Streambank Stabilisation of a Wetland in Rosemoor, George, Western Cape.

Freshwater Assessment Report

For:

George Municipality

By:

Dr. J.M. Dabrowski

(Confluent Environmental)

August 2022

confluent

aquatic consulting & research

Declaration of Specialist Independence

- I consider myself bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP);
- At the time of conducting the study and compiling this report I did not have any interest, hidden or otherwise, in the proposed development that this study has reference to, except for financial compensation for work done in a professional capacity;
- Work performed for this study was done in an objective manner. Even if this study results in views and findings that are not favourable to the client/applicant, I will not be affected in any manner by the outcome of any environmental process of which this report may form a part, other than being members of the general public;
- I declare that there are no circumstances that may compromise my objectivity in performing this specialist investigation. I do not necessarily object to or endorse any proposed developments, but aim to present facts, findings and recommendations based on relevant professional experience and scientific data;
- I do not have any influence over decisions made by the governing authorities;
- I undertake to disclose all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by a competent authority to such a relevant authority and the applicant;
- I have the necessary qualifications and guidance from professional experts in conducting specialist reports relevant to this application, including knowledge of the relevant Act, regulations and any guidelines that have relevance to the proposed activity;
- This document and all information contained herein is and will remain the intellectual property of Confluent Environmental. This document, in its entirety or any portion thereof, may not be altered in any manner or form, for any purpose without the specific and written consent of the specialist investigators.
- All the particulars furnished by me in this document are true and correct.

Dr. James Dabrowski (Ph.D., Pr.Sci.Nat. Water Resources; SACNASP Reg. No: 114084)

August 2022

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

1.1 Project Background

A wetland located in the suburb of Rosemoor, RE/464, George, receives high quantities of stormwater runoff from extensive hardened surfaces associated with adjacent urban industrial and residential areas. High stormwater inputs have resulted in incision of the wetland and erosion of the banks which presents a risk to some residential properties located immediately adjacent to the wetland. Nadeson Consulting Services carried out a site inspection on 22 October 2020 after which a detailed survey was conducted by Eden Geomatics Topographical & Engineering Surveyors in order to be able to carry out a detailed floodline analysis for the 1:50 and 1:100 year return period. The study recommended that erosion protection, in the form of gabion baskets and reno mattresses, be constructed along the eroded embankment to ensure the safety of existing residential buildings along the riverbank.

Construction of gabions and reno mattresses within the delineated area of the watercourse triggers listed activities listed under both the National Environmental Management Act (NEMA) and the National Water Act (NWA) and will therefore require applicable environmental and water use authorisations.

1.2 Key Legislative Requirements

1.2.1 National Environmental Management Act (NEMA, 1998)

According to the protocols specified in GN 320 (Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in Terms of Sections 24(5)(A) and (H) and 44 of the National Environmental Management Act, 1998, when Applying for Environmental Authorisation), assessment and reporting requirements for aquatic biodiversity are associated with a level of environmental sensitivity identified by the national web-based environmental screening tool (screening tool). An applicant intending to undertake an activity identified in the scope of this protocol on a site identified by the screening tool as being of:

- **Very High** sensitivity for aquatic biodiversity, must submit an Aquatic Biodiversity Specialist Assessment; or
- **Low** sensitivity for aquatic biodiversity, must submit an Aquatic Biodiversity Compliance Statement.

According to the protocol, prior to commencing with a specialist assessment a site sensitivity verification must be undertaken to confirm the sensitivity of the site as indicated by the screening tool:

- Where the information gathered from the site sensitivity verification differs from the screening tool designation of **Very High** aquatic biodiversity sensitivity, and it is found to be of a **Low** sensitivity, an Aquatic Biodiversity Compliance Statement must be submitted.
- Similarly, where the information gathered from the site sensitivity verification differs from the screening tool designation of **Low** aquatic biodiversity sensitivity, and it is found to be of a **Very High** sensitivity, an Aquatic Biodiversity Specialist Assessment must be submitted.

The screening tool identified the site as being of **Very High** aquatic biodiversity based on the fact that the proposed activities occur within a mapped wetland area and within an area that has been designated as a Strategic Water Source Area (SWSA).

1.2.2 National Water Act (NWA, 1998)

The Department of Water & Sanitation (DWS) is the custodian of South Africa's water resources and therefore assumes public trusteeship of water resources, which includes watercourses, surface water, estuaries, or aquifers. The National Water Act (NWA) (Act No. 36 of 1998) aims to protect water resources, through:

- The maintenance of the quality of the water resource to the extent that the water resources may be used in an ecologically sustainable way;
- The prevention of the degradation of the water resource; and
- The rehabilitation of the water resource.

A watercourse means:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and
- 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.

No activity may take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS). According to Section 21 (c) and (i) of the National Water Act, an authorization (Water Use License or General Authorisation) is required for any activities that impede or divert the flow of water in a watercourse or alter the bed, banks, course or characteristics of a watercourse. The regulated area of a watercourse for section 21(c) or (i) of the Act water uses means:

a) The outer edge of the 1 in 100-year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam;

b) In the absence of a determined 1 in 100-year flood line or riparian area the area within 100m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench (subject to compliance to section 144 of the Act); or

c) A 500 m radius from the delineated boundary (extent) of any wetland or pan.

According to Section 21 (c) and (i) of the NWA, any water use activities that do occur within the regulated area of a watercourse must be assessed using the DWS Risk Assessment Matrix (GN 509) to determine the impact of construction and operational activities on the flow, water quality, habitat and biotic characteristics of the watercourse. Low Risk activities require a General Authorisation (GA), while Medium or High Risk activities require a Water Use License (WUL).

1.3 Scope of Work

Based on the key legislative requirements listed above the scope of work for this report includes the following:

- Undertake a desktop study of relevant freshwater information for the site;
- Undertake a site visit to the study area;
- Classify and delineate the wetland affected by the proposed activities;
- Determine the present ecological state, functional importance and conservation value of the wetland that will be affected by the proposed activities;
- Describe and assess the significance of the potential impacts of two alternative designs on the wetland;
- Complete a Section 21 (c) and (i) DWS Risk Assessment Matrix to determine whether the proposed activities require a GA or a WUL; and
- Provide a summary of the findings in the form of a Freshwater Impact Assessment Report.

2. METHODS

2.1 Desktop Assessment

A desktop assessment was conducted to contextualize the affected watercourses in terms their local and regional setting, and conservation planning. An understanding of the biophysical attributes and conservation and water resource management plans of the area assists in the assessment of the importance and sensitivity of the watercourses, the setting of management objectives and the assessment of the significance of anticipated impacts. The following data sources and GIS spatial information were consulted to inform the desktop assessment:

- National Freshwater Ecosystem Priority Area (NFEPA) atlas (Nel at al., 2011);
- National Wetland Map 5 and Confidence Map (CSIR, 2018);
- Western Cape Biodiversity Spatial Plan (CapeNature, 2017); and
- DWS hydrological spatial layers.

2.2 Watercourse Assessment

Several site visits were undertaken during July and August 2022, with the objective classifying the wetland area affected by the proposed stream bank protection; determining the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS), and assessing the impacts of the proposed stream bank protection on the wetland.

2.2.1 Watercourse Classification

Classification of watercourses is important as this determines the PES and EIS assessment methodologies that can be applied. Furthermore, classification of the watercourse provides a fundamental understanding of the hydrological and geomorphic drivers that characterise the watercourse and therefore assists in the interpretation of impacts to the watercourse. The wetland was categorised into discrete hydrogeomorphic units (HGMs) based on their geomorphic characteristics, source of water and pattern of water flow through the watercourse. These HGMs were then classified according to Ollis et al. (2013).

2.2.2 Present Ecological State

An important factor that influences the diversity and abundance of aquatic communities is the condition of the surrounding physico-chemical habitat. Habitat loss, alteration, or degradation generally results in a decline in species diversity. The PES of the wetland was assessed using the Wet-Health methodology (see Appendix 1).

2.2.3 Ecological Importance and Sensitivity

The ecological importance of a watercourse is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. Ecological sensitivity refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (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. The EIS assessment methodology can be viewed in Appendix 2.

2.3 Impact Assessment

Development activities typically impact on the following important drivers of aquatic ecosystems:

- *Hydrology:* Impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes and base flows and modifications to general flow characteristics, 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 etc.);
- *Geomorphology:* This refers to the alteration of hydrological and geomorphological processes and drivers, and associated impacts to aquatic habitat and ecosystem goods and services primarily driven by changes to the sediment regime of the aquatic ecosystem and its broader catchment;
- *Modification of water quality:* This refers to the alteration or deterioration in the physical, chemical and biological characteristics of water within streams, rivers and wetlands, and associated impacts to aquatic habitat and ecosystem goods and services (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication etc.);
- *Fragmentation:* Loss of lateral and/or longitudinal ecological connectivity due to structures crossing or bordering watercourses (e.g. road or pipeline crossing a wetland);
- *Modification of aquatic habitat:* This refers to the physical disturbance of in-stream and riparian aquatic habitat and associated ecosystem goods and services including 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.)*;* and

- *Aquatic biodiversity:* Impacts on 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.

Modifications to these drivers ultimately influence the PES and EIS of a watercourse. Accordingly, impacts to the wetland were described and assessed based on their potential to modify each of the above-mentioned drivers of aquatic ecosystem health, using the PES and EIS of the watercourse as a baseline against which to assess impacts. The impact assessment methodology is described in the appendix to this report (Appendix 3).

3. ASSUMPTIONS & LIMITATIONS

- With ecology being dynamic and complex, there is the likelihood that some aspects (some of which may be important) may have been overlooked;
- This assessment is based on the findings of a visual assessment of the site combined with available desktop resources. This study was not informed by detailed hydraulic, hydrological, faunal or floral assessments;
- The PES and EIS assessments undertaken are largely qualitative assessment tools and thus the results are open to professional opinion and interpretation. An effort has been made to substantiate all claims where applicable and necessary.

4. STUDY SITE

The wetland is located within the urban center of the city of George, Western Cape, in quaternary catchments K30C of the Kromme Primary Catchment (Figure 1). The section of wetland to be rehabilitated is located within RE/464, located within the suburb of Rosemoor. The immediate catchment area of the wetland consists of mixed residential and industrial (mainly warehouses) land use and associated infrastructure (i.e. roads, stormwater and sewage networks etc.) (Figure 2).

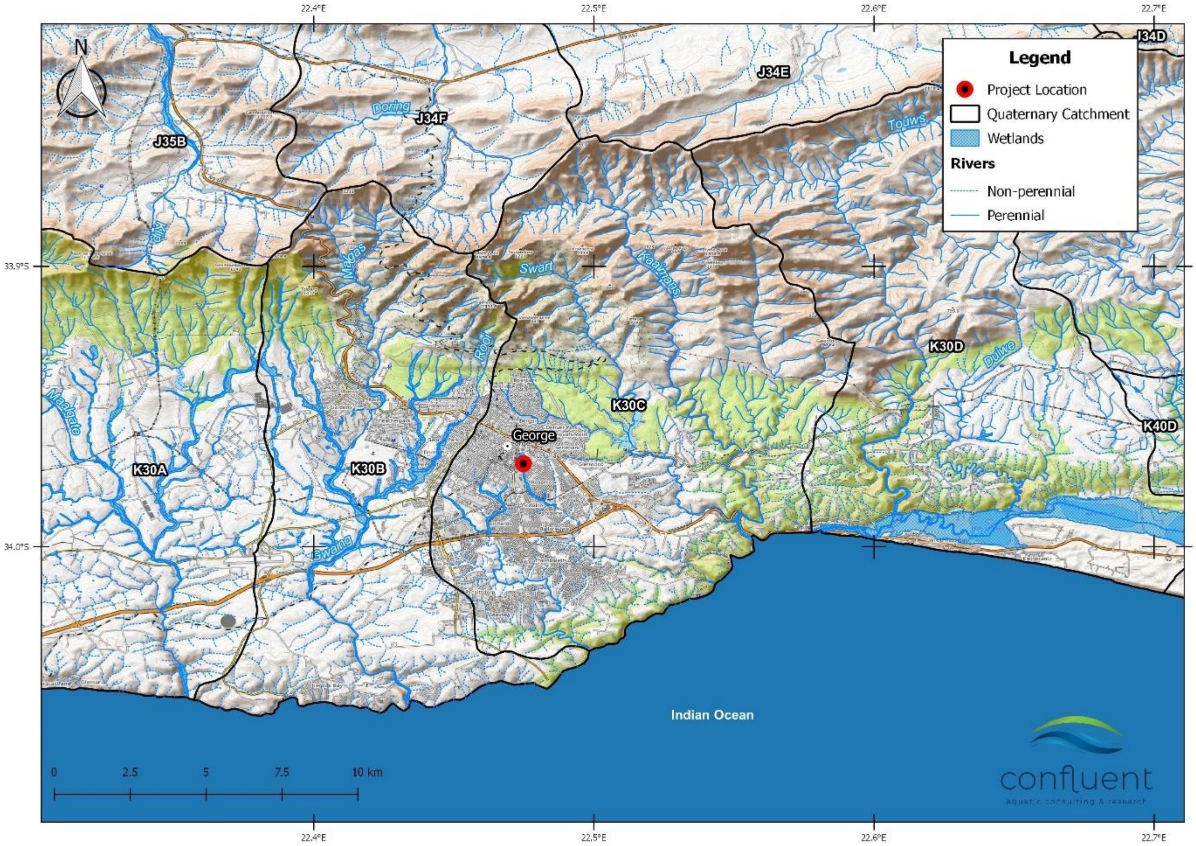

Figure 1: Location of the proposed streambank protection in quaternary catchment K30C

Figure 2: Location of project area within RE/464

5. SITE ASSESSMENT

5.1 Watercourse Classification

The site visit confirmed that the mapped wetland is a valley-bottom wetland. The wetland is located along a low gradient, relatively shallow valley bottom. The shallow gradient would ordinarily favour deposition of sediment and result in diffuse (as opposed to channelled) streamflow, ultimately resulting in prolonged saturation levels and high levels of organic matter in what was most likely historically an unchannelled valley bottom wetland. It was however clearly evident from the site visit that the wetland receives large volumes of stormwater inflows from the larger catchment area and from industrial areas located immediately adjacent to the wetland. Inputs of high volume, high velocity stormwater flows have resulted in the formation of a clear incised channel along most of the length of the wetland, resulting in the formation of more riverine habitat.

5.2 Present Ecological State (PES)

The surrounding urban and industrial areas have significantly impacted the ecological condition of the wetland. As described above the wetland receives considerably higher volumes of water due to extensive hardened surfaces in the catchment area, numerous bulk stormwater discharges and numerous smaller discharges from adjacent industrial properties (Figure 3). This was confirmed during a site visit conducted shortly after a very heavy rainfall event, which led to extensive flooding across the city of George. High stormwater inputs have altered both the hydrological and geomorphological characteristics of the wetland area, resulting in almost riverine conditions, an incised channel and loss of sediment from the bed and banks (due to high velocity, high energy stormwater flows) (Figure 4). This has resulted in the loss of wetland habitat and alteration from what was most likely an unchannelled valley bottom wetland (with high flood and sediment attenuation capacity) to a more channelled system. A stormwater outlet that discharges into the river in between Erf 21150 and Erf 21151 also likely contributes to the bank destabilisation. There is a high drop-off and the plunging effect would most likely have scoured the toe of the embankment which would have contributed to the erosion of the embankment in this area. Large sections of the western extent of the wetland have been historically infilled for the establishment of industrial warehouses. Dumping of rubble is also evident.

Mowing and clearing of vegetation immediately adjacent to the edge of the bank full channel is also most likely a factor that contributes to the erosion of the banks. Roots of vegetation play an important role in binding the soil and conversion from deeply rooted shrubs and trees to shallow-rooted kikuyu lawns will have compromised the ability of the streambank to withstand high volume stormwater flows. It was evident that the most serious bank erosion had occurred along sections where vegetation had been cleared right up to the edge of the embankment.

Water quality has been compromised by input of stormwater originating from urban and industrial areas and most likely by sewage input from leaking infrastructure and a pump station located further upstream. Large amounts of solid waste and litter were observed within the channel of the wetland and it was evident that garden waste, litter and ash and burned out coals are frequently dumped into the wetland

Based on the impacts observed the PES of the wetlands is **D – Largely Modified.**

Figure 3: Photographs broader catchment impacts including litter in the wetland south of Grens Road (A); sewage pipeline crossing the wetland (B); infilling of rubble along western boundary of the wetland (C); high volumes of stormwater entering the wetland upstream of erven 21150 and 21151 (D); and stormwater inputs from industrial areas along the western boundary of the wetland (E).

Figure 4: View of the wetland looking north from Grens Road (A); dumping of litter and garden waste into the wetland (B); eroded banks adjacent to Erf 21151 (C); erosion of banks Instream habitat and eroded banks of the wetland (top) and eroded channel adjacent to erven 21150 and 21151 (bottom).

Table 1: Summary of Wet-Health scores derived for the wetland.

Wetland	Scores
Hydrology	40 % (D/E)
Geomorphology	60 % (C/D)
Vegetation	60 % (C/D)
Overall	**51 % (D)**

5.3 Importance & Sensitivity

The overall importance and sensitivity of the both wetlands is **Moderate**, based primarily on the hydro-functional attributes that these type of wetlands offer (Table 3). These services have however been lost to some extent, due to the channelisation of the wetland, which compromises its ability to attenuate floods, sediment and filter and trap pollutants. Given the current PES, the location of the wetland within an intensive urban area and the relatively low diversity of habitat types, the ecological importance (Table 2) of the wetlands is relatively low. Direct human benefits are also low (Table 4).

Table 2. Ecological Importance and Sensitivity importance criteria for the wetland.

Criteria	Score
Biodiversity Support	
Presence of Red Data species	1
Populations of unique species	1
Migration/feeding/breeding sites	1
Average	**1**
Landscape Scale	
Protection status of wetland	1 – Poorly protected
Protection status of vegetation type	1 – Garden Grantie Fynbos
Regional context of the ecological integrity	1 – Largely modified from natural
Size and rarity of the wetland types present	2 – Moderate size – least threatened.
Diversity of habitat types	2 – Moderate (instream and marginal vegetation)
Average	**1.6**
Sensitivity of the Wetland	
Sensitivity to changes in floods	1
Sensitivity to changes in low flows	2
Sensitivity to changes in water quality	2
Average	**1.67**
ECOLOGICAL IMPORTANCE AND SENSITIVITY	**1.67 (Moderate)**

Table 3: Hydro-functional importance criteria results for the wetland.

Hydro-functional importance			Score
Regulating & supporting benefits		Flood attenuation	2
		Streamflow regulation	2
	Water quality enhancement	Sediment trapping	1
		Phosphate assimilation	1
		Nitrate assimilation	1
		Toxicant assimilation	1
		Erosion control	1
		Carbon storage	2
HYDRO-FUNCTIONAL IMPORTANCE			**1.4 (Moderate)**

Table 4: Direct human benefit importance criteria results for the wetland.

Direct human benefits		Score
Subsistence benefits	Water for human use	0
	Harvestable resources /cultivated foods	0
Cultural benefits	Cultural heritage	0
	Tourism and recreation & education and research	0
DIRECT HUMAN BENEFITS		**0**

6. IMPACT ASSESSMENT

Each of the impacts expected to occur during the construction and operational phase have been assessed in terms of their significance. The main impacts associated with the construction of the road is habitat loss and potential alteration of flow dynamics which could influence the hydro-geomorphological characteristics of the wetlands. The impact assessment takes the highly modified characteristics of the wetlands into account.

6.1 Description of Activities

The need for the stream bank stabilisation was initiated primarily as a result of risk posed to erven 21150 and 21151, the boundaries of which are located immediately adjacent to the eroded channel. Any further destabilisation of the bank therefore presents a risk to the residential buildings located on these properties. Alternative 1 therefore restricts gabions to the section of channel located adjacent to these properties (Figure 5). Alternative 2 proposes the placement of gabions along the entire length of the stream from Erf 21151 (starts at the same point as Alternative 1), all the way to Grens Road. The rationale for this alternative is that the entire length of this section of the channel is incised and eroded. Properties along this alternative are however set far back from the channel and are therefore not at imminent risk.

Figure 5: Map indicating proposed alternatives 1 and 2.

6.2 Planning and Layout Phase

Impact 1: Increased stream velocity caused by hardening of the bank

Hydrological armouring of stream banks (e.g. wooden retaining wall, rip rap or reno mattress constructions) is a common technique used to stabilise banks for erosion protection. They can tend to cause problems further downstream in that these hardened structures tend to increase the speed of water flow along an armoured reach, as the water has no points of friction to come up against and nothing to slow it down. This additional strength of flow can cause problems further downstream, as water is deflected off the hardened surface and directed at other points of the riverbank. The increased strength and speed of the water can increase erosive forces at these new locations, the result of which is the necessity of installing additional armouring, which merely moves the problem further down the stream. While the installation of gabions may cause flow energy to be deflected into the opposite bank it is important to note that there is sufficient space to accommodate some bank erosion along the western bank and no properties would be at risk.

	Alternative 1		Alternative 2	
	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity	Moderate	Low	Very high	High
Duration	Permanent	Permanent	Permanent	Permanent
Extent	Very limited	Very limited	Limited	Limited
Probability	Likely	Likely	Almost certain	Almost certain
Significance	**-60 (Minor)**	**-55 (Minor)**	**-90 (Moderate)**	**-84 (Moderate)**
Reversibility	High	High	High	High
Irreplaceability	Low	Low	Low	Low
Confidence	High	High	High	High

Mitigation

- The profile of the gabions must mimic the curved profile of the embankment so as to avoid creating sharp angles which could enhance the deflection of flow energy;
- Provision should be made for installing streambank protection on the opposite side of the bank. This should only be installed following an extended period of monitoring to determine whether additional protection is in fact necessary.

Impact 2: Scouring of bed and banks caused by stormwater discharge at Erf 21150

A pipe discharges stormwater from a headwall outlet on the perimeter of Erf 21150. The invert of the pipe is more than 1 m above the bed of the stream. High energy discharges during storm events could cause localised scouring of the bed and banks which could destabilise the gabion structures and cause slumping into the watercourse.

	Route 1		Route 2	
	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity	Low	Very low	Low	Very low
Duration	Permanent	Permanent	Permanent	Permanent
Extent	Very limited	Very limited	Very limited	Very limited
Probability	Certain	Unlikely	Certain	Unlikely
Significance	**-77 (Moderate)**	**-30 (Negligible)**	**-77 (Moderate)**	**-30 (Negligible)**
Reversibility	High	High	High	High
Irreplaceability	Low	Low	Low	Low
Confidence	High	High	High	High

Mitigation • The gabion design must incorporate adequate measures to dissipate the energy of stormwater discharged from the pipe outlet.

6.3 Construction Phase Impacts

Impact 3: Loss of wetland habitat caused by installation of gabions for streambank protection.

Installation of gabions will result in the loss of stream bank habitat. The embankment along this section is however highly incised and eroded and offers little in the way of functional wetland habitat.

	Alternative 1		Alternative 2	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity	Low	Very low	High	Moderate
Duration	Permanent	Permanent	Permanent	Permanent
Extent	Very limited	Very limited	Limited	Limited
Probability	Certain	Certain	Certain	Certain
Significance	**-77 (Moderate)**	**-70 (Minor)**	**-98 (Moderate)**	**-91 (Moderate)**
Reversibility	High	High	High	High
Irreplaceability	Low	Low	Low	Low
Confidence	High	High	High	High

Mitigation

- Areas where instream construction activities will take place must be confined to clearly demarcated areas so as to prevent unnecessary disturbance of instream and riparian habitat outside of these areas;
- Prevent uncontrolled access of vehicles into the watercourse;
- All waste materials must be collected and disposed of at a suitable waste facility; and
- The laydown area and stockpiles of construction materials must be placed outside of the channel of the watercourse (on as flat an area as possible) and protected (e.g. through use of sandbags and/or tarpaulins) to prevent materials being washed into the watercourse.

Impact 4: Sedimentation of wetland habitat caused by disturbance of bed and banks during placement of gabion boxes.

Preparation of the embankment for the placement of the gabions will expose soil which could lead to erosion of the embankment and sedimentation of wetland habitat. Placement of gabions will also result in the mobilisation of sediment from the stream bed.

	Alternative 1		Alternative 2	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity	Low	Very low	Moderate	Low
Duration	Short term	Short term	Short term	Short term
Extent	Limited	Very limited	Limited	Limited
Probability	Certain	Unlikely	Certain	Probably
Significance	**-56 (Minor)**	**-18 (Negligible)**	**-63 (Minor)**	**-32 (Negligible)**
Reversibility	High	High	High	High
Irreplaceability	Low	Low	Low	Low

Confidence	High	High	High	High

Mitigation measures:

- Construction activities must be timed to coincide with low rainfall probability (dry season) to avoid erosion of exposed banks;
- A temporary check dam (using sand bags) should be established upstream of the construction site to create dry working conditions. Water from upstream should be transferred through the construction area by an appropriately sized flexible pipe;
- Temporary straw-bale check dams can be placed across the channel, immediately downstream of the streambank protection as a back-up to trap high levels of sediment in the event of a high rainfall event. These must be removed as soon as construction is complete;
- A construction schedule must be developed and clearly defined so as to avoid multiple sites being exposed and unattended to at any moment in time. The completion date for each phase of development must be indicated and all clearing, excavation, and stabilisation operations must be completed before moving onto the next phase;
- Stockpiles of construction materials must be placed outside of the channel of the watercourse (on as flat an area as possible) and protected (e.g. through use of sandbags and/or tarpaulins) to prevent materials being washed into the watercourse;
- The area(s) chosen for the stockpiling of imported building materials should be demarcated, and notices put up declaring what must be stockpiled where; and
- Following the installation of gabions, any exposed banks must be stabilised with appropriate geotextiles or vegetated with appropriate indigenous vegetation.

Impact 5: Disturbance and pollution of wetland habitat caused by operation of vehicles and machinery in close proximity to the channel of the wetland.

Operation of heavy construction vehicles too close to the edge embankment of the channel could cause the bank to slip. In addition, construction vehicles and machinery operating in close proximity to the wetlands could potentially cause pollution due to spills and/or leaks of hydrocarbons (fuel and oil).

	Alternative 1		**Alternative 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity	Low	Low	Low	Low
Duration	Short term	Short term	Short term	Short term
Extent	Very limited	Very limited	Limited	Limited
Probability	Probably	Unlikely	Probably	Unlikely
Significance	**-28 (Negligible)**	**-21 (Negligible)**	**-32 (Negligible)**	**-24 (Negligible)**
Reversibility	High	High	High	High
Irreplaceability	Low	Low	Low	Low
Confidence	High	High	High	High

Mitigation

- Gabions will be packed by manual labour;
- No vehicles to operate within 5 m of the edge of the channel. Area must be demarcated to prevent access. Vehicles may only approach within 5 m where gabion materials need to be off-loaded;
- Excavators and all other machinery and vehicles must be checked for oil and fuel leaks daily. No machinery or vehicles with leaks are permitted to work in the watercourse;
- No fuel storage, refuelling, vehicle maintenance or vehicle depots to be allowed within the delineated area of the wetlands;

- Refuelling and fuel storage areas, and areas used for the servicing or parking of vehicles and machinery, must be located on impervious bases and should have bunds around them (sized to contain 110 % of the tank capacity) to contain any possible spills. These areas must not be located within any natural drainage areas or preferential flow paths and must be located more than 20 m away from the delineated area of each wetland;
- Chemical toilets should be provided on-site at 1 toilet per 10 persons;
- Waste from chemical toilets must be disposed of regularly (at least once a week) in a responsible manner by a registered waste contractor;
- Cement/concrete used in the construction must not be mixed on bare ground or within the watercourse. An impermeable/bunded area must be established in such a way that cement slurry, runoff and cement water will be contained and will not flow into the surrounding environment, the stream or riparian zone or contaminate the soil;
- Workers must be properly instructed in the proper care of the environment, especially with respect to poaching, disturbance of nesting and roosting areas, disposal of human waste, garbage etc;
- All waste generated on-site during construction must be adequately managed; and
- Separation and recycling of different waste materials should be supported.

Impact 6: Disturbance and pollution of wetland habitat caused by presence of construction personnel within the wetland.

The presence of construction workers working within the wetland area could lead to unnecessary disturbance of wetland habitat.

	Alternative 1		**Alternative 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity	Low	Very Low	Low	Very low
Duration	Brief	Brief	Brief	Brief
Extent	Very limited	Very limited	Very limited	Very limited
Probability	Probably	Unlikely	Probably	Unlikely
Significance	**-24 (Negligible)**	**-15 (Negligible)**	**-24 (Negligible)**	**-15 (Negligible)**
Reversibility	High	High	High	High
Irreplaceability	Low	Low	Low	Low
Confidence	High	High	High	High

Mitigation

- Chemical toilets should be provided on-site at 1 toilet per 10 persons;
- Waste from chemical toilets must be disposed of regularly (at least once a week) in a responsible manner by a registered waste contractor;
- Cement/concrete used in the construction must not be mixed on bare ground or within the watercourse. An impermeable/bunded area must be established in such a way that cement slurry, runoff and cement water will be contained and will not flow into the surrounding environment, the stream or riparian zone or contaminate the soil;
- Workers must be properly instructed in the proper care of the environment, especially with respect to poaching, disturbance of nesting and roosting areas, disposal of human waste, garbage etc;
- All waste generated on-site during construction must be adequately managed; and
- Separation and recycling of different waste materials should be supported.

6.4 Operational Phase

Impact 7: Scouring caused by presence of gabion structures **Scouring of the bed and banks of the wetland.**				
	Alternative 1		**Alternative 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity	Moderate	Low	High	Moderate
Duration	Ongoing	Ongoing	Ongoing	Ongoing
Extent	Very limited	Very limited	Limited	Limited
Probability	Probably	Unlikely	Probably	Probably
Significance	**-44 (Minor)**	**-30 (Negligible)**	**-52 (Minor)**	**-48 (Minor)**
Reversibility	High	High	High	High
Irreplaceability	Low	Low	Low	Low
Confidence	High	High	High	High

Mitigation

- The most upstream and downstream ends of the gabions must align (or be flush) with the existing stream bank so as to avoid any localised scour points caused by sudden obstructions to the natural flow path;
- All gabion weirs and instream bank protection structures must be inspected on a routine basis to ensure that the baskets are intact and that rocks have not displaced. Any faults must be immediately repaired; and
- Any scouring or undercutting caused by gabion weirs must be rehabilitated following the inputs of an aquatic ecologist.

Impact 8: De-stabilisation of bank caused by removal of riparian vegetation. Sections of the embankment from Grens Street further upstream have had riparian vegetation removed and lawns cultivated right up to the edge of the bank. The roots of riparian vegetation play an important role in binding soil and help to stabilises stream banks. The removal of the vegetation therefore contributes to the de-stabilisation of the bank. While increased stormwater inputs are the main cause of the stream incision, the lack of riparian vegetation contributes to the problem.				
	Alternative 1		**Alternative 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity	Moderate	Low	Moderate	Low
Duration	Ongoing	Ongoing	Ongoing	Ongoing
Extent	Limited	Limited	Limited	Limited
Probability	Likely	Unlikely	Likely	Unlikely
Significance	**-60 (Minor)**	**-33 (Negligible)**	**-60 (Minor)**	**-33 (Negligible)**
Reversibility	High	High	High	High
Irreplaceability	Low	Low	Low	Low
Confidence	High	High	High	High

Mitigation

- Lawns must be withdrawn from the edge of the stream bank and a 5 m riparian buffer, consisting of appropriate indigenous plants (including deep rooted shrubs and trees) must be re-established along the length of the eastern bank.

6.5 Recommended Alternative

Given the proximity of the bank erosion Erf 21150 and 21151 and high stormwater volumes entering the wetland, installation of gabions is regarded as a necessary and appropriate measure to protect these properties. Based on the impact assessment, Alternative 1 is preferred and recommended as all impacts can be mitigated to a minor or negligible level. This alternative would alleviate the immediate risk to adjacent properties and result in less disturbance and modification of wetland habitat (for both the construction and operational phase).

While Alternative 2 would stabilise a longer section of the stream bank, it is not required for the protection of properties (other than those protected under Alternative 1) and would only serve to treat the symptoms of a problem (i.e. bank erosion) as opposed to address the primary source (i.e. high stormwater volumes) of the problem. The broader rehabilitation of the wetland would need to follow a more holistic approach that would aim to reduce or attenuate stormwater flows in the wetland as a primary goal. Stabilisation of streambanks should then be addressed as a secondary goal, with consideration given to re-shaping and re-vegetation of the stream bank as an alternative to hard infrastructure (i.e. gabions). Often, re-shaping of banks in urban environments is restricted by the close proximity of property boundaries to the watercourse. In this particular case there is sufficient space to carry out such an approach.

It is important to note, that even under a broader stream rehabilitation process as described above, stabilisation of the embankment using gabions would still most likely be required in order to protect erven 21151 and 21150 as there is insufficient space along these properties to re-shape the banks to a suitable gradient.

7. DWS RISK ASSESSMENT MATRIX

Only risks associated with Alternative 1 were assessed as this was considered to be the preferred option.

According to Section 21 (c) and (i) of the NWA, any water use activities that do occur within the regulated area of a watercourse must be assessed using the DWS Risk Assessment Matrix (GN 509) to determine the impact of construction and operational activities on the flow, water quality, habitat and biotic characteristics of the watercourse. Low Risk activities require a General Authorisation (GA), while Medium or High Risk activities require a Water Use License (WUL). All sections of road that cross wetlands are located within the regulated area of a watercourse and the risk assessment matrix (Based on DWS 2015 publication: Section 21 (c) and (i) water use Risk Assessment Protocol) was implemented to assess risks for each activity associated with the construction and operational phase of the road crossings. The first stage of the risk assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change.

Risks for the construction (Table 5) and operational phase (Table 6) for Alternative 1 were assessed assuming full implementation of recommended mitigation measures as described in Section 6. All ratings fall within a Medium risk class but are regarded as borderline Low/Medium scores. Scores fall within the Medium risk class primarily because an average rating of 5 was assigned to the severity of impacts to flow regime, water quality, habitat and biota receptors (as prescribed by the risk matrix methodology for developments that occur within the delineated area of a wetland). Given the highly degraded nature of the wetland it is not anticipated that the placement of gabions will result in any further degradation in the PES or EIS, provided all mitigation measures stipulated in Section 6 are implemented. On this basis scores have been manually adjusted to provide a more realistic indication of impact (scores can be manually adjusted up to a maximum of 25 points).

Given the Low impact associated with all activities highlighted in this report, and according to Government Notice 509 of August 2016 (RSA, 2016) of the National Water Act, the construction and operation of the streambank stabilisation is Generally Authorised and does not require a Water Use License.

Table 5: Construction phase risk matrix completed by Dr. James Dabrowski (SACNASP registration number 114084). Severity scores assume full implementation of mitigation measures)

Activity	Aspect	Impact	Flow Regime	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures	Borderline LOW MODERATE Rating Classes	PES AND EIS OF WATERCOURSE
Excavation of banks (site preparation)	Operation of Construction Vehicles and Machinery	Contamination of watercourse with hydrocarbons	5	5	5	5	5	1	1	7	1	1	5	1	8	56	Medium	95	See Section 6 (Impact 5)	Low (55)	PES: D EIS: Moderate
	Exposed soil	Erosion of streambank	5	5	5	5	5	1	1	7	1	1	5	1	8	56	Medium	90	See Section 6 (Impact 4)	Low (55)	
	Stockpiling of excavated material	Erosion of stockpiles	5	5	5	5	5	1	1	7	1	1	5	1	8	56	Medium	95	See Section 6 (Impact 3)	Low (55)	
	Excavation of bed and banks	Loss of aquatic habitat	5	5	5	5	5	1	1	7	1	1	5	1	8	56	Medium	90	See Section 6 (Impact 3)	Low (55)	
Construction of gabions	Stockpiling of construction materials	Disturbance of aquatic habitat	5	5	5	5	5	1	1	7	1	1	5	1	8	56	Medium	95	See Section 6 (Impact 3)	Low (55)	
	Generation of waste material	Disturbance of aquatic habitat	5	5	5	5	5	1	1	7	1	1	5	1	8	56	Medium	95	See Section 6 (Impact 3)	Low (55)	
	Placement of gabions	Loss of aquatic habitat	5	5	5	5	5	1	1	7	1	1	5	1	8	56	Medium	95	See Section 6 (Impact 3)	Low (55)	
	Disturbance of stream bed and banks	Mobilisation of sediment	5	5	5	5	5	1	1	7	1	1	5	1	8	56	Medium	90	See Section 6 (Impact 4)	Low (55)	

Table 6: Operational phase risk matrix completed by Dr. James Dabrowski (SACNASP registration number 114084). Severity scores assume full implementation of mitigation measures)

Activity	Aspect	Impact	Flow Regime	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures	Borderline LOW MODERATE Rating Classes	PES AND EIS OF WATERCOURSE
Gabion structures	Deflection of high-volume stormwater floods	Erosion of opposite bank	5	5	5	5	5	1	1	7	2	1	5	1	9	63	Medium	90	See Section 6 (Impact 1 and 7)	Low (55)	PES: D EIS: Moderate
Maintenance of lawns along eastern embankment	Removal of riparian vegetation	Destabilisation of streambank	5	5	5	5	5	1	1	7	1	1	5	1	8	56	Medium	90	See Section 6 (Impact 8)	Low (55)	
Stormwater discharge from Erf 21151	Scouring of bed and banks	Destabilisation of streambank	5	5	5	5	5	1	1	7	1	1	5	1	8	56	Medium	95	See Section 6 (Impact 7)	Low (55)	

8. FRESHWATER CONSERVATION AND MANAGEMENT

8.1 National Freshwater Ecosystem Priority Areas (NFEPA)

The study site is located within sub-quaternary catchment (SQC) 9144 (Figure 6), which, according to the National Freshwater Ecosystem Priority Atlas (NFEPA, Nel et al., 2011), has not been classified as a FEPA (Freshwater Ecosystem Priority Area). The wetland and its catchment area therefore fall within an SQC that is not considered as being a priority for maintaining freshwater biodiversity at a national scale. This is largely as a result of the extensive urbanisation that has occurred in this catchment, which has led to the degradation of watercourses, particularly in their lower reaches.

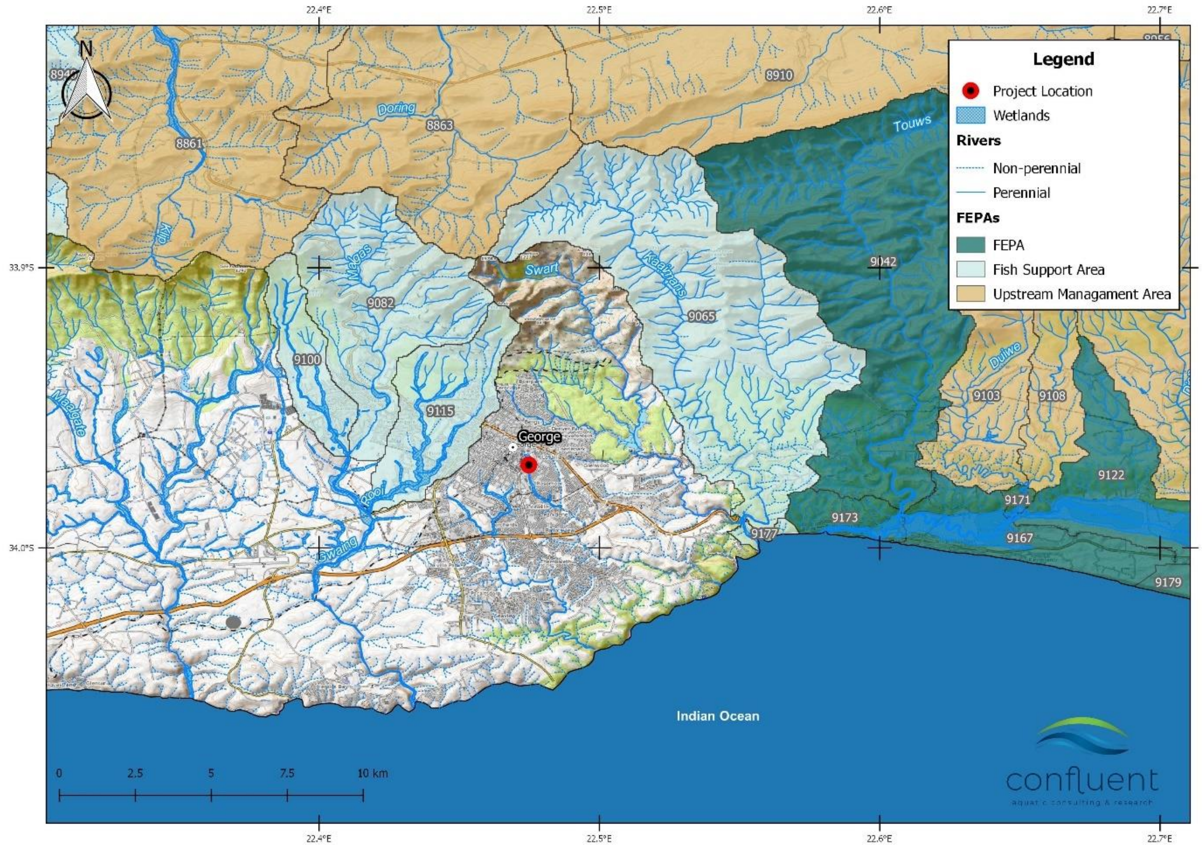

Figure 6: Map of the project area in relation to FEPAs.

8.2 Western Cape Biodiversity Spatial Plan (WCBSP)

According to the WCBSP for George, sections of the watercourse fall within aquatic Critical Biodiversity Areas (CBA1) and Ecological Support Areas (ESA2) (Figure 7). The management objectives of CBAs are described in Table 7, and includes the rehabilitation of degraded areas. ESA2 areas are not essential for meeting biodiversity targets but are important for supporting the functioning of more important CBA areas. ESAs should therefore be managed or restored to ensure that the ability to provide these supporting services is not compromised. In this respect, Alternative 1 is the most desirable as only a small section the length of the wetland will be affected by the streambank stabilisation. Furthermore, Alternative 2 will result in an extensive modification of wetland habitat and is therefore not aligned to the management objectives of the wetland.

Figure 7: Map of the stream bank protection in relation to the Western Cape Biodiversity Spatial Plan (WCBSP).

Table 7: Definitions and management objectives of the Western Cape Biodiversity Spatial Plan.

Category	Definition	Management Objective
CBA1	Areas in a natural condition that are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure.	Maintain in a natural or near-natural state, with no further loss of natural habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land uses are appropriate.
ESA2	Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of PAs or CBAs and are often vital for delivering ecosystem services.	Restore and/or manage to minimize impact on ecological processes and ecological infrastructure functioning, especially soil and water-related services, and to allow for faunal movement.

8.3 Strategic Water Source Area

Strategic Water Source Areas (SWSAs) are defined as areas of land that either:

a) Supply a disproportionate (i.e. relatively large) quantity of mean annual surface water runoff in relation to their size and so are considered nationally important; or

b) Have high groundwater recharge and where the groundwater forms a nationally important resource; or

c) Areas that meet both criteria (a) and (b).

The project area falls within the Outeniqua SWSA (Figure 8) which is considered to be of national importance. SWSAs are vital for water and food security in South Africa and also provide the water used to sustain the economy. Given this context, management and implementation guidelines have been developed with the objective of facilitating and supporting well-informed and proactive land management, land-use and development planning in these nationally important and critical areas (Le Maitre, et al., 2018). The primary principle behind this objective is to protect the quantity and quality of the water they produce by maintaining or improving their condition. The proposed development footprint falls within an urban 'working landscape' and in this context the management objectives are:

- To maintain at least the present condition and ecological functioning of these landscapes;
- To restore where necessary; and
- To limit or avoid further adverse impacts on the sustained production of high-quality water.

The proposed project will not have any effect on the production of high-quality water. The wetland receives water from an entirely urban area and is unlikely to be of good quality. The installation of streambank protection will not have an additional adverse impact on the quality of water. The primary objective that must therefore be met is to maintain the present ecological condition of the wetland and restore ecological function, where possible. In this respect, Alternative 1 will meet this objective, whilst still offering protection to high risk properties.

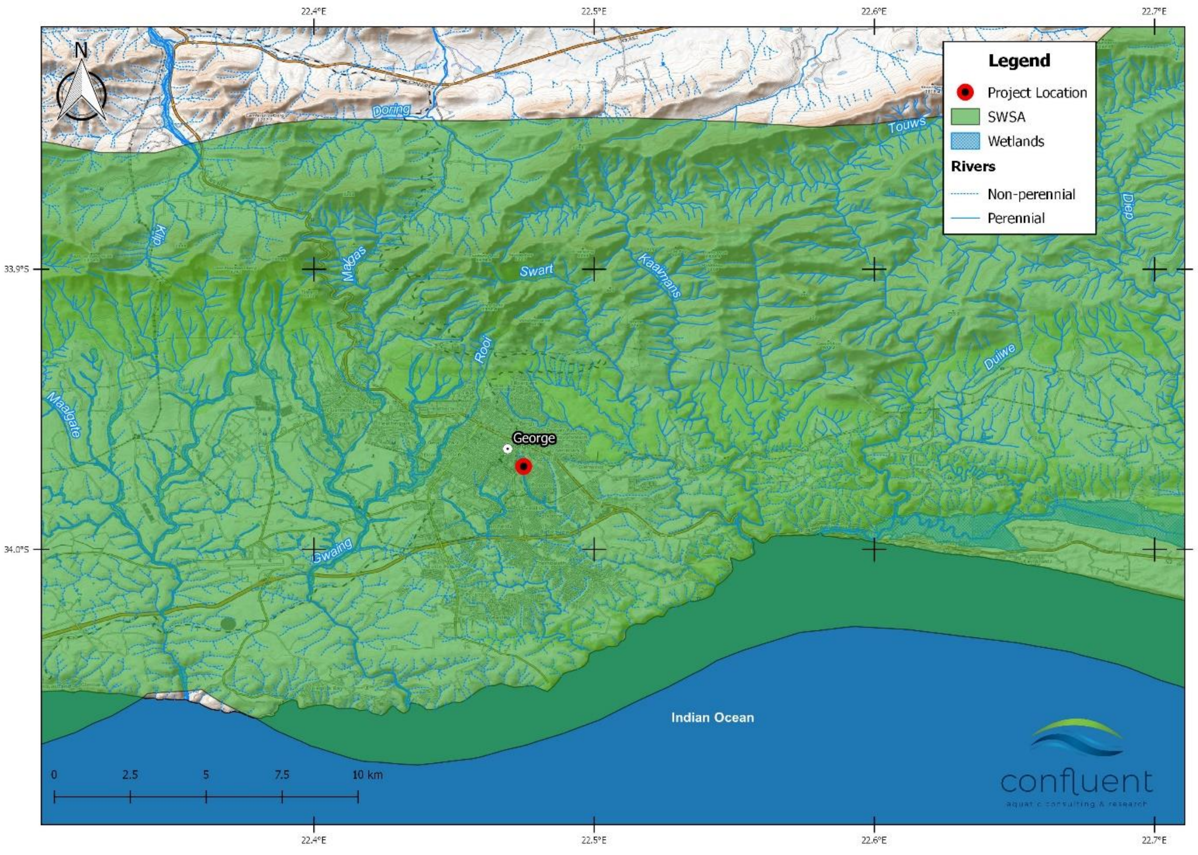

Figure 8: Map of the project area relative to mapped Strategic Water Source Areas (SWSAs)

9. CONCLUSION

The main intention of the stream rehabilitation is to protect properties and buildings located immediately adjacent to the watercourse. In this respect the placement of streambank stabilisation as per Alternative 1 is considered a necessity. The wetland has been highly modified from its natural state and the installation of gabions will not compromise the PES or EIS of the wetland and will not compromise national or provincial freshwater management and conservation objectives for the wetland. It is therefore recommended that Alternative 1 be authorised.

Streambank stabilisation using hard gabion approaches should however not be considered as the only solution for any future rehabilitation that might be required in this wetland. As highlighted in this report, the wetland is subjected to high volumes of stormwater runoff which is without doubt the main cause (or source) of the erosion of the bed and banks in this and in other urban settings. Any future watercourse rehabilitation must attempt to manage this main source of the problem, as opposed to merely attempting to fix the symptom of the problem through installation of hard infrastructure. The focus must therefore be on reducing stormwater inputs into the wetland or attenuating stormwater volumes through the construction of retention ponds, gabion weir structures etc. This approach will avoid the need for the construction of extensive hard infrastructure (i.e. as in Alternative 2) and will ultimately result in an improvement in the hydrological and ecological function of the wetland as well as the ecosystem services it provides.

10. COMPLIANCE STATEMENTS

In addition to aquatic biodiversity, the following environmental themes were highlighted as being relevant, requiring either a compliance statement or specialist assessment, depending on the outcomes of the site verification:

- Animal species (Medium Sensitivity)
- Plant species (Low Sensitivity)
- Terrestrial Biodiversity (Very High Sensitivity)

Compliance statements for all environmental themes were prepared based on the legislative requirements described in Section 1.2.1. The site verification and sensitivity took the following into consideration:

- The proposed activities are as described in Section 6, with Alternative 1 being the preferred option;
- The activities will be limited to stabilising the banks of the wetland. Construction and operational phase activities will therefore be restricted to the channel of the wetland and will not encroach into any terrestrial habitat; and
- Terrestrial habitat (as indicated by the 2018 NBA Ecosystem Threat Status) has been transformed from the critically endangered Garden Route Granite Fynbos to mowed and maintained lawns (comprising of *Pennisetum clandestinum*).

10.1 Animal Species

All species listed in the Environmental Screening Tool (EST) are considered to be of Medium Sensitivity (Table 8). This sensitivity is based on there being records for this species collected in the past prior to 2002 or being a natural area included in a habitat suitability model. Only the aquatic environment will be modified and the sensitivity of the species listed in Table 8 was therefore assessed with respect to their observed presence or likelihood to occur within the wetland. Several site visits were conducted for this purpose, all of which were conducted during July and August, 2022. The aquatic features have been described in detail in Section 5 of this report.

Table 8: Animal species highlighted by the Environmental Screeing Tool

Sensititivty	Features	Comment
Medium	*Afrixalus knysnae* (Amphibia)	Not observed
Medium	*Chlorotalpa duthieae* (Mammalia)	Not observed
Medium	*Philantomba monticola* (Mammalia)	Not observed
Medium	*Aneuryphymus montanus* (Invertebraeta)	Not observed

10.1.1 *Afrixalus knysnae*

Common Name: Knysna Leaf-Folding Frog
Red List Status: Endangered

Afrixalus knysnae are restricted to the southern Cape, in marshy areas in the coastal mosaic of montane fynbos and Afromontane forest (Du Preez and Carruthers, 2017). They typically inhabit shallow, endorheic systems (wetland flats, wetland depressions, small dams and shallow semi-permanent water) (IUCN, 2022) with abundant emergent aquatic vegetation, which is required in order to complete their breeding cycle. Species in this genus deposit between 20 and 50 eggs on vegetation above water, folded in a grass leaf (IUCN, 2022). Tadpoles emerge, drop into the water and remain there until metamorphosis. It is suspected that the species requires good water quality for breeding. According to De Lange and Du Preez (2018), all localities identified so far within its distribution show these typical habitat characteristics and the bottom substrate is usually highly compacted. The species has not been recorded in any localities where flowing water is present.

As described in Section 5, the wetland is heavily incised and flow is constricted to a narrow channel. Biotopes consist predominantly of shallow flowing riffle sections interspersed with deeper pools where flow speed is much reduced (Figure 9). The substrate consists of a mixture of fine sediments and gravel and a relatively high proportion of coarser material with high quantities of rubble (e.g. bricks and tiles) present. Vegetation is confined to the steep banks of the channel and no emergent aquatic vegetation was present within the channel. The banks of the active channel of the wetland are largely bare or covered in kikuyu grass (*Pennisetum clandestinum*). Water quality in the wetland is heavily influenced by stormwater received from a highly urbanised catchment. Sewage spills are also likely to occur given the location of a pump station further upstream and sewage lines that cross the wetland. Water is therefore not expected to be of a high quality.

The species was not observed during visual surveys or recorded on a song-meter (left on site overnight). While the season is not optimal for recording this species, based on the habitat preference described above, it is highly unlikely that this species is expected to occur within the wetland.

The sensitivity of this site with regards to this species is therefore considered to be **Low**.

Figure 9: Photographs showing typical instream biotopes present along the stream delineation including occasional deeper pools (left) and predominantly shallow, flowing runs and riffles (right).

10.1.2 Chlorotalpa duthieae

Common Name: Duthies Golden Mole
Red List Status: Vulnerable

The Duthies Golden Mole is a burrowing terrestrial species and occurs on alluvial sands and sandy loams in southern Cape Afrotemperate forests in the Fynbos and Moist Savanna biomes (IUCN, 2022). They construct shallow subsurface foraging tunnels that radiate outwards from under the roots of trees.

The sensitivity of this site with regards to this species is considered to be **Low** for the following reasons:

- This is a terrestrial, burrowing species and given its habitat requirements it is highly unlikely that it will occur within the channel of the wetland where the streambank stabilisation will be constructed; and
- The proposed activities will occur within the delineated area of a wetland and will therefore not affect any habitat that this species is dependent upon.

10.1.3 Philantomba monticola

Common Name: Blue Duiker
Red List Status: Vulnerable

Blue Duikers exist in a wide range of forested and wooded habitats, including primary and secondary forests, gallery forests, dry forest patches, coastal scrub farmland and regenerating forest (IUCN, 2022). They can persist in small patches of modified or degraded forest and thicket, even on the edge of urban centres.

The sensitivity of this site with regards to this species is considered to be **Low** for the following reasons:

- This is a terrestrial species and given its habitat requirements it is highly unlikely that it will occur within degraded aquatic wetland habitat where the streambank stabilisation will be constructed;

- It is also highly unlikely that the species will occur in the available terrestrial habitat adjacent to the wetland as this habitat has been transformed from natural fynbos to mowed and maintained kikuyu lawns;
- Existing terrestrial habitat will not be transformed from its current state and any disturbance to the site will be rehabilitated following completion of the project; and
- The species, or any signs of the species (including spoor, scat etc.) were not observed on the site.

10.1.4 Aneuryphymus montanus

Common Name: Yellow-winged Agile Grasshopper
Red List Status: Vulnerable

The species is associated with fynbos vegetation, where it has a preference for rocky foothills covered by evergreen sclerophyllous vegetation.

The sensitivity of this site with regards to this species is considered to be **Low** for the following reasons:

- This is a terrestrial species and given its habitat requirements it is highly unlikely that it will occur within degraded aquatic wetland habitat where the streambank stabilisation will be constructed;
- It is also highly unlikely that the species will occur in the available terrestrial habitat adjacent to the wetland as this habitat has been transformed from natural fynbos to mowed and maintained kikuyu lawns;
- Existing terrestrial habitat will not be transformed from its current state and any disturbance to the site will be rehabilitated following completion of the project; and
- The species was not observed on the site.

10.2 Terrestrial Plant Species

The length of the embankment that will be stabilised is either bare (i.e. where erosion has exposed the embankment) or predominantly covered in *P. clandestinum* (Figure 10). Other species that were observed included the following (none of which are species of conservation concern):

- *Acacia mearsnii* (Black wattle – alien invasive)
- *Acacia melanoxylon* (Blackwood - alien invasive)
- *Cortaderia selloana* (Pampas Grass- alien invasive)
- *Typha capensis* (Cape bulrush)
- *Juncus effusus* (Soft rush)
- *Nidorella ivifolia* (Bakbesembossie)
- *Canna sp.* (common garden plant)

Based on the site verification the sensitivity of the site is confirmed to be **Low** – as per the outcome of the Environmental Screening Tool.

Figure 10: Photograph showing typical vegetation present along banks that require stabilisation.

10.3 Terrestrial Biodiversity

Terrestrial biodiversity was characterised as Very High based on the criteria listed in Table 9.

Table 9: Terrestrial biodiversity senstivities identified by the Environmental Screening Tool

Sensitivity	Features	Comment
Very High	CBA2	Areas mapped as Terrestrial CBAs are in fact aquatic and have been addressed in the freshwater specialist assessment
Very High	ESA2	No construction in ESA2 – only vehicles to access the site.
Very High	Strategic Water Source Area	Will not affect the yield of the catchment area.
Very High	Critically Endangered Ecosystem	Completely transformed from Garden Route Granite Fynbos to maintained kikuyu lawns.

The site sensitivity for Terrestrial Biodiversity should however be considered as **Low** for the following reasons:

- The entire site is located within the urban extent of George and has been transformed from the mapped critically endangered vegetation type (Garden Route Granite Fynbos) to mowed and maintained kikuyu lawns (Figure 11);

- The proposed activities will take place within the delineated area of a wetland and will therefore not result in any further loss or disturbance to this critically endangered ecosystem or any natural terrestrial habitat;
- A small portion of the gabion structure will occur within an area that has been designated as Terrestrial CBA2. The gabions will however be placed along the banks of a wetland which is considered to be an aquatic feature. Impacts to the wetland have been addressed in the specialist freshwater assessment;
- The only activities that will occur within an ESA2 are the movement of vehicles to gain access to the site and the stockpiling of materials required to build the gabions. The proposed activities will not result in the modification of any ESA2 habitat, neither will they contradict the management objectives which are to:
    - Restore and/or manage to minimize impact on ecological processes and ecological infrastructure functioning, especially soil and water-related services, and to allow for faunal movement.

  As the ESA2 is integral to the protection of the wetland, these activities have been addressed in the specialist freshwater assessment;

- While the site does fall within a SWSA, the proposed activity is designed to prevent further degradation to the wetland. The activity will also not modify the catchment area of the wetland. It will in no way affect the ability of the watercourse to continue supplying water and will not affect the quality of the water further downstream. In this respect the proposed project will meet the management objectives for rivers in urban environments, which are to:
    - Maintain at least the present condition and ecological functioning of these landscapes,
    - Restore where necessary,
    - Limit or avoid further adverse impacts on the sustained production of high-quality water.

Figure 11: Photograph showing the presence of mowed and maintained lawns along the eastern extent of the wetland.

11. REFERENCES

CapeNature (2017). *2017 WCBSP George [Vector] 2017*. Available from the Biodiversity GIS website, downloaded on 26 March 2019.

Council for Scientific and Industrial Research (CSIR). (2018). National Wetland Map 5 and Confidence Map [Vector] 2018. Available from the Biodiversity GIS website, downloaded on 30 September 2020.

De Lange, F. and Du Preez, L.H. (2018). The tadpole of Afrixalus knysnae (Loveridge) (Anura: Hyperoliidae), with comments on reproductive biology. Zootaxa, 4521: (1) 121—124.

Du Preez, L.H. and Carruthers, V.C. (2017). Frogs of Southern Africa: A complete guide, Cape Town, Penguin Random House.

IUCN. (2022). The IUCN Red List of Threatened Species. Version 2018-2. Available at: http://www.iucnredlist.org (Accessed 20 August 2022).

Le Maitre, D.C., Walsdorff, A., Cape, L., SeyAler, H., Audouin, M, Smith-Adao, L., Nel, J.A., Holland, M. and Witthüser. K. (2018). Strategic Water Source Areas: Management Framework and Implementation Guidelines for Planners and Managers. WRC Report No. TT 754/2/18, Water Research Commission, Pretoria.

Milner, A.M. (1994). System recovery. In: Calow P and Petts GE (eds.): The rivers handbook. Vol. 2. Blackwell Scientific Publications. London.

Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L. and Nienaber, S. (2011). *Technical Report for the National Freshwater Ecosystem Priority Areas project.* WRC Report No. 1801/2/11. Water Research Commission, Pretoria, South Africa.

Ollis, D.J., Snaddon, C.D., Job, N.M. and Mbona, N. (2013). *Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems.* SANBI Biodiversity Series 22. South African National Biodiversity Institute, Pretoria

Resh, V.H., Brown, A.P., Covich, M.E., Gurtz, H.W., Li, G.W., Minshall, S.R., Reice, A.L., Sheldon, J.B., Wallace and Wissmar, R.C. (1988). The role of disturbance theory in stream ecology. Journal of the North American Benthological Society. 7: 433-455.

APPENDIX 1 – WET-HEALTH

Desktop and field data were captured in GIS software and used to populate the Level 1 WET-Health tool (Macfarlane et al., 2008) which was used to derive the PES of the wetland HGM units. The magnitude of observed impacts on the hydrological, geomorphological and vegetation components of the wetland were calculated and combined as per the tool to provide a measure of the overall condition of the wetland on a scale from 1-10. Resultant scores were then used to assign the wetland into one of six PES categories as shown in Table 10 below.

Table 10: Wetland Present Ecological State categories and impact descriptions.

Ecological Category	Description	Impact Score
A	Unmodified, natural.	0 – 0.9
B	Largely natural with few modifications / in good health. A small change in natural habitats and biota may have taken place but the ecosystem functions are still predominantly unchanged.	1 – 1.9
C	Moderately modified / fair condition. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	2 – 3.9
D	Largely modified / poor condition. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	4 – 5.9
E	Seriously modified / very poor condition. The loss of natural habitat, biota and basic ecosystem functions is extensive.	6 – 7.9
F	Critically modified / totally transformed. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota.	8 – 10

<u>Reference</u>

Macfarlane, D., Kotze, D., Ellery, W., Walters, D., Koopman, V., Goodman, P. and Goge, M. 2007. *WET-Health: A technique for rapidly assessing wetland health. Wetland Management Series.* Water Research Commission Report TT 340/09.

APPENDIX 2 – ECOLOGICAL IMPORTANCE AND SENSITIVITY (WETLANDS)

The revised method for the determination of the EIS of a wetland considers the three following ecological aspects (Rountree et al., 2013):

- **Ecological importance and sensitivity**
  - Biodiversity support including rare species and feeding/breeding/migration;
  - Protection status, size and rarity in the landscape context;
  - Sensitivity of the wetland to floods, droughts and water quality fluctuations.
- **Hydro-functional importance**
  - Flood attenuation;
  - Streamflow regulation;
  - Water quality enhance through sediment trapping and nutrient assimilation;
  - Carbon storage
- **Direct human benefits**
  - Water for human use and harvestable resources;
  - Cultivated foods;
  - Cultural heritage;
  - Tourism, recreation, education and research.

Each criterion is scored between 0 and 4, and the average of each subset of scores is used to derive a score for each of the three components listed above. The highest score is used to determine the overall Importance and Sensitivity category of the wetland system.

Table 11: Ecological importance and sensitivity categories. Interpretation of average scores for biotic and habitat determinants.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very high: Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

Reference:

Rountree, M.W., Malan, H.L., Weston, B.C. (2013). Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Version 2). Water Research Commission report No. 1788/1/12.

APPENDIX 3 - IMPACT ASSESSMENT METHODOLOGY

Individual impacts for the construction and operational phase were identified and rated according to criteria which include their intensity, duration and extent. The ratings were then used to calculate the consequence of the impact which can be either negative or positive as follows:

Consequence *= type x (intensity + duration + extent)*

Where type is either negative (i.e. -1) or positive (i.e. 1). The significance of the impact was then calculated by applying the probability of occurrence to the consequence as follows:

Significance *= consequence x probability*

The criteria and their associated ratings are shown in Table 12.

Table 12: Categorical descriptions for impacts and their associated ratings

Rating	Intensity	Duration	Extent	Probability
1	Negligible	Immediate	Very limited	Highly unlikely
2	Very low	Brief	Limited	Rare
3	Low	Short term	Local	Unlikely
4	Moderate	Medium term	Municipal area	Probably
5	High	Long term	Regional	Likely
6	Very high	Ongoing	National	Almost certain
7	Extremely high	Permanent	International	Certain

Categories assigned to the calculated significance ratings are presented in Table 13.

Table 13: Value ranges for significance ratings, where (-) indicates a negative impact and (+) indicates a positive impact

Significance Rating	Range	
Major (-)	-147	-109
Moderate (-)	-108	-73
Minor (-)	-72	-36
Negligible (-)	-35	-1
Neutral	0	0
Negligible (+)	1	35
Minor (+)	36	72
Moderate (+)	73	108
Major (+)	109	147

Each impact was considered from the perspective of whether losses or gains would be irreversible or result in the irreplaceable loss of biodiversity of ecosystem services. The level of confidence was also determined and rated as low, medium or high (Table 14).

Table 14: Definition of reversibility, irreplaceability and confidence ratings.

Rating	Reversibility	Irreplaceability	Confidence
Low	Permanent modification, no recovery possible.	No irreparable damage and the resource isn't scarce.	Judgement based on intuition.
Medium	Recovery possible with significant intervention.	Irreparable damage but is represented elsewhere.	Based on common sense and general knowledge
High	Recovery likely.	Irreparable damage and is not represented elsewhere.	Substantial data supports the assessment