Upgrade of Bulk Sewage Pipeline, Great Brak, Western Cape.

Specialist Estuarine Assessment

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EXECUTIVE SUMMARY

Confluent Environmental was appointed to conduct an estuarine assessment for the proposed upgrade of a bulk sewage pipeline located within the estuarine functional zone (EFZ) of the Great Brak Estuary. The proposed project entails the installation of a new Ø 300mm pipeline along an existing sewer line alignment. The primary objective of the sewer line upgrade will be to increase the capacity of the pipeline which is crucial to avoiding blockages and leaks associated with increased sewage flows as the town of Great Brak expands. In this respect, the project is aligned to many of the management objectives of the Great Brak Estuarine Management Plan (EMP) – particularly with respect to improving water quality in the estuary.

Existing catchment-scale impacts on the estuary relate primarily to the reduction in base and low flows caused by construction of weirs and small and large dams (most notably the Wolwedans Dam) in the catchment area and abstraction of water for irrigation and domestic water supply. These reduced flows have altered the magnitude of freshwater base flows and the seasonal distribution of flows and flood events into the estuary. This in turn has a significant impact on the dynamics of the estuary mouth, which remains closed for long periods of time due to the lack of regular flooding events. When large flow/flood events do occur, the mouth is artificially breached to prevent flooding of infrastructure and residential areas. Other impacts include alteration of the natural salinity gradient due to impedance of freshwater flows into the estuary and alteration to estuary mouth dynamics, degradation and/or loss of estuarine habitat through development (urban and agricultural) in the EFZ, nutrient inputs from agricultural activities, fishing pressures and human disturbance of birds. The estuary experiences frequent blooms of the nuisance filamentous macro-algae *Cladophera glomerata*, which is indicative of eutrophication caused by prolonged mouth closure that results in a combination of increased residence time of water in the estuary and recycling of nutrients from the benthos (Human et al., 2016). Based on these impacts the Present Ecological State (PES) of the estuary is **C/D**. According to Resource Quality Objectives (RQOs) set for the estuary, the Target Ecological Category (TEC) is **E**, indicating a high tolerance for development and utilisation of estuarine resources.

While the entire pipeline route is mapped within the EFZ, long sections of the route run through urbanised, transformed habitat. Five distinct zones (Zones A to E) have been identified and of these, only Zone D runs through estuarine habitat. A short length of the pipeline (~40 m – Zone A) runs adjacent to, but well outside of the delineated area of an unchannelled valley bottom wetland which is located outside of the EFZ. The majority of the upgrades to the sewage pipeline will occur in transformed sections of the EFZ (Zone B, C and E – total length of ~ 1 050 m) and no estuarine habitat will be directly disturbed in these zones. Where the pipeline does traverse estuarine habitat (Zone D for a length of ~ 725 m), it does so within an existing servitude and there will be no additional disturbance of estuarine habitat outside of this servitude. Upgrades to the pipeline in this zone will however result in disturbance to estuarine vegetation that, whilst maintained, does cover the existing servitude. Impacts to estuarine wetland habitat can be mitigated to a low or negligible significance of impact (for all phases of the project) and it is therefore recommended that authorisation for the upgrade is 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 (Ph.D., Pr.Sci.Nat. Water Resources; SACNASP Reg. No: 114084)

September 2025

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1 INTRODUCTION

1.1 Project Background

Confluent Environmental were appointed to conduct an estuarine assessment for the proposed upgrade of a bulk sewerage line from Amy Searle Street/Greenhaven to the cricket field sewerage pumpstation in Great Brak. The proposed project entails the installation of a new Ø300mm pipeline which will run along the edge of the estuarine functional zone (EFZ) of the Great Brak Estuary (Figure 1). The pipeline route will follow an existing pipeline servitude. The reporting requirements of this assessment are prescribed by the legislative requirements of the National Environmental Management Act (NEMA) and the National Water Act (NWA).

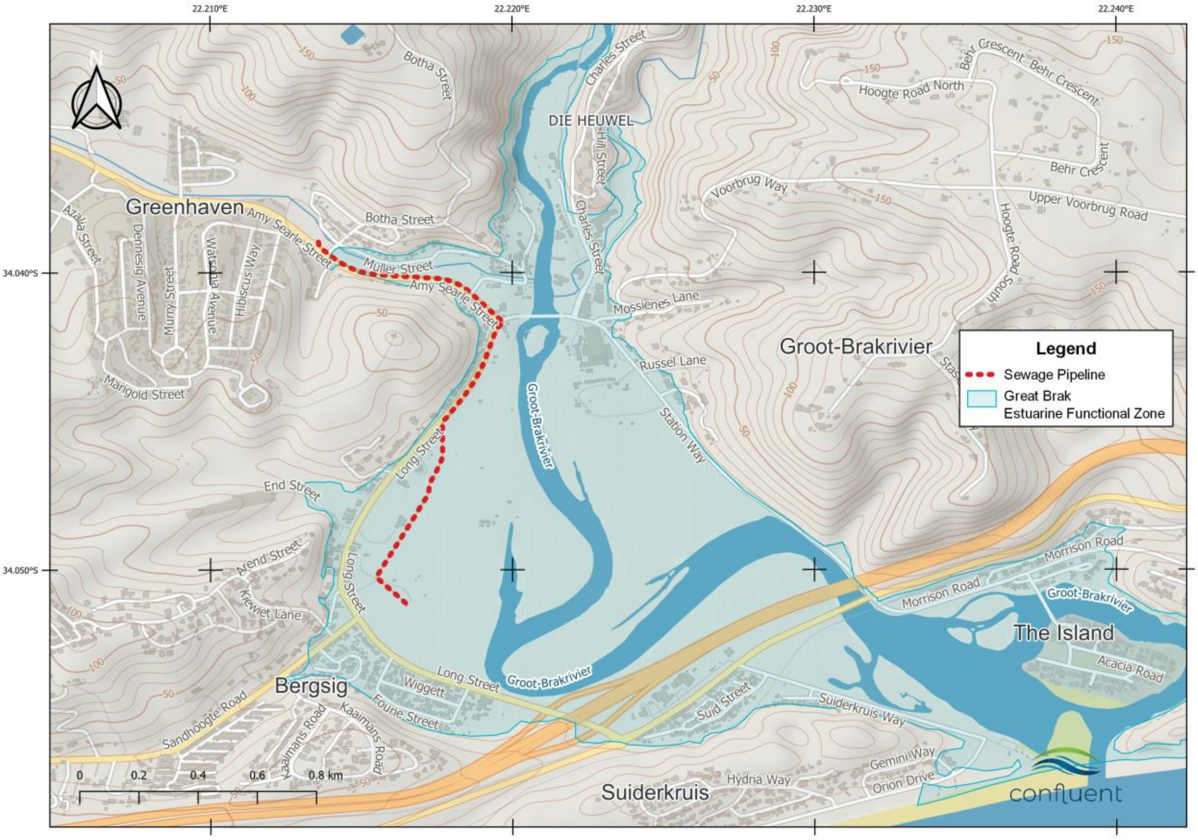

Figure 1: Proposed pipeline route in Great Brak.

1.2 Key Legislative Requirements

1.2.1 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.

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 pipeline will intersect with the Great Brak Estuary which has also been mapped as an aquatic critical biodiversity area (CBA). A detailed site verification visit was therefore undertaken to confirm the site sensitivity and report accordingly.

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.

According to Section 21 (c) and (i) of the NWA, no activity may take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS). Estuaries are, however, not defined as watercourses and maintenance or construction activities assessed as part of this report therefore do not require any Section 21 (c) or (i) water use authorisation in terms of the NWA.

1.3 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 estuary and provincial and national conservation plans relevant to the site;
- Undertake a site visit to the study area to verify the sensitivity of aquatic biodiversity affected by the proposed development; and
- Develop a plan to guide the timing, extent and execution of maintenance activities.
- Describe and assess the significance of the potential impacts of the proposed development on the estuarine environment;
- Recommend mitigation measures to minimise the potential negative impacts of rehabilitation activities on freshwater ecosystems; and
- Provide a report that meets the requirements of the NEMA as per Section 1.2.1 above.

1.4 Assumptions & Limitations

- Estuaries are highly dynamic systems and the assessment of impacts related to this development relied on a single site visit. While every effort has been made to increase the confidence of the assessment presented in this report, given the dynamic nature of estuaries, it is possible that certain impacts may have been overlooked.

2 METHODS

2.1 Estuarine Assessment

2.1.1 Desktop Assessment

A desktop assessment was conducted to contextualize the affected estuary in terms of its 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 estuary, 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, 2023);
- DWS hydrological spatial layers;
- Resource quality objectives (RQOs) set for the Breede-Gouritz WMA (DWS, 2018);
- The National Biodiversity Assessment (NBA) for estuaries (Van Niekerk et al., 2019);
- The desktop provisional eco-classification of the temperate estuaries of South Africa (Van Niekerk et al., 2014); and
- Great Brak Estuarine Management Plan (EMP) (DEADP, 2018)

2.1.2 Present Ecological State

According to Van Niekerk et al. (2014), the desktop Present Ecological State (PES) of all estuaries in South Africa was derived from several abiotic (hydrology, state of the mouth, salinity, water quality and physical habitat) and biotic (microalgae, macroalgae, invertebrates, fish and birds) indices of estuarine health. Based on the combined score for each of these indices an overall PES was derived and classified according to the categories defined in Table 1.

Table 1: Estuary health scoring system indicating the relationship between the six Ecological Categories and the loss of ecosystem condition and functionality.

Category	Description
A	**Natural:** The natural biotic processes should not be modified. The characteristics of the resource should be determined by unmodified natural disturbance regimes. There should be no human induced risks to the abiotic and biotic processes and function.
B	**Largely Natural:** A small change in natural habitats and biota may have taken place, but the ecosystem functions are essentially unchanged.
C	**Moderately Modified:** A loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged
D	**Largely Modified:** A large loss of natural habitat, biota, and basic ecosystem function has occurred.
E	**Seriously Modified:** The loss of natural habitat, biota and basic ecosystem function is extensive.
F	**Critically Modified:** Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural abiotic processes and associated biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

2.1.3 Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity (EIS) for all estuaries in South Africa was determined by Turpie and Clarke (2007). The EIS takes size, the rarity of the estuary type within its biographical zone, habitat, biodiversity and functional importance of the estuary into account. Biodiversity importance, in turn is based on the assessment of the importance of the estuary for plants, invertebrates, fish and birds, using rarity indices. These importance scores ideally refer to the system in its Present State. These criteria were each rated (out of a score of 100) and the average of all criteria was used as the final EIS Score (Table 2).

Table 2: Description of EIS Scores for estuaries derived by Van Niekerk et al. (2014).

EIS Score	Description
0 – 60	Average Importance
61 – 80	Important
80 – 100	High Importance

2.2 Wetland Assessment

2.2.1 Present Ecological State

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 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 3 below.

Table 3: 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

2.2.2 Ecological Importance and Sensitivity

The ecological importance of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales (Duthie, 1999). Ecological sensitivity refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Duthie, 1999). The Ecological Importance and Sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC). 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**

- o Water for human use and harvestable resources;
- o Cultivated foods;
- o Cultural heritage;
- o 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 4: 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

2.3 Impact Assessment

A site visit was conducted on the 14th of August 2025, with the primary objective of identifying existing impacts and assessing the impacts of the proposed pipeline upgrade on the estuary. The impact assessment methodology is described in the appendix to this report (Appendix 1). Development and maintenance activities typically impact on the following important drivers of estuaries:

- *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;
- *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 estuaries, 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 or estuary);
- *Modification of estuarine habitat:* This refers to the physical disturbance of in-stream and riparian aquatic and estuarine 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 ecosystem*;* and
- *Estuarine 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.

Construction and operational activities associated with the jetty were therefore assessed with respect to their impact on these drivers (if applicable).

3 PROPOSED DEVELOPMENT

In South Africa, the Estuarine Functional Zone (EFZ) is defined as the area that not only delineates the boundaries of the estuarine waterbody, but also the supporting physical and biological processes and adjacent habitats necessary for estuarine function and health (Van Niekerk et al., 2019). It includes all dynamic areas influenced by long-term estuarine sedimentary processes, multiple ecotones of floodplain and estuarine vegetation that contribute organic material and provide refuge from strong currents during high flow events. EFZs are currently delineated by the 5 m contour line and therefore include large areas of terrestrial habitat (much of which has been historically developed) that border the actual water body. The EFZ is now commonly used to delineate the spatial extent of the entire estuary.

The pipeline route runs adjacent to Amy Searle and Long streets (Figure 2). The upper, western most section of the pipeline is located adjacent to freshwater wetland habitat (i.e. outside of the EFZ). The majority of the pipeline is located within the EFZ and will be buried immediately adjacent to Amy Searle and Long streets (beneath the sidewalk). The southern most section of the pipeline deviates from Long Street, further in towards the EFZ and closer to open water estuarine habitat.

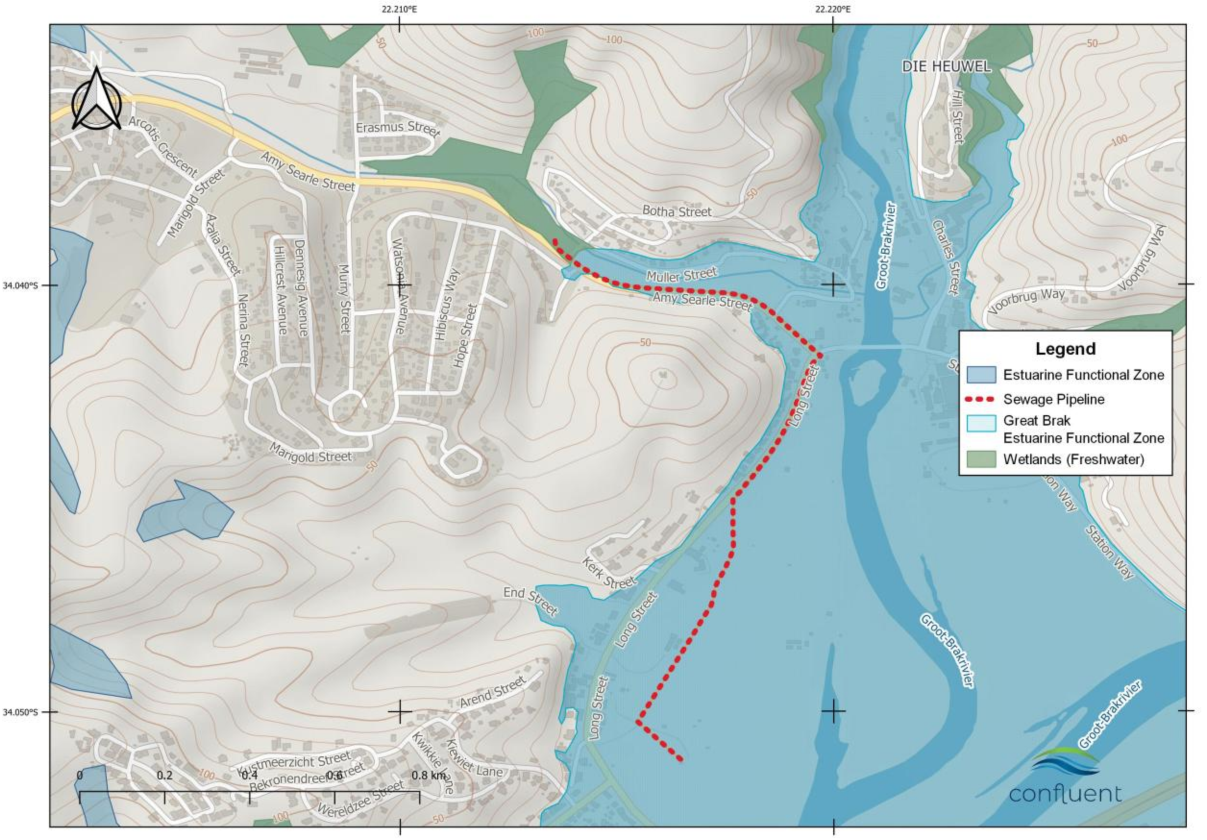

Figure 2: Mapped estuarine and freshwater wetland habitat (CSIR, 2018) relative to the pipeline route.

4 DESKTOP ASSESSMENT

The Great Brak estuary falls in quaternary catchment K20A (Figure 3). The main river flowing through the catchment area is the Groot Brak River. The estuary falls within level 22.02 of the Southern Coastal Belt ecoregion, which is characterised by moderately undulating plains of moderate relief with altitude ranging from 0 to 500 m above mean sea level. Mean annual precipitation for the catchment area is relatively high (between 300 and 700 mm per annum), and occurs year-round, with peaks in late winter and early spring (August to October).

According to Van Niekerk et al. (2019), the estuary is classified as a **warm temperate, large temporarily closed system** with the mouth closed for the majority of the time. The EFZ extends from the coast approximately 6.5 km further upstream, beyond the Searle's Bridge and further up the Great Brak River (Figure 2). The estuary is approximately 6 km long and has a water surface area of 0.6 km^2 at high tide, and a tidal prism of 0.3 x 10^6 m^3 (DEADP, 2018). The lower reaches of the estuary are mostly shallow (0.5 to 1.2 m deep), comprising of extensive sand banks. Deeper areas are associated with scouring zones near the rocky cliffs and bridges (Human et al., 2016). The middle reaches are also relatively shallow and are characterised by larger intertidal and floodplain salt marsh areas – much of which has been transformed into agricultural land. A summary of the composition of different natural habitat types occurring in the estuary is provided in (Table 5). A large proportion of the area of the EFZ has been transformed from natural habitat to schools and agricultural, commercial and residential properties.

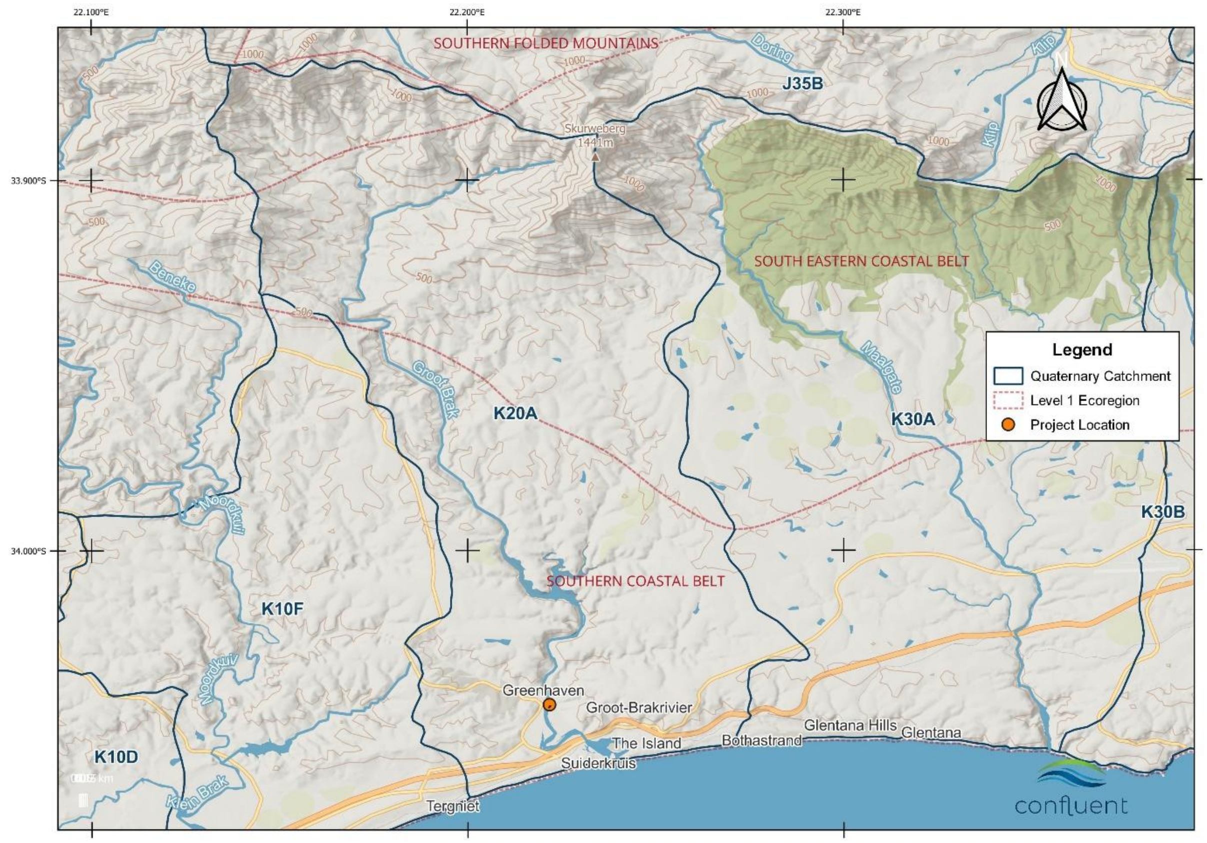

Figure 3: Location of the project area relative to quaternary catchment K20A.

Table 5: Compostion of different habitat types in the Great Brak estuary.

Habitat	Area (ha)	Area (%)
Inter-tidal Salt Marsh	13.0	12.3
Supratidal Salt Marsh	26.6	25.3
Submerged Macrophytes	0	0
Reeds & Sedges	2.5	2.4
Mangroves	0	0
Sand/Mud Banks	29.9	28.4
Open Water	33.1	31.5
Rocks	0	0
Swamp Forest	0	0
Macroalgae	0	0
TOTAL	**105.1**	**100**

According to the Great Brak EMP (DEADP, 2018) benthic invertebrates of the Great Brak estuary are dominated by the mudprawn *(Upogebia Africana),* the sandprawn *(Callianassa kraussi)* and the bivalve *(Loripes clausus)*. Diversity and abundance is considered to be low relative to other closed estuaries in the region. Zooplankton biomass and abundance in the estuary is typical of temporarily closed systems and is dominated by the copepods *Acartia longiptella* (during closed phases) and *Pseudodiaptomus hessei* (during open phases). A total of 33 species of fish from 21 families have been recorded from the Great Brak estuary, which is considered to be high compared to other temporarily open/closed estuaries in the region.

A total of 52 non-passerine waterbird species have been recorded on the Great Brak estuary (excluding vagrants), with 39 of these species being recorded during summer, and 41 in winter. Numbers of birds on the estuary are relatively low, however. The estuary supports an average of about 240 birds in mid-summer and 153 in mid-winter. The estuary is ranked 135th out of 258 estuaries in terms of its avifauna.

4.1 Freshwater Conservation & Management

4.1.1 National Freshwater Ecosystem Priority Atlas (NFEPA)

The Great Brak estuary is located in sub-quaternary catchment (SQC) 9083 (Figure 4), which, according to the National Freshwater Ecosystem Priority Atlas (NFEPA, Nel et al., 2011), has been classified as a Fish Support Area (FSA). FSAs are SQCs that are not necessarily in a good ecological condition but are still essential for protecting threatened or near-threatened freshwater fish species that are indigenous to South Africa. The management goal of FSAs is to prevent additional fish species from becoming threatened or to prevent threatened or near-threatened species from becoming extinct. In order to achieve these objectives, there should be no further deterioration in river condition. Freshwater fish species that are expected to occur in the Great Brak River are listed in Table 6. Of these species *A. mossambica* and *M. capensis* are likely to also occur within the estuary. Both of these species are catadromous and breed at sea, with juveniles migrating through estuaries and into freshwater systems until they reach maturity (after which they migrate back to the sea). *G. zebratus* and *S. capensis* are endemic to South Africa but are not expected to occur in estuarine environments.

Table 6: List of freshwater fish species that occur in the Great Brak River (DWS, 2014).

Scientific Name	Common Name
Anguilla mossambica	African Longfin Eel
Galaxius zebratus	Cape Galaxius
Myxus capensis	Freshwater Mullet
Sandelia capensis	Cape Kurper

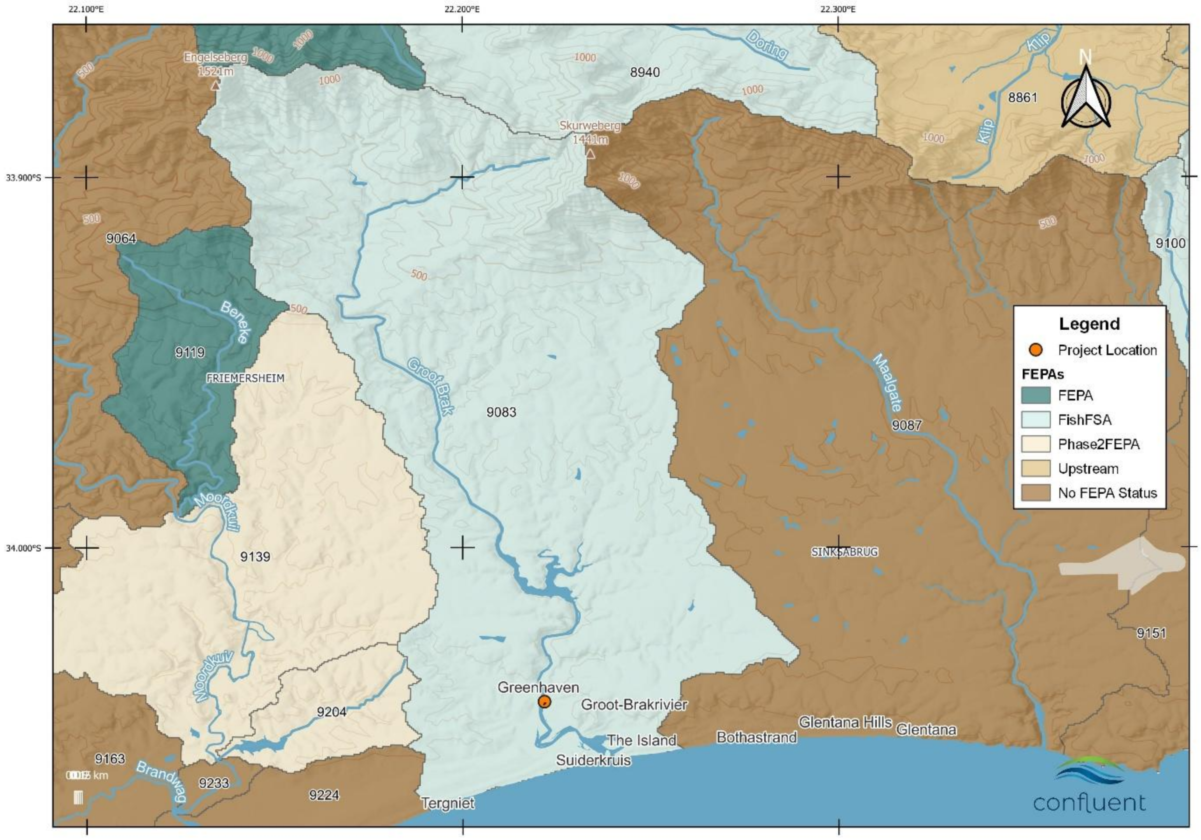

Figure 4: Map indicating the location of the project area in relation to FEPAs.

4.2 Western Cape Biodiversity Spatial Plan

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). According to the Western Cape Biodiversity Spatial Plan (WCBSP) for Mossel Bay, the lower, southern section of the pipeline traverses natural and modified aquatic CBAs (Figure 5). The northern section runs through modified terrestrial CBAs. Management objectives associated with aquatic CBAs are provided in Table 7.

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.
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.

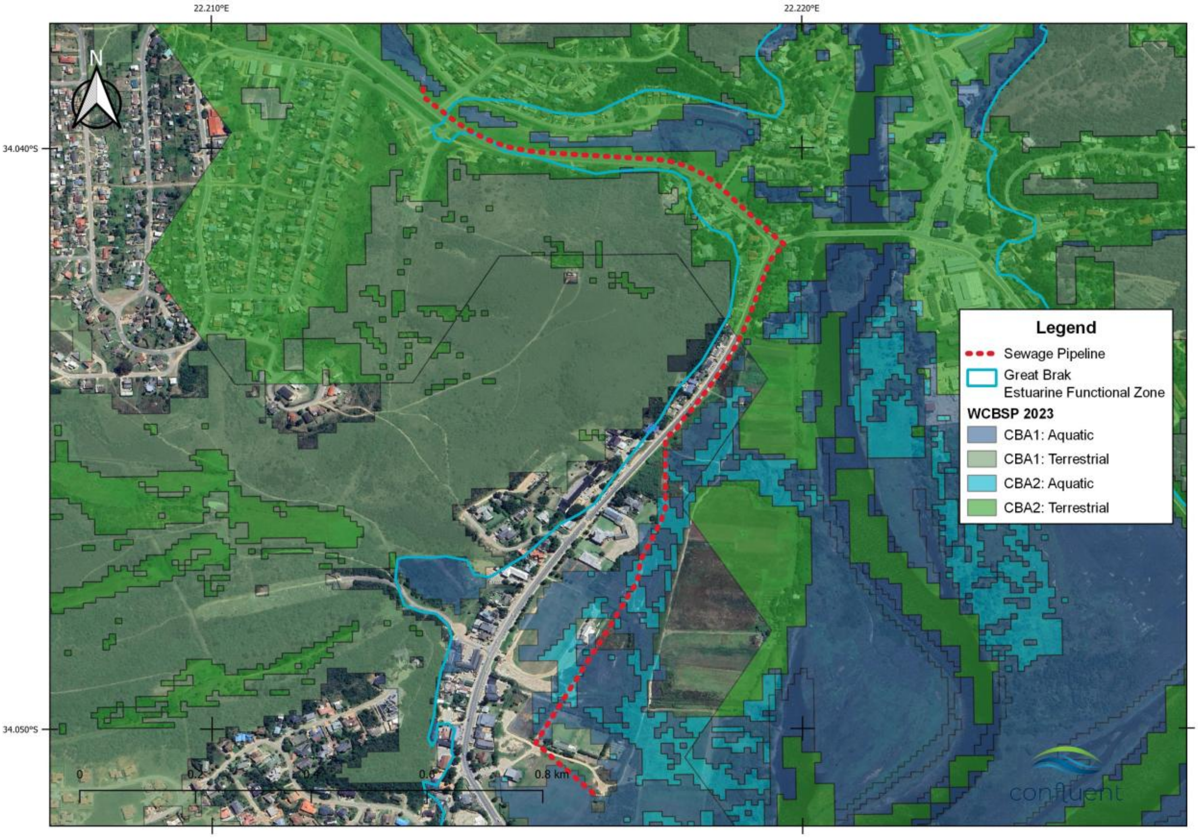

Figure 5: Map of the Western Cape Biodiversity Spatial Plan (WCBSP).

4.3 Great Brak Estuarine Management Plan

Estuaries are recognised as particularly sensitive and dynamic ecosystems and the National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008, as amended by Act 36 of 2014) (ICMA), via the prescriptions of the South African National Estuarine Management Protocol (the Protocol), require Estuary Management Plans (EMPs) to be prepared for estuaries in order to create informed platforms for efficient and coordinated estuarine management. To this end, the Great Brak River EMP was compiled in 2018 (DEADP, 2018) and provides a detailed situation assessment of the estuary as well as management objects aimed at achieving an agreed upon vision for the estuary which is as follows:

"The Great Brak River estuary is managed in a transparent, accountable and cooperative manner to ensure an appropriate balance between biodiversity conservation, recreational use, human safety and development, now and in the future."

Specific management objectives highlighted in the EMP that are relevant to the proposed development include are listed in Table 8. The primary objective of the sewer line upgrade will be to increase the capacity of the pipeline which is crucial to avoiding blockages and leaks associated with increased sewage flows as the town of Great Brak expands. In this respect, the project is aligned to many of the management objectives of the EMP – particularly with respect to improving water quality in the estuary.

Table 8: Management objectives included in the Estuarine Management Plan (EMP) for the Great Brak Estuary (objectives highlighted in bold are relevant to the proposed sewage line upgrade).

Description	Management Objectives
1. Conservation of estuarine biodiversity	• Zonation plan for the estuary approved and implemented. • Great Brak River EMP integrated within local, district and provincial level planning documents (IDPs and SDFs). • Alien vegetation clearing and monitoring operations in place. • **Future development on the estuary is constrained to ensure that it does not compromise estuary health, ecosystem functioning and/or sensitive species (e.g. no development in the 1:50 year flood line).** • Harvesting of living marine resources (fish and bait) on the estuary remains within sustainable limits, resource users do not exceed applicable size and bag limits
2. Restoration of estuary health	• Freshwater environmental reserve for the Great Brak River estuary implemented; revised dam operating rules for the Wolwedans are in force and respected. • **Quantity and quality of freshwater reaching the estuary adequate to restore and maintain estuary health.** • **Sewage and storm water entering the estuary monitored and controlled**
3. Effective and efficient mouth Management	• Mouth Management Plan (MMP) accepted and signed off by all relevant authorities (DWS, • Disaster Management, Weather SA, Eden and Mossel Bay Municipalities). • Beaching protocols are implemented in accordance with the accepted Mouth Management • Plan & approved Maintenance Management Plan (MMP).
4. Water quality management	• Water quality samples collected and analysed in accordance with EMP requirements. • Bacteriological (Faecal coliforms, E. coli and Enterococci) and physico-chemical parameters (nitrate, nitrite, ammonia, phosphorus, silica, suspended sediment, toxic substances) from water quality samples taken in the estuary.
5. Visitor management	• Informative and educational signage erected at key points access points that highlights the conservation importance and value of the Great Brak River estuary. • Visitors are sensitive to and aware of activities affecting health and functioning of the estuary, and management regulations governing use of the estuary. • Quality and quantity of visitor facilities (ablutions, parking, etc.) sufficient to meet visitor expectations and requirements**.**
6. Development planning	• **Future development on the estuary is constrained to ensure that it does not compromise the existing sense of place, conservation value and/or cultural heritage resources associated with the Great Brak River estuary**
7. Harmonious and effective Governance	• Great Brak River Estuary Advisory Forum convened and meets regularly. • Manager for the Great Brak River estuary appointed and capacitated • Arrangements for co-operative governance of the Great Brak River estuary defined and agreed to by all participating agencies. Finance required for implementation of the Great Brak River estuary EMP secured and available. • Adequate capacity and resources available for implementation of the EMP amongst participating agencies
8. Enhanced public awareness and appreciation for the Great Brak River estuary	• Functional and effective stakeholder communication, education and awareness programmes are in place. • Informative and educational signage erected at key access points that highlights the conservation importance and value of the Great Brak River estuary • Great Brak River estuary recognised as an important local ecotourism destination.
9. Research and monitoring	• Adequate research and monitoring is being conducted that allows for quantification of utilisation patterns, changes in abiotic and biotic health, and benefits accruing to local communities and national economy.

4.4 Resource Quality Objectives

The classification of water resources and development of Resource Quality Objectives (RQOs) for the Breede-Gouritz Catchment Management Area was finalised in 2018 (DWS, 2018). The estuary falls within quaternary catchment K20A, which falls within the G14 Gouritz-Olifants Integrated Unit of Analysis (IUA). The Water Resource Class for this IUA is III, indicating sustainable minimal protection and high utilisation. The estuary falls within G14-E16 priority resource unit, and gazetted RQOs are provided in Table 9 below. While the Present Ecological State (PES) of the estuary is C/D (Moderately to Largely Modified – see section 5.3), the Target Ecological Category (TEC) for the Great Brak Estuary been set as an **E (Seriously Modified)**, which indicates a highly impacted river with a low level of protection for high utilisation for socio-economic development.

Table 9: Resource Quality Objectives (RQOs) for the Great Brak estuary.

IUA	Class	Quaternary Catchment	RU	Resource Name	Biophysical Node Name	TEC	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
G14 Groot-Brak	III	K20A	G14-E16	Groot-Brak Estuary	gxi5	E	Quantity	Flow	MMR/MAR (% Nat)	Maintain a flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality.	Months: Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Annual MMR/MAR (% Nat): 62.2, 67.3, 55.3, 48.2, 43.4, 55.7, 49.2, 54.9, 38.3, 43.7, 63.4, 63.8, 56.2
							Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	River inflow: NOx-N not to exceed 100 µg/ℓ over 2 consecutive months, NH_3-N not to exceed 20 µg/ℓ over 2 consecutive months; Estuary (except during upwelling or floods): average NOx-N not to exceed 100 µg/ℓ, no single measurement to exceed 150 µg/ℓ, average NH_3-N not to exceed 20 µg/ℓ during survey, no single measurement to exceed 100 µg/ℓ
									DIP		River inflow: PO_4-P not to exceed 20 µg/ℓ over 2 consecutive months; Estuary (except during upwelling or floods): average PO_4-P not to exceed 20 µg/ℓ during survey, no single measurement to exceed 50 µg/ℓ
								Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	A salinity gradient should always be present in the upper reaches of the estuary (Zone D and F), an REI zone should always be present in the upper reaches of the estuary (Zone D and F), salinity should not exceed 35
								System variables	Dissolved oxygen	System variables not to exceed TPCs for biota	Entire estuary and river inflow: DO >5 mg/ℓ
									pH		6 < pH > 8.5 in estuary
								Pathogens	Enterococci	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 Enterococci/100 ml) (90th percentile)
									Escherichia coli		≤500 E. coli/100 ml (90th percentile)
							Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Closed mouth state should not increase by >10% from established baseline
								Sediment	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline

IUA	Class	Quaternary Catchment	RU	Resource Name	Biophysical Node Name	TEC	Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
							Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain low phytoplankton biomass. Maintain microalgal group diversity as measured for the baseline survey; phytoplankton biomass should not increase by more than 20% above baseline concentrations; phytoplankton group diversity to should not change more than 20% from baseline conditions; maintain high subtidal benthic microalgal biomass during the closed mouth phase and low intertidal benthic microalgal biomass during the open phase; Epipelic diatoms indicative of brackish conditions should be found during the closed phase.
								Macrophytes	Extent, distribution and richness of macrophytes	Maintain extent, distribution and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	Maintain distribution of macrophyte habitats as for present (2013): Submerged macrophyte, *Ruppia cirrhosa* beds: ~5 ha, *Zostera capensis* present during open mouth conditions, intertidal salt marsh: ~13 ha, supratidal and floodplain salt marsh: ~26.6 ha), Reed (*Phragmites australis)* and sedge stands in the middle / upper reaches: ~2.5 ha); prevent excessive filamentous macroalgal growth. Area covered should be half that covered by submerged macrophytes and less than 50 % of the open water surface area; maintain the zonation of salt marsh and distribution of different species along an elevation gradient. Ensure the long-term persistence of intertidal salt marsh species such as *Triglochin* spp. and *Cotula coronopifolia*; prevent hypersaline sediment and groundwater conditions in the salt marsh. Sediment electrical conductivity should be approximately 30 mS and similar to groundwater values.
								Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Density of mudprawns should exceed 100 – 150 burrow counts per m2 in the highest density areas; in the zooplankton, the density of Pseudodiaptomus hessei should exceed levels of about 5000-10000 m3 in the upper estuary in spring. Salinity variation in the estuary is highly variable and the mouth remains closed for extended periods - this may also lead to the temporary absence of some invertebrate species that might be expected to occur here.
								Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the five estuarine association categories in similar proportions (diversity and abundance) to that under the reference. Numerically, assemblage should comprise: Estuarine species (40-60%), Estuarine associated marine species (30-50%), Indigenous freshwater fish (1-5%); Category Ia species should contain viable populations of at least two species (e.g. *G. aestuaria*, & *Hyporamphus capensis*); Category IIa obligate dependents should be well represented by at least two large exploited species
								Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Retain species richness, abundance and density of bird counts of resident and migrant waders, gulls, terns, wading birds and waterfowl within 15 % of present state (2006).

5 ESTUARINE ASSESSMENT

5.1 Historical Impacts

Historical impacts relevant to the proposed pipeline upgrade are summarized as follows:

- 1939: The natural estuarine channel below the wetland ran in close proximity to present day Amy Searle Street (Figure 6).
- 1957: The channel had been straightened – presumably to drain the wetland during high flood events (Figure 6)
- 1989: Loss of wetland habitat associated with development of roads. Estuarine channel was realigned to flow further north of present-day Amy Searle Street (Figure 6).

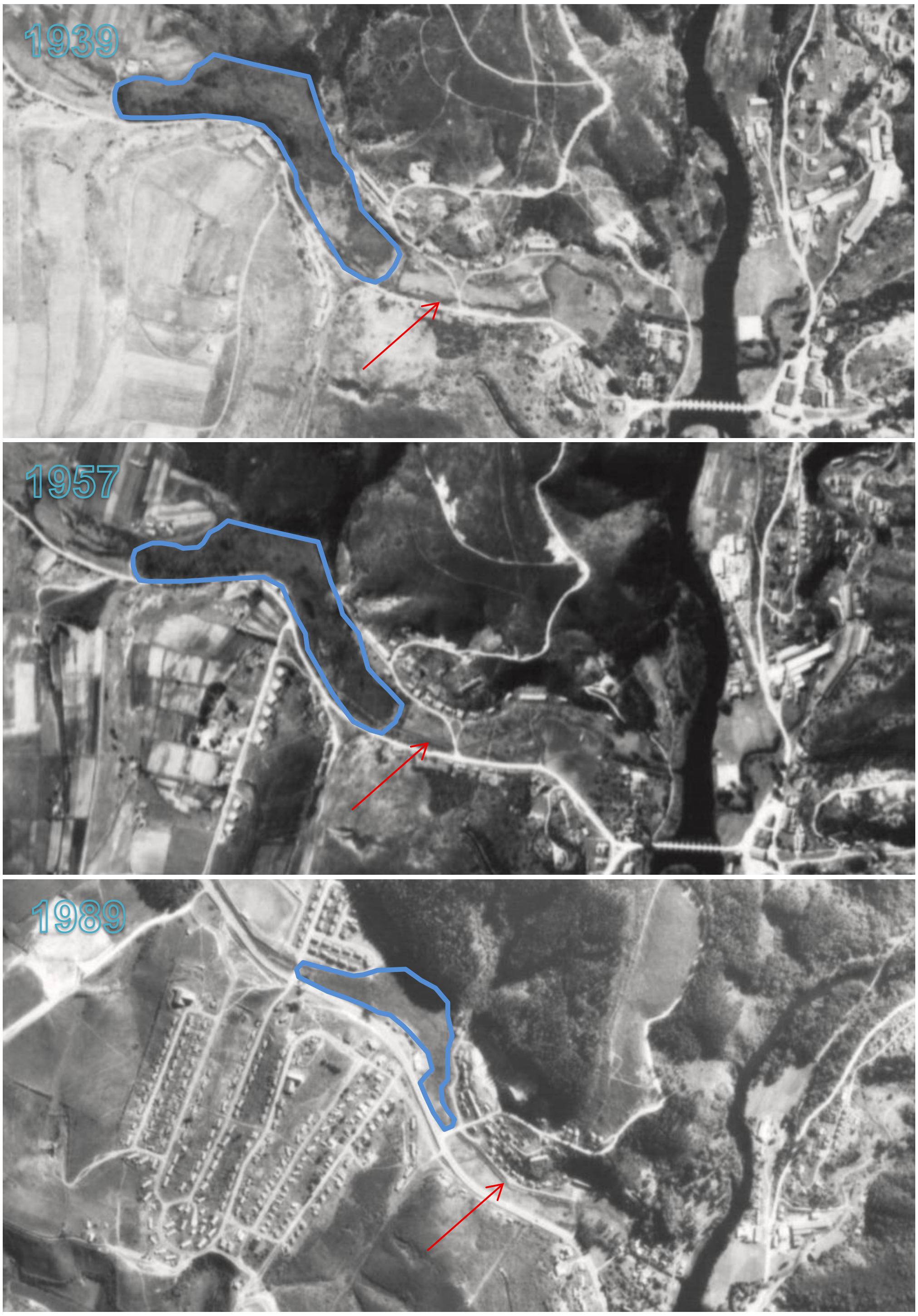

Figure 6: Historical images illustrating modifications to wetland habitat upstream and adjacent to Zone A (blue outline indicates the extent of the wetland and red arrow indicates the positions of the channel).

5.2 Existing Impacts

5.2.1 Catchment Scale Impacts

Broader catchment-scale impacts relate primarily to the reduction in base and low flows caused by construction of weirs and small and large dams (most notably the Wolwedans Dam) in the catchment area and abstraction of water for irrigation and domestic water supply. These reduced flows have altered the magnitude of freshwater base flows and the seasonal distribution of flows and flood events into the estuary. This in turn has a significant impact on the dynamics of the estuary mouth, which remains closed for long periods of time due to the lack of regular flooding events. When large flow/flood events do occur, the mouth is artificially breached to prevent flooding of infrastructure and residential areas. Other impacts include alteration of the natural salinity gradient due to impedance of freshwater flows into the estuary and alteration to estuary mouth dynamics, degradation and/or loss of estuarine habitat through development (urban and agricultural) in the EFZ, nutrient inputs from agricultural activities, fishing pressures and human disturbance of birds. The estuary experiences frequent blooms of the nuisance filamentous macro-algae *Cladophera glomerata*, which is indicative of eutrophication caused by prolonged mouth closure which results in a combination of increased residence time of water in the estuary and recycling of nutrients from the benthos (Human et al., 2016).

5.2.2 Site Specific Impacts

While the entire pipeline route is mapped within the EFZ, long sections of the route run through urbanised, transformed habitat. Five distinct zones have been identified (Figure 7).

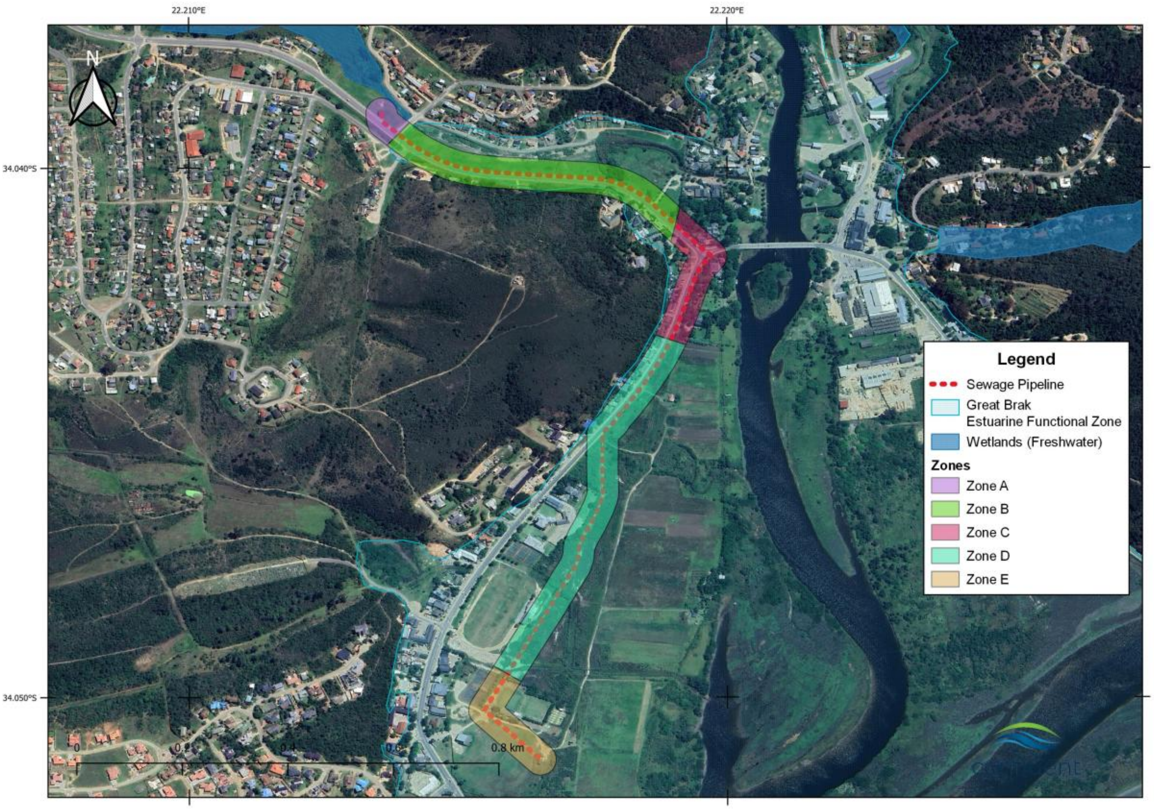

Figure 7: Habitat zones identified along the route of the proposed sewage pipeline upgrade.

Each of the zones is characterised as follows:

- **Zone A:** The upper-most manhole linked to the proposed pipeline upgrade is located adjacent to a channel that extends from a large *Phragmites australis* dominated unchannelled valley-bottom wetland (Figure 8). Other prominent species include *Nidorella ivifolia* and *Cyperus textilus.* The channel is narrow and receives stormwater input from the surrounding area. The channel drains water from the wetland and has been diverted from its original course, which used to run closer to Amy Searle Street (see Section 5.1). This wetland falls outside of the EFZ and is considered as freshwater habitat (not estuarine).

Figure 8: Photographs of the wetland (left) and the channel extending from the lower end of the wetland towards the EFZ (right).

- **Zone B:** The upper section of the pipeline (running adjacent to Amy Searle Street) runs through a grassed public open space area (Figure 9). Open water estuarine habitat has been transformed into a concrete-lined canal. The pipeline route along this section runs immediately beneath the sidewalk and does not traverse through any natural estuarine habitat. The closest distance to the canal is approximately 20 m. Several stormwater channels drain stormwater from Amy Searle Street down towards the canal. The canal has undergone many modifications in the past and has been diverted from its natural course (see Section 5.1). There is a patch of estuarine wetland vegetation that extends away from the channel towards Amy Searle Street. This is a remnant of the historical channel that used to run closer to Amy Searle Street (see Section 5.1). The wetland area is dominated by *P. australis* reedbeds but also includes *C. textilus* and *N. ivifolia*. There are clear signs of historical excavation within the wetland as was by vegetated mounds of soil around the perimeter (adjacent to Amy Searle Street). These mounds have been invaded by alien tree species – most notably *Melia azedarach* (Syringa).

Figure 9: Photographs of the grassed area adjacent to the canal (top left), the canal lined with open concrete pavers (top right), a stormwater channel leading from Amy Searle Street down towards the canal (bottom left) and a patch of remnant wetland vegetation in close proximity to Amy Searle Street (bottom right).

- **Zone C:** This section of the pipeline follows Long Street and runs immediately adjacent to the road and sidewalk. The pipeline runs through a transformed section of the EFZ and does not run through or adjacent to any natural estuarine habitat.
- **Zone D:** The pipeline route passes through natural, estuarine habitat located immediately adjacent to Long Street and eventually deviates from Long Street and passes through estuarine habitat, characterised by stands of *Phragmites australis* and patches of salt marsh vegetation (Figure 10). The habitat is supratidal and lies above the level of the highest high tide. Several stormwater channels that divert stormwater off of Long Street intersect with the pipeline route. While, the pipeline passes along an existing, disturbed servitude, the habitat immediately adjacent to the servitude is considered to the be sensitive. This zone largely coincides with mapped aquatic CBA1 and CBA2 habitat (Figure 5).

Figure 10: Examples of estuarine habitat located immediately adjacent to the sewer line servitude, including Juncus kraussii sedge beds (top left), P. australis reed beds (top right), salt marsh (bottom left) and vegetated stormwater channels extending from Long Street further into the interior of the EFZ (bottom right).

- **Zone E:** The final section of the pipeline passes through the Great Brak municipal sport grounds complex where any former natural estuarine habitat has once again been transformed (roads, parking areas and sports fields) - Figure 11.

Figure 11: Paved roads and sports fields in Zone E (left and right).

5.3 Present Ecological State (PES) and Ecological Importance & Sensitivity (EIS)

5.3.1 Great Brak Estuary

The rapid level assessment for the Great Brak estuary confirmed the Present Ecological State as **C/D – Moderately to Largely Modified** (Van Niekerk et al., 2014) indicating that while loss and/or change of natural habitat and biota has occurred, the basic ecosystem functions and processes remain predominantly unchanged. In this respect alterations to water quality and the hydrodynamics of the estuary (e.g. prolonged mouth closure) are considered the most important variable with respect to impacts on habitat (Table 10). This in turn has notably influenced the majority of biotic indicators, with macrophytes, fish and birds most heavily affected. The Recommended Ecological Category (REC) is also set at **D**. The EIS of the estuary is presented in Table 11 and is rated as **Important**.

Table 10: Present Ecological State (PES) of the Groot Brak Estuary as determined by Van Niekerk et al. (2015).

Variable	Weight
Hydrology	C
Hydrodynamics and Mouth Condition	C/D
Water Quality	D
Physical Habitat Alteration	B
Habitat Health Score	**C**
Microalgae	C/D
Macrophytes	D/E
Invertebrates	D
Fish	D/E
Birds	C
Biotic Health Score	**D**
PES	**C/D**

Table 11: Estuarine Importance Scores (EIS) of the Groot Brak Estuary (Turpie and Clark, 2007)

Criteria	Weight	Score
Estuary Size	15	90
Zonal Rarity Type	10	80
Habitat Diversity	25	10
Biodiversity Importance	25	80
Functional Importance	25	77
Weighted Estuary Importance Score		**63.25**

5.3.2 Unchannelled Valley Bottom Wetland

As described in Section 5.1, the extent of the wetland has decreased over time and has also been artificially drained, presumably to accommodate development within the adjacent areas and to control flooding. The short length of channel upstream of Botha Street, was originally part of this broader wetland area. Despite these modifications the wetland is relatively large, provides good habitat for aquatic biota and its hydro-functional attributes remain largely unchanged and the PES is C – Moderately Modified (Table 12).

Table 12: Present ecological state (PES) of the unchannelled valley bottom wetland.

Final (adjusted) Scores				
PES Assessment	Hydrology	Geomorphology	Water Quality	Vegetation
Impact Score	4.8	1.2	3.0	3.0
PES Score (%)	52%	88%	70%	70%
Ecological Category	D	B	C	C
Confidence (revised results)	Not rated	Not rated	Not rated	Not rated
Combined Impact Score	3.2			
Combined PES Score (%)	68%			
Combined Ecological Category	C			

The ecological importance and sensitivity of and the ecosystem services provided by the wetland are summarised as follows:

- The ecological importance and sensitivity of the wetland is **Moderate**. The wetland is relatively large and provides permanent reed-bed habitat which is likely to provide habitat for red-data bird species. The wetland is sensitive to changes in water quality and flow and (Table 13);
- The hydro-functional importance and sensitivity of the wetland is **Moderate**. The wetland does provide moderately important supporting and regulating ecosystem services, including flood attenuation, streamflow regulation and pollutant assimilation capabilities (Table 14);
- Provisioning (e.g. water for abstraction, harvestable materials, cultivated and livestock foods) and cultural (e.g. recreation, tourism, education and research) services provided by the wetland are **Low** (Table 15).
- The overall importance and sensitivity of the wetland is **Moderate.**

Table 13. Ecological Importance and Sensitivity criteria for the wetland.

Ecological Importance and Sensitivity	Score
Biodiversity Support	
Presence of Red Data species	2- Rare or endangered avifauna likely to utilise the wetland.
Populations of unique species	1 – Relatively low probability of unique species
Migration/feeding/breeding sites	1 – Low importance
Average	**1.66**
Landscape Space	
Protection status of wetland	1 – Public area
Protection status of vegetation type	0 – Vegetation has been transformed
Regional context of the ecological integrity	2 – Moderate (PES C)
Size and rarity of the wetland types present	2 – Moderate, relatively large, unchannelled valley bottom wetland
Diversity of habitat types	1 – Low diversity – dominated by *P. australis* reedbeds
Average	**1.2**
Sensitivity of Wetland	
Sensitivity to changes in floods	2 – Moderate sensitivity
Sensitivity to changes in low flows	3 – High sensitivity
Sensitivity to changes in water quality	1 – Low sensitivity
Average	**2**
ECOLOGICAL IMPORTANCE AND SENSITIVITY	**2 (Moderate)**

Table 14: Hydro-functional importance of the wetland.

Hydro-functional Importance			Score
Regulating & supporting benefits	Flood attenuation		2
	Streamflow regulation		2
	Water quality enhancement	Sediment trapping	2
		Phosphate assimilation	2
		Nitrate assimilation	2
		Toxicant assimilation	2
		Erosion control	1
	Carbon storage		2
HYDRO-FUNCTIONAL IMPORTANCE			**1.5 (Moderate)**

Table 15: Direct human benefit importance of the wetland.

Direct Human Benefits		Score
Subsistence benefits	Water for human use	0 – No formal abstraction occurring
	Harvestable resources/cultivated foods	1 – Reedbeds provide harvestable resources but unlikely to be heavily utilised
Cultural benefits	Cultural heritage	0
	Tourism and recreation Education and research	1 – Potential bird-watching opportunities
DIRECT HUMAN BENEFITS		**0.4 (Low)**

5.4 Sensitivity

Habitat zones (as described in Section 5.2.2) were assigned sensitivity ratings based on the proximity of the pipeline to estuarine habitat (Figure 12):

- Low sensitivity (Zone C and E): These zones are located outside of natural estuarine habitat and are unlikely to have any impact on aquatic biodiversity.
- Medium sensitivity (Zone A and B): These zones are located outside of natural freshwater and estuarine habitat but are in close enough proximity to warrant precautions that prevent impacts – particularly during the construction phase.
- High Sensitivity (Zone D): This zone traverses through or runs in very close proximity to natural estuarine habitat. Precautions must be taken to minimise impacts to natural estuarine habitat during the construction and operational phase.

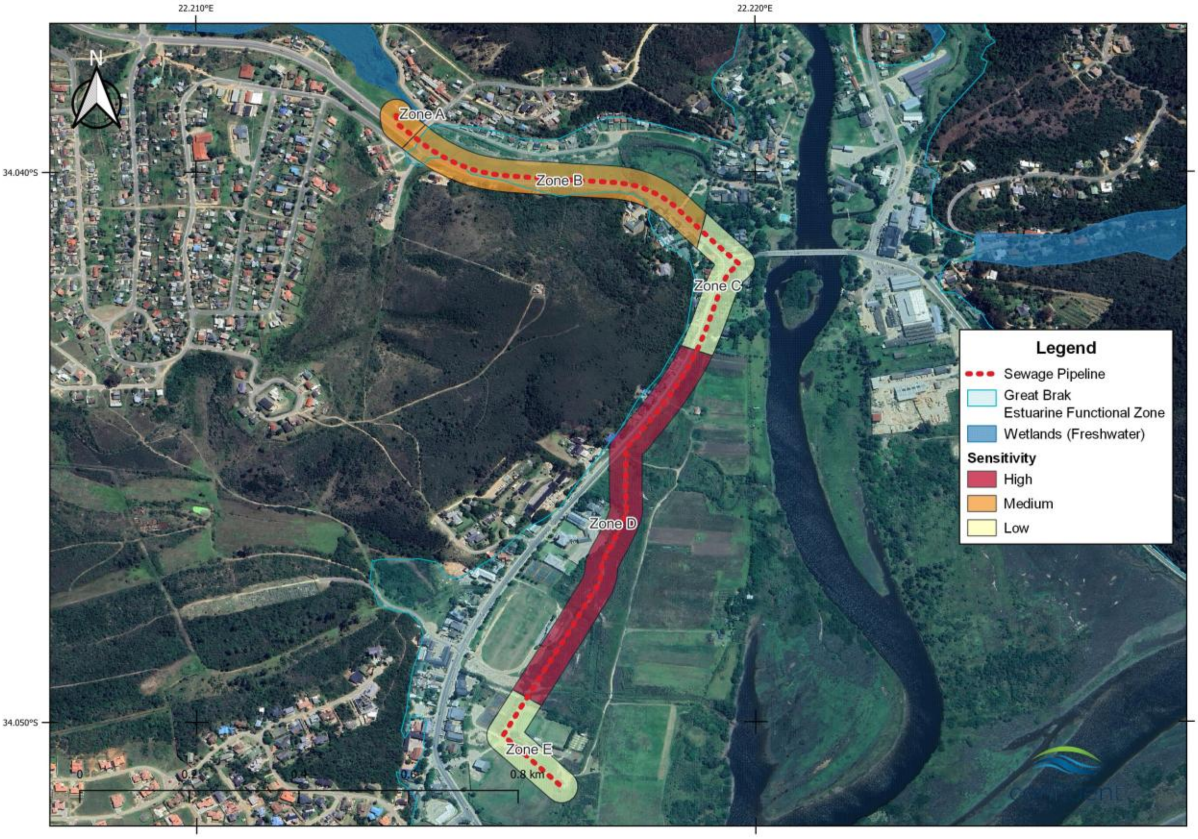

Figure 12: Sensitivity of zones.

6 IMPACT ASSESSMENT

The impact assessment follows the principals of the mitigation hierarchy which states that the next step along the hierarchy should only be followed once the previous step is no longer viable, and with valid reason (Figure 13). The impact assessment methodology is provided in the Appendix to this report.

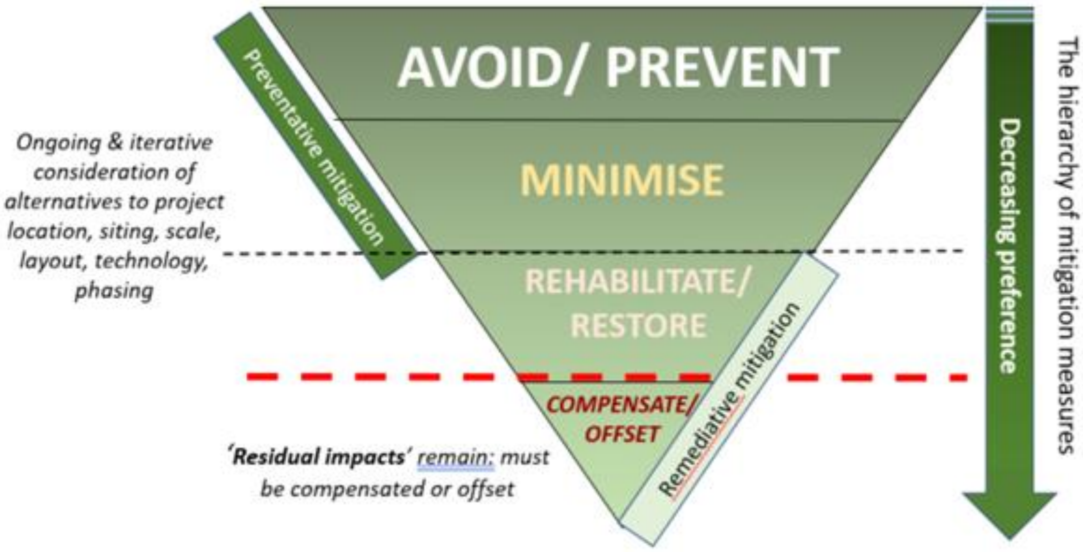

Figure 13: The mitigation hierarchy as presented in (Brownlie et al., 2023). The lower steps in the diagram should only be considered once the steps above have been duly considered.

6.1 Layout and Design Phase

Impact 1: Sewer line design in the flood line (applicable to all zones)

The entire pipeline route is located within the 1:50 and 1:100 year floodline. The primary concern around development of sewerage infrastructure in flood prone areas is prevention of the leakage of sewage during flood events which could pollute the wetland and estuary.

	Without Mitigation	With Mitigation
Intensity	High	High
Duration	Brief	Brief
Extent	Local	Local
Probability	Likely	Probably
Significance	**-50: Minor**	**-40: Minor**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- Air valves along sewer lines must be elevated above the 1:100-year flood line
- Sewer manhole covers should not be made of metal because of the risk of theft.
- Manholes must be designed to be watertight to prevent environmental contamination from leaking sewage and to avoid ingress of surface water during rainfall and flood events. Watertight manholes achieve this seal using components like gaskets on the manhole cover, proper joint sealing between sections, and leak-resistant pipe-to-manhole connections, which are essential for system integrity and cost efficiency.

6.2 Construction Phase

Impact 2: Disturbance of estuarine and wetland habitat caused by construction activities.

Construction activities in Zone A, B and D will take place in, or adjacent to natural freshwater and estuarine habitat. These activities include clearing of vegetation, excavation of trenches, stockpiling of materials and mixing of cement (e.g. for construction of manholes). Care must therefore be taken to minimise disturbance and impact on adjacent habitat.

	Without Mitigation	With Mitigation
Intensity	High	Moderate
Duration	Short term	Short term
Extent	Limited	Very limited
Probability	Almost certain	Unlikely
Significance	**-60: Minor**	**-24: Negligible**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- An Environmental Control Officer (ECO) must be appointed for the duration of the construction phase to monitor and report back on compliance with conditions of the environmental authorisation.

- Consult weather forecasts daily and weekly. Do not work during rainfall and minimise the storage of mobile materials in low-lying areas. Plan the construction area as if it could be inundated with floodwaters in the event of a significant rainfall event.
- Construction access for the pipeline through Zone D should utilise existing access points from Long Street. No new roads should be necessary.
- The width of the working area through Zone D must be as narrow as possible and must be clearly demarcated. Estuarine habitat outside of this demarcated area must be considered as No-Go areas.
- Revegetation of the pipeline through Zone D must be actively encouraged. The route is currently well covered by indigenous vegetation (e.g. sedges, *P. australis*, *Stenotaphrum secundatum* etc.). It is recommended that when trenching, a top layer of vegetation in association with 20-30 cm of soil should be removed and set aside for replanting or covering the filled in trench.
- Open trenching for sewer lines should be done in as short a stretch as possible and backfilled with material as soon as possible to reduce the likelihood of material loss in the event of flooding
- Keep a skip on site so that any waste materials can be conveniently discarded and removed. This includes small amounts of dirty water, such as that used for mixing concrete.
- Equipment and materials lay-down areas should be located away from estuarine habitat and stormwater channels leading into the estuary. Minimise the storage of loose materials in case of a flood event that could wash them into the estuary.
- Post-construction site clean-up must be completed to ensure the entire site footprint and surrounding area has been cleared of litter and any waste materials associated with construction. The ECO should be informed of the construction close-out and complete an inspection to ensure this measure has been implemented.
- The pipeline route through Zone D must be routinely inspected for the establishment of alien invasive plant species. This must be done at a high frequency following construction (i.e. monthly) and can be reduced once natural vegetation along the pipeline has recovered. These must be controlled by hand. No aerial application of herbicides is permitted. Herbicides may only be applied to cut-stumps and must be registered for use on the target plant species.

6.3 Operational Phase

Impact 3: Pollution of wetland and estuarine habitat caused by pipeline blockages.

There is a high likelihood that occasional leaks will occur due to blockages or damaged sections of the pipeline. Standard operating procedures must be developed and implemented in order to detect, respond to and contain leaks when these do occur. The objective is to reduce the risk of pollution entering the estuary.

	Without Mitigation	With Mitigation
Intensity	High	Moderate
Duration	Brief	Brief
Extent	Local	Local
Probability	Almost certain	Almost certain
Significance	**-60: Minor**	**-54: Minor**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- When blockages to sewerage infrastructure within the EFZ occur, the maintenance team should ensure a honey-sucker is on standby to mop up any spills or overflows for removal and disposal at the Wastewater Treatment Works.
- Any serious sewage spills that result in large quantities of sewage leaking from a pump station or manhole must be contained in a temporary coffer dam which can be constructed using sandbags for the walls and plastic sheeting as a base. From here, honey-suckers can collect sewage for removal.
- Any water-tight seals around manholes, joints or other access points that must be broken for maintenance should be replaced thereafter to ensure the mitigation measures to prevent water ingress or sewage leakage are maintained under flood scenarios.
- Keep sewer lines clear of dense vegetation to facilitate access and reduce the risk of roots cracking sewer lines.

Impact 4: Disturbance of wetland and estuarine habitat caused by maintenance on pipelines (Zone A, B and Zone D).

The operational phase primarily relates to maintenance and repairs required for the sewer lines within the EFZ. The proximity of the pipeline to estuarine habitat increases the risk that contractors appointed for maintenance could inadvertently create impacts to the estuary. Mitigation measures aim to reduce the risk of damage or disturbance to nearby estuarine or wetland habitat.

	Without Mitigation	With Mitigation
Intensity	High	Moderate
Duration	Short term	Short term
Extent	Limited	Very limited
Probability	Almost certain	Unlikely
Significance	**-60: Minor**	**-24: Negligible**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- All of the mitigation measures provided for the construction phase are applicable to maintenance work where applicable.

7 DWS RISK ASSESSMENT

Risks of activities associated with the phases of sewage pipeline upgrade to the unchannelled valley-bottom wetland were determined according 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 6). 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 6. A short section of the pipeline lies adjacent to a modified, artificially channelised section of the wetland. Impacts that will be affect the wetland (and measures that must be implemented in order to mitigate these impacts) are described in detail in Section 6 and are summarised as follows:

Design Phase

- Leaking manholes caused by stormwater ingress.

Construction Phase

- Erosion and sedimentation of the wetland due to clearance of vegetation and stockpiling of soil during the trench excavation.
- Contamination of watercourses by solid waste and chemical pollutants caused by construction activities.
- Physical disturbance of aquatic habitat caused by construction activities (including excavation of trenches, operation of vehicles, stockpiling of materials, management of waste).

Operational Phase

- Leaking manholes caused by blockages in the pipeline.
- Future maintenance of the pipeline.

Table 16: DWS risk assessment of the proposed Great Brak sewage pipeline upgrade on wetland habitat.

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											
			Name/s	PES	EIS	Hydrology	Water Quality	Geomorph	Vegetation	Fauna										
LAYOUT	Periodic flooding	Leaking manholes caused by stormwater ingress	Unchannelled VB Wetland	C	High	1	2	1	1	2	**4**	1	1	**6**	**4**	**24**	60%	**14.4**	**L**	High
CONSTRUCTION	Operation of machinery and construction vehicles	Spills and leaks of fuel and oil	Unchannelled VB Wetland	C	High	0	1	0	1	1	**2**	1	1	**4**	**4**	**16**	20%	**3.2**	**L**	High
		Disturbance of wetland habitat and water quality	Unchannelled VB Wetland	C	High	0	1	0	1	1	**2**	1	1	**4**	**4**	**16**	20%	**3.2**	**L**	High
	Construction workers working adjacent to delineated area of wetland	Disturbance of wetland habitat and water quality	Unchannelled VB Wetland	C	High	0	1	0	1	1	**2**	1	1	**4**	**4**	**16**	40%	**6.4**	**L**	High
	Excavation of trench to lay new pipeline	Erosion and sedimentation caused by clearing of vegetation and excavation of trench	Unchannelled VB Wetland	C	High	0	1	1	1	1	**2**	1	1	**4**	**4**	**16**	40%	**6.4**	**L**	High
	Construction of manhole	Pollution caused by mixing of cement	Unchannelled VB Wetland	C	High	0	1	0	1	1	**2**	1	1	**4**	**4**	**16**	20%	**3.2**	**L**	High
	Stockpiles and laydown areas	Sedimentation and pollution caused by erosion of stockpiles	Unchannelled VB Wetland	C	High	0	1	1	1	1	**2**	1	1	**4**	**4**	**16**	40%	**6.4**	**L**	High
		Disturbance of wetland habitat caused by placement of laydown areas and stockpiles	Unchannelled VB Wetland	C	High	1	0	1	1	1	**2**	1	1	**4**	**4**	**16**	20%	**3.2**	**L**	High
OPERATIONAL	Operation of Sewage Pipeline	Leaking manholes caused by blocked pipelines	Unchannelled VB Wetland	C	High	1	2	1	1	2	**4**	1	1	**6**	**4**	**24**	100%	**24**	**L**	High

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8 CONCLUSION

The majority of the upgrades to the sewage pipeline will occur in transformed sections of the EFZ (Zone A, B, C and E) and no estuarine habitat will be directly disturbed in these zones. Where the pipeline does traverse estuarine habitat (Zone D), it does so within an existing servitude. Impacts to estuarine wetland habitat can however be mitigated to a low or negligible significance of impact and it is recommended that authorisation for the upgrade is granted.

9 REFERENCES

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

CSIR (2018). National Wetland Map 5 and Confidence Map [Vector] 2018. Available from the Biodiversity GIS website, downloaded on 15 February 2021

DEADP (2018). Great Brak River Estuarine Management Plan.

Department of Water and Sanitation (DWS), 2014. Reserve Determination Studies for Surface Water, Groundwater, Estuaries and Wetlands in the Gouritz Water Management Area: Estuaries RDM Report – Rapid Assessment, Volume 1 (Klein Brak Estuary). Prepared by the Council for Scientific and Industrial Research (CSIR) for Scherman Colloty and Associates cc. Report no. RDM/WMA16/04/CON/0713, Volume 1.

Department of Water and Sanitation (DWS), 2018. Determination of Water Resources Classes and Resource Quality Objectives in the Breede-Gouritz Water Management Area: Outline of Resource Quality Objectives Report. Report No: RDM/WMA8/00/CON/CLA/0717

Human, L.R.D., Snow, G.C., and Adams, J.B. (2016). Responses in a temporarily open/closed estuary to natural and artificial mouth breaching. *South African Journal of Botany*. 107: 39-48.

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

Turpie, J.K. and Clark, B. (2007). Development of a conservation plan for temperate South African estuaries on the basis of biodiversity importance, ecosystem health and economic costs and benefits. C.A.P.E. Regional Estuarine Management Programme. Final Report; August 2007.

Van Niekerk, L., Adams, J.B., Lamberth, S.J., MacKay, C.F., Taljaard, S., Turpie, J.K., Weerts S.P. & Raimondo, D.C., 2019 (eds). South African National Biodiversity Assessment 2018: Technical Report. Volume 3: Estuarine Realm. CSIR report number CSIR/SPLA/EM/EXP/2019/0062/A. South African National Biodiversity Institute, Pretoria. Report Number: SANBI/NAT/NBA2018/2019/Vol3/A. http://hdl.handle.net/20.500.12143/6373 (Unproofed version).

Van Niekerk, L., Taljaard, S., Adams, J.B., Fundisi, D., Huizinga, P., Lamberth, S.J., Mallory, S., Snow, G.C., Turpie, J.K., Whitfield, A.K. and Wooldridge, T.H. (2014). *Desktop Provisional EcoClassification of the temperate estuaries of South Africa.* Water Research Commission Report No. K5/2187. Pretoria.

APPENDIX 1: 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 17.

Table 17: 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 18.

Table 18: 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 19).

Table 19: 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