
Maintenance Management Plan for the Bigai River Floodplain, Knysna, Western Cape.



Prepared for: Knysna Municipality

In terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998),
as amended & Environmental Impact Regulations 2014 March 2023

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DECLARATION OF CONSULTANTS INDEPENDANCE

This report was compiled by Jacqueline (Jackie) Dabrowski, the Director of Confluent Environmental (Pty) Ltd. Jackie holds a Ph.D. in Veterinary Science and her post-graduate studies were in the field of freshwater ecology. She has conducted research and published scientific articles on a range of topics including aquatic food webs, fish health, and trends in water quality, branchiopod diversity, and land-use impacts on water quality. Her consulting work has focussed on a range of environmental assessments of dams, rivers, estuaries, ephemeral watercourses and wetlands at various locations in South Africa.

At the time of conducting this study, I declare that:

- I am an independent specialist consulting in the field of Aquatic Science;
- I do not have any financial interest in the undertaking of the activity, apart from remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;
- I do not have any vested interest in the proposed activity proceeding;
- I will not engage in any conflicting interests in the undertakings of the activity;
- I undertake to disclose to the competent authority any relevant information with the potential to influence the decision of the competent authority or the objectivity of the report; and,
- I will provide the competent authority with access to all information at my disposal regarding the application, whether this information is favourable to the applicant or not.



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DECLARATION OF SPECIALIST INDEPENDENCE

The consulting services comprise an assessment of the potential sensitivity of the ecosystems and flora that fall within the development footprint for the site. The following declaration is given by the appointed specialist:

- 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 field assessment and compiling this report I did not have any interest, hidden or otherwise, in the proposed development that this report has reference to, except for financial compensation for work done in a professional capacity.
- Work performed for this site was done in an objective manner. Even if this 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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ACRONYMS

| | |
|----------------------|---|
| Alt. | Alternative |
| BGCMA | Breede-Gouritz Catchment Management Agency |
| BGIS | Biodiversity Geographic Information System |
| CARA | Conservation of Agricultural Resources Act (43 of 1983) |
| CBA | Critical Biodiversity Area |
| CDSM | Chief Directorate Surveys and Mapping |
| cm | Centimetre |
| DFFE | Department of Forestry Fisheries & Environment |
| DEA&DP | Department of Environmental Affairs & Development Planning (Western Cape) |
| DWS | Department of Water and Sanitation |
| EA | Environmental Authorisation |
| EAP | Environmental Impact Practitioner |
| ECO | Environmental Control Officer |
| EHS | Environmental, Health & Safety |
| EIA | Environmental Impact Assessment |
| ESA | Ecological Support Area |
| EMPr | Environmental Management Programme |
| GA | General Authorisation |
| GPS | Global Positioning System |
| ha | Hectare |
| I&APs | Interested and Affected Parties |
| L | Litre |
| m | Metre |
| m² | Square metres |
| m³ | Cubic metres |
| NEMA | National Environmental Management Act (107 of 1998, as amended in 2006) |
| NEMBA | National Environmental Management: Biodiversity Act (10 of 2004) |
| NSBA | National Spatial Biodiversity Assessment |
| NWA | National Water Act (36 of 1998) |
| SANBI | South Africa National Biodiversity Institute |
| SDF | Spatial Development Framework |
| S&EIR | Scoping & Environmental Impact Reporting |
| WULA | Water Use Licence Application |

1. BACKGROUND AND INTRODUCTION

Confluent Environmental (Pty) Ltd was appointed by Knysna Municipality to compile a Maintenance Management Plan (MMP) for the lower reaches of the Bigai River in Knysna. The purpose of the MMP is to consider maintenance actions required to alleviate flooding in the lower reaches of the Bigai River.

A number of flood-prone areas are highlighted in this assessment along with recommended maintenance actions to improve their ability to convey flood waters.

This plan was compiled in conjunction with the Knysna Municipality and the Knysna Golf Course who proposed a range of maintenance actions to alleviate flooding at various points.

These actions and others are presented in this plan along with other methods aimed at reducing flooding, without causing excessive negative impacts to the receiving environment.

Several of the areas highlighted for maintenance involve historical channels which have been excavated to improve drainage in low-lying areas. Significant flooding occurs on a fairly regular basis in the area, frustrating residents, workers and business owners who cannot cross road sections due to flooding which can remain *in situ* for weeks at a time.

Cape Environmental Assessment Practitioners (*Cape EAPrac*) was appointed to facilitate the public participation and stakeholder engagement process associated with the MMP procedures. The MMP was made available to stakeholders for a 30-day commenting period extending from 13 October – 13 November 2023. All comments received during this period have been considered and responded to where applicable. Copies of the submissions are appended to this MMP and Section 7 of this report reflects on the key issues raised.

The Knysna Municipality is the Applicant and will implement all actions outside of the Knysna Golf Course. The Knysna Golf Course is located on municipal ground (long-term lease agreement), but all maintenance actions will be carried out by groundsmen on their site.

No engineering solutions are proposed in this MMP, and specialist inputs are limited to those provided by the **aquatic and botanical/biodiversity specialists**, who is also the authors of the MMP (Dr J. Dabrowski and Ms Bianke Fouché).



Figure 1. Area covered by this Maintenance Management Plan in Knysna, Western Cape.

1.1 Maintenance Management Principles

This MMP is prepared using the guiding principles for landowners and managers considering the development of a MMP as provided in the MMP template for a watercourse (2017) as well as Appendix 4 of the Environmental Regulations (as amended). These are summarised as follows:

- Avoid and reduce unnecessary maintenance.
- The condition of physical and ecological processes that drive and maintain aquatic ecosystems in a catchment must inform a MMP relative to the desired state of the affected system.
- Management actions/outcomes must aim to prevent further deterioration to the condition of affected watercourses and, overall, be guided by a general commitment to improving and maintaining ecological infrastructure for the delivery of ecosystem services; and
- Managers and organs of state must identify, address and, where feasible, eliminate the factors that necessitate intrusive, environmentally damaging maintenance.

1.2 Relevant Legislation

The maintenance work proposed in this MMP is mostly located at sites which are either terrestrial or located within the Estuarine Functional Zone. Refer to Figure 2 for locations of culverts, channels and berm where maintenance is required. The definition of estuarine habitat in terms of listing Notice 3 (GN R 985) published under the NEMA EIA regulations (2014), defines an estuary as the Estuarine Functional Zone (EFZ) as defined in the National

Biodiversity Assessment: Estuary Component (van Niekerk & Turpie, 2012). The EFZ is delimited by the 5 m topographical contour surrounding an estuary.

The proposed maintenance includes:

- excavation of sediment (silt and other materials), as well as vegetation that has accumulated around existing infrastructure along the Bigai Wetland and within the Knysna Golf Course.

The excavation of sediment/silt/materials from an estuary/watercourse, alongside clearing of vegetation to chieve the excavations, trigger the following 'listed activities' in terms of the NEMA Environmental Regulations (2014, as amended):

| Listing Notice | Activity | Description |
|------------------|--|---|
| Listing Notice 1 | <u>Activity 19:</u> The infilling or depositing of any material or more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from (i) a watercourse, but excluding (b) for the maintenance purposes undertaken in accordance with a maintenance management plan. | Several areas within the study area require that sediment be removed to unblock channels/culverts (refer to Table 9 for specific locations and descriptions and Figure 2 for locations of culverts, channels and the berm where maintenance is required). The exact volume of material to be removed at these locations has not been determined since existing vegetation cover over blocked areas prevents accurate quantitative measurements. Based on the larger scale channel (500m long) and the maximum culvert length (14m) the maximum volume of material that may need to be excavated across the study site is 1512m ³ . |
| Listing Notice 1 | <u>Activity 19A:</u> The infilling or depositing of any material or more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 cubic metres from (ii) the littoral active zone, an estuary or a distance of 100m inland of the high-water mark of the sea or an estuary, whichever is the greater, but (g) excluding for the maintenance purposes undertaken in accordance with a maintenance management plan | Based on the larger scale channel (500m long) and the maximum culvert length (14m), as well as all of the identified culverts, the maximum volume of material that may need to be excavated across the study site is estimated at 1512m ³ . It is noted that the exact volume of material to be removed at these locations has not been determined accurately since existing vegetation cover over blocked areas prevents accurate quantitative measurements. |
| Listing Notice 3 | <u>Activity 12:</u> The clearance of an area of 300sq/m or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a | Noted that vegetation within most of the project area has been significantly modified is no long representative of the mapped Garden Route Shale Fynbos which is an Endangered vegetation type, however the site is still designated as a |

| | | |
|--|---|---|
| | <p>maintenance management plan (i) within critically or endangered ecosystems listed in NEMBA, (ii) within critical biodiversity areas, (iii) within the littoral active zone or 100m inland of the high-water mark of the sea or an estuarine functional zone, (iv) on land where such land was zoned open space, conservation or had an equivalent zoning, or (v) on land designated for protection or conservation in an EMF adopted, or a Spatial Development Framework adopted by the MEC or Minister.</p> | <p>CBA 1: Aquatic and where culverts/berm/channel must be cleared, associated vegetation removal (albeit limited) will be required. It is estimated that a <i>maximum</i> clearance of 3808m² of vegetation will be required to allow maintenance on all of the culverts, the artificial berm and channel as stipulated in this MMP. Specifications allow for clearance 2m each side of each culvert, as well as 2m into the wetland each side of the roads, as well as 2m wide clearance along the artificial berm/channel (900m and 500m long respectively).</p> |
|--|---|---|

This MMP considers regulations in the National Environmental Management: Protected Areas Act (Act 57 of 2003), specifically Regulations for the Proper Administration of the Knysna Protected Environment (GN R1175).

The Knysna Estuary is located within the SANParks Protected Area and is listed as the most important estuary in South Africa. The regulating authority is the national Department of Forestry, Fisheries and Environment (DFFE).

As affected areas of the Bigai Wetland are mostly freshwater in nature, the proposed maintenance actions to remove sediment and vegetation from culverts are defined as Section 21 c) and i) water uses in terms of the National Water Act (NWA, Act 36 of 1998). It is therefore necessary to consider the risk posed by the maintenance actions to the receiving aquatic ecosystem in the form of a Risk Matrix which is compiled by a **SACNASP-registered aquatic scientist** as well as a **SACNASP-registered botanist/biodiversity specialist** (as required by GN509 of 2016/GN 320 of 20/03/2020).

The outcome of the Risk Matrix is that the risks, in their mitigated state, is considered 'Low', as such the MMP has been Generally Authorised (GA) in terms of the National Water Act. The GA was issued on 12 October 2023 dated 02.10.2023. The regulating authority in for water use is the Breede Olifants Catchment Management Agency (BOCMA).

1.3 Scope of Work

The scope of work covered by this MMP incorporates aspects assessed during both desktop and field assessments. The following points were covered for each:

Desktop Assessment

- Review of flood-prone areas in the lower reaches of the Bigai River known to cause access problems for the local community.
- Review of methods proposed to alleviate flooding by the Knysna Municipality and the Knysna Golf Club. Reports listing infrastructure requiring maintenance were provided along with proposed methods to improve flood conveyance.

- Review previous reports compiled by engineering / environmental consultants on flooding in the Bigai River.
- Desktop assessment of affected areas using spatial data such as contours, mapped watercourses, conservation plans and historical aerial images.

Field Assessment

- Visually inspect flood-prone areas and problematic infrastructure where maintenance actions are proposed.
- Collect and analyse water samples to determine baseline water quality at key points.
- Consider proposed maintenance actions in the context of existing impacts affecting watercourses.

Report Compilation

- Compile a Maintenance Management Plan which provides clear, measurable and time framed maintenance measures to address flooding within the ambit of an MMP.
- Where work in Regulated Area of a watercourse is undertaken (as defined in the National Water Act) a Risk Matrix will be compiled to determine the level of risk posed by the maintenance actions to the watercourse concerned.

This MMP excludes the expansion and/or relocation of any structures and infrastructure, or the installation/development of any new structures/infrastructure as per the definitions provided in NEMA. In the event the Municipality determines that additional structures/infrastructure or expansion of existing structures/infrastructure is required the DFFE must be consulted to determine if additional Environmental Authorisation may be required.

2. SITE SENSITIVITY VERIFICATION

On 20 March 2020 the Minister of Forestry, Fisheries and the Environmental published the general requirements for undertaking site sensitivity verification for environmental themes for activities requiring environmental authorisation (Government Gazette No. 43110).

In terms of these requirements, prior to commencing with a specialist assessment, the **current land use** and **environmental sensitivity** of the site under consideration by the screening tool must be confirmed by undertaking a site sensitivity verification by either an EAP, or a specialist.

According to the Assessment Protocol for specialist involvement, if any part of the proposed development falls within an area of 'high' or 'very high' sensitivity, the requirements prescribed for such sensitivity must be followed.

1. The SSV must be undertaken by an EAP or a specialist
 - The site sensitivity verification report has been compiled by the EAP with input from respective aquatic and botanical/biodiversity specialists.
2. A preliminary on-site inspection must be undertaken
 - Site inspection as undertaken by the EAP on 24 July 2023.
3. A desktop analysis, using satellite imagery, must be undertaken, alongside any other applicable/ relevant information.
 - Consideration has been given to the George GIS Viewer, SANBI, NFEPA, Cape Farm Mapper spatial layers and Google Earth.



Image from Screening Tool identifying Archaeological & Cultural Heritage theme sensitivity for the property.

The maintenance work to be undertaken within the wetland will in no way impact on any known heritage/archaeological features since the clearing of sediment from culverts underneath roads and stormwater channels will take place in already modified environments.

Although the Screening Tool indicates the sensitivity for this theme as Low (not refuted by the EAP), it is submitted that the theme is not applicable to the maintenance work described in the MMP and no further specialist studies are required.

2.1.5 Civil Aviation (Medium Sensitivity)

The screening tool identified this theme as being “Medium”.

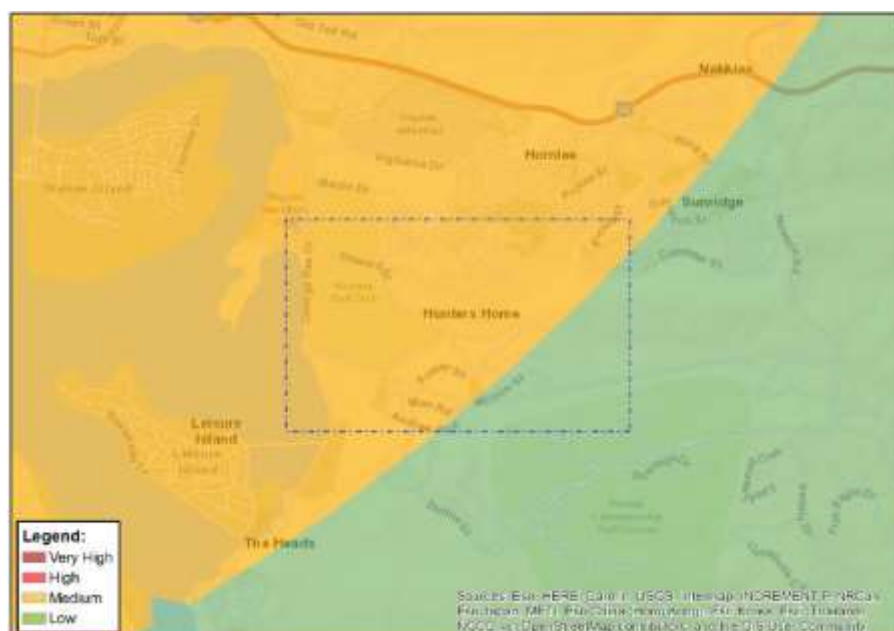


Image from Screening Tool identifying Civil Aviation theme sensitivity for the property.

The vegetation type indicated for this area according to the SANBI database is Garden Route Shale Fynbos (Endangered, VegMap 2018, Ecosystem Threat Status, 2021).

The botanist, Bianke Fouche who co-authored the MMP, comments on the fact that areas to the west of George Rex Drive and the golf course are *mapped* as Non-terrestrial estuarine vegetation, salt marsh, which has no conservation status. The vegetation on Erf 12403 is partially mapped as Non-terrestrial estuarine vegetation, reeds and sedges which reflects a more fresh water influence at the site as has been confirmed through site verification.

Site verification by the botanist confirms that parts of the golf course adjacent to George Rex Drive are presently dominated by saltmarsh as well as reeds and sedges. Vegetation within most of the project area has been significantly modified is **no long representative of the mapped vegetation type**. The area mapped as Garden Route Shale Fynbos which is an Endangered vegetation type has been **completely transformed** to create the Knysna golf course and surrounding suburbs.

The theme sensitivity is therefore refuted and a sensitivity rating of 'Low' awarded. Input from the botanical/biodiversity specialist has been accommodated as part of this MMP. No further specialist study is required for this theme.

2.9. Terrestrial Biodiversity (Very High Sensitivity)

The screening tool identified this as being "Very High":



Image from Screening Tool identifying Terrestrial Biodiversity theme sensitivity for the property.

According to the Western Cape Biodiversity Spatial Plan (WCBSP; 2017) some of the proposed maintenance sites (culverts, drainage channels, dumping sites) are located in **Critical Biodiversity Area 1** and **Protected Areas**.

The lower Bigai Wetland area is categorised as **CBA1: Aquatic**, and the Knysna Estuary up to and including sections of the Knysna Golf Course are part of the **SANParks Protected Area** (Garden Route National Park).

The maintenance work to be undertaken is very limited and distributed over a number of locations in the Bigai wetland system. The work areas are small and in places deemed more sensitive hand work only, with clearing of invasive alien vegetation, search and rescue of plants as well as replanting of said plants in the same area as further mitigation.

Based on the input from the aquatic and botanical/biodiversity specialists, the awarded sensitivity is refuted and instead this theme was awarded a sensitivity rating of 'Low'. Further separate specialist input from the aquatic/botanical/biodiversity specialists are not deemed necessary as the MMP itself addresses maintenance actions and intent of the Protocols (GN 320 of 20 March 2020).

3. DESKTOP ASSESSMENT

3.1 Geographic Scope

The geographical scope of this assessment covers the lower reaches of the Bigai River which is predominantly wetland habitat where it enters the Knysna Estuary. The work proposed will all take place on land owned by the Knysna Municipality which includes the Knysna Golf Course, although the groundskeepers at the golf course would implement the work on that property (Figure 2). Where question marks are indicated on Figure 2, this is where culverts are suspected, but could not be confirmed due to the extent of overgrown vegetation. The following areas are covered:

- Lower reaches of the Bigai Wetland in the vicinity of Thesen, Howard, Kennet and Wilson Streets.
- All existing culverts beneath roads in the suburbs of Hunters Home and Rexford that lead to the Bigai Wetland and Knysna Estuary.
- Existing drainage channels on the Knysna Golf Course which drain from the Bigai Wetland to the Knysna Estuary.
- An artificial berm constructed between the Knysna Golf Course and the Bigai Wetland to reduce the impact of flooding on the 9th hole.

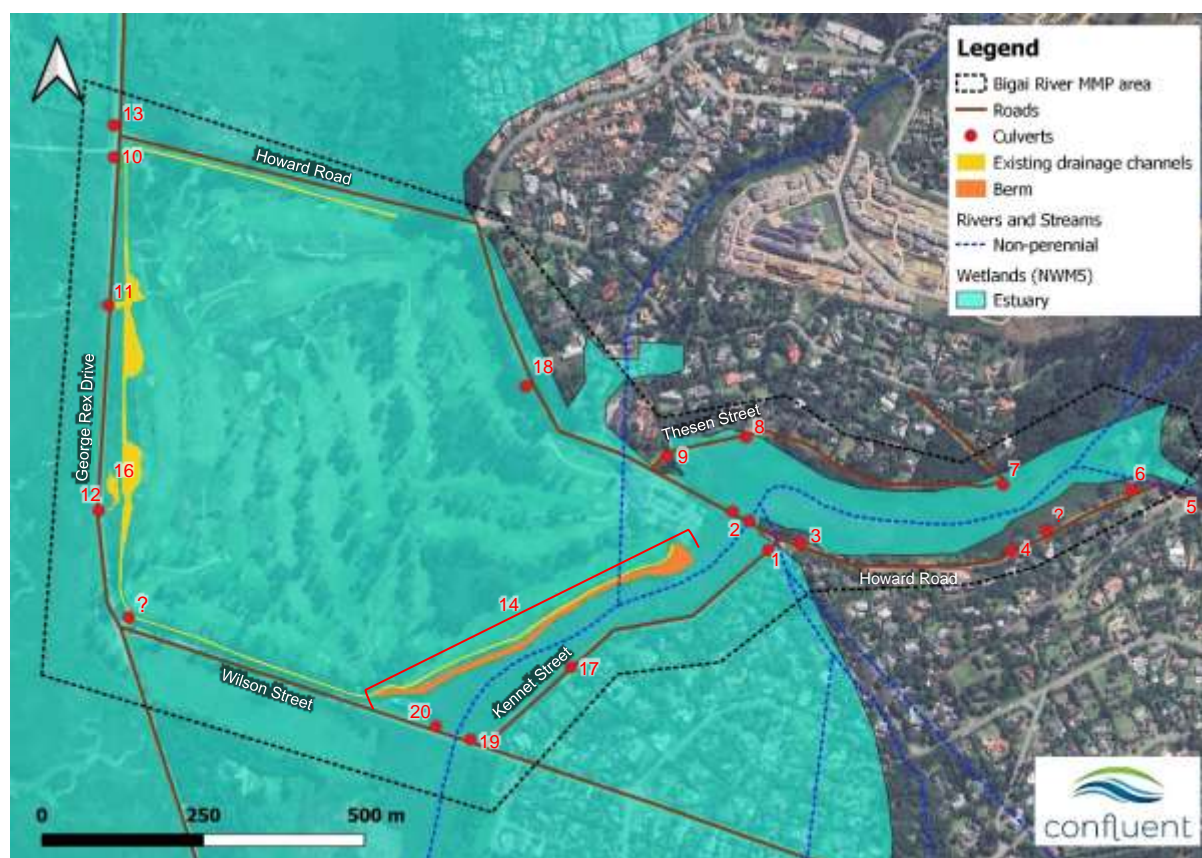


Figure 2. Area covered by this MMP indicating infrastructure and areas where maintenance is required.

3.2 Catchment Features

The Bigai River is in quaternary catchment K50B (Table 2). The Mean Annual Precipitation is 882 mm and the Mean Annual Runoff is 239 mm. Rainfall occurs year-round with seasonal peaks in spring and autumn (Figure 3). Rainfall can occur at a high intensity which has the potential to exacerbate the erosion potential of the site which is mapped as High.

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 - 1300 m.a.m.s.l.

Table 2. Summarised environmental features of the Bigai River and catchment.

| Feature | Description |
|--|--|
| Quaternary catchment | K50B |
| Mean Annual Runoff | 239 mm |
| Mean Annual Precipitation | 882 mm |
| Rainfall intensity | High (60.05) |
| Inherent erosion potential of soils (K-factor) | 0.57, High |
| Mapped Soil types | Podzolic soils: soils with a sandy texture, leached with a subsurface accumulation of organic matter, iron and aluminium oxides. |
| Ecoregion Level II | 20.02, South eastern coastal belt |
| NFEPA area | Sub-quaternary reach 9117, FEPA |

| | |
|-------------------------------|---|
| Mapped Vegetation Type | FFh9: Garden Route Shale Fynbos (Endangered; Vegmap, 2018) |
| Conservation | Protected Area: Garden Route National Park Critical Biodiversity Area 1: Aquatic, Wetland (CBA1; WCBSP) Garden Route Biosphere Reserve Outeniqua Strategic Water Source Area |

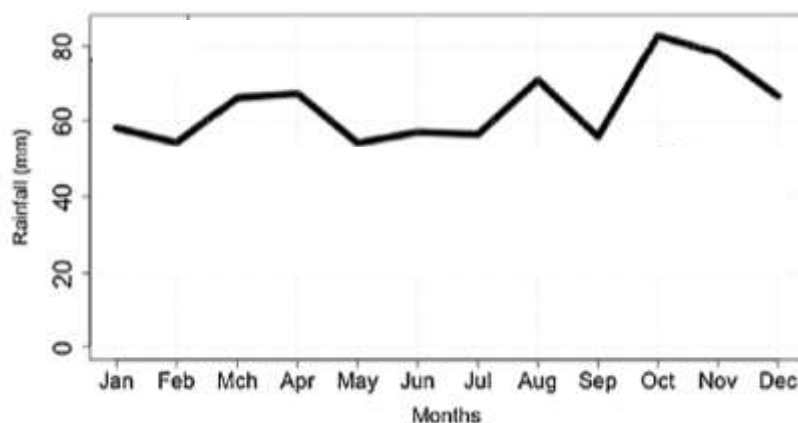


Figure 3. Area-averaged monthly rainfall for the coastal Southern Cape indicating peaks in Mar-Apr, Aug, and Oct. Data averaged between 1979 and 2011 (Engelbrecht *et al.*, 2015).

3.2.1 Western Cape Biodiversity Spatial Plan

According to the Western Cape Biodiversity Spatial Plan (WCBSP; 2017) some of the proposed maintenance sites (culverts, drainage channels, dumping sites) are located in Critical Biodiversity Area 1 and Protected Areas (Figure 4). The lower Bigai Wetland area is categorised as CBA1: Aquatic, and the Knysna Estuary up to and including sections of the Knysna Golf Course are part of the SANParks Protected Area (Garden Route National Park).

While this highlights the need to take a precautionary approach to maintenance considering local sensitivities, all proposed maintenance is to existing infrastructure.



Figure 4. Mapped areas identified in the Western Cape Biodiversity Spatial Plan (WCBSP; 2017).

3.2.2 National Freshwater Ecosystem Priority Areas

The project area is located within a sub-quaternary reach identified in the National Freshwater Ecosystem Priority Areas (NFEPA) as a **FEPA**, which is a Freshwater Ecosystem Priority Area (Nel *et al.*, 2011). FEPAs must remain in a good condition to manage and conserve freshwater ecosystems, and to protect water resources for human use. This does not mean these areas should be fenced off from humans, rather that they be supported by good planning, decision-making and management to ensure they are not degraded. The recommended condition for all FEPAs is an ecological category of A or B (Nel *et al.*, 2011).

3.2.3 Strategic Water Source Area

Most of the coastal areas south of the Outeniqua Mountain range, including the project area, area in 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.

3.3 Sub-catchment Land Use

The lower reaches of the Bigai Wetland primarily receive inflows from three natural tributaries draining the northern and eastern slopes of Noetzie Ridge. The sub-catchment for the Bigai River measures approximately 7.8 km². The northern tributaries flow from the densely

developed areas of Hornlee and Donkerhoek which have a combination of formal and informal housing. Sewage overflows and blockages are common and discharge into the Bigai River from various sources. The suburb of Hunters Estate consists of formal housing including a retirement estate and a private hospital. Development is high density with resulting high stormwater runoff rates. The southern part of the catchment drains the suburb of Rexford which is a formal residential area built on steeply sloping land. The eastern portion of the catchment has less transformed area and a largely natural stream flows into the Bigai River from this area.

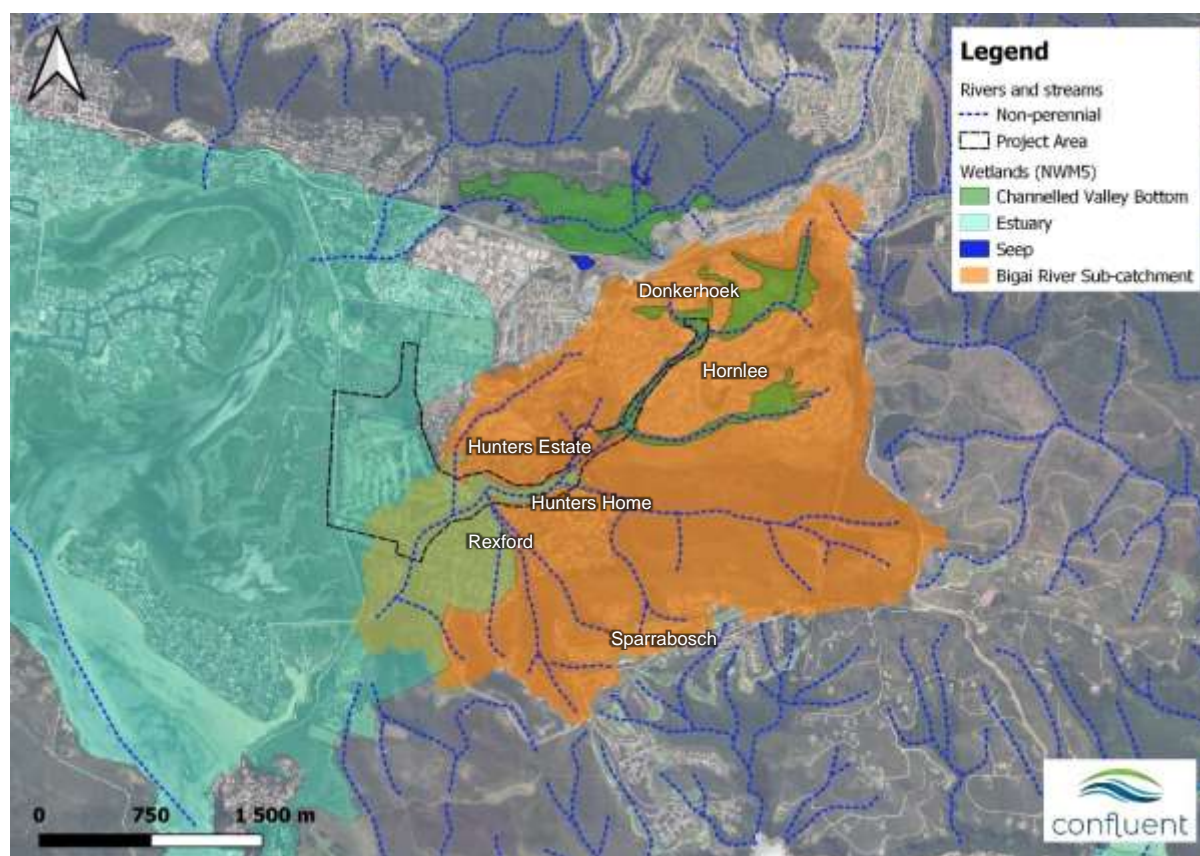


Figure 5. Mapped sub-catchment for the Bigai River showing the project area covered by this MMP indicating suburban areas.

3.4 Historical Assessment

The present location of Knysna Golf Course was set aside in the 1950s and it was described as “A swampy mosquito-infested area”. One of the golf club committee members invested his own time and resources to dig a drainage ditch using an excavator which runs along the boundary of the 15th hole. This canal carried much water off the course and into the lagoon. However, the golf course has always been prone to flooding, as soon after opening a period of prolonged wet weather resulted in the course closing for nine consecutive Saturdays due to flooding. (Source: Knysna Golf Course History).

In the 1970s or 80s an artificial soil berm was built between the golf course and the Bigai River to prevent floodwaters from entering the course. The berm runs adjacent to the drainage ditch which was excavated along the 9th hole.



Figure 6. Historical image of the Knysna Golf Course site during a flood event (Source: Knysna Golf Club History).

Historical aerial photos of the lower Bigai River / Wetland were sourced from the CD:NGI. In 1936 George Rex Drive was present, but the surrounding areas were still largely agricultural and the Bigai Wetland largely followed its original course. The present-day area of the Knysna Golf Course is shown in the 1936 image which indicates that a significant area of the western portion of the wetland was infilled to create the 9th hole of the golf course. A large proportion of the golf course area consisted of estuarine vegetation.

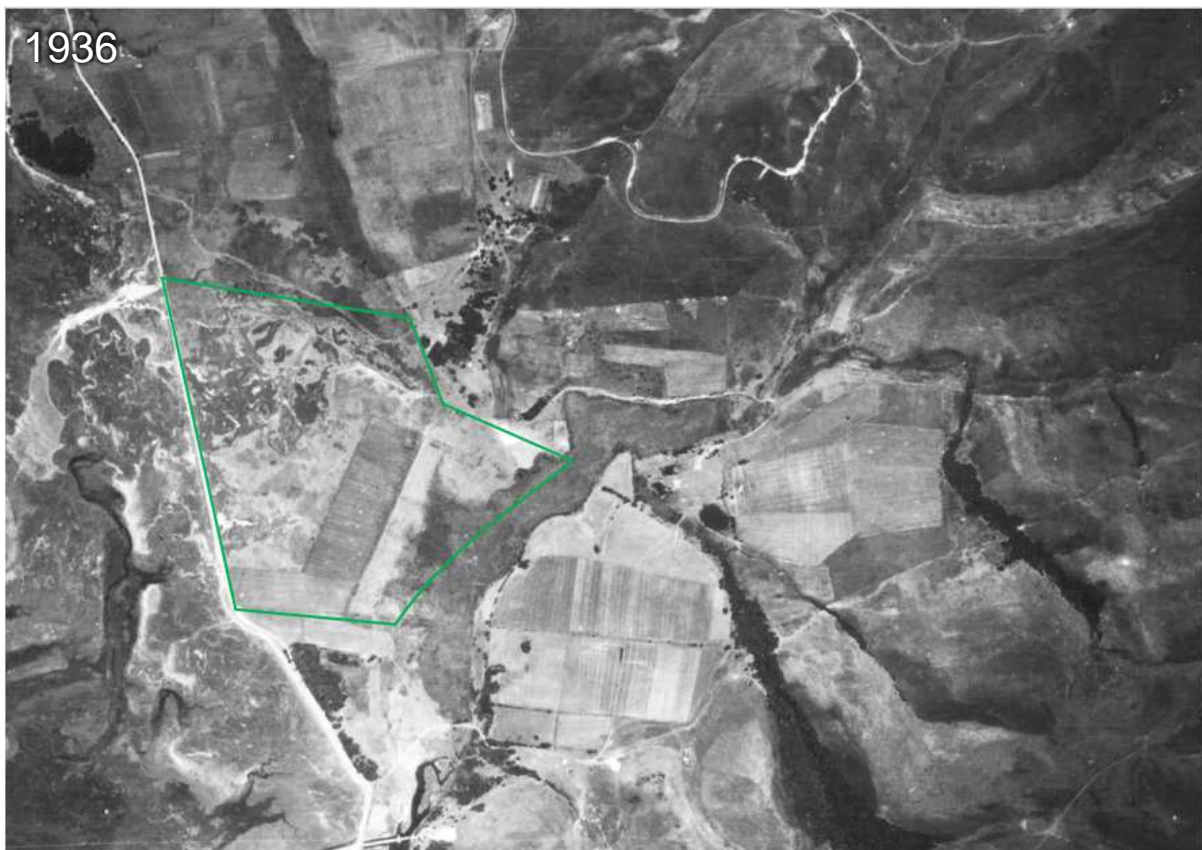




Figure 7. Historical aerial photos of the lower Bigai Wetland area in 1936 and 1974. Location of the golf course with construction of the golf course and streets are highlighted.

3.5 Site Contours

The Department of Environmental Affairs and Development Planning Spatial Information Management Unit has a database of 0,5 m contours for the 500m coastal zone for the Western Cape. These contours were modelled from a lidar survey conducted in 2013. While a decade has passed since then, the contours still provide insights into the accumulation of sediment in the Bigai Wetland which could be leading to reduced flows through the system. The contours do not extend to the Bigai River north of Howard Road.

Islands of sediment around Howard Street range between 3.5 and 4.0 m.a.m.s.l (light yellow in Figure 8). The height gradually decreases downstream to Wilson Street where elevation ranges between 2.0 and 2.5 m.a.m.s.l (medium to darker blue in Figure 8).

While it is likely that a repeat survey of this site would render new levels due to more recent sediment deposits and altered flow paths, observing the contours provide the following insights:

- The Knysna Golf Course is at a lower level than the Bigai River. The Golf Course ranges between 0.5 and 2.0 m.a.m.s.l, which means the Bigai River in the area around Howard Street is approximately 1.5 m to 2.0 m higher than the golf course. Assuming that the golf course and wetland were on more-or-less the same contours in 1936 this means a large quantity of sediment has accumulated in the wetland in excess of 10cubic metres.

- While height differences are minimal between Howard and Wilson Street, there is still a gradual decrease in levels in a downstream direction indicating that flow downstream would be maintained, albeit at a slow rate.
- There did not appear to be obvious plugs of sediment upstream or downstream of the few culverts which appear in relation to contours in Figure 8 (2013), indicating that sediment may be quite evenly distributed through the wetland. This makes sense because there are no channelled sections of the wetland, with water dispersing fairly uniformly across the site. However, this could only be confirmed with a repeat survey similar to that presented here.



Figure 8. Contours of the Bigai River between Howard Street and Wilson Street in relation to culverts. Based on 2013 Lidar survey of coastal areas (DEA&DP).

4. SITE ASSESSMENT

The Knysna Municipality, Knysna Golf Course and local resident's associations repeatedly highlight the same areas affected by flooding.

Each of these problem areas was visited and assessed to determine impacts contributing to poor drainage.

Several site visits were undertaken by the specialists, sometimes weeks after preceding rainfall. However, problem areas on Howard and Thesen Streets remained flooded during each site visit. This issue therefore requires serious and ongoing attention, as well as long-term alien vegetation management.

4.1 Flood-prone Areas

When high rainfall occurs, sections of Howard Street, Wilson Street and Thesen Street where they intersect with the Bigai Floodplain area become flooded and impassable by vehicles until floodwaters recede somewhat but can remain impassable by pedestrians for at least a week following rainfall. The 9th hole on the Knysna Golf Course becomes unplayable and cannot be maintained for months, negatively affecting revenue and play.

Flooding is being caused by several factors which are summarised as follows:

- Firstly, the lower reach of the Bigai River is naturally flat and poorly drained, being part of the Knysna Estuary. As a result of the low gradient, water tends to 'sit' in the system and drain very slowly (Figure 8).
- Erosion due to poorly managed development in the catchment has resulted in deposition of sediment in the lower Bigai River which has built up the riverbed over time (e.g. Figure 9).
- High nutrient inputs from the catchment due to leaking, blocked, and poorly functioning sewerage infrastructure have stimulated excessive growth of reeds such as *Typha capensis* and *Phragmites australis* which dominate vegetation at the site (Figure 9).
- Gradual silting up and blockage by vegetation of almost all culverts which are meant to drain the lower Bigai River.
- Siltation and vegetation growth in artificial drainage channels on the Knysna Golf Course and Erf 12403.



Figure 9. Photo taken on 31 March 2023 of a bulk sewerline that was opened to remove a blockage due to a walking crutch (arrow). Raw sewage and silt flowed straight downslope into the Bigai Wetland.

Photos of areas which are repeatedly flooded following rainfall events are presented in Table 2 and correspond to areas indicated in Figure 10.

Table 2. Flood-prone areas assessed in this MMP.

| Location | Photo | GPS Coordinate |
|--|--|---|
| <p>Howard Street near the Golf Course entrance – notice vegetation cover blocking the culverts that are suppose to drain below the street.</p> |  | <p>34° 3'30.89"S, 23° 4'48.73"E</p> |
| <p>Howard Street between the Knysna golf course and Erf 12403. Water flows from the site onto the road instead of through the existing culverts below the road.</p> |  | <p>34° 3'13.13"S, 23° 4'17.58"E</p> |
| <p>Wilson Street. Water flows over the surface of the road as it passed through the wetland preferentially towards the electrical sub-station which is not aligned with culverts and the culverts that are there are completely blocked.</p> |  | <p>34° 3'42.07"S, 23° 4'31.46"E</p> |
| <p>Thesen Street where water cannot drain through the culverts and vegetation cover is prevent the culverts from being unblocked.</p> |  | <p>34° 3'27.35"S, 23° 4'47.13"E</p> |

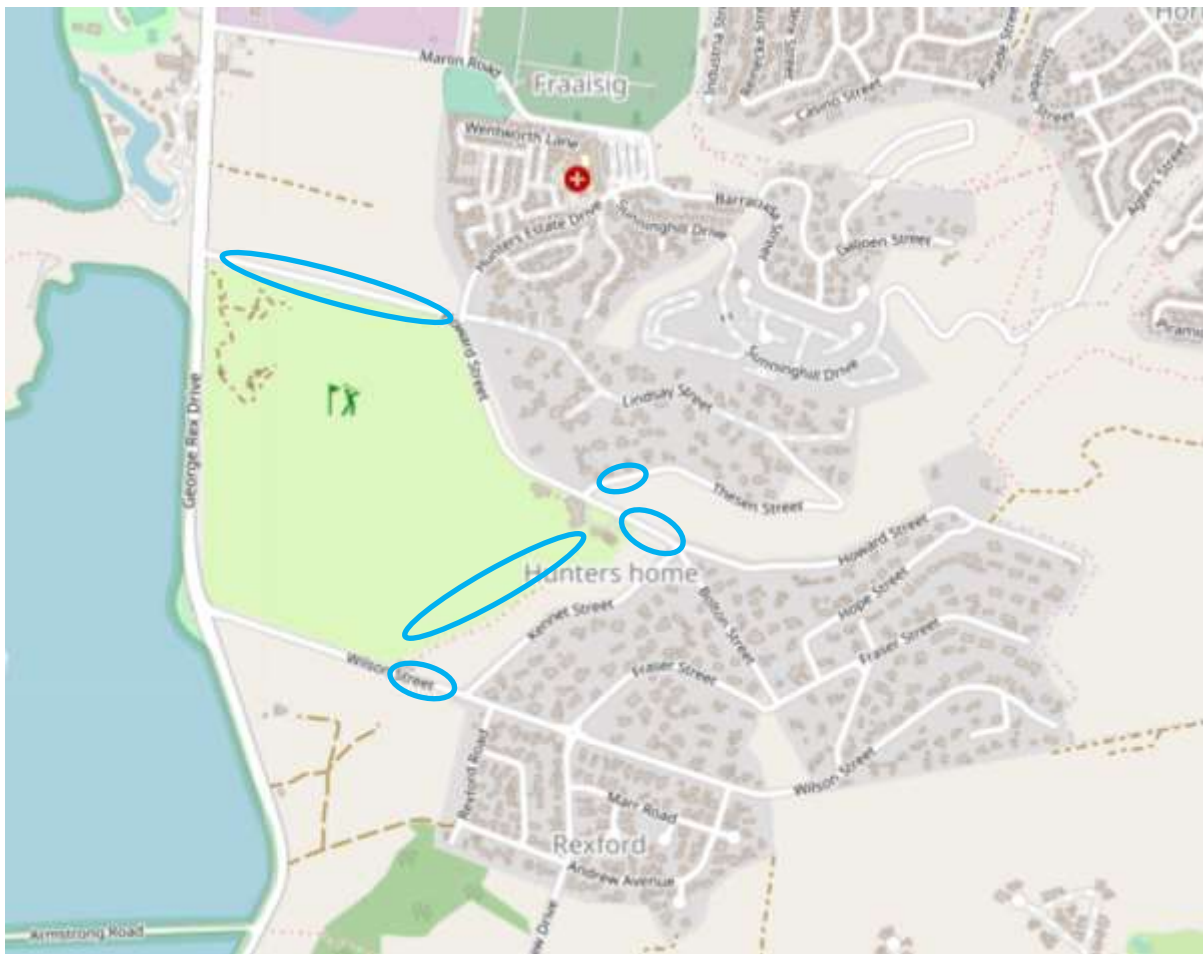


Figure 10. Street map of areas regularly affected by flooding encircled in blue.

4.2 Water Quality Results

One of the valuable ecosystem services provided by wetlands in urban environments is their improvement of water quality. This occurs when water polluted by chemicals, nutrients or suspended sediments is improved by flowing through the wetland, which acts as a biofiltration system. However, this function can become overwhelmed if a wetland is subject to very high inputs of polluted water for a sustained period of time.

While only providing a snapshot of the wetland’s function, relevant water quality parameters were measured as part of this study to gain a sense of water quality in the wetland. Samples

were collected at sites indicated in Figure 11 on 31 March 2023. A 1 litre sample was collected from each site using bottles pre-rinsed with water from the site, which were immediately kept on ice and subsequently refrigerated. Samples were submitted to Bemlab in Cape Town for analysis. Basic measurements of pH, dissolved oxygen, Electrical Conductivity and temperature were made at each site using a multiparameter Hanna meter.

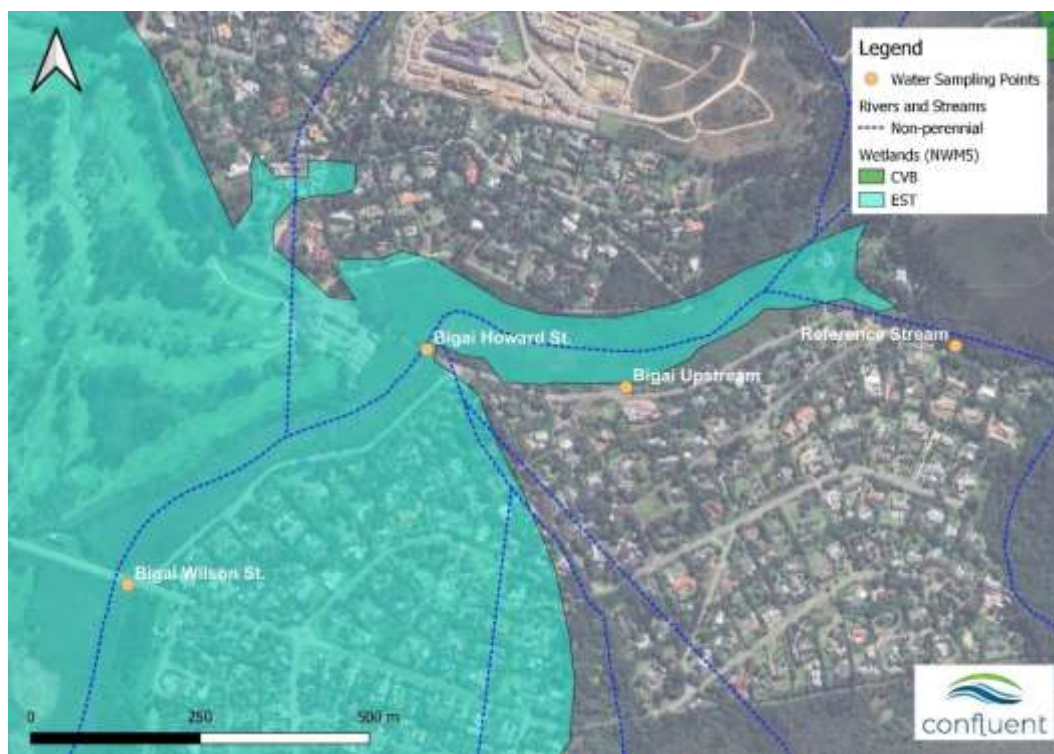


Figure 11. Four water sampling points along the Bigai Wetland and reference stream. Sampled on 31 March 2023.

Table 3. Water quality results from 4 samples collected on 31 March 2023 at locations in Figure 11.

| Parameter | Units | Reference Stream | Bigai Upstream | Bigai Howard Street | Bigai Wilson Street |
|------------------------------|-------------------------|------------------|----------------|---------------------|---------------------|
| pH | pH units | 6.5 | 7.01 | 6.55 | 6.95 |
| Electrical Conductivity | $\mu\text{S}/\text{cm}$ | 1 302 | 837 | 895 | 786 |
| Dissolved Oxygen | mg/L | 8.76 | 3.09 | 2.81 | 4.04 |
| Temperature | $^{\circ}\text{C}$ | 16.9 | 16.5 | 16.7 | 16.5 |
| Suspended Solids | mg/L | < 5.0 | < 5.0 | 55.0 | 20.0 |
| Total Nitrogen | mg/L | < 10.0 | 23.0 | 20.0 | <10.0 |
| Total Inorganic N | mg/L | < 0.05 | 18.5 | 16.3 | 6.9 |
| Ammonium (NH_4^+) | mg/L | < 0.05 | 17.8 | 15.7 | 6.7 |
| Ammonia | mg/L | < 0.05 | 0.71 | 0.62 | 6.9 |
| Nitrate (NO_3^-) | mg/L | < 0.18 | <0.18 | < 0.18 | 3.49 |
| Nitrite (NO_2^-) | mg/L | < 0.01 | <0.01 | 0.01 | <0,01 |
| Total Phosphorus* | mg/L | 0.25 | 1.9 | 5.0 | 2.3 |
| Orthophosphate | mg/L | < 0.08 | 0.99 | 0.56 | 0.81 |
| <i>E. coli</i> | Cfu/100ml | 340 | > 2000 | 420 | 510 |
| Faecal coliforms | Cfu/100ml | 390 | > 2000 | > 2000 | > 2000 |

*Total Phosphorus Eutrophication Categories: Oligotrophic (< 0.015); Mesotrophic (0.015-0.047); Eutrophic (0.047-0.13); Hypertrophic (> 0.130)

Water quality results presented in Table 3 provide an **indication of the level of nutrients, wastewater, and sediment** flowing through the system. The reference stream provides a comparison site with relatively fewer impacts anticipated due to minimal development in its catchment. Any impacts to the reference stream would likely originate from a single stream inflowing from the Sparrabosch area (Pezula Golf Estate; Figure 5) and a small part of Hunters Home, as all other streams flow through mostly natural areas. The following conclusions are made from a review of the water quality data:

- Total Phosphorus (TP) values place every sample point in the hypertrophic category on the scales of eutrophication (nutrient enrichment) using this metric (See footnote in Table 3). This is the **highest level of enrichment** likely to **cause nuisance growth of algae or aquatic plants**. While values in the Bigai wetland are orders of magnitude higher than those in the reference stream, the fact that TP is so high even in the reference stream indicates that **urban development throughout the catchment** negatively impacts **water quality** and is not being managed to preserve aquatic ecosystem health.
- Counts of *E. coli* and faecal coliforms give a good idea of the **levels of pollution** originating from **sewage-wastewater** as *E. coli* bacteria occurs in the guts of vertebrate animals (including humans) and can therefore only originate from faecal origin. Bacteria counts were **highest in the Bigai wetland**, particularly at the upstream site, which may have been related to a **sewage spill** observed on the same day as sampling (Figure 9). Although it is difficult to determine the degree to which that water would have dispersed through the system at the time of sampling. Again, the presence of *E. coli* in the reference stream indicate small amounts of **leaking sewage somewhere in the catchment**.
- The pattern of **Nitrogen distribution** through the wetland indicates **high inputs of Total Nitrogen** (including Organic N) in the upper reaches of the Bigai Wetland. The decrease in Total N and relative increase in Total Inorganic N either indicates a fresh input of N-enriched water upstream, or **nutrient spiralling downstream due to nitrification**.
- **Suspended solids** are an **indicator of the amount of suspended (mobile) sediment** in the water. None of the values were very high, which is to be expected because **water flows very slowly through the system**, providing **opportunity for all the sediment to settle out in the wetland** which contributes to blocking of the culverts/channels.

Nutrients and faecal bacterial counts in the Bigai Wetland system are **unacceptably high** from the perspective of aquatic ecosystem health and human health. Particularly as many workers need to wade bare-legged through the water on flooded roads. *E. coli* is a useful indicator organism of water polluted by sewage, but many other pathogenic (disease-forming) bacteria and viruses occur in water polluted by sewage.

4.3 Present Ecological State (PES)

The extent of the Bigai Wetland assessed in this report is indicated in Figure 2. This section of the wetland is classified as an Unchannelled Valley Bottom Wetland according to Ollis *et al.* (2013). No channels have formed within the wetland despite high volumes of stormwater inflow (Figure 12).



Figure 12. Drone image of the Bigai Wetland looking north-east with the 9th hole of the golf course to the left, and Kennet Street to the right.

4.3.1 PES Methods

The wetland PES was assessed using the Level 1 WET-Health assessment tool developed by Macfarlane *et al.* (2008). 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 method combines an assessment of hydrological, geomorphological and vegetation health in three modules.

Data collection involved a review of information from the desktop and field assessments considering 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. 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. The condition ranges in scale from 1-10 and resultant scores were then used to assign the wetland into one of six PES categories as shown in Table 4.

Table 4. Wetland Present Ecological State categories and impact descriptions.

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

4.3.2 PES Results

The results of each of the three modules for WET-Health yielded a score of 'D' which ultimately classed the Bigai Wetland in a category **D/E** which is **Largely to Seriously Modified**. The main impacts contributing to the declined state of the wetland are listed below:

- Wetland habitat loss due to construction of the 9th hole at the golf course.
- Loss of hydrological area due to construction of the 9th hole and the flood berm at the golf course.
- Large increase in runoff from the catchment increasing flood peaks and base flows.
- Increase in sedimentation through substantial areas of the wetland.
- Change in dominance of plants to alien species in some areas, and *Phragmites australis* and *Typha capensis* reeds across most of the wetland.

4.4 Ecological Importance and Sensitivity (EIS)

4.4.1 EIS 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 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 5).

Table 5. 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 |
|---|-----------------|---|
| <u>Very high:</u> 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 |
| <u>High:</u> 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 |
| <u>Moderate:</u> 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 |
| <u>Low/marginal:</u> 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 |

4.4.2 EIS Results

While **no Red Data or unique species** were observed during several field trips, it is not impossible that birds such as the Knysna Warbler could occur in the wetland. However, the presence of special species would only marginally alter the EIS which for the Bigai Wetland was classified as **High** (Table 6).

Table 6. Ecological Importance and Sensitivity for the Bigai Wetland.

| Ecological importance and sensitivity | Score 0-4 | Confidence 1-5 | Motivation |
|--|--------------|-------------------|--|
| Biodiversity support | 1.3 | | |
| Presence of Red Data species | 0 | 2 | None recorded and none expected |
| Populations of unique species | 0 | 2 | None recorded or observed |
| Migration/feeding/breeding sites | 4 | 5 | Used extensively by a range of birds and small to medium sized mammals. |
| Landscape scale | 2.8 | | |
| Protection status of wetland | 3 | 4 | Partly included in the Protected Area |
| Protection status of vegetation type | 4 | 4 | Critically Endangered |
| Regional context of the ecological integrity | 2 | 4 | There are similar wetlands in better condition, but not many |
| Size and rarity of the wetland types present | 3 | 4 | Relatively large wetland for a UVB |
| Diversity of habitat types | 2 | 4 | Marginal diversity as eutrophication and sedimentation have homogenised the environment. |
| Sensitivity of the wetland | | | |
| Sensitivity to changes in floods | 2 | 3 | Predominantly increased floods. |
| Sensitivity to changes in low flows | 2 | 4 | Vegetation die-back could occur |
| Sensitivity to changes in water quality | 2 | 4 | Change to an altered state of vegetation with different species dominant. |
| Hydrofunctional Importance | 2.3 | | |
| Direct human benefits | 0.8 | | |
| ECOLOGICAL IMPORTANCE AND SENSITIVITY | 2.8 | | HIGH |

4.4.3 Botanical and faunal sensitivities

Fouché (2023) confirms that according to SANBI Vegmap (2018) the mapped vegetation type in the project area is **Garden Route Shale Fynbos**. The conservation status of this vegetation type was revised from Vulnerable to Endangered in the gazetted revision of nationally listed ecosystems in need of protection (GN 2747 of the National Environmental Management Act: Biodiversity Act; Act No. 10 of 2004).

Areas to the west of George Rex Drive and the golf course are mapped as Non-terrestrial estuarine vegetation, salt marsh, which has no formal conservation status. The vegetation on Erf 12403 is partially mapped as Non-terrestrial estuarine vegetation, reeds and sedges which reflects a more fresh water influence at the site.

In reality, vegetation types do not follow a straight line, and the low-lying reaches of the Bigai River within the Estuarine Functional Zone were likely more saline in nature with estuarine vegetation. Historical photos of the golf course for instance, indicate vegetation similar to that in the larger estuarine area in 1936 (Figure 7). Parts of the golf course adjacent to George Rex Drive are presently dominated by saltmarsh as well as reeds and sedges.

Vegetation within most of the project area has been **significantly modified** is no long representative of the mapped vegetation type. The area mapped as Garden Route Shale Fynbos which is an Endangered vegetation type has been **completely transformed** to create the Knysna golf course and surrounding suburbs.

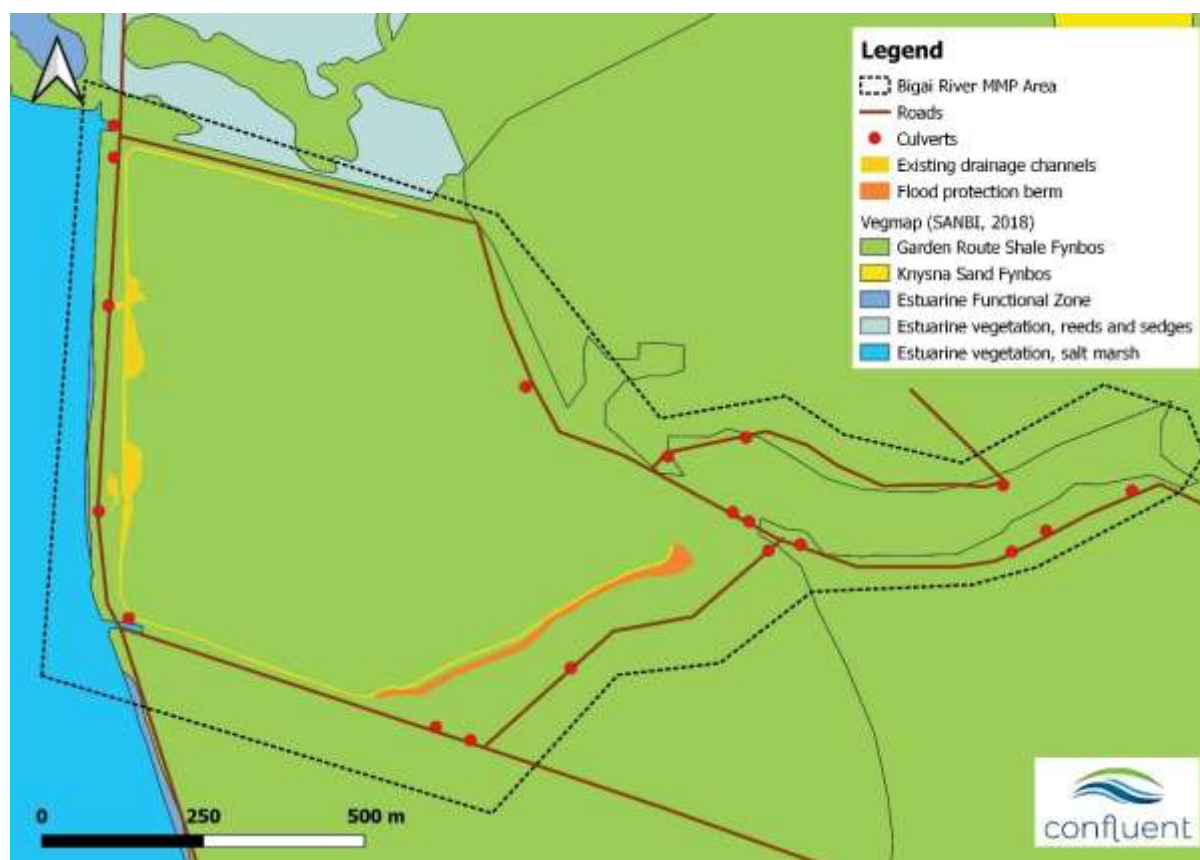


Figure 13. Mapped vegetation of the area covered by the MMP according to VegMap (2018).

The conservation importance of the Knysna Estuary is highly significant, and as it is the final sink for pollutants, litter, and sediment from the town of Knysna it is imperative that any maintenance of watercourses takes this into account. The Knysna Estuary is a unique estuarine system that has been ranked as the most important estuary in South Africa in terms of conservation importance.

Preservation of its fauna and flora alone would ensure that 42% of South Africa's estuarine biodiversity would be conserved (Turpie *et al.*, 2002). The estuary is home to a number of critically endangered invertebrate species including the Knysna seahorse (*Hippocampus capensis*), the pulmonate limpet (*Siphonaria compressa*) and the pansy shell (*Echinodiscus bisperforatus*; Angel *et al.*, 2006).

Considering the following (maximum) specifications for maintenance areas, it is anticipated that a maximum of 56m² of vegetation clearing may be required at each of the culvert positions¹ (estimated total 1 008m² cover both sides of the road at each position = 1 008m²). The clearance of vegetation along the berm (500m long), as well as the channel (900m long) is estimated at 2 800m² (clearance of at least 2m wide along these linear structures). The

¹ The widest culvert is measured at 12m, whilst the smallest is measured at 1m. The clearing must at least extend 2m beyond the culvert (length) and 2m into the wetland

combined maximum of vegetation removal necessary to allow maintenance of these structures/infrastructure is therefore estimated at 3 808m².

Refer to section 5 of this MMP for further details on invasive alien vegetation management as well as re-vegetation and rehabilitation measures applicable to the botanical/biodiversity themes.

5. MAINTENANCE ACTION PLAN

During each of the site visits, **every culvert** meant to drain the area of high flowing water through the Bigai wetland or surrounding areas **was inspected** to assess the level of blockage and free flow. Most culverts were **completely blocked** with **silt and vegetation**.

Photos of infrastructure and points where maintenance is required are presented in [Table 10](#).

The coordinates of each site are indicated and correspond with points indicated in [Figure 2](#).

Most culverts could be located, but some are well hidden by **dense vegetation** which will **require clearing** to access and maintain these culverts. Many **culverts were completely blocked with reeds and silt** and had standing water in them.

5.1 Timing of Maintenance Works

If possible, maintenance actions should take place during cooler winter months (April to August) as this is when most animals are not breeding. This may not be possible given the urgency of the required maintenance and unknown timeframes for approval of the authorisation. Work should not be undertaken when rainfall is predicted, during rainfall, or immediately post-rainfall. At least a day following significant rainfall events should be waited until work commences again.

Note that the Knysna Municipality obtained a Section 30A Directive on 13 October 2023 allowing urgent once-off repairs and maintenance work (some within the same area as what is covered in this MMP). This MMP will be valid for a period of five (5) years (which can be extended) to enable continued maintenance work in accordance with the scope of this MMP.

5.2 Order of Maintenance Works

All maintenance work described in this MMP is to take place in the direction from **upstream to downstream**. This is to protect the Knysna Estuary, and therefore the culverts along **George Rex Drive** should be scheduled for **clearance last**.

It is recommended that a **silt fence** be erected at the **outlet of each** of the culverts along **George Rex Drive** and remain in place until at least one significant rainfall has 'flushed' through with improved drainage.

Detailed methods for the installation of silt fences are provided in Section 4.5.

5.3 Clearance of Culverts

It is critical that all maintenance and remedial work activities to be undertaken, **must remain within** and must **not result in any expansion** of the existing footprints of the affected relevant structures.

In all cases where culverts must be cleared, the standard area for clearance should be to **expose the full area of concrete** (width x height) with an **additional 1 m on either side**, and **2 m beyond into either wetland or estuarine habitat**, maintaining the same depth.

Excavations are mostly **recommended by hand**, but a **small excavator working from the road surface** may be used for **larger culverts** where stipulated ([Table 10](#)).

Immediately following the clearance of all culverts on George Rex Drive, a **silt fence** must be constructed around the edge of the excavated area to reduce the impact of sedimentation in the estuary.

Detailed methods for the construction of silt fences is provided in Section 4.5.

5.4 Excavation of Drainage Channel

It is critical that all maintenance and remedial work activities to be undertaken, **must remain within** and must **not result in any expansion** of the existing footprints of the affected relevant structures.

The drainage channel on the golf course parallel to the Bigai River is completely overgrown with vegetation which limits the function of this channel in conveyance of flows.

Methods are provided in Table 10 for the **excavation of accumulated silt and vegetation**. Recommendations are made for the **disposal of silt on site in the golf course**. The golf course uses such silt for landscaping features along fairways, but the silt may not be used in any water features on the golf course.

Vegetation removal should aim to **remove all alien plants growing in the channel**, and where possible, retain indigenous wetland plants along the banks of the channel. Small wetland plants growing along in the channel itself are beneficial for water quality in terms of sediment trapping and nutrient removal. Where possible, indigenous wetland plants disturbed by excavations must be replanted.

5.5 Vegetation Management

5.5.1 Alien Invasive Plants

A list of commonly encountered alien vegetation throughout the Bigai Wetland area has been provided in [Table 2](#).

Adjacent to the drainage channel on the 9th hole the flood protection berm is covered by extensive establishment of alien vegetation (mainly *Acacia mearnsii* and *Acacia melanoxylon*), which must be cleared and managed on an ongoing basis through follow up clearing.

Manage large alien trees (mainly black wattle) growing along the top of the flood protection berm. These trees are prone to falling over, taking out large pieces of the berm with them. Removal of the trees is not only a legal requirement of the landowner (Knysna Municipality) but will prolong the life of the berm.

Such trees must be cut and the stumps treated with a registered herbicide (gel type is good as it does not dribble or spread easily). Woody material must not be discarded into the Bigai River or into the artificial drainage channel.



Figure 14. An example of extensive stands of alien vegetation in the drainage channel (*Canna indica*) and above on the flood berm (*Acacia mearnsii*) at the golf course.

Wherever alien plants listed in Table 2 are encountered during maintenance operations in this MMP, these **plants must be physically removed** or controlled using recognised best practice methods. However, herbicides may be used within wetland areas due to high risk of impacting aquatic life. **Ring barking is a good alternative** for larger trees in wetland areas.

Table 7. List of declared weeds and invaders recorded in the Bigai Wetland and along the artificial channel and berm at the golf course.

| Species Name | Common Name | Growth Form | NEMBA Category |
|---------------------------------|--------------------------|-----------------|----------------|
| <i>Acacia mearnsii</i> | Black wattle | Tree | 2 |
| <i>Acacia melanoxylon</i> | Australian blackwood | Tree | 2 |
| <i>Canna indica</i> | Garden canna lily | Shrub | 1b |
| <i>Cestrum laevigatum</i> | Inkberry | Shrub/tree | 1b |
| <i>Cirsium vulgare</i> | Spear thistle | Herb | 1b |
| <i>Cortaderia selloana</i> | Pampas grass | Grass | 1b |
| <i>Eucalyptus grandis</i> | Saligna gum | Tree | 2 |
| <i>Paraserianthes lophantha</i> | Australian albizia | Tree | 1b |
| <i>Pennisetum purpureum</i> | Elephant Grass | Very tall grass | 2 |
| <i>Ricinis communis</i> | Castor Oil Plant | Small tree | 2 |
| <i>Rubus sp.</i> | Bramble, Blackberry | Shrub | 1b |
| <i>Sambucus nigra</i> | Elderberry | Shrub/tree | 1b |
| <i>Solanum elaeagnifolium</i> | Silver-leaf bitter apple | Shrub | 1b |
| <i>Solanum mauritianum</i> | Bugweed | Shrub | 1b |
| <i>Vinca major</i> | Periwinkle | Herb | 1b |

Table 8. NEMBA categories for invasive alien plants.

| Invasive Status (category) | Description |
|----------------------------|-------------|
|----------------------------|-------------|

| | |
|------------------------------|---|
| Category 1b (Prohibited) | <ul style="list-style-type: none"> • Invasive species requiring compulsory control as part of an invasive species control program. • Remove and destroy. • Plants deemed to have such a high invasive potential that infestations can be placed under a government sponsored invasive species management program. • No permits can be issued. |
| Category 2 (Permit required) | <ul style="list-style-type: none"> • Invasive species regulated by area. • A demarcation permit is required to import, possess, grow, breed, move, sell, buy or accept as a gift any plants listed in Category 2. • No permits will be issued for these plants to exist in riparian zones. |

5.5.2 Revegetation with Indigenous Plants

Two areas where revegetation may be required would be the flood protection berm at the golf course, and to a lesser degree the drainage channel at the golf course.

It is anticipated that most of the **wetland plants disturbed during excavation** of the drainage channel would **rapidly re-establish**, but it is worthwhile indicating which are the indigenous species to preserve, an potentially saving these for replanting along the banks of the channel where possible. The aim is to **reduce open, disturbed areas of soil** which can be rapidly colonised by aliens, and erosion of the soil berm.

Given that *Phragmites australis* (Fluitjiesriet) and *Typha capensis* (Bullrushes) are already abundant at the site, **plant rescue efforts** must focus on other **wetland plant groups** such as sedges, rushes and restios, examples are indicated in Figure 15.





Figure 15. Examples of indigenous wetland plants found in the Bigai Wetland that can be rescued and replanted in disturbed areas along the golf course channel.

Revegetation of the berm is likely to be more difficult as the quality of soil is unknown, and the gradient of the slopes is high.

As a first step, **indigenous grass must be planted**, consisting of a mix of *Cynodon dactylon* (kweek) and *Stenotaphrum secundatum* (Buffalo grass) as this will provide a rapid cover and stabilise slopes.

It is recommended that **no trees be planted** on the berm, **only large, indigenous shrubs**, as these provide stability without taking half the berm with them if they fall over.

A list of recommended plant species which are indigenous to the area, obtainable from nurseries, and that occur in the local fynbos vegetation is presented in Table 9. The plants listed may not always be attainable, and therefore alternative species can be sought from local nurseries or landscapers provided the species occur naturally in the Knysna basin.

Table 9. Indigenous plant species recommended for revegetation of the flood berm at Knysna golf course.

| Species Name | Common Name | Growth Form |
|------------------------------|---------------------------------|--------------------|
| <i>Aristea capitata</i> | Blousuurkanol | Small tufted Shrub |
| <i>Aristida junciformis</i> | Ngoningoni three-awn | Large tufted grass |
| <i>Chlorophytum comosum</i> | Hen and chickens | Small tufted shrub |
| <i>Euryops virgineus</i> | Rivierharpuisbos | Medium Shrub |
| <i>Helichrysum cymosum</i> | Strawflower | Small Shrub |
| <i>Helichrysum petiolare</i> | Licorice plant | Small Shrub |
| <i>Metalasia densa</i> | Blombos | Medium Shrub |
| <i>Passerina corymbosa</i> | Gonna | Medium Shrub |
| <i>Psoralea affinis</i> | Blue bells bush / Fountain bush | Large Shrub |
| <i>Selago corymbosa</i> | Bitter bush | Shrublet |



5.6 Maintenance Action Plan




The action plan for each site where maintenance is required is presented in [Table 10](#). This table must be fully explained to workers and contractors who would undertake the stipulated maintenance actions prior to any maintenance work starting. The table must be read in conjunction with all preceding information in Section 5.




Table 9 contains the specific management actions for each of the identified sites. The management outcomes associated with all of these actions are similar throughout, being:




- maintaining good water quality,
- improving freshwater flow and
- reducing unwanted flooding.



Table 10. Locations and pictures of infrastructure where maintenance is required. Numbered locations refer to Figure 2.


| No. | Location | Photo | GPS Coordinate | Description | Maintenance Actions |
|-----|---|--|---|--|---|
| 1 | Kennet Street Street Parcel RE/2090 |  | 34° 3'32.50"S, 23° 4'50.66"E | Culvert. Water pushing up (observable flow) through the road surface | <ul style="list-style-type: none"> Investigate presence of culvert either side of the road. If present, the culvert must be cleared by hand of vegetation, sediment & litter. Area of clearance is along the length of each culvert plus a metre either side, to the depth of the concrete, and 2 m into the wetland. Sediment may be used by the golf course for landscaping excluding water features. |
| 2 | Howard Street 2 culverts up and downstream 10m and 4m in length Street Parcel RE/2090 |  | 4 m culvert: 34° 3'31.13"S, 23° 4'49.43"E & 10m culvert: 34° 3'30.68"S, 23° 4'48.46"E | Culverts completely covered by vegetation and silt up and downstream of the road crossing. | <ul style="list-style-type: none"> Vegetation and sediment must be cleared by hand or using a small excavator positioned on the road. Area of clearance is along the length of each culvert plus a meter either side (12m and 6m respectively), to the depth of the concrete, and 2 m into the wetland. Sediment may be used by the golf course for landscaping excluding water features. |



| | | | | | |
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| <p>3</p> | <p>Howard Street Street Parcel RE/2090</p> |  | <p>34° 3'32.28"S, 23° 4'52.47"E</p> | <p>2 m culvert blocked by vegetation and silt on both sides of the road.</p> | <ul style="list-style-type: none"> • Vegetation and sediment must be cleared by hand. • Area of clearance is along the length of each culvert plus a metre either side, to the depth of the concrete, and 2 m into the wetland. • Sediment may be used by the golf course for landscaping excluding water features. |
| <p>4</p> | <p>Howard Street Street Parcel RE/2090</p> |  | <p>34° 3'31.59"S, 23° 5'7.39"E</p> | <p><u>Possible</u> culvert blockage. Water standing on surface and draining onto road. Vegetation growing on road.</p> | <ul style="list-style-type: none"> • Investigate presence of culvert either side of the road. • If present, the culvert must be cleared by hand of vegetation, sediment & litter. • Area of clearance is along the length of each culvert plus a metre either side, to the depth of the concrete, and 2 m into the wetland. • Sediment may be used by the golf course for landscaping excluding water features. |
| <p>5</p> | <p>Howard Street Street Parcel RE/2090</p> |  | <p>34° 3'29.99"S, 23° 5'14.82"E</p> | <p>Culvert sides breaking apart. Require repairs. Culvert partially blocked with silt further down.</p> | <ul style="list-style-type: none"> • Not in a watercourse but needs repair work as the cement sides are breaking apart and siltation has occurred in the pipe. <ul style="list-style-type: none"> • Silt must be cleared out the pipe. |




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| <p>6</p> | <p>62 Howard Street Street Parcel RE/2090</p> |  | <p>34° 3'29.60"S, 23° 5'12.58"E</p> | <p>Culvert beneath driveway requires vegetation and silt clearance</p> | <ul style="list-style-type: none"> • Vegetation and sediment must be cleared by hand. • Area of clearance is along the length of each culvert plus a metre either side, to the depth of the concrete, and 2 m into the wetland. |
| <p>7</p> | <p>Thesen Street Street Parcel RE/2090</p> |  | <p>34° 3'29.32"S 23° 5'4.79"E</p> | <p>2 m culvert blocked with vegetation and silt which must be removed.</p> | <ul style="list-style-type: none"> • Vegetation and sediment must be cleared by hand. • Area of clearance is along the length of each culvert plus a metre either side, to the depth of the concrete, and 2 m into the wetland. • Sediment may be used by the golf course for landscaping excluding water features. |
| <p>8</p> | <p>Thesen Street Street Parcel RE/2090</p> |  | <p>34° 3'27.01"S, 23° 4'48.45"E</p> | <p>1 m Culvert is silted up and not draining beneath the road and into the wetland opposite. Both culvert sides to be cleared of silt and vegetation.</p> | <ul style="list-style-type: none"> • Vegetation and sediment must be cleared by hand. • Area of clearance is along the length of each culvert plus a metre either side, to the depth of the concrete, and 2 m into the wetland. • Sediment may be used by the golf course for landscaping excluding water features. |


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| <p>9</p> | <p>Thesen Street Street Parcel RE/2090</p> |  | <p>34° 3'27.89"S, 23° 4'44.54"E</p> | <p>2 m culvert is silted up and full of vegetation which must be cleared to restore flow conveyance.</p> | <ul style="list-style-type: none"> • Vegetation and sediment must be cleared by hand. • Area of clearance is along the length of each culvert plus a metre either side, to the depth of the concrete, and 2 m into the wetland. • Sediment may be used by the golf course for landscaping excluding water features. |
| <p>10</p> | <p>George Rex Drive Street Parcel RE/2090</p> |  | <p>34° 3'12.94"S, 23° 4'11.06"E</p> | <p>Culvert must be checked for flow conveyance. The invert level may be too high and require lowering. Silt and vegetation must be cleared if necessary.</p> | <ul style="list-style-type: none"> • Vegetation and sediment must be cleared by hand. • Area of clearance is along the length of each culvert plus a metre either side, to the depth of the concrete, and 2 m into the wetland. • Sediment may be used by the golf course for landscaping excluding water features. • As soon as the culvert is cleared, a silt fence must be installed on the estuary side of the culvert to prevent excessive siltation from entering the estuary. |
| <p>11</p> | <p>George Rex Drive Street Parcel RE/2090</p> |  | <p>34° 3'20.34"S, 23° 4'10.73"E</p> | <p>Culvert recently upgraded and functioning well. May require periodic clearance of silt and vegetation reducing conveyance.</p> | <ul style="list-style-type: none"> • If flows are blocked in either direction it is necessary to clear vegetation, silt and litter from the culvert by hand. • Area of clearance is aligned with the gabions, plus a metre either side, to the depth of the gabions and 2 m into the wetland / estuary. • Sediment may be used by the golf course for landscaping including water features. • As soon as the culvert is cleared, a silt fence must be installed on the estuary side of the culvert to prevent excessive siltation from entering the estuary. |

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| <p>12</p> | <p>George Rex Drive Street Parcel RE/2090</p> |  | <p>34° 3'30.62"S, 23° 4'10.14"E</p> | <p>Culvert currently blocked and requires periodic clearance of vegetation and silt.</p> | <ul style="list-style-type: none"> • Vegetation and sediment must be cleared by hand. • Area of clearance is along the length of each culvert plus a metre either side, to the depth of the concrete, and 2 m into the wetland/estuary. • Sediment may be used by the golf course for landscaping excluding water features. • As soon as the culvert is cleared, a silt fence must be installed on the estuary side of the culvert to prevent excessive siltation from entering the estuary. |
| <p>13</p> | <p>George Rex Drive Street Parcel RE/2090</p> |  | <p>34° 3'11.37"S 23° 4'11.40"E</p> | <p>Culvert pictured when it was last cleared in 2015, it is now blocked and needs to be cleared of silt again. Visible pipes are fibre cables and a water pipe.</p> | <ul style="list-style-type: none"> • Vegetation and sediment must be cleared by hand. • Area of clearance is along the length of each culvert plus a metre either side, to the depth of the concrete, and 2 m into the wetland/estuary. • Sediment may be used by the golf course for landscaping excluding water features. • As soon as the culvert is cleared, a silt fence must be installed on the estuary side of the culvert to prevent excessive siltation from entering the estuary. |

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| <p>14</p> | <p>Golf course 9th hole drainage channel (artificial) Erf 2233</p> |  | <p>900 m length from: 34° 3'33.03"S, 23° 4'44.66"E To 34° 3'35.83"S, 23° 4'11.96"E</p> | <p>Historical artificial channel that drains water off the 9th hole has silted up and requires sediment and vegetation removal.</p> | <ul style="list-style-type: none"> • Check the weather forecast and plan work for a dry spell lasting at least a week. • Excavate silt and vegetation in the direction from upstream to downstream. • Clearance can be by hand and/or a small excavator positioned on the adjacent fairway. • Clear silt and vegetation from the channel, measuring 2 m wide and 50-80 cm deep. • Ensure the channel is graded in a gentle slope in a downstream direction. • Clear 100m per week over 5 weeks. In this manner disturbance to wildlife will be minimised. • Alien plants should be removed during this process and include Canna lilies (<i>Canna indica</i>). <ul style="list-style-type: none"> • Cleared sediment can be used for landscaping outside of water features by the golf course. • Ensure excavator has no leaks and is in good working order. • All workers must dispose of litter or waste in bins and must not damage or pollute the drainage channel. |
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|-----------|---|--|---|---|--|
| <p>14</p> | <p>Golf course flood protection berm between 9th hole and Bigai Wetland Erf 2233</p> |  | <p>500 m length from 34° 3'33.03"S, 23° 4'44.66"E To 34° 3'39.76"S, 23° 4'27.74"E</p> | <p>Historical soil berm built to reduce flooding on golf course. Has numerous black wattles which must be removed.</p> | <ul style="list-style-type: none"> • Large black wattles (<i>Acacia mearnsii</i>) and Blackwood (<i>Acacia melanoxylon</i>) must be cut down and the stumps painted with gel-type herbicide registered for use, not a foliar spray. • Smaller trees can be hand-pulled or removed including roots using a Tree Popper. • Remove all cut biomass from the site and dispose of it at an appropriate green waste site. No material must be discarded in the Bigai Wetland or the drainage channel on either side of the berm. • Aim to achieve a minimum of 80% vegetation cover on the berm. |
| <p>16</p> | <p>Knysna Golf Course adjacent to George Rex Drive, this channel is adjacent to the above culvert. Erf 2232</p> |  | <p>34° 3'29.76"S 23° 4'11.43"E</p> | <p>A small embankment of sand and vegetation cuts off the internal from the external channel. A notch (yellow) of approximately 4m³ needs to be excavated to improve flow.</p> | <ul style="list-style-type: none"> • Dig out a section of 4 m³ of sediment in the embankment to improve through-flow between the drainage channel and the culvert leading to the estuary. <ul style="list-style-type: none"> • Digging must be done by hand. • Sediment can be used for landscaping in the golf course outside of water features. |

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| <p>17</p> | <p>Kennet Street Street Parcel RE/2090</p> |  | <p>34° 3'38.45"S, 23° 4'38.68"E</p> | <p>1 m culvert blocked with silt which must be excavated until the bottom later of concrete has been reached on both sides.</p> | <ul style="list-style-type: none"> • Vegetation and sediment must be cleared by hand. • Area of clearance is along the length of each culvert plus a metre either side, to the depth of the concrete, and 2 m into the wetland downstream. • Sediment may be used by the golf course for landscaping excluding water features. |
| <p>18</p> | <p>Howard Street Street Parcel RE/2090</p> |  | <p>34° 3'24.40"S, 23° 4'35.94"E</p> | <p>1 m culvert leading to the golf course needs to be cleared of silt and vegetation on both sides of the road.</p> | <ul style="list-style-type: none"> • Vegetation and sediment can be cleared by hand or using a small excavator working from the road. • Area of clearance is along the length of each culvert plus a metre either side, to the depth of the concrete, clearing can follow the channel as long as necessary to reach the drainage channel on the golf course perimeter. • Cleared sediment may be used by the golf course for landscaping excluding water features. |
| <p>19</p> | <p>Wilson Street Street Parcel RE/2090</p> |  | <p>34° 3'42.07"S, 23° 4'32.60"E</p> | <p>12m length Culvert under Wilson Street blocked with sediment and vegetation restricting flow.</p> | <ul style="list-style-type: none"> • Vegetation and sediment must be cleared by hand or using a small excavator positioned on the road. • Area of clearance is along the length of each culvert plus a meter either side (14m), to the depth of the concrete, and 2 m into the wetland. • Sediment may be used by the golf course for landscaping excluding water features. |

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|-----------|--|---|---|--|--|
| <p>20</p> | <p>Wilson Street Street Parcel RE/2090</p> |  | <p>34° 3'41.41"S, 23° 4'30.51"E</p> | <p>Culvert beneath Wilson street blocked with silt and vegetation restricting water flows.</p> | <ul style="list-style-type: none"> • Vegetation and sediment must be cleared by hand or using a small excavator positioned on the road. • Area of clearance is along the length of each culvert plus a meter either side (14m), to the depth of the concrete, and 2 m into the wetland. <p>Sediment may be used by the golf course for landscaping excluding water features.</p> |
|-----------|--|---|---|--|--|

5.7 Construction of Silt Fences

Movement of silt (during maintenance) requires sediment traps and silt fences that are designed to filter flowing water to the degree that pooling occurs upstream of the trap, allowing coarser-grained particles to settle out. Silt fences should be constructed using the following guidelines and referring to the images below:

- Use 80% shade-cloth;
- Support posts should be strong wooden stakes (not metal as this gets stolen) placed 1m apart;
- Top wire must be attached to the shade cloth;
- Posts must be installed on the downstream side of the shade-cloth;
- Shade-cloth must be buried into the downstream channel up to 20cm deep,
- Silt fences must be approximately 50 cm high;
- Wherever possible, single sheets of shade-cloth must be used without joins in material;
- Sediment build-up in the silt fence should be monitored following rainfall, and accumulated silt must be removed from the system.
- Once siltation has reduced following rainfall, the fence must be carefully removed.

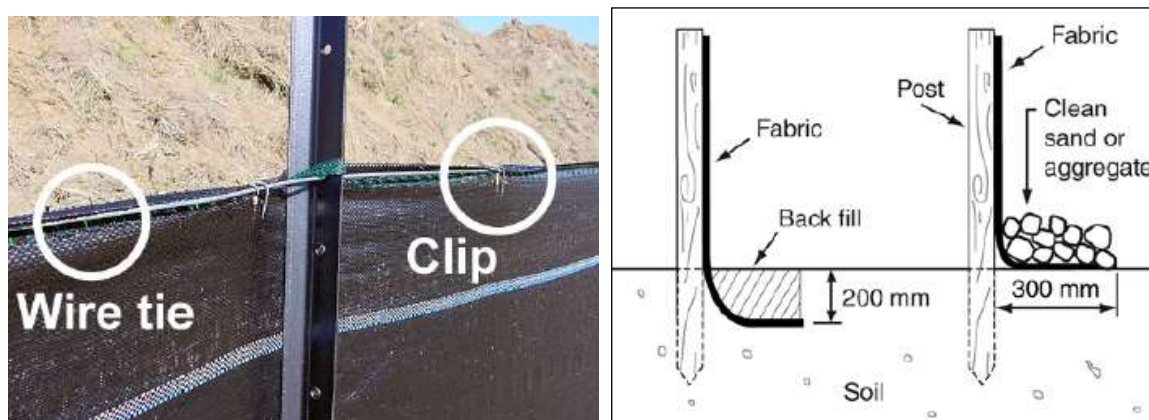


Figure 16. Instructions for installing a silt fence.

6. MONITORING ACTIONS

Short-term and long-term monitoring of the impacts of maintenance, along with indicators of when maintenance should happen again have been recommended.

6.1 Short-term monitoring

- Once maintenance work on George Rex Drive culverts has concluded, sediment controls (silt fences) must be checked after 2-3 days to ensure they are stable, and have not been stolen or vandalised;
- Silt fences must be checked on a regular basis following rainfall events to ensure they are intact. Accumulated silt must be removed from the silt fence. As long as they keep accumulating silt after rainfall they can be kept in place. Once fresh silt is no longer observed in silt fences following rainfall, they must be removed.

- ECO must be appointed to oversee the removal of vegetation/excavation/moving of material from the blocked culverts/stormwater channels and report on the compliance with the MMP to the DFFE on a monthly basis.

6.2 Long-term monitoring

- During and immediately following significant rainfall events, all culverts and channels identified in this MMP should be inspected by the Municipality to determine whether their function has been improved. Photos at each point must be taken as evidence of the level of drainage and function. This photographic record must be actively maintained by the Knysna Municipality Environmental Section.
- The flood protection berm along the 9th hole at the golf course must be monitored every 6 months for the ongoing management of alien vegetation. Once initial clearing has occurred, it is likely that numerous opportunistic alien plants will rapidly establish, making follow up clearance essential.
- Where culverts or channels may require renewed clearance to maintain their function, photos must be taken to show accumulation of silt or vegetation, and maintenance can proceed along the same parameters as described in this MMP.
- Areas where flooding is ongoing despite the actions taken in this MMP need to be documented and flagged, as alternative drainage or maintenance methods will be necessary and would form the subject of a Basic Assessment process in terms of NEMA.

7. RISK MATRIX

Methods used to complete the risk matrix are explained in Appendix 1 of this report. The assessment considers the risks in their mitigated state, and it is therefore imperative that measures to mitigate impacts are fully implemented for the level of risk to apply.

The outcome of the Risk Matrix was a Low Risk to the Bigai Wetland (Table 11). Impacts are mainly associated with risks to water quality and biota through the physical process of excavating sediment and vegetation. This activity is concentrated in a small area associated with each culvert, and where it occurs over a longer distance in the golf course drainage channel, the habitat is artificial and, in many areas, invaded by alien plants. Nonetheless, mitigation / control measures have been made to minimise and avoid impacts as far as possible. Based on the Low Risk outcome, a General Authorisation has been obtained for this MMP.

Table 11. Risk Matrix compiled for Maintenance Management Plan for the Bigai Wetland.

| Phases | 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 |
|--------|---|--|--|-------------|---------------|---------|-------|----------|---------------|----------|-------------|-----------------------|---------------------|--------------|-----------|------------|--------------|-------------|------------------|--|----------------------------|
| | Excavation of sediment and vegetation upstream and downstream of culverts | Siltation Downstream | Reduced water quality and downstream siltation | 0 | 1 | 1 | 0 | 0,5 | 1 | 1 | 2,5 | 1 | 1 | 5 | 3 | 10 | 25 | Low | 70 | <ul style="list-style-type: none"> Standardised area of clearance for all culverts is depth to concrete base, width of concrete plus 1m, and 2 m extended into the wetland. This will minimise the area of impact. Excavations to be undertaken using spades and hand tools unless specified at much larger culverts where a small excavator is more practical. Clearing of culverts to move from upstream to downstream thus reducing repeated impacts on the same area. For all culverts on George Rex Drive downstream culverts must be protected by a silt fence until siltation has ceased and they can be removed. | |
| | People working with tools and light machinery in wetland habitat | People working with tools and light machinery in wetland habitat | Wildlife mortalities, injury and disturbance | 0 | 0 | 1 | 2 | 0,75 | 1 | 1 | 2,75 | 1 | 1 | 5 | 3 | 10 | 27,5 | Low | 70 | <ul style="list-style-type: none"> Work to be undertaken during cooler winter months if feasible to avoid the breeding season. Standardised area of clearance for all culverts is depth to concrete base, width of concrete plus 1m, and 2 m extended into the wetland. This will minimise the area of impact. | |

| | | | | | | | | | | | | | | | | | | | | |
|--------------------------------|--|--|---|---|---|---|---|------|---|---|------|---|---|---|---|---|------|-----|----|---|
| Operational Phase: Maintenance | Excavation of sediment and vegetation from the artificial channel in the golf course | People working with tools, light machinery and a small excavator in artificial wetland habitat | Wildlife mortalities, injury and disturbance | 0 | 0 | 1 | 2 | 0,75 | 1 | 1 | 2,75 | 1 | 1 | 1 | 4 | 7 | 19,3 | Low | 80 | <ul style="list-style-type: none"> Excavations must be by hand or a small excavator where practical. The excavator must be positioned on the golf fairway and not in the channel itself. Only clear 100m per week for 5 weeks to reduce the impact to wildlife such as birds, frogs and small mammals Check the weather forecast and plan work for a dry spell lasting at least a week. Excavation should progress in the direction of upstream to downstream to avoid doubling up on impacts. Keep to the prescribed dimensions of the channel which is up to 2 m wide and between 50-80 cm deep. |
| | | | Siltation and water quality impacts | 0 | 1 | 1 | 1 | 0,75 | 1 | 1 | 2,75 | 1 | 2 | 1 | 3 | 7 | 19,3 | Low | 70 | |
| | Clearance of alien vegetation from the flood berm | Disturbance to vegetation and soil on the berm due to alien vegetation management | Habitat degradation or water quality impacts to the Bigai Wetland | 0 | 0 | 1 | 1 | 0,5 | 1 | 2 | 3,5 | 1 | 1 | 5 | 2 | 9 | 31,5 | Low | 70 | |

PES: D/E
EIS: High

8. STAKEHOLDER ENGAGEMENT

The MMP was subjected to public participation and stakeholder engagement took place through the following means:

- **Advert** placed in the *Knysna-Plett Herald* dated 12 October 2023;
- **Site notices** placed at ten (10x) highly visible locations within the study area where pedestrians/motorists could see them passing by;
- **Additional notice** put up at the Knysna Golf Club notice board as a public venue in proximity to the study area;
- **Written notifications** sent to mandated Authorities with copies of the MMP requesting their comment (SanParks, Provincial Coastal Management, DFFE Oceans & Coast, Provincial Department of Environmental Affairs & Development Planning, DFFE Biodiversity Directorate, Breede-Olifants Catchment Management Agency (representing Department of Water Affairs), CapeNature);
- Distribution of MMP to two applicable **Councillors** who was instructed to distribute it to residents via their channels of communication i.e. residents association, security groups etc.

KNYSNA-PLETT HERALD Donderdag 12 Oktober, 2023

RECYCLING PAPER

STEP 1
The separated paper is washed and mixed to create 'slurry'

STEP 2
Add different materials to the slurry to create different paper products

STEP 3
The slurry is spread using large rollers into large thin sheets

Cape Environmental Assessment Practitioners
Public Participation Process
MAINTENANCE MANAGEMENT PLAN
REPAIR & MAINTENANCE OF NUMEROUS ROAD CROSSINGS /
CULVERTS / STORMWATER CHANNELS WITHIN FLOOD PRONE AREAS OF
THE BIGAI WETLAND SYSTEM (Knysna)

Notice is hereby given of a Public Participation Process in terms of the National Environmental Management Act (NEMA, Act No 107 of 1998 as amended)

An application for a Maintenance Management Plan has been submitted to the National Department of Forestry, Fisheries & Environmental Affairs (DFFE) for urgent maintenance work along flood prone areas of the Bigai Wetland system in Knysna, Knysna Municipal District.

Activity: Maintenance on all existing culverts beneath roads in the suburbs of Hunters Home/Rexford that leads to the wetland, clearing of the existing drainage channels on the Knysna Golf Course which drain from the wetland, maintenance on the artificial berm between the golf course and wetland to reduce the impact of flooding on the 9th hole, as well as maintenance along the lower reaches of the Bigai Wetland in the vicinity of Thesen, Howard, Kennet and Wilson Streets to address flooding. Repair work must be undertaken in terms of an adopted Maintenance Management Plan (MMP) in terms of the national Environmental Management Act (NEMA) and General Authorisation (GA) in terms of the National Water Act (NWA).

DFFE Ref: 2023-08-0007 **WUL Ref:** WU30915

Location: Lower reaches of the Bigai Wetland system, Knysna Municipal District.

Applicant: Knysna Municipality **Environmental Practitioner:** Cape EAPrac

Information Available: Environmental Maintenance Management Plan (MMP)

30-day Commenting period: Friday, 13 October – Monday, 13 November 2023

Deviations/Exemptions: Notifying of immediate neighbouring property owners of affected work areas.

Listed activities: Listing Notice 1 (Activity 19, Activity 19A – working in, or in proximity to watercourses/within 100m from an Estuary). Listing Notice 3 (Activity 12 – clearance of indigenous vegetation within 100m of an Estuary or the Estuarine Functional Zone).

Interested & Affected Parties who may be affected/impacted by the proposed maintenance, are requested to register and respond to this notice by submitting their complete contact details and/or comments on the MMP to Cape EAPrac in writing (to address below) on or before **13 November 2023**.

Cape EAPrac – Attention: Louise-Mari van Zyl / Email: louise@cape-eaprac.co.za
PO Box 2070 George 6530; Telephone: 044 874 0365

Take Note: In terms of the POPIA legislation when registering as an ISAP, a person consents to the lawful processing of personal information for the intended purposes, as described by the Protection of Personal Information Act, 2013 (Act no. 4 of 2013). By registering/submitting comment, a person agrees that his/her contact details will, where required by a public body, be reflected in regulated reports that must be compiled and submitted to the general public, registered stakeholders, organs of state, as well as the competent authority for consideration and decision-making.

Date of Advertisement: 12 October 2023 (Knysna-Plett Herald)

Figure 17: Newspaper advert calling for stakeholders to review and comment on the MMP.





Submissions/acknowledgements were received from the following stakeholders:

- DFFE Biodiversity Directorate acknowledged receipt of the MMP (no formal comment);
- SanParks acknowledged receipt of the MMP (no formal comment);
- DFFE IEM submitted comment;
- DEADP Coastal Management submitted comment – no objection;
- BOCMA issued the General Authorisation for the activities;
- Four (4) members of the public registered/submitted comment (Burns, Olivier, Smithen, Turner).

The following key issues have been captured through the submissions received (refer to the attached Comments & Response Report for summary with responses, as well as copies of all of the submissions received during circulation of the draft MMP including the DFFE comment):

| Stakeholder | Comment |
|--------------|---|
| Mr P Burns | <ul style="list-style-type: none"> • Must also register ER, MJ & JT Steele owners of Erf 2176 Knysna (further details contained in submission document – not included here into the POPIA Regulations). • Concern about prima facie contraventions during the commenting period window on the MMP along Howard Street, the central river channel off Howard Street, the intersection of the main stream central channel, under road culverts on 2 November 2023; • Concerned about tender published by Knysna Municipality for a freshwater consultant to be appointed for the removal of silt/thinning of reeds between Howard Street and Wilson Street according to a S30A Directive; • Concern about the conflict of interest, legality of the MMP, contraventions of NEMA regulations (including listed activities as advertised), the EAP practice pursuant to the procedural requirements inclusive of the PPP content and practice prerequisites; • Concern about reference being made to 'silt' in above-mentioned tender without an assigned volume and the MMP does not refer to any soil/silt; • Concern about the tender being published with a scope of works already assigned before the end of the commenting period, as such the ability to provide valid bona fide commentary has been denied to I&APs; • Request (the EAP) to investigate these comment and to practice legality doctrine in attending to the recorded issues and made apparent the necessary disclosures. |
| Dr J Olivier | <ul style="list-style-type: none"> • Suggest that a committee (Bigai Committee) must be established with members consisting of residents around the wetland, the golf club, the municipality and SanParks; • The committee must be autonomous in order to make decisions into management/maintenance of the system; • Funding for the committee to operate must be provided for by the Municipality through its budget; • Sewage entering the system is shocking and an indication of municipal infrastructural deterioration. The Municipality must take responsibility for maintenance on the sewage infrastructure to prevent raw sewage from entering the wetland system; |

| | |
|---------------------------------|--|
| | <ul style="list-style-type: none"> The mismanagement of the infrastructure/maintenance is as a result of municipal failure, therefore the Municipality must not be the (alone) responsible party for effective management of the Bigai wetland system. |
| BOCMA | General Authorisation (GA) issued for all of the prescribed maintenance activities in the Bigai Wetland system. |
| Coastal Management (Provincial) | <ul style="list-style-type: none"> The Provincial Coastal Management Programme (endorsed 27 March 2023) includes estuary management (Provincial Estuarine Management Plan in the process of being approved); Bigai wetland system feeds into the Knysna Estuary which provides an important function of providing freshwater to the estuary but this function is being compromised by blockages in the wetland system; It is noted that no new structures are proposed. The estuarine functional zone (EFZ) has been adequately considered and the DEADP 2013 Lidar survey data for coastal areas has been considered as well. The MMP adequately considers critical biodiversity and ecological support areas in accordance with the Western Cape Biodiversity Spatial Plan (2017). The proposed mitigation measures as stipulated in the MMP are appropriate and practical. These measures must be strictly adhered to. The Coastal Management directorate therefore does not object to the MMP of the Bigai wetland system. The Municipality is reminded of their General Duty of Care and the remediation of environmental damage which also refers to one's duty to avoid causing adverse effects on the coastal environment. |
| DFFE IEM | <ul style="list-style-type: none"> Final EMMP must be correctly dated. The MMP refers to hand work and the use of small excavator (and does not involve construction or installation of new structures or infrastructure) – should there be a need to consider new structures or infrastructure it can result in additional impacts that may trigger 'listed activities' in which case the MMP must be amended and published for comments for a further 30-day commenting period prior to submission of the final report for review and decision-making. The MMP must include specific thresholds of materials to be excavated/removed as well as vegetation to be cleared in the description of the proposed project and a sub-activity 19a, b etc and this information must be included in the listed activities applicable to the maintenance. Ensure that other maintenance and remedial work activities to be undertaken must remain within and must not result in any expansion of the existing footprints of the affected relevant structures. Should any revision of the MMP trigger any listed activities without the exclusion (for maintenance management plans) an application for Environmental Authorisation must be lodged with the Competent Authority prior to the undertaking of such activities. Specialist studies must comply with the Specialist Protocols (refer to the Screening Tool) and specialists must be SACNASP registered. The final MMP must include proof of notification of the availability of the draft MMP including the Department's comments. |

| | |
|--|--|
| | <ul style="list-style-type: none"> • All comments obtained from I&APs must be taken into consideration in compiling the final MMP. • Comments & Response Report of all comments received, must be submitted with the final MMP. The report must incorporate all comments for the proposed maintenance. • The MMP must distinguish between impact management actions and impact management outcomes as required by Appendix 4 of the EIA Regulations as amended. |
|--|--|

Although approached for comment, the following Authorities did not submit formal comment during the stipulated commenting period:

- CapeNature
- Western Cape DEADP
- SanParks

Copies of the notifications of the Draft MMP is attached to this final EMMP as proof of consultation.

Based on the outcome of the stakeholder engagement process, it is submitted that there is support for the adoption of the Bigai Wetland System MMP from key authorities. Private residents who commented, raised concerns about overall Municipal management, but did not object to the proposed maintenance activities prescribed in the MMP. All comments obtained from I&APs have been taken into consideration in compiling this final MMP.

Improving the overall water quality and flow by removing blockages and managing biomass within the wetland, additional freshwater will reach the Knysna Estuary which is the most important estuary in South Africa. The recommendations for only permitting low impact actions that will not exceed the need for clearing of vegetation/silt/material by hand or with small excavators, aligns well with the conditions associated with maintenance management plan i.e. no additional structures/infrastructure, no expansion of structures/infrastructure so as to maintain in a like-for-like scenario to ensure continued functionality (of the system) and prevent unwanted flooding of the area.

9. CONCLUSIONS

In many ways the work proposed in this MMP is very basic and routine, simply involving the clearance of silt/material and vegetation from existing culverts and a man-made channels. It is not certain that flooding in the highlighted areas will be completely alleviated as a result of these limited actions, but it may be reduced. It is also acknowledged that this is the most work that can be achieved under a Maintenance Management Plan without the need for prior Environmental Authorisation. Any additional work proposed by the Knysna Municipality, to further alleviate flooding in the area, would need to be assessed and authorised to a further extent in terms of NEMA and the NWA.

This represents a precautionary approach to the environment, with an emphasis on monitoring the effects of simply undertaking routine maintenance of existing structures as a start.

Implementation of this MMP is not likely to result in major impacts to the Bigai Wetland or Knysna Estuary provided all mitigation measures are fully implemented and management outcomes are adhered to in accordance with the prescribed management actions.

Given the Low Risk outcome of the Risk Matrix, a General Authorisation has been obtained in terms of GN509 of the National Water Act and once adopted the Knysna Municipality must adhere to the recommendations and conditions of this MMP.

10. REFERENCES

Angel, A., Branch, G.M., Wanless, R.M. and Siebert, T., (2006). Causes of rarity and range restriction of an endangered, endemic limpet, *Siphonaria compressa*. *Journal of Experimental Marine Biology and Ecology*, 330 (1): 245-260.

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11. APPENDIX

11.1 Risk Matrix Methods

The risk assessment matrix (Based on DWS 2016 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 used in the impact assessment are as follows:

- 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.
- Severity refers to the degree of change to the status of each of the receptor. 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 13)
- Duration refers to the length of time over which the stressor will cause a change in the resource or receptor (Table 14)
- Frequency of activity refers to how often the proposed activity will take place (Table 15)
- Frequency of impact refers to the frequency with which a stressor (aspect) will impact on the resource (Table 16).

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 occurred within the delineated boundary of the wetland.

Table 12: 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 13: 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 14: 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 15: Scores used to rate the frequency of the activity

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

Table 16: 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 17: 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 18: 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 19: 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 20: 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 |