SCIENTIFIC AQUATIC SERVICES

FRESHWATER ECOSYSTEM ASSESSMENT

AS PART OF THE ENVIRONMENTAL AND WATER USE AUTHORISATION PROCESSES FOR THE PROPOSED MAKGANYANE IRON ORE MINE, NEAR BEESHOEK, NORTHERN CAPE PROVINCE.

Prepared for:	Greenmined Environmental (Pty) Ltd
Report author:	K. Coertze (Pri. Sci. Nat)
Report reviewer:	Stephen van Staden (Pr.Sci.Nat)
Report Reference:	SAS 25-0028
Report Date:	May 2025 (Amended July 2025)

Part of the SAS Environmental Group of Companies

Website: http://www.sasenvironmental.co.za

EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) (Pty) Ltd was appointed by Greenmined Environmental (Pty) Ltd to conduct a freshwater ecological assessment in support of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed Makganyane Iron Ore Mine, located near Beeshoek, Northern Cape Province. The proposed Mining Right Area (MRA) will include the following farm portions: Portion 2 (A Portion of Portion 1), Remainder Portion, Remainder Portion of Portion 1 and Portion 3 of the Farm Makganyane No. 667. However, this assessment was only undertaken for certain pre-selected areas, within the above-mentioned farm boundaries, associated with (i) an historical mining operational area, (ii) the proposed mining operation and (iii) a freshwater feature identified by the background databases. These areas along with a 200 m buffer assessment area is hereafter collectively referred to as the 'focus area' The proposed mining operation will include two open cast (OC) pits, a stockpile area and a waste dump area.

The site assessment undertaken in April 2025 confirmed the presence of two Episodic Drainage Lines (EDLs) without riparian vegetation located within the western portions of the focus and investigation areas (defined as a 500m radius around the focus area). The EDLs were assessed in a combined manner, due to their similar characteristics and was determined to be in a largely natural Present Ecological State (PES), of moderate Ecological Importance and Sensitivity (EIS) with a moderate to very low eco service provisioning potential (indicator specific).

Numerous artificial features were also identified during the site assessment which included Preferential Flow Paths (PFPs), and a recharge zone associated with the "desktop database defined freshwater feature" focus area. Neither the PFPs nor the recharge zone met the definition of a watercourse from an ecological perspective (as defined by the National Water Act [NWA]) and were therefore excluded from further assessment. Form a legal perspective, however, a 1 in 100 year floodline has been modelled for the recharge zone (The Biodiversity Company [TBC], 2025[2]) and as such does enjoy protection under the NWA. The hydrological assessment (TBC, 2025[2]) does not indicate any floodlines for the PFP's and therefore does not enjoy protection from a legal perspective.

The nature of potential impacts associated with the aspects and activities of the proposed development have been identified and assessed in the context of the application of the Department of Water and Sanitation (DWS) Risk Assessment Matrix (RAM) as included in Government Notice (GN) 4167 of 2023 as well as the provided Impact Assessment methodology. Most of the activities associated with the proposed mining development have been assessed to be associated with a "low" degree of risk to the freshwater environment, due to the suitably placement of infrastructure and the reshaping and redesigning of disturbance areas in consultation with the freshwater specialist and in line with the in line with the mitigation hierarchy (Department of Environmental Affair [DEA], 2011). The only exception is the construction and operation of the proposed Phase 2 OC pit which was assessed to have a moderate risk significance on the southern EDL. The moderate risk is ascribed to the fact that the Phase 2 OC pit area is located adjacent to and within in the 48 m ecological buffer of the southern EDL and would result in numerous indirect impacts which will need to be appropriately managed as per the recommendations set out in this report.

Provided that the mitigation measures, as stipulated in this report and the mitigation measures contained within the Stormwater Management Plan (SWMP) are strictly adhered to, the proposed Makganyane mining operation, from a water resource management point of view, can be considered acceptable for authorisation in terms of the EA and WUA processes.

MANAGEMENT SUMMARY

Scientific Aquatic Services (SAS) (Pty) Ltd was appointed by Greenmined Environmental (Pty) Ltd to conduct a freshwater ecological assessment in support of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed Makganyane Iron Ore Mine, located near Beeshoek, Northern Cape Province. The proposed Mining Right Area (MRA) will include the following farm portions: Portion 2 (A Portion of Portion 1), Remainder Portion, Remainder Portion of Portion 1 and Portion 3 of the Farm Makganyane No. 667. However, this assessment was only undertaken for certain pre-selected areas, within the above-mentioned farm boundaries, associated with (i) an historical mining operational area, (ii) the proposed mining operation and (iii) a freshwater feature identified by the background databases. These areas along with a 200 m buffer assessment area is hereafter collectively referred to as the 'focus area' The proposed mining operation will include two open cast (OC) pits, a stockpile area and a waste dump area.

The purpose of this report is to define the ecology of the freshwater ecosystems associated with the focus area and associated investigation area (defined as a 500 m radius around the focus area), in line with Government Notice (GN) 4167 as it relates to the National Water Act, Act no. 36 of 1998, as amended (NWA) in terms of freshwater characteristics, including mapping of the freshwater ecosystems, defining areas of increased Ecological Importance and Sensitivity (EIS) and defining the Present Ecological State (PES) of the freshwater ecosystems associated with the study and investigation areas. The report also aims to define the socio-cultural and ecological service provision of the freshwater ecosystems and additionally outlines the Recommended Ecological Category (REC), Recommended Management Objective (RMO) and Best Attainable State (BAS) for the freshwater ecosystems. The assessment took the following approach:

- A desktop study was conducted, in which possible freshwater ecosystems were identified for on-site investigation, and relevant national and provincial databases were consulted;
- The field assessment took place in April 2025 during which two Episodic Drainage Lines (EDLs) without riparian vegetation were identified in the western portions of the focus and investigation areas; and
- Numerous artificial features were also identified during the site assessment which included Preferential Flow Paths (PFPs), and a recharge zone associated with the "desktop database defined freshwater feature" focus area. Neither the PFPs nor the recharge zone met the definition of a watercourse from an ecological perspective (as defined by the National Water Act [NWA]) and were therefore excluded from further assessment. Form a legal perspective, however, a 1 in 100 year floodline has been modelled for the recharge zone (The Biodiversity Company [TBC], 2025[2]) and as such does enjoy protection under the NWA. The hydrological assessment (TBC, 2025[2]) does not indicate any floodlines for the PFP's and therefore does not enjoy protection from a legal perspective.

The results of the detailed assessment of EDLs are presented in Section 4 of this report, and are summarised in the table below:

Table A: Summary of the assessment results.

Freshwater Ecosystem	Present Ecological State (PES) / Ecostatus	Ecoservices	Ecological Importance and Sensitivity (EIS)	Recommended Ecological Category / Recommended Management Objective / Best Attainable State
EDLs	Largely Natural	Moderate to Very Low	Moderate	REC Category: B BAS Category: B RMO: Maintain

Following the freshwater ecosystem assessment, the DWS Risk Assessment Matrix (2023) and the EAP provided Impact Assessment was applied to determine the significance of impacts of the proposed mining and associated activities on the receiving freshwater environment. Most of the activities associated with the proposed mining development have been assessed to be associated with a "low" degree of risk to the freshwater environment, due to the suitably placement of infrastructure and the reshaping and redesigning of disturbance areas in consultation with the freshwater specialist and in line with the in line with the mitigation hierarchy (Department of Environmental Affair [DEA], 2011). The only

exception is the construction and operation of the proposed Phase 2 OC pit which was assessed to have a moderate risk significance on the southern EDL. The moderate risk is ascribed to the fact that the Phase 2 OC pit area is located adjacent to and within in the 48 m ecological buffer of the southern EDL and would result in numerous indirect impacts which will need to be appropriately managed as per the recommendations set out in this report.

Provided that the mitigation measures, as stipulated in this report and the mitigation measures contained within the Stormwater Management Plan (SWMP) are strictly adhered to, the proposed Makganyane mining operation, from a water resource management point of view, can be considered acceptable for authorisation in terms of the EA and WUA processes.

DOCUMENT GUIDE

The table below provides the specialist report requirements for the assessment and reporting of impacts on aquatic biodiversity in terms of Government Notice 320 as promulgated in Government Gazette 43110 of 20 March 2020 in line with the Department of Environmental Affairs screening tool requirements, as it relates to the National Environmental Management Act, 1998 (Act No. 107 of 1998).

No.	Requirements	Section in report
2.1	Assessment must be undertaken by a suitably qualified SACNASP registered specialist	Appendix H
2.2	Description of the preferred development site, including the following aspects-	
2.2.1	a. Aquatic ecosystem type b. Presence of aquatic species and composition of aquatic species communities, their habitat, distribution and movement patterns	Section 3.1, 4.2
2.2.2	Threat status, according to the national web based environmental screening tool of the species and ecosystems, including listed ecosystems as well as locally important habitat types identified	Section 3.1
2.2.3	National and Provincial priority status of the aquatic ecosystem (i.e. is this a wetland or river Freshwater Ecosystem Priority Area (FEPA), a FEPA sub- catchment, a Strategic Water Source Area (SWSA), a priority estuary, whether or not they are free-flowing rivers, wetland clusters, etc., a CBA or an ESA; including for all a description of the criteria for their given status	Section 3.1
2.2.4	A description of the Ecological Importance and Sensitivity of the aquatic ecosystem including: a. The description (spatially, if possible) of the ecosystem processes that operate in relation to the aquatic ecosystems on and immediately adjacent to the site (e.g. movement of surface and subsurface water, recharge, discharge, sediment transport, etc.); b. The historic ecological condition (reference) as well as Present Ecological State (PES) of rivers (in-stream, riparian and floodplain habitat), wetlands and/or estuaries in terms of possible changes to the channel, flow regime (surface and groundwater)	Section 4.3
2.3	Identify any alternative development footprints within the preferred development site which would be of a “low” sensitivity as identified by the national web based environmental screening tool and verified through the Initial Site Sensitivity Verification	Section 7
2.4	Assessment of impacts - a detailed assessment of the potential impact(s) of the proposed development on the following very high sensitivity areas/ features:	Section 8
2.4.1	Is the development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?	Section 4, 7 and 8
2.4.2	Is the development consistent with maintaining the Resource Quality Objectives for the aquatic ecosystems present?	Section 4
2.4.3	How will the development impact on fixed and dynamic ecological processes that operate within or across the site, including: a. Impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes (e.g. suppression of floods, loss of flood attenuation capacity, unseasonal flooding or destruction of floodplain processes); b. Change in the sediment regime (e.g. sand movement, meandering river mouth/estuary, changing flooding or sedimentation patterns) of the aquatic ecosystem and its sub-catchment; c. The extent of the modification in relation to the overall aquatic ecosystem (i.e. at the source, upstream or downstream portion, in the temporary / seasonal / permanent zone of a wetland, in the riparian zone or within the channel of a watercourse, etc.). d. Assessment of the risks associated with water use/s and related activities.	Section 4.3 and Section 8
2.4.4	How will the development impact on the functionality of the aquatic feature including: a. Base flows (e.g. too little/too much water in terms of characteristics and requirements of system);	Section 8

	b. Quantity of water including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over-abstraction or instream or off-stream impoundment of a wetland or river); c. Change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an unchannelled valley-bottom wetland to a channelled valley-bottom wetland); d. Quality of water (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication); and e. Fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal).	
2.4.5	How will the development impact on the functionality of the aquatic feature including: a. water including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over-abstraction or instream or off-stream impoundment of a wetland or river) b. Change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an unchannelled valley-bottom wetland to a channelled valley-bottom wetland). c. Quality of water (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication); d. Fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal); e. The loss or degradation of all or part of any unique or important features (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soil, etc.) associated with or within the aquatic ecosystem.	Section 8
2.4.6	How will the development impact on key ecosystem regulating and supporting services especially Flood attenuation; Streamflow regulation; Sediment trapping; Phosphate assimilation; Nitrate assimilation; Toxicant assimilation; Erosion control; and Carbon storage.	Section 8
2.4.7	How will the development impact community composition (numbers and density of species) and integrity (condition, viability, predator-prey ratios, dispersal rates, etc.) of the faunal and vegetation communities inhabiting the site?	Section 8
2.4.9	A motivation must be provided if there were development footprints identified as per paragraph 2.3 above that were identified as having a “low” biodiversity sensitivity and were not considered appropriate.	Section 7
3.	The report must contain as a minimum the following information:	
3.1	Contact details and curriculum vitae of the specialist including SACNASP registration number and field of expertise and their curriculum vitae;	Appendix H
3.2	A signed statement of independence by the specialist;	Appendix H
3.3	The duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	Section 1
3.4	The methodology used to undertake the impact assessment and site inspection, including equipment and modelling used, where relevant;	Appendix C & D
3.5	A description of the assumptions made and any uncertainties or gaps in knowledge or data as well as a statement of the timing and intensity of site inspection observations;	Section 1.4
3.6	Areas not suitable for development, to be avoided during construction and operation (where relevant);	Section 7
3.7	Additional environmental impacts expected from the proposed development based on those already evident on the site and a discussion on the cumulative impacts;	Section 8 (8.4)
3.8	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted protocol;	Section 5
3.9	Impact management actions and impact management outcomes proposed by the specialist for inclusion in the EMPr;	Section 8 (8.3)
3.10	A motivation where the development footprint identified as per 2.3 were not considered stating reasons why these were not being considered; and	Section 7
3.11	A reasoned opinion, based on the finding of the specialist assessment, regarding the acceptability or not, of the development and if the development should receive approval, and any conditions to which the statement is subjected.	Summaries and Section 9

TABLE OF CONTENTS

EXECUTIVE SUMMARY ..... **ii**
DOCUMENT GUIDE ..... **v**
TABLE OF CONTENTS ..... **vii**
LIST OF FIGURES ..... **viii**
LIST OF TABLES ..... **ix**
ACRONYMS ..... **xi**
1 INTRODUCTION **1**
1.1 Background and Locality 1
1.2 Technical Project Description 2
1.3 Scope of Work 9
1.4 Assumptions and Limitations 10
2 ASSESSMENT APPROACH AND METHODOLOGY **11**
2.1 Freshwater Ecosystem Definition 11
2.2 Desktop Study 11
2.3 Freshwater Ecosystem Site Assessment 11
2.4 Freshwater Ecosystem Detailed Assessment 12
2.5 Sensitivity Mapping 12
2.6 Risk and Impact Assessments and Recommendations 12
3 RESULTS OF THE DESKTOP ANALYSIS **13**
3.1 Analyses of Relevant Databases 13
4 FRESHWATER RESULTS **23**
4.1 Freshwater Ecosystem Delineation 23
4.2 Freshwater Ecosystem Characterisation 23
4.2.1 Preferential Flow Paths 24
4.2.2 Recharge Zone of an Unnamed Tributary 24
4.2.3 Episodic Drainage Lines without riparian vegetation 26
4.3 Freshwater Detailed Assessment Results 28
5 FRESHWATER BUFFERS **31**
6 LEGISLATIVE REQUIREMENTS **33**
6.1 Legislative Zones of Regulation 33
7 FRESHWATER SENSITIVITY VERIFICATION **39**
8 RISK AND IMPACT ASSESSMENTS **43**
8.1 Consideration of impacts and application of mitigation measures 43
8.2 Risk and Impact Assessment discussion of anticipated ecological impacts 45
8.3 Recommended Mitigation Measures 52
8.4 Cumulative and Residual Impacts 54
9 CONCLUSION AND RECOMMENDATIONS **56**
10 REFERENCES **58**
APPENDIX A – Terms of Use and Indemnity **60**
APPENDIX C – Method of Assessment **63**
APPENDIX D –Risk and Impact Assessment Methodologies **70**
APPENDIX E – Results of Field Investigation **77**
APPENDIX F – Risk Assessment Outcome **80**
APPENDIX G – General "Good Housekeeping" Mitigation Measures **88**
APPENDIX H – Specialist information **90**

LIST OF FIGURES

Figure 1: Locality of the focus and investigation areas in relation to the surrounding areas and roads. 4
Figure 2: Topographic locality map of the focus and investigation areas. 5
Figure 3: Affected farm portions associated with the proposed Makganyane mining operation. 6
Figure 4: Proposed layout of the Makganyane mining operation. 7
Figure 5: Conceptual SWMP (TBC, July 2025[1]). 8
Figure 6: Wetland occurrence in the focus and investigation areas according to the NFEPA Database. 16
Figure 7: Wetland vegetation types associated with the focus and investigation areas according to the NFEPA Database. 17
Figure 8: Wetland occurrence in the focus and investigation areas according to the NBA (2018) Wetland Database. 18
Figure 9: Ecologically important areas associated with the focus and investigation areas in terms of the Mining and Biodiversity Guidelines. 19
Figure 10: Areas of Conservation Importance according to the Northern Cape CBA Plan. 20
Figure 11: Land Types associated with the focus and investigation areas. 21
Figure 12: DWS RQOIS PES/EIS assessment point associated with the focus and investigation areas. 22
Figure 13: Representative photographs of the PFPs within the focus area. 24
Figure 14: Representative photographs of the recharge zone and the associated farm dam (top left) and signs of soil hydromorphy found 1 meter below surface (top right). The vegetation community (bottom) is characterised by plant species usually associated with overgrazing. 25
Figure 15: Freshwater ecosystem occurrence in the context of the focus and investigation areas. 27
Figure 16: Aquatic Ecological buffer associated with the EDLs. 32
Figure 17: NEMA EIA Regulation Freshwater -related ZoR associated with the focus and investigation areas. 36
Figure 18: GN 4167 and GN 704 Regulations Freshwater-related ZoRs associated with the focus and investigation areas. 37
Figure 19: NFEPA recommended 1km buffer around the FEPA River (verified as the recharge zone with associated 1:100 year floodline). 38
Figure 20: Aquatic (Freshwater) Biodiversity sensitivity associated with the focus area (blue shaded area) and investigation area (blue dashed outline) (DFFE Screening Tool: Accessed May 2025). 41
Figure 21: Field assessment tracks and points (undertaken between 1st – 3rd of April 2025). 42

LIST OF TABLES

Table 1: Desktop data relating to the characteristics of the freshwater ecosystems associated with the focus area and investigation area. 14
Table 2: Characterisation of the EDLs associated with the focus area according to the Classification System (Ollis et. al., 2013). 26
Table 3: Summary of the assessment of the EDLs associated with the western portions of the focus and investigation areas. 29
Table 4: Buffers as recommended by the buffer tool for the EDLs. 31
Table 5: Articles of Legislation and the relevant zones of regulation applicable to each article. 34
Table 6: Summary of the results of the DWS risk assessment matrix applied to the EDLs associated with the proposed Makganyane mining operation. 46
Table 7: Results of the Impact Assessment applied for the pre-construction phase activities. 50
Table 8: Results of the Impact Assessment applied for the construction phase activities. 50
Table 9: Results of the Impact Assessment applied for the operation phase activities. 50
Table 10: Results of the Impact Assessment applied for the decommissioning phase activities. 50
Table 11: Recommended Mitigation Measures. 52
Table 12: Summary of results of the field assessment. 56

GLOSSARY OF TERMS

Alien vegetation:	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome -usually international in origin.
Biodiversity:	The number and variety of living organisms on earth, the millions of plants, animals and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the ecosystems, ecological processes and landscape of which they are integral parts.
Buffer:	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area.
Catchment:	The area where water is collected by the natural landscape, where all rain and run-off water ultimately flows into a river, wetland, lake, and ocean or contributes to the groundwater system.
Delineation (of a wetland):	To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.
Ecoregion:	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas.
Fluvial:	Resulting from water movement.
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Groundwater:	Subsurface water in the saturated zone below the water table.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Hydrophyte:	Any plant that grows in water or on a substratum that is at least periodically deficient of oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Obligate species:	Species almost always found in wetlands (>99% of occurrences).
Perched water table:	The upper limit of a zone of saturation that is perched on an unsaturated zone by an impermeable layer, hence separating it from the main body of groundwater
Perennial:	Flows all year round.
Watercourse:	In terms of the definition contained within the National Water Act, a watercourse means: • A river or spring; • A natural channel which water flows regularly or intermittently; • A wetland, dam or lake into which, or from which, water flows; and • Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse; • and a reference to a watercourse includes, where relevant, its bed and banks
Wetland Vegetation (WetVeg) type:	Broad groupings of wetland vegetation, reflecting differences in regional context, such as geology, climate, and soils, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

ACRONYMS

AIP	Alien and Invasive Plant
°C	Degrees Celsius
BAS	Best Attainable State
CBA	Critical Biodiversity Area
DFFE	Department of Forestry, Fisheries and the Environment
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
EC	Ecological Class
ECO	Environmental Control Officer
EI	Ecological Importance
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMPr	Environmental Management Programme
ESA	Ecological Support Area
FEPA	Freshwater Ecosystem Priority Areas
GIS	Geographic Information System
GN	Government Notice
GPS	Global Positioning System
ha	Hectare
HGM	Hydrogeomorphic
IHI	Index of Habitat Integrity
km	Kilometres
m.a.m.s.l	Meter Above Mean Sea Level
m	meter
mm	millimetres
MAP	Mean Annual Precipitation
MRA	Mining Right Area
NEMA	National Environmental Management Act (Act 107 of 1998) as amended
NFEPA	National Freshwater Ecosystem Priority Areas
NBA	National Biodiversity Assessment
NWA	National Water Act (Act 36 of 1998) as amended
OC pit	Open Cast pit
ONA	Other Natural Area
PES	Present Ecological State
REC	Recommended Ecological Category
RMO	Resource Management Objective
RoW	Right of Way
RQIS	Research Quality Information Services
SACNASP	South African Council for Natural Scientific Professions
SANBI	South African National Biodiversity Institute
SAIIAE	South African Inventory of Inland Aquatic Ecosystems
SAS	Scientific Aquatic Services (Pty) Ltd
subWMA	Sub-Water Management Area
SWMP	Stormwater Management Plan
SWSA	Strategic Water Source Area
TBC	The Biodiversity Company (Pty) Ltd
WetVeg Groups	Wetland Vegetation Groups
WMA	Water Management Areas
WUA	Water Use Authorisation
ZoR	Zone of Regulation

1 INTRODUCTION

1.1 Background and Locality

Scientific Aquatic Services (SAS) (Pty) Ltd was appointed by Greenmined Environmental (Pty) Ltd to conduct a freshwater ecological assessment in support of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed Makganyane Iron Ore Mine, located near Beeshoek, Northern Cape Province. The proposed Mining Right Area (MRA) will include the following farm portions: Portion 2 (A Portion of Portion 1), Remainder Portion, Remainder Portion of Portion 1 and Portion 3 of the Farm Makganyane No. 667 (Figure 3). However, this assessment was only undertaken for certain pre-selected areas, within the above-mentioned farm boundaries, associated with (i) an historical mining operational area, (ii) the proposed mining operation and (iii) a freshwater feature identified by the background databases. These areas along with a 200 m buffer assessment area is hereafter collectively referred to as the 'focus area' (Figures 1 – 4). The focus area is located between Olifantshoek (33 kilometres [km]) north) and Postmasburg (46 km east) along the R385 road.

To identify all possible freshwater ecosystems that may potentially be impacted by the proposed development, a 500 m "zone of investigation" around the focus area, in accordance with Government Notice 4167 (GN 4167) of 08 December 2023 as it relates to the National Water Act (Act no. 26 of 1998), as amended (NWA), was used as a guide to assess possible sensitivities of the receiving environment. This area – i.e. the 500 m zone of investigation around the focus area - will henceforth be referred to as the "investigation area".

This current freshwater study aims to provide information to guide the proposed activities associated with the proposed development in the vicinity of freshwater ecosystems that fall within the proposed development footprint or which are located adjacent to the proposed development footprint, to ensure the ongoing functioning of the ecosystems, such that local and regional conservation requirements and the provision of ecological services in the local area are supported, while considering the need for sustainable economic development.

This report, after consideration of the above, must guide the proponent on the final layout of the proposed mining activities from a freshwater management perspective and indicate any development constraints that should be considered in line with the principles of sustainable development and Integrated Environmental Management.

1.2 Technical Project Description

The proposed Makganyane mining operation is proposing the extraction of iron ore material from two open cast pits (Phase 1 and Phase 2) whereafter the crushed raw material will be transported by means of trucks along the R385 road to the operational Beeshoek plant for processing. Once processed at the Beeshoek plant the concentrate will be transported from the Postmasburg area to Arcelormittal's Vanderbijlpark and Newcastle Works through a combination of rail and road transport.

The following information was extracted from the mining work programme submitted for a mining right application for Makganyane Iron Ore Mine (Assmang (Pty) Ltd):

- The proposed mining operations will include two open cast pits, stockpile area, waste rock dump area as well as a site camp (Figure 4). ***Although the freshwater feature identified by the background database (NFEPA, 2011 – Section 3.1:Figure 6) and the historical mining operation area forms part of the focus area, no development/activities are proposed in these areas.***
- Contractors will make use of diesel generated power supply and hence minimal electricity infrastructure will be required.
- A general water authorisation is available for 30 m³ per day. Should additional water be required, it would need to be purchased from a third party.
- Offices, parking and other supporting infrastructure will be constructed as required.

*It was assumed that the existing road network developed as part of the prospecting operation will be used for the mining operation as well which may require updates in certain areas.

Stormwater Management Plan (SWMP):

The below information was extracted from the SWMP developed for the proposed mining operation compiled by The Biodiversity Company [TBC] (2025[1]). The proposed stormwater infrastructure includes (Figure 5):

- **Dirty Stormwater channels** around the Waste Dump, Product Stockpiles and the Site Camp;
- **Two evaporation ponds**, with one being located at the Waste Dump and the other at the Stockpile area. These ponds will act as containment facilities for the dirty water emanating from the respective catchment areas. It is assumed that the runoff from these ponds will be utilised across the mining operations, specifically for dust suppression;

- Regarding Pit 1 and Pit 2, **sumps** are proposed for these areas. The location of the sumps would be at the lowest point within the respective pits. The sumps will collect runoff from within the pits as well as any decant as a result of the mining operations. It is assumed that the sumps within the pits will be kept as low as possible to cater for any runoff generated during rainfall events. The water contained within these sumps will be utilised across the mining operations, specifically for dust suppression;
- Furthermore, given the nature of the works envisaged within the respective pits, **silt fences** have been proposed downgradient of the respective pits with the aim of reducing sedimentation of the nearby freshwater ecosystems;
- Dirty stormwater channels are proposed around the site camp diverting runoff towards a sump with **an oil separator**. Excess water from the sump can be considered clean after passing through the oil separator and can be allowed to flow away from the site into the nearby system; and
- **Clean stormwater diversion channels** are proposed for the area between Pit 1 and the Waste Dump with the aim of diverting clean water away from operations towards the freshwater ecosystem located towards the east.

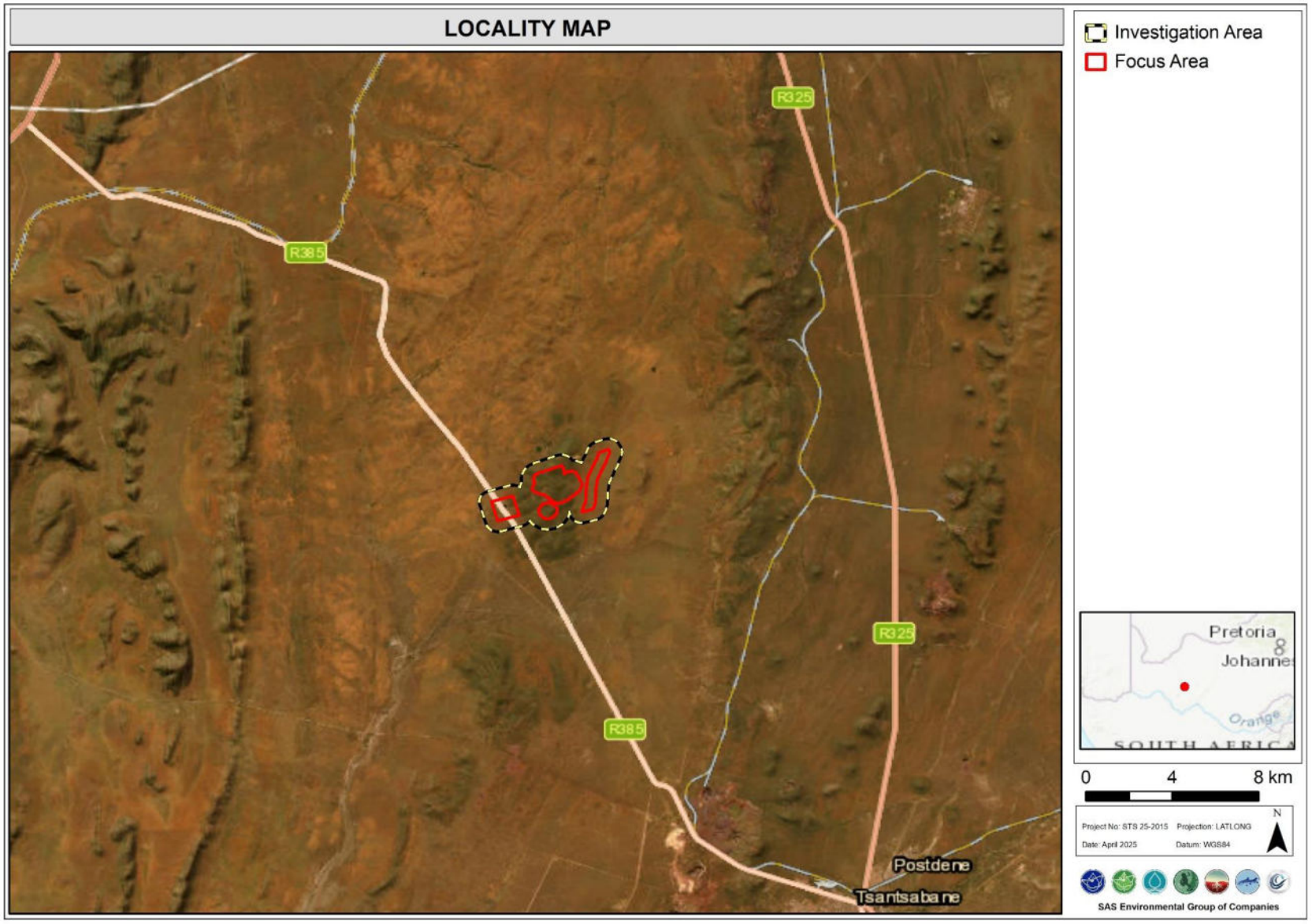


Figure 1: Locality of the focus and investigation areas in relation to the surrounding areas and roads.

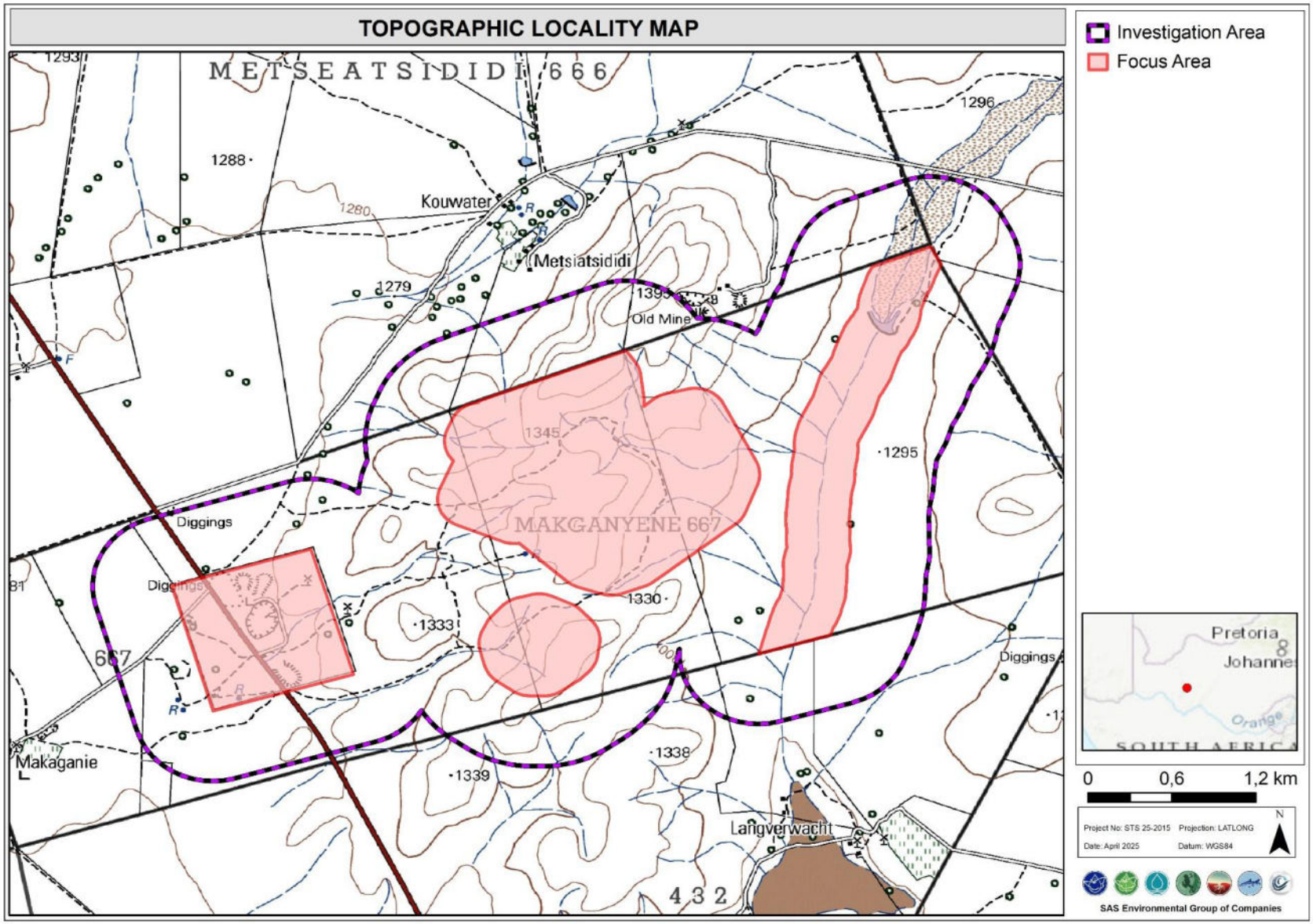


Figure 2: Topographic locality map of the focus and investigation areas.

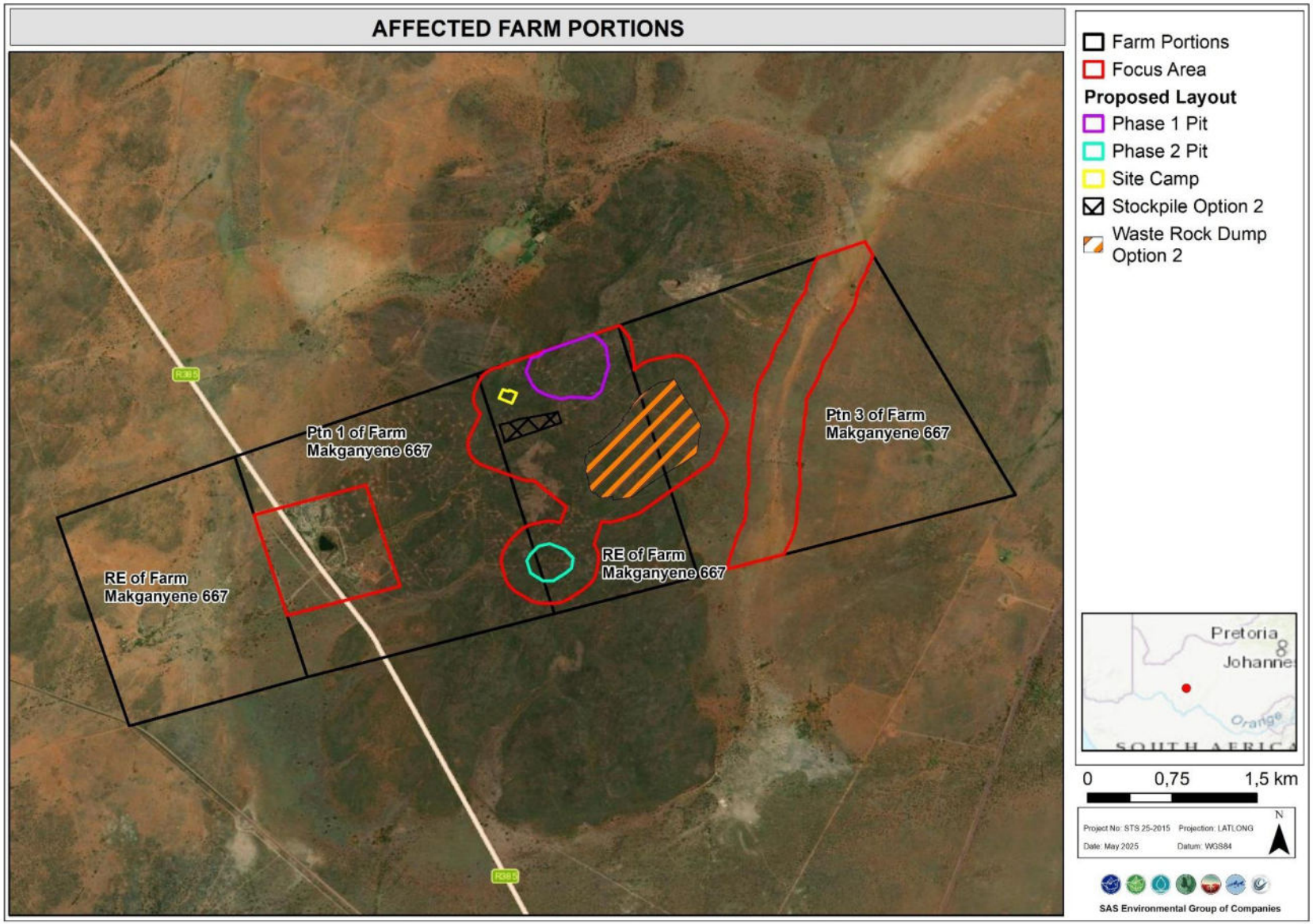


Figure 3: Affected farm portions associated with the proposed Makganyane mining operation.

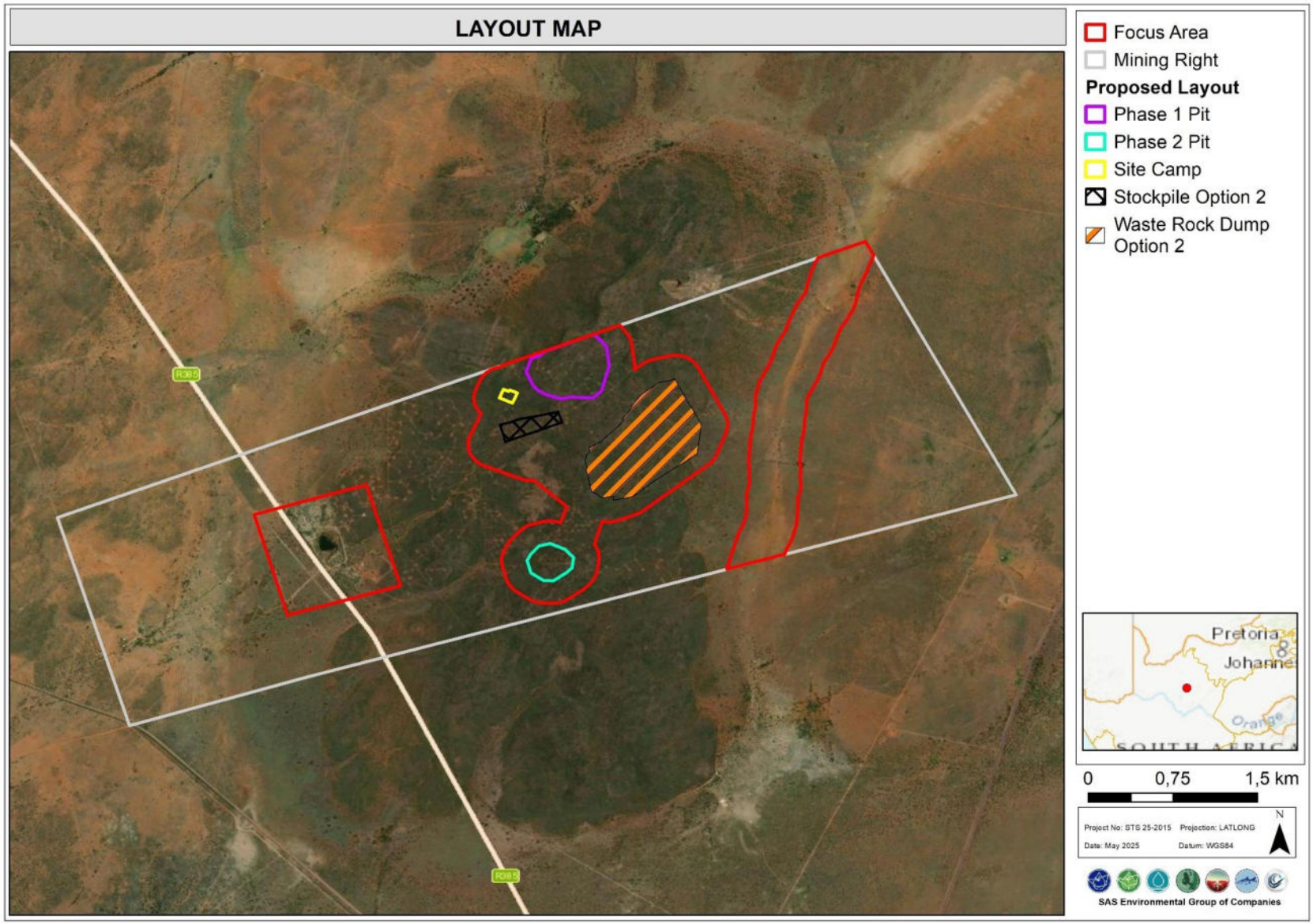


Figure 4: Proposed layout of the Makganyane mining operation.

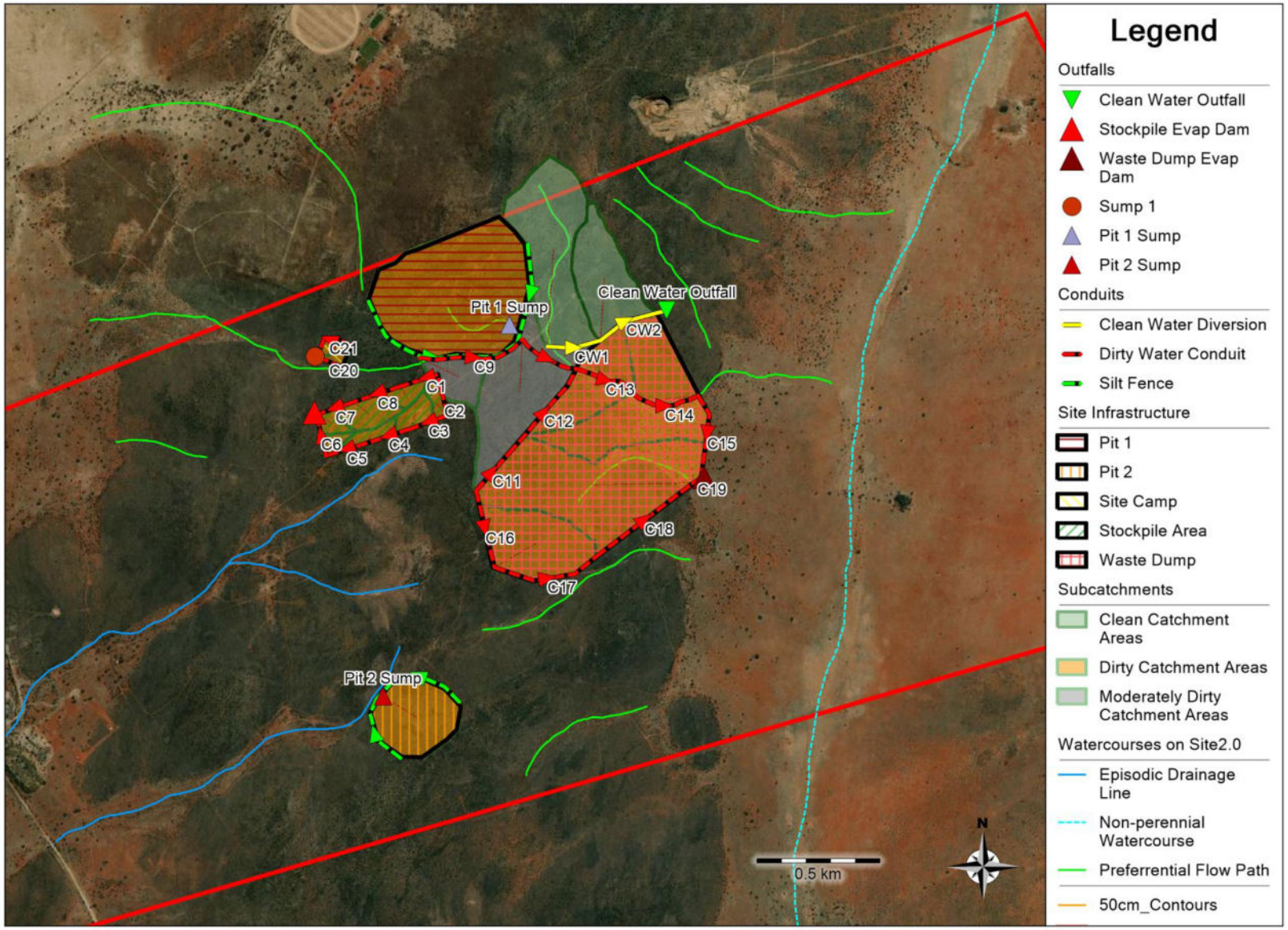


Figure 5: Conceptual SWMP (TBC, July 2025[1]).

1.3 Scope of Work

Specific outcomes in terms of this report are outlined below:

- A background study of relevant national, provincial and municipal datasets (such as the National Freshwater Ecosystem Priority Areas [NFEPA] 2011 database; the Department of Water and Sanitation (DWS) Research Quality Information Services [RQIS PES/EIS], 2014 database, National Biodiversity Assessment (NBA) 2018 database, and the Northern Cape Critical Biodiversity Areas 2016 database were undertaken to aid in defining the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the freshwater ecosystems in the focus area;
- The PES of the freshwater ecosystems was assessed according to the resource directed measures guideline as advocated by Macfarlane *et al.* (2008);
- The EIS of the freshwater ecosystems was determined according to the method described by Rountree and Kotze, (2013);
- The Ecoservices of the freshwater ecosystems were assessed according to "A technique for rapidly assessing ecosystem services supplied by wetlands" (Kotze *et al.,* 2020);
- The freshwater ecosystem boundaries, recommended development exclusion buffer and legislated zones of regulation (ZoR) were depicted for the freshwater ecosystems, where applicable;
- Allocation of a suitable Recommended Management Objective (RMO), Recommended Ecological Category (REC) and Best Attainable State (BAS) of the freshwater ecosystems were assigned based on the results obtained from the PES and EIS assessments;
- The Department of Water and Sanitation (DWS) Risk Assessment Matrix (as contained within GN 4167 of 2023) and the Environmental Assessment Practitioner (EAP) provided impact assessment was applied to identify potential impacts that may affect the freshwater ecosystems as a result of the proposed development, and to aim to quantify the significance thereof; and
- To present management and mitigation measures which should be implemented during the various development phases to assist in minimising the impact of the proposed development on the receiving freshwater environment.

1.4 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The freshwater ecosystems associated with the focus area were ground-truthed at strategically selected points of interest, however freshwater ecosystems within 500 m of the focus area (within the investigation area) were delineated in fulfilment of GN 4167 of the NWA using various desktop methods including use of topographic maps, historical and current digital satellite imagery and aerial photographs. Desk based delineations were ground-truthed where feasible. The delineations of freshwater ecosystems outside the focus area may not be utilised for any purpose, other than a baseline assessment. Any areas that may have additionally been mapped (within the investigation area) will require field-based delineation and ground-truthing as directed by applicable legislation and best practice methods;
- It is important to note that although all data sources used provide useful and often verifiable, high-quality data, the various databases used do not always provide an entirely accurate indication of the actual site characteristics within the focus area at the scale required to inform the authorisation process. However, this information is considered useful as background information to the study;
- Global Positioning System (GPS) technology is inherently inaccurate and some inaccuracies due to the use of handheld GPS instrumentation may occur. If more accurate assessments are required, the freshwater ecosystems will need to be surveyed and pegged according to surveying principles and with surveying equipment;
- Wetland, riparian and terrestrial zones create transitional areas where an ecotone is formed as vegetation species change from terrestrial to obligate/facultative species. Within this transition zone, some variation of opinion on the freshwater ecosystem boundaries may occur. However, if the DWAF (2008) method is followed, all assessors should get largely similar results;
- With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. It is, however, expected that the freshwater ecosystems that may be affected by the proposed activities have been accurately assessed and considered, based on the site observations undertaken in terms of freshwater ecosystem ecology; and
- It was assumed that the existing road network developed as part of the prospecting operation will be used for the proposed mining operation as well but would however require upgrades.

2 ASSESSMENT APPROACH AND METHODOLOGY

2.1 Freshwater Ecosystem Definition

For the purposes of this investigation, the definition of a watercourse and wetland habitat were taken as per that in the National Water Act, 1998 (Act No. 36 of 1998). The definitions are as follows:

A **watercourse** means:
(a) a river or spring;
(b) a natural channel in which water flows regularly or intermittently;
(c) a wetland, lake or dam into which, or from which, water flows; and
(d) any collection of water which the Minister may, by notice in the *Gazette,* declare to be a watercourse,
and a reference to a watercourse includes where relevant, its bed and banks.

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

Riparian habitat includes "the physical structure and associated vegetation of areas associated with a freshwater ecosystem which are commonly characterised by alluvial soil, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas".

For the purposes of this investigation, the definition of a freshwater ecosystem is considered to be synonymous with the definition of a watercourse as per the National Water Act, 1998 (Act No. 36 of 1998) as amended and the terms may be used interchangeably in this report.

2.2 Desktop Study

A desktop assessment was conducted as part of the freshwater study. Background study of relevant national, provincial and municipal datasets was undertaken to aid in defining the PES and EIS of the freshwater ecosystems. The results from the desktop assessment are presented in Section 3 of the report.

2.3 Freshwater Ecosystem Site Assessment

A field assessment was undertaken from the 1st – 3rd of April 2025, during which detailed assessments of the delineated freshwater ecosystems located in the focus and investigation areas were undertaken, at which time, factors affecting the integrity of the freshwater ecosystems were taken into consideration and aided in the determination of the functioning

and the ecological and socio-cultural services provided by the freshwater ecosystems. A detailed explanation of the methods of assessment undertaken is provided in Appendix C of this report.

2.4 Freshwater Ecosystem Detailed Assessment

As detailed in Section 1.2 above, the freshwater ecosystems associated with the focus area were assessed in terms of their PES, EIS and ecoservices provisioning (Please refer to Section 4).

2.5 Sensitivity Mapping

All freshwater ecosystems associated with the focus area were delineated with the use of a Global Positioning System (GPS). Geographic Information System (GIS) software was used to project these features onto aerial imagery and topographic maps. The sensitivity maps, which includes the scientifically derived buffer and applicable Zones of Regulations (ZoR) are presented in Sections 4 - 7 and must be used to guide the final design, layout and management of the proposed development.

2.6 Risk and Impact Assessments and Recommendations

Following the completion of the freshwater ecosystem assessment, the DWS Risk Assessment and Impact Assessment methodology (as provided by the EAP) were conducted (please refer to **Appendix D** for the methods of approach) and recommendations were developed to address and mitigate impacts associated with the proposed development. These recommendations also include general management measures, which apply to the proposed construction and operational activities. Mitigation measures have been developed to address issues in all phases throughout the life of the proposed development including planning, construction, operation and decommissioning.

3 RESULTS OF THE DESKTOP ANALYSIS

3.1 Analyses of Relevant Databases

The following section contains data accessed as part of the desktop assessment and are presented as a “dashboard” report below (Table 1). The dashboard report aims to present concise summaries of the data on as few pages as possible to allow for integration of results by the reader to take place. Where required, further discussion and interpretation is provided.

It is important to note that although all data sources used provide useful and often verifiable, high-quality data, the various databases used do not always provide an entirely accurate indication of the focus areas actual site characteristics at the scale required to inform the EA/WUA processes. Nevertheless, this information is considered useful as background information to the study, is important in legislative contextualisation of risk and impact, and was used as a guideline to inform the assessment and to focus on areas and aspects of increased conservation importance. It must, however, be noted that site assessment of key areas may potentially contradict the information contained in the relevant databases, in which case the site verified information must carry more weight in the decision-making process. The information contained in the dashboard report below is intended to provide background to the landscape of the focus area. Actual site conditions at the time of the assessment may differ to the background information provided by various datasets. Please refer to Section 4 for details pertaining to the site investigation.

Table 1: Desktop data relating to the characteristics of the freshwater ecosystems associated with the focus area and investigation area.

Aquatic ecoregion and sub-regions in which the focus and investigation areas fall	
Ecoregion	Southern Kalahari
Catchment	Orange
Quaternary Catchment	D73A
WMA	Lower Vaal
SubWMA	Molopo
Dominant characteristics of the Southern Kalahari (29.01) Ecoregion Level 2 (Kleynhans *et al.*, 2007).	
Dominant primary terrain morphology	Plains; moderate relief, Closed hills, mountains; moderate and high relief.
Dominant primary vegetation types	Karroid Kalahari Bushveld, Kalahari Mountain Bushveld, Kalahari Plateau Bushveld.
Altitude (m a.m.s.l)	700 to 1500
MAP (mm)	0 to 500
Coefficient of Variation (% of MAP)	30 to 40
Rainfall concentration index	60 to >65
Rainfall seasonality	Late summer
Mean annual temp. (°C)	16 to 22
Winter temperature (July)	0 to 22
Summer temperature (Feb)	16 to >32
Median annual simulated runoff	<5 to 40 mm
Ecological Status of the most proximal sub-quaternary reach (DWS, 2014)	
Sub-quaternary reach	D73A – 02698 (Unnamed river)
Proximity to focus area	Within eastern section (Figure 12)
Assessed by expert?	No (ephemeral feature)
PES Category Median	NA
Mean Ecological Importance (EI) Class	Low
Mean Ecological Sensitivity (ES) Class	NA
Stream Order	1
Default Ecological Class (based on median PES and highest EI or ES mean)	NA

Details of the area in terms of the National Freshwater Ecosystem Priority Area (NFEPA) (2011) database	
FEPACODE	The focus and investigation areas fall within a FEPA Catchment (FEPACODE 1). River FEPAs achieve biodiversity targets for river ecosystems and threatened fish species and were identified in rivers that are currently in a good condition. Although the FEPA status applies to the actual river reach within the sub-quaternary catchment the surrounding land and smaller stream network needs to be managed in a way that maintain the good condition of the river reach.
NFEPA Wetlands (Figure 6)	According to the NFEPA database, there is one artificial channelled valley bottom wetland (CVB) located in the eastern portion of the focus area, associated with the unnamed river. The CVB is considered heavily to critically modified ecological condition (Class Z).
Wetland Vegetation Type (Figure 7)	Most of the focus and investigation areas fall within the Eastern Kalahari Bushveld Group 3, while the remaining central portions fall within Eastern Kalahari Bushveld Group 4. The threat status of these groups is Least Threatened as provided by Mbona *et al* (2015).
NFEPA Rivers (Figure 6)	According to the NFEPA database, an unnamed river traverses the eastern portion of the focus and investigation areas and is indicated to be in a largely modified (Class B) (PES1999) and in a natural to near-natural (RIVERCON AB) ecological condition. According to the NFEPA Database the unnamed river is classified as a FEPA River, therefore in terms of the NFEPA Implementation Manual (2011), mining (and/or prospecting) is not considered a compatible land use within 1km (1000 m) of a buffer around a FEPA river. ***Please refer to Section 6.1 for further detail on the NFEPA buffer.***
Details of the area in terms of the National Biodiversity Assessment (2018): South African Inventory of Inland Aquatic Ecosystems (SAIIAE (Figure 8).	
According to the NBA 2018: SAIIAE there a river is indicated in the eastern section of the focus and investigation areas. The CVB as identified by the NFEPA Dataset is indicated to be a dam according to the NBA 2018 Artificial Wetlands Dataset. The NBA 2018 River dataset also indicates the unnamed river in the eastern portion of the focus area, which at the time of collating the NBA dataset, the feature was dry due to it being ephemeral in nature, indicating that it is data deficient. The Ecosystem Threat Status (ETS) of the river is considered critically endangered (CR) and the Ecosystem Protection Level (EPL) is considered Not Protected (NP).	
Detail of the focus and investigation areas according to the Strategic Water Source Areas (2017 & 2021) Database.	
Surface water SWSAs are defined as areas of land that supply a disproportionate (i.e., relatively large) quantity of mean annual surface water runoff in relation to their size. They include transboundary areas that extend into Lesotho and Swaziland. The sub-national Water Source Areas (WSAs) are not nationally strategic as defined in the report but were included to provide complete coverage	
The focus and investigation areas are not associated with any groundwater or surface water SWSAs.	

Detail of the focus and investigation areas in terms of the Mining and Biodiversity Guidelines (2013) (Figure 9).	National Web Based Environmental Screening Tool (2020) (Accessed 2025)(Refer to Section 7 below)
According to the Mining and Biodiversity Guidelines Database (2013) the eastern portion of the focus and investigation areas are considered of highest biodiversity importance. Risk for mining: Highest risk for mining. Implications for mining: Environmental screening, EIAs and their associated specialist studies should focus on confirming the presence and significance of these biodiversity features, and to provide a site-specific basis on which to apply the mitigation hierarchy to inform regulatory decision making for mining, water use licences, and EAs. If they are confirmed, the likelihood of a fatal flaw for new mining projects is very high because of the significance of the biodiversity features in these areas and the associated ecosystem services.	The Screening Tool is intended to allow for pre-screening of sensitivities in the landscape to be assessed within the EA process. This assists with implementing the mitigation hierarchy by allowing developers to adjust their proposed development footprint to avoid sensitive areas. The entire focus and investigation areas are located in an area considered to be of **very high aquatic biodiversity sensitivity**. The trigger features for the very high aquatic biodiversity sensitivity are due to the focus area being located within a FEPA subcatchment and the presence of wetlands and rivers, as confirmed by the NFEPA and NBA Databases.

Detail of the Assessment area in term of the Northern Cape Critical Biodiversity Areas (2016) (Figure 10).	
Critical Biodiversity Area (CBA)	The entire eastern section of the focus area is considered a Category 1 CBA which is considered an Irreplaceable Area. A CBA is an area that must remain in good ecological condition in order to meet biodiversity targets for ecosystem types, species of special concern or ecological processes. CBAs can meet biodiversity targets for terrestrial or aquatic features, or both. Together with protected areas, the portfolio of CBAs identified in a biodiversity plan must collectively meet biodiversity targets for representation of ecosystem types and species of special concern and may also meet biodiversity targets for some ecological processes (SANBI, 2017).
Ecological Support Area (ESA)	Most of the focus and investigation areas are classified as Ecological Support Area (ESAs). According to the Technical Guidelines for CBA Maps document ESAs are areas that must retain their ecological processes in order to meet biodiversity targets for ecological processes that have not been met in CBAs or protected areas; meet biodiversity targets for the representation of ecosystem types or Species of special concern when it's not possible to meet them in CBAs; support ecological functioning of protected areas or CBAs or a combination of these (SANBI, 2017).
Other Natural Area (ONA)	Small, scattered portions of the focus and investigation areas are classified as ONAs. According to the Technical Guidelines for CBA Maps document, ONA consist of all those areas in good or fair ecological condition that fall outside the protected area network and have not been identified as CBAs or ESAs (SANBI, 2017).
CBA Reasons	The 2016 Northern Cape CBAs database also includes the "reasons" layer, which is based on the planning units used in the spatial analysis and provides a list of biodiversity and ecological features found in each planning unit, which contribute to the biodiversity target (CBA Map Reason Metadata). According to this Northern Cape CBAs Reasons layer, the triggering biodiversity, and ecological features, for the ESAs and ONAs within the focus area include the following: Olifantshoek Plains Thornveld, Kuruman Mountain Bushveld, Postmasburg Thornveld, All Rivers, FEPA 500 m, FEPA subcatchment, Southern Kalahari Salt Pans, Landscape structural elements, all natural wetlands, and Conservation Areas.

Land Type Data (Job *et al.*, 2019) (Figure 11).
The potential presence of freshwater ecosystems in the focus and investigation areas can be examined in the context of the land type for the area. The majority of the focus and investigation areas fall within the **Ae12 land type** grouping and the remaining portions of the focus and investigation areas fall within **Ib238,Ag110 and Ae7** land type groupings. In the **Ae groupings** 40% of the landscape is occupied by Red and yellow, freely drained apedal soils of the Hutton, Griffin and Clovelly soils. Mishap and Glenrosa soils usually occupy significant proportions of the landscape. Soils with neocutanic, plinthic, duplex horizons and shallow black clay soils may occupy small proportions of the landscape. Katspruit, duplex soils and black clay soils usually occupy bottomland terrain positions with streambeds and erosion. **Ib groupings** are areas where the surface is dominated by exposed rocks and stones and the slopes are usually steep. The soils in the **Ag groupings** are areas were 1 >40 of the landscape is occupied by the red, freely drained apedal soils of the Hutton form. The remainder of the landscape is dominated by Mispah soils (on hard and poorly fractured rock) and Glenrosa soils (on fractured to partly weathered rock). The valley bottom consists of alluvium (Dundee and Oakleaf) soils together with calcareous Katspruit, duplex (Valsrivier, Sterkspruit) and black clay (Bonheim) soils.

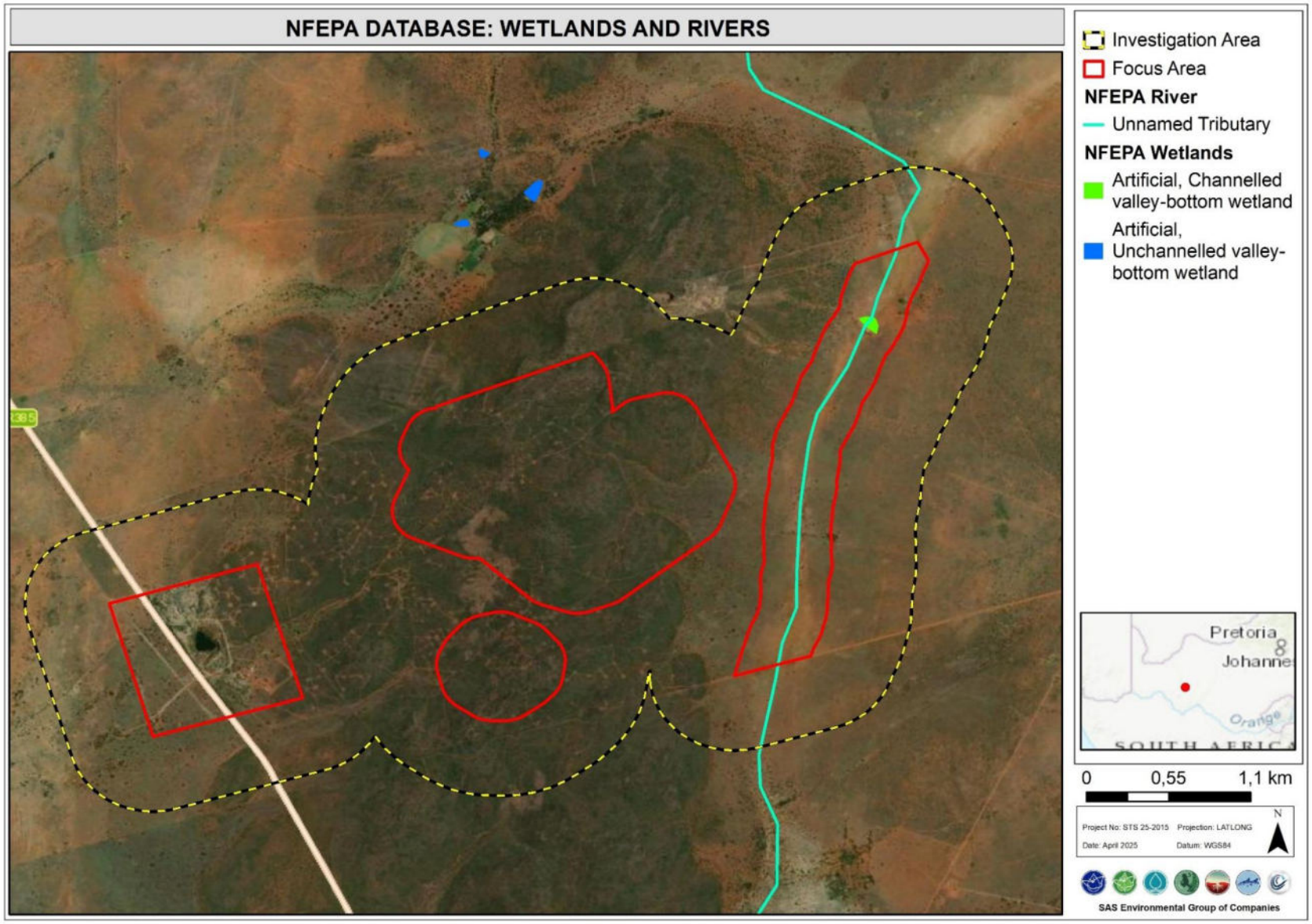


Figure 6: Wetland occurrence in the focus and investigation areas according to the NFEPA Database.

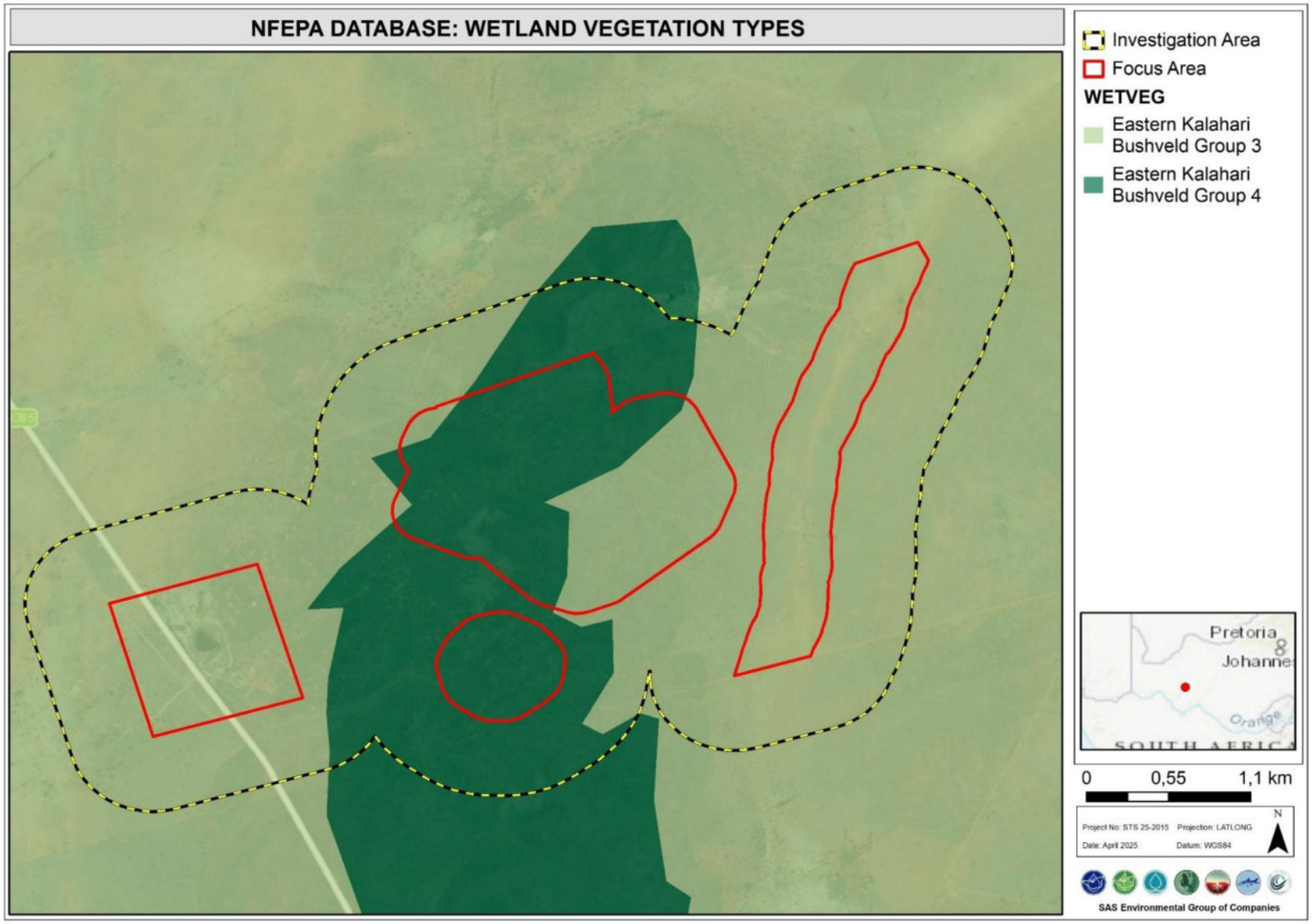


Figure 7: Wetland vegetation types associated with the focus and investigation areas according to the NFEPA Database.

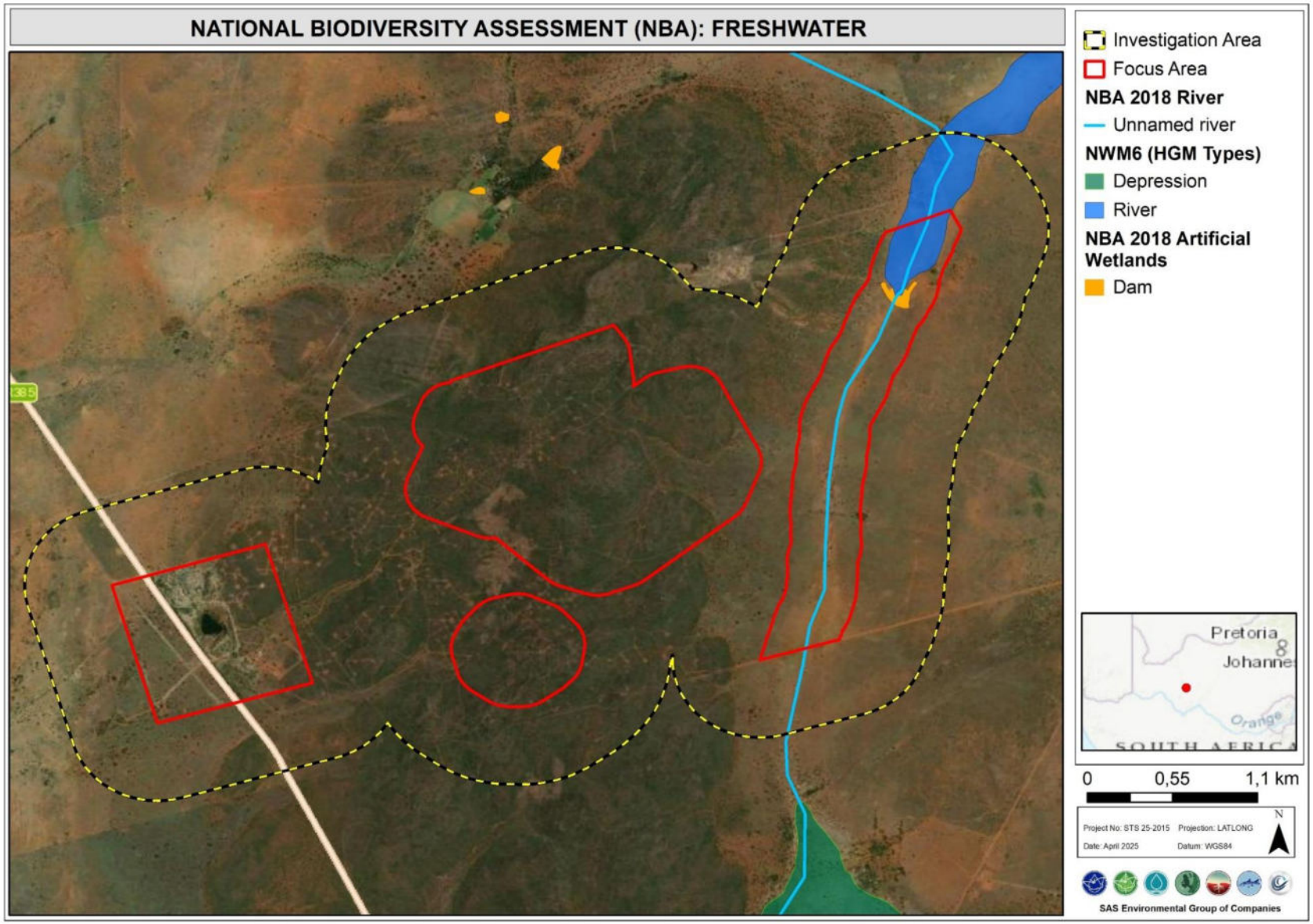


Figure 8: Wetland occurrence in the focus and investigation areas according to the NBA (2018) Wetland Database.

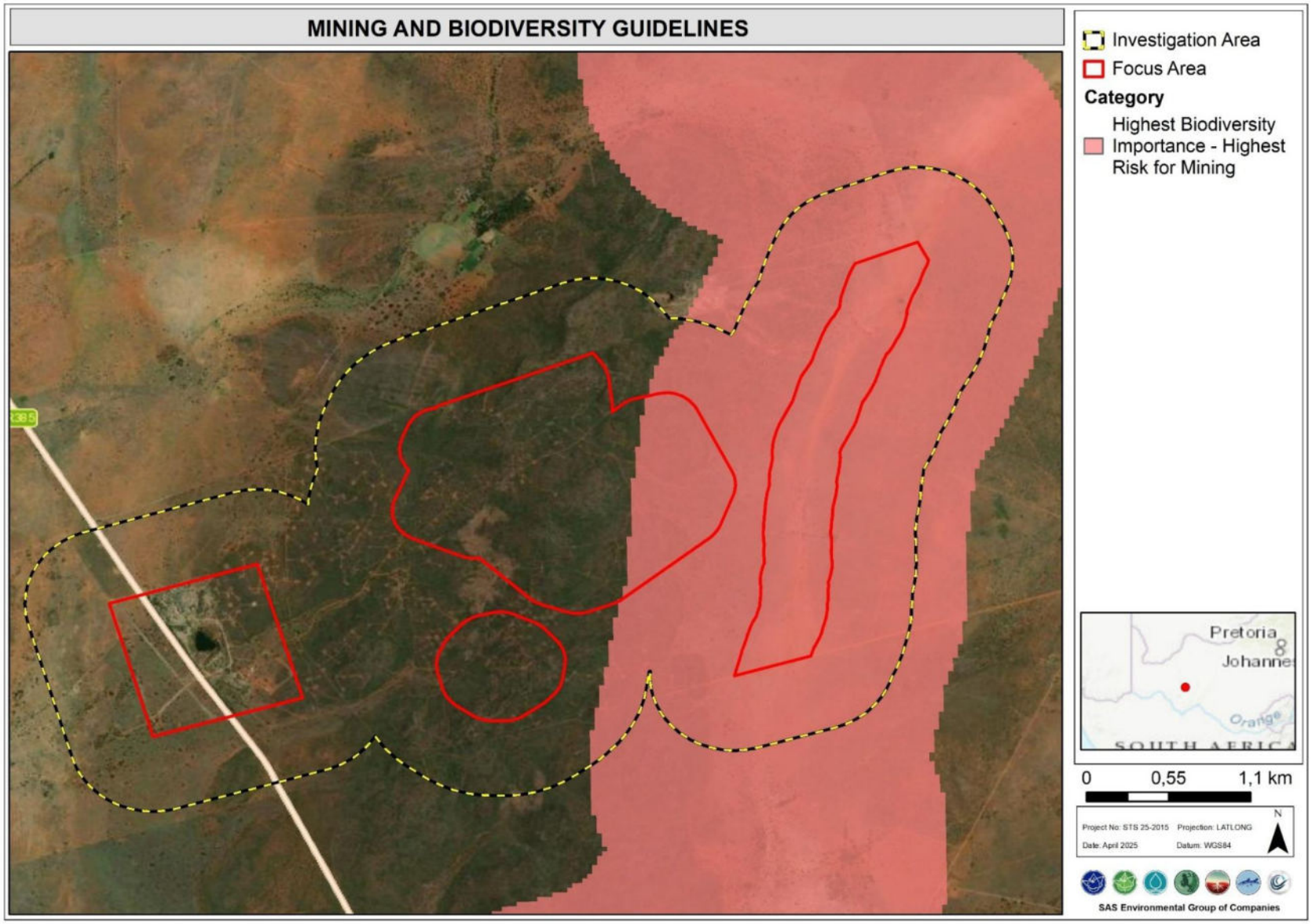


Figure 9: Ecologically important areas associated with the focus and investigation areas in terms of the Mining and Biodiversity Guidelines.

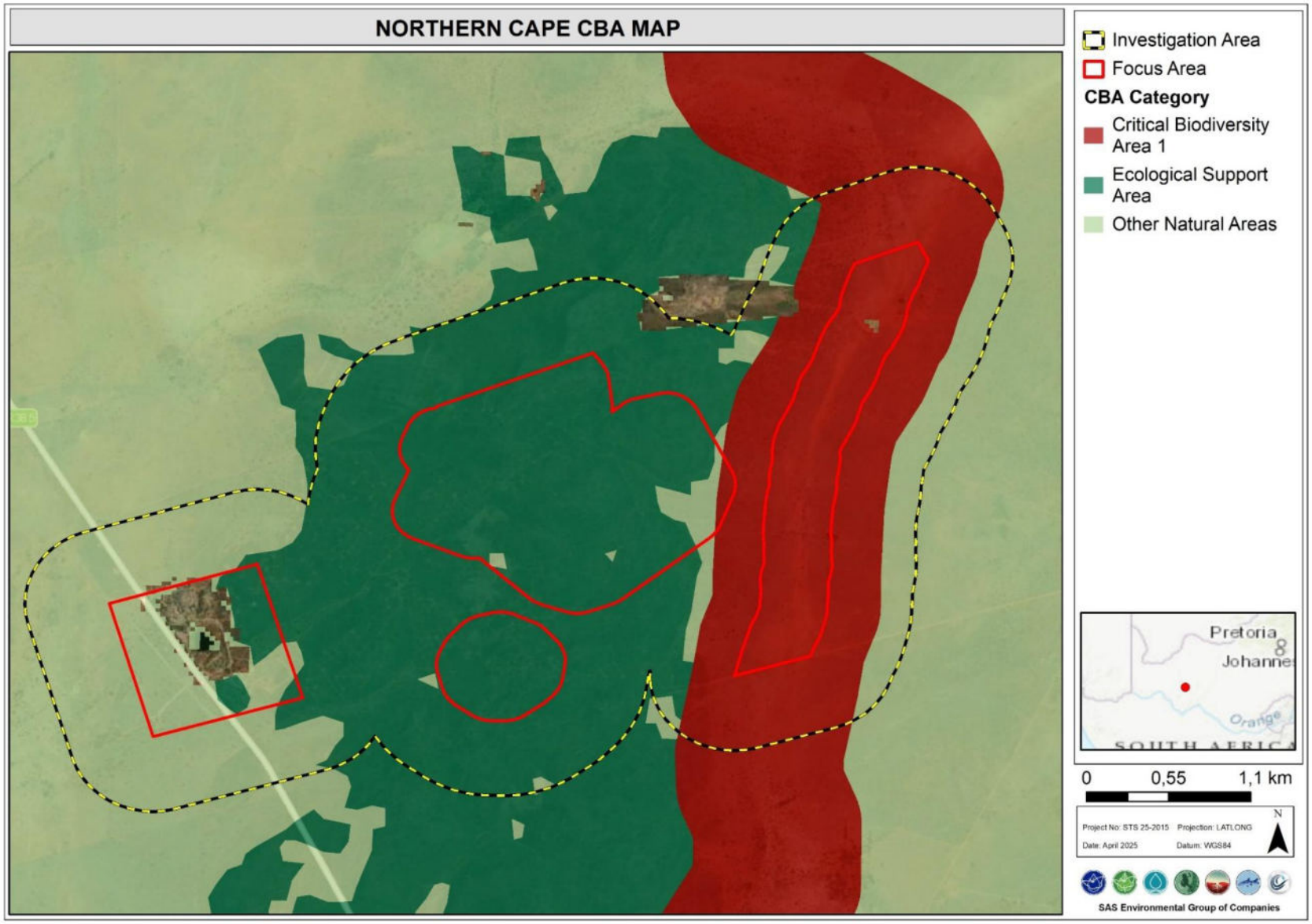


Figure 10: Areas of Conservation Importance according to the Northern Cape CBA Plan.

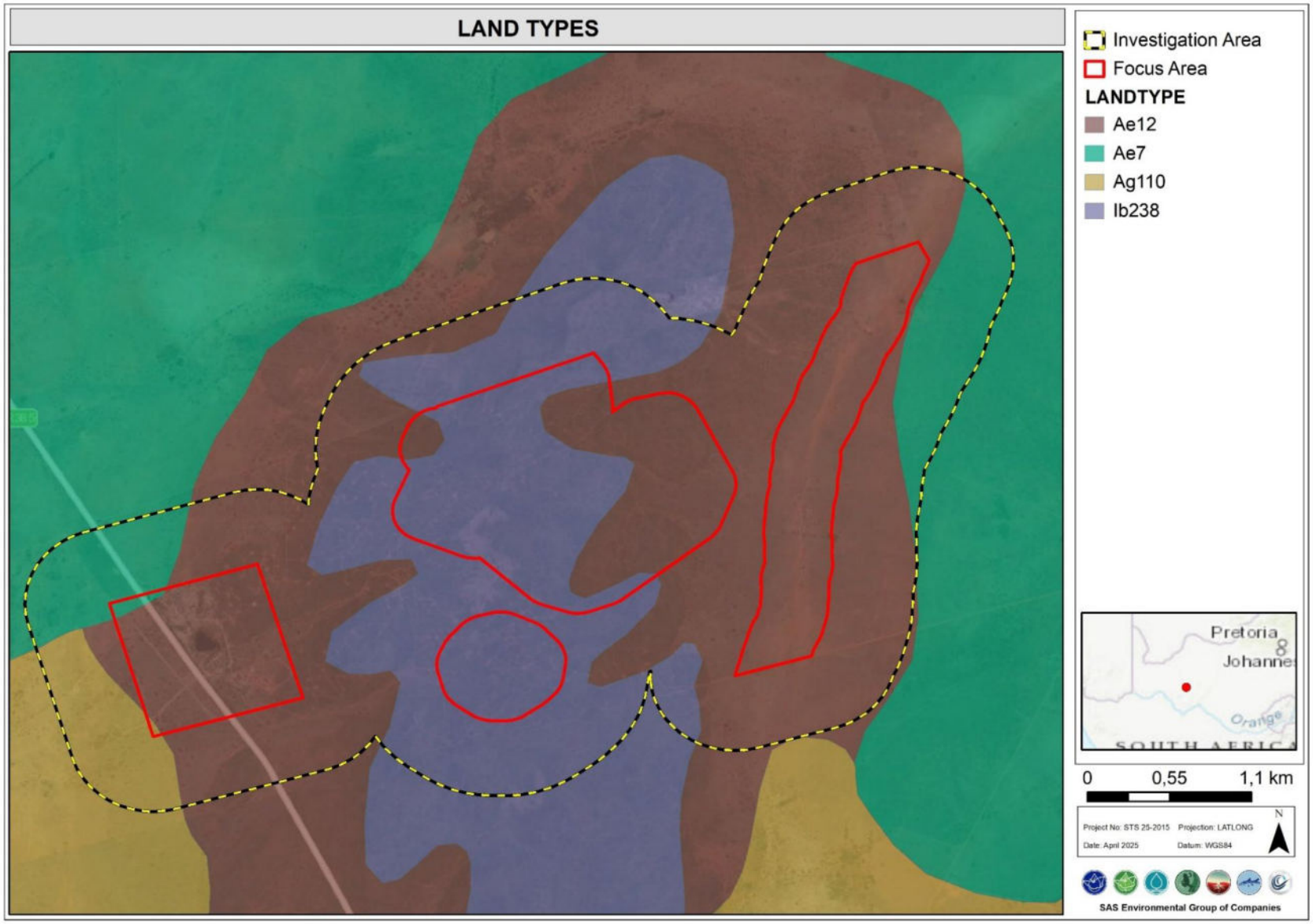


Figure 11: Land Types associated with the focus and investigation areas.

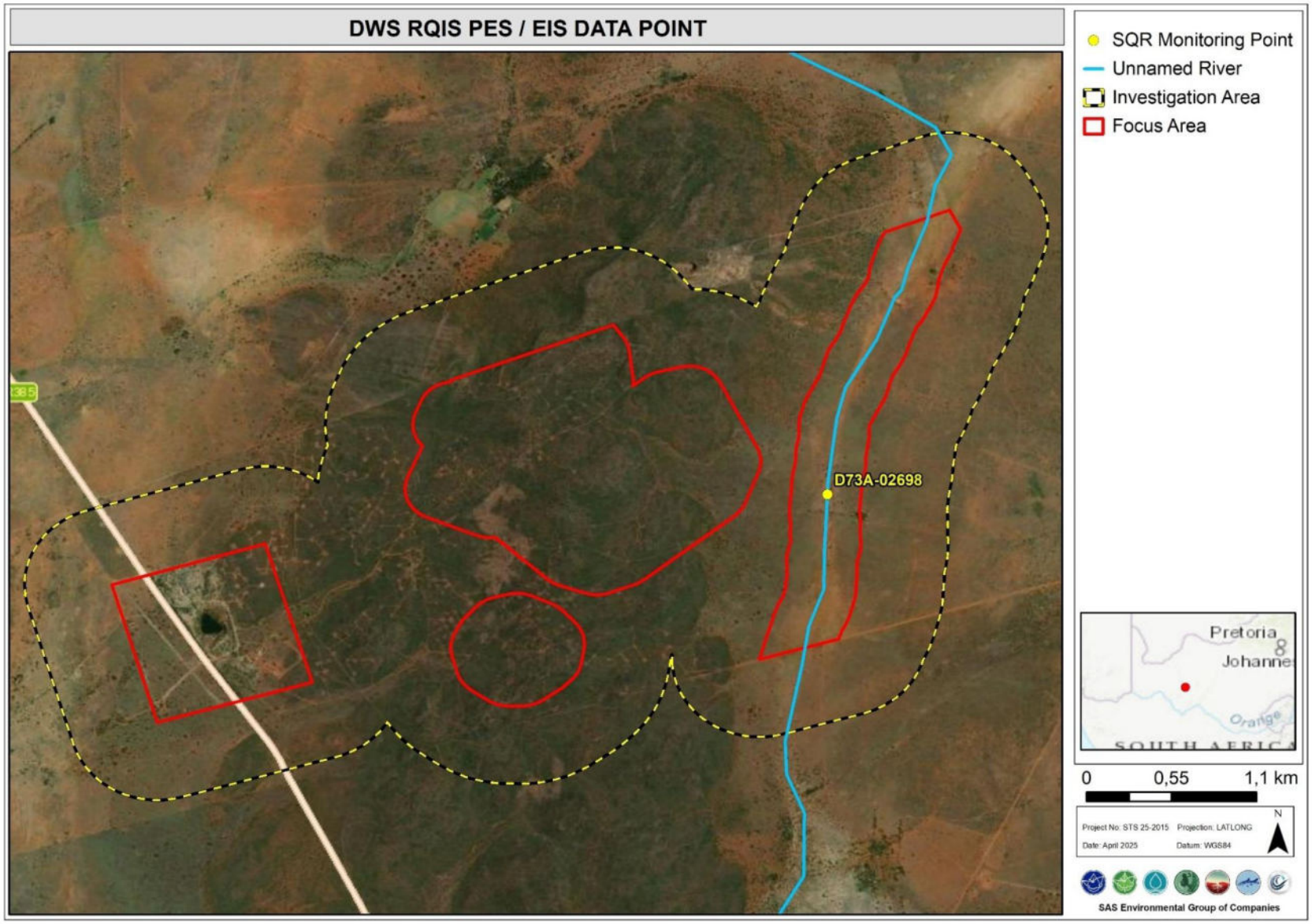


Figure 12: DWS RQOIS PES/EIS assessment point associated with the focus and investigation areas.

4 FRESHWATER RESULTS

4.1 Freshwater Ecosystem Delineation

During the assessment, the following indicators were used to identify and delineate the boundaries of the freshwater ecosystems:

- ***Topography/elevation*** was a key determinant in the identification of freshwater features. The linear features identified are all located between distinct valleys, whilst the recharge zone is located in a distinct, low-lying area in the landscape where surface water, when sufficient is present, will flow and/or accumulate;
- ***Sediment deposits*****:** lateral movement of alluvial soil and the subsequent deposition of sediment indicates minimum levels of inundation; thus a feature displaying such deposits is assumed to be seasonally inundated. The absence of such sediment deposits is inconclusive, and other indicators may be required to determine whether a feature is seasonally inundated. Whilst this is a subtle determinant of possible freshwater ecosystem conditions in some of the assessed features, it was nevertheless apparent in sufficient features to be utilised as an indicator;
- ***Soil wetness / morphological characteristics*****:** whilst soil wetness is considered by Day *et al* (2010) to be an unreliable indicator of freshwater ecosystems in arid areas, consideration was nevertheless given to the soil classification and morphological characteristics, such as mottling, when present; and
- ***Vegetation associated with riparian zones*** of the episodic drainage lines although not necessarily different in terms of species composition was slightly different in density. As such, the vegetation component was only used as a secondary confirmatory indicator in conjunction with topography and signs of lateral movement of alluvial soils.

4.2 Freshwater Ecosystem Characterisation

As noted above, various features displaying visual indicators of increased wetness were investigated during the site assessment and categorised according to their dominant characteristics, primarily topography, vegetation and soil characteristics. Of these features, two Episodic Drainage Lines (EDL) without riparian vegetation, numerous Preferential Flow paths (PFPs) and a recharge zone was identified. The PFPs and recharge zone are briefly discussed below, whilst the EDLs are discussed in detail in Section 4.3.

4.2.1 Preferential Flow Paths

PFPs are defined as areas where, when present, surface water flows but is not retained in the landscape for a sufficient period to encourage the establishment of a floral community that relies on an increased abundance of water within the effective rooting zone. PFPs receive surface sheet flow originating from the upgradient catchment which incises small channels, or 'rills' in the surface cumulatively defined as PFPs. PFPs are typically found draining off of steeply sloped terrain units, as in this case, and collect form higher order episodic drainage lines in the landscape. These PFPs lack riparian and wetland characteristics and may potentially only convey surface water for a short period of time after rainfall events (Figure 13). Thus, these features are not considered of ecological importance but contribute to the hydrological functioning of the drainage systems at large.

Figure 13: Representative photographs of the PFPs within the focus area.

4.2.2 Recharge Zone of an Unnamed Tributary

The "recharge zone" of a small unnamed tributary does not possess well-defined characteristics indicative of either wetland or riparian conditions, as illustrated in Figure 14 below. The vegetation composition of this area is dominated by species such as: *Pentzia incana, Seriphium plumosum, Cymbopogon sp* and *Hypperhennia sp.* None of these species are considered as indicators of wetland or riparian plant species and are usually associated with disturbance and overgrazing, as is the case in the recharge zone which is used for livestock grazing.

Furthermore, for an area to be classified as a watercourse, signs of a fluctuating water table (mottling, gleying) within the first 50 cm of the soil profile must be present. In the case of the recharge zone, no mottling or gleying was noted within the first 50 cm. However, at around

1 m depth, signs of soil hydromorphy were noted, which indicate subsurface lateral flow of water at a soil/bedrock interface (Figure 14: top right). As such it is likely that subsurface water from this area flows downgradient to an unnamed tributary, south of the focus area.

As such, and in consideration of the above, the recharge zone is a clearly defined low-lying area, which possesses a unique digital signature and based on analysis of available digital satellite imagery and the soil characteristics of the area, it is very likely that water from this area flows into an unnamed tributary and may contribute to the continued ecological functioning thereof. The importance of this feature from a hydropedological perspective in terms of its contribution to the recharge to the downstream system would need to be determined by a suitably qualified specialist.

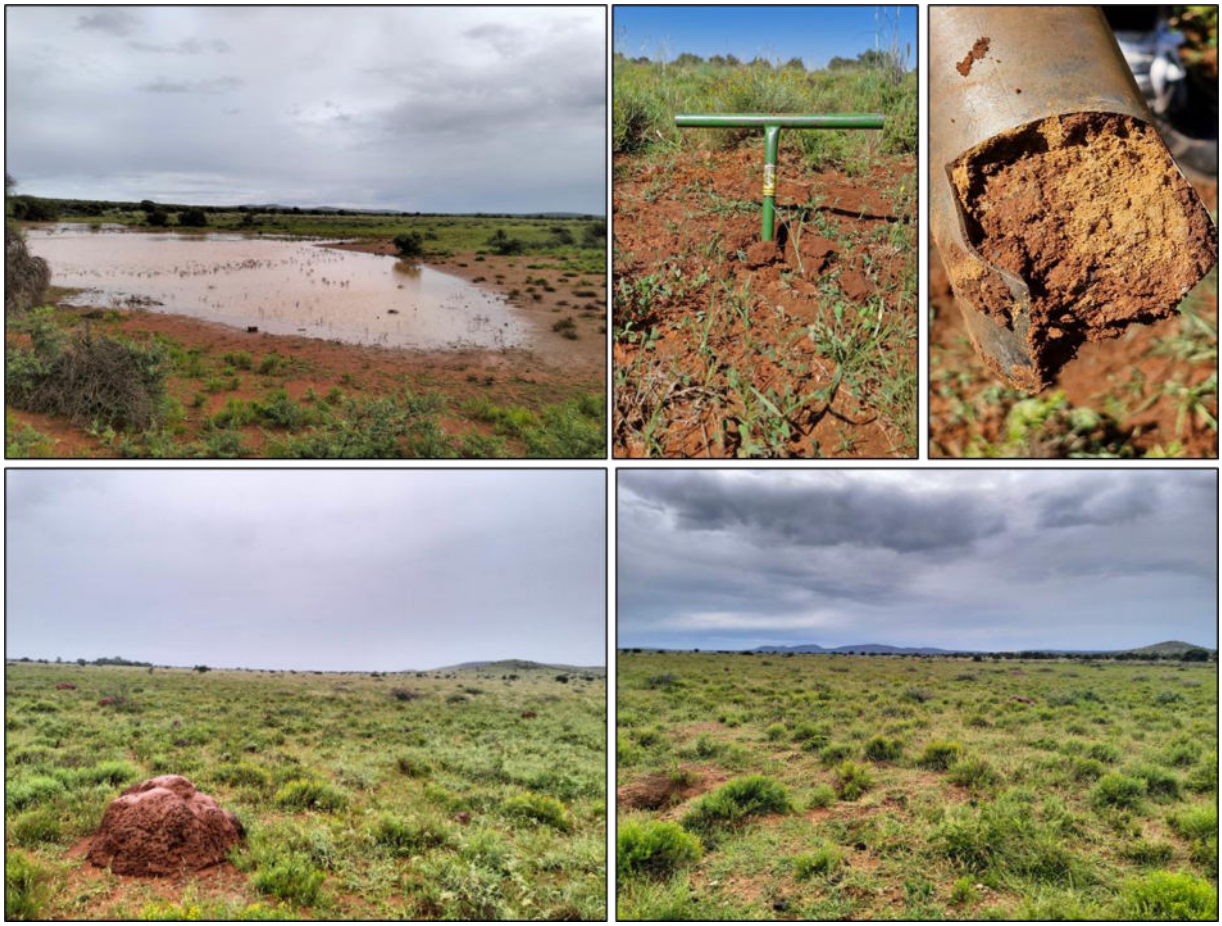


Figure 14: Representative photographs of the recharge zone and the associated farm dam (top left) and signs of soil hydromorphy found 1 meter below surface (top right). The vegetation community (bottom) is characterised by plant species usually associated with overgrazing.

Neither the PFPs nor the recharge zone met the definition of a watercourse from an ecological perspective (as defined by the NWA) and were therefore excluded from further assessment.

Form a legal perspective, however, a 1 in 100 year floodline has been modelled for the recharge zone (TBC, 2025[2]) and as such does enjoy protection under the NWA (Section 6: Figure 18). The hydrological assessment (TBC, 2025[2]) does not indicate any floodlines for the PFP's and therefore does not enjoy protection from a legal perspective.

4.2.3 Episodic Drainage Lines without riparian vegetation

EDLs without riparian vegetation are defined as episodic systems that support some vegetation that relies on an increased abundance of water within the effective rooting zone, but not to the degree that a riparian vegetation margin can form. These systems typically drain moderately sloped terrain units, as is applicable in this instance. The EDLs were classified according to the classification system (Ollis *et. al.*, 2013) as Inland Systems, falling within the Southern Kalahari Aquatic Ecoregion. The EDLs fall within the within Eastern Kalahari bushveld Group 4, which is considered to be Least Threatened according to Mbona *et al.,* (2015). The EDLs were further classified at Level 3 and Level 4 of the classification system as summarised in Table 2 below.

Table 2: Characterisation of the EDLs associated with the focus area according to the Classification System (Ollis *et. al*., 2013).

Freshwater Ecosystem	Level 3: Landscape unit	Level 4: HGM Type
Episodic Drainage Lines without riparian vegetation	**Valley floor:** The base of a valley, situated between two distinct valley side-slopes.	**River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.

The various features and drainage systems as described above are presented in relation to the focus area, investigation area and proposed mining activities in Figure 15 below.

The detailed assessment of the EDLs is detailed in Table 3 below (Section 4.3).

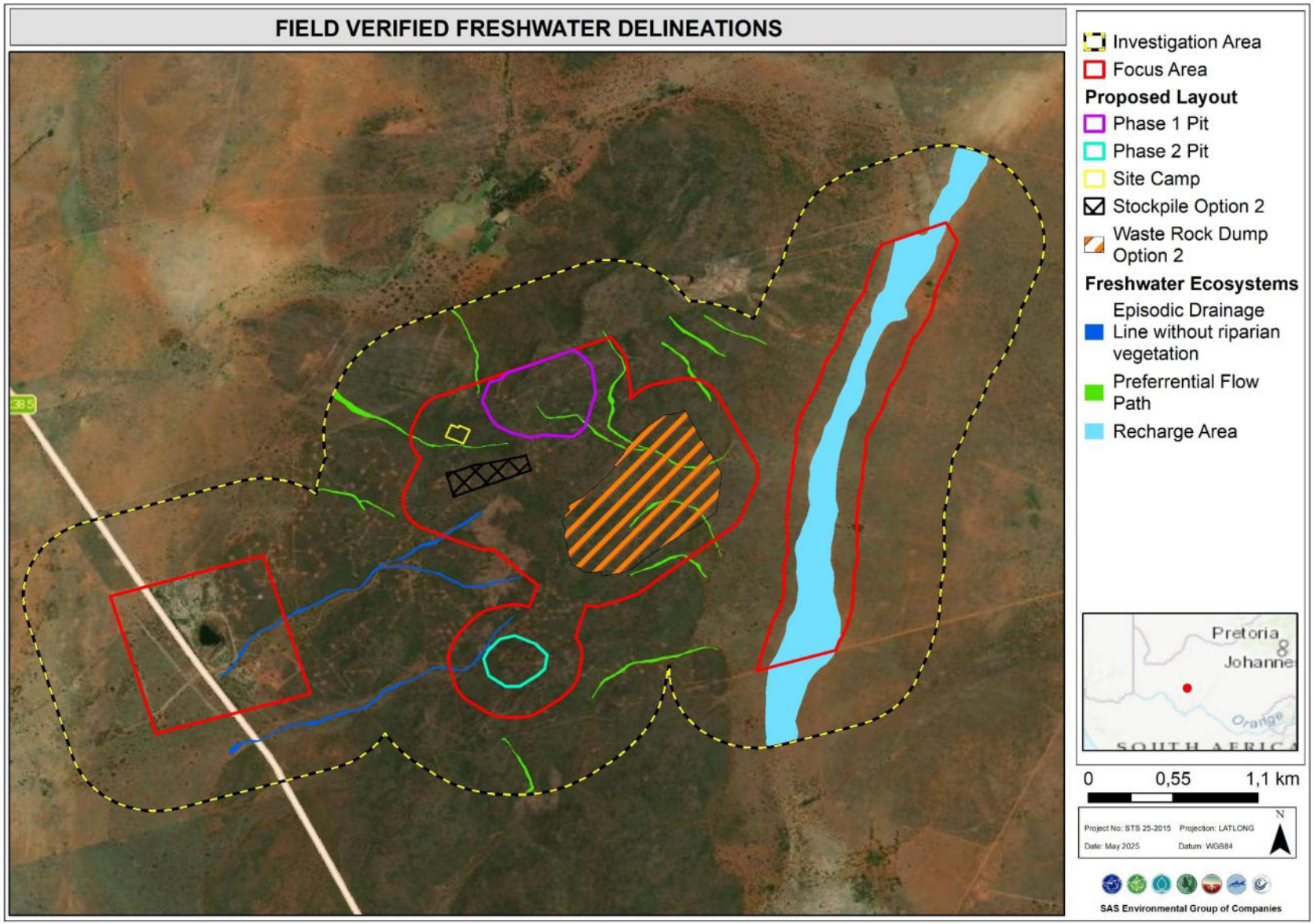


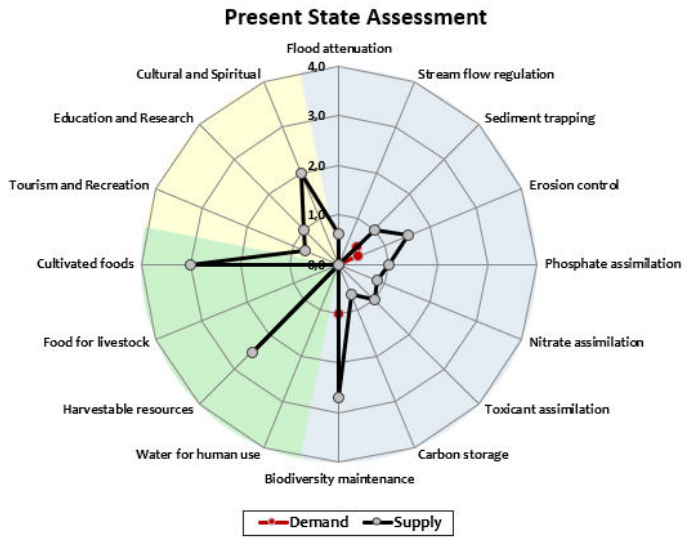
Figure 15: Freshwater ecosystem occurrence in the context of the focus and investigation areas.

4.3 Freshwater Detailed Assessment Results

Following the site visit, various assessments were undertaken in order to determine the PES, EIS, and ecological service provision of the identified EDLs as well as to assign an appropriate REC, RMO and BAS as described in Section 1.3 of this report.

Table 3 provides a summary of the ecological assessment of the EDLs in terms of relevant aspects (hydrology, geomorphology and vegetation components) associated with the EDLs. As the EDL's are located in close proximity (approximately 243 m), in the same catchment area and with similar limited impacts, the EDLs were assessed and discussed in a combined manner.

Table 3: Summary of the assessment of the EDLs associated with the western portions of the focus and investigation areas.

<table>
<tr><td colspan="2">Ecological & socio-cultural service provision graph:
 
</td><td colspan="2"> 
Photograph notes: (From left to right) indication of lateral movement of alluvial soil and visual representation of the EDLs associated with the western portions of the focus and investigation areas.</td></tr>
<tr><td>Ecoservice provision</td><td colspan="2">Biodiversity Maintenance – Moderate; Cultivated Foods – Moderately Low; Harvestable Resources – Low; All other – Very Low
As per the Wet-Ecoservices results, the highest rated ecosystem service associated with the EDLs is biodiversity maintenance to a moderate degree. The supply of the service has been rated as much higher than the demand, which is an accurate representation as the EDLs are not indicated by any database as an important freshwater feature and is only associated with a wetland vegetation type considered as least threatened. The EDLs do however fall within an ESA (Section 3.1). The supply of all other provisioning services is higher than the demand and is ascribed to the isolated setting of the EDLs on privately owned land.</td><td>PES discussion
Riparian Index of Habitat Integrity (IHI): B (Largely natural) (83.8%)
The EDLs were assessed to be in a largely natural ecological state which is ascribed to the isolated nature and minimal anthropogenic impacts imposed on the natural hydrologic regime, geomorphological processes and vegetation community of the systems. The only modifiers noted is wildlife grazing and movement (used as a corridor for herbivores) and the recent informal road crossings constructed within the systems as part of the Makganyane prospecting works (constructed between 2019 and early 2022). These impacts have resulted in changes to the hydrological functioning and sediment balance of the systems as well as Alien and Invasive Plant (AIP) encroachment.</td></tr>
<tr><td>EIS discussion</td><td colspan="3">EIS Category: Moderate (2.00)
The EDLs display a moderate EIS with biodiversity support and sensitivity of the EDLs to changes in low flows and floods being the most impactful aspect of ecological importance and sensitivity. The EDLs display important aspects of hydro-functional importance including streamflow regulation, flood attenuation (even if only provided seasonally during the rainy season) and breeding and feeding habitat for faunal species. The location of the EDLs on privately owned land restricts the direct human benefits associated with them.</td></tr>
</table>

<table>
<tr><th colspan="2">Freshwater Ecosystem drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):</th></tr>
<tr><td colspan="2">The EDLs are primarily driven by precipitation and runoff (i.e. surface water inputs), and as such is only in flow when sufficient rainfall is received in the region. It was apparent at the time of the assessment in April 2025 that although ample rain had fallen in the preceding weeks and during the site assessment for the stream to flow, small ponding areas occur along the course of the stream where instream infrastructure such as the informal road crossings, is in place. This leads to accumulation of sediment as the water stagnates. No other modifiers of the hydraulic regime were observed during the assessment.</td></tr>
<tr><td colspan="2">The geomorphological regime is similarly in a largely natural state, although increased sediment inputs are likely mostly due to trampling by large herbivores and some windborne sediment inputs are also likely. Minimal erosion was noted, nor was active erosion noted on digital satellite imagery. Despite the semi-arid climate, the ELDs are well-vegetated, and the absence of erosion is attributed to the vegetated state of the stream.

Due to the episodic nature of the drainage lines, the presence of surface water is very limited, as discussed above, and is largely due to precipitation. As such, water quality parameters were not taken.

The vegetation community of the EDLs did not distinctly differ from that of the surrounding terrestrial habitat, with the exception of a few individual Ziziphus mucronate, which although is a cosmopolitan species, seemed to favour EDL areas. Numerous AIPs were also noted o be associated with the EDLs and included, but are not limited to: Datura stramonium, Nicotiana glauca, Prosopis glandulosa var. torreyana, Solanum elaeagnifolium; Bidens pilosa, Chenopodium album, Schkuhria pinnata; and Tagetes minuta.

During the site assessment it was noted that herbivores use the EDLs as movement corridors as the systems are more easily accessible and less restrictive in terms of tree density.</td></tr>
<tr><td>REC, RMO & BAS Category</td><td>REC Category: B
RMO: Maintain
BAS: B (Maintain)
Since the EDLs have been assessed to be in a largely natural state with a moderate EIS rating, the ecological condition of the EDLs must be maintained and cannot be degraded. As no infrastructure is located within the delineated extents of the EDLs and only a portion of the Phase 2 OC pit and associated sump is located within the 48 m non-development buffer of the southern EDL, only potential indirect impacts to the southern EDL is envisioned. The stockpile area is also located in the immediate catchment of the northern EDL with limited indirect impacts envisioned, as described below. However, as these areas are small in relation to the entire extent of the EDLs, the ecological functioning of the systems are unlikely to be compromised, and the REC can be maintained with the implementation of the provided mitigation measures (Section 8.3).</td></tr>
<tr><td>Extent of modification anticipated</td><td>Moderate to Low
Indirect impacts associated with the Phase 2 OC pit and sump (within the 48 m non-development buffer of the southern EDL) and the stockpile area (within the immediate catchment of the northern EDL) will lead to a moderate to low degree of modification of the EDLs, respectively. The upgrading of existing informal road crossings within the EDLs will also lead to an overall low extent of modification. However, with the implementation of the recommended mitigation measures (Section 8.3) the anticipated modifications can be further reduced.</td></tr>
<tr><th colspan="2">Risk Assessment Outcome & Business Case:</th></tr>
<tr><td>MEDIUM TO LOW</td><td>The proposed Makganyane mining operation will lead to an overall low impact on the EDLs, with the only medium impact activity associated with the construction and operation of the Phase 2 OC pit and associated sump, located within the 48 m ecological buffer and GN 4167 100 m ZoR, of the southern EDL. However, with the implementation of the recommended mitigation measures, the risk can be suitable mitigated.</td></tr>
</table>

5 FRESHWATER BUFFERS

In order to offer a measure of protection to freshwater ecosystems, in general non-developable buffer areas are necessary to be designated around all freshwater ecosystems in the study and investigation areas. According to Macfarlane *et al.* (2015) the definition of a buffer zone is variable, depending on the purpose of the buffer zone, however in summary, it is considered "a strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another". Buffer zones are considered important to provide protection of basic ecosystem processes (in this case, the protection of wetland ecological services), reduce impacts on water resources arising from upstream activities (e.g. by removing or filtering sediment and pollutants), provision of habitat for aquatic and wetland species as well as for certain terrestrial species, and a range of ancillary societal benefits (Macfarlane *et. al,* 2015). It should be noted however that buffer zones are not considered to be effective mitigation against impacts such as hydrological changes arising from stream flow reduction, impoundments or abstraction, nor are they considered to be effective in the management of point-source discharges or contamination of groundwater, both of which require site-specific mitigation measures (Macfarlane *et. al,* 2015).

In order to provide a practical and scientifically defensible buffer, the scientific buffer Guideline tool (Macfarlane *et al*, 2015) was applied to the EDLs. The buffer assessment was determined using site-based parameters using data collected for the (on-site) detailed assessment of freshwater ecosystems in the focus area. Table 4 details the results of the refined buffer assessment and Figure 16 depict the application of the buffer to the study and investigation areas.

Table 4: Buffers as recommended by the buffer tool for the EDLs.

Freshwater Ecosystem	Construction phase buffer	Operational Phase buffer	Final aquatic impact buffer
EDLs	27 m	48 m	**48 m**

The final aquatic impact buffer requirement is based on the maximum of the recommended buffers for the construction and operational phases and taking practical considerations into account.

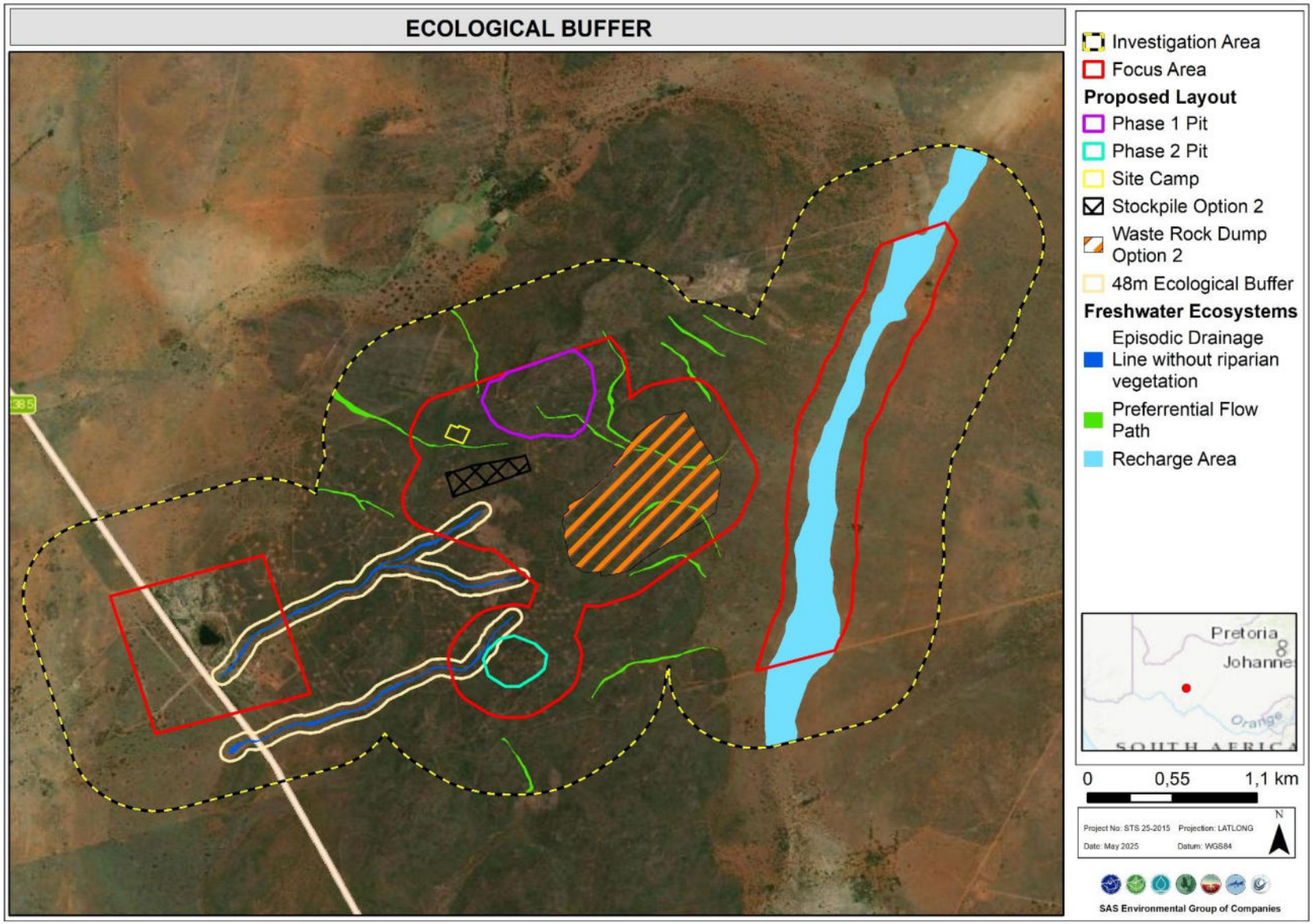


Figure 16: Aquatic Ecological buffer associated with the EDLs.

6 LEGISLATIVE REQUIREMENTS

The following legislative requirements and relevant provincial guidelines were taken into consideration during the assessment. A detailed description of these legislative requirements is presented in **Appendix B**:

- Constitution of the Republic of South Africa, 1996[1];
- The National Environmental Management Act, 1998 (Act No. 107 of 1998) as amended (NEMA);
- Environmental Impact Assessment Regulations, 2014, (GNR 982 in Government Gazette 38282 of 4 December 2014) as amended;
- The National Water Act, 1998 (Act No. 36 of 1998) as amended (NWA);
    - Government Notice 4167 (GN 4167) as published in the Government Gazette 49833 of 08 December 2023 as it relates to the NWA; and
    - Government Notice 704 as published in the Government Gazette 20119 of 1999 as it relates to the NWA.

6.1 Legislative Zones of Regulation

Certain articles of legislation related to the above Acts and legislation impose potential zones of regulation on freshwater ecosystems in both a national and provincial context. The Zones of Regulation (ZoR) are not necessarily development exclusion zones, rather areas in which EIA and WUA legislative tools have been introduced for the protection and sustainable use of freshwater resources by requiring that certain types of activities within a freshwater ecosystem, or within a certain distance of a freshwater ecosystem require authorisation. The definition and motivation for a regulated zone of activity for the protection of freshwater ecosystems can be summarised as follows:

[1] Since 1996, the Constitution has been amended by seventeen amendments acts. The Constitution is formally entitled the 'Constitution of the Republic of South Africa, 19996". It was previously also numbered as if it were an Act of Parliament – Act No. 108 of 1996 – but since the passage of the Citation of Constitutional Laws Act, neither it nor the acts amending it are allocated act numbers.

Table 5: Articles of Legislation and the relevant zones of regulation applicable to each article.

Regulatory authorisation required	Zone of applicability
Water Use Authorisation Application in terms of the National Water Act, 1998 (Act No. 36 of 1998) as amended.	Government Notice 4167 as published in the Government Gazette 49833 of 08 December 2023 as it relates to the National Water Act, 1998 (Act No.36 of 1998) as amended. In accordance with GN 4167, a regulated area of a watercourse in terms of water uses as listed in Section 21(c) and 21(i) is defined as: • **the outer edge of the 1 in 100-year flood line or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake, or dam**; • **in the absence of a determined 1 in 100-year flood line or riparian area the area within 100 m distance from the edge of a watercourse** where the edge of the watercourse (excluding flood plains) is the first identifiable annual bank fill flood bench; or • In respect of a wetland, a 500 m radius around the delineated boundary (extent) of any wetland, including pans.
	Government Notice 704 as published in the Government Gazette 20119 of 1999 as it relates to the National Water Act, 1998 (Act No. 36 of 1998). These Regulations, forming part of the NWA, were put in place in order to prevent the pollution of water resources and protect water resources in areas where mining activity is taking place from impacts generally associated with mining. It is recommended that the Makganyane Mining Project complies with GN 704 of the NWA, which states that: *No person in control of a mine or activity may:* *(a) locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year floodline or within a horizontal distance of 100 metres from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on waterlogged ground, or on ground likely to become waterlogged, undermined, unstable or cracked;* *(b) carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood-line or **within a horizontal distance of 100 metres from any watercourse** or estuary, whichever is the greatest;* According to the above, the activity footprint must fall outside of 100m from the delineated edge of the wetlands. Authorisation for activities within the regulated zone must be obtained.
Listed activities in terms of the EIA Regulations (2014), as amended[2].	**Activities of Listing Notice 1 (GN 983) of the National Environmental Management Act, 1998 (Act No.107 of 1998) EIA regulations, 2014 (as amended):** **Activity 12** *The development of—* *(i) dams or weirs, where the dam or weir, including infrastructure and water surface area, exceeds 100 square metres; or* *(ii) infrastructure or structures with a physical footprint of 100 square metres or more;* *where such development occurs—;* ***a) within a watercourse;*** *b) in front of a development setback;* *c) if no development setback exists, within **32 metres of a watercourse**, measured from the edge of a watercourse.* **Activities of Listing Notice 3 (GN 985) of the National Environmental Management Act, 1998 (Act No.107 of 1998) EIA regulations, 2014 (as amended) applicable to the Northern Cape Province.** ***Activity 14:*** *The development of—* *(i) dams or weirs, where the dam or weir, including infrastructure and water surface area, exceeds 10 square metres; or* *(ii) infrastructure or structures with a physical footprint of 10 square metres or more;* *where such development occurs—;*

[2] Note – only listing notice activities that are associated with a zone of regulation are detailed in this table. This does not exclude the applicability of other potentially applicable activities that relate to the freshwater environment (e.g., Listing Notice 1 Activity 19) or any other applicable listing notice activity to the proposed development. The applicable listing notices and activities must be confirmed by the EAP.

Regulatory authorisation required	Zone of applicability
	i. **Outside urban areas**: *(aa)* *A protected area identified in terms of NEMPAA, excluding conservancies;* *(bb)* *National Protected Area Expansion Strategy Focus areas;* *(cc)* *World Heritage Sites;* *(dd)* *Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority;* *(ee)* *Sites or areas identified in terms of an international convention;* *(ff)* ***Critical biodiversity areas or ecosystem service areas*** *as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;* *(gg)* *Core areas in biosphere reserves;* *(hh)* *Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve;* *(ii)* Areas seawards of the development setback line or within 1 kilometre from the high-water mark of the sea if no such development setback line is determined;

In consideration of the above, the applicable zones of regulation for the proposed development can be summarised as follows:

- 32 m Zone of Regulation (NEMA EIA Regulations);
- 100 m Zone of Regulation (GN 704);
- 100 m Zone of Regulation is applicable to the EDLs (GN 4167 in the absence of a determined 1: 100 year floodline); and
- 1:100 year floodline is applicable to the recharge zone (GN 4167) (as determined by the hydrologist – TBC [2025]).

In must also be noted that in terms of the NFEPA database (2011), the area defined as a recharge zone is considered a FEPA river in which mining (and/or prospecting) is not considered a compatible land use within 1 km (1000 m) of a buffer around a FEPA river (Section 3.1). As such a 1 km buffer area was generated around the 1:100 year floodline of the recharge zone, which indicates that a portion of the proposed Waste Rock Dump (Option 2) is located within the buffer area (Figure 19). The applicability of the NFEPA buffer area and the subsequent application implications/considerations must be determined by the EAP.

The respective zones of regulation as stipulated above are depicted in the figures below.

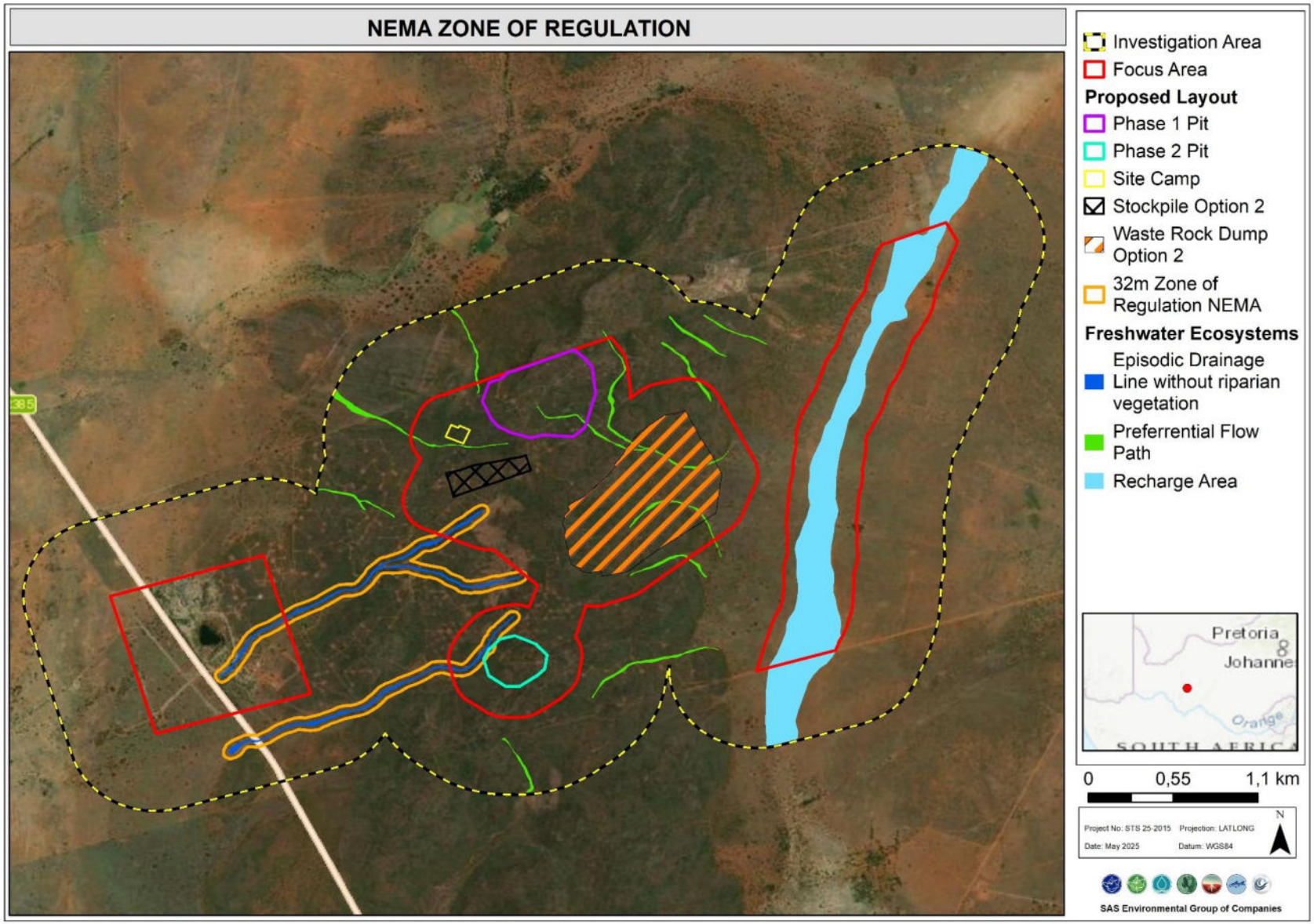


Figure 17: NEMA EIA Regulation Freshwater -related ZoR associated with the focus and investigation areas.

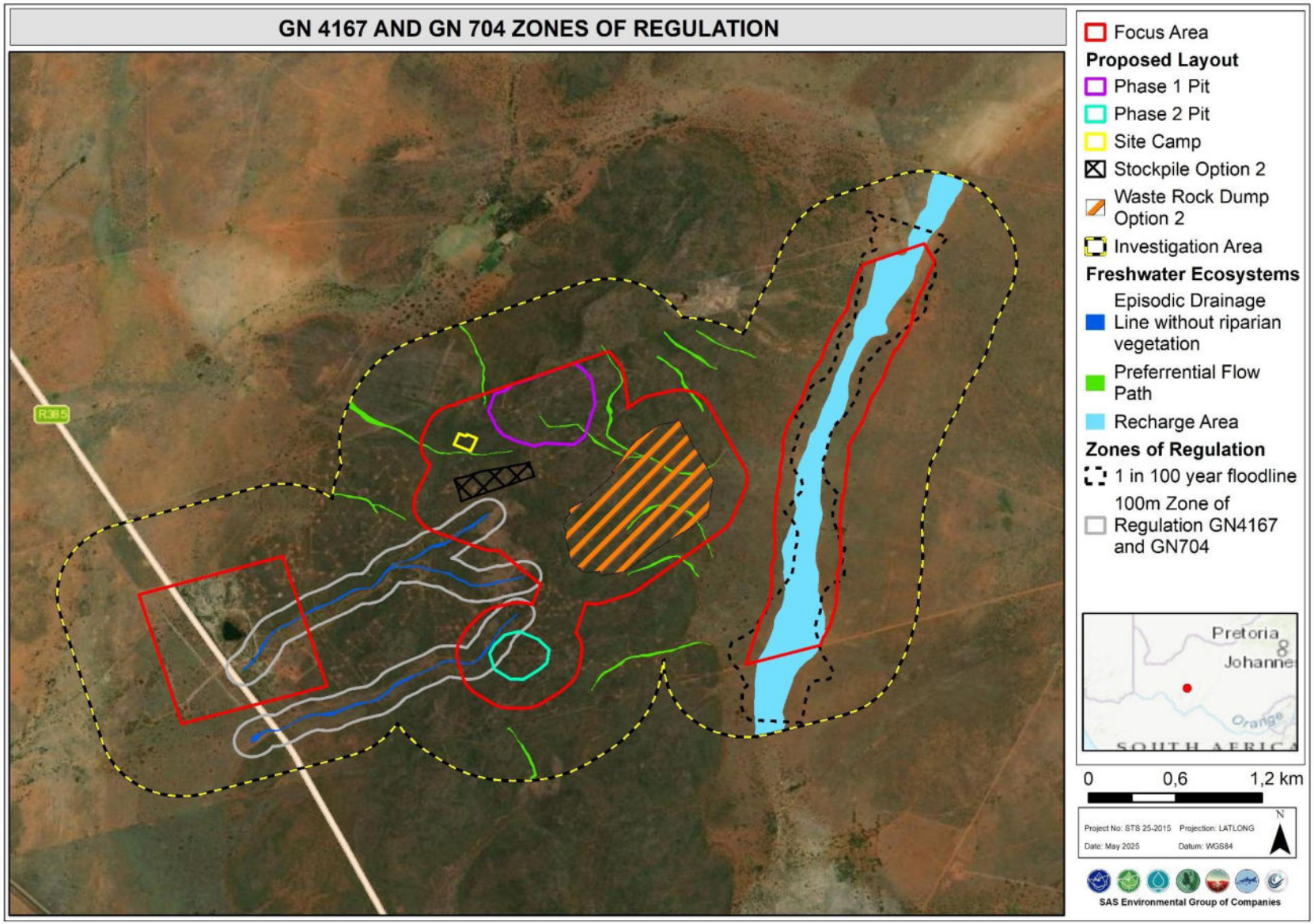


Figure 18: GN 4167 and GN 704 Regulations Freshwater-related ZoRs associated with the focus and investigation areas.

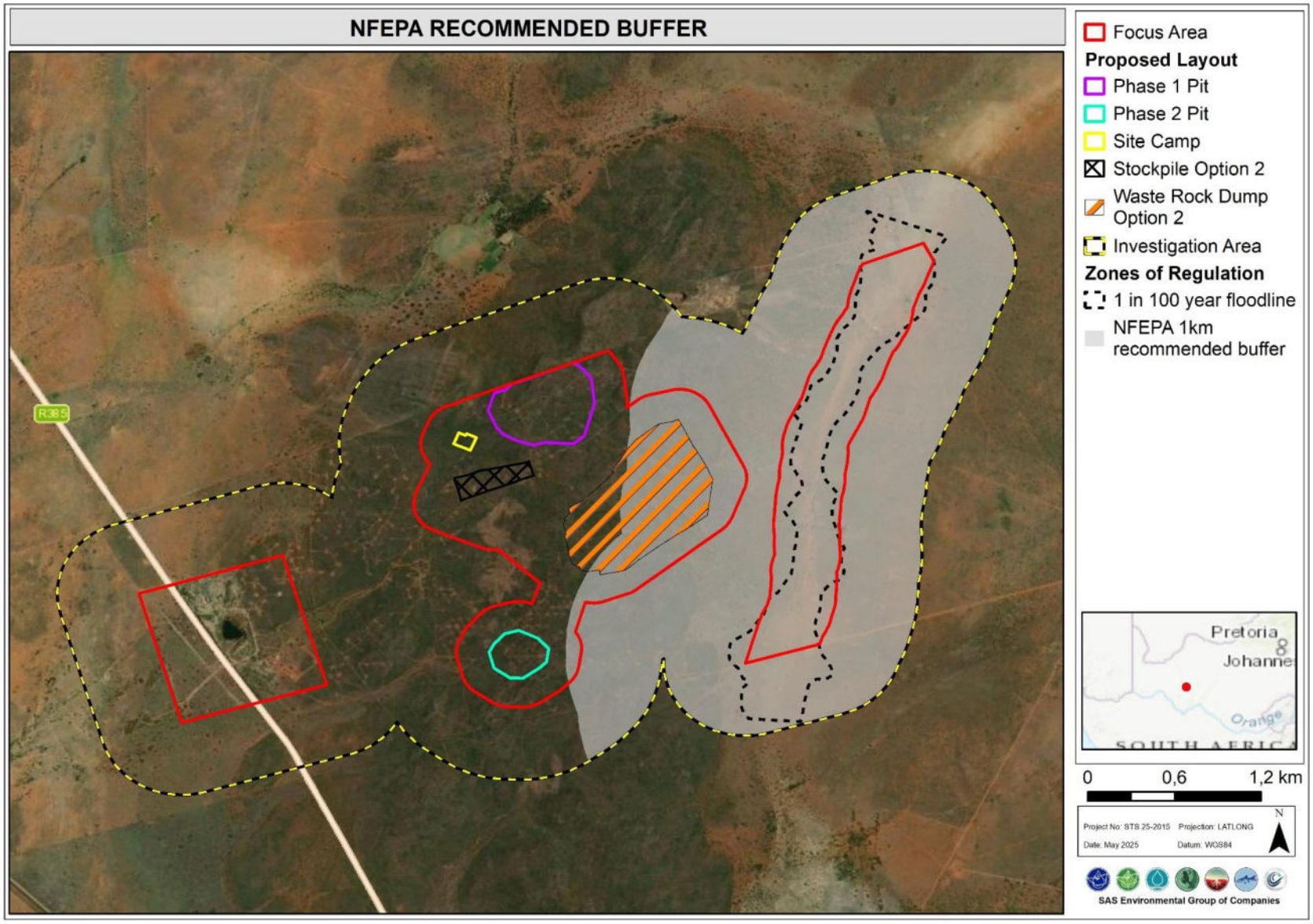


Figure 19: NFEPA recommended 1km buffer around the FEPA River (verified as the recharge zone with associated 1:100 year floodline).

7 FRESHWATER SENSITIVITY VERIFICATION

The protocol for the assessment of freshwater and aquatic biodiversity prepared in support of the Department of Forestry, Fisheries and Environment (DFFE) (previously the Department of Environmental Affairs (DEA)) National Web-based Environmental Screening Tool (2020), provides the criteria for the assessment and reporting of impacts on aquatic/freshwater biodiversity for activities requiring Environmental Authorisation (EA). For the aquatic biodiversity (freshwater) theme, the requirements are for sites which support various levels of biodiversity. The relevant aquatic biodiversity (freshwater) theme in the National Web-based Environmental Screening Tool (2020) has been provided by the South African National Biodiversity Institute (SANBI). Based on the sensitivity rating, a suitably qualified specialist must prepare the relevant report or opinion memorandum which is to be submitted as part of the EA application.

According to the guidelines, an applicant intending to undertake an activity on a site identified as being of “very high sensitivity” for an aquatic biodiversity theme must submit an Aquatic Biodiversity Impact Assessment, or if the area is identified as being of “low sensitivity” then an Aquatic Biodiversity Compliance Statement must be compiled and submitted to the competent authority. It is noted, however, that during a site survey undertaken by a suitably qualified freshwater ecologist should the sensitivity be determined different from that assigned by the screening tool (i.e. that a high risk to the regional aquatic biodiversity or freshwater ecosystems in the area is likely even though it is assigned as a “low” sensitivity, or if it is assigned a high sensitivity, however, the proposed development risks are deemed low) then the relevant assessment approach must be followed based on the site survey results and not the screening tool allocation.

As part of the process of the background information gathering, the screening tool was applied to the focus and investigation areas. According to the screening tool, the entirety of the focus and investigation areas are designated as an area of very high aquatic biodiversity (freshwater) sensitivity (Figure 20). Various triggers are listed for the designation of very high sensitivity:

- Located within a FEPA subcatchment; and
- The presence of wetlands and rivers, as confirmed by the NFEPA and NBA Databases.

Based on the site verification and detailed assessments undertaken by SAS (Pty) Ltd (Please refer to Figure 21 for the site visit tracks and points) and the findings thereof presented in this

report, the designation of very high freshwater sensitivity to the entirety of the focus and investigation areas is disputed. As a general principle, all freshwater ecosystems (EDLs) in the focus and investigation areas have been designated as sensitive features in line with the inherent sensitivity associated with freshwater ecosystems. For parts of the focus and investigation areas located outside of the delineated freshwater ecosystem boundaries which are designated by the web-based screening tool as areas of very high sensitivity, a designation of low sensitivity has been assigned.

Under the Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Aquatic Biodiversity, (GN320 of March 2020), for areas of moderate aquatic biodiversity sensitivity an Aquatic Biodiversity Assessment must be produced. Such a reporting approach has been followed in this instance.

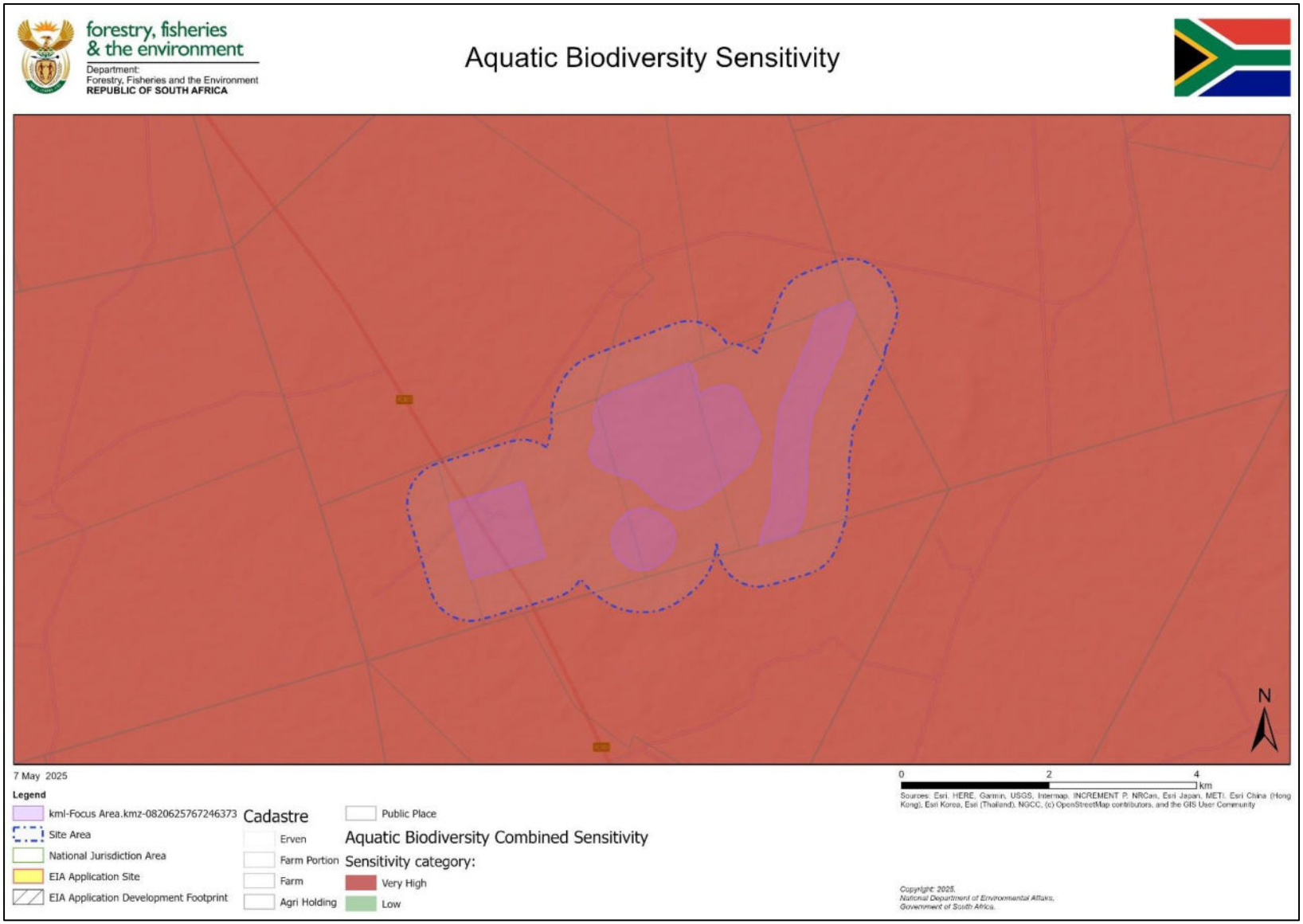


Figure 20: Aquatic (Freshwater) Biodiversity sensitivity associated with the focus area (blue shaded area) and investigation area (blue dashed outline) (DFFE Screening Tool: Accessed May 2025).

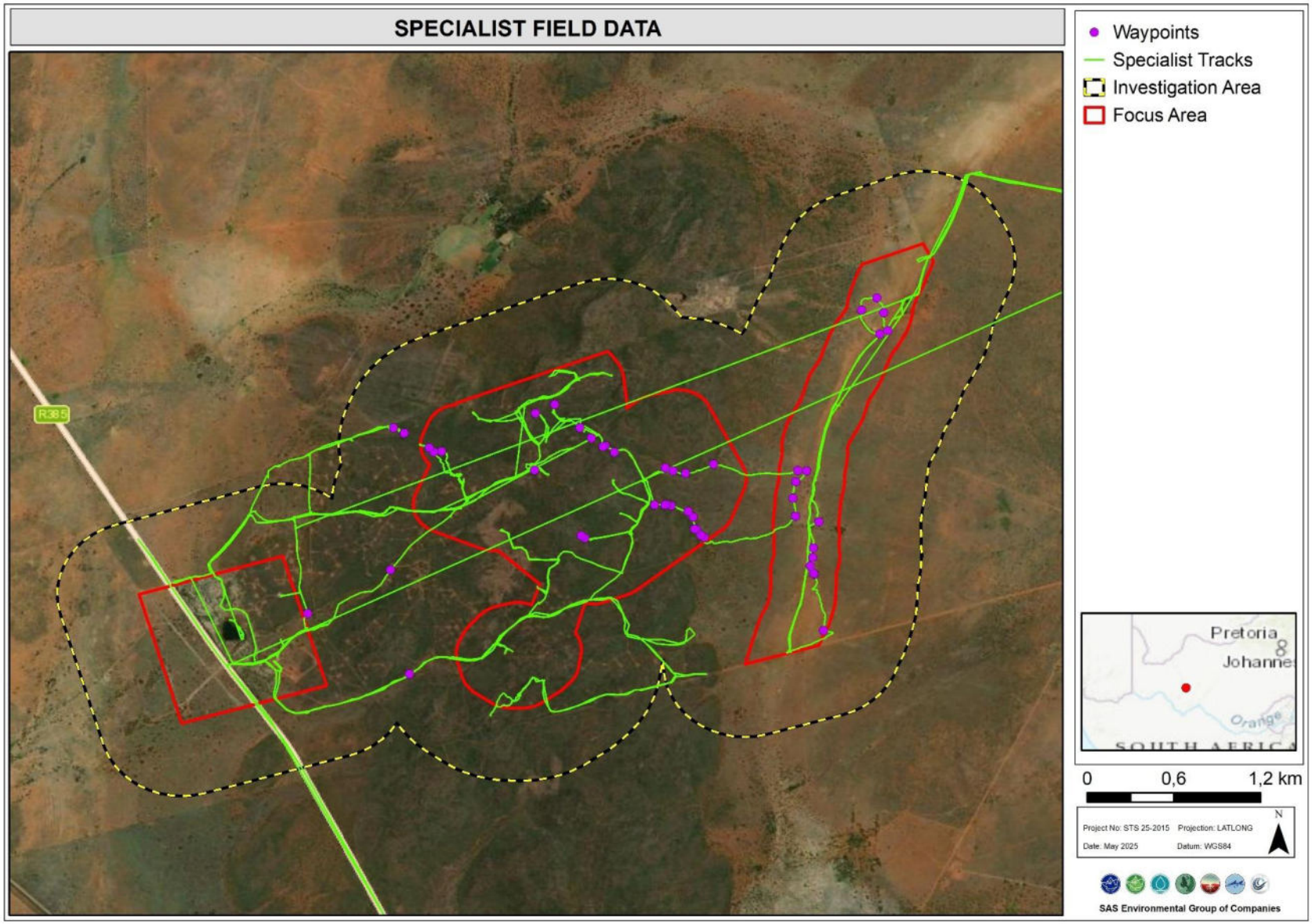


Figure 21: Field assessment tracks and points (undertaken between 1st – 3rd of April 2025).

8 RISK AND IMPACT ASSESSMENTS

This section provides the risk and impact assessment outcomes and highlights all potential impacts that may affect the identified freshwater ecosystems. The risk assessment is undertaken according to the DWS specified Risk Assessment Matrix (RAM) as promulgated in GN 4167 of 2023 as it relates to the NWA, whilst the impact assessment method was provided by the EAP for the project, Greenmined (Pty) Ltd. It is crucial to note that although these two methods may present different scores and impact significance ratings for the same activity, it is due to differences in their methodologies (refer to **Appendix D**) and not due to inconsistencies in their application. Each should be judged individually for their specified purpose; i.e., the use of the Impact Assessment method for the purposes of the Environmental Authorisation process, and the use of the DWS RAM (2023) to determine in consultation with the relevant competent authority whether there is a need to apply for a Water Use Authorisation. Management and mitigation measures are provided which must be implemented during the various development phases to assist in minimising the impact on the receiving environment.

8.1 Consideration of impacts and application of mitigation measures

Following the assessment of the freshwater ecosystems associated with the proposed development, the risk and impact assessments were applied to ascertain the significance of perceived impacts on the key drivers and receptors (hydrology, water quality, geomorphology, habitat and biota) of these freshwater ecosystems.

The points below summarise the considerations taken when applying the risk and impact assessments:

- The risk and impact assessments were applied considering the risk/impact significance of the proposed Makganyane mining operation as described in Section 1.2 and depicted in Figures 4 and 5;
- The DWS Risk Assessment Matrix (2023) was applied assuming that a high level of mitigation will be implemented, thus the results, provided in this report presents the perceived impact significance ***post-mitigation***. However, the impact assessment was undertaken for both pre- and post-mitigation implementation;
- In applying the risk and impact assessments, it was assumed that the mitigation hierarchy as advocated by the DEA *et al.* (2013) would be followed, i.e. the impacts

would first be avoided, minimised if avoidance is not feasible, rehabilitated as necessary and offset if required;

- As mentioned previously in Section 1.4, it was assumed that the existing informal road network, constructed as part of the prospecting activities, would be used. However, it is envisioned that upgrades to the roads would be required to allow for haul trucks to assess the mining operations. As such upgrading of existing roads traversing the EDLs were included in the assessments;
- Only activities within the GN 4167 100m ZoR of the EDLs and activities which pose a significant risk to the EDLs were assessed. As such, only impacts related to the Phase 2 OC pit and associated sump (within the GN 4167 100 m ZoR of the southern EDL) and the stockpile area (within the immediate catchment of the northern EDL) was assessed. The remaining proposed infrastructure (Phase 1 OC pit, site camp and waste rock dump) were not included in the assessment;
- In terms of stormwater management infrastructure, according to Figure 5, no stormwater infrastructure is located within the delineated extent of the freshwater ecosystems or the associated GN 4167 100 m ZoR. The only exception is the proposed Dirty water channel and sump around pit 1 which is located within the GN 4167 100 m ZoR and which is also likely to be within the 48 m ecological buffer of the EDLs. The remaining stormwater infrastructure (evaporation ponds, clean water channels and Pit 1 sump) has been suitably placed outside the GN 4167 100 m ZoR;
- The proposed release of treated clean water from the site camp area (via the oil separator) into the “nearby system” refers to the PFP, south of the site camp area. As the PFP is not considered a true watercourse, impacts to the system was not include in the RAM. Furthermore, the PFP does not form part of a flow path or watercourse network and as such no indirect or latent impacts are envisioned;
- Should the assessed layout change or detail regarding specific construction methods etc. become available, the risk and impact assessments would have to be re-evaluated; and
- Most impacts are considered easily detectable, with the exception of potential contamination of surface and groundwater which will require some effort. Assessing these potential impacts falls outside of the scope of this freshwater ecosystem study.

8.2 Risk and Impact Assessment discussion of anticipated ecological impacts

There are five key ecological impacts on freshwater ecosystems that are anticipated to occur namely:

- Loss of freshwater habitat and ecological structure resulting in impacts to biota;
- Changes to the sociocultural and service provision;
- Impacts on the hydrology and sediment balance of the freshwater ecosystems; and
- Impacts on water quality; and
- Proliferation of alien and invasive plants.

Various activities and development aspects may lead to these impacts, however, provided that the mitigation hierarchy is followed, some impacts can be avoided or adequately minimised where avoidance is not feasible. The mitigation measures provided in this report have been developed with the mitigation hierarchy in mind, and the implementation and strict adherence to these measures will assist in minimising the significance of impacts on the receiving environment.

The results of the risk assessment are summarised in Table 6 overleaf, whilst the outcome of the impact assessment is presented in Table 7 to Table 10 and the recommended mitigation measures, which must be implemented in order to reduce the impacts of the proposed activities are presented in Table 11 (Section 8.3).

Kindly refer to **Appendix F** for the full DWS risk assessment table scorings and **Appendix G** for general good housekeeping practices that must be implemented.

Table 6: Summary of the results of the DWS risk assessment matrix applied to the EDLs associated with the proposed Makganyane mining operation.

Phase	Activity	Impact	Potentially affected watercourses			Consequence	Likelihood	Significance	Risk Rating
			Name/s	PES	Overall Watercourse Importance				
PRE CONSTRUCTION	Potentially poor planning of stormwater management and pollution control for the project.	•Alteration of hydrology and geomorphology of receiving freshwater ecosystems and resulting degradation of freshwater habitat through poor stormwater design, or through poor design of clean and dirty water systems, including dirty water channels and evaporation pond/s.	Both EDLs	B	Moderate	**36**	40%	**14,4**	**L**
CONSTRUCTION	Clearing of vegetation and earthworks associated with the dirty water channel and sump within the 48 m ecological buffer and 100 m ZoR of the southern EDL.	•Earthworks could be potential sources of dust and sediment, which may be transported by wind and / or stormwater into the adjacent southern EDL; •Exposure and potential compaction of soil, leading to increased runoff, and erosion, and thus increased potential sedimentation of downgradient southern EDL, leading to smothering of the vegetation within the system; •Soil and stormwater contamination from oils and hydrocarbons originating from construction vehicles that could be transported as pollutants into the downgradient southern EDL; and •Increased risk of alien invasive vegetation proliferation.	Southern EDL	B	Moderate	**30**	80%	**24**	**L**
	Clearing of Vegetation and Topsoil Stripping in the Phase 2 OC footprint area (adjacent to and within the GN 4167 100m ZoR of the southern EDL) as the first step of open cast mining.		Southern EDL	B	Moderate	**36**	80%	**28,8**	**L**
	Creation of the stockpile within the immediate catchment of the northern EDL.	•Disturbances of soil leading to increased alien vegetation proliferation within the area immediately surrounding the stockpile, with the potential to affect the downgradient freshwater habitat; •Accidental / unplanned deposition of removed material within nearby freshwater habitat, thereby smothering vegetation; •Altered runoff patterns within the local catchment of the northern EDL, potentially leading to increased erosion and sedimentation of the downgradient system; and •Potential of stockpiled material slumping and entering the downgradient EDL, increasing the sediment loads therein.	Northern EDL	B	Moderate	**36**	40%	**14,4**	**L**

Phase	Activity	Impact	Potentially affected watercourses			Consequence	Likelihood	Significance	Risk Rating
			Name/s	PES	Overall Watercourse Importance				
	Upgrading of existing informal roads (if required) which bisect the EDLs and are located within the GN 4167 100m ZoRs.	•Earthworks and exposure of soil could result in sedimentation of the freshwater ecosystems, which may be transported as runoff into the downstream freshwater ecosystem areas and may smother vegetation associated with the freshwater ecosystems; •Altered water quality (if surface water is present) as a result of vehicle movement and construction activities; and •Proliferation of alien and/or invasive vegetation as a result of disturbances.	Both EDLs	B	Moderate	**36**	40%	**14,4**	**L**
OPERATIONAL	Undertaking of open cast mining (including blasting) adjacent to and within the GN 4167 100m ZoR of the southern EDL (Phase 2 OC pit)	•Destruction of natural habitat within the catchment of the southern EDL that will alter the pattern, timing and volumes of flow into the downgradient EDL; •Potential sedimentation of the downgradient southern EDL if mined material is washed or carried by wind into downstream reach; •Increased risk of pollution of surface water (when present) and shallow groundwater leading to impaired water quality (increase in salts and specific contaminants of concern and reduced pH), from various potential sources including: •Potential spillage of oils/hydrocarbons from mining equipment and vehicles; •Dewatering of the open cast pit and discharging of such water into the environment; and •Nitrates from residual blasting emulsion leading to eutrophication of the downgradient southern EDL.	Southern EDL	B	Moderate	**42**	80%	**33,6**	**M**

Phase	Activity	Impact	Potentially affected watercourses			Consequence	Likelihood	Significance	Risk Rating
			Name/s	PES	Overall Watercourse Importance				
	Operational reshaping of the Phase 2 open cast pit and associated rehabilitation (topsoil restoration and revegetation) adjacent to and within the GN 4167 100m ZoR of the southern EDL.	•Potential poor execution of open cast pit reshaping which may leave long term or permanent alterations in the landscape that will permanently affect runoff and interflow within the catchment of the southern EDL; •Potential dumping of waste rock / overburden into the adjacent EDL area, leading to smothering of vegetation; •Obstructions to flows as well as potential sedimentation and other pollution-related impacts; •Potentially poorly executed rehabilitation that could lead to poor coverage by vegetation of the rehabilitated area and subsequent development of erosion and sedimentation of the downgradient EDL; and •Potential decant of contaminated water from the reshaped portion of the open cast pit, resulting in contaminated water entering the receiving environment and subsequent loss of biodiversity in the downgradient EDL.	Southern EDL	B	Moderate	**36**	60%	**21,6**	**L**
	Transport of product from the open cast pits to the primary beneficiation plant (offsite) via the upgraded road which bisects the southern EDL and is located within the associated GN 4167 100m ZoR.	•Potential accidental spillage of blasted raw material in the EDL or catchment of the EDL, leading to potential smothering of freshwater vegetation, obstructions to flows as well as potential sedimentation and other pollution-related impacts in the downgradient / adjacent system.	Southern EDL	B	Moderate	**36**	80%	**28,8**	**L**
	Operation of the portion of the OC Pit 2 dirty water channel and sump within the GN 4167 100m ZoR of the southern EDL.	In the event of a leak, dirty water flow into the downgradient southern EDL which can lead to contamination of the system which would result in: •Alteration in water quality (if present); •Alteration of the run-off and hydrological flow regime and hydroperiod of the EDL; •Increased stream velocity resulting in the disturbance to vegetation and possible incision and soil erosion in the EDL; and •Potential changes in service provisioning potential of the system.	Southern EDL	B	Moderate	**30**	40%	**12**	**L**

Phase	Activity	Impact	Potentially affected watercourses			Consequence	Likelihood	Significance	Risk Rating
			Name/s	PES	Overall Watercourse Importance				
	Operation and maintenance of the upgraded road crossings within the EDLs.	•Concentrated runoff from the haul roads leading to erosion and subsequent sedimentation of the EDL habitats (increase in the sediment load) and increase in turbidity when surface water is present; and •Potential transport of spilled oils and hydrocarbons on the road surface into the downgradient reaches of the EDLs through stormwater, causing deterioration of surface water quality.	Both EDLs	B	Moderate	**36**	60%	**21,6**	**L**
DECOMMISIONING	Ongoing (long term) rehabilitation of the mining footprint areas within the GN 4167 100m ZoR of the EDLs.	•Compaction of soils due to vehicular movement; •Latent impacts of vegetation losses; •Increased runoff volumes and formation of preferential surface flow paths as a result of compacted soils, leading to potential development of erosion; and •Potential poor management of AIP vegetation which could lead to proliferation of AIPs in affected areas, leading to longer term colonisation of other areas.	Both EDLs	B	Moderate	**33**	60%	**19,8**	**L**
	Post-closure management activities.	•Contamination of water within the receiving environment as a result of mine water decant and subsequent reduction in water quality (increase in salts and specific contaminants of concern and reduced pH); and •Subsequent negative impacts on biota and vegetation that result in overall habitat degradation.	Both EDLs	B	Moderate	**48**	60%	**28,8**	**L**

Table 7: Results of the Impact Assessment applied for the pre-construction phase activities.

Activity: Potentially poor planning of stormwater management and pollution control for the project.																
Freshwater Ecosystem	Pre-mitigation								Post-mitigation							
	S	D	E	F	Pr	Co	L	Si	S	D	E	F	Pr	Co	L	Si
Both EDLs	3	3	2	5	2	2	3	9 (Low-Medium)	2	3	2	5	1	2	3	7 (Low-Medium)

Table 8: Results of the Impact Assessment applied for the construction phase activities.

Activity: Clearing of vegetation and earthworks associated with the dirty water channel and sump within the 48m ecological buffer and 100m ZoR of the southern EDL.																
Freshwater Ecosystem	Pre-mitigation								Post-mitigation							
	S	D	E	F	Pr	Co	L	Si	S	D	E	F	Pr	Co	L	Si
Southern EDL	2	4	1	1	3	2	2	5 (Low-Medium)	1	4	1	1	2	2	2	3 (Low)
Activity: Clearing of Vegetation and Topsoil Stripping in the Phase 2 OC footprint area (adjacent to and within the GN 4167 100m ZoR of the southern EDL) as the first step of open cast mining.																
Southern EDL	3	4	2	1	4	3	2	7 (Low-Medium)	1	4	2	1	3	2	2	4 (Low)
Activity: Creation of the stockpile within the GN 4167 100 m ZoR and catchment of the northern EDL.																
Northern EDL	4	4	2	1	4	3	2	8 (Low-Medium)	3	4	2	1	3	3	2	6 (Low-Medium)
Activity: Upgrading of existing informal roads (if required) which bisect the EDLs and are located within the GN 4167 100m ZoR.																
Both EDLs	5	2	1	5	3	2	4	10 (Medium)	3	2	1	5	2	2	3	7 (Low-Medium)

Table 9: Results of the Impact Assessment applied for the operation phase activities.

Activity: Undertaking of open cast mining (including blasting) adjacent to and within the GN 4167 100m ZoR of the southern EDL (Phase 2 OC pit)																
Freshwater Ecosystem	Pre-mitigation								Post-mitigation							
	S	D	E	F	Pr	Co	L	Si	S	D	E	F	Pr	Co	L	Si
Southern EDL	5	4	2	4	5	3	4	16 (Medium-High)	3	4	2	3	5	3	4	12 (Medium)
Activity: Operational reshaping of the Phase 2 open cast pit and associated rehabilitation (topsoil restoration and revegetation) adjacent to and within the GN 4167 100m ZoR of the southern EDL.																
Southern EDL	3	4	2	1	4	3	2	7 (Low-Medium)	1	4	2	1	3		2	4 (Low)
Activity: Transport of product from the open cast pit (Phase 2) to the primary beneficiation plant (offsite) via the upgraded road which bisects the southern EDL and is located within the associated GN 4167 100m ZoR																
Southern EDL	3	4	2	1	3	3	2	6 (Low-Medium)	2	4	2	1	2	2	1	4 (Low)
Activity: Operation of the portion of the OC Pit 2 dirty water channel and sump within the GN 4167 100m ZoR of the southern EDL.																
Southern EDL	3	2	1	1	3	2	2	4 (Low)	2	2	1	1	2	1	1	2 (Low)
Activity: Operation and maintenance of the upgraded road crossings within the EDLs.																
Both EDLs	3	2	1	1	3	2	2	4 (Low)	2	2	1	1	2	1	1	2 (Low)

S = Severity; D = Duration; E = Extent; F = Frequency; Pr = Probability; Co = Consequence; L = Likelihood; Si = Significance

Table 10: Results of the Impact Assessment applied for the decommissioning phase activities.

Activity: Ongoing (long term) rehabilitation of the mining footprint areas within the GN 4167 100m ZoR of the EDLs.																
Freshwater Ecosystem	Pre-mitigation								Post-mitigation							
	S	D	E	F	Pr	**Co**	**L**	**Si**	S	D	E	F	Pr	**Co**	**L**	**Si**
Both EDLs	2	5	2	4	2	**3**	**3**	**9 (Low-Medium)**	1	3	2	3	1	**1**	**2**	**3 (Low)**
Activity: Post-closure management activities.																
Both EDLs	1	5	2	4	2	2	**3**	**8 (Low-Medium)**	1	3	2	3	1	**1**	**2**	**3 (Low)**

S = Severity; D = Duration; E = Extent; F = Frequency; Pr = Probability; Co = Consequence; L = Likelihood; Si = Significance.

8.3 Recommended Mitigation Measures

Table 11: Recommended Mitigation Measures.

Pre Construction Phase
Activity: Potentially poor planning of stormwater management and pollution control for the project.
Mitigation Measures: •Stormwater generated from mining areas must not adversely affect downgradient freshwater ecosystems. Accordingly, a stormwater management plan must be developed for the proposed mine that ensures the separation of clean and dirty water in line with GN704. Stormwater management must be implemented continuously in terms of both mining and rehabilitation activities; •It is highly recommended that the clean and dirty water separation systems (including the evaporation pond/s) be located as far as practically and feasibly possible outside of the GN 4167 100m ZoR of the EDLs to minimise the potential risk of a spill and contamination; •All dirty water channels that could carry contaminated water must be suitably lined; and •The evaporation pond/s must be appropriately lined to ensure no leakage of dirty / polluted water occurs and must be designed to have sufficient capacity to hold the full design capacity inflow. The evaporation pond/s must be designed according to the Department: Water Affairs and Forestry Best Practice Guideline A4: Pollution control dams (2007).
Construction Phase
Activity: Clearing of vegetation and earthworks associated with the dirty water channel and sump within the 48m ecological buffer and 100m ZoR of the southern EDL.
Activity: Clearing of Vegetation and Topsoil Stripping in the Phase 2 OC footprint area (adjacent to and within the GN 4167 100m ZoR of the southern EDL) as the first step of open cast mining.
Mitigation Measures: •In line with the mitigation hierarchy, the stockpile area has been reshaped and redesigned to avoid the 48m non-development buffer area as well as the 100m GN 4167 ZoR, therefore limiting the potential indirect impacts as a result of catchment wide activities. This in itself is deemed a mitigation measure. •It was however not deemed feasible or practically possible to reshape or redesign the Phase 2 OC pit area. However, the recommended mitigation measures have been suitably designed to best limit potential indirect impacts. •Prior to the onset of any clearing, the approved works area must be demarcated (preferably as part of the proposed fencing of the mining footprint). It is critical that the reaches of the EDLs and the associated 48 m ecological buffer not located in the open cast or other mining infrastructure footprint be clearly demarcated as a no-access areas; •All vegetation removed as part of the site clearing activities (specifically where large areas need to be cleared) must be transported from the construction site (if not being used for rehabilitation purposes (may not be stockpiled) and disposed of at a registered waste disposal facility; •Stripping of topsoil and vegetation must by planned so that smaller areas (blocks) of vegetation are cleared systematically and only when excavation is immediately planned in that part of the footprint to avoid and minimise the area of exposed subsoils and time during which this is exposed. •Stormwater controls must be put in place on the downgradient side of the area being excavated and along the boundaries of any development exclusion area located downgradient of the works area so that as construction takes place, dirty water runoff is appropriately managed; and •It is recommended that an AIP control plan is developed, and that AIP control is implemented for the duration of the construction and mining periods.
Activity: Creation of the stockpile within the immediate catchment of the northern EDL (outside of the GN 4167 100m ZoR).
Mitigation Measures: •Stockpiling must be carefully monitored by the Environmental Control Officer (ECO) to ensure that all Environmental Management Programme (EMPr)-related control measures are implemented; •Any topsoil stockpile/s may not be left to become naturally revegetated (material stockpiles will be transported from site) as this is associated with a significant risk of alien invasive plant proliferation as well as erosion development; rather the topsoil stockpile/s must either be covered with tarpaulins or similar durable covering that will last for the duration of the works period, or be revegetated by means of hydroseeding with a suitable indigenous plant mix to prevent these from becoming eroded by rainfall and associated runoff or to prevent the stockpile from generating significant volumes of dust into surrounding areas; and •Silt and stormwater controls that are durable must be installed on the downgradient side of all stockpile area. It is recommended that a dirty water management system be installed around the stockpile boundaries to ensure that silt-laden water is properly managed.
Activity: Upgrading of existing informal roads (if required) which bisect the EDLs and are located within the GN 4167 100m ZoR.
Mitigation Measures: •The construction footprint must be limited to a construction Right of Way (RoW) that comprises a 5 m construction buffer (upstream and downstream of the freshwater ecosystem crossing) only to prevent indiscriminate movement of mining equipment in the system; •Upgrading of the informal roads must take cognisance of the delineated extent of the freshwater ecosystem traversed by the existing informal access road. Should the road be increased in width, the road must be expanded on the side opposite of a freshwater feature (where applicable), to ensure that the remaining natural buffer between the access road and the freshwater feature remains intact;

•Material to be used (gravel – if applicable) as part of the upgrading of the existing roads must be stockpiled outside the delineated extent of the freshwater ecosystems (preferably outside of the 48 m ecological buffer from the freshwater feature) to prevent sedimentation thereof and to avoid any other vegetation being impacted by the construction activities. These stockpiles may not exceed a height of 2 m and must be protected from wind using tarpaulins; •The disturbed area surrounding the road must be revegetated with suitable indigenous vegetation to prevent the establishment of alien vegetation species and to prevent erosion from occurring; •The alien vegetation management plan as compiled by the terrestrial/botanical ecologist is highly recommended and supported by the freshwater specialist and must be implemented concurrently with the commencement of construction; and •All existing alien and invasive vegetation must be removed. All material must be disposed of at a registered garden refuse site and may not be burned or mulched on site. ***With regards to excavation and soil compaction activities within the freshwater ecosystems:*** •Although the proposed freshwater ecosystems crossings upgrades are associated with generally existing informal roads, and as such the most significant impacts have already occurred, the existing gravel roads are relatively small and are lacking formal through-flow structures (pipe culverts are considered suitable in this context). The following are applicable with regards to excavation works and any concrete related activities: •During the excavation activities, any soil/sediment or silt removed from the freshwater ecosystem may be temporarily stockpiled in the construction ROW but outside the delineated extent of the freshwater ecosystem. These stockpiles may not exceed 2 m in height, and their footprint must be kept to a minimum; •Stockpiling of removed materials may only be temporary (may only be stockpiled during the period of construction at a particular site) and must be suitably disposed of; •Excavated materials must not be contaminated, and it must be ensured that the minimum surface area is taken up. Mixture of the lower and upper layers of the excavated soil must be kept to a minimum, for later usage as backfill material or as part of rehabilitation activities; •Care must be taken to ensure that no scouring or erosion occurs as a result of the proposed crossing; •All construction material (with specific mention of prefabricated culvert structures) must be stockpiled in the laydown area and must only be imported to the construction site when required; and •Construction equipment/vehicles used to install culvert structures must be parked on the existing road surface and may not enter the freshwater ecosystems.
Operational Phase
Activity: Undertaking of open cast mining (including blasting) adjacent to and within the GN 4167 100m ZoR of the southern EDL (Phase 2 OC pit)
Mitigation Measures: •The portions of the 48 m non development (ecological) buffer around the EDL, not impacted by the OC pit, must be maintained to provide some form of residual protection to the system from spill-over and edge effects of the mining operations; •Stormwater controls in the form of temporary berms and silt traps must be installed and maintained for the duration of the mining operations to prevent polluted sediment and other fines materials from being transported by stormwater into the downgradient reach of the system; •A monitoring programme must be implemented to detect and prevent the pollution of soil, surface water and groundwater; •Reduce airborne dust during blasting activities through damping dust generation areas with freshwater (although not in sufficient quantities to generate runoff); and •No dewatering operations from the pit must allow any discharge of such water into the natural environment, and all such water must be handled as part of the dirty water management system of the Phase 2 OC pit.
Activity: Operational reshaping of the Phase 2 open cast pit and associated rehabilitation (topsoil restoration and revegetation) adjacent to and within the GN 4167 100m ZoR of the southern EDL.
Mitigation Measures: •The reshaping of the western side of the Phase 2 OC pit within the 48 m ecological buffer ensure a natural gradient as possible, which fits into the overall landscape; •Reinstatement of substrate must allow interflow that mimics the direction of the slope to be reinstated; •Subsoil and topsoil restoration and revegetation, along with post-reshaping AIP control is recommended to be undertaken in the reshaped areas as soon as possible once reshaping is complete; •Rehabilitated areas in the open cast pit footprint must be revegetated with a range of species that is similar to the current species assemblage in line with the recommendations from a suitably qualified specialist; •Monitoring of erosion in the reshaped area must be undertaken and any developing rills / gullies must be immediately rehabilitated; •Follow up revegetation must be undertaken if bare areas develop or if seeding is unsuccessful to ensure that soils remain protected and not vulnerable to sheet and rill erosion; and •Sediment control measures must be installed for the reshaped area within 100m of the boundary of the southern EDL.
Activity: Operation of the portion of the OC Pit 2 dirty water channel and sump within the GN 4167 100m ZoR of the southern EDL.
Mitigation Measure: •All recommendations and mitigation measures as provided in the SWMP (TBC, 2025[1]) must be strictly adhered to; •Regular inspection of the dirty water channel must be undertaken;

•The EDL may not be inundated as a result of leaks of the dirty water channel (tearing in the lining), an emergency plan must be compiled to ensure a quick response and attendance to the matter in case of tearing in the dirty water channel lining; and •Only existing roadways must be utilised during maintenance and monitoring activities to avoid indiscriminate movement of vehicles.
Activity: Transport of product from the open cast pit (Phase 2) to the primary beneficiation plant (offsite) via the upgraded road which bisects the southern EDL and is located within the associated GN 4167 100m ZoR.
Mitigation Measures: •Only the approved haul route between blasting / extraction areas and screening / crushing plants must be used and must be strictly controlled through the compliance monitoring as associated with the EMPr; •Vehicles transporting product must not be overloaded to avoid spillage of product; •Vehicles transporting product must be maintained in a good working condition and no leaking vehicles and machinery must be allowed to travel on the haul road; and •Speed limits for vehicles transporting product must be strictly enforced.
Activity: Operation and maintenance of the upgraded road crossings within the EDLs.
Mitigation Measures: •No indiscriminate movement of maintenance equipment or vehicles through the freshwater ecosystems may be permitted during standard operational activities or maintenance activities. Use must be made of the existing road crossings only; •Unnecessary disturbances surrounding the perimeter of the surface infrastructure must be avoided; •Vehicles used in the development site must be regularly washed (on a non-permeable surface or off-site) to avoid the dispersal of seeds on any alien or invasive species into the freshwater ecosystems; •Ensure that routine inspections and monitoring of any instream infrastructure are undertaken to monitor any build-up of debris that will impact on structure integrity or lead to erosion and sedimentation. Furthermore, monitoring to determine the establishment of indigenous vegetation and the presence of any alien or invasive plant species; •Routine maintenance of the roads must be undertaken to ensure that no concentration of flow and subsequent erosion occurs due to the road crossings/instream infrastructure. Such maintenance activities must specifically be undertaken after high rainfall events; •During periodic maintenance activities of the roads, monitoring for erosion must be undertaken; and •Should erosion be observed, caused by the road crossings, the area must be rehabilitated by infilling the erosion gully and revegetation thereof with suitable indigenous vegetation. Use can also be made of rocks collected from the surrounding area to infill any area prone to erosion (however, these must be sustainably sourced not taken from the surrounding freshwater ecosystems including rivers in the local area).
Decommissioning phase
Activity: Ongoing (long term) rehabilitation of the mining footprint areas within the GN 4167 100m ZoR of the EDLs.
Mitigation Measures: •The topsoil along the roads and their immediate vicinity are likely to be contaminated by spilled material; all such material must be removed and disposed of in the waste material dumps of the mine or at a hazardous landfill site in the case of spilled material such as oils or other hydrocarbons. This material must not be utilised for restoration; •Should erosion gullies be noted, these areas must be rehabilitated by infilling them with suitable soil and ensuring the area is vegetated. The increased surface roughness will discourage concentrated flow paths to develop and ensure diffuse flow patterns; •All bare areas must be ripped and be revegetated within suitable indigenous vegetation species; •Follow up revegetation must take place where initial revegetation is not successful; and •Post-closure monitoring of the freshwater ecosystems (for a period of 3 years), with specific mention of the invasion of alien vegetation species) is recommended to be undertaken.
Activity: Post-closure management activities.
Mitigation Measures: •Potential points of decant and risks of water contamination as a result must be determined. The management and mitigation measures as recommended in the geohydrological study should be implemented to mitigate the potential impacts arising from decant of contaminated water from the mine into the receiving environment.

8.4 Cumulative and Residual Impacts

Cumulative impacts are not limited to the construction or operational phases of the proposed mining activities but may add to the impacts identified in Section 8.2 above. Freshwater ecosystems within the region are under continued threat due to expansion of mining operations in the surrounding landscape, as well as due to poor landuse practices such as overgrazing and not controlling invasive vegetation which can affect freshwater ecosystems. The demand for water and impounding small drainage lines has also led to significant loss of

recharge of watercourses in the region. In many cases the destruction of freshwater habitat within mining footprints continues to increase. There is thus an increased threat to freshwater ecosystems in the wider area in both the context of systems directly affected and those with mining operations in their catchments, leading to a decline in levels of freshwater ecosystem state and functionality over a wider, regional area. A key cumulative risk in the region is reduced water tables due to the formation of a cone of depression in groundwater which reduces freshwater ecosystems recharge. This has had a very significant impact on systems such as the Gamagara and Kuruman rivers.

As the proposed mining operation has been suitably designed to best avoid the EDLs and associated ecological buffer, along with the fact that the EDL systems are isolated and not connected to a larger system, no significant cumulative impacts are envisioned. That being said, the recommended mitigation measures, as outlined in Sectio 8.3 above, must be strictly adhered to.

Residual impacts arise from activities of which the effects persist long after the activity has ceased due to the self-perpetuating nature of such impacts (e.g. erosion). Residual impacts may cease with human remediation. Residual impacts could also result from the change in runoff and interflow characteristics from the catchment of the freshwater ecosystems in which the mining operation is proposed (includes open cast pits and the waste dump area). Runoff would occur in a modified way from the catchment of the systems once mining has occurred even if rehabilitated.

9 CONCLUSION

Scientific Aquatic Services (SAS) (Pty) Ltd was appointed by Greenmined Environmental (Pty) Ltd to conduct a freshwater ecological assessment in support of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed Makganyane Iron Ore Mine, located near Beeshoek, Northern Cape Province.

The site assessment undertaken in April 2025 confirmed the presence of two Episodic Drainage Lines (EDLs) without riparian vegetation, associated with the western portions of the focus and investigation areas. Numerous artificial features were also identified during the site assessment which included Preferential Flow Paths (PFPs), and a recharge zone associated with the "desktop database defined freshwater feature" focus area. Neither the PFPs nor the recharge zone met the definition of a watercourse from an ecological perspective (as defined by the NWA) and were therefore excluded from further assessment. Form a legal perspective, however, a 1 in 100 year floodline has been modelled for the recharge zone (TBC, 2025[2]) and as such does enjoy protection under the NWA (Section 6: Figure 18). The hydrological assessment (TBC, 2025[2]) does not indicate any floodlines for the PFP's and therefore does not enjoy protection from a legal perspective.

The table below provides a summary of the assessment of the EDLs as outlined in Section 4.

Table 12: Summary of results of the field assessment.

Freshwater Ecosystem	Present Ecological State (PES) / Ecostatus	Ecoservices	Ecological Importance and Sensitivity (EIS)	Recommended Ecological Category / Recommended Management Objective / Best Attainable State
EDLs	Largely Natural	Moderate to Very Low	Moderate	REC Category: B BAS Category: B RMO: Maintain

Following the freshwater ecosystem assessment, the DWS Risk Assessment Matrix (2023) and the EAP provided Impact Assessment was applied to determine the significance of impacts of the proposed mining and associated activities on the receiving freshwater environment. Most of the activities associated with the proposed mining development have been assessed to be associated with a "low" degree of risk to the freshwater environment, due to the suitable placement of infrastructure and the reshaping and redesigning of disturbance areas in consultation with the freshwater specialist and in line with the in line with the mitigation hierarchy (Department of Environmental Affair [DEA], 2011). The only exception is the construction and operation of the proposed Phase 2 OC pit which was assessed to have a

moderate risk significance on the southern EDL. The moderate risk is ascribed to the fact that the Phase 2 OC pit area is located adjacent to and within in the 48 m ecological buffer of the southern EDL and would result in numerous indirect impacts which will need to be appropriately managed as per the recommendations set out in this report.

Provided that the mitigation measures, as stipulated in this report and the mitigation measures contained within the SWMP are strictly adhered to, the proposed Makganyane mining operation, from a water resource management point of view, can be considered acceptable for authorisation in terms of the EA and WUA processes.

10 REFERENCES

Department of Water Affairs and Forestry (DWAF). 2008. *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas,* prepared by M. Rountree, A. L. Batchelor, J. MacKenzie and D. Hoare. Report no. X. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

Department of Water Affairs and Forestry (DWAF). 2005. *Final draft: A practical field procedure for identification and delineation of wetlands and Riparian areas.*

Department of Water and Sanitation (DWS). 2014. *A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Secondary: C2 Compiled by RQIS-RDM: Online available: https://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx*

Kleynhans C.J., Thirion C. and Moolman J. 2005. *A Level 1 Ecoregion Classification System for South Africa, Lesotho and Swaziland.* Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria

Kleynhans C.J., Thirion C., Moolman J, Gaulana L. 2007. *A Level II River Ecoregion Classification System for South Africa, Lesotho and Swaziland.* Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria

Kotze D.C., Marneweck G.C., Batchelor, A.L., Lindley D.S. and Collins N.B. 2009. *WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands.* WRC Report No TT 339/08, Water Research Commission, Pretoria.

Le Maitre DC, O'Farrell PJ and Reyers B. 2007 *Ecosystems services in South Africa: a research theme that can engage environmental, economic and social scientists in the development of sustainability science?* South African Journal of Science 103, September/October 2007

Macfarlane D.M. and Bredin I. 2017. Buffer Zone Guidelines for Rivers, Wetlands and Estuaries. Part 1: Technical Manual. WRC Report No. TT 715-1-17 May 2017.

Macfarlane D.M., Kotze D.C., Ellery W.N., Walters D., Koopman V., Goodman P. and Goge C. 2008. *WET-Health: A technique for rapidly assessing wetland health.* WRC Report No. TT 340/08. Water Research Commission, Pretoria.

Nel, JL, Driver, A., Strydom W.F., Maherry, A., Petersen, C., Hill, L., Roux, D.J, Nienaber, S., Van Deventer, H., Swartz, E. & Smith-Adao, L.B. 2011. *Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources.* Water Research Commission Report No. TT 500/11, Water Research Commission, Pretoria.

NFEPA: Driver, A., Nel, J.L., Snaddon, K., Murray, K., Roux, D.J., Hill, L., Swartz, E.R., Manuel, J. and Funke, N. 2011. Implementation Manual for Freshwater Ecosystem Priority Areas. Water Research Commission. Report No. 1801/1/11. Online available: http://bgis.sanbi.org/nfepa/project.asp

Ollis, D.J., Snaddon, C.D., Job, N.M. & Mbona, N. 2013. *Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems.* SANBI Biodiversity Series 22. South African Biodiversity Institute, Pretoria.

Rossouw, L., Avenant, M. F., Seaman, M. T., King, J. m., Barker, C. H., du Preez, P. J., Pelser, A. J., Roos, J. C., van Staden, J. J., van Tonder, G. J., and Watson, M. 2005. *Environmental Water Requirements in Non-Perennial Systems.* WRC Report 1414/1/05. Water Research Commission. Pretoria.

Rountree, M.W. and Kotze, D.C. 2013. Appendix A3: Ecological Importance and Sensitivity Assessment. In: Rountree, M. W., Malan, H.L., and Weston, B.C. Eds. *Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Version 2.0)*. WRC Report No. 1788/1/12. Pretoria.

The Biodiversity Company. 2025[1]. Stormwater Management Plan: Proposed Makganyane Iron Ore Mine, Tsantsabane Municipality, Northern Cape, South Arica.

The Biodiversity Company. 2025[2].Hydrological Assessment: Proposed Makganyane Iron Ore Mine, Tsantsabane Municipality, Northern Cape, South Arica.

Van Deventer, H.; Smith-Adao, L.; Mbona, N.; Petersen, C.; Skowno, A.; Collins, N.B.; Grenfell, M.; Job, N.; Lötter, M.; Ollis, D.; Scherman, P.; Sieben, E.; Snaddon, K. 2018. *South African Inventory of Inland Aquatic Ecosystems. South African National Biodiversity Institute, Pretoria. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847.*

Van Deventer, H., Smith-Adao, L., Collins, N.B., Grenfell, M., Grundling, A., Grundling, P-L., Impson, D., Job, N., Lötter, M., Ollis, D., Petersen, C., Scherman, P., Sieben, E., Snaddon,

K., Tererai, F. & Van der Colff, D. 2019. *South African National Biodiversity Assessment 2018: Technical Report. Volume 2b: Inland Aquatic (Freshwater) Realm. CSIR report number CSIR/NRE/ECOS/IR/2019/0004/A. South African National Biodiversity Institute, Pretoria. http://hdl.handle.net/20.500.12143/6230.*

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K. *2018. South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 November 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847.*

APPENDIX A – Terms of Use and Indemnity

INDEMNITY AND TERMS OF USE OF THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and SAS (Pty) Ltd and its staff reserve the right to, at their sole discretion, modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

Although SAS (Pty) Ltd exercises due care and diligence in rendering services and preparing documents, SAS (Pty) Ltd accepts no liability and the client, by receiving this document, indemnifies SAS (Pty) Ltd and its directors, managers, agents and employees against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by SAS (Pty) Ltd and by the use of the information contained in this document.

This report must not be altered or added to or used for any other purpose other than that for which it was produced without the prior written consent of the author(s). This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

APPENDIX B – Legislation

LEGISLATIVE REQUIREMENTS

The Constitution of the Republic of South Africa, 1996	The environment and the health and well-being of people are safeguarded under the Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996) by way of section 24. Section 24(a) guarantees a right to an environment that is not harmful to human health or well-being and to environmental protection for the benefit of present and future generations. Section 24(b) directs the state to take reasonable legislative and other measures to prevent pollution, promote conservation, and secure the ecologically sustainable development and use of natural resources (including water and mineral resources) while promoting justifiable economic and social development. Section 27 guarantees every person the right of access to sufficient water, and the state is obliged to take reasonable legislative and other measures within its available resources to achieve the progressive realisation of this right. Section 27 is defined as a socio-economic right and not an environmental right. However, read with section 24 it requires of the state to ensure that water is conserved and protected and that sufficient access to the resource is provided. Water regulation in South Africa places a great emphasis on protecting the resource and on providing access to water for everyone.
National Environmental Management Act (Act No. 107 of 1998) (NEMA)	The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations as amended in 2017, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact. Provincial regulations must also be considered.
National Environmental Management: Biodiversity Act (2004) (Act 10 of 2004) (NEMBA)	**Ecosystems that are threatened or in need of protection.** (1) (a) The Minister may, by notice in the Gazette, publish a national list of ecosystems that are threatened and in need of protection. *(b)* An MEC for environmental affairs in a province may, by notice in *the Gazette,* publish a provincial list of ecosystems in the province that are threatened and in need of protection. (2) The following categories of ecosystems may be listed in terms of subsection (1): *(a)* critically endangered ecosystems, being ecosystems that have undergone severe degradation of ecological structure, function or composition as a result of human intervention and are subject to an extremely high risk of irreversible transformation; *(b)* endangered ecosystems, being ecosystems that have undergone degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems; (c) vulnerable ecosystems, being ecosystems that have a high risk of undergoing significant degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems or endangered ecosystems; and *(d)* protected ecosystems, being ecosystems that are of high conservation value or of high national or provincial importance, although they are not listed in terms of paragraphs *(a), (b)* or (c).
The National Water Act 1998 (Act No. 36 of 1998) (NWA)	The National Water Act (NWA) (Act 36 of 1998) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS). Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) & (i).
Government Notice 4167 as published in the Government Gazette 49833 of 08 December 2023 as it relates to the NWA (Act 36 of 1998) as amended	GN 4167 outlines the parameters and process of a General Authorisation (GA), which replaces the need to apply for a licence in terms of Section 40 of the NWA, provided that the water use is within the limits and conditions of the GA. The notice replaces GN 509 of 2016. The GA sets out the need to determine the regulated area of a watercourse, as well as the degree of risk posed by an activity/ies related to a particular water use. In accordance with GN 4167 of December 2023, the regulated area of a watercourse for section 21c and 21i of the NWA, 1998 is defined as: a) the outer edge of the 1 in 100-year flood line or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake, or dam; b) in the absence of a determined 1 in 100-year flood line or riparian area the area within 100 m distance from the edge of a watercourse where the edge of the watercourse (excluding flood plains) is the first identifiable annual bank fill flood bench; or

	c) In respect of a wetland, a 500 m radius around the delineated boundary (extent) of any wetland, including pans. The GA only applies to the use of water in terms of Section 21(c) and (i) of the NWA where the risk class is LOW as determined through the application of the Risk Matrix as prescribed in the Notice. The GA also does not apply where other Section 21 water uses are triggered, does not apply for most sewage infrastructure and pipelines carrying hazardous materials, water uses associated with hazardous materials, water uses associated with water and wastewater treatment works, and for most mining-related water uses. The GA may be exercised as follows: i) Section 21(c) or (i) water use activities that are determined to pose a LOW Risk as determined through the application of the Risk Matrix as prescribed in the Notice can be undertaken subject to the general conditions of the GA; ii) Section 21(c) or (i) water use activities set out in Appendix D1 of the Notice can be undertaken without being subject to the requirement of a risk assessment and subject to the general conditions of the GA. Such water use activities in Appendix D1 include inter alia emergency river crossings, fence erection, solar renewable infrastructure that has no direct impact on watercourses and mini-scale hydropower developments; iii) Prescribed water use activities undertaken by certain State Owned Entities as detailed in Appendix D2 of the Notice can be undertaken without being subject to the requirement of a risk assessment and subject to the general conditions of the GA; iv) Maintenance work associated an existing lawful water use in terms of section 21(c) or (i) of the Act that has a LOW risk class as determined through the Risk Matrix can be undertaken ; v) River and stormwater management activities including maintenance of infrastructure as contained in a river management plan or similar management plan, may be conducted subject to the approval of such a plan by the relevant DWS regional office or catchment management agency; vi) Rehabilitation of wetlands or rivers where such rehabilitation activities has a LOW risk class as determined through the Risk Matrix can be conducted; and vii) Emergency work arising from an emergency situation and or incident associated with the persons' existing lawful water use entitlement can be undertaken, provided that all work is executed and reported in the manner prescribed in the Emergency protocol contained in Appendix C of the GA. A General Authorisation (GA) issued as per this notice will require the proponent to adhere with specific conditions, rehabilitation criteria and monitoring and reporting programme. Furthermore, the water user must ensure that there is a sufficient budget to complete, rehabilitate and maintain the water use as set out in this GA. Upon completion of the registration, the responsible authority will provide a certificate of registration to the water user within 30 working days of the submission. On written receipt of a registration certificate from the Department, the person will be regarded as a registered water user and can commence within the water use as contemplated in the GA.
Government Notice 704 Regulations as published in the Government Gazette 20119 of 1999 as it relates to the National Water Act, 1998 (Act No. 36 of 1998)	These Regulations were put in place in order to prevent the pollution of water resources and protect water resources in areas where mining activity is taking place from impacts generally associated with mining. It is recommended that the proposed project complies with Regulation GN 704 of the NWA which contains regulations on the use of water for mining and related activities aimed at the protection of water resources. GN 704 states that: *No person in control of a mine or activity may:* *(c) locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year floodline or within a horizontal distance of 100 metres from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on waterlogged ground, or on ground likely to become waterlogged, undermined, unstable or cracked;* According to the above, the activity footprint must fall outside of the 1:100 year floodline of the aquatic resource or 100m from the edge of the resource, whichever distance is the greatest.
Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA)	The obtaining of a New Order Mining Right (NOMR) is governed by the MPRDA. The MPRDA requires the applicant to apply to the DMR for a NOMR which triggers a process of compliance with the various applicable sections of the MPRDA. The NOMR process requires environmental authorisation in terms of the MPRDA Regulations and specifically requires the preparation of a Scoping Report, an EIA, an Environmental Management Programme (EMP), and a Public Participation Process (PPP).

APPENDIX C – Method of Assessment

1. Desktop Study

Prior to the commencement of the field assessment, a background study, including a literature review, was conducted in order to determine the ecoregion and Ecostatus of the larger aquatic system within which the watercourses present or in close proximity of the focus area are located. Aspects considered as part of the literature review are discussed in the sections that follow.

1.1 National Freshwater Ecosystem Priority Areas (NFEPA, 2011)

The NFEPA project is a multi-partner project between the Council of Scientific and Industrial Research (CSIR), Water Research Commission (WRC), South African National Biodiversity Institute (SANBI), DWA, South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The project responds to the reported degradation of freshwater ecosystem condition and associated biodiversity, both globally and in South Africa. It uses systematic conservation planning to provide strategic spatial priorities of conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development.

The NFEPA project aims to identify a national network of freshwater conservation areas and to explore institutional mechanisms for their implementation. Freshwater ecosystems provide a valuable, natural resource with economic, aesthetic, spiritual, cultural and recreational value. However, the integrity of freshwater ecosystems in South Africa is declining at an alarming rate, largely as a consequence of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (competition between stakeholders for utilisation) and institutional (building appropriate governance and co-management mechanisms).

The NFEPA database was searched for information in terms of conservation status of rivers, wetland habitat and wetland features present in the vicinity of or within the focus area.

2. Classification System for Wetlands and other Aquatic Ecosystems in South Africa

The watercourses encountered within the focus area were assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al*., 2013), hereafter referred to as the "Classification System". A summary of Levels 1 to 4 of the classification system are presented in Table C1 and C2, below.

Table C1: Proposed classification structure for Inland Systems, up to Level 3.

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	LEVEL 2: REGIONAL SETTING	LEVEL 3: LANDSCAPE UNIT
Inland Systems	DWA Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain
		Bench (Hilltop / Saddle / Shelf)

Table C2: Hydrogeomorphic (HGM) Unit for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

Level 1: Inland systems

From the Classification System, Inland Systems are defined as aquatic ecosystems that have no existing connection to the ocean[3] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but which are inundated or saturated with water, either permanently or periodically. It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

[3] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e., the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

Level 2: Ecoregions & NFEPA Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that has been included at Level 2 of the classification system is that of DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et al.,* 2005). There is a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland. DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) group's vegetation types across the country according to Biomes, which are then divided into Bioregions. To categorise the regional setting for the wetland component of the National Freshwater Ecosystem Priority Areas (NFEPA) project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting bioregions into smaller groups through expert input (Nel *et al*., 2011). There are currently 133 NFEPA WetVeg Groups. It is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

Level 3: Landscape Setting

At Level 3 of the Classification System, for Inland Systems, a distinction is made between four Landscape Units (Table C1) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et al.,* 2013):

- **Slope:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley;
- **Valley floor:** The base of a valley, situated between two distinct valley side-slopes;
- **Plain:** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land; and
- **Bench (hilltop/saddle/shelf):** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

Level 4: Hydrogeomorphic Units

Seven primary HGM Types are recognised for Inland Systems at Level 4A of the Classification System (Table C2), on the basis of hydrology and geomorphology (Ollis *et al*., 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat; and
- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa.

Similar terminology (but excluding categories for “channel”, “flat” and “valleyhead seep”) is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane *et al*., 2008), WET-IHI (DWAF, 2007) and WET-EcoServices (Kotze *et al*., 2020).

3. General Habitat Integrity

The general habitat integrity of each site was discussed based on the application of the Index of Habitat Integrity (Kleynhans *et al.* 2008). It is important to assess the habitat at each site in order to aid in the interpretation of the results of the community integrity assessments, by taking habitat conditions and impacts into consideration. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitat at each site. The method classifies habitat integrity into one of six classes, ranging from unmodified/natural (Class A) to critically modified (Class F), as indicated in Table C8 below.

Table C4: Classification of Present State Classes in terms of Habitat Integrity [Kleynhans *et al.* 2008]

Class	Description	Score (% of total)
A	Unmodified, natural.	90 - 100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80 - 89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60 - 79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 – 39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances, the basic ecosystem functions have been destroyed and the changes are irreversible.	0 - 19

4. Freshwater Ecosystem Function Assessment

“The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class”.[4] The assessment of the ecosystem services supplied by the identified watercourses was conducted according to the guidelines as described by Kotze *et al.* (2020). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Maintenance of biodiversity;
- Water supply for human use;
- Natural resources;

[4] Department of Water Affairs and Forestry, South Africa Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999

- Cultivated foods;
- Cultural significance;
- Tourism and recreation; and
- Education and research.

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the watercourses. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the watercourses.

Table C5: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

5. Ecological Importance and Sensitivity (EIS) (Rountree & Kotze, 2013)

The purposed of assessing importance and sensitivity of water resources is to be able to identify those systems that provide higher than average ecosystem services, biodiversity support functions or are especially sensitive to impacts. Water resources with higher ecological importance may require managing such water resources in a better condition than the present to ensure the continued provision of ecosystem benefits in the long term (Rountree & Kotze, 2013).

In order to align the outputs of the Ecoservices assessment (i.e. ecological and socio-cultural service provision) with methods used by the DWA (now the DWS) used to assess the EIS of other watercourse types, a tool was developed using criteria from both WET-Ecoservices (Kotze, *et, al,* 2009) and earlier DWA EIA assessment tools. Thus, three proposed suites of important criteria for assessing the Importance and Sensitivity for wetlands were proposed, namely:

- Ecological Importance and Sensitivity, incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWA and thus enabling consistent assessment approaches across water resource types;
- Hydro-functional importance, taking into consideration water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide; and
- Importance in terms of socio-cultural benefits, including the subsistence and cultural benefits provided by the wetland system.

The highest of these three suites of scores is then used to determine the overall Importance and Sensitivity category (Table C6) of the wetland system being assessed.

Table C6: Ecological Importance and Sensitivity Categories and the interpretation of median scores for biota and habitat determinants (adapted from Kleynhans, 1999).

EIS Category	Range of Mean	Recommended Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	>1 and <=2	C
Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	D

6. Recommended Management Objective (RMO) and Recommended Ecological Category (REC) Determination

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability but carries a higher risk of ecosystem failure" (DWA, 1999).

The RMO (table below) was determined based on the results obtained from the PES, reference conditions and EIS of the watercourse (sections above), with the objective of either maintaining, or improving the ecological integrity of the watercourse in order to ensure continued ecological functionality.

Table C7: Recommended management objectives (RMO) for water resources based on PES & EIS scores.

PES			Ecological and Importance Sensitivity (EIS)			
			Very High	High	Moderate	Low
	A	Pristine	A Maintain	A Maintain	A Maintain	A Maintain
	B	Natural	A Improve	A/B Improve	B Maintain	B Maintain
	C	Good	A Improve	B/C Improve	C Maintain	C Maintain
	D	Fair	C Improve	C/D Improve	D Maintain	D Maintain
	E/F	Poor	D* Improve	E/F* Improve	E/F* Maintain	E/F* Maintain

***PES Categories E and F are considered ecologically unacceptable (Malan and Day, 2012) and therefore, should a watercourse fall into one of these PES categories, an REC class D is allocated by default, as the minimum acceptable PES category.**

A watercourse may receive the same class for the REC as the PES if the watercourse is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as enhance the PES of the watercourse.

Table C8: Description of Recommended Ecological Category (REC) classes.

Class	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

7. Freshwater ecosystem delineation

The freshwater ecosystem delineation took place according to the method presented in the "Updated manual for the identification and delineation of wetland and riparian resources" published by DWAF in 2008. The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils;
- Vegetation adapted to saturated soils; and
- The presence of alluvial soils in stream systems.

According to the DWA (2005) like wetlands, riparian areas have their own unique set of indicators. It is possible to delineate riparian areas by checking for the presence of these indicators. Some areas may display both wetland and riparian indicators and can accordingly be classified as both. If you are adjacent to a watercourse, it is important to check for the presence of the riparian indicators described below, in addition to checking for wetland indicators, to detect riparian areas that do not qualify as wetlands. The delineation process requires that the following be taken into account:

- topography associated with the watercourse;
- vegetation; and
- alluvial soils and deposited material.

By observing the evidence of these features in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWA, 2005).

APPENDIX D –Risk and Impact Assessment Methodologies

DWS Risk Assessment

For the proponent to allow for sufficient consideration of all environmental impacts, impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing risks/impacts is outlined in the sections below.

The first stage of the risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below.

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that are possessed by an organisation;
- **Environmental impacts** are the consequences of these impacts on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is;
- **Receptors** can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as wetlands, flora and riverine systems;
- **Resources** include components of the biophysical environment;
- **Intensity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards;
- **Spatial scale** refers to the geographical scale of the impact; and
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria (refer to the table below). The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The intensity, spatial scale and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 75. The likelihood of the impact occurring is determined by assigning a likelihood score of between 20% and 100%. The values for likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary[5].

The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act, 1998 (Act No. 107 of 1998) in instances of uncertainty or lack of information, by increasing assigned ratings or adjusting final model outcomes. In certain instances, where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

[5] Some risks/impacts that have low significance will however still require mitigation.

"RISK ASSESSMENT KEY" (Based on DWS 2023 publication: Section 21 c and i water use Risk Assessment Protocol) GN4167 of December 2023 published in Government Gazette 49833 of 8 December 2023) (p208).

Table D1: Intensity (What is the intensity of the impact on the resource quality - hydrology, water quality, geomorphology, biota?)

Negative impacts	
Negligible / non-harmful; no change in PES	0
Very low / potentially harmful; negligible deterioration in PES (<5% change)	+1
Low / slightly harmful; minor deterioration in PES (<10% change)	+2
Medium / moderately harmful; moderate deterioration in PES (>10% change)	+3
High / severely harmful; large deterioration in PES (by one class or more)	+4
Very high / critically harmful; critical deterioration in PES (to E/F or F class)	+5
Positive impacts	
Negligible; no change in PES	0
Very low / potentially beneficial; negligible improvement in PES (<5% change)	-1
Low / slightly beneficial; minor improvement in PES (<10% change)	-2
Medium / moderately beneficial; moderate improvement in PES (>10% change)	-3
Highly beneficial; large improvement in PES (by one class or more) and/or increase in protection status	-4
Very highly beneficial; improvement to near-natural state (A or A/B class) and/or major increase in protection status	-5

*PES of affected watercourses must be considered when scoring Impact Intensity

Table D2: Spatial Scale (How big is the area that the activity is impacting on, relative to the size of the impacted watercourses?)

Very small portion of watercourse/s impacted (<10% of extent)	1
Moderate portion of watercourse/s impacted (10-60% of extent)	2
Large portion of watercourse/s impacted (60-80%)	3
Most or all of watercourse/s impacted (>80%)	4
Impacts extend into watercourses located well beyond the footprint of the activities	5

Table D3: Duration (How long does the aspect impact on the resource quality?)

Transient (One day to one month)	1
Short-term (a few months to 5 years) OR repeated infrequently (e.g. annually) for one day to one month	2
Medium-term (5 – 15 years)	3
Long-term (ceases with operational life)	4
Permanent	5

Table D4: Likelihood of impact (What is the probability that the activity will impact on the resource quality?)

Improbable / Unlikely	20%
Low probability	40%
Medium probability	60%
Highly probable	80%
Definite / Unknown	100%

Table D5: Rating Classes.

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 29	(L) Low Risk	Acceptable as is or with proposed mitigation measures. Impact to watercourses and resource quality small and easily mitigated, or positive.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notable and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
170 – 300	(H) High Risk	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

NOTE: A Low Risk class must be obtained for all activities to be considered for a GA

Table D6: Calculations.

Intensity = Maximum Intensity Score (negative value for positive impact)	MAX = 5
Severity = Intensity + Spatial Scale + Duration (<Intensity - Spatial Scale - Duration> for positive impact)	MAX = 15 (MIN = -15 for +ve impacts)
Consequence = Severity X Importance rating	MAX = 75
Significance\Risk = (Consequence X Likelihood) X (100/75)	MAX = 100

Impact Assessment

The environmental significance assessment methodology is based on the following determination:

Environmental Significance = Overall Consequence x Overall Likelihood

Determination of Overall Consequence

Consequence analysis is a mixture of quantitative and qualitative information, and the outcome can be positive or negative. Several factors can be used to determine consequence. For the purpose of determining the environmental significance in terms of consequence, the following factors were chosen: Severity/Intensity, Duration and Extent/Spatial Scale. Each factor is assigned a rating of 1 to 5, as described in the tables below.

Determination of Severity / Intensity

Severity relates to the nature of the event, aspect or impact to the environment and describes how severe the aspects impact on the biophysical and socio-economic environment.

Table D7: Table to be used to obtain an overall rating of severity, taking into consideration the various criteria.

TYPE OF CRITERIA	RATING				
	1	2	3	4	5
Quantitative	0-20%	21-40%	41-60%	61-80%	81-100%
Qualitative	Insignificant / Non-harmful	Small / Potentially harmful	Significant/ Harmful	Great/ Very harmful	Disastrous Extremely harmful
Social/ Community response	Acceptable / I&AP satisfied	Slightly tolerable / Possible objections	Intolerable/ Sporadic complaints	Unacceptable / Widespread complaints	Totally unacceptable / Possible legal action
Irreversibility	Very low cost to mitigate/ High potential to mitigate impacts to level of insignificance/ Easily reversible	Low cost to mitigate	Substantial cost to mitigate/ Potential to mitigate impacts/ Potential to reverse impact	High cost to mitigate	Prohibitive cost to mitigate/ Little or no mechanism to mitigate impact Irreversible
Biophysical (Air quality, water quantity and quality, waste production, fauna and flora)	Insignificant change / deterioration or disturbance	Moderate change / deterioration or disturbance	Significant change / deterioration or disturbance	Very significant change / deterioration or disturbance	Disastrous change / deterioration or disturbance

Determination of Duration

Duration refers to the amount of time that the environment will be affected by the event, risk or impact, if no intervention e.g. remedial action takes place.

Table D8: Criteria for the rating of duration.

RATING	DESCRIPTION
1	Up to ONE MONTH
2	ONE MONTH to THREE MONTHS (QUARTER)
3	THREE MONTHS to ONE YEAR
4	ONE to TEN YEARS
5	Beyond TEN YEARS

Determination of Extent/Spatial Scale

Extent or **spatial scale** is the area affected by the event, aspect or impact.

Table D9: Criteria for the rating of extent / spatial scale.

RATING	DESCRIPTION
1	Immediate, fully contained area
2	Surrounding area
3	Within Business Unit area of responsibility
4	Within the farm/neighbouring farm area
5	Regional, National, International

Determination of Overall Consequence

Overall consequence is determined by adding the factors determined above and summarized below and then dividing the sum by 3.

Table D10: Example of calculating overall consequence.

CONSEQUENCE	RATING
Severity	Example 4
Duration	Example 2
Extent	Example 4
SUBTOTAL	**10**
TOTAL CONSEQUENCE: (Subtotal divided by 3)	**3.3**

Determination of Likelihood

The determination of likelihood is a combination of Frequency and Probability. Each factor is assigned a rating of 1 to 5, as described below.

Determination of Frequency

Frequency refers to how often the specific activity, related to the event, aspect or impact, is undertaken.

Table D11: Criteria for the rating of frequency.

RATING	DESCRIPTION
1	Once a year or once/more during operation
2	Once/more in 6 Months
3	Once/more a Month
4	Once/more a Week
5	Daily

Determination of Probability

Probability refers to how often the activity or aspect has an impact on the environment.

Table D12: Criteria for the rating of probability.

RATING	DESCRIPTION
1	Almost never / almost impossible
2	Very seldom / highly unlikely
3	Infrequent / unlikely / seldom
4	Often / regularly / likely / possible
5	Daily / highly likely / definitely

Overall Likelihood

Overall likelihood is calculated by adding the factors determined above and summarized below, and then dividing the sum by 2.

Table D13: Example of calculating overall likelihood.

CONSEQUENCE	RATING
Frequency	Example 4
Probability	Example 2
SUBTOTAL	**6**
TOTAL LIKELIHOOD (Subtotal divided by 2)	**3**

Determination of Overall Environmental Significance

The multiplication of overall consequence with overall likelihood will provide the environmental significance, which is a number that will then fall into a range of **LOW, LOW-MEDIUM, MEDIUM, MEDIUM-HIGH** or **HIGH**, as shown in the table below.

Table D14: Determination of overall environmental significance.

SIGNIFICANCE OR RISK	LOW	LOW-MEDIUM	MEDIUM	MEDIUM-HIGH	HIGH
Overall Consequence X Overall Likelihood	1 - 4.9	5 - 9.9	10 - 14.9	15 – 19.9	20 - 25

Qualitative description or magnitude of Environmental Significance

This description is qualitative and is an indication of the nature or magnitude of the Environmental Significance. It also guides the prioritizations and decision making process associated with this event, aspect or impact.

Table D15: Description of environmental significance and related action required.

SIGNIFICANCE	LOW	LOW-MEDIUM	MEDIUM	MEDIUM-HIGH	HIGH
Impact Magnitude	Impact is of very low order and therefore likely to have very little real effect. Acceptable.	Impact is of low order and therefore likely to have little real effect. Acceptable.	Impact is real, and potentially substantial in relation to other impacts. Can pose a risk to company	Impact is real and substantial in relation to other impacts. Pose a risk to the company. Unacceptable	Impact is of the highest order possible. Unacceptable. Fatal flaw.
Action Required	Maintain current management measures. Where possible improve.	Maintain current management measures. Implement monitoring and evaluate to determine potential increase in risk. Where possible improve	Implement monitoring. Investigate mitigation measures and improve management measures to reduce risk, where possible.	Improve management measures to reduce risk.	Implement significant mitigation measures or implement alternatives.

Based on the above, the significance rating scale has been determined as follows:

HIGH: Of the highest order possible within the bounds of impacts which could occur. In the case of negative impacts, there would be no possible mitigation and / or remedial activity to offset the impact at the spatial or time scale for which it was predicted. In the case of positive impacts, there is no real alternative to achieving the benefit.

MEDIUM-HIGH: Impacts of a substantial order. In the case of negative impacts, mitigation and / or remedial activity would be feasible but difficult, expensive, time-consuming or some combination of these. In the case of positive impacts, other means of achieving this benefit would be feasible, but these would be more difficult, expensive, time-consuming or some combination of these.

MEDIUM: Impact would be real but not substantial within the bounds of those, which could occur. In the case of negative impacts, mitigation and / or remedial activity would be both feasible and fairly easily possible. In case of positive impacts; other means of achieving these benefits would be about equal in time, cost and effort.

LOW-MEDIUM: Impact would be of a low order and with little real effect. In the case of negative impacts, mitigation and / or remedial activity would be either easily achieved of little would be required, or both. In case of positive impacts alternative means for achieving this benefit would likely be easier, cheaper, more effective, less time-consuming, or some combination of these.

LOW: Impact would be negligible. In the case of negative impacts, almost no mitigation and or remedial activity would be needed, and any minor steps, which might be needed, would be easy, cheap, and simple. In the case of positive impacts, alternative means would almost all likely be better, in one or a number of ways, than this means of achieving the benefit.

INSIGNIFICANT: There would be a no impact at all – not even a very low impact on the system or any of its parts.

APPENDIX E – Results of Field Investigation

PRESENT ECOLOGICAL STATE (PES), ECOSERVICE PROVISION AND ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS) RESULTS

Table E1: Presentation of the results of the riparian IHI assessment applied to the EDLs.

	MRU
RIPARIAN IHI	
Base Flows	0,0
Zero Flows	1,0
Moderate Floods	-1,0
Large Floods	-0,5
HYDROLOGY RATING	**0,6**
Substrate Exposure (marginal)	1,0
Substrate Exposure (non-marginal)	0,5
Invasive Alien Vegetation (marginal)	1,0
Invasive Alien Vegetation (non-marginal)	0,0
Erosion (marginal)	0,5
Erosion (non-marginal)	0,0
Physico-Chemical (marginal)	0,0
Physico-Chemical (non-marginal)	0,0
Marginal	1,0
Non-marginal	0,5
BANK STRUCTURE RATING	**0,7**
Longitudinal Connectivity	2,0
Lateral Connectivity	0,5
CONNECTIVITY RATING	**1,4**
RIPARIAN IHI %	**83,8**
RIPARIAN IHI EC	**B**
RIPARIAN CONFIDENCE	**2,9**

Table E2: Presentation of the results of the Ecoservices assessment applied to the EDLs.

		Present State			
ECOSYSTEM SERVICE		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	0,6	0,0	0,0	Very Low
	Stream flow regulation	-	-	#VALUE!	#VALUE!
	Sediment trapping	1,0	0,5	0,0	Very Low
	Erosion control	1,5	0,4	0,2	Very Low
	Phosphate assimilation	1,0	0,0	0,0	Very Low
	Nitrate assimilation	0,8	0,0	0,0	Very Low
	Toxicant assimilation	1,0	0,0	0,0	Very Low
	Carbon storage	0,7	0,0	0,0	Very Low
	Biodiversity maintenance	2,7	1,0	1,7	Moderate
PROVISIONING SERVICES	Water for human use	0,0	0,0	0,0	Very Low
	Harvestable resources	2,5	0,0	1,0	Low
	Food for livestock	0,0	0,0	0,0	Very Low
	Cultivated foods	3,0	0,0	1,5	Moderately Low
CULTURAL SERVICES	Tourism and Recreation	0,8	0,0	0,0	Very Low
	Education and Research	1,0	0,0	0,0	Very Low
	Cultural and Spiritual	2,0	0,0	0,5	Very Low

Table E3: Presentation of the results of the EIS for the EDLs.

Ecological Importance and Sensitivity			EDLs
			Score (0-4)
Biodiversity support			A (average)
			2.00
Presence of Red Data species			1
Populations of unique species			2
Migration/breeding/feeding sites			3
Landscape scale			B (average)
			1.80
Protection status of the wetland			1
Protection status of the vegetation type			2
Regional context of the ecological integrity			3
Size and rarity of the wetland type/s present			1
Diversity of habitat types			2
Sensitivity of the wetland			C (average)
			2.00
Sensitivity to changes in floods			2
Sensitivity to changes in low flows/dry season			2
Sensitivity to changes in water quality			2
Hydro-Functional Importance			Score (0-4)
Regulating & supporting benefits	**Flood attenuation**		3
	Streamflow regulation		3
	Water Quality Enhancement	1	2
		0.5	1
		0.5	1
		0.5	1
		3	1
	Carbon storage		1
Direct Human Benefits			Score (0-4)
Subsistence benefits	***Water for human use***		0
	Harvestable resources		0
	Cultivated foods		0
Cultural benefits	***Cultural heritage***		0
	Tourism and recreation		0
	Education and research		0

APPENDIX F – Risk Assessment Outcome

Phase	Activity	Impact	Potentially affected watercourses		Intensity of Impact on Resource Quality					Overall Intensity	Spatial scale	Duration	Severity	Importance rating	Consequence	Likelihood	Significance	Risk Rating	Confidence level
			Name/s	PES	Abiotic Habitat (Drivers)		Biota (Responses)												
					Hydrology	Water Quality	Geomorphology	Vege	Fauna										
PRE CONSTRUCTION	Potentially poor planning of stormwater management and pollution control for the project.	•Alteration of hydrology and geomorphology of receiving freshwater ecosystems and resulting degradation of freshwater habitat through poor stormwater design, or through poor design of clean and dirty water systems, including dirty water channels and evaporation ponds.	Both EDLs	B	3	3	3	3	2	**6**	2	4	**12**	**3**	**36**	40%	**14.4**	**L**	Medium
CONSTRUCTION	Clearing of Vegetation and Topsoil Stripping in the Phase 2 OC footprint area (adjacent to and within the GN 4167 100m ZoR of the southern EDL) as the first step of open cast mining.	•Earthworks could be potential sources of dust and sediment, which may be transported by wind and / or stormwater into adjacent eastern EDL; •Exposure and potential compaction of soil, leading to increased runoff, and erosion, and thus increased potential sedimentation of downgradient eastern EDL, leading to smothering of the vegetation within the system; •Soil and stormwater contamination from oils and hydrocarbons originating from construction vehicles that could be	Southern EDL	B	4	4	4	4	4	**8**	2	2	**12**	**3**	**36**	80%	**28,8**	**L**	Medium

Phase	Activity	Impact	Potentially affected watercourses		Intensity of Impact on Resource Quality					Overall Intensity	Spatial scale	Duration	Severity	Importance rating	Consequence	Likelihood	Significance	Risk Rating	Confidence level
			Name/s	PES	Abiotic Habitat (Drivers)		Biota (Responses)												
					Hydrology	Water Quality	Geomorphology	Vege	Fauna										
	Clearing of vegetation and earthworks associated with the dirty water channel within the 48m ecological buffer and 100m ZoR of the southern EDL.	transported as pollutants into the downgradient eastern EDL; and •Increased risk of alien invasive vegetation proliferation.	Southern EDL	B	4	4	4	4	4	**8**	2	2	**12**	**3**	**36**	80%	**28.8**	**L**	Medium
	Creation of the stockpile within the GN 4167 100 m ZoR and catchment of the northern EDL.	•Disturbances of soil leading to increased alien vegetation proliferation within the area immediately surrounding the stockpile, with the potential to affect the downgradient freshwater habitat; •Accidental / unplanned deposition of removed material within nearby freshwater habitat, thereby smothering vegetation; •Altered runoff patterns within the local catchment of the northern EDL, potentially leading to increased erosion and sedimentation of the downgradient system; and •Potential of stockpiled material slumping and entering the downgradient EDL, increasing the sediment loads therein.	Northern EDL	B	2	3	3	4	2	**8**	2	2	**12**	**3**	**36**	40%	**14.4**	**L**	Medium

Phase	Activity	Impact	Potentially affected watercourses		Intensity of Impact on Resource Quality					Overall Intensity	Spatial scale	Duration	Severity	Importance rating	Consequence	Likelihood	Significance	Risk Rating	Confidence level
			Name/s	PES	Abiotic Habitat (Drivers)		Biota (Responses)												
					Hydrology	Water Quality	Geomorphology	Vege	Fauna										
	Upgrading of existing informal roads (if required) which bisect the EDLs and are located within the GN 4167 100m ZoR.	• Earthworks and exposure of soil could result in sedimentation of the freshwater ecosystems, which may be transported as runoff into the downstream freshwater ecosystem areas and may smother vegetation associated with the freshwater ecosystems; • Altered water quality (if surface water is present) as a result of vehicle movement and construction activities; and • Proliferation of alien and/or invasive vegetation as a result of disturbances.	Both EDLs	B	5	5	5	5	2	**10**	1	1	**12**	**3**	**36**	40%	**14.4**	**L**	Medium

Phase	Activity	Impact	Potentially affected watercourses		Intensity of Impact on Resource Quality					Overall Intensity	Spatial scale	Duration	Severity	Importance rating	Consequence	Likelihood	Significance	Risk Rating	Confidence level
			Name/s	PES	Abiotic Habitat (Drivers)		Biota (Responses)												
					Hydrology	Water Quality	Geomorphology	Vege	Fauna										
OPERATIONAL	Undertaking of open cast mining (including blasting) adjacent to and within the GN 4167 100m ZoR of the southern EDL (Phase 2 OC pit)	•Destruction of natural habitat within the catchment of the southern EDL that will alter the pattern, timing and volumes of flow into the downgradient EDL; •Potential sedimentation of the downgradient southern EDL if mined material is washed or carried by wind into downstream reach; •Increased risk of pollution of surface water (when present) and shallow groundwater leading to impaired water quality (increase in salts and specific contaminants of concern and reduced pH), from various potential sources including: •Potential spillage of oils/hydrocarbons from mining equipment and vehicles; •Dewatering of the open cast pit and discharging of such water into the environment; and •Nitrates from residual blasting emulsion leading to eutrophication of the downgradient southern EDL.	Southern EDL	B	4	4	3	3	3	**8**	2	4	**14**	**3**	**42**	80%	**33.6**	**M**	High

Phase	Activity	Impact	Potentially affected watercourses		Intensity of Impact on Resource Quality					Overall Intensity	Spatial scale	Duration	Severity	Importance rating	Consequence	Likelihood	Significance	Risk Rating	Confidence level
			Name/s	PES	Abiotic Habitat (Drivers)		Biota (Responses)												
					Hydrology	Water Quality	Geomorphology	Vege	Fauna										
	Operational reshaping of the Phase 2 open cast pit and associated rehabilitation (topsoil restoration and revegetation) adjacent to and within the GN 4167 100m ZoR of the southern EDL.	•Potential poor execution of open cast pit reshaping which may leave long term or permanent alterations in the landscape that will permanently affect runoff and interflow within the catchment of the southern EDL; •Potential dumping of waste rock / overburden into the adjacent EDL area, leading to smothering of vegetation; •Obstructions to flows as well as potential sedimentation and other pollution-related impacts; •Potentially poorly executed rehabilitation that could lead to poor coverage by vegetation of the rehabilitated area and subsequent development of erosion and sedimentation of the downgradient EDL; and •Potential decant of contaminated water from the reshaped portion of the open cast pit, resulting in contaminated water entering the receiving environment and subsequent loss of biodiversity in the downgradient EDL.	Southern EDL	B	3	3	3	3	2	**6**	2	4	**12**	**3**	**36**	60%	**21.6**	**L**	Medium

Phase	Activity	Impact	Potentially affected watercourses		Intensity of Impact on Resource Quality					Overall Intensity	Spatial scale	Duration	Severity	Importance rating	Consequence	Likelihood	Significance	Risk Rating	Confidence level
			Name/s	PES	Abiotic Habitat (Drivers)		Biota (Responses)												
					Hydrology	Water Quality	Geomorphology	Vege	Fauna										
	Transport of product from the open cast pit (Phase 2) to the primary beneficiation plant (offsite) via the upgraded road which bisects the southern EDL and is located within the associated GN 4167 100m ZoR.	•Potential accidental spillage of blasted raw material in the EDL or catchment of the EDL, leading to potential smothering of freshwater vegetation, obstructions to flows as well as potential sedimentation and other pollution-related impacts in the downgradient / adjacent system.	Southern EDL	B	1	3	2	3	2	**6**	2	4	**12**	**3**	**36**	80%	**28.8**	**L**	High
	Operation of the portion of the OC Pit 2 dirty water channel within the GN 4167 100m ZoR of the southern EDL.	In the event of a leak, dirty water flow into the downgradient southern EDL which can lead to contamination of the system which would result in: •Alteration in water quality (if present); •Alteration of the run-off and hydrological flow regime and hydroperiod of the EDL; •Increased stream velocity resulting in the disturbance to vegetation and possible incision and soil erosion in the EDL; and •Potential changes in service provisioning potential of the system.	Southern EDL	B	2	3	2	2	2	**6**	2	4	**12**	**3**	**36**	60%	**21.6**	**L**	Medium

Phase	Activity	Impact	Potentially affected watercourses		Intensity of Impact on Resource Quality					Overall Intensity	Spatial scale	Duration	Severity	Importance rating	Consequence	Likelihood	Significance	Risk Rating	Confidence level
			Name/s	PES	Abiotic Habitat (Drivers)		Biota (Responses)												
					Hydrology	Water Quality	Geomorphology	Vege	Fauna										
	Operation and maintenance of the upgraded road crossings within the EDLs.	•Concentrated runoff from the haul roads leading to erosion and subsequent sedimentation of the EDL habitats (increase in the sediment load) and increase in turbidity when surface water is present; and •Potential transport of spilled oils and hydrocarbons on the road surface into the downgradient reaches of the EDLs through stormwater, causing deterioration of surface water quality.	Both EDLs	B	2	3	2	2	2	**6**	2	4	**12**	**3**	**36**	60%	**21.6**	L	Medium
DECOMMISIONING	Ongoing (long term) rehabilitation of the mining footprint areas within the GN 4167 100m ZoR of the EDLs.	•Compaction of soils due to vehicular movement; •Latent impacts of vegetation losses; •Increased runoff volumes and formation of preferential surface flow paths as a result of compacted soils, leading to potential development of erosion; and •Potential poor management of AIP vegetation which could lead to proliferation of AIPs in affected areas, leading to longer term colonisation of other areas.	Both EDLs	B	3	2	2	3	2	**6**	2	3	**11**	**3**	**33**	60%	**19.8**	L	Medium

Phase	Activity	Impact	Potentially affected watercourses		Intensity of Impact on Resource Quality					Overall Intensity	Spatial scale	Duration	Severity	Importance rating	Consequence	Likelihood	Significance	Risk Rating	Confidence level
			Name/s	PES	Abiotic Habitat (Drivers)		Biota (Responses)												
					Hydrology	Water Quality	Geomorphology	Vege	Fauna										
	Post-closure management activities.	•Contamination of water within the receiving environment as a result of mine water decant and subsequent reduction in water quality (increase in salts and specific contaminants of concern and reduced pH); and •Subsequent negative impacts on biota and vegetation that result in overall habitat degradation.	Both EDLs	B	1	4	1	3	2	**8**	3	5	**16**	**3**	**48**	60%	**28.8**	**L**	Low

APPENDIX G – General "Good Housekeeping" Mitigation Measures

General construction management and good housekeeping practices

Latent and general impacts which may affect the freshwater ecology and biodiversity, will include any activities which take place in close proximity to the proposed development that may impact on the receiving environment. Mitigation measures for these impacts are highlighted below and are relevant to the watercourse identified in this report:

Development footprint

- All development footprint areas must remain as small as possible and must not encroach into the freshwater areas unless absolutely essential and part of the proposed development. It must be ensured that the freshwater habitat is off-limits to construction vehicles and non-essential personnel;
- The boundaries of footprint areas, including contractor laydown areas, must be clearly defined and all activities must remain within defined footprint areas. Edge effects will need to be extremely carefully controlled;
- Planning of temporary roads and access routes must avoid freshwater ecosystems and be restricted to existing roads where possible;
- Appropriate sanitary facilities must be provided for the life of the construction phase and all waste removed to an appropriate waste facility;
- All hazardous chemicals as well as stockpiles must be stored on bunded surfaces and have facilities constructed to control runoff from these areas;
- All hazardous storage containers and storage areas must comply with the relevant SABS standards to prevent leakage;
- No fires must be permitted in or near the construction area; and
- Ensuring that an adequate number of waste and "spill" bins are provided will also prevent litter and ensure the proper disposal of waste and spills.

Vehicle access

- All vehicles must be regularly inspected for leaks. Re-fuelling must take place offsite on a sealed surface area to prevent ingress of hydrocarbons into the topsoil;
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and spillage must be p prevented near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss; and
- All spills should they occur, should be immediately cleaned up and treated accordingly. Contaminated soil must be bagged and disposed of in hazardous waste receptacles.

Vegetation

- Removal of the alien and weed species encountered within the wetlands must take place to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal of species should take place throughout the construction, operational, and maintenance phases; and
- Species specific and area specific eradication recommendations:
  - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
  - Footprint areas must be kept as small as possible when removing alien plant species; and

- No vehicles must be allowed to drive through designated sensitive watercourse areas during the eradication of alien and weed species.

Soil

- Sheet runoff from access roads and the walk ways must be slowed down by the strategic placement of berms;
- As far as possible, all construction activities must occur in the low flow season, during the drier winter months;
- As much vegetation growth as possible (of indigenous floral species) should be encouraged to protect soil;
- No stockpiling of topsoil must take place within close proximity to the watercourse, and all stockpiles must be protected with a suitable geotextile to prevent sedimentation of the watercourse;
- All soil compacted as a result of construction activities as well as ongoing operational activities falling outside of project footprint areas must be ripped and profiled; and
- A monitoring plan for the development and the immediate zone of influence must be implemented to prevent erosion and incision.

Rehabilitation

- Construction rubble must be collected and disposed of at a suitable landfill site;
- All alien vegetation in the footprint area as well as immediate vicinity of the proposed development must be removed. Alien vegetation control must take place for a minimum period of two growing seasons after rehabilitation is completed; and
- Side slope and embankment vegetation cover must be monitored to ensure that sufficient vegetation is present to bind these soils and prevent further erosion.

APPENDIX H – Specialist information

DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

1. (a) (i) Details of the specialist who prepared the report

Kristen Coertze MSc (Botany) (University of the Free State)

Stephen van Staden MSc (Environmental Management) (University of Johannesburg)

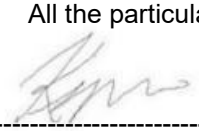
1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Kristen Coertze		
Postal address:	29 Arterial Road West, Oriel, Bedfordview, 2007		
Postal code:	1401	Cell:	
Telephone:	011 616 7893	Fax:	011 615 6240
E-mail:	kristen@sasenvgroup.co.za		
Qualifications	MSc (Botany) (University of the Free State) BSc (Hons) (Environmental Science) (University of the Free State) BSc (Environmental Science) (University of the Free State)		
Registration / Associations	Professional Scientist at South African Council for Natural Scientific Professions (Pri.Sci.Nat) Member of the Gauteng Wetland Forum Member of the Grassland Society of Southern Africa Member of the South African Wetland Society Golden Key Honorary Society		

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Kristen Coertze, declare that -

- I act as the **independent specialist** in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct



Signature of the Specialist

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, declare that -

- I act as the **independent specialist (reviewer)** in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct.

Signature of the Specialist

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF KRISTEN COERTZE

PERSONAL DETAILS

Position in Company	Freshwater Ecologist
Joined SAS Environmental Group of Companies	2021

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Professional Scientist at South African Council for Natural Scientific Professions (Pri.Sci.Nat #146386)
Member of the Gauteng Wetland Forum
Member of the Grassland Society of Southern Africa
Member of the South African Wetland Society
Golden Key Honorary Society

EDUCATION

Qualifications

MSc Botany (University of the Free State)	2023
BSc (Hons) Environmental Science (University of the Free State)	2019
BSc Geography and Environmental Science (University of the Free State)	2018

AREAS OF WORK EXPERIENCE

South Africa – Free State, Western Cape, Northern Cape, North West, Gauteng, Mpumalanga, Limpopo Provinces.
Central Africa – Democratic Republic of Congo (DRC)

DEVELOPMENT SECTORS OF EXPERIENCE

1. Linear developments (energy transmission, telecommunication, pipelines, roads)
2. Renewable energy (wind and solar)
3. Commercial development
4. Residential development
5. Industrial/chemical
6. Mining: Cole, chrome Platinum Group Metals (PGMs)
7. Agriculture

KEY SPECIALIST DISCIPLINES

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Freshwater Offset Plan
- Maintenance and Management Plans
- Plant Species and Landscape Plans

Legislative Requirements, Processes and Assessments

Water Use Applications (Water Use License Applications / General Authorisations)

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Group CEO, Water Resource Discipline Lead, Managing Member, Ecologist, Aquatic Ecologist
Joined SAS Environmental Group of Companies	2003 (year of establishment)

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)
Accredited River Health Practitioner by the South African River Health Program (RHP)
Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum
Member of the Gauteng Wetland Forum
Member of International Association of Impact Assessors (IAIA) South Africa;
Member of the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications

MSc Environmental Management (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000

Short Courses

Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, focusing on WULAs and IWWMPs	2017
Tools for Wetland Assessment (Rhodes University)	2017
Legal liability training course (Legricon Pty Ltd)	2018
Hazard identification and risk assessment training course (Legricon Pty Ltd)	2018
Wetland Management: Introduction and Delineation (WLID1502S) (University of the Free State)	2018
Hydropedology and Wetland Functioning (TerraSoil Science and Water Business Academy)	2018

AREAS OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe Zambia
Eastern Africa – Tanzania Mauritius
West Africa – Ghana, Liberia, Angola, Guinea Bissau, Nigeria, Sierra Leona
Central Africa – Democratic Republic of the Congo

DEVELOPMENT SECTORS OF EXPERIENCE

1. Mining: Coal, chrome, Platinum Group Metals (PGMs), mineral sands, gold, phosphate, river
2. Linear developments (energy transmission, telecommunication, pipelines, roads)
3. Minerals beneficiation
4. Renewable energy (Hydro, wind and solar)
5. Commercial development
6. Residential development
7. Agriculture
8. Industrial/chemical

KEY SPECIALIST DISCIPLINES

Legislative Requirements, Processes and Assessments

- Water Use Applications (Water Use Licence Applications / General Authorisations)
- Environmental and Water Use Audits
- Freshwater Resource Management and Monitoring as part of EMPR and WUL conditions

Freshwater Assessments

- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant Species and Landscape Plans
- Freshwater Offset Plans
- Hydropedological Assessment
- Pit Closure Analysis

Aquatic Ecological Assessment and Water Quality Studies

- Habitat Assessment Indices (IHAS, HRC, IHIA & RHAM)
- Aquatic Macro-Invertebrates (SASS5 & MIRAI)
- Fish Assemblage Integrity Index (FRAI)
- Fish Health Assessments
- Riparian Vegetation Integrity (VEGRAI)
- Toxicological Analysis
- Water quality Monitoring
- Screening Test
- Riverine Rehabilitation Plans

Biodiversity Assessments

- Floral Assessments
- Biodiversity Actions Plan (BAP)
- Biodiversity Management Plan (BMP)
- Alien and Invasive Control Plan (AICP)
- Ecological Scan
- Terrestrial Monitoring
- Biodiversity Offset Plan

Soil and Land Capability Assessment

- Soil and Land Capability Assessment
- Hydropedological Assessment

Visual Impact Assessment

- Visual Baseline and Impact Assessments
- Visual Impact Peer Review Assessments