Proposed Hartland II School and Hospital Development, RE/219, Vaale Valley, Western Cape.

Aquatic Biodiversity Specialist Assessment

Prepared For: Sharples Environmental Services

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- I consider myself bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP);
- At the time of conducting the study and compiling this report I did not have any interest, hidden or otherwise, in the proposed development that this study has reference to, except for financial compensation for work done in a professional capacity;
- Work performed for this study was done in an objective manner. Even if this study results in views and findings that are not favourable to the client/applicant, I will not be affected in any manner by the outcome of any environmental process of which this report may form a part, other than being members of the general public;
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- All the particulars furnished by me in this document are true and correct.

Specialist: Dr. James Dabrowski (Ph.D., Pr.Sci.Nat. Water Resources)

Date: 27 January 2026

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Confluent Environmental was appointed by Sharples Environmental Services (SES) to undertake an aquatic biodiversity assessment for the proposed development of a university, school and hospital on the Remainder of Farm 219 Vaale Valley (RE/219), near Mossel Bay, Western Cape. The scope of work for this report is guided by the legislative requirements of the National Environmental Management Act (NEMA) and the National Water Act (NWA).

1.1 National Environmental Management Act

According to the protocols specified in GN 1540 (Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in Terms of Sections 24(5)(A) and (H) and 44 of the National Environmental Management Act, 1998, when Applying for Environmental Authorisation), assessment and reporting requirements for aquatic biodiversity are associated with a level of environmental sensitivity identified by the national web-based environmental screening tool (screening tool). An applicant intending to undertake an activity identified in the scope of this protocol on a site identified by the screening tool as being of:

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

The screening tool classified the site as being of **Low** aquatic biodiversity. According to the protocol, a site sensitivity verification must be undertaken to confirm the sensitivity of the site as indicated by the screening tool.

1.2 Scope of Work

The objectives of this assessment included the following:

- To undertake a desktop analysis and site inspection to verify the sensitivity of aquatic biodiversity; and
- Compile a site sensitivity verification report for aquatic biodiversity for the proposed development footprint.

2. APPROACH

The determination of the site sensitivity relied upon the following approaches:

- Interrogation of available desktop resources including:
  - DWS spatial layers;
  - National Freshwater Ecosystem Priority Areas (NFEPA) spatial layers (Nel et al., 2011);
  - National Wetland Map 5 and Confidence Map (CSIR, 2018); and
  - Western Cape Biodiversity and Spatial Plan (WCBSP) for Mossel Bay (CapeNature, 2017).
- A site visit was undertaken, during which time the following activities were undertaken:

- Identification and classification of watercourses within the footprint of the site according to methods detailed in Ollis et al. (2013);
- Soil augering to confirm the presence of soil indicators (DWAF, 2005) that may indicate the presence of a wetland (if applicable); and
- Identification of hydrophilic plant species that may indicate the presence of wetland plant species (if applicable).

3. ASSUMPTIONS & LIMITATIONS

- The site visit represents a brief temporal snapshot of conditions on the site. Changes in season or short-term changes in climatic conditions may possibly result in the formation of aquatic habitats (e.g. temporary or seasonal wetlands) under significantly wetter conditions. Despite this limitation the sensitivity of aquatic biodiversity on the site was determined with a very high level of confidence.

4. DESKTOP SURVEY

RE/219 is located within Primary Catchment K (Kromme) between the towns of Klein-Brak and Hartenbos and is located in quaternary catchments K10B, which forms part of the Breede-Olifants Catchment Management Area (Figure 1). The main river draining the catchment is the Hartenbos River, which originates from the lower foothills of the Outeniqua Mountains to the north-east. The catchment area is relatively small, draining and area of approximately 205 km^2. The entire catchment falls within the Southern Coastal Belt ecoregion which is generally characterised by undulating plains and mountains of moderate relief (0- 500 m a.m.s.l.). The mean annual rainfall is 446 mm, with the majority occurring during the winter months.

The project area of interest (PAOI) (i.e. the proposed development footprint) is located immediately west of the R102 and covers a relatively small portion of the larger farm portion. A non-perennial drainage line is mapped to run through the southern section of the property and also runs through the proposed development area (Figure 2). A large proportion of the property has been transformed into agricultural fields, while the remainder of the property is undeveloped and is mapped as critically endangered Garden Route Granite Fynbos. The proposed development footprint falls entirely within a transformed agricultural area.

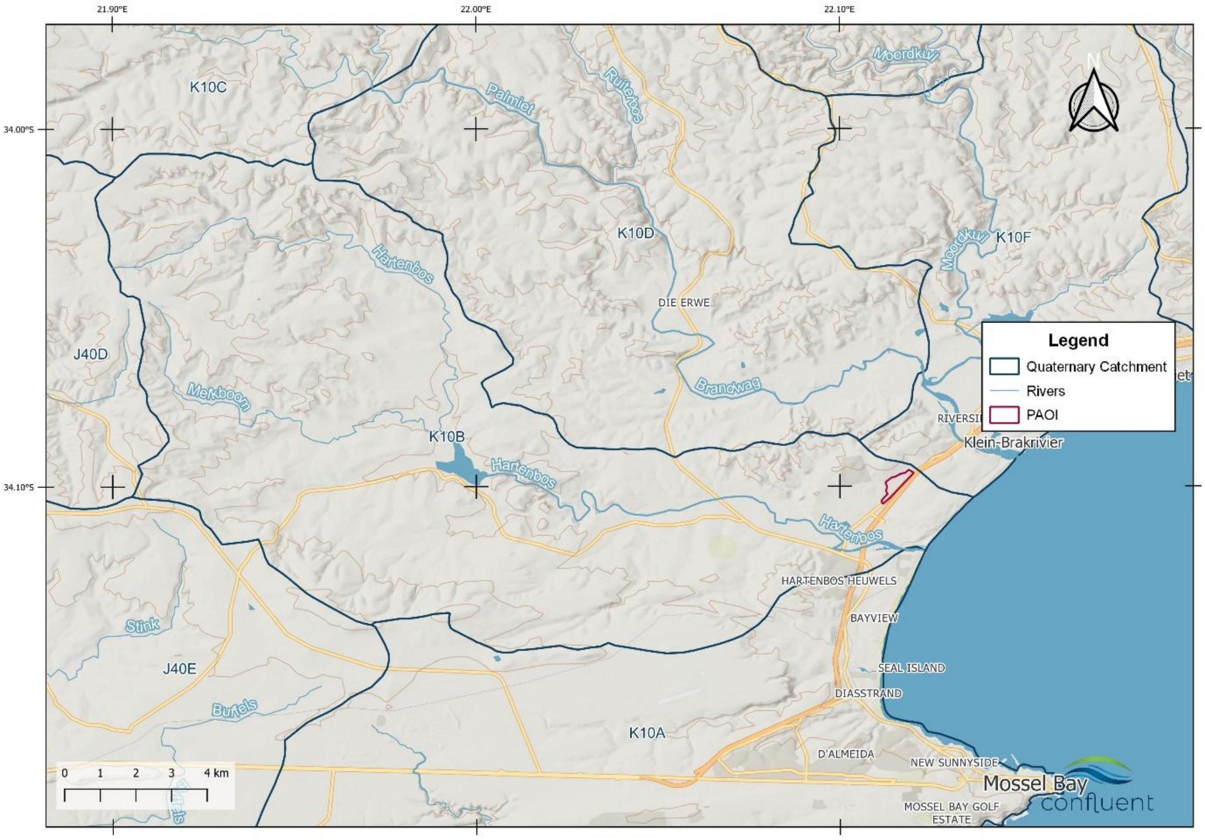

Figure 1: Map indicating the location of the Project Area of Interest (PAOI).

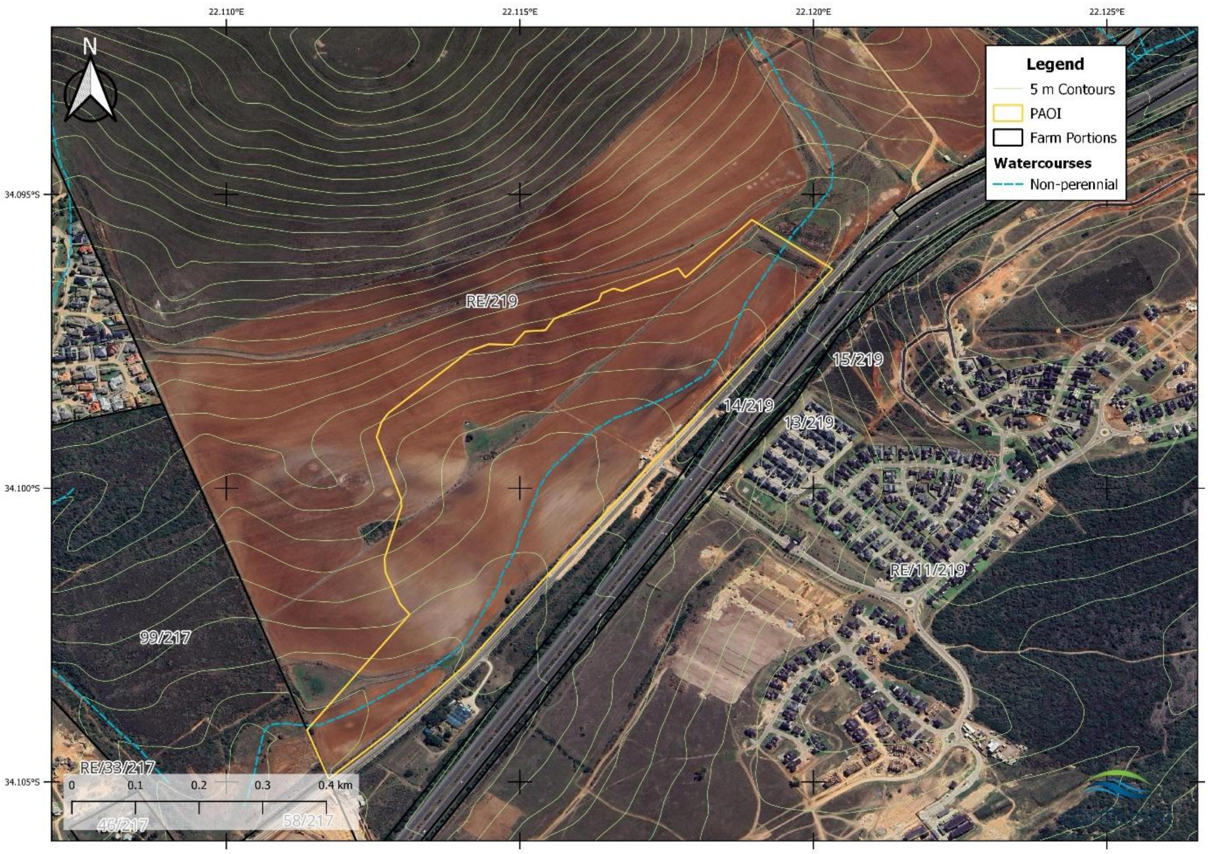

Figure 2: Location of the property and the development footprint in relation to mapped freshwater features.

4.1 Western Cape Biodiversity Spatial Plan

The main purpose of a biodiversity spatial plan is to ensure that the most recent and best quality spatial biodiversity information can be accessed and used to inform land use and development planning, environmental assessments and authorisations, natural resource management and other multi-sectoral planning processes. The WCBSP plan achieves this by providing a map of terrestrial and freshwater areas that are important for conserving biodiversity pattern and ecological processes – these areas are called Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs). No aquatic features have been identified as CBAs or ESAs, which indicates that no aquatic features have been identified as being important for the conservation of aquatic biodiversity or supporting ecological process. (Figure 3).

Figure 3: Map of the development footprint in relation to the 2023 Western Cape Biodiversity Spatial Plan (WCBSP).

5. SITE VISIT

The PAOI was traversed by vehicle and by foot on the 7th of October 2024. The PAOI covers a gently sloping valley, through which the non-perennial watercourse is mapped to run. The site visit confirmed that the entire PAOI was cultivated with wheat and no obvious watercourse was observed (Figure 4A & B). Historical Google Earth satellite imagery confirms that the entire PAOI has been cultivated since at least 2005 (the year of the earliest available image - Figure 5). A dam is located to the north-west of the PAOI and receives water from a stormwater headwall outlet (presumably draining the R102) as well as from a gently sloping valley that drains the low hills to the north (Figure 4C and D). The non-perennial drainage line is mapped to run through this valley, however there is no distinct channel upstream of the dam and the entire area has been transformed for cultivation and an ostrich camp. Flow paths indicating flow of water along the valley bottom downstream of the dam are only visible in historical aerial images taken during wetter periods (e.g. when the dam periodically overflows – see Figure 5 - 2018). These images also show excavated channels which are presumably dug to drain the fields during these wetter periods (see Figure 5 – 2013). Intermittent flows ultimately flow into a small dam on the western boundary of the property (Figure 4F). Beyond the property boundaries, the watercourse drains along a very poorly defined channel and into a stormwater drainage network that presumably discharges into the Hartenbos Estuary. While the PAOI is regularly ploughed and planted, it is clear that the valley is a low point in the landscape and that permanent, non-perennial aquatic features are likely to re-establish should ploughing of the fields cease. The dam was not full at the time of the visit but did host dense reed beds (mainly *Typha capensis*) and a variety of wetland bird species were utilising the dam.

Figure 4: Photographs showing cultivated wheat fields along the entire extent of the PAOI (A and B); the larger dam to the east (C [stormwater outlet circled in red] and D), the smaller dams to the north (E) and west (F).

A smaller dam is located along the northern boundary (Figure 4E) and is fed by surface runoff from the hills to the north as well as from a scour valve that drains a Petro SA water line that runs through the property. The dam is densely vegetated (predominantly by kikuyu) and appears to be only temporarily inundated following scouring of the pipeline and serves more of an attenuation function as opposed to a storage function.

Figure 5: Selection of historical Google Earth images showing cleared, ploughed fields within the PAOI (2024 and 2022), and signs of periodic flow through the fields (2018) and a linear excavated trench to drain the fields (2013).

5.1 Present Ecological State

As illustrated in Figure 5, at most times of the year, the entire watercourse is ploughed over and covered by wheat crop (as was the case during the site visit). The bed and banks of the watercourse have therefore been entirely transformed to accommodate agricultural crops. A channel resembling a watercourse is only visible during wetter periods, when surface runoff erodes a linear drainage line through the field. Channels are periodically excavated in order to drain water from the field. Riparian vegetation has been completely removed and has been replaced by seasonal agricultural crops. The PES is **E – Seriously Modified** - the loss of natural habitat, biota and basic ecosystem functions is extensive (Table 1).

Table 1: Scores attributed to modifications used to assess the Present Ecological State (PES) of the watercourse.

Modification	Scores
Instream Habitat	
Water abstraction	**15 –** Abstraction from instream dam
Flow modification	**15 –** Flow regulated by a dam in the catchment area.
Bed modification	**22 –** Entire riverbed seasonally transformed into cultivated agriculture
Channel modification	**22 –** River channel seasonally transformed into cultivated agriculture
Physico-chemical modification	**15 –** Agricultural runoff (salts, fertilisers and pesticides)
Inundation	**0 –** None
Alien macrophytes	**0** – None
Alien aquatic fauna	**0** - None
Rubbish dumping	**0 –** None
Instream IHI score	**32 (E – Seriously Modified)**
Riparian Habitat	
Vegetation removal	**22** – Riparian habitat removed
Invasive vegetation	**16** – Riparian vegetation replaced by agricultural crops
Bank erosion	**0 -** None
Channel modification	**22 –** River channel seasonally transformed into cultivated agriculture
Water abstraction	**3** – Minimal impacts on riparian vegetation.
Inundation	**0 –** None
Flow modification	**0** – Moderately affected.
Physico-chemical modification	**0 –** None
Riparian IHI Score	**26 (F – Critically Modified)**
Combined Score	**30 (E – Seriously Modified)**

5.2 Ecological Importance and Sensitivity

The watercourse is only visible during wetter periods and the main function is to convey intermittent flows to downstream habitats. The watercourse provides no permanent habitat for aquatic biota and does not host any unique or endangered aquatic biota. The watercourse offers no migration route or refuge for instream and riparian biota. The watercourse is not important at any scale for supporting aquatic biodiversity and is not sensitive to changes in flow or water quality. The EIS is therefore **Low** (Table 2).

Table 2: Scores attributed to determinants used to assess the Ecological Importance and Sensitivity (PES) of the watercourse.

Determinant	Score
Presence of Rare & Endangered Species	**0** – No rare or endangered taxa at any scale.
Populations of Unique Species	**0 –** No populations of unique species.
Intolerant Biota	**0** – Rarely if any biota expected with any dependence on flowing water.
Species/Taxon Richness	**1** - Not significant at any scale.
Diversity of Habitat Types or Features	**1** – Not significant at any scale.
Refuge value of habitat types	**1** – Not significant at any scale.
Sensitivity of habitat to flow changes	**1** – Intermittent flow – not sensitive to flow changes.
Sensitivity to flow related water quality changes	**1** – Intermittent flow – not sensitive to water quality changes.
Migration route for instream and riparian biota	**0** – The stream delineation is not of any importance in terms of connectivity for the survival of biota upstream and downstream.
Protection Status	**0** – Not important at any scale
EIS Score	**2 (Moderate Importance and Sensitivity)**

5.3 Sensitivity Mapping

Buffer zones have been defined as a strip of land with a use, function or zoning specifically designed to act as barriers between human activities and sensitive water resources with the aim of protecting these water resources them from adverse negative impacts. Buffer zones are regarded as possibly the most effective means of mitigating impacts of adjacent anthropogenic land use activities on aquatic ecosystems. Considering the watercourse does periodically flow, a recommended buffer width was determined in order to protect the watercourse from construction and operational phase impacts and most importantly, mitigate against pollution and sedimentation of more sensitive downstream habitats. The buffer was estimated based on buffer zone guidelines developed by Macfarlane and Bredin (2017). These guidelines estimate required buffer zone widths based on a combination of input parameters which include, *inter alia*, the nature of the activity and associated impacts, basic climatic and soil conditions. Relevant input parameters used to determine the width of the buffer are provided in Table 3. A recommended buffer width of 15 m was determined for the watercourse.

Table 3: Input parameters used to determine the buffer width for watercourses identified in or adjacent to the PAOI.

Input Parameter	Value
MAP	446
Rainfall Intensity	48 – Zone 2 (Moderate)
Soil SCS	C
Slope of Catchment	Gentle (2 – 10 %)
Slope of Buffer	Gentle (2 – 10 %)
Soil erosion potential	0.39 – 0.5 (Moderate)
Vegetation Characteristics	Poor
Soil Permeability	High
Buffer Width	15 m

6. SITE DEVELOPMENT PLAN

The proposed site development plan (SDP) is indicated in Figure 6. The entire development footprint is approximately 26.83 ha and will comprise a university campus (3.1 ha), secondary school (12.56 ha), a hospital (8.06 ha) and associated roads and services (bulk water supply, sewage reticulation etc.). The footprint will cover the non-perennial watercourse. A diversion would therefore be required to route intermittent flows around the development. The most likely route would be immediately adjacent to the R102 (i.e. to the east of the proposed development).

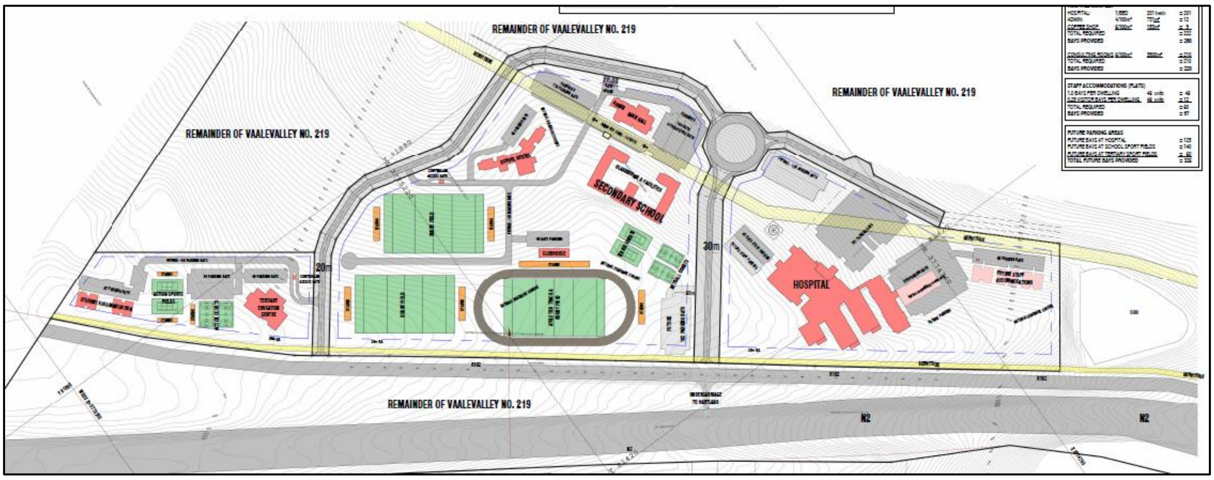

Figure 6: Proposed site development plan (SDP) for Hartland II.

7. IMPACT ASSESSMENT

7.1 Layout Phase

Impact 1: Impact of diversion of watercourse on instream habitat and aquatic biota

The development footprint will require that seasonal, intermittent flows through the watercourse are diverted around the development footprint area. This will require the establishment of a new diversion channel. Given the highly transformed nature of the watercourse and the very low importance of the watercourse for hosting aquatic biodiversity, the diversion of the watercourse through an artificial channel is not considered as a high intensity impact. The main purpose would be to ensure that intermittent flows continue to be conveyed to downstream habitats. A diversion channel would achieve this purpose and would have negligible impacts on aquatic biodiversity.

	Without Mitigation	With Mitigation
Intensity	Negligible	Negligible
Duration	Permanent	Permanent
Extent	Limited	Limited
Probability	Unlikely	Unlikely
Significance	**-30 (Negligible)**	**-30 (Negligible)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- Creation of a diversion channel/swale must be prioritised during the early phase of the project so that intermittent flows do not flow through an active construction site.

Impact 2: Impact of diversion channel on erosion and sedimentation A new diversion channel would receive intermittent flows as well as increased stormwater flows from the development. The diversion channel must be designed to accommodate these flows and to prevent erosion of the diversion channel and sedimentation of downstream habitat.		
	Without Mitigation	**With Mitigation**
Intensity	Moderate	Low
Duration	Permanent	Permanent
Extent	Limited	Very limited
Probability	Likely	Unlikely
Significance	**-65 (Minor)**	**-33 (Negligible)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- Permeable check dams (e.g. rock-filled gabions) can be incorporated into the design of the diversion channel/swale to slow surface flows and attenuate stormwater runoff that is likely to originate from the development area;
- The banks must be sloped (1:4 vertical to horizontal) and must be vegetated with an indigenous grass mix to avoid erosion of the bed and banks and sedimentation of downstream habitats;
- Culverts beneath road crossings must be appropriately sized (i.e. must be sized according to the natural width of the channel) and must not result in concentrated, high energy flow downstream of the crossing. Stormwater flows must not be channelled to a narrower section of the channel. In this respect box culverts are recommended.
- Stream bed and bank protection must be incorporated below road crossings. The diversion channel should be buffered by a 15 m buffer which must be vegetated with and indigenous grass mix.

7.2 Construction Phase

Impact 3: Clearing of vegetation causing erosion and sedimentation of aquatic habitat The newly established channel while unnatural – will convey surface runoff from the development footprint to areas downstream of the development footprint. Mitigation must therefore focus on preventing eroded soil and sediment from the construction site washing into the diversion channel.		
	Without Mitigation	**With Mitigation**
Intensity	Moderate	Low
Duration	Short term	Short term
Extent	Limited	Very limited
Probability	Likely	Unlikely
Significance	**-45 (Minor)**	**-21 (Negligible)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- The 15 m buffer must be demarcated, and, apart from access to the construction site over the diversion channel, must be considered as a no-go area;
- Silt fencing must be installed along the length of the outside of the buffer (i.e. 15 m away from the edge of the channel);

- Ensure that vegetation clearing is conducted in parallel with the construction progress to minimise erosion and runoff;
- Revegetate exposed areas once construction has been completed'
- Ensure that stormwater and runoff generated by hardened surfaces is discharged into retention areas (i.e. swales or retention ponds), to avoid concentrated runoff and associated erosion; and
- Stockpiling must take place outside of the designated buffer. All stockpiles must be protected from erosion, surrounded by bunds and stored on flat areas where run-off will be minimised.

Impact 4: Pollution of diversion channel caused by construction activities.

The newly established channel while unnatural – will convey surface runoff from the development footprint to areas downstream of the development footprint. Mitigation must therefore focus on preventing contamination of the diversion channel with pollutants originating from the construction site.

	Without Mitigation	With Mitigation
Intensity	Moderate	Low
Duration	Short term	Short term
Extent	Limited	Very limited
Probability	Likely	Unlikely
Significance	**-45 (Minor)**	**-21 (Negligible)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- The 15 m buffer must be demarcated, and, apart from access to the construction site over the diversion channel, must be considered as a no-go area;
- Restrict vehicle access to single points that are clearly demarcated;
- Working areas must be clearly demarcated and no vehicle access or disturbance must take place outside of demarcated areas;
- Excavators and all other machinery and vehicles must be checked for oil and fuel leaks daily. No machinery or vehicles with leaks are permitted to work in any natural or artificial watercourse;
- No fuel storage, refuelling, vehicle maintenance or vehicle depots to be allowed within the buffer of the watercourse;
- Refuelling and fuel storage areas, and areas used for the servicing or parking of vehicles and machinery, must be located on impervious bases and should have bunds around them (sized to contain 110 % of the tank capacity) to contain any possible spills;
- Contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly;
- Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel throughout the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation) and must be routinely serviced; and
- No dumping of construction material on-site may take place.

7.3 Operational Phase

Impact 5: Impact of stormwater runoff on the erosion and sedimentation of the diversion channel Increased surface runoff from impermeable surfaces results in the input of high volumes of water at high velocity, which can lead to erosion of the diversion channel and sedimentation of downstream habitats.		
	Without Mitigation	**With Mitigation**
Intensity	Moderate	Low
Duration	Permanent	Permanent
Extent	Limited	Very limited
Probability	Likely	Unlikely
Significance	**-65 (Minor)**	**-33 (Negligible)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- Implementation of additional SuDS measures is required to attenuate stormwater onsite and reduce stormwater impacts to an appropriate level. It is recommended that the stormwater management plan for the development should align with the City of Cape Town urban stormwater impacts policy which requires 24 hour extended detention of the 1-year return interval, 24-hour storm event. In addition to rainwater harvesting (which will be implemented as part of the stormwater management plan) the following must, inter alia, be considered:
- Swales and detention ponds can be incorporated into the open space network to attenuate stormwater runoff, encourage infiltration and reduce the speed, energy and volumes at which stormwater is discharged from the site;
- Use of permeable paving to encourage infiltration into the soil;
- Use of retention ponds and artificial wetlands to capture stormwater runoff and prevent its discharge from the site; and
- Discharge headwalls at the ends of stormwater pipes must be equipped with stilling basins and erosion protection to decrease storm water velocities, spread the flows and prevent erosion at the outlets.

8. DWS RISK ASSESSMENT

Risks of activities associated with the proposed development were determined according to the risk assessment matrix developed as part of GN 4167 of 2023 (Section 21 (c) and (i) water use Risk Assessment Protocol) - Table 4. The first stage of the risk assessment is the identification of environmental activities, aspects and impacts and essentially mirror those that were identified in the impact assessment (see Section 7). The intensity of impact to receptors and resources (i.e. hydrology, water quality, geomorphology, biota and vegetation) is rated (from 0 to 5, representing negligible and very high impact, respectively), which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. Risks were then quantified based on the anticipated spatial scale, duration and likelihood of occurrence and assumed the full implementation of recommended mitigation measures described in Section 7.

Given the Seriously Modified ecological condition of the watercourse and its Low EIS, the creation of a diversion channel to accommodate the development is considered a Low risk and will have negligible impacts on aquatic biota. As specified in section 7 above, mitigation measures must be implemented to ensure that the diversion channel is not eroded or polluted due to construction activities, or due to the operation of instream (e.g. road-crossings) or stormwater infrastructure. The creation of the diversion channel together with the implementation of a 15 m buffer is likely to result in a similar, if not improved ecological function compared to that currently provided by the watercourse.

Table 4: DWS Risk Assessment for the diversion of a watercourse on the Remainder of Farm 219 Vaale Valley (RE/219)

Phase	Activity	Impact	Potentially affected watercourses: Name/s	PES	EIS	Intensity of Impact on Resource Quality – Abiotic Habitat (Drivers): Hydrology	Water Quality	Geomorph	Biota: Vegetation	Fauna	Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating (with mitigation)	Confidence level
LAYOUt & DESIGN	Diversion of non-perennial watercourse	Loss of habitat and aquatic biodiversity	Non-perennial watercourse	E	Low	1	1	1	0	0	**2**	4	5	**11**	**2**	**22**	20%	**4.4**	**L**	High
		Erosion of channel caused by poor design of channel and associated infrastructure.	Non-perennial watercourse	E	Low	1	1	1	0	0	**2**	4	5	**11**	**2**	**22**	40%	**8.8**	**L**	High
CONSTRUCTION	Clearing of vegetation	Ersosion and sedimentation of downstream habitat	Non-perennial watercourse	E	Low	1	2	1	0	0	**4**	4	2	**10**	**2**	**20**	40%	**8**	**L**	High
	Operation of vehicles	Pollution of diversion channel from spills/leaks of hydrocarbons	Non-perennial watercourse	E	Low	1	2	1	0	0	**4**	4	2	**10**	**2**	**20**	40%	**8**	**L**	High
	Sewage/sanitation services for construction workers	Pollution of diversion channel by sewage leaks/spills	Non-perennial watercourse	E	Low	1	2	1	0	0	**4**	4	2	**10**	**2**	**20**	20%	**4**	**L**	High
		Pollution caused by mixing of cement	Non-perennial watercourse	E	Low	0	1	0	1	1	**2**	4	2	**8**	**2**	**16**	20%	**3.2**	**L**	High
	Stockpiles and laydown areas	Sedimentation and pollution caused by erosion of stockpiles	Non-perennial watercourse	E	Low	0	1	0	1	1	**2**	4	2	**8**	**2**	**16**	20%	**3.2**	**L**	High
OPERATIONAL	Increased stormwater discharge from impermable surfaces	Modification of streamflow hydraulics causing scouring/erosion of bed and banks	Non-perennial watercourse	E	Low	2	2	2	1	1	**4**	4	5	**13**	**2**	**26**	40%	**10.4**	**L**	High

9. CONCLUSION

The entire PAOI below the northern dam is regularly ploughed and planted and at the time of the site visit there was no functional aquatic habitat present that supports any aquatic biodiversity. Historical aerial images do however show evidence of periodic surface flows along the former alignment of the natural drainage channel through the agricultural fields and it is likely that if agricultural activities ceased, a more prominent natural drainage channel would form. Considering the development will intersect with the current alignment of the intermittent watercourse, a diversion channel will have to be created to direct intermittent surface flows around the development.

Given the seriously modified nature of the watercourse, together with its Low EIS, the diversion of the watercourse is not considered as a significant impact to aquatic biodiversity. Nevertheless, given hydrological connectivity to downstream water resources, mitigation measures must be implemented to ensure that the diversion channel is not eroded or polluted due to construction activities or stormwater runoff. The creation of the diversion channel together with the implementation of a 15 m buffer is likely to lead result in a similar, if not improved ecological function compared to that currently provided by the watercourse.

10. REFERENCES

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APPENDIX 1 – INDEX OF HABITAT INTEGRITY

Index of Habitat Integrity (IHI; Kleynhans, 1996). The IHI was regarded as the most appropriate method for assessing riverine habitats as it is not dependent on flow in the watercourse and, therefore, produces results that are directly comparable across perennial and non-perennial systems. The IHI was developed as a rapid assessment of the severity of impacts on criteria affecting habitat integrity within a river reach. Instream (water abstraction; flow modification; bed modification; channel modification; physico-chemical modification; inundation; alien macrophytes; rubbish dumping) and riparian (vegetation removal, invasive vegetation, bank erosion, channel modification, water abstraction, inundation, flow modification, physico-chemistry) criteria are assessed as part of the index. Each of the criteria are given a score (from 0 to 25, corresponding to no and very high impact, respectively – Table 5) based on their degree of modification, along with a confidence rating based on the level of confidence in the score.

Weighting scores are used to assess the extent of modification for each criterion (*x*):

$$Weighted\ Score = \frac{IHI_x}{25} \times Weight_x$$

Where;

- IHI = rating score for the criteria (Table 5);
- 25 = maximum possible score for a criterion; and
- Weight = Weighting score for the criteria (Table 6).

Table 5: Descriptive classes for the assessment of habitat modifications (Kleynhans, 1996)

Impact Class	Description	Score
None	No discernible impact, or the modification is located in a way that has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.	1-5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability is limited.	6-10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.	11-15
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 affected.	16-20
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.	21-25

Table 6: Criteria and weights used for the assessment of instream and riparian zone habitat integrity

Instream Criteria	Weight	Riparian Zone Criteria	Weight
Water abstraction	14	Indigenous vegetation removal	13
Flow modification	13	Exotic vegetation encroachment	12
Bed modification	13	Bank erosion	14
Channel modification	13	Channel modification	12
Water quality	14	Water abstraction	13
Inundation	10	Inundation	11
Exotic macrophytes	9	Flow modification	12
Exotic fauna	8	Water quality	13
Solid waste disposal	6		
TOTAL	**100**		**100**

The estimated impacts of all criteria calculated this way are summed, expressed as a percentage and subtracted from 100 to arrive at an assessment of habitat integrity for the instream and riparian components, respectively. An IHI class indicating the present ecological state of the river reach is then determined based on the resulting score (ranging from Natural to Critically Modified – Table 7).

Table 7: Index of habitat integrity (IHI) classes and descriptions

Integrity Class	Description	IHI Score (%)
A	Unmodified, natural.	> 90
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80 – 90
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60 – 79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 – 39
F	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.	0 – 19

Reference:

Kleynhans, C.J. (1996). A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhu River (Limpopo system, South Africa) Journal of Aquatic Ecosystem Health 5:41-54 1996.

APPENDIX 2 – ECOLOGICAL IMPORTANCE & SENSITIVITY (RIVERS)

The ecological importance and sensitivity (EIS) of the watercourse was assessed using a method developed by Kleynhans (1999). In summary, several biological and aquatic habitat determinants are assigned a score ranging from 1 (low importance or sensitivity) to 4 (high importance or sensitivity). These determinants include the following:

- **Biodiversity support:**
  - Presence of Red Data species;
  - Presence of unique instream and riparian biota;
  - Use of the ecosystem for migration, breeding or feeding.
- **Importance in the larger landscape:**
  - Protection status of the watercourse;
  - Protection status of the vegetation type;
  - Regional context regarding ecological integrity;
  - Size and rarity of the wetland types present;
  - Diversity of habitat types within the wetland.
- **Sensitivity of the watercourse:**
  - Sensitivity of watercourse to changes in flooding regime;
  - Sensitivity of watercourse to changes in low flow regime, and
  - Sensitivity to water quality changes.

The median value of the scores for all determinants is used to assign an EIS category according to Table 8.

Table 8: Ecological importance and sensitivity categories. Interpretation of average scores for biotic and habitat determinants.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very high: Quaternaries/delineations that are considered to be unique on a national or even international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use.	>3 and <=4	A
High: Quaternaries/delineations that are considered to be unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases, may have a substantial capacity for use.	>2 and <=3	B
Moderate: Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually not very sensitive to flow modifications and often have a substantial capacity for use	>1 and <=2	C
Low/marginal: Quaternaries/delineations that are not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have a substantial capacity for use.	>0 and <=1	D

Reference:

Kleynhans, C.J. (1999). Resource Directed Measures for Protection of Water Resources: River Ecosystems. R7: Assessment of Ecological Importance and Sensitivity.

APPENDIX 3: IMPACT ASSESSMENT METHODOLOGY

Individual impacts for the construction and operational phase were identified and rated according to criteria which include their intensity, duration and extent. The ratings were then used to calculate the consequence of the impact which can be either negative or positive as follows:

Consequence *= type x (intensity + duration + extent)*

Where type is either negative (i.e. -1) or positive (i.e. 1). The significance of the impact was then calculated by applying the probability of occurrence to the consequence as follows:

Significance *= consequence x probability*

The criteria and their associated ratings are shown in Table 9.

Table 9: Categorical descriptions for impacts and their associated ratings

Rating	Intensity	Duration	Extent	Probability
1	Negligible	Immediate	Very limited	Highly unlikely
2	Very low	Brief	Limited	Rare
3	Low	Short term	Local	Unlikely
4	Moderate	Medium term	Municipal area	Probably
5	High	Long term	Regional	Likely
6	Very high	Ongoing	National	Almost certain
7	Extremely high	Permanent	International	Certain

Categories assigned to the calculated significance ratings are presented in Table 10.

Table 10: Value ranges for significance ratings, where (-) indicates a negative impact and (+) indicates a positive impact

Significance Rating	Range	
Major (-)	-147	-109
Moderate (-)	-108	-73
Minor (-)	-72	-36
Negligible (-)	-35	-1
Neutral	0	0
Negligible (+)	1	35
Minor (+)	36	72
Moderate (+)	73	108
Major (+)	109	147

Each impact was considered from the perspective of whether losses or gains would be irreversible or result in the irreplaceable loss of biodiversity of ecosystem services. The level of confidence was also determined and rated as low, medium or high (Table 11).

Table 11: Definition of reversibility, irreplaceability and confidence ratings.

Rating	Reversibility	Irreplaceability	Confidence
Low	Permanent modification, no recovery possible.	No irreparable damage and the resource isn't scarce.	Judgement based on intuition.
Medium	Recovery possible with significant intervention.	Irreparable damage but is represented elsewhere.	Based on common sense and general knowledge
High	Recovery likely.	Irreparable damage and is not represented elsewhere.	Substantial data supports the assessment