Upgrading of Stormwater Infrastructure, Rosemoor, George, Western Cape.

Aquatic Biodiversity – Specialist Assessment

Prepared For: Sharples Environmental Services

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EXECUTIVE SUMMARY

Sharples Environmental Services (SES) has been appointed by Lyners Engineers on behalf of the George Municipality (applicant), to conduct the Environmental Impact Assessment process for the proposed upgrading of stormwater infrastructure of Rosemoor, George, Western Cape. The proposed upgrades have prompted to the need to obtain the relevant environmental and water authorisations as required by the National Environmental Management Act (NEMA) and the National Water Act (NWA), respectively.

The stormwater outlets fall within the upper reaches of the Meul River, which falls within quaternary catchment K30C and in the Outeniqua Strategic Water Source Area (SWSA). The Meul River originates from the industrial centre of George and passes through a combination of formal residential areas and informal settlements (with poor access to water and sanitation services). Sewage spills from blocked manholes and failing pump stations frequently result in sewage spills, which has resulted in closure of recreational activities at Ballots Bay (where the Meul River discharges into the sea). Stormwater outlets will be upgraded at five locations in the upper catchment area of the river. The majority of these outlets are located on relatively steep slopes that drain towards the Meul River and an eastern tributary of the Meul River.

Wetland vegetation (dominated by *Cliffortia odorata*) is located along the valley slopes adjacent to the banks of the watercourses and is consistent with a hillslope seep wetland. The wetland extends along the entire length of the river reach – on both sides of the channel. The eastern tributary is mapped as a non-perennial drainage line, but the site visit confirmed the presence of a seep wetland along the adjacent slopes – similar to the seep wetland along the Meul River. The formation of seep wetlands along the gentle slopes of valleys is consistent with the soil type in George (i.e. a coarsely textured A horizon overlying a relatively impervious clay enriched B horizon). The seep wetland features are sustained primarily by lateral sub-surface flow which is prevented from penetrating the deeper impervious B horizon and expresses near the surface as it travels down the relatively gentle slopes. The gentle slopes allow water to be retained in the soil profile for an extended period of time, leading to seasonally saturated conditions and the establishment of wetland vegetation. The most likely original reference configuration of the aquatic features is a seep wetland which would have historically fed a non-perennial river channel abutting the wetland. Over time this channel has become severely modified due to stormwater inputs from the urban catchment area, leading to a narrow, incised channel. Alien invasive species are not prolific within the seep wetland but do occur throughout and, amongst others, include *Cenchrus clandestinus* (kikuyu grass), *Solanum mauritanium*, *Acaia mearnsii* and *Rubus sp.*. Water quality is badly affected by urban runoff and sewage spills and leaks. Solid waste pollution is high due to high rates of dumping and littering in the immediate catchment areas. The Present Ecological State (PES) of the wetland is D (Largely Modified).

Four of the five existing stormwater outlets discharge into the seep wetland habitat along the slopes of the river. Lack of erosion protection at these outlets has caused deep erosion gullies that extend into wetland habitat along the Meul River. Given the management objectives for SWSAs, it is important that the proposed upgrades are undertaken at all sites so as to alleviate erosion problems. Upgrades are likely to result in a Low Negative construction phase impact (assuming implementation of mitigation measures). For the operational phase the upgraded stormwater outlets will result in reduced impacts relative to the No-Go scenario, which will result in continued erosion of wetland habitat below the outlets. It is therefore recommended that authorisation for the upgrade of stormwater infrastructure in Rosemoor be granted.

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 (PhD)

July 2025

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1. INTRODUCTION

Sharples Environmental Services (SES) has been appointed by Lyners Engineers on behalf of the George Municipality (applicant), to conduct the Environmental Impact Assessment process for the proposed upgrading of stormwater infrastructure of Rosemoor, George, Western Cape. The proposed upgrades have prompted to the need to obtain the relevant environmental and water authorisations as required by the National Environmental Management Act (NEMA) and the National Water Act (NWA), respectively.

1.1 Key Legislative Requirements

1.1.1 National Environmental Management Act (NEMA, 1998)

According to the protocols specified in GN 1540 (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.

The screening tool classified the sites as being of **Very High** aquatic biodiversity due to the following reasons:

- All sites are located within the Outeniqua Strategic Water Source Area.
- Some sites are indicated to occur within wetlands that have been categorised as Critical Biodiversity Areas (CBAs).

According to the protocol, a site sensitivity verification must be undertaken to confirm the sensitivity of the site as indicated by the screening tool.

1.1.2 National Water Act

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. 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 watercourse, and
- A reference to a watercourse includes, where relevant, its bed and banks.

For the purposes of this assessment, a wetland area is defined according to the NWA (Act No. 36 of 1998):

"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil".

Wetlands must therefore have one or more of the following attributes to meet the NWA wetland definition (DWAF, 2005):

- A high water table that results in the saturation at or near the surface, leading to anaerobic conditions developing in the top 50 cm of the soil;
- Wetland or hydromorphic soils that display characteristics resulting from prolonged saturation, i.e. mottling or grey soils; and
- The presence of, at least occasionally, hydrophilic plants, i.e. hydrophytes (water loving plants).

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 4167) 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).

1.2 Scope of Work

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

- A desktop review of freshwater features and provincial and national freshwater conservation plans relevant to the site.
- Undertake a site visit to the study area to classify and assess the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of affected watercourses;
- Assess impacts associated with the proposed stormwater upgrades; and
- Determine the level of water use authorisation required (i.e. GA or WUL) as required by the NWA.

2. APPROACH

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:

- DWS spatial layers;
- National Freshwater Ecosystem Priority Areas (NFEPA) spatial layers (Nel et al., 2011);
- National Wetland Map 5 and Confidence Map (CSIR, 2018) – the latest national wetland inventory map for South Africa;
- Western Cape Biodiversity and Spatial Plan (WCBSP) for George (CapeNature, 2017).

2.2 Site Assessment

A site visit was undertaken on the 18th of July 2024, with the objective of identifying and classifying watercourses affected by the upgrades; determining their PES and EIS, and assessing the impacts of the upgrades on watercourses.

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. Watercourses were 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 Wetland Delineation

Wetlands are described by the National Water Act (Act 36 of 1998) as:

"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

According to DWAF (2005) wetlands must have one or more of the following attributes:

- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation;
- The presence, at least occasionally, of plants that grow in water saturated conditions (hyrdophytes or obligate wetland plants);
- A high water table that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil.

The boundary of the wetland was delineated in accordance with DWAF (2005) guidelines which considers the following four specific indicators:

- The Terrain Unit Indicator: Identifies 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 (i.e. mottling and gleying within 50 cm of the soil surface); and
- The Vegetation Indicator: Identifies hydrophilic vegetation associated with frequently saturated soils.

The boundary of wetlands was determined by identifying the presence or absence of the combination of indicators mentioned above at selected points in the field.

2.2.3 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 affected watercourses was assessed using the WET-Health v2.0 methodology (see Appendix 1).

2.2.4 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 of affected watercourses was assessed using the methodology described in Appendix 2.

3. ASSUMPTIONS & LIMITATIONS

- The assessment of the site visit represents a brief temporal snapshot of conditions on the site. Changes in season or short-term changes in climatic conditions may possibly result in the formation of aquatic habitats (e.g. temporary or seasonal wetlands) under significantly wetter conditions. Despite this limitation the sensitivity of aquatic biodiversity on the site was determined with a very high level of confidence.
- Assessment of impacts was based on the technical design drawings provided.

4. DESKTOP SURVEY

The stormwater outlets fall within the upper reaches of the Meul River, which falls within quaternary catchment K30C (Figure 1). The main rivers draining this catchment are the Swart and Kaaimans, both of which originate in the Outeniqua Mountains. The Meul is a smaller river system that flows for a relatively short distance before flowing into the sea. The project area falls within the South-Eastern Coastal Belt (20) Level 1 ecoregion (20.02 Level 2 Ecoregion), which is characterized by moderately undulating plains and low mountains with altitude ranging from 0 to 1 300 m above mean sea level. Mean annual precipitation for the catchment area is approximately 800 mm per year and occurs all year-round, with peaks in October to

November and March to April. Dominant natural vegetation in the vegetation comprises broadly of fynbos, renosterveld, dune thicket, and afro-montane forest.

Soils in the catchment area are relatively shallow consisting of a diagnostic pedocutanic duplex soil, with a clear textural contrast between the A and B horizon. The B horizon is however heavily enriched with clay, which serves as a barrier to both root growth and water movement. Sub-surface water therefore tends to flow laterally over the top of the B horizon, through the more coarsely textured A horizon. In addition, the area falls within a very high intensity rainfall zone (Macfarlane and Bredin, 2017). For these reasons, soils are highly erodible and is undoubtedly a contributing factor to the extent of erosion observed in and around watercourses – particularly where stormwater is discharged.

The Meul River originates from the industrial centre of George and passes through a combination of formal residential areas and informal settlements (with poor access to water and sanitation services). Sewage spills from blocked manholes and failing pump stations frequently result in sewage spills into both rivers, which has resulted in closure of recreational activities at Ballots Bay (where the Meul River discharges into the sea). Stormwater outlets (labelled RSW1 to RSW5) will be upgraded at five locations in the upper catchment area of the river. The majority of these outlets are located on relatively steep slopes that drain towards nearby watercourses (Figure 2).

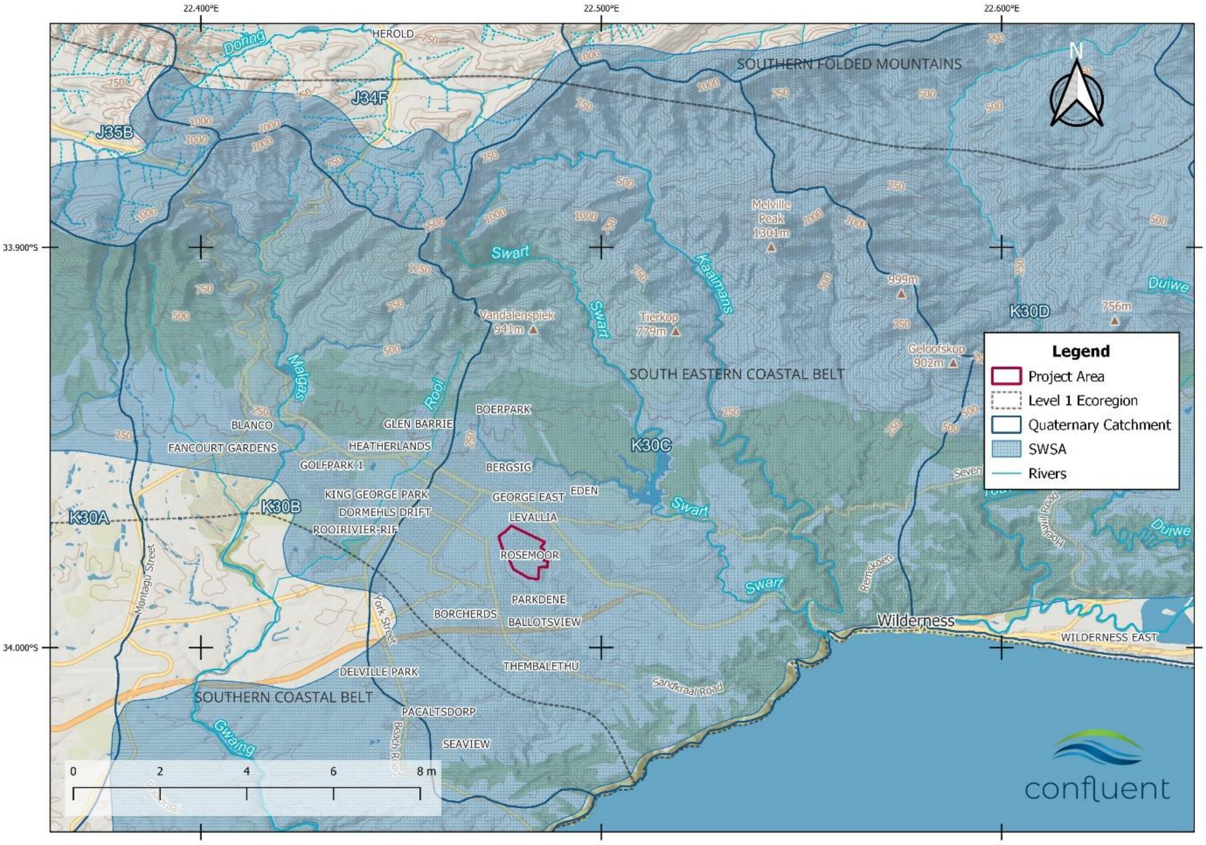

Figure 1: Map indicating the location of the stormwater outlets in quaternary catchment K30C.

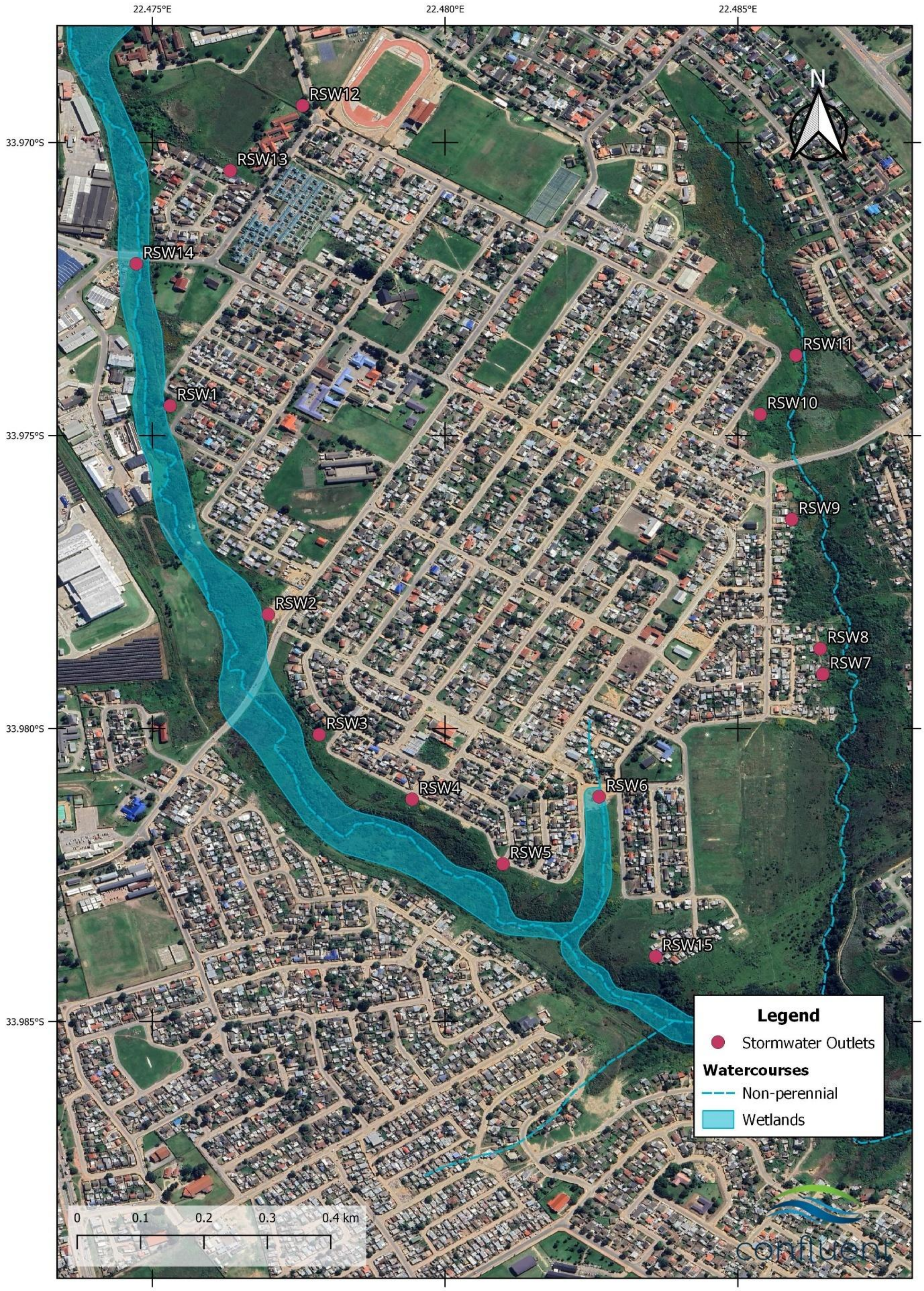

Figure 2: Map showing the stormwater outlets in relation to mapped watercourses.

4.1.1 National Freshwater Ecosystem Priority Areas

The Meul River is located within sub-quaternary catchment (SQC) 9144 (Figure 3), which, according to the National Freshwater Ecosystem Priority Atlas (NFEPA, Nel et al., 2011), has not been classified as a Freshwater Ecosystem Priority Area (FEPA). The catchment area therefore falls 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 the catchment area, which has led to the wide-scale degradation of watercourses, particularly in their lower reaches.

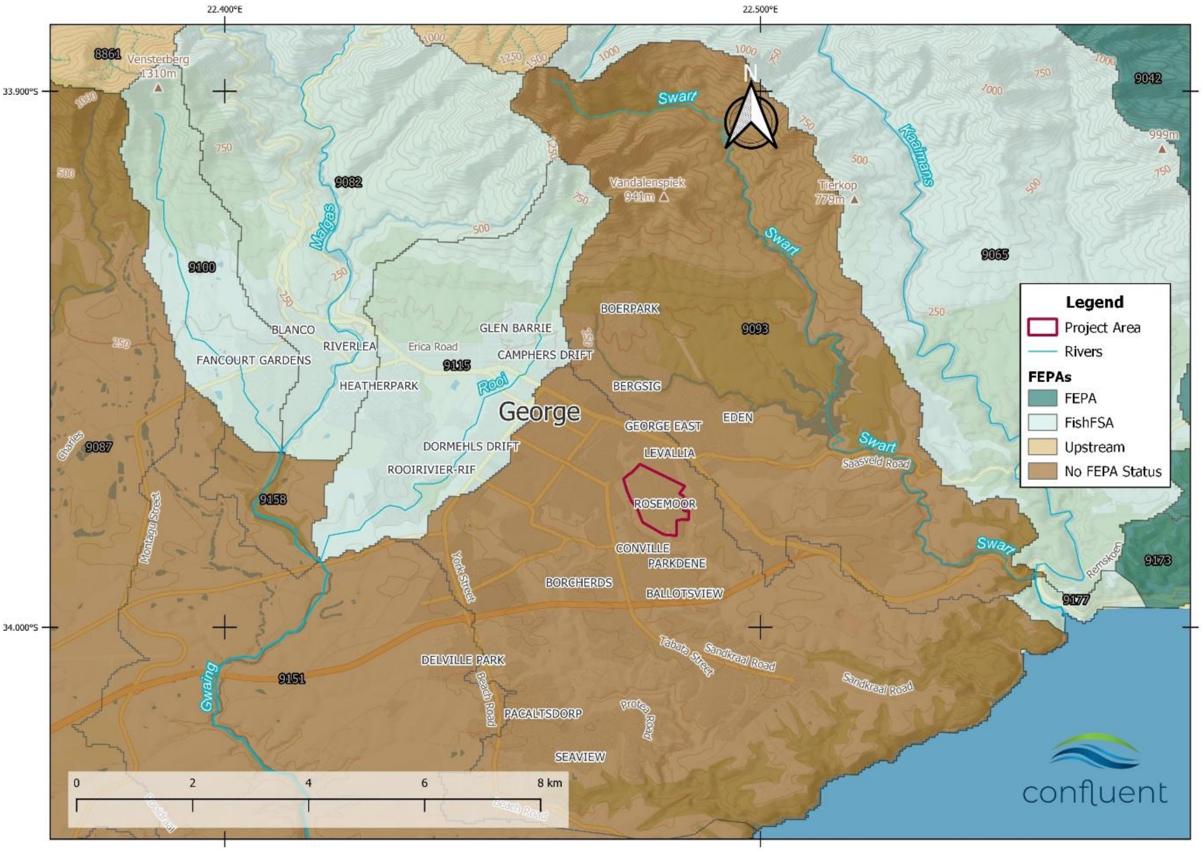

Figure 3: Map indicating the location of the stormwater outlets sites relative to Freshwater Ecosystem Priority Areas.

4.1.2 Strategic Water Source Area

The project area falls within the Outeniqua Strategic Water Source Area (SWSA), which is considered to be of national importance (Figure 1). 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).

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.

In this respect, maintenance activities that minimize erosion and maintain and protect infrastructure are aligned to the broader management objectives for areas in urban SWSAs.

4.1.3 Western Cape Biodiversity Spatial Plan (WCBSP)

The main purpose of a biodiversity spatial plan is to ensure that the most recent and best quality spatial biodiversity information can be accessed and used to inform land use and development planning, environmental assessments and authorisations, natural resource management and other multi-sectoral planning processes. The WCBSP plan achieves this by providing a map of terrestrial and freshwater areas that are important for conserving biodiversity pattern and ecological processes – these areas are called Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs).

With the exception of RSW14 fall within or immediately adjacent to terrestrial CBA2 areas (Figure 4). These are considered as degraded areas that are required in order to meet biodiversity targets and have been assigned as CBA status due to the presence of the critically endangered Garden Granite Fynbos vegetation type. Small patches of the wetland along the Meul River have been assigned as aquatic CBA2. Aquatic CBA2 areas are degraded watercourses that are required in order to meet biodiversity targets for species, ecosystems or ecological processes and infrastructure (Table 1).

Table 1: WCBSP categories and associated management objectives.

Category	Description	Management Objectives
CBA2	Areas in a degraded or secondary 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 habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land-uses are appropriate.

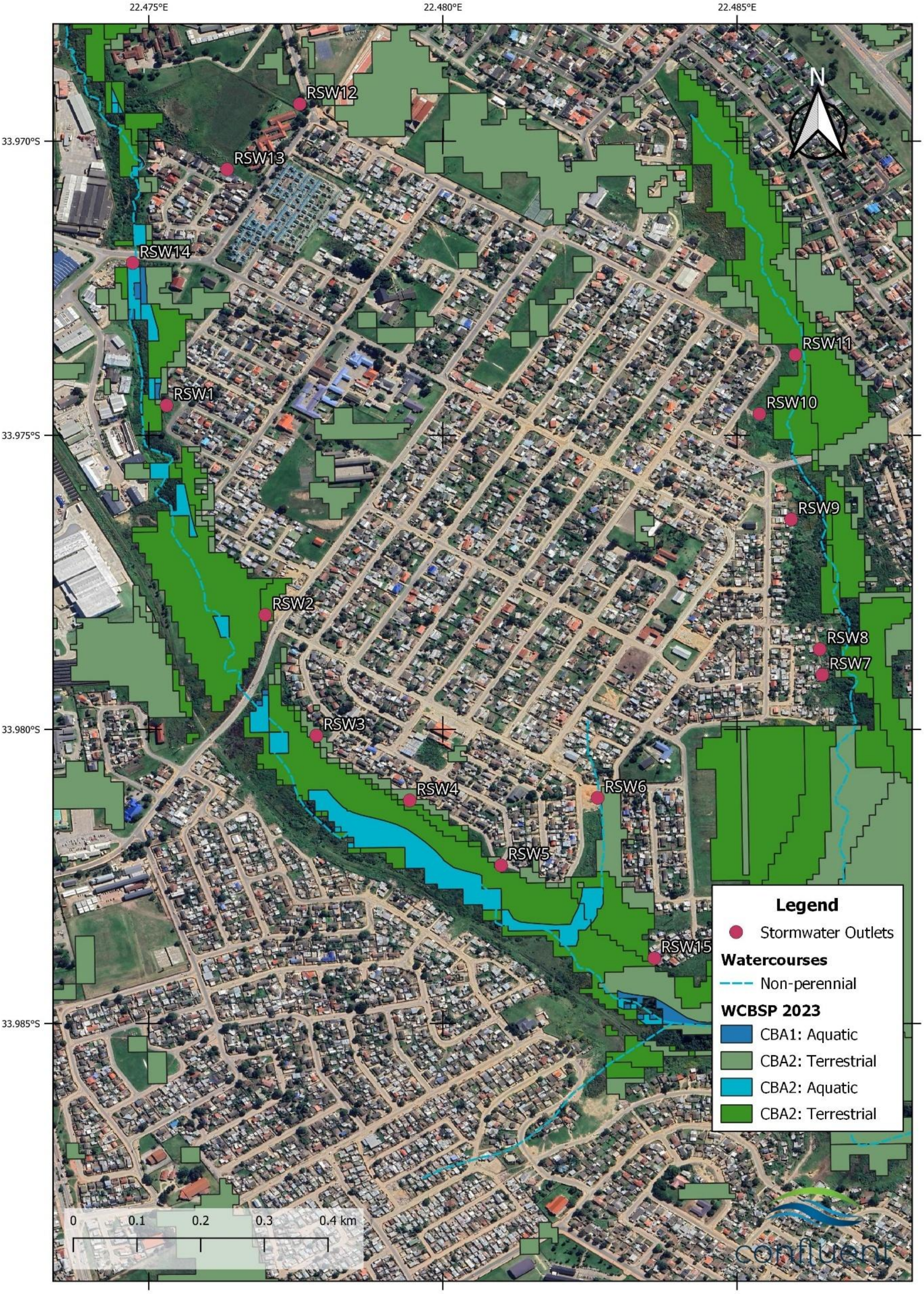

Figure 4: Location of the stormwater outlets in relation to the Western Cape Biodiversity Spatial Plan.

5. PROPOSED UPGRADES

The upgrade of stormwater infrastructure will involve building headwall outlets and a 6 m gabion mattress for erosion protection (Figure 5 and Figure 6). These will replace existing outlets which currently have no headwalls and no erosion protection.

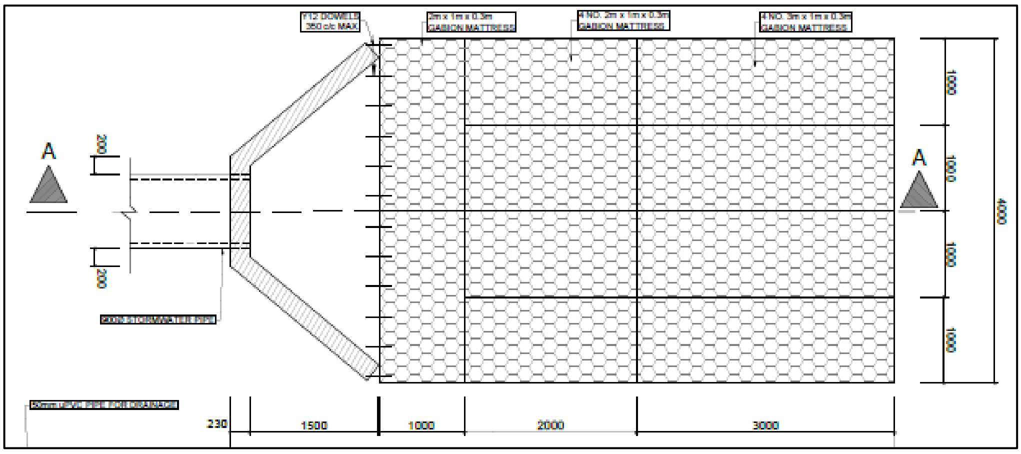

Figure 5: Plan view of proposed stormwater upgrades.

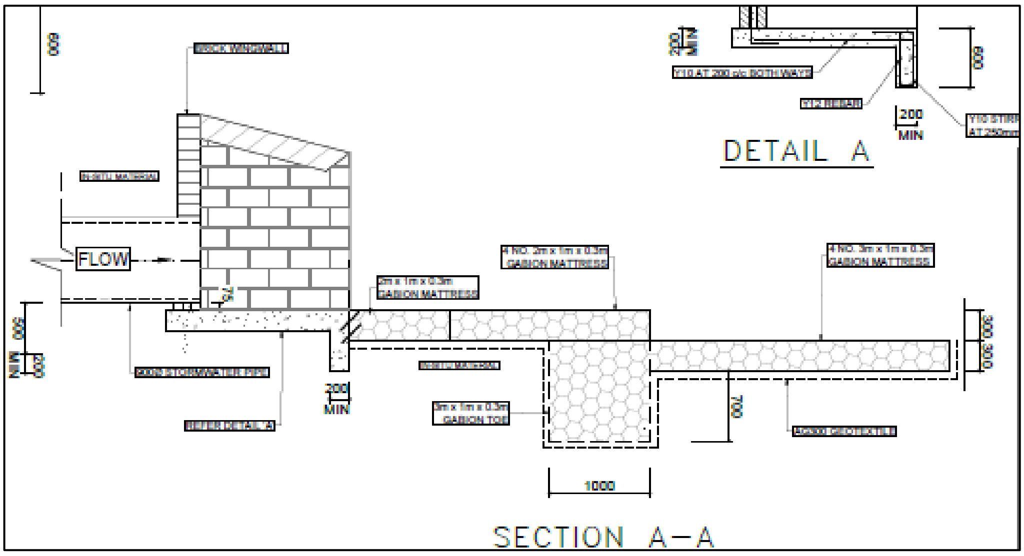

Figure 6: Section view of proposed stormwater upgrades.

6. SITE VISIT

6.1 Watercourse Classification

Watercourses affected by the upgrades include the upper most reaches of the Meul River and an eastern tributary that meets the Meul River below RSW4. The length of the upper Meul River is mapped as an unchannelled valley bottom wetland (Figure 2). These systems are typically located along low gradient, valley bottoms, which favours diffuse flow and hence the lack of a distinct channel. The site visit revealed a prominent, incised channel with steep, vertical banks, ranging between 2 to 3 m high and is therefore not consistent with the diagnostic features of an unchannelled valley bottom wetland (Figure 8). It is possible that the watercourse was originally a very narrow unchannelled valley bottom wetland that has become severely incised (and modified) over time. While a clear, narrow, linear length of drainage can be observed in historical imagery it cannot be confirmed with any certainty whether the drainage was an unchannelled wetland or a channelled non-perennial stream.

Figure 7: Historical aerial image (1936) indicating poorly defined drainage lines (indicated by red arrows) associated with the Meul River (red arrows) and its eastern tributary (green arrows).

Wetland vegetation (dominated by *Cliffortia odorata* in the more seasonally saturated interior and *Nidorella ivifolia* on the drier temporarily saturated margins) is located along the valley slopes adjacent to the banks of the channel (but not along the valley bottom) and is consistent with a hillslope seep wetland (Figure 8). The wetland extends along the entire length of the river reach – on both sides of the channel. The eastern tributary is mapped as a non-perennial drainage line, but the site visit confirmed the presence of a seep wetland along the adjacent slopes – similar to the seep wetland along the Meul River. The formation of seep wetlands along the gentle slopes of valleys is consistent with the soil type in George (i.e. a coarsely textured A horizon overlying a relatively impervious clay enriched B horizion). The seep wetland features are sustained primarily by lateral sub-surface flow which is prevented from penetrating the deeper impervious B horizon and expresses near the surface as it travels down the relatively gentle slopes. The gentle slopes allow water to be retained in the soil profile for an extended period of time, leading to seasonally saturated conditions and the establishment of wetland vegetation. Further downstream (far below project area of interest below the N2 highway), the gradient of these slopes becomes steeper and water is retained in the soil profile for a shorter duration, and wetland habitat is replaced by woody vegetation typical of a riverine riparian zone. The most likely original reference configuration of the aquatic features is a seep wetland which would have historically fed a non-perennial river channel abutting the wetland. Over time this channel has become severely modified due to stormwater inputs from the urban catchment area. Alien invasive species are not prolific within the seep wetland but do occur throughout and, amongst others, include *Cenchrus clandestinus* (kikuyu grass), *Solanum mauritanium*, *Acaia mearnsii* and *Rubus sp.*. In some areas, where invasion is more dense, the woody structure contributes to confining high flows to the channel, exacerbating channel incision. Outlets RSW1-3 and 5 all discharge into the seep wetland habitat along the slopes of the river.

RSW4 discharges onto a gently sloping plain that has been mapped as an unchannelled valley bottom wetland (Figure 10). The upper section of this mapped area overlies a flat area with no valley (or valley-bottom) and is therefore not consistent with a valley-bottom wetland. An obvious valley only forms closer to the confluence with the Meul River. The upper flat area is heavily transformed and clearly receives high volumes of stormwater from the outlet which has created an incised channel than extends all the way down into the valley. Wetland vegetation has colonised sections of the channel (mainly *Typha capensis*).

A more accurate delineation of the wetland seep is provided in Figure 11 and includes wetland seep habitat along the eastern tributary of the Meul River.

Figure 8: Photographs showing the steeply incised riverine channel of the Meul River (top right and left) and a section of the wetland seep along the slopes of the river (bottom).

Figure 9: Photographs showing wetland vegetation along the length of the eastern tributary of the Meul River.

Figure 10: Photographs below RSW4 illustrating the incised channel below the outlet showing signs of soil saturation and colonisation by wetland plants (T. capensis).

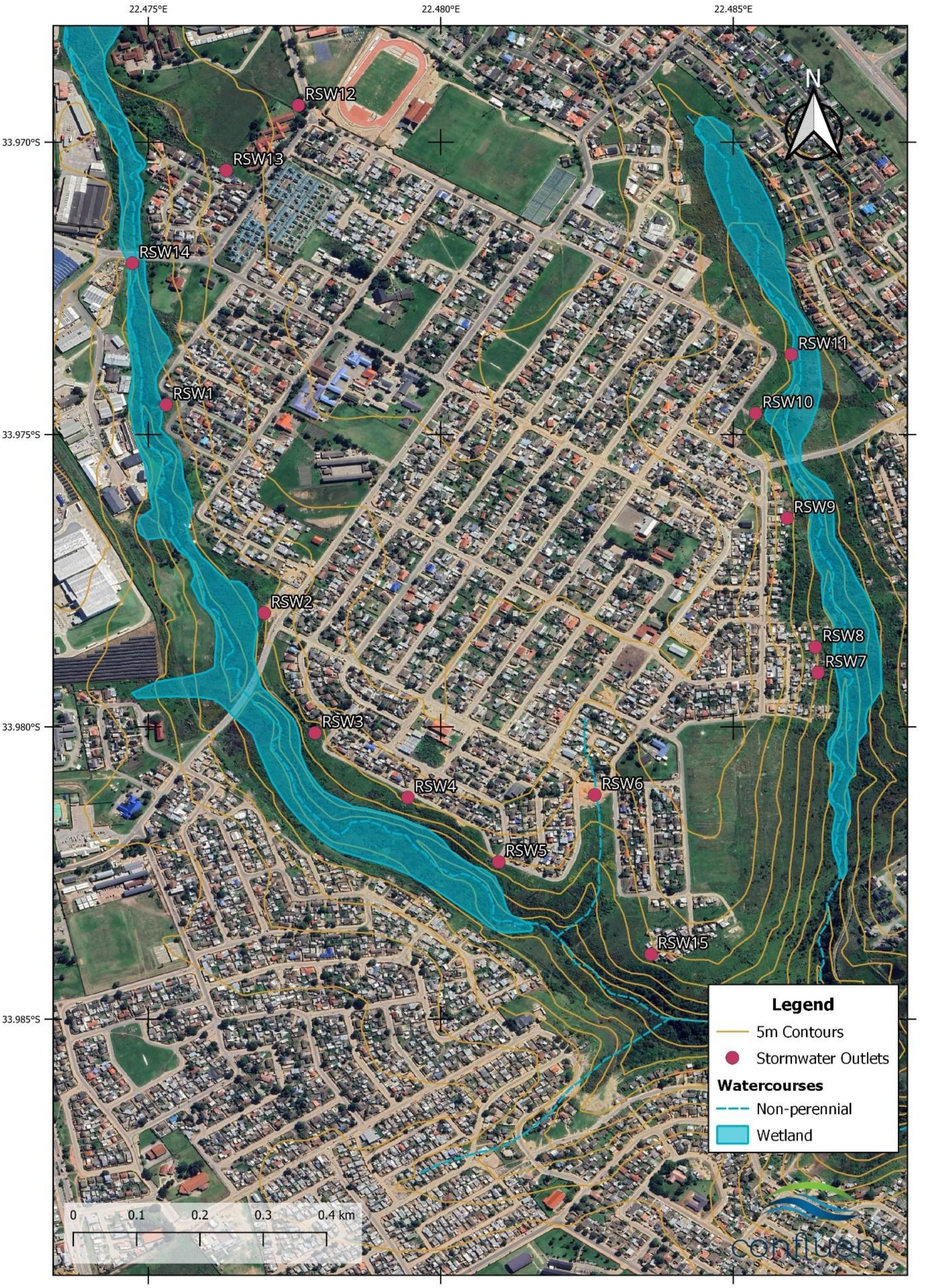

Figure 11: Map showing the delineated extent of seep wetlands along the Meul River and its eastern tributary.

6.2 Site Description

6.2.1 RSW1

The exact location of the existing stormwater outlet could not be located in the field. The river along the reach is heavily incised and the wetland seep was confined to a narrow band along the slope. Wetland vegetation is dominated by *C. odorata* and *N. ivifolia* along the drier outer margins. The invasive *C. clandestinus* is relatively abundant throughout the site.

Figure 12: Photographs showing the incised channel of the Meul River.

6.2.2 RSW2

RSW2 is located at the top of a relatively wide, gently sloping valley. The wetland seep is located along the slopes (up to 50 m in width) and is dominated by *C. odorata* and invaded by *C. clandestinus* on the margins (Figure 13). The outlet of the existing stormwater pipe discharges relatively high up onto the unprotected slope and has caused a significant erosion gulley that extends into wetland seep vegetation along the banks. Significant quantities of solid waste and litter have been dumped into the erosion gulley, which acts as source of solid waste pollution to the wetland and Meul River.

Figure 13: Photographs showing the wetland seep along the slopes (left) and the deep erosion gulley below the RSW2 stormwater outlet.

6.2.3 RSW3

RSW3 is very similar to RSW2. The valley is slightly more confined and slopes are slightly steeper. Wetland seep vegetation also lines these slopes but shows a more distinct saturation zonation, with *N. ivifolia* dominating the upper steeper slopes (where soil saturation is more temporary) and *C. odorata* dominating the gentler, lower slopes where saturation is more prolonged and seasonal. Similar to RSW2, the outlet discharges onto the slope and has caused a significant erosion gulley below the outlet (Figure 14). Very high quantities of solid waste and litter have been dumped into the gulley. Significant quantities of solid waste and litter have been dumped into the erosion gulley, which acts as source of solid waste pollution to the wetland and Meul River.

Figure 14: Photographs showing the erosion gulley below RSW3.

6.2.4 RSW4

RSW4 is located outside of the delineated area of the wetland. It discharges onto a steep slope that is well vegetated and no obvious erosion was visible (Figure 15). Minor quantities of litter were observed at the outlet.

Figure 15: Photographs showing well vegetated slopes below RSW4.

6.2.5 RSW5

RSW5 is also located outside of the delineated wetland area. The outlet pipe was blocked with litter and the headwall had been demolished. An excavation below the outlet was visible, presumably in an effort to maintain or repair the outlet. No erosion was visible below the outlet.

Figure 16: Photographs of RSW5 showing the blocked outlet pipe, demolished headwall and excavation.

6.2.6 RSW6

As described above, RSW6 discharges onto a gently sloping plain that ultimately drains down towards the Meul River. The outlet is not located within a watercourse. Stormwater discharge has led to the formation of a narrow, incised channel that leads down to the river (Figure 17). Wetland vegetation has colonised this channel (mainly *Typha capensis*) and as with other stormwater outlets, levels of litter and dumping were high.

Figure 17: Photographs showing the RSW6 stormwater outlet.

6.2.7 RSW7-RSW9

RSW7 to RSW9 all discharge into the eastern tributary of the Meul River. These outlets are located immediately adjacent to an informal housing area and could not be accessed at the time of the site visit.

6.2.8 RSW10

RSW10 discharges into wetland seep habitat (dominated by *C. odorata*) lining the edge of the eastern tributary of the Meul River. The outlet is at a relatively low elevation and there were no obvious signs of erosion towards the nearby wetland Significant quantities of solid waste and litter have been dumped into the erosion gulley, which acts as source of solid waste pollution to the wetland and Meul River.

Figure 18: Photographs showing the RSW10 outlet.

6.2.9 RSW11

RSW11 discharges into wetland seep habitat lining the edge of the eastern tributary of the Meul River. In contrast to other stormwater outlets included in this assessment, it discharges at a comparatively lower elevation on a more gentle slope. Thus, while an erosion gulley was present at the outlet, its width and depth is not as severe as at other sites (e.g. RSW2 and RSW3) - Figure 19.

Figure 19: Photograph showing the RSW11 stormwater outlet.

6.2.10 RSW12 & RSW13

Both of these outlets discharge into vacant land, that does not fall within the delineated area of a wetland Figure 3. These outlets were not accessible at the time of the site visit, however their upgrade is unlikely to have any effect on any wetland habitat.

6.2.11 RSW14

RSW14 discharges onto the top of the eastern bank of the Meul River downstream of where Grens Street crosses the river. While high quantities of litter were evident, the discharge has not caused any serious erosion of the embankment (Figure 20).

Figure 20: Photograph showing the RSW14 stormwater outlet

6.2.12 RSW15

RSW15 is located adjacent to the Meul River. The topography is steeper and the watercourse grades into a more confined valley with no associated weep wetland habitat.

6.3 Site Sensitivity Verification

The site visit confirmed that the stormwater outlets currently discharge directly into a highly modified wetland seep system and that upgrades to most of the stormwater outlets will occur in or directly adjacent to wetland habitat. The sensitivity of aquatic biodiversity is therefore confirmed as **Very High**.

7. AQUATIC ASSESSMENT

7.1 Present Ecological State

While the main Meul River and the eastern tributary can be considered as two distinct hydrogeomorphic units, they are very similar in terms of their fundamental hydrological and geomorphological drivers and the impacts that they currently experience. They were therefore assessed collectively as a single wetland seep system.

The surrounding urban and industrial areas have significantly impacted the ecological condition of the seep wetland system. 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 and residential properties (Figure 3). High stormwater inputs have altered both the hydrological and geomorphological characteristics of the channel, resulting in a heavily incised channel (up to 3 m deep) and a net loss of sediment from the system. The incised channel acts as a drain and will have contributed to accelerating the drawdown of water through the soil profile of the adjacent wetland seeps (i.e. drying out wetland habitat to an extent). Large sections of the western extent of the Meul River have been historically infilled for the establishment of industrial warehouses (above and below Grens Street).

In some stretches, mowing and clearing of vegetation immediately adjacent to the edge of the bank full channel has also contributed to the erosion of the banks of the channel. 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 severely compromised by input of stormwater originating from urban and industrial areas and by sewage input from leaking infrastructure. Bulk sewer pipelines are located along the entire length of the channel and are frequently blocked, leading to the discharge of raw sewage into the system. Large amounts of solid waste and litter were observed within the channel and it was evident that large scale dumping of rubble and waste occurs along the length of the wetland and particularly in the eroded stormwater outlets.

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

Table 2: Wet Health scores for the seep wetland system along the Meul River and its eastern tributary.

PES Assessment	Hydrology	Geomorphology	Water Quality	Vegetation
Impact Score	5.6	2.8	3.3	4.0
PES Score (%)	44%	72%	67%	60%
Ecological Category	D	C	C	D
Trajectory of change	↑	↑	↑	
Confidence (revised results)	Medium	Not rated	Not rated	Not rated
Combined Impact Score	4.1			
Combined PES Score (%)	59%			
Combined Ecological Category	D			

7.2 Ecological Importance and Sensitivity

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 of the wetland is relatively **Low** (Table 3). The seep wetland is primarily driven by sub-surface flows and is therefore not sensitive to changes in flows and floods or water quality. The wetland does offer some **Moderate** hydro-functional attributes in terms of supporting streamflow regulation (e.g. discharging sustained base sub-surface flows into the channel) and assimilating pollutants derived from diffuse surface runoff from the surrounding urban catchment (Table 4). Direct human benefits are **Low** (Table 5).

Table 3. 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 – Moderately protected
Protection status of vegetation type	1 – Moderately protected
Regional context of the ecological integrity	1 – Largely modified from natural
Size and rarity of the wetland types present	2 – Moderate size – vulnerable.
Diversity of habitat types	1 – Low diversity
Average	**1.2**
Sensitivity of the Wetland	
Sensitivity to changes in floods	1
Sensitivity to changes in low flows	1
Sensitivity to changes in water quality	1
Average	**1**
ECOLOGICAL IMPORTANCE AND SENSITIVITY	**1.2 (Moderate)**

Table 4: Hydro-functional importance criteria results for the wetland.

Hydro-functional importance			Score
Regulating & supporting benefits	Flood attenuation		1
	Streamflow regulation		2
	Water quality enhancement	Sediment trapping	2
		Phosphate assimilation	2
		Nitrate assimilation	2
		Toxicant assimilation	2
		Erosion control	3
	Carbon storage		1
HYDRO-FUNCTIONAL IMPORTANCE			**1.9 (Moderate)**

Table 5: 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**

8. IMPACT ASSESSMENT

8.1 Construction Phase

8.1.1 Impact 1: Generic Construction Phase Impacts

General construction impacts associated with vehicles, workers and storage of construction equipment and include the following:

- Pollution of watercourses through leakage of fuels, oils, and other pollutants from vehicles and construction machinery, or from washing of equipment and vehicles;
- The presence of construction workers on site will require the need for appropriate ablution facilities. Poor management of these facilities could potentially lead to sewage spills or leaks which could contaminate watercourses;
- Storage of construction materials or the temporary lay-down of equipment within an area that drains in the direction of the watercourse;
- Dumping of excavated material into the watercourse;
- Poor management of waste generated during construction activities;
- Increased pedestrian and vehicular traffic in close proximity to watercourses; and
- Mixing of concrete or cement in or in close proximity to watercourses.

8.1.1.1 Mitigation

- 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 wetland;
- 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;
- No laydown areas, stockpiling of construction materials or excavated topsoil is permitted within delineated wetland areas;
- Stockpiles
- 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 delineated extent of the wetlands. 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 or contaminate the soil;
- Construction within wetland seep areas must be confined to clearly demarcated areas so as to prevent unnecessary disturbance of wetland habitat outside of these areas;
- 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.;
- Construction areas to be inspected on a regular basis (at least weekly) by an appropriately qualified ECO for signs of disturbance, sedimentation and pollution

during the construction phase. If signs of disturbance, sedimentation or pollution are noted, immediate action should be taken to remedy the situation and, if necessary, a freshwater ecologist should be consulted for advice on the most suitable remediation measures.

	Stormwater Upgrades	No Go
Nature of impact:	Management of construction site and workers	
Extent and duration of impact:	Site-Specific & Short Term	
Consequence of impact or risk:	Disturbance and pollution of wetland habitat	
Probability of occurrence:	Highly Probable	
Degree to which the impact may cause irreplaceable loss of resources:	Marginal Loss	
Degree to which the impact can be reversed:	Fully Reversible	
Indirect impacts:	None	
Cumulative impact prior to mitigation:	Medium	
Significance rating of impact prior to mitigation:	**Medium Negative**	**No Impact**
Degree to which the impact can be avoided:	High	
Degree to which the impact can be managed:	High	
Degree to which the impact can be mitigated:	High	
Proposed mitigation:	See Section 8.1.1.1	
Residual impacts:	Very Low	
Cumulative impact post mitigation:	Negligible	
Significance rating of impact after mitigation	**Low Negative**	**No Impact**

8.1.2 Impact 2: Mobilisation of Sediment Caused by the Excavation of the Bed & Banks for Construction of Stormwater Outlets

Installation of stormwater infrastructure on slopes will require the excavation of sections of the banks which will expose bare soil to the environment and could lead to high rates of erosion and sedimentation, particularly during heavy rainfall events. This can result in high levels of turbidity as well as infilling of wetland habitat by high sediment loads. Given the current PES of affected wetlands these impacts are not expected to be particularly severe if the appropriate mitigation measures are implemented. There is no impact associated with the No-Go option.

8.1.2.1 Mitigation

- Construction activities must be timed to coincide with low rainfall probability (dry season) to avoid erosion of exposed banks;
- Existing erosion gulleys must be backfilled and re-profiled to match natural contours/slopes;
- Since stormwater outlets will be built where erosion potential is high, construction must be sequenced so that they are put in place with the minimum possible delay. Disturbance/excavation of areas where stormwater outlets are to be constructed must

be undertaken only when final placement can follow immediately following the initial disturbance;

- 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;
- Construction within wetland seep areas must be confined to clearly demarcated areas so as to prevent unnecessary disturbance of wetland habitat outside of these areas;
- Following backfilling and construction of stormwater infrastructure, exposed unvegetated slopes must be stabilised with appropriate geotextiles (e.g. SoilSaver®) or vegetated with appropriate indigenous vegetation. Banks should ideally be regraded to a achieve slopes of 1:4 or flatter; and
- Wooden stakes must be used to anchor erosion control mats as there is a high probability that metal stakes will be stolen.

	Stormwater Upgrades	No Go
Nature of impact:	Excavation of banks	
Extent and duration of impact:	Site-Specific & Short Term	
Consequence of impact or risk:	Erosion and sedimentation of wetland habitat	
Probability of occurrence:	Highly Probable	
Degree to which the impact may cause irreplaceable loss of resources:	Marginal Loss	
Degree to which the impact can be reversed:	Fully Reversible	
Indirect impacts:	None	
Cumulative impact prior to mitigation:	Medium	
Significance rating of impact prior to mitigation:	**Medium Negative**	**No Impact**
Degree to which the impact can be avoided:	High	
Degree to which the impact can be managed:	High	
Degree to which the impact can be mitigated:	High	
Proposed mitigation:	See Section 0	
Residual impacts:	Very Low	
Cumulative impact post mitigation:	Negligible	
Significance rating of impact after mitigation	**Low Negative**	**No Impact**

8.1.3 Impact 3: Disturbance of Aquatic and Riparian Habitat caused by the Excavation of the Bed & Banks

Additional impacts associated with the construction phase involve the loss of additional habitat and biota as a result of disturbances (e.g. from construction vehicles and machinery) that occur outside of the areas designated for the installation of stormwater outlets. Given the current PES of the watercourses these impacts are not expected to be particularly severe if the appropriate mitigation measures are implemented. There is no impact associated with the No-Go option.

8.1.3.1 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; and
- A single point of access must be used to access each site.

	Stormwater Upgrades	No Go
Nature of impact:	Excavation of banks	
Extent and duration of impact:	Site-Specific & Short Term	
Consequence of impact or risk:	Disturbance of wetland habitat	
Probability of occurrence:	Highly Probable	
Degree to which the impact may cause irreplaceable loss of resources:	Marginal Loss	
Degree to which the impact can be reversed:	Fully Reversible	
Indirect impacts:	None	
Cumulative impact prior to mitigation:	Medium	
Significance rating of impact prior to mitigation:	**Medium Negative**	**No Impact**
Degree to which the impact can be avoided:	High	
Degree to which the impact can be managed:	High	
Degree to which the impact can be mitigated:	High	
Proposed mitigation:	See Section 8.1.3.1	
Residual impacts:	Very Low	
Cumulative impact post mitigation:	Negligible	
Significance rating of impact after mitigation	**Low Negative**	**No Impact**

8.2 Operational Phase

8.2.1 Impact 4: Modification to Wetland Habitat Caused by Discharge of Stormwater Runoff.

The most serious impacts related to stormwater discharge relates to the input of high volumes of water at high velocity, which has already caused erosion of wetland seep habitat. Considering that all outlets currently discharge stormwater into the Meul River and associated wetland habitat, the intensity of impact has been assessed relative to the current scenario. In this respect the addition of energy dissipation structures designed to reduce the velocity of the water discharged which will help to prevent erosion problems and represents a positive impact. The No-Go scenario will result in continued erosion of wetland seep habitat and deposition of high quantities of sediment into the river.

8.2.1.1 Mitigation

- The stormwater outlet structures must be inspected on a routine basis to ensure that is free of any blockages and debris and is operating according to design specifications;
- The bed and banks of the river must be routinely inspected (especially following heavy rainfall events) to ensure that the outlet structure is not causing unnecessary erosion of the bed and banks of the river. Any erosion observed must immediately be attended to through appointment of a suitably qualified aquatic specialist;

- All gabion 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
- Gabion structures must be lined with geotextiles to prevent the migration of fines that would otherwise undermine these structures.

	Stormwater Upgrades	No Go
Nature of impact:	Discharge of stormwater into wetland habitat	Discharge of stormwater into wetland habitat
Extent and duration of impact:	Site-Specific & Long Term	Site-Specific & Long Term
Consequence of impact or risk:	Reduced erosion of wetland habitat	Erosion of wetland habitat
Probability of occurrence:	Highly Probable	Definite
Degree to which the impact may cause irreplaceable loss of resources:	Marginal Loss	Marginal Loss
Degree to which the impact can be reversed:	Fully Reversible	Fully Reversible
Indirect impacts:	None	None
Cumulative impact prior to mitigation:	Low	Medium
Significance rating of impact prior to mitigation:	**Low Positive**	**High Negative**
Degree to which the impact can be avoided:	High	High
Degree to which the impact can be managed:	High	High
Degree to which the impact can be mitigated:	High	High
Proposed mitigation:	See Section 8.2.1.1	None – No Go
Residual impacts:	Low	Moderate
Cumulative impact post mitigation:	Low	Negligible
Significance rating of impact after mitigation	**Low Positive**	**High Negative**

9. DWS RISK ASSESSMENT

Risks of activities associated with the phases of stormwater upgrade to the seep wetlands were determined according to the risk assessment matrix developed as part of GN 4167 of 2023 (Section 21 (c) and (i) water use Risk Assessment Protocol). The first stage of the risk assessment is the identification of environmental activities, aspects and impacts and essentially mirror those that were identified in the impact assessment (see Section 8). The intensity of impact to receptors and resources (i.e. hydrology, water quality, geomorphology, biota and vegetation) is rated (from 0 to 5, representing negligible and very high impact, respectively), which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. Risks were then quantified based on the anticipated spatial scale, duration and likelihood of occurrence and assumed the full implementation of recommended mitigation measures described in Section 8. Construction and operational phase impacts can be summarised as follows:

- Given the highly modified nature of the affected watercourse and the fact that most upgrades will occur outside of delineated wetland areas, it is unlikely that the proposed upgrades will result in any deterioration in the PES or EIS during the construction phase and impacts can be mitigated to a low level of risk.
- From an operational perspective, impacts are considered to be positive. As highlighted above, all stormwater outlets are existing and are currently discharging stormwater into the Meul River and associated wetland habitat. Lack of erosion protection is causing erosion of the banks and wetland habitat at numerous of these outlets. Upgrading the

outlets by including energy dissipation and erosion protection will result in an improvement over the current scenario.

Given that all proposed activities fall within a Low Risk class (Table 6) the stormwater upgrades would require a General Authorisation as opposed to a comprehensive WUL.

Table 6: DWS Risk Assessment for the upgrade of stormwater outlets in Rosemoor, George.

Phase	Activity	Impact	Potentially affected watercourses			Intensity of Impact on Resource Quality					Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating (with mitigation)	Confidence level
						Abiotic Habitat (Drivers)			Biota (Responses)											
			Name/s	PES	EIS	Hydrology	Water Quality	Geomorph	Vegetation	Fauna										
CONSTRUCTION	Operation of machinery and construction vehicles	Spills and leaks of fuel and oil	Meul	D	Moderate	1	2	1	1	1	**4**	1	1	**6**	**3**	**18**	40%	**7.2**	L	High
		Disturbance of wetland habitat and water quality	Meul	D	Moderate	2	2	2	2	2	**4**	1	1	**6**	**3**	**18**	60%	**10.8**	L	High
	Construction workers working within delineated area of wetland	Disturbance of wetland habitat and water quality	Meul	D	Moderate	1	1	1	1	1	**2**	1	1	**4**	**3**	**12**	40%	**4.8**	L	High
	Construction of stormwater infrastructure (stepped gabions, reno mattress etc.)	Erosion and sedimentation caused by clearing of vegetation and excavation of banks	Meul	D	Moderate	2	2	2	2	2	**4**	2	2	**8**	**3**	**24**	60%	**14.4**	L	High
		Pollution caused by mixing of cement	Meul	D	Moderate	0	1	0	1	1	**2**	1	2	**5**	**3**	**15**	20%	**3**	L	High

Phase	Activity	Impact	Potentially affected watercourses			Intensity of Impact on Resource Quality					Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating (with mitigation)	Confidence level
						Abiotic Habitat (Drivers)			Biota (Responses)											
			Name/s	PES	EIS	Hydrology	Water Quality	Geomorph	Vegetation	Fauna										
	Stockpiles and laydown areas	Sedimentation and pollution caused by erosion of stockpiles	Meul	D	Moderate	0	1	0	1	1	**2**	1	2	**5**	**3**	**15**	20%	**3**	L	High
		Disturbance of wetland habitat caused by placement of laydown areas and stockpiles	Meul	D	Moderate	1	0	2	2	1	**4**	1	2	**7**	**3**	**21**	20%	**4.2**	L	High
OPERATIONAL	Discharge of Stormwater from Upgraded Outlets	Modification of streamflow hydraulics causing scouring/erosion of bed an banks	Meul	D	Moderate	1	1	1	1	1	**2**	2	4	**8**	**3**	**24**	20%	**4.8**	L	High
		Erosion of wetland habitat	Meul	D	Moderate	-2	-2	-2	-2	-2	**-4**	2	4	**-10**	**3**	**-30**	60%	**-18**	+	High

10. CONCLUSION

Lack of erosion protection at stormwater outlets that discharge relatively high up on slopes has caused extensive erosion gullies that extend into wetland habitat along the Meul River. Given the management objectives for SWSAs, it is important that the proposed upgrades are undertaken at all sites so as to alleviate erosion problems. Upgrades are likely to result in a Low Negative construction phase impact (assuming implementation of mitigation measures). For the operational phase the upgraded stormwater outlets will incorporate energy dissipation and erosion control structures which will result in improved mitigation of stormwater discharge into the Meul River system and can be considered a positive impact relative to the No-Go scenario, which will result in continued erosion of wetland habitat below the outlets. It is therefore recommended that authorisation for the upgrade of stormwater infrastructure in Rosemoor be granted. In terms of the NWA, the upgrades will require a General Authorisation.

11. REFERENCES

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APPENDIX 1: WET HEALTH 2.0

WET-Health 2.0 is designed to assess the PES of a wetland by scoring the perceived deviation from a theoretical reference condition, where the reference condition is defined as the un-impacted condition in which ecosystems show little or no influence of human actions. In thinking about wetland health or PES, it is thus appropriate to consider 'deviation' from the natural or reference condition, with the ecological state of a wetland taken as a measure of the extent to which human impacts have caused the wetland to differ from the natural reference condition. Whilst wetland features vary considerably from one wetland to the next, wetlands are all broadly influenced/ by their climatic and geological setting and by three core inter-related drivers, namely hydrology, geomorphology and water quality. The biology of the wetland (in which vegetation generally plays a central role) responds to changes in these drivers, and to activities within and around the wetland. The interrelatedness of these four components is illustrated schematically in Figure 1 below and forms the basis of the modular-based approach adopted in WET-Health Version 2.

Desktop and field data were captured in GIS software and used to populate the Level 1 WET-Health tool (Macfarlane et al., 2020) which was used to derive the PES of the wetland HGM units. The magnitude of observed impacts on the hydrological, geomorphological, water quality 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 7 below.

Table 7: Wetland Present Ecological State (PES) categories and impact descriptions.

ECOLOGICAL CATEGORY	DESCRIPTION	IMPACT SCORE*	PES SCORE (%)*
A	Unmodified, natural.	0-0.9	90-00
B	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	80-89
C	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	60-79
D	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	40-59
E	Seriously modified. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	20-39
F	Critically modified. 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	0-19

<u>Reference:</u>

Macfarlane, D.M., Ollis, D.J. and Kotze, D.C. (2020). WET-Health (Version 2.0). *A Refined Suite of Tools for Assessing the Present Ecological State of Wetland Ecosystems*. WRC Report No. TT 820/20. Water Research Commission, Pretoria, South Africa.

APPENDIX 2: ECOLOGICAL IMPORTANCE & SENSITIVITY (RIVERS)

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 8: 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.