APPENDIX H: WETLAND AND AQUATIC ECOLOGY STUDY

JINDAL IRON ORE (PTY) LTD - MELMOTH IRON ORE MINE PROJECT, MTHONJANENI LOCAL MUNICIPALITY, KWAZULU NATAL

Wetland & Aquatic Ecosystem Impact Assessment




Report No: EP561-01B

Date: 7th March 2023

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Prepared for: **SLR Consulting (South Africa) (Pty) Ltd**

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SPECIALIST ASSESSMENT REPORT DETAILS AND DECLARATION OF INDEPENDENCE

This is to certify that the following report has been prepared as per the requirements of:

- Section 32 (3) of the NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (Act No. 107 OF 1998) ENVIRONMENTAL IMPACT ASSESSMENT REGULATIONS 2014 as per Government Notice No. 38282 GOVERNMENT GAZETTE, 4 DECEMBER 2014 (as amended in 2017).
- The Department of Human Settlements, Water & Sanitation for Water Use Licensing and aquatic assessment as outlined in the '*Regulations Regarding the Procedural Requirements for Water Use License Applications and Appeals*' contained in the Government Gazette No. 40713 of 24 March 2017.

Assessment Title:	Jindal Iron Ore (Pty) Ltd – Melmoth Iron Ore Mine Project – Wetland & Aquatic Ecosystem Impact Assessment.
Location:	Melmoth, Mthonjaneni Local Municipality, KwaZulu Nata, South Africa
Report No.	561-01B
Version No.	3.0
Date:	7th March 2023
Authors:	Shaun McNamara (*MSc.) (Primary Author)* Ross Van Deventer (*MSc.)(Contributing Author)*
Field of study/expertise:	Wetland & Aquatic Ecology
Externally reviewed by:	Leo Quayle (*Pr.Sci.Nat*)
Client:	SLR Consulting (South Africa) (Pty) Ltd

I, **Shaun McNamara**, hereby declare that this report has been prepared independently of any influence or prejudice as may be specified by the relevant environmental authorities.

Signed: ______________________ Date: 7th March 2023

Details of Specialist Team

The relevant experience of specialist team members involved in the compilation of this report are briefly summarized below. *Curriculum Vitae* of the specialist team are available on request.

Specialist	Role	Details
Leo Quayle (*Pr.Sci.Nat.*) GIS Specialist & Aquatic Ecologist	Internal Review & Sign-off	Leo has a master's degree in environmental management and is an independent professional natural scientist working as an associate of Eco-Pulse. He is registered with the South African Council of Natural Scientific Professionals (SACNASP) in the fields of Water Resources and Ecology. He has 18 years of experience and a broad interest in various environmental and planning fields. He has worked locally and internationally as a project leader, GIS specialist/environmental planner and aquatic ecologist. He has worked on a variety of environmental management projects focusing on strategic environmental planning, water resources and catchment management and risk and vulnerability assessment with a focus on ecosystem services, land degradation and climate change. He has worked extensively in the aquatic ecological space focusing on water quality, river health and biomonitoring.
Shaun McNamara Wetland & Aquatic Ecologist Eco-Pulse	Fieldwork and primary author	Shaun is a Scientist at Eco-Pulse with an Honours degree in Environmental Water Management, with a strong focus on integrated catchment management and wetland ecology. He also holds an MSc in Geography with his dissertation focusing on fluvial geomorphology and processes of wetland formation and evolution. Shaun has experience in the collection and analysis of data relating to wetland and aquatic assessments. Shaun is an accredited SASS5 practitioner.
Ross Van Deventer Wetland & Aquatic Scientist	Project manager, fieldwork and contributing author	Ross has an MSc (Environmental Science) with training in integrated environmental management along with specialist training in the field of water resource management and aquatic science. His specialised training is further complemented by experience gained at Eco-Pulse Environmental Consulting Services through a broad range of wetland and aquatic studies. He has a passion for rivers and is competent in the application of current best practise guidelines and assessments tools with a growing experience base in water quality assessments. Ross has gained sound experience in undertaking specialist fish studies whilst he also accredited in the application of the SASS5 bio-monitoring technique.

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LIST OF ACRONYMS

AMD – Acid Mine Drainage
BFS - Bankable Feasibility Study
BIF - Banded Iron Formations
BMP – Best Management Practices
CR – Critically Endangered
CSIR - Council for Scientific and Industrial Research
HGM - Hydrogeomorphic
HPGR - High Pressure Grinding Roll
IFC – International Finance Corporation
IEM - Integrated Environmental Management
IUCN - International Union for Conservation of Nature
KZN – KwaZulu-Natal

DMR – Department of Mineral Resources
DWA – Department of Water Affairs
DWAF – Department of Water Affairs and Forestry
DWS – Department of Water and Sanitation
EAP - Environmental Assessment Practitioner
ECO – Environmental Control Officer
EIA - Environmental Impact Assessment
EIS – Ecological Importance and Sensitivity
EKZNW - Ezemvelo Kwa-Zulu Natal Wildlife
ESIA - Environmental and Social impact Assessment
EMPr – Environmental Management Programme
EN – Endangered
ETS - Ecosystem Threat Status
FEPA – Freshwater Ecosystem Priority Area
FSCP - Freshwater Systematic Conservation Plan
GA – General Authorization
GG – Government Gazette
GIS - Geographic Information System
GLV – General Limit Value
GN – General Notice
GPS - Global Positioning System
LC – Least Concern
MRA - Mining Right Application
NBA – National Biodiversity Assessment
NEMA - National Environmental Management Act
NFEPA - National Ecosystem Priority Area
NGI - National Geo-spatial Information
NWA – National Water Act
UCVB – Unchanneled Valley Bottom Wetland
PCD – Pollution Control Dam
PES – Present Ecological State
PPP - Public Participation Process
PR - Prospecting Right
REC – Recommended Ecological Category
RMO - Recommended Management Objectives
ROM – Run of Mine
SANBI – South African National Biodiversity Institute
SASS5 – South Africa Scoring System Version 5
TSF - Tailings Storage Facility
VU – Vulnerable
WRC – Water Research Commission
WRD – Waste Rock Dump
WULA - Water Use License Application

EXECUTIVE SUMMARY

This report sets out the findings of the **Wetland & Aquatic Ecosystem Impact Assessment** to inform the application for 1) environmental approval in terms of the NEMA: EIA Regulations (2014, *as amended*) and 2) a water use license application (WULA) in terms of the National Water Act, for the proposed Jindal Iron Ore Mining Project. An assessment of wetland and aquatic ecosystems was undertaken by Eco-Pulse Environmental Consulting Services in 2021. The main findings of the baseline assessment have been summarized below.

Background and Locality:

Jindal Iron Ore (Pty) Ltd (Jindal) holds two Prospecting Rights (PR) within the Mthonjaneni Local Municipality in KwaZulu Natal. The prospecting rights were granted to Jindal by the Kwazulu-Natal Department of Economic Development, Tourism and Environmental Affairs (EDTEA) in 2015. The prospecting right areas are referred to as 'North Block' (PR 10644) and 'South Block' (PR 10652) (Figure A). Together these prospecting blocks have an area of approximately 20 170ha. The South Block is located immediately north of Goedertrouw Dam along the Mhlatuze River, approximately 18km north of Eshowe and 17km south of Melmoth. The North Block is located approximately 12km east of Melmoth. The general project area is approximately 60km inland of Richards Bay.

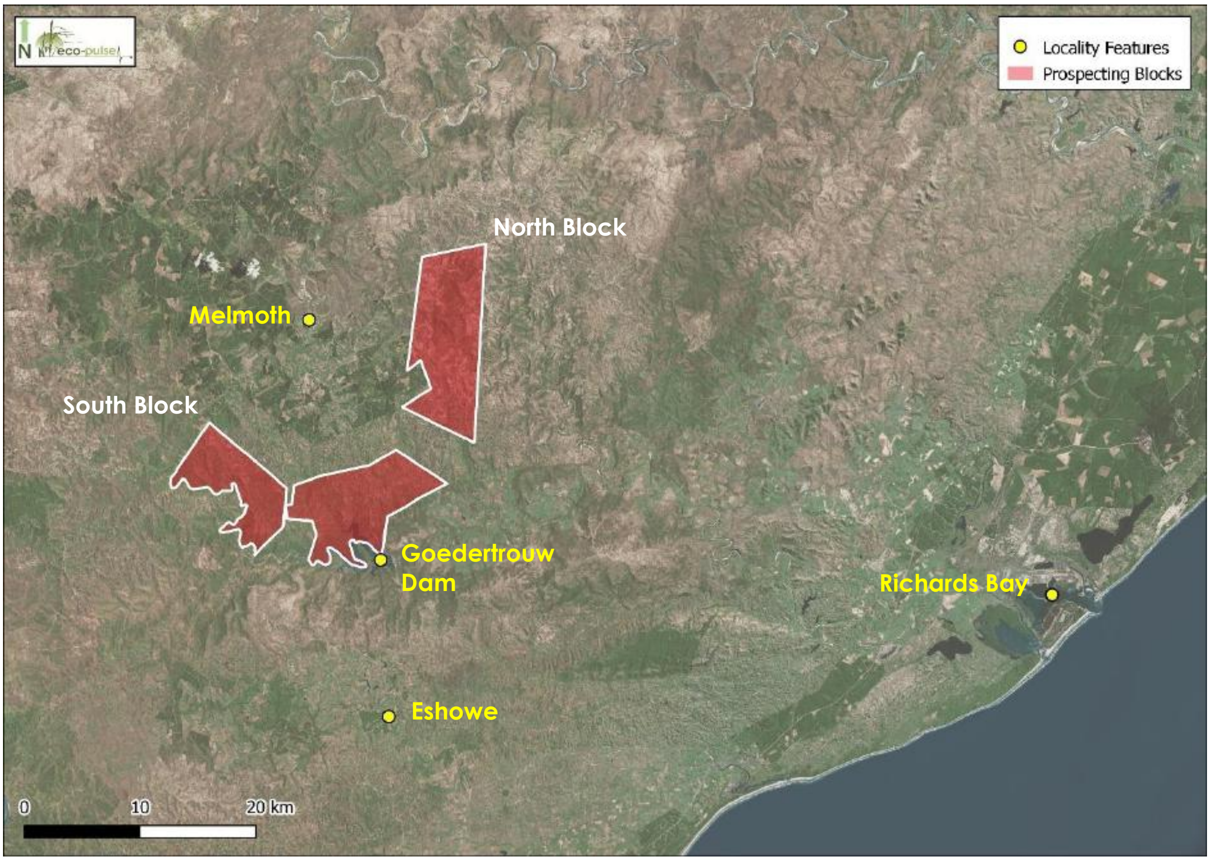

Figure A. North and South prospecting blocks in relation to key locality features

Drainage Context:

The majority of the South Bock is located within Department of Water and Sanitation (DWS) quaternary catchment W12B. A portion of the eastern extent of the South Block crosses into W12D (**Figure 8**). The primary river draining both catchments is the Mhlatuze River. This river forms the southern boundary of the South Block. The Goedertrouw Dam, located along the Mhlatuze River forms part of the South block. The Goedertrouw Dam is a regional water supply dam built in the 1980s. A large tributary of the Mhlatuze River, the KwaMazula River, drains much of the central portion of the South Block. This tributary meets the Mhlatuze River at the location of the Goedertrouw Dam. A dense drainage network of 1st, 2nd and 3rd order tributaries is linked to the Mhlatuze and KwaMazula Rivers.

The North Block is located within DWS quaternary catchment W12C (**Figure 9**). the primary river draining this catchment is the Mfule River. This river is the ultimate receiver of water from the dense drainage network of rivers and wetlands within the North Block. The reach of the Mfule River that exists within the North Block is downstream of its confluence with the Mfulazane River and upstream of its confluence with the Nhlozane River.

Watercourse Delineation & Classifications:

South Block:

A total of five hundred and ninety-nine (599) river / stream units and twenty-two (22) wetland units were identified and classified in the South Block study area. This included watercourses of the following classifications:

Rivers and Streams:

- Mountain Headwater Streams – 431 units
- Mountain Streams – 154 units
- Transitional Rivers – 10 units
- Upper Foothill Rivers – 3 units
- Lowland River (Mhlatuze River) – 1 unit

Wetlands:

- Seep Wetlands – 11 units
- Unchanneled Valley Bottom Wetlands – 12 units

The watercourse map for the South Block is shown in **Figure 16**. A summary of the number of different river / stream and wetland types across the South Block is provided below.

Rivers and Streams:

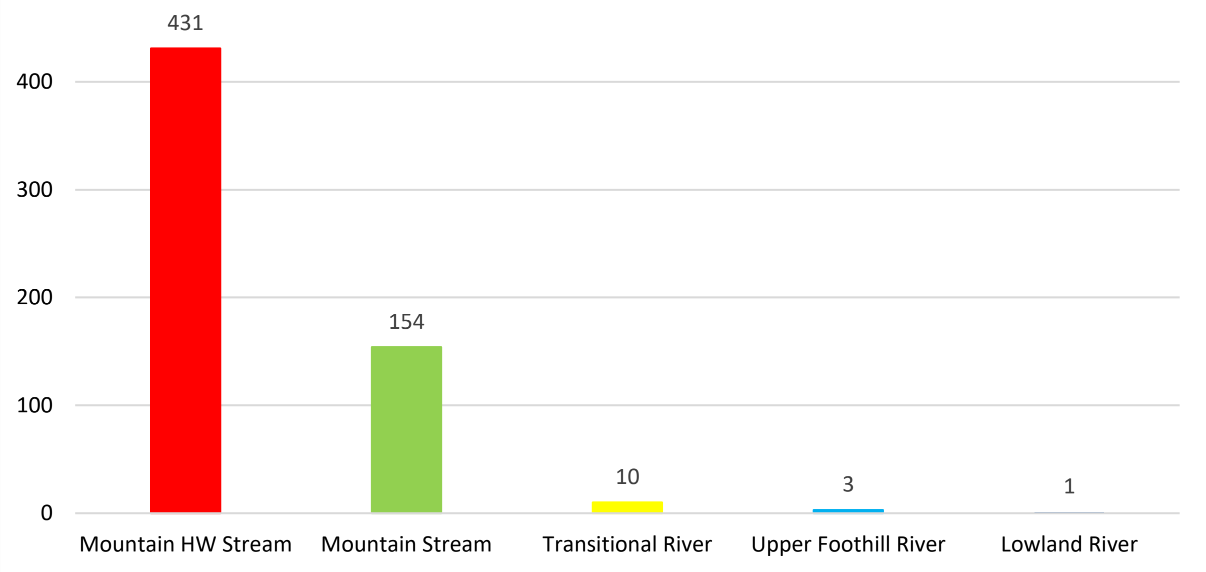

Figure B. Summary of the different river and stream types within the South Block.

Wetlands:

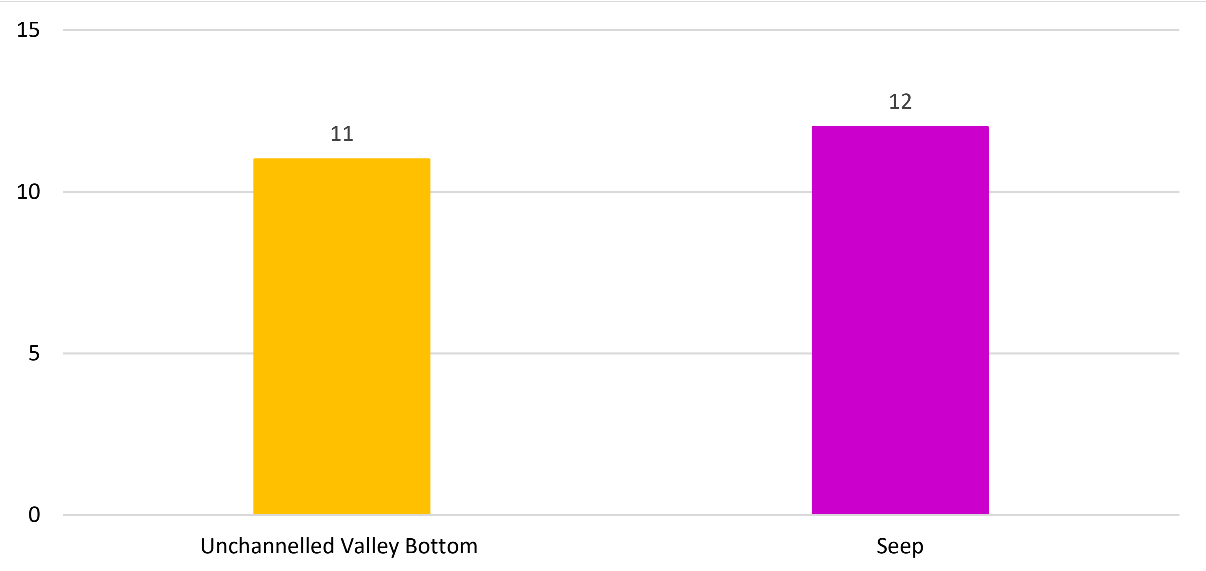

Figure C. Summary of the different wetland types within the South Block

Given the size and dense drainage network that characterises the study area, the process unit classification and assessment approach was applied to the following watercourse types:

- Mountain Headwater Streams *(divided into four [4] process unit groups)*
- Mountain Streams *(divided into four [4] process unit groups)*
- Seep Wetlands *(divided into three [3] process unit groups)*
- Unchanneled Valley Bottom Wetlands *(divided into two [2] process unit groups)*

All Transitional Rivers, Upper Foothill Rivers, and Lowland Rivers were assessed as individual watercourse units.

North Block:

A total of three hundred and thirty-one (331) river / stream units and sixty-three (63) wetland units were identified and classified in the North Block study area. This included watercourses of the following classifications:

Rivers and Streams:

- Mountain Headwater Streams – 253 units
- Mountain Streams – 62 units
- Transitional Rivers – 12 units
- Upper Foothill Rivers – 2 units
- Lower Foothill River (Mfule River) – 1 unit
- Lowland River (Mfule River) – 1 unit

Wetlands:

- Seep Wetlands – 23 units
- Unchanneled Valley Bottom Wetlands – 40 units

The watercourse map for the North Block is shown in **Error! Reference source not found.**. A summary of the number of different river / stream and wetland types across the South Block is provided below.

Rivers and Streams:

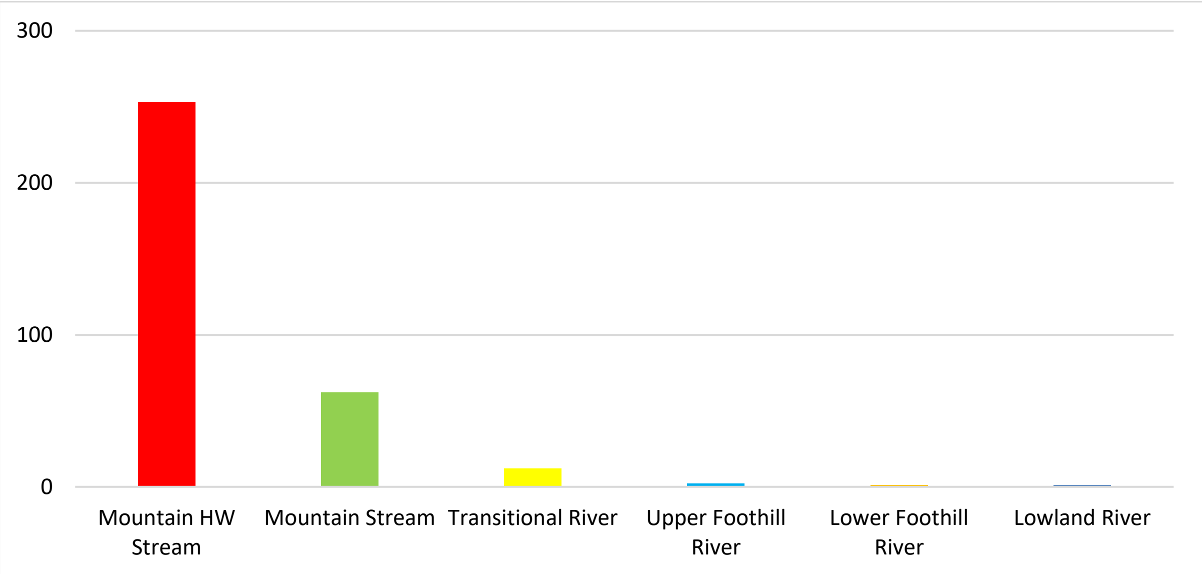

Figure D. Summary of the different river and stream types within the North Block.

Wetlands:

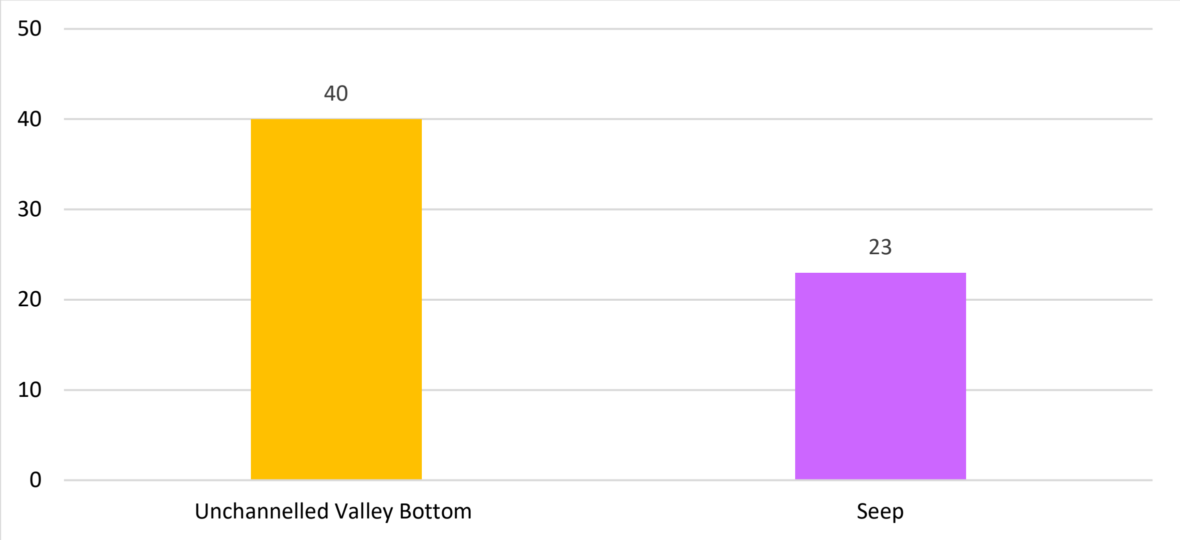

Figure E. Summary of the different wetland types within the North Block

South Block Baseline PES, EIS and REC:

A summary of the Present Ecological State (PES), Ecological Importance and Sensitivity (EIS) and Recommended Ecological Category (REC) for all assessed watercourses within the South Block is presented below. The factors affecting the baseline assessment outcomes are outlined in Chapter 4.

Table A. Summary of the PES, EIS and REC for all assessed watercourses within the South Block.

Watercourse Units	PES	EIS	REC	RMO
		Rivers & Streams		
Stream Process Unit 01 (Mountain HW Streams)	**A: Natural**	**D: Low**	A	Maintain PES
Stream Process Unit 07 (Mountain HW Streams)	**C: Fair**	**D: Low**	C	Maintain PES
Stream Process Unit 02 (Mountain HW Streams)	**B: Largely Natural**	**D: Low**	B	Maintain PES
Stream Process Unit 03 (Mountain HW Streams)	**C Fair**	**D: Low**	C	Maintain PES
Stream Process Unit 04 (Mountain Streams)	**A: Natural**	**D: Low**	A	Maintain PES
Stream Process Unit 08 (Mountain Streams)	**C: Fair**	**D: Low**	C	Maintain PES
Stream Process Unit 05 (Mountain Streams)	**B: Largely Natural**	**D: Low**	B	Maintain PES
Stream Process Unit 06 (Mountain Streams)	**C Fair**	**D: Low**	C	Maintain PES

Watercourse Units	PES	EIS	REC	RMO
SE-Transitional River-455	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SE-Transitional River-462	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SE-Transitional River-468	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SE-Transitional River-469	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SE-Transitional River-470	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SW-Transitional River-463	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SW-Transitional River-467	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SW-Transitional River-471 (KwaMazula River)	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SW-Transitional River-502	**D: Poor**	**C: Moderate**	D	Maintain PES
SW-Transitional River-544	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SE-Upper Foothill River-466	**C: Fair**	**C: Moderate**	C	Maintain PES
SW-Upper Foothill River-456	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SW-Upper Foothill River-457	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SW-Lowland River-461 (Mhlatuze River)	**B: Largely Natural**	**B: High**	A/B	Maintain PES
Wetlands				
Wetland Process Unit Group 01	D: Poor	C: Moderate	D	Maintain PES
Wetland Process Unit Group 02	**C: Fair**	D: Low	C	Maintain PES
Wetland Process Unit Group 03	**C: Fair**	D: Low	C	Maintain PES
Wetland Process Unit Group 04	**C: Fair**	C: Moderate	C	Maintain PES
Wetland Process Unit Group 05	**C: Fair**	C: Moderate	C	Maintain PES

North Block Baseline PES, EIS and REC:

A summary of the PES, EIS, and REC for all assessed watercourses within the North Block is presented below. The factors affecting the baseline assessment outcomes are outlined in Chapter 4.

Table B. REC and RMO for the delineated watercourse units based on their PES and EIS ratings.

Watercourse Units	PES	EIS	REC	RMO
		Rivers & Streams		
Stream Process Unit 01 (Mountain HW Streams)	**A: Natural**	**D: Low**	A	Maintain PES
Stream Process Unit 07 (Mountain HW Streams)	**C: Fair**	**D: Low**	C	Maintain PES
Stream Process Unit 02 (Mountain HW Streams)	**B: Largely Natural**	**D: Low**	B	Maintain PES
Stream Process Unit 03 (Mountain HW Streams)	**C Fair**	**D: Low**	C	Maintain PES
Stream Process Unit 04 (Mountain Streams)	**A: Natural**	**D: Low**	A	Maintain PES
Stream Process Unit 08 (Mountain Streams)	**C: Fair**	**D: Low**	C	Maintain PES
Stream Process Unit 05 (Mountain Streams)	**B: Largely Natural**	**D: Low**	B	Maintain PES
Stream Process Unit 06 (Mountain Streams)	**C Fair**	**D: Low**	C	Maintain PES
N - Transitional River - 1	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 274	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 276	**C Fair**	**C: Moderate**	C	Maintain PES
N - Transitional River - 277	**C Fair**	**C: Moderate**	C	Maintain PES
N - Transitional River - 278	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 279	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 280	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 281	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 282	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 283	**B: Largely Natural**	**C: Moderate**	B	Maintain PES

Watercourse Units	PES	EIS	REC	RMO
N - Transitional River - 284	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 331	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N-Upper Foothill River-275	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N-Upper Foothill River-297	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Lower Foothills River - 285 (Middle Mfule River)	**B: Largely Natural**	**B: High**	A/B	Improve PES
N - Lowland River – 286 (Lower Mfule River)	**B: Largely Natural**	**B: High**	A/B	Improve PES
Wetlands				
Wetland Process Unit Group 01	D: Poor	C: Moderate	D	Maintain PES
Wetland Process Unit Group 02	**C: Fair**	D: Low	C	Maintain PES
Wetland Process Unit Group 03	**C: Fair**	D: Low	C	Maintain PES
Wetland Process Unit Group 04	**C: Fair**	C: Moderate	C	Maintain PES
Wetland Process Unit Group 05	**C: Fair**	C: Moderate	C	Maintain PES

Impact Significance Assessment:

Given the early planning stage of this project key information required to accurately assess potential impacts and risks to freshwater ecosystems is not available. It should therefore be noted that this impact assessment has been completed at a broad project level and only considers the plan outlined in Section 1.2, which has been derived from the AMEC Prefeasibility Engineering Study (2015).

As such, this impact assessment should be regarded as preliminary and indicative, and subject to more detailed impact evaluations once appropriately detailed information becomes available.

Given that this project is in a planning phase, this impact assessment has been subject to several key assumptions. These are outlined in Chapter 6. Should any of these assumptions not be accurate, this impact assessment will need to be updated.

A summary table containing the impact significance assessment ratings (for a ‘poor’ and ‘good’ mitigation scenario) and for each mining phase is included below.

- The most significant construction (mine development) phase impacts are likely to be the direct physical loss or modification of freshwater habitat at road crossing locations and in instances were infrastructure advances into delineated watercourses.
- Construction phase impacts - hydrological and geomorphological process impacts could be of 'Medium' significance where additional flows along wetland and rivers trigger erosional processes, and bulk earthworks which would result in large volumes of sediment frequently being delivered to watercourses.
- The most significant operation phase impacts are likely to be associated with notable direct physical destruction of freshwater habitat area at the location of the mine pit and waste rock dump, the potential for appreciable hydrological and geomorphological modifications to watercourses during the mining operational phase, and the inherent risks of Acid Mine Drainage (AMD) and other water pollution streams emanating from the mine operation. It is Eco-Pulses understanding that the potential and severity of AMD associated with this mining project will be addressed as a standalone study. The assessment of the significance of impacts associated with AMD in this report would need to be updated based on the more detailed AMD study.

Table C. Impact assessment significance summary table for the iron ore mining project phases.

Impact Type	Impact Significance Rating	
	'poor' mitigation scenario	'good' mitigation scenario
CONSTRUCTION / ESTABLISHMENT PHASE		
Direct physical loss or modification of freshwater habitat	Medium	Medium
Alteration of hydrological and geomorphological processes	Medium	Low
Impacts to water quality	Medium	Low
Impacts to ecological connectivity and/or ecological disturbance impacts	Low	Low
OPERATIONAL (MINING) PHASE		
Direct physical loss or modification of freshwater habitat	High	Medium
Alteration of hydrological and geomorphological processes	High	Medium
Impacts to water quality	High	Medium
Impacts to ecological connectivity and/or ecological disturbance impacts	Medium	Low
CUMULATIVE		
Direct physical loss or modification of freshwater habitat	High	Medium
Alteration of hydrological and geomorphological processes	High	Medium
Impacts to water quality	High	Medium
Impacts to ecological connectivity and/or ecological disturbance impacts	Medium	Low

Biodiversity Offsets

Offsets are a means of compensating for significant and residual (permanent) impacts to natural habitat and would only be advocated once all other possible means of mitigation have been considered and exhausted, including avoidance and mitigation of impact significance, or where onsite rehabilitation cannot remediate impacts substantially. Based on the mine layout included in this application a total of 11.17 ha of freshwater habitat stands to be permanently altered (infilled or mined out) during the construction and operation of the mine (**Table 69** and **Table 71**). This includes 0.62 ha of critically endangered wetland habitat. Given that the conservation / threat status of all wetlands in the study area is considered critically endangered with little to no protection of this wetland vegetation group, any destruction of wetland habitat, no matter how large or small, is likely to require some form of an offset as compensation for the loss. The proposed loss of freshwater habitat across the mine site is considered a significant residual adverse impact on biodiversity which should be compensated for using offsets ('high' significance rating for operation phase direct habitat loss under the current layout scenario [**Table 72**]). With the majority of residual freshwater habitat loss at this stage of planning being river and streams features rather than wetland units, it is recommended that the residual impacts to freshwater habitat be investigated and addressed as part of an overall biodiversity offset investigation (terrestrial and freshwater, combined), rather than through a specific wetland offset investigation. This would however need to be confirmed through consultation with the relevant environmental authorities.

As stipulated in the KwaZulu-Natal (KZN) biodiversity offset guidelines published by Ezemvelo Kwa-Zulu Natal Wildlife (EKZNW) in 2013, potential offsets should be investigated during the project EIA phase. This would involve more detailed investigation into offset requirements, informed by detailed layout and mining plans for the project. Ultimately, prior to initiation of the project an Offset Assessment Report would need to be produced and approved followed by an Offset Management Plan, as per the Ezemvelo Kwa-Zulu Natal Wildlife minimum requirements for biodiversity offsets. Sufficient motivation will also need to be provided by the mining applicant as to why avoidance of freshwater habitat cannot be achieved and therefore why an offset is required.

DWS Risk Assessment to Inform Section 21 (c) and (i) Water Use Licencing:

Open pit mining projects in general are known to be associated with high risks to water resources, including surface and groundwater systems. Whilst risks associated with the construction phase of the mining project can generally be managed to 'low' overall levels, most of the operational mining risks to watercourses are considered moderate to high and will be difficult to mitigate. Whilst there are potential mitigation options to assist with mitigating these moderate to high rated risks, **the overall project risk is still likely to remain at least a 'moderate' level**. The mining project therefore cannot be generally authorised under the General Authorisation (GA) for Section 21 c and i water uses. Therefore, a full Water Use License Application (WULA) is required for the project.

Additionally, General Notice (GN) 509. GN 509, published in Government Gazette (GG) no. 40229 under Section 39 of the National Water Act (Act no. 36 of 1998) in August 2016, allows for Section 21 (c) and (i) water uses to be generally authorised if risks can be reduced to an acceptable level, there is however no GA notice for the remaining Section 21 water uses. This project will trigger several water uses beyond (c) and (i), and will require a full WULA on that basis, also.

It is important to also note that the Risk Assessment in this section overlaps strongly with the impact significance assessment findings which is to be expected since the risk ratings should in essence align to a large degree with the impact ratings.

Table D. Summary of the risk matrix assessment scores and ratings for each activity and risk group.

Activity	Aspects	Impact	Risk Rating	Revised Risk Rating for Borderline LOW / MODERATE Rating Classes
CONSTRUCTION PHASE	Infilling of watercourses and accidental direct physical modification to freshwater habitat during construction.	Direct physical loss or modification of freshwater habitat	**Moderate**	**Moderate**
	increase in sediment supply to watercourses associated with trenching taking place within and near watercourse units. Temporary alteration of natural water distribution patterns.	Alteration of hydrological and geomorphological processes	**Moderate**	**Low**
	Potential elevated sediment delivery (and associated turbidity) to watercourses and potential pollution related to accidental spillages / leakages of fuels and chemicals during construction.	Impacts to water quality	**Moderate**	**Low**
	Presence of workers and heavy machinery in the general vicinity of onsite watercourses creating noise, vibrations, and dust.	Impacts to ecological connectivity and/or ecological disturbance impacts	**Moderate**	**Low**
OPERATIONAL PHASE	Accidental direct physical modification to river or stream habitat during operation phase maintenance and repair.	Direct physical loss or modification of freshwater habitat	**High**	**NA**
	Operation phase storm water management. (i) high runoff volumes incite erosion along watercourses, and large volumes of sediment are regularly deposited into nearby watercourses, (ii) the thirty-two (32) watercourses in the proposed waste rock dump footprint will have their hydrological and geomorphological characteristics permanently altered, and (iii) where the seasonality and habitat characteristics of SE-Upper Foothill River-466 notably altered.	Alteration of hydrological and geomorphological processes	**High**	**NA**
	Risk of potential hydrocarbon (fuel/oil) spills, polluted storm water runoff, sedimentation, and potential AMD, treated effluent discharge from onsite sewer treatment plant.	Impacts to water quality	**High**	**NA**
	The presence of workers and machinery during infrastructure repairs and maintenance, and the use of the developed area by cars and people creating ecological noise and vibration disturbances.	Impacts to ecological connectivity and/or ecological disturbance impacts	**Moderate**	**Moderate**

Layout Planning Recommendations:

Preliminary recommended buffer zone widths

The buffer model by Macfarlane & Bredin (2016) allows the user to choose a land use / activity type and produces a buffer output for that activity type for two (2) scenarios based on potential risks associated with the proposed project type, in conjunction with the sensitivity of wetland and aquatic resources. These two scenarios are (i) without specific mitigation; and (ii) with specific impact/risk mitigation. In this case the following land use / activity was used to provide preliminary buffer widths for processing and mine support infrastructure (taken directly from the options provided by the tool):

- Plant and plant waste from high-risk mine operations
  - Waste generated from plant and plant waste from processing of minerals and metals extracted from the ground, which pose a high risk to water quality and water resources. These include Antimony (Large mines), Asbestos, base metals (Copper Cadmium, Cobalt, <u>Iron ore</u>, Molybdenum, Nickel, Tin, Vanadium), Chrome (Large mines), Coal, Gold, silver, uranium, Zinc and Lead.

The results of the buffer tool assessment are presented below and includes the two potential scenarios the tool accounts for in its outputs/results (i.e. (i) without specific mitigation; and (ii) with specific impact/risk mitigation).

Under a 'with mitigation' scenario final buffer model outputs for rivers and wetlands recommend a 61m and 54m buffer width respectively for any heavy industrial activities planned, a 33m and 34m width respectively for any high-density residential activities planned and a 17m buffer width for both wetlands and rivers for any low impact mixed-use activities planned. It is important to note that the 17m buffer recommended by the buffer tool for rivers under a low-impact mixed use scenario with best practice mitigation applied, is lower than the standard 30m buffer recommended in the draft Guidelines for Biodiversity Impact Assessment (EKZNW, 2011) and therefore the buffer has been revised to 30m for rivers under this land-use scenario in accordance with these provincial guidelines (see the buffer map in Figure 9). Typical mitigation and best-practice measures likely to be required under a specific impact/risk mitigation scenario include measures such as the demarcation of construction servitudes; runoff, erosion, and sediment control; soil, hazardous substances, wastewater management, solid waste management, and storm water management; a freshwater ecosystem rehabilitation strategy; invasive alien plant control; noise dust and light pollution minimisation and a freshwater ecosystem monitoring plan.

Table E. Summary of the outcomes of the watercourse buffer model (Macfarlane & Bredin, 2016).

		Recommended Buffer Width	
		Plant and plant waste from high-risk mine operations	
Watercourse Type	**Project Phase**	With Mitigation	Without Mitigation
Rivers/ Streams	Construction	28m	55m

	Operation	28m	100m
	Final	**28m**	**100m**
Wetlands	Construction	25	50
	Operation	25	85
	Final	**25**	**85**

Infrastructure Siting Consideration

While broad-level planning has highlighted potential mining and processing areas, detailed designs and layouts have not yet been completed. In further planning of potential mining activities, implementing the 'impact mitigation hierarchy' (discussed above) will be essential in attempting to avoid, reduce and mitigate potential mining-related risks and impacts to the environment. For this to be achieved every attempt should be made to avoid/prevent impacts to important water resources through refinements to project design and the siting of mining infrastructure, mining areas, site camps and material storage, stockpiling and dump sites. Based on the preliminary layout, Eco-Pulse have provided basic siting recommendations for several proposed activities / infrastructures.

Waste Rock Dump

It is understood by Eco-Pulse that the final sizing and location of the waste rock dump is largely finalized with the Geotheta (2023) conceptual design to be carried forward. Whilst Eco-Pulse understand that the WRD will require a large area, and that watercourse habitat loss is a likely outcome of the establishment and operation of the dump, the project design team must endeavour to select a WRD location and size that will affect (directly and indirectly) as few watercourses as is possible.

South East Pit

In accordance with the mitigation hierarchy, the first step when planning the layout of a project such as a mine should be to consider options in project location, siting, scale, layout, technology, and phasing to avoid impacts on biodiversity and water resources. In the case of the mine pit, Eco-Pulse provided a recommendation to resize the pit to avoid crossing a sub-catchment at the current southern extent of the pit. This was considered by Jindal with Eco-Pulse ultimately being informed that resizing the pit would fundamentally alter the project, and that this was not feasible. This assessment therefore only considered the pit that is displayed in **Figure 2**.

Processing Plant, Primary Crusher & Incoming Power Yard

In its currently proposed location, the processing plant footprint coincides with the headwater areas of two (2) Mountain Headwater Streams, a single (1) wetland, and a single (1) Mountain Stream (**Figure 35**). Additionally, the proposed location of the incoming power yard coincides with a single (1) wetland.

Whilst the primary crusher does not overlay with any mapped watercourses, it does advance into the preliminarily recommended watercourse buffer zone area (with and without mitigation) for a (1) Mountain Headwater Stream and a (1) Mountain Stream (**Figure 36**). Without re-siting this infrastructure, the above-mentioned watercourses stand to be directly or indirectly impacted by the proposed infrastructure. In accordance with the mitigation hierarchy, it is necessary for the design team to explore all possible siting, re-sizing, and layout adjustment options to avoid direct loss of watercourse habitat, and to effectively mitigate potential indirect impacts to watercourses through the implementation of sustainable design principles.

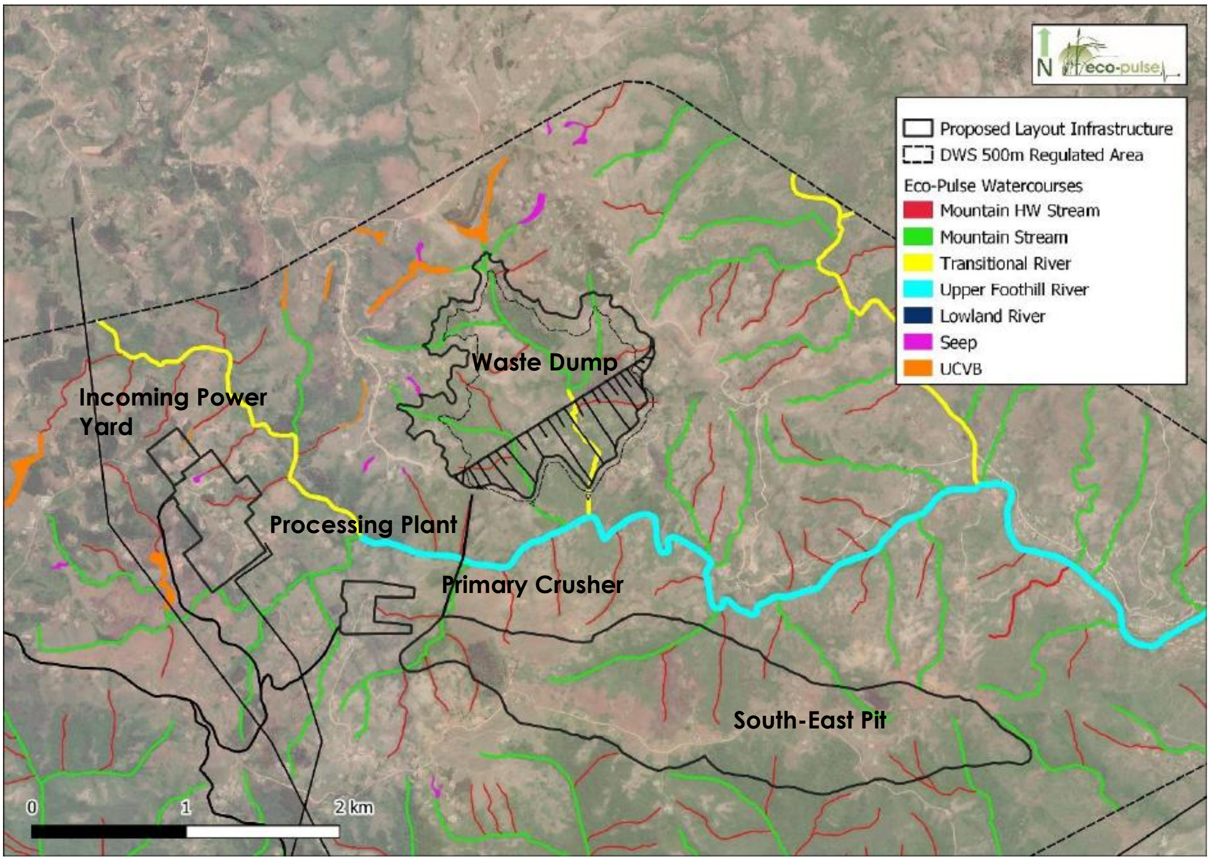

Figure F. Processing Plant, Primary Crusher, and Incoming Power Yard footprint areas in relation to watercourses mapped by Eco-Pulse.

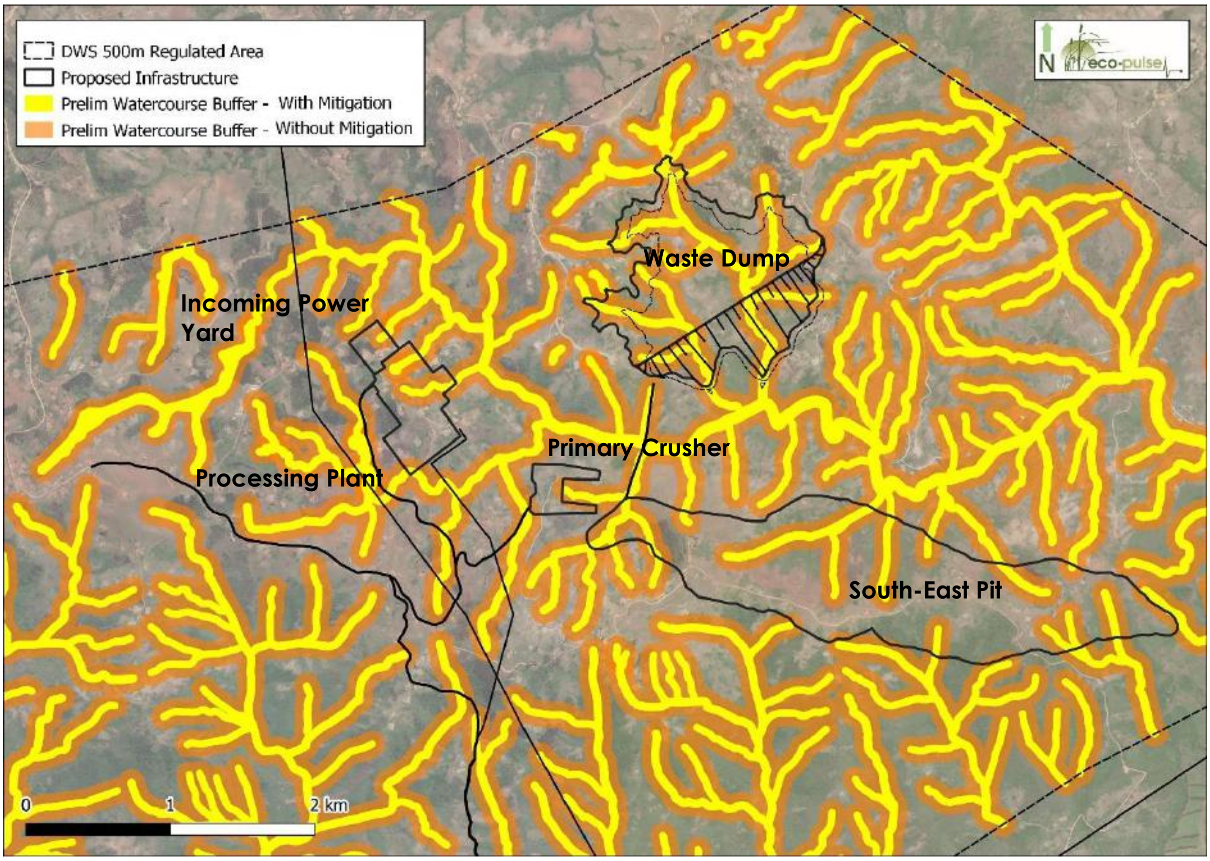

Figure G. Preliminary recommended wetland and aquatic buffer widths in relation to the proposed locations of the Processing Plant, Primary Crusher, and Incoming Power Yard.

Access Road

It is understood by Eco-Pulse that the presently proposed access road is a preliminary alignment that may experience notable change as the project advances. During road alignment planning, in line with the principles of the mitigation hierarchy, Eco-Pulse would encourage the design team to make use of existing roads as far as practically possible, and to limit the required number of watercourse crossings, especially new watercourse crossings. A review of the road alignment provided to Eco-Pulse shows that the alignment follows an existing unpaved road with three (3) existing watercourse crossings. Under the current alignment there is, however, an approximately 1.5km long length of road leading to the processing plant that runs through 'virgin' land, and which would involve crossing two (2) new watercourses.

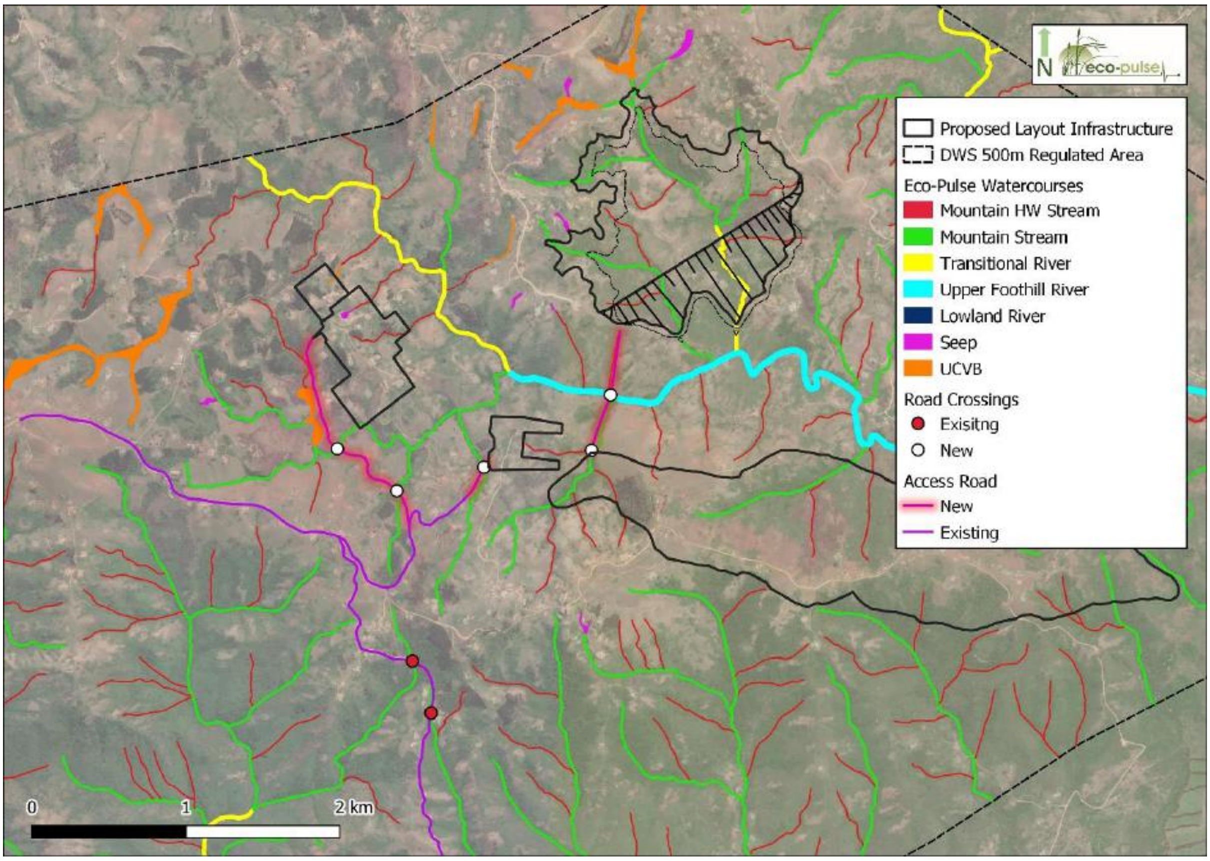

Figure H. Presently proposed road alignment showing the sections which follow an existing road and those that do not.

Road Crossing Design Considerations

Preliminary road crossing design recommendations are provided below for inclusion in the continued layout planning process.

Crossing Type and Design:

- Should existing road crossings be deemed inadequate or inappropriate to allow for flow to pass through the crossing unimpeded, the crossing should be upgraded.
- For all crossing types and designs, flow through road crossings should not be unnecessarily concentrated and flow velocity should not be increased. In this regard, crossings should ideally be in the form of a single span bridge or box / portal culverts across the entire width of the watercourse. Pipe culverts should be avoided.
- For new and upgraded road crossings, the decision between bridges and box culvert crossings should be a trade-off between the cost, importance, and sensitivity of the watercourse, and predicted impact of the crossing to watercourse hydrology.
- Erosion protection and energy dissipation measures should be established at all crossing outlets e.g., stilling basins and reno-mattresses.

Stormwater Management Considerations

- Adequate stormwater management must be incorporated into the design of all proposed mine and mine related infrastructure to prevent channel incision, erosion, and the associated sedimentation of onsite watercourses.
- A formal stormwater management plan must be developed for the mining operation. This should be done by a suitably qualified engineer with input from a wetland / aquatic ecologist, and a hydropedologist.
- The stormwater system should ideally be designed to handle flows associated with the full range of expected storm events (1:1-year – 1:100-year flood / storms).
- It is important to minimise runoff generation (through minimising the extent of hard standing and using rainwater harvesting techniques with all buildings) and to maximise runoff infiltration within the footprint of proposed infrastructure and within the recommended wetland / aquatic buffer zones. Recommended infiltration structures include the use of permeable options for surfacing of parking areas, bioretention areas, unlined detention basins, infiltration basins, and grassed swales.
- Related to the previous point, it is important that runoff generated by the development is not discharged back into the environment via concentrated point source outlets. An engineer should therefore be consulted to determine the best approach to achieving diffuse stormwater flow through the aquatic buffer zone area.
- Where possible stormwater runoff should be directed into, and conveyed by, open, permeable swales. These features should be well vegetated with indigenous fast growing grass species and stabilised by means of gabion or concrete check walls to prevent erosion and vertical incision. This will provide for some filtration and removal of pollutants (e.g., oils and hydrocarbons), provide some attenuation by increasing the time runoff takes to reach low points, and will reduce the energy of storm water flows within the stormwater system through increased roughness when compared with pipes and concrete V-drains.
- Stormwater outlet design recommendations:
    - Many smaller stormwater outlets must be favoured over a few large outlets.
    - Outfalls should not release stormwater directly down steep slopes.
    - All outlets must be designed to dissipate the energy of outgoing flows to levels that present a low erosion risk. In this regard, suitably designed energy dissipation (e.g., stilling basins) and erosion protection structures (Reno-mattresses) should be installed at appropriate locations.
- All stormwater generated by the proposed onsite infrastructure must receive appropriate filtering and treatment prior to discharge into the freshwater environment. Furthermore, all treatment should occur within the development footprint. This is particularly true for the crusher and processing plant, with runoff from these locations posing a risk to water quality of downstream watercourses.
- To function adequately, it is critically important that the onsite stormwater system be regularly maintained over time. This must be written into the operational Environmental Management Programme (EMPr) for the project.

- It is important that clean and dirty stormwater separation systems be in place prior to construction commencing and must be maintained for the duration of the mines operational life, until site closure and rehabilitation has been completed and signed off.

1. INTRODUCTION

1.1 Background and Locality

Jindal Iron Ore (Pty) Ltd (Jindal) holds two Prospecting Rights (PR) within the Mthonjaneni Local Municipality in KwaZulu Natal. The prospecting rights were granted to Jindal by the Kwazulu-Natal Department of Mineral Resources (DMR) in 2011 and were renewed until February 2022. The prospecting right areas are referred to as 'North Block' (PR 10644) and 'South Block' (PR 10652). Together these prospecting blocks have an area of approximately 20 170ha. The South Block is located immediately north of Goedertrouw Dam along the Mhlatuze River, approximately 18km north of Eshowe and 17km south of Melmoth (**Figure 1**). The North Block is located approximately 12km east of Melmoth. The general project area is approximately 60km inland of Richards Bay.

Prospecting in the area by Jindal and other companies has revealed that the prospecting blocks contain banded iron formations (BIF) in the form of magnetite, a magnetically recoverable mineral of high iron content, and amphibole grunerite, a mineral of low iron content that is not recoverable. For a time, the global iron ore price was not sufficient to make mining feasible for Jindal within the study area. An increase in the iron ore price in 2019-2020 has however encouraged Jindal to pursue the Melmoth Iron Ore Project. Therefore, in January 2021 Jindal appointed SLR Consulting (South Africa) (Pty) Ltd (SLR) as the independent environmental assessment practitioner (EAP) to undertake environmental and social impact assessment studies (ESIA) and to conduct a public participation process (PPP) for a Mining Right Application (MRA) for the proposed project. Eco-Pulse were subsequently appointed by SLR to conduct a freshwater wetland and aquatic ecosystem assessment for the project to inform planning and to meet the project environmental authorisation requirements.

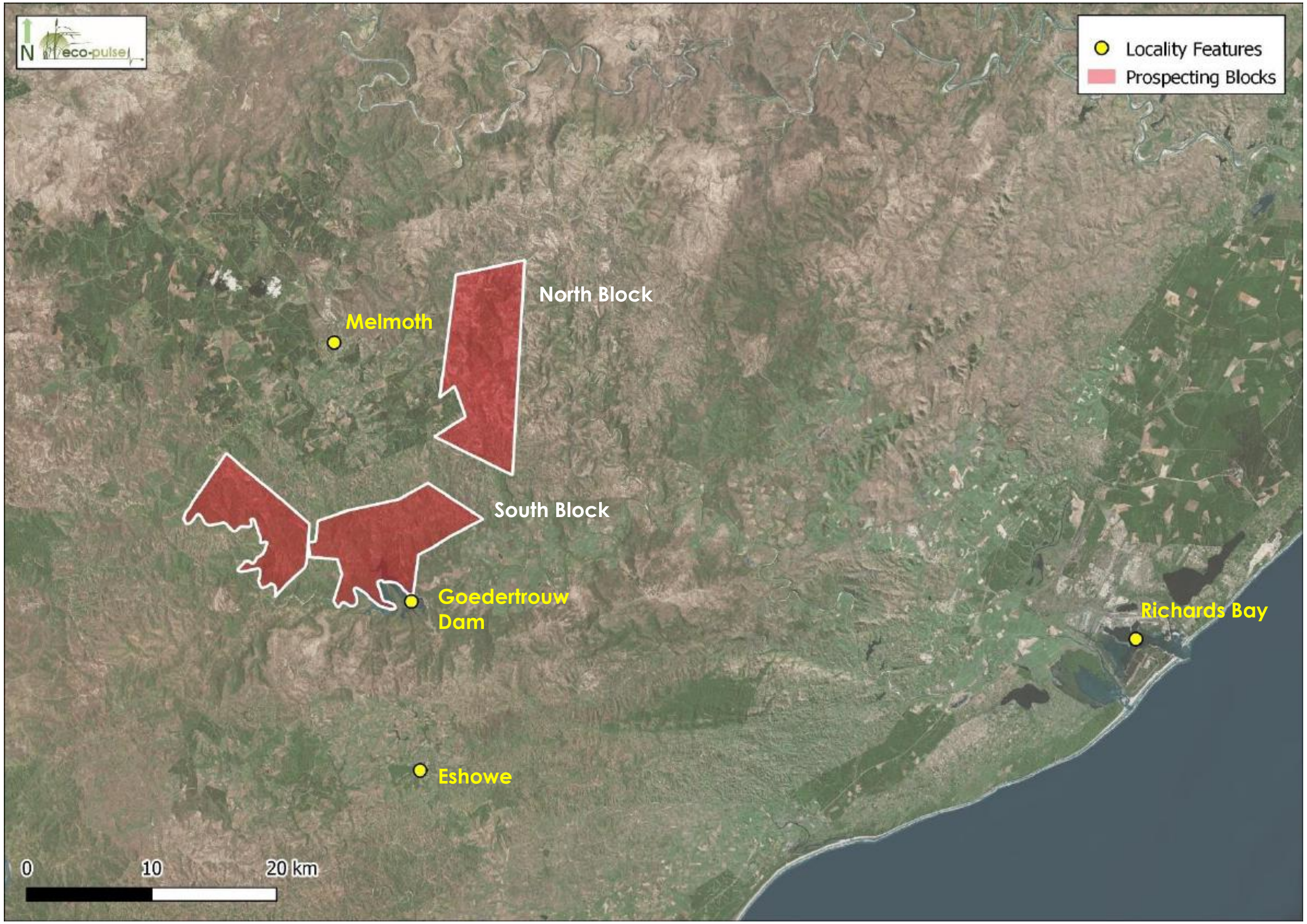

Figure 1. North and South prospecting blocks in relation to key locality features

1.2 Project Description

Whilst it is Jindal's intent to consolidate the Prospecting Rights for the North and South Blocks into a single Mining Right, the development of the mine and mining infrastructure is to be undertaken in a phased approach with mining only currently proposed in the south-eastern section of the South Block (**Figure 2**). Therefore, while the MRA and ESIA will consider both the North and South Blocks, there will be a specific focus on the South Block of the Melmoth Iron Ore Project as described in this section.

1.2.1 Project Design

The current mine plan, except for the proposed waste rock dump (WRD), has been derived from the AMEC Prefeasibility Engineering Study (2015). The design and footprint for the WRD facility was developed by Geotheta and provided to Eco-Pulse for inclusion in this assessment in December 2022. The final scale plan and location of mining and mine infrastructure will be determined by the Bankable Feasibility Study (BFS) presently underway, with inputs from this ESIA process. A broad description of the project is, however, outlined below:

An open cast pit mining operation is proposed to be developed in the south-eastern section of the South Block. Approximately 800 million tonnes of ore are expected to be mined from the pit over its lifetime (estimated to be approximately 25 years) generating approximately 32 million tonnes per annum (mtpa) of iron ore. Waste rock will be stripped from the pit at a ratio of approximately 0.5 tonnes of waste rock per 1 tonne of ore. The waste rock will be disposed of onto a WRD. This is to be located within the Mining Right Area. Drilling and blasting techniques will be used to excavate the iron ore. The excavated iron ore will be loaded onto trucks and transported to a Run-of-Mine (ROM) ore stockpile area before being transferred to the processing plant for milling and magnetic separation. The processing plant will produce iron ore concentrate and a tailings slurry. The approximately 7.5 mtpa of iron ore concentrate (consisting of 67% Fe) will be transported to the Richards Bay Port via either rail or pipeline (still to be determined). The concentrate will be exported as there are limited local markets. The tailings will be disposed of into a tailings storage facility (TSF) (subject to a separate application process). Associated infrastructure to support the mine will include access and haul roads, electrical transmission lines and sub-stations, raw water abstraction and pipelines, stormwater management infrastructure, tailings pipelines, concentrate pipelines, offices, change house, workshops, and perimeter fencing (amongst others).

Some of the infrastructure required for the mine (e.g., the access road, pipelines and TSF) may be located outside of the Mining Right Area. While the access road and water supply pipelines are part of this application to the DMR, certain other infrastructure will be subject to separate application, assessment, and approval processes, as required by the applicable legislation. Additional detail on the major infrastructure is provided below.

South East Pit:

The final dimensions of the South East Pit have not yet been determined and the pit as shown in **Figure 2** may end up being 2 or 3 separate pits. The South East Pit as shown is approximately 4 km long (east to west) and approximately 1km wide (north to south) at its widest point. The final pit dimensions will be defined in the BFS.

Waste Rock Dump:

WRDs are required to accommodate overburden and waste rock excavated as part of the mining process. The WRD, designed at a conceptual level by Geotheta (2023), has been planned to fit into the existing contours for stability and ultimate closure rehabilitation. The WRD design includes a safety berm and stormwater diversion trenches upslope and downslope of the berm. The proposed position is included in **Figure 2**.

Crushing and Screening:

ROM ore will be transported via haul truck to a semi-mobile in pit primary crusher. Primary crushed ore will be transported from the in pit primary crusher to the ROM stockpile via overland conveyor. ROM ore will be reclaimed from the ROM stockpile for further crushing before being deposited onto the crushed ore stockpile.

Processing Plant:

Ore from the crushed ore stockpile will be fed into the processing plant. The processing plant will be designed to process 32 mtpa of iron ore. Iron ore will be processed using crushing, milling and magnetic separation techniques. The plant will produce wet iron ore concentrate which will be exported. The plant will also produce thickened wet tailings slurry which will be deposited on a TSF as discussed below. The following standard activities are proposed as part the processing operations:

- Crushing and Screening.
- High Pressure Grinding Roll (HPGR) and ball/pebble milling.
- Magnetic separation and concentrate re-grind.
- Tailing's disposal (separate application process).
- Concentrate Dewatering and Filtration.
- Transport, storage, and shipment of product.

Water Infrastructure:

The mining operations will require water for the processing plant, dust control, for vehicle wash down and for the change house and office use. Water will be recycled to the grinding circuit from the TSF and the concentrate filters, thereby minimising daily water usage. There will be a need for make-up water to replace water losses from seepage and evaporation. It is anticipated that the make-up water would be acquired from the KZN bulk water supply authority. However, a water supply analysis will be undertaken as part of this project which will determine water demand and where water would come from. Water requirements are likely to reduce as the pit deepens due to the reuse of water that collects within the pit. In addition, water management infrastructure will be required including dirty water dams, pollution control dams and storm water management. The location and design of these will be identified as the Project progresses.

Office Complex & Sewage Treatment Plant:

An office complex is required to accommodate all management, technical, and administration staff for the mine. The office complex will include a car park, canteen, meeting rooms, hall, training complex, security and first aid station. The site will have a dedicated sewerage treatment plant the detail of which is to be considered as part of the BFS.

Workshops:

Engineering and vehicle workshops, tyre shops, wash down areas, garages, fuel depots and explosive magazines will be located at the centre of the activity that the facility services for ease of access. The detail will be considered as part of the BFS.

Access Road:

A proposed access road has been indicated in **Figure 2** (for illustration only at this stage). Further studies will be undertaken during the BFS, and enquiries will be made with landowners about potential route planning, to identify possible access routes for the transport of labour, equipment, and materials to the site during the construction phase and for other activities during the operational, decommissioning and closure phases.

Power Supply:

Existing 400 / 600 KV transmission lines owned by Eskom run through the South Block to a point approximately 700m from the envisioned main plant intake substation. The lines are relatively new and have adequate installed capacity for the mine requirements. Connecting distribution lines and a substation will be required for the mining operations.

1.2.2 Proposed Activities to be Authorised Separately from the Current MRA

There are several processes and infrastructures that are integral to a mining operation that have not yet been finalised but will be required for the proposed operations and would have to be approved through an Environmental Authorisation before any development or mining could take place. These are discussed in this section.

Tailings Storage Facility and Associated Infrastructure:

The TSF study is currently underway but will be run as a separate ESIA process.

Transport of Concentrate to Richard's Bay for Export:

The final mode of transportation of the concentrate from the processing plant to the Richards Bay Port for export has not yet been finalised and further studies are being undertaken to assess which is the most economically viable whilst at the same time determining the potential environmental and social impacts associated with each option. The following options are currently being assessed:

- Transport of concentrate by road (approximately 70 km).
- Upgrade of the existing railway to Richards Bay. Transport of concentrate by rail (from the nearby Nkwalini rail siding) (approximately 80 km) – a slurry pipeline from the processing plant to the rail siding to be included (approximately 5 km); and
- A slurry pipeline from the processing plant to the Richards Bay Port (approximately 60 km).

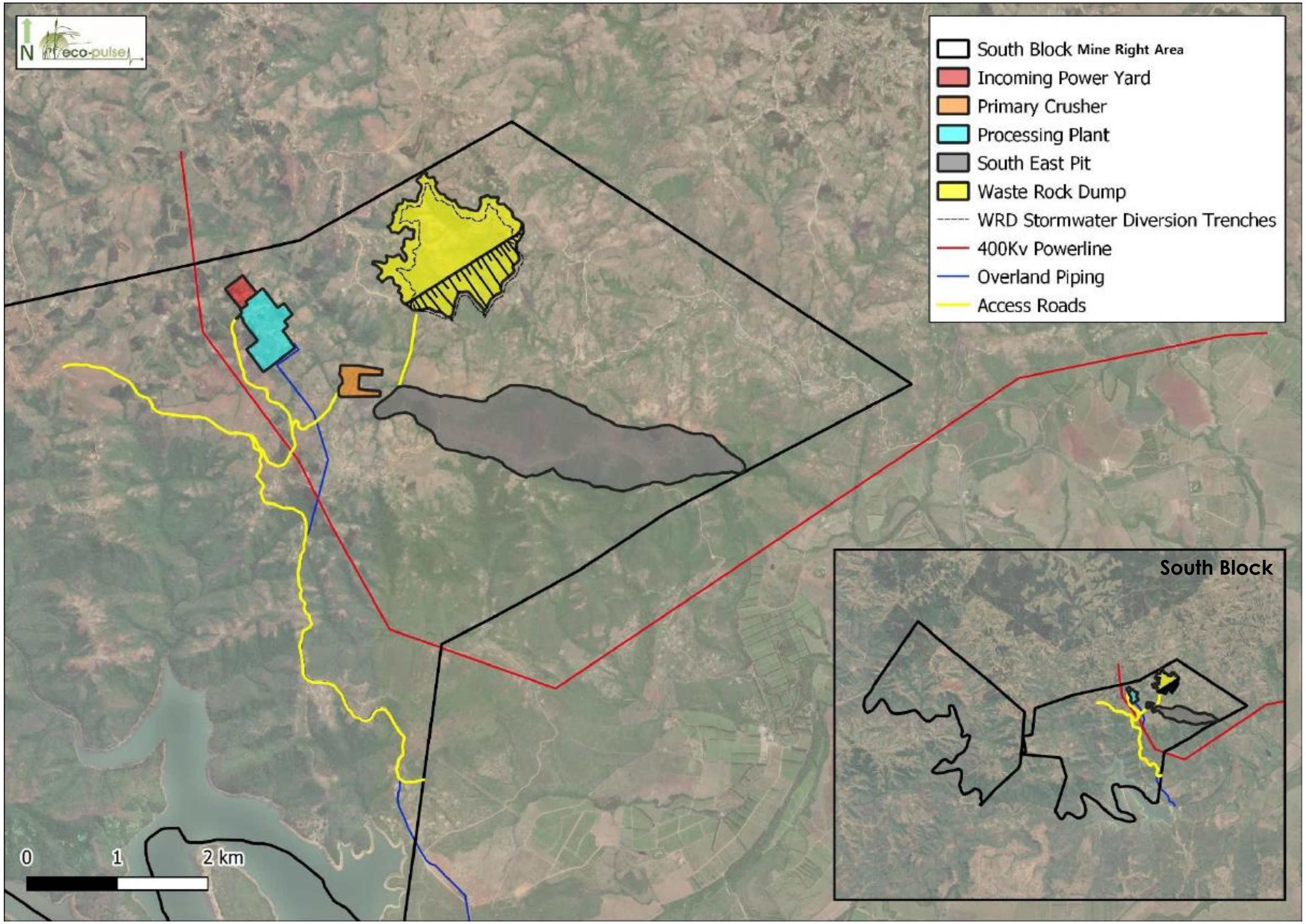

Figure 2. Site layout map

1.3 Scope of Work

This wetland and aquatic ecosystem assessment was undertaken in a systematic, phased manner, as presented in the diagram below (**Figure 3**). Detail for the assessment procedures undertaken during each assessment phase are presented in the sub-sections that follow. More specific detail on the assessments methods and procedures used as part of this study can be found in Chapter 2, below.

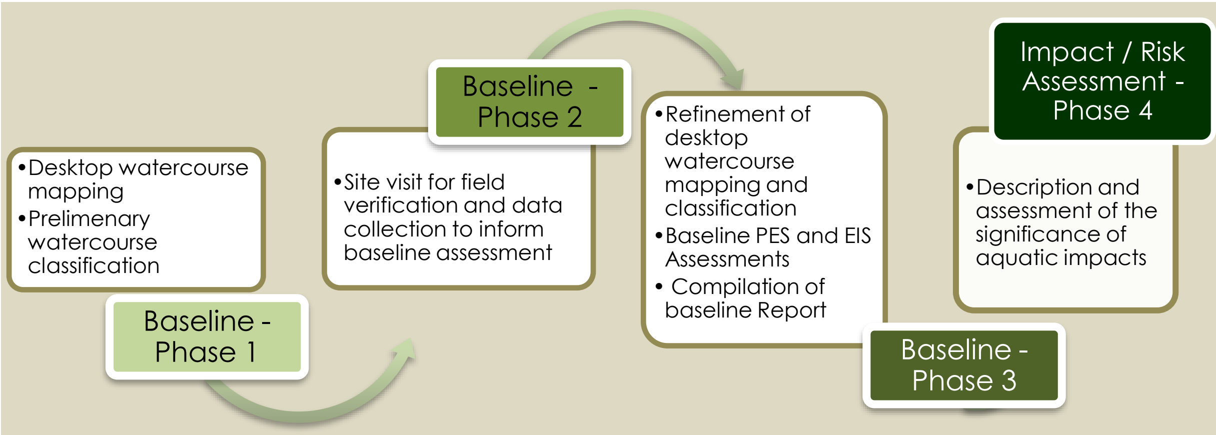

Figure 3. Diagram showing the phased approach adopted for this study.

Baseline Assessment - Phase 1: Desktop mapping

- Desktop mapping of all watercourses (wetlands and rivers) within the North and South Blocks, including within a 500m buffer around these blocks (Department of Water and Sanitation [DWS] regulated area for National Water Act [NWA] Section 21 c and i water uses). Mapping was informed by 20m elevation contours and colour aerial imagery. Existing Geographic Information System (GIS) watercourse datasets were used to guide the mapping process. Datasets included the KwaZulu Natal 1: 50 000 topographic map river lines layer (National Geo-spatial Information), the national wetland map (version 5) (SANBI, 2018), and the South African Inventory on Inland Aquatic Ecosystems GIS layer (SANBI, 2018).
- Desktop classification of all mapped watercourses using the National Wetland Classification Guidelines (Ollis et al., 2013).

Baseline Assessment - Phase 2: Field visit

- Eco-Pulse conducted field visits to the South Block to gather the following infield data:
  - Watercourse delineation verification data for a selected subset of desktop mapped watercourses.
  - South African Scoring System Version 5 (SASS5) aquatic macroinvertebrate surveys at selected river sites.
  - In-situ and grab water quality sampling at selected river sites.
  - Fish surveys using the electrofishing technique at selected river sites.
- SASS5 surveys, fish surveys and water quality sampling procedures were completed at a total of seven (7) river sites within the South Block. River assessment sites targeted perennial system within

the South Block with site selection seeking to achieve a spread of sites throughout the South Block Study Area. This data was used to inform the Present Ecological State (PES) assessments of selected perennial rivers within the South Block study area.

- **Note:** no field visits were conducted within the North Block study area as SLR advised Eco-Pulse to avoid that area due to potential security concerns. All assessments for the North Block are therefore at a desktop level, without infield verification.

Baseline Assessment - Phase 3: Mapping refinements, baseline watercourse assessments and report compilation

- Refinement of desktop watercourse mapping in the South Block by extrapolating infield delineation data to similar watercourse types across the study area.
  - No refinements to desktop watercourse mapping were done for the North Block as no field verification process was undertaken in that portion of the study area.
- Baseline habitat assessment:
  - Assessment of the PES of delineated watercourses.
  - Assessment ecosystem services provided by wetlands.
  - Assessment of the Ecological Importance and Sensitivity (EIS) of delineated watercourses.
    - **Note:** PES and EIS assessments were done at a 'process unit' level for all wetlands, mountain streams and mountain headwater streams. For larger river systems, PES and EIS was assessed for individual watercourses.
  - Determination of the recommended ecological category (REC) and recommended management objectives for the delineated watercourses.

Impact & Risk Assessment – Phase 4

- Description and assessment of the significance of aquatic impacts for all project phases (construction, mining / operation).
- Application of the "DWS Risk Assessment Matrix" at a project level, as detailed in the General Authorization in terms of Section 39 of the National Water Act No. 36 of 1998 for Water Uses as defined in Section 21 I or Section 21 (i), as contained in Government Gazette No. 40229, 26 August 2016 and contained within the DWS document titled 'Section 21 (c) and (i) Risk-based assessment and authorization, October 2014, Edition 2' to inform water use licensing requirements for the project (i.e. full WULA vs GA).
- Provision of planning and project design recommendations, including wetland and aquatic buffer zones at a broad desktop level using national guidelines (Macfarlane & Bredin, 2016).
- Provision of impact and risk mitigation measures and management recommendations for the various project phases.
- Broad conceptual wetland/river rehabilitation strategy to be provided to meet WULA requirements (no detailed rehabilitation plan was developed at this stage).
- Assessment of the need and desirability for wetland offsets.

- Identification of fatal flaws and broad cumulative impacts to wetland and aquatic resources in the region.
- Identification of assumptions, limitations, and information gaps.
- Recommendations for further studies (where relevant).
- Scientific Reporting: Compilation of a single combined Specialist Wetland & Aquatic Assessment Report including all relevant maps and supporting information.

1.4 Regulatory Framework

Relevant environmental legislation pertaining to the protection and use of aquatic ecosystems (i.e., wetlands and rivers) in South Africa has been summarized in the sub-sections that follow.

1.4.1 South African Constitution 108 of 1996

The Constitution of the Republic of South Africa (Act. No. 108 of 1996) is the supreme law and cannot be superseded by any other. Among other things the Constitution states that everyone has the right to:

- an environment that is not harmful to their health or well-being; and
- to have the environment protected, for the benefit of present and future generations.

The Constitution places responsibility on local authorities to provide citizens with:

- Refuse removal, refuse dumps and solid waste disposal.
- Water and sanitation services.
- Domestic wastewater and sewage disposal; and
- Socio-economic development.

1.4.2 National Environmental Management Act 107 of 1998

This is a fundamentally important piece of legislation and effectively promotes sustainable development and entrenches principles such as the 'precautionary approach' and the 'polluter pays' and requires responsibility for impacts to be taken throughout the life cycle of a project. The legislation acknowledges that sustainable development must integrate social, economic and environmental factors and that everyone has the right to an environment that is protected for the benefit of present and future generations. The legislation prevents pollution and ecological degradation, promotes conservation, and secures ecologically sustainable development and use of natural resources, while promoting justifiable economic and social development.

A fundamental aspect of the National Environmental Management Act (NEMA) is the provision for integrated environmental management (IEM). This provision forms the foundation of the Environmental Impact Assessment (EIA) framework and Environmental Authorisation process, the regulating instrument towards which this report is directed. Section 23 (2) of NEMA gives the following IEM objectives:

(a) promote the integration of the principles of environ-mental management set out in section 2 into the making of all decisions which may have a significant effect on the environment:
(b) identify, predict, and evaluate the actual and potential impact on the environment. socio-economic conditions and cultural heritage. the risks and consequences and alternatives and options for mitigation of activities, with a
view to minimizing negative impacts. maximizing benefits. and promoting compliance with the principles of environmental management set out in section 2.
(c) ensure that the effects of activities on the environment receive adequate consideration before actions are taken in connection with them.
(d) ensure adequate and appropriate opportunity for public participation in decisions that may affect the environment.
(e) ensure the consideration of environmental attributes in management and decision-making which may have a significant effect on the environment; and
(f) identify and employ the modes of environmental management best suited to ensuring that a particular activity is pursued in accordance with the principles of environmental management set out in section 2.

A. Environmental Impact Assessment (EIA) Regulations

Regulations have been promulgated in terms of Chapter 5 of NEMA and were published on 4 December 2014 in Government Notice No. R. 32828. These regulations regulate the procedure and criteria relating to the submission, processing, and consideration of, and decision on applications for environmental authorisations. In addition, listing notices (GN 983-985) list activities which are subject to an environmental assessment.

B. National Environmental Management: Biodiversity Act No. 10 of 2004

The intention of this Act is to protect species and ecosystems and promote the sustainable use of indigenous biological resources. It addresses aspects such as protection of threatened ecosystems and imposes a duty of care relating to listed invasive alien plants.

C. The National Environmental Management: Waste Act No. 59 of 2008

The National Environmental Management: Waste Act (Act No. 59 of 2008) provides legislation regulating waste management to protect health and the environment by providing measures to prevent pollution and ecological degradation and secure ecologically sustainable development through norms and standards, licensing, and control, regulating waste management activities, while providing remediation of contaminated land. The objectives of the Act are:

a) To protect health, well-being, and the environment by providing reasonable measures for
    - minimizing the consumption of natural resources.
    - avoiding and minimizing the generation of waste.
    - reducing, re-using, recycling, and recovering waste.

- treating and safely disposing of waste as a last resort.
- preventing pollution and ecological degradation.
- securing ecologically sustainable development while promoting justifiable economic and social development.
- promoting and ensuring the effective delivery of waste services.
- remediating land where contamination presents, or may present, a significant risk of harm to health or the environment; and
- achieving integrated waste management reporting and planning.

b) To ensure that people are aware of the impact of waste on their health, well-being, and the environment.

c) To secure an environment that is not harmful to health and well-being.

1.4.3 The National Water Act 36 of 1998

The NWA imposes a 'duty of care' on all landowners, to ensure that water resources are not polluted. The following clause is applicable in this case:

19 (1) "*An owner of land, a person in control of land or a person who occupies or uses the land on which (a) any activity or process is or was performed or undertaken, which causes, has caused or likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing, or recurring"*

Chapter 4 of the National Water Act is of relevance to watercourses and addresses the use of water and stipulates the various types of licensed and unlicensed entitlements to the use water. Water use is defined very broadly in the Act and effectively requires that. Any activity which entails a use of water as defined in the act requires a water use license

A. Water-Use Licensing in South Africa

Certain development-related activities require the application for a water use license where activities trigger Section 21 of the National Water Act (No. 36 of 1998). According to the Act, water use must be licensed unless its use is excluded. In terms of regulation 3(b)(i) of the Water Use Registration Regulations published under Government Notice R1352 in Government Gazette 20606 of 12 November1999, a person who uses water as contemplated in section 21 of the National Water Act, 1998 (Act No. 36 of 1998) must, when called upon by the responsible authority to do so, register the water use. Registration is the process of officially notifying the Department of a water use. There are several reasons why water users are required to register their water use with the DWS, the most important being:

- to manage and control water resources for planning and development.
- to protect water resources against over-use, damage, and impacts; and
- to ensure fair allocation of water among users.

Currently Section 21 (c) and (i) Gas do not apply to the use of water within a 500m radius from the boundary of any watercourse. Should construction/development within these boundaries be considered, licensing and registration will have to take place. Any new water-user who fails to comply with the terms and conditions of the General Authorisations for listed activities in terms of Section 21 of the NWA, must approach the DWS for a water-use license. The following is a list of all Section 21 water use activities that could be triggered by development activities in the vicinity of water resources and would require a water use license from the DWS:

a) taking water from a water resource.

b) storing water.

c) impeding or diverting the flow of water in a watercourse.

d) engaging in a stream flow reduction activity contemplated in section 36.

e) engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1).

f) discharging waste or water containing waste into a water resource through a pipe, canal sewer, sea outfall or another conduit.

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

h) disposing in any manner of water which contains waste from, or which has been heated in. any industrial or power generation process.

i) altering the bed, banks, course, or characteristics of a watercourse.

j) removing, discharging, or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.

k) using water for recreational purposes.

General Authorisations (GAs)

These have been promulgated under the National Water Act and were published under GNR 665 of 6 September 2013. Any uses of water which do not meet the requirements of Schedule 1 of the NWA or which do not qualify under the GAs, require a license which should be obtained from the DWS. A GA is not relevant to this MRA as a WUL will be applied for.

1.4.4 International Finance Corporation (IFC) Biodiversity Performance Standards

IFC's Sustainability Framework articulates the Corporations strategic commitment to sustainable development and is an integral part of the IFC's approach to risk management (IFC Performance Standard 6, 2012). Performance Standard 6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development.

2. APPROACH AND METHODS

2.1 General Assessment Approach

The general approach to the freshwater assessment was based on the proposed framework for freshwater ecosystems assessment proposed in the Water Research Commission's (WRC) report titled: 'Development of a decision-support framework for wetland assessment in South Africa and a Decision-Support Protocol for the rapid assessment of wetland ecological condition' (Ollis *et al*., 2014). This is shown in **Figure 4**.

Note that the aquatic assessment report has been developed in line with the requirements of the DWS for Water Use Licensing, as outlined in the 'Regulations Regarding the Procedural Requirements for Water Use License Applications and Appeals' contained in the Government Gazette No. 40713 of 24 March 2017 and in accordance with the requirements in the latest NEMA Minimum Requirements and Protocol for Specialist Aquatic Biodiversity Impact Assessment as contained in the "*Procedures to be followed for the assessment and minimum criteria for reporting of identified environmental themes of Section 45 (a) and (h) of the National Environmental Management Act, 1998, when applying for Environmental Authorization*", contained in Government Gazette No. 648 (10 May 2019).

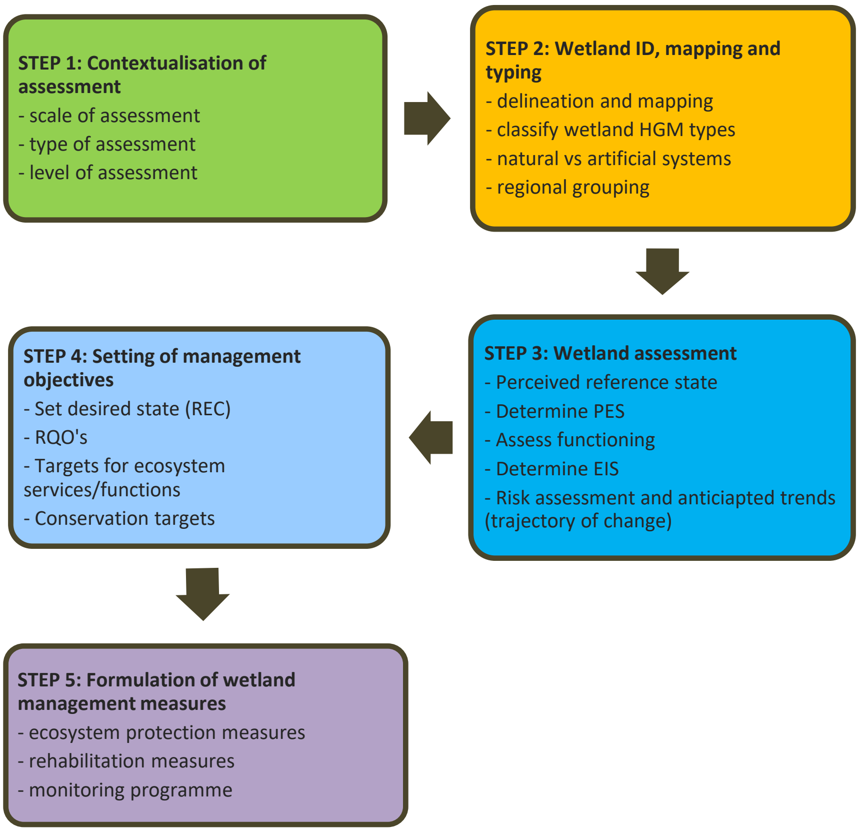

Figure 4. Proposed decision-support framework for wetland/aquatic assessment in SA (after Ollis et al., 2014)

2.2 Assessment Methods

The following section sets out the methods for this wetland and aquatic ecosystem baseline assessment.

2.2.1 Desktop Review of Biophysical & Conservation Context

The data sources and GIS spatial information listed in **Table 1** were consulted to inform the specialist assessment. The data type, relevance to the project and source of the information has been provided.

Table 1. Data sources and GIS information used to inform the baseline assessment.

DATA/COVERAGE TYPE	RELEVANCE	SOURCE
Biophysical Context		
Colour aerial photography	*Desktop mapping of drainage network, wetlands, etc.*	National Geo-spatial Information (NGI) (online)
Latest Google Earth ™ imagery	*To supplement available aerial photography where needed*	Google Earth™ On-line
Department of Water Affairs (DWA) Eco-regions (GIS Coverage)	*Classification of local Ecoregions*	DWA (2005)
Geomorphological Provinces of South Africa	*Understand regional geomorphology controlling the physical environment*	Partridge *et al.* (2010)
NFEPA: river and wetland inventories (GIS Coverage)	*Highlight potential onsite and local rivers and wetlands*	WRC (2011)
Conservation Context		
Inland Aquatic (Freshwater) Realm of the 2018 SANBI National Biodiversity Assessment (GIS Coverage)	*Provides insight into the national conservation planning status of watercourses in the study area*	Van Deventer et al. (2019)
NFEPA: River, wetland, and estuarine FEPAs (GIS Coverage)	*Shows location of national aquatic ecosystems conservation priorities*	WRC (2011)
KZN Freshwater Systematic Conservation Plan (GIS Coverage)	*Provincial conservation planning importance of aquatic and terrestrial resources.*	(EKZNW, 2007)

2.2.2 Watercourse Mapping, Classification & Verification

2.2.2.1 Desktop Watercourse Mapping:

All watercourses occurring within the North and South Blocks, and within a 500m area surrounding these blocks, were delineated at a desktop level by analysing available digital elevation contours and colour aerial photography. Digitization and mapping were undertaken using QGIS 2.10 GIS software. All mapped watercourses were then classified in terms of their Hydrogeomorphic (HGM) type (wetlands) or longitudinal zonation (streams and rivers) in accordance with the national wetland/river classification defined by Ollis et al. (2013).

South Block Field Verification:

A team of wetland and aquatic ecologists undertook a series of site visits to the South Block to verify watercourse delineations and to gather data to inform the watercourse PES and EIS assessments. Given the size of the study area, the field verification process focused on visiting a subset of each wetland HGM type and a subset of each river longitudinal zonation type in a variety of different settings across the South block area. Wetland, stream, and river delineation data was collected at visited watercourses using the methods outlined in *A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas'* (DWAF, 2005). The collected watercourse delineation data was used to inform the watercourse mapping refinement and extrapolation process outlined below.

Note: No field visit was undertaken to the North Block as Eco-Pulse were advised by SLR to avoid the area due to potential security issues. In addition, no development is currently proposed in this area. All watercourses in the North Block are therefore desktop delineated with no verification process or ground truthing having been conducted.

2.2.2.2 Watercourse Mapping Refinements and Extrapolations:

Rivers and Stream - Prior to Eco-Pulse undertaking the visit to the South Block, all river features were mapped as centre lines. Following the field verification process, the river lines were converted to polygon features by buffering the mapped lines, with each longitudinal zonation type being assigned a standard buffer width. For the South Block, the selected buffer widths for each zonation type were informed by infield delineation sampling, with this information being extrapolated across the study area. Buffer widths were not informed by infield delineations in the North Block and are based on data collected from the South Block, and on an analysis of available aerial imagery. The selected buffer widths for each longitudinal zonation are summarised in **Table 2**.

Wetlands - Wetlands were mapped at a desktop level as polygon features, which were refined following Eco-Pulses field visit. Wetland boundary refinements were based on wetland delineation data collected from a selected subset of wetlands within the South Block study area, with information being used to refine the desktop delineations of all wetlands in the South Block. No field visit was undertaken to the North Block. All wetlands in the north Block were therefore delineated at a desktop level with no verification or extrapolation process.

Table 2. Summary of the buffer widths applied to the mapped river lines for each river longitudinal zonation type.

Longitudinal Zonation	Buffer width
Mountain Headwater Stream	3m
Mountain Stream	8m

Transitional River	20m
Upper Foothills River	35m
Lower Foothills River	60m
Lowland River	North Block – 70m South Block – 90m

Note: A map showing Eco-Pulses field visit Global Positioning System (GPS) tracks and waypoint markers is presented in **Annexure A** to provide an indication of the coverage of Eco-Pulses infield data collection for the South Block study area.

2.2.3 Watercourse Process Unit Grouping

Given the extent of the study area, and the numerous watercourses associated within it, it was not feasible to conduct detailed baseline assessments on each individual watercourse unit due to time and budget constraints. Instead, a '**Process Units' based approach** was adopted for this project. 'Process Units' in this context refer to wetlands or rivers of the same general type in terms of their classification, with similar existing impacts to ecosystem health, similar processes, and ecological functions.

Note: Process unit grouping have not been completed for watercourses in the North Block at this time as this baseline assessment report focusing largely on the South Block study area. This is because this is where mining is planned with no immediate plans to mine in the North Block currently being in place.

2.2.3.1 Stream Process Units Grouping:

For streams, the process unit approach was applied to all Mountain Headwater Streams and Mountain Streams as these watercourses were numerous across the study area. All other rivers were assessed individually. Therefore, the following river zonation types were assessed individually for both the North and South Blocks:

- Transitional Rivers
- Upper Foothill Rivers
- Lower Foothill Rivers
- Lowland Rivers

Process unit groupings for Mountain Headwater Streams and Mountain Streams were based largely on catchment characteristics and condition, as catchment processes are a major driver influencing stream functional diversity, and stream ecological condition. Sub-catchment areas across the South-East block with similar landcover characteristics were therefore delineated and grouped, with different longitudinal zonation's (Mountain Headwater Stream or Mountain Stream) within the delineated sub-catchments being grouped as a process unit.

2.2.3.2 Wetland Process Unit Grouping:

Wetland process unit grouping involved assigning each of the mapped wetlands to a process unit group according to the following criteria:

- Wetland HGM type.
- Individual wetland catchment condition and biophysical characteristics.
- Level of wetland disturbance/impact.

2.2.4 Watercourse Labelling System

All watercourses were assigned a unique label using the following label system:

1. Watercourses were divided into either the North or South Block
2. South Block - Watercourses were divided into the South East or South West portion of the greater South Block using the abbreviation 'SE' and 'SW', respectively. The divide between the SE and SW is shown in Figure 5, below.
    - The divison of the South Block into these two areas was done to isolate the watercourses in the eastern portion of the study area, where all infrastrcuture is to be located, from the western portion of the study area, which are to remain unimpacted by the proposed mine develoopment as they are located in a landscape setting that are not hydroloigcally connected to the planned infrastrcuture. <u>This division will be important when reporting on project impacts at a later stage of the assessment procedure.</u>
3. Divison of watercourses into their prcoess unit groups (for mountain headwater streams, mountain streams and wetlands) or river longitudinal zonation (for transitional rivers, upper foothill rivers, lower foothill rivers, and lowland rivers). The label divisions at this level are therefore as follows:
    - Stream Process Unit 01 (PU01)
    - Stream Process Unit 02 (PU02)
    - Stream Process Unit 03 (PU03)
    - Stream Process Unit 04 (PU04)
    - Stream Process Unit 05 (PU05)
    - Stream Process Unit 06 (PU06)
    - Stream Process Unit 07 (PU07)
    - Stream Process Unit 08 (PU08)
    - Transitional River
    - Upper Foothill River
    - Lower Foothill River
    - Lowland River
    - Wetland Process Unit 01 (WET-PU01)
    - Wetland Process Unit 02 (WET-PU02)
    - Wetland Process Unit 03 (WET-PU03)
    - Wetland Process Unit 04 (WET-PU04)
    - Wetland Process Unit 05 (WET-PU05)
4. Watercourses were then assigned a unique ID number ranging from 1 to 599.

Examples of a complete watercourse label for the South Block would then be the following:

- SW-PU02-454 (South West Block – Stream Process Unit 02 – ID NO. 454)
- SE-Transitional River-455 (South East Block – Transitional River – ID NO. 455)
- SW-WET-PU01-18 (South West Block – Wetland Process Unit 01 – ID NO. 18)

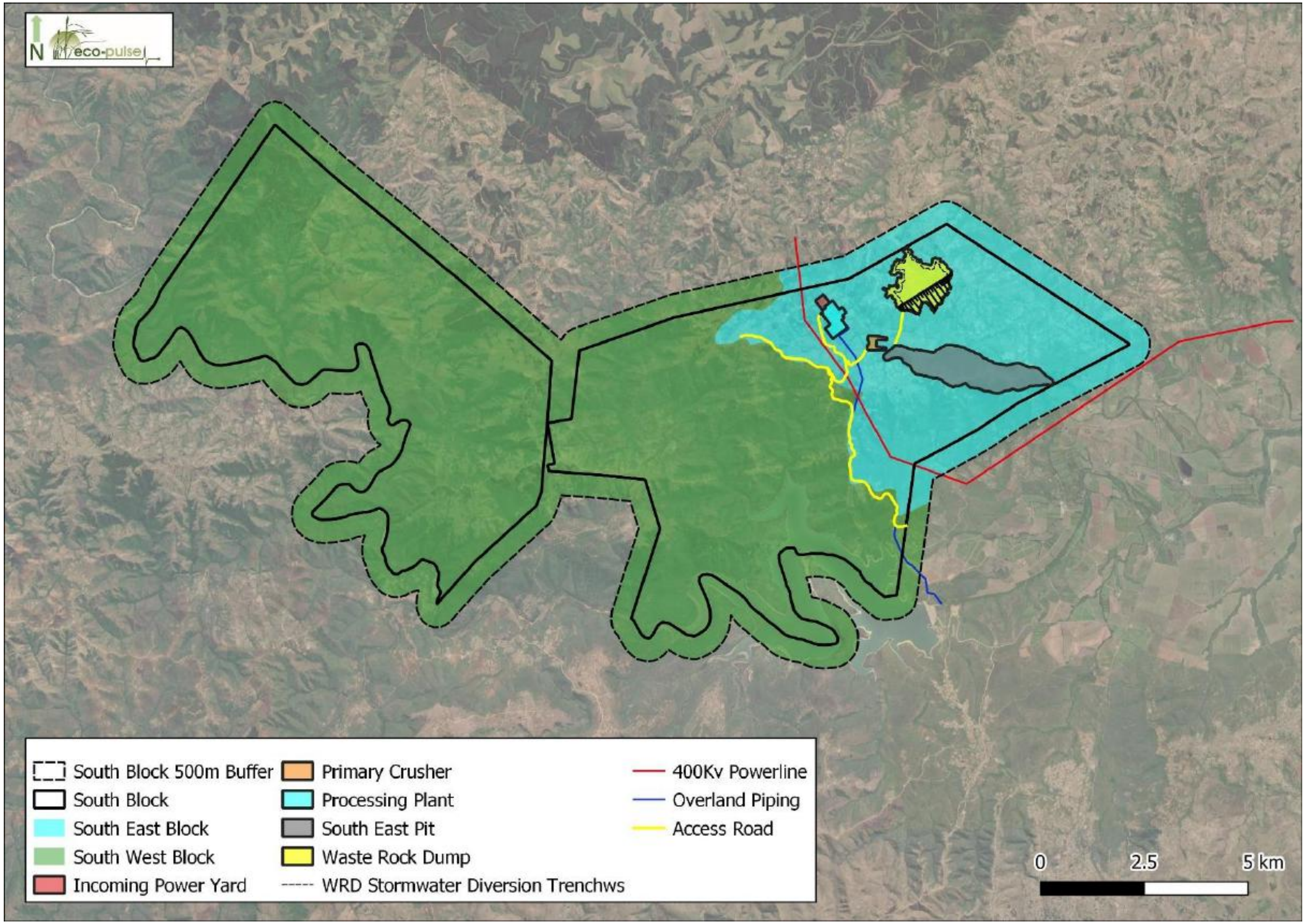

Figure 5. Division of the South Block into the South-East and South-West sub-blocks for watercourse labelling purposes.

2.2.5 Baseline Assessment Methods

Published methods of data collection and analysis were employed for the baseline delineation, classification, PES, EIS and functional assessments. **Table 3** summarises the methods, techniques and tools that were used to assess the watercourse units and includes the relevant published guidelines and assessment tools / methods / protocols utilised.

Table 3. Summary of methods used in the assessment of delineated water resource units.

Method/Technique		Reference for Methods/Tools Used
Riparian and wetland areas delineation		A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005)
Classification of riparian and wetland units		National Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis et al., 2013) Classification system for channelled watercourses (Eco-Pulse, 2013)
Rivers/Streams	**SASS 5**	The South African Scoring System (SASS) Version 5 Rapid Bioassessment Method for Rivers (Dickens & Graham, 2002)
	Ichthyofaunal survey	Ichthyofaunal survey methods (Eco-Pulse, 2017)
	Present Ecological State	Index of Habitat Integrity (IHI) (after Kleynhans, 1996).
	Riparian Ecological Importance & Sensitivity	Freshwater/Aquatic EIS tool (Eco-Pulse, 2017)
Wetlands	**Present Ecological State (**	WET-Health assessment (Macfarlane *et al*., 2008).
	Functional Importance (Eco-services assessment)	WET-EcoServices assessment (Kotze *et al*., 2019).
	Wetland Ecological Importance & Sensitivity	Wetland EIS assessment tool developed by Eco-Pulse based on Rountree and Kotze (2013) and Duthie (1999).

Note: Whilst desktop delineations and classifications into watercourse HGM types were completed, no baseline ecosystem assessments have been completed for watercourses in the North Block at this time as this assessment and report are focused largely on the South Block study area. This is because this is where mining is planned with no immediate plans to mine in the North Block currently being in place.

2.3 Impact Assessment Framework & Methodology

For the purposes of this study, the assessment of potential freshwater impacts was undertaken using a methodology supplied to Eco-Pulse by SLR. Eco-Pulse described impacts under four (4) distinct 'groups' with impact significance assessed for each group based on a range of assessment criteria. The general framework for the freshwater impact assessment is shown below in **Table 4**. This assessment was informed by baseline information contained in this report relating to the sensitivity of freshwater habitats and potential occurrence of protected species, as well as on information relating to the proposed development.

Table 4. Wetland and aquatic ecosystem impact assessment framework for development projects.

WETLAND & AQUATIC ECOSYSTEM IMPACT ASSESSMENT FRAMEWORK	
DEVELOPMENT ACTIVITIES	
Construction Phase Description:	Operation Phase Description:
Establishment of all mine related infrastructure.	Extraction of material from the mine pit and the processing of this material into iron ore concentrate. This includes the use of the WRD area.
FRESHWATER ECOSYSTEM IMPACT & RISK ASSESSMENT GROUPS	
1	Direct physical loss or modification of freshwater habitat.
2	Alteration of hydrological and geomorphological processes (*flow, erosion & sediment regime changes*).
3	Impacts to water quality.
4	Impacts to ecological connectivity and / or ecological disturbance impacts.

The significance of potential impacts associated with the proposed development on freshwater ecosystems was assessed for the following scenarios:

- **Realistic "poor mitigation" scenario** – this is a realistic worst-case scenario involving the poor implementation of construction mitigation, bare minimum incorporation of recommended design mitigation, poor operational maintenance, and poor onsite rehabilitation.
- **Realistic "good" scenario** – this is a realistic best-case scenario involving the effective implementation of construction mitigation, incorporation of most of the design mitigation, good operational maintenance, and successful rehabilitation.

2.4 Cumulative Impact Significance Assessment

A "cumulative impact" is defined in the EIA regulations, 2014 as '*past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to the existing and reasonably foreseeable impacts eventuating from similar or diverse activities*'.

The IFC (2013) defines cumulative impacts as '*those that result from the successive, incremental, and/or combined effects of an action, project, or activity (collectively referred to … as "developments") when added to other existing, planned, and/or reasonably anticipated future ones*' and further states that '*For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognised as important on the basis of scientific concerns and/or concerns of affected communities*.'

Eco-Pulse conducted a predictive cumulative impact significance assessment that considered current impacts to freshwater resources in the South Block study area, along with those likely to emerge because of the proposed Jindal mine project, and potential future impacts in the study area associated with human habitation and use of the area. The cumulative impact assessment was completed using the same framework and methodology outlined in Section 2.3, above.

2.5 DWS Risk Assessment Methodology

Government Notice 509 of 2016 published in terms of Section 39 of the NWA sets out the terms and conditions for the General Authorization of Section 21(c)[1] and 21(i)[2] water uses, key among which is that only developments posing a 'Low Risk' to watercourses can apply for a GA. Note that the GA does not apply to the following activities:

- Water use for the rehabilitation of a wetland as contemplated in GA 1198 contained in GG 32805 (18 December 2009).
- Use of water within the 'regulated area'[3] of a watercourse where the Risk Class is **Medium or High.**
- Where any other water uses as defined in Section 21 of the NWA must be applied for.
- Where storage of water results from Section 21 (c) and/or (i) water use.
- Any water use associated with the construction, installation or maintenance of any sewerage pipeline, pipelines carrying hazardous materials and to raw water and wastewater treatment works.

To this end, the DWS have developed a Risk Assessment Matrix/Tool to assess water risks associated with development activities. The DWS Risk Matrix/Assessment Tool (based on the DWS 2015 publication: 'Section 21 c and i water use Risk Assessment Protocol') was applied to the proposed project. The tool uses the following approach to calculating risk:

RISK = CONSEQUENCE X LIKELIHOOD

whereby:

CONSEQUENCE = SEVERITY + SPATIAL SCALE + DURATION

and

LIKELIHOOD = FREQUENCY OF ACTIVITY + FREQUENCY OF IMPACT + LEGAL ISSUES + DETECTION

The key risks associated with the proposed development project are presented in **Table 4** and are again outlined below:

1. Direct physical loss or modification of freshwater habitat.
2. Alteration of hydrological and geomorphological processes (flow, erosion & sediment regime changes).
3. Impacts to water quality (pollution).

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[1] 21(c): Impeding or diverting the flow of water in a watercourse
[2] 21(i): Altering the bed, banks, course or characteristics of a watercourse
[3] The 'regulated area' of a watercourse; for Section 21 (c) or (i) of the Act refers to:

i. The outer edge of the 1:100 yr flood line and/or delineated riparian habitat, whichever is greatest, as measured from the centre of the watercourse of a river, spring, natural channel, lake or dam.
ii. In the absence of a determined 1:100 yr flood line or riparian area, refers to the area within 100m from the edge of a watercourse (where the edge is the first identifiable annual bank fill flood bench).
iii. A 500m radius from the delineated boundary of any wetland or pan.

4. Impacts to ecological connectivity and/or ecological disturbance impacts

For each of the above stressors, risk was assessed qualitatively using the DWS risk matrix tool.
It is important to note that the risk matrix/assessment tool also makes provision for the downgrading of risk to low in borderline moderate/low cases subject to independent specialist motivation granted that (i) the initial risk score is within twenty-five (25) risk points of the 'Low' class and that mitigation measures are provided to support the reduction of risk. The tool was applied to the project for the highest risk activities and watercourses and was used to inform WUL requirements for the proposed development.

2.6 Assumptions & Limitations

The following limitations and assumptions apply to this baseline wetland and aquatic ecosystem assessment:

2.6.1 General assumptions & limitations

- This report deals exclusively with a defined area and the extent and nature of watercourses in that area.
- Additional information used to inform the assessment was limited to desktop data and GIS coverage's available for the province at the time of the assessment.
- All field assessments were limited to day-time assessments.
- No field visit was taken to the North Block study area. All watercourse delineations and baseline assessments for that area were done at a desktop level.

2.6.2 South Block Sampling limitations & assumptions

- Given the size of the study area, and time constraints and access constraints, most watercourses in the study area could not be verified in the field.
- Sampling by its nature means that not all parts of the study area were visited. The assessment findings are thus only applicable to those areas sampled, which were extrapolated to the rest of the study area.
- Systematic sampling of selected watercourses was undertaken. The outer boundary of the riparian and wetland zones identified can be considered accurate in the vicinity of these transects. Between transects the outer boundary had to be extrapolated using aerial photography and 20m elevation contours and, as such, the accuracy of such extrapolated sections has limitations and is open to the interpretation of the delineator.
- A Soil Munsell Colour Chart was used to determine the soil matrix colour of the soil sampled. However, it is important to note that the recording of the colours using the soil chart is highly subjective and varies significantly depending on soil moisture and the prevailing light conditions. In this case, all the soils sampled were dry and sampling was undertaken in sunny conditions.

- Soil wetness indicators (i.e., soil mottles, grey soil matrix), which in practice are primary indicators of hydromorphic soils, are not seasonally dependent (wetness indicators are retained in the soil for many years) and therefore seasonality has no influence on the delineation of wetland areas.
- The accuracy of the delineations is based solely on the recording of the onsite wetland and riparian indicators using a GPS. GPS accuracy will therefore influence the accuracy of the mapped sampling points and therefore water resource boundaries, and an error of 1-5m can be expected. All soil/vegetation/terrain sampling points were recorded using a Garmin Montana™ GPS and captured using GIS for further processing.
- All vegetation information recorded was based on the onsite visual observations of the author and no formal vegetation sampling was undertaken. Furthermore, only dominant, and noteworthy plant species were recorded. Thus, the vegetation information provided has limitations for true botanical applications.
- Although every effort was made to correctly identify the plant species encountered onsite, wetland plants, particularly the *Cyperaceae* (sedge) family, are notoriously difficult to identify to species level. Every effort as made to accurately identify plants species but where identification to species level could not be determined, such species were only identified to genus level.
- With ecology being dynamic and complex, there is the likelihood that some aspects (some of which may be important) may have been overlooked.
- While disturbance and transformation of habitats can lead to shifts in the type and extent of freshwater ecosystems, it is important to note that the current extent and classification is reported on here.
- Infield soil sampling and vegetation observations were only undertaken at strategic sampling points within the habitats likely to be negatively affected. Sampling by its nature, means that generally not all aspects of ecosystems can be assessed and identified.

2.6.3 'Seasonality' of the Assessment

Eco-Pulse undertook an infield watercourse delineation in April 2021. One infield visit does not fully cover the seasonal variation in conditions at the site. Nevertheless, seasonality is not a key factor for the target study area surveyed, and no further seasonal surveys will be required, for the following reasons:

- Soil wetness indicators (i.e. soil mottles, grey soil matrix), which in practice are primary indicators of hydromorphic soils, are not seasonally dependent (wetness indicators are retained in the soil for many years) and therefore seasonality has no influence on the delineation of wetland areas.
- While aquatic invertebrate and fish populations and communities may vary seasonally linked with breeding and/or temperature changes (to name a few), these were not accounted for in a once-off survey undertaken and are not deemed necessary for a project of this nature and based on the nature of the receiving environment.

2.6.4 Baseline Ecological Assessment

- The mapping, description, and assessment of wetland/river PES & EIS was undertaken at desktop level with limited field verification. Collected data was extrapolated for the broader project area. Areas assessed only at a desktop level therefore have a relatively low level of confidence.
- The PES and EIS assessments make use of qualitative assessment tools and thus the results are open to professional opinion and interpretation. Eco-Pulse has tried to substantiate all claims where applicable and necessary.
- The EIS assessment did not specifically address in detail all the finer-scale ecological aspects of the water resources such as a list of aquatic fauna likely to occur (i.e. invertebrates, amphibians and fish) within and make use of these systems.
- With ecology being dynamic and complex, some aspects (some of which may be important) may have been overlooked.
- 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 and only provide a very general indication of the composition of the wetland/riverine vegetation communities.
- Additional information used to inform the assessment was limited to data and GIS coverage's available for the province at the time of the assessment.

2.6.5 Impact Assessment

- Given the early planning stage of this project key information required to accurately assess potential impacts and risks to freshwater ecosystems is not available. It should therefore be noted that this impact assessment has been completed at a broad project level and only considers the plan outlined in Section 1.2, which has been derived from the AMEC Prefeasibility Engineering Study (2015). As such, this impact assessment should be regarded as preliminary and indicative, and subject to more detailed impact evaluations once appropriately detailed information becomes available. In particular, more detailed information is required regarding the stormwater management plan for all proposed infrastructure, the plan and design for infrastructure required to treat domestic wastewater, contaminated runoff, and other polluted water that may be discharged into the environment and plans and processes to handle potential acid mine drainage (AMD) associated the operation of the mine.
- Key Omissions from Impact Significance Assessment include:
    - The establishment and operation of the conveyor system that will transport crushed material to the ROM stockpile.
    - The TSF (part of a separate application process).
    - The transport of tailings from the plant to the TSF.
    - Construction and operation of the office complex that is to include all staff accommodation, a car park, canteen, meeting rooms, etc.

  - Establishment of powerlines to provide electricity to the operation. Establishment and operation of any required railway lines and / or slurry pipelines required to transport the processed iron ore concentrate away from the site.
- The assessment of impacts and recommendation of mitigation measures was undertaken at a desktop level and based on the assessor's working knowledge and experience with similar mining projects.
- The impact assessment was only undertaken for a single development scenario under two mitigation scenarios referred to as the 'realistic poor mitigation' and 'realistic good mitigation' scenarios.
- 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 development projects.
- The impact descriptions and assessment are based on the author's understanding of the proposed development based on information provided.
- Evaluation of the significance of impacts with mitigation considers mitigation measures provided in this report and standard mitigation measures included in the Environmental Management Programme (EMPr).

3. DESKTOP BIOPHYSICAL & CONSERVATION CONTEXT ASSESSMENT

3.1 Biophysical Setting & Context

3.1.1 Ecoregion Data (DWAF, 2007)

DWAF (2007) level II ecoregions are essentially regions within which there is a relative similarity in the mosaic of ecosystems and ecosystem components such as physiography, climate, rainfall, geology, and potential natural vegetation (DWAF: Ground Water Dictionary). The North and South Blocks cross two (2) level II ecoregions; (i) North Eastern Uplands – 14.05 and (ii) North Eastern Uplands – 14.06 (**Figure 6**). A summary of the biophysical information associated with each of these level II ecoregions is summarised in **Table 5**.

Figure 6. Level II Ecoregions (DWAF, 2007) associated with the study area.

Table 5. Summary of the biophysical characteristics associated with the level II ecoregions that occur in the study area.

Biophysical Attribute	North-Eastern Uplands – 14.05	North-Eastern Uplands – 14.06
Typical terrain morphology	Highly dissected low undulating mountains	Highly dissected low undulating mountains, undulating hills, undulating lowlands
Mean annual precipitation (mm)	600-700	700-1000
Rainfall seasonality	Mid-Summer, Early Summer, Late Summer	Mid-Summer
Mean annual temperature (C)	15-22	19-22
Median annual simulated runoff (mm)	650-810	750-810

3.1.2 Regional Geology

The 1: 1 000 000 chronostratigraphic map of the Republic of South Africa and the kingdoms of Lesotho and Swaziland (Council for geoscience, 2008 last updated in 2013) provides descriptions of the various geologies found across the study area. These are shown in **Figure 7**, below.

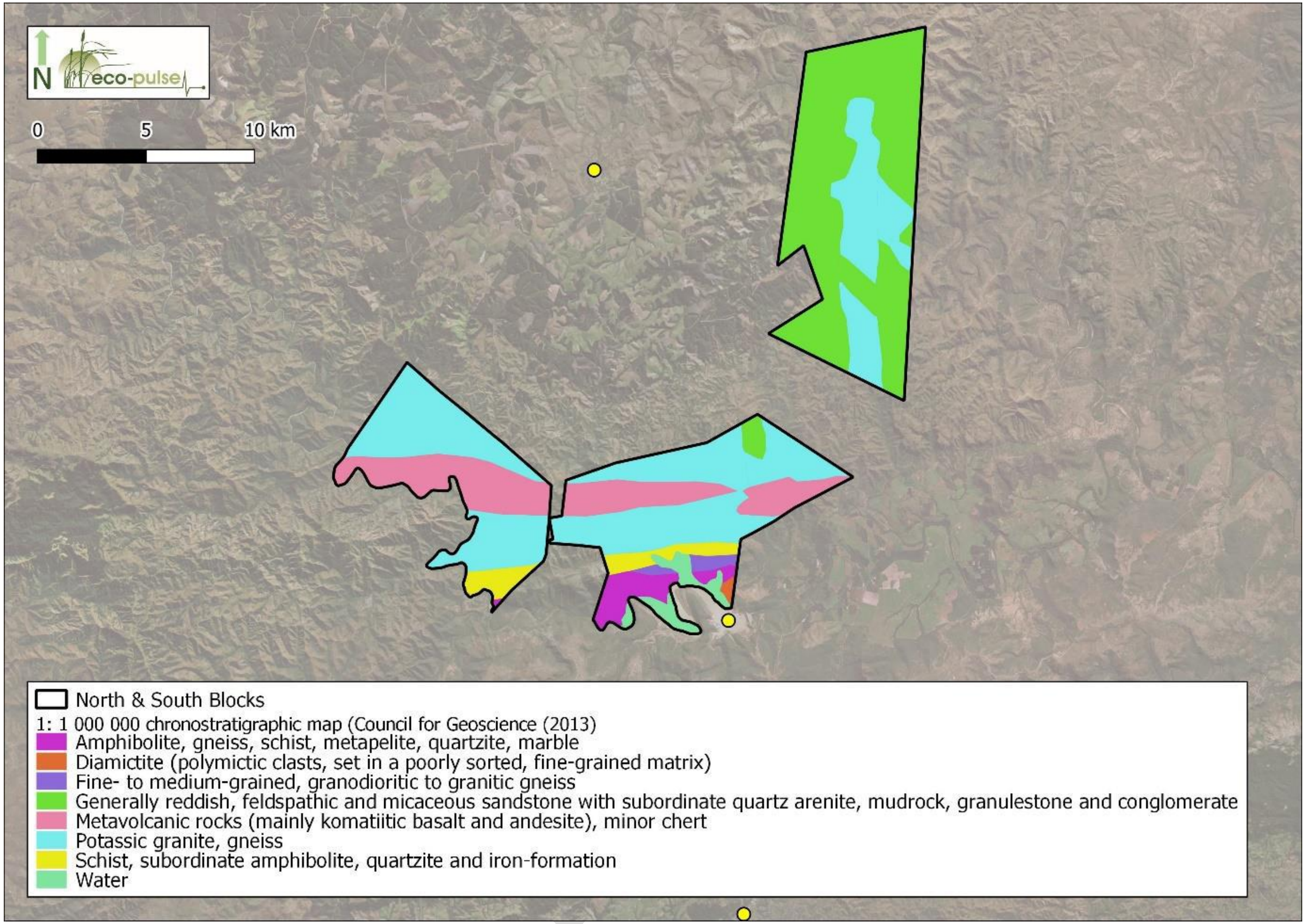

Figure 7. Map indicating the location and extent of geologies across the study area according to the RSA Council for Geoscience (2008) Map.

3.2 Drainage Context

3.2.1 South Block

The majority of the South Bock is located within DWS quaternary catchment W12B. A portion of the eastern extent of the South Block crosses into W12D (**Figure 8**). The primary river draining both catchments is the Mhlatuze River. This river forms the southern boundary of the South Block. The Goedertrouw Dam, located along the Mhlatuze River forms part of the South block. The Goedertrouw Dam is a regional water supply dam built in the 1980s. A large tributary of the Mhlatuze River, the KwaMazula River, drains much of the central portion of the South Block. This tributary meets the Mhlatuze River at the location of the Goedertrouw Dam. A dense drainage network of 1st, 2nd and 3rd order tributaries is linked to the Mhlatuze and KwaMazula Rivers.

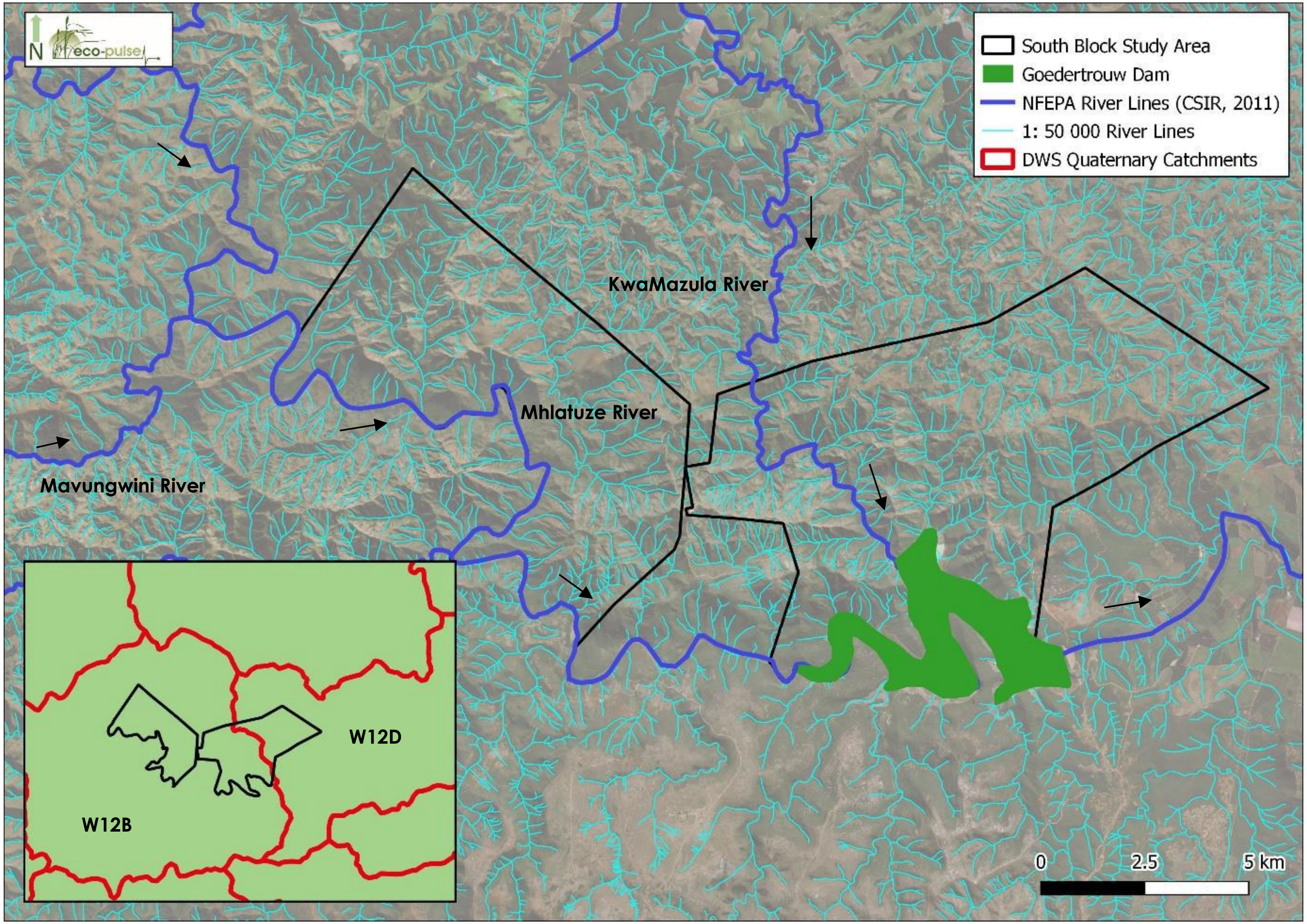

Figure 8. Drainage context of the South Block study area.

3.2.2 North Block

The North Block is located within DWS quaternary catchment W12C (**Figure 9**). the primary river draining this catchment is the Mfule River. This river is the ultimate receiver of water from the dense drainage network of rivers and wetlands within the North Block. The reach of the Mfule River that exists within the North Block is downstream of its confluence with the Mfulazane River and upstream of its confluence with the Nhlozane River.

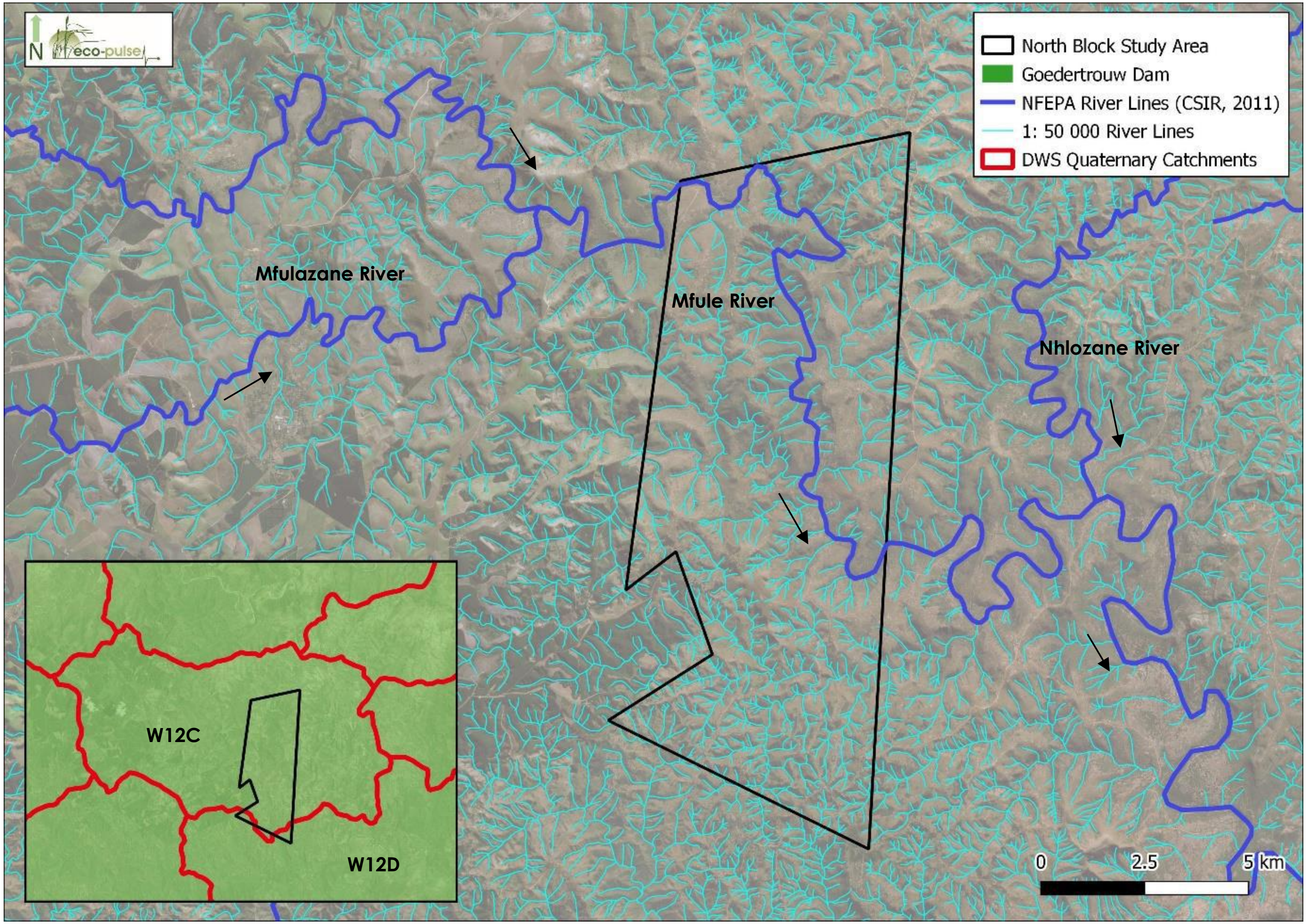

Figure 9. Drainage context of the North Block study area

3.3 Freshwater Conservation Context

3.3.1 National Conservation Context

The National Freshwater Ecosystem Priority Areas (NFEPA) assessment (Nel *et al.*, 2011) and the Inland Aquatic / Freshwater Realm of the latest National Biodiversity Assessment were screened for the study area to gain an understanding of the national conservation importance of onsite freshwater resources. The results of this screening process are presented below.

3.3.1.1 National Freshwater Ecosystem Priority Areas (NFEPA) (Nel et al., 2011):

The South Block coincides with a total of five (5) catchment planning NFEPA catchment planning units. These are as follows:

- Planning Unit 3479
- Planning Unit 3334
- Planning Unit 3336
- Planning Unit 3356
- Planning Unit 3388

None of these units have been assigned a management status by the NFEPA Project (**Figure 10**). There are no NFEPA catchment planning units downstream of the South Block study area with a specific management status.

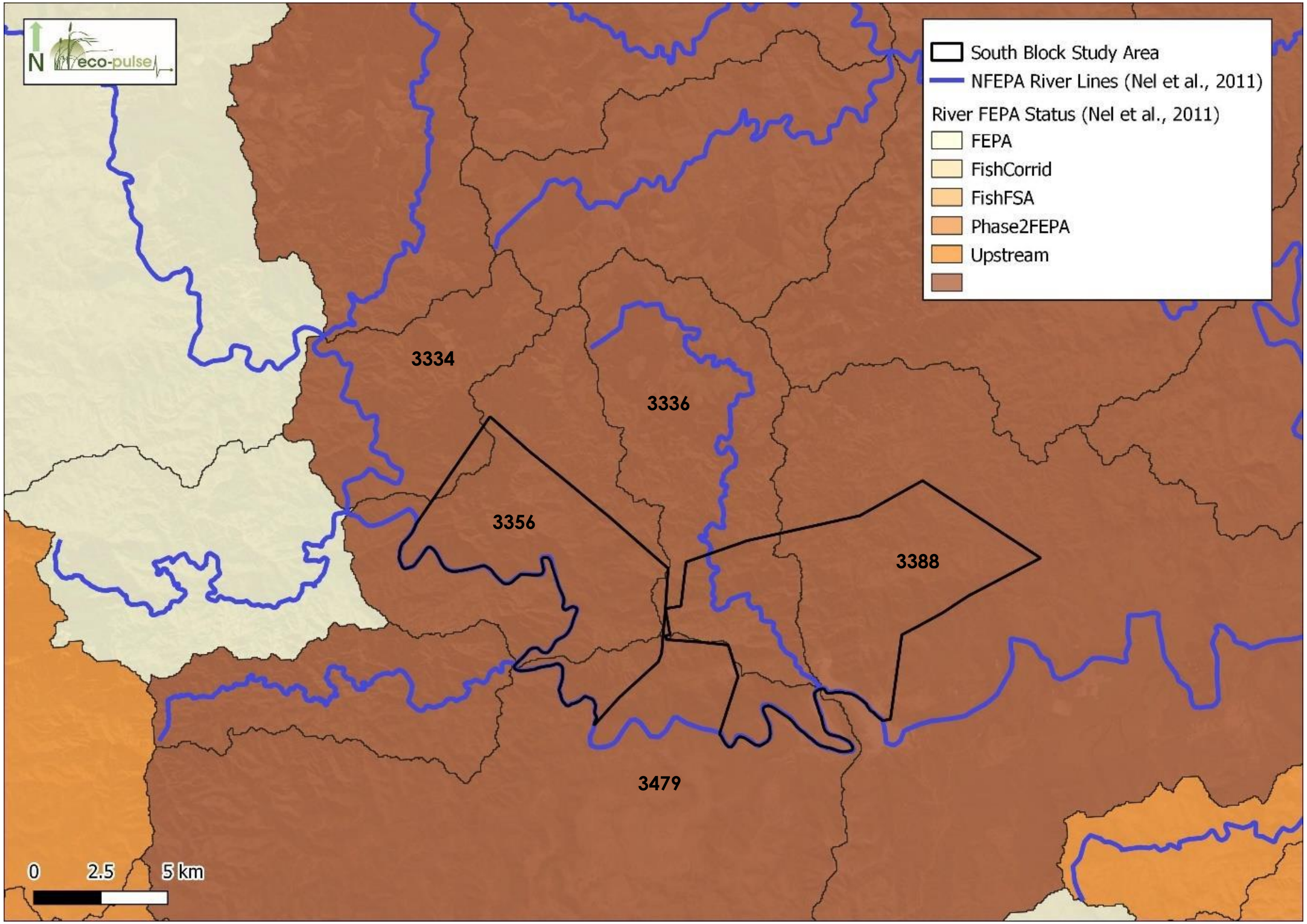

Figure 10. NFEPA catchment planning unit statuses for the South Block

The North Block coincides with a total of four (4) catchment planning NFEPA catchment planning units. However, most of the study area falls within a single catchment planning unit. The catchment planning units associated with the North Block are as follows:

- Planning Unit 3303
- Planning Unit 3232
- Planning Unit 3225
- Planning Unit 3388

None of these units have been assigned a management status by the NFEPA Project (**Figure 11**). There are no NFEPA catchment planning units downstream of the North block study area with a specific management status.

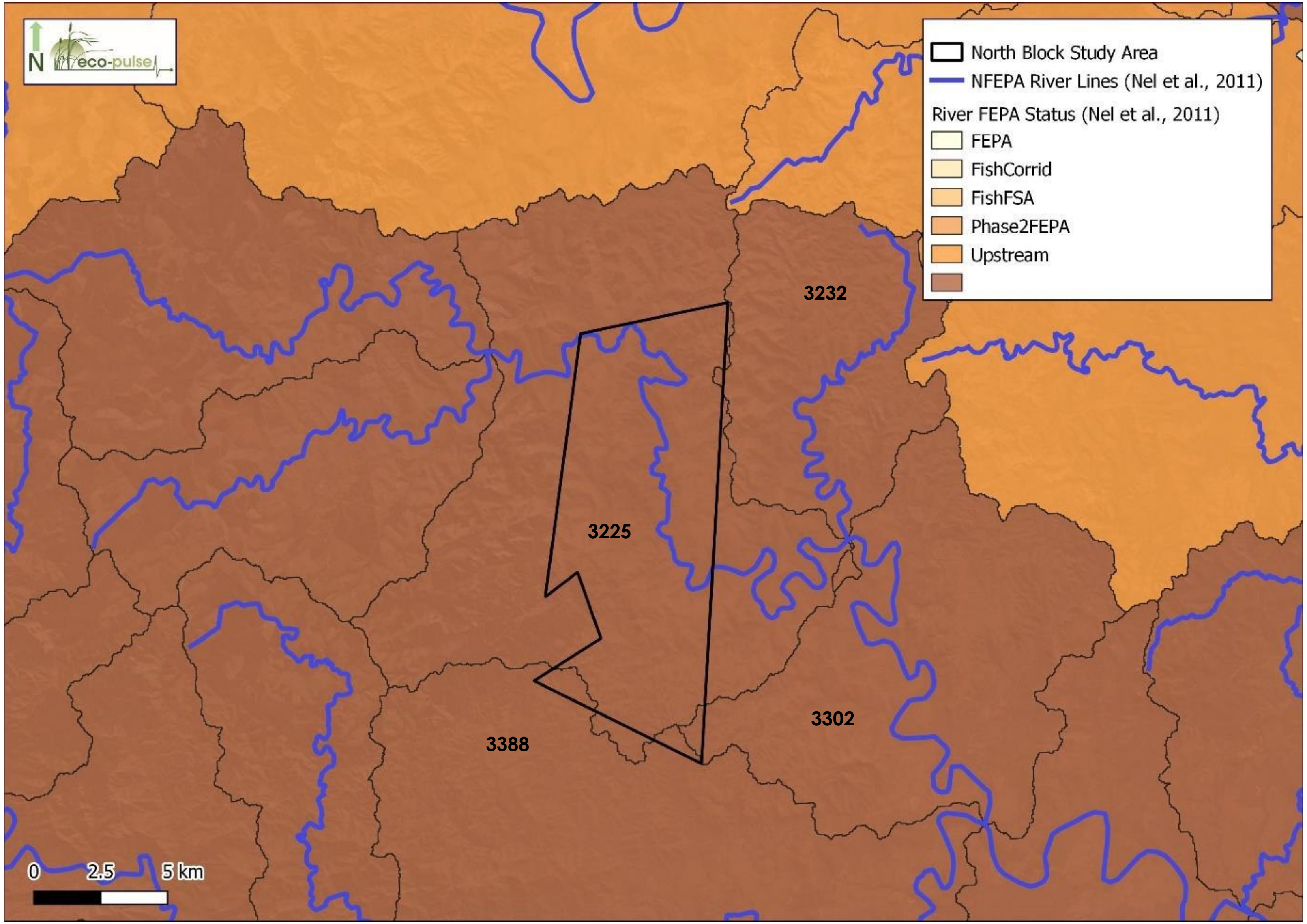

Figure 11. NFEPA catchment planning unit statuses for the North Block

3.3.1.2 National Biodiversity Assessment (NBA) – Inland Aquatic / Freshwater Realm (Van Deventer et al., 2018):

Wetlands:

The Inland Aquatic / Freshwater Realm of the latest National Biodiversity Assessment has assigned ecosystem threat statuses (ETS) to wetland ecosystem types across South Africa. In the latest NBA, a wetland ecosystem is a combination wetland HGM type (which represent functional wetland diversity), and spatial bioregions (which represent broad bioclimatic regions). The NBA considers four (4) HGM types and thirty-seven (37) bioregions, resulting in hundred and forty-eight (148) potential wetland ecosystem types across the country. Two (2) bioregions occur in the South Block. These are the sub-escarpment grassland and sub-escarpment savanna bioregions. Three (3) bioregions occur in the North Block. These are the sub-escarpment grassland, lowveld, and zonal / intrazonal forest bioregions (**Figure 12**). No ETS has, however, been assigned to wetlands in the zonal / intrazonal forest bioregion.

The ecosystem threat status of the different wetland ecosystem types in the study area are summarized in **Table 6**. The latest NBA rates eight (8) of the twelve (12) possible wetland ecosystem types in the study area as Critically Endangered. Three (3) different wetland types are considered Endangered, and a single wetland type is considered Vulnerable. A description of the different threat statuses is as follows:

- **Critically Endangered** - ≤ 20% of wetland ecosystems of this type remain in natural / near natural condition in the country.
- **Endangered** - ≤ 35% of wetland ecosystems of this type remain in natural / near natural condition in the country.
- **Vulnerable** - ≤ 60% of wetland ecosystems of this type remain in natural / near natural condition in the country.
- **Least Threatened** - > 60% of wetland ecosystems of this type remain in natural / near natural condition in the country.

Table 6. National Biodiversity Assessment threat statuses and protection levels for wetland ecosystem types in the study area.

Bioregion	Wetland HGM Type			
	Channeled Valley Bottom	Unchanneled Valley Bottom	Seep	Depression
Sub-escarpment grassland	Critically Endangered	Critically Endangered	Critically Endangered	Endangered
Sub-escarpment savanna	Critically Endangered	Critically Endangered	Critically Endangered	Endangered
Lowveld	Critically Endangered	Critically Endangered	Endangered	Vulnerable
Zonal / intrazonal forest	Not Rated			

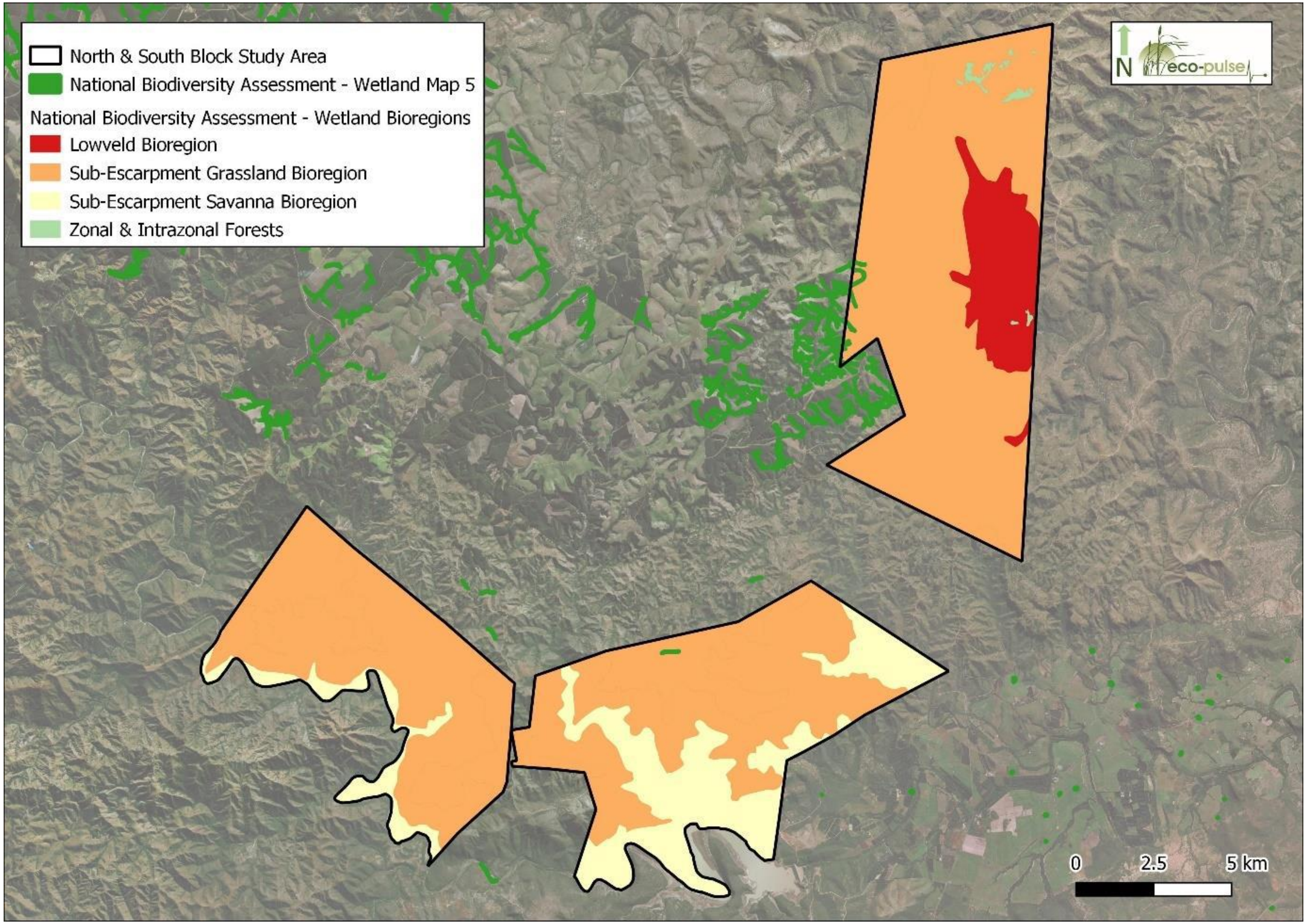

Figure 12. National Biodiversity Assessment bioregions associated with the study area.

Rivers:

River ecosystem types are characterised at three (3) levels by the latest NBA. These levels are:

1. DWAF (2005) Level I Ecoregion (broad ecological context)
2. Flow variability (permanent or non-permanent)
3. Longitudinal zonation (mountain stream, upper foothill, lower foothill, and lowland rivers)

A single (1) level I ecoregion covers both the South and North Blocks (**Figure 6**). This ecoregion is the North Eastern Uplands (Ecoregion 14). The different river ecosystem types and their associated ETS are summarised in **Table 7**, below. The NBA rates all permanently flowing rivers and streams in the North Eastern uplands region as Least Threatened. For non-permanently flowing rivers and streams, mountain stream are considered Least Threatened, upper foothill rivers are considered Endangered, whilst lower foothill and lowland rivers are Critically Endangered. A description of the different threat statuses is as follows:

- **Critically Endangered** - ≤ 20% of river ecosystems of this type remain in natural / near natural condition in the country.
- **Endangered** - ≤ 35% of river ecosystems of this type remain in natural / near natural condition in the country.
- **Vulnerable** - ≤ 60% of river ecosystems of this type remain in natural / near natural condition in the country.
- **Least Threatened** - > 60% of river ecosystems of this type remain in natural / near natural condition in the country.

Table 7. Summary of the NBA river ecosystem types and their ecosystem threat statuses for the North Eastern Uplands ecoregion.

	Longitudinal Zonation			
Flow	**Mountain Stream**	**Upper Foothill River**	**Lower Foothill River**	**Lowland River**
Permanent	Least Threatened	Least Threatened	Least Threatened	Least Threatened
Non-Permanent	Least Threatened	Endangered	Critically Endangered	Critically Endangered

3.3.2 Provincial Conservation Context

3.3.2.1 KwaZulu-Natal Freshwater Systematic Conservation Plan (FSCP) (EKZNW, 2007)

The KZN FSCP (EKZNW, 2007) was analysed to inform the assessment of provincial level aquatic conservation priorities and sensitivities. The location and classification of river sub-catchment according to the KZN FSCP (EKZNW, 2007) is shown in **Figure 13**, below. A total of thirteen (13) sub-catchment planning units occurs within the South Block. Twelve (12) of these planning units were assigned an Available status. A single planning unit (Unit ID: 3248) was assigned an Earmarked status. Eleven (11) sub-catchment planning units occur within the North Block, all of which have an Available status. There are no Conserved catchment planning units in the study area. A description of the planning unit statuses according to FSCP are outlined below:

- Available – Largely untransformed biodiversity area suitable for meeting biodiversity targets should they be required.
- Earmarked – Optimal biodiversity areas that are required to meet biodiversity targets.
- Conserved – Formally protected areas that are contributing to meeting biodiversity targets.

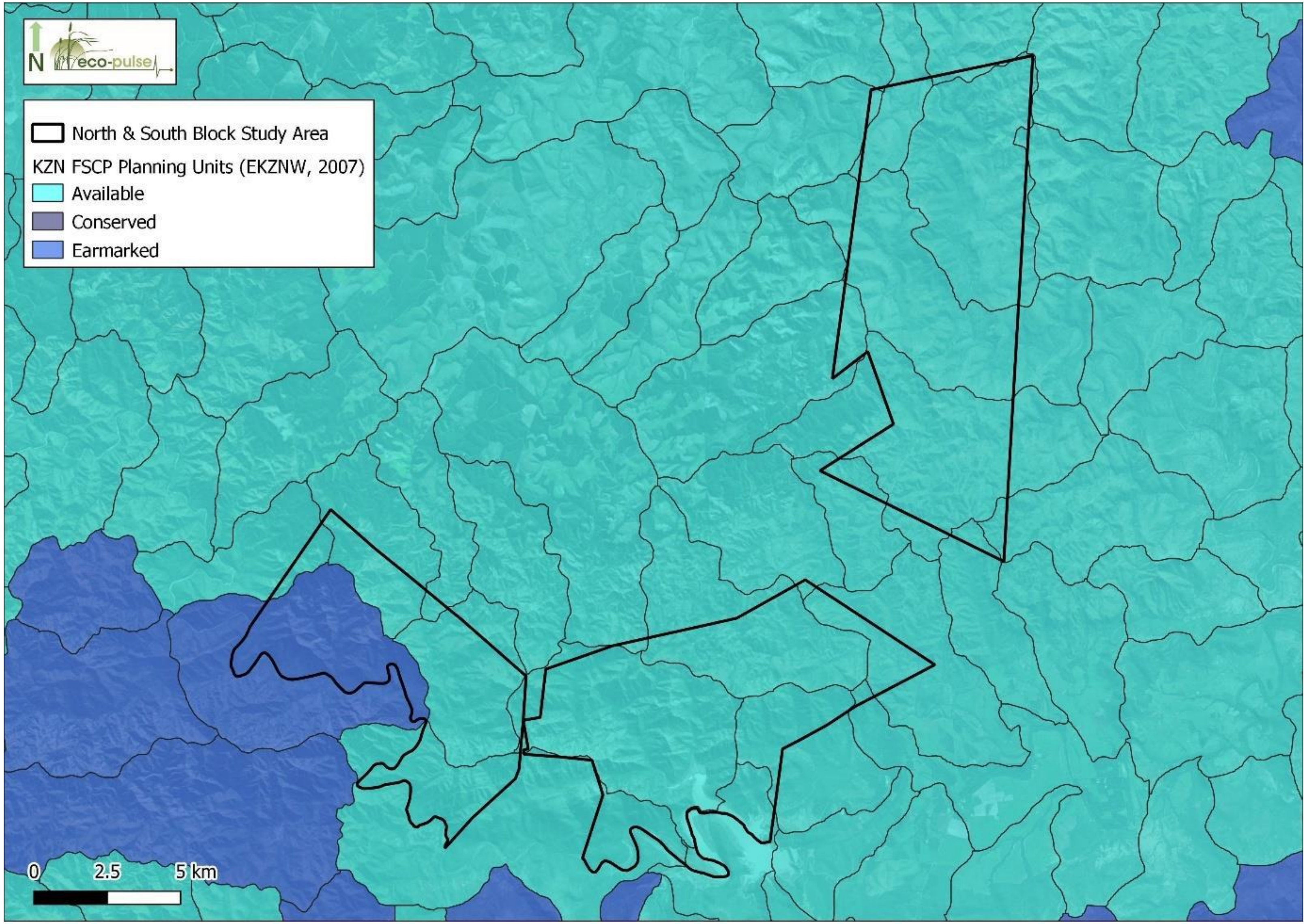

Figure 13. Conservation status of river sub-catchments planning units with conservation priorities according to KwaZulu Natal FSCP (EKZNW, 2007).

3.4 Summary of Existing Desktop Studies - Major Rivers

3.4.1 DWS Desktop Assessment (2014)

The DWS Resource Quality Information Services compiled a desktop assessment of the Present Ecological State (PES), Ecological Importance (EI) and Ecological Sensitivity (ES) per sub-quaternary reach for secondary catchments in South Africa. The outcomes of the assessment for rivers within the South and North Blocks is presented in **Table 8**, below, with a short discussion on the outcomes of the assessment per river also provided.

Mhlatuze River – South Block:

Two (2) sub-quaternary reaches of the Mhlatuze coincide with South Block study. The division of these reaches is the Goedertrouw Dam wall, with reach W12B-03479 extending upstream of the dam and W12D-03388 extending downstream. The reach upstream of the dam is rated as largely natural, while the reach downstream of the dam was rated as largely modified (**Table 8**). The study highlights rural settlements, invasive alien plant encroachment and flooding from the Goedertrouw dam as the activities impacting river health of the reach upstream of the dam. The desktop study indicates that water abstraction for cultivation, invasive alien plants and road crossings are the major factors affecting river PES for the reach downstream of the dam.

KwaMazula River – South Block

The KwaMazula River, which runs through the central part of the South Block, was assessed as a single reach (W12B-03336). This river reach was assessed as being largely natural (**Table 8**). Impacts to the health of this system were recorded as being forestry practices and sugarcane cultivation within its upper reaches, and the presence of the Goedertrouw Dam along its lower reaches, which has flooded out a section of the system.

Mfule River – North Block

The sub-quaternary reach of the Mfule River that runs through the North Block was assessed as being in largely natural condition (**Table 8**). The activities highlighted as impacting the health of the system were rural settlements, invasive alien plant encroachment and abandoned agricultural lands.

Table 8. Summary of the desktop PES and EIS information for the Mhlatuze, KwaMazula, and Mfule Rivers (DWS, 2014).

River	Reach Code	PES Assessed by Expert	PES	EI	ES
South Block of Study Area					
Mhlatuze	W12B-03479	Yes	B: Largely Natural	High	High
	W12D-03388	Yes	D: Largely Modified	Moderate	High
KwaMazula River	W12B-03479	Yes	B: Largely Natural	High	High

North Block of Study Area					
Mfule River	**W12C-03225**	Yes	B: Largely Natural	High	High

4. SOUTH BLOCK BASELINE ASSESSMENT FINDINGS

4.1 Watercourse Classification & Habitat Characteristics

A total of five hundred and ninety-nine (599) river / stream units and twenty-two (22) wetland units were identified and classified in the South Block study area. This included watercourses of the following classifications:

Rivers and Streams:

- Mountain Headwater Streams – 431 units
- Mountain Streams – 154 units
- Transitional Rivers – 10 units
- Upper Foothill Rivers – 3 units
- Lowland River (Mhlatuze River) – 1 unit

Wetlands:

- Seep Wetlands – 11 units
- Unchanneled Valley Bottom Wetlands – 12 units

The watercourse map for the South Block is shown in **Figure 16**. A summary of the number of different river / stream and wetland types across the South Block is provided below.

Rivers and Streams:

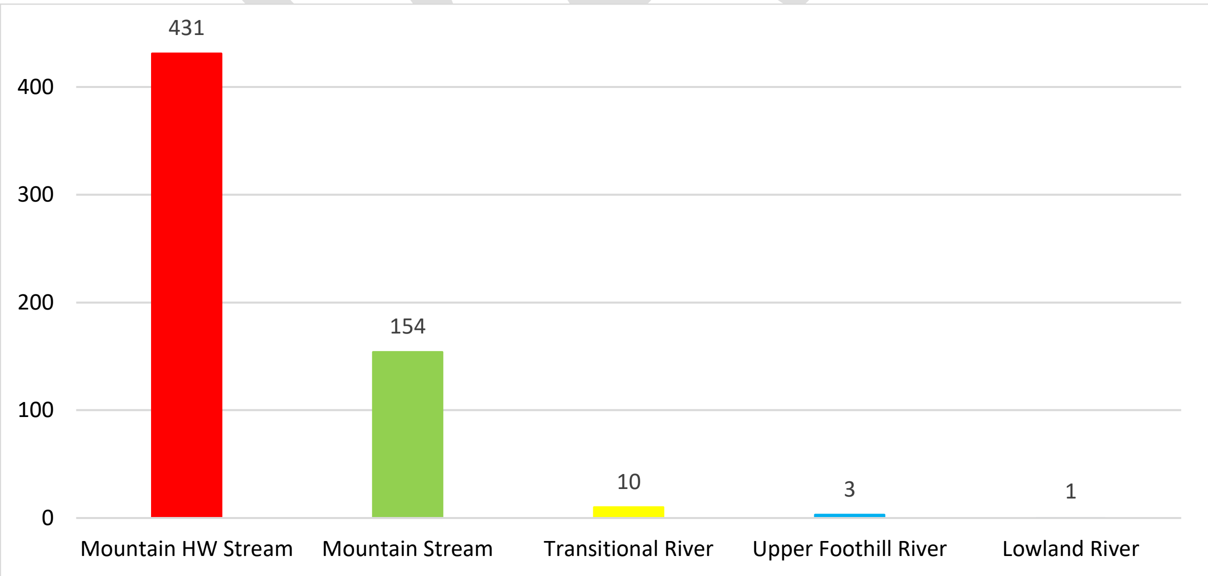

Figure 14. Summary of the different river and stream types within the South Block.

Wetlands:

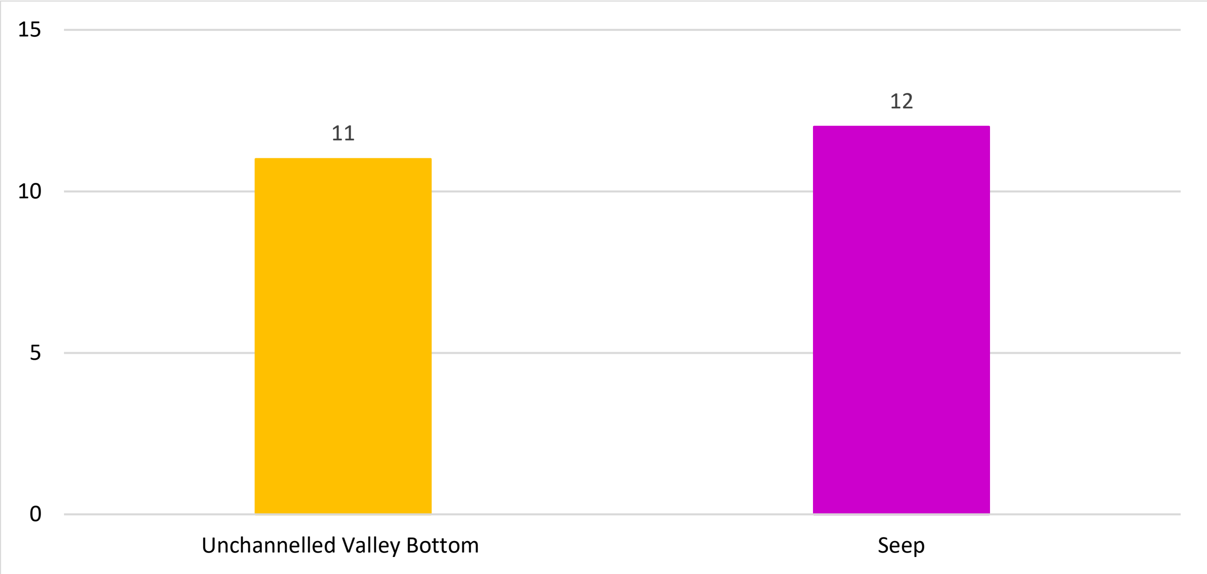

Figure 15. Summary of the different wetland types within the South Block

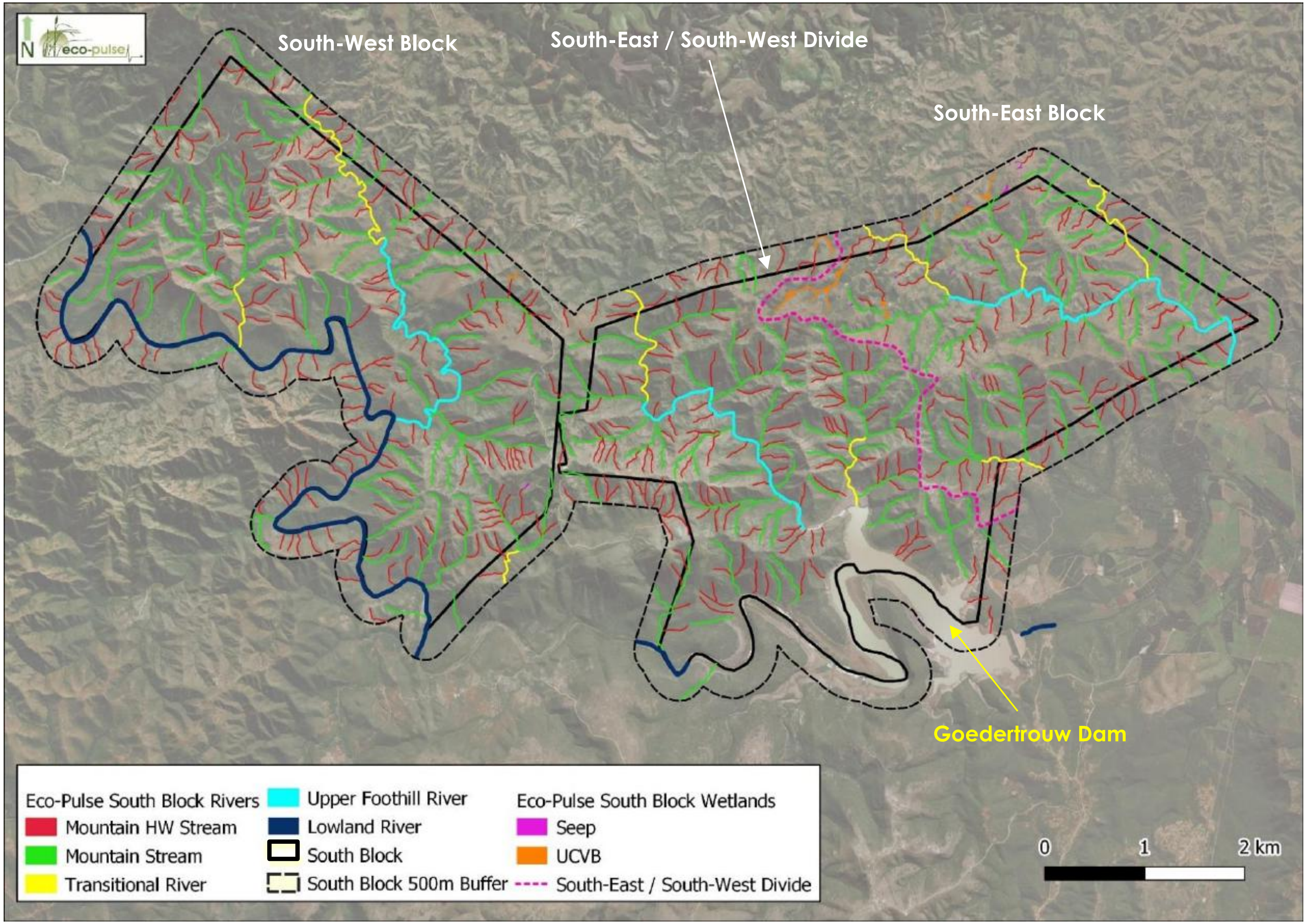

Figure 16. Watercourse delineation and classification map for the South Block.

Given the size and dense drainage network that characterises the study area, the process unit classification and assessment approach was applied to the following watercourse types:

- Mountain Headwater Streams *(divided into four [4] process unit groups)*
- Mountain Streams *(divided into four [4] process unit groups)*
- Seep Wetlands *(divided into three [3] process unit groups)*
- Unchanneled Valley Bottom Wetlands *(divided into two [2] process unit groups)*

All Transitional Rivers, Upper Foothill Rivers, and Lowland Rivers were assessed as individual watercourse units. The process unit groupings (Mountain Headwater Streams, Mountain Streams, Wetlands) and assessment units (Transitional Rivers, Upper Foothill Rivers and Lowland Rivers) for the South Block are shown in **Figure 17**, below. Summaries for each unit, including biophysical descriptions are outlined in the subsections which follow. Given the size of the study area, Eco-Pulse was only able to visit a subset of streams in each process unit group in the South Block. The process unit biophysical descriptions in **Tables 9-30** below are therefore based on the visited watercourses, with the detail from these watercourses being extrapolated to other streams in the same process.

Note: All watercourses in the study area were given a unique watercourse identification code. The code system is as follows:

- Block division-watercourse type-unique number

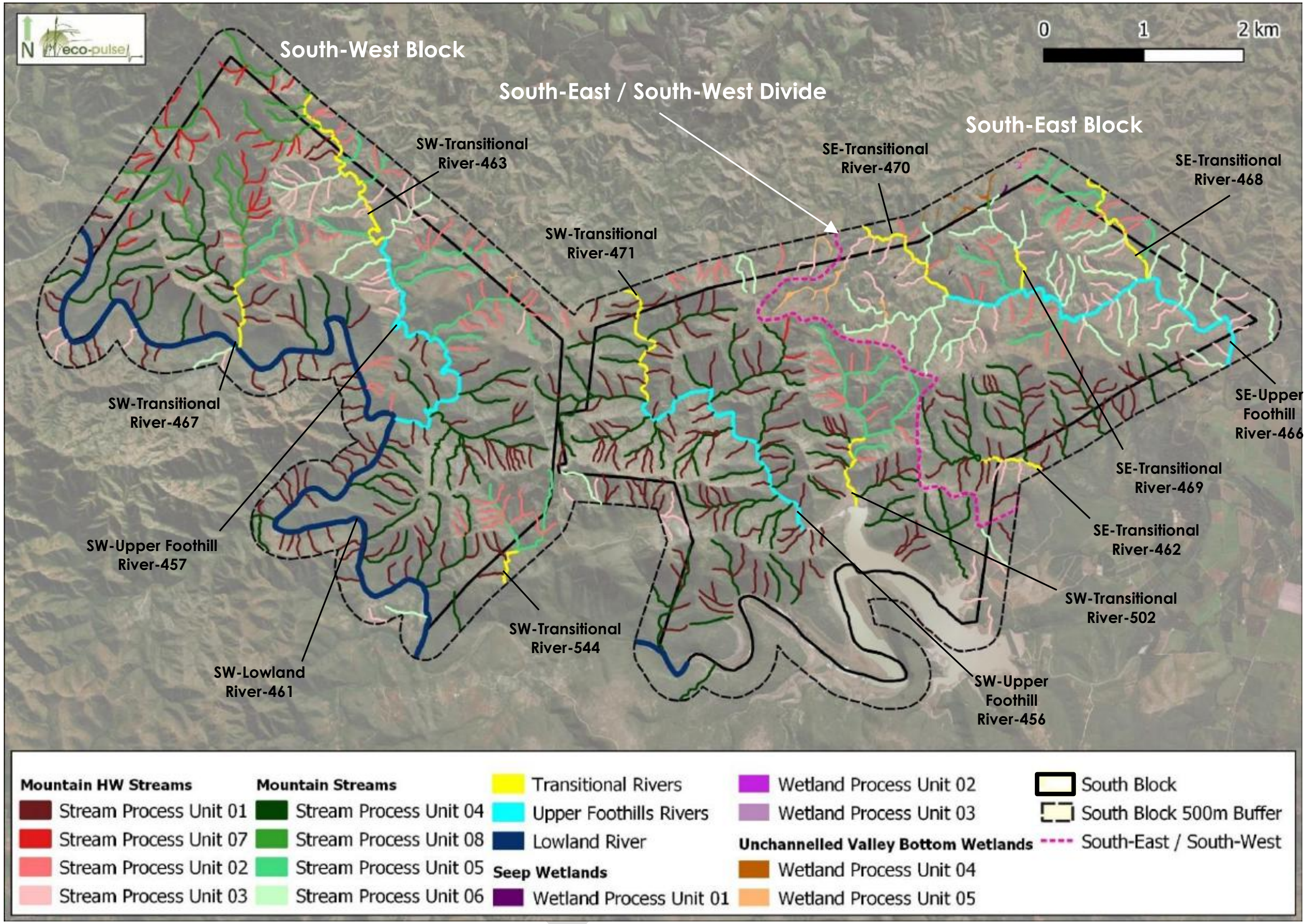

Figure 17. River, stream, and wetland assessment units for the South Block

4.1.1 Mountain Headwater Streams

The four-hundred and thirty-one (431) Mountain Headwater Streams mapped in the South Block were divided into four (4) different process unit groups as follows:

- Process Unit Group 01 – 235 units
- Process Unit Group 07 – 32 units
- Process Unit Group 02 – 90 units
- Process Unit Group 03 – 74 units

A summary of the division of the Mountain Headwater Streams into process unit groups is presented in **Figure 18**. The location of the different process unit groups can be seen in **Figure 17**, above. Biophysical descriptions for each Mountain Headwater stream Process Unit Group are presented in the tables which follow.

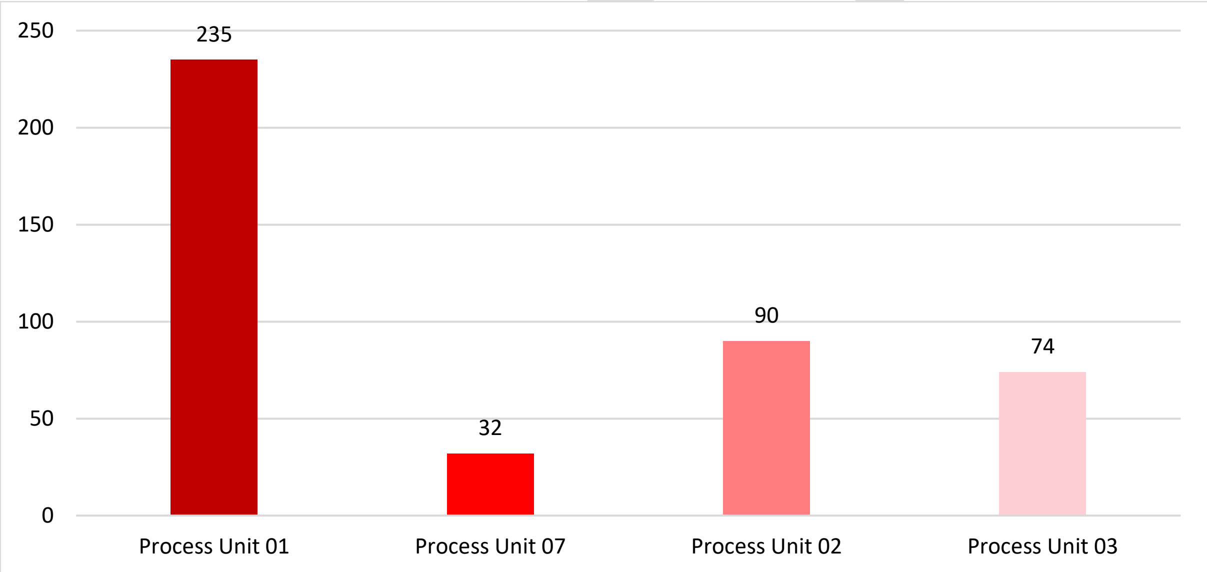

Figure 18. Summary of the division of the South Block Mountain Headwater streams into Process Unit Groups.

Table 9. Summary of key features of South Block River 'Process Unit' group 01.

Mountain Headwater Stream – Process Unit 01	
Number of Stream Units in Process Group	235
General Catchment Description	Largely natural / semi-natural with little interruption to expected natural catchment processes.
General Unit Description	Steep streams with small catchments areas. Minimal bed and bank modifications.
Expected Biophysical Characteristics	
Flow	Ephemeral - Flows are only expected along these units for a short period following high rainfall events.
General Substrate Type	Alluvial.

Mountain Headwater Stream – Process Unit 01	
General Instream Biotopes	Dry alluvial stream bed.
Expected Riparian Features	Macro channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone with minimal alien invasive plant species.

Selected photos of watercourses from Process Unit 01:

Photo 01: Overview of watercourse unit SE-PU01-141.

Photo 02: Overview of watercourse unit SE-PU01-142.

Table 10. Summary of key features of South Block River 'Process Unit' group 07.

Mountain Headwater Stream – Process Unit 07	
Number of Stream Units in Process Group	32
General Catchment Description	Vegetation dominated by commercial forestry plantation species.
General Unit Description	Steep streams with small catchment areas. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone.
Expected Biophysical Characteristics	
Flow	Ephemeral - Flows are only expected along these units for a short period following high rainfall events.
General Substrate Type	Alluvial.
General Instream Biotopes	Dry alluvial stream bed.
Expected Riparian Features	Macro channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone that is dominated by woody and herbaceous alien plant species.

Selected photos of watercourses from Process Unit 07

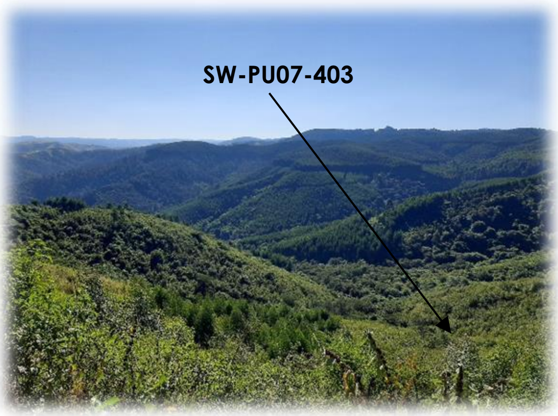

Photo 03: Overview of watercourse unit SW-PU07-403. Notable in the photo is the commercial forestry which dominates the catchment area.

Photo 04: Riparian and active channel area of watercourse unit SW-PU07-364. Vegetation dominated by dense woody IAPs.

Table 11. Summary of key features of South Block River 'Process Unit' group 02.

Mountain Headwater Stream – Process Unit 02	
Number of Stream Units in Process Group	90
General Catchment Description	Vegetation dominated by woody and herbaceous invasive alien plant species. Emergence of alien plants is likely linked to historic ploughing and forestry, and / or present-day overgrazing and frequent burning.
General Unit Description	Steep streams with small catchment areas. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone.
Expected Biophysical Characteristics	
Flow	Ephemeral - Flows are only expected along these units for a short period following high rainfall events.
General Substrate Type	Alluvial.
General Instream Biotopes	Dry alluvial stream bed.
Expected Riparian Features	Macro channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone that is dominated by woody and herbaceous alien plant species.

Selected photos of watercourses from Process Unit 02:

Photo 03: Channel bed of watercourse unit SE-PU02-443 which is overgrown with woody invasive vegetation.

Photo 04: Overview of watercourse unit SE-PU02-597.

Table 12. Summary of key features of South Block River 'Process Unit' group 03.

Mountain Headwater Stream – Process Unit 03	
Number of Stream Units in Process Group	74
General Catchment Description	Dominated by rural settlements and homesteads. Vegetation dominated by woody and herbaceous invasive alien plant species.
General Unit Description	Steep streams with small catchment areas. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone. Clearing of indigenous trees from riparian zone is common.
Expected Biophysical Characteristics	
Flow	Ephemeral - Flows are only expected along these units for a short period following high rainfall events.
General Substrate Type	Alluvial.
General Instream Biotopes	Dry alluvial stream bed.
Expected Riparian Features	Macro channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone that is dominated by woody and herbaceous alien plant species.

Selected photos of watercourses from Process Unit 03:

Photo 05: Overview of watercourse unit SE-PU03-447.

Photo 06: Upstream view of watercourse unit SE-PU03-70.

4.1.2 Mountain Streams

The one-hundred and fifty-four (154) Mountain Streams mapped in the South Block were divided into four (4) different process unit groups as follows:

- Process Unit Group 04– 81 units
- Process Unit Group 08 – 12 units
- Process Unit Group 05 – 23 units
- Process Unit Group 06 – 38 units

A summary of the division of the Mountain Streams into process unit groups is presented in **Figure 19**. The location of the different process unit groups can be seen in **Figure 17**, above. Biophysical descriptions for each Mountain Headwater Stream Process Unit Group are presented in the tables which follow.

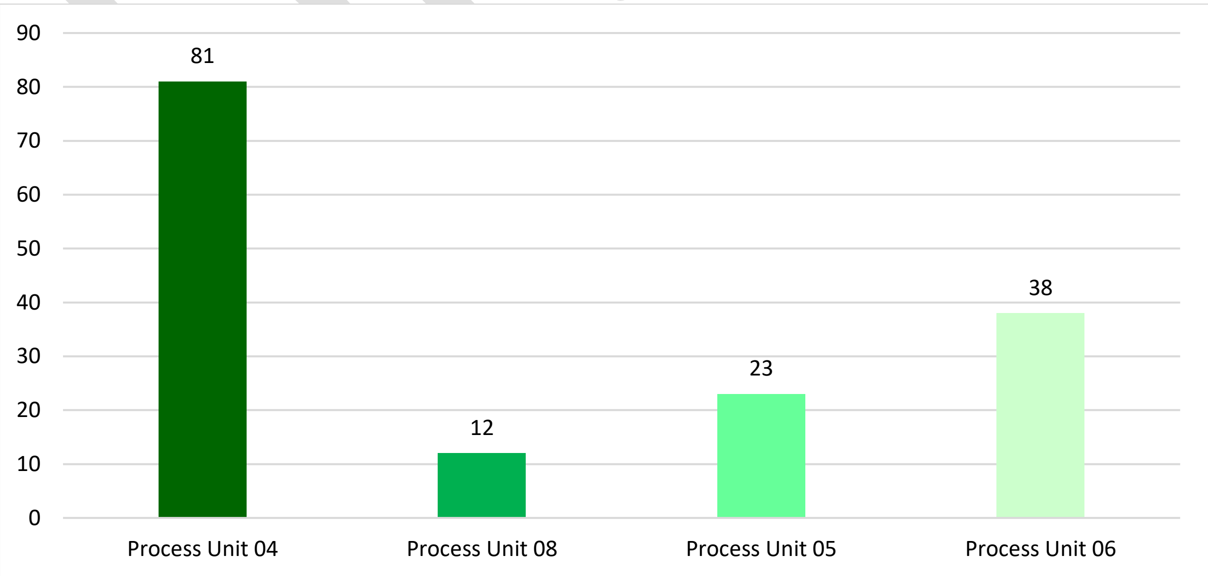

Figure 19. Summary of the division of the South Block Mountain Streams into Process Unit Groups

Table 13. Summary of key features of South Block River 'Process Unit' group 04.

Mountain Stream – Process Unit 04	
Number of Stream Units in Process Group	81
General Catchment Description	Largely natural / semi-natural with little interruption to expected natural catchment processes.
General Unit Description	Moderately steep streams with small catchments areas. Minimal bed and bank modifications.
Expected Biophysical Characteristics	
Flow	Seasonal
General Substrate Type	Mixed bedrock and alluvial.
General Instream Biotopes	Pool, riffles, runs.
Expected Riparian Features	Macro channel bank. Active channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone with minimal alien invasive plant species. **Active Channel:** • Some herbaceous marginal vegetation. Instream vegetation lacking.

Selected photos of watercourses from Process Unit 04:

Photo 07: Overview of the upstream reaches of watercourse unit SE-PU04-500.

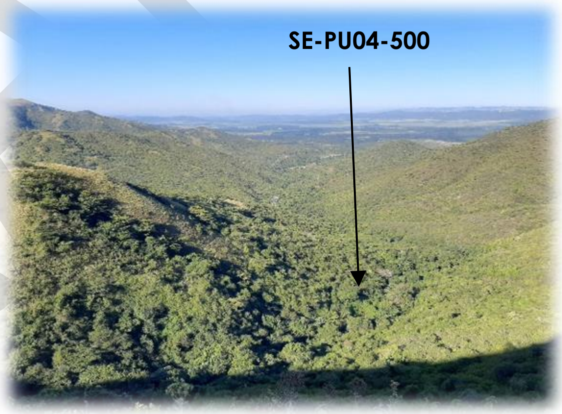

Photo 08: Overview of the downstream reaches of watercourse unit SE-PU04-500.

Table 14. Summary of key features of South Block River 'Process Unit' group 08.

Mountain Stream – Process Unit 08	
Number of Stream Units in Process Group	12
General Catchment Description	Vegetation dominated commercial forestry plantation species.
General Unit Description	Moderately steep streams with small catchments areas. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone.
Expected Biophysical Characteristics	
Flow	Seasonal

Mountain Stream – Process Unit 08	
General Substrate Type	Mixed bedrock and alluvial.
General Instream Biotopes	Pool, riffles, runs.
Expected Riparian Features	Macro channel bank. Active channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone that is dominated by woody and herbaceous alien plant species. **Active Channel:** • Some herbaceous marginal vegetation. Instream vegetation lacking.

Selected photos of watercourses from Process Unit 08:

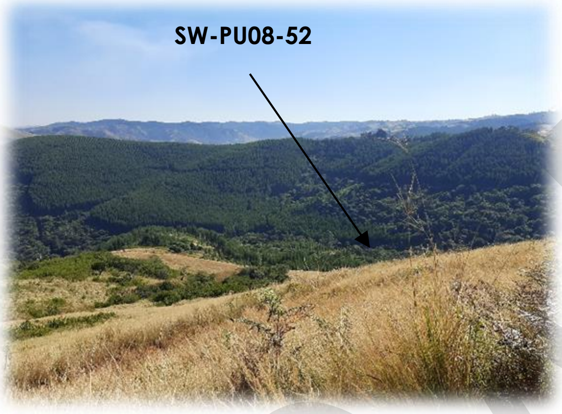

Photo 03: Overview of watercourse unit SW-PU08-402.

Photo 04: Riparian and active channel area of watercourse unit SW-PU08-588.

Table 15. Summary of key features of South Block River 'Process Unit' group 05.

Mountain Stream – Process Unit 05	
Number of Stream Units in Process Group	23
General Catchment Description	Vegetation dominated by woody and herbaceous invasive alien plant species. Emergence of alien plants is likely linked to historic ploughing and forestry, or present-day overgrazing and frequent burning.
General Unit Description	Moderately steep streams with small catchment areas. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone.
Expected Biophysical Characteristics	
Flow	Seasonal
General Substrate Type	Mixed bedrock and alluvial.
General Instream Biotopes	Pool, riffles, runs.
Expected Riparian Features	Macro channel bank. Active channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone that is dominated by woody and herbaceous alien plant species. **Active Channel:** • Some herbaceous marginal vegetation. Instream vegetation lacking.

Selected photos of watercourses from Process Unit 05:

Photo 09: Lower reaches of watercourse unit SE-PU05-485.

Photo 10: Upper reaches of watercourse unit SE-PU05-503.

Table 16. Summary of key features of South block River 'Process Unit' group 06.

Mountain Stream – Process Unit 06	
Number of Stream Units in Process Group	38
General Catchment Description	Dominated by rural settlements and homesteads. Vegetation dominated by woody and herbaceous invasive alien plant species.
General Unit Description	Moderately steep streams with small catchment areas. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone. Clearing of indigenous trees from riparian zone is common.
Expected Biophysical Characteristics	
Flow	Seasonal
General Substrate Type	Mixed bedrock and alluvial.
General Instream Biotopes	Pool, riffles, runs.
Expected Riparian Features	Macro channel bank. Active channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone that is dominated by woody and herbaceous alien plant species. **Active Channel:** • Some herbaceous marginal vegetation. Instream vegetation lacking.

Selected photos of watercourses from Process Unit 06:

Photo 11: Lower reaches of watercourse unit SE-PU06-01.

Photo 12: Upper reaches of watercourse unit SE-PU06-02.

4.1.3 Transitional Rivers

Ten (10) Transitional Rivers were identified in the South Block. Each of these has been assigned a unique label, with each of these river units being assessed and reported on individually. The labels for Transitional River units are as follows, with the location of these units being presented in **Figure 17**, above:

- SE-Transitional River-455
- SE-Transitional River-462
- SE-Transitional River-468
- SE-Transitional River-469
- SE-Transitional River-470
- SW-Transitional River-463
- SW-Transitional River-467
- SW-Transitional River-471 (KwaMazula River)
- SW-Transitional River-502
- SW-Transitional River-544

Four (4) Transitional Rivers were visited during Eco-Pulses field visit. The visited Transitional Rivers are:

- SE-Transitional River-462
- SE-Transitional River-468
- SE-Transitional River-470
- SW-Transitional River-471 (KwaMazula River)

Summaries of the key biophysical characteristics of each of these visited Transitional River units is presented in the tables below. For the river units not visited by Eco-Pulse, the descriptions and assessments of these watercourse were done at a desktop level and relied on the extrapolation of field data from those Transitional Rivers that were visited. The assumed biophysical characteristics of the Transitional Rivers that were not visited by Eco-Pulse are summarised in a combined table below (**Table 21**).

Table 17. Summary of the key features of SE-Transitional River-462.

SE-Transitional River-462	
Field Visit	Yes
Longitudinal zone	Transitional River
Flow	Seasonal to weakly perennial
Substrate type	Bedrock dominated with reaches dominated by sandy alluvium
Instream biotopes observed	• Riffles, rapids and runs (cobbles, boulders, and bedrock sheets) • Pools (cobbles, boulders, and bedrock sheets) • Marginal vegetation
Riparian features observed	• Active channel banks • Macro channel bank
Vegetation characteristics	**Macro Bank & Flood Terrace:** • Dominant and sub-dominant species: *Ficus sur, acacia sp.* • Moderately abundant species: *Biancaea decapetala* • Low abundant species: *Solanum mauritianum* **Active Channel:** • Dominant and sub-dominant species: *Coix lacryma-jobi, Ageratum houstonianum* • Moderately abundant species: *Chromolaena odorata* • Low abundant species: *Commelina benghalensis*

Selected Photos of SE-Transitional River-462:

Photo 19: Downstream photo of a reach of SE-Transitional River-462 that is characterised by an alluvial bed.

Photo 20: Downstream photo of a reach of SE-Transitional River-462 that is characterised by a bedrock bed.

Table 18. Summary of the key features of SE-Transitional River-468.

SE-Transitional River-468	
Field Visit	Yes
Longitudinal zone	Transitional River
Flow	Perennial
Substrate type	Dominated by sandy alluvium and cobbles. Scatted bedrock boulders along course.
Instream biotopes observed	• Riffles, rapids and runs (cobbles, boulders, and bedrock sheets) • Pools (Gravel, sand, cobbles, boulders) • Marginal vegetation
Riparian features observed	• Active channel banks • Macro channel bank
Vegetation characteristics	**Macro Bank & Flood Terrace:** • Dominant and sub-dominant species: *Stenotaphrum clandestine, Sporobolus africanus* • Moderately abundant species: *Sesbania punicea, Senna didymobotrya, Ficus sur, Ludwigia octovalvis*

SE-Transitional River-468	
	• Low abundant species: *Arundinella nepalensis* **Active Channel:** • Dominant and sub-dominant species: *Leersia hexandra, Ischaemum fasciculatum* • Moderately abundant species: *Cyperus latifolius* • Low abundant species: *Fimbristylis sp., Pycreus Polystachyos*

Selected Photos of SE-Transitional River-468:

Photo 19: Downstream photo of a reach of SE-Transitional River-468 at the location of a causeway road crossing.

Photo 20: Upstream facing photo of SE-Transitional River-468, with impoundment from a road crossing visible in the photograph.

Table 19. Summary of the key features of SE-Transitional River-470.

SE-Transitional River-470	
Field Visit	Yes
Longitudinal zone	Transitional River
Flow	Perennial
Substrate type	Bedrock dominated
Instream biotopes observed	• Riffles, rapids and runs (cobbles, boulders, and bedrock sheets) • Pools (cobbles, boulders, and bedrock sheets) • Marginal vegetation
Riparian features observed	• Active channel banks • Macro channel bank
Vegetation characteristics	**Macro Bank & Flood Terrace:** • Dominant and sub-dominant species: *Syzigium cordatum, Acacia sp.* • Moderately abundant species: *Ficus sur* • Low abundant species: *Ludwigia Octovalvis* **Active Channel:** • Dominant and sub-dominant species: *Leersia hexandra, Ischaemum fasciculatum* • Moderately abundant species: *Juncus lomatophyllus, Pycreus polystachyos* • Low abundant species: *Persicaria attenuata, Ludwigia Octovalvis, Centella asiatica*

Selected Photos of SE-Transitional River-470:

Photo 19: Downstream photo of a reach of SE-Transitional River-470 that is characterised by a bedrock bed.

Photo 20: Downstream photo of a reach of SE-Transitional River-470 that is characterised by a bedrock bed.

Table 20. Summary of the key features of SW-Transitional River-471.

SW-Transitional River-471 (KwaMazula River)	
Field Visit	Yes
Longitudinal zone	Transitional River
Flow	Perennial
Substrate type	Dominated by sandy alluvium and cobbles. Scattered bedrock boulders along course.
Instream biotopes observed	• Riffles, rapids and runs (cobbles, boulders, and bedrock sheets) • Pools (Gravel, sand, cobbles, boulders) • Marginal vegetation
Riparian features observed	• Active channel banks • Macro channel bank
Vegetation characteristics	**Macro Bank & Flood Terrace:** • Dominant and sub-dominant species: *Stenotaphrum clandestine, Sporobolus africanus* • Moderately abundant species: *Sesbania punicea*, *Senna didymobotrya, Ficus sur, Ludwigia octovalvis* • Low abundant species: *Arundinella nepalensis* **Active Channel:** • Dominant and sub-dominant species: *Leersia hexandra, Ischaemum fasciculatum* • Moderately abundant species: *Cyperus latifolius* • Low abundant species: *Fimbristylis sp., Pycreus Polystachyos*

Selected Photos of SW-Transitional River-471:

Photo 19: Downstream photo of a reach of SW-Transitional River-471.

Photo 20: Upstream photo of a reach of SW-Transitional River-471.

Table 21. Summary of the assumed biophysical features of the South Block Transitional Rivers not visited by Eco-Pulse during the field visits.

Unit Label	Assumed flow	Assumed substrate type	Assumed instream biotopes	Assumed riparian features
SE-Transitional River-455	Seasonal to Perennial	Bedrock dominated with reaches of sandy alluvium	• Riffles, rapids and runs • Pools • Marginal vegetation	• Active channel banks • Macro channel bank
SE-Transitional River-469				
SW-Transitional River-463				
SW-Transitional River-467				
SW-Transitional River-502				
SW-Transitional River-544				

4.1.4 Upper Foothill Rivers

Three (3) Upper Foothill Rivers were identified in the South Block. Each of these has been assigned a unique label, with each of these river units being assessed and reported on individually. The labels for each Upper Foothill River unit are as follows, with the location of these units being presented in **Figure 17**, above:

- SE-Upper Foothill River-466
- SW-Upper Foothill River-456
- SW-Upper Foothill River-457

Two (2) Upper Foothill Rivers were visited during Eco-Pulses field visit. The visited Upper Foothill River are:

- SE-Upper Foothill River-466
- SW-Upper Foothill River-457

Summaries of the key biophysical characteristics of each of the visited Upper Foothill River units is presented in the tables below. For the river unit not visited by Eco-Pulse, the descriptions and assessments of these watercourse were done at a desktop level and relied on the extrapolation of field data from those Upper Foothill Rivers that were visited. The assumed biophysical characteristics of the Upper foothill River that was not visited by Eco-Pulse is summarised in Table.

Table 22. Summary of the key features of SE-Upper Foothill River-466

SE-Upper Foothill River-466	
Field Visit	Yes
Longitudinal zone	Upper Foothills River
Flow	Perennial
Substrate type	Dominated by cobbles and boulders with reaches of sandy alluvium
Instream biotopes observed	• Riffles, rapids and runs (cobbles, boulders, and bedrock sheets) • Pools (Gravel, sand, cobbles, boulders, and bedrock sheets) • Marginal vegetation
Riparian features observed	• Active channel banks • Macro channel bank
Vegetation characteristics	**Marco Bank & Flood Terrace:** • Dominant and sub-dominant species: *Stenotaphrum clandestine*, *Sporobolus africanus* • Moderately abundant species: *Sesbania punicea, Senna didymobotrya, Ficus sur, Ludwigia octovalvis* • Low abundant species: *Arundinella nepalensis* **Active Channel:** • Dominant and sub-dominant species: *Leersia hexandra, Ischaemum fasciculatum* • *Moderately abundant species: Cyperus latifolius* • Low abundant species: *Fimbristylis sp., Pycreus Polystachyos*

Selected Photos of SE-Upper Foothill River-466:

Photo 19: Upstream overview of a reach of SE-Upper Foothill River-466.

Photo 20: Upstream view of the channel for a reach of SE-Upper Foothill River-466.

Table 23. Summary of the key features of SW-Upper Foothill River-457

SW-Upper Foothill River-457	
Field Visit	Yes
Longitudinal zone	Upper Foothills River
Flow	Perennial
Substrate type	Dominated by gravel and stones. Certain reaches dominated by sand. Scattered cobbles and boulders.
Instream biotopes observed	• Riffles, rapids and runs (cobbles, boulders, and bedrock sheets) • Pools (Gravel, sand, cobbles, boulders, and bedrock sheets) • Marginal vegetation
Riparian features observed	• Active channel banks • Macro channel bank
Vegetation characteristics	**Marco Bank & Flood Terrace:** • Dominant and sub-dominant species: *Syzigium cordatum, Biancaea decapetala* • Moderately abundant species: *Lantana camara, acacia sp.* • Low abundance species: *Psidium guajava*

SW-Upper Foothill River-457	
	Active Channel: • Dominant and sub-dominant species: *Cyperus latifolius, Commelina benghalensis* • Moderately abundant species: *Ischaemum fasciculatum* • Low abundance species: *Centella asiatica*

Selected Photos of SE-Upper Foothill River-457:

Photo 19: Upstream overview of a reach of SE-Upper Foothill River-467.

Photo 20: Upstream view of the channel for a reach of SE-Upper Foothill River-467.

Table 24. Summary of the key features of SW-Upper Foothill River-456

SW-Upper Foothill River-456	
Field Visit	No
Longitudinal zone	Upper Foothills River
Assumed flow	Perennial
Assumed substrate type	Dominated by gravel and stones. Certain reaches dominated by sand. Scattered cobbles and boulders.
Assumed instream biotopes observed	• Riffles, rapids and runs (cobbles, boulders, and bedrock sheets) • Pools (Gravel, sand, cobbles, boulders, and bedrock sheets) • Marginal vegetation
Assumed riparian features observed	• Active channel banks • Macro channel bank

4.1.5 Lowland River – Mhlathuze River

Table 25. Summary of the key features of SW-Lowland River-461 (Mhlathuze River)

SW-Lowland River-461 (Mhlatuze River)	
Field Visit	Yes
Longitudinal zone	Lowland River
Flow	Perennial
Substrate type	Dominated by sand, gravel, and stones. Scattered cobbles and boulders.
Instream biotopes observed	• Riffles and runs (cobbles, boulders) • Pools (Gravel, sand, cobbles, boulders) • Marginal vegetation
Riparian features observed	• Active channel banks • Macro channel bank
Vegetation characteristics	Marco Bank & Flood Terrace: • Dominant and sub-dominant species: *Stenotaphrum clandestine, Sporobolus africanus*

SW-Lowland River-461 (Mhlatuze River)	
	• Moderately abundant species: *Sesbania punicea, Senna didymobotrya, Ficus sur, Ludwigia octovalvis* • Low abundant species: *Arundinella nepalensis* Active Channel: • Dominant and sub-dominant species: *Leersia hexandra, Ischaemum fasciculatum* • Moderately abundant species: *Cyperus latifolius*

Selected Photos of Lowland River-461:

Photo 19: Downstream view of the channel for a reach of SW-Lowland River-461.

Photo 20: Upstream view of the channel for a reach of SW-Lowland River-461.

4.1.6 Seep Wetlands

The twelve (12) Seeped Wetlands mapped in the South Block were divided into three (3) different process unit groups as follows:

- Wetland Process Unit Group 01 – 7 units
- Wetland Process Unit Group 02 – 2 units
- Wetland Process Unit Group 03 – 3 units

Wetlands from two (2) of the Seep Wetland Process Unit groups were visited by Eco-Pulse during the field visit. The process unit groups visited by Eco-Pulse were:

- Wetland Process Unit Group 01
- Wetland Process Unit Group 03

A summary of the division of the Seep Wetlands into process unit groups is presented in **Figure 20**. The location of the different process unit groups can be seen in **Figure 17**, above. Biophysical descriptions for each Seep Wetland Process Unit Group are presented in the tables which follow. For Wetland Process Unit Group 02, the biophysical descriptions of these wetlands are assumed based on desktop information and extrapolation of data collected from other wetland units as no wetlands from this group were visited by Eco-Pulse.

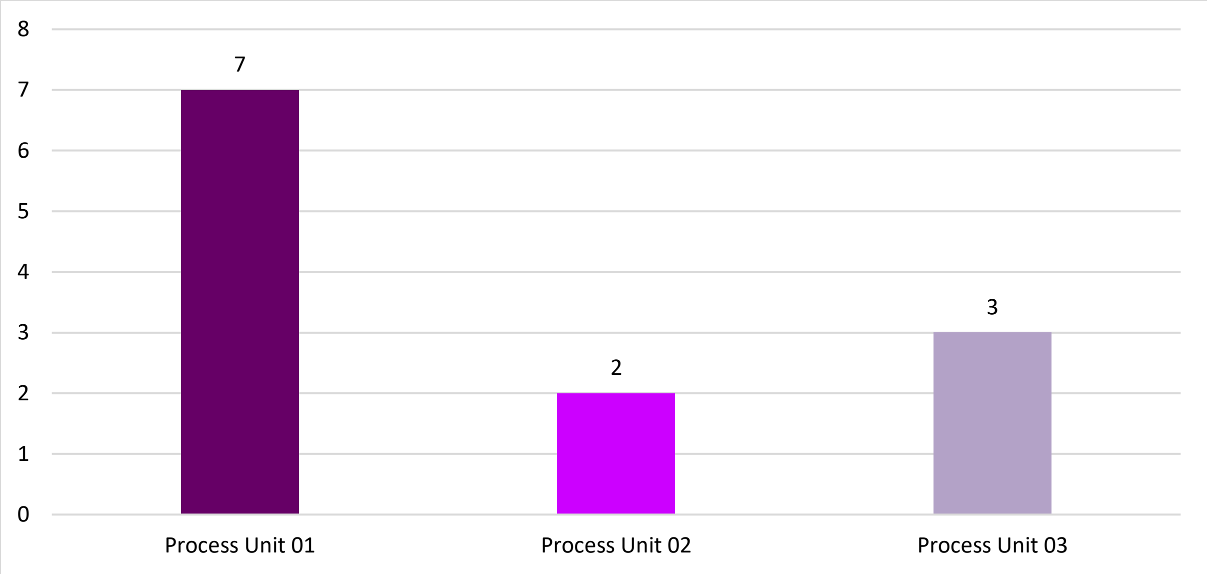

Figure 20. Summary of the division of the South Block seep wetlands into Process Unit Groups.

Table 26. Summary of key features of South Block wetland 'Process Unit' group 01.

Seep Wetland - Process Unit 01	
Number of Stream Units in Process Group	7
General Unit Description	**Cultivated headwater seep wetlands.**
General Catchment Description	Scattered houses and degraded secondary grassland (over grazing). Scattered woody IAPs.
Biophysical Characteristics	
Dominant wetness zone	Temporary / Seasonal
Dominant water input	Diffuse sub-surface flow
Low flow pattern	Diffuse sub-surface flow
General soil characteristics	<u>Temporary Soils:</u> 0-10cm: Grey-brown clay loam (7.5YR 4/2). No soil mottles. 40-50cm: Grey-brown clay loam (7.5YR 4/2). Low abundance of orange soil mottles. <u>Seasonal Soils:</u> 0-50cm: Grey-brown clay loam (7.5YR 4/1). Abundant orange mottles.
General vegetation characteristics	*Dominant:* Various subsistence crops including *Colocasia esculenta, spinach and potatoes* Moderate: *Ageratum houstonianum, Cyperus latifolius, Ludwigia octovalvis* Low: *Cyclosorus interruptus, Psidium guajava*

Selected photos of watercourses from Seep Wetland Process Unit 01:

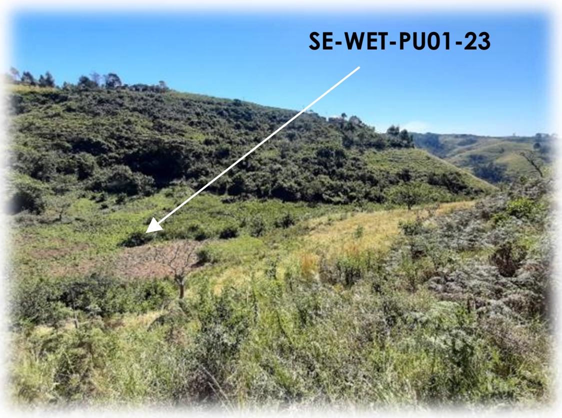

Photo 01: Overview of watercourse unit SE-WET-PU01-23 which is being heavily utilised for subsistence agriculture.

Photo 02: Overview of watercourse unit SE-WET-PU01-22 which is being heavily utilised for subsistence agriculture.

Table 27. Summary of key features of South Block wetland 'Process Unit' group 02.

Seep Wetland - Process Unit 02	
Number of Stream Units in Process Group	2
HGM Classification	Seep wetland
General Unit Description	**Hygrophilous grassland seep wetlands**
General Catchment Description	Scattered houses and degraded secondary grassland (over grazing). Scattered woody IAPs.
Biophysical Characteristics	
Assumed Dominant wetness zone	Temporary
Assumed Dominant water input	Diffuse sub-surface flow
Assumed Low flow pattern	Diffuse sub-surface flow
Assumed General soil characteristics	Temporary Soils: 0-10cm: Grey-brown clay loam (7.5YR 4/2). No soil mottles. 40-50cm: Grey-brown clay loam (7.5YR 4/2). Low abundance of orange soil mottles. Seasonal Soils: 0-50cm: Grey-brown clay loam (7.5YR 4/1). Abundant orange mottles.
General vegetation characteristics	*Hygrophilous grassland species and moderately abundant facultative (wet) sedge species.*

Table 28. Summary of key features of South Block wetland 'Process Unit' group 03.

Seep Wetland - Process Unit 03	
Number of Stream Units in Process Group	3
HGM Classification	Seep wetland
General Unit Description	**Previously cultivated / disturbed seeps that have been colonized by dense woody and herbaceous IAPs.**
General Catchment Description	Scattered houses and degraded secondary grassland (over grazing). Scattered woody IAPs.
Biophysical Characteristics	

Seep Wetland - Process Unit 03	
Dominant wetness zone	Temporary / Seasonal
Dominant water input	Diffuse sub-surface flow
Low flow pattern	Diffuse sub-surface flow
General soil characteristics	Temporary Soils: 0-10cm: Grey-brown clay loam (7.5YR 4/2). No soil mottles. 40-50cm: Grey-brown clay loam (7.5YR 4/2). Low abundance of orange soil mottles. Seasonal Soils: 0-50cm: Grey-brown clay loam (7.5YR 4/1). Abundant orange mottles.
General vegetation characteristics	*Temporary Zone: Dominated by woody and herbaceous IAPs.* *Seasonal Zone: Dominated by Cyperus latifolius and other facultative (wet) sedge species.*

Selected photos of watercourses from Seep Wetland Process Unit 03:

Photo 01: Downstream view of watercourse unit SE-WET-PU03-12.

Photo 02: Upstream view of watercourse unit SE-WET-PU01-12.

4.1.7 Unchanneled Valley Bottom Wetlands

The eleven (11) Valley Bottom Wetlands mapped in the South Block were divided into two (2) different process unit groups as follows:

- Wetland Process Unit Group 04 – 7 units
- Wetland Process Unit Group 05 – 4 units

Only wetlands from Wetland Process Unit Group 04 were visited in the field. For Wetland Process Unit Group 05, the biophysical descriptions of these wetlands are assumed based on desktop information and extrapolation of data collected from other wetland units as no wetlands from this group were visited by Eco-Pulse

A summary of the division of the Valley-Bottom Wetlands into process unit groups is presented in **Figure 21**. The location of the different process unit groups can be seen in **Figure 17**, above. Biophysical descriptions for each Valley-Bottom Wetland Process Unit Group are presented in the tables which follow.

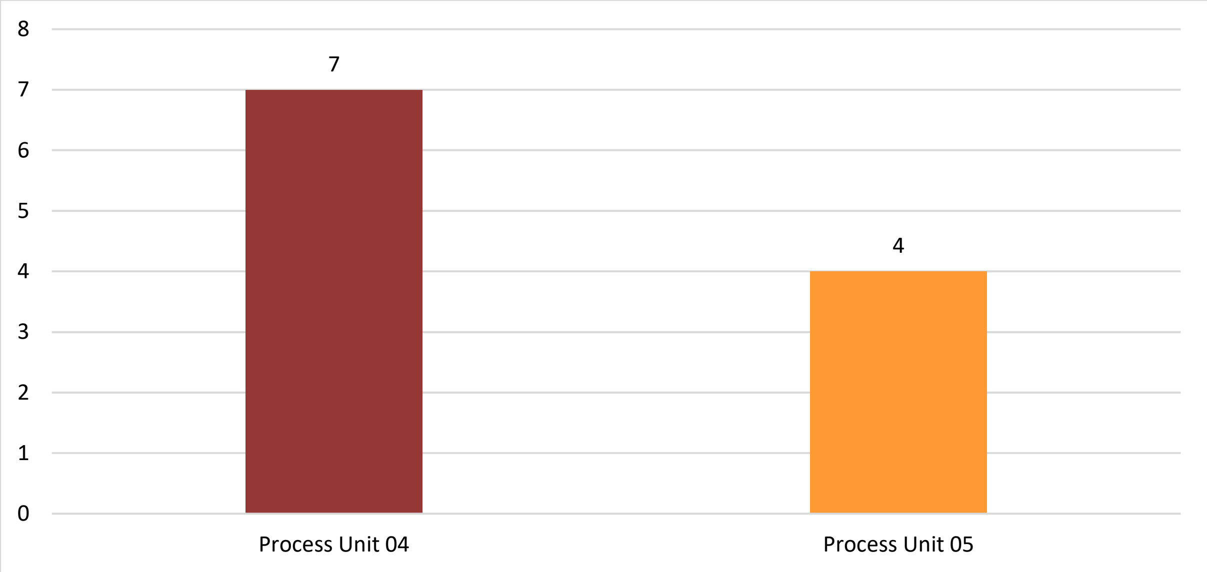

Figure 21. Summary of the division of the South Block valley-bottom wetlands into Process Unit Groups.

Table 29. Summary of key features of South Block wetland 'Process Unit' group 04.

Unchanneled Valley Bottom Wetland – Process Unit 04	
Number of Stream Units in Process Group	7
HGM Classification	Unchanneled Valley Bottom Wetland
General Unit Description	**Narrow valley bottom wetlands with notable edge IAPs pressure.**
General Catchment Description	Scattered houses and degraded secondary grassland (over grazing). Scattered woody IAPs.
Biophysical Characteristics	
Dominant wetness zone	Seasonal
Dominant water input	Diffuse sub-surface flow
Low flow pattern	Diffuse surface flow
General soil characteristics	Temporary Soils: 0-10cm: Grey-brown clay loam (7.5YR 4/2). No soil mottles. 40-50cm: Grey-brown clay loam (7.5YR 4/2). Low abundance of orange soil mottles. Seasonal Soils: 0-50cm: Grey-brown clay loam (7.5YR 4/1). Abundant orange mottles. Permanent Soils: 0-50cm: Grey clay loam (7.5YR 5/1). No mottles.
General vegetation characteristics	*Temporary Zone: Dominated by woody and herbaceous IAPs (ageratum Houstonian, Lantana camara, Acacia mearnsii) and grass species (Eragrostis plana, Paspalum urvillei, Sporobolus africanus).* *Seasonal & Permanent Zone: Sedgeland dominated by Pycreus polystachyos and Cyperus latifolius.*

Selected photos of watercourses from Wetland Process Unit 04:

Photo 01: Downstream view of watercourse unit SE-WET-PU04-10.

Photo 02: Overview of watercourse unit SE-WET-PU04-11.

Table 30. Summary of key features of South Block wetland 'Process Unit' group 05.

Unchanneled Valley Bottom Wetland – Process Unit 05	
Number of Stream Units in Process Group	4
HGM Classification	Unchanneled Valley Bottom Wetland
General Unit Description	**Broad valley bottom wetlands with notable edge IAPs pressure.**
General Catchment Description	Scattered houses and degraded secondary grassland (over grazing). Scattered woody IAPs.
Biophysical Characteristics	
Dominant wetness zone	Permanent
Dominant water input	Diffuse sub-surface flow
Low flow pattern	Diffuse surface flow
General soil characteristics	Temporary Soils: 0-10cm: Grey-brown clay loam (7.5YR 4/2). No soil mottles. 40-50cm: Grey-brown clay loam (7.5YR 4/2). Low abundance of orange soil mottles. Seasonal Soils: 0-50cm: Grey-brown clay loam (7.5YR 4/1). Abundant orange mottles. Permanent Soils: 0-50cm: Grey clay loam (7.5YR 5/1). No mottles.
General vegetation characteristics	*Temporary Zone: Dominated by woody and herbaceous IAPs and grass species* *Seasonal & Permanent Zone: facultative wet sedge species.*

4.2 Rivers & Streams - Present Ecological State (PES) Assessment

This section presents the outcomes of the present ecological state (PES) assessment for the river and stream units within the South Block study area. Index of Habitat Integrity (IHI) (Kleynhans, 1996) assessments were completed for all process unit groups (Mountain Headwater Streams and Mountain Streams) and for all individually assessed watercourse units (Transitional Rivers, Upper Foothill Rivers, and Lowland Rivers). For selected perennial river systems, the IHI assessment was supplemented by in-situ and laboratory water quality analyses, aquatic macroinvertebrate surveys (SASS5 methodology), and fish surveys. These supplementary PES assessment procedures were completed for five (5) river units (**Table 31**). For the Mhlatuze River (SW-Lowland River-461), these assessment procedures were completed at three (3) separate sites along its length (**Figure 22**).

The PES assessment procedures implemented for each river / stream are summarized in **Table 31**, below. The location of each of the water quality analyses, aquatic macroinvertebrate survey (SASS5 methodology), and fish survey sites is shown in **Figure 22**.

Table 31. summary of the river / stream PES assessment procedures implemented on each watercourse within the South Block.

			PES Assessment Procedures			
Watercourse	**Type**	**Field visit**	**Water Quality**	**SASS5**	**Fish Survey**	**IHI**
Stream Process Unit 01	Mountain Headwater Stream	Yes (Subset)	Not applicable to seasonal and ephemeral streams			✓
Stream Process Unit 07						✓
Stream Process Unit 02						✓
Stream Process Unit 03						✓
Stream Process Unit 04	Mountain Stream	Yes (Subset)				✓
Stream Process Unit 08						✓
Stream Process Unit 05						✓
Stream Process Unit 06						✓
SE-Transitional River-455	Transitional River	No	×	×	×	✓
SE-Transitional River-462		Yes	×	×	×	✓
SE-Transitional River-468		Yes	×	×	×	✓

SE-Transitional River-469		No	×	×	×	✓
SE-Transitional River-470		Yes	✓	✓	✓	✓
SW-Transitional River-463		No	×	×	×	✓
SW-Transitional River-467		No	×	×	×	✓
SW-Transitional River-471 (KwaMazula River)		Yes	✓	✓	✓	✓
SW-Transitional River-502		No	×	×	×	✓
SW-Transitional River-544		No	×	×	×	✓
SE-Upper Foothill River-466	Upper Foothill River	Yes	✓	✓	✓	✓
SW-Upper Foothill River-456		No	×	×	×	✓
SW-Upper Foothill River-457		Yes	✓	✓	✓	✓
SW-Lowland River-461 ((Mhlatuze River)	Lowland River	Yes	✓	✓	✓	✓

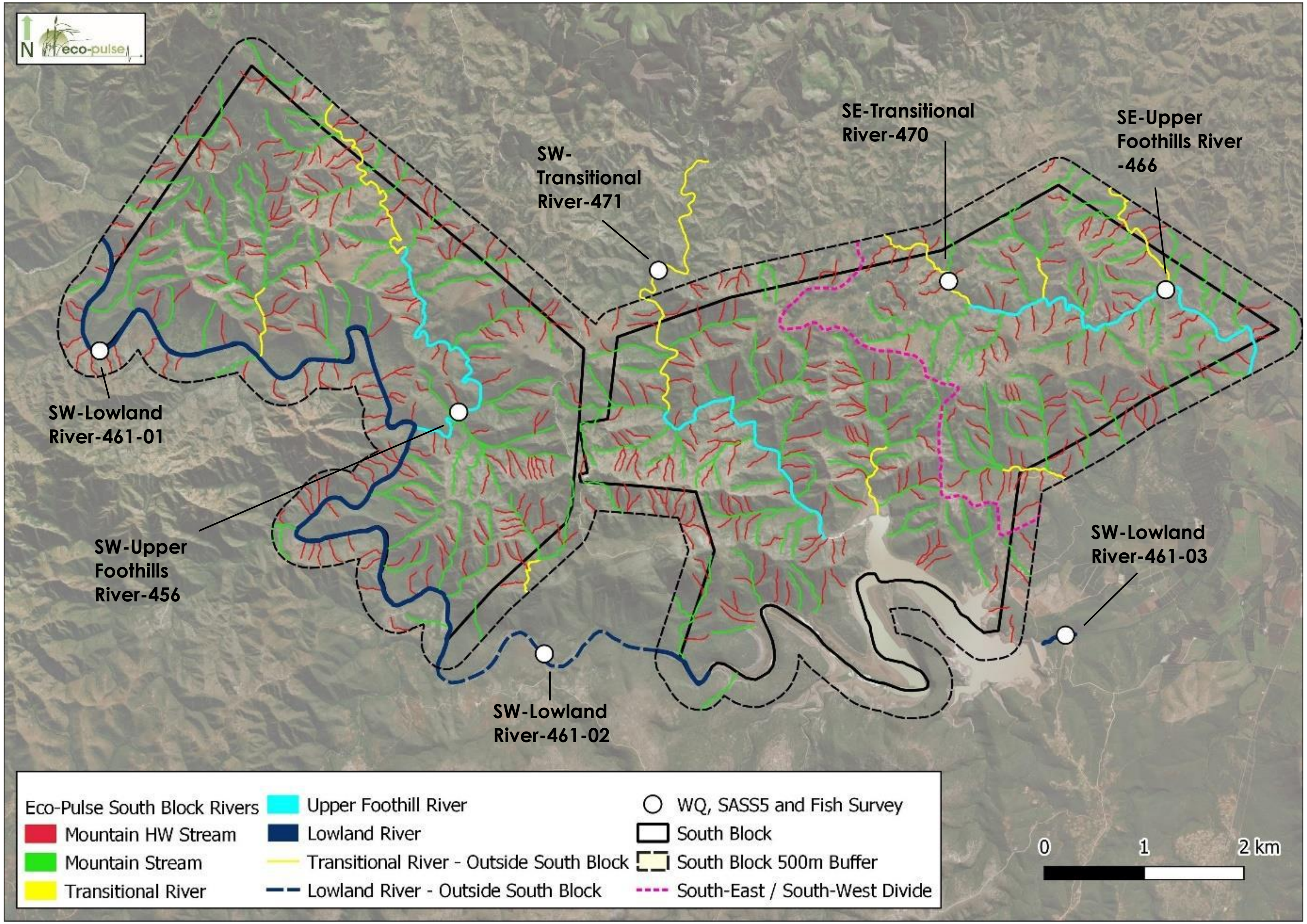

Figure 22. Location of the water quality analyses, SASS5 and fish survey sites within the South Block study area.

4.2.1 Water Quality Analysis

The results of the water quality analysis for each monitoring site are presented in **Table 32**. Notable outcomes are discussed and interpreted in the sub-sections that follow.

Table 32. In-situ and laboratory water quality results for each sampled site

	Mhlatuze River			KwaMazula River			
	SW-Lowland River-461-01 Upstream	SW-Lowland River-461-02 Middle	SW-Lowland River-461-03 Downstream	SW-Transitional River-471	SE-Transitional River-470	SE-Upper Foothills River-466	SW-Upper Foothills River-456
In-situ Water Quality Readings							
Temperature (°C)	15.9	15.6	20.4	15.7	14.7	19.2	15.1
Dissolved Oxygen (% saturation)	103.3	102.0	97.8	99.7	98.2	90.2	101.5
Specific Conductance (µS/cm)	100.9	106.1	116.7	100.01	100.01	107.1	119.7
pH (pH units)	7.18	7.55	7.20	7.03	7.03	6.65	6.96
Water Quality Laboratory Analysis Results							
Chemical Oxygen Demand (mg O2/ℓ)	<25	<25	<25	<25	<25	<25	<25
Ammonia (mg N/ℓ)	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Nitrate/nitrite (mg N/ℓ)	<0.25	<0.25	<0.25	1.13	<0.25	<0.25	<0.25
Orthophosphate (mg N/ℓ)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Suspended Solids at 105 °C (mg/ℓ)	<18	<18	<18	22	<18	<18	<18
***E. coli* (MPN/100mℓ)**	82	261	13	93	27	435	38

4.2.1.1 SW-Lowland River-461 (Mhlatuze River)

Water quality samples were taken at three (3) locations along the reach of the Mhlatuze River that runs along the South Block. This included two (2) sites upstream of the Goedertrouw Dam (SW-Lowland River-461-01 and SW-Lowland River-461-02) and a single site immediately downstream on the Goedertrouw Dam wall (SW-Lowland River-461-03). The outcomes of the water quality analyses along the Mhlatuze River indicate that water quality was 'good' at the time of sampling with no sampled determinants being of concern. There are no notable differences in any determinants between the three (3) sites along the Mhlatuze River, indicating that there are no land uses or point source activities within the South Block study area that are contributing to a notable reduction in water quality along the Mhlatuze River system. Minimal quantities of *E. coli* were, however, noted at each sample site. The presence of *E. coli* is most likely associated with the use of the river a source of water for cattle belonging to local communities. The low *E. coli* levels are not considered problematic for aquatic ecosystem health.

4.2.1.2 SW-Transitional River-471

A sample was taken at a single location along the middle reach of SW-Transitional River-471. Due to access constraints the sample site was upstream of the northern boundary of the South block. The water quality analysis at this site suggests that water quality along the river was generally 'good' at the time of sampling. The only notable determinant was the slightly elevated Nitrate / Nitrite level (1.13 mg N/ℓ). In South Africa, inorganic nitrogen concentrations in unimpacted surface water systems are usually below 0.5 mg N/ℓ (DWAF, 1996). Elevated nitrogen level in surface water systems is typically a concern as it promotes rapid plant and algal growth which can lead to eutrophic conditions and ecological degradation. 1.13 mg N/ℓ is considered mesotrophic by the South Africa water quality guidelines for aquatic ecosystems (DWAF, 1996). Mesotrophic surface water systems are usually productive systems with high biotic diversity, but which experience nuisance aquatic plant growth and algal blooms. The source of nutrients along this river is likely to be a small rural community located 900m upstream of the sample site which make regular use of the river.

4.2.1.3 SE-Transitional River-470

A sample was taken at a single location along the lower reach of SE-Transitional River-470. The water quality analysis at this site suggests that water quality along this river was 'good' at the time of sampling with no sampled determinants being of concern.

4.2.1.4 SE-Upper Foothills River-466

A sample was taken at a single location along the lower reach of SE-Upper Foothills River-466. This site is downstream of the sample site along SE-Transitional River-470. The water quality analysis at this site suggests that water quality along this reach was 'good' at the time of sampling with no sampled determinants being of concern. There is no notable change in any sampled determinant between SE-Transitional River-470 and SE-Upper Foothills River-466. This suggests that there are no land uses or point source activities within the catchment of this watercourse that are contributing to a notable reduction in water quality.

4.2.1.5 SW-Upper Foothills River-456

A sample was taken at a single location along the lower reach of SE-Upper Foothills River-456. The water quality analysis at this site suggests that water quality along this river was 'good' at the time of sampling with no sampled determinants being of concern.

4.2.2 SASS5: Aquatic Macroinvertebrate Assessment

Aquatic macroinvertebrate (SASS5) surveys were conducted at the six (6) sites shown in **Figure 22**. The outcomes of the SASS5 assessments are summarized in **Table 33** and are described in more detail below. The list of aquatic macroinvertebrates noted at each of the sample sites is presented in **Annexure B.**

Table 33. Results of the SASS5 assessment for the assessed rivers.

	Site	No. Taxa	SASS5 Score	ASPT	**Ecological Category** (Dallas, 2007)
	North-Eastern Uplands Ecoregion – Lower Geomorphic Zone				
Mhlatuze River	**SW-Lowland River-461-01**	17	108	6.35	**B: Good Largely natural with few modifications**
	SW-Lowland River-461-02	19	123	6.47	**A: Natural Unmodified**
	SW-Lowland River-461-03	14	99	7.07	**B: Good Largely natural with few modifications**
	North-Eastern Uplands Ecoregion – Upper Geomorphic Zone				
KwaMazula River	**SW-Transitional River-471**	24	159	6.63	**B: Good Largely natural with few modifications**
	SE-Transitional River-470	24	160	6.67	**B: Good Largely natural with few modifications**
	SE-Upper Foothills River-466	26	179	6.88	**B: Good Largely natural with few modifications**
	SW-Upper Foothills River-456	24	159	6.63	**B: Good Largely natural with few modifications**

4.2.2.1 SW-Lowland River-461 (Mhlatuze River)

According to the Dallas (2007) SASS5 data interpretation guidelines, the upstream (SW-Lowland River-461-01) and downstream (SW-Lowland River-461-03) Mhlatuze River sample sites fall within the 'B: Good' ecological category for the North-Eastern Uplands Ecoregion – Lower Geomorphic Zone. The middle sample site (SW-Lowland River-461-02) falls within the 'A: Natural' ecological category. These outcomes emphasize that the water quality conditions along the sampled length of the Mhlatuze River are good with the system being able to host several highly sensitive aquatic macroinvertebrate taxa. The only notable trend emerging from the SASS5 assessment results is a decline in the number of taxa noted at the downstream site (SW-Lowland River-461-03) (**Figure 23**). This is likely due to reduction in sampled biotope diversity immediately downstream of the Goedertrouw Dam outlet, which was releasing water at the time of the assessment. The high flows associated with the dam release meant that sampling the full range of available biotopes at this site was difficult and dangerous. The average sensitivity score per taxon (ASPT) noted at this site is, however, above 7 (out of a possible 15). This shows the site is suitable to play host to sensitive taxa.

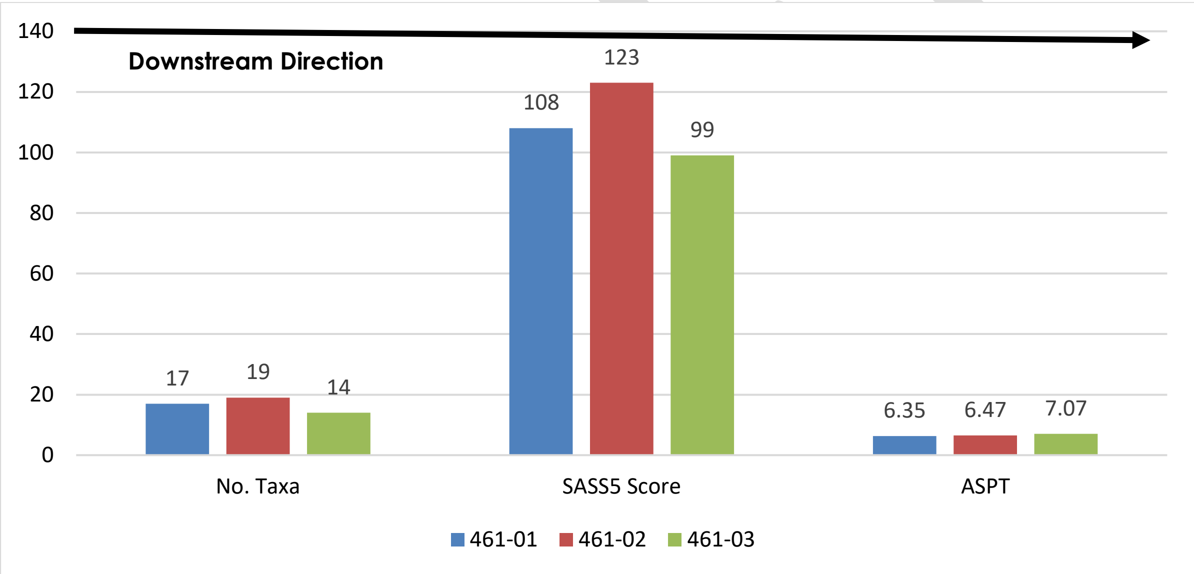

Figure 23. Summary of the SASS5 assessment results for the three (3) sites along the Mhlatuze River (SW-Lowland River-461).

4.2.2.2 Transitional and Upper Foothill Rivers

Each of the sampled Transitional and Upper Foothill Rivers fall within the 'B: Good' Dallas (2007) ecological category for the North-Eastern Uplands Ecoregion – Upper Geomorphic Zone. These outcomes emphasize that the water quality conditions along the sampled rivers is of good quality with the sampled systems being able to host several highly sensitive aquatic macroinvertebrate taxa.

A notable trend from the Transitional and Upper Foothill River SASS5 assessments was that there was little difference in the SASS5 indices of sample sites SE-Transitional River-470 and SE-Upper Foothills River-466, which are hydrologically linked (**Figure 22**, **Figure 24**).

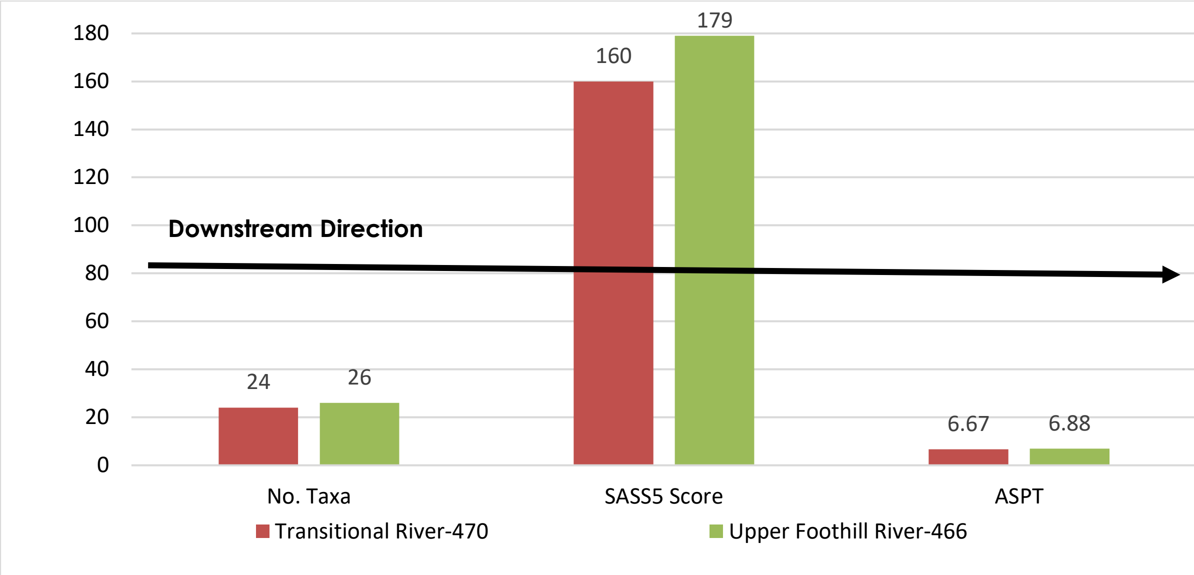

Figure 24. Summary of the SASS5 assessment results for SE-Transitional River-470 and SE-Upper Foothills River-466, which are hydrologically linked.

4.2.3 Fish Survey

Fish surveys were used to inform river PES, and the EIS assessment. Fish survey outcomes are presented in **Table 34**. Notable outcomes are discussed and interpreted below. Keys for interpreting the data in **Table 34** are presented in **Table 35** and **Table 36**.

Table 34. Summary of fish species presence and sensitivity based on DWS desktop dataset (DWS, 2014).

			DWS Sensitivity Ratings		DWS Confidence in Presence			Mhlathuze River			KwaMazula River			
Scientific Name	Common Name	IUCN Threat Status	Phys-chem	No-flow	Upper Mhlatuze	Lower Mhlatuze	KwaMazula	SW-Lowland River-461-01	SW-Lowland River-461-02	SW-Lowland River-461-03	SW-Transitional River-471	SE-Transitional River-470	SE-Upper Foothills River-466	SW-Upper Foothills River-456
Acanthopagrus berda	River bream	LC	1.8	1.1	M	M	N/A							
Anguilla bicolor	Shortfin eel	NT	2.7	2.8	N/A	M	N/A							
Anguilla marmorata	Giant mottled eel	LC	2.5	2.8	H	H	M			1				
Anguilla mossambica	Longfin eel	NT	2.5	2.8	H	H	M							
Awaous aeneofuscus	Freshwater goby	LC	2.8	2	H	H	L							
Clarias gariepinus	Sharptooth catfish	LC	1	1.7	H	M	M	1	4	1				
Coptodon rendalli	Redbreast tilapia	LC	2.1	1.8	H	M	H							
Enteromius gurneyi	Redtail barb	VU	4	2	H	M	M				30	30	5	
Enteromius paludinosus	Straightfin barb	LC	1.8	2.3	H	H	H							
Enteromius trimaculatus	Threespot barb	LC	1.8	2.7	H	H	H	11	15	5	1		2	10
Enteromius viviparus	Bowstripe barb	LC	3	2.3	H	H	M							
Gilchristella aestuaria	Estuarine round-herring	LC	3	1.5	N/A	M	N/A							
Glossogobius callidus	River goby	LC	2.3	1.5	M	M	L							
Glossogobius giuris	Tank goby	LC	2.5	1.7	M	M	L							
Labeo cylindricus	Redeye labeo	LC	3.1	3.1	N/A	M	N/A							
Labeo molybdinus	Leaden labeo	LC	3.2	3.3	H	H	M	30	25	2				10
Labeobarbus natalensis	Kwazulu-Natal Yellowfish	LC	3	3.5	H	H	M	5	10	5	50		5	40
Marcusenius caudisquamatus[4]	Bulldog	EN	3.4	3	H	H	M	2	5					2
Lacustricola johnstoni	Johnston's topminnow	LC	3.8	1.5	L	M	N/A							
Lacustricola katangae	Striped topminnow	LC	3	1.2	N/A	M	N/A							

[4] No sensitivity ratings were available for *Marcusenius caudisquamatus* in the DWS (2014) spreadsheets. As such, ratings provided were based on those of *Marcusenius pongolensis*.

			DWS Sensitivity Ratings		DWS Confidence in Presence			Mhlathuze River			KwaMazula River			
Scientific Name	**Common Name**	**IUCN Threat Status**	**Phys-chem**	**No-flow**	**Upper Mhlatuze**	**Lower Mhlatuze**	**KwaMazula**	**SW-Lowland River-461-01**	**SW-Lowland River-461-02**	**SW-Lowland River-461-03**	**SW-Transitional River-471**	**SE-Transitional River-470**	**SE-Upper Foothills River-466**	**SW-Upper Foothills River-456**
Lacustricola myaposae	Natal topminnow	NT	4	3	N/A	H	M							
Oreochromis mossambicus	Mozambique tilapia	VU	1.3	0.9	H	H	M		10					
Pseudocrenilabrus philander	Southern mouthbrooder	LC	1.4	1	H	H	M			5				
Redigobius dewaali	Checked goby	LC	3.5	1	L	N/A	N/A							
Serranochromis meridianus	Lowveld largemouth	EN	3	1	L	N/A	N/A							
Silhouettea sibayi	Sibayi goby	EN	0	0	H	N/A	N/A							
Tilapia sparrmanii	Banded tilapia	LC	1.4	0.9	H	M	H							4
							Number of species	**5**	**6**	**6**	**3**	**1**	**3**	**5**

Table 35. Key for species 'physio-chemical' and 'No-flow sensitivity' (DWS, 2014).

Score	Sensitivity class	Physio-chemical sensitivity	No-flow sensitivity
1-2	Tolerant (Low/Very Low Sensitivity)	Breed under severely modified physio-chemical conditions.	Species not requiring flow during any part of the life cycle. However, increased habitat suitability and availability resulting from increased flow can be expected to benefit such species. With some species, flow will stimulate breeding activities and stimulate migration.
>2-3	Moderately tolerant (Moderate sensitivity)	Breed under moderately modified physio-chemical conditions.	Species requiring flow during certain phases of the life-cycle - to breed habitats (often fast flows) for instance or make nursery areas with suitable cover available. Generally, increased habitat suitability and availability resulting from increased flow can be expected to benefit such species. Flow will stimulate breeding activities and stimulate migration.
>3-4	Moderately intolerant (High Sensitivity)		
>4-5	Intolerant (Very High Sensitivity)	Breed under unmodified or near natural physio-chemical conditions.	Species requiring flow during all phases of the life cycle. Often prefer fast flow and clear water and use these conditions both for breeding and feeding purposes.

Table 36. Key for fish species 'confidence in presence' rating (DWS, 2014).

Score	Confidence rating	Description
1	Low (L)	The species has not been recorded in the Sub Quaternary reach (SQ) but based on the local species "pool", the PES, the species sensitivity and the SQ similarity to other SQs where the species occurs (Level 2 ecoregion, Geozone, altitude and habitats available), is expected to be present.
3	Moderate (M)	The species has not been recorded recently in the SQ but based on the PES and species sensitivity it is expected to be present. Where the general PES for the SQ has changed, there are still sections suitable for habitation by the species.
5	High (H)	The species has recently been recorded in the SQ. The PES has not changed to such extent that it would be expected to be absent.

A total of nine (9) fish species were recorded across all sites during once-off field surveys. Of the species recorded, *Labeo molybdinus, Enteromius gurneyi, Labeobarbus natalensis and Marcusenius caudisquamatus* were the most sensitive. These four (4) species are considered 'Moderately Intolerant' (High Sensitivity) to either modified physio-chemical water quality or 'no-flow' conditions. These species can breed under moderately modified physio-chemical conditions but do not breed under largely to seriously modified physio-chemical conditions. These species require flow during certain phases of their life cycles, either to stimulate breeding activities and migration, or for nursery habitats. These species have also evolved habitat preference for flowing, well aerated river reaches within their ranges. See **Table 34** for individual species sensitivity ratings and keys that follow for guidance on interpretation.

In addition to the species recorded during fish surveys, *Micropanchax myaposae* was identified by DWS (2014) as occurring within the lower Mhlatuze sub-quaternary river reach. *M. myaposae* is regarded as 'Moderately Intolerant' (High Sensitivity) to modified water quality and 'Moderately Tolerant' (moderate sensitivity) to 'no-flow' conditions.

In terms of Threat Status, most of the recorded species are regarded as Least Concern (LC) according to the International Union for Conservation of Nature (IUCN). Most notably from the species recorded during surveys was *M. caudisquamatus*, classified as 'Endangered', and *Oreochromis mossambicus* and *E. gurneyi* which are classified as 'Vulnerable'. It is also important to note that *M. caudisquamatus* was named a new species of *Marcusenius* by Maake *et al.* (2014). The species range is recorded as being limited to the Mhlatuze and Nseleni river systems. This species was recorded at two of the sample sites along Mhlatuze River sites (SW-Lowland River-461-01 and SW-Lowland River-461-02) and one of the tributary sites (SW-Transitional River-471).

4.2.4 Index of Habitat Integrity (IHI) Assessment

The IHI assessment tool (Kleyhans, 1996) was applied at a process unit group level for all Mountain Headwater Streams and all Mountain Streams. Individual IHI assessments were completed for all Transitional Rivers, Upper Foothill Rivers and Lowland Rivers (Mhlatuze River). Where possible the IHI assessments were supplemented by data collected during site visits, including infield observations, water quality data, aquatic macroinvertebrate (SASS5) surveys, and fish surveys. In the case of the Mhlatuze River (SW-Lowland River-461), a single IHI assessment was completed for the full reach of the river that occurs within the South Block study area. This IHI assessment therefore considered the water quality analyses, macroinvertebrate (SASS5) survey, and fish survey results from the three (3) sample sites along the assessed reach (**Figure 22**). The results of the IHI assessment are presented in **Table 37**, including a short comment on notable features influencing the IHI scores.

Table 37. Summary of the IHI (habitat) assessment outcomes for the South Block.

Watercourse(s)	Sampling procedures used to inform IHI	Instream Habitat Score	Riparian Habitat Score	Overall PES Score	Overall Ecological Category (EC)	Comment
Stream Process Unit 01 (Mountain HW Streams)	• Visual observations of selected units. Extrapolation of information to other applicable units. • Desktop analysis of catchment impacts	0.31	0.30	0.31	A: Natural	Largely natural catchment with no / limited direct impacts to watercourse units. Stream processes and morphology are therefore generally intact.
Stream Process Unit 07 (Mountain HW Streams)		1.81	2.89	2.24	C: Fair	Catchment dominated by commercial plantation. Notable encroachment of invasive tree and shrub species into the riparian zone. Altered catchment runoff process associated with forestry, leading to altered stream flow and channel characteristics. Watercourses regularly crossed by forestry roads, causing direct impacts.
Stream Process Unit 02 (Mountain HW Streams)		1.18	2.94	1.88	B: Largely Natural	Catchment contains high levels of woody and herbaceous invasive alien plant species, likely linked to historic ploughing and forestry, or present-day overgrazing and frequent burning. Watercourse processes remain largely intact but riparian vegetation has experienced the encroachment of IAPs. Some signs of altered channel morphology.
Stream Process Unit 03 (Mountain HW Streams)		2.05	2.23	2.12	C Fair	Catchment dominated by rural settlements and homesteads. Catchment vegetation dominated by woody and herbaceous invasive alien plant species. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone. Clearing of indigenous trees from riparian zone is common.
Stream Process Unit 04 (Mountain Streams)		0.31	0.30	0.31	A: Natural	Steep streams with small catchments areas. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone. Clearing of indigenous trees from riparian zone is common.
Stream Process Unit 08 (Mountain Streams)		1.181	2.76	2.19	C: Fair	Catchment dominated by commercial plantation. Notable encroachment of invasive tree and shrub species into the riparian zone. Altered catchment runoff process associated with forestry, leading to altered stream flow and channel characteristics. Watercourses regularly crossed by forestry roads, causing direct impacts.
Stream Process Unit 05 (Mountain Streams)		1.18	2.94	1.88	B: Largely Natural	Catchment contains high levels of woody and herbaceous invasive alien plant species, likely linked to historic ploughing and forestry, or present-day overgrazing and frequent burning. Watercourse processes remain largely intact but riparian vegetation has experienced the encroachment of IAPs. Some signs of altered channel morphology.
Stream Process Unit 06 (Mountain Streams)		2.22	2.37	2.28	C Fair	Catchment dominated by rural settlements and homesteads. Catchment vegetation dominated by woody and herbaceous invasive alien plant species. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone. Clearing of indigenous trees from riparian zone is common.

Watercourse(s)	Sampling procedures used to inform IHI	Instream Habitat Score	Riparian Habitat Score	Overall PES Score	Overall Ecological Category (EC)	Comment
SE-Transitional River-455	• Extrapolation of data collected from similar sampled river systems • Desktop analysis of catchment impacts	1.54	1.76	1.63	B: Largely Natural	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics. Reaches of the river in the vicinity of homesteads have experienced vegetation clearing and IAP encroachment.
SE-Transitional River-462	• Visual observations • Desktop analysis of catchment impacts	1.54	1.76	1.63	B: Largely Natural	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics. Reaches of the river in the vicinity of homesteads have experienced vegetation clearing and IAP encroachment.
SE-Transitional River-468	• Visual observations • Desktop analysis of catchment impacts	1.80	1.86	1.82	B: Largely Natural	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics. Reaches of the river in the vicinity of homesteads have experienced vegetation clearing and IAP encroachment.
SE-Transitional River-469	• Extrapolation of data collected from similar sampled river systems • Desktop analysis of catchment impacts	1.80	1.81	1.81	B: Largely Natural	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics. Reaches of the river in the vicinity of homesteads have experienced vegetation clearing and IAP encroachment.
SE-Transitional River-470	• Water quality analysis • SASS5 survey • Fish survey • Visual observations • Desktop analysis of catchment impacts	1.80	1.86	1.82	B: Largely Natural	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics. Reaches of the river in the vicinity of homesteads have experienced vegetation clearing and IAP encroachment. Water quality along the assessed reach is 'good', and instream biotopes are largely uninterrupted allowing this reach to host sensitive aquatic fauna.
SW-Transitional River-463	• Extrapolation of data collected from similar sampled river systems • Desktop analysis of catchment impacts	1.56	1.65	1.60	B: Largely Natural	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics. Reaches of the river in the vicinity of homesteads have experienced vegetation clearing and IAP encroachment.
SW-Transitional River-467	• Extrapolation of data collected from similar sampled river systems • Desktop analysis of catchment impacts	1.46	1.35	1.41	B: Largely Natural	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics. Limited disturbance from homesteads, but potential historic impacts to watercourse associated with ceased agriculture.
SW-Transitional River-471	• Water quality analysis • SASS5 survey • Fish survey • Visual observations	1.80	1.86	1.82	B: Largely Natural	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics. Reaches of the river in the vicinity of homesteads have experienced vegetation clearing and IAP encroachment. Water quality along the assessed reach is 'good', and instream biotopes are largely uninterrupted allowing this reach to host sensitive aquatic fauna.

Watercourse(s)	Sampling procedures used to inform IHI	Instream Habitat Score	Riparian Habitat Score	Overall PES Score	Overall Ecological Category (EC)	Comment
	• Desktop analysis of catchment impacts					
SW-Transitional River-502	• Extrapolation of data collected from similar sampled river systems • Desktop analysis of catchment impacts	2.43	1.87	2.20	**D: Poor**	Upper reaches of watercourse reach are unimpacted by catchment or direct activities. Lower reach of the watercourse inundated by the Goedertrouw Dam when the dam is full. This has drastically altered the natural channel and flow characteristics of an approximately 800m long reach of this river unit. This is more than half the length of the assessed reach.
SW-Transitional River-544	• Extrapolation of data collected from similar sampled river systems • Desktop analysis of catchment impacts	1.24	0.89	1.10	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics. Reaches of the river in the vicinity of homesteads have experienced vegetation clearing and IAP encroachment.
SE-Upper Foothill River-466	• Water quality analysis • SASS5 survey • Fish survey • Visual observations • Desktop analysis of catchment impacts	2.25	2.14	2.21	**C: Fair**	High number of rural homesteads located along the length of this river. Water quality and aquatic faunal surveys suggest that there has been limited impacts to water quality or biotope diversity, but visual observations of the reach revealed that long reach of the river have experienced vegetation removal and IAP encroachment. Several informal or poorly designed road crossings along the length of this watercourse reach are having a localised impact of flow patterns.
SW-Upper Foothill River-456	• Water quality analysis • SASS5 survey • Fish survey • Visual observations • Desktop analysis of catchment impacts	1.87	1.89	1.88	**B: Largely Natural**	Upper reaches of watercourse reach are unimpacted by catchment or direct activities. Lower reach of the watercourse inundated the Goedertrouw Dam when the dam is full. This has drastically altered the natural channel and flow characteristics of an approximately 900m long reach of this river unit. The total length of the river is however approximately 6km, with much of the watercourse being in a largely natural state.
SW-Upper Foothill River-457	• Extrapolation of data collected from similar sampled river systems • Desktop analysis of catchment impacts	1.82	1.41	1.66	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics. Reaches of the river in the vicinity of homesteads have experienced vegetation clearing and IAP encroachment. Water quality along the assessed reach is 'good', and instream biotopes are largely uninterrupted allowing this reach to host sensitive aquatic fauna.
SW-Lowland River-461 (Mhlatuze River)	• Water quality analysis (3 x sites) • SASS5 survey (3 x sites) • Fish survey (3 x sites) • Visual observations (3 x sites) • Desktop analysis of catchment impacts	1.83	2.00	1.90	**B: Largely Natural**	Major impacts to the assessed reach of the Mhlatuze River are the impoundment and inundation of a section of the watercourse by the Goedertrouw Dam. The infield sampling did however indicate that there has been limited water quality modification along the assessed reach. IAP encroachment is impacting natural riparian vegetation, most notably in the vicinity of the rural settlements where vegetation removal is an ongoing issue.

4.3 Rivers & Streams – Ecological Importance & Sensitivity (EIS) Assessment

River Ecological Importance (EI) is an expression of the importance of the aquatic resources for the maintenance of biological diversity and ecological functioning on local and wider scales; whilst Ecological Sensitivity (ES) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007). The EIS of rivers and streams in the South block was assessed using a tool developed by Eco-Pulse (2017), based on the DWAF EIS tool (Kleynhans, 1999). A summary of the EIS of rivers and streams associated with the South Block is shown in **Table 38**. A description of the outcomes of the assessment is presented below.

Mountain Headwater Stream & Mountain Streams (Process Units 01 – 08):

- All Mountain Headwater and Mountain Streams were rated as being of 'Low' EIS. Important considerations for the EIS assessment for onsite streams include the following:
  - Streams in the study area are 'Least Threatened' in terms of conservation threat status (NBA, 2018) and are not considered Freshwater Ecosystem Priority Areas (FEPAs) in terms of the NFEPA project (CSIR, 2011) (**Table 7**).
  - These streams units do not host important or sensitive taxa and provide only limited refugia for biota due to their ephemeral / seasonal flow.
  - The stream units are likely to be moderately sensitive to flow related changes and changes in water quality due to their prevailing ephemeral / seasonal flow conditions.
  - Despite the low diversity of instream habitat and absence of sensitive/intolerant biota, these stream units have relatively high levels of connectivity with the downstream watercourses. This makes these watercourses important wildlife corridors.

Transitional and Upper foothill Rivers

- All Transitional and Upper Foothill rivers were rated as being of 'Moderate' EIS. Important considerations for the EIS assessment for onsite streams include the following:
  - Rivers in the study area are 'Least Threatened' in terms of conservation threat status (NBA, 2018) and are not considered Freshwater Ecosystem Priority Areas (FEPAs) in terms of the NFEPA project (CSIR, 2011) (**Table 7**).
  - The perennial flow that characterises these river units means that they are likely to play host to a range of aquatic fauna that rely on the year-round presence of water for them to survive and breed.
  - These rivers likely provide vital refugia to aquatic fauna, especially during times of environmental stress such as low-flow / drought periods. The species relying on this system are therefore likely to be sensitive to reductions in flow.
  - The SASS5 and fish surveys revealed that several intolerant macro-invertebrate and fish species rely on these river systems, with these species likely using the available habitat to breed and complete their life cycles.
  - These river systems have the potential to host *M. caudisquamatus* (Endangered on the

IUCN List), *O. mossambicus* (Endangered on the IUCN List) and *E. gurneyi* (Endangered on the IUCN List).
    - These river systems host *M. caudisquamatus,* which was described as a new species of the genus *Marcusenius* by Maake et al. (2014). The species' range is recorded as being limited to only the Mhlatuze and Nseleni river systems. This species was recorded at SW-Upper Foothills River-456. The presence of this unique and range restricted species within the rivers of the study area makes these systems important habitat.
    - The diversity of instream habitat available to aquatic fauna makes these rivers ecologically important.

<u>Lowland River – Mhlatuze</u>

- The assessed reach of the Mhlatuze River (SW-Lowland River-461) was rated as being of <u>'High'</u> EIS. Important considerations for the EIS assessment for onsite streams include the following:
    - Rivers in the study area are 'Least Threatened' in terms of conservation threat status (NBA, 2018) and are not considered Freshwater Ecosystem Priority Areas (FEPAs) in terms of the NFEPA project (CSIR, 2011) (**Table 7**).
    - The diversity of instream habitat types and the perennial nature of flow along river reach R01 means that the unit is well suited to provide good quality refugia for aquatic biota during time of environmental stress.
    - The importance of instream and riparian habitat of the reach R01 is further supported by high levels of connectivity of habitat, both laterally and longitudinally, with the buffer around this river remaining largely intact. This suggests that the assessed reach of the Mhlatuze River serves as an important corridor that supports the movement of local wildlife.
    - The SASS5 and fish surveys revealed that several intolerant macro-invertebrate and fish species rely on the assessed reach, with these species likely using the available habitat to breed and complete their life cycles.
    - This river systems hosts *M. caudisquamatus* (Endangered on the IUCN List), *O. mossambicus* (Endangered on the IUCN List) and *E. gurneyi* (Endangered on the IUCN List).
    - This river systems hosts *M. caudisquamatus,* which was described as a new species of the genus *Marcusenius* by Maake et al. (2014). The species' range is recorded as being limited to only the Mhlatuze and Nseleni river systems. The presence of this unique and range restricted species within the rivers of the study area makes these systems important habitat.
    - The high flow volume of the system means it can buffer minor changes in flow condition and water quality, without incurring major impacts to habitat and biota.

Table 38. Summary of EIS scores and overall EIS rating for the assessed South Block River and stream

Watercourse(s)	Hosts Rare & endangered	Unique species (endemic, isolated, etc.)	Intolerant species sensitive to flow/water quality modifications	Species/taxon richness	Diversity of habitat types	Refugia for biota	Sensitivity to flow changes	Sensitivity to flow related water quality changes	Migration route/corridor (instream & riparian)	Importance of conservation & natural areas	EIS Score	EIS Class
	Scores (out of 4) and Rating											
Stream Process Unit 01 (Mountain HW Streams)	0.0 (None)	0.0 (None)	0.0 (None)	1.0 (Low)	0.0 (None)	0.0 (None)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	0.5 (none)	**0.25**	**D: Low**
Stream Process Unit 07 (Mountain HW Streams)	0.0 (None)	0.0 (None)	0.0 (None)	1.0 (Low)	0.0 (None)	0.0 (None)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	0.5 (none)	**0.25**	**D: Low**
Stream Process Unit 02 (Mountain HW Streams)	0.0 (None)	0.0 (None)	0.0 (None)	1.0 (Low)	0.0 (None)	0.0 (None)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	0.5 (none)	**0.25**	**D: Low**
Stream Process Unit 03 (Mountain HW Streams)	0.0 (None)	0.0 (None)	0.0 (None)	1.0 (Low)	0.0 (None)	0.0 (None)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	0.5 (none)	**0.25**	**D: Low**
Stream Process Unit 04 (Mountain Streams)	0.0 (None)	0.0 (None)	0.0 (None)	2.0 (Mod)	1.0 (Low)	1.0 (Low)	3.0 (High)	3.0 (High)	2.0 (Mod)	0.0 (None)	1.00	**D: Low**
Stream Process Unit 08 (Mountain Streams)	0.0 (None)	0.0 (None)	0.0 (None)	2.0 (Mod)	1.0 (Low)	1.0 (Low)	3.0 (High)	3.0 (High)	2.0 (Mod)	0.0 (None)	1.00	**D: Low**

Watercourse(s)	Hosts Rare & endangered	Unique species (endemic, isolated, etc.)	Intolerant species sensitive to flow/water quality modifications	Species/taxon richness	Diversity of habitat types	Refugia for biota	Sensitivity to flow changes	Sensitivity to flow related water quality changes	Migration route/corridor (instream & riparian)	Importance of conservation & natural areas	EIS Score	EIS Class
Stream Process Unit 05 (Mountain Streams)	0.0 (None)	0.0 (None)	0.0 (None)	2.0 (Mod)	1.0 (Low)	1.0 (Low)	3.0 (High)	3.0 (High)	2.0 (Mod)	0.0 (None)	1.00	**D: Low**
Stream Process Unit 06 (Mountain Streams)	0.0 (None)	0.0 (None)	0.0 (None)	2.0 (Mod)	1.0 (Low)	1.0 (Low)	3.0 (High)	3.0 (High)	2.0 (Mod)	0.0 (None)	1.00	**D: Low**
SE-Transitional River-455	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
SE-Transitional River-462	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
SE-Transitional River-468	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
SE-Transitional River-469	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
SE-Transitional River-470	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**

Watercourse(s)	Hosts Rare & endangered	Unique species (endemic, isolated, etc.)	Intolerant species sensitive to flow/water quality modifications	Species/taxon richness	Diversity of habitat types	Refugia for biota	Sensitivity to flow changes	Sensitivity to flow related water quality changes	Migration route/corridor (instream & riparian)	Importance of conservation & natural areas	EIS Score	EIS Class
SW-Transitional River-463	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
SW-Transitional River-467	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
SW-Transitional River-471	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
SW-Transitional River-502	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
SW-Transitional River-544	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
SE-Upper Foothill River-466	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
SW-Upper Foothill River-456	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**

Watercourse(s)	Hosts Rare & endangered	Unique species (endemic, isolated, etc.)	Intolerant species sensitive to flow/water quality modifications	Species/taxon richness	Diversity of habitat types	Refugia for biota	Sensitivity to flow changes	Sensitivity to flow related water quality changes	Migration route/corridor (instream & riparian)	Importance of conservation & natural areas	EIS Score	EIS Class
SW-Upper Foothill River-457	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
SW-Lowland River-461 (Mhlatuze River)	3.0 (High)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	2.0 (Mod)	3.0 (High)	2.0 (Mod)	3.0 (High)	3.0 (High)	0.0 (None)	2.50	**B: High**

4.4 Wetlands - Present Ecological State (PES) Assessment

Wetland PES was assessed using the WET-Health (Macfarlane *et al*., 2008) assessment tool. The Wetland PES assessments were completed at a process unit level. The outcomes of the Wetland PES assessment are summarised in **Table 39** , including a comment on notable features impacting wetland PES.

Table 39. Summary of the PES assessment results for the Wetland process unit groups in the South Block.

Wetland Process Unit	HGM Type	Hydrology PES Category	Geomorphology PES Category	Vegetation PES Category	Overall PES Category	Key Impact(s)
Wetland Process Unit Group 01	**Seep**	**D**	**C**	**D**	**D: Largely Modified**	Vegetation - Wetlands belonging to this group were heavily utilized for subsistence farming, with most of the wetland area being planted to crops, mostly *Colocasia esculenta*. Hydrology - Reduced runoff to wetland due to woody IAPs within catchment areas. Increased on site water use due to presence of crops and woody IAPs within wetland area. Altered flow through wetland due to drainage and cultivation. Geomorphology – Altered wetland geomorphic structure due to regular cultivation. Sediment loss from wetland area due to drainage and entrainment of bare cultivated areas.
Wetland Process Unit Group 02		**C**	**C**	**C**	**C: Moderately Modified**	Vegetation - Encroachment of woody IAPs into wetland area. Altered hygrophilous grassland composition due to overgrazing and burning. Hydrology – Increased runoff volumes and velocities due to reduced wetland and catchment basal cover (overgrazing and burning). Geomorphology – Increased sediment inputs associated with reduced catchment basal cover.
Wetland Process Unit Group 03		**D**	**C**	**D**	**C: Moderately Modified**	Vegetation - intense encroachment of woody IAPs into wetland area. Hydrology – Increased runoff volumes and velocities due to reduced wetland and catchment basal cover (overgrazing and burning). Geomorphology – Increased sediment inputs associated with reduced catchment basal cover.

Wetland Process Unit Group 04	**Unchanneled Valley Bottom**	**C**	**C**	**C**	**C: Moderately Modified**	Vegetation - Encroachment of woody IAPs into wetland area. Altered hygrophilous grassland composition due to overgrazing and burning. Central, permanently inundated wetland areas remain largely intact. Hydrology – Increased runoff volumes and velocities due to reduced wetland and catchment basal cover (overgrazing and burning). Geomorphology – increased sediment inputs associated with reduced catchment basal cover.
Wetland Process Unit Group 05		**C**	**C**	**C**	**C: Moderately Modified**	Vegetation - Encroachment of woody IAPs into wetland area. Altered hygrophilous grassland composition due to overgrazing and burning. Central, permanently inundated wetland areas remain largely intact. Hydrology – Increased runoff volumes and velocities due to reduced wetland and catchment basal cover (overgrazing and burning). Geomorphology – increased sediment inputs associated with reduced catchment basal cover.

4.5 Wetlands – Ecosystem Services Assessment

An assessment of wetland ecosystem services (i.e., wetland functionality) was conducted using the WET-Ecoservices tool. (Kotze *et al.*, 2019). The Wetland ecosystem services assessments were completed at a process unit level across two (2) themes, namely:

- Regulating Services
- Provisioning and Cultural Services

The outcomes of the ecosystem services assessment are summarised in **Table 40** and **Table 41**.

4.5.1 Regulating Services

The most important regulating service provided by wetlands belonging to each of the three (3) seep wetland process unit groups is carbon storage (**Table 40**). This service refers to the trapping of carbon in waterlogged wetland soils, principally as organic matter, thereby contributing positively as a carbon sink, which is of significance for global climate change. The seasonally saturated soils that occur within the wettest parts of the South Block seep wetlands makes these units reasonably well suited to supply this service. The generally small seep wetland size, modified nature, and the lack of demand for regulating services in the context of the study site means that seep wetlands are not of notable regulatory importance for other assessed services.

The unchanneled valley bottom wetlands within the South Block are of Very High importance for carbon storage services. These wetlands were largely dominated by permanently saturated soils which are characterised by nominal decomposition rates for accumulated organic matter. The valley bottom wetlands are also larger in size than the seeps and therefore have the capacity to act as carbon sinks on a larger scale than the small seep units. Another important regulatory service provided by the valley bottom wetlands is sediment trapping. These wetlands are well placed to provide this service as they are robustly vegetated and are characterised by diffuse flow patterns, creating favourable conditions for sediment accumulation.

Table 40. Summary of regulating services importance scores and overall importance rating for each South Block wetland process unit group.

Wetland Process Unit Groups	Regulating Services Scores (0-4)								Importance Rating
	Flood attenuation	Streamflow regulation	Sediment trapping	Erosion control	Phosphate removal	Nitrate removal	Toxicant removal	Carbon storage	
01 (Seep)	0.0	0.8	1.0	0.6	0.6	0.4	0.3	1.7	Moderate
02 (Seep)	0.0	1.3	1.0	0.2	0.6	0.5	0.3	1.8	Moderate

Wetland Process Unit Groups	Regulating Services Scores (0-4)								Importance Rating
	Flood attenuation	Streamflow regulation	Sediment trapping	Erosion control	Phosphate removal	Nitrate removal	Toxicant removal	Carbon storage	
03 (Valley Bottom)	0.1	0.5	1.0	0.8	0.6	0.4	0.3	2.1	Moderate
04 (Valley Bottom)	0.1	1.3	2.4	1.1	2.0	1.8	1.4	3.3	Very High
05 Valley Bottom)	0.1	1.5	2.4	1.1	2.0	1.9	1.5	3.4	Very High

4.5.1 Provisioning and Cultural Services

Seeps belong to process unit group 01 are of Moderately-High provisioning importance. This rating is a result of these wetlands being used for the cultivation of subsistence crops, and the reasonably high dependence of local households on the food grown within these wetlands given the isolated and low-income nature of the study area. Seep wetlands belonging to process units' groups 02 and 03 are of Moderately-Low cultural and provisioning importance.

The valley bottom wetlands within the study area are of Moderate provisioning importance. this score comes because of the permanent diffuse flow along the valley bottom wetlands, which could serve as an important water source for local communities. The demand for water abstraction from wetlands for drinking or agriculture is, however, low due to the difficulties with accessing water from the wetlands, and the use of boreholes as a primary water abstraction method by local communities in the South Block.

Table 41. Summary of provisioning & cultural services importance scores and overall importance rating for each South Block wetland process unit group.

Wetland Process Units	Provisioning & Cultural Services Scores (0-4)							Overall Rating
	Water supply	Harvestable natural resources	Food for livestock	Cultivated foods	Tourism and recreation	Education and research	Cultural and spiritual	
01 (Seep)	0.5	0.7	0.0	2.5	0.0	0.0	1.0	Moderately-High
02 (Seep)	0.0	0.0	1.3	1.5	0.0	0.0	1.0	Moderately-Low
03 (Valley Bottom)	0.0	1.2	0.0	1.5	0.0	0.0	1.0	Moderately-Low
04 (Valley Bottom)	1.7	1.2	0.0	1.8	0.0	0.0	1.0	Moderate
05 Valley Bottom)	1.7	1.2	0.0	1.3	0.0	0.0	1.0	Moderate

4.6 Wetland EIS Assessment

Wetland EIS Assessments were conducted for all wetland process unit groups. The wetland EIS assessment involved rating four (4) major components, namely:

- Ecological Importance in terms of biodiversity maintenance (from ecosystem services assessment).
- Ecological Importance in terms of cultural and provisions functions (from ecosystem services assessment).
- Ecological Importance in terms of regulating functions (from ecosystem services assessment)
- Ecological sensitivity.

A summary of the EIS assessment is provided in **Table 42**. Wetlands associated with process unit groups 01, 04 and 05 were assessed as being of **'Moderate' EIS,** whilst groups 02 and 03 were of **'Low' EIS.** Key factors driving the wetland EIS assessments were the following:

- Wetland belonging to process unit group 01 are considered important as they are associated with food provision in the form of subsistence cultivation. These seep wetlands were, however, not considered ecologically sensitive.
- Wetlands belonging to process unit group 02 and 03 are both of low ecological importance as they provide limited vital ecosystem services. These wetlands were not considered ecologically sensitive.
- Wetlands belonging to process units 04 and 05 are considered ecologically important because of the role they play as carbon sinks. These wetlands are also considered ecologically sensitive to changes in flow and sediment inputs as they rely on aggradational processes and permanent diffuse flow for their functioning and evolution.

Table 42. Summary of EIS scores and overall EIS rating for the assessed South Block wetland process unit groups

	Rating (out of 4)			
Wetland Process Units	**Ecological Importance**	**Ecological Sensitivity**	**Overall EIS Score**	**Overall EIS Rating**
01 (Seep)	2.50	1.10	2.05	**Moderate**
02 (Seep)	1.50	1.10	1.05	**Low**
03 (Valley Bottom)	1.50	1.10	1.05	**Low**
04 (Valley Bottom)	2.20	2.20	2.30	**Moderate**
05 (Valley Bottom)	2.20	2.20	2.30	**Moderate**

4.7 Recommended Ecological Categories (REC) & Recommended Management Objectives (RMOs)

The recommended ecological category (REC) is the target or desired state of resource units that is required to meet water resource management objectives and quality targets. It is determined through the consideration of the PES, EIS and realistic opportunities to improve the PES, driven by context and setting. The modus operandi followed by DWAF's Directorate: Resource Directed Measures (RDM) is that if the EIS is high or very high, the ecological management objective should be to improve the condition of the river (Kleynhans & Louw, 2007). However, the causes related to PES should also be considered to determine if improvement is realistic and attainable (Kleynhans & Louw, 2007). This relates to whether the problems in the catchment can be addressed and mitigated (Kleynhans & Louw, 2007). If the EIS is evaluated as moderate or low, the ecological aim should be to maintain the river in its PES (Kleynhans & Louw, 2007). Within the Ecological Reserve context, Ecological Categories A to D can be recommended as future states depending on the EIS and PES (Kleynhans & Louw, 2007). Ecological Categories E and F PES are regarded as ecologically unacceptable, and remediation is needed if possible (Kleynhans & Louw, 2007). A generic matrix for the determination of RECs and RMOs for water resources is shown in **Table 43**, below.

Table 43. Generic matrix for the determination of REC and RMO for water resources (based on Kleynhans and Louw, 2007).

			EIS			
			Very high	**High**	**Moderate**	**Low**
PES	**A**	**Pristine/Natural**	A Maintain	A Maintain	A Maintain	A Maintain
	B	**Largely Natural**	A Improve	A/B Improve	B Maintain	B Maintain
	C	**Fair**	B Improve	B/C Improve	C Maintain	C Maintain
	D	**Poor**	C Improve	C/D Improve	D Maintain	D Maintain
	E/F	**Very Poor**	D Improve	E/F Improve	E/F Improve	E/F Improve

Based on the matrix in **Table 43**, the minimum recommended management objective (RMO) for all watercourses in the South Block study area, except for SW-Lowland River-461 (Mhlatuze River), is to maintain the current PES (**Table 44**). The RMO for the assessed reach of the Mhlatuze River would be to improve its current PES to sustain and improve the important ecological functions it provides.

Table 44. REC and RMO for the delineated watercourse units in the South Block based on their PES and EIS ratings.

Watercourse Units	PES	EIS	REC	RMO
Rivers & Streams				
Stream Process Unit 01 (Mountain HW Streams)	**A: Natural**	**D: Low**	A	Maintain PES

Watercourse Units	PES	EIS	REC	RMO
Stream Process Unit 07 (Mountain HW Streams)	**C: Fair**	**D: Low**	C	Maintain PES
Stream Process Unit 02 (Mountain HW Streams)	**B: Largely Natural**	**D: Low**	B	Maintain PES
Stream Process Unit 03 (Mountain HW Streams)	**C Fair**	**D: Low**	C	Maintain PES
Stream Process Unit 04 (Mountain Streams)	**A: Natural**	**D: Low**	A	Maintain PES
Stream Process Unit 08 (Mountain Streams)	**C: Fair**	**D: Low**	C	Maintain PES
Stream Process Unit 05 (Mountain Streams)	**B: Largely Natural**	**D: Low**	B	Maintain PES
Stream Process Unit 06 (Mountain Streams)	**C Fair**	**D: Low**	C	Maintain PES
SE-Transitional River-455	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SE-Transitional River-462	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SE-Transitional River-468	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SE-Transitional River-469	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SE-Transitional River-470	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SW-Transitional River-463	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SW-Transitional River-467	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SW-Transitional River-471 (KwaMazula River)	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SW-Transitional River-502	**D: Poor**	**C: Moderate**	D	Maintain PES
SW-Transitional River-544	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SE-Upper Foothill River-466	**C: Fair**	**C: Moderate**	C	Maintain PES
SW-Upper Foothill River-456	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SW-Upper Foothill River-457	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
SW-Lowland River-461 (Mhlatuze River)	**B: Largely Natural**	**B: High**	A/B	Improve PES
		Wetlands		
Wetland Process Unit Group 01	D: Poor	C: Moderate	D	Maintain PES

Watercourse Units	PES	EIS	REC	RMO
Wetland Process Unit Group 02	**C: Fair**	D: Low	C	Maintain PES
Wetland Process Unit Group 03	**C: Fair**	D: Low	C	Maintain PES
Wetland Process Unit Group 04	**C: Fair**	C: Moderate	C	Maintain PES
Wetland Process Unit Group 05	**C: Fair**	C: Moderate	C	Maintain PES

5. NORTH BLOCK BASELINE ASSESSMENT FINDINGS

This section presents the desktop baseline assessment findings for the North Block. All baseline assessments for the North Block were completed at a desktop level with no field verification having been completed. The baseline assessment information in this chapter could be used to guide mine layout planning. It would however be necessary to update this desktop baseline assessment information with field verified delineation and baseline data as part of any future EIA or WUL applications.

5.1 Watercourse Classification & Habitat Characteristics

A total of three hundred and thirty-one (331) river / stream units and sixty-three (63) wetland units were identified and classified in the North Block study area. This included watercourses of the following classifications:

Rivers and Streams:

- Mountain Headwater Streams – 253 units
- Mountain Streams – 62 units
- Transitional Rivers – 12 units
- Upper Foothill Rivers – 2 units
- Lower Foothill River (Middle Mfule River) – 1 unit
- Lowland River (Lower Mfule River) – 1 unit

Wetlands:

- Seep Wetlands – 23 units
- Unchanneled Valley Bottom Wetlands – 40 units

The watercourse map for the North Block is shown in **Figure 27**. A summary of the number of different river / stream and wetland types across the South Block is provided below.

Rivers and Streams:

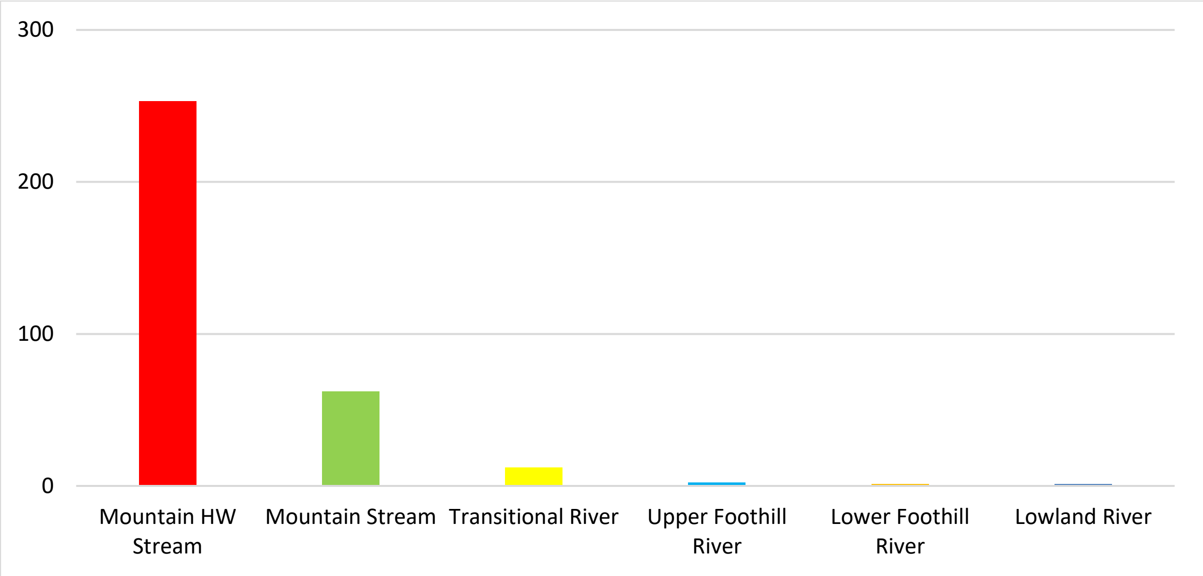

Figure 25. Summary of the different river and stream types within the North Block.

Wetlands:

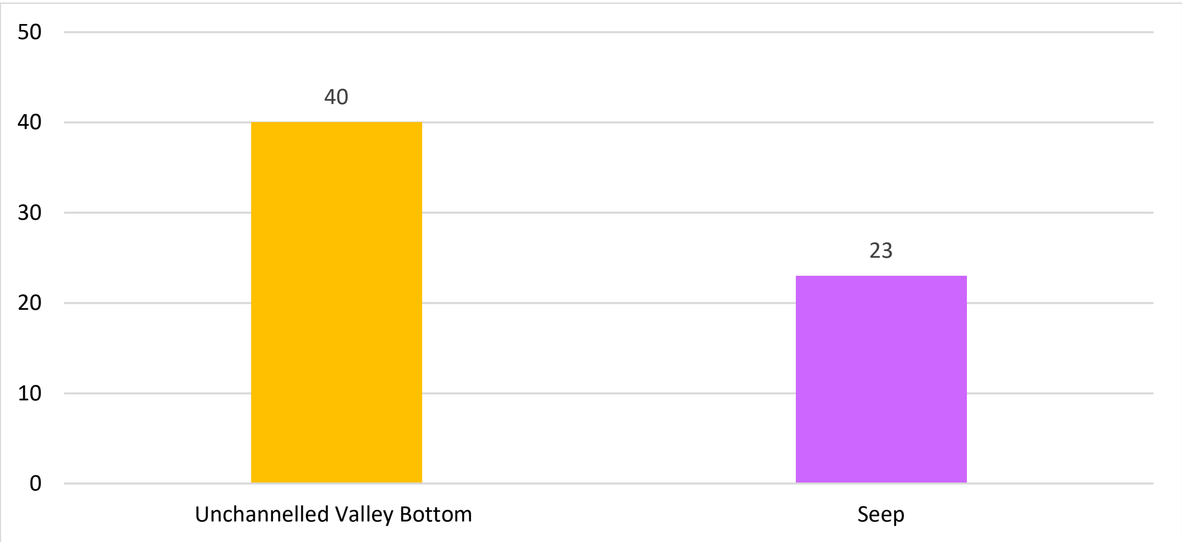

Figure 26. Summary of the different wetland types within the North Block

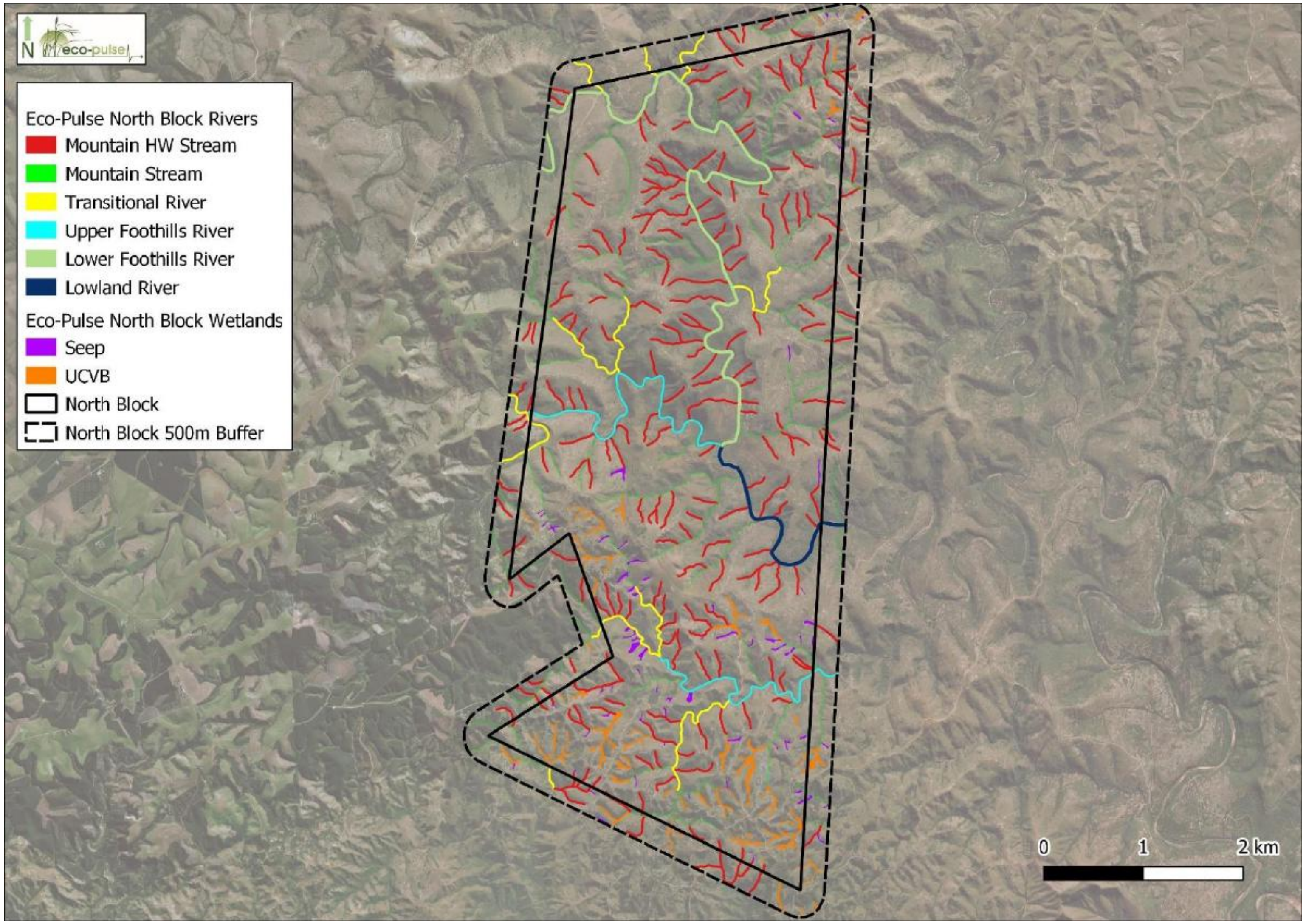

Figure 27. Watercourse delineation and classification map for the North Block.

Given the size and dense drainage network that characterises the North Block study area, the process unit classification and assessment approach was applied to the following watercourse types:

- Mountain Headwater Streams *(divided into four [4] process unit groups)*
- Mountain Streams *(divided into four [4] process unit groups)*
- Seep Wetlands *(divided into three [3] process unit groups)*
- Unchanneled Valley Bottom Wetlands *(divided into three [3] process unit groups)*

All Transitional Rivers, Upper Foothill Rivers, and Lowland Rivers were assessed at a desktop level as individual watercourses. The process unit groupings (Mountain Headwater Streams, Mountain Streams, Wetlands) and assessment units (Transitional Rivers, Upper Foothill Rivers and Lowland Rivers) for the North Block are shown in **Figure 28**, below.

Note that no field visits were conducted within the North Block as part of this assessment. The summaries for each assessed North Block unit, outlined in the subsections which follow, are therefore assumed.

Note: All watercourses in the study area were given a unique watercourse identification code. The code system is as follows:

- Block division-watercourse type-unique number

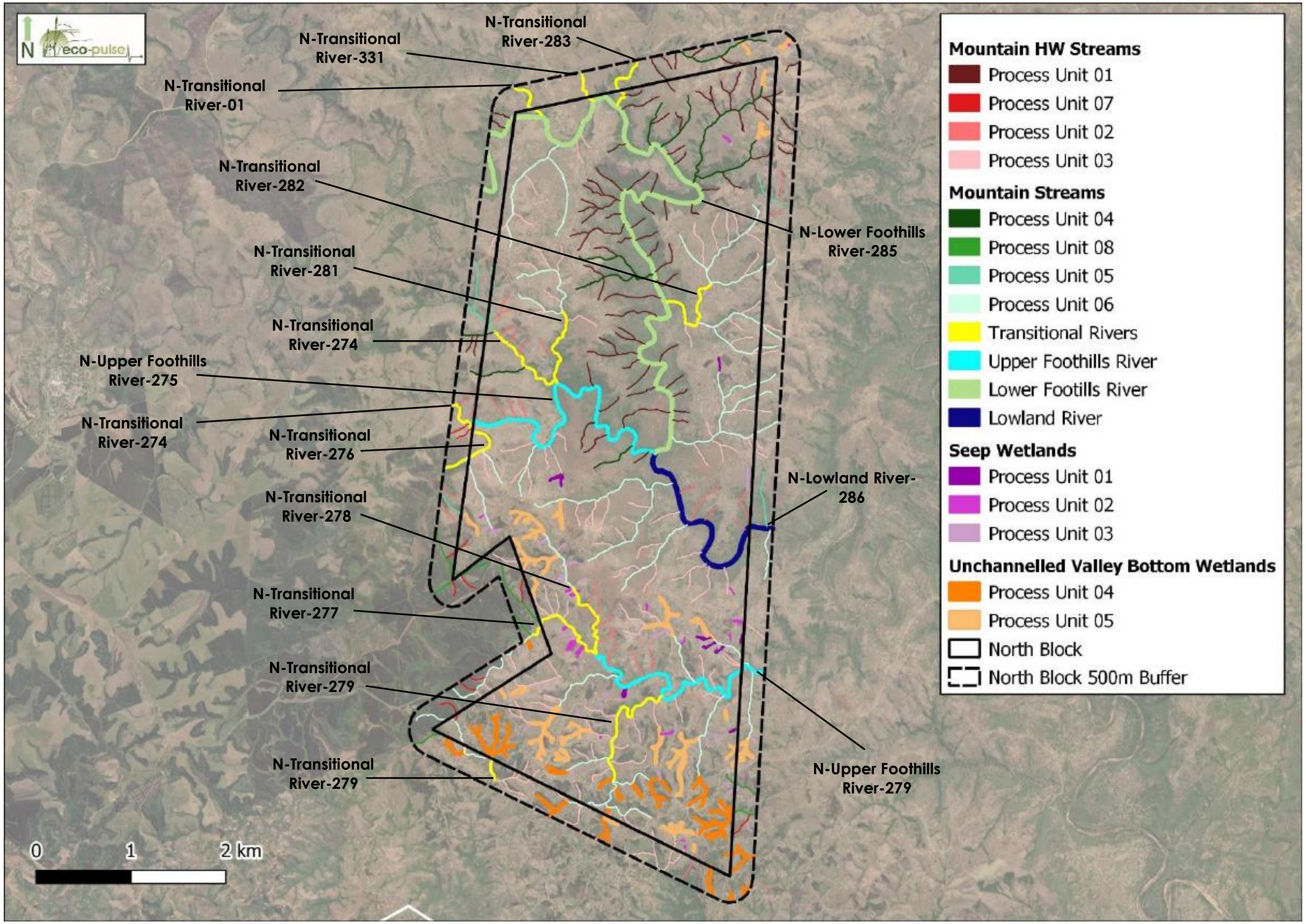

Figure 28. River, stream, and wetland assessment units for the North Block

5.1.1 Mountain Headwater Streams

The two-hundred and fifty-three (253) Mountain Headwater Streams mapped in the North Block were divided into four (4) different process unit groups as follows:

- Process Unit Group 01 – 94 units
- Process Unit Group 07 – 10 units
- Process Unit Group 02 – 30 units
- Process Unit Group 03 – 119 units

A summary of the division of the Mountain Headwater Streams into process unit groups is presented in **Figure 29**. The location of the different process unit groups can be seen in **Figure 28**, above. Desktop level biophysical descriptions for each Mountain Headwater stream Process Unit Group are presented in the tables which follow.

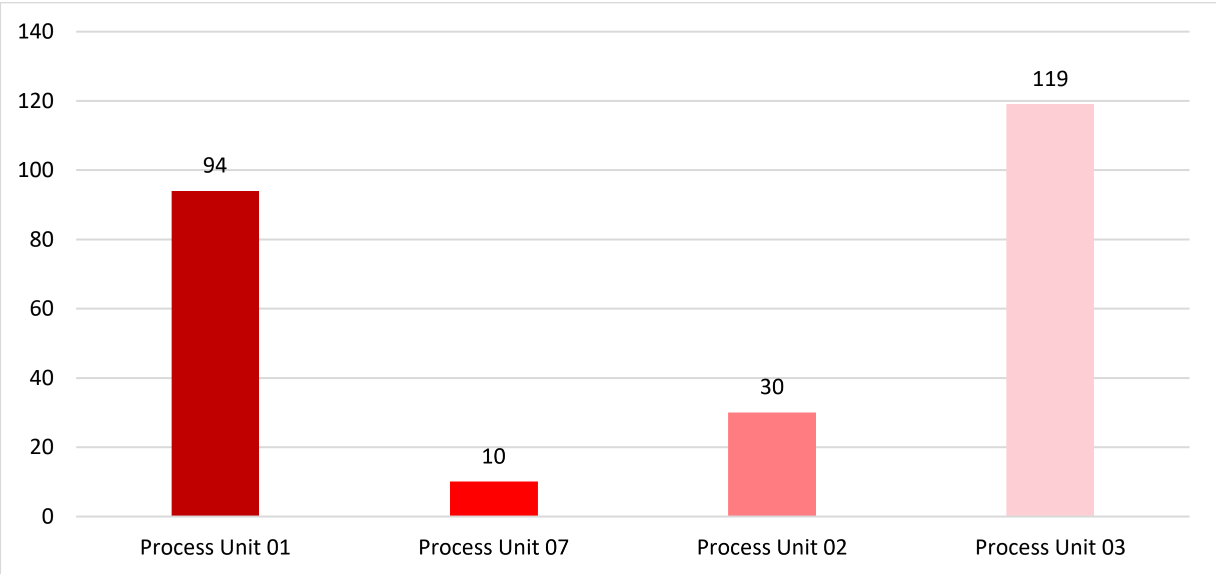

Figure 29. Summary of the division of the North Block Mountain Headwater streams into Process Unit Groups.

Table 45. Summary of key features of North Block River 'Process Unit' group 01.

Mountain Headwater Stream – Process Unit 01	
Number of Stream Units in Process Group	94
General Catchment Description	Largely natural / semi-natural with little interruption to expected natural catchment processes.
General Unit Description	Steep streams with small catchments areas. Minimal bed and bank modifications.
Expected Biophysical Characteristics	
Flow	Ephemeral - Flows are only expected along these units for a short period following high rainfall events.
General Substrate Type	Alluvial.

Mountain Headwater Stream – Process Unit 01	
General Instream Biotopes	Dry alluvial stream bed.
Expected Riparian Features	Macro channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone with minimal alien invasive plant species.

Table 46. Summary of key features of North Block River 'Process Unit' group 07.

Mountain Headwater Stream – Process Unit 07	
Number of Stream Units in Process Group	10
General Catchment Description	Vegetation dominated commercial forestry plantation species.
General Unit Description	Steep streams with small catchments areas. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone.
Expected Biophysical Characteristics	
Flow	Ephemeral - Flows are only expected along these units for a short period following high rainfall events.
General Substrate Type	Alluvial.
General Instream Biotopes	Dry alluvial stream bed.
Expected Riparian Features	Macro channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone that is dominated by woody and herbaceous alien plant species.

Table 47. Summary of key features of North Block River 'Process Unit' group 02.

Mountain Headwater Stream – Process Unit 02	
Number of Stream Units in Process Group	30
General Catchment Description	Vegetation dominated by woody and herbaceous invasive alien plant species. Emergence of alien plants is likely linked to historic ploughing and forestry, and / or present-day overgrazing and frequent burning.
General Unit Description	Steep streams with small catchments areas. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone.
Expected Biophysical Characteristics	
Flow	Ephemeral - Flows are only expected along these units for a short period following high rainfall events.
General Substrate Type	Alluvial.
General Instream Biotopes	Dry alluvial stream bed.
Expected Riparian Features	Macro channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone that is dominated by woody and herbaceous alien plant species.

Table 48. Summary of key features of North Block River 'Process Unit' group 03.

Mountain Headwater Stream – Process Unit 03	
Number of Stream Units in Process Group	119
General Catchment Description	Dominated by rural settlements and homesteads. Vegetation dominated by woody and herbaceous invasive alien plant species.
General Unit Description	Steep streams with small catchments areas. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone. Clearing of indigenous trees from riparian zone is common.
Expected Biophysical Characteristics	
Flow	Ephemeral - Flows are only expected along these units for a short period following high rainfall events.
General Substrate Type	Alluvial.
General Instream Biotopes	Dry alluvial stream bed.
Expected Riparian Features	Macro channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone that is dominated by woody and herbaceous alien plant species.

5.1.2 Mountain Streams

The sixty-two (62) Mountain Streams mapped in the North Block were divided into four (4) different process unit groups as follows:

- Process Unit Group 04– 10 units
- Process Unit Group 08 – 8 units
- Process Unit Group 05 – 6 units
- Process Unit Group 06 – 38 units

A summary of the division of the Mountain Streams into process unit groups is presented in **Figure 30**. The location of the different process unit groups can be seen in **Figure 28**, above. Desktop level biophysical descriptions for each Mountain Stream Process Unit Group are presented in the tables which follow.

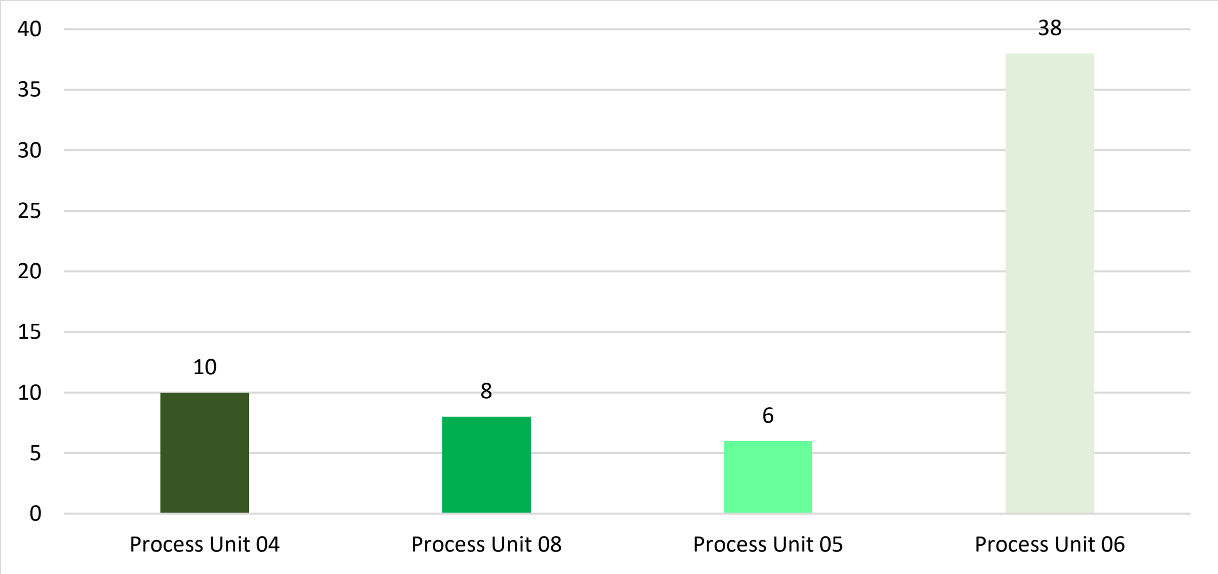

Figure 30. Summary of the division of the North Block Mountain Streams into Process Unit Groups

Table 49. Summary of key features of North Block River 'Process Unit' group 04.

Mountain Stream – Process Unit 04	
Number of Stream Units in Process Group	10
General Catchment Description	Largely natural / semi-natural with little interruption to expected natural catchment processes.
General Unit Description	Moderately steep streams with small catchments areas. Minimal bed and bank modifications.
Expected Biophysical Characteristics	
Flow	Seasonal
General Substrate Type	Mixed bedrock and alluvial.
General Instream Biotopes	Pool, riffles, runs.
Expected Riparian Features	Macro channel bank. Active channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone with minimal alien invasive plant species. **Active Channel:** • Some herbaceous marginal vegetation. Instream vegetation lacking.

Table 50. Summary of key features of North Block River 'Process Unit' group 08.

Mountain Stream – Process Unit 08	
Number of Stream Units in Process Group	8
General Catchment Description	Vegetation dominated commercial forestry plantation species.
General Unit Description	Moderately steep streams with small catchments areas. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone.

Mountain Stream – Process Unit 08	
Expected Biophysical Characteristics	
Flow	Seasonal
General Substrate Type	Mixed bedrock and alluvial.
General Instream Biotopes	Pool, riffles, runs.
Expected Riparian Features	Macro channel bank. Active channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone that is dominated by woody and herbaceous alien plant species. **Active Channel:** • Some herbaceous marginal vegetation. Instream vegetation lacking.

Table 51. Summary of key features of North Block River 'Process Unit' group 05.

Mountain Stream – Process Unit 05	
Number of Stream Units in Process Group	6
General Catchment Description	Vegetation dominated by woody and herbaceous invasive alien plant species. Emergence of alien plants is likely linked to historic ploughing and forestry, or present-day overgrazing and frequent burning.
General Unit Description	Moderately steep streams with small catchments areas. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone.
Expected Biophysical Characteristics	
Flow	Seasonal
General Substrate Type	Mixed bedrock and alluvial.
General Instream Biotopes	Pool, riffles, runs.
Expected Riparian Features	Macro channel bank. Active channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone that is dominated by woody and herbaceous alien plant species. **Active Channel:** • Some herbaceous marginal vegetation. Instream vegetation lacking.

Table 52. Summary of key features of North Block River 'Process Unit' group 06.

Mountain Stream – Process Unit 06	
Number of Stream Units in Process Group	38
General Catchment Description	Dominated by rural settlements and homesteads. Vegetation dominated by woody and herbaceous invasive alien plant species.
General Unit Description	Moderately steep streams with small catchments areas. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone. Clearing of indigenous trees from riparian zone is common.
Expected Biophysical Characteristics	
Flow	Seasonal

Mountain Stream – Process Unit 06	
General Substrate Type	Mixed bedrock and alluvial.
General Instream Biotopes	Pool, riffles, runs.
Expected Riparian Features	Macro channel bank. Active channel bank.
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone that is dominated by woody and herbaceous alien plant species. **Active Channel:** • Some herbaceous marginal vegetation. Instream vegetation lacking.

5.1.3 Transitional Rivers

Twelve (12) Transitional Rivers were identified in the North Block. Each of these has been assigned a unique label, with each of these river units being assessed and reported on individually. The labels for Transitional River units are as follows, with the location of these units being presented in **Figure 28**, above:

- N - Transitional River - 1
- N - Transitional River – 274
- N - Transitional River – 276
- N - Transitional River – 277
- N - Transitional River – 278
- N - Transitional River – 279
- N - Transitional River – 280
- N - Transitional River – 281
- N - Transitional River – 282
- N - Transitional River – 283
- N - Transitional River – 284
- N - Transitional River - 331

The assumed biophysical characteristics of the North Block Transitional Rivers are summarised in a combined table below (**Table 53**).

Table 53. Summary of the assumed biophysical features of the North Block Transitional Rivers

Unit Label	Assumed flow	Assumed substrate type	Assumed instream biotopes	Assumed riparian features
N - Transitional River - 1	Seasonal to Perennial	Bedrock dominated with reaches of sandy alluvium	• Riffles, rapids and runs • Pools • Marginal vegetation	• Active channel banks • Macro channel bank
N - Transitional River - 274				
N - Transitional River - 276				
N - Transitional River - 277				

N - Transitional River - 278	
N - Transitional River - 279	
N - Transitional River - 280	
N - Transitional River - 281	
N - Transitional River - 282	
N - Transitional River - 283	
N - Transitional River - 284	
N - Transitional River - 331	

5.1.4 Upper Foothill Rivers

Two (2) Upper Foothill Rivers were identified in the North Block. Each of these has been assigned a unique label, with each of these river units being assessed and reported on individually. The labels for each Upper Foothill River unit are as follows, with the location of these units being presented in **Figure 28** above:

- N-Upper Foothill River-275
- N-Upper Foothill River-297

The assumed biophysical characteristics of the North Block Upper Foothills Rivers are summarised in a combined table below (**Table 54**).

Table 54. Summary of the assumed biophysical features of the North Block Transitional Rivers

Unit Label	Assumed flow	Assumed substrate type	Assumed instream biotopes	Assumed riparian features
N-Upper Foothill River-275 N-Upper Foothill River-297	Perennial	Dominated by gravel and stones. Certain reaches dominated by sand. Scattered cobbles and boulders.	• Riffles, rapids and runs (cobbles, boulders, and bedrock sheets) • Pools (Gravel, sand, cobbles, boulders, and bedrock sheets) • Marginal vegetation	• Active channel banks • Macro channel bank

5.1.5 Lower Foothills River – Middle Mfule River

Table 55. Summary of the key features of N - Lower Foothills River - 285 (Middle Mfule River)

N - Lower Foothills River - 285 (Middle Mfule River)	
Longitudinal zone	Lower Foothills River
Flow	Perennial
Expected Substrate type	Dominated by gravel and stones. Certain reaches dominated by sand. Scattered cobbles and boulders.

N - Lower Foothills River - 285 (Middle Mfule River)	
Expected Instream biotopes	• Riffles and runs (cobbles, boulders) • Pools (Gravel, sand, cobbles, boulders) • Marginal vegetation
Expected Riparian features	• Active channel banks • Macro channel bank
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone with some alien invasive plant species. **Active Channel:** • Some herbaceous marginal vegetation.

5.1.6 Lowland River – Lower Mfule River

Table 56. Summary of the key features of N - Lowland River – 286 (Lower Mfule River)

N - Lowland River – 286 (Lower Mfule River)	
Longitudinal zone	Lowland River
Flow	Perennial
Expected Substrate type	Dominated by sand, gravel, and stones. Scattered cobbles and boulders.
Expected Instream biotopes	• Riffles and runs (cobbles, boulders) • Pools (Gravel, sand, cobbles, boulders) • Marginal vegetation
Expected Riparian features	• Active channel banks • Macro channel bank
Expected Vegetation characteristics	**Macro Bank:** • Wooded riparian zone with some alien invasive plant species. **Active Channel:** • Some herbaceous marginal vegetation.

5.1.7 Seep Wetlands

The sixty-nine (69) Seep Wetlands mapped in the North Block were divided into three (3) different process unit groups as follows:

- Wetland Process Unit Group 01 – 8 units
- Wetland Process Unit Group 02 – 18 units
- Wetland Process Unit Group 03 – 43 units

A summary of the division of the Seep Wetlands into process unit groups is presented in **Figure 31**. The location of the different process unit groups can be seen in **Figure 31**, above. Expected biophysical characteristics for each Seep Wetland Process Unit Group are presented in the tables which follow.

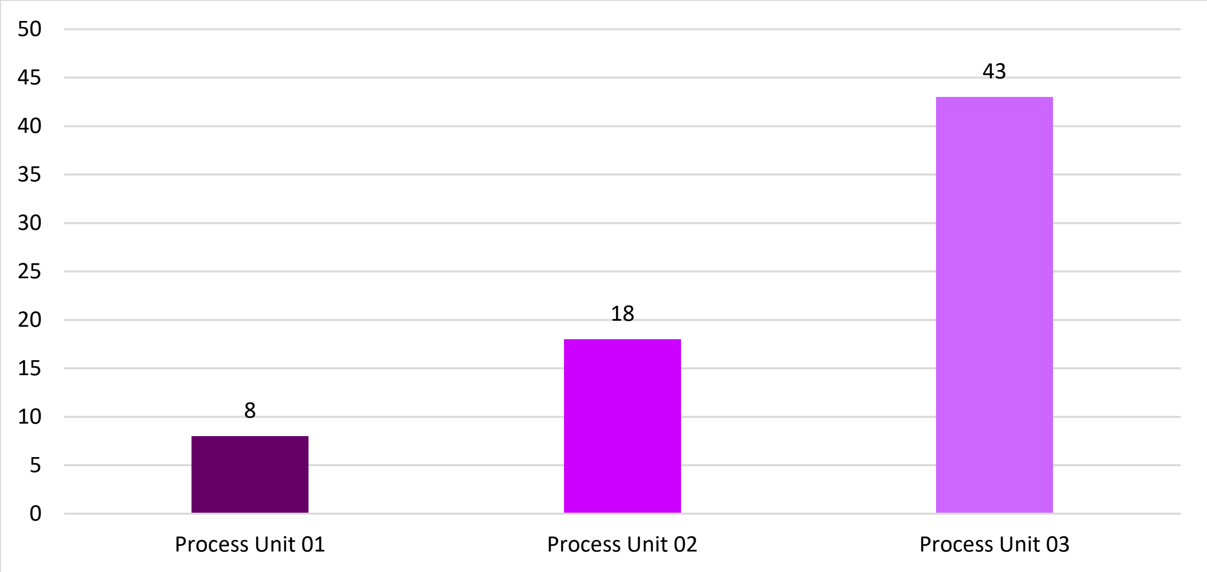

Figure 31. Summary of the division of the North Block seep wetlands into Process Unit Groups.

Table 57. Summary of key features of North Block wetland 'Process Unit' group 01.

Seep Wetland - Process Unit 01	
Number of Stream Units in Process Group	8
General Unit Description	**Cultivated headwater seep wetlands.**
General Catchment Description	Scattered houses and degraded secondary grassland (over grazing). Scattered woody IAPs.
Expected Biophysical Characteristics	
Dominant wetness zone	Temporary / Seasonal
Dominant water input	Diffuse sub-surface flow
Low flow pattern	Diffuse sub-surface flow
General vegetation characteristics	*Dominant:* Various subsistence crops

Table 58. Summary of key features of North Block wetland 'Process Unit' group 02.

Seep Wetland - Process Unit 02	
Number of Stream Units in Process Group	18
HGM Classification	Seep wetland
General Unit Description	**Hygrophilous grassland seep wetlands**
General Catchment Description	Scattered houses and degraded secondary grassland (over grazing). Scattered woody IAPs.
Expected Biophysical Characteristics	
Assumed Dominant wetness zone	Temporary
Assumed Dominant water input	Diffuse sub-surface flow
Assumed Low flow pattern	Diffuse sub-surface flow

Seep Wetland - Process Unit 02	
General vegetation characteristics	*Hygrophilous grassland species and moderately abundant facultative (wet) sedge species.*

Table 59. Summary of key features of North Block wetland 'Process Unit' group 03.

Seep Wetland - Process Unit 03	
Number of Stream Units in Process Group	43
HGM Classification	Seep wetland
General Unit Description	**Previously cultivated / disturbed seeps that have been colonized by dense woody and herbaceous IAPs.**
General Catchment Description	Scattered houses and degraded secondary grassland (over grazing). Scattered woody IAPs.
Expected Biophysical Characteristics	
Dominant wetness zone	Temporary / Seasonal
Dominant water input	Diffuse sub-surface flow
Low flow pattern	Diffuse sub-surface flow
General vegetation characteristics	*Temporary Zone: Dominated by woody and herbaceous IAPs.* *Seasonal Zone: Dominated by Cyperus latifolius and other facultative (wet) sedge species.*

5.1.8 Unchanneled Valley Bottom Wetlands

The forty (40) Valley Bottom Wetlands mapped in the North Block were divided into two (2) different process unit groups as follows:

- Wetland Process Unit Group 04 – 17 units
- Wetland Process Unit Group 05 – 23 units

A summary of the division of the Valley-Bottom Wetlands into process unit groups is presented in **Figure 32**. The location of the different process unit groups can be seen in **Figure 28**, above. Expected biophysical characteristics for each Valley-Bottom Wetland Process Unit Group are presented in the tables which follow.

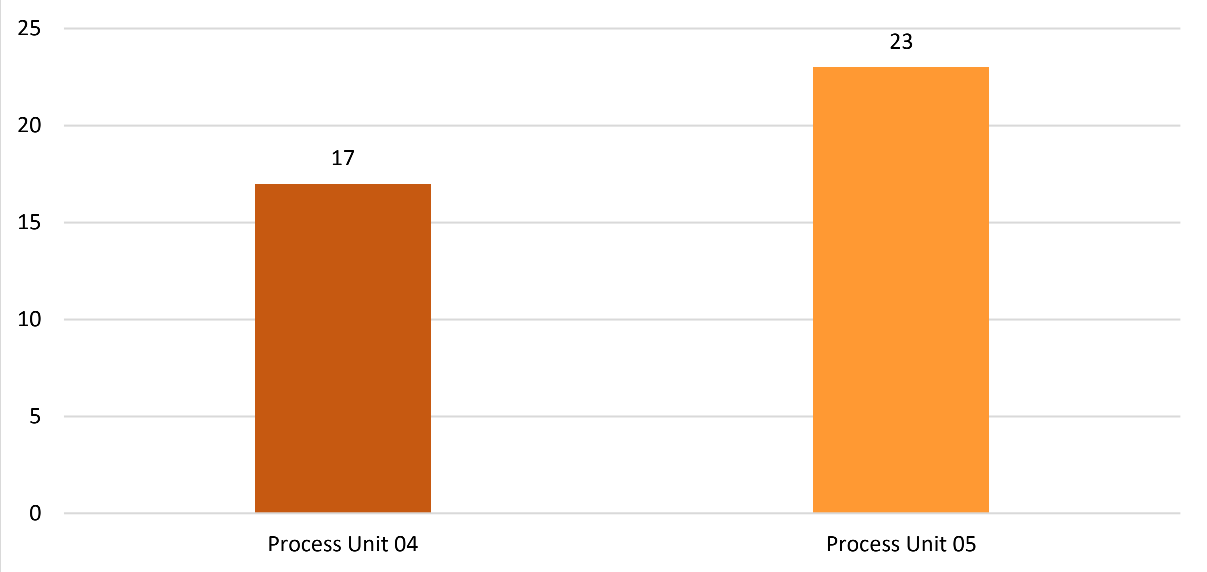

Figure 32. Summary of the division of the North Block valley-bottom wetlands into Process Unit Groups.

Table 60. Summary of key features of North Block wetland 'Process Unit' group 04.

Unchanneled Valley Bottom Wetland – Process Unit 04	
Number of Stream Units in Process Group	17
HGM Classification	Unchanneled Valley Bottom Wetland
General Unit Description	**Narrow valley bottom wetlands with notable edge IAPs pressure.**
General Catchment Description	Scattered houses and degraded secondary grassland (over grazing). Scattered woody IAPs.
Expected Biophysical Characteristics	
Dominant wetness zone	Seasonal
Dominant water input	Diffuse sub-surface flow
Low flow pattern	Diffuse surface flow
General vegetation characteristics	*Temporary Zone: Dominated by woody and herbaceous IAPs* *Seasonal & Permanent Zone: Sedgeland*

Table 61. Summary of key features of wetland 'Process Unit' group 05.

Unchanneled Valley Bottom Wetland – Process Unit 05	
Number of Stream Units in Process Group	23
HGM Classification	Unchanneled Valley Bottom Wetland
General Unit Description	**Broad valley bottom wetlands with notable edge IAPs pressure.**
General Catchment Description	Scattered houses and degraded secondary grassland (over grazing). Scattered woody IAPs.
Expected Biophysical Characteristics	
Dominant wetness zone	Permanent
Dominant water input	Diffuse sub-surface flow

Unchanneled Valley Bottom Wetland – Process Unit 05	
Low flow pattern	Diffuse surface flow
General vegetation characteristics	*Temporary Zone: Dominated by woody and herbaceous IAPs and grass species* *Seasonal & Permanent Zone: facultative wet sedge species.*

5.2 Rivers & Streams - Present Ecological State (PES) Assessment

This section presents the outcomes of the desktop PES assessment for the river and stream units within the North Block study area. IHI (Kleynhans, 1996) assessments were completed for all process unit groups (Mountain Headwater Streams and Mountain Streams) and for all individually assessed watercourse units (Transitional Rivers, Upper Foothill Rivers, Lower Foothill Rivers, and Lowland Rivers).

5.2.1 Index of Habitat Integrity (IHI) Assessment

The IHI assessment tool (Kleyhans, 1996) was applied at a process unit group level for all Mountain Headwater Streams and all Mountain Streams. Individual IHI assessments were completed for all Transitional Rivers, Upper Foothill Rivers, Lower Foothill River, and Lowland Rivers. This was done at a desktop level using aerial imagery and Eco-Pulses understanding of rivers in similar environments.

Table 62. Summary of the IHI (habitat) assessment outcomes for the North Block.

Watercourse(s)	Instream Habitat Score	Riparian Habitat Score	Overall, PES Score	Overall Ecological Category (EC)	Comment
Stream Process Unit 01 (Mountain HW Streams)	0.31	0.30	0.31	A: Natural	Largely natural catchment with no / limited direct impacts to watercourse units. Stream processes and morphology are therefore generally intact.
Stream Process Unit 07 (Mountain HW Streams)	1.81	2.89	2.24	C: Fair	Catchment dominated by commercial plantation. Notable encroachment of invasive tree and shrub species into the riparian zone. Altered catchment runoff process associated with forestry, leading to altered stream flow and channel characteristics. Watercourses regularly crossed by forestry roads, causing direct impacts.
Stream Process Unit 02 (Mountain HW Streams)	1.18	2.94	1.88	B: Largely Natural	Catchment contains high levels of woody and herbaceous invasive alien plant species, likely linked to historic ploughing and forestry, or present-day overgrazing and frequent burning. Watercourse processes remain largely intact but riparian vegetation has experienced the encroachment of IAPs. Some signs of altered channel morphology.
Stream Process Unit 03 (Mountain HW Streams)	2.05	2.23	2.12	C Fair	Catchment dominated by rural settlements and homesteads. Catchment vegetation dominated by woody and herbaceous invasive alien plant species. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone. Clearing of indigenous trees from riparian zone is common.
Stream Process Unit 04 (Mountain Streams)	0.31	0.30	0.31	A: Natural	Steep streams with small catchments areas. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone. Clearing of indigenous trees from riparian zone is common.
Stream Process Unit 08 (Mountain Streams)	1.181	2.76	2.19	C: Fair	Catchment dominated by commercial plantation. Notable encroachment of invasive tree and shrub species into the riparian zone. Altered catchment runoff process associated with forestry, leading to altered stream flow and channel characteristics. Watercourses regularly crossed by forestry roads, causing direct impacts.
Stream Process Unit 05 (Mountain Streams)	1.18	2.94	1.88	B: Largely Natural	Catchment contains high levels of woody and herbaceous invasive alien plant species, likely linked to historic ploughing and forestry, or present-day overgrazing and frequent burning. Watercourse processes remain largely intact but riparian vegetation has experienced the encroachment of IAPs. Some signs of altered channel morphology.
Stream Process Unit 06 (Mountain Streams)	2.22	2.37	2.28	C Fair	Catchment dominated by rural settlements and homesteads. Catchment vegetation dominated by woody and herbaceous invasive alien plant species. Frequent signs of channel incision and high levels of invasive alien plant encroachment into the riparian zone. Clearing of indigenous trees from riparian zone is common.

Watercourse(s)	Instream Habitat Score	Riparian Habitat Score	Overall, PES Score	Overall Ecological Category (EC)	Comment
N - Transitional River - 1	1.54	1.76	2.63	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics.
N - Transitional River - 274	1.24	0.89	1.10	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics.
N - Transitional River - 276	2.69	1.87	2.36	**C Fair**	Watercourse catchment dominated by commercial forestry. The instream and riparian ecological integrity have likely been impacted due to this land use.
N - Transitional River - 277	2.14	1.74	1.98	**C Fair**	Watercourse catchment dominated by commercial forestry. The instream and riparian ecological integrity have likely been impacted due to this land use.
N - Transitional River - 278	1.54	1.86	1.67	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics.
N - Transitional River - 279	1.56	1.65	1.60	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics.
N - Transitional River - 280	1.80	1.81	1.80	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics.
N - Transitional River - 281	1.80	1.86	1.82	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics.

Watercourse(s)	Instream Habitat Score	Riparian Habitat Score	Overall, PES Score	Overall Ecological Category (EC)	Comment
N - Transitional River - 282	1.80	1.86	1.82	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics.
N - Transitional River - 283	1.54	1.76	1.63	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics.
N - Transitional River - 284	1.82	1.41	1.66	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics.
N - Transitional River - 331	1.54	1.76	1.63	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics.
N-Upper Foothill River-275	1.83	2.00	1.90	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics.
N-Upper Foothill River-297	1.83	2.00	1.90	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics.
N - Lower Foothills River - 285 (Middle Mfule River)	1.71	1.84	1.76	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics.
N - Lowland River – 286 (Lower Mfule River)	1.71	1.84	1.76	**B: Largely Natural**	Watercourse processes remain largely intact, with limited alterations to channel morphology and characteristics.

5.3 Rivers & Streams – Ecological Importance & Sensitivity (EIS) Assessment

River EI is an expression of the importance of the aquatic resources for the maintenance of biological diversity and ecological functioning on local and wider scales; whilst ES refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007). The EIS of rivers and streams in the North block was assessed using a tool developed by Eco-Pulse (2017), based on the DWAF EIS tool (Kleynhans, 1999). This was done at a desktop level using aerial imagery and Eco-Pulses understanding of rivers in similar environments. A summary of the EIS of rivers and streams associated with the North Block is shown in **Table 63**. A description of the outcomes of the assessment is presented below.

Table 63. Summary of EIS scores and overall, EIS rating for the assessed North Block rivers and streams

Watercourse(s)	Hosts Rare & endangered	Unique species (endemic, isolated, etc.)	Intolerant species sensitive to flow/water quality modifications	Species/taxon richness	Diversity of habitat types	Refugia for biota	Sensitivity to flow changes	Sensitivity to flow related water quality changes	Migration route/corridor (instream & riparian)	Importance of conservation & natural areas	EIS Score	EIS Class
Scores (out of 4) and Rating												
Stream Process Unit 01 (Mountain HW Streams)	0.0 (None)	0.0 (None)	0.0 (None)	1.0 (Low)	0.0 (None)	0.0 (None)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	0.5 (none)	**0.25**	**D: Low**
Stream Process Unit 07 (Mountain HW Streams)	0.0 (None)	0.0 (None)	0.0 (None)	1.0 (Low)	0.0 (None)	0.0 (None)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	0.5 (none)	**0.25**	**D: Low**
Stream Process Unit 02 (Mountain HW Streams)	0.0 (None)	0.0 (None)	0.0 (None)	1.0 (Low)	0.0 (None)	0.0 (None)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	0.5 (none)	**0.25**	**D: Low**
Stream Process Unit 03 (Mountain HW Streams)	0.0 (None)	0.0 (None)	0.0 (None)	1.0 (Low)	0.0 (None)	0.0 (None)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	0.5 (none)	**0.25**	**D: Low**
Stream Process Unit 04 (Mountain Streams)	0.0 (None)	0.0 (None)	0.0 (None)	2.0 (Mod)	1.0 (Low)	1.0 (Low)	3.0 (High)	3.0 (High)	2.0 (Mod)	0.0 (None)	1.00	**D: Low**
Stream Process Unit 08 (Mountain Streams)	0.0 (None)	0.0 (None)	0.0 (None)	2.0 (Mod)	1.0 (Low)	1.0 (Low)	3.0 (High)	3.0 (High)	2.0 (Mod)	0.0 (None)	1.00	**D: Low**

Watercourse(s)	Hosts Rare & endangered	Unique species (endemic, isolated, etc.)	Intolerant species sensitive to flow/water quality modifications	Species/taxon richness	Diversity of habitat types	Refugia for biota	Sensitivity to flow changes	Sensitivity to flow related water quality changes	Migration route/corridor (instream & riparian)	Importance of conservation & natural areas	EIS Score	EIS Class
Stream Process Unit 05 (Mountain Streams)	0.0 (None)	0.0 (None)	0.0 (None)	2.0 (Mod)	1.0 (Low)	1.0 (Low)	3.0 (High)	3.0 (High)	2.0 (Mod)	0.0 (None)	1.00	**D: Low**
Stream Process Unit 06 (Mountain Streams)	0.0 (None)	0.0 (None)	0.0 (None)	2.0 (Mod)	1.0 (Low)	1.0 (Low)	3.0 (High)	3.0 (High)	2.0 (Mod)	0.0 (None)	1.00	**D: Low**
N - Transitional River - 1	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
N - Transitional River - 274	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
N - Transitional River - 276	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
N - Transitional River - 277	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
N - Transitional River - 278	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**

Watercourse(s)	Hosts Rare & endangered	Unique species (endemic, isolated, etc.)	Intolerant species sensitive to flow/water quality modifications	Species/taxon richness	Diversity of habitat types	Refugia for biota	Sensitivity to flow changes	Sensitivity to flow related water quality changes	Migration route/corridor (instream & riparian)	Importance of conservation & natural areas	EIS Score	EIS Class
N - Transitional River - 279	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
N - Transitional River - 280	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
N - Transitional River - 281	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
N - Transitional River - 282	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
N - Transitional River - 283	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
N - Transitional River - 284	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
N - Transitional River - 331	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**

Watercourse(s)	Hosts Rare & endangered	Unique species (endemic, isolated, etc.)	Intolerant species sensitive to flow/water quality modifications	Species/taxon richness	Diversity of habitat types	Refugia for biota	Sensitivity to flow changes	Sensitivity to flow related water quality changes	Migration route/corridor (instream & riparian)	Importance of conservation & natural areas	EIS Score	EIS Class
N-Upper Foothill River-275	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
N-Upper Foothill River-297	3.0 (High)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	3.0 (High)	3.0 (High)	0.0 (None)	2.00	**C: Moderate**
N - Lower Foothills River - 285 (Middle Mfule River)	3.0 (High)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	2.0 (Mod)	3.0 (High)	2.0 (Mod)	3.0 (High)	3.0 (High)	0.0 (None)	2.50	**B: High**
N - Lowland River – 286 (Lower Mfule River)	3.0 (High)	2.0 (Mod)	2.0 (Mod)	3.0 (High)	2.0 (Mod)	3.0 (High)	2.0 (Mod)	3.0 (High)	3.0 (High)	0.0 (None)	2.50	**B: High**

5.4 Wetlands - Present Ecological State (PES) Assessment

Wetland PES was assessed using the WET-Health (Macfarlane *et al.*, 2008) assessment tool. The Wetland PES assessments were completed at a process unit level. The outcomes of the Wetland PES assessment are summarised in **Table 64**.

Table 64. Summary of the PES assessment results for the Wetland process unit groups in the North Block.

Wetland Process Unit	HGM Type	Hydrology PES Category	Geomorphology PES Category	Vegetation PES Category	Overall, PES Category	Likely Key Impact(s)
Wetland Process Unit Group 01	Seep	D	C	D	D: Largely Modified	Vegetation - Heavily utilized for subsistence farming. Hydrology - Reduced runoff to wetland due to woody IAPs within catchment areas. Increased on site water use due to presence of crops and woody IAPs within wetland area. Altered flow through wetland due to drainage and cultivation. Geomorphology – Altered wetland geomorphic structure due to regular cultivation. Sediment loss from wetland area due to drainage and entrainment of bare cultivated areas.
Wetland Process Unit Group 02		C	C	C	C: Moderately Modified	Vegetation - Encroachment of woody IAPs into wetland area. Altered hygrophilous grassland composition due to overgrazing and burning. Hydrology – Increased runoff volumes and velocities due to reduced wetland and catchment basal cover (overgrazing and burning). Geomorphology – Increased sediment inputs associated with reduced catchment basal cover.
Wetland Process Unit Group 03		D	C	D	C: Moderately Modified	Vegetation - intense encroachment of woody IAPs into wetland area. Hydrology – Increased runoff volumes and velocities due to reduced wetland and catchment basal cover (overgrazing and burning). Geomorphology – Increased sediment inputs associated with reduced catchment basal cover.

Wetland Process Unit Group 04	**Unchanneled Valley Bottom**	**C**	**C**	**C**	**C: Moderately Modified**	Vegetation - Encroachment of woody IAPs into wetland area. Altered hygrophilous grassland composition due to overgrazing and burning. Central, permanently inundated wetland areas remain largely intact. Hydrology – Increased runoff volumes and velocities due to reduced wetland and catchment basal cover (overgrazing and burning). Geomorphology – increased sediment inputs associated with reduced catchment basal cover.
Wetland Process Unit Group 05		**C**	**C**	**C**	**C: Moderately Modified**	Vegetation - Encroachment of woody IAPs into wetland area. Altered hygrophilous grassland composition due to overgrazing and burning. Central, permanently inundated wetland areas remain largely intact. Hydrology – Increased runoff volumes and velocities due to reduced wetland and catchment basal cover (overgrazing and burning). Geomorphology – increased sediment inputs associated with reduced catchment basal cover.

5.5 Wetlands – Ecosystem Services Assessment

An assessment of wetland ecosystem services (i.e., wetland functionality) was conducted using the WET-Ecoservices tool. (Kotze *et al.*, 2019). The Wetland ecosystem services assessments were completed at a process unit level across two (2) themes, namely:

- Regulating Services; and
- Provisioning and Cultural Services.

The outcomes of the ecosystem services assessment are summarised in **Table 65** and **Table 66**.

5.5.1 Regulating Services

The most important regulating service provided by wetlands belonging to each of the three (3) seep wetland process unit groups is carbon storage (**Table 65Table 40**). Another important regulatory service provided by the valley bottom wetlands is sediment trapping. These wetlands are well placed to provide this service as they are assumed to be robustly vegetated and are characterised by diffuse flow patterns, creating favourable conditions for sediment accumulation.

Table 65. Summary of regulating services importance scores and overall importance rating for each North Block wetland process unit group.

Wetland Process Unit Groups	Regulating Services Scores (0-4)								Importance Rating
	Flood attenuation	Streamflow regulation	Sediment trapping	Erosion control	Phosphate removal	Nitrate removal	Toxicant removal	Carbon storage	
01 (Seep)	0.0	0.8	1.0	0.6	0.6	0.4	0.3	1.7	Moderate
02 (Seep)	0.0	1.3	1.0	0.2	0.6	0.5	0.3	1.8	Moderate
03 (Valley Bottom)	0.1	0.5	1.0	0.8	0.6	0.4	0.3	2.1	Moderate
04 (Valley Bottom)	0.1	1.3	2.4	1.1	2.0	1.8	1.4	3.3	Very High
05 Valley Bottom)	0.1	1.5	2.4	1.1	2.0	1.9	1.5	3.4	Very High

5.5.2 Provisioning and Cultural Services

Seeps belong to process unit group 01 are of Moderately-High provisioning importance. This rating is a result of these wetlands being used for the cultivation of subsistence crops, and the reasonably high dependence of local households on the food grown within these wetlands. Seep wetlands belonging to process units' groups 02 and 03 are of Moderately-Low cultural and provisioning importance.

The valley bottom wetlands within the study area are of Moderate provisioning importance. this score comes because of the permanent diffuse flow along the valley bottom wetlands, which could serve as an important water source for local communities.

Table 66. Summary of provisioning & cultural services importance scores and overall importance rating for each North block wetland process unit group.

Wetland Process Units	Provisioning & Cultural Services Scores (0-4)							Overall Rating
	Water supply	Harvestable natural resources	Food for livestock	Cultivated foods	Tourism and recreation	Education and research	Cultural and spiritual	
01 (Seep)	0.5	0.7	0.0	2.5	0.0	0.0	1.0	Moderately-High
02 (Seep)	0.0	0.0	1.3	1.5	0.0	0.0	1.0	Moderately-Low
03 (Valley Bottom)	0.0	1.2	0.0	1.5	0.0	0.0	1.0	Moderately-Low
04 (Valley Bottom)	1.7	1.2	0.0	1.8	0.0	0.0	1.0	Moderate
05 Valley Bottom)	1.7	1.2	0.0	1.3	0.0	0.0	1.0	Moderate

5.6 Wetland EIS Assessment

Wetland EIS Assessments were conducted for all wetland process unit groups. The wetland EIS assessment involved rating four (4) major components, namely:

- Ecological Importance in terms of biodiversity maintenance (from ecosystem services assessment).
- Ecological Importance in terms of cultural and provisions functions (from ecosystem services assessment).
- Ecological Importance in terms of regulating functions (from ecosystem services assessment).
- Ecological sensitivity.

A summary of the EIS assessment is provided in **Table 67**. Wetlands associated with process unit groups 01, 04 and 05 were assessed as being of **'Moderate' EIS**, whilst groups 02 and 03 were of **'Low' EIS.** Key factors driving the wetland EIS assessments were the following:

- Wetland belonging to process unit group 01 are considered important as they are associated with food provision in the form of subsistence cultivation. These seep wetlands were, however, not considered ecologically sensitive.
- Wetlands belonging to process unit group 02 and 03 are both of low ecological importance as they provide limited vital ecosystem services. These wetlands were not considered ecologically sensitive.
- Wetlands belonging to process units 04 and 05 are considered ecologically important because of the role they play as carbon sinks. These wetlands are also considered ecologically sensitive to changes in flow and sediment inputs as they rely on aggradational processes and permanent diffuse flow for their functioning and evolution.

Table 67. Summary of EIS scores and overall, EIS rating for the assessed North Block wetland process unit groups

	Rating (out of 4)			
Wetland Process Units	**Ecological Importance**	**Ecological Sensitivity**	**Overall, EIS Score**	**Overall, EIS Rating**
01 (Seep)	2.50	1.10	2.05	**Moderate**
02 (Seep)	1.50	1.10	1.05	**Low**
03 (Valley Bottom)	1.50	1.10	1.05	**Low**
04 (Valley Bottom)	2.20	2.20	2.30	**Moderate**
05 (Valley Bottom)	2.20	2.20	2.30	**Moderate**

5.7 Recommended Ecological Categories (REC) & Recommended Management Objectives (RMOs)

Based on the matrix in **Table 43**,, the minimum RMO for all watercourses in the North Block study area, N - Lower Foothills River - 285 (Middle Mfule River) and N - Lowland River – 286 (Lower Mfule River) is to maintain the current PES (**Table 68**). The RMO for the N - Lower Foothills River – 285 and N - Lowland River – 286 is to improve PES.

Table 68. REC and RMO for the delineated watercourse units based on their PES and EIS ratings.

Watercourse Units	PES	EIS	REC	RMO
Rivers & Streams				
Stream Process Unit 01 (Mountain HW Streams)	**A: Natural**	**D: Low**	A	Maintain PES
Stream Process Unit 07 (Mountain HW Streams)	**C: Fair**	**D: Low**	C	Maintain PES
Stream Process Unit 02 (Mountain HW Streams)	**B: Largely Natural**	**D: Low**	B	Maintain PES
Stream Process Unit 03 (Mountain HW Streams)	**C Fair**	**D: Low**	C	Maintain PES
Stream Process Unit 04 (Mountain Streams)	**A: Natural**	**D: Low**	A	Maintain PES
Stream Process Unit 08 (Mountain Streams)	**C: Fair**	**D: Low**	C	Maintain PES
Stream Process Unit 05 (Mountain Streams)	**B: Largely Natural**	**D: Low**	B	Maintain PES
Stream Process Unit 06 (Mountain Streams)	**C Fair**	**D: Low**	C	Maintain PES
N - Transitional River - 1	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 274	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 276	**C Fair**	**C: Moderate**	C	Maintain PES
N - Transitional River - 277	**C Fair**	**C: Moderate**	C	Maintain PES
N - Transitional River - 278	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 279	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 280	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 281	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 282	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 283	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 284	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Transitional River - 331	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N-Upper Foothill River-275	**B: Largely Natural**	**C: Moderate**	B	Maintain PES

Watercourse Units	PES	EIS	REC	RMO
N-Upper Foothill River-297	**B: Largely Natural**	**C: Moderate**	B	Maintain PES
N - Lower Foothills River - 285 (Middle Mfule River)	**B: Largely Natural**	**B: High**	A/B	Improve PES
N - Lowland River – 286 (Lower Mfule River)	**B: Largely Natural**	**B: High**	A/B	Improve PES
Wetlands				
Wetland Process Unit Group 01	D: Poor	C: Moderate	D	Maintain PES
Wetland Process Unit Group 02	**C: Fair**	D: Low	C	Maintain PES
Wetland Process Unit Group 03	**C: Fair**	D: Low	C	Maintain PES
Wetland Process Unit Group 04	**C: Fair**	C: Moderate	C	Maintain PES
Wetland Process Unit Group 05	**C: Fair**	C: Moderate	C	Maintain PES

6. IMPACT SIGNIFICANCE & RISK ASSESSMENT

This section deals with the assessment of the potential construction and operation phase risks and impacts. Potential impact consequences are discussed and assessed separately for the construction and operational phases under 'realistic poor' and 'realistic good' or 'best practice' mitigation scenarios as defined in the 'methods' section of this report (refer to Section 2.3).

Given the early planning stage of this project key information required to accurately assess potential impacts and risks to freshwater ecosystems is not available. It should therefore be noted that this impact assessment has been completed at a broad project level and only considers the plan outlined in Section 1.2. The current mine plan, except for the WRD is conceptual and has been derived from the AMEC Prefeasibility Engineering Study (2015). The design and footprint for the WRD facility was developed by Geotheta and provided to Eco-Pulse for inclusion in this assessment in December 2022.

As such, this impact assessment should be regarded as preliminary and indicative, and subject to more detailed impact evaluations once appropriately detailed information becomes available.

Given that this project is in the planning phase, this impact assessment has been subject to several key assumptions. These are outlined below. Should any of these assumptions not be accurate, this impact assessment will need to be updated.

Access Roads:

- Existing road crossings along the proposed access route will remain as they are with no expected direct impacts to watercourses at those locations.
- New road crossings along the proposed access route will be no more than 10m wide.

South East Pit:

- The pit displayed in **Figure 2** has been included in this impact assessment. Should the size or location of the pit change in any way, this impact significance assessment would need to be updated.

Waste Rock Dump:

- The rock dump area displayed in **Figure 2** has been included in this impact assessment.
- It is assumed that the entire area displayed in **Figure 2** will ultimately be filled in and watercourses in this zone will be permanently altered.

Crushing and Screening:

- The primary crusher plant area displayed in **Figure 2** has been included in this impact assessment.
- Primary crushed ore will be transported from the pit to a stockpile at the primary crusher plant via overland conveyor. The location of the proposed conveyor system is currently unknown. The establishment and operation of this conveyor system has therefore been omitted from this impact assessment.

Processing Plant:

- The primary crusher plant area displayed in **Figure 2** has been included in this impact assessment.
- The plant will produce thickened wet tailings slurry which will be deposited on a TSF. The TSF has not been included in this assessment, neither has the transport of tailings from the plant to the TSF. This will be covered in a separate assessment process.

Water Supply:

- It is anticipated that the make-up water would be acquired from the KZN bulk water supply authority. Abstraction of water from onsite or nearby watercourses has therefore not been assessed.

Office Complex & Sewage Treatment Plant:

- The location and layout of the planned office complex is currently unknown. The construction and operation of this facility has therefore been excluded from this study.
- The location, technology, capacity, discharge volumes etc., of the sewage treatment plant are not known. It has, however, been assumed for the sake of this assessment that the treatment plant will be located beyond any watercourses, including an appropriate buffer. It has also been assumed that effluent discharge from the plant will enter a mountain headwater stream via a protected outfall and that all discharges will meet General Limit Values (GLVs) as stipulated in the National Water Act (36 of 1998).

Power Supply:

- Power supply is assumed to be from Existing 400 kV transmission lines owned by Eskom. The establishment of new powerlines has not been included in this assessment.

Transport of Concentrate to Richard's Bay for Export:

- The final mode of transportation of the concentrate from the processing plant to the Richards Bay Port for export has not been decided. This activity and any associated infrastructure have not been assessed.

Stormwater Management:

- It is assumed that the stormwater system will be designed to handle flows associated with the full range of expected storm events (1:1-year – 1:100-year flood / storms).
- It is assumed that clean and dirty stormwater runoff will be managed separately, and that no contaminated stormwater will intentionally be released into the environment.
- It is assumed that all stormwater management infrastructure (attenuation ponds, etc.) and other water storage facilities (i.e.: process water storage) will be located outside of watercourses.
- It is assumed that a portion of the stormwater and all process water generated by the mine will be collected, appropriately treated, and recycled at the site for use in dust control and other appropriate uses. It is assumed that the remaining portion of the stormwater will be discharged into the environment via a formal stormwater management system.
- Where stormwater is discharged into the environment it is assumed that an appropriate number of outlets will be utilised and that these will be designed to dissipate the energy of outgoing flows to levels that present a low erosion risk.

Based on the above assumptions, a list of infrastructure and activities not included in this impact assessment has been provided below. These will need to be incorporated in the impact assessment process once appropriate information is available to do so.

Key Omissions from Impact Significance Assessment:

- The establishment and operation of the conveyor system that will transport crushed material to the ROM stockpile.
- The TSF.
- The transport of tailings from the plant to the TSF.
- Construction and operation of the office complex that is to include all staff accommodation, a car park, canteen, meeting rooms, etc.
- Establishment of powerlines to provide electricity to the operation.
- Establishment and operation of any required railway lines and / or slurry pipelines required to transport the processed iron ore concentrate away from the site.

For the purposes of the impact assessment, the construction / establishment phase is assumed to consist of the following activities:

- Upgrading of existing road alignment (**Figure 37**).
- Construction of new road alignment (**Figure 37**).
- Construction of the primary crusher.
- Construction of incoming power yard.
- Construction of a single sewerage treatment plant (assumed to be located beyond any watercourses and associated buffers).
- Construction of a single workshop facility (assumed to be located beyond any watercourses and associated buffers).

For the purposes of the impact assessment, the operation phase is assumed to consist of the following activities:

- Extraction of material from the mine pit.
    - Although the advancement and growth of the mine pit will be an ongoing operational process, the full extent of the proposed mine pit has been assessed.
- Accumulation of waste rock at the designated dump site.
    - Although the accumulation of material in the waste rock dump will be an ongoing operational process, the full extent of the dump site has been assessed.
- Crushing, processing and storage of material extracted from the mine pit.

6.1 Direct Physical Loss or Modification of Freshwater Habitat

6.1.1 Construction / Establishment Phase

Key Assumptions:

- It was confirmed by Kate Hamilton of SLR that there are no plans in place at this time to re-site the power yard and process plant despite this infrastructure encroaching into delineated watercourse boundaries. The realistic 'good' and 'poor' mitigation scenarios have therefore both considered the planned permanent destruction of freshwater habitat at these locations.
- The realistic 'good' mitigation scenario assumes that infilling of watercourses will occur at the two new road crossing locations but that this will be limited to the width of the road at these locations (assumed to be a 20m wide road crossing). The freshwater habitat type to be impact at these locations are least threatened mountain headwater streams. This scenario further assumes that no new direct physical destruction or modification of freshwater habitat will occur at the exiting road crossings which are likely to require upgrading.
- It is assumed that bulk water supply pipeline crossings will be buried in the road fill where the pipeline aligns with the access road. At new bulk water supply pipeline crossing locations, it is assumed that pipe bridges will be utilised rather than trenching the pipe through the bed of crossed streams (**Figure 37**). It is therefore assumed that the construction of the bulk water pipeline will not result in permanent watercourse destruction.

The mine plan will involve the construction of an access road. Under the proposed alignment there is an approximately 1.5km length of road leading to the processing plant that runs through 'virgin' land, and which would involve crossing two (2) mountain streams (new road crossings) (**Figure 37**) (SE-PU06-12 and SE-PU06-487). There is an additional approximately 250m length of proposed access road near the primary crusher that does not following an existing alignment, and which crosses a mountain stream (SE-PU6-11). Each of these watercourses is in fair ecological condition (C PES Category) and was rated as being of low overall EIS. An approximately 800m length of road linking the mine pit and the WRD is also proposed. This access road will require new road crossings of two (2) additional watercourses (SE-Upper Foothill River-466 and SE-PU06-486). Depending on the road crossing design and level of mitigation during construction, it is possible that a loss of freshwater habitat could occur due to infilling at these locations.

The proposed power yard footprint coincides with the headwaters of a valley bottom wetland (SE-WET-PU04-6). This wetland is moderately modified (C PES Category) and was rated as being of moderate overall EIS. The process plant area intersects a seep wetland (SE-WET-PU01-23), two (2) mountain headwater streams (SE-PU03-103 and SE-PU03-447), and a Mountain Stream (SE-PU06-487). Each of these watercourses are in fair ecological condition (C PES Category) and were rated as being of low overall EIS. Under the current mine infrastructure layout, the construction phase of the project would result in the permanent destruction or alteration of approximately 0.65ha of freshwater habitat (**Table 69**). This includes 0.27ha of critically endangered wetland habitat (NBA – Inland Aquatic / Freshwater Realm [Van Deventer et al., 2018]) (**Figure 33**).

Given that there are no plans to re-site infrastructure despite it encroaching into various watercourses, the realistic 'poor' and 'good' mitigation scenarios for construction phase direct physical loss / modification of freshwater habitat impact sign was assessed as being of 'Medium' significance.

Table 69. Summary of the construction phase direct habitat loss under the current mine plan.

Watercourse Type	NBA Threat Status	Infrastructure Type: Incoming Power Yard	Infrastructure Type: New Road Crossing	Infrastructure Type: Process Plant	Total (ha)
Mountain HW Stream	**LT**	0.0	0.0	0.18	**0.18**
Mountain Stream	**LT**	0.0	0.10	0.04	**0.14**
Upper Foothills River	**LT**	0.0	0.04	0.0	**0.04**
Seep	**CR**	0.0	0.0	0.21	**0.21**
Unchanneled Valley Bottom Wetland	**CR**	0.06	0.0	0.0	**0.06**
Total (ha)		**0.06**	**0.14**	**0.44**	**0.64**

Table 70. Construction phase direct physical loss or modification of freshwater habitat impact significance rating.

Description of Impact		
Construction Phase - Direct Physical Loss or Modification of Freshwater Habitat		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Realistic 'Poor' Mitigation**	**Realistic 'Good' Mitigation**
Intensity	High	High
Duration	Permanent	Permanent
Extent	Site	Site
Consequence	Medium	Medium
Probability	Definite / Continuous	Definite / Continuous
Significance	**Medium**	**Medium**
Confidence	High	High

Key mitigation recommendations:

- Avoid delineated wetlands and riparian areas during layout planning for mine infrastructure and stockpile areas. This should be done through the consideration of the watercourse delineations provided as part of this assessment. It would however be ideal for a wetland and aquatic ecologist to do more detailed watercourse delineation sampling at locations of proposed encroachment to increase delineation accuracy at those locations.
- Limit the number of required road crossings as far as practically possible.
- Utilise best practice design principles at all road crossing locations where crossings of watercourses are unavoidable.
- Undertake the construction of any road or pipeline crossings of perennial rivers/wetland during low flows (winter season).
- Limit instream habitat disturbance during crossing construction phase. This can be achieved through the implementation of the No-go area demarcation recommendations provided in Section 7.6.1 of this report.
- Implement post-construction wetland and river rehabilitation strategy as and where necessary.
- Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.

6.1.2 Operation Phase

Key Impact Assessment Assumptions:

- Whilst the project planning team have an obligation to avoid directly or indirectly impacting on watercourses as far as is practically possible, as per the guidance provided in the mitigation hierarchy (Figure 30), it is believed that the direct and permanent destruction of large areas of freshwater habitat will be unavoidable due to the large mine pit and waste rock dump, which are necessary for the project to be commercially viable.

While the final dimensions of the South East Pit have not yet been determined, a total of fourteen (14) watercourses exist within its current proposed footprint. This includes nine (9) mountain headwater streams and five (5) mountain streams. These watercourses stand to be partially or completely modified as pit mining advances. It is possible that additional watercourses in the vicinity of the mine pit will also be directly impacted as part of pit establishment and ongoing mining processes.

The final waste rock dump dimensions will be defined in the BFS. However, based on the latest layout provided to Eco-Pulse (December 2022), when at capacity, the dump site footprint intersects with a total of fourteen (14) watercourses. This includes six (6) mountain headwater streams, six (6) mountain streams, one (1) transitional river, and one (1) seep wetland. Each of these watercourses is at risk of incurring direct physical habitat loss or modifications of habitat as the waste rock dump is established as mining progresses. Therefore, based on the mine plan, when the proposed mine pit and waste rock dump have reached maximum use / capacity, the operation phase of the mine project will have resulted in the direct and permanent physical destruction of 9.80ha of freshwater habitat by the time the full extent of the pit has been utilised. This includes 0.02ha of critically endangered wetland habitat.

During the mine operation phase additional areas of freshwater habitat could also be impacted by workers and machinery during watercourse crossing repair and maintenance, and through the potential injudicious movement of vehicles and people across the site that may cause habitat disturbance unless water resources are appropriately safeguarded.

In addition to the direct physical loss of wetland and riparian habitat, additional habitat losses of watercourse areas could occur due to the infilling or altering of recharge zones and catchment areas. This is explained further under the operation phase impacts to hydrological and geomorphological processes (Section 6.2.2).

As the avoidance of direct impacts at the location of the proposed rock dump and mining pit are unavoidable for this project to be feasible, operation phase direct physical loss / modification of freshwater habitat impact significance was assessed as being ‘High’ in both a realistic ‘poor’ and ‘good’ mitigation scenario.

Table 71. Summary of the operation phase direct habitat loss under the current mine plan.

		Infrastructure Type		
Watercourse Type	**NBA Threat Status**	**Mine Pit**	**Waste Rock Dump**	**Total (ha)**
Mountain HW Stream	**LT**	0.88	0.81	**1.69**
Mountain Stream	**LT**	2.43	4.04	**6.47**
Transitional River	**LT**	0.0	1.60	**1.60**
Seep	**CR**	0.0	0.02	**0.02**
Total (ha)		**3.31**	**6.48**	**9.78**

Table 72. Operation phase direct physical loss or modification of freshwater habitat impact significance rating.

Description of Impact		
Operation Phase - Direct Physical Loss or Modification of Freshwater Habitat		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Realistic 'Poor' Mitigation**	**Realistic 'Good' Mitigation**
Intensity	High	High
Duration	Permanent	Permanent
Extent	Local	Local
Consequence	High	High
Probability	Definite / Continuous	Definite / Continuous
Significance	**High**	**High**
Confidence	High	High

Key mitigation recommendations:

- Avoid delineated wetlands and riparian areas during mining, including the dumping of overburden and placement of stockpiles.
- Undertake any watercourse crossing repairs and/or maintenance during low flows (winter season).
- Limit instream habitat disturbance during future repairs and/or maintenance.
- Implement post-construction river rehabilitation strategy where necessary.
- Limit access to instream and riparian habitat.
- Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.

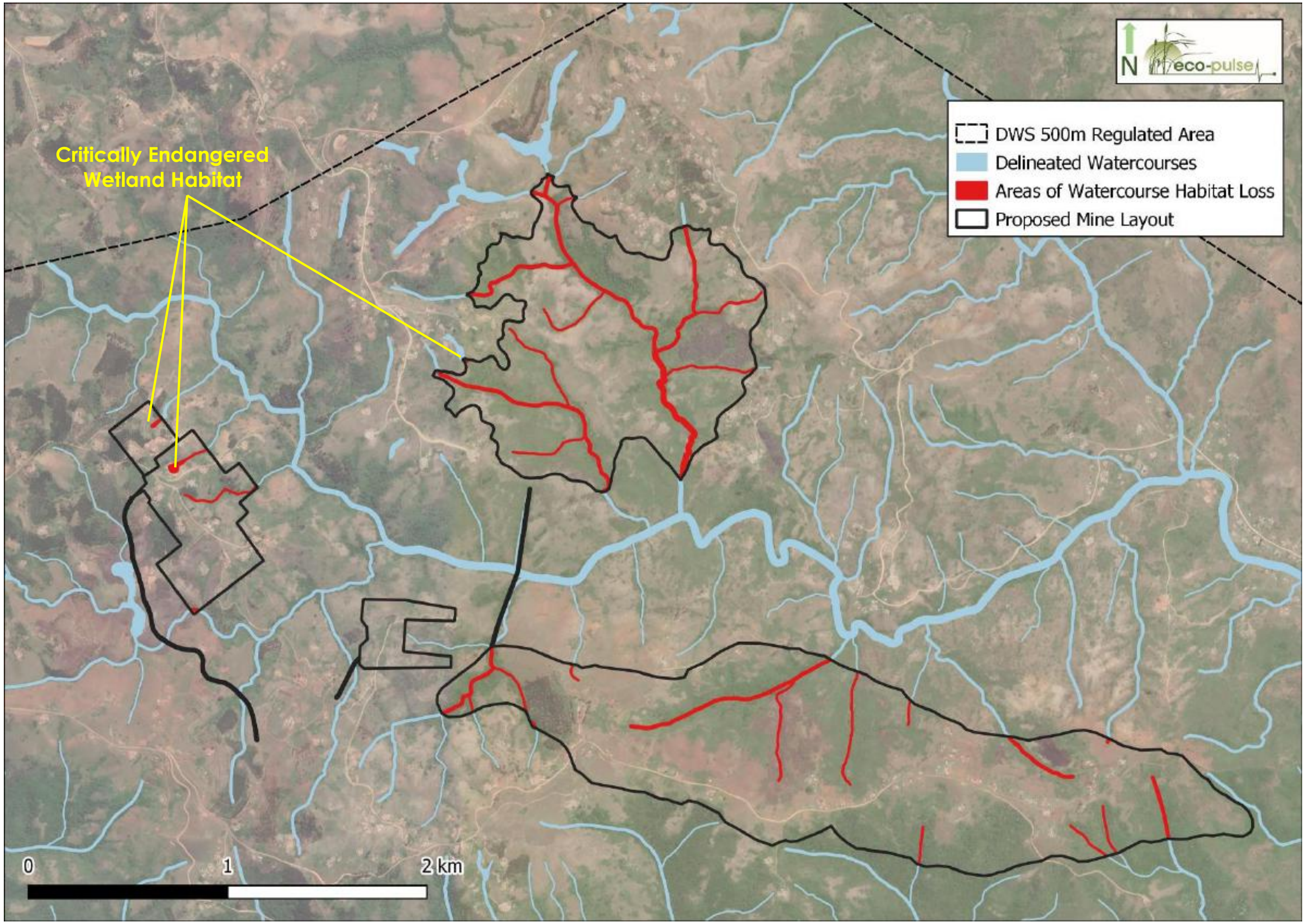

Figure 33: Areas where loss of watercourse habitat is set to take place under the currently proposed layout.

6.1.3 Cumulative Across the South Block

Given the largely rural and isolated nature of the study area existing direct physical impacts to watercourses caused by people who live in the area are largely limited to the use of most wetlands for subsistence agriculture, the removal of indigenous tree species from river and stream riparian zone, and road crossings across watercourses. As the area becomes more populated over time it is likely that the extent of these impacts will increase, but to a negligible degree. Additionally, the Goedertrouw Dam, built in the early 1980s, has inundated an approximately 11km long reach of the Mhlatuze River system and the lower reaches of several mountain and mountain headwater streams. The currently proposed mining project would result in a further permanent loss of 10.43ha of freshwater habitat, including a total of 0.3ha of critically endangered wetland.

In a realistic 'good' and 'poor' mitigation scenario, which considers the current proposed layout, cumulative direct physical loss / modification of freshwater habitat impact significance was assessed as being 'High'.

Table 73. Cumulative direct physical loss or modification of freshwater habitat impact significance rating.

Description of Impact		
Cumulative - Direct Physical Loss or Modification of Freshwater Habitat		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction & Operation	
Criteria	**Realistic 'Poor' Mitigation**	**Realistic 'Good' Mitigation**
Intensity	High	High
Duration	Permanent	Permanent
Extent	Local	Local
Consequence	High	High
Probability	Definite / Continuous	Definite / Continuous
Significance	**High**	**High**
Confidence	High	High

6.2 Alteration of Hydrological and Geomorphological Processes

6.2.1 Construction / Establishment Phase

Where mining related infrastructure traverses' watercourses (road crossings), damming / obstruction / redirection and / or canalisation of a watercourse could lead to the alteration of flows and natural channel processes. Potential impacts may include altered flow seasonality, bed and bank erosion, and the inundation of habitat. Vegetation removal and earthworks associated with the establishment of onsite infrastructure will also reduce basal vegetation cover at the site. This will reduce rainfall infiltration rates, thus increasing the volume of surface stormwater runoff being delivered to onsite watercourses. The removal of soil from the site will also limit the 'soil water store' potential of the area, contributing to increased runoff volumes. The additional flows along wetland and rivers could trigger erosional processes. Bulk earthworks will also disturb and expose notable areas of bare soil that is likely to be mobilised by wind and water during storm events. This could result in sediment frequently being delivered to watercourses in higher than natural volumes. Although the above-mentioned impacts will be temporary due to the short-term nature of the construction period, the size of the site and expected scale of bulk earthworks means that runoff and sediment related impacts to onsite watercourses is a likely outcome during the construction phase of the mine.

In a realistic 'poor' mitigation scenario, where high runoff volumes incite isolated erosion along watercourses near construction sites, and large volumes of sediment are regularly deposited into nearby watercourses following storms, construction phase hydrological and geomorphological impact significance was assessed as being 'Medium'. The likelihood of occurrence and extent of impact to watercourse hydrology and geomorphology can be managed through site specific impact mitigation measures (Chapter 7). Therefore, where best practical mitigation is implemented, significance can be reduced to a 'Low' level.

Table 74. Construction phase alteration of hydrological and geomorphological processes impact significance rating.

Description of Impact		
Construction Phase - Alteration of Hydrological and Geomorphological Processes		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Realistic 'Poor' Mitigation**	**Realistic 'Good' Mitigation**
Intensity	Medium	Medium
Duration	Medium	Short
Extent	Local	Site
Consequence	Medium	Low
Probability	Definite / Continuous	Probable
Significance	**Medium**	**Low**
Confidence	Medium	Medium

Key mitigation recommendations:

- Avoid delineated wetlands and riparian areas during layout planning for mine infrastructure and stockpile areas.
- Limit the number of required road crossings as far as practically possible.
- Utilise best practice design principles at all road crossing locations where crossings of watercourses are unavoidable.
- Undertake the construction of any road or pipeline crossings of perennial rivers/wetland during low flows (winter season).
- Limit instream habitat disturbance during crossing construction phase.
- Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
- Ensure that clean and dirty water separation systems are in place prior to construction commencing.
- Implement post-construction watercourse rehabilitation strategy as and where necessary.
- Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.

6.2.2 Operation Phase

Hardened surfaces associated with the power yard, processing plant, and other infrastructure will reduce infiltration rates in the catchments of watercourses, which could lead to increased runoff reaching downslope watercourses. Additionally, the operation of the mine pit will expose notable areas of bare earth and bedrock to surface weather elements (mine pit and waste rock dump). As the exposed bedrock has minimal rainfall infiltration potential, it is expected that runoff volumes from the mine pit and WRD will increase as mining advances (increase in impermeable surface area as the mine grows). If this stormwater is not effectively managed it can cause both dryland and watercourse erosion, which has implications for the ecological condition of watercourses downslope of planned infrastructure. Reduced infiltration across the site could result in erosion along nearby watercourses within the study area. Erosion and associated sedimentation of watercourses poses a great risk to the geomorphological / functional integrity of wetlands, rivers and streams and can also affect system hydrology. For example, the excessive deposition of sediment within wetlands and riparian areas can result in the alteration of flow paths and channel gradients. Regular excessive sedimentation along water courses can also lead to the siltation of in-stream habitats. The discharge of treated effluent from the proposed sewage treatment plant will alter flow along the receiving watercourse, assumed to a mountain headwater stream. This will alter the natural flow regime of the watercourse and could instigate erosion without proper design and planning. The mine pit and WRD also have the potential to interrupt the recharge areas of wetlands located lower than these features in the hydrological profile, effectively de-watering them. This would result in the complete or partial loss of the functional processes of such wetlands. The same could be true of rivers, where catchments are removed by mining, leading to complete loss of downstream riverine habitat.

Most notable, however, is that the WRD will fill in several watercourses, permanently altering the natural hydrological and geomorphological characteristics of these units. With a lack of design and layout information to assume otherwise, it has been supposed that the WRD will impede and alter flow entering the dump area from the upstream watercourse network. This will alter the flow and sediment input characteristics of the reach of SE-Upper Foothill River-466 located downstream of the proposed WRD. This could permanently and drastically alter the seasonality and habitat characteristics of the full length of this watercourse.

In a realistic 'poor' mitigation scenario, where (i) high volumes incite erosion along watercourses, and large volumes of sediment are regularly deposited into nearby watercourses, (ii) the thirty-two (32) watercourses in the proposed WRD footprint have their hydrological and geomorphological characteristics permanently altered, and (iii) where the seasonality and habitat characteristics of SE-Upper Foothill River-466 are notably altered, operation phase hydrological and geomorphological impact significance was assessed as being 'High'. Points (ii) and (iii) are largely unavoidable when assessing the mining plan. It would, however, be possible to limit the extent of hydrological and geomorphological impacts through appropriate layout planning and operational mitigation measures. The impact significance has therefore been reduced to 'Medium) in a 'good' mitigation scenario (all mitigation measures provided below are implemented).

Table 75. Operation phase alteration of hydrological and geomorphological processes impact significance rating.

Description of Impact		
Operation Phase - Alteration of Hydrological and Geomorphological Processes		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Operation	
Criteria	**Realistic 'Poor' Mitigation**	**Realistic 'Good' Mitigation**
Intensity	Medium	Medium
Duration	Permanent	Permanent
Extent	Regional	Local
Consequence	High	Medium
Probability	Definite / Continuous	Definite / Continuous
Significance	**High**	**Medium**
Confidence	Low	Low

Note: The operation phase hydrological and geomorphological process impact significance assessment is low confidence due to the lack of key information to support an appropriately detailed assessment. This would include detailed operational and stormwater management designs and layouts indicating the manner and volumes of water to be discharged into the environment, and hydrological modelling to determine the impact of the altered flow on receiving watercourses. This would include the anticipated impact of the WRD on the flow and sediment inputs along SE-Upper Foothill River-466. It would also be necessary to develop a detailed design for the proposed sewage treatment plant, including treatment capacity and discharge volumes. This information would also need to be included in the hydrological modelling assessment. Until this information is available and included in the wetland and aquatic impact significance assessment, the rating in this report should be considered preliminary and indicative, only.

Key mitigation recommendations:

- Avoid delineated wetlands, riparian areas, and critical watercourse recharge areas during layout planning for mine infrastructure and stockpile areas.
- Avoid delineated wetlands and riparian areas during mining, including the dumping of overburden and placement of stockpiles.
- Adequate stormwater management must be incorporated into the design of all proposed mine and mine related infrastructure to prevent channel incision, erosion, and the associated sedimentation of onsite watercourses.
- A formal stormwater management plan must be developed for the mining operation. This should be done by a suitably qualified engineer with input from a wetland / aquatic ecologist, and a hydropedologist.
- The stormwater system should ideally be designed to handle flows associated with the full range of expected storm events (1:1-year – 1:100-year flood / storms).
- Implement best practice road crossing design that limits scouring and deflects debris and sediment / other natural substrate around these structures.

6.2.3 Cumulative Across the South Block

The generally low settlement density associated with the study area means that there are limited major alterations to catchment runoff patterns and processes. There would however be at least a minor increase in sediment delivery volumes to watercourses, and slight alteration to flood peaks, especially in the more densely settled areas of the South Block. These impacts are however expected to be having a minimal overall impact of the hydrological and geomorphological functioning of most onsite watercourses. local populations in the study area are likely to utilize water from seasonally and perennially flowing watercourses for domestic use. Overall abstraction volumes are however not expected to have a notable affect on these systems or those downstream. Future impacts to geomorphological and hydrological functioning of onsite watercourses due to the rural habitation of the area are not expected to be significant. The Goedertrouw Dam has altered natural flow and sediment distribution regimes for the inundated reach of the Mhlatuze system, as well as river reaches downstream of the dam (DWS, 2022).

In addition to the above mentioned existing impacts, the mining project would be a major activity potentially affecting hydrological and geomorphological integrity of local water resources. Therefore, cumulatively, in a realistic ‘poor’ mitigation scenario, hydrological and geomorphological impact significance was assessed as being ‘High’. It would, however, be possible to limit the extent of hydrological and geomorphological impacts to the region through appropriate layout planning and operational mitigation measures. The impact significance has therefore been reduced to ‘Medium) in a ‘good’ mitigation scenario (all mitigation measures provided below are implemented).

Table 76. Cumulative alteration of hydrological and geomorphological processes impact significance rating.

Description of Impact		
Operation Phase - Alteration of Hydrological and Geomorphological Processes		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction & Operation	
Criteria	**Realistic 'Poor' Mitigation**	**Realistic 'Good' Mitigation**
Intensity	Medium	Medium
Duration	Permanent	Permanent
Extent	Regional	Local
Consequence	High	Medium
Probability	Definite / Continuous	Definite / Continuous
Significance	**High**	**Medium**
Confidence	Low	Low

6.3 Impacts to Water Quality

6.3.1 Construction / Establishment Phase

Key Assumptions:

- Portable toilets will be used during the mine construction phase such that no treated or untreated sewage generated by the workforce will be released into the environment.

It is anticipated that water quality impacts during construction will be limited to potential elevated sediment delivery (and associated turbidity) to watercourses and potential pollution related to accidental spillages / leakages of fuels and chemicals during construction activities. If poorly managed, construction phase impacts to water quality could be of 'Medium' significance where large sediment plumes and / or hazardous substance spills are not effectively mitigated. Mitigation measures relating to the runoff, erosion, sediment, and hazardous substance control during construction are provided in Section 7.6. Implementing these measures will reduce the extent and probability of water quality impacts. The impact significance could therefore be reduced to 'Low'.

Table 77. Construction phase water quality impact significance rating.

Description of Impact		
Construction Phase – Impacts to Water Quality		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Realistic 'Poor' Mitigation**	**Realistic 'Good' Mitigation**
Intensity	High	High
Duration	Short	Short
Extent	Local	Site

Consequence	Medium	Low
Probability	Definite / Continuous	Probable
Significance	**Medium**	**Low**
Confidence	Medium	Medium

Key mitigation recommendations:

- Avoid delineated wetlands and riparian areas during layout planning for mine infrastructure and stockpile areas.
- Ensure that clean and dirty water separation systems are in place prior to construction commencing.
- Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
- Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
- Undertake the construction of any road or pipeline crossings of perennial rivers/wetland during low flows (winter season).
- Limit instream habitat disturbance during crossing construction phase.

6.3.2 Operation Phase

Most mining operations share similar sets of activities, processes, or products that generate contaminants which can potentially enter freshwater environments as surface runoff or via subsurface water movement. Notable potential operation phase sources of pollutants associated with the mining project which could alter surface water quality include:

- Exposure of bare soils.
- Spillage of hydrocarbon fuels and other chemicals.
- Surface runoff from overburden stockpiles and WRDs.
- Iron ore dust reaching watercourses.
- Acid mine drainage (AMD) impacts from stockpile runoff if not managed correctly.
- Pollution control dam (PCD) overflow/failure during extreme events.
- Solid waste pollution (including litter).
- Discharge of effluent from the sewage treatment infrastructure.
- Leakages from sewage treatment and reticulation infrastructure.
- Runoff of partially treated sewage water being re-used for mine operation purposes.
- Altered watercourse flow regimes and associated turbidity / sedimentation.

Contaminated runoff and the discharge of polluted water has the potential to negatively impact aquatic faunal and floral species that are sensitive to changes in water quality (especially from toxicant inputs). The impact on the receiving freshwater environment will depend on the volume of water being discharged, the severity of water contamination and the degree to which dilution takes place in the receiving water resource.

AMD is the most widely recognised water pollution problem resulting from mining activities. Iron ore mines are known to be associated with the AMD phenomenon due to the presence of iron-sulphide chemical compounds (Akcil & Koldas, 2006). AMD is highly acidic water, usually containing high concentrations of metals, sulphides, and salts. The major source of AMD at many mines relate to freshly exposed rock surfaces (pits or underground rock faces), unlined PCDs and the product stockpiles (in this case, iron ore), and discard dumps. According to Watcher and Blackwood (1978), mineral constituents of AMD of concern include:

- Sulphates of iron and aluminium in solution because of pyritic oxidation.
- Solid mineral debris and sediment, and
- Dissolved and colloidal products of geochemical origin.

The iron sulphates cause low pH values and may result in corrosiveness, and toxicity to aquatic life. Changes in pH associated with AMD can alter the abiotic template and radically perturb the entire supported trophic web of plants and animals. Although water quality impacts can be relatively localised, in certain circumstances the impact of AMD can spread well beyond the site boundary. Naicker et al. (2003) report that the effect of the contaminated water, particularly AMD from mine shafts and stockpile seepage, can persist for more than 10 km beyond the source.

Where impacts and risks are poorly managed, this impact could be of 'High' significance. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 7 of this report), this can be potentially reduced to a 'Medium' level.

Table 78. Operation phase water quality impact significance rating.

Description of Impact		
Operation Phase – Impacts to Water Quality		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Operation	
Criteria	**Realistic 'Poor' Mitigation**	**Realistic 'Good' Mitigation**
Intensity	High	High
Duration	Long	Long
Extent	Regional	Local
Consequence	High	Medium
Probability	Definite / Continuous	Probable
Significance	**High**	**Medium**
Confidence	Low	Low

Note: The operation phase water quality impact significance assessment is low confidence. Without more specific knowledge regarding the likelihood and expected intensity of key potential pollution sources such as AMD, and how water quality pollution streams will be managed, this assessment can only be considered conceptual and indicative. It would also be necessary to know which watercourses would be the likely receptors of water quality pollution streams, the volume and expected pollution concentration of water being discharged, and the degree to which dilution takes place in the receiving water resource. This information would need to be captured in a formal report for incorporation into this impact significance assessment.

It is Eco-Pulses understanding that the potential and severity of AMD associated with this mining project will be addressed as a standalone study. The assessment of the significance of impacts associated with AMD in this report would need to be updated based on the more detailed AMD study.

Key mitigation recommendations:

- The potential for this mine to generate AMD must be assessed and if AMD is deemed to be a potential problem, the treatment of mine water decant will be necessary.
- As a general principle, clean and dirty/polluted water must be kept separate. This can be achieved through designing a closed stormwater management system for dirty/polluted catchments.
- Sewer treatment plant design and operation to meet relevant discharge standards with compliance monitoring.
- The design of the sewage treatment plant must allow for any large variations in flow and organic loading, both on a diurnal and seasonal basis, that are typically experienced by small treatment plants serving small groups of people (Gaydon et al., 2007). Some form of flow balancing may be necessary to deal with these variations (often accomplished by incorporating an enlarged septic tank ahead of the biological treatment stage).
- The location of RoM and tailings stockpiles, and retention dams should be carefully evaluated regarding the likelihood of pollution of water resources because of drainage and/or seepage into downstream areas. Site-specific mitigation measures must then be put in place to reduce risks.
- PCDs must be designed to capture all dirty water runoff from the mine, including the discard dumps and stockpile areas and must be designed to contain at least a 1: 100-year rainfall event.
- Monthly inspections and maintenance of PCDs, stockpiles and mine discard dumps will be required to reduce the risk of failure and contamination.
- Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
- Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
- Wherever possible, treated water should be reused in the mining process.
- A suitably qualified aquatic specialist should be appointed to develop and initiate a water quality and aquatic bio-monitoring programme for the site to include wetlands and rivers/streams immediately adjacent to and/or downstream of mining operations. Water quality samples should ideally be collected at strategic locations monthly with aquatic biomonitoring taking place at least bi-annually.

6.3.3 Cumulative Across the South Block

Existing impacts to the water quality of watercourses in the South Block study are generally limited as indicated by the outcomes of the water quality analysis (Section 4.2.1), the aquatic macroinvertebrate assessment (Section 4.2.2), and the fish survey (Section 4.2.3). As the population of the area expands into the future additional sources of water quality pollutants could emerge. The overall significance of these impacts is however expected to remain low given the rural nature of the area. The proposed mine operation will however represent the most significant threat to local and regional water quality along watercourses as it outlined in Sections 6.3.1 and 6.3.2, above, Therefore, where impacts and risks are poorly managed, this impact could be of 'High' significance. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 7 of this report), this can be potentially reduced to a 'Medium' level.

Table 79. Cumulative water quality impact significance rating.

Description of Impact		
Cumulative – Impacts to Water Quality		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction & Operation	
Criteria	**Realistic 'Poor' Mitigation**	**Realistic 'Good' Mitigation**
Intensity	High	High
Duration	Long	Long
Extent	Regional	Local
Consequence	High	Medium
Probability	Definite / Continuous	Probable
Significance	**High**	**Medium**
Confidence	Low	Low

6.4 Impacts to Ecological Connectivity and/or Ecological Disturbance Impacts

6.4.1 Construction / Establishment Phase

During construction the presence of workers and heavy machinery in the general vicinity of onsite watercourses is likely to create noise, vibrations and dust which have the potential to temporarily disturb and displace fauna that make use of onsite watercourse corridors for movement and refuge. Such faunal species are likely to include amphibians, reptiles, birds, and small mammals. Where construction activities within watercourses require a dry working area, rivers may be temporarily impounded, or flow diverted (such as during road crossing construction and upgrades). This will have a temporary impact on the movement of aquatic biota and will affect the connectivity between river reaches.

Where impacts and risks are poorly managed, this impact could be of a 'Moderately-Low' significance. Guidance for minimizing construction phase noise and dust pollution is provided in Section 7.6.4. Additionally, the guidance around 'no-go' areas during construction should be followed to avoid unnecessary ecological disturbance. Implementing these measures will reduce the extent and probability of ecological disturbance impacts. The impact significance rating will however remain 'Low'

Table 80. Construction phase impacts to ecological connectivity and/or ecological disturbance Impacts significance rating.

Description of Impact		
Construction Phase – Impacts to Ecological Connectivity and/or Ecological Disturbance Impacts		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Realistic 'Poor' Mitigation**	**Realistic 'Good' Mitigation**
Intensity	Medium	Medium
Duration	Short	Short
Extent	Local	Site
Consequence	Low	Low
Probability	Definite / Continuous	Probable
Significance	**Low**	**Low**
Confidence	Medium	Medium

Key mitigation recommendations:

- Limit instream habitat disturbance as far as possible.
- Limit construction of instream structures to low flows during the dry (winter) season.
- Restrict worker and machinery access to the construction site and site camp.
- Prohibit poaching or collection of plants and biota during construction.
- Remove temporary diversions and impoundments once construction is complete.
- Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.

6.4.2 Operation Phase

Road crossings and infilled or heavily modified watercourse reaches (i.e., mined out reaches or reaches filled with waste rock deposits) will present a barrier to invertebrate and fish movement. This is likely to have the most significant impact on perennial watercourses such as SE-Transitional River-470, SE-Transitional River-469, and SE-Upper Foothill River-466, which all fall within the current WRD footprint. The SASS5 and fish surveys conducted along SE-Transitional River-470 and SE-Upper Foothill River-466 indicate that these systems host diverse aquatic fauna, many of which are known to be sensitive to water quality and flow alterations. Notable impacts to fish species may include the fragmentation of breeding/spawning areas with potential long-term detrimental effect on fish feeding, spawning and reproduction cycles and the isolation of fish populations, potentially reducing genetic variability and the resilience of populations to environmental change. Notably the vulnerable *Enteromius gurneyi* was noted along SE-Transitional River-470, while the endangered *Marcusenius caudisquamatus* was noted along SE-Upper Foothill River-466.

The presence of workers and machinery, and the need for blasting during mining will create long-term ecological noise and vibration disturbances that could impact on amphibians, reptiles, birds, and small mammals that use watercourse corridors for refuge. The temporary diversion and/or impoundment of flows to create a 'dry' working area during road crossing repairs could temporarily impact habitat connectivity. The disturbance of natural areas by mining-related activities can lead to optimal conditions for alien invasive plants to invade these areas. The establishment of alien and invasive plant species in natural areas may be caused by the following mining-related activities: vegetation clearing and disturbance, establishment of access/haul roads, tipper trucks are implicated in the dispersal of propagules to newly mined areas, incorrect rehabilitation and remediation methods, soil erosion linked with mining disturbance, and dumping/litter. Invasive alien plants can rapidly transform natural areas, displacing indigenous flora and fauna. In addition, certain alien plants exacerbate soil erosion whilst others contribute to a reduction in stream flows.

In a realistic 'poor' mitigation scenario, operation phase ecological disturbances were rated as being of 'Medium' significance. This rating is based on the potential impacts on fish and other aquatic faunal assemblages through habitat fragmentation along SE-Transitional River-470, SE-Transitional River-469, and SE-Upper Foothill River-466 by the WRD. It is also based on the potential for water quality impacts emanating from the operation of the mine to advance downstream, affecting faunal assemblages for a long distance (>10km) downstream of the study area. Whilst habitat fragmentation by the WRD, and noise disturbance during mining are unavoidable under the current layout, where best practical mitigation is implemented regarding water pollution control and minimizing other ecological disturbances (as listed below and explained in detail in Section 7.7 of this report), this can be managed to a 'Low' significance level.

Table 81. Operation phase impacts to ecological connectivity and/or ecological disturbance Impacts significance rating.

Description of Impact		
Operation Phase – Impacts to Ecological Connectivity and/or Ecological Disturbance Impacts		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Operation	
Criteria	**Realistic 'Poor' Mitigation**	**Realistic 'Good' Mitigation**
Intensity	Medium	Medium
Duration	Long	Long
Extent	Regional	Site
Consequence	Medium	Low
Probability	Definite / Continuous	Definite / Continuous
Significance	**Medium**	**Low**
Confidence	Medium	Medium

Key mitigation recommendations:

- Avoid delineated wetlands and riparian areas during layout planning for mine infrastructure and stockpile areas.
- Avoid delineated wetlands and riparian areas during mining, including the dumping of overburden and placement of stockpiles.
- Restrict worker and machinery access to areas outside of sensitive environments.
- Prohibit poaching or collection of plants and biota.
- Remove temporary diversions and impoundments once repair/maintenance work is complete.
- Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.

6.4.3 Cumulative Across the South Block

The settle of the area by humans, with the rural settlements expanding over time, exist as an ecological disturbance for fauna that make use of watercourses and riparian corridors for movement and refuge. The connectively of semi – to largely intact watercourses and riparian zones across the study area is however good, meaning that aquatic and terrestrial fauna should be able to freely move and reside within the area under current and future settlement conditions. The proposed mine would be the most notable activity in the area responsible for creating ecological noise and vibration disturbances that could impact on amphibians, reptiles, birds, and small mammals that use watercourse corridors for refuge. For this and the other reasons described in Section 6.4.1 and 6.4.2, in a realistic 'poor' mitigation scenario, operation phase ecological disturbances were rated as being of 'Medium' significance. Where best practical mitigation is implemented regarding water pollution control and minimizing other ecological disturbances (as listed below and explained in detail in Section 7.7 of this report), this can be managed to a 'Low' significance level.

Table 82. Cumulative impacts to ecological connectivity and/or ecological disturbance Impacts significance rating.

Description of Impact		
Cumulative – Impacts to Ecological Connectivity and/or Ecological Disturbance Impacts		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Construction & Operation	
Criteria	**Realistic 'Poor' Mitigation**	**Realistic 'Good' Mitigation**
Intensity	Medium	Medium
Duration	Long	Long
Extent	Regional	Site
Consequence	Medium	Low
Probability	Definite / Continuous	Definite / Continuous
Significance	**Medium**	**Low**
Confidence	Medium	Medium

6.5 Impact Significance Assessment Summary Table

A summary table containing the impact significance assessment ratings (for a 'poor' and 'good' mitigation scenario) and for each mining phase is included below.

- The most significant construction (mine development) phase impacts are likely to be the direct physical loss or modification of freshwater habitat at road crossing locations and in instances were infrastructure advances into delineated watercourses.
- Construction phase impacts hydrological and geomorphological process impacts could be of 'Medium' significance where additional flows along wetland and rivers trigger erosional processes, and bulk earthworks will result in large volumes of sediment frequently being delivered to watercourses.
- The most significant operation phase impacts are likely to be associated with direct physical destruction of freshwater habitat area at the location of the mine pit and waste rock dump, the potential for appreciable hydrological and geomorphological modifications to watercourses during the mining operational phase, and the inherent risks of AMD and other water pollution streams emanating from the mine operation.

Table 83. Impact significance assessment summary table for the iron ore mining project phases.

Impact Type	**Impact Significance Rating**	
	'poor' mitigation scenario	**'good' mitigation scenario**
CONSTRUCTION / ESTABLISHMENT PHASE		

Impact Type	Impact Significance Rating	
	'poor' mitigation scenario	'good' mitigation scenario
Direct physical loss or modification of freshwater habitat	Medium	Medium
Alteration of hydrological and geomorphological processes	Medium	Low
Impacts to water quality	Medium	Low
Impacts to ecological connectivity and/or ecological disturbance impacts	Low	Low
OPERATIONAL (MINING) PHASE		
Direct physical loss or modification of freshwater habitat	High	High
Alteration of hydrological and geomorphological processes	High	Medium
Impacts to water quality	High	Medium
Impacts to ecological connectivity and/or ecological disturbance impacts	Medium	Low
CUMULATIVE		
Direct physical loss or modification of freshwater habitat	High	High
Alteration of hydrological and geomorphological processes	High	Medium
Impacts to water quality	High	Medium
Impacts to ecological connectivity and/or ecological disturbance impacts	Medium	Low

6.6 Risk Assessment to inform S21 c & i Water Use Licensing

It is our understanding that the purpose of the risk matrix tool developed by the DWS is to give a preliminary indication of the likely impact / degree of change (consequence) of activities (water uses) on local and regional water resources. For the purposes of this study, the degree of change is reflected in PES change and/or the change in the supply of regulating ecosystem services. A summary of the potential risk and impacts ratings for the proposed development activities is provided in **Table 84** below.

Open pit mining projects in general are known to be associated with high risks to water resources, including surface and groundwater systems. Whilst risks associated with the construction phase of the mining project can generally be managed to 'low' overall levels, most of the operational mining risks to watercourses are considered moderate to high and will be difficult to mitigate. Whilst there are potential mitigation options to assist with mitigating these moderate to high rated risks, **the overall project risk is still likely to remain at least a 'moderate' level**. The mining project therefore cannot be generally authorised under the GA for Section 21 c and i water uses. Therefore, a full WULA is required for the project.

Additionally, General Notice (GN) 509. GN 509, published in Government Gazette (GG) no. 40229 under Section 39 of the National Water Act (Act no. 36 of 1998) in August 2016, allows for Section 21 (c) and (i) water uses to be generally authorised if risks can be reduced to an acceptable level. There is, however, no GA notice for the remaining Section 21 water uses. This project will trigger several water uses beyond (c) and (i), and will require a full WULA on that basis, also.

It is important to also note that the Risk Assessment in this section overlaps strongly with the impact significance assessment findings which is to be expected since the risk ratings should in essence align to a large degree with the impact ratings.

Table 84. Summary of the risk matrix assessment scores and ratings for each activity and risk group.

Activity	Aspects	Impact	Risk Rating	Revised Risk Rating for Borderline LOW / MODERATE Rating Classes
CONSTRUCTION PHASE	Infilling of watercourses and accidental direct physical modification to freshwater habitat during construction.	Direct physical loss or modification of freshwater habitat	Moderate	Moderate
	increase in sediment supply to watercourses associated with trenching taking place within and near watercourse units. Temporarily alteration natural water distribution patterns.	Alteration of hydrological and geomorphological processes	Moderate	Low
	Potential elevated sediment delivery (and associated turbidity) to watercourses and potential pollution related to accidental spillages / leakages of fuels and chemicals during construction.	Impacts to water quality	Moderate	Low
	Presence of workers and heavy machinery in the general vicinity of onsite watercourses creating noise, vibrations, and dust.	Impacts to ecological connectivity and/or ecological disturbance impacts	Moderate	Low
OPERATIONAL PHASE	Accidental direct physical modification to river or stream habitat during operation phase maintenance and repair.	Direct physical loss or modification of freshwater habitat	High	NA
	Operation phase storm water management. (i) high runoff volumes incite erosion along watercourses, and large volumes of sediment are regularly deposited into nearby watercourses, (ii) the thirty-two (32) watercourses in the proposed rock dump have their hydrological and geomorphological characteristics permanently altered, and (iii) where the seasonality and habitat characteristics of SE-Upper Foothill River-466 notably altered.	Alteration of hydrological and geomorphological processes	High	NA
	Risk of potential hydrocarbon (fuel/oil) spills, polluted storm water runoff, sedimentation, and potential Acid Mine Drainage (AMD), treated effluent discharge from onsite sewer treatment plant	Impacts to water quality	High	NA
	The presence of workers and machinery during infrastructure repairs and maintenance, and the use of the developed area by cars and people creating ecological noise and vibration disturbances.	Impacts to ecological connectivity and/or ecological disturbance impacts	Moderate	Moderate

For further details on risk assessment scores and ratings refer to ***Annexure C*** *of this report.*

7. LAYOUT PLANNING & IMPACT MITIGATION RECOMMENDATIONS

A strong legislative framework backs up South Africa's obligations to numerous international conservation agreements and creates the necessary enabling legal framework for the protection and management of freshwater resources in the country. Within this framework, it is illegal to deliberately damage wetlands and rivers without appropriate authorisation. The law therefore places, directly and indirectly, the responsibility on landowners and other responsible parties, to manage wetland and aquatic ecosystems and to restore them where relevant.

According to the NEMA, sensitive, vulnerable, highly dynamic, or stressed ecosystems, such as wetlands or rivers require specific attention in management and planning procedures, especially where they are subject to significant usage and development pressure. NEMA also requires that the 'precautionary principle' be applied, meaning "a risk-averse and cautious approach which takes into account the limits of current knowledge about the consequences of decisions and actions". Effective measures must therefore be implemented to pro-actively prevent degradation of the region's water resources. ***Ultimately, the risk of water resource degradation and biodiversity reduction / loss must drive sustainability in development design.***

Of importance is the requirement of 'duty of care' with regards to environmental remediation stipulated in Section 28 of NEMA:

Duty of care and remediation of environmental damage: "(1) *Every person who causes has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing, or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.*"

The protection of water resources begins with the avoidance of adverse impacts and where such avoidance is not feasible; to apply appropriate mitigation in the form of reactive practical actions that minimize or reduce such impacts. The mitigation of negative impacts on wetland and aquatic resources is a legal requirement for authorisation purposes and must take on different forms depending on the significance of impacts and the particulars of the target area being affected. This generally follows the 'mitigation hierarchy' (**Figure 34**), which aims firstly at avoiding disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided, to minimise, rehabilitate, and then finally offset any remaining significant residual impacts.

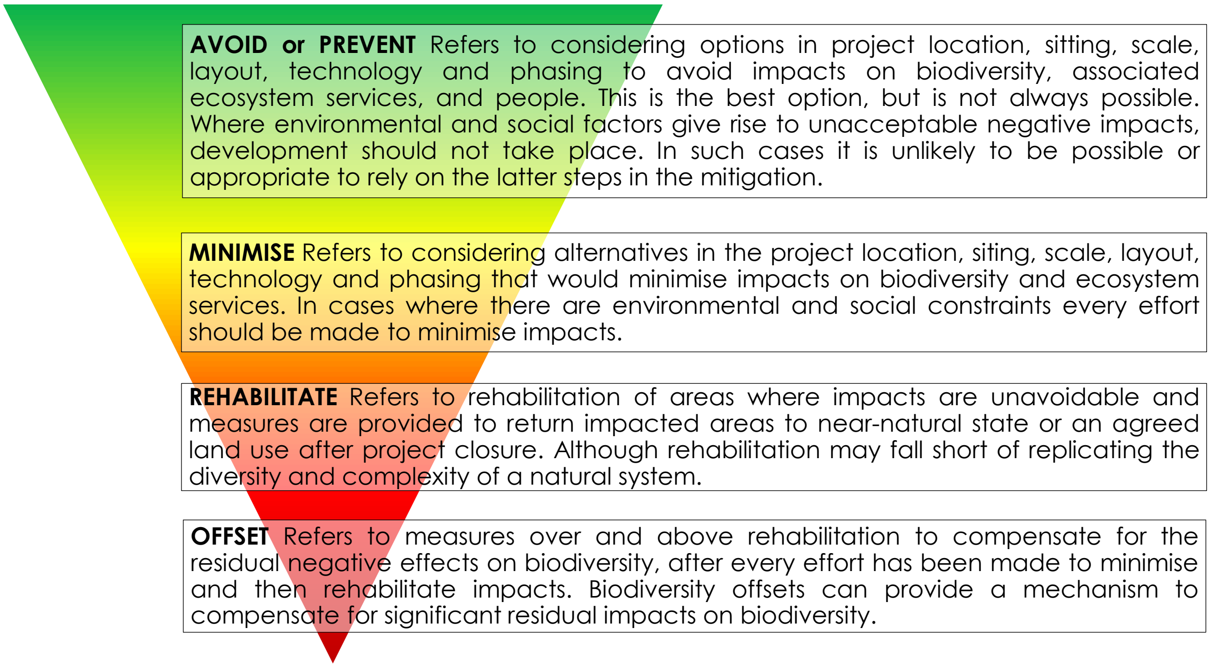

Figure 34. Diagram illustrating the 'mitigation hierarchy' (after DEA *et al.*, 2013).

The mitigation hierarchy is inherently proactive, requiring the on-going and iterative consideration of alternatives in terms of project location, siting, scale, layout, technology, and phasing until the proposed development can be best accommodated without incurring significant negative impacts to the receiving environment. Therefore, based on the current project layout and the nature of the surrounding environment, Eco-Pulse have identified key project elements that should be considered to avoid unnecessary impacts, namely

- Preliminary wetland and aquatic buffer zone considerations,
- Infrastructure siting considerations,
- Powerline, pipeline, and road watercourse crossing design considerations,
- Stormwater management design considerations.

7.1 Wetland & Aquatic Buffer Zone Recommendations

'Buffer zones' (also termed "development set-backs") are essentially strips of undeveloped and vegetated land typically designed to act as a protective barrier between human activities and ecosystems / habitats such as wetlands and rivers. Research shows that buffer zones are useful at performing a wide range of functions such as sediment trapping and nutrient retention, and in doing so, play an important role in protecting water resources to some degree from adverse water quality and sediment impacts that are typically associated with adjacent human land-uses and development. Although there are no formal requirements regarding the establishment of buffers around water resources in the South African legislation, the application of buffers is aligned with the principles of the National Water Act (1998), which aim to maintain water quality and preserve natural aquatic habitats and ecosystem functions.

A national protocol for buffer determination around rivers, wetlands, and estuaries (Macfarlane & Bredin, 2016) has been developed and represents emerging best-practice in aquatic buffer zone determination. The methodology and accompanying buffer zone determination tool were used to develop preliminary watercourse buffer requirements for the project. These initial buffer zones are provided to serve as an initial guide to inform project design and layout planning.

7.1.1 Preliminary recommended buffer zone widths

Note: Mining (extraction of minerals / resources from the actual pit / shaft, not necessarily the operation of plant and processing infrastructure) is recognised as an activity with potentially high risks to water resources. A number of these risks are not addressed by the Macfarlane & Bredin (2016) buffer zone guidelines which focus primarily on mitigating impacts from diffuse source pollutants in surface runoff. For example, the guidelines do not specifically address impacts of mining on groundwater and hillslope hydrological processes which may be important aspects to consider when establishing set-back requirements.

The preliminary recommended buffer zone widths provided in this report have therefore not attempted to provide appropriate buffer widths for the mitigation of impacts to watercourses associated with proposed pit and waste rock dump. These buffer widths would need to be investigated and determined through input from detailed geohydrological and hydropedological investigations, commissioned specifically for the purpose of deciding on appropriate buffer widths for those activities. The hydropedological study should also investigate and identify wetland and riparian zone recharge areas to avoid habitat loss through the infilling of these key areas.

The preliminary buffer widths provided below relate to the processing and mine support infrastructure (power yard, primary crusher, and the processing plant). The preliminary recommended buffer zones will likely need to be revised and refined at a later planning stage when more specific designs for proposed infrastructure are available for interrogation and incorporation into the buffer width determination process.

The buffer model by Macfarlane & Bredin (2016) allows the user to choose a land use / activity type and produces a buffer output for that activity type for two (2) scenarios based on potential risks associated with the proposed project type, in conjunction with the sensitivity of wetland and aquatic resources. These two scenarios are (i) without specific mitigation; and (ii) with specific impact/risk mitigation. In this case the following land use / activity was used to provide preliminary buffer widths for processing and mine support infrastructure (taken directly from the options provided by the tool):

- Plant and plant waste from high-risk mine operations
  - Waste generated from plant and plant waste from processing of minerals and metals extracted from the ground, which pose a high risk to water quality and water resources. These include Antimony (Large mines), Asbestos, base metals (Copper Cadmium,

Cobalt, Iron ore, Molybdenum, Nickel, Tin, Vanadium), Chrome (Large mines), Coal, Gold, Silver, Uranium, Zinc and Lead.

The results of the buffer tool assessment are presented in **Table 85**, below and includes the two potential scenarios the tool accounts for in its outputs/results (i.e. (i) without specific mitigation; and (ii) with specific impact/risk mitigation).

Under a 'with mitigation' scenario final buffer model outputs for rivers and wetlands recommend a 61m and 54m buffer width respectively for any heavy industrial activities planned, a 33m and 34m width respectively for any high-density residential activities planned and a 17m buffer width for both wetlands and rivers for any low impact mixed-use activities planned. It is important to note that the 17m buffer recommended by the buffer tool for rivers under a low-impact mixed use scenario with best practice mitigation applied, is lower than the standard 30m buffer recommended in the draft Guidelines for Biodiversity Impact Assessment (EKZNW, 2011) and therefore the buffer has been revised to 30m for rivers under this land-use scenario in accordance with these provincial guidelines (see the buffer map in **Figure 36**). Typical mitigation and best-practice measures likely to be required under a specific impact/risk mitigation scenario include measures such as the demarcation of construction servitudes; runoff, erosion, and sediment control; soil, hazardous substances, wastewater management, solid waste management, and storm water management; a freshwater ecosystem rehabilitation strategy; invasive alien plant control; noise, dust and light pollution minimisation and a freshwater ecosystem monitoring plan.

Table 85. Summary of the outcomes of the watercourse buffer model (Macfarlane & Bredin, 2016).

		Recommended Buffer Width	
		Plant and plant waste from high-risk mine operations	
Watercourse Type	**Project Phase**	With Mitigation	Without Mitigation
Rivers/ Streams	Construction	28m	55m
	Operation	28m	100m
	Final	**28m**	**100m**
Wetlands	Construction	25	50
	Operation	25	85
	Final	**25m**	**85m**

7.1.2 Additional buffer zone requirements

Although the width of the buffer zone is an important primary consideration in protecting freshwater resources from adjacent impacts, several additional factors should also be considered when establishing and maintaining buffers:

- Buffer zones have their limitations and need to be considered in conjunction with other mitigation measures, which may be required to address specific impacts for which buffer zones are not particularly well suited. From an industrial perspective, it is important to note that changes in hydrology and potential toxic contaminants may not be adequately catered for through application of preliminary buffer zones proposed.
- It is imperative that activities within the recommended buffer zones are controlled or restricted. Management should be directed to ensure that erosion is prevented, and vegetation cover maximised to ensure maximum buffer zone efficiency.
- Buffer zones are also considered important in maintaining and even enhancing the functioning of riverine areas as natural wildlife corridors for species movement up and down valley lines. Buffers in this context may provide additional habitat and facilitate the movement of species to non-breeding habitats (e.g., certain frog species that migrate into terrestrial areas at certain times). The buffers established should therefore be maintained as natural open space/conservation areas and linkages. Existing slopes should be maintained, and the existing indigenous vegetation communities maintained or restored/enhanced where relevant.

7.2 Infrastructure Siting Consideration

While broad-level planning has highlighted potential mining and processing areas, detailed designs and layouts have not yet been completed. In further planning of potential mining activities, implementing the 'impact mitigation hierarchy' (discussed above) will be essential in attempting to avoid, reduce and mitigate potential mining-related risks and impacts to the environment. For this to be achieved every attempt should be made to avoid/prevent impacts to important water resources through refinements to project design and the siting of mining infrastructure, mining areas, site camps and material storage, stockpiling and dump sites. Based on the current layout, Eco-Pulse have provided basic siting recommendations for several proposed activities / infrastructures.

7.2.1 Waste Rock Dump

It is understood by Eco-Pulse that the final sizing and location of the waste rock dump is largely finalized with the Geotheta (2023) conceptual design to be carried forward. Whilst Eco-Pulse understand that the WRD will require a large area, and that watercourse habitat loss is a likely outcome of the establishment and operation of the dump, the project design team must endeavour to select a WRD location and size that will affect (directly and indirectly) as few watercourses as is possible.

7.2.2 South East Pit

In accordance with the mitigation hierarchy, the first step when planning the layout of a project such as a mine should be to consider options in project location, siting, scale, layout, technology, and phasing to avoid impacts on biodiversity and water resources. In the case of the mine pit, Eco-Pulse provided a recommendation to resize the pit to avoid crossing a sub-catchment at the current southern extent of the pit. This was considered by Jindal with Eco-Pulse ultimately being informed that resizing the pit would fundamentally alter the project, and that this was not feasible. This assessment therefore only considered the pit that is displayed in **Figure 2**.

7.2.1 Processing Plant, Primary Crusher & Incoming Power Yard

In its currently proposed location, the processing plant footprint coincides with the headwater areas of two (2) Mountain Headwater Streams, a single (1) wetland, and a single (1) Mountain Stream (**Figure 35**). Additionally, the proposed location of the incoming power yard coincides with a single (1) wetland. Whilst the primary crusher does not overlay with any mapped watercourses, it does advance into the preliminarily recommended watercourse buffer zone area (with and without mitigation) for a (1) Mountain Headwater Stream and a (1) Mountain Stream (**Figure 36**). Without re-siting this infrastructure, the above-mentioned watercourses stand to be directly or indirectly impacted by the proposed infrastructure. In accordance with the mitigation hierarchy, it is necessary for the design team to explore all possible siting, re-sizing, and layout adjustment options to avoid direct loss of watercourse habitat, and to effectively mitigate potential indirect impacts to watercourses through the implementation of sustainable design principles.

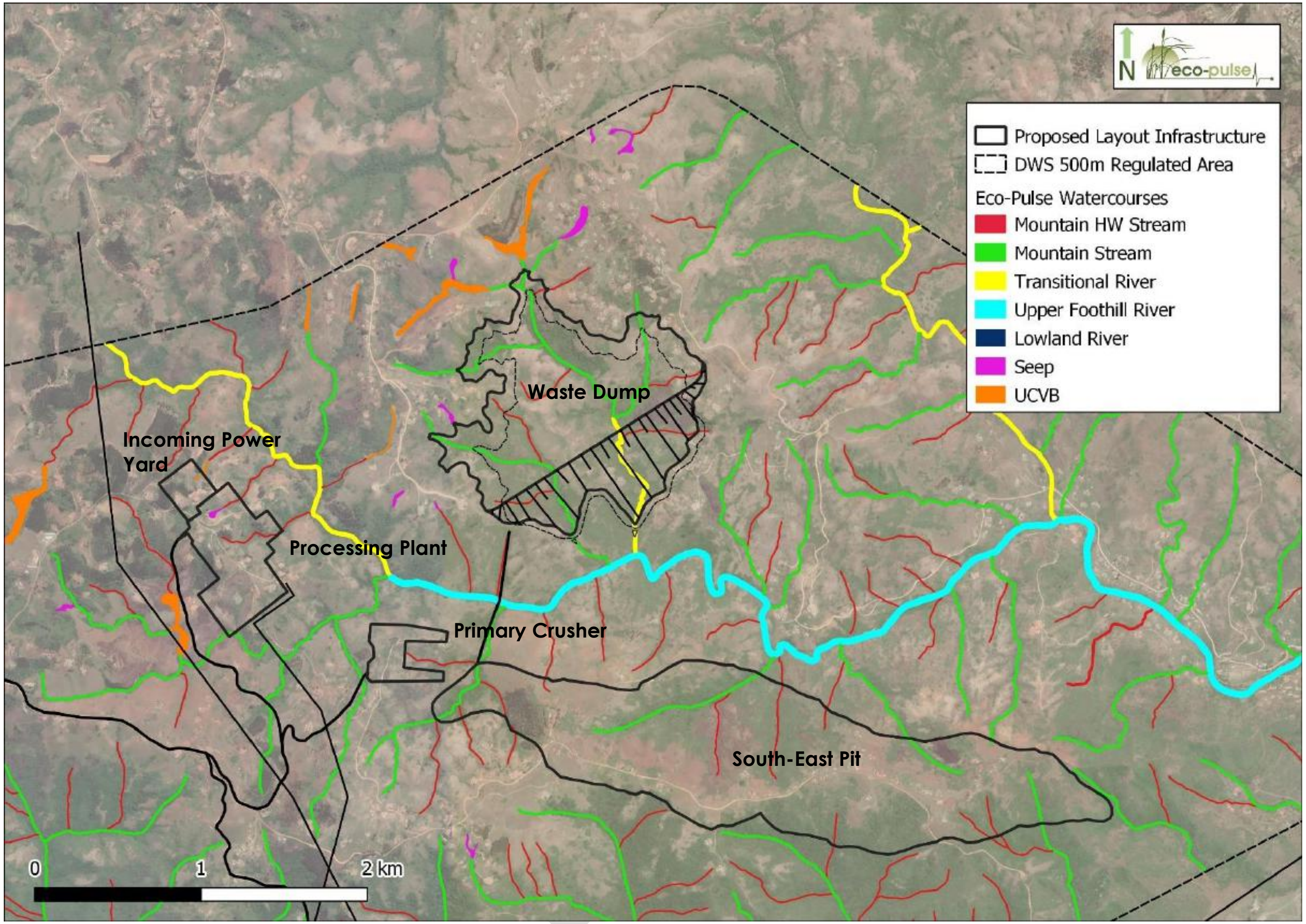

Figure 35. Processing Plant, Primary Crusher, and Incoming Power Yard footprint areas in relation to watercourses mapped by Eco-Pulse.

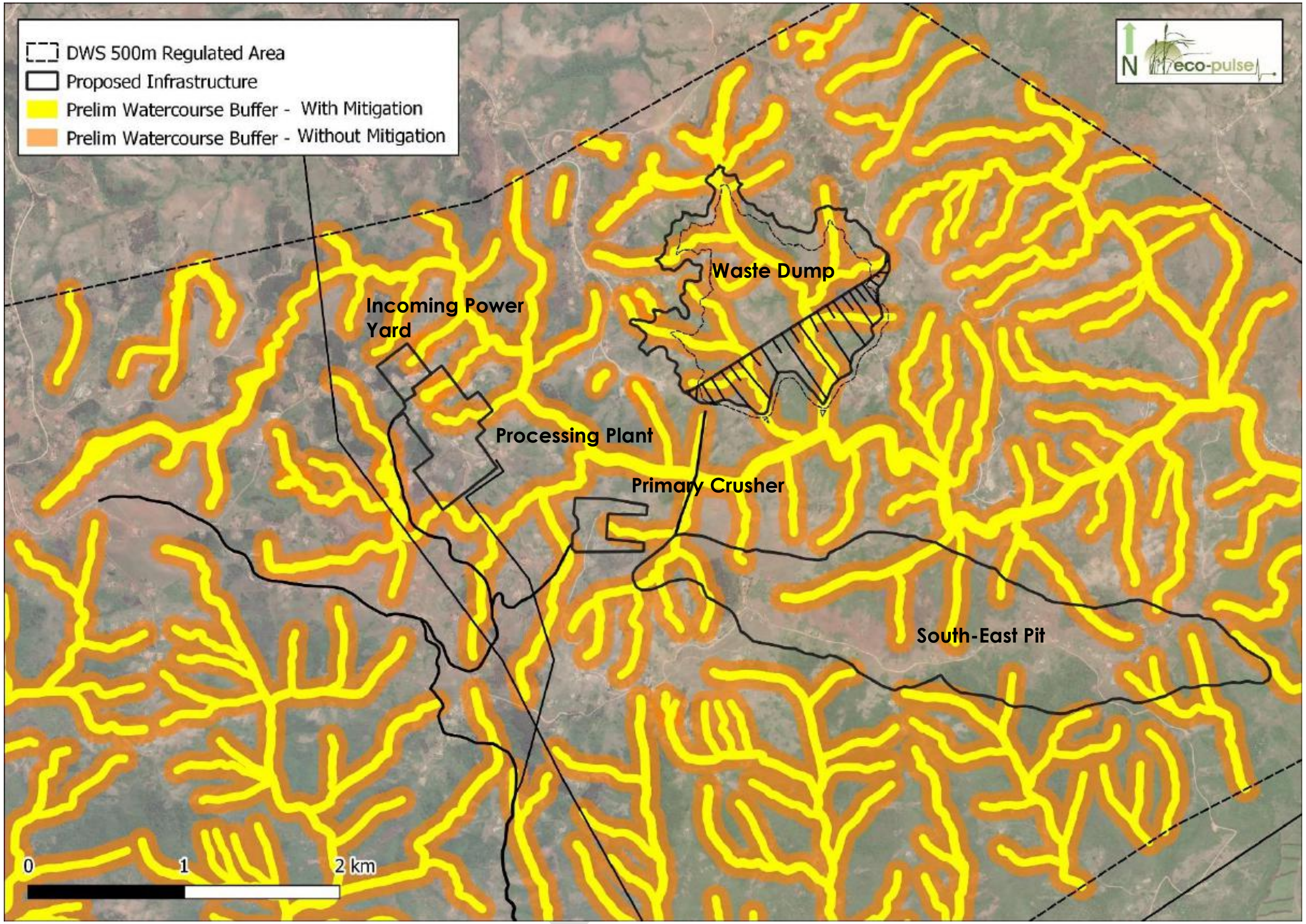

Figure 36. Preliminary recommended wetland and aquatic buffer widths .

7.2.2 Access Road

It is understood by Eco-Pulse that the presently proposed access road is a preliminary alignment that may experience notable change as the project advances. During road alignment planning, in line with the principles of the mitigation hierarchy, Eco-Pulse would encourage the design team to make use of existing roads as far as practically possible, and to limit the required number of watercourse crossings, especially new watercourse crossings. A review of the road alignment provided to Eco-Pulse shows that the alignment follows an existing unpaved road with three (3) existing watercourse crossings.

Under the proposed alignment there is an approximately 1.5km length of road leading to the processing plant that runs through 'virgin' land, and which would involve crossing two (2) mountain streams (Figure 37) (SE-PU06-12 and SE-PU06-487). There is an additional approximately 250m length of proposed access road near the primary crusher that does not following an existing alignment, and which crosses a mountain stream (SE-PU6-11). Each of these watercourses is in fair ecological condition (C PES Category) and were rated as being of low overall EIS. An approximately 800m length of road linking the mine pit and the waste rock dump is also proposed. This access road will require new road crossings of two (2) additional watercourses (SE-Upper Foothill River-466 and SE-PU06-486).

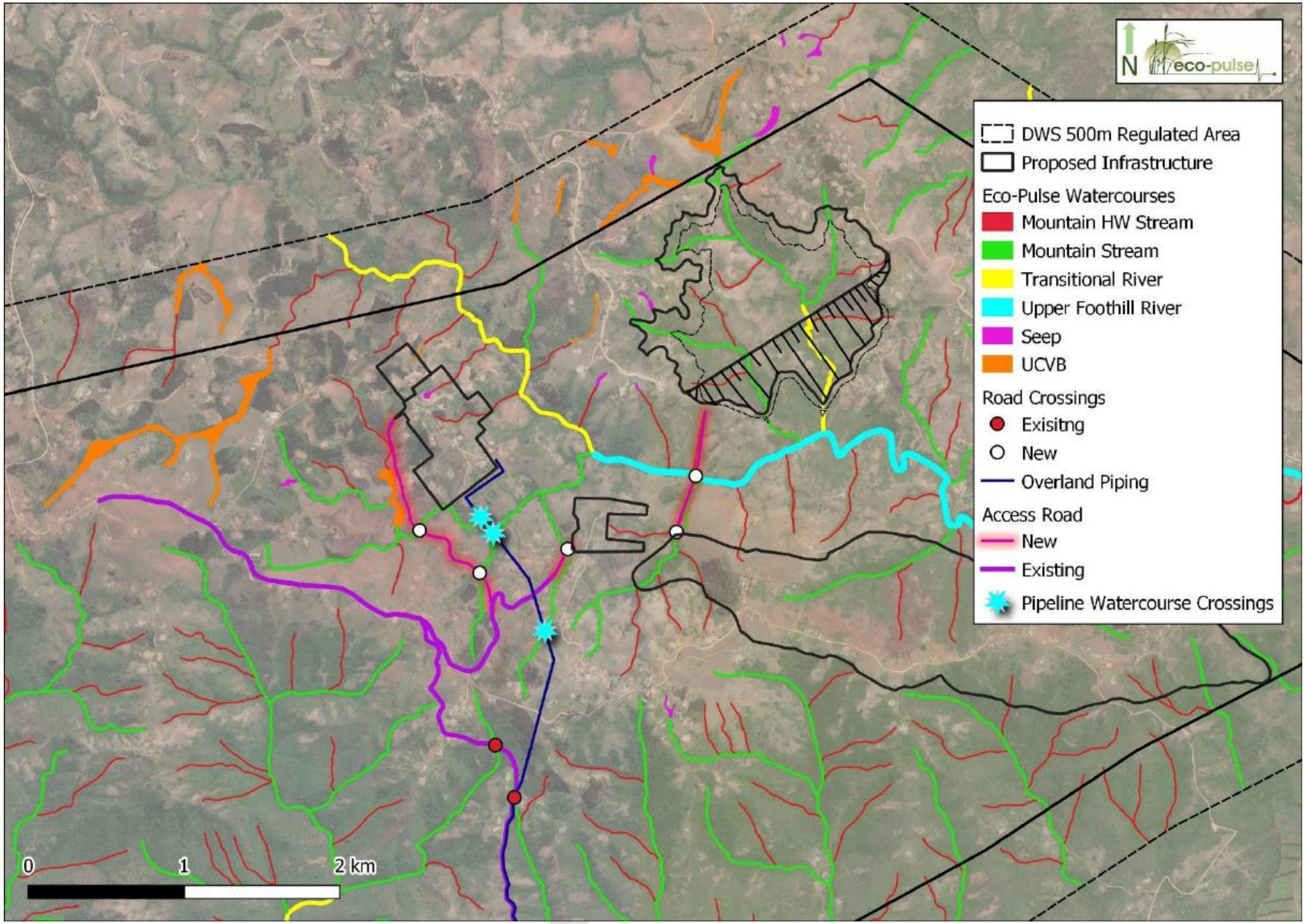

Figure 37. Presently proposed road alignment showing the sections which follow an existing road and those that do not.

7.3 Road Crossing Design Considerations

Preliminary road crossing design recommendations are provided below for inclusion in the continued layout planning process.

7.3.1 Crossing Type and Design:

- Should existing road crossings be deemed inadequate or inappropriate to allow for flow to pass through the crossing unimpeded, the crossing should be upgraded.
- For all crossing types and designs, flow through road crossings should not be unnecessarily concentrated and flow velocity should not be increased. In this regard, crossings should ideally be in the form of a single span bridge or box / portal culverts across the entire width of the watercourse. Pipe culverts should be avoided.
- For new and upgraded road crossings, the decision between bridges and box culvert crossings should be a trade-off between the cost, importance, and sensitivity of the watercourse, and predicted impact of the crossing to watercourse hydrology.
- Erosion protection and energy dissipation measures should be established at all crossing outlets e.g., stilling basins and reno-mattresses.

7.3.2 Box Culvert Crossing Design:

- The key impact minimisation measure for watercourse crossings is the establishment of an adequate number of box culverts to ensure that the culverts span the entire width of the channel being crossed to minimise flow concentration / constriction as far as practically possible.
- Culverts should ideally be sized to allow passage to not only water, but the other materials that might be mobilized (i.e., debris).
- The inlet of the culvert base should match the elevation of the stream bed so that there is no culvert base perching (if culvert inlet higher than river bed) or a drop into the culvert (if culvert inlet lower than bed).
- Erosion protection structures should be established at all culvert outlets to reduce bed erosion / scour. Such structures include Reno-mattresses and/or stilling basins established at the current stream bed surface.

Note: Inadequate design and installation of culverts may result in culvert failure. Box 1 (below) summarises some key causes of culvert failure for consideration.

Box 1: Possible causes of culvert failure

Culvert failure can have far reaching impact on aquatic resources, particularly those related to system hydrology, erosion/ sedimentation, and aquatic biota. Attention should therefore be given to the following to mitigate against possible failure of installed culverts:

- Inadequate culvert capacity for the calculated stream flow.
- Structural failure due to excessive soil loading.
- Wash-out due to water overtopping the road.

- End scouring from poor end treatment and lack of erosion protection.
- Improper jointing resulting in water piping along the outside of the culvert.
- Erosion due to excessive water transport of sand and gravel, arising from the acceleration of flow through the culvert.
- Corrosion from acid or salt laden soils and water.
- Improper inlet and outlet structures, resulting in embankment failures.
- Improper alignment of the culvert relevant to the natural channel, resulting in scour of the embankment at the inlet.
- Poor installation and/or bedding condition resulting in settlement, joint separation, or structural failure of the culvert.

7.3.3 Bridge Design (if required):

- Bridge platforms should ideally be established above the major storm event flood levels e.g., 1:100-year flood level.
- If possible, every effort should be made to span the entire watercourse. If this is not possible, the number of the piers and their bases / footers should be minimised.
- All piers (and bases / footers) should be aligned parallel to the direction of flow.
- The surface of the pier bases / footers should be established at the existing bed level so that flow and sediment patterns are not altered. Under no circumstances should the pier bases / footers be established above or below the bed surface level / elevation.

7.4 Bulk Water Supply Pipeline Design Considerations

An overland bulk water supply pipeline is proposed from the Goedertrouw Dam wall to the processing plant. The proposed pipeline is aligned with an existing road for much of its length, where it will cross over two (2) mountain streams (**Figure 37**). Approximately 2km of the pipeline does however branch off from the access road. This 2km stretch of overland pipeline will cross three (3) mountain streams. The following layout and design consideration apply to the pipeline crossings:

- Crossings points should be aligned along areas or corridors of existing disturbance where possible (e.g., along existing roads), and should ideally be buried within the road fill.
- At the locations where the pipeline crosses a watercourse but is not aligned with an existing road the pipeline crossings should be via pipe bridge rather than trenched.
    - Pipe bridges must be designed such that pipes are suspended sufficiently high above the channel bed and above the high-water mark so as not to interfere with natural flow regimes and such that pipes do not act as traps for debris and sediment transported through the channel.
    - Pipe bridge piers should be placed on either side of the watercourse for smaller rivers/streams and not to be placed within the channel bed.
- Pipeline crossings must be aligned at right angles to flow.

7.5 Stormwater Management Design Considerations

- Adequate stormwater management must be incorporated into the design of all proposed mine and mine related infrastructure to prevent channel incision, erosion, and the associated sedimentation of onsite watercourses.
- A formal stormwater management plan must be developed for the mining operation. This should be done by a suitably qualified engineer with input from a wetland / aquatic ecologist, and a hydropedologist.
- The stormwater system should ideally be designed to handle flows associated with the full range of expected storm events (1:1-year – 1:100-year flood / storms).
- It is important to minimise runoff generation (through minimising the extent of hard standing and using rainwater harvesting techniques with all buildings) and to maximise runoff infiltration within the footprint of proposed infrastructure and within the recommended wetland / aquatic buffer zones. Recommended infiltration structures include the use of permeable options for surfacing of parking areas, bioretention areas, unlined detention basins, infiltration basins, and grassed swales.
- Related to the previous point, it is important that runoff generated by the development is not discharged back into the environment via concentrated point source outlets. An engineer should therefore be consulted to determine the best approach to achieving diffuse stormwater flow through the aquatic buffer zone area.
- Where possible stormwater runoff should be directed into, and conveyed by, open, permeable swales. These features should be well vegetated with indigenous fast growing grass species and stabilised by means of gabions or concrete check walls to prevent erosion and vertical incision. This will provide for some filtration and removal of pollutants (e.g., oils and hydrocarbons), provide some attenuation by increasing the time runoff takes to reach low points, and will reduce the energy of storm water flows within the stormwater system through increased roughness when compared with pipes and concrete V-drains.
- Stormwater outlet design recommendations:
    - Many smaller stormwater outlets must be favoured over a few large outlets.
    - Outfalls should not release stormwater directly down steep slopes.
    - All outlets must be designed to dissipate the energy of outgoing flows to levels that present a low erosion risk. In this regard, suitably designed energy dissipation (e.g., stilling basins) and erosion protection structures (Reno-mattresses) should be installed at appropriate locations.
- All stormwater generated by the proposed onsite infrastructure must receive appropriate filtering and treatment prior to discharge into the freshwater environment. Furthermore, all treatment should occur within the development footprint. This is particularly true for the crusher and processing plant, with runoff from these locations posing a risk to water quality of downstream watercourses.
- To function adequately, it is critically important that the onsite stormwater system be regularly maintained over time. This must be written into the operational EMPr for the project.

- It is important that clean and dirty stormwater separation systems be in place prior to construction commencing and must be maintained for the duration of the mines operational life, until site closure and rehabilitation has been completed and signed off.

7.6 Pollution Control Dam (PCD) Design and Placement

- All PCDs retaining contaminated storm water and wastewater considered harmful to the environment must be provided with a suitable liner system to limit/prevent contaminated seepage from entering the local groundwater system and/or surface water catchments.
- A leak detection system must be installed for all PCDs retaining polluted wastewater.
- All PCDs should be designed with sufficient capacity and operated at a level to allow for the accommodation of storm events and hence manage the spillage frequency.
- Polluted water retained in the PCDs must be treated and recycled/reused in the mining process.
- Low risk polluted water retained in the PCDs should be used for suppressing dust from roads.
- PCDs are not to be located within wetlands or rivers unless appropriate motivation for why this cannot be accomplished is provided by the design engineers, in which case the least ecologically important/sensitive watercourses must be selected first for this purpose, with input from the wetland/aquatic specialist.

7.7 Construction Phase Mitigation and Management Measures

Key construction phase mitigation measures to address the preliminary impacts identified in Chapter 06 are outlined below.

7.7.1 'No-Go' Areas During Construction.

- All watercourses must be considered no-go areas for the duration of the construction process.
- Construction staff and machine operators must be informed of the location of all watercourses in the vicinity of the construction site.
- No areas outside the construction footprint may be cleared and stripped of vegetation. To this end the outer edges of construction sites must be demarcated using a high visibility barrier / fencing. The demarcation must be signed off by the project Environmental Control Officer (ECO).
- Access to and from construction areas should, as far as practically possible, be via existing roads.
- All disturbed areas beyond the demarcated construction area that are intentionally or accidentally disturbed must be immediately rehabilitated to the satisfaction of the ECO.

7.7.2 Runoff, Erosion, and Sediment Control

- Wherever possible, existing vegetation cover at the site should be maintained during the construction phase. The unnecessary removal of groundcover from slopes must be prevented, especially on steep slopes.

- Where possible construction roads should be aligned along contours rather than downslopes to avoid these features generating excessive sediment laden runoff.
- All bare slopes and surfaces to be exposed to the elements during clearing and earthworks must be protected against erosion using rows of hay-bales, sandbags and/or silt fences aligned along the contours and spaced at regular intervals to break the energy of surface flows.
- The use of hay-bale berms, sandbags and/or silt fences is particularly important in areas where surface runoff is concentrated (e.g.: rills, road stormwater discharge points etc.).
- Once shaped, all exposed/bare surfaces and embankments must be re-vegetated immediately.
- If re-vegetation of exposed surfaces cannot be established immediately due to construction phasing issues, temporary erosion and sediment control measures must be maintained until such a time that re-vegetation can commence.
- All temporary erosion and sediment control measures must be monitored for the duration of the construction phase and repaired immediately when damaged. All temporary erosion and sediment control structures must only be removed once vegetation cover has successfully recolonised and covered the affected areas.
- After heavy rainfall events, site checks must be conducted for erosion damage and rehabilitate this damage immediately. Erosion rills and gullies must be filled-in with appropriate material and / or silt fences until vegetation has re-colonised the rehabilitated area.

7.7.3 Hazardous Substances / Materials Management

- The proper storage and handling of hazardous substances (e.g., fuel, oil, cement, etc.) needs to be administered.
- Mixing and / or decanting of all chemicals and hazardous substances must take place on an impermeable surface and must be protected from the ingress and egress of stormwater.
- Drip trays should be utilised at all fuel dispensing areas and whenever refuelling is carried out, including when portable re-fuelling systems are used.
- No refuelling, servicing or chemical storage should occur near any watercourse. In this regard watercourse buffer zones should be adhered to.
- Hazardous substance storage and refuelling areas must be bunded prior to their use on site during the construction period. Bund walls should be high enough to contain at least 110% of any stored volume. The surface of the bunded area should be graded downwards to the centre so that spillage may be collected and satisfactorily disposed of.
- An emergency spill response procedure must be formulated for the site, and staff are to be trained in spill response.
- All necessary equipment for dealing with spills of fuels / chemicals must be available at the site.
- Spills must be cleaned up immediately and contaminated soil / material disposed of appropriately at a registered site.
- Drums must be kept on site to collect contaminated soil. These should be disposed of at a registered waste site.

- Contaminated water containing fuel, oil or other hazardous substances must never be released into the environment. It must be disposed of at an appropriately registered site.
- Vehicle maintenance should not take place on site unless a specific bunded area with a roof covering is constructed for such a purpose.

7.7.4 Noise & Dust Pollution Minimisation

- Temporary noise pollution due to construction works should be minimized where possible.
- Water trucks will be required to suppress dust.

7.8 Operational Phase Mitigation and Management Measures

7.8.1 Storm Water Management

Storm water infrastructure will require regular on-going maintenance to ensure optimal functioning. At a minimum this should include silt and debris/litter removal from catch pits, filtration devices and attenuation ponds, and maintenance and repair of stormwater outlets to ensure the optimal functioning of such systems.

7.8.2 Contingency Plan for Freshwater Ecosystems

An environmental contingency plan for freshwater ecosystems should be included in the Operational EMPr for the development. This plan should assist in the identification of abnormal/unforeseen environmental incidents and provide guidance for action in the event of an environmental emergency. The contingency plan should provide a framework of organisational responsibility and actions to be taken in the event of an incident. The plan should identify key personnel and their responsibilities in terms of preparing for abnormal incidents/events and identifying and responding to incidents including reporting on emergencies, and implementing measures to contain and mitigate impacts to aquatic ecosystems.

7.8.3 Freshwater Ecosystem Monitoring Programme

Given the threat of a decline in water quality of onsite and downstream watercourses associated with the development, it is important that a detailed freshwater ecosystem monitoring plan be developed for the site. This should involve at least monthly water quality monitoring and bi-annual aquatic biomonitoring of water resource units (rivers/streams) in the vicinity of the development. This should also include regular (daily or weekly) basic visual inspections by the ECO and support staff, documenting issues such as:

- Invasive Alien Plant infestation.
- Scouring and deposition associated with storm water runoff.
- Development of erosion head cuts.
- Channel incision downstream of development.

- Blockage/siltation of culverts/pipes/side drains.
- Scouring at the location of stormwater outlets.
- Erosion or instability of road embankments.

The results of the surface water quality and aquatic biomonitoring assessments must be used to inform further management actions, remedial measures and/or the revision of mitigation strategies aimed at protecting watercourses in the study area and downstream from water quality impacts associated with the development.

The set of guidelines provided in **Annexure D** should be used to inform the development and implementation of an appropriate water quality and aquatic bio-monitoring programme for the mining project.

7.8.4 Landscaping Recommendations

It is recommended that landscaping promote the use of indigenous species common to the region and that as much natural ground cover as possible is established on the site to help with binding soils and encouraging rainfall and stormwater runoff infiltration.

7.8.5 Alien Plant Monitoring and Control

In line with the requirements of Section 2(2) and Section 3 (2) the National Environmental Management: Biodiversity Act (NEM:BA), which obligates the landowner/developer to control IAPs on his property, all IAPs within the development property must be controlled on an on-going basis. In terms of section 75 of NEMBA, the following applies to the control & eradication of invasive species:

- The control and eradication of a listed invasive species must be carried out by means of methods that are appropriate for the species concerned and the environment in which it occurs.
- Any action taken to control a listed invasive species must be executed with caution and in a manner that may cause the least possible harm to biodiversity and damage to the environment.
- The methods employed to control and eradicate a listed invasive species must also be directed at the offspring, propagating material, and re-growth of such invasive species in order to prevent such species from producing offspring, forming seed, regenerating or re-establishing itself in any manner.
- It is recommended that bi-annual alien plant clearing be undertaken by the mine operator throughout construction. Thereafter, alien plant clearing should be undertaken annually.

7.9 Biodiversity Offsets

Offsets are a means of compensating for significant and residual (permanent) impacts to natural habitat and would only be advocated once all other possible means of mitigation have been considered and exhausted, including avoidance and mitigation of impact significance, or where onsite rehabilitation cannot remediate impacts substantially. Based on the mine layout included in this application a total of 28.5 ha of freshwater habitat stands to be permanently altered (infilled or mined out) during the construction and operation of the mine (**Table 69** and **Table 71**). This includes 1.39 ha of critically endangered wetland habitat. Given that the conservation / threat status of all wetlands in the study area is considered critically endangered with little to no protection of this wetland vegetation group, any destruction of wetland habitat, no matter how large or small, is likely to require some form of an offset as compensation for the loss. The proposed loss of freshwater habitat across the mine site is considered a significant residual adverse impact on biodiversity which should be compensated for using offsets ('high' significance rating for operation phase direct habitat loss under the current layout scenario [**Table 72**]). With the majority of residual freshwater habitat loss at this stage of planning being river and streams features rather than wetland units, it is recommended that the residual impacts to freshwater habitat be investigated and addressed as part of an overall biodiversity offset investigation (terrestrial and freshwater, combined), rather than through a specific wetland offset investigation. This would, however, need to be confirmed through consultation with the relevant environmental authorities.

As stipulated in the KZN biodiversity offset guidelines published by Ezemvelo Kwa-Zulu Natal Wildlife in 2013, potential offsets should be investigated during the project EIA phase. This would involve more detailed investigation into offset requirements, informed by detailed layout and mining plans for the project. Ultimately, prior to initiation of the project an Offset Report would need to be produced and approved followed by an Offset Management Plan, as per the Ezemvelo Kwa-Zulu Natal Wildlife minimum requirements for biodiversity offsets. Sufficient motivation will also need to be provided by the mining applicant as to why avoidance of freshwater habitat cannot be achieved and therefore why an offset is required.

8. CONCLUSION

The baseline assessment for the South Block (PR 10652) revealed that most watercourses in this area are rivers and streams. The rivers and streams ranged from a D (Poor Condition) to A (Natural Condition) ecological category. Most were Low to Moderate EIS, with the exception being the assessed reach of the Mhlatuze River, which was assessed as being of High EIS. A total of twenty-three (23) wetland units were mapped within the South Block. This consisted of eleven (11) unchanneled valley bottom wetlands and twelve (12) seeps. These ranged from a D (Poor Condition) to C (Fair Condition) ecological category and from Low to Moderate EIS. A desktop delineation and baseline assessment were completed for the North Block (PR 10644). This assessment revealed that most watercourses in this area were also rivers and streams, with some unchanneled valley bottom wetlands and seeps also being identified. The baseline assessment for the North Block could be used to guide mine layout planning. It would, however, be necessary to update the desktop baseline assessment information with field verified delineation and baseline data as part of any future EIA or WUL applications.

Given the early planning stage of this project key information required to accurately assess potential impacts and risks to freshwater ecosystems is not available. It should therefore be noted that this impact assessment has been completed at a broad project level and only considers the plan outlined in Section 1.2, which has been derived from the AMEC Prefeasibility Engineering Study (2015). As such, this impact assessment should be regarded as preliminary and indicative, and subject to more detailed impact evaluations once appropriately detailed information becomes available.

The impact significance assessment revealed that the most significant construction (mine development) phase impacts are likely to be the direct physical loss or modification of freshwater habitat at road crossing locations and in instances were infrastructure advances into delineated watercourses. Construction phase impacts hydrological and geomorphological process impacts could be of 'Medium' significance where additional flows along wetland and rivers trigger erosional processes, and bulk earthworks will result in large volumes sediment frequently being delivered to watercourses The most significant operation phase impacts are likely to be associated with, notable direct physical destruction of freshwater habitat area at the location of the mine pit and waste rock dump, the potential for appreciable hydrological and geomorphological modifications to watercourses during the mining operational phase, and the inherent risks of AMD and other water pollution streams emanating from the mining operation.

Based on the mine layout included in this application a total of 10.43 ha of freshwater habitat stands to be permanently altered (infilled or mined out) during the construction and operation of the mine (**Table 69** and **Table 71**). This includes 0.3 ha of critically endangered wetland habitat. Given that the conservation / threat status of all wetlands in the study area is considered critically endangered with little to no protection of this wetland vegetation group, any destruction of wetland habitat, no matter how large or small, is likely to require some form of an offset as compensation for the loss. The proposed loss of freshwater habitat across the mine site is considered a significant residual adverse impact on biodiversity which should be compensated for using offsets 'high' significance rating for operation phase direct habitat loss under the current layout scenario [**Table 72**]. An offset is therefore likely to be required to mitigate the residual biodiversity losses associated with this proposed project. As stipulated in the KZN biodiversity offset guidelines published by Ezemvelo Kwa-Zulu Natal Wildlife in 2013, potential offsets should be investigated during the project EIA phase. This would involve more detailed investigation into offset requirements, informed by detailed layout and mining plans for the project. Ultimately, prior to initiation of the project an Offset Report would need to be produced and approved followed by an Offset Management Plan, as per the Ezemvelo Kwa-Zulu Natal Wildlife minimum requirements for biodiversity offsets. Sufficient motivation will also need to be provided by the mining applicant as to why avoidance of freshwater habitat cannot be achieved and therefore why an offset is required.

The DWS Risk Assessment Matrix for Section 21 (c) and (i) water use licencing revealed that risks associated with the construction phase of the mining project can be managed to 'low' overall levels, most of the operational mining risks to watercourses are considered moderate to high and will be difficult to mitigate. Whilst there are potential mitigation options to assist with mitigating these moderate to high rated risks, the overall project risk is still likely to remain at least a 'moderate' level. The mining project therefore cannot be generally authorised under the GA for Section 21 c and i water uses. Therefore, a full WULA is required for the project. Additionally, General Notice (GN) 509. GN 509, published in Government Gazette (GG) no. 40229 under Section 39 of the National Water Act (Act no. 36 of 1998) in August 2016, allows for Section 21 (c) and (i) water uses to be generally authorised if risks and be reduced to acceptable level, there is however no GA notice for the remaining Section 21 water uses. This project will trigger several water uses beyond (c) and (i), and will require a full WULA on that basis, also.

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10. ANNEXURES

Annexure A – Field GPS Tracks & Waypoint Markers

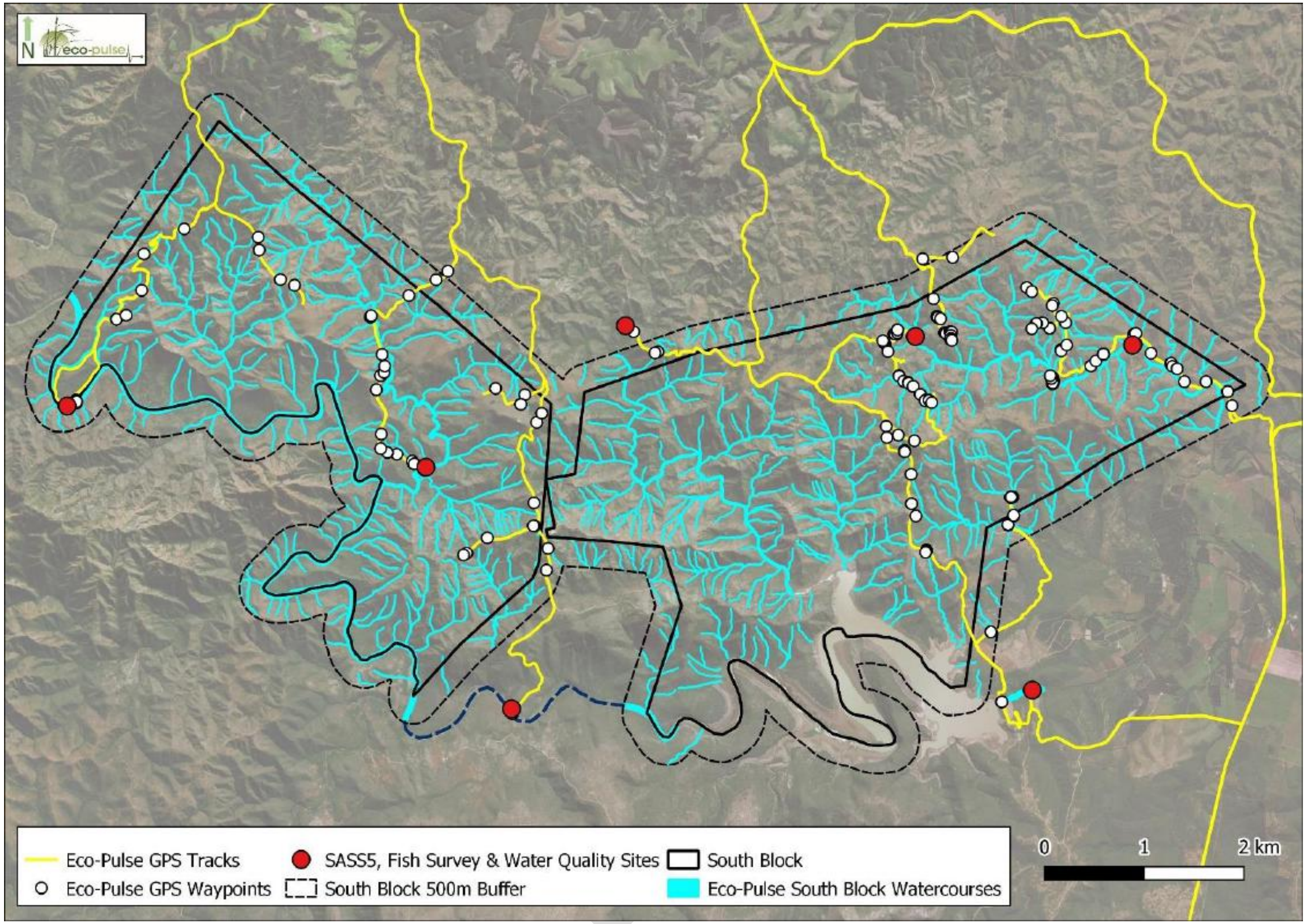

Figure 38. Field GPS tracks and waypoint markers for the South Block

Annexure B: List of Macro-Invertebrate Taxa Recorded at Each Sample Site

Table 86. List of macro-invertebrate taxa recorded at site SW-Lowland River-461-01.

Taxon	Quality Value (out of 15) 1 = low 15 = high
Oligochaeta (Earthworms)	1
Perlidae	12
Baetidae > 2 sp	12
Heptageniidae (Flatheaded mayflies)	13
Leptophlebiidae (Prongills)	9
Coenagrionidae (Sprites and blues)	4
Aeshnidae (Hawkers & Emperors)	8
Gomphidae (Clubtails)	6
Libellulidae (Darters/Skimmers)	4
Naucoridae* (Creeping water bugs)	7
Pleidae* (Pygmy backswimmers)	4
Veliidae/M...veliidae* (Ripple bugs)	5
Leptoceridae	6
Gyrinidae* (Whirligig beetles)	5
Ceratopogonidae (Biting midges)	5
Chironomidae (Midges)	2
Tabanidae (Horse flies)	5

Table 87. List of macro-invertebrate taxa recorded at site SW-Lowland River-461-02.

Taxon	Quality Value (out of 15) 1 = low 15 = high
Oligochaeta (Earthworms)	1
Potamonautidae* (Crabs)	3
Atyidae (Freshwater Shrimps)	8
Perlidae	12
Baetidae > 2 sp	12
Heptageniidae (Flatheaded mayflies)	13
Leptophlebiidae (Prongills)	9
Tricorythidae (Stout Crawlers)	9
Coenagrionidae (Sprites and blues)	4
Corduliidae (Cruisers)	8
Gomphidae (Clubtails)	6
Libellulidae (Darters/Skimmers)	4
Belostomatidae* (Giant water bugs)	3
Leptoceridae	6
Elmidae/Dryopidae* (Riffle beetles)	8
Gyrinidae* (Whirligig beetles)	5
Chironomidae (Midges)	2
Simuliidae (Blackflies)	5
Tipulidae (Crane flies)	5

Table 88. List of macro-invertebrate taxa recorded at site SW-Lowland River-461-03.

Taxon	Quality Value (out of 15) 1 = low 15 = high
Atyidae (Freshwater Shrimps)	8
Potamonautidae* (Crabs)	3
Baetidae > 2 sp	12
Heptageniidae (Flatheaded mayflies)	13
Leptophlebiidae (Prongills)	9
Tricorythidae (Stout Crawlers)	9
Chlorocyphidae (Jewels)	10
Coenagrionidae (Sprites and blues)	4
Gomphidae (Clubtails)	6
Hydropsychidae 2 sp	6
Leptoceridae	6
Gyrinidae* (Whirligig beetles)	5
Thiaridae* (=Melanidae)	3
Corbiculidae (Clams)	5

Table 89. List of macro-invertebrate taxa recorded at site SW-Transitional River-471.

Taxon	Quality Value (out of 15) 1 = low 15 = high
Oligochaeta (Earthworms)	1
Potamonautidae* (Crabs)	3
Perlidae	12
Baetidae 2 sp	6
Baetidae > 2 sp	12
Heptageniidae (Flatheaded mayflies)	13
Leptophlebiidae (Prongills)	9
Tricorythidae (Stout Crawlers)	9
Chlorocyphidae (Jewels)	10
Coenagrionidae (Sprites and blues)	4
Aeshnidae (Hawkers & Emperors)	8
Corduliidae (Cruisers)	8
Gomphidae (Clubtails)	6
Libellulidae (Darters/Skimmers)	4
Naucoridae* (Creeping water bugs)	7
Pleidae* (Pygmy backswimmers)	4
Veliidae/M...veliidae* (Ripple bugs)	5
Hydropsychidae 2 sp	6
Philopotamidae	10
Gyrinidae* (Whirligig beetles)	5
Hydrophilidae* (Water scavenger beetles)	5
Ceratopogonidae (Biting midges)	5
Chironomidae (Midges)	2
Simuliidae (Blackflies)	5

Table 90. List of macro-invertebrate taxa recorded at site SE-Transitional River-470.

Taxon	Quality Value (out of 15) 1 = low 15 = high
Potamonautidae* (Crabs)	3
Atyidae (Freshwater Shrimps)	8
Perlidae	12
Baetidae 2 sp	6
Heptageniidae (Flatheaded mayflies)	13
Leptophlebiidae (Prongills)	9
Tricorythidae (Stout Crawlers)	9
Chlorocyphidae (Jewels)	10
Coenagrionidae (Sprites and blues)	4
Aeshnidae (Hawkers & Emperors)	8
Corduliidae (Cruisers)	8
Gomphidae (Clubtails)	6
Libellulidae (Darters/Skimmers)	4
Gerridae* (Pond skaters/Water striders)	5
Naucoridae* (Creeping water bugs)	7
Pleidae* (Pygmy backswimmers)	4
Veliidae/M...veliidae* (Ripple bugs)	5
Hydropsychidae 2 sp	6
Philopotamidae	10
Leptoceridae	6
Gyrinidae* (Whirligig beetles)	5
Chironomidae (Midges)	2
Simuliidae (Blackflies)	5
Tabanidae (Horse flies)	5

Table 91. List of macro-invertebrate taxa recorded at site SE-Upper Foothill River-466.

Taxon	Quality Value (out of 15) 1 = low 15 = high
Potamonautidae* (Crabs)	3
Atyidae (Freshwater Shrimps)	8
Perlidae	12
Baetidae > 2 sp	12
Caenidae (Squaregills/Cainfles)	6
Heptageniidae (Flatheaded mayflies)	13
Leptophlebiidae (Prongills)	9
Tricorythidae (Stout Crawlers)	9
Chlorocyphidae (Jewels)	10
Aeshnidae (Hawkers & Emperors)	8
Corduliidae (Cruisers)	8
Gomphidae (Clubtails)	6
Libellulidae (Darters/Skimmers)	4
Belostomatidae* (Giant water bugs)	3
Pleidae* (Pygmy backswimmers)	4
Veliidae/M...veliidae* (Ripple bugs)	5
Hydropsychidae 2 sp	6

Philopotamidae	10
Leptoceridae	6
Dytiscidae/Noteridae* (Diving beetles)	5
Gyrinidae* (Whirligig beetles)	5
Chironomidae (Midges)	2
Dixidae* (Dixid midge)	10
Simuliidae (Blackflies)	5
Tabanidae (Horse flies)	5
Tipulidae (Crane flies)	5

Table 92. List of macro-invertebrate taxa recorded at site SW-Upper Foothill River-456.

Taxon	Quality Value (out of 15) 1 = low 15 = high
Oligochaeta (Earthworms)	1
Potamonautidae* (Crabs)	3
Perlidae	12
Baetidae > 2 sp	12
Heptageniidae (Flatheaded mayflies)	13
Leptophlebiidae (Prongills)	9
Tricorythidae (Stout Crawlers)	9
Calopterygidae ST,T (Demoiselles)	10
Chlorocyphidae (Jewels)	10
Coenagrionidae (Sprites and blues)	4
Aeshnidae (Hawkers & Emperors)	8
Gomphidae (Clubtails)	6
Libellulidae (Darters/Skimmers)	4
Corixidae* (Water boatmen)	3
Gerridae* (Pond skaters/Water striders)	5
Naucoridae* (Creeping water bugs)	7
Hydropsychidae 2 sp	6
Philopotamidae	10
Dytiscidae/Noteridae* (Diving beetles)	5
Gyrinidae* (Whirligig beetles)	5
Ceratopogonidae (Biting midges)	5
Chironomidae (Midges)	2
Simuliidae (Blackflies)	5
Tabanidae (Horse flies)	5

Annexure C: DWS Risk Matrix Assessment Table.

Activity	Aspect	Flow Regime	Physico & chemical (water Quality)	Habitat (Geomogh & Vegetation)	Biota	Severity	Spatial Scale	Duration	Consequence	Frequency of Activity	Frequency of Impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence Level	Revised Risk Rating	Borderline LOW / MODERATE Rating Classes
Contruction Phase	Direct physical loss or modification of freshwater habitat	1	1	5	2	**2.25**	1	2	**5.25**	1	5	5	1	**12**	**63**	**Moderate**		38	**Low**
	Alteration of hydrological and geomorphological processes	3	2	2	1	**2**	2	2	**6**	1	4	5	1	**11**	**66**	**Moderate**		41	**Low**
	Impacts to water quality	1	3	2	2	**2**	2	2	**6**	1	4	5	1	**11**	**66**	**Moderate**		41	**Low**
	Impacts to ecological connectiv ity and/or ecological disturbance impacts	1	1	2	2	**1.5**	2	2	**5.5**	1	4	5	1	**11**	**60.5**	**Moderate**		35.5	**Low**
Operation Phase	Direct physical loss or modification of freshwater habitat	3	2	5	3	**3.25**	2	5	**10.25**	5	5	5	2	**17**	**174.25**	**High**		149.25	**Moderate**
	Alteration of hydrological and geomorphological processes	4	2	4	2	**3**	3	4	**10**	5	5	5	2	**17**	**170**	**High**		145	**Moderate**
	Impacts to water quality	1	4	4	4	**3.25**	3	4	**10.25**	5	5	5	2	**17**	**174.25**	**High**		149.25	**Moderate**
	Impacts to ecological connectiv ity and/or ecological disturbance impacts	1	1	2	2	**1.5**	2	4	**7.5**	5	1	5	1	**12**	**90**	**Moderate**		65	**Moderate**

Annexure D: Guidelines for Developing and Implementing an Aquatic Monitoring Programme

Monitoring Objectives

The monitoring programme should be informed by the following broad objectives:

- To identify several monitoring sites which will be located to give a clear understanding of the quality of the water and river health both upstream and downstream of proposed mining activities.
- To develop baseline data against which to assess future readings.
- To define a programme which gives optimal results without being unduly costly or difficult to implement; and
- To provide a framework for future management of river water quality and river/wetland health.

Monitoring Sites

The location of monitoring sites for surface water, ground water and aquatic biomonitoring, will need to be identified prior to mining operations occurring. These sites will need to be identified with the assistance of an aquatic ecologist once mining sites/pits and associated ancillary infrastructure have been finalized. Monitoring points on watercourses downstream of any proposed mining operation/activities will need to be selected. An upstream (control/reference) site will also need to be included in the aquatic monitoring programme.

Baseline Monitoring

Prior to any mining/construction activities taking place, a set of wet and dry season baseline monitoring results will need to be obtained to gauge the reference levels of the receiving aquatic environment prior to activities taking place. This will provide an important set of baseline data which can be used to compares future results.

Water Quality Monitoring Requirements

Water quality/chemistry determinands that should ideally be included in the water sampling and analysis are specified in the table below.

Table 93. Potential water quality determinands for monitoring.

Determinands	Unit of measure
Temperature	^0C
pH	pH units
Conductivity mS/m	mS/m
Total suspended solids (TSS)	mg/l
Total dissolved solids (TDS)	mg/l
Turbidity	NTU
Nitrate	mg N/l
Ammonia	mg N/l
Iron	mg Fe/l
Manganese	mg Mn /l
Phosphorus	SRP µg P/l, TP µg P/l)
Coliforms, *E. coli*	Count/100ml

TPH (Total Petroleum Hydrocarbon) concentration	Gasoline Range Organics Diesel Range Organics phases. BTEX (benzene, toluene, ethylbenzene, and xylene)
Sulphates	mg/l
Full metal screening	mg/l

Surface and ground water quality monitoring should initially be undertaken on a monthly basis through the pre-construction and construction periods and into mining operation. The frequency of monitoring may be reduced to a bi-monthly or even quarterly programme upon review of the monitoring results by an aquatic ecologist.

Water samples are to be collected at a site where there is running water. If depth allows for sampling options, the water must come from the middle of the water column. All analyses must be done by an accredited (SANAS) laboratory. Sampling procedure, storage and delivery times should be according to the relevant laboratory requirements for water samples which will be dictated by the particular water parameters requiring analysis (the specific laboratory responsible for sample analysis should be approached for these details prior to water sampling).

Aquatic Biomonitoring Requirements

Suitably qualified aquatic ecologists will need to be approached to undertake the relevant aquatic biomonitoring for selected sites. **Table 94,** below, provides a summary of some of the common river biomonitoring methods/tools typically used in river biomonitoring programmes in South Africa.

Table 94. Common assessment methods used by the National River Health Programme and similar river biomonitoring projects in KZN.

Component	Tool/Method
In-stream biota and water quality	Macroinvertebrate Surveys SASS (South African Scoring System)
	Diatoms
	Fish Surveys
In-stream habitat	Index of Habitat Integrity (IHI)
Riparian vegetation	Riparian Vegetation Response Assessment Index (VEGRAI)
	Sampling spatial extent, age, and structure of invasive plant species
	Fixed point photos
Geomorphology	Geomorphic Assessment Index (GAI)
	In-stream sediment sampling to monitor riverbed composition and distribution
	Monitoring to assess changes in the distribution and abundance of in-stream habitats such as pools and riffles and off-channel habitats such as oxbows, distributaries, etc
	Use of sediment pins/chains
	River channel cross-sections using topographical surveys
	Visual assessment and rating of bank erosion and channel scouring
	Fixed point photos

Aquatic biomonitoring should be done on a quarterly basis throughout the mining operational phase.

Analysis and Comparison of Results

Water chemistry results will need to be compared against the Target Water Quality Range (TWQR) for Aquatic Ecosystems such that results can be easily classified as compliant or non-compliant. These are set out in the South African Water Quality Guidelines for Aquatic Ecosystems (DWAF, 1996). Where no standards exist, results should be compared against the baseline water chemistry data and a threshold of potential concern should be developed developed (10-15% difference to baseline for example) to estimate compliance. For biomonitoring data (fish, SASS, etc.) this will need to be compared against available data for the area and the baseline dataset to document changes in ecological condition. Ultimately, this data should be used to inform any deviation from the baseline river condition established during baseline monitoring.

Reporting of Monitoring Results

Results and outputs of the monitoring programme (including water quality and river biomonitoring) will need to be reported in the form of a single aquatic monitoring report. This report should be compiled on an annual basis and will need to document the sampling/analysis methods used, and the main findings of the monitoring programme (including trends with respect to data analysis). Recommendations in terms of non-compliance of results should also be documented in the report. Reports will need to be submitted to the relevant Environmental Authorities.