Upgrade of the Fancourt Golf Club Security Fence Crossing the Modder River, George, Western Cape.

Management and Maintenance Plan

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GLOSSARY

Aquatic Biodiversity	The variety of plant and animal life in water ecosystems, relevant to the study due to the site's proximity to potential water bodies.
Desktop Review	Preliminary assessment based on existing data and information, conducted prior to on-site investigations.
Erosion Control Methods	Techniques employed to prevent or minimize soil erosion, such as haybale check dams or silt fencing, crucial in areas with high inherent erosion potential.
Freshwater Ecosystem Priority Area (FEPA)	Designated areas of high importance for freshwater ecosystem conservation, identified as a sensitivity feature in the DFFE screening tool.
Site Assessment	Comprehensive evaluation of the proposed development site, including the identification of wetlands, watercourses, and soil characteristics.
Sensitivity	The degree to which a particular area or ecosystem is susceptible to disturbance or impact, crucial in determining potential environmental consequences.
Terrestrial Critical Biodiversity Area (CBA1)	A designation indicating the significance of the area's biodiversity on land.
Topography	The physical features of the land surface, considered for its potential influence on drainage and ecological features.
Wetland	An area where water covers the soil, or is present either at or near the surface, contributing to biodiversity and ecological significance.
Western Cape Biodiversity Spatial Plan (WCBSP)	A plan indicating categorized areas based on their ecological importance in the Western Cape region.

ABBREVIATIONS

CBA:	Critical Biodiversity Area
CD:NGI:	Chief Directorate: National Geo-spatial Information
DFFE:	Department of Environment, Forestry and Fisheries
DWAF:	Department of Water Affairs and Forestry
DWS:	Department of Water & Sanitation
EIS:	Ecological Importance and Sensitivity
ESA:	Ecological Support Area
FEPA:	Freshwater Ecosystem Priority Area
GA:	General Authorisation
GPS:	Global Positioning System
NEMA:	National Environmental Management Act
NFEPA:	National Freshwater Ecosystem Priority Areas
NWA:	National Water Act
NWM5:	National Wetland Map 5
SACNASP:	South African Council for Natural Scientific Professions
WCBSP:	Western Cape Biodiversity Spatial Plan
WUL:	Water Use License

1. INTRODUCTION

Confluent Environmental was requested to provide a specialist aquatic biodiversity assessment in support of a Management and Maintenance Plan (MMP) for the purpose of replacing and re-designing an existing security fence that crosses the Modder River, along the northern boundary of the Fancourt Golf Estate. The fence is located along the northern boundary of the property, adjacent to the R404 (Montagu Street). The current design is susceptible to flood damage (requiring frequent repair) and displacement of existing gabion structures used to support the fence currently poses an erosion risk to the watercourse.

The scope of work for this report is guided by the legislative requirements of the National Environmental Management Act (NEMA) as well as the National Water Act (NWA).

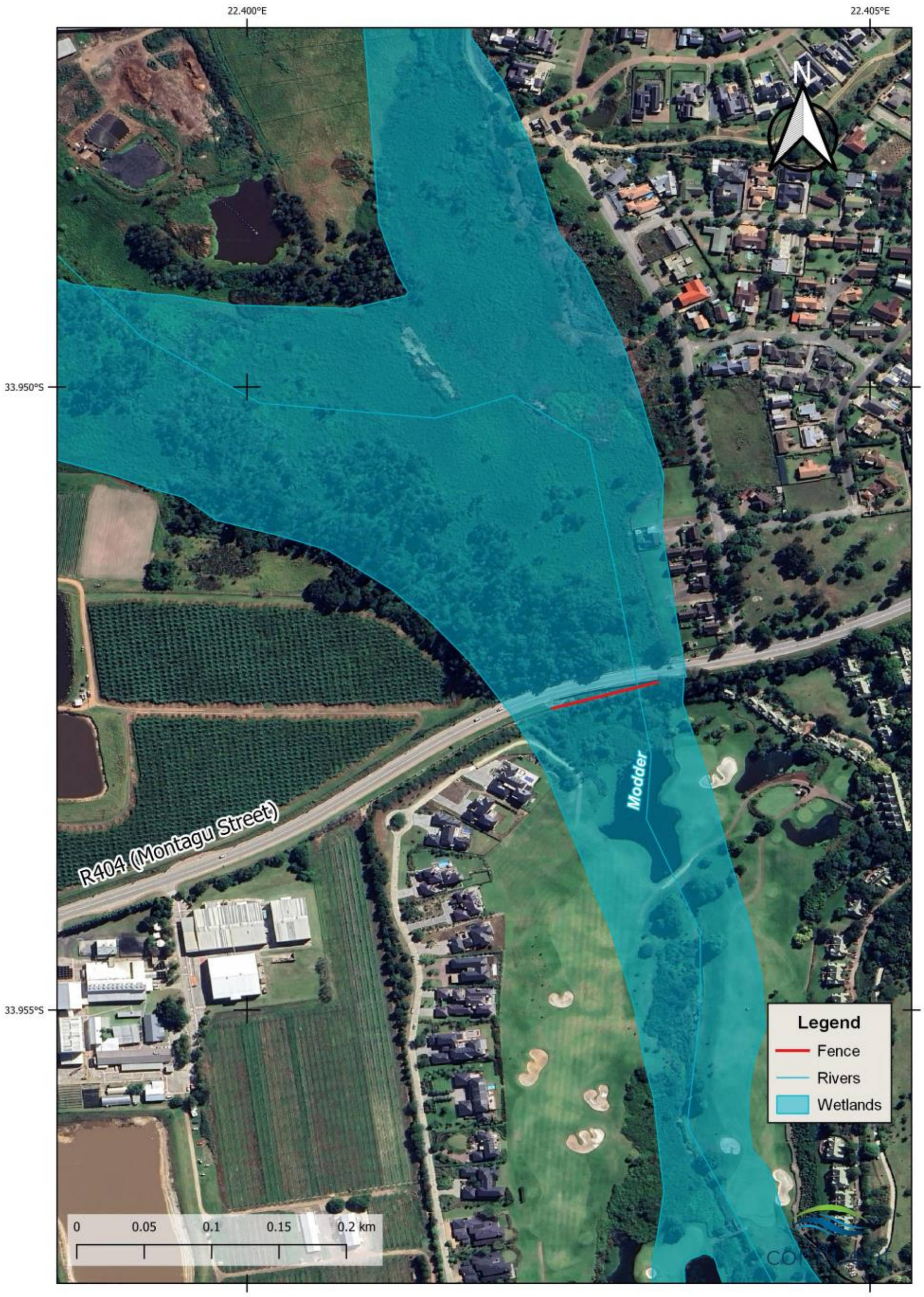

Figure 1. Location of properties comprising the proposed development area.

1.1 Key Legislative Requirements

1.1.1 National Environmental Management Act

A Management and Maintenance Plan (MMP) is a document that describes maintenance activities that need to take place within a watercourse. The MMP specifically relates to Activities 19 and 27, as listed in the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended (NEMA) Environmental Impact Assessment (EIA) Regulations Listing Notice 1 of 2014 (GN R. 327), as amended. In line with the MMP, infilling or removal of more than 10 m^3 material within a watercourse, and/or the clearance of 1 ha or more of indigenous vegetation, are allowed only if the works are undertaken for maintenance purposes AND form part of the EMMP when approved by the Department of Environmental Affairs and Development Planning (DEA&DP).

1.1.2 National Water Act

The Department of Water & Sanitation (DWS) is the custodian of South Africa's water resources and therefore assumes public trusteeship of water resources, which includes watercourses, surface water, or aquifers. A watercourse means:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and
- Any collection of water which the Minister may, by notice in the Gazette, declare to be watercourse, and

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

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

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

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

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

a) The outer edge of the 1 in 100-year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam;
b) In the absence of a determined 1 in 100-year flood line or riparian area the area within 100m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench (subject to compliance to section 144 of the Act); or
c) A 500 m radius from the delineated boundary (extent) of any wetland or pan.

According to Section 21 (c) and (i) of the NWA, any water use activities that do occur within the regulated area of a watercourse must be assessed using the DWS Risk Assessment Matrix (GN4167) to determine the impact of construction and operational activities on the flow, water quality, habitat and biotic characteristics of the watercourse. Low-Risk activities require a General Authorisation (GA), while Medium or High-Risk activities require a Water Use License (WUL).

2. METHODS

2.1 Watercourse Classification

Classification of watercourses is important as this determines the assessment methodologies that can be applied. Furthermore, classification of the watercourse provides a fundamental understanding of the hydrological and geomorphic drivers that characterise the watercourse and therefore assists in the interpretation of impacts to the watercourse. The affected watercourse was categorised into discrete hydrogeomorphic units (HGMs) based on its geomorphic characteristics, source of water and pattern of water flow through the watercourse. These HGMs were then classified according to Ollis et al. (2013).

2.2 Wetland Delineation

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

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

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

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

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

- The Terrain Unit Indicator: Identifies those parts of the landscape where wetlands are more likely to occur;

- The Soil Form Indicator: Identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation;
- The Soil Wetness Indicator: Identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation (i.e. mottling and gleying within 50 cm of the soil surface); and
- The Vegetation Indicator: Identifies hydrophilic vegetation associated with frequently saturated soils.

The boundary of the wetland was determined by identifying the presence or absence of the combination of indicators mentioned above at selected points in the field. The location of soil augering points used to assess soil wetness were marked on a hand-held GPS and saturation zones were classified according to the soil wetness indicators as follows:

- Temporary Zone: Short periods of saturation (less than three months per annum) characterised by few high chroma mottles and minimal grey matrix (< 10 %).
- Seasonal Zone: Significant periods of wetness (at least three months per annum) characterised by many low chroma mottles and a grey matrix.
- Permanent Zone: Wetness all year round characterised by a prominent grey matrix and few to no high chroma mottles.

Auger points that showed no sign of saturation were classified as 'Dry'. All augering points were imported into GIS software and, in combination with aerial imagery and other site observations of vegetation indicators, were used to plot the boundary of the wetland.

2.3 Present Ecological State (PES)

WET-Health 2.0 is designed to assess the PES of a wetland by scoring the perceived deviation from a theoretical reference condition, where the reference condition is defined as the un-impacted condition in which ecosystems show little or no influence of human actions. Whilst wetland features vary considerably from one wetland to the next, wetlands are all broadly influenced/ by their climatic and geological setting and by three core inter-related drivers, namely hydrology, geomorphology and water quality. The biology of the wetland (in which vegetation generally plays a central role) responds to changes in these drivers, and to activities within and around the wetland. The interrelatedness of these four components is forms the basis of the modular-based approach adopted in WET-Health Version 2. Desktop and field data were captured in GIS software and used to populate the Level 1 WET-Health tool (Macfarlane et al., 2020) which was used to derive the PES of the wetland HGM units. The magnitude of observed impacts on the hydrological, geomorphological, water quality and vegetation components of the wetland were calculated and combined as per the tool to provide a measure of the overall condition of the wetland on a scale from 1-10. Resultant scores were then used to assign the wetland into one of six PES categories as shown in Table 1 below.

Table 1: Wetland Present Ecological State (PES) categories and impact descriptions.

ECOLOGICAL CATEGORY	DESCRIPTION	IMPACT SCORE*	PES SCORE (%)*
A	Unmodified, natural.	0-0.9	90-00
B	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	80-89
C	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2-3.9	60-79
D	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	40-59
E	Seriously modified. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	20-39
F	Critically modified. Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	0-19

2.4 Ecological Importance and Sensitivity

Ecosystem services in were assessed using WET-EcoServices Version 2 (Kotze, Macfarlane and Edwards, 2021). 16 different ecosystem services were evaluated and included:

- Flood attenuation
- Streamflow regulation
- Sediment trapping
- Phosphate assimilation
- Nitrate assimilation
- Toxicant assimilation
- Erosion control
- Carbon storage
- Biodiversity maintenance
- Provision of water for human use
- Provision of harvestable resources
- Food for livestock
- Provision of cultivated foods
- Cultural and spiritual experience
- Tourism and recreation
- Education and research

WET-EcoServices provides a set of indicators (e.g. slope of the wetland) rated on a five-point scale of 0 to 4 that reflect the supply/capability of a wetland for each of the 16 different ecosystem services listed above. An Excel™ based spreadsheet tool has been developed to conduct the assessment. For each ecosystem service, indicator scores are combined automatically in an algorithm given in the spreadsheet that has been designed to reflect the relative importance and interactions of the attributes represented by the indicators to arrive at an overall supply score. In addition, the demand for the ecosystem service is assessed based on the wetland's catchment context (e.g. toxicant sources upstream), the number of beneficiaries and their level of dependency, which are also all rated on a five-point scale. Again, an algorithm automatically combines the indicator scores relevant to demand to generate a demand score. A single overall importance score is generated for each ecosystem service by combining the supply and demand scores. This aggregation therefore places somewhat more emphasis on supply than demand, with the supply score acting as the starting score for a “moderate” demand scenario. The importance score is, however, adjusted by up to one class up where demand is “very high” and by up to one class down where demand is “very low”. The overall importance score can then be used to derive an importance category for reporting purposes.

3. CATCHMENT CONTEXT

3.1 Catchment Features

The project area is located in quaternary catchment K30B, which extends from the Outeniqua Mountains to the north, all the way to the coast. The main river draining the catchment is the Gwaing River (Figure 2) which is fed by several tributaries, all of which originate from the mountains at the top of the catchment. The Modder River also originates from the Outeniqua Mountains, after which it flows through an agricultural area and then through the Fancourt Golf Estate after which it meets up with the Malgas River to form the Gwaing River. According to the latest national wetlands geospatial database (CSIR, 2018) most of the length of the Modder River is mapped as an unchannelled valley bottom (UVB) wetland (Figure 3).

The project area falls within the South-Eastern Coastal Belt (20) Level 1 ecoregion (20.02 Level 2 Ecoregion), which is characterized by moderately undulating plains and low mountains with altitude ranging from 0 to 1 300 m above mean sea level. Watercourses are typically located at the base of relatively steep slopes. Mean annual precipitation for the catchment area is high (approximately 800 mm per year) and occurs all year-round, with peaks in October to November and March to April. Dominant natural vegetation in the vegetation comprises broadly of fynbos, renosterveld, dune thicket, and afro-montane forest.

Soils in the catchment area are relatively shallow consisting of a diagnostic pedocutanic duplex soil, with a clear textural contrast between the A and B horizon. The B horizon is however heavily enriched with clay, which serves as a barrier to both root growth and water movement. Sub-surface water therefore tends to flow laterally over the top of the B horizon, through the more coarsely textured A horizon. In addition, the area falls within a very high rainfall and high rainfall intensity zone, which, in urban areas with a high proportion of impervious surfaces, results in the production of very large volumes of high energy stormwater (Table 2). For these reasons, soils are highly erodible and is undoubtedly the main cause of relatively widespread bank erosion and channel incision of urban watercourses in and around George.

Table 2. Summary of relevant catchment features for the proposed development area.

Feature	Description
Quaternary catchment	K30B
Mean Annual Runoff	300 mm
Mean Annual Precipitation	787 mm
Inherent erosion potential of soils (K-factor)	0.74 (Very High)
Rainfall intensity	Very High
Ecoregion Level II	20.02, Southeastern coastal belt
Geomorphological Zone	Upper Foothill
NFEPA area	Sub-quaternary reach 9093 and 9144, no FEPA.
Mapped Vegetation Type	FFg 5: Garden Route Granite Fynbos (CR: Critically Endangered)
Conservation	None

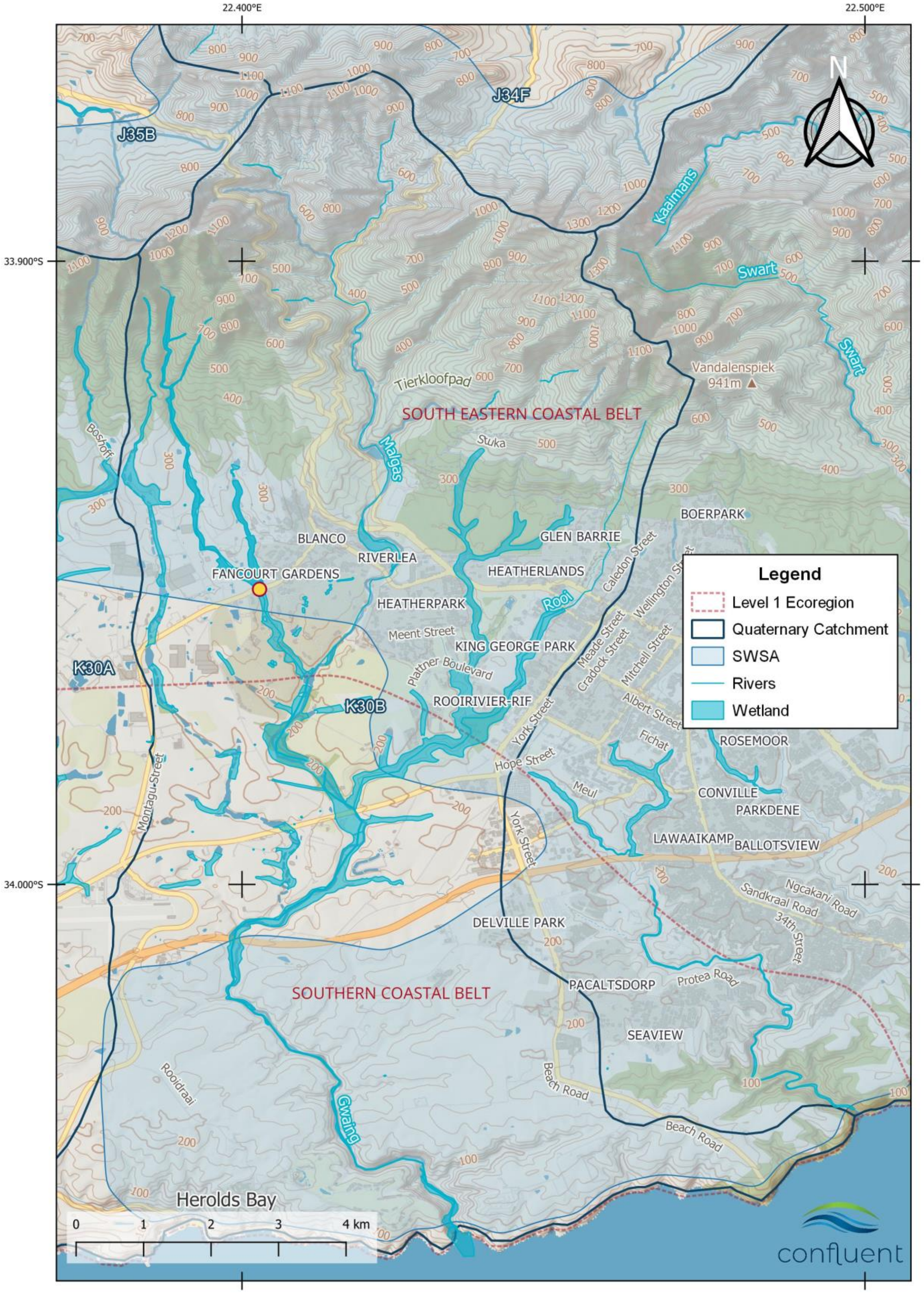

Figure 2. Map indicating the proposed development area in quaternary catchment K30B.

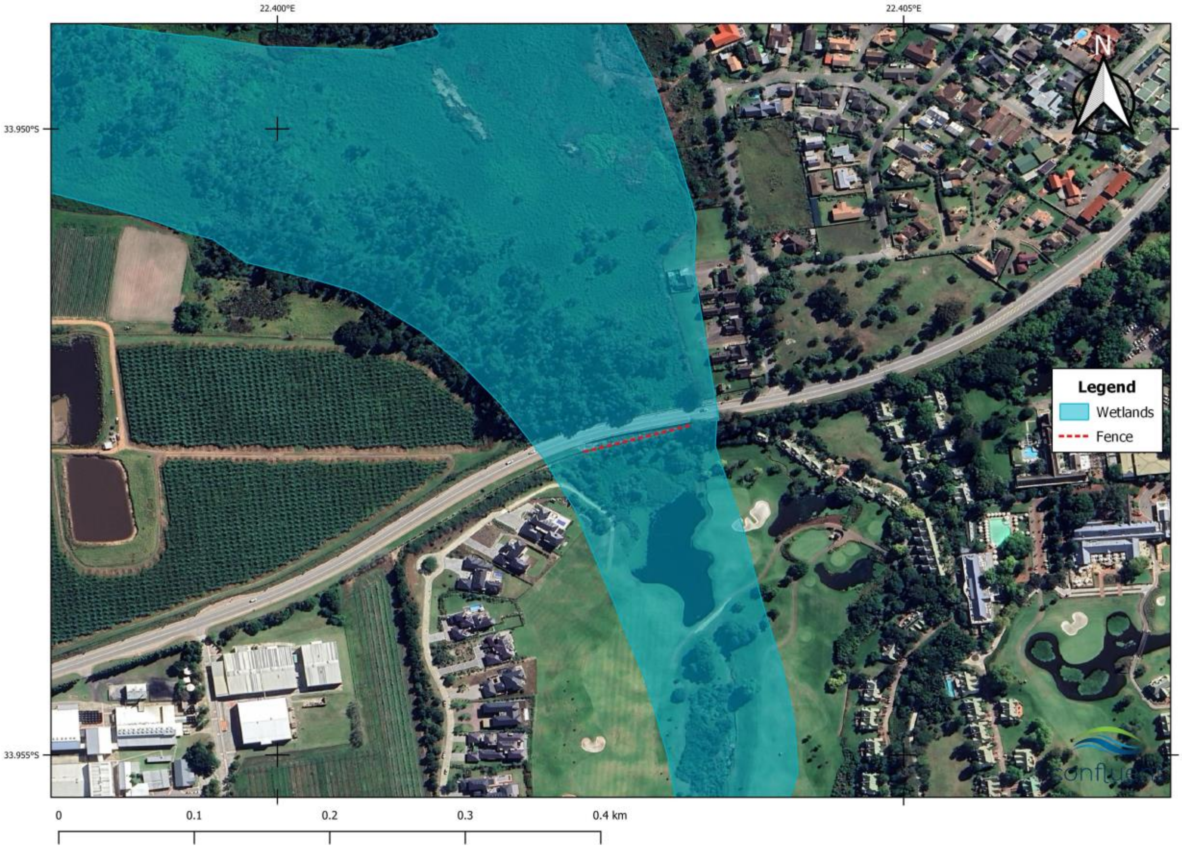

Figure 3: The proposed development area in relation to mapped watercourses.

3.2 Conservation and Catchment Management

3.2.1 Western Cape Biodiversity Spatial Plan

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

The affected section of the Modder River has been designated as an ESA2 (Figure 4), which are considered to be relatively degraded aquatic features that are not considered important for meeting biodiversity targets, but do provide an important hydrological function in terms of delivering surface water flows to larger more important systems and are also important from the perspective of providing corridors for faunal movement. Management objectives associated with these biodiversity categories are provided in Table 3.

Figure 4. The proposed development area to mapped conservation features of the Western Cape Biodiversity Spatial Plan (2017).

Table 3. Definitions and objectives for conservation categories identified in the Western Cape Biodiversity Spatial Plan (WCBSP, 2017).

WCBSP Category	Definition	Management Objective
Ecological Support Area 2 (ESA2)	Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of PAs or CBAs, and are often vital for delivering ecosystem services.	Restore and/or manage to minimize impact on ecological processes and ecological infrastructure functioning, especially soil and water-related services, and to allow for faunal movement.

2.3.3 Strategic Water Source Area

The project area falls within the Outeniqua Strategic Water Source Area (SWSA) (Figure 2), which is considered to be of national importance. High volumes of rainfall over the steep slopes of the Outeniqua Mountains to the north generate high volumes of runoff relative to surface area. Furthermore, the lack of anthropgenic activities in these mountainous areas generates water of a very good quality. SWSAs are defined as areas of land that either:

a) Supply a disproportionate (i.e. relatively large) quantity of mean annual surface water runoff in relation to their size and so are considered nationally important; or

b) Have high groundwater recharge and where the groundwater forms a nationally important resource; or

c) Areas that meet both criteria (a) and (b).

SWSAs are vital for water and food security in South Africa and also provide the water used to sustain the economy. Given this context, management and implementation guidelines have been developed with the objective of facilitating and supporting well-informed and proactive land management, land-use and development planning in these nationally important and critical areas (Le Maitre, et al., 2018). The primary principle behind this objective is to protect the quantity and quality of the water they produce by maintaining or improving their condition. The proposed development footprint falls within an urban 'working landscape' and in this context the management objectives are:

- To maintain at least the present condition and ecological functioning of these landscapes;
- To restore where necessary; and
- To limit or avoid further adverse impacts on the sustained production of high-quality water.

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/maintenance activities that cause unacceptable and irreparable impacts. Any maintenance activities must therefore strive to ensure that watercourses continue to provide high volumes of good quality water.

4. HISTORICAL ASSESSMENT

- An aerial image from 1974 shows a broad wetland area upstream and downstream of the current location of the fence (Figure 5). The entire width of the wetland was vegetated and there was no clear sign of a channel through the wetland. This, in combination with the general flat topography of the area, is consistent with an UVB wetland. The wetland does show signs of invasion by alien tree species – most likely *Eucalyptus* and *Acacia mearnsii* (Black Wattle).
- An aerial image from 1991, clearly illustrates the loss of wetland habitat south of the R404 in association with the development of the Fancourt Golf Estate. Wetland habitat upstream the R404 remains intact (although still partially invaded by invasive alien tree species).
- Most recent image (2024) shows small remaining pockets of wetland vegetation south of the R404. The majority of the former wetland area has been confined to a distinct channel running through the golf course.

Figure 5: Historical images from 1974 indicating the former extent of the UVB wetland (A); and from 1991 (B) and 2024 (C), showing large-scale loss of wetland habitat south of the R404. Red line indicates the current location of the fence that will be upgraded.

5. SITE ASSESSMENT

The existing fence runs through the Modder River immediately downstream of the R404 bridge that crosses the river. The wetland area has been largely transformed by infrastructure associated with the existing fence and the bridge and there is minimal natural, functional wetland habitat present. The bed of the river beneath the bridge has been heavily modified and, from upstream to downstream, includes a concrete slab below the bridge and a section of riverbed covered by bidem and wire mesh (presumably to protect to the riverbed post construction of the bridge).

Currently the fence is strung across fence posts that have been embedded in a gabion wall foundation that runs across the entire width of the river (Figure 6). Along its western most alignment the gabion wall has been displaced and is leaning over in a downstream direction (Figure 7). This displacement has created a narrow channel in between the gabion wall and the riverbed. Preferential flows along this channel (and towards a gap in the gabion wall) has caused some erosion of the riverbed, which is beginning to migrate upstream towards the bridge (Figure 8). The drop-off between the higher elevation of the riverbed and the lower elevation at the base of the gabion wall creates a knickpoint and there are signs of headcut erosion beginning at preferential flow paths along the riverbed (Figure 9). Culverts are located beneath the concrete slab – but it is uncertain how functional this infrastructure is. Concentrated flow through the wetland has resulted in erosion around these culverts. Evenly placed gaps in the gabion wall allow lower flows to pass through the wall, while higher flows will pass over the wall. There is a small patch of wetland habitat downstream of the fence followed by a small dam. Concentrated flows through the gaps in the gabion wall have caused eroded channels to form through this short wetland area. The eastern alignment of the gabion wall is intact – the top of gabion wall is elevated slightly above the level of the riverbed and will obstruct lower flows, diverting them towards a gap in the gabion wall. The wetland area upstream of the bridge remains intact and has largely retained its UVB characteristics and verified watercourses are mapped in Figure 10.

Figure 6: Photographs indicating the western (red arrow) and eastern (yellow arrow) alignment of the fence and the bridge crossing the wetland upstream of the fence.

Figure 7: Channelled flow between the partially displaced gabion wall and the elevated riverbed along the western alignment of the fence

Figure 8: Photograph taken during a heavy rainfall event (4 June 2024) which shows the displaced gabion along the western alignment and channelled flow in between the gabion wall and the elevated riverbed (red arrow) toward a gap in the gabion wall.

Figure 9: Photographs showing signs of erosion upstream of the fence (A); erosion around a culvert beneath the bridge, most likely caused by more channelised flow through gaps in the gabion wall (B); partial undermining of the concrete slab beneath the bridge (C); and intact gabions along the eastern alignment of the fence – slightly elevated above the level of the riverbed (D).

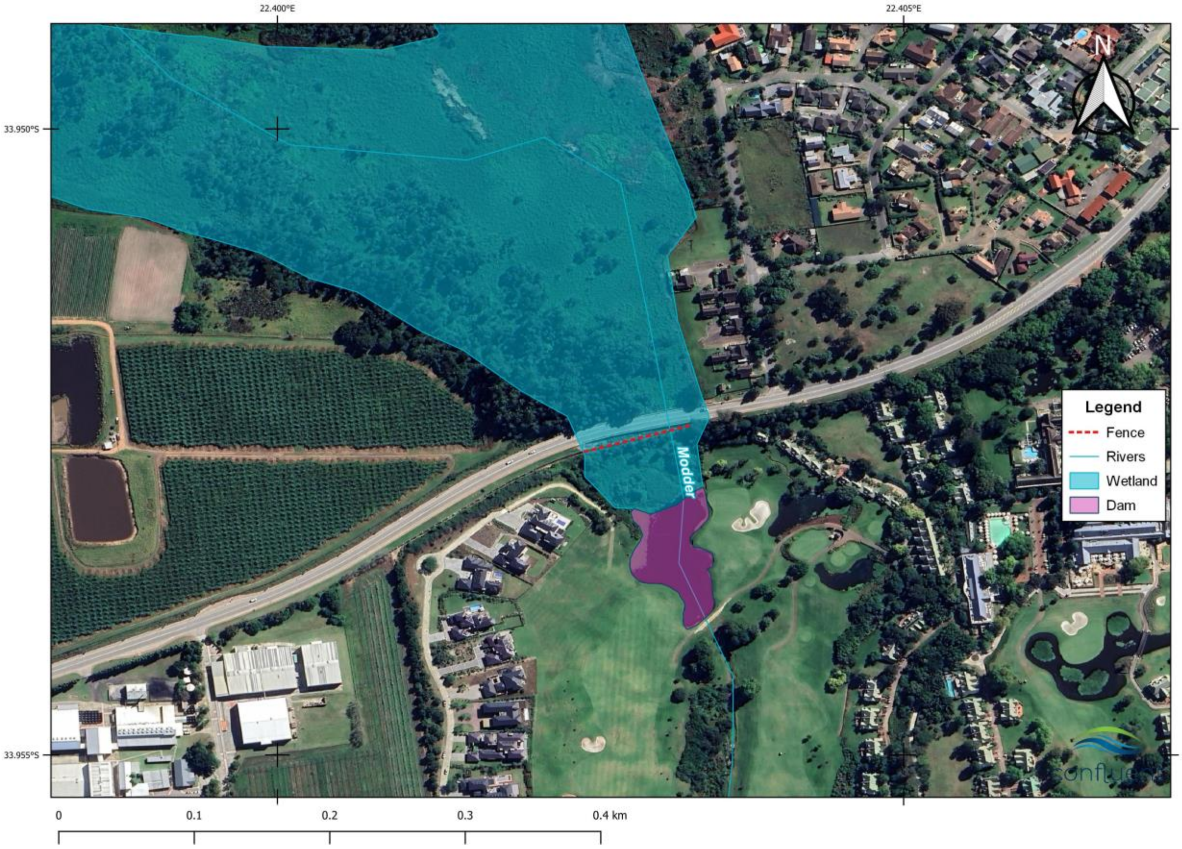

Figure 10: Map indicating delineated wetlands in the development area.

6. AQUATIC ASSESSMENT

6.1 Wetland Classification

The historical assessment together with the site visit confirms the presence of an UVB wetland along the affected section of the Modder River. These wetlands typically occur along relatively broad, unconfined, low gradient valley bottoms. In their natural state they provide excellent ecosystem services as flow through the wetland is diffuse, resulting in excellent flood attenuation, streamflow regulation and pollutant assimilation services (Figure 11).

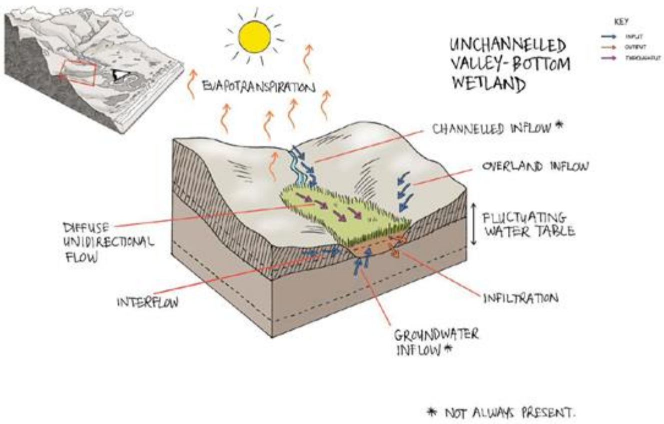

Figure 11: Conceptual illustration of an unchannelled valley-bottom wetland, showing the typical landscape setting and the dominant inputs, throughputs and outputs of water. (Source: Ollis et al., 2013)

6.2 Present Ecological State

At a broader scale, the most significant impact on the wetland has been direct loss of habitat associated with agricultural expansion (in the mid-reaches) and the historical development of the Fancourt Golf Estate in the lower reaches (see Section 4). Infilling of the wetland, particularly in the lower reaches, has resulted in a far more confined valley bottom which still has had to accommodate high volumes of runoff from the mountains, in combination with increased stormwater flows from urbanisation of the catchment area. High flow volumes through a narrower, more confined valley bottom has led to erosion and channelisation of the wetland through the Golf Estate. As a result, much of the ecosystem services typically provided by UVB have been lost south of the R404. The existing fence, bridge crossing and culverts represents a highly modified section of the wetland, and there is very little natural wetland habitat present. The PES of the wetland is assessed as **D** (**Largely Modified**).

Table 4: Table of PES assessment conducted for the unchannelled valley bottom wetland.

Unadjusted (modelled) Scores				
PES Assessment	**Hydrology**	**Geomorphology**	**Water Quality**	**Vegetation**
Impact Score	5.7	4.1	1.0	5.2
PES Score (%)	43%	59%	90%	48%
Ecological Category	**D**	**D**	**B**	**D**
Combined Impact Score	4.2			
Combined PES Score (%)	58%			
Combined Ecological Category	**D**			
Hectare Equivalents	49.3 Ha			

6.3 Ecological Importance & Sensitivity

A number of agricultural properties are located further downstream and the wetland therefore provides and important provisioning service in terms of water for human consumption (Figure 12). While the demand for regulating services (e.g. pollutant assimilation) is Moderate, the degraded state of the wetland means that it can no longer supply these services effectively. The wetland does not provide any cultural services and the demand for these services is also Low. Overall, the ecological importance of the wetland is **Low**.

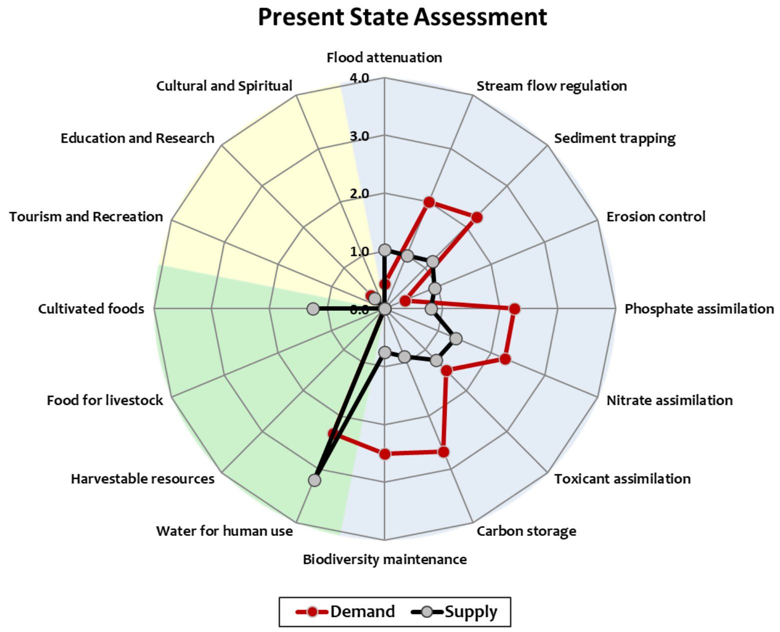

Figure 12: Graph indicating the supply and demand of ecosystem services assessed for the Modder River wetland.

7. PROPOSED MAINTENANCE

7.1 Existing Fence

As described above, the existing fence (particularly the supporting gabion wall running across the channel) is dilapidated and needs to be repaired or replaced. The current state of the fence and its overall design is not considered optimal for the following reasons:

- The displaced gabion wall has created a sharp, vertical drop (between 0.5 and 1 m) in elevation along the western alignment of the gabion. This has already caused some localised erosion of the riverbed and represents a significant risk to the wetland. Failure to address this problem will result in further erosion of the riverbed which could also potentially place infrastructure upstream of the fence at risk.
- The gabion wall impedes flow and concentrates flows along specific sections of the channel which has resulted in erosion and formation of channels through wetland habitat downstream of the wall.
- The design of the fence cannot accommodate flood events and associated flood debris and will require ongoing maintenance.

7.2 Proposed Fence

The intention is to remove all of the existing gabions, fence poles, fence and install a new fence designed to give way (‘fail’) during floods when flood debris pushes up against it and return to the original position/or gets replaced after the worst of the water’s gone past). The design of the new fence is provided in (Figure 13) and can be summarised as follows:

- Collapsed gabions and existing fence footings will be demolished and removed along the western alignment of the fence.

- Gabions along the eastern alignment will remain *in-situ*, but will be lowered to be level with the riverbed.
- New fence line supports will be installed to be level with the riverbed.
- Sacrificial fence panels will be suspended from a suspended cable (connected to the new fence line supports) that runs across the channel. The sacrificial fence panels will be allowed to break loose from the riverbed and hinge off the supporting cable above during flooding.
- Permanent electrical fence wires will run above the sacrificial fence panels.
- Material from existing gabion walls will be used to reshape and protect the riverbed from erosion once the gabion walls have been removed.

The design of the proposed fence represents an improvement in the current design for the following reasons:

- The new design is likely to be more accommodating of flood events and should reduce the need for maintenance of the fence and associated disturbance in the wetland.
- The gabion walls, which are currently concentrating flows through the wetland and - in their failed state - causing erosion of the riverbed, will be demolished and removed from the wetland.
- The new design reduces the extent of built infrastructure in the wetland and will facilitate unimpeded flow across the entire extent of the valley bottom, thus being more representative of natural flow conditions.

An important aspect that must however be addressed is rehabilitation of the riverbed once the gabion wall is removed along the western alignment of the existing fence. Displacement of the existing gabion wall has caused a vertical drop-off along the riverbed. Water flowing over such drop-offs erodes the riverbed and can lead to headcut erosion (i.e. migration of the nickpoint further upstream) which potentially places existing infrastructure at risk. There are already signs of such erosion taking place, and while not serious at this stage, will become more severe in the short to medium term. Removal of the gabion will result in a vertical drop-off. Re-shaping and protection of the riverbed is therefore required once the gabion wall is removed in order to prevent erosion and damage to infrastructure (e.g. bridge and new fence)

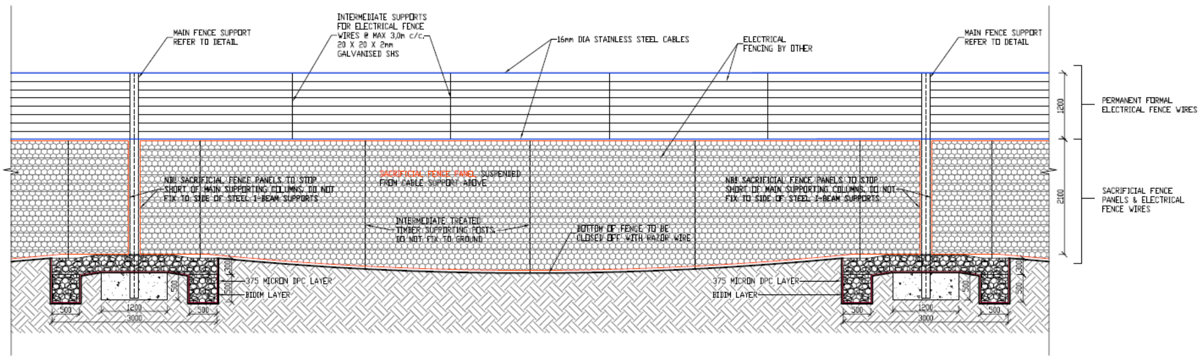

Figure 13: Diagram illustrating the proposed design of the fence.

7.3 Method Statements

Method statements aimed at mitigating impacts associated with the construction and operation of the new fence are described below. As highlighted above there is very little natural wetland habitat present within the area that will be disturbed and mitigation measures are aimed primarily at protecting the riverbed and protecting more sensitive wetland habitat located downstream of the fence.

7.3.1 Removal of Existing Fence

Fence removal includes the physical removal of the fence and associated infrastructure (e.g. gabion wall, poles, fence foundations etc.). The fence must be removed in such a manner that it does not cause degradation to the river. Generic impacts are associated with the presence/operation of workers, machinery and materials required for maintenance activities within the watercourse and include the following:

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

7.3.1.1 Impact Mitigation

- Areas where instream maintenance activities will take place must be confined to clearly demarcated areas so as to prevent unnecessary disturbance of instream habitat outside of these areas.
- Fence removal must be timed to coincide with low rainfall probability (dry season – May to August) to avoid erosion of exposed riverbed;
- A phased approach is recommended so that specific sections of the existing fence alignment can be isolated and kept dry during removal of the gabion wall. Dry working conditions must be created through the construction a temporary partial stream diversion (or coffer dam) which must adhere to the following principles:
    - The diversion must be constructed with sandbags combined with an impermeable plastic sheet;
    - Ensure that barrier structures are of sufficient height to prevent overflows from flooding the enclosed work area. The sandbag barrier must have at least 0.5 m of freeboard (i.e. the top of the barrier must be 0.5 m higher than the highest floodwater level);
    - The width of the base of the sandbag barrier must be 0.5 m wider than the height of the barrier;

- Lay first course/bottom layer of bags perpendicular to flow direction of watercourse (Figure 14);
- Offset the bags from the previous row in the same course to form a brick pattern (Figure 14);

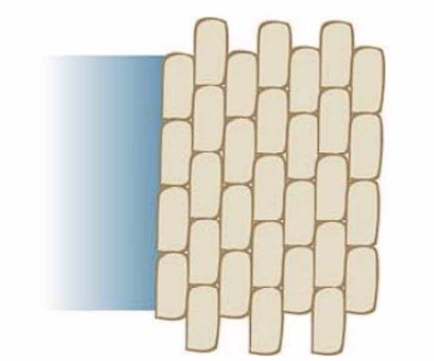

Figure 14: Lay the first layer of sandbags in a brick pattern, perpendicular to flow direction (arrow) (Source: Province of Manitouba: https://www.gov.mb.ca/emo/pdfs/sandbag.pdf)

- Rotate bags 90 degrees when laying second course of sandbags. Keep seal side of bag towards water/river. Ensure sandbags are well packed against each other and firmly in place (Figure 15);

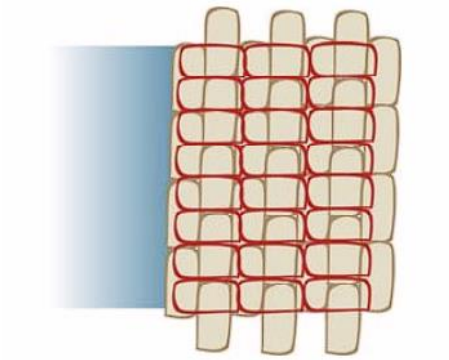

Figure 15: Orientate second layer of sandbags (red) 90 degrees to orientation of first layer (Source: Province of Manitouba: https://www.gov.mb.ca/emo/pdfs/sandbag.pdf)

- Weave the polyethylene sheet between the courses of sandbags as to have at least one layer of sandbags protecting the polyethylene sheet from debris punctures (Figure 16).

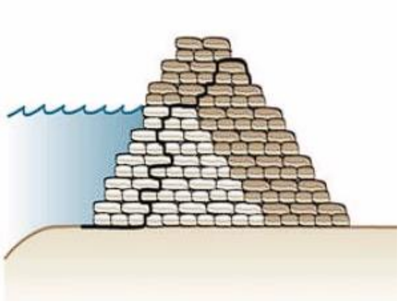

Figure 16: Weave an impermeable plastic sheet (black line) in between the layers of sandbags (Source: Province of Manitouba: https://www.gov.mb.ca/emo/pdfs/sandbag.pdf)

- Placement activities should minimize vegetation removal and disturbance of adjacent areas to the maximum extent practicable

  - Ensure that barrier structures are of sufficient height to prevent waves or overflows from flooding the enclosed work area.
  - Waters adjacent to the barrier structures should be inspected for turbidity on a continuous basis. Excessive turbidity should be addressed and eliminated to the extent possible.

- Diversion must not result in the passage of sediment-laden water into downstream areas, or cause erosion of the bed and banks of the watercourse;
- Stockpiles of excavated soil or rocks must be placed outside of the delineated area of the wetland on as flat an area as possible and protected (using a tarpaulin or plastic sheeting) to prevent surface runoff of material into the watercourse;
- Excavated material that will not be re-cycled for use in the maintenance activities (e.g. wire mesh, bidem etc.) must be removed from the site and disposed of at a suitable facility;
- Chemical toilets should be provided on-site at 1 toilet per 10 construction workers/personnel;
- Waste from chemical toilets must be disposed of regularly (at least once a week) in a responsible manner by a registered waste contractor;
- Excavators and all other machinery and vehicles must be checked for oil and fuel leaks daily. No machinery or vehicles with leaks are permitted to work in the watercourse;
- No fuel storage, refuelling, vehicle maintenance or vehicle depots to be allowed within the watercourse; and
- Refuelling and fuel storage areas, and areas used for the servicing or parking of vehicles and machinery, must be located on impervious bases and should have bunds around them (sized to contain 110 % of the tank capacity) to contain any possible spills;
- Re-vegetation of any exposed areas (i.e. access routes, stockpile areas etc.) must be implemented timeously. In this regard, the banks should be appropriately and incrementally re-vegetated as soon as construction allows; and
- The watercourse must be inspected on a regular basis (at least weekly) by an appropriately qualified Environmental Control Officer (ECO) for signs of disturbance, sedimentation and pollution during maintenance activities. If signs of disturbance, sedimentation or pollution are noted, immediate action should be taken to remedy the situation and, if necessary, a freshwater ecologist should be consulted for advice on the most suitable remediation measures.

7.3.2 Construction of New Fence

Construction of the fence will involve construction of the supporting columns (concrete foundation, gabion boxes, reno mattress and I-section columns).

7.3.2.1 Impact Mitigation

- Areas where construction activities will take place must be confined to clearly demarcated areas so as to prevent unnecessary disturbance of instream habitat outside of these areas.
- Since the supporting columns will be installed within the riverbed, construction must be sequenced so that they are put in place with the minimum possible delay.

Disturbance of areas where supporting columns are to be constructed must be undertaken only when final preparation and placement can follow immediately behind the initial disturbance;

- Dry working conditions must be established by constructing temporary stream diversions (as described in Section 7.3.2.1 above);
- A construction schedule must be developed and clearly defined so as to avoid multiple sites being exposed and unattended to at any moment in time. The completion date for each phase of development must be indicated and all clearing, excavation, and stabilisation operations must be completed before moving onto the next phase.
- Cement/concrete used in the construction must not be mixed on bare ground or within the watercourse. An impermeable/bunded area must be established in such a way that cement slurry, runoff and cement water will be contained and will not flow into the surrounding environment, the stream or riparian zone or contaminate the soil;
- All waste materials must be collected and disposed of at a suitable waste facility; and
- The laydown area and stockpiles of construction materials must be placed outside of the delineated wetland area (on as flat an area as possible) and protected (e.g. through use of sandbags and/or tarpaulins) to prevent materials being washed into the watercourse.

7.3.3 Reshaping and Rehabilitation of Riverbed

As described above, removal of the gabion wall will result in a vertical drop-off that will be highly susceptible to erosion. It is recommended that the drop-off is protected by Void-Filled Riprap (VFR), which is essentially a construction material used to emulate natural riffle rock found in coarse gravel and cobble bed streams. The goal of VFR is to fill the voids of the conventional riprap (typically made up using large rocks) using a broad range (or size classes) of materials (cobbles, gravels, sands, and onsite soils) to emulate natural riffle rock. The mixture should create a dense, interlocking mass that keeps water flowing on the surface, mimicking a natural stream bed and encouraging growth of vegetation in trapped sediment. Material from the gabion structures that will be demolished can be used as a contributing material to the VFR.

Figure 17: Example of VFR illustrating a homogenous mix of materials of different size classes.

7.3.3.1 Impact Mitigation

- Calculations must be done to determine the size of the largest rocks required for the VFR to withstand peak flows. It is anticipated that rocks larger than those used in the existing gabions will need to be imported to the site;

- The area(s) chosen for the stockpiling of excavated and imported VFR materials must be demarcated, and notices put up declaring what must be stockpiled where. No materials may be stockpiled within the delineated wetland area.
- Dry working conditions must be established by constructing temporary stream diversions (as described in Section 7.3.2.1 above).
- Prior to the placement of VFR, the vertical drop-off must be reshaped to a sloping gradient (1:2). The surface of the slope must be reasonably smooth, and free of mounds, dips, etc.
- The reshaped riverbed must be lined with a geotextile, the purpose of which is to retain the coarser particles of the riverbed while remaining permeable enough to allow water to move through the filter in both directions (infiltration and exfiltration). The geotextiles must have adequate strength to withstand installation stresses during placement.
- The geotextile must be placed in such a manner that placement of the overlying materials will not excessively stretch or tear the geotextile.
- VFR must be placed so that is reasonably homogeneous, with the larger rocks uniformly distributed and firmly in contact with the smaller rocks and gravel filling the voids between the larger rock. Hand placement of void filling material must be completed to ensure a final surface which is smooth and with no voids greater than 10 cm present between rocks.
- VFR must be provided with a key (or toe down) below the elevation of the riverbed. The depth of the key should be at least as great as the depth of the anticipated long-term bed degradation plus the scour at the toe.

7.3.4 Future Maintenance (Operational Phase)

Given the design of the fence, routine maintenance will be required following flood events. This may include *inter-alia* repair to fence posts, re-installation of fence panels and maintenance of VFR.

7.3.4.1 Impact Mitigation

- A schedule must be drawn up to prompt inspection of the fence and VFR (at least once a month for the first six months and then once every six months thereafter), so that any maintenance activities can be undertaken timeously so as to prevent damage to infrastructure and deterioration of the watercourse;
- Any maintenance required for the fence must adopt the mitigation measures specified under Section 7.3.2.1 and 7.3.3.1.

8. DWS RISK ASSESSMENT

In terms of legislation pertaining to the NWA, the development falls within the regulated area of the wetland. Risks of activities associated with the development to the adjacent wetlands were determined according to the risk assessment matrix developed as part of GN 4167 of 2023 (Section 21 (c) and (i) water use Risk Assessment Protocol) - Table 5. The first stage of the risk assessment is the identification of environmental activities, aspects and impacts and essentially mirror those that were identified in the impact assessment (see Section 7). The intensity of impact to receptors and resources (i.e. hydrology, water quality, geomorphology, biota and vegetation) is rated (from 0 to 5, representing negligible and very high impact, respectively), which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. Risks were then quantified based on the anticipated spatial scale, duration and likelihood of occurrence and assumed the full implementation of recommended mitigation measures described in Section 7.

In summary, assuming mitigation measures are implemented, the construction of the new fence can be implemented with a Low Risk to the watercourse. In particular, the new fence design results in an improvement of hydrological flows through the wetland due to removal of the gabion wall which currently impedes flows and causes erosion of the riverbed.

Table 5: Construction and operational phase risk matrix completed by Dr. JM Dabrowski (SACNASP registration number 114084). Severity scores assume full implementation of mitigation measures).

Phase	Activity	Impact	Potentially affected watercourses			Intensity of Impact on Resource Quality					Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating (with mitigation)	Confidence level
						Abiotic Habitat (Drivers)			Biota (Responses)											
			Name/s	PES	Ecological Importance	Hydrology	Water Quality	Geomorph	Vegetation	Fauna										
CONSTRUCTION	Removal of Fence	Erosion and sedimentation caused by removal of gabion wall	Modder River	D	Moderate	0	2	2	0	1	4	1	1	6	3	18	60%	10.8	L	High
		Waste Materials	Modder River	D	Moderate	1	1	1	1	1	2	1	2	5	3	15	40%	6	L	High
		Contamination of watercourses by hydrocarbons (oil and fuel) and sewage (ablution facilities)	Modder River	D	Moderate	0	1	0	1	1	2	1	2	5	3	15	40%	6	L	High
	Construction of New Fence	Disturbance to wetland habitat	Modder River	D	Moderate	1	1	0	1	1	2	1	1	4	3	12	40%	4.8	L	High
		Erosion and sedimentation caused by excavating the riverbed	Modder River	D	Moderate	0	1	1	1	1	2	1	2	5	3	15	60%	9	L	High
		Concrete mixing	Modder River	D	Moderate	0	1	0	1	1	2	1	2	5	3	15	20%	3	L	High
	Reshaping and Rehabilitation of Riverbed	Disturbance to wetland habitat during placing of VFR	Modder River	D	Moderate	1	1	0	1	1	2	1	2	5	3	15	40%	6	L	High
OPERATIONAL	New Fence	Flows through the fence will be dispersed across the width of the fence	Modder River	D	Moderate	-3	-1	-2	-2	-1	-6	2	4	-12	3	-36	60%	-21.6	+	High
		VFR may cause unintended erosion of riverbed.	Modder River	D	Moderate	2	0	2	1	1	4	1	4	9	3	27	80%	21.6	L	High

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9. CONCLUSION

- The proposed design of the new perimeter fence represents an improvement over the existing design, which currently impedes and concentrates flows, and is causing erosion and channelisation of the wetland.
- Rehabilitation of the drop-off caused by the historical installation of the gabion wall using carefully placed VFR is essential to ensure that the removal of the gabion wall will not result in erosion of the riverbed in the short to medium term.
- The fence and VFR must be routinely monitored following high rainfall and flooding events to ensure that a) damaged structures are repaired and b) the riverbed is not eroding.

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