Aquatic Biodiversity Impact Assessment

Proposed construction of Plett Lagoon residential estate on Erf 6503, Plettenberg Bay, Western Cape

Prepared for Cape EAPrac (Pty) Ltd

by

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DECLARATION OF CONSULTANTS INDEPENDANCE

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.

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Qualifications: BSc, BSc Honours (Entomology), MSc & PhD (Veterinary Science)

Expertise: > 13 years' experience working on aquatic ecosystems across South Africa, with a focus on the Southern Cape in the last 6 years. Includes research and consulting expertise, having published > 10 water-related research articles and compiled > 150 aquatic specialist reports. Research and consulting have been in a range of sectors including agriculture, urban developments, linear structures, renewable energy, conservation, and mining.

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1. INTRODUCTION

Confluent Environmental Pty (Ltd) were appointed by Cape EAPrac to provide aquatic specialist inputs to the proposed residential development known as Plett Lagoon Estate on RE/6503 (Figure 1). The property is approximately 18.4 hectares in extent and is in the town of Plettenberg Bay between the Keurbooms Estuary to the east and the Plettenberg Bay Primary School to the west. Site access is via Beacon Way on the southwestern corner of the property. The eastern portion of the site is below the 5 m.a.m.s.l. contour which places it in the Estuarine Functional Zone of the Keurbooms Estuary Figure 1.

Figure 1. Proposed site of a housing development known as Plett Lagoon Estate on RE/6503, Plettenberg Bay.

1.1 The Proposed Development

The Site Development Plan (SDP) is presented in Figure 2. The proposed residential development at Plett Lagoon Estate will have split-zoning as follows:

- Residential Zone 1: 2.27 ha
- Residential Zone 2: 2.67 ha
- Residential Zone 4: 0.74 ha
- Open Space Zone 2: 0.66 ha
- Open Space Zone 3: 10.44 ha (includes wetland area)

Housing and amenities will consist of:

- Single Residential: 37 Erven

- General Apartments: 40 Units
- Guardhouse, Refuse room etc.

Following identification and delineation of the wetland on site, the Site Development Plan was scaled back to exclude the wetland with the result that 10.5 hectares (almost 60%) of the site will be zoned as public open space and managed as a nature conservation area by the development's body corporate (Figure 2).

Aspects of the development that may influence the wetland and Keurbooms estuary include the management of stormwater and wastewater from the site. Vita Engineers provided a Civil Engineering Services Report (June 2023) for the site which states the following:

<u>Stormwater Management</u>

- The pre-development site drains from the higher lying western boundary to the lower lying eastern boundary.
- The site is underlain by aeolian sands several metres thick with high permeability, therefore promoting the infiltration of surface water runoff from the site.
- A network of swales along roads has been proposed as the main SuDS-based attenuation feature. The swales aim to attenuate peak flows to pre-development runoff rates and to treat stormwater runoff by percolation through sands.
- Channels with flow velocities > 1m/s will be lined and protected with open pavers, while unlined channels with lower flow velocities will be vegetated.

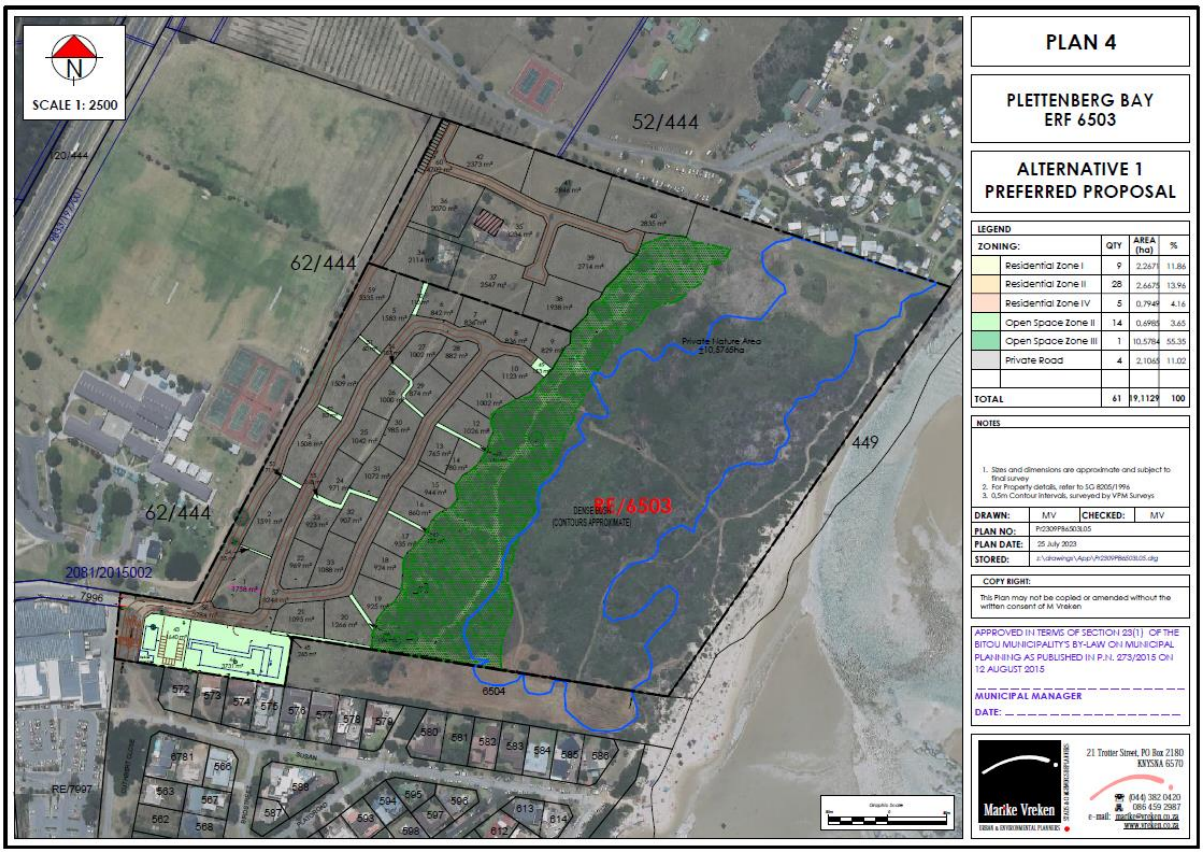

Figure 2. Proposed Site Development Plan for RE/6503, Plettenberg Bay.

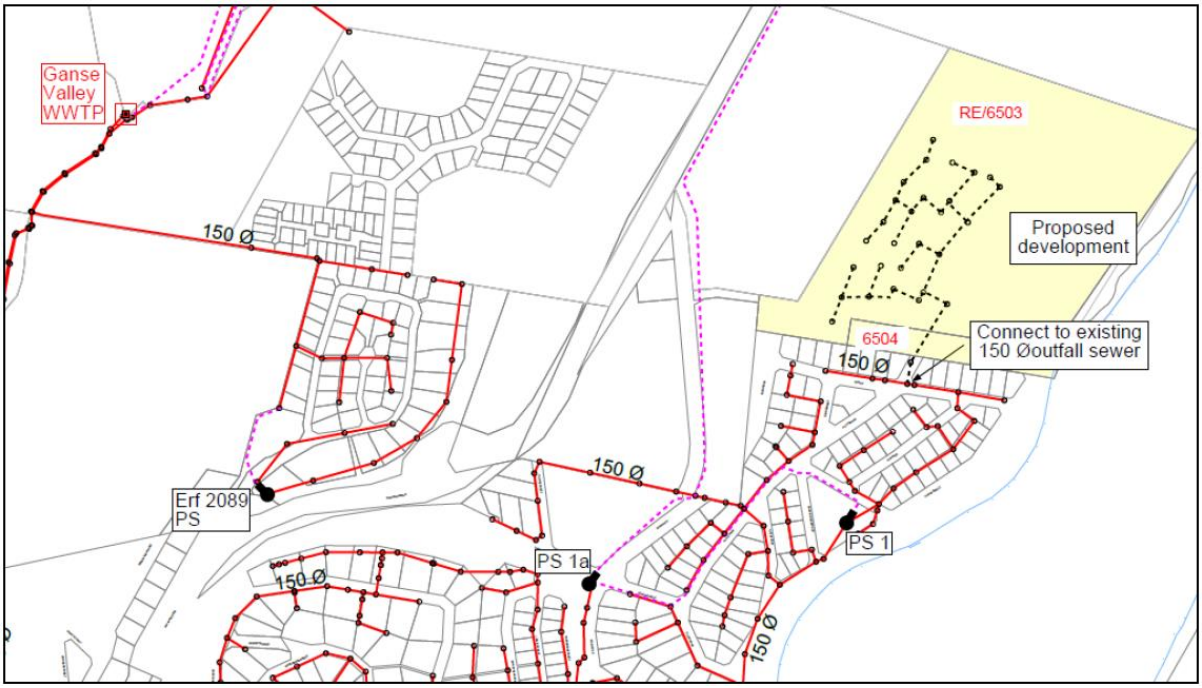

Figure 3. External sewer masterplan extracted from GLS Consulting (Feb, 2023).

Sanitation

The plan compiled by GLS Consulting followed the analysis of the bulk municipal sewer infrastructure capacity, and the impact of the proposed development on the existing infrastructure. The plan concludes that the proposed development can be accommodated within the existing Plettenberg Bay Pump Station 1 drainage area. Further, there is sufficient capacity in the existing Plettenberg Bay sewer system to accommodate the proposed development. The report recommends that the sewer connection be to the existing 150 mm diameter outfall sewer on Susan Street as indicated in Figure 3. Proposed internal sewerlines will be 169 mm diameter uPVC class 34 gravity pipe network.

1.2 DFFE Screening Tool Results

According to the Department of Environment, Forestry and Fisheries (DFFE) screening tool, aquatic biodiversity at the site has a **Very High** sensitivity (Figure 4). The sensitivity features identified are:

- Critical Biodiversity Area 1 – Aquatic
- Keurbooms Estuary
- FEPA Sub-catchment
- Wetlands (Estuary)

As both an estuary and freshwater wetland are located at the site, the scope of work for this report is guided by the legislative requirements of the National Environmental Management Act (NEMA) and the National Water Act (NWA; Act No 36 of 1998).

Figure 4. Results of the DFFE Screening Tool which indicate Very High Sensitivity of the Aquatic Biodiversity theme.

1.3 Scope of work

According to the protocols specified in GN 320 (Protocol for the specialist assessment and minimum report content requirements for environmental impacts on aquatic biodiversity) of the National Environmental Management Act (NEMA; Act No. 107 of 1998), assessment and reporting requirements for aquatic biodiversity are associated with a level of environmental sensitivity identified by the national web-based environmental screening tool (screening tool). An applicant intending to undertake an activity identified in the scope of this protocol on a site identified by the screening tool as being of:

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

The objectives of this assessment included the following:

- To undertake a Site Sensitivity Verification for aquatic biodiversity using desktop analysis and a site inspection. Sensitivity will be verified as either **Very High** or **Low**; and,
- Compile an Aquatic Biodiversity Compliance Statement or Aquatic Biodiversity Specialist Assessment based on the sensitivity verification for the site. This includes assessment of the following:

  Interrogation of available desktop resources including:

  - DWS spatial layers (1:50 000 rivers)
  - National Freshwater Ecosystem Priority Areas (NFEPA) spatial layers (Nel *et al.,* 2011)
  - National Wetland Map 5 and Confidence Map (CSIR, 2018)

- Western Cape Biodiversity Spatial Plan (WCBSP, 2017).

Conduct a site visit to determine the site sensitivity:

- Identification and classification of watercourses within and adjacent to the site according to methods detailed by Ollis *et al*. (2013);
- Determine the watercourse Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) using an appropriate method (if watercourses are present).
- Delineate wetland / riparian areas following methods prescribed by DWAF (2015).
- Determine an appropriate buffer for wetland areas using the site-specific buffer tool developed by Macfarlane and Bredin (2016).

This report will also meet the requirements for a Water Use License Application (WULA) which will be required given installation and connection to sewage pipelines will be necessary within the regulated area of a wetland (defined as 500 m from a wetland). The relevant water uses will be:

Section 21 c) impeding or diverting the flow of water in a watercourse;

Section 21 i) altering the bed, banks, course or characteristics of a watercourse; and,

Section 21 g) disposing of waste in a manner which may detrimentally impact on a water resource.

1.4 Assumptions and Exclusions

The site visit was undertaken on 21 May 2023 which is considered Winter. It is possible that sensitive features such as rare or unique biota (e.g. amphibians), plants or habitat were not observed during the site visit, but are influenced by season, time of day, flow level or vegetation cover. However, recent good rainfall along with rainfall during the site visit meant that wetland features were quite evident and easily identified. In fact, this May was considered the 6th wettest May on record since the late 1800s (*pers. comm*. J. Crowther, local dairy farmer).

2. CATCHMENT CONTEXT

2.1 Catchment features

The development site is located at the lower extent of quaternary catchments K60E and K60G which drain the Keurbooms River to the east and the Piesang River to the west respectively. The property is located adjacent to the Keurbooms River. Rainfall is relatively high by South African standards with a Mean Annual Precipitation of 647 mm which can fall with a Very High intensity. Coupled with the High erodibility of soils in the area, erosion of soils and stormwater management are factors which must always be carefully considered when planning a development (Table 1 & Figure 5).

Table 1. Summary of relevant catchment features for the proposed development area.

Feature	Description
Quaternary catchment	K60E & K60G
Mean Annual Runoff	101 mm
Mean Annual Precipitation	647 mm (weather station No. 0014633W)
Inherent erosion potential of soils (K-factor)	0.56, High
Rainfall intensity	Very High
Ecoregion Level II	20.02, Southeastern coastal belt
Geomorphological Zone	Floodplain / Estuary
NFEPA area	Sub-quaternary reach 9188, Fish FEPA
Mapped Vegetation Type	FFg5: Garden Route Shale Fynbos (Endangered; FFh9) and Goukamma Dune Thicket (Least Concern; AT36)
Soils	Soils with limited pedological development
Conservation	Critical Biodiversity Area 1 and 2 (Terrestrial & Aquatic; WCBSP, 2017)

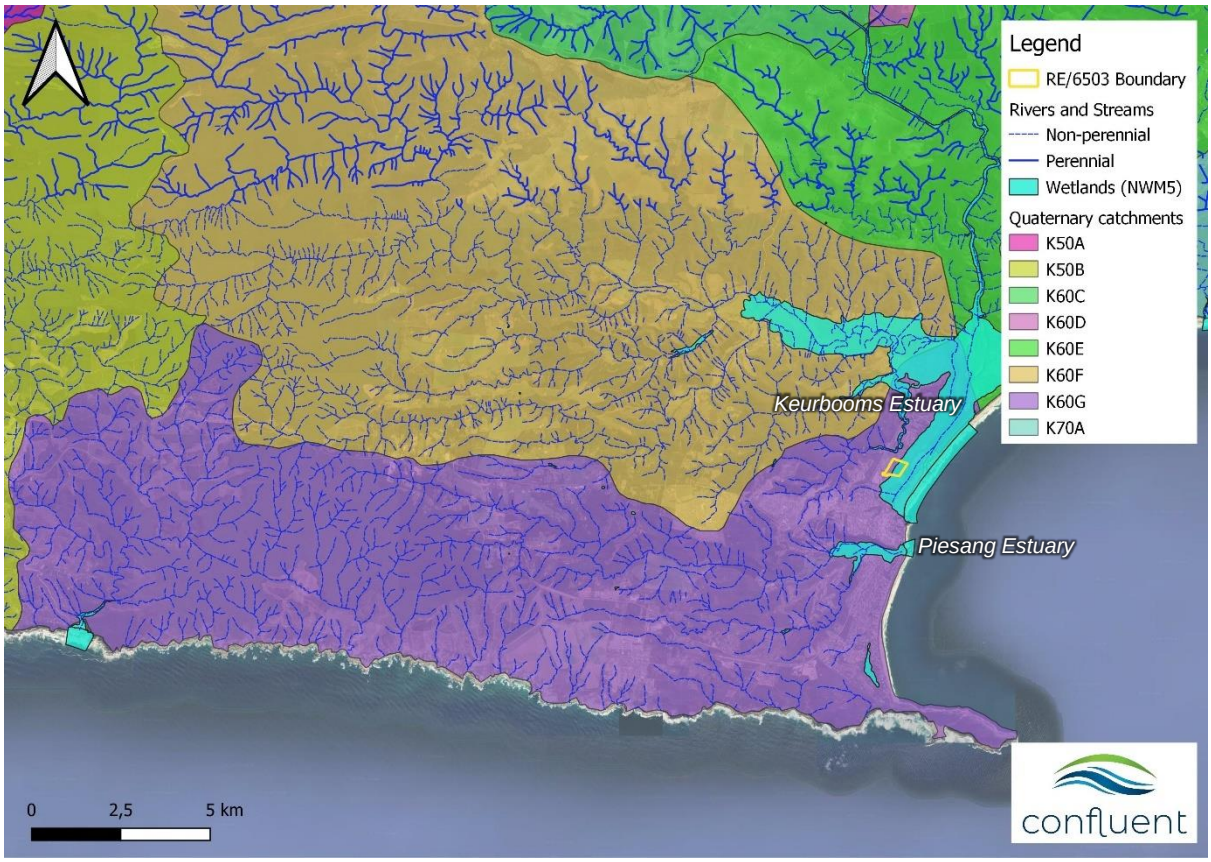

Figure 5. Location of the property at the boundary of quaternary catchments K60E and K60G.

Rainfall occurs year-round with seasonal peaks in spring and autumn (Figure 6).

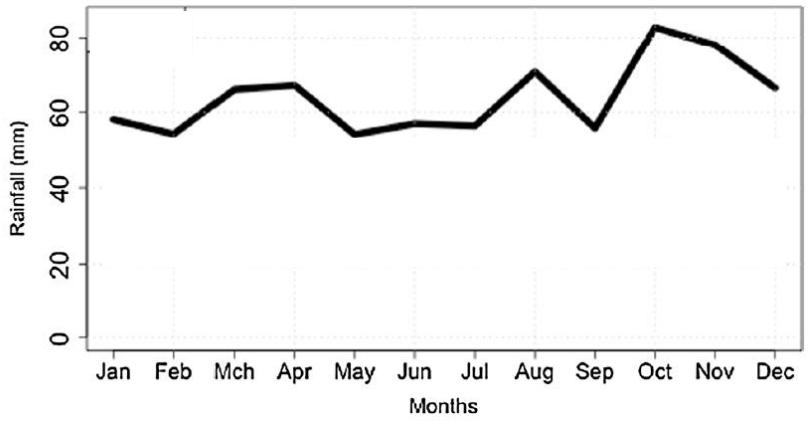

Figure 6. Area-averaged monthly rainfall for the coastal Southern Cape indicating peaks in Mar-Apr, Aug, and Oct. Data averaged between 1979 and 2011 (Engelbrecht *et al*., 2015).

The project area is located within the southeastern coastal belt (Ecoregion Level 2:20.02). The terrain is described as closed hills of moderate and high relief and moderately undulating plains. Altitude ranges between 0 – 1 300 m.a.m.s.l.

2.2 Vegetation

The mapped vegetation type on the western half of the property Garden Route Shale Fynbos which is categorised as Endangerd (FFh9; NVM, 2018), while the eastern half of the property is Goukamma Dune Thicket which is classed as Least Concern (AT36; Figure 7). Vegetation in the Keurbooms Estuary is mapped as non-terrestrial, which is correct as most of the vegetation is considered aquatic.

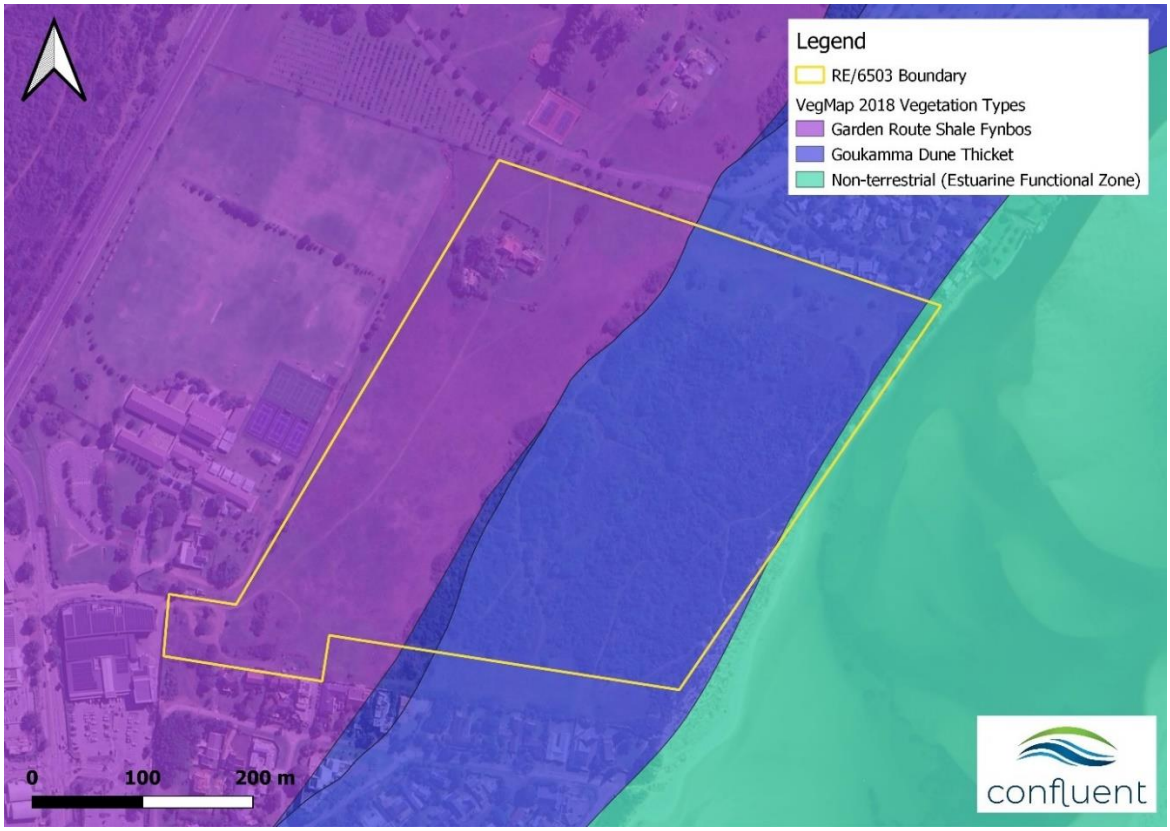

Figure 7. Mapped vegetation at the site according to VegMap (2018).

2.3 Conservation and catchment management

2.3.1 WCBSP

The Western Cape Biodiversity Spatial Plan (WCBSP; 2017) indicates the western half of the site as a Critical Biodiversity Area 2, which corresponds with the higher-lying area (Figure 8). The eastern half of the site and Keurbooms Estuary are mapped as a Critical Biodiversity Area 1, mostly consisting of Aquatic habitat. The definition and management objectives of each of these classes are described in Table 2.

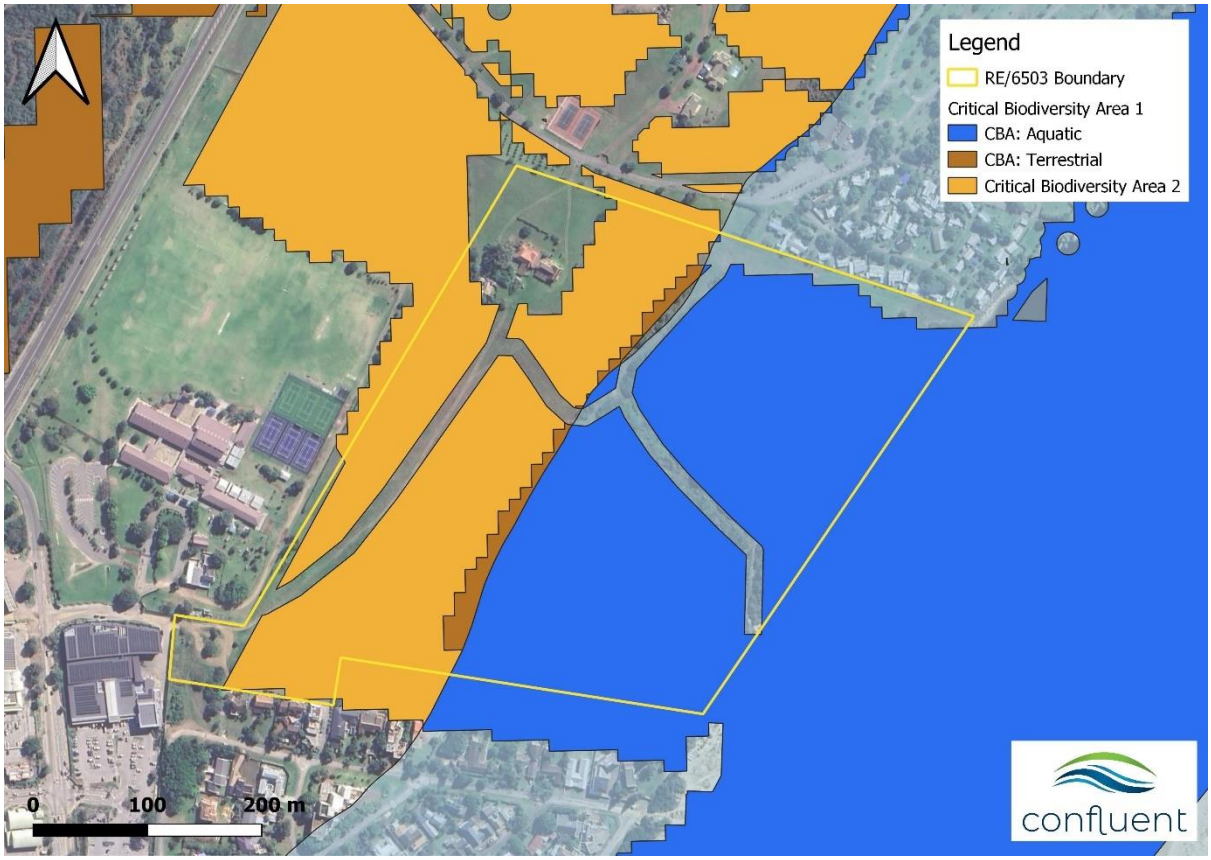

Figure 8. Mapped conservation features of the Western Cape Biodiversity Spatial Plan (2017).

Necessary actions in relation to the WCBSP are to ensure that development on the site does not result in negative impacts to ecological structure and function of watercourses adjacent to the site.

Table 2. Definitions and objectives for conservation categories identified in the Western Cape Biodiversity Spatial Plan (WCBSP, 2017).

WCBSP Category	Definition	Management Objective
Critical Biodiversity Area 1 (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.

Critical Biodiversity Area 2 (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.

2.3.2 NFEPA

According to the National Freshwater Ecosystem Priority Atlas (NFEPA; Nel *et al*., 2011) the sub-quaternary reach (SQR 9188) is classified as a FishFEPA, which is a Fish Support Area.

Fish Support Areas were identified in river systems in a good ecological state (PES A or B) and that have been identified as FEPAs (Freshwater Ecosystem Priority Areas). These rivers contribute to national biodiversity goals and support sustainable use of water resources. Fish Support Areas also include sub-quaternary catchments that are important for the migration of threatened or near threatened species.

This is due to the presence of Endangered or Critically Endangered fish in the quinary catchment of the Keurbooms River. Fish recorded in the system include the extremely range restricted *Pseudobarbus* sp. nov. 'Keurbooms' (previously *Pseudobarbus tenuis*), *Pseudobarbus afer* (Endangered, Eastern Cape Redfin), and *Sandelia capensis* (Data Deficient, Cape Kurper).

Generally, *Pseudobarbus tenuis* occurs in the headwater streams while *Psuedobarbus afer* occurs in the forested peat-stained water. The main threat to these fishes is through the introduction of predatory alien fish species of bass and trout. Impacts related to forestry and agriculture are also known to affect populations.

2.3.3 Strategic Water Source Area

Aquatic biodiversity within the site has been identified as Very High. One of the reasons is that the site falls within the Outeniqua Strategic Water Source Area for surface water (SWSA-sw). SWSAs are defined as areas of land that supply a disproportionate (ie. Relatively large) quantity of mean annual runoff in relation to their size and are therefore considered nationally relevant (Le Maitre *et al*., 2018). A key objective in the management of SWSAs is to ensure the quantity and quality of water within and flowing from SWSAs is protected from developments that cause unacceptable and irreparable impacts.

2.4 Mapped Watercourses

The only mapped aquatic feature proximal to the site is the Keurbooms Estuary which is indicated as the area below the 5 m.a.m.s.l. contour (Figure 1 and Figure 9). The 0.5 m contours are shown for this area as they provide a more detailed picture of the micro-topography.

2.4.1 Keurbooms-Bitou Estuary

The estuary feeds what is known as the Keurbooms Lagoon. The Present Ecological State of the estuary is classified as A/B, and the same category is applicable for the Recommended

Ecological Category. The estuary has a high conservation value, supporting one of only three known populations of the iconic Knysna Seahorse occurring in *Zostera* (segrass) beds. In terms of management objectives, the Keurbooms-Bitou Estuarine Management Plan (K-BEMP) states that formal protection mechanisms to obtain conservation status for land parcels within or spanning the EFZ must be investigated. In terms of land-use and infrastructure, the following relevant guidelines are provided in the K-BEMP:

- Planning should allow for the maintenance of a riparian zone along the length of the estuary where sensitive habitats (e.g. wetlands, supratidal saltmarsh and indigenous vegetation) occur. The implementation of the CML, CPZ, floodlines and inclusion of Critical Biodiversity Areas within all planning schemes should allow for this.

- Development and land use in the catchment and estuarine area should not lower water quality or interfere with normal hydrodynamic or sedimentary processes and cycles;

These management guidelines will be considered in view of the proposed development of the Plett Lagoon Estate.

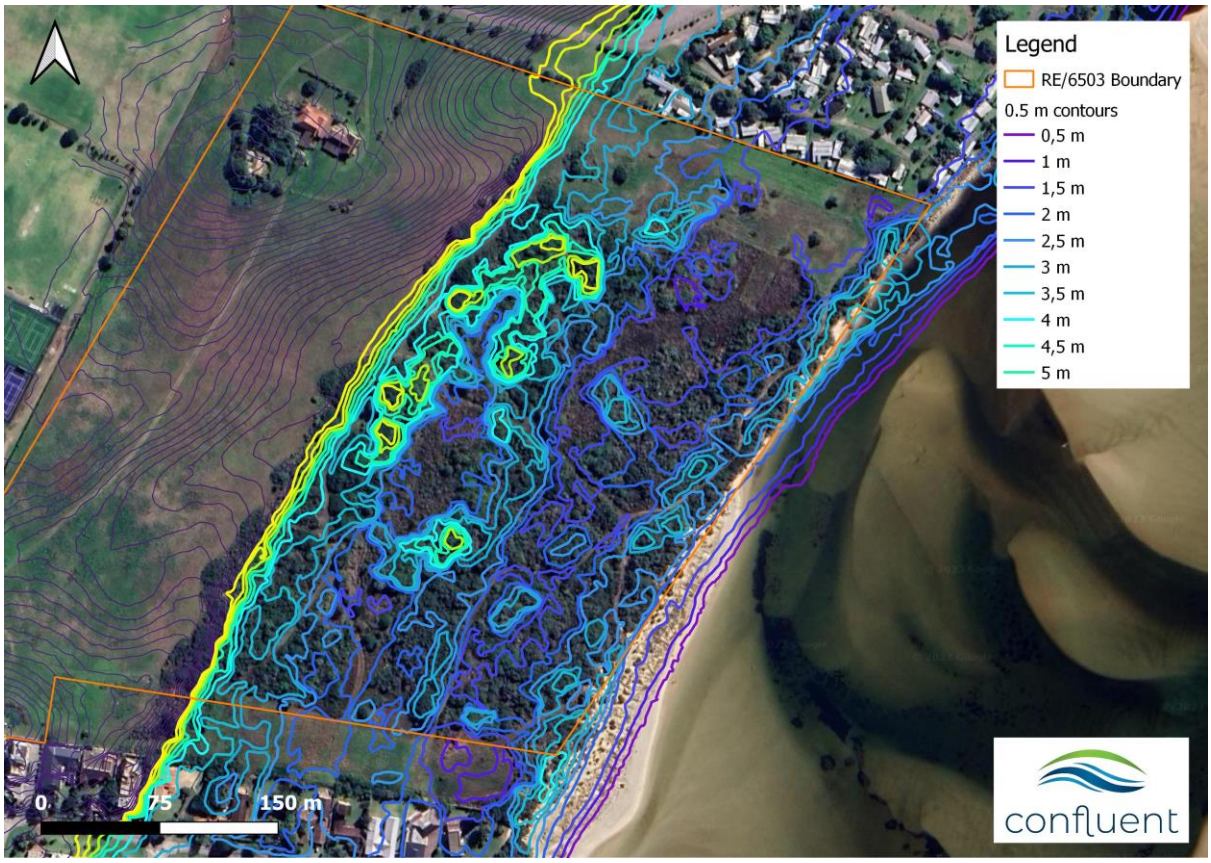

Figure 9. RE/6503 site contours at 0.5m intervals highlighted below the 5m contour which defines the Estuarine Functional Zone (EFZ).

2.5 Historical assessment

Historical aerial and satellite photos were examined of the site over a period of approximately 8 decades (Figure 10).In the earliest photo from 1936, very little development had occurred either on the property itself or in the neighbouring properties. The difference between the more

grassy, open vegetation to the west of the site, compared to the more densely vegetated eastern portion is evident throughout the site's history. Dense vegetation along the lagoon no the neighbouring properties was cleared for construction of housing developments around the 1970s. The residence located on RE/6503 in the northern corner was evident as a small settlement in 1936 and has always been the site of a residence to the present day. Footpaths through the wetland were evident from 2011, although they were probably present for a while before then, but overgrown.

Figure 10. Historical photos showing the approximate property boundary for a period of 86 years (CD:NGI & Google Earth imagery).

3. SITE ASSESSMENT

3.1 Site visit

The site was visited on 21 May 2023. Above average rainfall had been experienced in the Garden Route in May and it rained periodically during the site assessment. An extensive area of 5.2 km was walked to assess aquatic features where accessible (Figure 11).

Figure 11. GPS track of route walked during the site assessment on 21 May 2023.

3.2 Wetland Delineation

Wetlands were delineated using a combination of hydrophilic plant species, soils with redoximorphic features (e.g. mottling and/or gleying; Figure 12), and topographical location (Figure 13).

A wide variety of wetland plant species were observed throughout the wetland area. These were dominated by freshwater species but included a few species typically located in the supratidal zone of estuaries. Species considered to be obligate as well as facultative wetland plants were recorded (Table 3).

Table 3. Wetland plant species identified in the depression on RE/6503.

Common name	*Species name*
Fluitjiesriet	*Phragmites australis*
Vleibiesie / knobby club-rush	*Ficinia nodosa*
Impepho / fume everlasting	*Helichrysum cymosum*
Arum lily	*Zantedeschia aethiopica*
White carpet	*Falkia repens*
Brak rush	*Juncus krausii*
Oak waxberry	*Morella quercifolia*
Cogon grass	*Imperata cylindrica*
Manyspike flatsedge	*Cyperus polystachyus*
Slender knotweed	*Persicaria decipiens*
Water pimpernel	*Samolus porosus*
Black bog-rush	*Schoenus nigricans*
Brook weed	*Samolus valerandi*

Hydric soils display indicators which are predominantly formed by the accumulation or loss of iron, manganese, sulfur or carbon under permanent or periodic saturated and anaerobic conditions. Sandy soils such as those on the RE/6503 seldom show the same degree of mottling and gleying as saturated or seasonally saturated soils with a higher clay content. Nonetheless, soils from multiple points showed degrees of mottling and gleying in permanent and seasonal zones of the wetland, and standing water was often present from 30 cm depth (Figure 12).

Figure 12. Wetland soil indicators observed at the site.

Wetland vegetation and soil auger results observations were combined with the fine-scale site topography to delineate the depression wetland as indicated in Figure 13. The wetland is mostly located below the 2.5 m to 3 m.a.m.s.l. contours at the site.

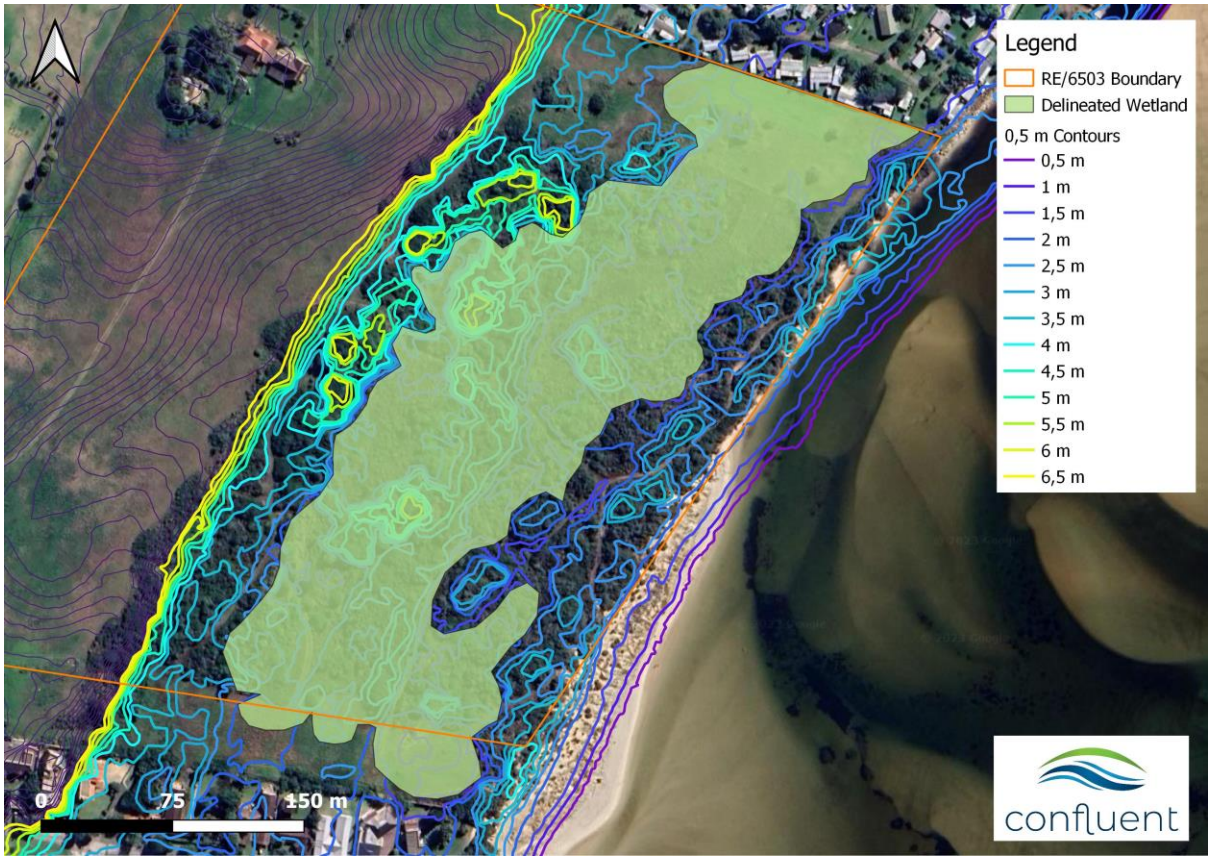

Figure 13. Wetland delineation based on soil, vegetation, and topography of the site.

3.3 Wetland Classification

The interdunal water-filled depression is classified as a depression wetland (Ollis *et al*., 2013; Figure 14). No channelled flow into or out of the depression is present and the wetland is inward draining (endorheic).

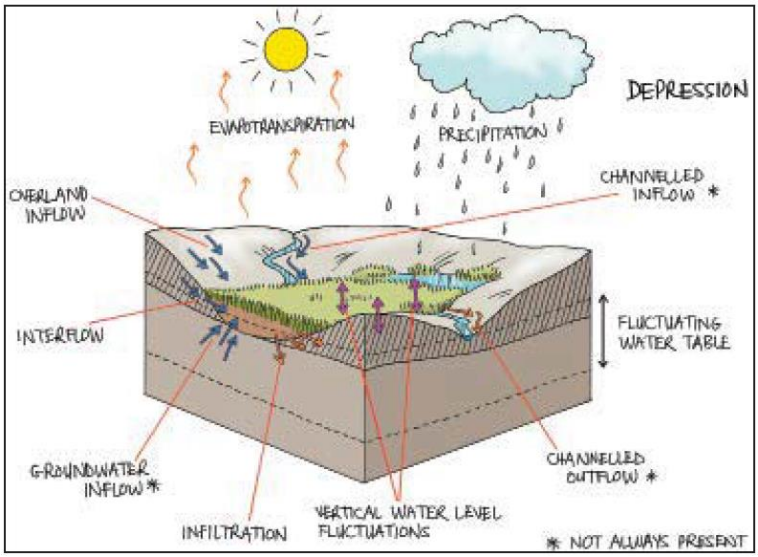

Figure 14. Conceptual illustration of the interdunal depression wetland (from Ollis *et al*., 2013).

Figure 15. Photos of various wetland and estuarine features on RE/6503.

3.4 Wetland Buffer

Buffers are located where the land meets a delineated watercourse, and refer to the zone where these two habitats interface. Buffer areas are linear zones adjacent to watercourses managed with the intention of protecting water resources from diffuse pollution associated with adjacent land uses. In addition, they provide habitat for wildlife within, and act as corridors for movement, feeding and breeding through fragmented landscapes. In this case the buffer performs an important function for the maintenance of conectivity between the lagoon and the wetland. It buffers not only the lagoon from the development, but also the wetland from the

development. The width of the aquatic impact buffer zone was determined to be **30 m** through use of the site-based wetland buffer tool developed by Macfarlane & Bredin (2017).

Figure 16. Delineated wetlands and 30 m wetland buffer in relation to the remainder of the site.

4. ECO-CLASSIFICATION

4.1 Present Ecological State (PES)

The PES of the wetland was determined using the updated WET-Health Version 2 method described by Macfarlane *et al.* (2020). Methods for the assessment are provided in Appendix 1. The result of the assessment was an overall **PES of A, Natural,** although the score was close to the boundary with B, Largely Natural. Minor impacts have occurred which have slightly reduced the state of the wetland from its natural reference condition (Figure 17). These are summarised as follows:

- Natural wetland and thicket vegetation has been invaded in isolated areas by alien invasive plants.
- An area of approximately 0.7 ha of wetland vegetation to the north is mowed on a regular basis. There are areas of alien invasion within the mowed area.
- Existing roads and walking paths are established through the wetland and surrounding area. These are maintained by vegetation trimming and are infrequently travelled by vehicle.

Most impacts affect vegetation which is reflected in the score of B, Largely Natural, determined in the PES assessment. Minimal impacts were observed to affect the wetland's hydrology water quality or geomorphology.

Table 4. Summarised Present Ecological State determined for the depression wetland using WET-Health.

Final (adjusted) Scores				
PES Assessment	Hydrology	Geomorphology	Water Quality	Vegetation
Impact Score	1,2	0,3	1,2	1,9
PES Score (%)	91%	97%	90%	81%
Ecological Category	**A**	**A**	**A**	**B**
Trajectory of change	↓	↓	→	→
Confidence (revised results)	High	High	Medium	High
Combined Impact Score	1,1			
Combined PES Score (%)	91%			
Combined Ecological Category	**A**			
Hectare Equivalents	5,2 Ha			

Figure 17. Photos of various impacts affecting vegetation of the wetland.

4.2 Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity (EIS) was determined using methods provided in Appendix 2 which was developed by Rountree *et al*. (2013). The EIS of the wetland was determined to be '**Very High'** (Table 5). The definition of wetlands in this category is as follows:

"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."

An important aspect of this wetland type's sensitivity is that it is inward draining (endorheic) and therefore any water, sediment or material inputs cannot be 'flushed out' of the system.

Table 5. Summarised Ecological Importance and Sensitivity of East and West Wetland.

Ecological importance and sensitivity	Score 0-4	Confidence 1-5	Motivation
Biodiversity support	**3.6**		
Presence of Red Data species	3	3	None observed in wetland, but Plett lagoon is home to Knysna seahorses and the wetland plays a supportive role.
Populations of unique species	4	3	Diverse and abundant population of wetland plants creating unique habitat which usually supports unique vertebrate and invertebrate species.
Migration/feeding/breeding sites	4	4	Habitat for amphibians, reptiles, small mammals, birds etc. Good connectivity between the wetland and lagoon.
Landscape scale	**3.4**		
Protection status of wetland	3	4	Identified as CBA1 on WCBSP and ownership is private (not public open space).
Protection status of vegetation type	3	4	Located at ecotone between disturbed fynbos (mapped CR) and thicket / wetland / estuarine vegetation (LC).
Regional context of the ecological integrity	4	4	In good condition for peri-urban wetland but will be increasingly pressured if proposed development go ahead.
Size and rarity of the wetland types present	4	4	Moderate to large size and one of the last remaining interdunal depression wetlands along the Keurbooms Lagoon.
Diversity of habitat types	3	4	Areas of seasonal, temporary and permanent wetland interspersed with thicket 'islands'. Relatively diverse habitats.
Sensitivity of the wetland	**3**		
Sensitivity to changes in floods	3	3	Erosion of slopes to the west would result in sediment deposition and vegetation smothering in the wetland. Thicket areas would be inundated leading to vegetation transition.
Sensitivity to changes in low flows	2	3	Loss of permanent wetland vegetation, but water levels already fluctuate to an extent.

Sensitivity to changes in water quality	4	4	High nutrients can transform vegetation to a greater dominance by reeds such as *Typha capensis* and *Phragmites australis*.
Hydrofunctional Importance	**2**	**3**	
Direct human benefits	**1.8**	**3**	
ECOLOGICAL IMPORTANCE AND SENSITIVITY	**3.6**	**VERY HIGH**	

5. LEGISLATIVE IMPLICATIONS

5.1 Site Sensitivity Verification

The Site Sensitivity in terms of Aquatic Biodiversity for Option C is **confirmed as Very High** as indicated by the DFFE Screening Tool because significant wetland habitat is present on the site.

5.2 Water Use Authorisation

The presence of a wetland on the property means that the construction and operation of the proposed housing development would be taking place in the Regulated Area of a Watercourse as defined in GN509 of the National Water Act. For wetlands this is defined as the area within a 500m radius of the wetland. The installation of new sewerage pipelines for the development is an activity which is currently excluded from the General Authorisation, meaning it would be necessary to apply for a Water Use License.

A specialist impact assessment for all phases of the proposed development will be compiled in order to meet the requirements for both the NEMA and the NWA.

6. IMPACT ASSESSMENT

Methods used for the impact assessment are provided in Appendix 3. The impact assessment follows the mitigation hierarchy of avoidance, minimisation of impacts, restoration of damaged ecosystems and offsets for residual damage, prioritised in that order.

6.1 Design and Layout Phase

6.1.1 Stormwater management

The stormwater management plan compiled by Vita Consulting Engineers proposes SuDS-type design features for the management of stormwater which are fully supported. The report acknowledges the high erodibility of soils on the site. Being downslope of the proposed development the wetland is vulnerable to smothering by transported sediment from eroded slopes, and being inward draining, this material would eventually form terrestrialised islands with different vegetation, most likely being colonised by alien plant species. Avoidance of erosion is therefore the primary aim of managing stormwater on the site. The following additional mitigation measures are recommended to further reduce impacts:

- Wherever possible driveways and parking areas must use open paver / permeable paving systems such as grass blocks or sudpave-type products. This will utilise the highly permeable nature of soils at the site to reduce runoff to roads in > 1:5 year rainfall events.

- Stormwater outlets leading towards the wetland will need to consider the steep slope between the development level and wetland. On average there is a drop of approximately 4 m over which stormwater must be delivered to the wetland without causing erosion. It is recommended that stormwater outlets:

a) Follow existing roads and pathways where vegetation is regularly trimmed to navigate the slope between the higher ground and wetland area (Figure 18). This will have the added benefit that residents will see any erosion, slippage or litter accumulated in the stormwater outflows, and report it to the Homeowners Association for attention.

b) The stormwater outflow point use a series of stepped gabions protected by reno mattress to break the fall of water to navigate the slope. This should end in a stilling basin which would act as a sump.

c) A gabion walled stilling basin with no concentrated outflow at the lower ground level be constructed to break the final fall of water and to allow water to seep out of gabions in multiple directions to the wetland beyond. The base of the stilling basin should be slightly below ground level on reno mattress to reduce subsidence, and all reno or gabion structures must be protected with geotextile to prevent malformation due to slumping in the sandy soil.

Figure 18. Proposed stormwater outlet points utilising existing tracks to and through the wetland.

6.1.2 Fenceline

As the wetland area is the last remaining area of significant wetland and natural vegetation remaining along the western shoreline of the Keurbooms Lagoon, it is important to protect the function as an ecological corridor. Wildlife currently move between the wetland and lagoon area, and an important function of the wetland is the provision of shelter and habitat for feeding, breeding and movement. The following mitigation measures are recommended:

- The fenceline should enclose the residential area only, and not the wetland area. The final location is yet to be determined but should minimise the disturbance of natural vegetation on the slope as far as possible. This is very important for the ongoing stability of the slope which is protected by established vegetation.
- Install code-operated pedestrian gates along the fenceline aligned to existing pathways and roads to allow joggers and walkers access to the wetland and lagoon.
- Use alternative security measures to monitor the wetland such as guarding or cctv cameras.

- IT is assumed that typical Clearvu-type fencing would be preferred, however this seriously restricts the movement of any animals. Install larger grid sections along the base of the fenceline in a few sections, to allow smaller-bodied vertebrates to move in and out of the residential area.
- Do not use any electric strands along the base of the fenceline.

6.2 Construction Phase Impact Assessment

6.2.1 Pre-construction wetland rehabilitation

The wetland is in a very good ecological state, apart from a few impacts which are discussed in the PES section. It is recommended that prior to commencement of construction, these impacts be dealt with to improve the wetland's condition and ensure that best practice management of the wetland commences early on. Mitigation of existing impacts will result in a positive outcome if all mitigation measures are implemented (Table 6).

Table 6. Construction phase: pre-construction wetland rehabilitation.

Project phase	**Construction**			
Impact	**Pre-construction wetland rehabilitation**			
Description of impact	**Habitat degradation by alien vegetation and through mowing**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Control alien vegetation in isolated stands where it occurs. No herbicide to be used in the wetland. Large trees must be fully ring-barked, while smaller plants can be hand-pulled or removed using a tree popper. Shrubs of bramble and Lantana must be cut back with clippers until the stump is visible, which must then be removed. • All vegetation biomass must be removed from the wetland and disposed of at a green waste dump. No vegetation must be dumped in the wetland. • Follow up alien must be conducted every 6 months following initial clearing to ensure emergent seedlings are consistently removed. • Cease mowing the northern area of the wetland barring one path that can be maintained for access to the lagoon and a strip large enough for a single vehicle along the boundary fenceline.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Positive	
Duration	Medium term	Impact will last between 5 and 10 years	Brief	Impact will not last longer than 1 year
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	Very low	Natural and/ or social functions and/ or processes are slightly altered	Very high	Natural and/ or social functions and/ or processes are majorly altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Likely	The impact may occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Minor - positive**	
Comment on significance				
Cumulative impacts				

6.2.2 Unnecessary disturbance to sensitive areas

The wetland and buffer are no-go zones for any workers, equipment, vehicles, or materials for the duration of the development. Access is only permitted for specific work to construct

stormwater outlets for instance. As the slope is also sensitive to erosion and disturbance of vegetation, it is recommended that termporary fencing be established along the edge of the slope identifying it as a No-go area. Sensitive areas must be established using temporary fencing and signage before commencement of construction and all personnel involved in the project must be briefed about no-go areas. Impacts are likely to be a negligible negative if all mitigation measures are fully implemented (Table 7).

Table 7. Construction phase: Unnecessary disturbance to sensitive areas.

Project phase	**Construction**			
Impact	**Disturbance to wetland and buffer areas**			
Description of impact	**Vehicles, workers and materials active in wetland and buffer areas**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Pre-construction, temporary fencing must be erected along No-Go areas with the top of the slope leading to the wetland indicated as the sensitive feature. • Signage indicating No-go areas must be placed on fencing. • All contractors must attend a site induction and be briefed that vehicles, workers, equipment and materials may not encroach into No-Go areas around wetlands. • Consider the termination of contracts or fines for encroachment into the no-go area.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	Impact will last between 1 and 5 years	Immediate	Impact will self-remedy immediately
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Unlikely	Has not happened yet but could happen once in the lifetime of the
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	High	The resource is irreparably damaged and is not represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance	The impact of unnecessarily increasing the footprint of disturbance by entering no-go areas can be mitigated to a large extent by full implementation of these mitigation measures.			
Cumulative impacts	Not applicable			

6.2.3 Stormwater runoff during construction

Effective management of stormwater during construction can have a significant impact on the state of the wetland and buffer in the long term. Management interventions need to consider proactive and reactive measures to mitigate the impacts of stormwater runoff as the site topography evolves during the construction phase. Mitigation measures are recommended, and if fully monitored and implemented the impacts could be minimised to a negligible negative level (Table 8).

Table 8. Construction phase: stormwater runoff from the site

Project phase	**Construction**			
Impact	**Stormwater runoff from the site**			
Description of impact	**Sedimentation in the wetland and creation of preferential flow paths**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• The objective of stormwater managmeent during the construction phase is to eliminate the risk as far as possible of discharging sediment-laden water downslope into the wetland. • Daily and weekly site meetings must consider forecasted rainfall to avoid working during such periods, and to plan accordingly for predicted high rainfall events. Work on the site must cease altogether during rainfall. • The site office must have a store of materials suitable for rapid response to erosion control such as shade-cloth (silt-fencing), haybales (check-dams), wooden droppers, hessian fabric, and fencing wire. • All material stores should be kept on flat areas and bunded to prevent material loss during rainfall. • When construction commences in the residential area, create a compacted, low soil berm along the permiter of the site approximatly 400 mm high to retain stormwater on site and reduce runoff to surrounding areas. • Monitor the site during / following periods of rainfall, and install haybale check dams at points where runoff collects and could overtop / breach the soil berm. • Following rainfall, any water that must be pumped out of pools in excavated areas must not be directed to the wetland. The soil berm system or a temporary haybale check dam can be constructed to contain water until it seeps into the ground or slowly disperses through the haybales which act as a filter.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Medium term	Impact will last between 5 and 10 years	Brief	Impact will not last longer than 1 year
Extent	Local	Extending across the site and to nearby settlements	Limited	Limited to the site and its immediate surroundings
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Unlikely	Has not happened yet but could happen once in the lifetime of the
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance	Risk reduction is dependent on proactive and reactive mitigation measures as contruction progresses across the site.			
Cumulative impacts	Not applicable			

6.2.4 Construction phase: Excessive disturbance for construction of stormwater outflows

Construction of the stormwater outflows will need to be undertaken down the slope towards the wetland area. Care must be taken during this exercise to ensure this doesn't result in an excessive footprint of disturbance which could result in serious erosion associated with the outflow channels. Mitigation measures are provided in Table 9.

Table 9. Construction phase: Disturbance during construction of stormwater outflows

Project phase	**Construction**			
Impact	**Excessive disturbance for construction of stormwater outflows**			
Description of impact	**Loss of stabilising vegetation leading to erosion and sedimentation in the wetland**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• A maximum 2 m footprint of disturbance either side of each stormwater outlet to the wetland is acceptable. This area must be fenced off with temporary fencing or pegged, so that workers know the maximum limit of disturbanc to soil or vegetation. • Where vegetation is in the way of works, it shoud be trimmed or cut, and the roots and soil must not be disturbed. • Where gabions / reno mattresses must be installed, excavations and installation should be undertaken by hand wherever possible, and work should preferably be done from the road / pathway-side as the primary access point. • All excavated soil and / or cut and removed vegetation must be disposed of via the residential area and not dumped in the wetland. No materials used in the construction of the stormwater outflow can be dumped in the wetland. • Works should commence in the direction from bottom to top, so that the stilling basin is created first and can catch any sedimentationt that occurs upslope during construction of the outflow.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Medium term	Impact will last between 5 and 10 years	Brief	Impact will not last longer than 1 year
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Moderate	Natural and/ or social functions and/ or processes are moderately altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance				
Cumulative impacts	Despite there being multiple (3 or 4) outlets, these should be aligned with existing pathways and roads, limiting the cumulative impacts.			

6.2.5 Construction phase: installation of fence

In many instances, the construction of fencelines in residential estates can have a significant impact on the natural environment. Fencelines can cross watercourses and migration corridors, and their construction can involve significant earth-moving and vegetation clearance. This is not considered necessary for the development, and measures to mitigate impacts associated with an anticipated fenceline are provided in Table 10.

Table 10. Construction phase: Installation of fenceline

Project phase	**Construction**			
Impact	**Greater than necessary footprint for fenceline installation**			
Description of impact	**Loss of stabilising vegetation habitat disturbance**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• The limit of disturbance along the fenceline area is 2 m on the residential side of the development. • The fenceline can be installed with the help of a small machine such as a bobcat, but should otherwise be installed by hand. • Vegetation obstructing work on the fenceline should be cut or trimmed, and not uprooted. As this could lead to soil erosion. • Disturbed soil along the fenceline on the side of the residential development should be revetated with low growing indigenous grass such as Cynodon dactylon (kweek) and / or Stenotaphrum secondatum (buffalo grass). This can create a relatively open area along the fenceline which can be monitored or patrolled.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Medium term	Impact will last between 5 and 10 years	Brief	Impact will not last longer than 1 year
Extent	Local	Extending across the site and to nearby settlements	Limited	Limited to the site and its immediate surroundings
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Likely	The impact may occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance				

6.3 Operational Phase Impact Assessment

6.3.1 Stormwater Management

Sloped areas leading to the wetland where stormwater outflows are located are very sensitive to high velocity, concentrated inflows of water, which could cause erosion. Even a single severe event can result in creation of an erosion gully, depositing sediment in the wetland and destabilising the slope. This impact should be avoided at all costs. Mitigation measures have been recommended in Table 11 which should reduce the risk to a negligible negative level. However, it is emphasised that monitoring is required to ensure that despite all the SuDS-type interventions aimed at attenuating stormwater and other flows emanating from the site, proactive stormwater management and erosion-control must be implemented.

Table 11. Operational Phase: Stormwater management

Project phase	**Operation**			
Impact	**Damage caused by stormwater runoff**			
Description of impact	**Slope erosion and sedimentation of the wetland**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• The site should be assessed by an aquatic specialist 6 months following conclusion of construction to confirm that stormwater management infrastructure is functional and not causing any impacts to the wetland. • Stormwater management infrastructure such as swales, drains and culverts must be routinely monitored and maintained to ensure they are free of blockages and functional. This includes a regular inspection of all stormwater outflows to identify any emerging erosion issues, and keep the structures clear of excessive siltation and litter. • Where erosion is occurring, immediately identify and control the origin of the flow path, and protect the site of erosion by replacing soil with soil from the site, and stabilising with indigenous vegetation found on the site. Where more serious interventions are required spot installations of gabions may be suitable for stabilisation provided they are not in the wetland buffer or in the wetland itself. As far as possible, flows must be attenuated, and the source of erosion controlled upslope within the residential area. • Eroded areas of the steep banks must be refilled with topsoil (from the site), reseeded with indigenous vegetation, covered with a light mulch and protected with soil saver mats. The use of silt fencing can be extended to problem areas to provide further protection.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Medium term	Impact will last between 5 and 10 years	Brief	Impact will not last longer than 1 year
Extent	Local	Extending across the site and to nearby settlements	Very limited	Limited to specific isolated parts of the site
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Likely	The impact may occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance				
Cumulative impacts	Not applicable			

6.3.2 Operational phase: Alien Vegetation

Every effort must be made to ensure the area disturbed during construction is kept free of alien vegetation. This includes not only the residential area, but the wetland and buffer too. Follow up alien vegetation control must take place on a routine basis bi-annually in perpetuity. Provided the recommended mitigation measures are followed the impacts are predicted to be a Negligible Positive (Table 12).

Table 12. Operational Phase Impact: Alien vegetation establishment

Project phase	**Operation**			
Impact	**Alien vegetation establishment**			
Description of impact	**Establishment of aliens in disturbed areas post-construction resulting in habitat degradation**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Follow up inspection and control of alien vegetation in the residential development and the wetland on a 6-monthly basis. • No herbicides to be used in the wetland or wetland buffer. Sprays and / or cut-stump treatments may be used in the residential areas. • Ensure bare areas of vegetation are replanted with indigenous vegetation that occurs naturally on the site. • Under no circumstances may removed alien plants be discarded in the wetland. The HOA must inform the landscaping / gardening team that no dumping of vegetation or discarding of waste material may happen in the wetland or buffer area.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Positive	
Duration	Medium term	Impact will last between 5 and 10 years	Brief	Impact will not last longer than 1 year
Extent	Local	Extending across the site and to nearby settlements	Very limited	Limited to specific isolated parts of the site
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Negligible - positive**	
Comment on significance				
Cumulative impacts	Not applicable			

6.3.3 Operational phase: Landscaping and pathways maintenance

Project phase	**Operation**			
Impact	**Landscaping and recreational pathways maintenance**			
Description of impact	**Inappropriate mowing, planting or trimming of vegetation leading to habitat degradation**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Mowing of the wetland area to the north of the site must cease altogether. The only areas that can be mowed are the existing pathways and a 2 m strip along the residential side of the fenceline. One pathway can be maintained through the northern area of the wetland which is currently mowed. • Only existing pathways through the wetland and buffer may be maintained. Maintenance involves removal of alien vegetation (previously discussed), trimming and weed eating of pathways. No disturbance to plant roots or soil is permitted. • No herbicides can be used to maintain pathways in the wetland area or buffer. • The existing footprint of the pathways may not be enlarged. • Do not plant any exotic plants that do not occur naturally at the site in any area of the wetland or buffer. ie. under no circumstances may kikuyu grass be planted in any part of the wetland or buffer.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Positive	
Duration	Short term	Impact will last between 1 and 5 years	Brief	Impact will not last longer than 1 year
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Unlikely	Has not happened yet but could happen once in the lifetime of the
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - positive**	
Comment on significance				
Cumulative impacts	No applicable.			

Table 13. Operational phase: Leaking sewage infrastructure

While significant efforts have been made to ensure sewage pump stations and infrastructure are well planned, positioned and maintained within the development, experience has shown that even well-intentioned developments can have periodic problems with leaking, blocked or overflowing sewerage pipes or pump stations. Maintenance and regular inspections are key to ensuring that any issues are detected and dealt with early. Mitigation measures are provided in Table 14.

Table 14. Operational phase impact: leaking, blocked or overflowing sewerage infrastructure.

Project phase	**Operation**			
Impact	**Leaking, blocked or overflowing sewerage infrastructure**			
Description of impact	**Pollution and eutrophication of the wetland leading to habitat degradation and impacts to biota**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• All sewerage infrastructure must be well maintained and kept free of obscuring vegetation. Manholes, sewerlines, and the pump stations must be accessible, easily observed, and routinely inspected for leaks or blockages. • Emergency response measures to sewage spillages should be maintained on site, including lime to treat sewage and sand bags to contain spill and limit their dispersal. An emergency response protocol must be established by management of the HOA. • Residents should be provided with information of what can / cannot be flushed into toilets. This knowledge is often assumed, but is frequently over-estimated. Even educated people treat a toilet like a rubbish bin. • Ensure sufficient backup power systems are available for the operation of pump stations during load shedding and at peak times (e.g. December).**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	Impact will last between 1 and 5 years	Brief	Impact will not last longer than 1 year
Extent	Local	Extending across the site and to nearby settlements	Limited	Limited to the site and its immediate surroundings
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Probable	The impact has occurred here or elsewhere and could therefore occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance				
Cumulative impacts	Not applicable			

7. CONCLUSIONS

The proposed residential development known as Plett Lagoon Estate initially included housing which extended into the wetland area. Since biodiversity specialist inputs have been provided, the proposed development has been significantly reduced to the current Site Development Plan which excludes any development from the wetland and buffer area entirely.

Mitigation measures proposed to manage both stormwater and sewage on site have been carefully considered in the report provided by Vita Consulting Engineers. The SuDS-type interventions proposed in this report provide confidence that stormwater can be effectively managed on site, with minimal risk to the wetland's habitat and water quality. A few additional mitigation measures in terms of the design and layout of stormwater outflows were recommended in this report.

The wetland was classified as a depression with a PES of A (Natural) and an EIS of 'Very High'. As the last remaining natural wetland habitat on the western bank of Keurbooms Lagoon, the wetland has great significance. A wetland buffer of 30 m was recommended and not only protects the wetland from the residential development upslope, but provides a level

of connectivity between the terrestrial and wetland areas with the lagoon. The impact assessment determined most of the construction and operational phase impacts to be a Negligible negative with some impacts being a negligible positive.

Development of the Plett Lagoon Estate is supported provided the residential areas are planned outside of the wetland and buffer area, and the wetland is conserved and well maintained.

8. APPENDICES

8.1 Present Ecological State Methods

The wetland area was assessed using the Level 2 WET-Health assessment tool developed by Macfarlane *et al*. (2020). The tool aims to assess the integrity of a wetland which is defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition. The reference condition is inferred from conceptual models of the selected hydrogeomorphic wetland type. The method combines an assessment of hydrological, geomorphological, water quality and vegetation health four modules.

Data collection involved a desktop review of the extent and intensity of catchment land use impacts and was undertaken using historical and recent aerial imagery of the site (Chief Directorate: National Geo-spatial Information and satellites). Fieldwork onsite involved the identification and recording of observable impacts to the wetland at the site of relevant activities as well as at reference points upstream and downstream of the activities, and in the catchment area of the wetland. The magnitude of observed impacts to the hydrological, geomorphological and vegetation components of the wetland were calculated and combined as per the tool to provide a measure of the overall wetland condition of the wetland. Resultant scores were then used to assign the wetland into one of six PES categories as shown in Table 15.

Table 15. Wetland Present Ecological State categories and impact descriptions.

Ecological Category	Description	PES Score
A	Unmodified, natural.	90-100%
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.	80-89%
C	Moderately modified / fair condition. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79%
D	Largely modified / poor condition. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59%
E	Seriously modified / very poor condition. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39%
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.	0-19%

8.2 Ecological Importance and Sensitivity Methods

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 enhancement 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 16).

Table 16.Ecological importance and sensitivity categories for wetlands. 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

8.3 Impact Assessment Methods

Criteria are ascribed for each predicted impact. These include the intensity (size or degree scale), which also includes the type of impact, being either a positive or negative impact; the duration (temporal scale); and the extent (spatial scale), as well as the probability (likelihood). The methodology is quantitative, whereby professional judgement is used to identify a rating for each criterion based on a seven-point scale (Table 17) and the significance is auto-generated using a spreadsheet through application of the calculations.

For each predicted impact, certain criteria are applied to establish the likely **significance** of the impact, firstly in the case of no mitigation being applied and then with the most effective mitigation measure(s) in place.

These criteria include the **intensity** *(*size or degree scale), which also includes the **nature** of impact, being either a positive or negative impact; the **duration** (temporal scale); and the **extent** (spatial scale). These numerical ratings are used in an equation whereby the **consequence** of the impact can be calculated. Consequence is calculated as follows:

Consequence = type x (intensity + duration + extent)

To calculate the significance of an impact, the **probability** (or likelihood) of that impact occurring is applied to the consequence.

Significance = consequence x probability

Depending on the numerical result, the impact would fall into a significance category as negligible, minor, moderate or major, and the type would be either positive or negative.

Table 17. Assessment criteria for the evaluation of impacts

Criteria	Numeric Rating	Category	Description
Duration	1	Immediate	Impact will self-remedy immediately
	2	Brief	Impact will not last longer than 1 year
	3	Short term	Impact will last between 1 and 5 years
	4	Medium term	Impact will last between 5 and 10 years
	5	Long term	Impact will last between 10 and 15 years
	6	On-going	Impact will last between 15 and 20 years
	7	Permanent	Impact may be permanent, or in excess of 20 years
Extent	1	Very limited	Limited to specific isolated parts of the site
	2	Limited	Limited to the site and its immediate surroundings
	3	Local	Extending across the site and to nearby settlements
	4	Municipal area	Impacts felt at a municipal level
	5	Regional	Impacts felt at a regional level
	6	National	Impacts felt at a national level
	7	International	Impacts felt at an international level
Intensity	1	Negligible	Natural and/ or social functions and/ or processes are negligibly altered
	2	Very low	Natural and/ or social functions and/ or processes are slightly altered
	3	Low	Natural and/ or social functions and/ or processes are somewhat altered
	4	Moderate	Natural and/ or social functions and/ or processes are moderately altered

Criteria	Numeric Rating	Category	Description
	5	**High**	Natural and/ or social functions and/ or processes are notably altered
	6	**Very high**	Natural and/ or social functions and/ or processes are majorly altered
	7	**Extremely high**	Natural and/ or social functions and/ or processes are severely altered
Probability	**1**	**Highly unlikely / None**	Expected never to happen
	2	**Rare / improbable**	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
	3	**Unlikely**	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
	4	**Probable**	Has occurred here or elsewhere and could therefore occur
	5	**Likely**	The impact may occur
	6	**Almost certain / Highly probable**	It is most likely that the impact will occur
	7	**Certain / Definite**	There are sound scientific reasons to expect that the impact will definitely occur

When assessing impacts, broader considerations are also considered. These include the level of confidence in the assessment rating; the reversibility of the impact; and the irreplaceability of the resource as set out in (Table 18, Table 19, & Table 20), respectively.

Table 18. Definition of confidence ratings.

Category	Description
Low	Judgement is based on intuition
Medium	Determination is based on common sense and general knowledge
High	Substantive supportive data exists to verify the assessment

Table 19. Definition of reversibility ratings.

Category	Description
Low	The affected environment will not be able to recover from the impact - permanently modified
Medium	The affected environment will only recover from the impact with significant intervention
High	The affected environmental will be able to recover from the impact

Table 20. Definition of irreplaceability ratings.

Category	Description
Low	The resource is not damaged irreparably or is not scarce
Medium	The resource is damaged irreparably but is represented elsewhere

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