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AQUATIC BIODIVERSITY IMPACT ASSESSMENT

PROPOSED UPGRADE OF THE RAW WATER ABSTRACTION WORKS AND PUMP STATION, MOORDKUIL RIVER, PORTION 15, 24 AND 25 OF THE FARM KLIPHEUVEL, MOSSEL BAY

DATE: 26 June 2026

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V4

Specialist Assessment Protocol Index

Report reference to Table 1 - Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Aquatic Biodiversity

2. Aquatic Biodiversity Specialist Assessment	
2.1. The assessment must be prepared by a specialist registered with the South African Council for Natural Scientific Professionals (SACNASP), with expertise in the field of aquatic sciences.	Colin Fordham SACNASP Registration number 400166/14 (Ecology)
2.2. The assessment must be undertaken on the preferred site and within the proposed development footprint.	Section 1- Introduction 1.1 Location 1.2 Description of the Mining Right Area: Existing and Proposed
2.3. The assessment must provide a baseline description of the site which includes, as a minimum, the following aspects:	
2.3.1. a description of the aquatic biodiversity and ecosystems on the site, including;	Section 6 – Affected Environment Section 7 – Results 7.1 -Identified Aquatic Habitats
(a) aquatic ecosystem types; and (b) presence of aquatic species, and composition of aquatic species communities, their habitat, distribution and movement patterns;	Section 6 – Affected Environment
2.3.2. the threat status of the ecosystem and species as identified by the screening tool;	Areas of Very High 1.4 -Screening tool results Section 6.5 –Conservation context Section 6.4 - SAIIAE
2.3.3. an indication of the national and provincial priority status of the aquatic ecosystem, including a description of the criteria for the status (i.e. if the site includes a wetland /river freshwater ecosystem priority area or sub catchment, a strategic water source area, a priority estuary, whether or not they are free-flowing rivers, wetland clusters, a critical biodiversity or ecologically sensitivity area); and	Section 6 – Affected Environment ESA aquatic
2.3.4. a description of the ecological importance and sensitivity of the aquatic ecosystem including:	Section 7 – Results Section 7.1 Identified aquatic habitat Section 6 – Affected Environment
(a) the description (spatially, if possible) of the ecosystem processes that operate in relation to the aquatic ecosystems on and immediately adjacent to the site (e.g. movement of surface and subsurface water, recharge, discharge, sediment transport, etc.); and	Section 6 – Affected Environment Section 7.1 – Identified aquatic habitat Section 7 - Results

(b) the historic ecological condition (reference) as well as present ecological state of rivers (in-stream, riparian and floodplain habitat), wetlands and/or estuaries in terms of possible changes to the channel and flow regime (surface and groundwater).	
2.4. The assessment must identify alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification and which were not considered appropriate.	Section 8 – Potential Impacts Section 7 – Results Refer to SSVR
2.5. Related to impacts, a detailed assessment of the potential impacts of the proposed development on the following aspects must be undertaken to answer the following questions:	
2.5.1. is the proposed development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?	Refer to Section 9 –Impact assessment and tables
2.5.2. is the proposed development consistent with maintaining the resource quality objectives for the aquatic ecosystems present?	
2.5.3. how will the proposed development impact on fixed and dynamic ecological processes that operate within or across the site? This must include:	Section 8 – Potential Impacts
(a) impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes (e.g. suppression of floods, loss of flood attenuation capacity, unseasonal flooding or destruction of floodplain processes); (b) will the proposed development change the sediment regime of the aquatic ecosystem and its sub-catchment (e.g. sand movement, meandering river mouth or estuary, flooding or sedimentation patterns); (c) what will the extent of the modification in relation to the overall aquatic ecosystem be (e.g. at the source, upstream or downstream portion, in the temporary / seasonal / permanent zone of a wetland, in the riparian zone or within the channel of a watercourse, etc.); and (d) to what extent will the risks associated with water uses and related activities change;	Section 8.2 – Impact 2: Flow pattern changes 8.3 – Impact 3: Erosion and Sedimentation Section 8.1 – Impact 1: Loss of riparian habitat Section 8.4 – Impact 4: Water Quality impacts
2.5.4. how will the proposed development impact on the functioning of the aquatic feature? This must include:	Section 9 – Impact Significance Assessment
(a) base flows (e.g. too little or too much water in terms of characteristics and requirements of the system); (b) quantity of water including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over-abstraction or instream or off-stream impoundment of a wetland or river); (c) change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an unchannelled valley-bottom wetland to a channelled valley-bottom wetland); (d) quality of water (increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication); (e) fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal); and (f) the loss or degradation of all or part of any unique or important features associated with or within the aquatic	Refer to Section 9 –Impact assessment and tables Section 8 – Potential Impacts Section 9 - Impact Assessment

ecosystem (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soils, etc.);	
2.5.5. how will the proposed development impact on key ecosystems regulating and supporting services especially:	Low Impact (after mitigation) Section 9 – Impact Significance Assessment
(a) flood attenuation; (b) streamflow regulation; (c) sediment trapping; (d) phosphate assimilation; (e) nitrate assimilation; (f) toxicant assimilation; (g) erosion control; and (h) carbon storage?	Section 8 – discussion of potential impacts
2.5.6. how will the proposed development impact community composition (numbers and density of species) and integrity (condition, viability, predator-prey ratios, dispersal rates, etc.) of the faunal and vegetation communities inhabiting the site?	Section 8.1 and Impact Table of Section 9.2
2.6. In addition to the above, where applicable, impacts to the frequency of estuary mouth closure should be considered, in relation to: (a) size of the estuary; (b) availability of sediment; (c) wave action in the mouth; (d) protection of the mouth; (e) beach slope; (f) volume of mean annual runoff; and (g) extent of saline intrusion (especially relevant to permanently open systems).	N/A
2.7. The findings of the specialist assessment must be written up in an Aquatic Biodiversity Specialist Assessment Report that contains, as a minimum, the following information:	
2.7.1. contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae;	Appendix 2 – Specialist curriculum vitae
2.7.2. a signed statement of independence by the specialist;	Below Declaration of Independence –Page vi and Appendix 3
2.7.3. a statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	4.2 – Site assessment Section 4 – Approach and methodology Section 5 - Assumptions
2.7.4. the methodology used to undertake the site inspection and the specialist assessment, including equipment and modelling used, where relevant;	Section 4 – Approach and methodology

Declaration of Independence

SPECIALIST REPORT DETAILS

This report has been prepared as per the requirements of the Environmental Impact Assessment Regulations and the National Environmental Management Act (Act 107 of 1998), any subsequent amendments and any relevant National and / or Provincial Policies related to biodiversity assessments. This also includes the minim requirements as stipulated in the National Water Act (Act 36 of 1998), as amended in Water Use Licence Application and Appeals Regulations, 2017 Government Notice R267 in Government Gazette 40713 dated 24 March 2017, which includes the minimum requirements for an Aquatic Biodiversity Report.

Report prepared by: Colin Fordham (400166/14 Ecology)

Expertise / Field of Study: Colin is a SACNASP registered Professional Natural Scientist (Pr. Sci. Nat.) ecologist with 14 years of experience in the environmental sector. He began his career in environmental consulting, spending six years compiling ecological and aquatic specialist reports for diverse development applications across Southern Africa. He then joined CapeNature as a Land Use Scientist, where he reviewed specialist reports to ensure compliance with best practices and legislation, before being promoted to senior management as a Landscape Conservation Intelligence Manager for five years.

As a Senior Landscape Conservation Intelligence Manager (LCIM) at CapeNature, Colin led a team of ecological specialists and land use staff, providing strategic direction and ensuring the delivery of high-quality scientific outputs. His role encompassed knowledge generation and dissemination, capacity building, ecological monitoring and strategic adaptive management, equipping him with the leadership and expertise to tackle complex ecological challenges.

I, **Colin Fordham** declare that this report has been prepared independently of any influence or prejudice as may be specified by the National Department of Environmental Affairs Fisheries and Forestry and or Department of Water and Sanitation.

Signed:… .... Date:…26 June 2026 …………

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SUMMARY

Upstream Consulting has been appointed by Sharples Environmental Services to undertake an aquatic biodiversity impact assessment for the proposed upgrading of the Moordkuil River Pumpstation, near Klein Brak River, Western Cape. The study area lies within the Southern Coastal Belt DWA Level 1 Ecoregion and DWS quaternary catchment K10F of the Gouritz Catchment Management Area. The Moordkuil River, a tributary of the Klein Brak River, is the largest river in this catchment. There are several unnamed perennial and non-perennial tributaries and dams in this catchment, with much abstraction occurring for agricultural practices. The Moordkuil River is categorised as having a Present Ecological State (PES) score of C, which is Moderately modified.

The site sits at an elevation of between 1 and 15 m.a.s.l. on a moderately steep banks riparian section adjacent to the river. According to the latest national desktop river and wetland inventories the Moordkuil River is incorrectly classified as an estuary at this location. The road bridge prevents any saltwater ingress. NFEPA or National Wetland Map 5 wetlands are located in the study area and none of these will not be impacted by the proposed alternatives expect the Moordkuil River. According to national river map all these systems eventually drain into the Moordkuil River. Within the larger 500m buffer area there is an additional three non-perennial systems.

A site assessment was conducted on the 28th of February 2025 to confirm desktop findings, gather additional information, and define the boundaries of the aquatic habitat. General observations were made with regards to the vegetation, fauna and current impacts. This cumulated in the drafting of a Site Sensitivity Verification Report to confirm the findings of the DFFE screening report.

The Moordkuil Perennial River (PR) Hydrogeomorphic (HGM) unit 1 is the system within which the abstraction point for the pumpstation is located and the only system that will be impacted. It is classified as a Perennial River system. It's vegetation, hydrology and geomorphological states are modified, but are currently stable. No rare or endangered aquatic biota were found on site.

Two design alternatives and a No-Go alternative were assessed. Impact assessment determined that, after mitigation, none of the various Alternatives have irreversibly high impacts. The lowest impacts were for the No-Go Alternative, with both alternative 1 and 2 having very similar impacts. Of the three site camps only Site Camp 3 is feasible with Site Camps 1 and 2 being fatally flawed.

Mitigation should focus on minimising the construction footprint and impacts on the hydrological and geomorphological characteristics of the watercourse. A robust monitoring programme should be developed and audited annually by a SACNASP registered ecologist.

In conclusion, there are no fatal flaws associated with the proposed alternatives, provided all the mitigation measures are strictly implemented and monitored. The proposed project requires water use authorisation in terms of Chapter 4 and Section 21 of the National Water Act No. 36 of 1998, prior to the commencement of activities.

1 INTRODUCTION

Upstream Consulting was appointed by Sharples Environmental Services (Pty) Ltd to undertake an aquatic biodiversity sensitivity assessment for the proposed upgrade of the raw water abstraction works and pump station, Moordkuil River, located on Portions 15, 24 and 25 of the farm Klipheuvel, Mossel Bay, Western Cape.

1.1 LOCATION

The site is located 4km north of Klein Brak River. Refer to Figure 1. The study area for assessment included a 500m radius from the proposed development footprint.

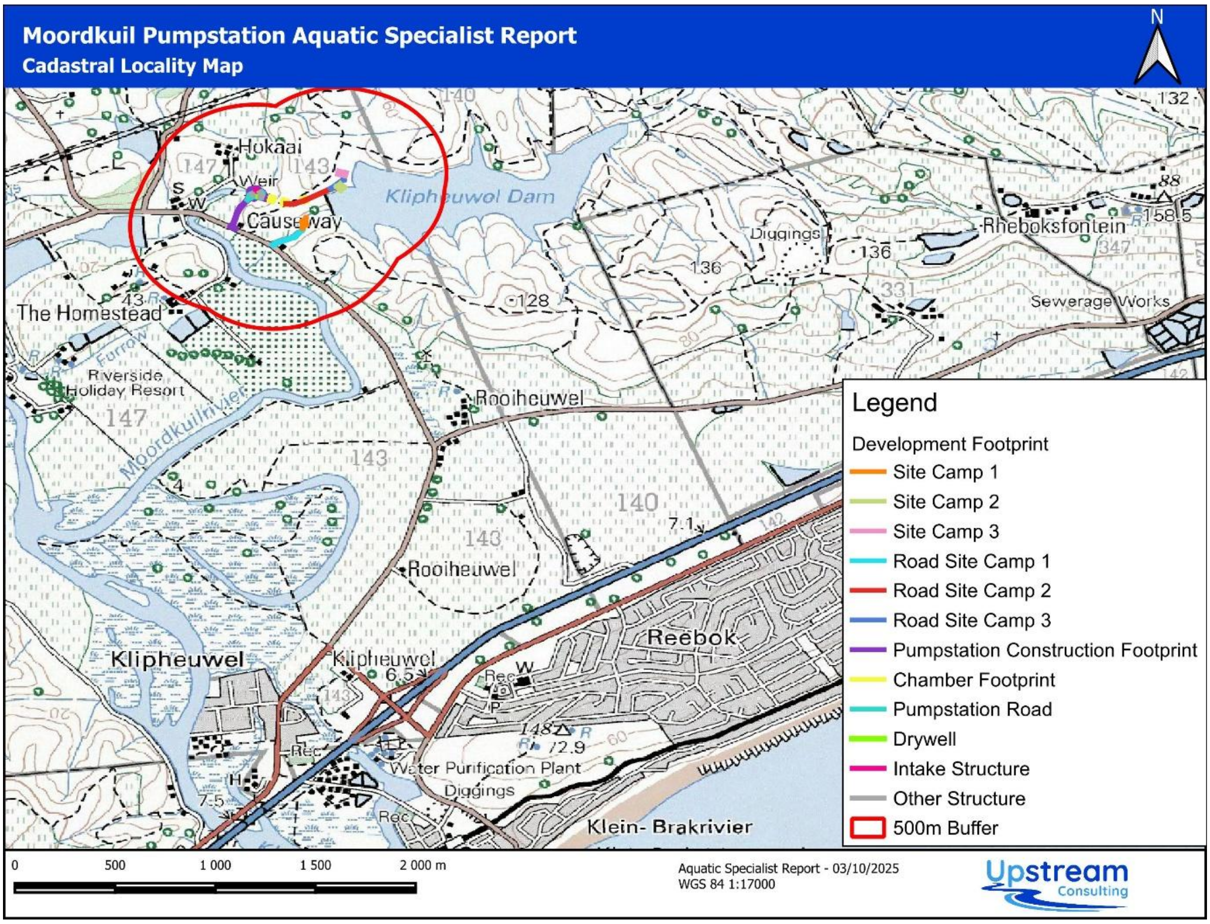

Figure 1: *Cadastral Locality map, illustrating project location and 500m buffer*

1.2 PROJECT DESCRIPTION

The following information was supplied by Sharples Environmental Services cc (SES) and the engineering report

"Sharples Environmental Services cc (SES) has been appointed as the independent Environmental Assessment Practitioner (EAP) to conduct the Environmental Impact

Assessment process for the proposed upgrade of the raw water abstraction works and pump station, Moordkuil River, Portion 15, 24 and 25 of the farm Klipheuvel, Mossel Bay. The proposed development site is at the existing raw water abstraction works and pump station (been in operation since 1980), on the Moodkuil River bank located in Mossel Bay in the Western Cape Province. Currently access to the site can be obtained from the N2 National Road, onto Blesbok Road and then via an existing gravel road to the site.

BACKGROUND TO PROPOSED DEVELOPMENT AND NEED FOR THE UPGRADE:

The existing raw water abstraction works (been here since 1980) was designed to abstract 800 litres per second of water from the Moordkuil river and to pump the water to the Klipheuwel Dam for storage. The Klipheuwel Dam is one of four reservoirs from which Mossel Bay residents receive their water. Only one of the existing two axial pumps is currently operational, which means that the facility is operating at half its original intended design capacity. The existing axial pump station design is outdated and it is not able to be maintained / repaired due to the unavailability of parts and other maintenance restrictions (unable to remove parts easily, axial pumps are not protected from silt and are subject to repeated wear and tear). It is therefore required to upgrade the existing raw water abstraction works and pump station with more modern technology that will be low maintenance, cost effective and efficient (able to abstract water at the full original intended design capacity of 800 litres per second and low maintenance).

DESCRIPTION OF PROPOSED DEVELOPMENT:

The proposed development project entails the upgrade of the existing Raw Water Abstraction Works and PumpStation. In summary, the following is proposed to be constructed:

- *The construction of a new reinforced concrete inlet hopper structure for the pump station;*
- *The construction of pipe protection ramp structure for the pipes into the existing pump station building.*
- *The reinstatement of the existing gravel access road from Blesbok Road to the site (180m long and 3.6m wide) by reinstating the existing gravel road, within the same development footprint, which has become almost impassable due to water ingress into the existing layerworks (farmers leaking irrigation channel). The final road is proposed to be 3m wide. 300mm is proposed on each side for the bottom layerworks that have to be wider than the top layerworks to transfer vehicle loads to the soil. The proposed affected area will be 3.6m but the final road will be 3m wide. The existing road is that its layerworks would also have been similar to the proposed reinstatement design.*
- *A new concrete road (in an already disturbed area mostly). The new concrete road proposed is approximately 500m^2 and ranges in width from 3m to 7.4m (in order for a 5 ton truck to turn around);*
- *Construction of an access ramp to the hopper;*
- *The construction of a new water meter chamber next to the pump station. The development footprint of the water meter chamber is approximately 20m^2;*
- *Replacing of three air-valves and construction of new chambers around the air-valves;*

- *Installation of new pipework, pumps and motor control centers;*
- *Installation of other mechanical items such as cover, trash-racks, etc.*
- *Upgrading of the electrical supply and breakers within the existing pump station building;*
- *Installation of a sediment barrier downstream of the crossing to curb sediment generation in the river;*
- *Final reinstatement of the river bed to the requirements of the CEMP;*

The concrete inlet hopper structure is proposed to be anchored to the bedrock by means of piling foundations. In order to install the piles, a pile rig needs to obtain access in the correct position. It is for this reason that a temporary platform structure is required to be constructed within the Moordkuil River.

The area where the inlet hopper (and the associated pile foundations) is proposed to be constructed is below the 1:10 year floodline, within the river. It is therefore required to construct a coffer dam around the area where the inlet hopper structure is proposed to be built in order to have a dry area for construction and concrete setting.

All of the above, except for the proposed temporary platform, cement access road, new water meter chamber and sediment barrier, are proposed within the existing development footprint. It is also proposed to demolish the existing underwater cement bag wall, existing above water concrete steps and the existing underwater concrete plinths for the existing pipes.
Please refer to the proposed site layout plans below (Figures 2 and 3).

UPDATED INFORMATION APRIL 2025: The updated information is illustrated in Figure 2, the access road from Blesbok Road will remain a gravel surface but will still be upgraded to improve accessibility. As the road approaches the pump station, it will be resurfaced with concrete. Following this, vegetation will be cleared to enable the construction of a platform for the temporary pumps and the installation of the rising main leading to Klipheuvel Dam.

UPDATED INFORMATION SEPTEMBER 2025: A hydrological study of the riverbed, revealed the location of a large rock outcrop upstream of the preferred design. This outcrop resulted in the project alternatives changing to two new conceptual designs being assessed for the pumpstation illustrated in Figure 3 (a - c) as per Concept design report. Three site camp alternatives however also need to be investigated in term of the EIA process (Figure 2a and 3).

UPDATED INFORMATION OCTOBER 2025: The design of the pumpstation also now includes the construction of gabions for scour protection around infrastructure (Figure 2b).

UPDATED JUNE 2026: The project was resubmitted to DFFE for Environmental Authorisation, resulting in a new DFFE Screening Tool Report being generated. This report has subsequently been updated to verify the revised screening results and assess their implications for the aquatic specialist assessment.

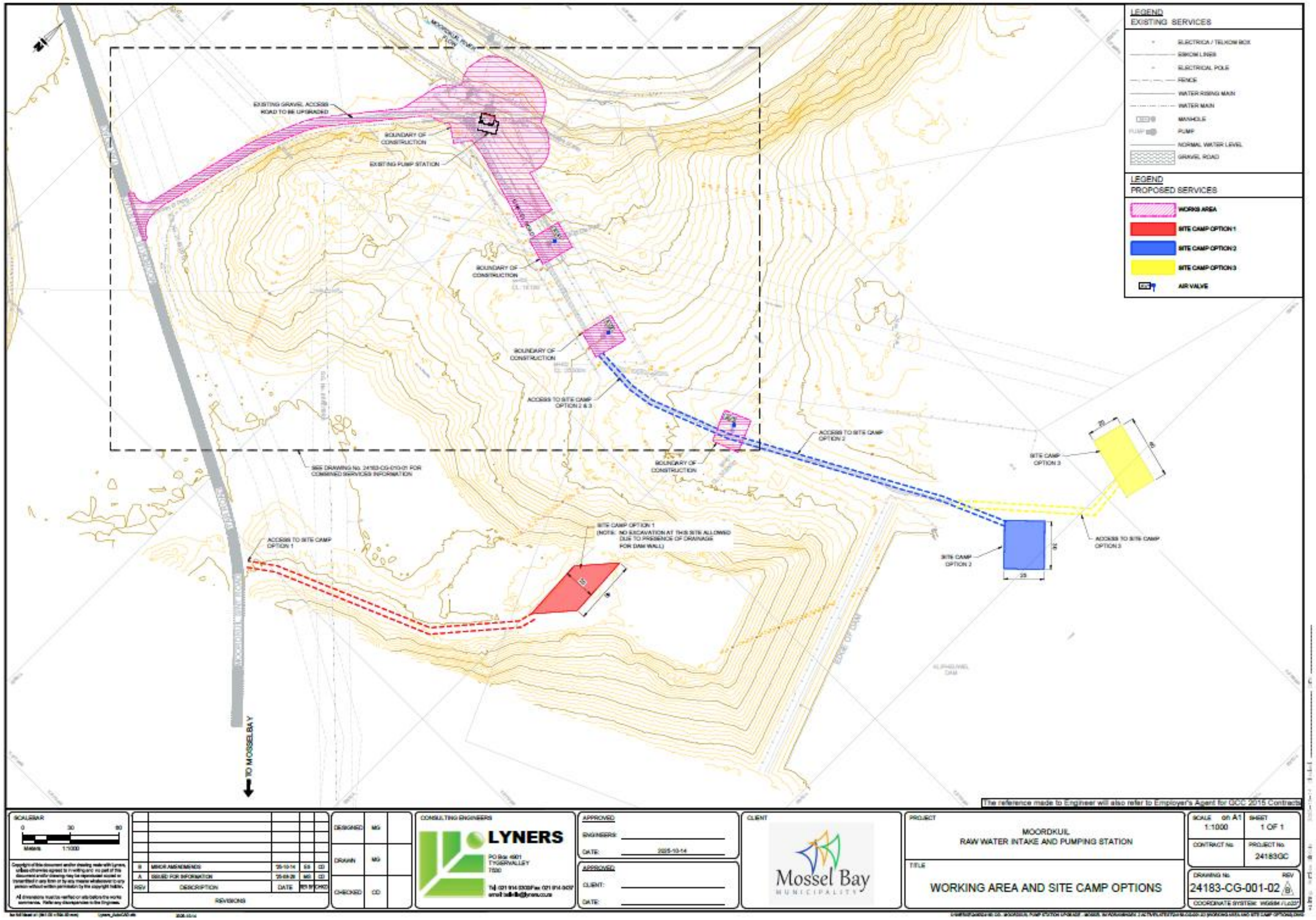

Figure 2a: *Site Layout Plan showing the proposed construction activities as outlined and three site camp alternatives.*

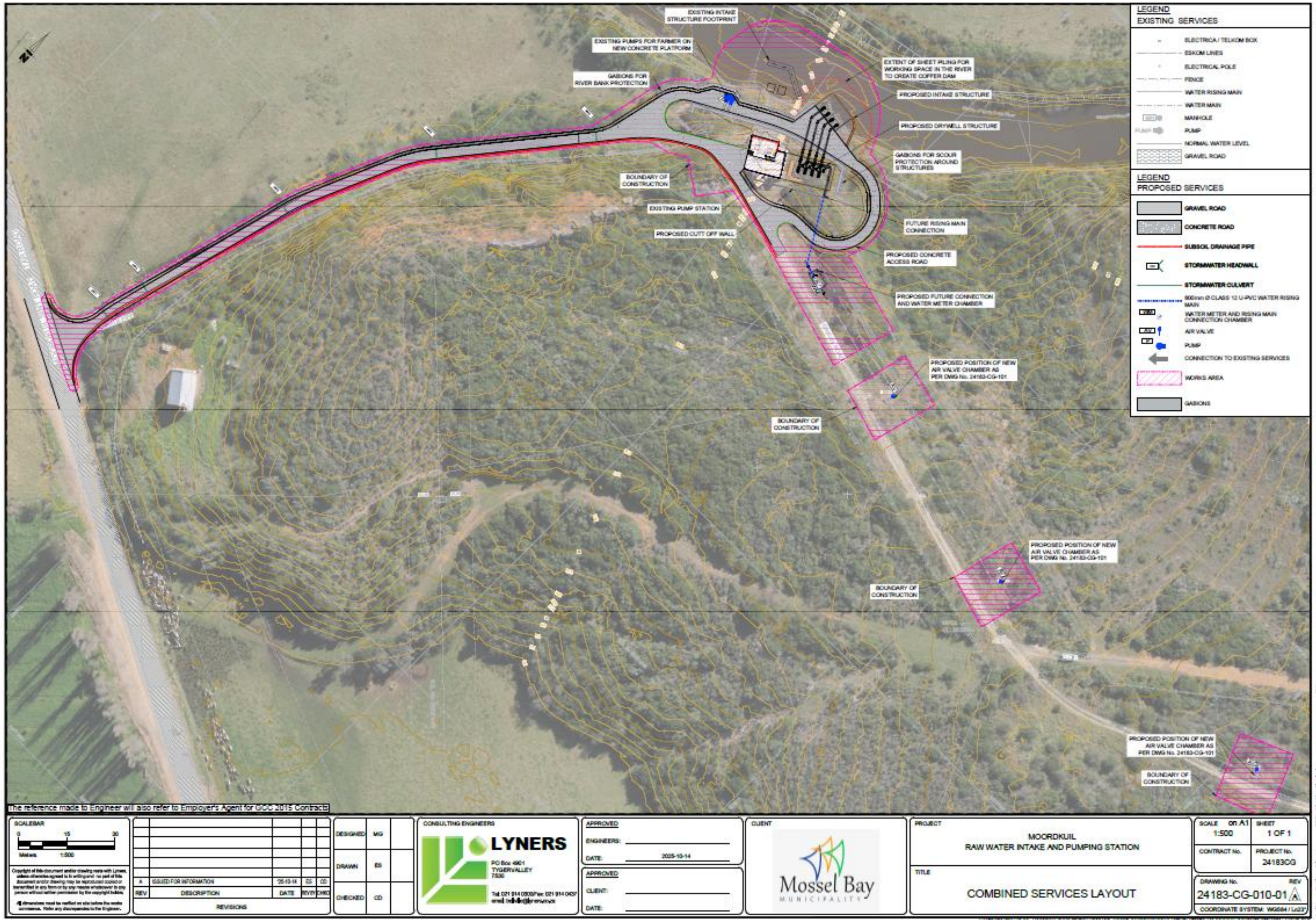

Figure 3b: *Site Layout Plan showing the combined services and new gabion structure.*

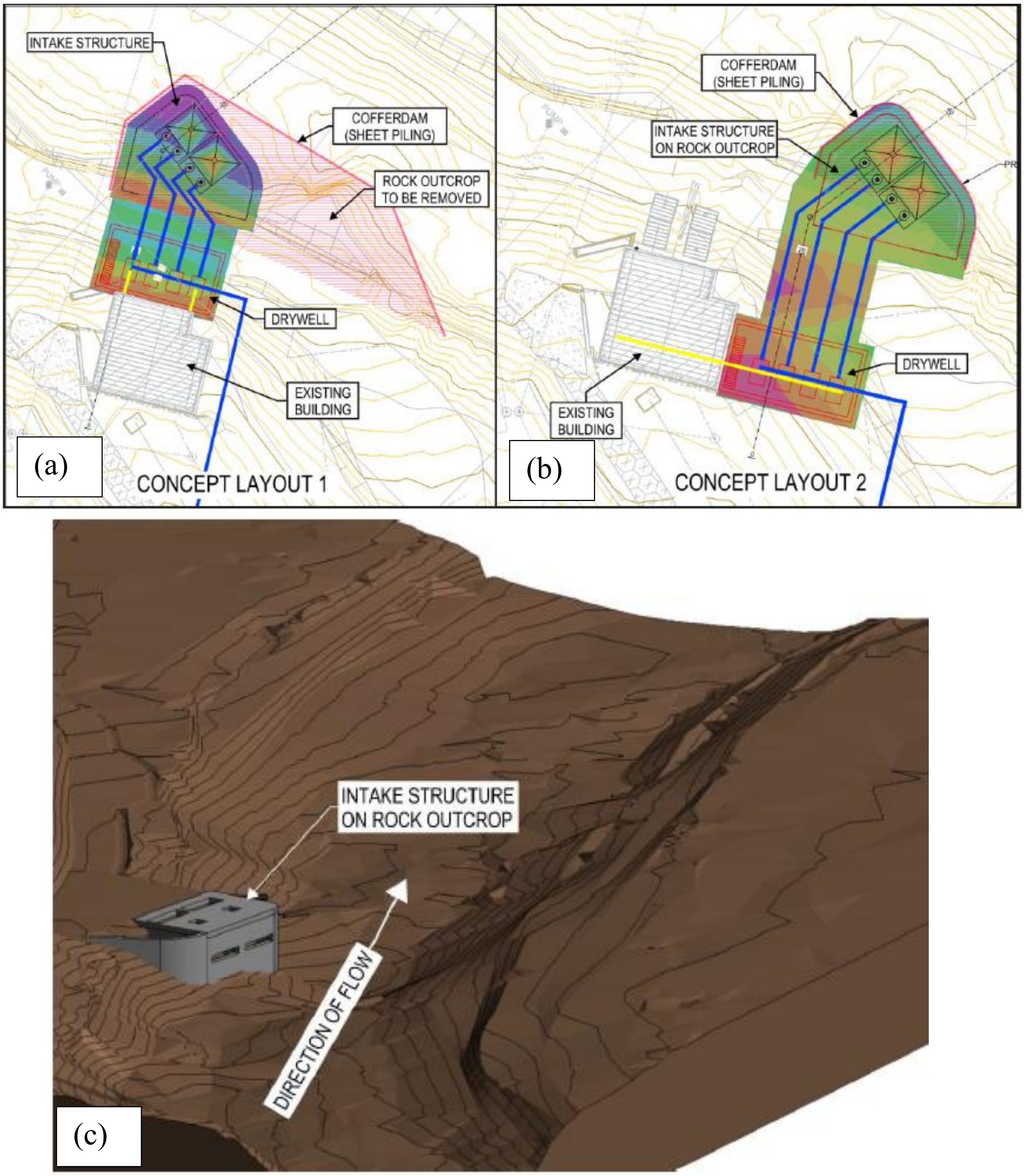

***Figure 4**: Site layout plan showing the proposed abstraction point designs (a) and (b), as well as a 3D design of the river bed showing location of inlet structure on top of existing bedrock (c).*

1.3 Alternatives

The following two alternatives were provided by SES to be assessed within this report (Figure 2).

Alternative 1: Due to the location of the rocky outcrop, for this design to be feasible from a hydrological perspective, the outcrop will need to be removed and intake structure placed directly in front of the existing facility.

Alternative 2: This alternative is preferred by the engineers and client as it has technological advantages and does not involve the removal of the rocky outcrop and allows for the installation of a drywell adjacent to the existing building.

1.4 Screening Tool Results

The National Web based Environmental Screening Tool was utilised for this proposal in terms of the Environmental Impact Assessment (EIA) Regulations 2014, as amended, to screen the proposed site for any environmental sensitivity. The Screening Tool identifies related exclusions and/ or specific requirements including specialist studies applicable to the proposed site. The Screening Tool allows for the generating of a Screening Report referred to in Regulation 16 (1) (v) of the Environmental Impact Assessment Regulations 2014, as amended whereby a Screening Report is required to accompany any application for Environmental Authorisation. Requirements for the assessment and reporting of impacts of development on aquatic biodiversity are set out in the *'Protocol for the assessment and reporting of environmental impacts on aquatic biodiversity published in Government Notice No. 648, Government Gazette 45421, on the 10 of May 2020'*.

Based on the DFFE Screening Tool, the pump station and its associated infrastructure, as well as one of the site camps, are located within an area of Very High aquatic biodiversity sensitivity. The drainage features within the study area are assigned a Very High aquatic biodiversity sensitivity rating due to the presence of CBA Estuary, CBA River, Estuary, Estuary_Klein Brak and Rivers sensitivity features. Consequently, the project required a Site Sensitivity Verification Report (SSVR) to verify the Screening Tool results and determine the appropriate level of specialist assessment. The Screening Tool results were verified through the SSVR (Appendix 5), which confirmed the Very High aquatic biodiversity sensitivity of the site. Accordingly, a full Aquatic Biodiversity Impact Assessment was required and has been compiled in accordance with the National Environmental Management Act (Act 107 of 1998) Environmental Impact Assessment Regulations and the Protocol for the Specialist Assessment and Minimum Report Content Requirements for Aquatic Biodiversity (Government Notice 320 of 2020).

2 RELEVANT LEGISLATION

The protection of water resources is essential for sustainable development and therefore many policies and plans have been developed, and legislation promulgated, to protect these sensitive ecosystems. Table 1 below outlines the environmental legislation relevant to the project.

Table 1: Relevant environmental legislation

Legislation	Relevance
South African Constitution 108 of 1996	The constitution includes the right to have the environment protected
National Environmental Management Act 107 of 1998	Outlines principles for decision-making on matters affecting the environment. Chapter 1(4r) states that sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure. Section 24 of NEMA requires that the potential impact on the environment, socio-economic conditions and cultural heritage of activities that require authorisation, must be investigated and assessed prior to implementation, and reported to the authority.
Environmental Impact Assessment (EIA) Regulations	The 2014 regulations have been promulgated in terms of Chapter 5 of NEMA and were amended on 7 April 2017 in Government Notice No. R. 326. In addition, listing notices (GN 324-327) lists activities which are subject to an environmental assessment.
The National Water Act 36 of 1998	The proposed project may require a Water Use License (WUL) in terms of Chapter 4 and Section 21 of the National Water Act No. 36 of 1998. Chapter 4 of the National Water Act addresses the use of water and stipulates the various types of licensed and unlicensed entitlements to the use of water.
Conservation of Agricultural Resources Act (Act 43 of 1983)	CARA is to provide for the conservation of the natural agricultural resources by the maintenance of production potential of land, by the combating and prevention of erosion and weakening or destruction of the water sources, and by the protection of the vegetation and the combating of weeds and invader plants.
National Environmental Management: Biodiversity Act No. 10 of 2004	This is to provide for the management and conservation of South Africa's biodiversity through the protection of species and ecosystems; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits.
Western Cape Biodiversity Act (Act No. 6 of 2021)	The Western Cape Biodiversity Act provides a framework for the protection, conservation, and management of biodiversity in the province, including Critical Biodiversity Areas (CBAs). It ensures that land-use planning, and development decisions consider the ecological value of CBAs to maintain biodiversity and ecosystem services. The Act aligns with national biodiversity priorities and mandates the identification, designation, and protection of ecologically significant areas. It also supports sustainable land-use practices and promotes conservation stewardship to prevent habitat degradation and biodiversity loss.

3 TERMS OF REFERENCE

- Contextualization of the study area in terms of important biophysical characteristics and the latest available aquatic conservation planning information (including but not limited to the South African Inventory of Inland Aquatic Ecosystems (SAIIAE), vegetation, CBAs, Threatened ecosystems, any Red data book information, NFEPA data, broader catchment drainage and protected areas).
- Desktop delineation and illustration of all watercourses within and surrounding the study area utilising available site-specific data such as aerial photography, contour data and water resource data.
- Prepare a map demarcating the respective watercourses or wetland/s, within the study area. This will demonstrate, from a holistic point of view the connectivity between the site and the surrounding regions, i.e. the hydrological zone of influence while classifying the hydrogeomorphic type of the respective water courses / wetlands in relation to present land-use and their current state. The maps depicting demarcated waterbodies will be delineated to a scale of 1:10 000, following the methodology described by the DWS.
- A risk/screening assessment of the identified aquatic ecosystems to determine which ones will be impacted upon and therefore require ground truthing and detailed assessment.
- Ground truthing, identification, delineation and mapping of the aquatic ecosystems in terms of the Department of Water and Sanitation (DWAF 2008) *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas*.
- Classification of the identified aquatic ecosystems in accordance with the, 'National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa' (Ollis *et al.* 2013) and WET-Ecoservices (Kotze *et al.* 2009).
- Conduct a Present Ecological State (PES), functional importance assessment and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland and riparian habitats.
- Identification, prediction and description of potential impacts on aquatic habitat during the construction and operational phases of the project. Impacts are described in terms of their extent, intensity, and duration. The other aspects that must be included in the evaluation are probability, reversibility, irreplaceability, mitigation potential, and confidence in the evaluation.
- All direct, indirect, and cumulative impacts for each alternative will be rated with and without mitigation to determine the significance of the impacts.
- Recommend actions that should be taken to avoid impacts on aquatic habitat, in alignment with the mitigation hierarchy, and any measures necessary to restore disturbed areas or ecological processes.
- Rehabilitation guidelines for disturbed areas associated with the proposed project and monitoring.

4 APPROACH AND METHODS

This study followed the approaches of several national guidelines with regards to wetland/ riparian assessment. See Appendix 1. The following approach to the aquatic habitat assessment is undertaken:

4.1 Desktop Assessment Methods

The contextualization of the study area was undertaken in terms of important biophysical characteristics and the latest available aquatic conservation planning information (i.e. existing data for coastal management lines, NFEPA identified rivers and wetlands, critical biodiversity areas (WBSP 2023), estuaries, vegetation units, ecosystem threat status, catchment boundaries, geology, land uses, etc.) in a Geographical Information System (GIS). A South African Inventory of Inland Aquatic Ecosystems (SAIIAE) was established during the National Biodiversity Assessment of 2018 (Van Deventer *et al.* 2018). The SAIIAE offers a collection of data layers pertaining to ecosystem types and pressures for both rivers and inland wetlands. National Wetland Map 5 includes inland wetlands and estuaries, associated with river line data and many other data sets within the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) 2018. It is imperative to develop an understanding of the regional drainage setting and longitudinal dynamics of the watercourses. The conservation planning information aids in the determination of the level of importance and sensitivity, management objectives, and the significance of potential impacts.

Following this, desktop delineation and illustration of all watercourses within the study area was undertaken utilising available site-specific data such as aerial photography, contour data and water resource data. Digitization and mapping were undertaken using QGIS 3.40 GIS software. These results, as well as professional experience, allowed for the identification of sensitive habitat that could potentially be impacted by the project and therefore required ground truthing and detailed assessment.

4.2 Baseline Assessment Methods

A site assessment was conducted on the 28th of February 2025 (which covered the entire area and subsequent site camp locations) to confirm desktop findings, gather additional information, and define the boundaries of the aquatic habitat. General observations were made with regards to the vegetation, fauna and current impacts. The identified aquatic ecosystems were classified in accordance with the, '*National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa'* (Ollis *et al*. 2013) and *WET-Ecoservices* (Kotze *et al.* 2009).

Infield delineation was undertaken with a hand-held GPS for mapping of any potentially affected aquatic ecosystems, in alignment with standard field-based procedures in terms of the Department of Water and Sanitation (DWAF 2008) *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas*. The delineation is based upon observations of the landscape setting, topography, vegetation and soil characteristics (using a hand held soil auger for wetland soils).

Determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) assessment of the delineated river/riparian habitats was undertaken utilising:

- Qualitative Index of Habitat Integrity (IHI) tool adapted from (Kleynhans, 1996) – PES
- DWAF (DWS) River EIS tool (Kleynhans, 1999) – EIS

The watercourse was classified as a Perennial River, as per the national classification system, which includes any system with a channel that permanently contains surface flow and/or concentrates runoff.

Determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland habitat was undertaken utilising:

- The health/condition or Present Ecological State (PES) of the wetland was assessed using the WET-Health assessment tool Version 2 (Macfarlane *et al.* 2020), which is based on an understanding of both catchment and on-site impacts and the impact that these aspects have on system hydrology, geomorphology and the structure and composition of wetland vegetation.
- The WET-Ecoservices tool (Kotze *et al.,* 2020) is utilised to assess the goods and services that the individual wetlands under assessment provide, thereby aiding informed planning and decision-making. Wetland benefits can be classified into goods/products (directly harvested from wetlands), functions/ services (performed by wetlands), and ecosystem scale attributes. The tool provides guidelines for scoring the importance of a wetland in delivering each of 15 different ecosystem services (including flood attenuation, sediment trapping and provision of livestock grazing).

4.3 Impact Assessment Methods

The approach adopted is to identify and predict all potential direct and indirect impacts resulting from an activity from planning to rehabilitation. Thereafter, the impact significance is determined. Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). The degree of significance depends upon three dimensions: the measurable characteristics of the impact (e.g. intensity, extent and duration), the importance societies/communities place on the impact, and the likelihood / probability of the impact occurring. Unknown parameters are given the highest score as significance scoring follows the Precautionary Principle. A methodology for assigning scores to the respective impacts is described in Appendix 1.

Cumulative impacts affect the significance ranking of an impact because the impact is taken in consideration of both onsite and offsite sources. For example, pollution making its way into a river from a development may be within acceptable national standards. Activities in the surrounding area may also create pollution which does not exceed these standards. However, if both onsite and offsite pollution activities take place simultaneously, the total pollution level may exceed the standards. For this reason, it is important to consider impacts in terms of their cumulative nature.

4.4 MITIGATION AND MONITORING

Actions are thereafter recommended to prevent and mitigate the identified impacts on aquatic habitat, in alignment with the mitigation hierarchy, as well as any measures necessary to restore disturbed areas or ecological processes. No-Go Areas were determined, and any necessary monitoring protocol was provided.

5 ASSUMPTIONS AND LIMITATIONS

- Aquatic ecosystems vary both temporally and spatially. Once-off surveys such as this can miss certain ecological information due to seasonality, thus limiting accuracy and confidence.
- The locations of the proposed activities were provided by the client. Due to the level of detail provided, it is recommended that the final layout design and method statement be approved by the aquatic specialist prior to implementation.
- While disturbance and transformation of habitats can lead to shifts in the type and extent of aquatic ecosystems, it is important to note that the current extent and classification is reported on here.
- All soil/vegetation/terrain sampling points were recorded using a Garmin Global Positioning System (GPS) and captured using Geographical Information Systems (GIS) for further processing.
- Infield soil and vegetation sampling was only undertaken within a specific focal area around the proposed activities, while the remaining watercourses were delineated at a desktop level with limited accuracy.
- No detailed assessment of aquatic fauna/biota (e.g. fish, invertebrates, microphytes, etc.) was undertaken, and not deemed necessary.
- The vegetation information provided is based on observation not formal vegetation plots. As such species documented in this report should be considered as a list of dominant and/or indicator wetland/riparian species.
- There were no seasonal limitations presented during assessment and the confidence level is high.
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field survey and based on the assessor's working knowledge and experience with similar projects. The degree of confidence is considered high.

6 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The desktop/ screening study was informed by the available datasets relevant to water resources, as well as historic and the latest aerial imagery, to develop an understanding of the fluvial processes of the study area. The relevant spatial information regarding the site is described below.

The study area lies within the Southern Coastal Belt DWA Level 1 Ecoregion and DWS quaternary catchment K10F of the Gouritz Catchment Management Area. The Moordkuil River, a tributary of the Klein Brak River, is the largest river in this catchment. There are many unnamed perennial and non-perennial tributaries and dams in this catchment, with much abstraction occurring for agricultural practices. The Moordkuil River is categorised as being in moderate health, having a Present Ecological State (PES) score of C, which is Moderately modified.

The site sits at an elevation of between 1 and 15 m.a.s.l. on a moderately steep bank of the riparian section adjacent to the river. According to the latest national desktop river and wetland inventories, the Moordkuil River is incorrectly classified as an estuary at this location (Figure 4). The DC 4 road bridge prevents any saltwater ingress from the estuary. There are NFEPA or National Wetland Map 5 wetlands in the study area that will not be impacted by the proposed development. According to national river map all these systems eventually drain into the Moordkuil River. Within the larger 500m buffer area there is an additional three non-perennial systems.

The study area is outside of any within the desktop mapped Strategic Water Source Areas (Figure 5). However, according to the Western Cape Biodiversity Spatial Plan (WCBSP) (CapeNature, 2023) the biodiversity priority areas mapped by the WCBSP relative to the study area are shown in Figure 6. It indicates that the drainage lines support CBA 1 River, CBA 2 Estuary and CBA 2 Terrestrial. The WCBSP identifies biodiversity priority areas, Critical Biodiversity Areas, Ecological Support Areas (ESAs) and Other Natural Areas (ONA), which, together with Protected Areas (PA), are important for the persistence of a viable representative sample of all ecosystem types and species, as well as the long-term ecological functioning of the landscape. The primary purpose of a map of CBAs and ESAs is to guide decision-making about where best to locate development. Only low-impact, biodiversity- sensitive land-uses are appropriate within CBA. No rare or endangered aquatic biota were identified on site.

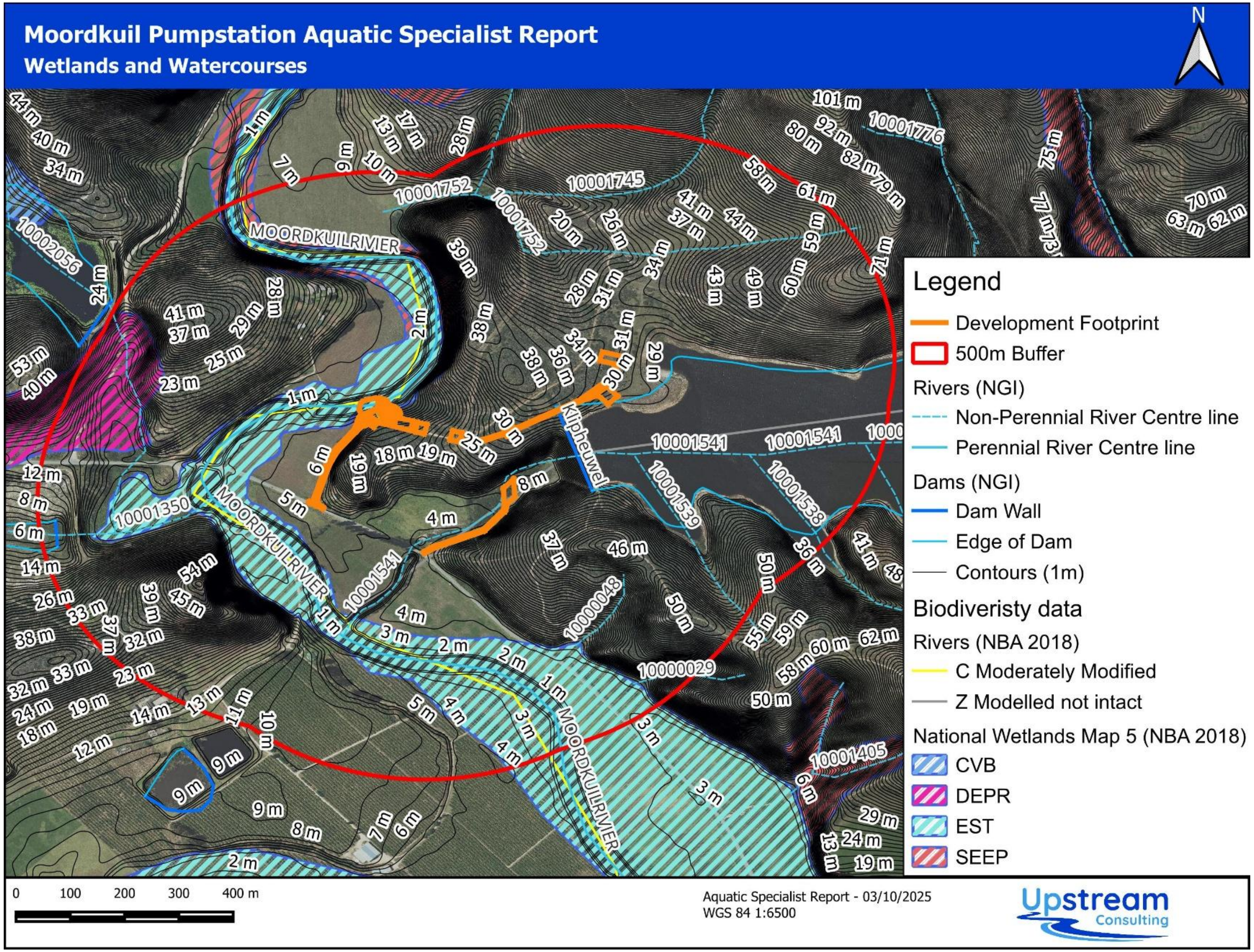

Figure 5: *The site in relation to the national wetland and river desktop data inventories*

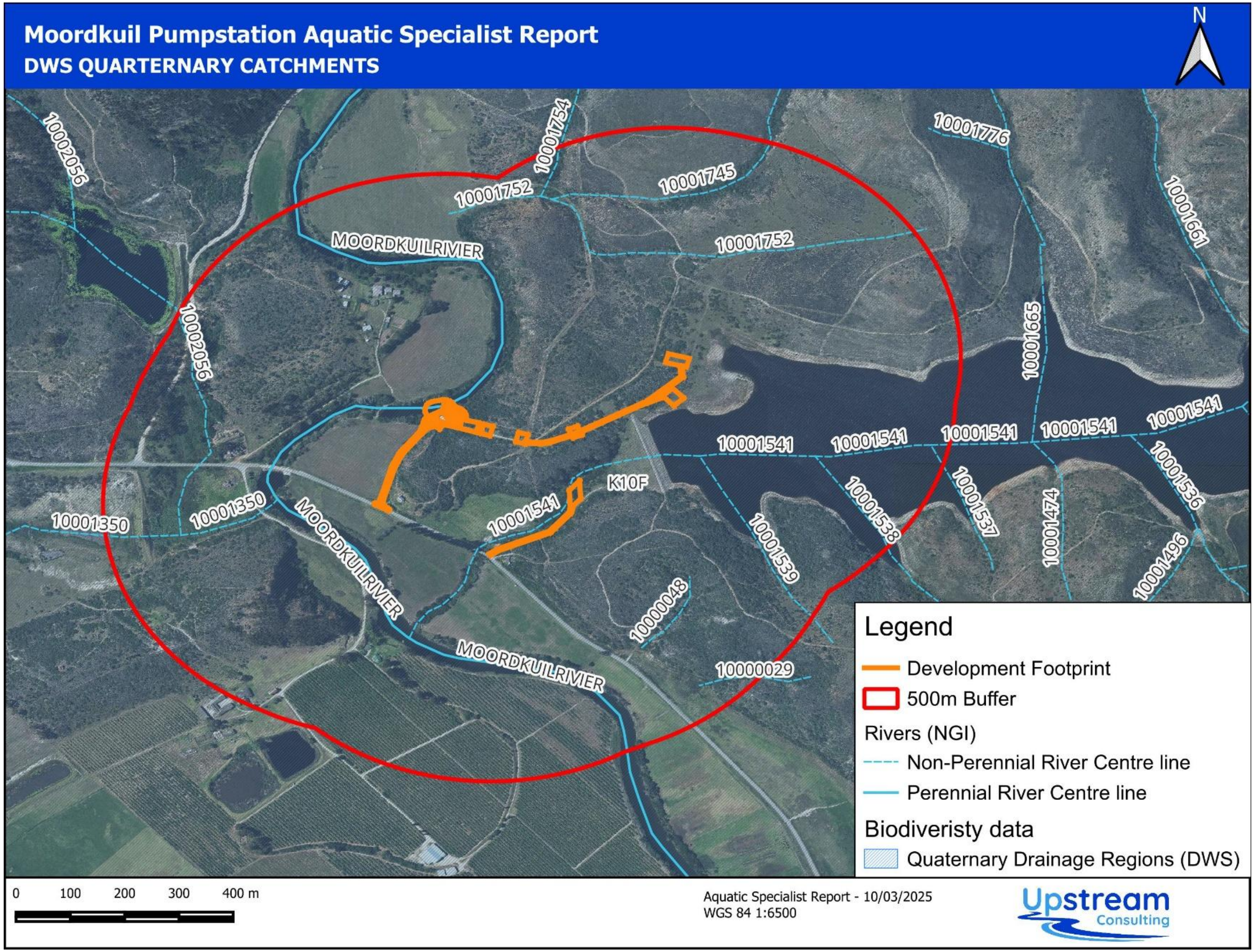

Figure 6: *Map of the site in relation to SWSAs and quaternary catchments*

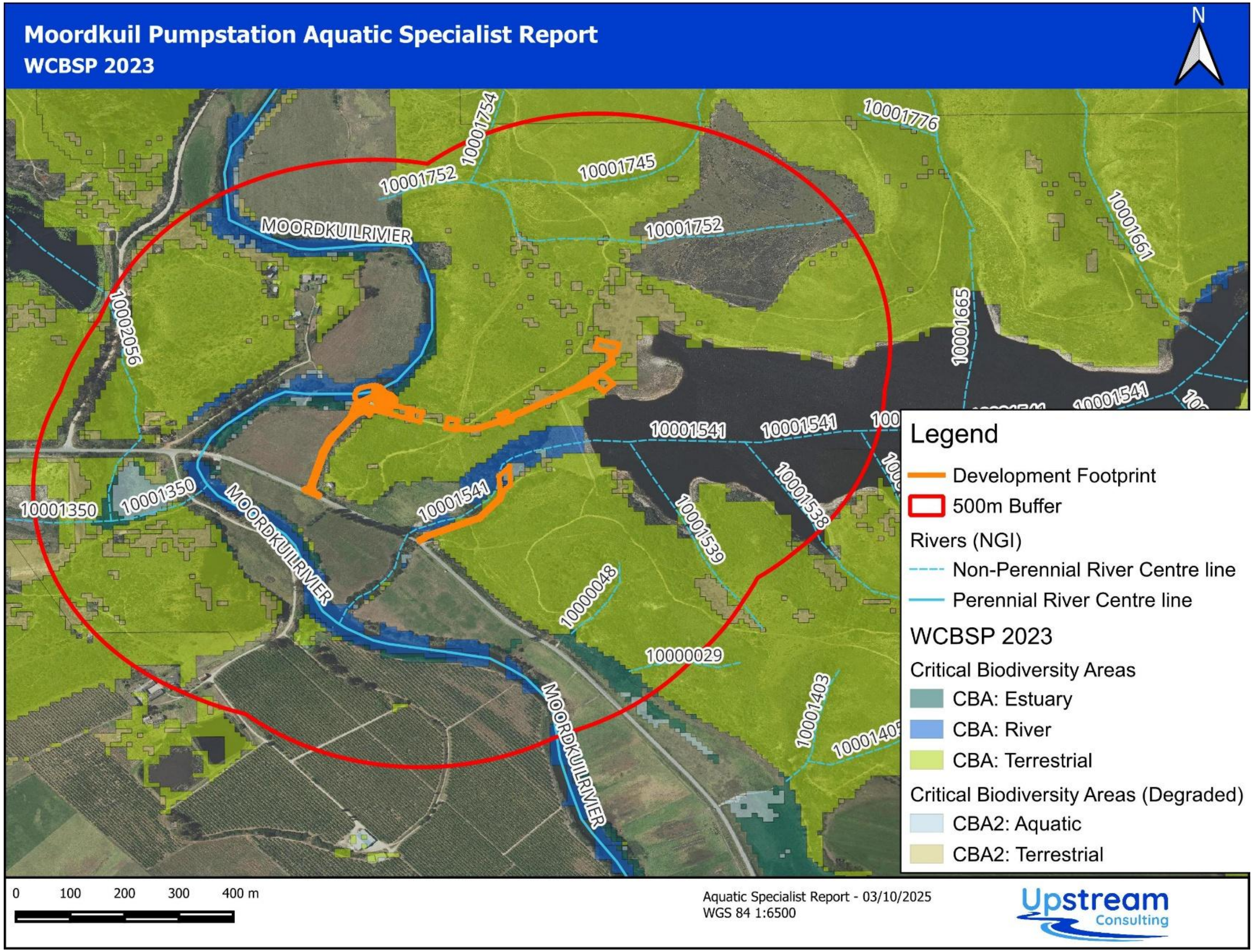

***Figure** 7: Map of the site in relation to the WCBSP conservation priority areas (WCBSP 2023)*

6.1 HISTORIC CONTEXT AND FUTURE THREATS

Through reviewing historical aerial imagery, the site has been significantly disturbed since prior to 1964 (Figure 7). The extent of agricultural activities in the area changed drainage patterns and resulted in siltation, while dams constructed reduced available water to the freshwater and estuarine systems. Over time, the agricultural activities have resulted in the loss of additional riparian habitat and transformed surface runoff patterns. The DC4 road, and farming access roads (old and new) have all caused localised flow confinement through infilling and installation of pipe culverts. In short, the past catchment land use practices and associated infrastructure have impacted several watercourses in the immediate and surrounding environment. However, this study is only reporting on any potential impacts from the upgrading and expansion of the pumpstation, not all the past impacts. It is however important to understand the broader historic context of the study area for this assessment. Therefore, it is noted that the watercourses under assessment were already in a modified ecological state. Presently the impacts of the pumpstation on aquatic biodiversity include the on-going abstraction of freshwater from the Moordkuil River.

Future threats to the watercourses of the study area include additional agricultural expansion and climate change. The expansion of the agricultural activities and infrastructure in the form of additional dams has the potential to result in decrease water availability, and quality to the freshwater and estuarine systems, while climate change is expected to alter the hydrological and geomorphological characteristics. The changes in rainfall patterns and flood intensity, interspersed with prolonged droughts, are expected to impact both surface and groundwater systems in the region. Engineering designs for the pumpstation specifically need to be designed to account for increase in intense flooding events which may initiate erosion and loss of infrastructure.

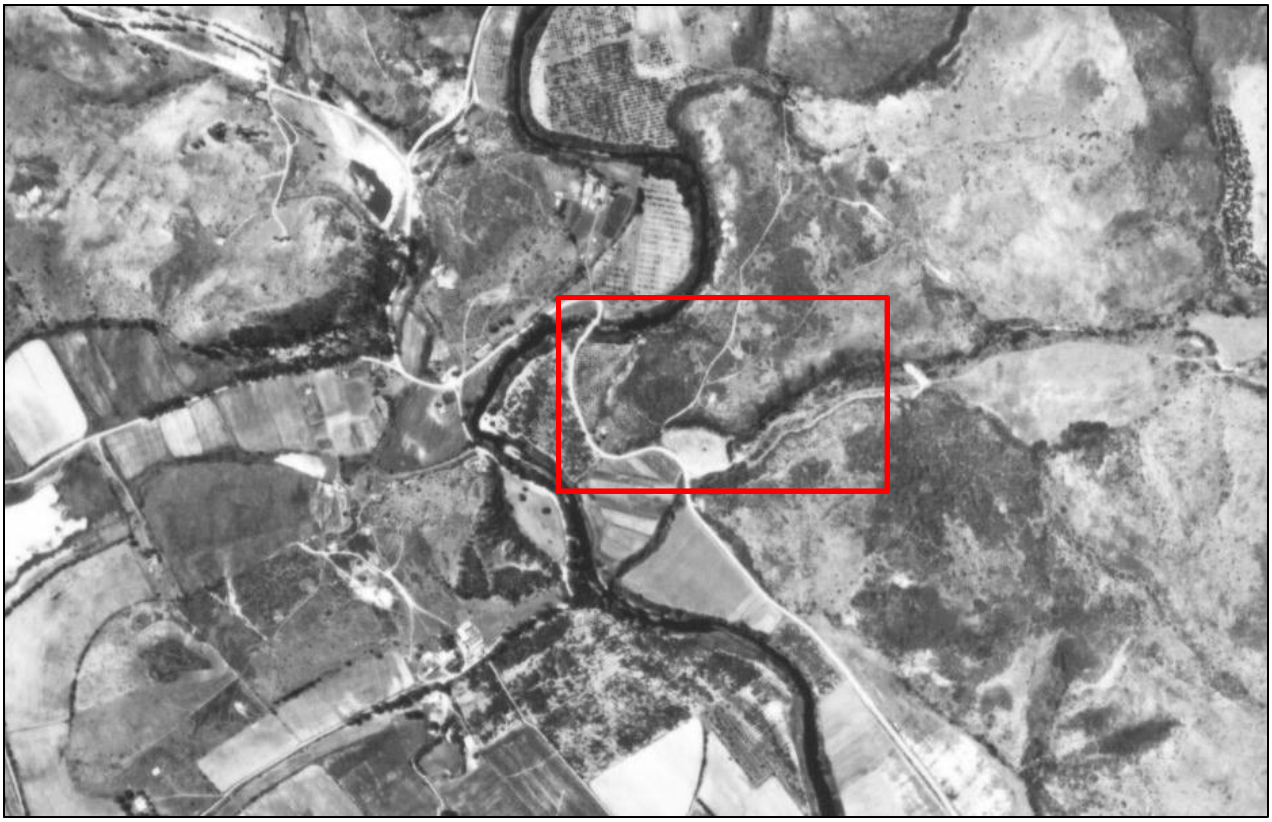

Figure 8: *Aerial imagery taken of the area in 1964, prior to the construction of the Klipheuwel dam built in 1982. Approximate location of works illustrated by red box.*

7 RESULTS

The aquatic habitats within a 500m radius of the proposed project were identified and mapped on a desktop level utilising available data. To identify the wetland/river types, using Kotze *et al.* (2009) and Ollis *et al*. (2013), a characterisation of hydrogeomorphic (HGM) types was conducted. Following the desktop findings, the infield site assessment confirmed the location and extent of these systems. Subsequent screening provided an indication of which of these systems may potentially be impacted upon by the project. There are several factors which influence the level of impact, such as type of system, position of the system in relation to the project and position the system is located in the landscape.

7.1 IDENTIFIED AQUATIC HABITATS

Following the contextualisation of the study area with the available desktop data, a site visit was conducted to groundtruth the findings and delineate the aquatic habitat within study area. The Moordkuil Perennial River (PR) Hydrogeomorphic (HGM) unit 1 is the system within which the abstraction point for the pumpstation is located and the only system that will be impacted by the construction of the facilities, HGM 3 will be impacted by the establishment of construction of site camp 2. In total there are ten different HGM units identified and mapped within the 500m study area. The additional information collected in the field allowed for the development of an improved baseline river and wetland delineation map (Figure 8).

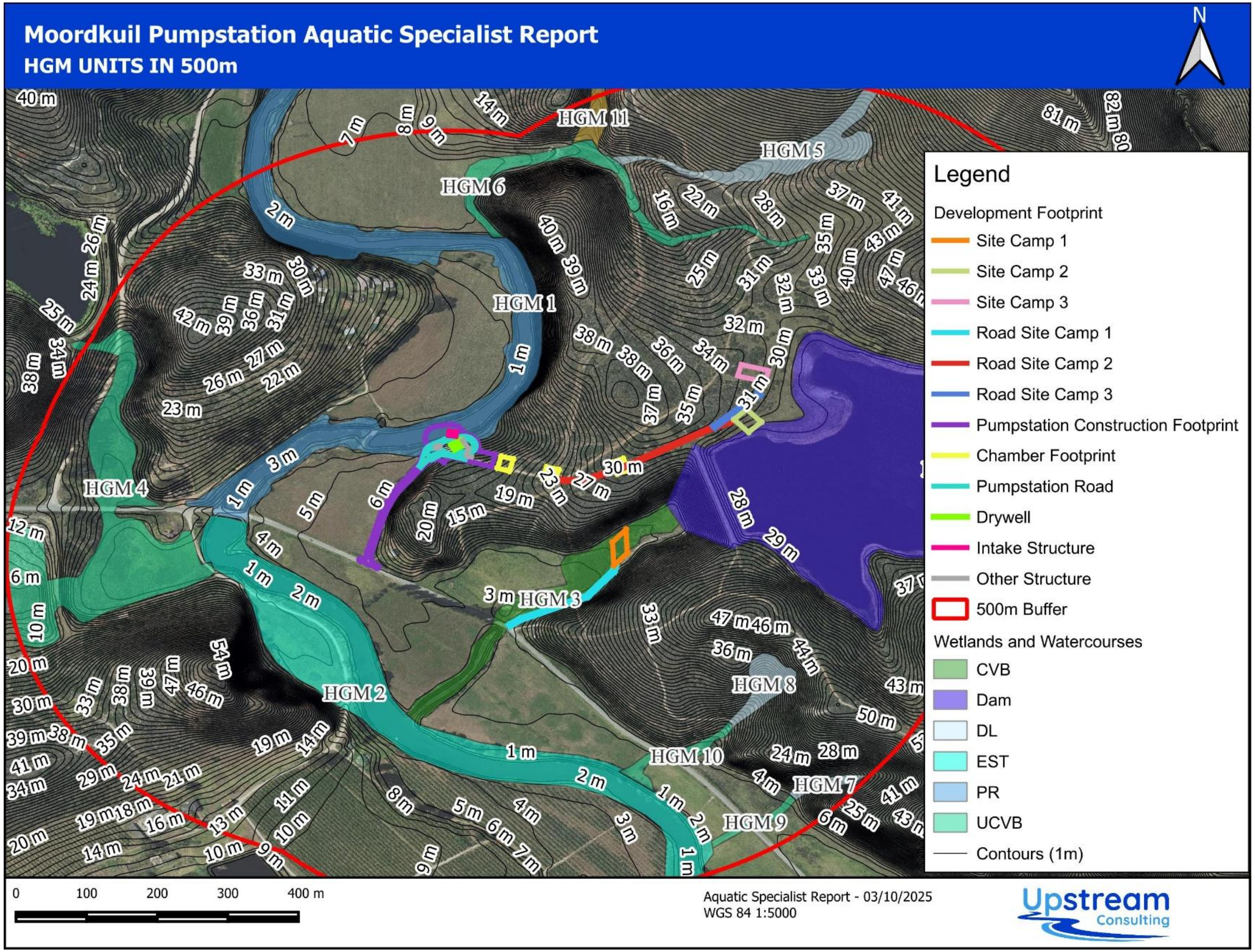

Figure 9: *Map of the delineated aquatic habitat within the study area following site verification.*

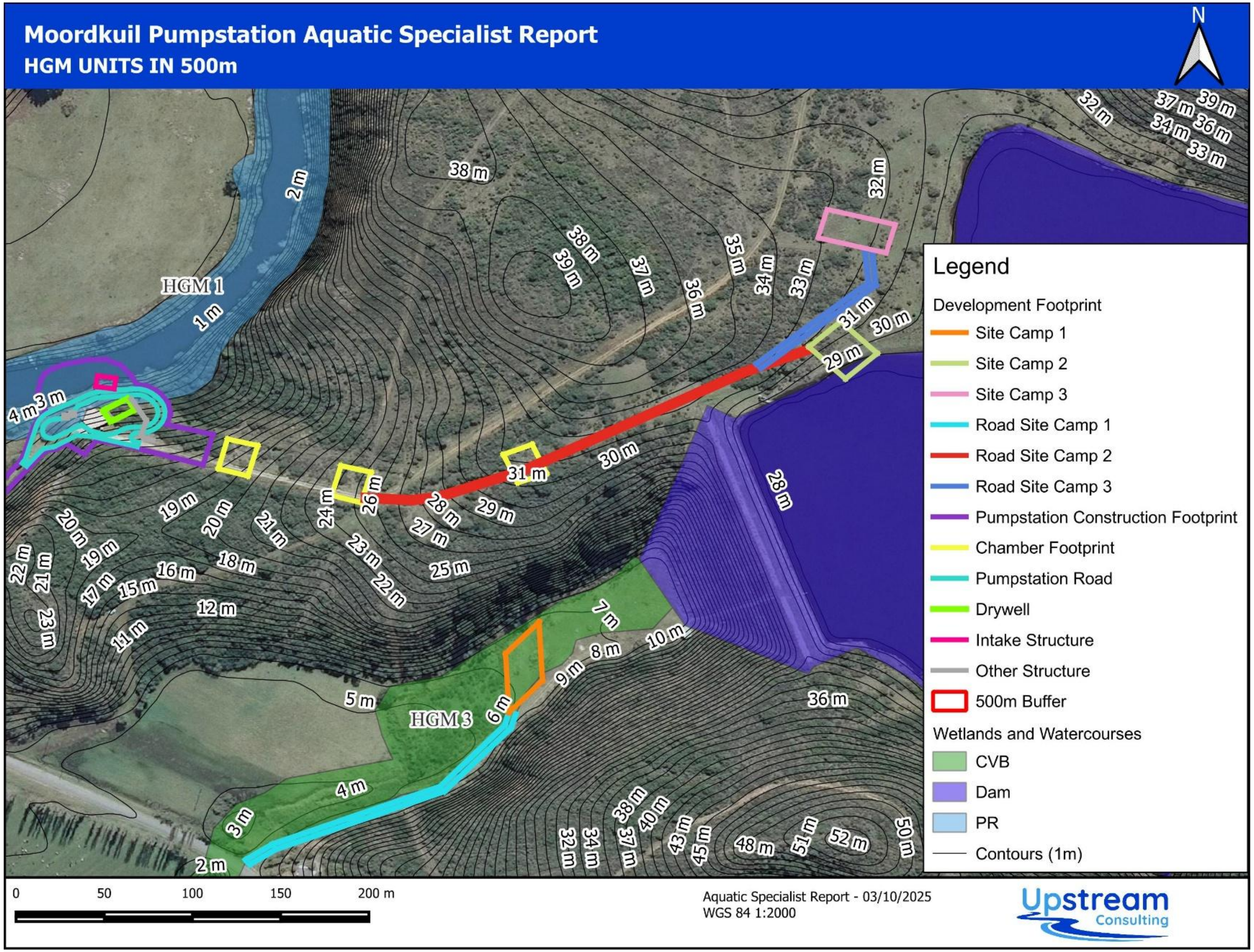

Figure 10: *A map of the delineated aquatic habitat relative to the development footprint at a larger scale to illustrate scope of works relative to aquatic habitat.*

7.2 DESCRIPTION OF AQUATIC HABITAT

7.2.1 HGM1 –Moordkuil Perennial River (PR)

This the largest mainstream perennial water source in the catchment and is split into two HGM units, HGM 1 and HGM 2, but only HGM 1 will be impacted by this proposed development of any of the two alternatives. The existing pumpstation abstracts water directly from the system and pumps it to the Klipheuwel Dam. Roads have been built through the HGM unit and farming activities dominates its banks (Plates 1 and 2).

The existing infrastructure was built on site in 1980, since then the area has rehabilitated itself accordingly (Plates 1 and 2). The old road acts as weir (Plate 3) and the new DC4 road is the location of the ebb and flow for the estuary (Plate 4). The perennial presence of water has resulted in the riparian system being well vegetated, as can be seen in detail in Plate 2. Indigenous plant species observed on-site include *Vachellia karroo, Searsia lucida, S. glauca, Diospyros dichrophylla, Euclea racemosa* subsp. *racemosa, Carissa bispinosa* subsp. *bispinosa, Leonotis leonurus, Chasmanthe aethiopica, Carpobrotus edulis, Senecio radicans, Pteridium aquilinum, Cynodon dactylon, Ehrharta erecta,* and *Ficinia indica*. Along the river's marginal zones, indigenous vegetation is predominantly composed of the common reed (*Phragmites australis*), along with various sedges and rushes such as *Cyperus textilis, Pycreus polystachyos, Typha capensis* and *Juncus kraussii*.

The riparian zone has been significantly altered through the agricultural and construction activities, with much of the native vegetation removed, leading to the encroachment of invasive alien species such as *Acacia mearnsii, Arundo donax, Cenchrus clandestinus*, *Cestrum laevigatum, Pennisetum purpureum, Ricinus communis, Solanum mauritianum,* and *Nicotiana rustica*.

The geomorphology of the HGM unit is stable, but it has been modified at catchment level by the impact of dams and agricultural activities. The erosion of the east bank downstream at the start of the estuary (Plate 4), is indicative of sediment starvation of that water column. Freshwater and estuarine systems require a balanced sediment input to maintain geomorphological stability, as sediment supply influences channel morphology, bank integrity, and overall system resilience. Catchment instream dams act as sediment traps, reducing sediment availability within the water column, and disrupting natural depositional processes. This sediment deficit, when combined with vegetation transformation and increased surface runoff results in habitat modification, which exacerbates erosional processes within these systems.

The slope and original topographical setting of this HGM unit are only slightly modified by the presence of the weir and roads. These freshwater systems naturally flatten out before entering estuarine systems. Little modification has occurred to the topographical setting of the unit.

The hydrological regime of the system, has been historically highly modified. Within the catchment (both upstream and downstream), the system's habitat has been transformed, and it is moderately farmed, by both livestock and croplands. There is much direct abstraction taking place from the watercourse for agricultural activities and domestic water use (Plate 5). On its various tributaries upstream, there are several instream dams. These provide both water to the farm homesteads and water for irrigation purposes, while the Moordkuil Pumpstation further reduces available water to the HGM unit.

(a) West bank adjacent to pumpstation

(b) East bank opposite the pumpstation

Plate 1: *Photographs taken of the west (a) and east banks (b) of the Moordkuil River showing the extent of agricultural activities which are adjacent to the riparian vegetation, note the extensive number of alien plant species.*

Plate 2: *A photograph taken upstream from the weir illustrating the extent of alien plant species domination of the riparian area and pumpstation location*

Plate 3: *A photograph taken of the old road crossing the Moordkuil River, which acts as a weir for the pumpstation*

Plate 4: *A photograph taken of the current road crossing the Moordkuil River, which prevents salt water ingress from the estuary downstream. Note the steep eroded east bank.*

Plate 5: *The abstraction point of the pumpstation (a), (b) one of the farmers three large pumps abstracting water from the weir*

7.2.1 HGM3 – Channelled Valley Bottom Wetland

HGM unit 3 is channelled valley bottom wetland on which the Klipheuwel dam is located. The existing pumpstation abstracts water directly from the system and pumps it to the Klipheuwel Dam. Like HGM 1, roads have been built through the HGM unit and farming activities dominates its banks (Plates 1 and 2).

As already discussed the Klipheuwel dam in 1982, and the current pastures were established within the extent of the HGM 3 prior to 1964 (Figure 7) (Plates 6 and 7). The access road to the Klipheuwel Dam is located adjacent to HGM 3 road (Plate 8). The non-perennial HGM unit is well vegetated. Indigenous plant species observed on-site is similar to the species dominating HGM 1 and includes *Vachellia karroo, Searsia lucida, S. glauca, Diospyros dichrophylla, Euclea racemosa* subsp. *racemosa, Carissa bispinosa* subsp. *bispinosa, Leonotis leonurus, Chasmanthe aethiopica, Carpobrotus edulis, Senecio radicans, Pteridium* *aquilinum, Cynodon dactylon, Ehrharta erecta,* and *Ficinia indica*. HGM 3 also has common reed (*Phragmites australis*), along with various sedges and rushes such as *Cyperus textilis, Pycreus polystachyos, Typha capensis* and *Juncus kraussii* all growing within the seasonal zones of the system. Invasive alien species such as *Acacia mearnsii, Arundo donax, Cenchrus clandestinus*, *Cestrum laevigatum, Pennisetum purpureum, Ricinus communis, Solanum mauritianum,* and *Nicotiana rustica* are also present within the system due to historical transformation of habitat

The geomorphology of the HGM unit is currently stable, but it has been modified at catchment level by the impact of the Klipheuwel dam and agricultural activities. There is a channel which has formed and a sump located nearer to the gravel road for stock watering purposes (Plate 6). The Kilpheuwel dam would have starved sediment starvation out of that water column, contributing to the establishment of the channel. As previously discussed freshwater and estuarine systems require a balanced sediment input to maintain geomorphological stability, as sediment supply influences channel morphology, bank integrity, and overall system resilience. Catchment instream dams act as sediment traps, reducing sediment availability within the water column, and disrupting natural depositional processes. This sediment deficit, when combined with vegetation transformation and increased surface runoff results in habitat modification, which exacerbates erosional processes within these systems.

The slope and original topographical setting of this HGM unit are only slightly modified by the presence of the Klipheuwel Dam and pastures. As previously discussed, these freshwater systems naturally flatten out before entering estuarine systems. Little modification has occurred to the topographical setting of the unit.

The hydrological regime of the system has been historically highly modified, by the construction of the Klipheuwel dam. Within the catchment (both upstream and downstream), the system's habitat has been transformed, and it is moderately farmed, by both livestock and pasture. There establishment of the dam would have exacerbated the non-perennial nature of the system and reduced the volume of water available to HGM 3.

Both Site Camp 1 (Plates 9 and 10) and Site Camp 2 (Plate 11) alternatives are proposed to be located within this HGM unit. The location of Site Camp 3 is outside the extent of the HGM unit (Plate 12)

Plate 6: *Pasture established within the original extent of HGM 3, downstream of Klipheuwel Dam*

Plate 7: *Upstream extent of pasture within the original extent of HGM 3, downstream of Klipheuwel Dam*

Plate 8: *Access Road built on banks of HGM 3 to the base of the Klipheuwel Dam wall.*

Plate 9: *Well grazed banks of HGM 3, below the Klipheuwel Dam and approximate location of Site Camp 1 (red box), within the extent of HGM 3.*

Plate 10: *Approximate location of Site Camp 1 within the extent of HGM 3 at the base of the Klipheuwel Dam wall.*

Plate 11: *Well grazed banks of Klipheuwel Dam and approximate location of Site Camp 2 (red box), within the extent of a full Klipheuwel Dam.*

Plate 12: *Approximate location of Site Camp 3 adjacent to the Klipheuwel Dam.*

7.3 PES

The Present Ecological State (PES) of a river or wetland represents the extent to which it has changed from the reference or near pristine condition (Category A) towards an impacted system which can be critically modified at Category F. The PES of the four impacted systems for this project were determined. The three wetland systems were classified according to the WET Health V2 tool (Macfarlane *et al.*, 2020) and the two River systems were classified according to the rapid Index of Habitat Integrity (IHI) tool (Kleynhans, 1996).

7.3.1 Riparian PES

The rapid Index of Habitat Integrity (IHI) tool (Kleynhans, 1996) was used to determine the PES of the HGM 1 Moordkuil River by comparing the current state of the in-stream and riparian habitats (with existing impacts) relative to the estimated reference state without anthropogenic impacts. Following assessment and given the extent of various impacts, HGM 1 was determined to have a PES score category of 'C' (Table 2).

Table 2: HGM units 1 Present Ecological State

Resource	IHI Score (Average % Intact)	Class	Rationale
HGM 1	60,00	C	The system has been largely impacted by flow, and bank condition modifications. The majority of the system has being impacted through water abstraction and agricultural activities. The riparian zone has been subjected to habitat loss due to clearance and a high level of alien plant infestation. A large loss of natural habitat, biota and basic ecosystem functions has occurred.

The trajectory of change is likely to be stable. The management objective should be to maintain the integrity of the systems and prevent any further degradation.

7.3.2 Wetland PES

The one wetland system impacted by the proposed alternatives is HGM 3 which has been subjected to habitat loss and disturbance, erosion, construction of the Klipheuwel Dam and significant hydrological changes as well as alien species infestation. There are also significant water quality changes through pasture establishment. These impacts on the watercourse have resulted in a Largely Modified state from the reference condition. Therefore, this wetland falls within the 'D' category for PES Refer to Table 3 for a summary of PES score for this system. The recommended management objective is to maintain the PES to a 'D' category.

Table 3: HGM 3 Present Ecological State

	Wetland PES Summary			
Wetland name	HGM 3			
Assessment Unit	Channelled VB wetland			
Areal extent (Ha)	48,5 Ha			
PES Assessment	Hydrology	Geomorphology	Water Quality	Vegetation
Impact Score	6,1	5,1	4,2	5,5
PES Score (%)	39%	49%	58%	45%
Ecological Category	E	D	D	D
Trajectory of change	→	→	→	→
Combined Impact Score	5,5			
Combined PES Score (%)	45%			
Combined Ecological Category	D			

7.4 Ecosystem services and EIS

Wetlands are globally threatened ecosystems and are well-recognized for the ecosystem services which they supply. Furthermore, these ecosystems make potentially important ecosystem services contributions to several broad-scale imperatives of government, including water resource management; biodiversity conservation; human safety and disaster resilience; socio-economic development and poverty elimination; and climate change mitigation and adaptation. Individual wetland/riparian areas differ according to their characteristics, contexts and the suite of ecosystem services which they supply to society (Kotze *et al*. 2020). Thus, there is a need to assess and compare wetland areas in terms of ecosystem services delivery.

A WET-Ecoservices (Version 2) (Kotze *et al.*, 2020) is a field-based assessment was undertaken to assess the ecosystem services supplied by the different wetland and riparian systems. The assessment technique has recently been revised and now distinguishes clearly both ecosystem services' supply and the demand for all ecosystem services. This helps determine the potential of the wetland for delivering ecosystem services, by understanding its capacity to produce a service while also considering the societal demand for that service.

7.4.1 HGM 3 system

The HGM 3 channelled valley bottom wetland exhibits a critical role in providing essential ecosystem services, primarily related to water supply and purification, though it faces severe local pressure from provisioning demands and structural instability (Table 4 and Figure 10).

The most significant ecosystem service provided by this wetland is Water for human use, which holds the highest ecological importance score. This is primarily due to the presence of the Klipheuwel Dam, a major water supply feature situated on the system. A second major ecosystem service is for Cultivated foods, which exhibits the maximum Demand score (4.0). In contrast, the Supply score (1.8) is low, reflecting a substantial shortfall. This indicates that the pastures and agricultural areas surrounding the wetland rely heavily on external inputs to sustain productivity, as the wetland itself cannot meet these demands. Similarly, Biodiversity maintenance records a high Demand (4.0) but a weak Supply (1.9), underscoring that the ecological integrity of the wetland is under severe stress relative to the value society places on this function.

The wetland nevertheless performs strongly in certain regulating services, particularly those related to pollutant removal. Toxicant assimilation achieves the highest Supply score (3.8), while Nitrate assimilation (3.3) further confirms the wetland's effective biofiltration capacity likely mitigating nutrient and contaminant loads from adjacent agricultural land use practices.

In contrast, the physical stability of the system remains a major concern. Erosion control shows a very high Demand (4.0) but an extremely low Supply (0.8), indicating a critical functional deficit. The wetland currently lacks the structural integrity needed to stabilise its own bed and banks an issue that will inevitably impair both its hydrological regulation and water quality enhancement functions if left unaddressed.

Other regulating services, such as Carbon storage (Supply 1.9) and Streamflow regulation (Supply 1.5), appear to be underdeveloped or underperforming, which aligns with their moderate and very low importance scores, respectively.

In contrast, Food for livestock a provisioning service tied to grazing capacity is currently well-balanced, with Supply (1.5) exceeding Demand (1.3). This suggests that grazing intensity is sustainable under current conditions.

Lastly, the wetland demonstrates strong potential for non-extractive benefits, with Tourism and Recreation (Supply 3.5) and Cultural and Spiritual use (Supply 3.0) showing high inherent capacity. However, Demand for these services remains minimal (0.3 and 0.0, respectively), implying that the wetland's cultural and recreational value is largely overlooked in the current socio-economic landscape.

Overall, while the channelled valley-bottom wetland plays a crucial role in water provision and pollutant attenuation, its long-term sustainability is threatened by structural instability and unsustainable pressure from provisioning services. Strategic restoration efforts should therefore prioritise bank and bed stabilisation, alongside measures that enhance regulating and supporting functions critical to maintaining water quality and ecological balance.

Table 4: Summary of Ecosystem Services Assessment for the HGM 3 wetland

		Present State			
ECOSYSTEM SERVICE		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	1,3	0,2	0,0	Very Low
	Stream flow regulation	0,0	4,0	1,2	Low
	Sediment trapping	2,3	0,0	0,8	Very Low
	Erosion control	0,8	4,0	1,3	Low
	Phosphate assimilation	2,3	0,0	0,8	Very Low
	Nitrate assimilation	2,3	0,0	0,8	Low
	Toxicant assimilation	3,8	0,0	2,3	Moderately High
	Carbon storage	1,9	2,7	1,7	Moderate
	Biodiversity maintenance	1,9	4,0	2,4	Moderately High
PROVISIONING SERVICES	Water for human use	4,0	4,0	4,0	Very High
	Harvestable resources	3,0	0,3	1,7	Moderately Low
	Food for livestock	1,5	1,3	0,7	Very Low
	Cultivated foods	1,8	4.0	3,0	High
CULTURAL SERVICES	Tourism and Recreation	3,5	0,3	2,2	Moderate
	Education and Research	1,8	0,3	0,4	Very Low
	Cultural and Spiritual	3,0	0,0	1,5	Moderately Low

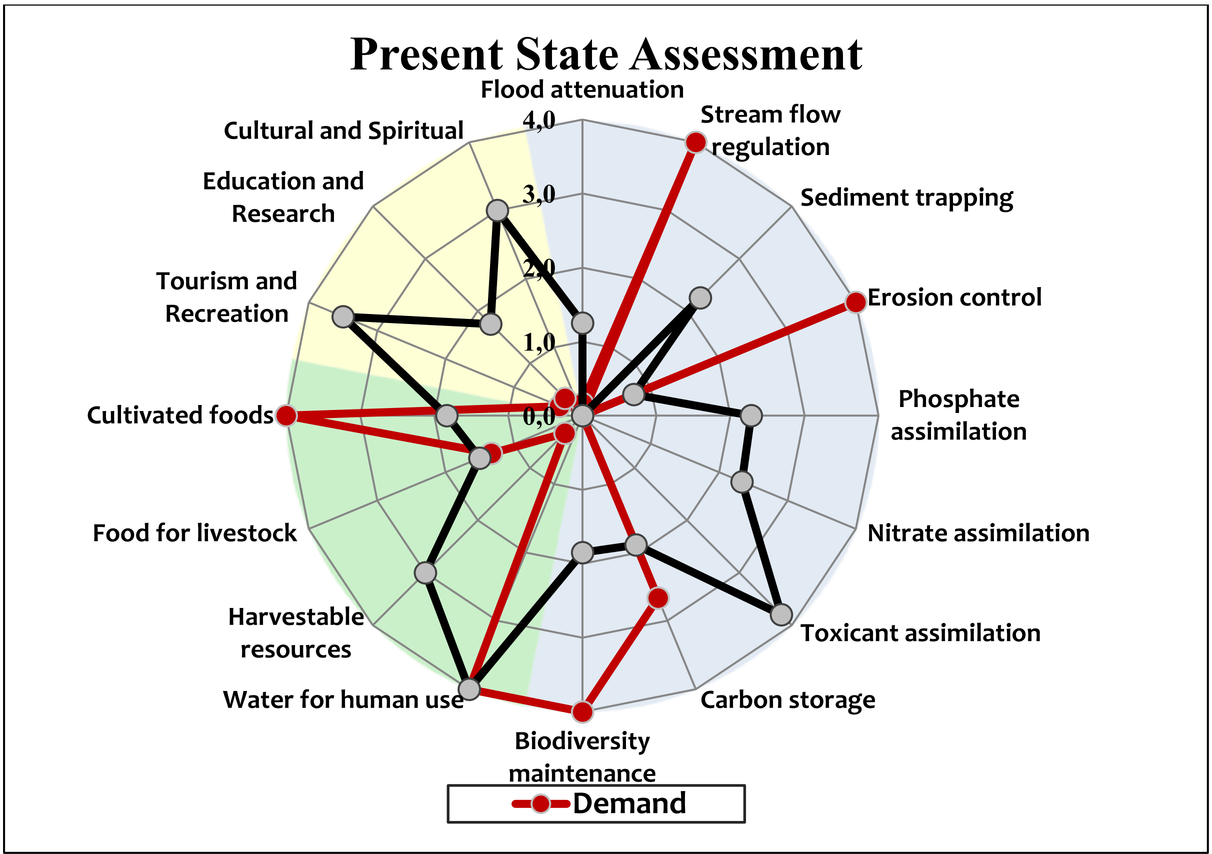

Figure 11: Spider diagram showing the demand and supply of various ecosystem services by HGM 3 wetland in the systems current present ecological state.

7.1 Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) assessment method, as outlined by Rountree and Kotze (2013), provides a structured, scientifically grounded approach for evaluating the capacity of a wetland to support biodiversity, maintain ecological processes, and sustain ecosystem resilience. EIS determines the significance of a watercourse in terms of conservation priority and its sensitivity to disturbances or changes in land use. The EIS score guides decision-making during environmental assessments by identifying wetlands that warrant higher protection, even if they are degraded, due to their irreplaceable ecological functions. It ensures that development planning aligns with ecosystem sustainability principles as outlined in the National Water Act and NEMA.

The majority of the EIS information is sourced from the WET Ecosystem services tool assessment data. As can be seen from Table 5 the highest score was achieved from the was Direct Benefits to Society Score (2.85), this is due to the presence of the Klipheuwel Dam on the HGM 3 unit. The biodiversity importance score was also significant (2.33), this is primarily due to the presence of Critical Biodiversity Area in terms of the Western Cape Biodiversity Spatial Plan (CapeNature 2023) and the Critically Endangered vegetation unit within which the HGM unit is present. The Functional and hydrological importance score was less important as the Klipheuwel Dam highly regulates the HGM 3 units EIS.

Table 5: Summary of EIS score for the HGM 3 wetland system

SUMMARY	HGM 3	
	Score (out of 4)	**Rating**
BIODIVERSITY IMPORTANCE	2,33	Moderate
FUNCTIONAL/HYDROLOGICAL IMPORTANCE	1,84	Low-Moderate
DIRECT BENEFITS TO SOCIETY	2,85	Moderate
Ecological Importance and Sensitivity (EIS)	**2,34**	**Moderate**

7.2 EIS – HGM 1

The Ecological Importance and Sensitivity (EIS) of riparian areas is a representation of the importance of the aquatic resource for the maintenance of biological diversity and ecological functioning, whilst Ecological Sensitivity (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance (Kleynhans & Louw, 2007).

The DWAF (DWS) River EIS tool (Kleynhans, 1999) was used to inform the EIS assessment and produced a High EIS score for the watercourse. The Moordkuil River is recognized for its high ecological importance and sensitivity (Table 3), primarily due to its support of indigenous fish species, including the Cape galaxias (*Galaxias zebratus*), Cape kurper (*Sandelia capensis*), and Eastern Cape redfin (*Pseudobarbus afer*), as well as its unique and sensitive macroinvertebrate communities. It acts as an important refugia for fauna in a farmed landscape and as an important stormwater system for the surrounding landscape.

Table 6: Summary of Ecosystem Service Assessment for the HGM 1 Moordkuil River

RIPARIAN SYSTEM	ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORY (EIS)	RATIONALE
HGM 1 – Moordkuil River	**HIGH EC=B**	*There are rare and endangered fish species, but minimal diversity of habitat types, no sensitivity to water quality changes, medium species richness. Remaining patches of indigenous riparian vegetation provide refuge for animals and a short corridor between the valley bottom and hilltops. The site is also classified as CBA.*

7.3 Aquatic Buffer Zones

An aquatic buffer zones are defined as a zone of vegetated land designed and managed so that sediment and pollutant transport carried from source areas via diffuse surface runoff is reduced to acceptable levels (Macfarlane and Bredin 2016). A buffer area between activities and watercourses can assist with managing a variety of potential impacts and protecting the system from PES and EIS deterioration.

Currently there are no formalised riverine or wetland buffer distances provided by the provincial authorities and as such the buffer model as described Macfarlane and Bredin (2017) for wetlands, rivers and estuaries was used. Using the buffer tool, it was determined that a 28m buffer zone should be adopted around the HGM 3 system for the Site Camps. The two alternatives are already located within the extent of the HGM 1 respectively and no further encroachment outside of the construction footprint should be permitted.

Adopting aquatic buffer zones between development activities and watercourses can significantly reduce potential impacts. Therefore, the buffer zones (28m in width) shown in Figure 11 are recommended for this project.

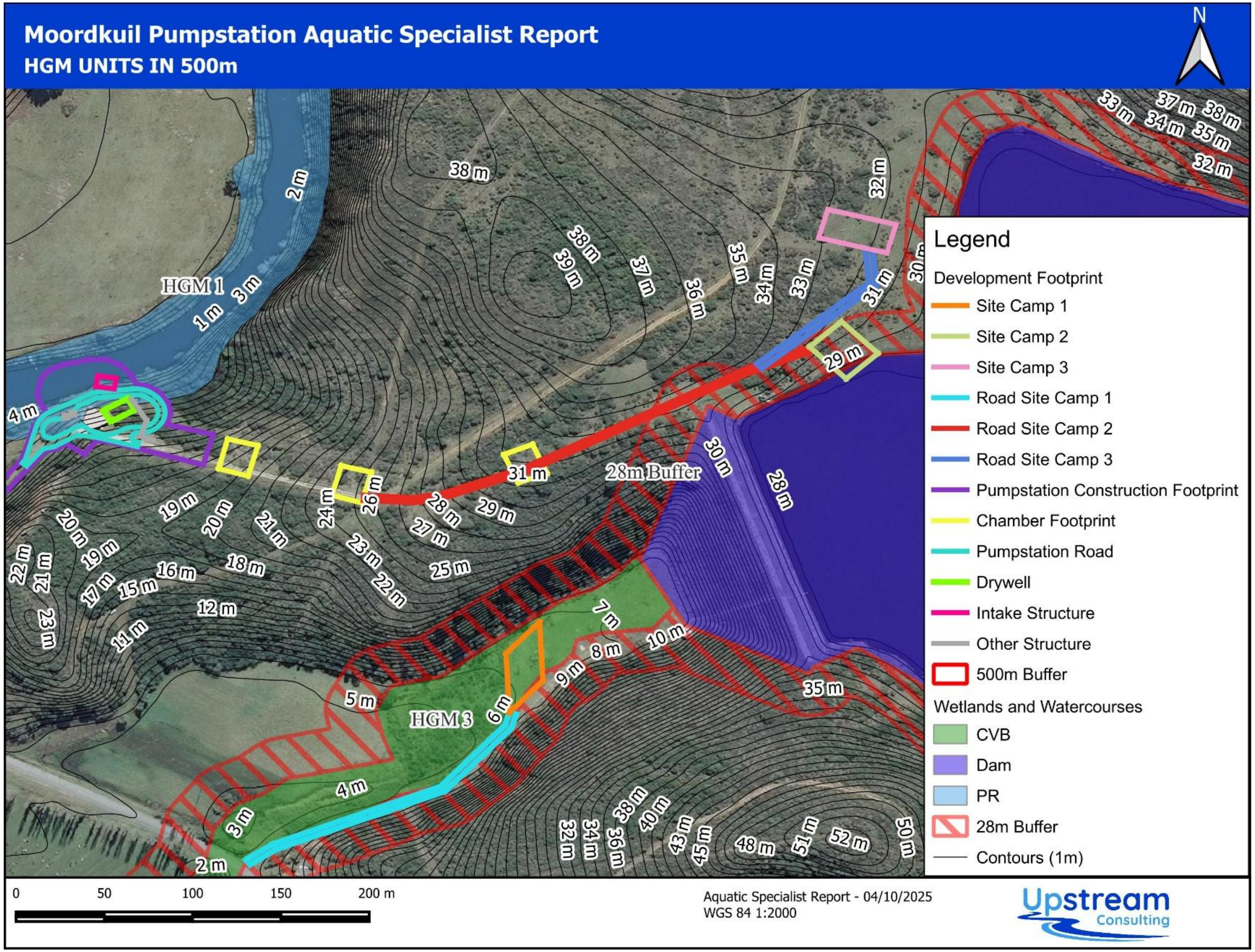

Figure 12: Recommended aquatic buffer areas

8 POTENTIAL IMPACTS

The nature of any activities within the riparian zone and potentially within wetland areas is such that it carries a high intensity impact upon the environment. The level of impact upon aquatic biodiversity depends on several factors, such as proximity to water courses, surrounding topography, construction methods, etc. These activities result in physical and biological changes on a landscape-scale through direct habitat loss/ modification and the generation of unconsolidated fine sediments. Typical threats also include poorly managed stormwater runoff which indirectly results in erosion, uncontrolled soil movement, and the sedimentation of downstream habitats. The level of significance of these impacts lies within their effect upon the existing form and function of the identified watercourses.

Given the proposed scope of works for the three site camps, only Site Camp 3 is deemed feasible. Both Site Camps 1 and 2 are within the extent of HGM 3 and would require significant additional implementation of mitigation hierarchy, beyond standard mitigation measures as these camps would result in the net loss of wetland habitat. Alternative 1 design will involve a similar construction footprint to Alternative 2. This will be due to Alternative 1 needing to still remove the rocky outcrop that Alternative 2 would prefer to place the infrastructure on. The reinstatement of access roads will follow the alignment of existing roads. The construction activities for both alternatives, either removal of the rock outcrop (or place infrstructure on the rocky outcrop) and both alternatives will have associated infrastructure and the installation of dry well and infrastructure adjacent the existing pumpstation and the various site camp establishments. Alternative 2 will however result in additional loss of riparian vegetation, while both alternatives will have similar hydrological impacts. These proposed activities are discussed, assessed in the following sections in terms the risk of degrading the ecological state of the aquatic ecosystems as well as the potential impacts to those ecosystems. The following identified impacts of the project were assessed, which are aligned with those contained in the Biodiversity Assessment Protocol and detailed in Table 7 below:

Table 7: Impacts assessed in alignment with the Biodiversity Assessment Protocol

Biodiversity Assessment Protocol Impacts found applicable to this project	**Impacts assessed in this report below**
Faunal and vegetation communities inhabiting the site	Impact 1
Fragmentation (physical loss of ecological connectivity and or CBA corridors)	Impact 1 and 2
Changes in numbers and density of species	Impact 1 and 2
Water quality changes (increase in sediment, organic loads, chemicals or eutrophication	Impact 3 and 4
Hydrological regime or Hydroperiod changes (Quantity changes such as abstraction or diversion)	Impact 2
Streamflow regulation	Impact 3
Erosion control	Impact 3
Cumulative Impacts	Impact 5

8.1 IMPACT 1: DISTURBANCE OR LOSS OF AQUATIC HABITAT

The disturbance of aquatic vegetation and habitat refers to the direct physical destruction or disturbance of biota caused by vegetation clearing, stockpiling, and excavation, as well as encroachment and colonisation of habitat by invasive alien plants. Indirectly, the movement of soil and incorrectly placed material can also result in the burial of aquatic habitat. Disturbance or loss of aquatic habitat also results in fragmentation of ecological corridors and loss of habitat refugia for faunal species.

While the project will result in disturbance to aquatic vegetation and biota due to the scope of works occurring within the watercourse(s), these are likely to be localised impacts and can be minimised and mitigated for. Of the two alternatives the greatest disturbance/loss of aquatic habitat will occur for Alternative 2.

8.2 IMPACT 2: SURFACE WATER FLOW PATTERN CHANGES WITHIN THE RIPARIAN HABITAT AND MOORDKUIL RIVER IN FORM AND FUNCTION, I.E. CHANGES TO THE HYDROLOGICAL REGIME

This includes the changes in the quantity, timing and distribution of water inputs and flows within a watercourse and riparian habitat. Possible ecological consequences associated with this impact may include deterioration in freshwater ecosystem integrity, reduction/loss of habitat for aquatic dependent flora and fauna, and a reduction in the supply of ecosystem goods and services.

If designed correctly, the placement of infrastructure such as the coffer dams of either alternative within the weir in a small river like the Moordkuil River can be minimized, but the impacts on the hydrodynamics of the project cannot be entirely avoided. The structures proposed will alter local flow patterns, sediment transport, and erosion processes, engineering designs can reduce the risk of adverse impacts. Localised scour at the edges of the coffer dams and potential sediment deposition upstream are expected but can be managed through appropriate design and placement. Similarly, while turbulence and vortex formation may occur, their effects can be mitigated with well-planned flow diversion measures.

Additionally, seepage and piping erosion risks can be controlled through appropriate materials and sealing techniques, ensuring structural stability. Temporary backwater effects upstream and increased flow velocity downstream are inherent but can be accounted for in the design to prevent significant bank erosion or disruption of aquatic habitats. By integrating scour protection, controlled flow releases, and sediment management strategies, the infrastructure can be implemented with minimal long-term ecological disturbance while fulfilling its intended function.

For all areas that are cleared of vegetation, but especially for areas within riparian and wetland areas (applicable for both alternatives), ineffective site stormwater management, particularly in periods of high runoff, can lead to soil erosion from confined flows, such as some rill and gully erosion on a slope. These impacts can be avoided with appropriate stormwater management, such as catch-pits, infiltration berms, retention ponds, etc. However, with a suitable stormwater mitigation measure, the hydrological regime can be maintained.

In general during the operational phase both alternatives will have similar hydrological impacts.

8.3 Impact 3: Sedimentation and erosion

Sedimentation and erosion refer to the alteration in the physical characteristics of a watercourse as a result of increased turbidity and sediment deposition, caused by soil erosion and earthworks that are associated with construction activities, as well as instability and collapse of unstable soils during project operation. These impacts can result in the deterioration of aquatic ecosystem integrity and a reduction/loss of habitat for aquatic dependent flora & fauna. While sediment is essential to natural river structural integrity and functioning, when received in concentration and/or duration beyond natural regimes, it becomes a pollutant.

Sedimentation of the watercourses remains the main threat from the implementation of this project and working within the water column. Site preparation and stockpiling will result in the exposure of bare soils and material upslope of aquatic habitat and decrease the soil binding capacity and cohesion of the soils and thus increase the risk of erosion and sedimentation downslope. This activity may cause the burying of aquatic habitat (especially for the removal of the rock required for Alternative 1). Erosion could also be initiated if stockpiles and adequate stormwater management systems are not designed appropriately. However, these impacts are manageable and can be avoided\minimised.

8.4 Impact 4: Potential impact on surface water quality

Water and/or soil pollution cause negative changes in the physical, chemical and biological characteristics of water resources (i.e. water quality). This can result in possible deterioration in aquatic ecosystem integrity and a reduction in species diversity. During all phases of the project there is potential for hydrocarbon pollution from heavy vehicles within the catchment and littering. Hydrocarbons including petrol/diesel and oils/grease/lubricants associated with machinery may potentially enter the systems by means of surface runoff or infiltration though sediments.

Currently, there is evidence of potential hydrocarbon spills at the site and pollution from activities related to machinery and farmers pump maintenance in the riparian corridor. Any surface water will be impacted by silt-laden/ contaminated runoff water from the construction activities. These impacts can be avoided with the implementation of mitigation measures, adherence to the EMP, and appropriate monitoring/ site management. The impacts for both alternatives will likely be similar as the scope of works is within the extent of aquatic habitat and it associated buffer area.

8.5 IMPACT 5: CUMULATIVE IMPACTS

Cumulative impacts on the environment can result from broader, long-term changes and not only as a result of a single activity. They are rather from the combined effects of many activities overtime. The proposed upgrade to the existing pump station and access road will take place within a cultivated landscape where prior impacts have already moderately to significantly altered the river's ecological condition. The upgrade is not expected to cause further substantial change, and with proper mitigation, construction-related impacts can be minimized to a negligible level. In the long term, the upgraded structure has been designed to have minimal influence on the river's hydraulics.

Mitigation, including appropriate design and monitoring can reduce any residual cumulative impact to acceptable levels. The nature of the watercourses in the study area has afforded them the ability to absorb impacts from disturbances in the catchment and remain ecologically stable. Both alternatives will have similar small cumulative impacts.

9 IMPACT SIGNIFICANCE

Both alternatives have similar impacts all of which can be mitigated. Alternative 1 has marginally higher risk of sedimentation and increased turbidity during construction due to the removal of the rock. Alternative 2 poses more likelihood of impacting the riparian vegetation. Both have similarly low hydrological and cumulative impacts, especially in the context of the site being located upstream of a weir. The after-mitigation significance assumes the best possible scenario where best practice and the recommendations of this report are applied.

Table 8: *Impact assessment summary for Impact 1 – Disturbance/ loss of aquatic biota*

PHASE:	Site Preparation and Construction Phase		
Potential impact and risk:	The disturbance or loss of aquatic fauna and flora from direct physical destruction or disturbance which can result in further deterioration of aquatic habitat integrity, habitat fragmentation, and a reduction in the supply of ecosystem services.		
Nature of impact:	Negative		
Alternative:	**Alternative 1**	**Alternative 2**	**No-Go**
Extent and duration of impact:	Site and long-term	Local and long-term	None
Magnitude of impact or risk:	Low	Moderate	
Probability of occurrence:	Probable	Highly probable	
Degree to which the impact may cause irreplaceable loss of resources:	Low	Low	
Degree to which the impact can be reversed:	Recoverable	Recoverable	
Indirect impacts:	Probable	Probable	
Cumulative impact prior to mitigation:	Low	Low	
Significance rating of impact prior to mitigation	Low	Medium	
Degree to which the impact can be avoided:	Partially	Barely	
Degree to which the impact can be managed:	High	High	
Degree to which the impact can be mitigated:	Can be mitigated	Can be mitigated	
Proposed mitigation:	**Design Phase:** • A construction method statement must be compiled and available on site. It must consider the no go area and include methods to avoid unnecessary disturbance. **Construction Phase:** • Any contractor found working within No-Go areas must be fined as per fining schedule/system setup for the project. • It is the contractor's responsibility to continuously monitor the area for newly established alien species during the		Duty of Care- Alien clearing and pollution control

	contract and establishment period, which if present must be removed. A list of these species needs to be added with photos into the EMPr. Removal of these species shall be undertaken in a way which prevents any damage to the remaining indigenous species and inhibits the re-infestation of the cleaned areas. Any use of herbicides in removing alien plant species is required to be investigated by the ECO before use. • Where vegetation has been cleared in the riparian area it is recommended that cover components be reinstated appropriately. Only indigenous species are to be considered. • Monitoring by an independent ECO during construction in all phases. • The construction of both interim and permanent structures within the river channel should be minimized wherever possible, ensuring minimal disruption to flow patterns. In particular, the implementation of erosion control measures on the opposite bank should be avoided. **Operational Phase:** • In the long term, the maintenance and management of the infrastructure should follow an approved Environmental Management Plan for the Operational Phase, which must include the removal of invasive alien vegetation in the riparian zone adjacent to the pump station and access road.		
Residual impacts:	Very Low	Low	
Cumulative impact post mitigation:	Low	Low	
Significance rating of impact after mitigation	Very Low	Low	None

Table 9: *Impact assessment summary for Impact 2 – changes to the hydrological regime*

PHASE:	Design phase, site preparation, construction and operational phase
Potential impact and risk:	Changes to the natural movement of water flow through the Moordkuil River and its associated buffer, by construction of infrastructure within the water column and riparian habitat. These changes can result in altered flow patterns, sediment transport, and erosion. Localized scour, sediment deposition upstream, and increased downstream velocity is possible to occur around water column infrastructure. There are risks of improperly designed infrastructure causing water column turbulence and vortex formation.
Nature of impact:	Negative

Alternative:	Alternative 1	Alternative 2	No-Go
Extent and duration of impact:	Site and permanent	Site Specific and permanent	None
Magnitude of impact or risk:	Low	Low	
Probability of occurrence:	Definite	Highly probable	
Degree to which the impact may cause irreplaceable loss of resources:	Marginal loss	Marginal loss	
Degree to which the impact can be reversed:	Barely Reversible	Reversible	
Indirect impacts:	Highly Probable	Improbable	
Cumulative impact prior to mitigation:	Low	Negligible	
Significance rating of impact prior to mitigation	Low	Low	
Degree to which the impact can be avoided:	Cannot be avoided	Barely	
Degree to which the impact can be managed:	Partially	Can be managed	
Degree to which the impact can be mitigated:	Can be mitigated	Can be mitigated	
Proposed mitigation:	**Design phase considerations** • **Optimized Placement & Orientation** – Where possible position the cofferdam to minimize disruption to the main flow path and align it with the natural flow direction to reduce turbulence. • **Permeability Considerations** – If necessary, utilise a slotted or porous section to allow controlled water passage and reduce sudden pressure changes. • **Energy Dissipation Structures** – Where necessary consider including stepped weirs, baffles, or flow deflectors to prevent excessive velocity increases and turbulence. • **Scour and Erosion Protection** – Where necessary design reinforced edges with riprap, gabions, or concrete aprons to prevent localized scour. • **Sediment Transport Management** – Where necessary ensure the structure allows for natural sediment movement to prevent excessive upstream deposition or downstream erosion. **Site Preparation Phase** • **Establish Controlled Access Routes:** Limit disturbance to water		Duty of Care- Alien clearing and pollution control and maintenance of infrastructure activities.

	flow and minimize construction-related runoff. • **Flow Diversion & Bypass Measures:** If possible install a controlled bypass system (e.g., pipes or channels) to maintain continuous downstream flow. Ensure the bypass capacity matches or exceeds expected base flow conditions. • **Contaminant Spill prevention measures**: Store fuels, cement and chemicals away from the river and have containment measures in place. **Construction Phase** • **Control Water Flow During Construction:** Carefully manage the rate and timing of water released during construction to avoid surges and ensure consistent downstream flow. • **Regular ECO Water Quality Monitoring:** Conduct monitoring of water quality to track turbidity and contamination levels. • **Limit Water Diversion Duration:** Minimize the time the flow is disrupted by construction activities to reduce impact on aquatic ecosystems. • **Controlled Dewatering:** If contaminated, remove contaminated water onto shore and treat accordingly. Do not discharge untreated contaminated water back into the system • **Efficient Temporary River Channel Construction:** If required, implement bypasses and pumps with minimal disruption to the river's natural hydrology. **Operational Phase** • **Flood Control Measures:** Regularly assess river levels and implement flood mitigation measures as required. • **Maintenance work**: Any work associated with the maintenance of the water column infrastructure should be minimized in both spatial extent and duration. Preferably such work should take place during the drier months (December to April) to reduce hydrological impacts.	

	• **Emergency infrastructure repair**: Any flood damaged infrastructure should be repaired as soon as it is safe, and possible, to do so, to prevent further degradation and hydrological impacts.		
Residual impacts:	Low	Negligible	
Cumulative impact post mitigation:	Low	Negligible	
Significance rating of impact after mitigation	Low	Very Low	None

Table 10: *Impact assessment summary for Impact 3 – Geomorphological changes from erosion and sedimentation*

PHASE:	Design phase, site preparation, construction and operational phase		
Potential impact and risk:	Changes to the form and geomorphological processes from clearing riparian vegetation and construction within the watercourse due to potential erosion and sedimentation from hydrological changes and increased sediment inputs.		
Nature of impact:	Negative		
Alternative:	**Alternative 1**	**Alternative 2**	**No-Go**
Extent and duration of impact:	Local and short term	Site Specific and short term	None
Magnitude of impact or risk:	Moderate	Low	
Probability of occurrence:	Probable	Probable	
Degree to which the impact may cause irreplaceable loss of resources:	Marginal loss	Marginal loss	
Degree to which the impact can be reversed:	Barely Reversible	Partially reversible	
Indirect impacts:	Highly Probable	Improbable	
Cumulative impact prior to mitigation:	Medium	Low	
Significance rating of impact prior to mitigation	Moderate	Low	
Degree to which the impact can be avoided:	Low	Medium	
Degree to which the impact can be managed:	High	High	
Degree to which the impact can be mitigated:	Can be mitigated	Can be mitigated	

Proposed mitigation:	**Design phase considerations** • **Optimized Placement & Orientation** – Where possible position the cofferdam to minimize disruption to the main flow path and align it with the natural flow direction to reduce turbulence. • **Permeability Considerations** – If necessary, utilise a slotted or porous section to allow controlled water passage and reduce sudden pressure changes. • **Energy Dissipation Structures** – Where necessary consider including stepped weirs, baffles, or flow deflectors to prevent excessive velocity increases and turbulence. • **Scour and Erosion Protection** – Where necessary, design reinforced edges with riprap, gabions, or concrete aprons to prevent localized scour. • **Sediment Transport Management** – Where necessary ensure the structure allows for natural sediment movement to prevent excessive upstream deposition or downstream erosion. **Site Preparation Phase:** • **Establish sediment control barriers:** Install sediment fences, silt curtains, or berms around construction zones to contain sediment and prevent it from reaching water bodies. • **Stabilise disturbed areas:** Apply erosion control techniques such as mulching, vegetation, or geotextiles to stabilize disturbed soils and reduce sediment runoff. **Construction Phase:** • **Sediment trapping measures:** Install sediment traps or basins at strategic points along construction sites to capture and manage sediment and minimise downstream contamination. • **Minimize disturbed areas:** Limit the footprint of the construction zone and avoid unnecessary soil disturbance to reduce the potential for sediment mobilization.	Duty of Care- Alien clearing and pollution control and maintenance of infrastructure activities.

	• **Monitor sedimentation:** ECO monitor turbidity levels upstream and downstream of construction site to confirm the efficiency of mitigation measures and make adjustments as needed. • **Water diversion techniques:** Divert clean water away from construction areas using berms or temporary channels to prevent sediment-laden water from entering watercourses. • **Control stormwater runoff:** Use temporary sediment control measures, such as erosion mats or check dams, to control runoff and prevent excessive sedimentation during heavy rainfall events. **Operational Phase:** • **Maintain natural water column sediment levels:** Regularly clean and maintain coffer dam, and filtration systems to ensure they continue functioning effectively in capturing sediment and returning captured sediment back to the water column. • **Vegetative stabilization:** Promote the growth of native vegetation in areas susceptible to erosion to stabilize soil and reduce sediment generation over time. • **Revegetation of exposed soils:** In any areas that have been disturbed, replant vegetation and apply soil stabilisation techniques to prevent erosion and further sediment loss. • **Flood Control Measures:** Regularly assess river levels and implement flood mitigation measures as required. • **Maintenance work**: Any work associated with the maintenance of the water column infrastructure should be minimized in both spatial extent and duration. Preferably such work should take place during the drier months (December to April) to reduce hydrological impacts. • **Emergency infrastructure repair**: Any flood damaged infrastructure should be repaired as soon as it is safe, and possible, to do	

	so, to prevent further degradation and hydrological impacts.		
Residual impacts:	Medium	Low	
Cumulative impact post mitigation:	Low	Low	
Significance rating of impact after mitigation	Low	Very Low	None

Table 11: *Impact assessment summary for Impact 4 – Water quality deterioration*

PHASE:	Site preparation, construction		
Potential impact and risk:	Changes to the natural water quality parameters resulting in reduced ecosystem integrity and decreased biodiversity.		
Nature of impact:	Negative		
Alternative:	**Alternative 1**	**Alternative 2**	**No-Go**
Extent and duration of impact:	Local and medium term	Local and short term	None
Magnitude of impact or risk:	Medium	Medium	
Probability of occurrence:	Probable	Improbable	
Degree to which the impact may cause irreplaceable loss of resources:	Marginal loss	Marginal loss	
Degree to which the impact can be reversed:	Barely Reversible	Barely Reversible	
Indirect impacts:	Probable	Probable	
Cumulative impact prior to mitigation:	Low	Low	
Significance rating of impact prior to mitigation	Medium	Low	
Degree to which the impact can be avoided:	Barely	Partially	
Degree to which the impact can be managed:	Partially	Can be managed	
Degree to which the impact can be mitigated:	Can be mitigated	Can be mitigated	
Proposed mitigation:	**Site Preparation & Construction Phase:** • **Pollution Prevention:** ○ Establish designated fuelling and maintenance areas away from the watercourse to prevent fuel and oil spills. ○ Store hazardous materials (e.g., cement, fuels,		Duty of Care- Alien clearing and pollution control and maintenance of infrastructure activities.

	chemicals) in bunded areas away from the river. ○ Implement spill response procedures and have spill kits on-site. ○ Ensure proper waste disposal, including construction debris and domestic waste, to prevent contamination. • **Stormwater Management:** ○ Design temporary stormwater control measures to prevent runoff from carrying pollutants into the river. ○ Use infiltration trenches or constructed wetlands to filter runoff before it enters the watercourse. **Operational Phase:** • **Monitoring & Maintenance:** ○ Regularly monitor water quality parameters (e.g., turbidity, dissolved oxygen, nutrients, heavy metals) to detect any degradation. ○ Implement adaptive management strategies if water quality deteriorates over time. • **Vegetative Buffer Zones:** ○ Maintain or restore riparian vegetation to filter runoff, stabilize banks, and improve water quality. ○ Prevent livestock access to the river and site camps near infrastructure to reduce nutrient loading and bank erosion. • **Long-Term Pollution Control:** ○ Establish protocols for handling accidental spills or contamination events.	

	o Ensure all waste is deposed of at a registered waste disposal site.		
Residual impacts:	Low	Low	
Cumulative impact post mitigation:	Low	Negligible	
Significance rating of impact after mitigation	Low	Low	None

The No-Go Alternative was determined to have no new impacts upon aquatic biodiversity and is therefore the preferred alternative from an aquatic perspective. The No-Go alternative also assumes the reinstatement of the second pump and resumption of original designed abstraction rates. It is important to note that a no-go scenario assumes the management of alien invasive plants in the drainage areas and pollution prevention, activities which are not currently evident. The implementation of these measures would improve the present ecological state of the system.

The Department of Water and Sanitation's Draft Rehabilitation Management Guidelines for Wetlands (DWS, 2024) explicitly adopts the "*No Net Loss*" principle, stating that wetland offsets should be implemented "*to achieve No Net Loss and preferably a net gain with respect to the full spectrum of functions and values provided by wetlands.*" The Guidelines emphasise that offsets are a last resort, to be considered only after all reasonable measures to avoid, minimise, and rehabilitate impacts have been exhausted (DWS, 2024). The impacts of using Site Camps 1 and 2 will result in direct wetland loss and therefore those are fatally flawed for use. Only Site Camp 1 will be considered acceptable.

10 CONCLUSION

The aquatic habitats within 500m of the project footprint were identified and mapped on a desktop level using available data. Following this, a site assessment was conducted to confirm desktop findings, gather additional information, and define the boundaries of the aquatic habitat. The groundtruthed findings are largely in alignment with the information of the desktop databases.

Risk assessment determined that there are two potentially impacted HGM units, namely the riparian system of the Moordkuil River, which is a perennial system, and HGM unit 3 which is a channelled valley bottom system. The Moordkuil River is the existing abstraction point and is already subjected to impacts from abstraction activities and is the location where both alternatives. However, the remaining habitat still provides important ecosystem services. It was recommended that no further deterioration of the habitat must be allowed outside of the designated construction footprint.

Impact assessment determined that after mitigation, Alternatives 1 and 2 both have similarly low impacts (after mitigation). The lowest impacts were from the No-Go Alternative. Mitigation should focus on minimising construction footprint and reduction of impacts on the hydrological and geomorphological characteristics of the watercourse. A robust monitoring programme should be developed and audited annually by a SACNASP registered ecologist.

In conclusion, there are fatal flaws associated with the proposed establishment of Site Camp 1 and 2 as the principals of impact avoidance (if possible), should have been implemented. The No-Go Alternative has the lowest impacts and therefore is the preferred alternative (from a freshwater perspective), but Site Camp 3 is acceptable, provided all the mitigation measures are strictly implemented and monitored. The proposed project requires water use authorisation in terms of Chapter 4 and Section 21 of the National Water Act No. 36 of 1998, prior to the commencement of activities.

11 REFERENCES

BROMILOW, C. 2001. Problem Plants of South Africa: a Guide to the Identification and Control of more than 300 invasive plants and other weeds. Briza Publications, Pretoria.

CAPENATURE. 2024. 2023 Western Cape Biodiversity Spatial Plan and Guidelines.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, 1999a. Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems Version 1.0, Pretoria.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY, 2005. A Practical Field Procedure for Identification and Delineation of Wetland and Riparian areas. Edition 1, September 2005. DWAF, Pretoria.

DEPARTMENT OF WATER AND SANITATION (DWS). 2024. *Draft Rehabilitation Management Guidelines for Wetlands.* Pretoria: Department of Water and Sanitation, Republic of South Africa.

KLEYNHANS, C.J., 1996. Index of Habitat Integrity (IHI).

KLEYNHANS, CJ, THIRION, C AND MOOLMAN, J (2005). A Level I River Ecoregion classification System for South Africa, Lesotho and Swaziland. Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

KOTZE, D.C., MACFARLANE, D. AND EDWARDS, R. 2020. WET-EcoServices (Version 2) A technique for rapidly assessing ecosystem services supplied by wetlands and riparian areas. WRC Report No. 2737/1/21.

KOTZE, D.C., MARNEWECK, G.C., BATCHELOR, A.L., LINDLEY, D.S. AND COLLINS, N.B. 2009. WET-Ecoservices: A technique for rapidly assessing ecosystem services supplied by wetlands.

LAWRENCE, D.P., 2007. Impact significance determination - Designing an approach. Environmental Impact Assessment Review 27: 730 - 754.

LE MAITRE, D.C., SEYLER, H., HOLLAND, M., SMITH-ADAO, L., NEL, J.L., MAHERRY, A. AND WITTHÜSER, K. (2018) Identification, Delineation and Importance of the Strategic Water Source Areas of South Africa, Lesotho and Swaziland for Surface Water and Groundwater. Report No. TT 743/1/18, Water Research Commission, Pretoria.

NAIMAN, R.J., AND H. DECAMPS. 1997. The ecology of interfaces -- riparian zones. Annual Review of Ecology and Systematics 28:621-658

MUCINA, L. AND RUTHERFORD, M. C. (EDS) 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

POOL-STANVLIET , R., DUFFELL-CANHAM, A., PENCE, G. AND SMART, R. (2017). The Western Cape Biodiversity Spatial Plan Handbook. Stellenbosch: Cape Nature.

ROGERS KH. 1995. Riparian Wetlands. In: Wetlands of South Africa, Cowan GI (ed). Department of Environmental Affairs and Tourism: Pretoria.

VAN GINKEL, C.E., GLEN, R.P., GORDAN-GRAY, K.D., CILLIERS, C.J., MUASYA AND VAN DEVENTER, P.P., 2011. Easy identification of some South African Wetland Plants (Grasses, Resticios, Sedges, Rushes, Bulrushes, Eriocaulons and Yellow-eyed grasses). WRC Report No. TT 459/10.

APPENDIX 1 –DETAILED METHODOLOGY

For reference the following definitions are as follows:

- **Drainage line**: A drainage line is a lower category or order of watercourse that does not have a clearly defined bed or bank. It carries water only during or immediately after periods of heavy rainfall i.e. non-perennial, and riparian vegetation may not be present.
- **Perennial and non-perennial:** Perennial systems contain flow or standing water for all or a large proportion of any given year, while non-perennial systems are episodic or episodic and thus contains flows for short periods, such as a few hours or days in the case of drainage lines.
- **Riparian**: the area of land adjacent to a stream or river that is influenced by stream-induced or related processes. Riparian areas which are saturated or flooded for prolonged periods would be considered wetlands and could be described as riparian wetlands. However, some riparian areas are not wetlands (e.g. an area where alluvium is periodically deposited by a stream during floods but which is well drained).
- **Wetland**: 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 under normal circumstances supports or would support vegetation typically adapted to life in saturated soil (Water Act 36 of 1998); land where an excess of water is the dominant factor determining the nature of the soil development and the types of plants and animals living at the soil surface (Cowardin *et al*., 1979).
- **Water course**: as per the National Water Act means -
  (a) a river or spring;
  (b) a natural channel in which water flows regularly or intermittently;
  (c) a wetland, lake or dam into which, or from which, water flows; and
  (d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks

11.1 WETLAND DELINEATION AND HGM TYPE IDENTIFICATION

Wetland delineation includes the confirmation of the occurrence of wetland and a determination of the outermost edge of the wetland. The outer boundary of wetlands was identified and delineated according to the Department of Water Affairs wetland delineation manual 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005a). Wetland indicators were used in the field delineation of the wetlands: position in landscape, vegetation and soil wetness (determined through soil sampling with a soil auger and the examining the degree of mottling).

Four specific wetland indicators were used in the detailed field delineation of wetlands, which include:

- The Terrain Unit Indicator helps to identify 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.
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

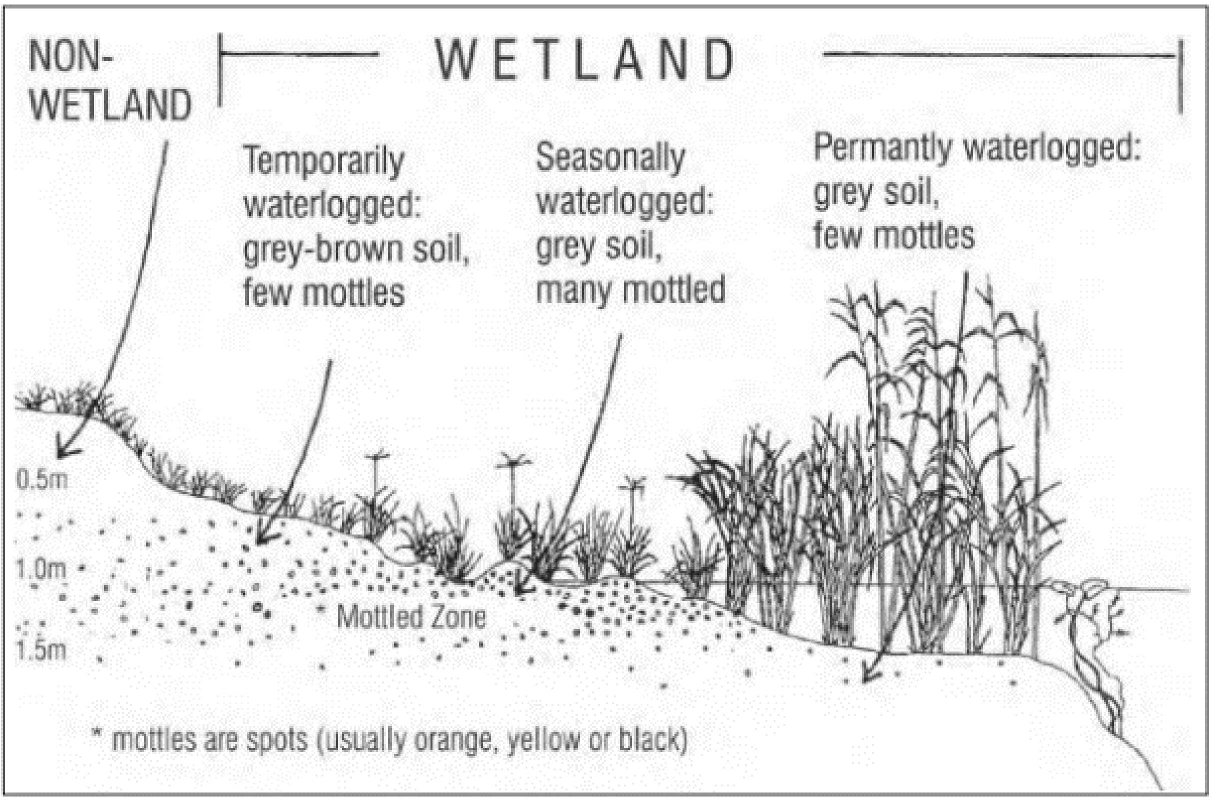

Figure A12.1a: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the middle to the edge of the wetland. Source: Donovan Kotze, University of KwaZulu-Natal.

According to the wetland definition used in the National Water Act, vegetation is the primary indicator, which must be present under normal circumstances. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role. The reason is that vegetation responds relatively quickly to changes in soil moisture regime or management and may be transformed; whereas the morphological indicators in the soil are far more permanent and will hold the signs of frequent saturation long after a wetland has been drained (perhaps for several centuries).

The permanent, seasonal and temporary wetness zones can be characterised to some extent by the soil wetness indicators that they display (Table A12.1a)

A12.1a: Soil Wetness Indicators in the various wetland zones

TEMPORARY ZONE	SEASONAL ZONE	PERMANENT ZONE
Minimal grey matrix (<10%)	Grey matrix (<10%)	Prominent grey matrix
Few high chroma mottles	Many low chroma mottles present	Few to no high chroma mottles
Short periods of saturation (less than three months per annum)	Significant periods of wetness (at least three months per annum)	Wetness all year round (possible sulphuric odour)

Table A12.1b: Relationship between wetness zones and vegetation types and classification of plants according to occurrence in wetlands

Vegetation	Temporary Wetness Zone	Seasonal Wetness Zone	Permanent Wetness Zone
Herbaceous	Predominantly grass species; mixture of species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas	Hydrophilic sedges and grasses restricted to wetland areas	Dominated by: (1) emergent plants, including reeds (*Phragmites australis*), a mixture of sedges and bulrushes (Typha capensis), usually >1m tall; or (2) floating or submerged aquatic plants.
Woody	Mixture of woody species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas.	Hydrophilic woody species restricted to wetland areas	Hydrophilic woody species, which are restricted to wetland areas. Morphological adaptations to prolonged wetness (e.g. prop roots).
Symbol	Hydric Status	Description/Occurrence	
Ow	Obligate wetland species	Almost always grow in wetlands (>90% occurrence)	
Fw/F+	Facultative wetland species	Usually grow in wetlands (67-99% occurrence) but occasionally found in non-wetland areas	
F	Facultative species	Equally likely to grow in wetlands (34-66% occurrence) and non-wetland areas	
Fd/F-	Facultative dryland species	Usually grow in non-wetland areas but sometimes grow in wetlands (1-34% occurrence)	
D	Dryland species	Almost always grow in drylands	

In order to identify the wetland types, using Kotze *et al.* (2009) and Ollis *et al*. (2013), a characterisation of hydrogeomorphic (HGM) types was conducted. These have been defined based on the geomorphic setting of the wetland in the landscape (e.g. hillslope or valley bottom, whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated), how water flows through the wetland (diffusely or channelled) and how water exits the wetland (Figure A12.1b).

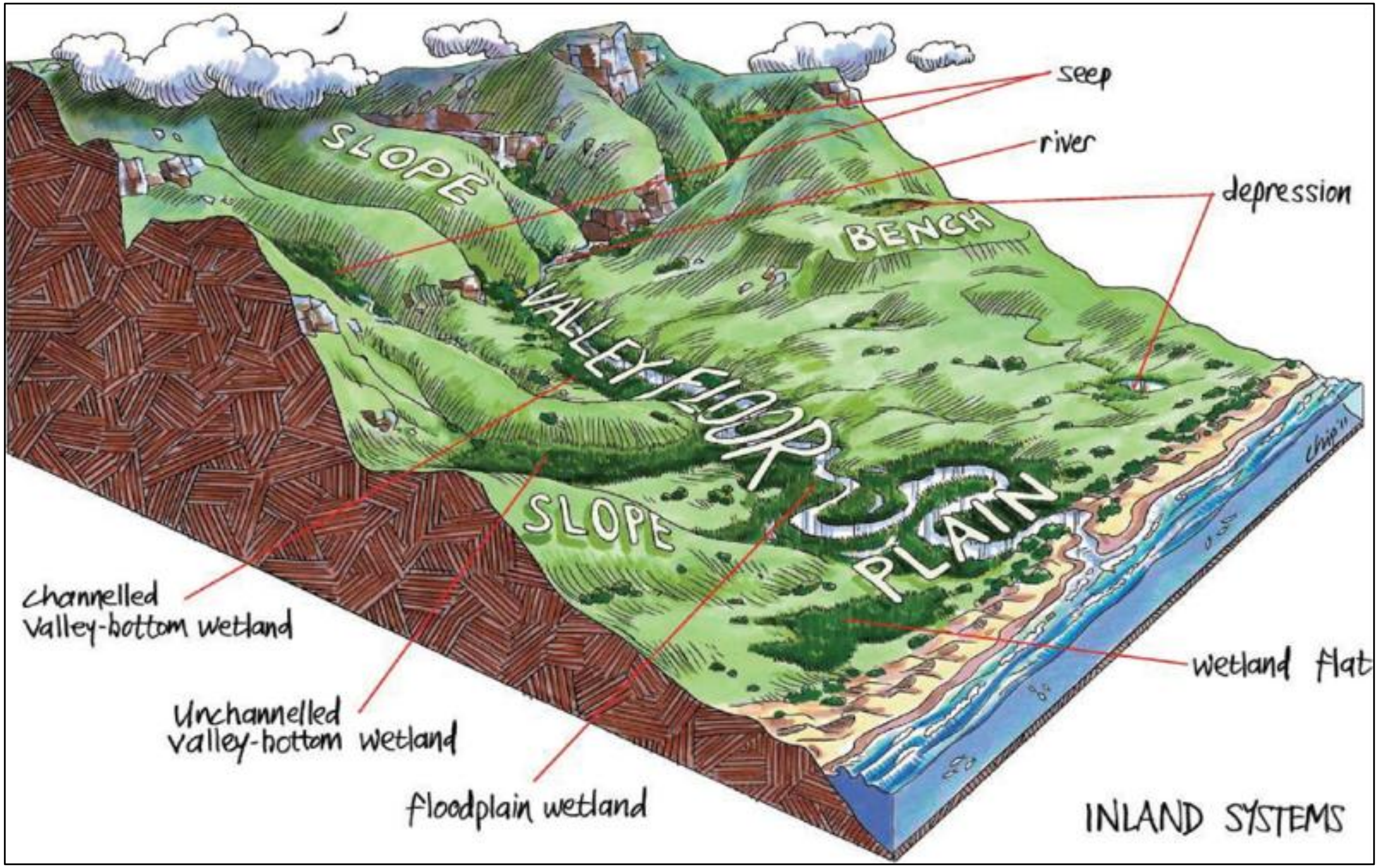

Figure A12.1b: Illustration of wetland types and their typical landscape setting (From Ollis et al. 2013)

11.2 DELINEATION OF RIPARIAN AREAS

Riparian zones are described as “the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas” i , Riparian zones can be thus be distinguished from adjacent terrestrial areas through their association with the physical structure (banks) of the river or stream, as well as the distinctive structural and compositional vegetation zones between the riparian and upland terrestrial areas (Figure 12.2a). Unlike wetland areas, riparian zones are usually not saturated for a long enough duration for redoxymorphic features to develop. Riparian zones instead develop in response to (and are adapted to) the physical disturbances caused by frequent overbank flooding from the associated river or stream channel.

Like wetlands, riparian areas can be identified using a set of indicators. The indicators for riparian areas are: - **Landscape position**; - Alluvial soils and recently deposited material; - **Topography** associated with riparian areas; and - **Vegetation** associated with riparian areas. Landscape Position As discussed above, a typical landscape can be divided into 5 main units), namely the: - Crest (hilltop); - Scarp (cliff); - Midslope (often a convex slope); - Footslope (often a concave slope); and - Valley bottom. Amongst these landscape units, riparian areas are only likely to develop on the valley bottom landscape units (i.e. adjacent to the river or stream channels; along the banks comprised of the sediment deposited by the channel). Alluvial soils are soils derived from material deposited by flowing water, especially in the valleys of large rivers. Riparian areas often, but not always, have alluvial soils. Whilst the presence of alluvial soils cannot always be used as a primary indicator to accurately delineate riparian areas, it can be used to confirm the topographical and vegetative indicators. Quaternary alluvial soil deposits are often indicated on geological maps, and whilst the extent of these quaternary alluvial deposits usually far exceeds the extent of the contemporary riparian zone; such indicators are useful in identifying areas of the landscape where wider riparian zones may be expected to occur.

Topography and recently deposited material associated with riparian areas The National Water Act definition of riparian zones refers to the structure of the banks and likely presence of alluvium. A good indicator of the presence of riparian zones is the presence of alluvial deposited material adjacent to the active channel (such as benches and terraces), as well as the wider incised “macro-channels” which are typical of many of southern Africa’s eastern seaboard rivers. Recently deposited alluvial material outside of the main active channel banks can indicate a currently active flooding area; and thus the likely presence of wetlands. Vegetation associated with riparian areas unlike the delineation of wetland areas, where redoxymorphic features in the soil are the primary indicator, the identification of riparian areas relies heavily on vegetative indicators. Using vegetation, the outer boundary of a riparian area can be defined as the point where a distinctive change occurs: - in species composition relative to the adjacent terrestrial area; and - in the physical structure, such as vigour or robustness of growth forms of species similar to that of adjacent terrestrial areas. Growth form refers to the health, compactness, crowding, size, structure and/or numbers of individual plants.

As with the delineation approach for wetlands, the field delineation method for riparian areas focuses on two main indicators of riparian zones: - **Vegetation Indicators**, and - **Topography** of the banks of the river or stream.

Additional verification can be obtained by examining for any recently alluvial deposited material to indicate the extent of flooding and thus obtain at least a minimum riparian zone width. The following procedure should be used for delineation of riparian zones: A good rough indicator of the outer edge of the riparian areas is the edge of the macro channel bank. This is defined as the outer bank of a compound channel, and should not be confused with the active river or stream channel bank. The macro-channel is an incised feature, created by uplift of the subcontinent which caused many rivers to cut down to the underlying geology and creating a sort of "restrictive floodplain" within which one or more active channels flow. Floods seldom have any known influence outside of this incised feature. Within the macro-channel, flood benches may exist between the active channel and the top of the macro channel bank. These depositional features are often covered by alluvial deposits and may have riparian vegetation on them. Going (vertically) up the macro channel bank often represents a dramatic decrease in the frequency, duration and depth of flooding experienced, leading to a corresponding change in vegetation structure and composition.

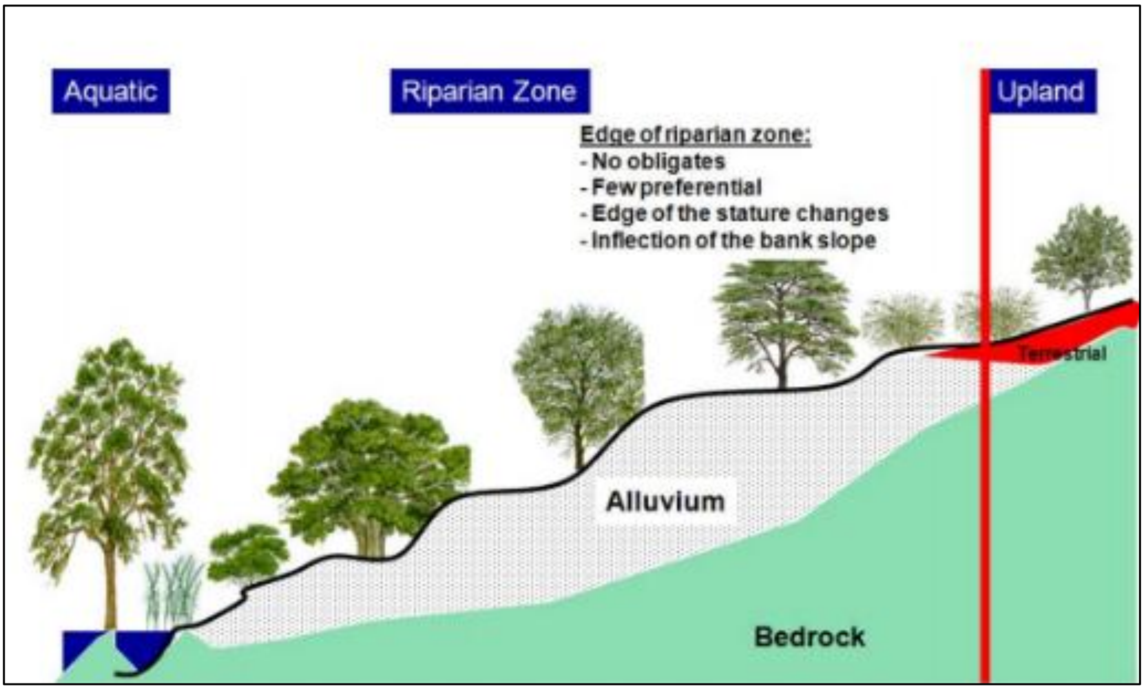

Figure A12.2a: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river. Note the coincidence of the inflection (in slope) on the bank with the change in vegetation structure and composition. The edge of the riparian zone coincides with an inflection point on the bank; where there are not obligates upslope; few preferential. The boundary also coincides with the outer edge of the stature differences (DWAF 2008).

11.3 Present Ecological State (PES) – Wetlands

WET-Health assists in assessing the health of wetlands using indicators based on geomorphology, hydrology and vegetation. For the purposes of rehabilitation planning and assessment, WET-Health helps users understand the condition of the wetland in order to determine whether it is beyond repair, whether it requires rehabilitation intervention, or whether, despite damage, it is perhaps healthy enough not to require intervention. It also helps diagnose the cause of wetland degradation so that rehabilitation workers can design appropriate interventions that treat both the symptoms and causes of degradation. WET-Health is tailored specifically for South African conditions and has wide application, including assessing the Present Ecological State of a wetland.

WET-Health is a tool designed to assess the health or integrity of a wetland. Wetland health is defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition. This technique attempts to assess hydrological, geomorphological and vegetation health in three separate modules.

Hydrology is defined in this context as the distribution and movement of water through a wetland and its soils. This module focuses on changes in water inputs as a result of changes in catchment activities and characteristics that affect water supply and its timing, as well as on modifications within the wetland that alter the water distribution and retention patterns within the wetland.

Geomorphology is defined in this context as the distribution and retention patterns of sediment within the wetland. This module focuses on evaluating current geomorphic health through the presence of indicators of excessive sediment inputs and/or losses for clastic (minerogenic) and organic sediment (peat).

Vegetation is defined in this context as the vegetation structural and compositional state. This module evaluates changes in vegetation composition and structure as a consequence of current and historic onsite transformation and/or disturbance.

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. The tool attempts to standardise the way that impacts are calculated and presented across each of the modules. This takes the form of assessing the spatial extent of impact of individual activities and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact (Table A12.2a).

Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions. Resultant health scores fall into one of six health categories (A-F) on a gradient from "unmodified/natural" (Category A) to "severe/complete deviation from natural" (Category F) as depicted in Table A12.2b, below. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic systems.

An overall wetland health score was calculated by weighting the scores obtained for each module and combining them to give an overall combined score using the following formula:

Overall health rating = [(Hydrology*3) + (Geomorphology*2) + (Vegetation*2)] / 7

This overall score assists in providing an overall indication of wetland health/functionality which can in turn be used for recommending appropriate management measures.

Table A12.2a: Guideline for interpreting the magnitude of impact on integrity

Impact Category	Description	Score
None	No discernible modification or the modification is such that it has no impact on this component of wetland integrity.	0 – 0.9
Small	Although identifiable, the impact of this modification on this component of wetland integrity is small.	1 – 1.9
Moderate	The impact of this modification on this component of wetland integrity is clearly identifiable, but limited.	2 – 3.9
Large	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a highly detrimental effect on this component of wetland integrity. Much of the wetland integrity has been lost but remaining integrity is still clearly identifiable.	6 – 7.9
Critical	The modification is so great that the ecosystem processes of this component of wetland integrity are almost totally destroyed, and 80% or more of the integrity has been lost.	8 – 10

Table A12.2b. Health categories used by WET-Health for describing the integrity of wetlands (after Macfarlane et al., 2008).

Impact Category	Description	Range	Pes Category
None	Unmodified, natural.	0 – 0.9	A
Small	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	B
Moderate	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	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4 – 5.9	D
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features	6 – 7.9	E
Critical	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	F

11.4 WETLAND FUNCTIONAL IMPORTANCE (GOODS AND SERVICES)

WET-EcoServices is used to assess the goods and services that individual wetlands provide, thereby aiding informed planning and decision making. It is designed for a class of wetlands known as palustrine wetlands (i.e. marshes, floodplains, vleis or seeps). The tool provides guidelines for scoring the importance of a wetland in delivering each of 20 different ecosystem services (including flood attenuation, sediment trapping and provision of livestock grazing). The first step is to characterise wetlands according to their hydro-geomorphic setting (e.g. floodplain). Ecosystem service delivery is then assessed either at Level 1, based on existing knowledge or at Level 2, based on a field assessment of key descriptors (e.g. flow pattern through the wetland).

The overall goal of WET-EcoServices is to assist decision makers, government officials, planners, consultants and educators in undertaking quick assessments of wetlands, specifically in order to reveal the ecosystem services that they supply. This allows for more informed planning and decision making. WET-EcoServices includes the assessment of several ecosystem services (listed in Table A12.4a) - that is, the benefits provided to people by the ecosystem.

Ecosystem services supplied by wetlands	Indirect benefits	Regulating and supporting benefits		Flood attenuation	The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream
				Streamflow regulation	Sustaining streamflow during low flow periods
			Water quality enhancement benefits	Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters
				Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters
				Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters
				Toxicant assimilation	Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters
				Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation.
				Carbon storage	The trapping of carbon by the wetland, principally as soil organic matter
	Direct benefits	**Biodiversity maintenance**[2]			Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity
		Provisioning benefits		Provision of water for human use	The provision of water extracted directly from the wetland for domestic, agriculture or other purposes
				Provision of harvestable resources	The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.
				Provision of cultivated foods	The provision of areas in the wetland favourable for the cultivation of foods
		Cultural benefits		Cultural heritage	Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants
				Tourism and recreation	Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife
				Education and research	Sites of value in the wetland for education or research

Table A12.4a: Ecosystem services assessed by WET-Ecoservices

11.5 PRESENT ECOLOGICAL STATE (PES) – RIPARIAN

Habitat is one of the most important factors that determine the health of river ecosystems since the availability and diversity of habitats (in-stream and riparian areas) are important determinants of the biota that are present in a river system (Kleynhans, 1996). The 'habitat integrity' of a river refers to the "maintenance of a balanced composition of physic-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region" (Kleynhans, 1996). It is seen as a surrogate for the assessment of biological responses to driver changes.

DWAF have developed a modified IHI, designed to accommodate the time constraints associated with desktop assessments or for instances where a rapid assessment of river conditions is required. The protocol does not distinguish between instream and riparian habitat and addresses six simple metrics to obtain an indication of Present Ecological State (PES). Each of the criteria are rated on a scale of 0 (close to natural) to 5 (critically modified) (Table A1.1) according to the following metrics:

- Bed modification
- Flow modification
- Inundation
- Bank condition
- Riparian zone condition
- Water quality modification

This assessment was informed by (i) a site visit where potential impacts to each metric were assessed and evaluated and (ii) an understanding of the catchment feeding the river and landuses / activities that could have a detrimental impact on river ecosystems.

Table A1.1: The rating scale for each of the various metrics in the assessment

Rating Score	Impact Class	Description
0	None	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.
0.5 - 1.0	Low	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.
1.5 - 2.0	Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.
2.5 - 3.0	Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.

3.5 - 4.0	Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.
4.5 - 5.0	Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.

The six metric ratings of the HGM under assessment are then averaged, resulting in one value. This value determines the Habitat Integrity PES category for the HGM (Table A1.2).

Table A1.2: The habitat integrity PES categories

Habitat Integrity PES Category	Description
A: Natural	Unmodified, natural.
B: Good	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C: Fair	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D: Poor	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E: Seriously modified	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F: Critically modified	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

11.6 Ecological Importance & Sensitivity – Riparian

The ecological importance of a wetland/river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Kleynhans & Louw, 2007; Resh et al., 1988; Milner, 1994). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity (Table A1.3).

The scores assigned to the criteria in Table A1.3 were used to rate the overall EIS of each mapped unit according to Table A1.4, below, which was based on the criteria used by DWS for river eco-classification (Kleynhans & Louw, 2007) and the WET-Health wetland integrity assessment method (Macfarlane et al., 2008).

Table A1.3: Components considered for the assessment of the ecological importance and sensitivity of a riparian system. An example of the scoring has also been provided.

Ecological Importance and Sensitivity assessment (Rivers)		
Determinants		Score (0-4)
BIOTA (RIPARIAN & INSTREAM)	Rare & endangered (range: 4=very high - 0 = none)	0,5
	Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	0,0
	Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	0,5
	Species/taxon richness (range: 4=very high - 1=low/marginal)	1,5
RIPARIAN & INSTREAM HABITATS	Diversity of types (4=Very high - 1=marginal/low)	1,0
	Refugia (4=Very high - 1=marginal/low)	1,5
	Sensitivity to flow changes (4=Very high - 1=marginal/low)	1,0
	Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	1,0
	Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	1,0
	Importance of conservation & natural areas (range, 4=very high - 0=very low)	2
MEDIAN OF DETERMINANTS		1,00
ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORY (EIS)		LOW, EC=D

Table A1.4: The ratings associated with the assessment of the EIA for riparian areas

Rating	Explanation
None, Rating = 0	Rarely sensitive to changes in water quality/hydrological regime
Low, Rating =1	One or a few elements sensitive to changes in water quality/hydrological regime
Moderate, Rating =2	Some elements sensitive to changes in water quality/hydrological regime
High, Rating =3	Many elements sensitive to changes in water quality/ hydrological regime
Very high, Rating =4	Very many elements sensitive to changes in water quality/ hydrological regime

11.7 Impact Assessment Method

Description and determination of the significance of the predicted impacts in terms of the criteria below to ensure a consistent and systematic basis for the decision-making process. Significance is numerically quantified on the basis score of the following impact parameters:

1. ***Extent* (E)** of the impact: The geographical extent of the impact on a given environmental receptor.

2. ***Duration* (D)** of the impact: The length of permanence of the impact on the environmental receptor.
3. ***Reversibility* (R) of the impact**: The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change
4. ***Magnitude* (M)** of the impact: The degree of alteration of the affected environmental receptor.
5. ***Probability* (P)** of the impact: The likelihood of the impact actually occurring.

A widely accepted numerical quantification of significance is the formula:
S=(E+D+R+M)*P
Where: *Significance=(Extent+Duration+Reversibility+Magnitude) * Probability*

The significance of environmental impacts is determined and ranked by considering the criteria presented in **Table 11.7A** below. All criteria are rank according to 'Very Low', 'Low', 'Moderate', 'High' and 'Very High' and are assigned scores of 1 to 5 respectively.

Table 12.7A***: Defining the significant in terms of the impact criteria.***

Impact Criteria	Definition	Score	Criteria Description
Extent (E)	Site	1	Impact is on the site only
	Local	2	Impact is localized inside the activity area
	Regional	3	Impact is localized outside the activity area
	National	4	Widespread impact beyond site boundary. May be defined in various ways, e.g. cadastral, catchment, topographic
	International	5	Impact widespread far beyond site boundary. Nationally or beyond
Duration (D)	Immediate	1	On impact only
	Short term	2	Quickly reversible, less than project life. Usually up to 5 years.
	Medium term	3	Reversible over time. Usually between 5 and 15 years.
	Long term	4	Longer than 10 years. Usually for the project life.
	Permanent	5	Indefinite
Magnitude (M)	Very Low	1	No impact on processes
	Low	2	Qualitative: Minor deterioration, nuisance or irritation, minor change in species/habitat/diversity or resource, no or very little quality deterioration. Quantitative: No measurable change; Recommended level will never be exceeded.

Impact Criteria	Definition	Score	Criteria Description
	Moderate	3	Qualitative: Moderate deterioration, discomfort, Partial loss of habitat /biodiversity /resource or slight or alteration. Quantitative: Measurable deterioration; Recommended level will occasionally be exceeded.
	High	4	Qualitative: Substantial deterioration death, illness or injury, loss of habitat /diversity or resource, severe alteration or disturbance of important processes. Quantitative: Measurable deterioration; Recommended level will often be exceeded
	Very High	5	Permanent cessation of processes
Reversibility (R)	Reversible	1	Recovery which does not require rehabilitation and/or mitigation.
	Recoverable	3	Recovery which does require rehabilitation and/or mitigation.
	Irreversible	5	Not possible, despite action. The impact will still persist, and no mitigation will remedy or reverse the impact.
Probability (P)	Improbable	1	Not likely at all. No known risk or vulnerability to natural or induced hazards
	Low Probability	2	Unlikely; low likelihood; Seldom; low risk or vulnerability to natural or induced hazards
	Probable	3	Possible, distinct possibility, frequent; medium risk or vulnerability to natural or induced hazards.
	Highly Probable	4	Highly likely that there will be a continuous impact. High risk or vulnerability to natural or induced hazards
	Definite	5	Definite, regardless of prevention measures.

The *significance* (s) of potential impacts identified according to the criteria above has been colour coded for the purpose of comparison. This colour coding will be used in impact tables.

Significance is deemed Negative (-)		
0 - 30	**31 - 60**	**61 - 100**
Low	**Medium**	**High**

APPENDIX 2- SPECIALIST CV

CURRICULUM VITAE

COLIN JUSTIN FORDHAM

BSC (BOTANY, BIOCHEMISTRY)

BSC BOTANY HONOURS (ENVIRONMENTAL MANAGEMENT)

MSC ENTOMOLOGY (BIOLOGICAL CONTROL)

Colin Justin Fordham

25 Blommekloof Street, Denneoord, George• **Cell:**0827889739,
• **Email**: colin@upstreamconsulting.co.za

Personal Information

Professional profile:

A highly motivated, confident, and diligent professional with exceptional communication skills, passionate about solving complex challenges. Adept at leveraging technology and software solutions to enhance organizational systems and functionality. Well-presented, ambitious, and goal-oriented with a strong drive to achieve success.

Skills:

- Extensive experience managing budgets and complex teams of staff who vary in skillsets, experience and opinions.
- Extensive conservation expertise in managing, analysing, and implementing ecological monitoring projects of varying complexity across Marine, Estuarine, Freshwater and Terrestrial ecosystems within seven Nature Reserves in the Western Cape.
- Vast experience managing, compiling and implementing large scale conservation and environmental projects, such as BMPs, PAMPs, EIA's, BAR's and various specialist studies while working as a senior manager, environmental consultant, ecological specialist.
- Extremely respectful of different cultures, religious and ethnic beliefs and I enjoy interacting with a wide variety of people.
- Exceptional knowledge of South African ecosystems, conservation policy and legislation.
- Extensive Southern Africa botanical, coastal and freshwater habitat assessment skills as well as experience in alien plant removal and rehabilitation techniques.
- Excellent knowledge of Southern Africa, geographically and culturally.
- Highly computer literate and skilled, with knowledge of various Microsoft Office, QGIS, ArcGIS, ArcView (v3 & v9.1 &v10), Manifold (v7&v8) mapping systems and programs. I also have experience with working with Miradi Conservation software.
- Excellent verbal, report writing and presenting skills.

Date of birth: 8th December 1982

Marital status: Married, no dependants

Health: Excellent

Criminal record: None

Country of origin: South Africa

ID Number: 8212085221086

Languages: Fluent in English, Afrikaans and Xhosa

Driver's License: Code 14, EC

Skippers License: River boats up to 9m.

Summary of Employment and Tertiary Education:

- Landscape Conservation Intelligence Manager - CapeNature (2019 – 2025)
- Land Use Scientist – CapeNature (2016 – 2019)
- Wetland Specialist, KSEMS (August 2015 – June 2016)
- Environmental Consultant and Ecologist, AGES (January 2012 – August 2015)
- MSC at Rhodes University (March 2010 – December 2012)

- CES – (March 2008 – February 2010) Environmental Scientist, Botanical\GIS Specialist and Ecologist
- BSC and BSC Honours at Nelson Mandela University (2001-2007).

Work Experience

CapeNature Landscape Conservation Intelligence Manager (LCIM) (2019 – 2025)

The purpose of the LCIM is to provide strategic leadership and overall accountability for the management, conservation and the promotion of human, natural and heritage assets in a CapeNature Landscape through best practice, within relevant legislative frameworks and the provision of a professional knowledge generation, capacity building and information management service, that enables strategic adaptive biodiversity management. The LCIM forms part of the Landscape Management Team, with Landscape Ecologist, Ecological Coordinator, Ecological Technician, GIS Technician and Technical Assistant all reporting to the LCIM.

As a LCIM, my key responsibilities included:

- Ensuring that Managed data, knowledge, and information flowed to produce high-quality intelligence, facilitating strategic adaptive management across priority landscape projects.
- Providing ecological decision support to guide landscape conservation through the coordination and scientific analysis of data for management planning and assessments.
- Facilitating integrated landscape and protected area planning by ensuring the development and review of key documents, such as Protected Area Management Plans (PAMPs), species Biodiversity Management Plans and ecological monitoring protocols.
- Leading capacity-building efforts to support conservation management, ecosystem resilience, and the coordination of stakeholders to ensure effective landscape conservation.
- Ensuring performance, governance, and risk management of Landscape Conservation Intelligence (LCI) through effective leadership and strategic oversight.
- Developing and reviewing landscape intelligence products, including eco-matrices, biodiversity planning documents, and data management tools, ensuring their alignment with conservation goals.
- Providing expert ecological input into landscape assessments, including site-specific impact assessments, spatial biodiversity planning, and biodiversity offset strategies.
- Managing and optimising budget allocations, ensuring financial control over the expenditure related to biodiversity projects and landscape conservation activities.
- Coordinating biodiversity data collection and monitoring activities, ensuring accurate fieldwork for priority landscape monitoring projects and habitat/species assessments.
- Sustaining key partnerships with municipalities, biosphere partners, academic institutes, and stakeholders to advance landscape custodianship and biodiversity conservation.

- Providing formal and informal decision support on biodiversity planning, permit applications, and development proposals, ensuring compliance with environmental legislation.
- Monitoring and reviewing conservation actions, including eco-matrix updates and biodiversity management plans, and facilitated input into landscape planning and expansion initiatives.
- Facilitating the development of key strategic documents, including the annual Integrated Work Plans (IWP) and APO (Annual Planning Objectives), aligning conservation priorities with landscape-level planning.
- Contributing to the development and review of biodiversity management guidelines, protocols, and spatial planning tools to ensure effective conservation strategies across landscapes.
- Reviewing and approving Protected Area Management Plans (PAMPs), contributing to the strategic vision and operational planning for the expansion and management of protected areas.
- Managing team performance, including the implementation of performance agreements, appraisals, and staff development plans, fostering a high-performance culture in the landscape team.
- Representing CapeNature at forums, workshops, and conferences, providing expert contributions and expanding the network of stakeholders committed to biodiversity conservation.
- Providing scientific analysis of biodiversity data, interpreting landscape data sources and providing actionable recommendations for biodiversity management.
- Engaging in active governance and compliance oversight, ensuring that landscape conservation units adhered to corporate policies, standards, and environmental legislation.
- Optimising staff capacity by facilitating training programs, supporting GIS and ecological training for landscape teams, and enhancing skills to support landscape conservation goals.

CapeNature Land Use Advice Scientist (June 2016 – 2019)

The purpose of a CapeNature Land Use Advice Scientist is to provide specialised ecological expertise and guidance in land-use planning, development, and conservation. This role ensures that land-use decisions align with biodiversity conservation priorities, legal requirements, and sustainable environmental practices. Key responsibilities include evaluating the ecological impacts of proposed developments, reviewing specialist reports, advising on biodiversity offsets, and promoting the integration of conservation objectives into regional and local planning frameworks. The position also involves contributing to the development of biodiversity management tools, supporting research and monitoring programs, and fostering collaboration between stakeholders to protect and enhance natural ecosystems in the Western Cape.

As a Land Use Scientist, my key responsibilities included:

- Reviewing specialist reports and planning applications, providing ecological expertise to support land-use decision-making.
- Evaluating and advising on biodiversity offsets, ensuring compliance with conservation priorities and environmental regulations.
- Assessing site sensitivities and the potential ecological impacts of land-use applications, offering guidance to competent authorities.
- Developing biodiversity legislative tools, including Biodiversity Management Plans (BMPs), Alien Invasive Species (AIS) management plans, and spatial biodiversity plans.
- Identifying and recommending opportunities to expand the conservation estate through stewardship programs and other mechanisms.
- Attending site inspections, resolving development queries, and reporting non-compliance to relevant authorities.
- Representing CapeNature at conservation forums, workshops, and conferences, contributing scientific expertise.
- Supporting biodiversity research and monitoring efforts, publishing findings to inform conservation strategies.
- Maintaining an up-to-date database of land-use applications and biodiversity offsets to guide planning.
- Providing training and support to staff on environmental legislation and conservation guidelines.

Wetland Specialist, KSEMS (August 2015 – June 2016)

- Project Management and coordination of sub-consultants as well as budget control handling
- Compiling specialist wetland assessments, with specific reference to estuaries, riparian zones, wetlands, coastal forests, grasslands and savannahs.
- Compilation of maps using GIS systems and analysis of data, using GIS systems
- General assistance regarding administration, co-ordination, project management and report production activities related to business projects.

Environmental Consultant, AGES (January 2012 – August 2015) and CES (March 2008 – February 2010) Environmental Scientist, Botanical\GIS Specialist and Ecologist.

- Project Management and coordination of sub-consultants as well as budget control handling
- Assisting the compilation of Environmental Impact Assessment (EIA) and Botanical Survey reports, including Multivariate analysis.

- Assisting with specialist faunal and floral studies, with specific reference to estuaries, riparian zones, wetlands, coastal forests, grasslands and savannas.
- Compilation\assisting with the compilation of the following reports\studies; Environmental Impact Assessments (EIA), Basic Assessments, Scoping Reports, Environmental Management Plans, Baseline Surveys and Botanical Surveys.
- Compilation of maps using GIS systems and analysis of data, using GIS systems
- Also, general assistance regarding administration, co-ordination, project management and report production activities related to business projects.

Department of Botany, NMMU, (2005-2007)

Environmental Consultant:

- Assisted in the undertaking of an EIA, for the augmentation of a water supply for Nieu Bethesda, including the construction of a pump station and two water reservoirs. Was directly responsible for the compilation of a botanical species list from samples taken from the site.

Laboratory Technician\Teaching experience (2005 & 2006, 2010 and 2011 at Rhodes University):

- 1st year student demonstrator
    - Taught students weekly and assisted in smooth and safe operation of laboratory equipment during student practical sessions.

South African Railways Contract Work, (Spoornet), (2004-2007)

- Preformed alien plant removal contracts for family business as a supervisor of a team varying from 2 – 8 men.
- Was responsible for the identification and eradication of alien plant species, application of herbicide and preservation of protected species.

Qualifications

BSc, (majored in Botany and Biochemistry, (2001-2005)
BSc Honours - Botany (Environmental Management), (2006-2007)
MSc Entomology (Biological Control) - Passed

A GIS analysis of the dominant aquatic alien macrophytes and a baseline assessment of the macroinvertebrates associated with *Myriophyllum spicatum* L. in the Vaal River.

The MSc was conducted on the *Myriophyllum spicatum* L. infestation in the Vaal River. It focused on the observed switch of Alternate Stable States, from a floating plant (water hyacinth) dominated state, to a submerged aquatic alien plant (*M. spicatum*) dominated stable state.

This study required GIS analysis of satellite imagery to determine when and where the switch in dominance occurred, and how this new state would impact the future control of water hyacinth and *M. spicatum* by Working for Water teams.

Additional analysis was conducted on how the water and sediment nutrient levels could have been affected by the change in dominance. An insect faunal survey was also conducted to determine how indigenous insects were impacting and limiting the spread of *M. spicatum*. It was envisaged that this baseline study would allow the Rhodes Department of Entomology to quantify the impact that future biological control agents would have on the existing *M. spicatum* population.

Additional Short Courses Completed

- Biological Control Short Course – Prof Martin Hill, Rhodes University February 2010.
- ArcGIS Short Course – Prof Gillian McGregor, Rhodes University, April 2010.
- Project Management Course – Chris Upfold - April 2008
- EIA Course – Rhodes University – Pass (Highly Competent) (Nov 2008)
- CES Courses
    - Financial Management of Projects (Oct 2008)
    - Basic Assessments (Oct 2008)
- Wetland Delineation and Assessment Short Course – Pass (Sep 2009)
- Biological Control Short Course – Pass (February 2010)
- Conservation Coaches Short Course – Pass (February 2018)

Presentations and Posters:

- Twenty-one presentations given on behalf of CapeNature while working as a Land Use Scientist and as a Landscape Conservation Intelligence Manager.
    - These were presented to a wide range of stakeholders, as well as fellow scientists and members of the public. Both in person and virtually on MS Teams and Zoom platforms.
    - Facilitated seventeen different large-scale workshops for various CapeNature conservation orientated products.

- Constructed wetlands and their efficiency for wastewater treatment, Nelson Mandela Metropolitan University. March 2006
- Mapping the *Myriophyllum spicatum* infestation in the Vaal River and its implications for biocontrol. Weeds Workshop Conference 30th August -3rd September 2010.
- A baseline study of the insects associated with an infestation of *Myriophyllum spicatum* L. in the Vaal River. Entomology Society (3rd – 6th July 2011)
- A GIS analysis of the macrophytes in the Vaal River and a baseline survey of the invertebrates associated with Myriophyllum spicatum. Weeds Workshop (6th – 9th July 2011)

References

Mr Garth Mortimer

CapeNature (now working for Caledonian Climate)

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Mr Mbulelo Jacobs

CapeNature

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Dr Ernst Baard

CapeNature

Position: Executive Director: Conservation Operations

Telephone Number: 082 414 0424

Email: ebaard@capenature.co.za

APPENDIX 3 - DRAFT MONITORING PLAN

- • **Contents**

- **RESPONSIBLE PERSON**
- **Appointment:**

A SACNASP-registered scientist must be appointed to oversee and conduct monitoring activities requiring specialist input or analysis.

- **Monitoring Schedule:**
    - o **Before Construction**: Conduct baseline monitoring.
    - o **During Construction**: Perform monitoring monthly.
    - o **Post-Construction**: Conduct monitoring annually, or as recommended by the scientist after the first operational phase monitoring report.
- **Duties:**
    - o Conduct site inspections, collect water quality samples, and perform fixed-point photography.
    - o Analyze the results and compile a brief report detailing compliance levels and recommendations.
    - o Submit the report to the relevant authorities.

- **MONITORING POINTS**
- **Identification and Marking:**

Establish permanent and clearly mark (or GPS point) three monitoring points:

1. Upstream: To provide background conditions unaffected by the development.
2. At the mine: To assess direct impacts of runoff.
3. Downstream: To evaluate the cumulative effects of the development.

- **Documentation:**

Use fixed-point photography to create a visual record at each monitoring point, supporting observational notes.

- **MONITORING FREQUENCY**
    - Baseline Data: Collect data before any commencement on site.
    - During Construction: Conduct monitoring monthly.
    - Operational Phase: Conduct monitoring annually, or as advised by the scientist following initial reporting.

- **VARIABLES TO MEASURE**

Water Quality

Test for parameters such as:

- Total Suspended Solids (mg/l)
- Nitrate Nitrogen (mg/l as N)
- Nitrite Nitrogen (mg/l as N)
- Ammonia Nitrogen (mg/l as N)
- Ortho Phosphate (mg/l as P)
- E. coli (count per 100 ml)
- Ammonium (mg/l as N)
- Total Kjeldahl Nitrogen (mg/l as N) – not that important
- Total Phosphate (mg/l as P)
- Total Residual Chlorine (µg/L) – not that important
- Free chlorine (mg/l) – not that important
- EC
- pH
- COD
- and any specific pollutants like hydrocarbons or heavy metals.

- Sample Collection: Use sterilized bottles for sample collection and ensure samples are analyzed in an accredited laboratory.
- On-Site Testing: Utilize field kits for measuring pH, DO, and temperature.

Flow Patterns

Observations: Note whether water is present, its level, and its movement (e.g., standing, slow, fast flow).

Visual Observations: Regularly observing water levels and flow patterns at specific points along the watercourse can provide insights into any noticeable changes. You can use simple markers like stakes or painted rocks at key locations to track water levels over time.

Erosion and Sedimentation

- Visual Inspections: Check for signs of erosion, bank instability, and sediment accumulation.
    - Control Structures: Inspect sediment control measures and stormwater outlets for functionality.
    -

Vegetation

- Invasive Species: Identify any alien invasive plants and document any encroachment into buffer zones.
- Habitat Condition: Record signs of vegetation degradation or habitat change.

- **REPORTING AND ADAPTIVE MANAGEMENT**
    - **Record-Keeping:**

Maintain a detailed logbook (e.g., Excel spreadsheet) of all monitoring activities, including:

o Weather conditions o Observations o Collected data

Photographic Records: Take regular photographs from fixed points to observe any changes in flow characteristics, water clarity, and the presence of sediment.

- **Reporting Schedule:**

  o During Construction: Submit quarterly reports. o Post-Construction: Submit annual reports.

- **Report Content:**

  o Analysis of trends o Photographs o Deviations from baseline conditions o Recommendations for corrective actions

- **Non-Compliance Response:**

  o Notify authorities immediately upon identifying non-compliance. o Consult with the SACNASP scientist to determine corrective measures. o Implement actions to rectify issues and achieve compliance within one week.

- • **ADAPTIVE MANAGEMENT**
    - **Additional Measures:**

If necessary, and only after consultation with the scientist/ authorities, implement additional controls, such as: o Installing sediment traps o Adjusting stormwater management structures o Reinforcing erosion control mechanisms

- **Plan Review:**

Reassess the effectiveness of monitoring and mitigation measures and update the plan as needed, in consultation with aquatic specialists.

- **Stakeholder Communication:**

Engage with relevant stakeholders and authorities if significant impacts occur and collaborate on solutions.

APPENDIX 4 -SPECIALIST DECLARATION

Specialist Company Name:	Upstream Consulting			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	NA
Specialist name:	Colin Fordham			
Specialist Qualifications:	M.Sc. – Entomology (Biological Control) B. Sc. (Hons) - Botany (Environmental Management) B.Sc. – Botany and Biochemistry SACNASP registered Professional Wetland Scientist			
Professional affiliation/registration:	Colin Fordham is a SACNASP registered Professional Natural Scientist (Pr. Sci. Nat.) Ecologist with 14 years of experience in the environmental and conservation sectors.			
Physical address:	25 Blommekloof Street, George			
Postal address:	25 Blommekloof Street, George			
Postal code:	6530	Cell:	0648575560	
Telephone:		Fax:		
E-mail:	Colin@upstreamconsulting.co.za			

DECLARATION BY THE SPECIALIST

I, __Colin Fordham_________________________________, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority 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 the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist
Name of Company: Upstream Consulting
DATE: 26/06/2026
Project: Moordkuil River Pumpstation Upgrade

APPENDIX 5 -SITE SENSITIVITY VERIFICATION REPORT (SSVR)

Site verification report – Aquatic Ecology

Government Notice No. 645, dated 10 May 2019, includes the requirement that an Initial Site Sensitivity Verification Report must be produced for a development footprint. As per Part 1, Section 2.3, the outcome of the Initial Site Verification must be recorded in the form of a report that-

(a) Confirms or disputes the current use of the land and environmental sensitivity as identified by the national web based environmental screening tool;
(b) Contains a motivation and evidence of either the verified or different use of the land and environmental sensitivity;
(c) Is submitted together with the relevant reports prepared in accordance with the requirements of the Environmental Impact Assessment Regulations.

This report has been produced specifically to consider the aquatic ecology theme and addresses the content requirements of (a) and (b) above. The report will be appended to the respective specialist study included in the BAR Reports produced for the projects.

Site sensitivity based on the aquatic biodiversity theme included in the Screening Tool and specialist assessment

Based on the DFFE Screening Tool, the pump station and its associated infrastructure, as well as one of the site camps construction footprints, are located within an area of Very High aquatic biodiversity sensitivity (Figures 1 and 2). The DFFE Screening Tool indicates that the drainage features within the study area are assigned a Very High aquatic biodiversity sensitivity rating due to the presence of the CBA Estuary, CBA River, Estuary, Estuary_Klein Brak and Rivers sensitivity features. Consequently, the project required an assessment of potential impacts on aquatic biodiversity in accordance with the applicable NEMA Environmental Impact Assessment Regulations and associated protocols.

MAP OF RELATIVE AQUATIC BIODIVERSITY THEME SENSITIVITY

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity
Very High	CBA: Estuary
Very High	CBA: River
Very High	Estuary
Very High	Estuary_Klein Brak
Very High	Rivers

Figure 1: DFFE Screening Tool results for the Moordkuil Pumpstation and its associated infrastructure.

MAP OF RELATIVE AQUATIC BIODIVERSITY THEME SENSITIVITY

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity
Very High	CBA: River
Very High	Rivers

Figure 2: DFFE Screening Tool results for the proposed site camp locations.

The site verification assessment was undertaken and submitted to the client. The Very High aquatic biodiversity sensitivity rating for the sites was confirmed. Based on the DFFE Screening Tool, the various sites are located within areas of Very High sensitivity due to the presence of CBA River and Rivers features.

The site verification specialist findings were informed by a site visit undertaken on the 28th of February 2024. The photographs within Plates 1 and 2 below show the various aquatic features present on site. This information was then compared to current wetland inventories, 1: 50 000 topocadastral surveys mapping and the site. A baseline map was then developed (Figures 1 and 2).

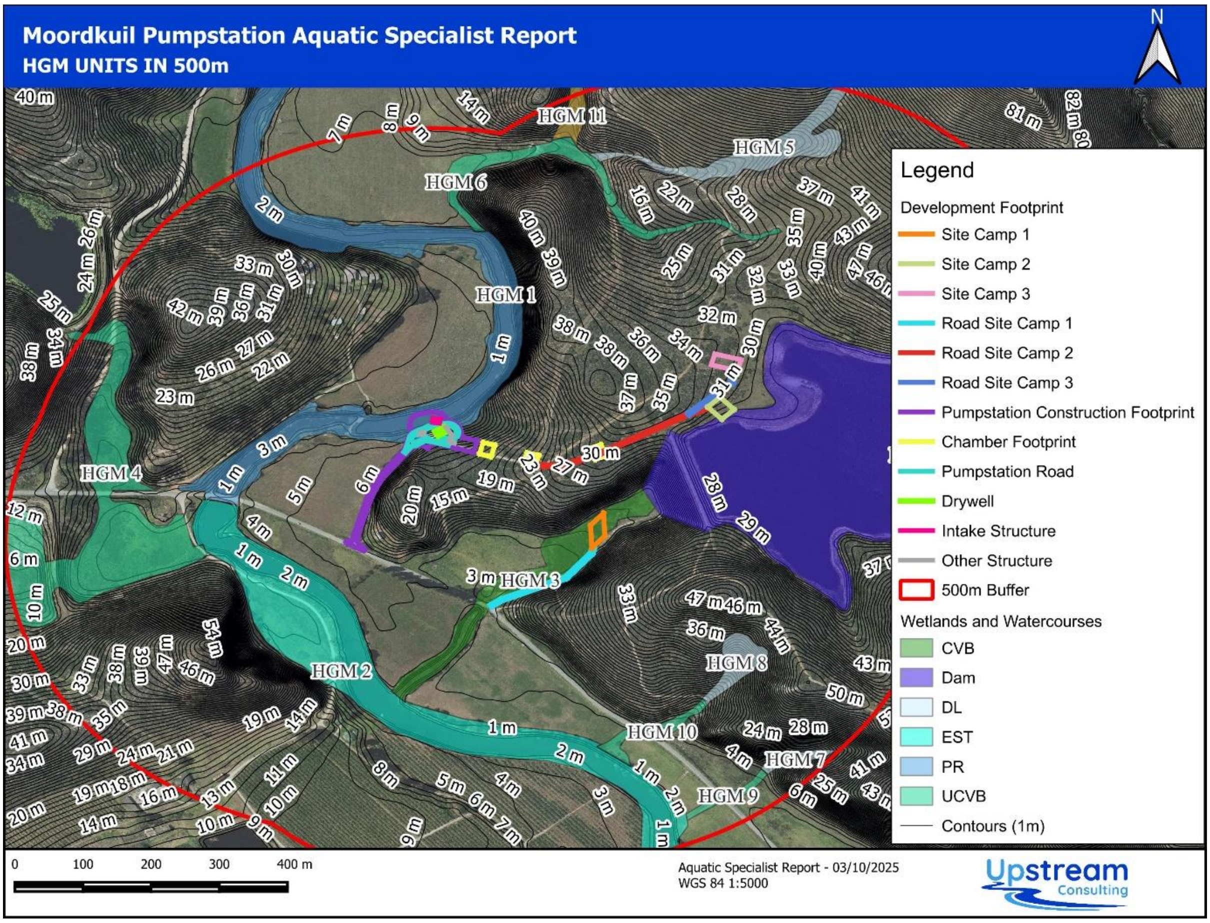

Figure 3: Delineated aquatic habitat within the study area

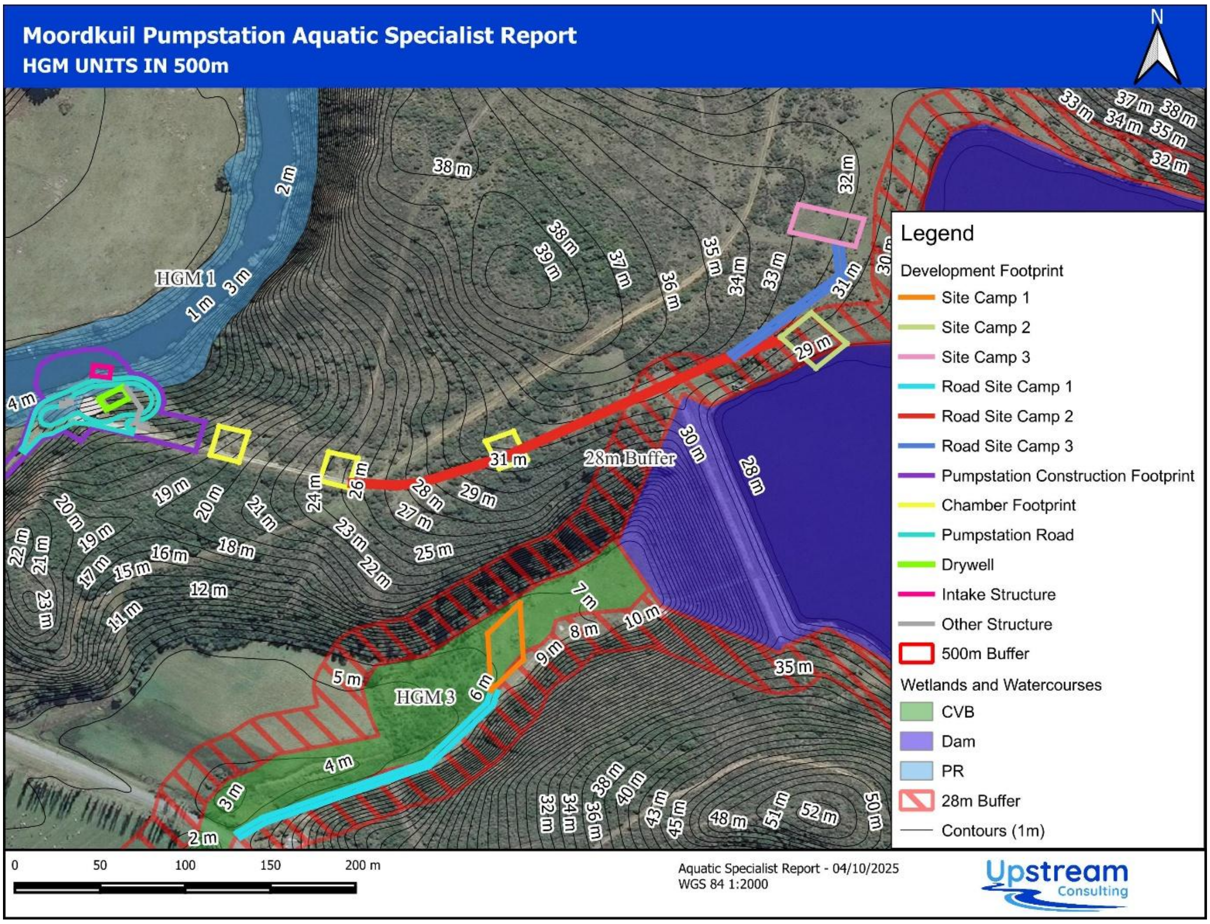

Figure 4: Delineated aquatic habitat within the study area, with buffer areas.

Plate 1: A photograph of the Moordkuil River from which the pumpstation abstracts water.

Plate 2: A photograph of the Moordkuil River from the weir looking upstream at the pumpstation to be upgraded.

<u>Motivation of the outcomes of the sensitivity map and key conclusions</u>
In conclusion, the DFFE Screening Tool resulted in Very High sensitivity ratings within the development footprint, and surrounding area, CBA 1 River and Rivers features were confirmed on site. The site should be assessed as sensitive with regards to aquatic biodiversity due to these aspects

It is recommended that a full Aquatic Biodiversity Impact Assessment is undertaken for the project.

The environmental sensitivity input received from the aquatic ecology specialist will be taken forward and considered within the formal EA process and the impact to these areas assessed. Appropriate layout and development restrictions will be implemented within the development footprint to ensure that the impact to aquatic ecology is deemed acceptable by the aquatic ecologist.