS systems attempt to maintain or mimic the natural flow systems as well as prevent the wash-off of urban pollutants to receiving waters.
- 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). Baffles in the stormwater conduits are effective. 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. 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.

- The stormwater management infrastructure must be designed to ensure the runoff from the development is not highly contaminated or concentrated before entering the surrounding area. Any stormwater retention ponds or berms must be located outside of the buffer area.
- The adoption of the 30m aquatic buffer zone between the development infrastructure and HGM1.
- The volume and velocity of water must be reduced through discharging the surface flow at multiple locations surrounding the development.
- Effective stormwater management must include effective stabilisation (gabions and Reno mattresses) of exposed soil. Contingency plans must be in place for high rainfall events which may occur during construction.
- If flower/plant beds are to be established adjacent to hard surfaces, then these should be designed to receive storm water from hardened surfaces and should be planted with robust indigenous species that to contribute to storm water management objectives.
- Storm water should be harvested onsite from roofed surfaces thus reducing the quantity (volume) of water received by downstream water resources as surface flow.
- The project will need to comply with all regulations of the National Water Act (Act 36 of 1998), including the protection of downstream users, and minimise any potential ecological impacts upon water resources.

10.4 Mitigation of aquatic habitat disturbance

- A construction method statement must be compiled and available on site. It must consider the buffer zone and include methods to avoid unnecessary disturbance and prevent material being washed downslope into the river.
- The edges of the pipeline construction servitude, as well as the development area, relative to the aquatic habitat must be clearly staked-out and demarcated prior to construction commencing.
- 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.
- Access to and from the development area should be either via existing roads or within the construction servitude. Any contractor found working within No-Go areas must be fined as per fining schedule/system setup for the project.
- Following construction, it is important to stabilise any steep, bare areas on the slope and river banks via geotextiles and/or revegetation.
- 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.

- Where vegetation has been cleared in the buffer and open ground in the riparian area has resulted (i.e. where indigenous vegetation has been replaced by dense alien plant infestations or construction access routes), it is recommended that cover components be reinstated appropriately. Only indigenous species are to be considered.

11 CONCLUSION

The aquatic habitats within a 500 meter radius of the proposed development were identified and mapped on a desktop level utilising available data. Following the desktop findings, a site assessment was conducted to verify the location and extent of these systems. Two watercourses and three dams were identified within the property boundary. Five other watercourses and several dams are situated within a 500m radius.

It was determined that the watercourses in the study area are no longer functioning in a natural manner and the riparian habitat has already been significantly altered. The systems have a Low EIS. It is recommended that basic rehabilitation of the riparian zone be undertaken, and that a formal alien invasive plant control plan be compiled and implemented (not only limited to the Eucalyptus and Wattle trees).

The direct and indirect impacts associated with the project were assessed as:

- Impact 1: Disturbance of aquatic habitat and biota during pipeline construction and site development
- Impact 2: Increased surface water runoff and stormwater flow patterns on form and function during the construction and into the operational phase, i.e. changes to the hydrological regime
- Impact 3: Changes to hydrological regime that could also lead to sedimentation and erosion, which could also occur in the operational phase
- Impact 4: Potential impact on localised surface water quality
- Impact 5: Cumulative impacts on the aquatic resources of the area, such as the Swart River downstream

It was determined that, after mitigation, the overall impacts associated with the latest project layout (Alternative A) are of Low negative significance to aquatic biodiversity, while Alternative B (which encroaches into the buffer zone) will have Medium to Low impact significance. Therefore, Alternative A is the preferred development proposal from an aquatic perspective, but there are no high impacts associated with either proposal. The No-Go Alternative was determined to have no new impacts upon aquatic biodiversity.

The HGM1 stream is in a largely modified condition and the project activities, after mitigation, will not cause further deterioration of any water resources. A rehabilitation and stormwater management plan should be compiled to prevent further erosion and sedimentation within the watercourses, as well as prevent contaminated water from entering the surrounding environment. Adherence to buffer zones, and a stormwater management plan incorporating SUDS, will protect aquatic habitat from the majority of potential impacts. The development is unlikely to impact upon the desktop mapped Strategic Water Source Area. The proposed development requires a Water Use License (WUL) in terms of Chapter 4 and Section 21 (c) and (i) of the National Water Act No. 36 of 1998 and this must be secured prior to the commencement of construction.

In conclusion, from a purely aquatic perspective, there are no fatal flaws associated with development, provided all the mitigation measures are strictly adopted.

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APPENDIX 1 –DETAILED METHODOLOGY

For reference the following definitions are as follows:

- **Drainage line**: A drainage line is a lower category or order of watercourse that does not have a clearly defined bed or bank. It carries water only during or immediately after periods of heavy rainfall i.e. non-perennial, and riparian vegetation may not be present.
- **Perennial and non-perennial:** Perennial systems contain flow or standing water for all or a large proportion of any given year, while non-perennial systems are episodic or ephemeral and thus contains flows for short periods, such as a few hours or days in the case of drainage lines.
- **Riparian**: the area of land adjacent to a stream or river that is influenced by stream-induced or related processes. Riparian areas which are saturated or flooded for prolonged periods would be considered wetlands and could be described as riparian wetlands. However, some riparian areas are not wetlands (e.g. an area where alluvium is periodically deposited by a stream during floods but which is well drained).
- **Wetland**: land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which under normal circumstances supports or would support vegetation typically adapted to life in saturated soil (Water Act 36 of 1998); land where an excess of water is the dominant factor determining the nature of the soil development and the types of plants and animals living at the soil surface (Cowardin *et al*., 1979).
- **Water course**: as per the National Water Act means -
  (a) a river or spring;
  (b) a natural channel in which water flows regularly or intermittently;
  (c) a wetland, lake or dam into which, or from which, water flows; and
  (d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks

12.1 WETLAND DELINEATION AND HGM TYPE IDENTIFICATION

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

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

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur.

- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation.
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

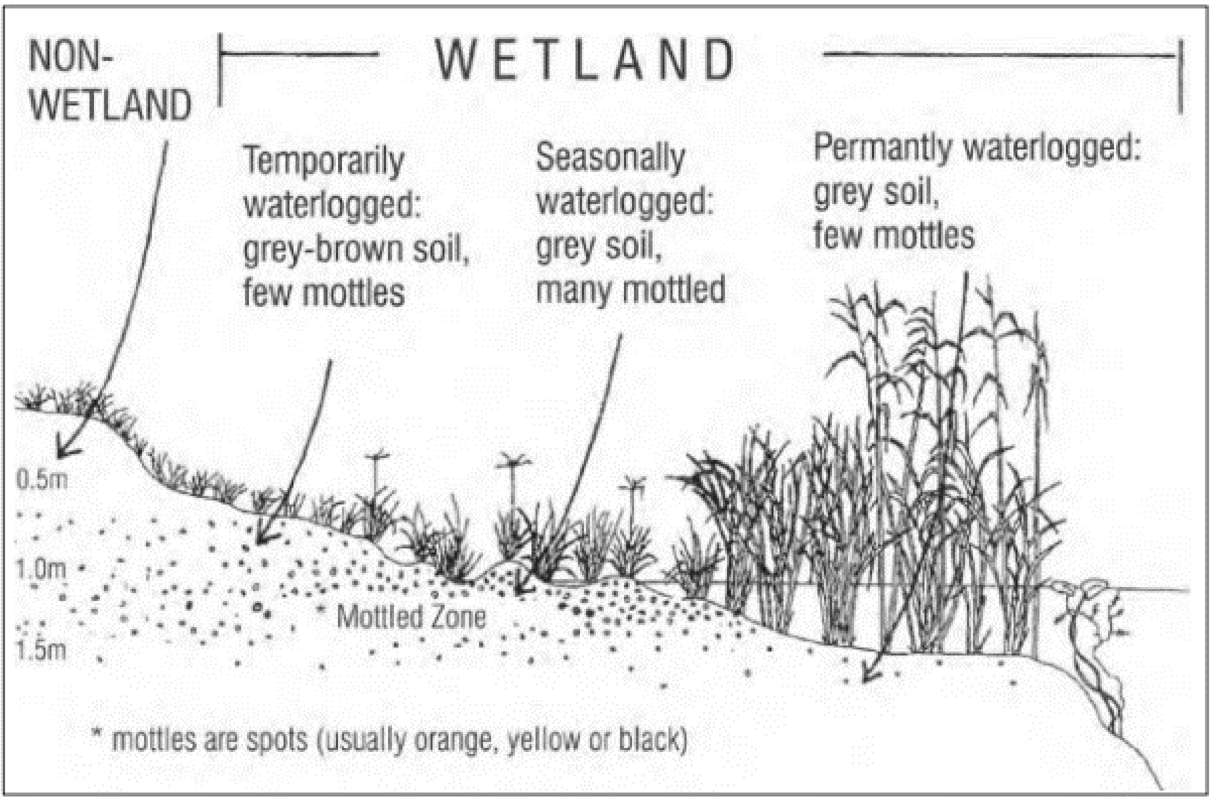

Figure A12.1a: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the middle to the edge of the wetland. Source: Donovan Kotze, University of KwaZulu-Natal.

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 A12.1a)

A12.1a: 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 A12.1b: 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 A12.1b).

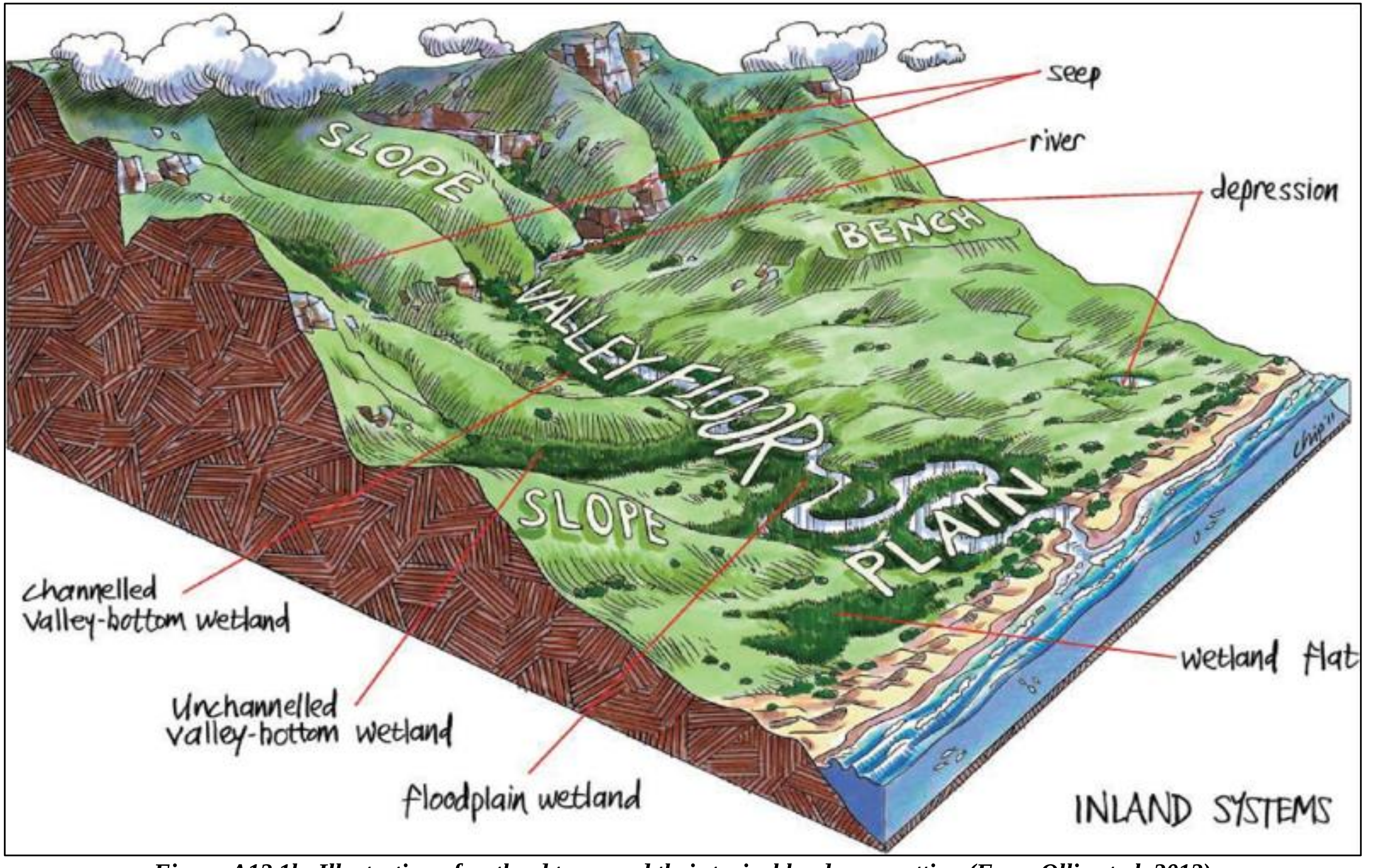

Figure A12.1b: Illustration of wetland types and their typical landscape setting (From Ollie et al. 2013)

12.2 DELINEATION OF RIPARIAN AREAS

Riparian zones are described as “the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas” 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 (Figure 12.2a). 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 As discussed above, 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.

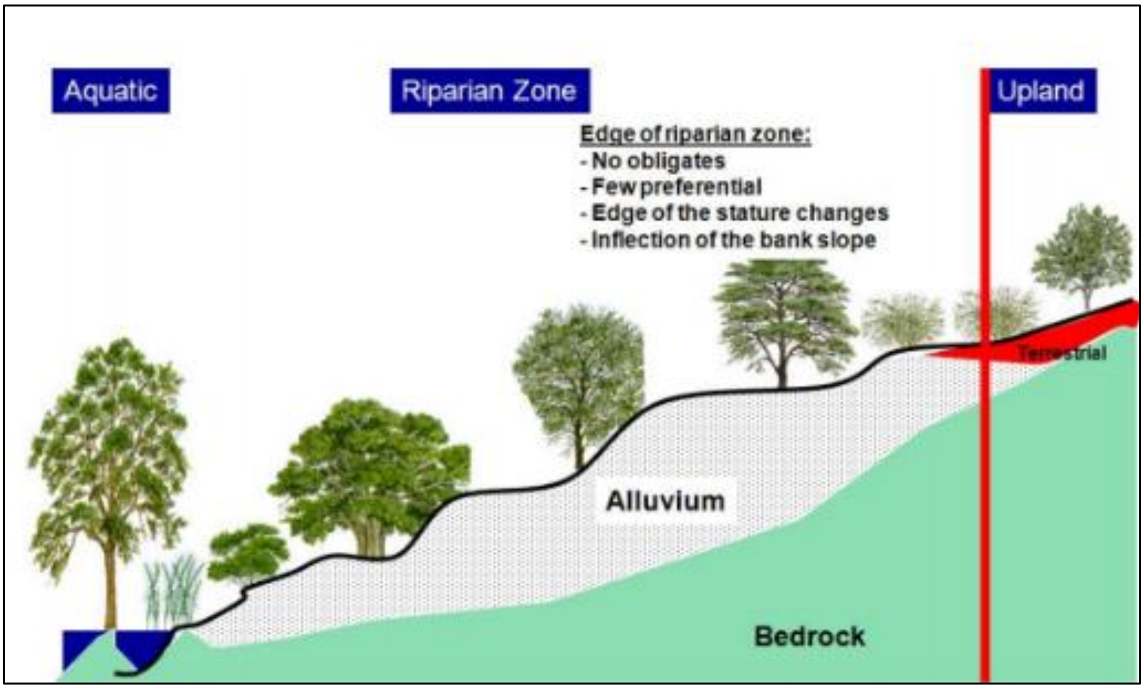

Figure A12.2a: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river. Note the coincidence of the inflection (in slope) on the bank with the change in vegetation structure and composition. The edge of the riparian zone coincides with an inflection point on the bank; where there are not obligates upslope; few preferential. The boundary also coincides with the outer edge of the stature differences (DWAF 2008).

12.3 PRESENT ECOLOGICAL STATE (PES) – WETLANDS

WET-Health assists in assessing the health of wetlands using indicators based on geomorphology, hydrology and vegetation. For the purposes of rehabilitation planning and assessment, WET-Health helps users understand the condition of the wetland in order to determine whether it is beyond repair, whether it requires rehabilitation intervention, or whether, despite damage, it is perhaps healthy enough not to require intervention. It also helps diagnose the cause of wetland degradation so that rehabilitation workers can design appropriate interventions that treat both the symptoms and causes of degradation. WET-Health is tailored specifically for South African conditions and has wide application, including assessing the Present Ecological State of a wetland.

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 A12.2a).

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 A12.2b, below. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic systems.

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.

Table A12.2a: Guideline for interpreting the magnitude of impact on integrity

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

Table A12.2b. Health categories used by WET-Health for describing the integrity of wetlands (after Macfarlane et al., 2008).

Impact Category	Description	Range	Pes Category
None	Unmodified, natural.	0 – 0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1 – 1.9	B
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2 – 3.9	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4 – 5.9	D
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features	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

12.4 WETLAND FUNCTIONAL IMPORTANCE (GOODS AND SERVICES)

WET-EcoServices is used to assess the goods and services that individual wetlands provide, thereby aiding informed planning and decision making. It is designed for a class of wetlands known as palustrine wetlands (i.e. marshes, floodplains, vleis or seeps). The tool provides guidelines for scoring the importance of a wetland in delivering each of 20 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 A12.4a) - that is, the benefits provided to people by the ecosystem.

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

Table A12.4a: Ecosystem services assessed by WET-Ecoservices

12.5 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 A1.1) 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 A1.1: 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 A1.2).

Table A1.2: The habitat integrity PES categories

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

12.6 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 A1.3).

The scores assigned to the criteria in Table A1.3 were used to rate the overall EIS of each mapped unit according to Table A1.4, 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 A1.3: 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

Table A1.4: The ratings associated with the assessment of the EIA for riparian areas

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

12.7 IMPACT SIGNIFICANCE ASSESSMENT METHODOLOGY

Description and determination of the significance of the predicted impacts in terms of the criteria below to ensure a consistent and systematic basis for the decision-making process. Significance is numerically quantified on the basis score of the following impact parameters:

1. ***Extent* (E)** of the impact: The geographical extent of the impact on a given environmental receptor.
2. ***Duration* (D)** of the impact: The length of permanence of the impact on the environmental receptor.

3. ***Reversibility* (R) of the impact**: The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change
4. ***Magnitude* (M)** of the impact: The degree of alteration of the affected environmental receptor.
5. ***Probability* (P)** of the impact: The likelihood of the impact actually occurring.

A widely accepted numerical quantification of significance is the formula:

S=(E+D+R+M)*P

Where: *Significance=(Extent+Duration+Reversibility+Magnitude) * Probability*

The significance of environmental impacts is determined and ranked by considering the criteria presented in **Table 12.1A** below. All criteria are rank according to 'Very Low', 'Low', 'Moderate', 'High' and 'Very High' and are assigned scores of 1 to 5 respectively.

Table 16*2.1A*: Defining the significant in terms of the impact criteria.

Impact Criteria	Definition	Score	Criteria Description
Extent (E)	Site	1	Impact is on the site only
	Local	2	Impact is localized inside the activity area
	Regional	3	Impact is localized outside the activity area
	National	4	Widespread impact beyond site boundary. May be defined in various ways, e.g. cadastral, catchment, topographic
	International	5	Impact widespread far beyond site boundary. Nationally or beyond
Duration (D)	Immediate	1	On impact only
	Short term	2	Quickly reversible, less than project life. Usually up to 5 years.
	Medium term	3	Reversible over time. Usually between 5 and 15 years.
	Long term	4	Longer than 10 years. Usually for the project life.
	Permanent	5	Indefinite
Magnitude (M)	Very Low	1	No impact on processes
	Low	2	Qualitative: Minor deterioration, nuisance or irritation, minor change in species/habitat/diversity or resource, no or very little quality deterioration. Quantitative: No measurable change; Recommended level will never be exceeded.
	Moderate	3	Qualitative: Moderate deterioration, discomfort, Partial loss of habitat /biodiversity /resource or slight or alteration.

Impact Criteria	Definition	Score	Criteria Description
			Quantitative: Measurable deterioration; Recommended level will occasionally be exceeded.
	High	4	Qualitative: Substantial deterioration death, illness or injury, loss of habitat /diversity or resource, severe alteration or disturbance of important processes. Quantitative: Measurable deterioration; Recommended level will often be exceeded
	Very High	5	Permanent cessation of processes
Reversibility (R)	Reversible	1	Recovery which does not require rehabilitation and/or mitigation.
	Recoverable	3	Recovery which does require rehabilitation and/or mitigation.
	Irreversible	5	Not possible, despite action. The impact will still persist, and no mitigation will remedy or reverse the impact.
Probability (P)	Improbable	1	Not likely at all. No known risk or vulnerability to natural or induced hazards
	Low Probability	2	Unlikely; low likelihood; Seldom; low risk or vulnerability to natural or induced hazards
	Probable	3	Possible, distinct possibility, frequent; medium risk or vulnerability to natural or induced hazards.
	Highly Probable	4	Highly likely that there will be a continuous impact. High risk or vulnerability to natural or induced hazards
	Definite	5	Definite, regardless of prevention measures.

The *significance* (s) of potential impacts identified according to the criteria above has been colour coded for the purpose of comparison. This colour coding will be used in impact tables.

Significance is deemed Negative (-)		
0 - 30	**31 - 60**	**61 - 100**
Low	**Medium**	**High**

APPENDIX 2- SPECIALIST CV

CURRICULUM VITAE

Debra Jane Fordham

Cell: 0724448243
Email: debrajanefordham@gmail.com
Date of birth: 26th August 1987
Country of origin: South Africa
ID Number: 8708260094081

Professional profile

Debbie is a registered ecologist (119102), with over 8 years of working experience, largely specialising in aquatic ecology. She has authored over 80 reports and applications and she constantly contributes to the scientific and local community. Most of her projects involve (as a minimum) in-depth wetland and river field delineation (including soil investigations via augering, vegetation identification, and classifying the hydrological characteristics), laboratory analysis (such as water quality and sediment analysis), classification, characterisation, ecological health and ecosystem functioning assessments (using the latest available tools), as well as impact rating, buffer determinations, mitigation recommendations and detailed rehabilitation plans. She is highly proficient using GIS software to incorporate accurate spatial analysis and visual aids (No Go Area maps etc.) into her reports.

Debbie holds a M.Sc. degree in Environmental Science from Rhodes University, by thesis, entitled: The geomorphic origin and evolution of the Tierkloof Wetland, a peatland dominated by Prionium serratum in the Western Cape. She is a member of scientific organisations such as the Society of Wetland Scientists (SWS), the South African Wetland Society (SAWS), the Southern African Association of Geomorphologists (SAAG), and the International Association for Impact Assessment (IAIAsa). Debbie is registered with SACNASP in the field of Ecological Science (Reg Number: 119102).

Tertiary Education

- M.Sc. Environmental Science (Rhodes University):
  Master of Science thesis entitled: The geomorphic origin, evolution and collapse of a peatland dominated by Prionium serratum: a case study of the Tierkloof Wetland, Western Cape.
- BA Hons. Environmental Science (Rhodes University):
  Honours dissertation: The status and use of Aloe ferox. Mill in the Grahamstown commonage, South Africa.
  Courses: Wetland Ecology, Environmental Water Quality /Toxicology, Biodiversity, Non-Timber Forest Products (NTFPs) and Rural Livelihoods, Environmental Impact Assessment (EIA), Statistics
- BA - Environmental Science and Geography (Rhodes University)

Work Experience:
- Ecological specialist (2022/03/01 – present)
- Sharples Environmental Services cc (2016/08/10 – 2022/03/01)

Position: Aquatic Ecologist and WULA Manager
- KSEMS Environmental Consulting (2015/08/10 - 2016/07/31)

Position: Wetland specialist
- AGES EC (Pty) Ltd (2014/10/01 – 2015/08/10)

Position: Aquatic Ecologist and WULA Manager
- Environmental Impact Management Services (2014/02/04-2014/02/07)

Position: Environmental consultant
- Rhodes University Alumni Relations (2010/04/01 – 2010/12/17)

APPENDIX 3 - SITE SENSITIVITY VERIFICATION REPORT

Site verification report – Aquatic Ecology

Government Notice No. 645, dated 10 May 2019, includes the requirement that an Initial Site Sensitivity Verification Report must be produced for a project footprint. As per Part 1, Section 2.3, the outcome of the Initial Site Verification must be recorded in the form of a report that-

- Confirms or disputes the current use of the land and environmental sensitivity as identified by the national web based environmental screening tool;
- Contains a motivation and evidence of either the verified or different use of the land and environmental sensitivity;

Is submitted together with the relevant reports prepared in accordance with the requirements of the Environmental Impact Assessment Regulations.

This report has been produced specifically to consider the aquatic ecology theme and addresses the content requirements of (a) and (b) above. The report will be appended to the respective specialist study included in the Scoping and EIA Reports produced for the projects.

Site sensitivity based on the aquatic biodiversity theme included in the Screening Tool and specialist assessment

Based on the DFFE Screening Tool, there are areas of Very High Aquatic Biodiversity sensitivity.

The site verification specialist findings were informed by a site visit undertaken in January 2023. The photographs within the Figures 2 to 3 below show the various aquatic features present on site. This information was then compared to current wetland inventories, 1: 50 000 topocadastral surveys mapping of the site. A baseline map was then developed (Figure 1).

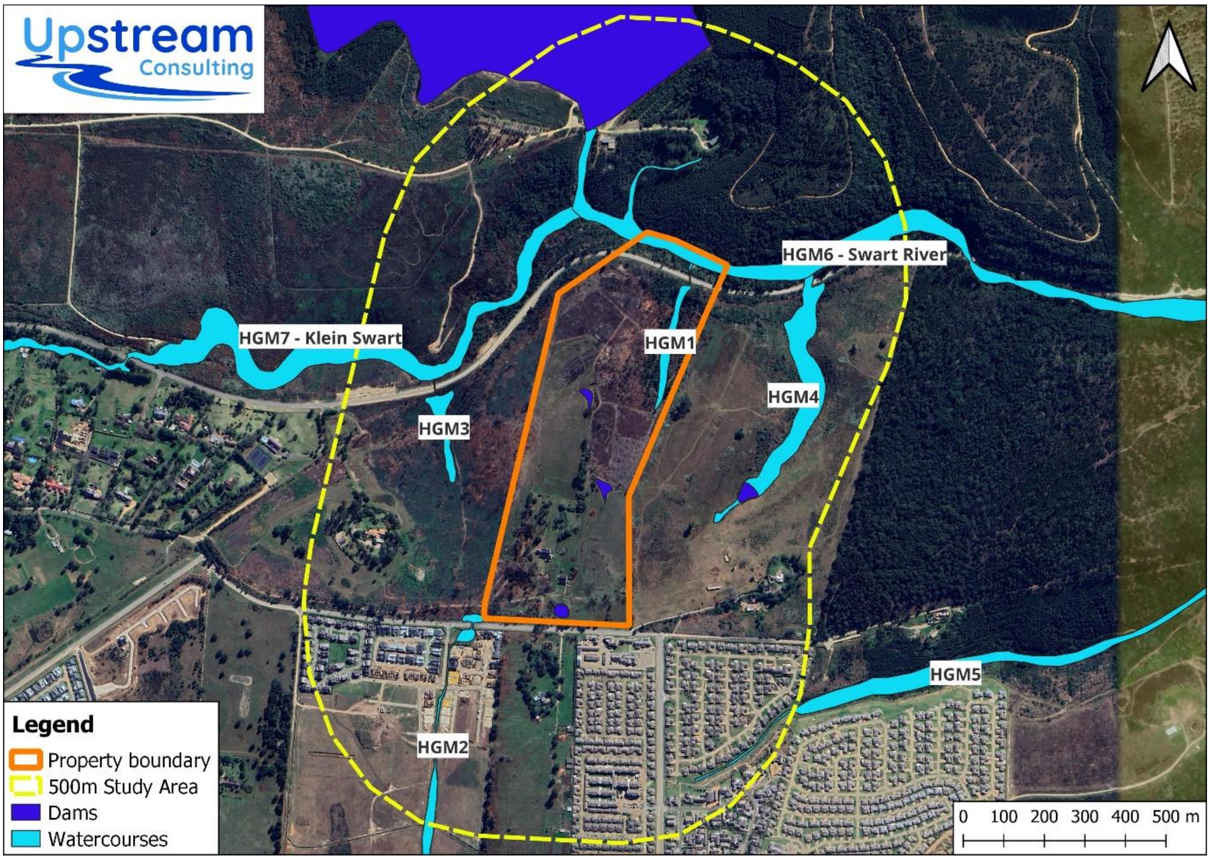

Figure 1: Delineated aquatic habitat within the study area

Figure 2: A photograph of a drainage line within the area proposed for development

Figure 3: A photograph of a small dam on the property

Motivation of the outcomes of the sensitivity map and key conclusions:

In conclusion, the DFFE Screening Tool resulted in Very High sensitivity ratings within the site footprint, and surrounding area, due to the SWSA. Following site verification, this Very High sensitivity rating is confirmed.

It is recommended that a full Aquatic Biodiversity Impact Assessment is undertaken for the project.

The environmental sensitivity input received from the aquatic ecology specialist will be taken forward and considered within the formal EA process and the impact to these areas assessed.