Residential Development on Portions 66 and 67 of Farm 443, Plettenberg Bay, Western Cape.

Freshwater Assessment Report – Draft Final

February 2023

confluent
aquatic consulting & research

Compiled By:

Dr. J.M. Dabrowski

james@confluent.co.za

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)

January 2023

EXECUTIVE SUMMARY

An application has been submitted by Mr. Kyle Powter to rezone Portions 66 and 67 of Farm 443, Plettenberg Bay into fifteen residential erven ranging in size from 763 to 1316 m^2. Upon review of the Draft Basic Assessment Report, the Department of Environmental Affairs and Development Planning (DEADP) noted that a wetland lies immediately to the west of the properties and requested that a specialist aquatic biodiversity assessment be undertaken to understand the following uncertainties and aspects:

a) The hydrological functioning of the wetland at a landscape level and the impacts of the proposed development and the infrastructure and upgraded road situated on the edge of the wetland;

b) The ecological connectivity of the wetland to the surrounding land and other ecological processes (dune system) as well as the site;

c) How the proposed development will impact on the functioning of the aquatic feature;

d) The impact of road and stormwater infrastructure and functioning thereof (inter alia stormwater outlets) on the wetland; and

e) Whether the proposed development is consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal.

The scope of work for this report is therefore to address the above-mentioned requirements as well as additional legislative requirements of the National Environmental Management Act (NEMA) and the National Water Act (NWA).

The proposed development occurs adjacent to a large depression wetland. The entire wetland is densely vegetated, predominantly by *Phragmites australis* (interspersed by a variety of other aquatic plants including *Typha capensis* and *Persicaria sp.*), which indicates that the main extent of wetland is permanently saturated and at least seasonally inundated. The entire wetland falls below the 5 m contour and the permanently saturated soils are most likely sustained by a high water table that remains at or near the ground surface for some or all of the year. Flow into the wetland is derived from overland surface runoff generated from the surrounding catchment area which slopes steeply from all directions into the wetland.

The Present Ecological State of the wetland is B (Largely Natural), indicating that despite the extensive urban development in the surrounding area the natural hydrological and geomorphological functions of the wetland have remained largely unaltered. The wetland is ecologically important at a local scale, most notably in terms of its connection to the Robberg peninsula (Robberg Nature Reserve) and the broader Robberg Coastal Corridor. The development will however occur well outside of the delineated area of the wetland which is also buffered by a well-vegetated buffer zone that ranges between 20 and 40 m in width, that is expected to provide adequate protection from surface runoff impacts (e.g. sediment inputs). Impacts associated with the development and the associated upgrade of Robberg Road are expected to be negligible to minor and no significant modification to the hydrology, geomorphology or vegetation of the wetland is anticipated – provided that the recommended mitigation measures are implemented.

In terms of the DWS Risk Assessment, while construction and operational phase activities present a low risk to the wetland and are unlikely to affect the current PES of the wetland, the new rising sewage main that connects the development to municipal network is an exclusion

under the General Authorisation. The applicant will therefore need to apply for a Water Use License.

In summary the development is unlikely to affect the current PES of the wetland and is therefore considered to be acceptable from an aquatic biodiversity perspective.

TABLE OF CONTENTS

DECLARATION OF SPECIALIST INDEPENDENCE 2
1. INTRODUCTION 4
1.1 PROJECT BACKGROUND 4
1.2 KEY LEGISLATIVE REQUIREMENTS 4
1.2.1 National Environmental Management Act (NEMA, 1998) 4
1.2.2 National Water Act (NWA, 1998) 5
2. SITE VERIFICATION 6
2.1 CATCHMENT CHARACTERISTICS 6
2.2 WATERCOURSE CLASSIFICATION 8
2.3 PROJECT DESCRIPTION 8
2.4 SITE SENSITIVITY 10
3. METHODS 10
3.1 WATERCOURSE ASSESSMENT 10
3.1.1 Present Ecological State 10
3.1.2 Ecological Importance and Sensitivity 11
3.2 IMPACT ASSESSMENT 12
4. FRESHWATER CONSERVATION AND MANAGEMENT 12
4.1 NATIONAL FRESHWATER ECOSYSTEM PRIORITY AREAS (NFEPA) 12
4.2 WESTERN CAPE BIODIVERSITY SPATIAL PLAN (WCBSP) 13
4.3 NATIONAL BIODIVERSITY ASSESSMENT 14
5. WATERCOURSE ASSESSMENT 14
5.1 PRESENT ECOLOGICAL STATE (PES) 14
5.2 ECOLOGICAL IMPORTANCE AND SENSITIVITY 17
6. IMPACT ASSESSMENT 19
6.1 CONSTRUCTION PHASE IMPACTS 19
6.2 OPERATIONAL PHASE 21
7. SECTION 21 C & I RISK ASSESSMENT 23
8. CONCLUSION 27
9. REFERENCES 28
APPENDIX 1 - IMPACT ASSESSMENT METHODOLOGY 29
APPENDIX 2 – DWS RISK ASSESSMENT METHODOLOGY 31

LIST OF TABLES

Table 1: Wetland classes and descriptions. 10
Table 2: Ecological importance and sensitivity categories. Interpretation of average scores for biotic and habitat determinants. 11
Table 3: Definitions and management objectives of the Western Cape Biodiversity Spatial Plan. 14
Table 4: Scores for criteria used to assess the PES of a depression wetland where 0 = Critically Modified; 1 = Largely Modified; 2 = Seriously Modified; 3 = Moderately Modified; 4 = Largely Natural; and 5 = Natural. 16
Table 5. Ecological Importance and Sensitivity importance criteria results for the wetland. 18
Table 6: Hydro-functional importance criteria results for the wetland. 18
Table 7: Direct human benefits associated with the wetland. 19
Table 8: Construction phase risk matrix completed by Dr. James Dabrowski (SACNASP registration number 114084). Severity scores assume full implementation of mitigation measures) 25
Table 9: Operational phase risk matrix completed by Dr. James Dabrowski (SACNASP registration number 114084). Severity scores assume full implementation of mitigation measures) 26
Table 10: Categorical descriptions for impacts and their associated ratings 29
Table 11: Value ranges for significance ratings, where (-) indicates a negative impact and (+) indicates a positive impact 29
Table 12: Definition of reversibility, irreplaceability and confidence ratings. 30
Table 13: Scores used to rate the impact of the aspect on resource quality (flow regime, water quality, geomorphology, biota and habitat) 32
Table 14: Scores used to rate the spatial scale that the aspect is impacting on. 32
Table 15: Scores used to rate the duration of the aspects impact on resource quality 32
Table 16: Scores used to rate the frequency of the activity 32
Table 17: Scores used to rate the frequency of the activity's impact on resource quality 32
Table 18: Scores used to rate the extent to which the activity is governed by legislation 32
Table 19: Scores used to rate the ability to identify and react to impacts of the activity on resource quality, people and property. 33
Table 20: Rating classes 33
Table 21: Calculations used to determine the risk of the activity to water resource quality 33

LIST OF FIGURES

Figure 1: Map indicating the location of the development relative to the K60G catchment area. 7
Figure 2: Map indicating a large depression wetland that occurs immediately to the west of the development. 7
Figure 3: Proposed layout of the development. 9
Figure 4: Map of the project area in relation to FEPAs. 13

Figure 5: Map of the wetland in relation to the Western Cape Biodiversity Spatial Plan (WCBSP). 14

Figure 6: Historical (1936) and present-day aerial imagery of the wetland. 15

Figure 7: Photographs showing Robber Road running along the eastern perimeter of the wetland (in between Portions 66 and 67 of Farm 443 and the wetland) – A; extensive reed beds of *Phragmites australis* – B & C; well vegetated buffer in between the edge of the wetland and Robberg Road – D & E and dense thickets of *Rubus sp.* - F. 16

1. INTRODUCTION

1.1 Project Background

An application has been submitted by Mr. Kyle Powter to rezone Portions 66 and 67 of Farm 443, Plettenberg Bay into fifteen residential erven ranging in size from 763 to 1316 m^2. Upon review of the Draft Basic Assessment Report, the Department of Environmental Affairs and Development Planning (DEADP) noted that a wetland lies immediately to the west of the properties and requested that a specialist aquatic biodiversity assessment be undertaken to understand the following uncertainties and aspects:

a) The hydrological functioning of the wetland at a landscape level and the impacts of the proposed development and the infrastructure and upgraded road situated on the edge of the wetland;

b) The ecological connectivity of the wetland to the surrounding land and other ecological processes (dune system) as well as the site;

c) How the proposed development will impact on the functioning of the aquatic feature;

d) The impact of road and stormwater infrastructure and functioning thereof (inter alia stormwater outlets) on the wetland; and

e) Whether the proposed development is consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal.

The scope of work for this report is therefore to address the above-mentioned requirements as well as additional legislative requirements of the National Environmental Management Act (NEMA) and the National Water Act (NWA).

1.2 Key Legislative Requirements

1.2.1 National Environmental Management Act (NEMA, 1998)

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

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

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

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

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

The screening tool identified the site as being of **Low** aquatic biodiversity.

1.2.2 National Water Act (NWA, 1998)

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

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

A watercourse means:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

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

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

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

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

According to Section 21 (c) and (i) of the NWA, any water use activities that do occur within the regulated area of a watercourse must be assessed using the DWS Risk Assessment Matrix (GN 509) to determine the impact of construction and operational activities on the flow, water quality, habitat and biotic characteristics of the watercourse. Low Risk activities require a General Authorisation (GA), while Medium or High Risk activities require a Water Use License (WUL). *According to Section 3 (e) of GN 509 a GA does not however apply to "any*

water use in terms of Section 21 (c) or (i) of the Act associated with the construction, installation or maintenance of any sewerage pipelines, pipelines carrying hazardous materials and to raw water and wastewater treatment works." In such circumstances a WUL would be required.

2. SITE VERIFICATION

A desktop assessment was conducted to contextualize the affected watercourse 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 watercourses, the setting of management objectives and the assessment of the significance of anticipated impacts. The following data sources and GIS spatial information were consulted to inform the desktop assessment:

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

A site visit was undertaken on the 13th of December 2022, with the objective of verifying the site sensitivity, and, if applicable, classifying the watercourse (according to Ollis et al., 2013) and assessing the impacts of the proposed development on the watercourse.

2.1 Catchment Characteristics

The farm portions are located along Robberg Road in the southern-most extent of Plettenberg Bay in quaternary catchment K60G of the Kromme Primary Catchment (Figure 1). The catchment area falls within the South-Eastern Coastal Belt ecoregion, which is characterised by closed hills and mountains of moderate to high relief, with altitude ranging from 0 to 1 300 m above mean sea level. Mean annual precipitation for the catchment area is high (780 mm per annum), and occurs year-round, with peaks in October to November and March to April. A large depression wetland is mapped to occur immediately to the west of the development (Figure 2). The entire delineated wetland lies below the 5 m contour line and no watercourses are mapped to flow into or out of the wetland.

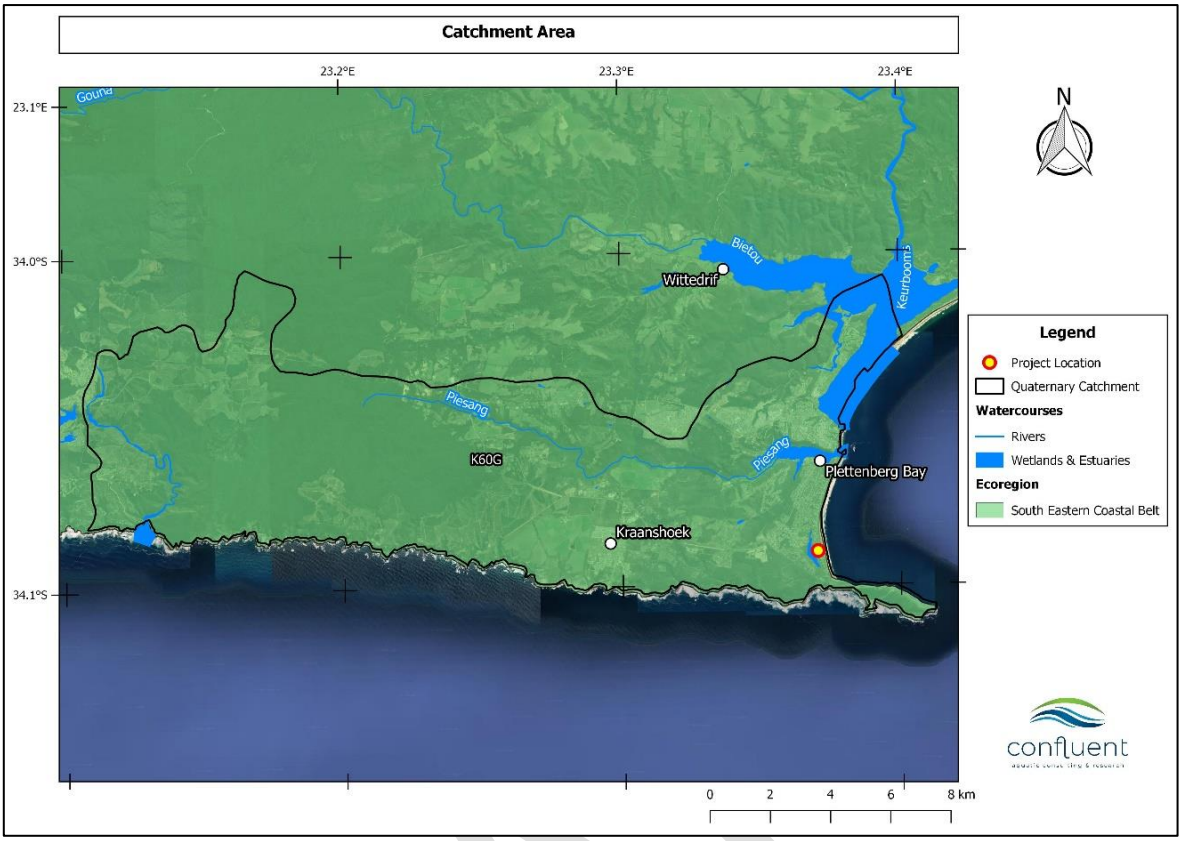

Figure 1: Map indicating the location of the development relative to the K60G catchment area.

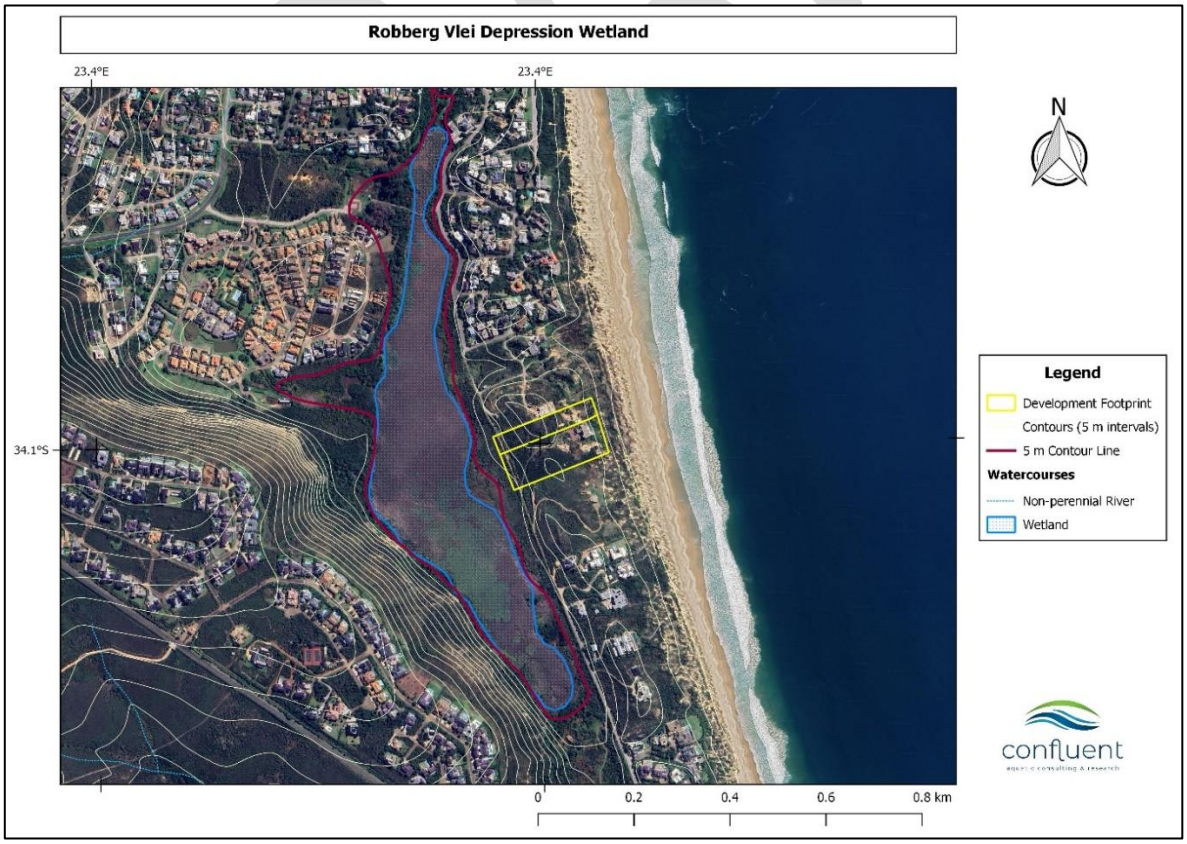

Figure 2: Map indicating a large depression wetland that occurs immediately to the west of the development.

2.2 Watercourse Classification

The site visit confirmed the presence of a longitudinal depression wetland to the west of the development. The wetland is constrained by an extension on the Robberg peninsula formation to the west (comprising of a high elevation layered sandstone, conglomerate and Table Mountain quartzite geological formation) and a lower elevation sandy coastal dune system to the east (see Figure 2 to view contours of the surrounding area). The wetland is endorheic and has no outflow. The entire wetland is densely vegetated, predominantly by *Phragmites australis* (interspersed by a variety of other aquatic plants including *Typha capensis* and *Persicaria sp.*), which indicates that the main extent of wetland is permanently saturated and at least seasonally inundated. The margins of the wetland are characterised by species that favour seasonally saturated soils (e.g. *Nidorella ivifolia*). The entire wetland falls below the 5 m contour and the permanently saturated soils are most likely sustained by a high water table that remains at or near the ground surface for some or all of the year. Flow into the wetland is derived from overland surface runoff generated from the surrounding catchment area which slopes steeply from all directions into the wetland. The western slopes in particular are likely to be an important source of surface flow as they cover a large area along the border (approximately 800 m in length) that drops steeply down towards the wetland, dropping in elevation from 65 down to 5 m.a.m.s.l (over a distance of approximately 200 m). The eastern slopes are lower lying, sandy vegetated dunes where surface runoff into the wetland is not expected to be an important contribution to the hydrology of the system. Some sub-surface flow through the dune system into the wetland is likely but is not expected to form a significant contribution of flows into the wetland.

2.3 Project Description

The proposed development will allow for the development of 15 residential zone erven ranging from 763 m^2 to 1316 m^2 as per site development plan 66/67/443 SDP/4 dated 8 April 2021. As per the engineering report, the development has a small catchment area and is located on a dune system with sandy soils. Only one row of erven drain towards the west and in the direction of the wetland. There is a further 30 to 40 m of services, road servitude and natural vegetation in between the delineated boundary of the wetland and the lower ends of the western-most erven. The gravel section of Robberg Road also requires upgrading to include alignment, stormwater and a 4.5 m wide tarred surface up to the proposed entrance to the site. According to the engineering report, due to the sandy dune system, significant runoff is not envisaged and most of the stormwater runoff will be accommodated on site through dissipation into large open areas that will be incorporated into the layout. Runoff from the internal roads will be drained into a grassed trapezoidal channel which will drain into a gabion retention chamber where water will percolate into the soil.

The site is 200 m from the municipal sewer network that will convey the sewage through a series of pumpstations through the Piesang Valley sewer scheme to the Ganze Vallei sewer purification works. Due to lay of land the development requires that at least one internal sewer pumpstation will be required. A new pipeline will be constructed to convey sewage from the development to the Plettenberg Bay A 110 mm rising sewer main. The existing Municipal system has spare capacity, and no upgrades are required.

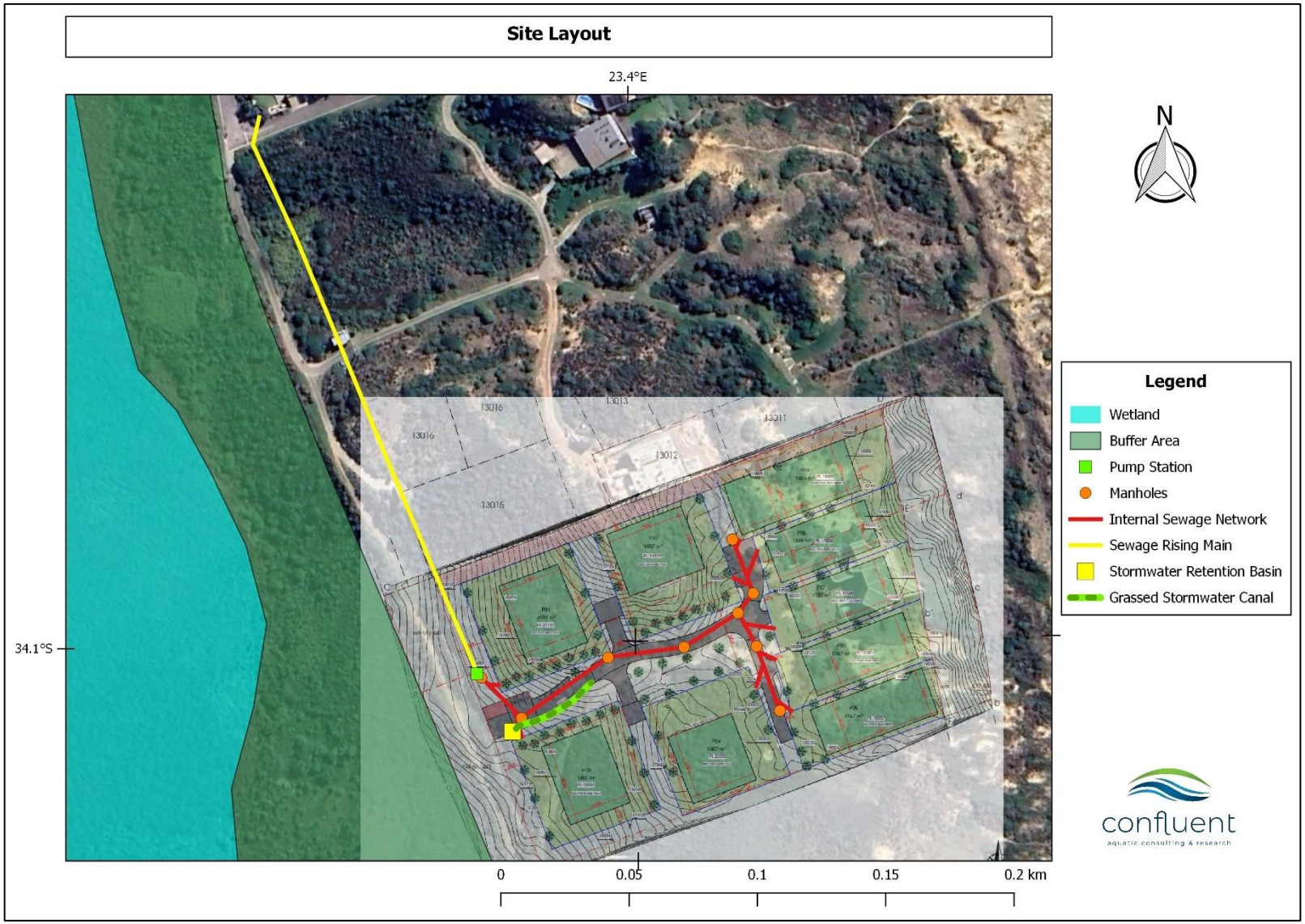

Figure 3: Proposed layout of the development.

2.4 Site Sensitivity

The sensitivity of the site was considered to be **Very High** for the following reasons:

- The development occurs in relatively close proximity to the wetland; and
- The proposed development can potentially alter surface and sub-surface flow dynamics on which the wetland is partially dependent and should therefore be assessed.

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

- Undertake a desktop study of relevant freshwater information for the site;
- Undertake a site visit to the study area to verify the sensitivity of the site;
- Determine the present ecological state, functional importance and conservation value of the watercourses that will be affected by the proposed activities;
- Describe and assess the significance of the potential impacts of the construction and operation of the pumpstation on watercourses; and
- Provide a summary of the findings in the form of a Specialist Aquatic Biodiversity Report that complies to GN320 of the NEMA.

3. METHODS

3.1 Watercourse Assessment

3.1.1 Present Ecological State

Based on the recommendations of Ollis et al. (2014), the RDM 1999 scoresheet for assessing the Habitat Integrity of Palustrine Wetlands was used to determine the PES for the depression wetland. This method involves scoring various hydrological, geomorphological, water quality and biotic criteria with a score ranging from 0 (critically modified) to 5 (natural or unmodified). The average score is used to define the overall PES of the depression wetlands according to Table 1.

Table 1: Wetland classes and descriptions.

Ecological Category	Description	Impact Score
A	Unmodified, natural.	4 – 5
B	Largely natural with few modifications / in good health. A small change in natural habitats and biota may have taken place but the ecosystem functions are still predominantly unchanged.	3 – 4
C	Moderately modified / fair condition. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	2 – 3
D	Largely modified / poor condition. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	1 – 2
E	Seriously modified / very poor condition. The loss of natural habitat, biota and basic ecosystem functions is extensive.	0 - 1
F	Critically modified / totally transformed. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota.	0

3.1.2 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 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 2: 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	>1 and <=2	C

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.		
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

3.2 Impact Assessment

The impact assessment methodology is described in the appendix to this report (Appendix 1). Development activities typically impact on the following important drivers of natural and artificial watercourses:

- *Hydrology:* Impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes and base flows and modifications to general flow characteristics, including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over-abstraction or instream or off-stream impoundment of a wetland or river etc.);
- *Geomorphology:* This refers to the alteration of hydrological and geomorphological processes and drivers, and associated impacts to aquatic habitat and ecosystem goods and services primarily driven by changes to the sediment regime of the aquatic ecosystem and its broader catchment;
- *Modification of water quality:* This refers to the alteration or deterioration in the physical, chemical and biological characteristics of water within streams, rivers and wetlands, and associated impacts to aquatic habitat and ecosystem goods and services (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication etc.);
- *Fragmentation:* Loss of lateral and/or longitudinal ecological connectivity due to structures crossing or bordering watercourses (e.g. road or pipeline crossing a wetland);
- *Modification of aquatic habitat:* This refers to the physical disturbance of in-stream and riparian aquatic habitat and associated ecosystem goods and services including the loss or degradation of all or part of any unique or important features associated with or within the aquatic ecosystem (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soils, etc.); and
- *Aquatic biodiversity:* Impacts on community composition (numbers and density of species) and integrity (condition, viability, predator prey ratios, dispersal rates, etc.) of the faunal and vegetation communities inhabiting the site.

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

4. FRESHWATER CONSERVATION AND MANAGEMENT

4.1 National Freshwater Ecosystem Priority Areas (NFEPA)

The study site is located within sub-quaternary catchment (SQC) 9144 (Figure 4), which, according to the National Freshwater Ecosystem Priority Atlas (NFEPA, Nel et al., 2011), has not been classified as a FEPA (Freshwater Ecosystem Priority Area). The development 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 due to the fact that there is not a major river that drains the SQC.

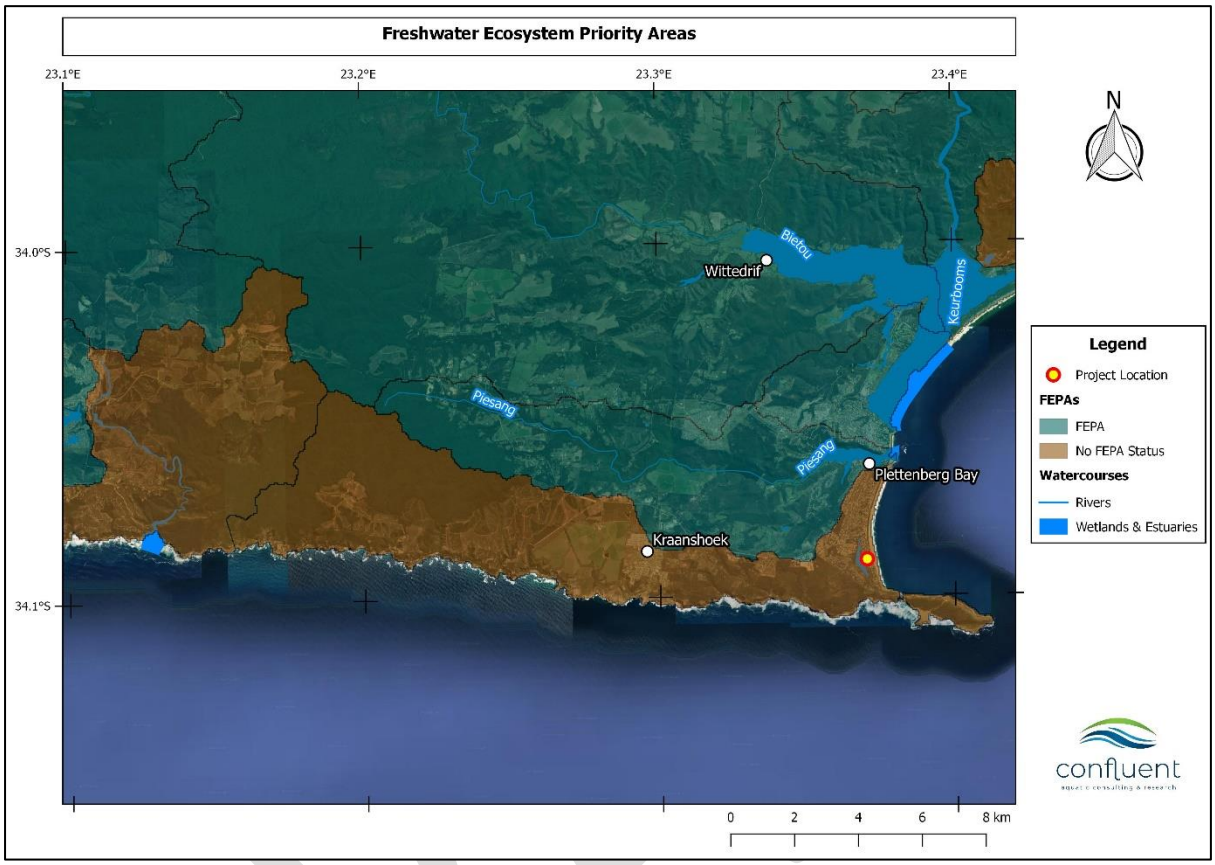

Figure 4: Map of the project area in relation to FEPAs.

4.2 Western Cape Biodiversity Spatial Plan (WCBSP)

According to the WCBSP for Bitou, the wetland is not recognised as an aquatic feature and the majority of the wetland has been assigned as a terrestrial Ecological Support Area (ESA) (Figure 5) that forms part of a coastal corridor. The management objectives of ESAs are described in (Table 3). ESAs are not essential for meeting biodiversity targets but are important for supporting the functioning of more important CBA areas. ESAs should therefore be managed or restored to ensure that the ability to provide these supporting services is not compromised. In this respect, it is important that the development does not adversely affect the functioning of the wetland area should also maintain some connectivity between the wetland and other habitats within the coastal corridor.

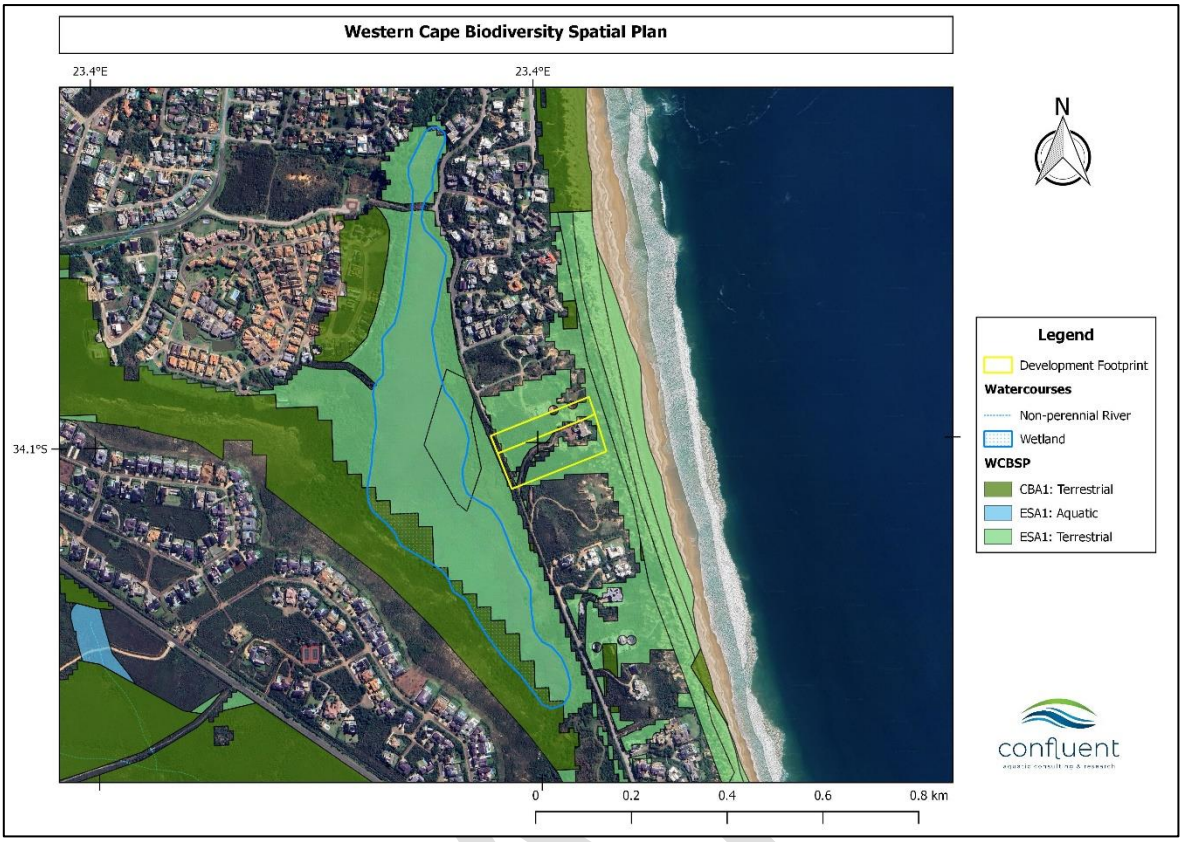

Figure 5: Map of the wetland in relation to the Western Cape Biodiversity Spatial Plan (WCBSP).

Table 3: Definitions and management objectives of the Western Cape Biodiversity Spatial Plan.

Category	Definition	Management Objective
ESA2	Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of PAs or CBAs and are often vital for delivering ecosystem services.	Maintain in a functional, near-natural state. Some habitat loss is acceptable, provided the underlying biodiversity objectives and ecological functioning are not compromised.

4.3 National Biodiversity Assessment

According to the 2018 National Biodiversity Assessment the wetland occurs in the Eastern Fynbos-Renosterveld Bioregion and is classified as a depression wetland. The ecosystem threat status of depression wetlands in this bioregion is Vulnerable and the protection status is Poorly Protected (Van Deventer et al., 2018).

5. WATERCOURSE ASSESSMENT

5.1 Present Ecological State (PES)

Historical imagery indicates that the wetland has changed little since the first available aerial photographs (in 1936). At that time the wetland was surrounded by agricultural fields which have now been replaced by extensive residential developments (Figure 6). These are all located outside of the delineated wetland area. The eastern border of the wetland is bordered

by relatively low-density residential developments which is protected by a well vegetated buffer that varies in width from 40 to 90 m. Robberg Road runs between these developments and the buffer (Figure 7). The northern and north-western boundary of the wetland is bordered by denser residential developments. Main impacts to the wetland are primarily hydrological as a result of increased stormwater inputs on the one hand and possibly some interception of sub-surface interflow as a result of the residential developments on the other. Sediment inputs to the wetland are not expected to be significantly higher than under natural conditions. Low densities of alien invasive plant species were observed within the buffer area (mainly *Acacia cyclops* and some dense thickets of bramble - *Rubus sp.*). Overall, despite the high levels of urbanisation in the surrounding area, the main hydrological, geomorphological and vegetation features of the wetland are relatively unaffected and the PES of the wetland is B (Largely Natural) (Table 4).

Figure 6: Historical (1936) and present-day aerial imagery of the wetland.

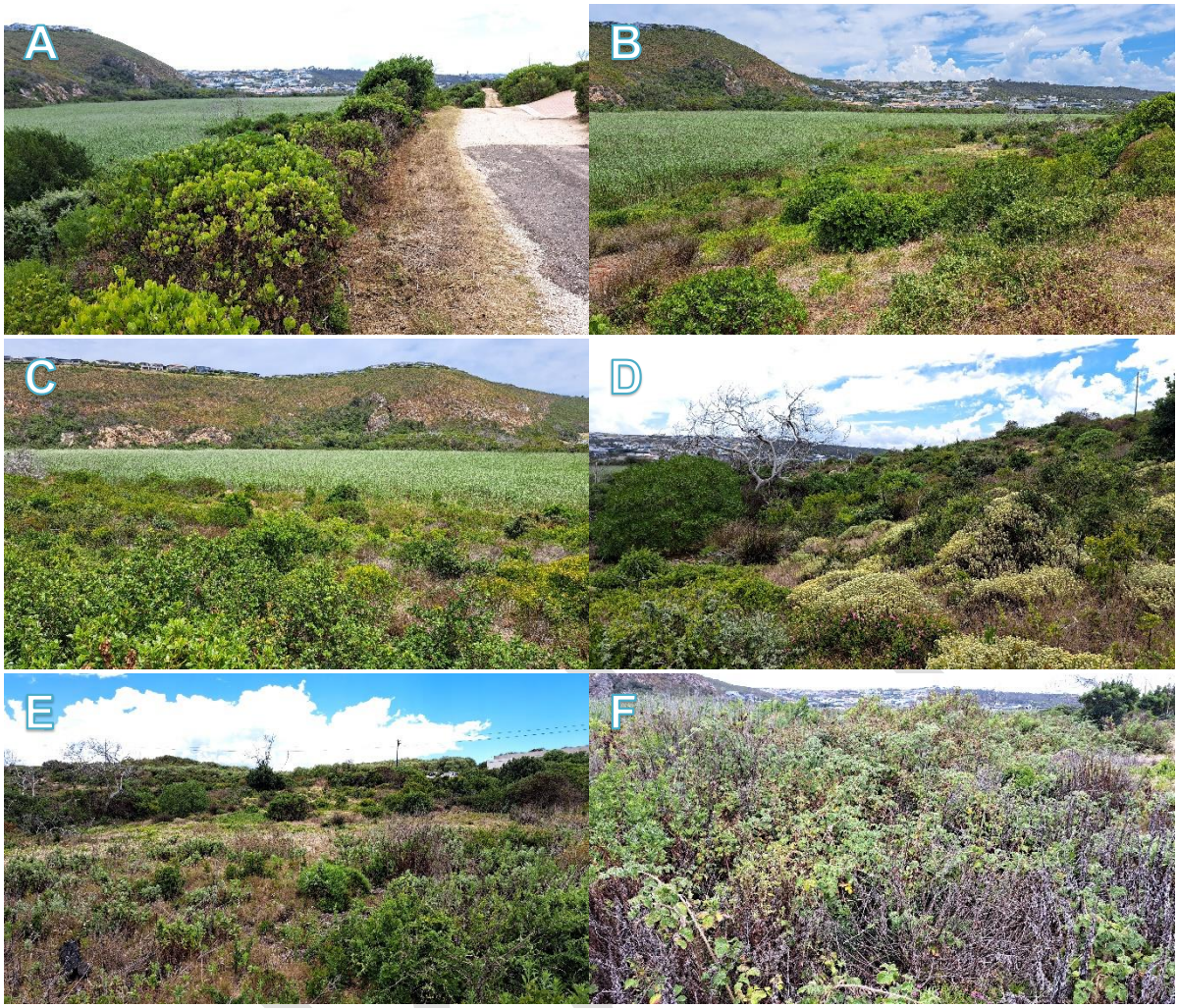

Figure 7: Photographs showing Robberg Road running along the eastern perimeter of the wetland (in between Portions 66 and 67 of Farm 443 and the wetland) – A; extensive reed beds of *Phragmites australis* – B & C; well vegetated buffer in between the edge of the wetland and Robberg Road – D & E and dense thickets of *Rubus sp.* - F.

Table 4: Scores for criteria used to assess the PES of a depression wetland where 0 = Critically Modified; 1 = Largely Modified; 2 = Seriously Modified; 3 = Moderately Modified; 4 = Largely Natural; and 5 = Natural.

Criteria	Relevance	Score	Confidence
Hydrological			
Flow modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.	4	4
Permanent inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.	4	4

Criteria	Relevance	Score	Confidence
Water quality			
Water quality modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland	3	3
Sediment load modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.	4	4
Hydraulic / Geomorphological			
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.	5	4
Topographic alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities which reduces or changes wetland habitat directly or through changes in inundation patterns.	3	4
Biota			
Terrestrial encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.	4	3
Indigenous vegetation removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.	4	3
Invasive plant encroachment	Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).	3	4
Alien fauna	Presence of alien fauna affecting faunal community structure.	5	4
Overutilisation of biota	Overgrazing, over-fishing, etc.	5	4
MEAN SCORE		**4**	**3.6**
MINIMUM SCORE		**3**	
Overall PES%		**80 %**	
Overall PES		**B**	

5.2 Ecological Importance and Sensitivity

The wetland is large and provides substantial breeding habitat for birds and other fauna and there is a reasonable likelihood that it hosts Red-Data species wetland species. It is also relatively well connected to the Robberg Nature Reserve and the larger Robberg Coastal Corridor and is therefore important in terms of providing ecological connectivity across a large area. It is not a particularly sensitive wetland type, which partly explains why it remains in relatively good ecological condition given the extensive urban development that has occurred in the surrounding area (Table 5). Given its isolation from a broader hydrological network it provides limited hydrological functionality but is relatively important from the perspective of assimilating pollutants and providing a sink for carbon storage (Table 6). In terms of direct

human benefits the wetland does provide some important recreational attributes (e.g. bird-watching and hiking) – but overall provides minimal direct human benefits (Table 7). Overall, the EIS of the wetland is **Moderate**.

Table 5. Ecological Importance and Sensitivity importance criteria results for the wetland.

Ecological importance and sensitivity	Score	Motivation
Biodiversity support		
Presence of Red Data species	2	Likely – vulnerable vegetation type.
Populations of unique species	1	No uncommonly large populations of wetland species expected.
Migration/feeding/breeding sites	2	Large area and extensive reed beds provide important breeding sites at a local scale.
Average	**1.6**	
Landscape scale		
Protection status of wetland	2	Not protected – public area, but connected to Robberg Coastal Corridor
Protection status of vegetation type	1	Poorly protected (NBA, 2018)
Regional context of the ecological integrity	3	PES B, well connected to larger Robberg Coastal Corridor
Size and rarity of the wetland types present	2	Large wetland, relatively uncommon throughout the landscape.
Diversity of habitat types	1	Low diversity - uniform *P. australis* reed-bed throughout the wetland area.
Average	**1.8**	
Sensitivity of the wetland		
Sensitivity to changes in floods	1	Depression wetland – not sensitive to changes in flood dynamics.
Sensitivity to changes in low flows	1	Depression wetland – not sensitive to changes in flows.
Sensitivity to changes in water quality	1	Densely vegetated – not sensitive to change in water quality.
Average	**1**	
ECOLOGICAL IMPORTANCE AND SENSITIVITY	**1.8 (Moderate)**	

Table 6: Hydro-functional importance criteria results for the wetland.

Hydro-functional importance			Score	Motivation
Regulating & supporting benefits	Flood attenuation		1	Some benefit
	Streamflow regulation		0	None – isolated and does not for part of a larger hydrological network
	Water quality enhancement	Sediment trapping	2	Assimilates pollutants from urban runoff
		Phosphate assimilation	2	
		Nitrate assimilation	2	
		Toxicant assimilation	2	
		Erosion control	0	No benefit
	Carbon storage		2	Some benefit - large area with dense reed beds
HYDRO-FUNCTIONAL IMPORTANCE			**1.4 (Moderate)**	

Table 7: Direct human benefits associated with the wetland.

Direct human benefits		Score	Motivation
Subsistence benefits	Water for human use	0	None
	Harvestable resources / cultivated foods	0	None
Cultural benefits	Cultural heritage	0	None
	Tourism and recreation	2	Locally important for bird-watching and other recreational activities (walking and cycling)
	Education and research	1	Some
DIRECT HUMAN BENEFITS		**0.6 (Low)**	

6. IMPACT ASSESSMENT

Impacts expected to occur during the construction and operational phase have been assessed in terms of their significance. The main impacts associated with the construction phase are sedimentation caused by erosion. For the operational phase the potential modification to hydrology is considered to be the most relevant impact. In assessing impacts it was noted that there is a well-established buffer zone between the development and the delineated edge of the wetland, which provides substantial protection from diffuse/nonpoint source impacts associated with the development (e.g. sediment in runoff).

6.1 Construction Phase Impacts

Impact 1: Sedimentation of the wetland caused by erosion from the construction site.

The lower section of the development slopes down towards the wetland. Clearing areas of the site and the road in preparation for construction will expose bare soil which could potentially be mobilised into the wetland during heavy rainfall events. The buffer is however expected to provide good protection under such circumstances.

	Without Mitigation	With Mitigation
Intensity	Moderate	Low
Duration	Short term	Brief
Extent	Very limited	Very limited
Probability	Likely	Unlikely
Significance	**-40: Minor (-)**	**-18: Negligible (-)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation

- A silt fence must be installed perpendicular to the angle of the slope to trap any soil or sediment mobilised from the site during the construction phase. Silt fences must be installed between the site and the Robberg Road, and in between Robberg Road and the buffer;
- The site must be monitored after every rainfall event to ensure that no sediment is being washed into the wetland by erosion;
- The laydown area and stockpiles of construction materials or excavated materials must be located on as flat an area as possible and should not drain towards the wetland. If necessary,

stockpiles must be protected (e.g. through use of sandbags and/or tarpaulins) to prevent materials being washed downslope towards the wetland.

Impact 2: Pollution of wetland and buffer caused by waste generated by the construction process.

Construction activities are likely to generate significant quantities of solid waste that could pollute the wetland and buffer area. In addition, the high numbers of construction workers present on site will generate a significant amount of human waste, which could also pollute the wetland.

	Without Mitigation	With Mitigation
Intensity	Low	Very low
Duration	Short term	Brief
Extent	Very limited	Very limited
Probability	Likely	Unlikely
Significance	**-35: Negligible (-)**	**-15: Negligible (-)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation

- All construction waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported;
- All construction waste materials must be collected and disposed of at a suitable waste facility;
- No dumping of construction material within the wetland or wetland buffer may take place;
- The buffer and wetland area must be monitored on a weekly basis to clean-up any waste that may have been blown from the construction site; and
- Adequate sanitary facilities and ablutions must be provided for all personnel throughout the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation);

Impact 3: Impairment of water quality and disturbance to buffer caused by the operation of vehicles and heavy machinery within close proximity to the wetland.

Operation of vehicles in close proximity to the wetland could result in spillages or leaks of hydrocarbons (fuel and oil) and could lead to unnecessary disturbance of the wetland and its buffer.

	Without Mitigation	With Mitigation
Intensity	Low	Very low
Duration	Short term	Brief
Extent	Very limited	Very limited
Probability	Likely	Unlikely
Significance	**-35: Negligible (-)**	**-15: Negligible (-)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation

- Construction activities must be confined to clearly demarcated areas so as to prevent unnecessary disturbance to the wetland and buffer;

- No vehicles are to park or operate within the buffer of the wetland (i.e. all activities must be restricted to Robberg Road or the eastern side of Robberg Road);
- 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 on site;
- No fuel storage, refuelling, vehicle maintenance or vehicle depots to be allowed on the slope leading towards 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. These areas must not be located within any natural drainage areas or preferential flow paths and must be located outside of the buffer of the wetland; and
- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly

6.2 Operational Phase

Impact 4: Alteration of surface flows into the wetland caused by increased stormwater runoff.

The development will result in an increase in the area of paved/hardened surfaces. This will generate increased volumes of stormwater runoff which will flow down towards the wetland. The main entrance road leading from Robberg Road into the development is also likely to become an important conduit for stormwater down towards the wetland. The upgraded section of Robberg Road will also generate a slight increase in stormwater runoff from the road surface. Existing developments along tarred sections of Robberg Road (to the south) have not resulted in obvious impacts the wetland as a result of stormwater runoff. Adequate management of stormwater should therefore effectively minimise the intensity of this impact.

	Without Mitigation	With Mitigation
Intensity	Moderate	Low
Duration	Ongoing	Ongoing
Extent	Very limited	Very limited
Probability	Almost certain	Unlikely
Significance	**-66: Minor (-)**	**-30: Negligible (-)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- Each house must be fitted with a 5000 litre rainwater collection tank;
- Driveways must be constructed from grass blocks to facilitate percolation into the soil and reduce surface runoff;
- A trapezoidal grass block drain will be constructed to collect surface runoff from the road, which will also facilitate percolation into the soil;
- Water from the drain will be discharged into an effective 1,2m deep stilling gabion chamber that will also serve as a silt trap. The retention chamber will facilitate percolation and will not have an outlet. The majority of stormwater will therefore be attenuated onsite;
- The retention chamber must be routinely maintained to ensure that is has sufficient capacity to accommodate appropriate design floods;
- A suitable stormwater plan must be compiled for the section of Robberg Road that will be tarred and upgraded. The plan must discharge stormwater into the adjacent buffer area without causing

any erosion. The runoff velocity of stormwater must therefore be reduced with energy dissipaters prior to discharge into the wetland buffer.

Impact 5: Alteration of sub-surface flows into the wetland caused by impervious surfaces and foundations.

Hardened surface and establishment of foundations for houses may impede sub-surface flows towards the wetland, although these are not expected to form a major or important contribution to the water balance of the wetland. This is supported by the fact that the numerous developments around the wetland do not appear to have affected the size of the wetland area over time which has remained constant.

	Without Mitigation	With Mitigation
Intensity	Very low	Negligible
Duration	Ongoing	Ongoing
Extent	Very limited	Very limited
Probability	Probably	Probably
Significance	**-36: Minor (-)**	**-32: Negligible (-)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- Stormwater management will encourage infiltration of water into the soil profile through use of grass-pavers on driveways, grassed stormwater channels and a gabion retention chamber.

Impact 6: Fragmentation of Ecological Support Area.

The properties fall within an ESA that has been designated as an ecological corridor that connects the wetland to the undeveloped dune system that runs along the length of the Robberg Beach. It is likely that some wildlife may use the wetland as a refuge and move in between the wetland and the coastal dune system. The development of the property will fragment this ESA which could affect the movement of wildlife.

	Without Mitigation	With Mitigation
Intensity	Moderate	Low
Duration	Permanent	Permanent
Extent	Very limited	Very limited
Probability	Almost certain	Probably
Significance	**-72: Minor (-)**	**-44: Minor (-)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- The eastern and western border of the servitude running along the northern boundary of the development must remain unfenced to allow wildlife to move between the coastal dune system and the wetland. Vegetation within this servitude should also not be cleared and must be maintained in a natural state. Control of alien invasive species must be undertaken if necessary.

Impact 7: Sewage spills caused by operation of the new sewage pipeline

The sewage reticulation will require the construction of a sewage pumpstation to pump sewage from the development along a new sewage rising main and into the existing municipal gravity network. Spillage from pumpstations frequently occur due lack of maintenance and, more recently, due to loadshedding. Impacts from spillages are not anticipated to have a high intensity impact on the wetland due to the wide buffer in between the wetland and the development. Furthermore, the lack of flow through the wetland system will result in a very localised impact should spillages occur. Finally, the dense vegetation and hithroughout the wetland will further limit the migration of spills and break harmful bacteria down relatively quickly

	Without Mitigation	With Mitigation
Intensity	Low	Very Low
Duration	Short term	Brief
Extent	Very limited	Very limited
Probability	Likely	Unlikely
Significance	**-40: Minor (-)**	**-18: Negligible (-)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation

- Undertake routine maintenance of pumps and other critical infrastructure according to a prescribed schedule;
- Plan sewage transfers so as to avoid unnecessary overloading of the pumpstation or the rising main, particularly during peak periods; and
- The design of the pumpstation will allow for 11 hours of emergency storage – which is almost three times the requirement of 4 hours and should therefore be able to accommodate loadshedding schedules.

7. SECTION 21 C & I RISK ASSESSMENT

The risk assessment matrix (Based on DWS 2015 publication: Section 21 (c) and (i) water use Risk Assessment Protocol) was implemented to assess risks for each activity associated with the construction and operational phase. The first stage of the risk assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions and methodology applied in the impact assessment are provided in Appendix 2. In assessing the risks the following points were considered:

- The development will take place well outside of the delineated area of the wetland;
- The wetland is well protected by a broad, well vegetated, sandy buffer that will provide good protection against diffuse impacts associated with the development; and
- Risks were assessed assuming full implementation of recommended mitigation measures (as described in Section 6).

In summary the proposed development poses a **Low Risk** to the wetland (Table 8 and Table 9). However, given that a new rising sewage main will be constructed to connect the

development to the municipal network, authorisation of the development under a General Authorisation is not applicable. The applicant will therefore have to apply for a Water Use License.

Table 8: Construction phase risk matrix completed by Dr. James Dabrowski (SACNASP registration number 114084). Severity scores assume full implementation of mitigation measures)

Activity	Aspect	Impact	Flow Regime	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures	PES AND EIS OF WATERCOURSE
Clearing of vegetation and preparation of the site	Exposed Soil	Erosion and sedimentation	1	2	1	1	1.3	2	1	4.3	1	2	5	1	9	39	Low	95	See Section 6 (Impact 1)	PES: B EIS: Moderate
	Stockpiling of excavated material	Erosion of stockpiles	1	1	1	1	1	2	1	4	1	2	5	1	9	36	Low	90	See Section 6 (Impact 1)	
	Operation of Construction Vehicles and Machinery	Contamination of wetland with hydrocarbons	1	2	1	2	1.5	2	1	4.5	1	2	5	1	9	40.5	Low	90	See Section 6 (Impact 3)	
Construction of Houses	Generation of waste material	Disturbance of aquatic habitat	1	2	2	1	1.5	2	1	4.5	1	2	5	1	9	40.5	Low	95	See Section 6 (Impact 2)	

Table 9: Operational phase risk matrix completed by Dr. James Dabrowski (SACNASP registration number 114084). Severity scores assume full implementation of mitigation measures)

Activity	Aspect	Impact	Flow Regime	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures	PES AND EIS OF WATERCOURSE
Hardened surfaces	Stormwater runoff	Alteration of wetland hydroperiod (increased flows)	2	1	1	1	1.3	2	1	4.3	1	2	5	1	9	39	Low	90	See Section 6 (Impact 4)	PES: B EIS: Moderate
Building foundations	Impeding subsurface flows	Alteration of wetland hydroperiod (decreased flows)	1	1	1	1	1	2	1	4	1	2	5	1	9	36	Low	90	See Section 6 (Impact 5)	
Sewage Pipeline	Spillages	Wastewater contamination of wetland	1	2	1	1	1.3	2	1	4.3	1	2	5	1	9	39	Low[1]	90	See Section 6 (Impact 7)	

[1] While the risk has been evaluated as low, the construction and subsequent operation of a new sewage pipeline does not qualify for a General Authorisation. This activity will therefore require a Water Use License.

8. CONCLUSION

The proposed development occurs adjacent to a large depression wetland. The PES of the wetland is B, indicating that despite the extensive urban development in the surrounding area the natural hydrological and geomorphological functions of the wetland have remained largely unaltered. The wetland is ecologically important at a local scale, most notably in terms of its connection to the Robberg peninsula (Robberg Nature Reserve) and the broader Robberg Coastal Corridor. The development will however occur well outside of the delineated area of the wetland which is also buffered by a well-vegetated buffer zone that ranges between 20 and 40 m in width, that is expected to provide adequate protection from surface runoff impacts (e.g. sediment inputs). Impacts associated with the development and the associated upgrade of Robberg Road are expected to be relatively minor and no significant modification to the hydrology, geomorphology or vegetation of the wetland is anticipated – provided that the recommended mitigation measures are implemented.

In terms of the DWS Risk Assessment, while construction and operational phase activities present a low risk to the wetland and are unlikely to affect the current PES of the wetland, the new rising sewage main that connects the development to municipal network is an exclusion under the General Authorisation. The applicant will therefore need to apply for a Water Use License.

In summary the development is unlikely to affect the current PES of the wetland and is therefore considered to be acceptable from an aquatic biodiversity perspective.

9. REFERENCES

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

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

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

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

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

Ollis, D.J.; Day, J.A.; Malan, H.L.; Ewart-Smith, J.L. and Job, N. (2014) *Development of Decision-Support Tools for Assessment of Wetland Present Ecological Status (PES)* WRC Report TT 609/14. Water Research Commission, Pretoria, South Africa.

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

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.

Van Deventer, H.; Smith-Adao, L.; Mbona, N.; Petersen, C.; Skowno, A.; Collins, N.B.; Grenfell, M.; Job, N.; Lötter, M.; Ollis, D.; Scherman, P.; Sieben, E.; Snaddon, K. 2018. South African Inventory of Inland Aquatic Ecosystems. South African National Biodiversity Institute, Pretoria. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847.

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 10.

Table 10: 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 11.

Table 11: 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 12).

Table 12: 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

APPENDIX 2 – DWS RISK ASSESSMENT METHODOLOGY

Definitions:

- An activity is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation;
- An aspect is an 'element of an organizations activities, products and services which can interact with the environment'. The interaction of an aspect with the environment may result in an impact;
- Environmental impacts are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity;
- Resources are components of the biophysical environment and include the flow regime, water quality, habitat and biota of the affected watercourse; and
- Severity refers to the degree of change to the status of each of the receptors (Table 13). An overall severity score is calculated as the average of all scores receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- Spatial extent refers to the geographical scale of the impact (Table 14).
- Duration refers to the length of time over which the stressor will cause a change in the resource or receptor (Table 15).
- Frequency of activity refers to how often the proposed activity will take place (Table 16).
- Frequency of impact refers to the frequency with which a stressor (aspect) will impact on the resource (Table 17).

Method:

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria (refer to the table below). The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity, impact, legal issues and the detection of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 20. The values for likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary. In accordance with the method stipulated in the risk assessment key, all impacts for flow regime, water quality, habitat and biota were scored as a 5 (i.e. average Severity score of 5) as all activities will occur within the delineated boundary of the wetland.

Table 13: Scores used to rate the impact of the aspect on resource quality (flow regime, water quality, geomorphology, biota and habitat)

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5
Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland.	

Table 14: Scores used to rate the spatial scale that the aspect is impacting on.

Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighbouring areas (downstream within quaternary catchment)	3
National (impacting beyond secondary catchment or provinces)	4
Global (impacting beyond SA boundary)	5

Table 15: Scores used to rate the duration of the aspects impact on resource quality

One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	2
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5

Table 16: Scores used to rate the frequency of the activity

Annually or less	1
Bi-annually	2
Monthly	3
Weekly	4
Daily	5

Table 17: Scores used to rate the frequency of the activity's impact on resource quality

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

Table 18: Scores used to rate the extent to which the activity is governed by legislation

No legislation	1
Fully covered by legislation (wetlands are legally governed)	5

Table 19: Scores used to rate the ability to identify and react to impacts of the activity on resource quality, people and property.

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Table 20: Rating classes

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.
56 – 169	(M) Moderate Risk	Risk and impact on watercourses are notable and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
170 – 300	(H) High Risk	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

Table 21: Calculations used to determine the risk of the activity to water resource quality

Consequence = Severity + Spatial Scale + Duration
Likelihood = Frequency of Activity + Frequency of Incident + Legal Issues + Detection
Significance\Risk = Consequence x Likelihood